APPENDIX 9-1

NOVEMBER 2020 PEATSLIDE ENVIRONMENTAL REPORT

Planning and Environmental Consultants

Environmental Report

November 2020 Peat Slide at Meenbog Wind Farm, Co. Donegal and subsequent Restoration and Remediation Works

DOCUMENT DETAILS

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1. INTRODUCTION

This Environmental Report compiles and presents information relating to the peat slide that occurred at the Meenbog Wind Farm site on 12th November 2020. This report includes information on the peat slide, the resultant emergency, restoration and remediation works carried out in response to the peat slide, and the environmental monitoring data that was collected prior to, during and following the peat slide, up to the recent past (Q4 2023).

The purpose of this report is to inform an assessment of potential cumulative and in-combination effects of the peat slide and associated restoration and remediation works, to be undertaken by the environmental professionals responsible for the preparation of a remedial Environmental Impact Assessment (rEIAR) and remedial Natura Impact Statement (rNIS) forming part of an application for substitute consent being submitted to An Bord Pleanála.

An Bord Pleanála (the Board) granted planning permission via the Strategic Infrastructure Development (SID) process to Planree (applicant) for a 19-turbine wind farm development in Meenbog, Co. Donegal (ABP Ref: PA05E.300460) on 25th June 2018. The Meenbog wind farm site is located approximately 8km southwest of the twin towns of Ballybofey and Stranorlar and approximately 12km northeast of Donegal Town.

Construction work commenced on the permitted wind farm in November 2019. Approximately 90% of the civil engineering works, including wind farm access roads, electricity substation, turbine hardstands, turbine bases, peat repositories and borrow pit areas at the wind farm site were substantially completed over the following 12-month period up to November 2020.

On 12th November 2020, during the construction of a permitted access road to turbine T7, a peat slide or peat failure occurred. The works that were underway at the time in the area where the peat slide occurred, were fully permitted and were being undertaken in line with the project design that had been subject to both Environmental Impact Assessment (EIA) and Appropriate Assessment (AA). The Environmental Protection Agency (EPA) engaged the services of ARUP Consulting Engineers, to advise and represent the EPA on the geotechnical and peat stability aspects of the investigations. Following extensive additional site investigation work, geotechnical analysis, site meetings and/or reporting undertaken by both Fehily Timoney and Company and Ionic Consulting on behalf of Planree, and ARUP on behalf of the EPA, the EPA, by notice dated 28th April 2021, concluded that the issues identified had been satisfactorily addressed pursuant to the Environmental Liability Regulations.

2. BACKGROUND

2.1 Planning History

Planning permission was granted under the Strategic Infrastructure Development (SID) process by An Bord Pleanála (ABP Ref: PA05E.300460) on 25th June 2018, for a 19 no. turbine wind farm development in Meenbog (and surrounding townlands), Co. Donegal, subject to 20 no. conditions.

The full development description of the Meenbog wind farm, for the purposes of the SID application is set out as follows:

> *"In accordance with Section 37E of the Planning and Development Act 2000, as amended, Planree Limited gives notice of its intention to make an application for a ten year planning permission to An Bord Pleanála in relation to the following proposed development in the townlands of Meenbog (ED Goland), Croaghonagh and Cashelnavean, County Donegal.*
>
> *The proposed development will constitute the provision of the following:*
>
> - *(i) Up to 19 no. wind turbines with a generating capacity in excess of 50MW, and maximum overall ground to blade tip heights of up to 156.5 metres;*
> - *(ii) 1 no. permanent Meteorological Mast up to a maximum height of 110 metres;*
> - *(iii) 1 no. 110kV Electrical substation with 2 no. control buildings with welfare facilities, associated electrical plant and equipment, security fencing and waste water holding tank;*
> - *(iv) Internal wind farm underground cabling;*
> - *(v) 110kV underground grid connection cabling;*
> - *(vi) Upgrade of access junctions;*
> - *(vii) Upgrade of existing tracks, roads and provision of new site access roads and hardstand areas;*
> - *(viii) 3 no. borrow pits;*
> - *(ix) 2 no. temporary construction compounds;*
> - *(x) Recreation and amenity works, including marked trails (upgrade of existing tracks and provision of new tracks), picnic, amenity and play areas, car parking and vehicular access;*
> - *(xi) Site drainage;*
> - *(xii) Forestry Felling;*
> - *(xiii) Permanent signage;*
> - *(xiv) All associated site development and ancillary works.*
>
> *This application is seeking a ten-year permission and 30 year operational life from the date of commissioning of the wind farm.*
>
> *An Environmental Impact Assessment Report (EIAR) and Natura Impact Statement (NIS) have been prepared in respect of the proposed development. The proposed development is likely to have significant effects on the environment of Northern Ireland."*

The planning permission was varied on 7th June 2019, when the Board determined that in accordance with section 146B(3)(a) of the Planning and Development Act, 2000, the previously issued planning consent for the permitted wind farm development should be altered in accordance with the plans and particulars received on 14th day of February, 2019. This was to allow the applicant to utilise-a larger turbine rotor diameter but which remains within the consented design envelope and parameters (i.e. tip-height of 156.5m, with no alteration to permitted layout).

2.2 Site Location

The site of the Meenbog Wind Farm development is located at Meenbog, Croaghonagh and other townlands (associated with the wind farm's off-site grid connection), approximately 8km southwest of the twin towns of Ballybofey and Stranorlar and approximately 12km northeast of Donegal Town. The site adjoins County Tyrone and is located approximately 19km west of Castlederg. A site location map is presented in Figure 2.1 on the following page.

The wind farm site is dominated by commercial forestry plantations that have been planted over blanket bog. The elevation of the wind farm ranges between approximately 86 metres O.D. and 327 metres O.D. with the majority of the site sloping in a north or north-westerly direction. A small section on the south of the site slopes to the southeast. The wind farm site adjoins Northern Ireland border along its eastern and south-eastern boundaries.

There was a network of long-established existing forestry roads providing access in and around the site. The site drains directly to the Bunadowen River and the Shruhangarve River which are tributaries of the Mourne Beg River. The closest Natura 2000 site is the River Finn, Special Area of Conservation (SAC). The River Finn SAC runs along the south-eastern boundary of the site and forms the County boundary between Donegal and Tyrone. The SAC follows the river network established by the River Finn and its tributaries which flow along the border with and within County Tyrone in Northern Ireland, as well as flowing through Ballybofey/Stranorlar. Natural Heritage Areas (NHAs) can be found to the west of the study area. These areas are Lough Hill Bog NHA, Meenagarranroe Bog NHA, Cashelnaveen NHA, Barnesmore Bog NHA and Croaghonagh bog which is a proposed NHA and SAC. Croagh Bog, an Area of Special Scientific Interest (ASSI) runs along a portion of the southern boundary of the study area. The River Foyle (ASSI), Killester Forest, Bogs and Lakes (ASSI) and Essan, Burn and Moneyfarmore (ASSI) can be found further south of the study area in County Tyrone.

3. PEAT SLIDE

On 12th November 2020, during the construction of a permitted access road to turbine T7, a peat slide or peat failure occurred. The works that were underway at the time in the area where the peat slide occurred, were fully permitted as part of the wind farm's planning permission and were being undertaken in line with the project design that had been subject to EIA.

This report section consists of an extract from a Peat Stability Assessment report prepared by Fehily Timoney & Company (FTC) following the peat slide and submitted to the Environmental Protection Agency, which forms Appendix 6-2 of the remedial EIAR forming part of the substitute consent application documents.

3.1 Description of Failure

The failure scar morphology comprises three distinct parts, namely an upper scar and lower scar which provided the source area for the failed peat, and a run-out trail along which the failed peat was essentially deposited. The scar morphology indicates that failure was most likely a flow slide, similar to that described by Meyerhof (1957) for sensitive clays.

Flow slides are commonly recognised due to the scar forming a "bottleneck" morphology as material locally and retrogressively fails by localised sliding from the side and the upslope margins of the initial localised failure at the downslope margin (mouth) of the scar. Failed material subsequently flows out of the mouth of the scar. In this manner, the scar is retrogressively widened with increasing distance from the initial localised failure. This is explained in further detail below.

The three distinct parts of the peat failure are shown in Figure 3.1, which should be viewed when reading the description below.

Figure 1 Extent of peat failure of 12 November 2020

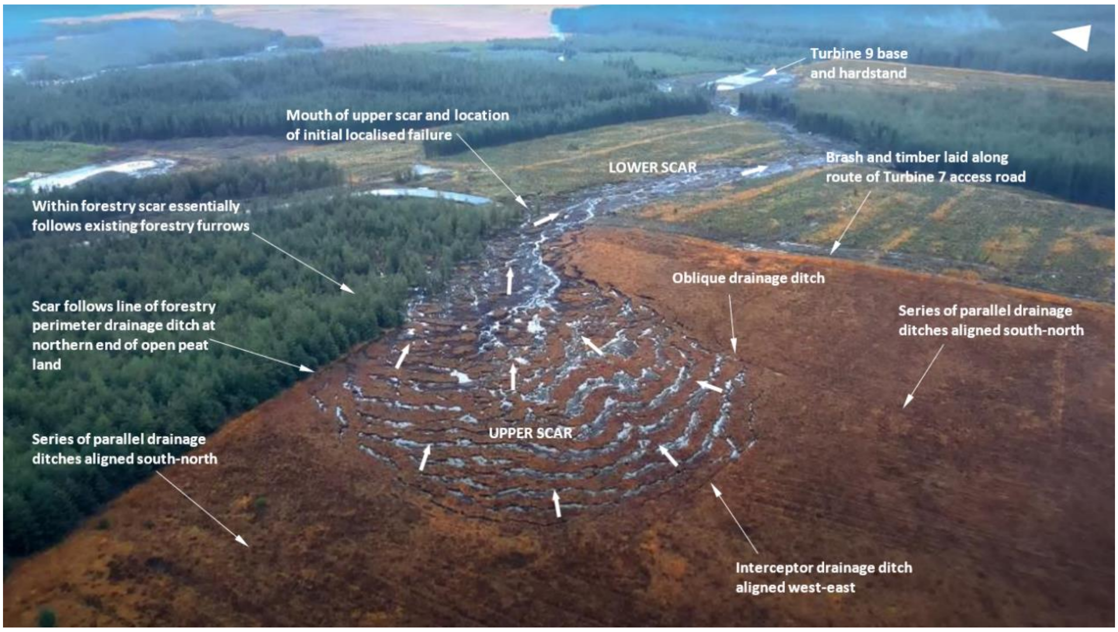


Figure 2 Peat failure location

1. *Upper scar. This comprised the primary source area of the failed material. The upper scar was about 260m long by up to about 120m wide. The head of the failure scar was within open peat land. The southern part of the scar was also within open peat land. The northern part of the scar was within forestry plantation.*

   The estimated total area of the upper scar is about 2.4ha. Based on visual inspection the central part of the upper scar has probably decreased in elevation by about 3m. The decrease in elevation reduces towards the perimeter of the scar and would be expected to be similar to the existing ground elevation a short distance beyond the scar's perimeter.

   The basal failure surface is within the lower part of the peat, within an estimated 0.2m of the underlying mineral soil. A minor stream now flows through the central portion of the scar and the base of this stream is on the underlying mineral soil. The origin for the water within the stream appears to be mostly from surface run-off and existing drains that feed into the back of the scar.

   The pattern of displaced peat within the upper scar forms a series of concentric rafts that have moved laterally and downslope towards the mouth of the scar (Figure 3.2). The concentric rafts have to varying degrees partly detached and moved downslope but would have had insufficient inertia to exit the upper scar. These concentric rafts provide a buttressing effect to the peat behind, and effectively support the side-wall of the upper scar. Typically 1 to 1.5m of vertical exposed peat face is observed. The upper scar forms a saucer shape with the width of the downslope mouth (bottleneck) much narrower (about 43m) than the maximum scar width (120m). This gives a ratio of mouth to maximum width of about 0.17.

   Whilst most of the area of the upper scar is within open peat land that has no drainage, the perimeter extent of the upper scar was significantly controlled by existing drainage ditches and forestry furrows in the area (Figure 3.2). To the south there is a series of parallel drainage ditches (less than about 1m deep) that feed water northwards towards the failure scar. These parallel drainage ditches feed into an interceptor drainage ditch aligned west-east. This interceptor has essentially controlled the southern limit of the scar. To the east the scar is controlled by an oblique drainage ditch. To the north the scar follows the line of the forestry perimeter drainage ditch before extending further *northwards into the forestry plantation where the scar essentially is controlled by the forestry furrows.*

2. *Lower scar. This comprised a secondary source area of the failed material. The lower scar is rectilinear and essentially follows the slope gradient (Figure 3.2. The lower scar was about 260m long by about 43m wide. The head of the lower scar is taken at the downslope mouth of the upper scar and essentially coincides with the upslope boundary of a recently felled forestry plantation. The lateral perimeter of the scar essentially follows the existing forestry furrows. The estimated total area of the lower scar is about 1.18ha.*

   Based on visual inspection the depth of the lower scar is estimated at 1.5m to 2m. The floor of the scar is undulating and contains some isolated rafts of peat debris. There is evidence of exposed rock within the floor of the scar and a shear surface, which suggests that the shearing has occurred within the basal part of the peat.

   The lower scar represents a translational sliding of peat. It is considered likely that the lower scar formed due to an initial failure at the head of the scar at the location of the floating road that was being constructed at the time of the failure. This initial failure caused loss of strength at the head of the lower scar which caused the peat to progressively fail downslope.

   The perimeter extent of the lower scar was controlled by existing forestry furrows which are aligned downslope in the direction of peat movement. Adjacent to the scar the existing forestry furrows have generally acted as tension cracks with the furrows opening up. Any localised failure of these tension cracks is unlikely to result in larger scale failure.

   At the downslope margin of the lower scar the peat debris impacted an existing stand of forestry plantation causing some trees to topple, however the forestry resisted the impact of the peat debris and prevented the peat debris from continuing on the same path. At this location, the peat debris entered the channel of Shruhangarve Stream which flows in a northeast direction (Figure 3.1). The peat debris would have initially started to accumulate at this location but due to the preferential flow path provided by the stream channel, and in combination with water flowing within the stream, the debris changed direction and followed the stream channel. Inspection of this location shows that there is peat debris accumulation, which as partly blocked the flow in the stream. Below the lower scar and within the Shruhangarve Stream channel there is a net accumulation of failed material.

3. *Run-out trail. The run-trail follows the Shruhangarve Stream for about 2.44km where it passes the Shruhangarve Bridge and then extends a further 0.74km to the Mourne Beg River (Figure 3.1). The total distance along the Shruhangarve Stream is about 3.2km. For the purpose of this report the extent of the run-out is taken to where the peat debris enters the Mourne Beg River.*

   Inspection of the run-out trail along the channel of the Shruhangarve Stream indicates that whilst there is evidence of scouring and erosion of the floor of the channel there is generally a net accumulation of failed material. The accumulation takes the form of general peat debris and isolated rafts of peat on the banks of the stream which form levees. An approximate estimate of the extent of the accumulated peat debris on the stream banks is about 5 to 10m either side of the stream with a thickness of less than 1m.

It is assumed that on reaching the Mourne Beg River the dilution effect due to the greater flow volume within the river would essentially cause most of the peat debris to go into suspension, and from a geotechnical viewpoint this would not be considered as part of the run-out trail.

3.2 Failure Volume

The plan extent of the upper and lower failure scars was surveyed on 19 November 2020 using a hand-held GPS. Survey points were taken around the perimeter of the scar together with peat depth probes. Preliminary volumes calculated from this survey are an estimate.

The upper scar is about 260m long measured from the furthest upslope point to the approximate downslope limit at the mouth of the upper scar, at the location of the floating road that was being constructed at the time of the failure. The maximum width of the upper scar is about 120m. The estimated total area of the upper scar is about 2.4ha. Peat depth probes around the perimeter of the upper scar showed an average peat depth of 2.7m, though locally depths of in excess of 3.5m were recorded.

Based on the above assuming that the full depth of peat failed, which is considered the case then the total failure volume from the upper scar is estimated at 2.4 x 104m by 2.7m which totals about 65,000m^3.

The lower scar is about 260m long measured from the downslope limit at the mouth of the upper scar to where it meets the Shruhangarve Stream. The width of the lower scar is estimated as 43m. The estimated total area of the lower scar is about 1.18ha. Peat depth probes around the perimeter of the lower scar showed an average peat depth of 1.8m.

Based on the above, assuming that the full depth of peat failed, then the total failure volume from the lower scar is estimated at 1.18 x 104m x 1.8m which totals about 21,240m^3.

Total failure volume is therefore 65,000m^3 + 21,240m^3 which is 86,240m^3.

The actual volume of failed material that left the failure scar would be less than the total failure volume as a notable proportion of the failed material still remains in the upper scar. An approximate estimate of failed material remaining in the upper scar is say 30%, which means that about 45,500m^3 of failed material left the upper scar.

Total failure volume that left the failure scars is therefore estimated based on the preliminary survey of 45,500m^3 + 21,240m^3 which is 65,740m^3.

It is difficult to estimate the volume of failed material that has accumulated along the run-out trail due to the variation in accumulation amounts. An approximate estimate of the accumulated failure volume is as follows: 3180m length x 15m wide x 0.5m deep, which gives say 24,000m^3. An amount of failure material has also been retained on site by a check barrage constructed downstream shortly after the failure.

3.3 Sequence and Mechanism of Peat Failure

Based on the above, the following postulated sequence and mechanism of failure is considered to have resulted in the peat failure of 12 November 2020.

1. *Construction of floating road. A floating road was under construction towards T7. Construction works for the floating road had progressed to essentially the downslope margin of the upper scar prior to the peat failure. The access track and T7 hard stand and base to the south of the peat failure had yet to be constructed though preparatory works had started, such as laying of timbers and brash along the line of the access track to T7. Excavators had laid and passed over the timber and brash a number of times.*

Based on witness statements, the failure occurred at about 13:25pm whilst the floating road was being constructed. A localised section of floating road about 20m in length failed, which appears to be the first observed sign of instability.

2. *Localised failure of floating road. The loading from the construction of the floating road would have increased the applied stress through the full depth of the underlying peat over the full width of the road. Where unforeseen weaker peat was present, loading from the floating road likely resulted in localised failure within the peat. The loading from the construction would have comprised a combination of the road material and construction plant. The failure, initially localised beneath the recently loaded area, resulted in the development of a rupture surface and hence a decrease to the residual strength of the peat.*

   This localised area of peat would have continued to fail along the rupture surface with further loss of shear strength and disturbance reducing the residual strength to the remoulded strength, which would be negligible within the catotelm layer (humified lower layer) in the peat. This would have caused the peat catotelm layer to essentially turn to 'slurry' and a section of the floating road to move downslope.

   Where there were drains passing below the floating road, such as the forestry perimeter drainage ditch at the northern end of the open peat land (Figure 3.2), then this would have severed the acrotelm layer (upper fibrous layer) of the peat where most of the intrinsic (tensile) strength of the peat lies.

3. *Retrogressive failure upslope. Once the initial localised failure had occurred below the floating road and the failed peat started to move downslope this removed lateral support to the peat upslope within the flat plateau area, which contained a large body of notably saturated and very weak peat.*

   The slope immediately upslope of the initial localised bearing failure would have then subsequently failed along a similarly localised rupture surface with further loss of strength and disturbance reducing the residual strength to the remoulded strength, which would again have caused the peat to essentially turn to slurry and move downslope.

   This successive localised failure and movement of peat downslope retrogressed upslope until a critical mass of peat had failed that sufficient lateral stress was applied to cause failure of the intact peat on the downslope side of the floating road.

4. *Progressive failure downslope. Once a critical mass of peat had failed upslope then the lateral applied stress would have exceeded the shear strength of the intact peat on the downslope side of the floating road. At this point, the peat downslope would have failed progressively in a not dissimilar localised manner that occurred upslope, that is successive localised failure though along a basal rupture (shear) surface with movement of peat.*

5. *Propagation of failure. As the downslope peat progressively failed and moved this caused subsequently more peat to fail within the upper scar. The peat in the margins of the upper scar were significantly weak that they were not self-supporting. As such, the upper scar enlarged as material locally and retrogressively failed by localised sliding then flowing from the side and the upslope margins of the scar into the centre of the scar to form a saucer shape. The enlargement of the saucer was as a result of the large body of notably saturated and very weak peat.*

   The mouth of the upper scar remained relatively narrow compared to the upslope width chiefly as the mass of the failed material was focused on the mouth. It is also *likely that there was a zone, in part, of relatively higher strength peat along the downslope edge of the flat plateau area, due to a greater degree of drainage.*

The lower scar remained essentially the same width as the mouth of the upper scar. This in part is because the peat within the lower scar has relatively higher strength and as such collapse of the side walls and lateral enlargement of the scar was not possible.

The flow slide continued to propagate retrogressively upslope and progressively downslope setting in motion a critical mass that essentially continued downslope until it encountered an existing stand of forestry plantation beside the Shruhangarve Stream channel which resisted the further propagation of the failure mechanism.

The failure continued to propagate retrogressively upslope forming the enlarged upper scar until stability was achieved due to accumulated failed debris remaining within the upper scar. The accumulated failed debris acted as a support to the peat on the margins of the upper scar and prevented further enlargement of the upper scar.

As mentioned above, the peat failure is considered to be a flow slide due to the upper scar forming a "bottleneck" morphology as material locally and retrogressively failed by localised sliding from the side and the upslope margins of the scar into the centre of the scar to form a saucer shape. The lower scar failed progressively by essentially translational sliding, which whilst still considered to be a flow slide is slightly different in nature.

The failure occurred entirely within the peat. There was no evidence of underlying soils failing.

The run-out trail below the lower scar followed the Shruhangarve Stream channel and was essentially here there was a net accumulation of failed material as the failure debris moved downstream. There was essentially no substantive failure of in situ material along the run-out trail.

3.4 Contributory Causes of Peat Failure

The following are considered to be the key contributory causes of the peat failure of 12 November 2020. For the peat failure to occur all or at least most of these key contributory factors were required to be present. One or a few of these factors only are highly unlikely to cause the scale of the peat failure that occurred.

1. *Construction of floating road. The construction works for the floating road triggered a localised initial peat failure within the underlying insitu peat. It would not be uncommon for sections of floating road to undergo excessive movement due to localised weakening within the underlying peat, however at this location a number of other contributory factors caused an escalation of the initial localised failure.*

2. *Unforeseen zone of weak peat. It is considered that a zone of unforeseen weaker peat was present below the floating road that resulted in localised failure within the underlying insitu peat. The nearest strength testing showed undrained shear strengths in the range 7 to 12kPa, which would not be considered sufficiently low to result in failure. Where there were drains passing below the floating road, which occurred at about the location of the failure, then this would have severed the acrotelm layer (upper fibrous layer) of the peat where most of the intrinsic strength of the peat lies.*

3. *Body of very weak peat immediately upslope. Essentially immediately upslope of the floating road was a flat plateau area that was partly formed of essentially a large body of notably saturated and very weak peat. This body of saturated and very weak peat relied for lateral stability on the peat slope upon which the floating road was being constructed. Hand vane results by FT post-failure showed undrained shear strengths in the range 2 to*

9kPa, with an average value of slightly less than about 5kPa. These low recorded peat strengths are significantly lower than the site-wide results and would represent a body of very weak peat.

4. *Rainfall intensity and pattern. A combination of preceding heavy rainfall and the pattern of weather recorded over the preceding months likely contributed to the failure. The failure was not triggered by an intense rainfall event. Whilst there was no clear significant peak rainfall duration period immediately prior to the peat failure, the combination of a significant dry spell (April and May 2020) followed by relatively high daily rainfall amounts (from June 2020 onwards) likely contributed to the peat failure. The significant and sustained dry spell would have caused drying leading to shrinkage and cracking of the near surface acrotelm layer in the peat particularly along forestry furrows and drainage lines. Subsequent run-off from rainfall would have then gained ingress to the peat at depth via the cracking.*

5. *Drainage and surface water ingress into peat. The existing forestry drainage pattern, which is present in the 1995 aerial photographs of the site, in the flat plateau area directed surface water from rainfall towards the body of very weak peat that ultimately failed, notably along a series of parallel drainage ditches aligned south-north which run for about 230m and flow towards the southern limit of the upper scar. Whilst these forestry drainage ditches meet an forestry interceptor drainage ditch aligned west-east it is not known if this interceptor ditch was functioning.*

6. *Topography. The initiation of the failure occurred at a convex break in the peat slope, at the location of the floating road. A convex break in slope is commonly cited as the location for peat failures for a number of reasons. In this particular case, the convex break in slope marks the transition from a plateau area upslope containing deeper and very weak and saturated peat compared to downslope where the peat is not as deep and has relatively greater strength. At the convex break in slope it is likely that in many cases there is a zone of relatively higher strength peat, due to a greater degree of drainage, that essentially acts to support the very weak and saturated peak present in the plateau area upslope.*

7. *Downslope felled forestry on peat. The area downslope of the floating road comprised a forestry plantation that had been felled a few years in advance of the wind farm construction. The area comprised forestry furrows and drains aligned downslope on peat slopes with a peat depth of about 1.8m. In itself, this area is not unique nor would it represent an increased stability risk. However the presence of furrows and drains aligned downslope on peat slopes, which have severed the acrotelm layer and the likely blockage of drainage following felling operations allowed the slope to readily fail once localised failure was initiated upslope. The failure through this area exploited the existing forestry furrows which are lines of weakness. Peat failures controlled by existing forestry furrows has been previously recorded many times.*

8. *Existing drainage and extent of failure. The existing forestry drainage within the peat is considered to have directed and concentrated surface run-off to the upper scar located in the flat plateau area. To the south of the upper scar a series of parallel drainage ditches (less than about 1m deep) feed water northwards towards the failure scar. Following the failure, inspection of these ditches showed water feeding into the scar. Whilst not a direct cause of the peat failure the existing drainage ditches and forestry furrows significantly controlled the extent of the upper scar. The extent of the lower scar was essentially controlled by existing forestry furrows aligned downslope in the direction of peat failure movement. Adjacent to the scar the existing forestry furrows have generally acted as tension cracks with the furrows opening up.*

4. REGULATORY & STATUTORY PROCESSES

4.1 Environmental Protection Agency

As a result of the November 2020 peat failure on-site, the Environmental Protection Agency (EPA) initiated an investigation in early December 2020, the scope of which included the peat stability assessments carried out in relation to the development at Meenbog, both as part of development consent applications and ones carried out pursuant to the failure incident. The Agency issued directions under Regulation 8(1)(b), Regulation 8(1)(a) and Regulation 8(1) of the European Communities (Environmental Liability) Regulations 2008 between December 2020 and April 2021, and other correspondence thereafter.

Over the course of the ten months between December 2020 and September 2021, extensive additional site investigation work, geotechnical analysis, site meetings and/or reporting, was undertaken by both Fehily Timoney and Company (FTC) and Ionic Consulting on behalf of Planree, and ARUP on behalf of the EPA. Following submission of the final FTC report in August 2021 (which forms Appendix 6-2 of the remedial EIAR forming part of the substitute consent application documents), by 28th September 2021, the EPA were able to confirm in writing for Planree that:

> *"I am to advise that the revised Peat Stability Assessment prepared by FTC and submitted to the EPA pursuant to 1 and 2 above addresses the conclusions/recommendations set out in previous EPA correspondence. The issues identified in correspondence from the EPA on the 29th July 2021 have been satisfactorily addressed. Compliance with the EPA Direction from 1st April is now confirmed."*

A copy of the EPA letter dated 28th September 2021 from which the above text is extracted, is included in Appendix A to this report.

4.2 Donegal County Council

As a result of the November 2020 peat failure on-site, Donegal County Council (DCC) initiated an investigation, which resulted in the issuance of notices under Section 12 of the Local Government (Water Pollution) Act, 1977 dated 17th November 2020 and 27th November 2020. Two notices, dated 17th November 2020 and 27th November 2020 required:

1. *The immediate halting of construction works and the taking of all practicable measures to mitigate against further discharges to waters;*
2. *An Action Plan, detailing the engineering measures identified and considered necessary to:*
    a. *Eliminate of limit the release of further polluting matter from the area where the landslide occurred, from areas up gradient of the land slide and from areas down gradient of the landslide where material has been deposited,*
    b. *prevent the catastrophic release of material built up behind the existing improvised impoundment structure on site, (taking into consideration projected rainfall amounts) and,*
    c. *mitigate against the further dispersal of peat and sediment, deposited along the banks of the Shruhangarve, by the watercourse through and beyond the confines of the site.*
3. *A written report detailing:*
    a. *All monitoring data accumulated by environmental consultants on discharges from the site to the Bunadowen river prior to the 1-2th November 2020, (at the closest point to the confluence)*

b. *All monitoring data on discharges from the site to the Bunadowen river since the incident on the 12th November 2020, including monitoring points (upstream & downstream) which would indicate the actual impact on key pollution indicators such as suspended solids.*
c. *Any technical assessment or ecological studies carried out by appropriately qualified personnel to determine the potential impact on the Bunadowen River of discharging surface water from the slip area by the pumping regime, before its introduction.*
d. *Any technical assessments or ecological studies completed since the introduction of the additional discharge to the Bunadowen river catchment*
e. *Any flow measurements indicating the% increase in volume in the Bunadowen river.*

Between December 2020 and August 2021, four individual Action Plans were prepared to remediate and mitigate the effects of the peat slide incident, which included measures for the restoration of the Shruhangarve stream. The Action Plans are described further in Section 5 below.

Following receipt of the necessary approvals from DCC with respect to the proposals contained within each of the Action Plans, the proposed measures were implemented on-site as expeditiously as possible or at the appropriate time of year where certain measures were seasonally dependent. All measures proposed in the four separate Action Plans and approved by DCC to remediate and mitigate the effects of the peat failure through the installation of enhanced environmental protection measures and habitat restoration measures, were completed successfully.

The significant efforts to restore and reinstate the effects of the peat slide were acknowledged in a letter dated 31st May 2022 issued by Dr. Joe Ferry, Acting Section Executive Scientist with Donegal County Council, in which he stated:

> *"I would like to commend your company and the staff involved in the restoration work, which has been very well designed and executed so far, and for their courtesy and co-operation since the incident began. The past month hasn't been very favourable in this part of the country for growth, which has set back final approval, but hopefully we'll see some heat to remedy that shortly."*

In a further letter dates 11th July 2022, Dr. Ferry in confirming that DCC were in a position to close out the Section 12 notices issued, commented as follows:

> *"I believe Donegal Co. Council is now in a position to close out all of the Section 12 notices issued, as all of the seeded areas have shown encouraging signs of growth and establishment, (which reduces the likelihood of any significant sediment release), and the monitoring data obtained for the Shruhangarve and Mournebeg has been satisfactory.*
>
> *We would like to commend your company and the staff involved in the restoration work, which has been very well designed and executed, and for their courtesy and co-operation since the incident began. We would also encourage you to maintain your commitment and place a strong emphasis and vigilance on the current surface water quality monitoring programmes, as the project moves into the next phases."*

Copies of Donegal County Council's correspondence dated 31st May 2022 and 11th July 2022 are included as Appendix B.

5. EMERGENCY AND RESTORATION WORKS

5.1 Emergency Works

From the onset of the peat failure on the 12th November, a series of emergency works were immediately implemented on-site to limit the environmental effects of the incident. All on-site construction personnel were immediately redeployed to deal with the emergency situation, which was very fast moving, and additional machinery, labour and technical resources were drafted on to the site over the following hours, days and weeks.

The first stage was the immediate response within the first 24-72 hours which consisted of emergency measures to prevent further material from entering local watercourses.

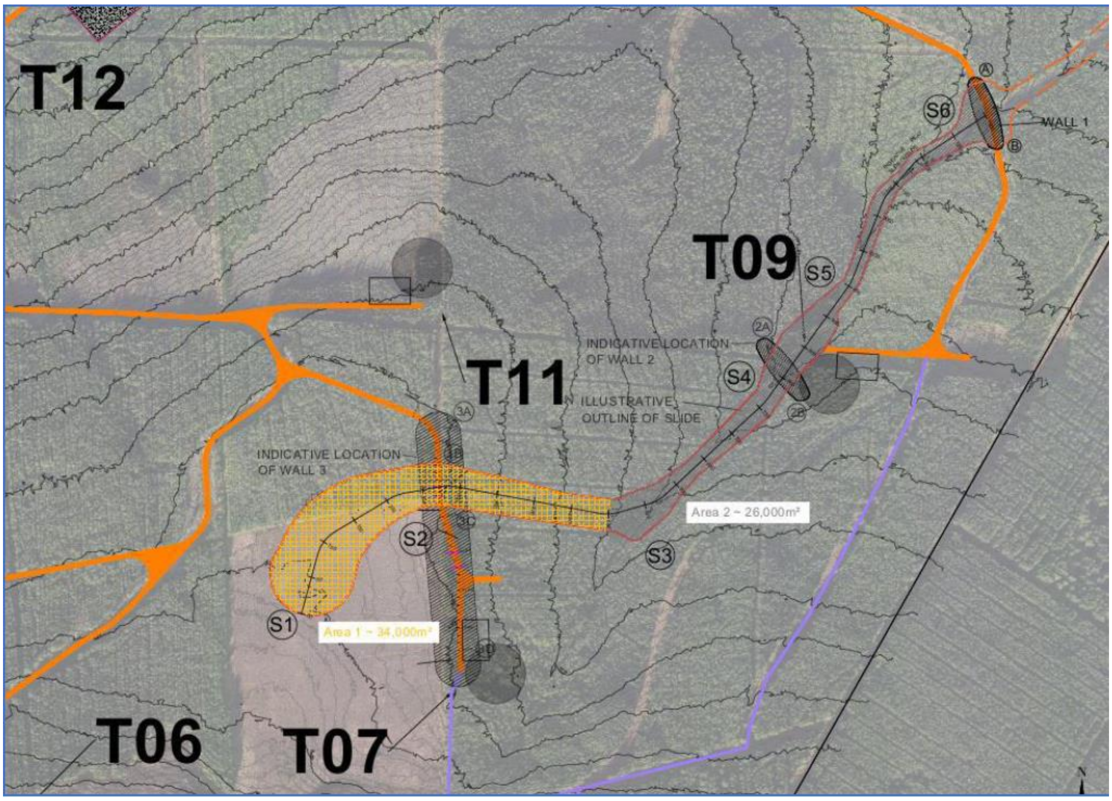


Figure 3 Emergency works area overview map

The immediate plan was to introduce check barrages to prevent the slide from reaching any watercourses in line with the project CEMP. Immediate action was taken to reinforce and increase the height of the accessible roadway leading to T9. This road was already acting as a check barrage, retaining some of the slide material to the south, however it was at the point of being overtopped by the slide material. It was also evident that this was the only location where it would be safe to gain immediate access to initiate the CEMP measures.

Works commenced at the roadway to T9 (referred to as Wall 1 in Figure 3 above) on the afternoon of the 12th November 2020 as soon as an inspection had been conducted to ensure it was safe for personnel to work in the area. The initial aim was to raise the berm by 1.5m-2m for a length of approximately 100m along the area retaining the slide, this was further raised over the following days by up to 3.8m from the original design level. Following initial emergency works carried out on 12th November, works continued to implement the final detailed design and were completed by 21st November 2020.

A detailed geotechnical assessment undertaken identified the risk of further peat movement upslope of the slide initiation point in the peatland area (refer to point S1 in Figure 3) was still significant. Two other points for further check barrages were identified, denoted as 'Wall 2' and 'Wall 3' in Figure 3 to mitigate against this potential risk. Access for construction of Wall 2 would be from the hardstanding at T9 and access for Wall 3 would be from the last section of road constructed to solid formation on the approach to the turbine 7 (T7) location. Wall 3 was prioritised it was located immediately downslope of an area of unstable peat where significant volumes of water or liquefied peat was released.

Works commenced as soon as a geotechnical assessment could be completed and an appropriate civil works design could be developed. Construction of this berm referred to as 'Wall 3' commenced on 17th November 2020.

As soon as Wall 1 was completed and safe access and egress could be maintained to T9 via the access road, and also the section of Wall 3 past the slide affected area was constructed, construction of Wall 2 was considered. Due to increased rainfall it was observed that an excessive amount of water was flowing towards Wall 1. A decision was taken at this time to prioritise drainage of the area and strategic pumping of clean water away from the area affected by the slide. Clean water was intercepted and diverted from upstream of the slide area and discharged to the North of Wall 1. Soiled water was also removed via pumping from the area adjacent to T9. These works commenced on 25th November 2020.

A description of the emergency works undertaken in the immediate aftermath of the peat slide, prepared by Ionic Consulting, the Designer and Geotechnical Engineers for the works, is included as Appendix 1 of Appendix C to this report.

As the emergency phase of works concluded, the focus transitioned to a longer-term series or phased restoration works.

5.2 Restoration Works

Following the 12th November peat failure, on behalf of Planree, MKO immediately commenced the preparation of a detailed programme of environmental protection measures and habitat restoration measures. The measures were proposed in Action Plans, submitted for approval to DCC.

The first Action Plan (Version 1.0) was submitted to DCC on 3rd December 2020, was approved by DCC on 5th March 2021, and all proposed measures were completed in the subsequent weeks. Action Plan Version 1.0 is included in Appendix C of this report.

The second Action Plan (Version 2.0) was submitted to DCC on 8th March 2021, was approved by DCC on 20th April 2021, and the approval required the proposed measures to be implemented in full within 3 months. Action Plan Version 2.0 is included in Appendix D of this report. Action Plan Version 2.0 included three appendices, which also formed the appendices for Version 1.0 of the Action Plan, and therefore to avoid unnecessary repetition, these appendices are not included in Appendix D.

The third Action Plan (Version 3.0) was submitted to DCC on 27th May 2021, was approved on 9th July 2021, and the approval required the proposed measures to be implemented in full within 3 months. Action Plan Version 3.0 is included in Appendix E of this report. Action Plan Version 3.0 included three appendices, which also formed the appendices for Version 1.0 of the Action Plan, and therefore to avoid unnecessary repetition, these appendices are not included in Appendix E. Other appendices of Version 3.0 not included in earlier Action Plans are included in Appendix E. Version 3 of the Action Plan also includes a Peatland Restoration Plan (Appendix 4), which itself includes a Botanical Survey.

The fourth and final Action Plan (Version 4.0) was submitted to DCC on 27th September 2021, was approved on 4th November 2021, and the approval required the proposed measures to be implemented in full within 8 months. Action Plan Version 4.0 is included in Appendix F of this report. Version 4.0 of the Action Plan also includes a Planting Methodology (Appendix 1).

The Action Plans should be read in full to understand the restoration and remediation proposals, the rationale and the designs that were proposed and approved by DCC. Each Action Plan was also the subject of an Article 6(3) Appropriate Assessment Screening Report, which concluded the proposed works, individually or in-combination with other plans or projects, would not be likely to have a significant effect on any European site, in view of the said sites' conservation objectives, and therefore an appropriate assessment was not required.

All proposed and approved restoration works were successfully completed to over the period from March 2021 to May 2022. In addition to the correspondence confirming DCC's satisfaction with the remedial and restoration works to allow the close out of the Section 12 notices, referred to in Section 4 of this report above, Appendix G includes further email correspondence from Dr. Joe Ferry (Acting Senior Executive Scientist, Donegal County Council), dated 25th January 2024, which stated the following:

> *"I visited the site on the 31st August last year, with colleagues Patrick Gallagher from Environment and Martin McDermott from Planning, in the company of Chris O'Mahoney, and we were satisfied with the outcome of the remedial and restoration works completed. I think the main scar area will require a bit more time to fully establish complete vegetative cover, ie native grasses & heather, along with the deciduous trees planted already, which should afford good protection in time to the Sruhangarve stream down gradient of the area. There was no evidence during that visit of any sediment loss from that area or ingress to the stream. The other areas downstream of the site and immediately upstream of the confluence with the Mournebeg river have recovered exceptionally well, at least from a visual perspective. I think overall both MKO and Planree have managed the aftermath of this unfortunate incident in a very professional manner and appear to have achieved the best possible environmental outcomes in the circumstances."*

6. SURVEYS, MONITORING AND ASSESSMENTS

In the period since the occurrence of the peat slide on the Meenbog wind farm on 12th November 2020, various surveys, monitoring programmes and assessments have been undertaken to quantify, assess and/or report on the effects of the peat slide, the effectiveness of the restoration and remediation works undertaken and the state of the recovering and residual environment. The surveys, monitoring programmes and assessments collectively report on the state of the recovering and residual environment, following the November 2020 peat slide.

The surveys, monitoring programmes and assessments will be outlined and referenced in this report section. It is deliberately not intended to recreate, summarise or interpret them in this report. The relevant surveys, monitoring programmes and assessments will instead be referenced in their full form, to allow their full content be reviewed and considered as if part of this report.

The purpose of this report is to inform an assessment of potential cumulative and in-combination effects of the peat slide and associated restoration and remediation works, to be undertaken by the environmental professionals responsible for the preparation of a remedial Environmental Impact Assessment (rEIAR) and remedial Natura Impact Statement (rNIS) forming part of an application for substitute consent being submitted to An Bord Pleanála.

Where the surveys, monitoring programmes and assessments to be referenced here have been included elsewhere in the rEIAR or rNIS forming part of the substitute consent application documents, the document will be referenced as per its location in the rEIAR or rNIS, rather than being unnecessarily reproduced in this report. This report will itself be appended to the rEIAR and rNIS forming part of the substitute consent application documents, so any documents referenced here will be available within the same document suite.

The surveys, monitoring programmes and assessments to be referenced here are summarised below, in reverse chronological order of when they were produced, starting with the latest report prepared most recently.

Biodiversity Impact Assessment Report

The Biodiversity chapter of the March 2024 *'Remedial Environmental Impact Assessment Report'* (rEIAR) accompanying this substitute consent application, contains the following information:

- Biological Water Quality Assessment (Q-value) Results for the period 2020, 2021 and 2023, including of the Shruhangarve stream and Mourne Beg river;
- Results of badger surveys conducted between 2021 and 2023;
- Results of otter surveys conducted between 2021 and 2023;
- Results of surveys of other faunal species conducted between 2021 and 2023.

These survey results further inform the assessment of the residual environment post peat slide, the effectiveness of the restoration and remediation works undertaken and the state of the recovering and residual environment.

Land, Soils and Geology Impact Assessment Report

The Land, Soils and Geology chapter of the March 2024 *'Remedial Environmental Impact Assessment'* Report (rEIAR) accompanying this substitute consent application, contains the following information:

- Peat Stability Assessment of the Meenbog Wind Farm Site (August 2021), as prepared by Fehily Timoney and Company, intended to:

1. *Review of construction works at the site, namely but not limited to turbine bases, access roads, hard stands, peat repositories and borrow areas.*
2. *Review of ground conditions at the wind farm site with particular reference to ground conditions at the location of peat failures.*
3. *Site inspection and selected investigation of the ground conditions at the site.*
4. *Detailed site inspection and reporting of the 12 November 2020 peat failure.*
5. *Identification of previous peat failures and instability at the site.*
6. *Qualitative assessment of peat stability at the site.*
7. *Findings and mitigation measures.*

- Peat Stability Quantitative Assessment (August 2021), as prepared by Ionic Consulting, intended to assess the stability of peat along and adjacent to the wind farm infrastructure, including both the already constructed sections of the site and the remaining works areas;
- Technical Note (October 2023), as prepared by AFRY Ireland Ltd., intended to report on a 2023 site visit to inspect and comment on the current status of the site in relation to peat stability at the site.

These reports further inform the assessment of the residual environment post peat slide, the effectiveness of the restoration and remediation works undertaken and the state of the recovering and residual environment.

Hydrology and Hydrogeology Impact Assessment Report

The Hydrology and Hydrogeology chapter of the March 2024 *'Remedial Environmental Impact Assessment Report'* (rEIAR) accompanying this substitute consent application, contains the following survey information:

- EPA (surface) water quality monitoring for 2010 to 2019 (pre-construction), November 2019 to November 2020 (during construction), and post-November 2020 (after peat slide) up to 2022;
- Additional biological water quality assessments (Section 7.3.7.3) for the pre-construction and construction phases;
- Surface water quality monitoring (Section 7.3.7.4) to establish a pre-construction baseline and extensive monitoring conducted during the construction phase.

These monitoring and survey results and assessment further inform the assessment of the residual environment post peat slide, the effectiveness of the restoration and remediation works undertaken and the state of the recovering and residual environment.

Aquatic Macroinvertebrate Sampling Report

An *'Aquatic Macroinvertebrate Sampling Report'* of the Meenbog Peatslide Remediation Q-Value Monitoring was prepared by MKO in December 2023. This assessment forms Appendix 5-4 of the rEIAR accompanying this substitute consent application.

The report presents the results of surveys for aquatic macroinvertebrates conducted for Q-Value determination to continue environmental monitoring of the Mourne beg River following a peat slide at the Meenbog wind farm. Sampling was carried out at 10 sites along the Mourne Beg River and its tributaries, the Bunadaowen River and the Shruhangarve River, on the 3rd and 4th of October 2023. Previous sampling has been undertaken in 2021 and 2020 as part of the ongoing environmental monitoring. The report investigates whether any differences in macroinvertebrate communities occurred as a result of the peat slide.

Aquatic & fisheries assessment of peat slide impacts on the Mourne Beg River catchment draining Meenbog wind farm, Co. Donegal

An *'Aquatic & fisheries assessment of peat slide impacts on the Mourne Beg River catchment draining Meenbog wind farm, Co. Donegal'* was prepared by Triturus Environmental Ltd. in April 2022. This assessment forms Appendix 5-2 of the rEIAR accompanying this substitute consent application.

The report presents the findings of a fisheries and aquatic habitat assessment of the Mourne Beg catchment draining Meenbog wind farm. The surveys focused on the Shruhangarve and downstream Mourne Beg River to determine impacts to fish populations, fish spawning and nursery habitat. The assessment also considered direct impacts to riverbed condition in addition to biological water quality and hydromorphology. Long-term Loughs Agency fisheries data and salmonid spawning (redd count) data was also reviewed and used to inform our assessment. A total of 18.95km of riverine channel was surveyed, both upstream and downstream of the peat impact zone, in July and October 2021.

Peatland Restoration Plan

A *'Peatland Restoration Plan'* for the Meenbog peat slide remediation was prepared by MKO in May 2021. This plan already forms Appendix 1, of Appendix 4, of Action Plan 3.0, included in Appendix E of this report.

The plan was prepared to describe the measures that were employed to stabilise, restore and monitor peatland habitats in the area where the peat slippage occurred. The plan describes the upland blanket bog vegetation occurring within and adjacent to the area where the slip occurred as well as a review of the current hydrological conditions on the site. This is followed by a description of the proposed management actions to assist in the restoration of this peatland and the proposed monitoring programme.

Botanical Survey

A *'Botanical Survey'* was prepared by MKO in April 2021, within five months of the peat slide occurring, and was previously submitted to Donegal County Council as part of Action Plan 3.0. This Botanical Survey report already forms Appendix 4 as part of Action Plan 3.0, included in Appendix E of this report.

The botanical survey presents the results of assessments of habitats within the study area, on both the habitats occurring within area where the peat slide occurred and within the adjacent intact peatland habitat.

Borrow Pit and Peat Cell Restoration and Remediation Plan

A *'Borrow Pit and Peat Cell Restoration and Remediation Plan'* was prepared was prepared by MKO in February 2021, within three months of the peat slide occurring, and was previously submitted to Donegal County Council. This assessment does not form part of the rEIAR accompanying the substitute consent application, and therefore is included as Appendix H of this report.

The purpose of this plan was to provide a framework for the restoration and remediation of the borrow pits and peat storage cells located on the Meenbog wind farm site. Implementation of the plan would ensure the longterm sustainability of these features and minimise any potential for environmental effects associated with them.

Assessment of Impacts on Merlin and Hen Harrier arising from Peat Slide

An *'Assessment of Impacts on Merlin and Hen Harrier arising from Peat Slide'* report was prepared by MKO in January 2021, within two months of the peat slide occurring, and was previously submitted to the EPA. This assessment does not form part of the rEIAR accompanying the substitute consent application, and therefore is included as Appendix I of this report.

The report assesses the potential significant effects that the peat slide may have on hen harrier and merlin. Firstly, a brief description of the evaluation criteria and assessment methods is provided. This is followed by a description of the survey methodologies that were followed and the survey results are reported. This is followed by a thorough assessment of the potential effects of the peat slide on hen harrier and merlin.

Preliminary Watercourse, Otter and Macro-Invertebrate Assessment

A *'Preliminary Watercourse, Otter and Macro-Invertebrate Assessment'* of the environs of the Meenbog Wind Farm, Shruhangarve stream and Mourne Beg River, Co. Donegal, was prepared by MKO in January 2021, within two months of the peat slide occurring, and was previously submitted to the EPA. This assessment forms Appendix 5-1 of the rEIAR accompanying this substitute consent application.

The assessment report reports on ecological walkover surveys and kick sampling for macro-invertebrates completed at various locations along the Mourne Beg River and its tributaries. These surveys were designed to be a rapid assessment, with the information gained to be used to inform the scope of any further or additional surveys that may be required to fully assess the nature, scale and extent of any environmental damage that may have occurred as a result of the peat slide. The report draws some preliminary conclusions as to the ecological impact of the peat slide on the receiving environment and the scope of any further surveys required.

Preliminary Surface Water Quality Assessment

A *'Preliminary Surface Water Quality Assessment'* of the Meenbog wind farm was prepared by MKO in January 2021, within two months of the peat slide occurring, and was previously submitted to the EPA. This assessment does not form part of the rEIAR accompanying the substitute consent application, and therefore is included as Appendix J of this report.

The report presents background information in respect of the geological, hydrogeological and hydrological setting of the wind farm site, and provides a preliminary assessment of the resulting environmental impacts on surface water quality arising from the peat slide event.

APPENDIX A

EPA LETTER

(28TH SEPTEMBER 2021)

Office of Environmental Enforcement

South/South West Region
Environmental Protection Agency
Regional Inspectorate, Inniscarra
County Cork, Ireland

Cigireacht Regíunach, Inis Cara
Contae Chorcaí, Éire

T: +353 21 487 5540
F: +353 21 487 5545
E: **info@epa.ie**
W: **www.epa.ie**

LoCall: 1890 33 55 99

Via e-mail to michaelmurnane@turnkeydev.com 28th September 2021

To: Planree Limited
Lissarda Industrial Estate
Lissarda
Co Cork

EPA Reference Number ELD200005/Corr(2) /Planree

The EPA Direction issued pursuant to Regulation 8(1) of the European Communities (Environmental Labilities) Regulations 2008 (as amended), dated 1st April 2021 required, inter alia, that;

1. **Planree Limited** shall arrange for the completion, by an appropriately qualified independent person, of a revised and updated peat stability assessment in line with best practice and guidance and addressing the conclusions and recommendations of the EPA report.
2. **Planree Limited** shall arrange for the submission of a report on the assessment in 1 above which shall provide all relevant information and evidence necessary for the EPA to assess the adequacy of the peat stability assessment. This report shall be submitted by the 30th April 2021

The Environmental Protection Agency refers to email correspondence dated 27/08/2021 to the Agency from MKO, consultants acting on behalf of Planree Limited, received in response to EPA correspondence issued 29th July 2021 2021, attaching *Peat Stability Assessment of Meenbog Windfarm Site* (August 2021; Fehily Timoney).

I am to advise that the revised Peat Stability Assessment prepared by FTC and submitted to the EPA pursuant to 1 and 2 above addresses the conclusions/recommendations set out in previous EPA correspondence. The issues identified in correspondence from the EPA on the 29th July 2021 have been satisfactorily addressed. Compliance with the EPA Direction from 1st April is now confirmed.

It is important that the mitigation measures proposed are implemented for the remaining works to be completed at the site. The detailed design for civil works should be informed by this updated assessment.

This correspondence is without prejudice to any legislative obligations on the operator other than under the Environmental Liability Regulations, or interactions with other Regulatory Authorities in respect of Meenbog Wind Farm. You are reminded of your obligations under Regulation 7(1) of the European Communities (Environmental Liability) Regulations 2008 (S.I. 547 of 2008) to take necessary preventive measures to deal with any imminent threat of environmental damage.

Dated this 28th day of September 2021

Signed on behalf of the Agency:

Jim Moriarty

Jim Moriarty
Senior Inspector
Office of Environmental Enforcement, EPA

APPENDIX B

DCC LETTERS

(11TH JULY 2022; 31ST MAY 2022)

Comhairle Contae
Dhún na nGall
Donegal County Council

11th July 2022

Mr. Michael Murnane
Planree Ltd.,
Lissarda Industrial Park,
Lissardagh,
Co. Cork
P14 YN56

Ref. No. 22/48A

Re: Meenbog Wind Farm – Notices under Section 12 of the WPA

Dear Mr. Murnane,

Further to your letter of 16th May 2022, in relation to the above, I write to advise you of the Council's response, taking into account the findings of the most recent site visit, on Friday 8th instant, which can be summarised as follows:

1. The restoration works physically completed in mid-May, including the seeding of exposed peat, have now reached the stage where the desired vegetation cover has become established in most areas. The planting of saplings in open areas along the banks of the stream has also been successful, although there are a few areas where additional planting may be recommended.
2. The area below Wall 1, the first area to be seeded, remains in good condition and has taken on the appearance of a natural, undisturbed habitat.
3. The area immediately above Wall 1 featuring a small pond, has shown an improvement in vegetation cover since the previous inspection.
4. Between Wall 1 and Wall 2, there are extensive areas which had been sown in mid-May and there are encouraging signs of growth along the banks of the stream which is clearly defined, with clean gravel evident in its bed.
5. The area between this section and the right turn up to the scar area and Wall 3 was restored in mid-May and grass is now growing through the coir matting in most areas.
6. The small stream coming down the hill from wall 3 has been joined to the main channel at an acute angle, which minimizes the risk of bank erosion, and there are signs of vegetation cover becoming established.
7. The section leading uphill to Wall 3 was reseeded late last year but any growth emerging at that time has since died away, requiring further reseeding to be done. The trees planted in this area have survived.

I believe Donegal Co. Council is now in a position to close out all of the Section 12 notices issued, as all of the seeded areas have shown encouraging signs of growth and establishment, (which reduces the likelihood of any significant sediment release), and the monitoring data obtained for the Shruhangarve and Mournebeg has been satisfactory.

We would like to commend your company and the staff involved in the restoration work, which has been very well designed and executed, and for their courtesy and co-operation since the incident began. We would also encourage you to maintain your commitment and place a strong emphasis and vigilance on the current surface water quality monitoring programmes, as the project moves into the next phases.

Yours sincerely

Joe Ferry, (Dr)
A/Senior Executive Scientist

Photo 1- area where Wall 2 was located, showing new vegetation growth, 8/7/22


Photo 2 - area upstream of Wall 2 was located, showing grass growth in coir matting, 8/7/22


Photo 3 – sapling growing in area where wall 2 was located, 8/7/22

Photo 4- confluence of stream from Wall 3 & Sruhangarve stream, 8/7/22

Photo 5 - Sruhangarve stream, looking up towards Wall 3, 8/7/22

Comhairle Contae
Dhún na nGall
Donegal County Council

www.ccdhunnangall.ie www.donegalcoco.ie

31st May 2022

Mr. Michael Murnane
Planree Ltd.,
Lissarda Industrial Park,
Lissardagh,
Co. Cork
P14 YN56

Ref. No. 22/14A

Re: Meenbog Wind Farm – Notices under Section 12 of the WPA

Dear Mr. Murnane,

Further to your letter of 16th May 2022, in relation to the above, I write to advise you of the Council's response, taking into account the findings of the recent site visit on Friday 20th instant which can be summarised as follows:

1. While the restoration works may have been physically completed, including the seeding of exposed peat, much of this work has been recent and as yet it is not possible to conclude that the desired vegetation cover will become established.
2. The area below Wall 1 was the first area to be seeded, with the stream pathway reinforced by coir matting prior to Christmas 2020, and this has returned to what looks like its former condition.
3. The area above Wall 1 features a small pond, which wasn't there previously and there are areas of exposed peat which are not yet covered in vegetation.
4. Between Wall 1 and Wall 2, (the latter which doesn't exist as a barrier anymore), there are extensive areas which have been sown but in which there are no signs of growth as yet, but the stream is clearly defined.
5. The area between this section and the right turn up to the scar area and Wall 3 has only recently been restored and coir matting is visible, with no new growth as yet.
6. The section leading up hill to Wall 3 was reseeded late last year but any growth emerging at that time has since died away, requiring further reseeding to be done. The trees planted in this area have survived.

In looking at the conditions in the last of the 3 notices, Ref No: 21/14, I would draw your attention to the following, in light of the above observations:

<u>*Schedule A*</u>

1. *The Holder shall carry out restoration works in order to eliminate or limit the release of polluting matter (peat or sediment) from the areas of the peat slide, and down gradient of it, where material has been deposited and mitigate against the further dispersal of peat and sediment, deposited along the banks of the Shruhangarve stream, by the water-course through and beyond the confines of the Meenbog Wind Farm site.*

I believe it would be premature for us to close out this notice until the recently seeded areas show some signs of growth and establishment, in order to reduce the likelihood of significant sediment release. If the weather and growing conditions are suitable over the coming weeks and months, we can organise a further site visit and would have no difficulty in closing out the notices if there has been improvement in that regard.

I would like to commend your company and the staff involved in the restoration work, which has been very well designed and executed so far, and for their courtesy and co-operation since the incident began. The past month hasn't been very favourable in this part of the country for growth, which has set back final approval, but hopefully we'll see some heat to remedy that shortly.

Yours sincerely

Joe Ferry

Joe Ferry, (Dr)
A/Senior Executive Scientist

APPENDIX C

ACTION PLAN – VERSION 1.0

Peat Slide Action Plan – Version 1.0

Meenbog Wind Farm

DOCUMENT DETAILS

Client:	**Planree Limited**
Project Title:	**Meenbog Wind Farm**
Project Number:	**201174**
Document Title:	**Peat Slide Action Plan – Version 1.0**
Document File Name:	**201174 - Action Plan Version 1.0 F 2020.12.04**
Prepared By:	**MKO** **Tuam Road** **Galway** **Ireland** **H91 VW84**

Planning and Environmental Consultants

Rev	Status	Date	Author(s)	Approved By
01	Draft	03/12/2020	BK; TB; PR; MW; MG; SC	BK / MW
02	Final	04/12/2020	BK; TB; PR; MW; MG; SC	BK / MW

Table of Contents

1. INTRODUCTION

1.1 Background

McCarthy Keville O'Sullivan Ltd. (MKO) have been requested by Planree Limited (Planree) to provide technical assistance and prepare an Action Plan following a peat slide incident at the Meenbog Wind Farm construction site on the 12th November. Since the appointment by Planree, MKO have been coordinating a team of ecologists, hydrologists, environmental scientists, environmental engineers and aquatic ecologists to prepare an Action Plan that would make recommendations to mitigate the effects of the incident.

This Action Plan has also been prepared specifically to inform Planree's response to a notice issued by Donegal County Council (DCC) dated 17th November issued under Sections 10(5), 12(1) and 23(1) of the Local Government (Water Pollution) Acts, relating to the discharge of peat, sediment and heavily soiled water from the wind farm site under construction at Meenbog, Ballybofey, Co. Donegal to the Shruhangarve stream and Mourne Beg River commencing on the 12th and 13th November 2020.

1.2 Scope of Action Plan

DCC's letter of 17th November requested Action Plan, in the form of a written report, by submitted to Donegal County Council detailing the engineering measures identified and considered necessary to:

> (a) eliminate or limit the release of further polluting matter from the area where the landslide occurred, from areas up gradient of the land slide and from areas down gradient of the landslide where material has been deposited,
>
> (b) prevent the catastrophic release of material built up behind the existing improvised impoundment structure on site, (taking into consideration projected rainfall amounts) and,
>
> (c) mitigate against the further dispersal of peat and sediment, deposited along the banks of the Shruhangarve, by the watercourse through and beyond the confines of the site.

This Action Plan has been prepared by MKO for Planree Limited in response to the DCC requests outlined above. The description of emergency engineering works undertaken to date which address Point (a) and (b) above has been compiled by Ionic Consulting and is set out in Section 2.

The MKO proposals are included herein as a series of recommendations for Planree Limited or their contractors to implement on-site.

MKO has prepared this action plan to allow Planree Limited present it and the recommendations contained herein as Planree Limited's proposals to Donegal County Council along with the necessary commitments to their effective implementation.

MKO is not responsible for the implementation of the proposed measures contained herein on-site, but will monitor the implementation of any measures that might be proposed by Planree as part of an expanded role for the on-site Environmental Clerk of Works.

This Action Plan has been prepared as a "Version 1" document and is by no means exhaustive or limited. Further recommendations are likely to be brought forward to address the situation on-site and in the downstream watercourses as a result of ongoing water monitoring efforts, ecological surveys, seasonal factors, the trialling of certain recommendations on site and the contributions from other stakeholders and regulatory authorities whose input will be very much welcomed and carefully considered.

1.3 Contributors

The following people contributed to the preparation of the Action Plan and the recommendations contained herein.

Brian Keville – MKO (Environmental Director)

Brian has over 20 years' professional experience as an environmental consultant having graduated from the National University of Ireland, Galway with a first class honours degree in Environmental Science. Brian's professional experience has focused on project and environmental management, and environmental impact assessments. Brian has acted as project manager and lead-consultant on numerous environmental impact assessments, across various Irish counties and planning authority areas. These projects have included large infrastructural projects such as roads, ports and municipal services projects, through to commercial, mixed-use, industrial and renewable energy projects. The majority of this work has required liaison and co-ordination with government agencies and bodies, technical project teams, sub-consultants and clients.

Michael Watson – MKO (Environment Team Project Director)

Michael is Project Director and head of the Environment Team in McCarthy Keville O'Sullivan (MKO). Michael has over 18 years' experience in the environmental sector. Following the completion of his Master's Degree in Environmental Resource Management, Geography, from National University of Ireland, Maynooth he worked for the Geological Survey of Ireland and then a prominent private environmental & hydrogeological consultancy prior to joining MKO in 2014. Michael's professional experience includes managing Environmental Impact Assessments, EPA License applications, hydrogeological assessments, environmental due diligence and general environmental assessment on behalf of clients in the wind farm, waste management, public sector, commercial and industrial sectors nationally. Michael also has a Bachelor of Arts Degree in Geography and Economics from NUI Maynooth, is a Member of IEMA, a Chartered Environmentalist (CEnv) and Professional Geologist (PGeo).

Thomas Blackwell – MKO (Senior Environmental Consultant)

Thomas is a Senior Environmental Consultant with MKO with over 15 years of progressive experience in environmental consulting. Thomas holds a BA (Hons) in Geography from Trinity College Dublin and a M.Sc. in Environmental Resource Management from University College Dublin. Prior to taking up his position with MKO in August 2019, Thomas worked as a Senior Environmental Scientist with HDR, Inc. in the United States and held previous posts with private consulting firms in both the USA and Ireland. Thomas is a registered Professional Wetland Scientist with the Society of Wetland Scientists with specialist knowledge in wetland assessment and delineation, mitigation planning and design, stream geomorphic assessment, and stream and wetland restoration design. Thomas' key areas of expertise include fluvial geomorphology and stream restoration design. Thomas has provided stream restoration design, and construction oversight for numerous private and publicly funded projects in multiple jurisdictions.

Pat Roberts – MKO (Principal Ecologist)

Pat joined MKO (then Keville & O'Sullivan Associates) in 2005 following completion of a B.Sc. in Environmental Science. He has extensive experience of providing ecological services in relation to a wide range of developments at the planning, construction and monitoring stages. He has wide experience of large scale industrial and civil engineering projects. He is highly experienced in the completion of ecological baseline surveys and impact assessment at the planning stage. He has worked closely with construction personnel at the set-up stage of numerous construction sites to implement and monitor any prescribed best practice measures. He has designed numerous Environmental Operating

Plans and prepared many environmental method statements in close conjunction with project teams and contractors. He has worked extensively on the identification, control and management of invasive species on numerous construction sites.

John Hynes – MKO (Ecology Team Project Director)

John Hynes is a Senior Ecologist with McCarthy O'Sullivan Ltd. with over 7 years of experience in both private practice and local authorities. John holds a B.SC in Environmental Science and a M.Sc. in Applied Ecology. John has specialist knowledge in Flora and Fauna field surveys. Geographic Information Systems, data analysis, Appropriate Assessment, Ecological Impact Assessment and Environmental Impact Assessment. Since joining MKO John has been involved as a Senior Ecologist on a significant range of energy infrastructure, commercial, national roads and private/public development projects. John has project managed a range of strategic infrastructure and development projects across the Ireland and holds CIEEM membership.

Owen Cahill – MKO (Project Environmental Engineer)

Owen is an Environmental Engineer with McCarthy O'Sullivan Ltd. with over 11 years of experience in the environmental management and construction industries. Owen holds BSc. (Hons) and MSc. in Construction Management and a Masters in Environmental Engineering. Owen has project managed the Environmental Impact Assessment of a range of development projects across the Ireland and holds Full Membership with the Institute of Environmental Management & Assessment and is a Chartered Environmentalist.

Michael Gill – Hydro-Environmental Services

Michael Gill is an Environmental Engineer with over 18 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms in Ireland. He has also managed EIA/EIS assessments for infrastructure projects and private residential and commercial developments. In addition, he has substantial experience in wastewater engineering and site suitability assessments, contaminated land investigation and assessment, wetland hydrology/hydrogeology, water resource assessments, surface water drainage design and SUDs design, water quality protection, water treatment systems and surface water/groundwater interactions.

Steve Coates – SLR Consulting Limited

Steve is SLR's Principal Aquatic Ecologist and is a national authority on fish ecology with over 30 years' experience on water and civil engineering projects. He has a long-standing track record of supporting sustainable development and enhancement gain and has spent the past three decades working within salmonid and cyprinid catchments. He is a highly skilled scientific practitioner in the fields of biological, environmental and fisheries science; environmental impact assessment (EIA), and aquatic ecology. He is a chartered member of the Royal Society of Biology (CBIOL MRSB) and the Institution of Water and Environmental Management (CWEM MCIWEM) and a member of the Institute of Fisheries Management (MIFM).

Cormac Ó Dubhthaigh – Ionic Consulting Limited

Cormac is the Civil Engineering Manager at Ionic Consulting and joined the company in 2009. He holds a first class honours B.E. Civil Engineering degree from UCD and also completed an M.Eng.Sc. masters degree in Structural Engineering in UCD in 1996. He has considerable experience in the design of wind farm infrastructure including roads, hardstandings, wind turbine foundations, substations, bridges and associated works, with design experience on over 30 wind farms. He has previous experience in Ireland and Australia working with leading civil engineering consultancies including ARUP and Roughan & O'Donovan. He is a chartered member of Engineers Ireland (CEng MIEI).

Claire Looney – Ionic Consulting Limited

Claire is a Senior Project Manager with Ionic Consulting and has more than 14 years' experience in the energy sector, both in Ireland and internationally. She leads a team focussing on the delivery of onshore windfarms in Ireland, from pre-construction through to operational takeover with specific focus on Health & Safety, contract administration and programme delivery. She acts as the PSDP and Project Manager for a number of windfarms in Ireland. She is a chartered engineer and holds an honours degree in Electrical Engineering from UCC.

2. EMERGENCY WORKS

The following summary of emergency works undertaken on site has been prepared by Ionic Consulting (Ionic), and the Ionic briefing note from which this content was taken is included in full in Appendix 1.

As set out in the notice and in line with section 6.1.5 of the project Construction and Environmental Management Plan ("CEMP"), we can confirm that following the peat slide on 12th Nov 2020, all construction works were ceased on the wind farm site as soon as notice of the incident was provided to site management. The only activities undertaken were those works required to ensure construction areas were left in a safe condition. Once all personnel on site had been safely accounted for, available resources were then immediately re-directed towards mitigating against further discharges to watercourses. The response to the peat slide can be split into stages which are set out below.

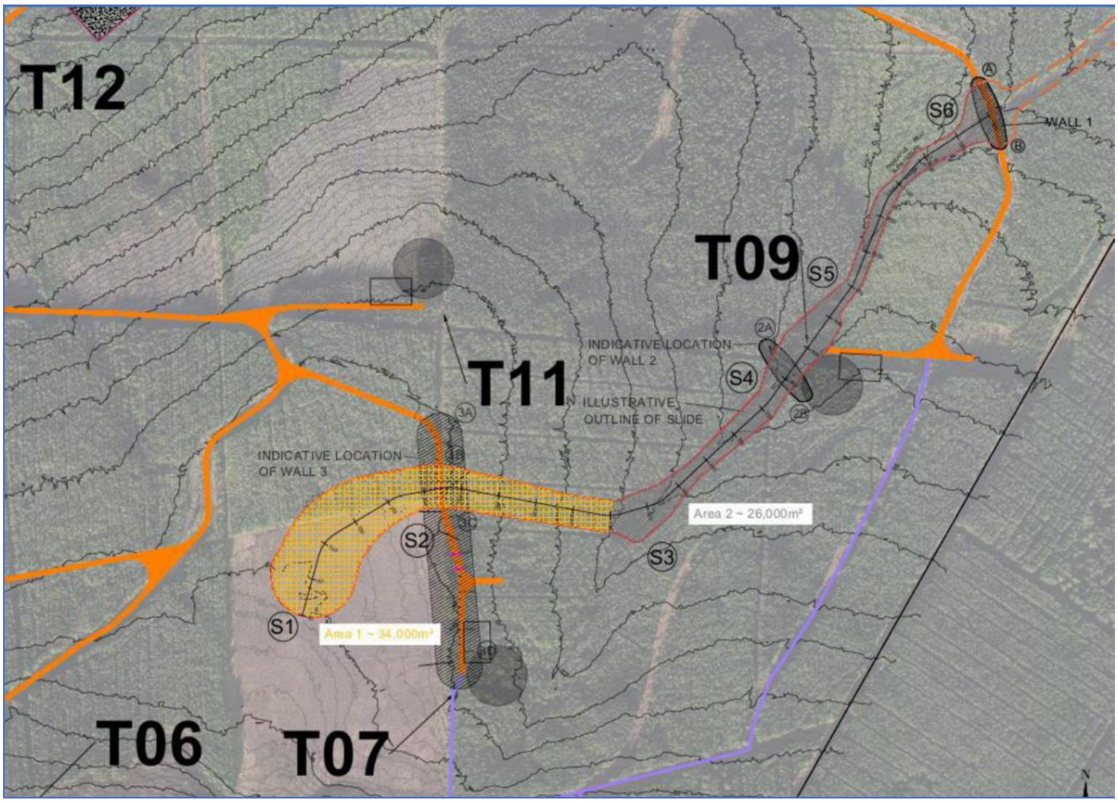


Figure 2.1 Overview map of works area

Step 1 - Immediate actions:

The first stage was the immediate response within the first 24-72hours which consisted of emergency measures to prevent further material from entering local watercourses. Ionic Consulting who are the Designer and Geotechnical Engineers for the works were consulted. It was possible to undertake a drone survey relatively quickly following the incident as a drone was available on site. Based on the available information the slide path could be determined and an assessment of safe access points was undertaken.

It was evident that majority of the material that slid was deposited between points S3 and S6 shown on Figure 2.1 above, largely because of the shallower gradient and also by the existing roadway leading to turbine no. 9 (T9). This unstable, water-laden material presented the most immediate risk in terms of pollution of watercourses with the concern that the roadway could be overtopped by material being retained to the South. This risk was exacerbated by the fact that the slide material had entered the local stream (at approximately point 'S3' in Figure 2.1) and water from the surrounding catchment entering the stream would be retained behind the roadway (identified as 'Wall 1' in Figure 2.1). A secondary risk in terms of immediate further pollution of watercourses was the risk of additional movement of material from the area upslope of the slide initiation point (to the South and west of point 'S1' in Figure 2.1.

To mitigate against the risks above, the immediate aim was to introduce check barrages to prevent the slide from reaching any watercourses in line with the CEMP. Immediate action was taken to reinforce and increase the height of the accessible roadway leading to T9. The reason works commenced at this point was two-fold:

> 1) This road was already acting as a check barrage, retaining some of the slide material to the South however it was at the point of being overtopped by the slide material.
>
> 2) Following remote consultation with geotechnical consultant Ionic Consulting and with the information from the initial drone survey of the area it was evident that this was the only location where it would be safe to gain immediate access to initiate the CEMP measures.

Works commenced at the roadway to T9 (referred to as Wall 1 in Figure 2.1 above) on the afternoon of the 12th November 2020 as soon as an inspection had been conducted to ensure it was safe for personnel to work in the area. It was not possible to produce a detailed design in this timeframe given the need for immediate action however the proposed works were reviewed and progressed in consultation with the Designer Ionic Consulting. The initial aim was to raise the berm by 1.5m-2m for a length of approximately 100m along the area retaining the slide, this was further raised over the following days by up to 3.8m from the original design level.

The primary aim of Wall 1 was to limit or prevent the flow of liquefied peat into watercourses beyond the site. The existing pipe was largely blocked due to the deposited peat, and though water continued to flow through and around the wall, including seepage through the existing pipe, the majority of the peat slurry and solid clumps of peat were retained.

Step 2 -Assessment:

Before progressing works at any other points on site, more detailed geotechnical assessment was required in order to:

> a) Establish safe areas for access on site and to identify unsafe or potentially unstable areas on site
>
> b) Assess what additional emergency measures were necessary to prevent further movement of peat or material

Close monitoring of the slide area by drone continued on a daily basis. Upcoming weather forecasts were reviewed to consider additional rainfall events and potential impact on stability of the area. Ionic Consulting have a site engineer with daily presence on site, and engineers visited the site on 13th Nov 2020 and on six further occasions in the first 2 weeks for the purpose of this assessment.

In addition to the geotechnical assessment it is noted that MKO the environmental and ecological consultant appointed for the project attended site to assess both the Shruhangarave Stream and Mourne Beg River from the 13th Nov 2020 and a new monitoring programme was developed, with support from HES, for these two watercourses including laboratory analysis and visual checks implemented daily.

Step 3 Additional Emergency Measures:

Following further assessment a detailed design for 'Wall 1' was developed by Ionic Consulting. This consisted of a large stone berm raised from original road level of 217.2mOD to 221.0mOD to provide additional containment for deposited peat. A design risk assessment and detailed design are appended for reference. Please refer to drawing MNBG d021.9.1 - Wall 1 Berm (T9 Spur)_RevB and MNBG hs004.5 Design Risk Assessment - T7 Peat Slide Stabilisation RevC (included in Appendix 2 of this Action Plan). Following initial emergency works carried out on 12th November works continued to implement the final detailed design and were completed by 21st Nov 2020.

The detailed geotechnical assessment undertaken in step 2 identified the risk of further peat movement upslope of the slide initiation point in the peatland area (refer to point S1 in Figure 2.1) was still significant. Two other points for further check barrages were identified, denoted as 'Wall 2' and 'Wall 3' in Figure 2.1 to mitigate against this potential risk. Access for construction of Wall 2 would be from the hardstanding at T9 and access for Wall 3 would be from the last section of road constructed to solid formation on the approach to the turbine 7 (T7) location. Wall 3 was prioritised for the following reasons:

a) Wall 3 was located immediately downslope of an area of unstable peat where significant volumes of water or liquefied peat was released, and given the visual signs of further propagating cracks from aerial drone footage it was considered a priority to stabilise this upslope material.

b) Wall 3 is an 'on-land' check barrage as opposed to Wall 2 which is located 'in-stream' which was considered to present a lesser risk to pollution of watercourses

c) The construction of Wall 2 could not safely commence until Wall 1 was complete whereas access was immediately available to Wall 3 prior to the completion of works at Wall 1.

As there was a short section of floating road approaching T7 remaining following the peat slide, the Designer and geotechnical consultant Ionic Consulting Ltd advised that this check barrage be installed upslope of the existing roadway. Again, a detailed design was developed prior to the commencement of the works. Consideration was given to drainage through the check barrage for geotechnical purposes. A design risk assessment and detailed design are also appended for these works for reference. Please refer to drawing MNBG d021.7.4 T7 Slide Berm Details_Rev B and MNBG hs004.5 Design Risk Assessment - T7 Peat Slide Stabilisation RevC (included in Appendix 2 of this Action Plan)..

Works commenced as soon as a geotechnical assessment could be completed and an appropriate civil works design could be developed. Construction of this berm referred to as 'Wall 3' commenced on 17th Nov 2020.

MKO continued to fulfil the Environmental Clerk of Works (ECoW) role during the emergency works and expanded the water quality monitoring programme that was already underway.

As soon as Wall 1 was completed and safe access and egress could be maintained to T9 via the access road, and also the section of Wall 3 past the slide affected area was constructed, construction of Wall 2 was considered. Due to increased rainfall it was observed that an excessive amount of water was flowing towards Wall 1. A decision was taken at this time to prioritise drainage of the area and strategic pumping of clean water away from the area affected by the slide. Clean water was intercepted and diverted from upstream of the slide area and discharged to the North of Wall 1. Soiled water was also removed via pumping from the area adjacent to T9. These works commenced on 25th November.

Current situation:

As of today (3rd December), Wall 1 has been constructed and Wall 3 is nearing completion, and these works are deemed to have largely stabilised the area. A drainage and pumping arrangement has been implemented which combined has substantially reduced the level of water flowing towards Wall 1. Wall 2 is under construction and it is expected no further check barrages will be necessary.

It is noted that is was neither practical nor safe to implement immediate measures downstream of Wall 1 where it is noted a quantity of material has been deposited to either side of the watercourse leading to the Shruhangarve river prior to this time. As referenced above, a monitoring programme has been implemented. It is anticipated that further mitigation measures will be required to address this material downstream of Wall 1 in the short to medium term.

3. CURRENT SITE HYDROLOGY

Upstream of Wall 1 a series of emergency works have been substantially completed to a) stabilise the ground to prevent further peat movement, and b) to manage surface water and protect downstream water quality.

The catchment upstream of Wall 1 is ~0.85km^2 in area. Surface water flows from this catchment will vary with preceding rainfall and catchment wetness. At this time of year there is little or no evapotranspiration. Catchment area maps have been prepared for the Shruhangarve sub-catchment in which the peat slide occurred, and one is included as HES Figure No. P1249-5_D101 below.

3 no. stone structures have been constructed to stabilise the peat, Wall 1, Wall 2 and Wall 3. Wall 3 is the furthest up the catchment and is located along the T7 (turbine 7) access track. Wall 1 is the lower structure and is constructed perpendicular to the Shruhangarve stream along the line of the T9 access track. Wall 2 is the intermediate structure and is located west of T9 (turbine 9).

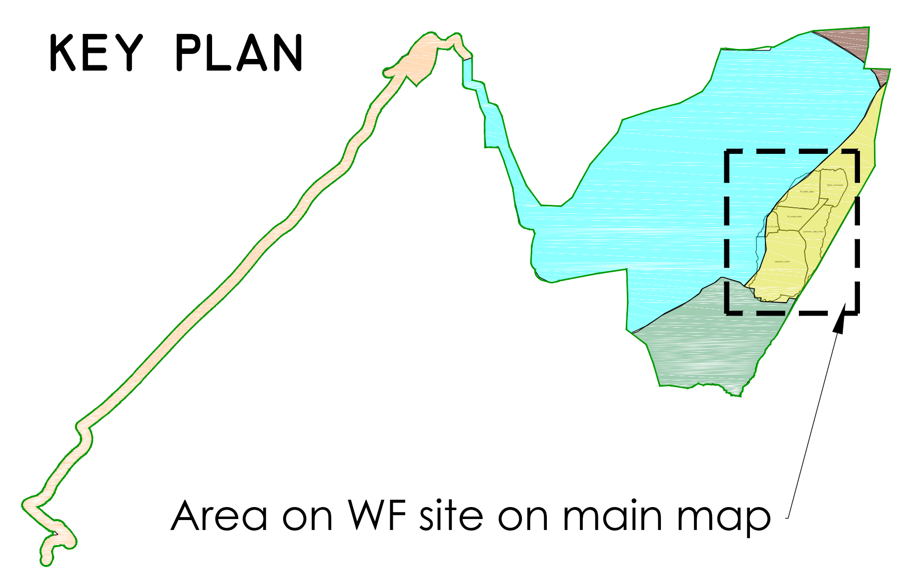
Following the peat slide event (12th November), and after the initial geotechnical stabilisation works, one of the focuses on site was to attempt to divert as much clean water as possible around Wall 1, and back into the Shruhangarve stream. The purpose here was to prevent flow through the pond behind Wall 1 as this holds significant volumes of loose peat and sludge which will be mobilised by larger throughflows. Based on initial estimations, HES determined that ~59% (Upstream clean and Upstream_east_clean) of the total catchment upstream of the slide could be diverted around Wall1. In order to implement this, a diversion drain and two sumps (initial settlement sump to capture any large solids, and second pump sump from which water is pumped) were created to the southwest of T9. An 8" pump and backup 6" pump are operational, and pumping water from this clean water area around Wall 1 (Discharge 1). There are further opportunities to divert additional clean water (~10-18%) from the western side of the catchment (T9_west_clean). This is being assessed on the ground to determine what is possible, bearing in mind that health and safety is also a major factor to be considered.

At Wall 2 a series of linear attenuation/settlement ponds (2 no.), and sumps (2 no.) have been created. These capture soiled water coming from the upstream slip area and currently from the catchment to the west of the slip area. This soiled water is pumped from the second sump (again, an initial settlement sump to capture any large solids, and second pump sump were installed) from which water is pumped and diverted around Wall1. This water is treated via a settlement tank and silt bags (Discharge 2).

At Wall 3 a temporary pumping arrangement diverts water away from downstream of Wall 3 to the north. The purpose of this pumping was to prevent significant water flows down through the slip area and reduce the risk of further destabilisation. The catchment upstream of Wall 3 is relatively small and as such pumping flows are also relatively small (Discharge 5).

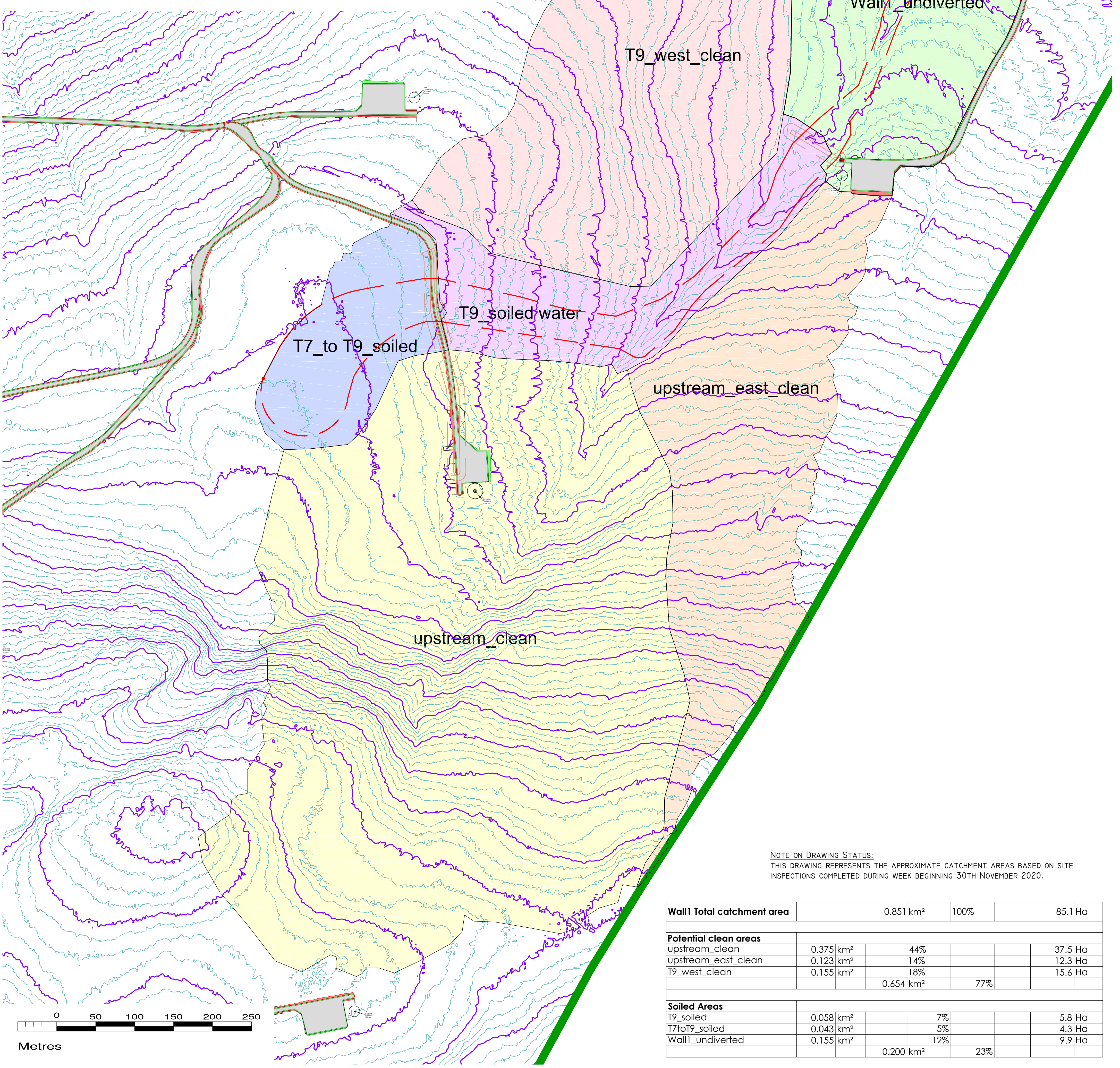
At Wall 1, there are two further discharges. The first is overflow from the pond behind Wall 1, and this overflow occurs through 2 no. 600mm pipes (Discharge 2). In recent days (week beginning 30th November) following dry weather flows through these pipes has slowed to the trickle. As outlined above much of the runoff water from the catchment is being diverted around the pond upstream of Wall 1. The second discharge at Wall 1 is seepage flow through the southern (lower) end of Wall 1. This flow is captured in a sump downstream of Wall 1 and pumped laterally into the main channel of the Shruhangarve (Discharge 3). The purpose here is to prevent flows down through the forestry which could destabilise the peat there, and also remobilise some of the loose peat/sludge that coats the ground following the peat slide.

Figure 3.1 below shows a flow diagram of the current water flow and pumping arrangements on-site.



LEGEND

- Glendergan River Catchment
- Shrugangarve Stream Catchment
- Mourne Bog Direct Catchment
- Bunadaowent River Cacthment
- Lowerymore River Catchment



NOTE ON DRAWING STATUS:
THIS DRAWING REPRESENTS THE APPROXIMATE CATCHMENT AREAS BASED ON SITE INSPECTIONS COMPLETED DURING WEEK BEGINNING 30TH NOVEMBER 2020.

Wall1 Total catchment area			0.851	km²	100%		85.1	Ha
Potential clean areas								
upstream_clean	0.375	km²		44%			37.5	Ha
upstream_east_clean	0.123	km²		14%			12.3	Ha
T9_west_clean	0.155	km²		18%			15.6	Ha
			0.654	km²	77%			
Soiled Areas								
T9_soiled	0.058	km²		7%			5.8	Ha
T7toT9_soiled	0.043	km²		5%			4.3	Ha
Wall1_undiverted	0.155	km²		12%			9.9	Ha
			0.200	km²	23%			

LEGEND

- SITE LAYOUT
- BOG SLIDE AREA
- SITE BOUNDARY
- WALL1_UNDIVERTED CATCHMENT
- UPSTREAM-EAST-CLEAN CATCHMENT
- UPSTREAM_CLEAN CATCHMENT
- T7_TO_T9_SOILED CATCHMENT
- T9_SOILED WATER CATCHMENT
- T9_WEST_CLEAN CATCHMENT

DRAWING NOTES
1. DRAWINGS ISSUED ARE FOR ILLUSTRATIVE PURPOSES ONLY.
2.
3. DO NOT SCALE OFF THIS DRAWING.

Date	Description	Chkd	Signed

Revisions

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Job: MEENBOG WF, CO. DONEGAL

Title: BOG SLIDE CATCHMENT AREAS

Figure No: P1249-5_D101

Drawing No: P1249-5-1220-A3-D101-00B

Sheet Size: A3	Project No.: P1249-5
Scale: 1:5,000 (A3)	Drawn By: MG/GD
Date: 04/12/2020	Checked By: MG

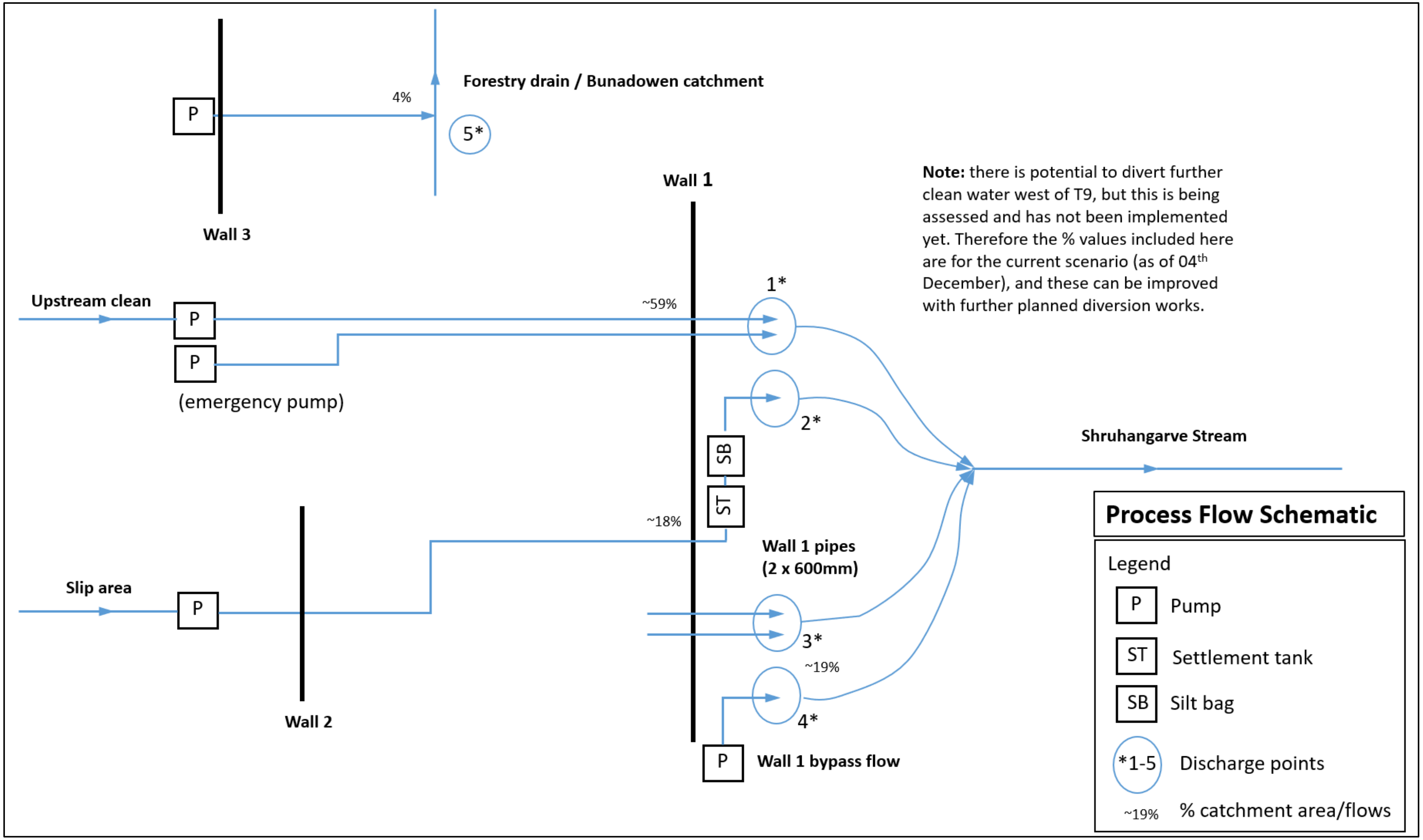


Figure 3.1 Flow diagram of current water flows and pumping arrangements on-site

4. RECOMMENDED FUTURE PHILOSOPHY

The emergency works undertaken and now substantially completed on site since the original peat slide on the 12th/13th November have stabilised the situation on the ground to allow a considered view now be taken on future recommendations and measures that will further improve water quality and eventually restore and reinstate the river channel to the greatest extent possible.

In the case of certain recommendations and requirements, it will likely be better to do nothing else in the short term during the wetter winter months. However, over the medium to long term, specific interventions will be required as if nothing is done, peat deposited downstream as a result of the slide will gradually continue to make its way into downstream watercourses over time, by creep and by being washed by runoff and flood flows).

Some fundamental principles are recommended for any works being considered and implemented in this and future Action Plans:

1. Do not do anything that makes the current improving situation worse from a water quality, habitats or protected species perspective, even on a temporary basis, until the proposed measures have been considered and recommended from an ecological, hydrological and geotechnical perspective to have longer term benefits, and detailed method statements are developed to minimise any potential for negative effects.
2. Do not consciously do anything that causes a soiled discharge, even if only temporary.

There will be very limited or no entirely risk-free options. However, any option recommended and selected will have to be justifiable and demonstrated to be preferred (or least worst) option out of a number that will have been considered.

Any works will require continuous turbidity monitoring and will have to cease and be further modified if causing increased turbidity levels.

5. ACTION PLAN RECOMMENDATIONS

5.1 Introduction

Recommendations are set on in the below section of the Action Plan under three categories:

1. Water quality protection measures – currently under consideration
2. Water quality monitoring – currently underway
3. Ecological surveys – scheduled

The recommendations for water quality protection measures have been made by way of this Action Plan to Planree.

The recommendations for water quality monitoring have been made previously to Planree and MKO are currently undertaking this monitoring.

The recommended ecological surveys have been proposed to Planree by MKO (with input from SLR Consulting), have been accepted by Planree, but have not yet commenced.

5.2 Water Quality Protection Measures

A series of recommendations to protect water quality are outlined in this section of the Action Plan.

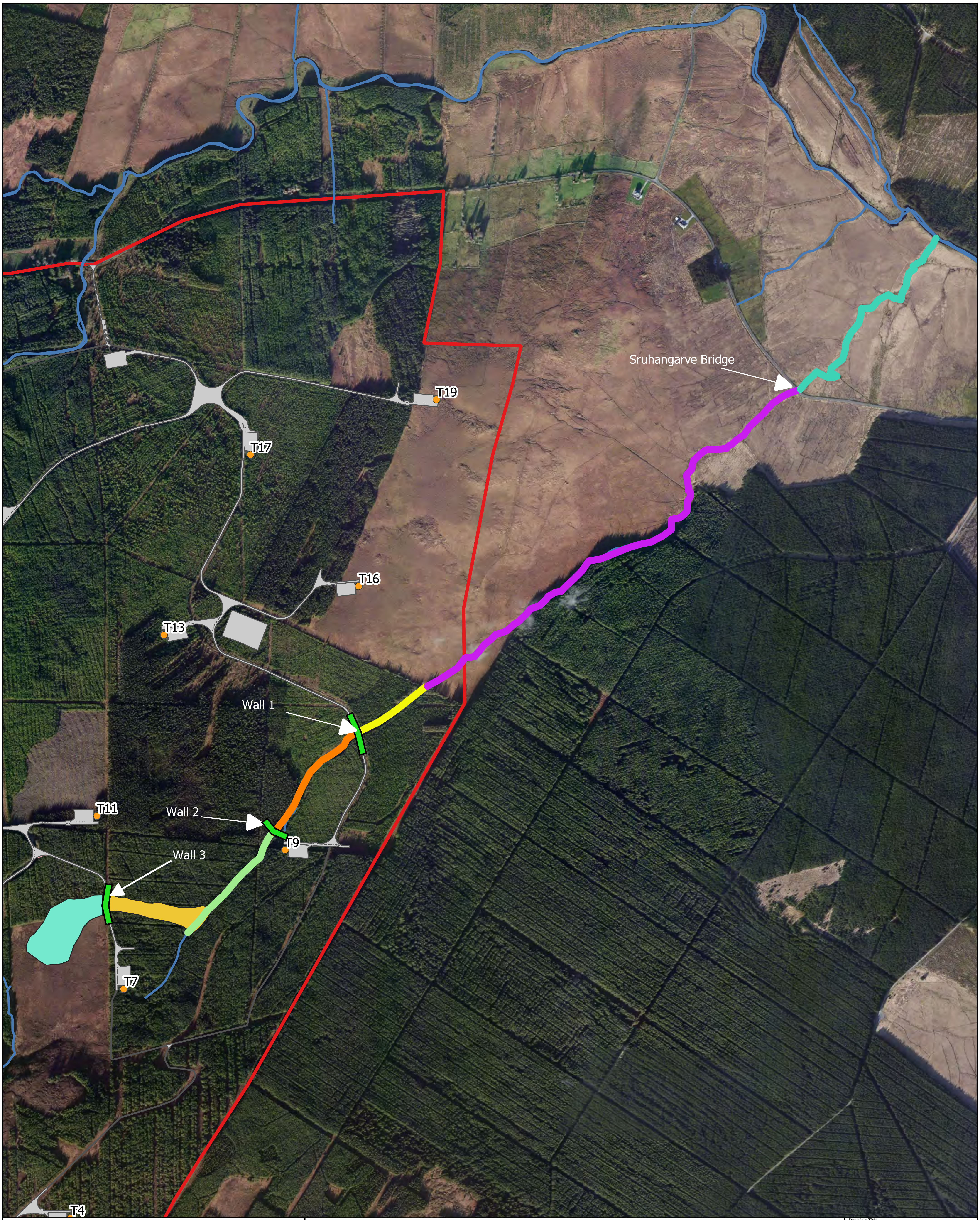
MKO has prepared this action plan and the recommendations contained herein to allow Planree Limited present their proposals to Donegal County Council along with the necessary commitments to the effective implementation of the proposals.

MKO is not responsible for the implementation of the proposed measures contained herein on-site, but will monitor the implementation of any measures that might be proposed by Planree as part of an expanded role for the on-site Environmental Clerk of Works.

The objectives of each of the water quality protection measures proposed below are described in terms of the required measures outlined in Donegal County Council's notice dated 17th November, as follows:

- Eliminate or limit the release of further polluting matter from the area where the landslide occurred.
- Eliminate or limit the release of further polluting matter from areas up gradient of the land slide.
- Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.
- Prevent the catastrophic release of material built up behind the existing improvised impoundment structure on site.
- Mitigate against the further dispersal of peat and sediment, deposited along the banks of the Shruhangarve, by the watercourse through and beyond the confines of the site.

For the purposes of describing the recommended water quality protection measures, Figure 5.1 has been prepared which divides the Shruhangarve stream into five sections or reaches, and these reaches will be referred to further below.



Map Legend

Peatslip
- Main Slip Area
- Slide Path

Stream Reaches
- Stream Reach 1
- Stream Reach 2
- Stream Reach 3
- Stream Reach 4
- Stream Reach 5
- Rivers/Streams
- Meenbog WF Project Boundary
- Proposed Permanent Development Footprint
- Proposed Turbine Locations

N

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Drawing Title	
Meenbog Peatslide Remediation Areas	
Project Title	
Meenbog Windfarm	
Drawn By: TJB	Checked By: BK
Project No.: 201174	Drawing No.: Figure 5.1
Scale: 1:10000	Date: 18/11/2020

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5.2.1 Recommendation 1 – Impound water and sediment behind Wall 1

Present situation informing recommendations

Large volumes of sediment have been successfully impounded behind Wall 1 and prevented from entering downstream watercourses, as evident in Figures 5.2 and 5.3 below. The volumetric measurement of these sediment volumes is presently underway and will be reported in future iterations of the Action Plan. Approximately 79% of water flows entering the Shruhangarve catchment upstream of Wall 1 have been intercepted upstream of the impounded sediment and diverted away from the sediment impounded behind Wall 1, thereby minimising the re-mobilisation of the impounded sediment, but larger volumes of water are likely to continue to reach the upstream side of Wall 1 in periods of heavier and prolonged rainfall.

There currently appears to be minimal seepage of water through Wall 1, likely because any void spaces have become plugged with suspended peat and the bypass flows already in place around Wall 1.

Figure 5.2 Water and sediment impoundment area upstream of Wall 1 showing stabilised situation and deposits of peat up to surface of water

Figure 5.3 Aerial image of water and peat impoundment area upstream of Wall 1 showing large volums of impounded peat and clearly identifiable channel for water reaching Wall 1

Objectives of recommendations

1. Eliminate or limit the release of further polluting matter from the area where the landslide occurred.
2. Eliminate or limit the release of further polluting matter from areas up gradient of the land slide.
3. Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.
4. Prevent the catastrophic release of material built up behind the existing improvised impoundment structure on site.

Recommended measures

1. Continue to intercept as much water as possible upstream of Wall 1 and overpump it to the downstream site of Wall 1 to minimise the amount of water reaching the upstream side of Wall 1.
2. Keep existing overflow pipe clear to be able to release any excess build-up of water behind Wall 1 in order to maintain the structural integrity of Wall 1.
3. Maintain overflow pipe at existing level and install flow meter in pipe.
4. Prevent any overflow of water around sides of Wall 1 by building up level of wall/road.
5. Install course screen (type to be confirmed) around inlet to pipe to prevent large pieces of suspended peat blocking the pipe.
6. Continue to assess rate of seepage through Wall 1, and if necessary, seal upstream side of Wall 1 to minimise seepage through wall (using vertical timbers, peat plug etc.).

5.2.2 Recommendation 2 – Intercept clean water

Present situation informing recommendations

Large volumes of clean water are already being successfully intercepted upstream of the peat slide area on the Shruhangarve stream as a result of the emergency works now substantially completed on site, and are being prevented from reaching the peat slide area and becoming entrained with sediment, see Figure 5.4 below. Further volumes of clean water are being intercepted as overland flow, and prevented from reaching the peat slide area and becoming entrained with sediment. The more "clean" water that can be intercepted upstream or upgradient of the peat slide area, the less water will become soiled. Intercepting as much clean water as possible and diverting or pumping it to the downstream side of Wall 1 keeps that clean water clean and prevents that water mobilising further sediment or deposited peat sludge it might otherwise encounter.

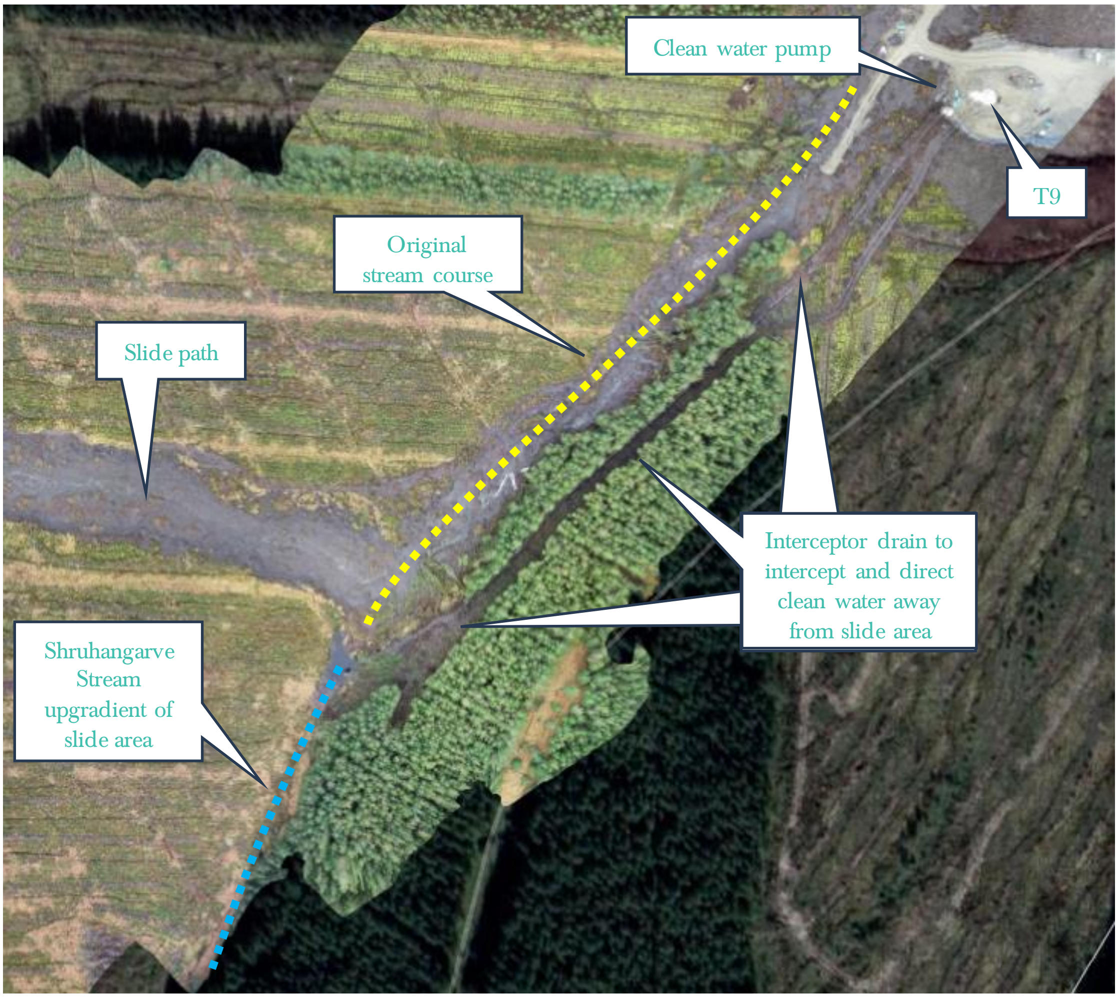


Figure 5.4 Aerial view of Stream Reach 1, showing interceptor drains collecting clear water for pumping around peat slide area

Analysis of the Shruhangarve catchment topography upstream of Wall 1 undertaken since the peat slide has divided it into "clean" and "soiled" sub-catchment areas, as detailed on HES Figure No. P1249-5_D101 included above. Clean water is already being intercepted from the sub-catchment areas labelled as "upstream_clean" and "upstream_east_clean" on HES Figure No. P1249-5_D101. The focus will next move to trying to intercept clean water from the area labelled "T9_west_clean" on HES Figure No. P1249-5_D101. If it proves possible to intercept water from the "T9_west_clean" area, after that, any further efforts are considered likely to yield diminishing returns and may not be justifiable given the extent of further works required. This requires further assessment from a geotechnical perspective, and should not be completed unless deemed safe from a slope stability perspective.

Objectives of recommendations

1. Eliminate or limit the release of further polluting matter from the area where the landslide occurred.
2. Eliminate or limit the release of further polluting matter from areas up gradient of the land slide.
3. Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.
4. Mitigate against the further dispersal of peat and sediment, deposited along the banks of the Shruhangarve, by the watercourse through and beyond the confines of the site.

Recommended measures

1. Continue to analyse catchment topography and forestry drainage features to identify other routes of clean water interceptor drains/sumps.
2. Specifically target area west of T9, west of stream (labelled "T9_west_clean" on HES Figure No. P1249-5_D101) for further interception of clean water. Possible interception/pumping arrangement shown in Figure 5.5 below to be developed further and approved by ecologist, hydrologist and geotechnical engineer before implementation.
3. Minimise the need for pumping, using gravity flows wherever possible.
4. Where necessary, identify safe pumping locations at the end of interceptor drain.
5. Ensure all pumps and fuels bowsers are bunded or double-skinned.
6. Pump and/or pipe intercepted clean water to downstream side of Wall 1.
   Discharge all intercepted and piped clean water onto rock armour downstream of Wall 1 to minimise further erosion from channel bed/bank and all diffuse dispersed flow to naturally reconcentrate in existing stream channel.

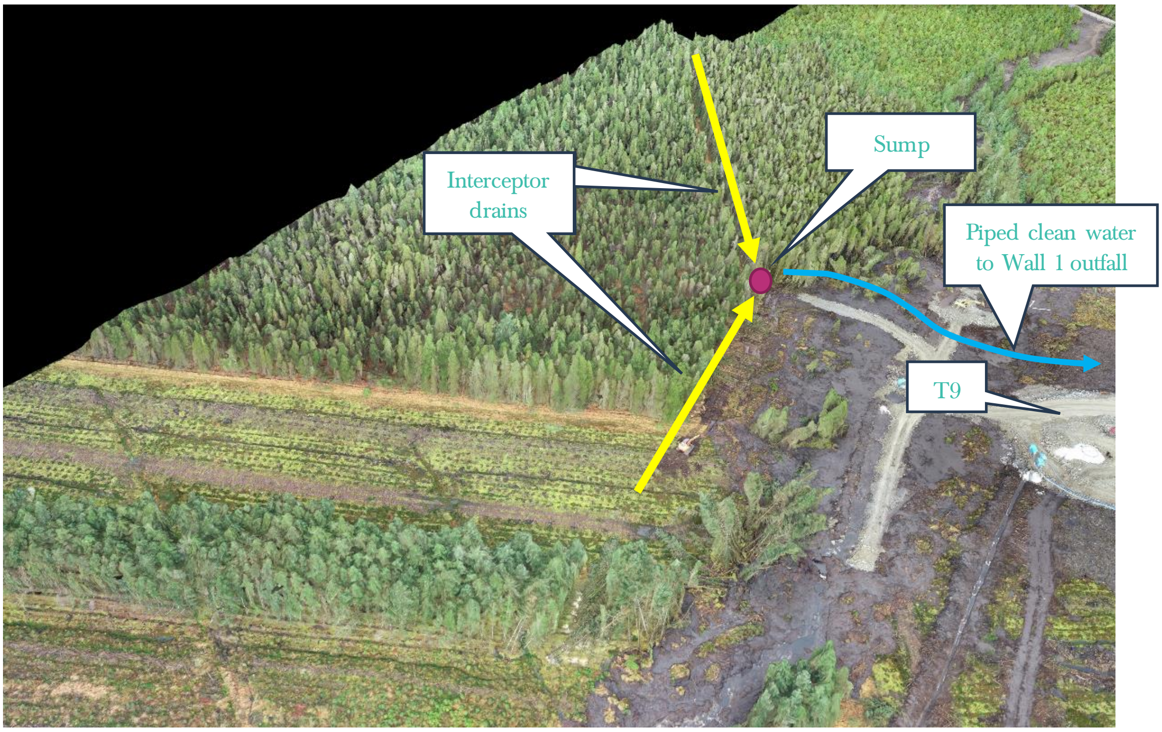


Figure 5.5 Clean water interceptor drains and pumping arrangement for area west of T9 (for illustrative purposes only)

5.2.3 Recommendation 3 – Stabilise downstream deposits of peat on stream banks

Present situation informing recommendations

Large volumes of peat mobilised during the peat slide were deposited along the downstream reaches of the Shruhangarve stream during the peat slide event. The spatial and volumetric measurement of these peat deposits is presently underway and will be reported in future iterations of the Action Plan. The deposits extend to varying widths along the banks Shruhangarve stream for a distance of approximately 2.4 kilometres downstream of Wall 1 as far as the Mourne Beg River. Recent drone flight imagery taken along the Mourne Beg River will be used to assess if any such deposits of peat are present along the banks of that river.

The Shruhangarve stream downstream of Wall 1 continues to flow within the original natural stream channel, but larger flows during and after large rainfall events have caused some secondary mobilisation of the peat that would have been originally deposited on the stream banks. While the majority of the streambank peat deposits appear relatively stable, overland flows from the adjacent bog habitat towards the stream have caused some further mobilisation of the deposited peat in particular locations. It is not considered justifiable to leave the peat deposits in place without mitigation, as to do so would result in further secondary mobilisation of the deposited peat into the adjacent stream.

Figure 5.6 Peat deposited on stream bank downstream of Wall 1, with intact vegetation partially visible and larger deposits of peat further back from stream edge

Objectives of recommendations

1. Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.

2. Mitigate against the further dispersal of peat and sediment, deposited along the banks of the Shruhangarve, by the watercourse through and beyond the confines of the site.

Recommended measures

1. Continue to inspect stream banks to identify nature and depth of peat deposits, access options, ground conditions, etc. to assess safety of work areas, safe work methods, means of handling and delivering materials, etc.
2. Quantify distances, areas and volumes of deposited peat sludge from drone imagery, including larger deposition areas, to prioritise areas for work.
3. Confirm land access rights and arrangements.
4. Using manual labour, access the stream bank on foot where peat deposits are low, and clear a working area of approx. 1.5-metres along the stream bank of all excess peat deposits sitting on the surface. Peat removed from surface of stream bank to be placed further back from stream bank.
5. Install silt fencing along cleared path on stream bank, taking care to follow manufacture's specifications and ensure bottom of fence is property buried into ground surfacer and adequate fencing stakes are installed are regular intervals to support fence and the silt that will build up behind it. Specification for Terrastop silt fencing is included in Appendix 3.
6. Where vegetation remains intact under the cleared path, this will be left to regenerate naturally.
7. If any areas along the cleared path are devoid of natural vegetation, CoirMesh will be laid over the bare ground to prevent soil erosion and siltation of the watercourse. Specification for CoirMesh is included in Appendix 3.
8. No work on the stream bank should take place during or immediately periods of heavy rainfall.
9. Peat clearance, silt fence and CoirMesh installation to be carried out while taking extreme care not to damage stream bank, keep pedestrian traffic along the stream bank to a minimum, and prevent peat deposits entering stream.
10. Maintain localised drainage pathways to prevent build up of open water behind silt fencing.
11. Inspect silt fencing regularly (at least weekly) and undertake repairs and maintenance as required.
12. Provide training on installation techniques to installation crews and have supervising ecologist or environmental in situ for first days of installation to ensure proper installation techniques are being used. Monitoring works regularly thereafter.
13. Divide works areas into sections and assign installation crews to sections.
14. In Spring/Summer 2021, deeper deposits of peat will be pulled back from behind silt fence and spread locally at shallower depths for reseeding with appropriate seed mix to be selected by ecologist. Where access allows, peat deposits to be removed and spread using low-pressure mechanical excavator working in a single pass to minimise tracking across the peatland habitat. Excavator to be left in situ overnight if work cannot be completed in a single day, and use different routes to exit site if required for refuelling.
15. Maintain silt fence in place for as long as necessary until all bare peat had reseeded and demonstrated to have well-establish root system of surface vegetation, capable or binding material together. Silt fence only to be removed with approval of supervising ecologist.


Figure 5.7 Terrastop silt fence properly buried into ground surface acting as effective silt barrier


Figure 5.8 Terrastop silt fence installed on a riverbank preventing silt and soiled water reaching watercourse


Figure 5.9 CoriMesh biodegradable woven coconut fibre used on bare surfaces to prevent erosion and promote revegetation


Figure 5.10 Grass growing up through CoriMesh on previously bare soil surface.

5.2.4 Recommendation 4 – Trial sediment capture in the Shruhangarve stream

Present situation informing recommendations

The water quality situation has stabilised since the completion of the emergency works and suspension of all other works within the Shruhangarve catchment. As other recommendations are implemented to improve the water quality over the longer term, manage and remove residual peat deposited upstream and eventually restore and reinstate the Shruhangarve stream to the greatest extent possible, some silt will become mobilised and will make its way into the stream channel.

The suspended peat material is colloidal in nature and does not easily settle out once suspended in water, particularly in a stream such as the Shruhangarve. Therefore, it is intended to trial the use of Sedimats in the lowest reach of the Shruhangarve in an attempt to capture some of the peat suspended in the stream that would otherwise reach the Mourne Beg River and downstream receptors. Specification details for the Sedimat product is included in Appendix 4.

The effectiveness of the proposed Sedimats cannot be guaranteed, and therefore this recommendation is being made on a trial basis, with the trial to be extended and repeated if proven to be effective.

Figure 5.11 Sedimat installed on stream bed to trap suspended sediment through upper layer of jute mesh and lower layers of wood wool.

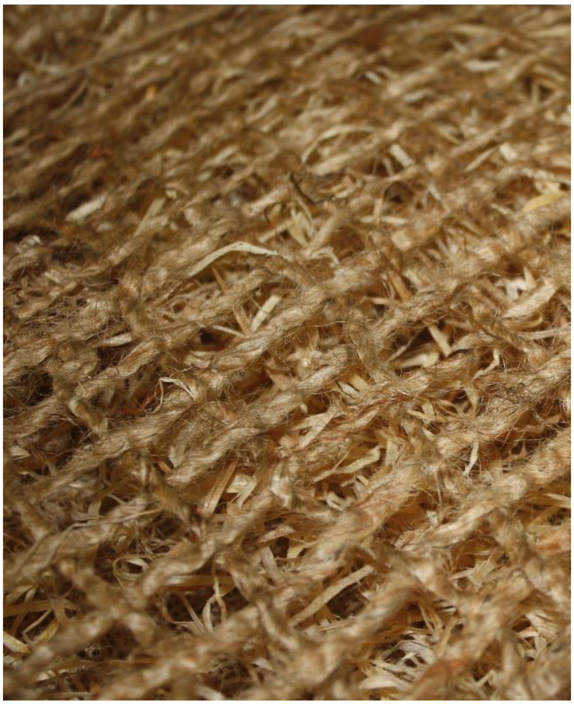


Figure 5.12 Narrow view of Sedimat with layered jute mesh and wood wool

Figure 5.13 "Full" Sedimat after having been removed from stream bed

Objectives of recommendations

1. Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.
2. Mitigate against the further dispersal of peat and sediment, deposited along the banks of the Shruhangarve, by the watercourse through and beyond the confines of the site.

Recommended measures

1. Inspect Stream Reach 5 for low gradient, slower flowing sections suitable for the installation of the Sedimat, with good access, ideally for machine removal.
2. Confirm land access rights and arrangements.
3. Calculate length of Sedimat required in stream channel based on flow measurements as per manufacturer's instructions.
4. Install Sedimat flat on stream bed, taking care to follow manufacturer's instructions. and leave in situ for a number of weeks, inspecting regularly for effectiveness.
5. Repeat as necessary in further locations if proven to be effective.
6. If effective, inspect Sedimats regularly and replace when mats are full of sediment.
7. Take care in the removal of full mats, and place further Sedimats temporarily downstream of removal location to capture any "leakage" of silt from the full Sedimat.

5.2.5 Recommendation 5 – Install water treatment system

Present situation informing recommendations

While the water quality situation on-site and in the downstream catchments has stabilised since the completion of the emergency works and suspension of all other works within the Shruhangarve catchment, a portion (currently 21%) of the rainfall entering the upper reaches of the Shruhangarve catchment is still coming into contact with the peat slippage area, disturbed ground and deposited peat, and there is currently no effective means of treating this soiled water prior to its discharge to the downstream side of Wall 1. This is not recommended beyond the immediate short term and should be rectified as soon as possible.

Over the medium to long term it will also be necessary to carry out works in the catchment to manage and remove residual peat deposited upstream of Wall 1 and eventually restore and reinstate the Shruhangarve stream to the greatest extent possible. These works have the potential to mobilise and release peat sediment into downstream in the absence of mitigation. A water treatment system is recommended as the only realistic means of preventing the uncontrolled release of sediment during future phases of remedial works upstream of Wall 1, but more details are required before a definitive set of recommendations can be made.

Discussion are ongoing with a number of water treatment system providers to provide water treatment proposals, both in the short term and in the longer term, during future remedial works phases. Outlined below is a summary of the outcome of tests completed by Siltbuster, and some information relating to the use of a similar system on the Corrib Gas Pipeline project, where discharge occurred to an SAC receiving waterbody.

Please note, the system outlined below is provided for information purposes only and as an indication of what can be provided, but no commercial arrangement has been initiated to date. The intention here is to provide information regarding what can be achieved and the general setup of such a system. Further detail will be provided once discussions advance with the treatment system providers and a more firm proposal is available, following further engagement with stakeholders and regulatory authorities.

Objectives of recommendations

1. Eliminate or limit the release of further polluting matter from the area where the landslide occurred.
2. Eliminate or limit the release of further polluting matter from areas up gradient of the land slide.
3. Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.
4. Prevent the catastrophic release of material built up behind the existing improvised impoundment structure on site.

Further information

Laboratory Test Results

A 5-litre raw sample water (untreated, unsettled sample from upstream of Wall 1) was sent to Siltbuster[1] on the 20th November 2020 for analysis which is summarised below. The output of the analysis determines the appropriate treatment proposals.

1 Siltbuster Limited, Kingswood Gate, Monmouth, Monmouthshire, UK https://www.siltbuster.co.uk

Initial analysis of the as received sample indicated a TSS of 4,570 mg/L and pH of 5.2 [H+]. The raw sample also contained a large amount of organic matter in the form of roots, twigs and vegetation.

The received sample was allowed to settle for 30 minutes to replicate intended onsite primary attenuation lagoon and pH remained the same, and TSS was reduced by 57% to 1,975 mg/L. The intended primary settlement pond will help remove any heavier large peat particles and other organic detritus.

A series of secondary settlement tests were then completed without the aid of pre-treatment chemicals and these results are shown in Table 5.1 below.

These tests confirmed that the remaining particles in suspension exhibited very slow and/or non-settling characterises within water, and that that the typical target discharge level of <60mg/l could not be achieved using a purely gravity based system due to their particle size and subsequently low settling velocity.

Table 5.1: Gravity Settlement Test results (without chemical treatment)

Time (minutes)	Settling Velocity (m/h)	Total Suspended Solids TSS (mg/L)
3	2	1,948
6	1	1,930
12	0.5	1,947
30	0.2	1,923
60	0.1	1,753
120	0.05	1,750

Improved settling characteristics was then achieved using a three-stage chemical pre-treatment and the results are shown in Table 5.2 below.

- Ferric Chloride,
- Sodium hydroxide
- Anionic polymer

Table 5.2: Settlement Test results (with chemical pre-treatment)

Time (minutes)	Rise Rate (m/hr)	TSS (mg/L)	% Removal TSS	pH
15	0.4	19	99.04	6.87
30	0.2	17	99.63	6.87

<u>Based upon the sample provided; it is was determined that a total suspended solids (TSS) content of <60mg/l can only be viably achieved through the use of pre-treatment water chemicals to enhance the settling velocity of the solids you intend to capture.</u>

Treatment System Proposal

One proposed treatment system being considered is a Siltbuster MT30, chemical dosing system & 4 No. HB50s which has a typical operating range of between 8-120m^3/hr. The system will consist of the following:

- Feed pond, primary settlement lagoon
- Feed pumps (diesel with fuel bowsers)
- Electrical supply (generator and fuel bowser)
- Clean water supply by bowser (2/3 m^3 every couple of days for Polymer make up, and feed supply for the safety showers)
- Bunded chemical storage area (e.g. bunded 20' container)
- Siltbuster MT30 Chemical Pre-Treatment System
  - Inlet magnetic flow meter, to record the volume of water treated
  - pH adjustment system
  - Siltbuster Mix Tank (MT30) to allow the controlled mixing of the treatment chemicals
  - Flow proportional control system for coagulant and flocculant polymer dosing
  - Coagulant dosing pump
  - Flocculant make-up system
  - 1 No IBC spill stand/containment bunds for the temporary storage of chemicals.
  - Siltbuster HB50 Gravity Operated Settlement Units (Recovery of Suspended Solids): 4 No Siltbuster Lamella Clarifier Units to separate the suspended solids from the treated water.
- Safety showers, fed from the clean water supply
- Sludge pond/sump (gravity drainage from HB50hoppers, and sludge is transferred to sludge disposal area (remote peat storage area)
- Monitoring/sampling of treated water
- Discharge pipework

Treatment System Layout and Configuration

A photographic example of the system layout is shown in Figure 5.14 below. The total plan area of the core water treatment system is approximately 50-60 m^2.

- MT30 – 3.5mW x 6.1mL = 21.35m2
- HB50 – 1.7mW x 3.8mL x 4 no. = 25.84m^2

Figure 5.14: MT30 Chemical Pre-Treatment system with 4 No Lamella clarifiers

Treatment System Controls

Power requirements include a minimum 20KVA generator, 3-phase, 415V earth plus neutral, adjustable earth leakage or minimum 300 mA RCD.

There will be a flow proportional control system for coagulant and flocculant polymer dosing. The use of flow proportional dosing system minimises the risk associated with the overdosing of the treatment chemicals, and any potential for carry over into the discharge. The minimum amount of chemical additives are dosed at all times.

A coagulant dosing pump and associated pipe-work will allow the automatic flow proportional addition of the coagulant.

The pumped raw waters will be delivered to the Treatment Plant at a steady continuous rate so as to reduce the total suspended solids content prior to discharge, and to maximise the efficiency of the treatment process.

Use of Siltbuster Systems

Standard settlement or coarse filtration alone will not clean peat water to a standard suitable for discharge to a salmonid river.

The reason we have proposed Siltbuster with chemical treatment is that this type of system is an industry standard in the UK and is one that is recommended by the Environment Agency and planning authorities for all kinds of sites, including sites with sensitive downstream watercourses. It is this sensitivity that is the driver for use of such systems, i.e. the approach is that it is better to treat the water on site to the highest standard available.

There is a perception that chemical treatment is too risky as such chemicals are toxic. The reality is that chemicals (flocculants and coagulants) are used in almost every water treatment plant across the country. Furthermore, dosing rates of chemical to initiate settlement is small, being in the order of 2-10 mg/L. Any perception of vast quantities of chemicals being used is incorrect, as dosing rates are small, and all dosing is completed on a flow proportioned basis.

Consultant hydrologist Michael Gill has direct experience of using Siltbsuter systems on the Corrib Onshore Pipeline construction works in Co. Mayo, and based on observation and operation of the system over some 5000 hours in 2012 and 2013 two things are known:

1. Lamella plate clarifier system such as Siltbusters work very well in peatland environments when used in combination with 3-stage chemical treatment
2. Monitoring data indicate no carry-over of treatment chemicals in the post treatment discharge.

An example of treatment capability of Siltbuster systems from Corrib is provided in Figure 5.15. This is a duration curve of downstream water quality data post Siltbuster treatment. The system was setup so that any water not meeting discharge criteria was recycled back to the settlement ponds. The graph shows all data, and only 24 treated water (discharge water) data points out of 1194 records were above 20 mg/L (i.e. recycling occurred at these times).

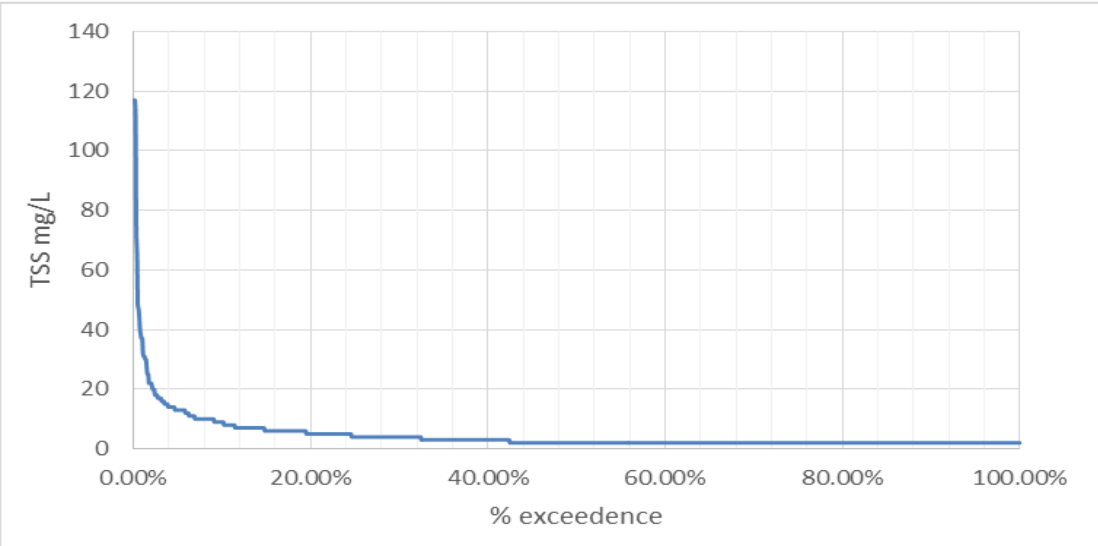


Figure 5.15. TSS treatment data using Siltbuster systems (with 3 stage chemical dosing).

5.2.6 Recommendation 6 – Remove deposited peat from impoundment area upstream of Wall 1

Present situation informing recommendations

Large volumes of silt have been successfully impounded behind Wall 1 and prevented from entering downstream watercourses. The volumetric measurement of these silt volumes is presently underway and will be reported in future iterations of the Action Plan. Water flows have been largely intercepted upstream of the impounded silt and diverted away from the silt impounded behind Wall 1, thereby minimising the re-mobilisation of the impounded silt.

The long-term recommendation is to restore the natural water flows in the Shruhangarve stream and reinstate the stream to the greatest extent possible. To do so will require the silt and sediment that has accumulated behind Wall 1 to be removed and the area stabilised before normal flows can be restored in the channel and through a culvert under Wall 1 which was originally intended as a access road to Turbine 9.

Objectives of recommendations

1. Eliminate or limit the release of further polluting matter from the area where the landslide occurred.
2. Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.
3. Prevent the catastrophic release of material built up behind the existing improvised impoundment structure on site.

Recommended measures

1. Complete volumetric calculations of silt and sediment volumes impounded upstream of Wall 1.
2. In Spring/Summer 2021, after having allowed time for water levels behind Wall 1 to decrease and the material to partially dry out, begin to recover as much deposited peat as possible from the upstream side of Wall 1, using long reach excavators working from the top of Wall 1.
3. With further engineering input, investigate feasibility of creating cells behind Wall 1 as water levels lowers and material dries out to assist recovering further volumes.
4. Transport recovered peat sludge to on-site treatment/management area. Consider treatment/management options further over coming period, including:
    - Using existing on-site peat storage areas, with enhanced Siltbuster-type water treatment at outfall.
    - Lined settlement lagoon with centrifuge, sludge treatment and water treatment.
    - Tanker peat sludge off-site to licensed facility.
5. Selected treatment/management option to determine other actions.
6. After all recoverable peat has been removed from the area upstream of Wall 1, the remaining peat deposits and unvegetated surface will be stabilised using soil erosion prevention materials, such as CoirMesh prior to reseeding, as shown in Figures 5.16 and 5.17 below.
7. More detailed recommendations for the removal of the peat and stabilisation of the unvegetated surfaces that remain will be developed in future iterations of the Action Plan.

Plate 5.16 Large-scale use of CoriMesh to stabilise exposed ground, as likely required upstream of Wall 1 once large peat deposits are removed

Plate 5.17 Large-scale use of CoriMesh to establish vegetated surfaces on drainage channel embankments

5.2.7 Recommendation 7 – Stabilise upstream deposits of peat on stream bank

Present situation informing recommendations

Large volumes of peat were deposited on the banks of the Shruhangarve stream during the peat slide. Upstream from Wall 1 and T9 along stream reaches 1 and 2, these deposits will need to be stabilised and every effort made to prevent them being gradually washed into the stream channel before normal water flows can be restored in the Shruhangarve stream.

Peat sludge is deposited along the 850m stretch of the Shruhangarve upstream of Wall 1, up to distances of 35 metres from the stream channel. While water and silt are being impounded upstream of Wall 1, the priority will be on stabilising the material in stream reach 1, but stream reach 2 will also require similar remedial works before normal water flows can be restored in the Shruhangarve stream.

Access to certain areas in these stream reaches will be by forestry and ground conditions limited, and while it might be possible to get machinery into locations, it is impractical to expect to be able to remove the deposited peat material without causing further damage to the peatland habitats or constructing further access roads, which are both considered unwarranted.

Objectives of recommendations

1. Eliminate or limit the release of further polluting matter from the area where the landslide occurred.
2. Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.
3. Mitigate against the further dispersal of peat and sediment, deposited along the banks of the Shruhangarve, by the watercourse through and beyond the confines of the site.

Recommended measures

1. Inspect stream banks to identify nature and depth of deposited peat, access options, ground conditions, etc to assess safety of work areas, safe work methods, means of handling and delivering materials, etc.
2. Quantify distances, areas and volumes of deposited peat from drone imagery, including larger deposition areas, to prioritise areas for work.
3. Utilise stabilisation methods and materials proven to be effective on the section of the Shruhangarve downstream of Wall 1.
4. Installation techniques and timing may have to be adjusted based on water flows in stream linked to rainfall.
5. Where machine access is possible and practical, use low-pressure excavators to remove excessive depths of deposited peat and spread out on surrounding ground to prevent future slumping of peat deposits. Then stabilise spread material.
6. Divide works areas into sections and assign installation crews to sections.
7. After the depth of all reachable areas of deposited peat have reduced, the remaining peat deposits and unvegetated surface will be stabilised using soil erosion prevention materials, such as CoirMesh prior to reseeding, as shown in Figures 5.16 and 5.17 above.
8. Seed the peat sludge deposits in Spring/Summer 2020 with appropriate seed mix (to be selected).
9. More detailed recommendations for the removal of the peat and stabilisation of the unvegetated surfaces that remain will be developed in future iterations of the Action Plan when access options to the areas in question have been further investigated.

5.2.8 Recommendation 8 – Stream restoration

Present situation informing recommendations

Approximately 850 metres of the Shruhangarve Stream upstream of Wall 1 have been impacted by the peat slide (Stream Reaches 1 and 2). Mass movement and deposition of peat in this area has substantially damaged the original stream channel resulting in a loss of instream habitat in this area.

It is proposed to use natural channel design techniques to re-establish a functional stream channel in these reaches. The restoration design process will focus on the development of a stream design that is appropriate in terms of channel cross-sectional dimension, plan, and profile, and that will therefore be stable in the long term. In addition, the design will incorporate design elements to provide appropriate in-stream aquatic habitat. Stream banks and the riparian zone will be revegetated with native species with a view to enhancing bank stability in the new channel and reducing potential soil erosion in the riparian area.

Objectives of recommendations

1. Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.
2. Mitigate against the further dispersal of peat and sediment, deposited along the banks of the Shruhangarve, by the watercourse through and beyond the confines of the site.

Recommended measures

1. Conduct geomorphological survey of Shruhangarve Stream both upstream of the slip area and downstream of Wall 1. Survey to include detailed cross sections, long profile, pebble counts, and analysis of radius of curvature in stream meanders.
2. Conduct desktop analysis of the impacted portion of Sruhangarve Stream (Reaches 1 and 2) along with field survey of impacted reaches to attempt to classify the likely character of the lost stream reaches.
3. Identify and conduct geomorphological survey of suitable reference reach stream channel.
4. Use reference reach data, survey of unimpacted and/or moderately impacted stream reaches, to develop dimensionless ratios to inform the conceptual design of new channel for Reaches 1 and 2.
5. Design will include in-stream structures and a detailed planting plan utilising appropriate native species.
6. Before stream design can be finalised or implemented, a geotechnical solution to stabilising the peat slide path will be required.
7. The impoundment area behind Wall 1 will need to be dewatered and accumulated peat sludge removed before design can be finalised.
8. Once the proposed restoration design has been finalised and approved work should commence at the upstream end and work down.
9. All work will be conducted in the dry, therefore pump arounds will be necessary.
10. More detailed recommendations for the restoration of the stream will be developed in future iterations of the Action Plan.

5.2.9 Further Recommendations

The recommendations outlined above are not by no means exhaustive or limited.

Further recommendations are currently and will continue to be developed to deal with the various reaches of the affected Shruhangarve stream. These will be detailed in future iterations of the Action Plan to further address the situation on-site and in the downstream watercourses as a result of ongoing water monitoring efforts, ecological surveys, seasonal factors, the trialling of certain recommendations on site and the contributions from other stakeholders and regulatory authorities whose input will be very much welcomed and carefully considered.

5.3 Water Quality Monitoring

5.3.1 Introduction

The following surface water quality monitoring programme of the Shruhangarve, Mourne Beg and Derg rivers has been implemented to monitor water quality downstream of the Meenbog Wind Farm. This monitoring programme is being undertaken in addition to the monitoring proposal for the construction phase of the Meenbog Wind Farm as set out in Section 5.2 of the Construction and Environmental Management Plan (CEMP). This supplementary monitoring programme combines the use of laboratory analysis, water quality monitoring instrumentation and visual inspection to develop a comprehensive schedule of monitoring of all watercourses that exist both at the site and the surrounding area.

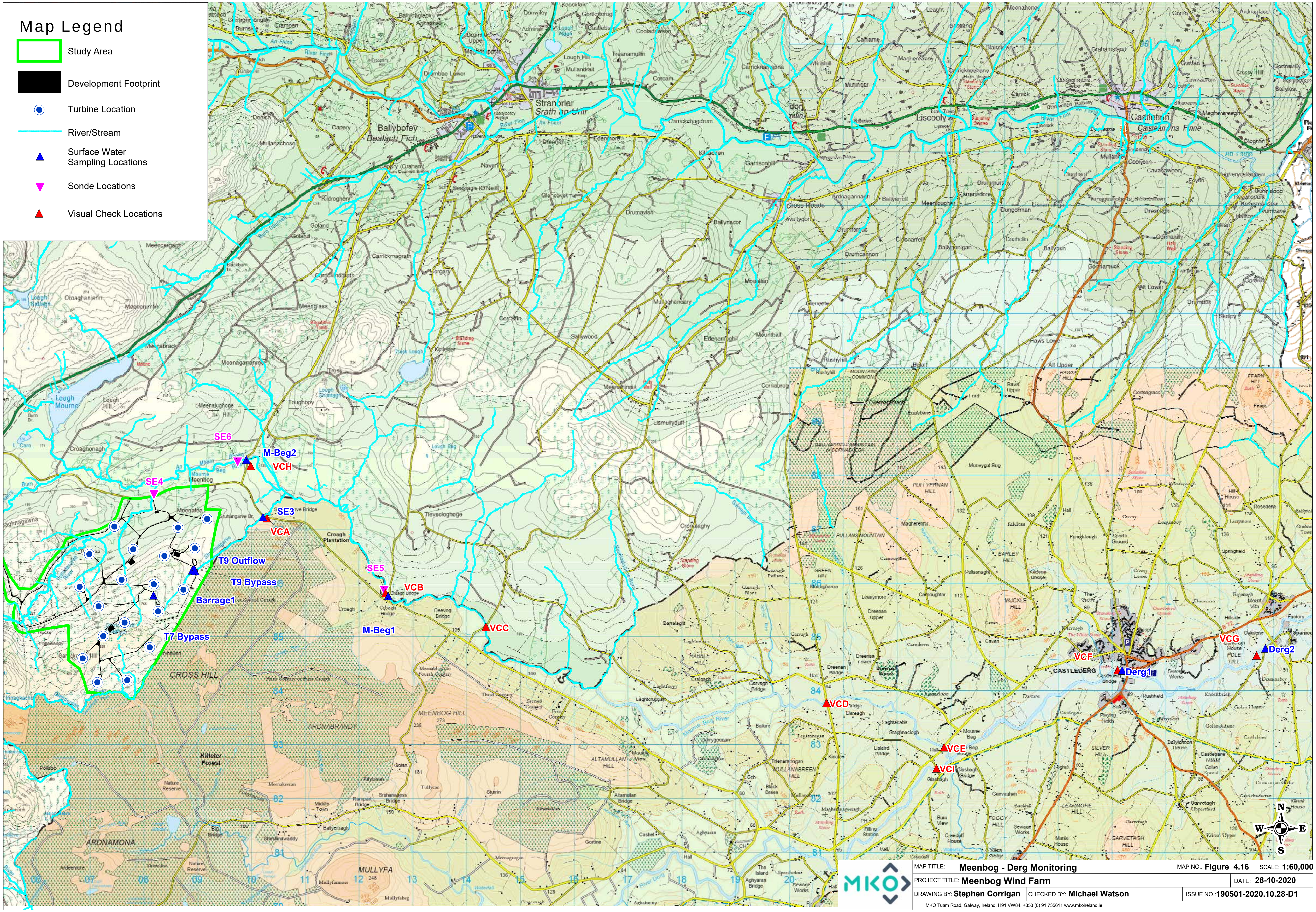
This water monitoring programme is the subject of independent review by the supervising hydrologist who will provide the necessary guidance on the monitoring requirements. The water monitoring programme is outlined in the following sections.

5.3.2 Drainage Inspection and Monitoring

In addition to the daily visual inspections carried out at the wind farm site (CEMP Section 5.2), daily visual inspections of watercourses are being undertaken at various locations adjacent to Turbine no. 7 and 9 and along the Shruhangarve, Mourne Beg and Derg rivers. The details of the visual check locations are set out in Table 5.3 and mapped in Figure 5.18.

Table 5.3 Visual Inspection Locations

ID	Easting (IG)	Northing (IG)	Analysis	Frequency	Task
VC-A	210286	387213	Visual Inspection to determine water quality	Daily	The visual inspection carried out at each Visual Check (VC) location is undertaken to determine the quality of water within a watercourse in terms of its visual appearance and checking for the presence of suspended sediment or a turbid complexion in the water. As outlined on the Daily Visual Inspection sheets, a scoring system has been devised to rate water quality at each VC in terms of: 1. Water clear – no issues 2. Water turbid with a visible peaty tinge (naturally occurring in waters drained from peatlands and not related to the wind farm works) 3. Water silty as a result of works NOT associated with the wind farm works 4. Water silty as a result of works associated with the wind farm works.
VC-B	212491	385822		Daily	
VC-C	214359	385195		Daily	
VC-D	220693	383782		Daily	
VC-E	222878	382954		Daily	
VC-F	226104	384388		Daily	
VC-G	228689	384662		Daily	
VC-H	209984	388188		Daily	
VC-I	222735	382563		Daily	



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The visual inspection sheets and photographic records are being kept in the environmental file on site. Inspection points also include the additional laboratory analysis sampling points and the sonde locations as outlined in Figure 5.18.

5.3.3 Monitoring Parameters

The analytical determinants of the monitoring programme (including limits of detection and frequency of analysis) will be as per S.I. No. 272 of 2009 European Communities Environmental Objectives (Surface Waters) Regulations, S.I. No. 722 of 2003 European Communities (Water Policy) Regulations and European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009. The suites of parameters will include:

Suite 1

- Total Suspended Solids (mg/l)
- Ammoniacal Nitrogen as NH3 (mg/l)
- Ammoniacal Nitrogen as NH4 (mg/l)
- Nitrite (NO2) (mg/l)
- Ortho-Phosphate (P) (mg/l)
- Nitrate (NO3) (mg/l)
- Phosphorus (unfiltered) (mg/l)
- Chloride (mg/l)
- Biochemical Oxygen Demand (BOD) (mg/l)
- pH
- Electrical Conductivity
- Temperature
- Dissolved Oxygen

Suite 2

- Turbidity (NTU) (hand held turbidity meter)

Suite 3

- Turbidity (NTU) (sonde measured)

Suite 4

- Arsenic Dissolved filtered
- Cadmium Dissolved filtered
- Calcium Dissolved filtered
- Chromium Dissolved filtered
- Copper Dissolved filtered
- Lead Dissolved filtered
- Iron Dissolved filtered
- Magnesium Dissolved filtered
- Mercury Dissolved filtered
- Nickel Dissolved filtered
- Potassium Dissolved filtered
- Sodium Dissolved filtered
- Zinc Dissolved filtered
- Phosphorus Dissolved filtered
- Total Petroleum Hydrocarbons CWG (Speciated)
- Gasoline Range Organics (Aliphatic/Aromatic Split)
- VOCs
- Total Phenols

- BTEX
- Chlorophenols
- Sulphate
- Chloride
- Nitrate
- Nitrite
- Molybdate Reactive Phosphorus (MRP unfltered)
- Ortho Phosphate
- Ammonia Low Level
- Ammoniacial Nitrogen
- Total Alkalinity
- BOD
- COD
- Conductivity
- pH
- TOC
- Suspended Solids
- Hardness

5.3.4 Laboratory Analysis Sampling

Laboratory analysis of a range of parameters with relevant regulatory limits and Environmental Quality Standards (EQSs) is being undertaken on a daily basis. The sample locations are located at bypass drains and outflows at Turbines no's 7 and 9 and Wall 1 all within the wind farm site as well as locations along the Shruhangarve, Mourne Beg and Derg rivers. The details of the surface water sampling locations are as outlined in Table 5.4 and mapped in Figure 5.18. All samples will be sent for analysis to an independent laboratory.

In addition, turbidity readings using a hand held turbidity meter are being taken at all surface water monitoring points which are the subject of the independent laboratory analysis as outlined in Figure 5.18. These daily turbidity readings will provide site management with current readings on water quality for these watercourses in advance of the results for each locations being received from the testing laboratory, which has a minimum five day turnaround for results.

Table 5.4 Sample Locations for Laboratory Analysis

ID	Easting (IG)	Northing (IG)	Testing Parameters	Frequency	Task
Sample locations on the wind farm site from discharges from behind the Barrage to the Shruhangarve and water that is pumped to the Bunadaowen river					
T7 Bypass	208213	385750	Suite 1 Suite 2	Daily	Sampling to be undertaken on a daily basis for laboratory analysis to provide trends on water quality for the parameters being tested. Each sample location is photograph as record of the appearance of the watercourse during the sampling
Barrage (Wall) 1	208940	386246		Daily	
T9 Bypass	208946	386238		Daily	
T9 Outflow	208722	385883		Daily	
Sample location on the Shruhangarve river upstream of the confluence with the Mourne Beg river					
SE3	210212	387234	Suite 1 Suite 2	Daily	Sampling to be undertaken on a daily basis for laboratory analysis to provide trends on water quality for the parameters being tested. Each sample location is photograph as record of the appearance of the watercourse during the sampling
Sample location on the Mourne Beg river upstream of the confluence with the Shruhangarve					
M-Beg 2	209903	388303	Suite 1 Suite 2	Daily	Sampling to be undertaken on a daily basis for laboratory analysis to provide trends on water quality for the parameters being tested. Each sample location is photograph as record of the appearance of the watercourse during the sampling
Sample location on the Mourne Beg river downstream of the confluence with the Shruhangarve					
M-Beg 1	212542	385764	Suite 1 Suite 2	Daily	Sampling to be undertaken on a daily basis for laboratory analysis to provide trends on water quality for the parameters being tested. Each sample location is photograph as record of the appearance of the watercourse during the sampling
Sample locations on the Derg River downstream of the confluence with the Mourne Beg river					
Derg 1	226189	384383	Suite 1 Suite 2	Daily	Sampling to be undertaken on a daily basis for laboratory analysis to provide trends on water quality for the parameters being tested. Each sample location is photograph as record of the appearance of the watercourse during the sampling
Derg 2	228852	384793		Daily	

5.3.5 Continuous Turbidity Monitoring

Turbidity monitors or sondes are installed at locations surrounding the wind farm site as outlined in Figure 5.18. The sondes provide continuous readings for turbidity levels at two new locations both upstream and downstream of the Mourne Beg river. This equipment will be supplemented by daily visual inspections at their locations as outlined in Table 5.5 and mapped in Figure 5.18.

Table 5.5 Continuous Turbidity Monitoring (Sonde) Locations

ID	Easting (IG)	Northing (IG)	Testing Parameters	Frequency	Summary
SE1	202046	384649	Suite 3	Continuous	Sonde has been recording turbidity continuously since September 2019 in the Lowreymore river south of the Barnesmore Gap
SE3	210212	387234		Continuous	Sonde had been recording turbidity in the Shruhangarve since September 2019 until it was taken away by material from the peat slippage. Now that water quality has returned to a level that it is possible to accurately measure turbidity using a sonde, a replacement sonde will be installed to re-commence continuous turbidity monitoring at this location week commencing 07/12/20.
SE4	208185	387675		Continuous	Sonde has been recording turbidity continuously since September 2019 in the Bunadaowen river north of the Meenbog WF site
SE5	212530	385761		Continuous	Sonde has been recording turbidity continuously since 19/11/20 in the Mourne Beg river downstream of the confluence with the Shruhangarve to provide water quality data downstream from the Shruhangarve
SE6	209915	388320		Continuous	Sonde has been recording turbidity continuously since 26/11/20 in the Mourne Beg river upstream of the confluence with the Shruhangarve to provide water quality data upstream from the Shruhangarve.

5.3.6 Aquatic Ecology Baseline Monitoring

It is proposed to undertake surface water sampling to establish baseline conditions as part of an aquatic ecology assessment of the Shrunhangarve stream and Mourne Beg rivers. Two rounds of sampling, in spring and summer at 10 no. sample locations will be carried out. The approximate locations of these sample points has to be determined in consultation with the project ecologists. Surface water samples will be sent to an independent testing laboratory for analysis for the parameters listed under Suite 4 below.

5.3.7 Surface Water Monitoring Reporting

Visual inspection, turbidity monitoring data and laboratory analysis results of water quality monitoring will be used to further inform future recommendations that are made or revised in subsequent iterations of this Action Plan.

All water monitoring reports will be available to Donegal County Council on request at any time.

5.4 Ecological Surveys

5.4.1 Introduction

A comprehensive schedule and scope of aquatic ecology surveys is planned, coordinated by MKO ecologists with the assistance of SLR. Using SLR's experience of similar schemes and aquatic studies within Ireland, a 'best practise approach' for the selection of the monitoring techniques has been compiled.

The scope and purpose of the aquatic surveys planned are to:

1. Establish baseline conditions in the river.
2. Assess the damage caused as a result of the peat slide.
3. Consider measures that could be employed to ameliorate any impacts.
4. Monitor conditions within the river in the long term.

MKO ecologists will also be completing a detailed assessment of the potential impacts that the peat slide may have had on bird species, known from the Meenbog wind farm site and surrounding area. This assessment will include a study of all known ornithological data including the location of roosts, nest sites and foraging areas for sensitive species. An assessment will be made as to whether the peat slide has had the potential to impact or have impacted on ornithological receptors and will, if required, include additional monitoring.

MKO ecologists will be completing detailed botanical surveys of the peatlands within the Meenbog wind farm site and along the banks of the Shruhangarve, to assess the impact of the peat slide on them, to evaluate their condition and to advise on any measures that may be employed to enhance their conservation.

To establish baseline conditions in the river, the following aquatic surveys outlined below are proposed.

5.4.2 River Invertebrates (Q values and RICT)

Macro-invertebrate samples will be collected from 10 sampling locations by kick sampling to calculate Q-ratings/RICT (NOTE: the catchment is cross border and two river invertebrate status calculations are required for Water Framework Directive (WFD) in order to comply with EPA/NIEA guidance. Sampling will follow 'Guidelines for the selection of sampling methods and devices for benthic macroinvertebrates in fresh waters' (ISO 10870:2012).

Samples collected and associated data will provide a WFD classification according to Toner et al., 2005 for Ireland and standard UK River Prediction and Classification System (RIVPACS) and river assessment method benthic invertebrate fauna invertebrates (General Degradation): Whalley, Hawkes, Paisley & Trigg (WHPT) metric in River Invertebrate Classification Tool (RICT).

5.4.3 Specialist river electrofishing

Fish monitoring will be guided by CEN - EN 14962 Water quality - Guidance on the scope and selection of fish sampling methods. Sampling methods within rivers have been categorised and in order to evaluate the fish population parameters such as species composition, abundance and age structure. These include, site specific backpack electrofishing at the 10 sites to be identified for water quality and invertebrate sampling.

5.4.4 River Habitat Survey (RHS) and Fish Habitat Survey

Approximately 20 km of downstream river channel to be surveyed, which would include the 10-water quality/river invertebrate sites. The fisheries habitat is assessed using the Life Cycle Unit Method (LCUM) developed in Northern Ireland by Kennedy[2] which is currently used by the Loughs Agency and the optimal survey period for field study is during low river flow which enables visual habitat observation[3]. River Habitat Survey (RHS) follows standard methodology developed within the UK[4].

Any potential areas of lamprey habitat (potential breeding and juvenile habitat i.e. sediment banks will also be identified during this survey. Standard lamprey habitat assessment would follow guidance by the European Commission's LIFE Nature programme (Maitland, 2003) and the Scottish Fisheries Coordination Centre (Marine Scotland, 2007).

5.4.5 Aquatic Vegetation

Aquatic vegetation would be recorded on a 'presence absence' basis at each of the 10 sites identified for water quality and invertebrate sampling (four riverine sites and six sampling stations within the estuary). Monitoring would be guided by Common Standards Monitoring Guidance for Rivers (JNCC 2016). This survey would also record the aquatic vegetation (emergent and floating vegetation) and would be carried out in conjunction with macro-invertebrate and fish surveys.

5.4.6 Hydromorphology Assessment

The hydromorphology assessment would be guided by the River Hydromorphology Assessment Technique (RHAT) Training Manual (NIEA 2014). It would be conducted over the 10 sites identified for water quality and invertebrate sampling (four riverine sites and six sampling stations within the estuary) and would be carried out in conjunction with macro-invertebrate and fish surveys.

5.4.7 Future phases

Future phases of surveys and assessment will be detailed and developed further as the results of the baseline surveys become available and will be included in future iterations of the Action Plan.

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2 Kennedy GJA (1984). Evaluation of Techniques for Classifying Habitats for Juvenile Salmon (Salmo salar L.). Proceedings of the Atlantic Salmon Trust Workshop on Stock Enhancement
3 Department of Agriculture Northern Ireland (2005). The Evaluation of Habitat for Salmon and Trout. Advisory Leaflet No. 1. Fisheries Division, Stormont, Belfast.
4 Environment Agency (2003). River Habitat Survey in Britain and Ireland – Field Survey Guidance Manual: 2003 version, Environment Agency, Scottish Environmental Protection Agency (SEPA) & Environment & Heritage Service (NI).

APPENDIX 1

IONIC CONSULTING LTD. EMERGENCY WORKS DESCRIPTION

Title:	**Meenbog Windfarm Emergency Works**
Reference:	MNBG r049 Rev C
Author:	Claire Looney
Date:	4th December 2020

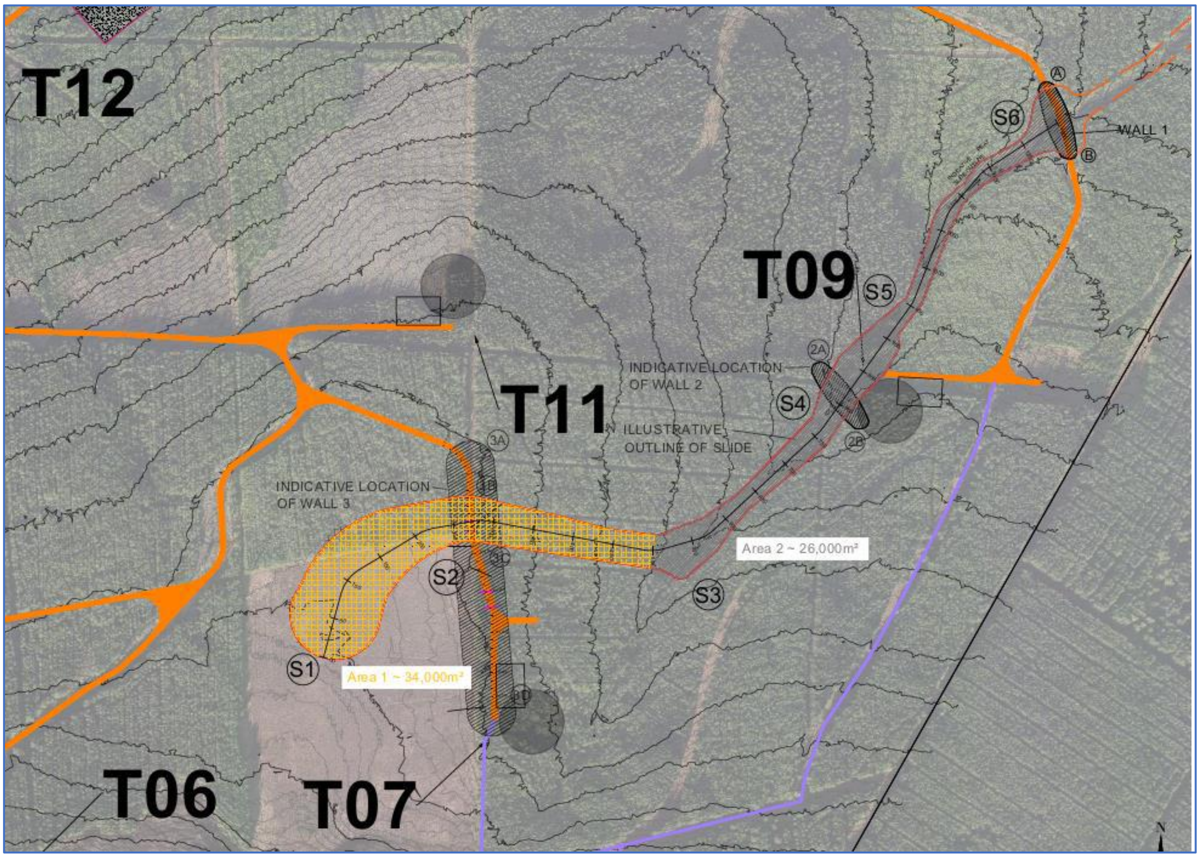


Figure 1 – Overview map of works area

As set out in the notice and in line with section 6.1.5 of the project Construction and Environmental Management Plan ("CEMP"), we can confirm that following the peat slide on 12th Nov 2020, all construction works were ceased on the wind farm site as soon as notice of the incident was provided to site management. The only activities undertaken were those works required to ensure construction areas were left in a safe condition. Once all personnel on site had been safely accounted for, available resources were then immediately re-directed towards mitigating against further discharges to watercourses. The response to the peat slide can be split into stages which are set out below.

Step 1 - Immediate actions:

The first stage was the immediate response within the first 24-72hours which consisted of emergency measures to prevent further material from entering local watercourses. Ionic Consulting who are the Designer and Geotechnical Engineers for the works were consulted. It was possible to undertake a drone survey relatively quickly following the incident as a drone was available on site. Based on the available information the slide path could be determined and an assessment of safe access points was undertaken.

It was evident that majority of the material that slid was deposited between points S3 and S6 shown on Figure 1 above, largely because of the shallower gradient and also by the existing roadway leading to turbine no. 9 (T9). This unstable, water-laden material presented the most immediate risk in terms of pollution of watercourses with the concern that the roadway could be overtopped by material being retained to the South. This risk was exacerbated by the fact that the slide material had entered the local stream (at approximately point 'S3' in Figure 1) and water from the surrounding catchment entering the stream would be retained behind the roadway (identified as 'Wall 1' in Figure 1). A secondary risk in terms of immediate further pollution of watercourses was the risk of additional movement of material from the area upslope of the slide initiation point (to the South and west of point 'S1' in Figure 1.

To mitigate against the risks above, the immediate aim was to introduce check barrages to prevent the slide from reaching any watercourses in line with the CEMP. Immediate action was taken to reinforce and increase the height of the accessible roadway leading to T9. The reason works commenced at this point was two-fold:

1) This road was already acting as a check barrage, retaining some of the slide material to the South however it was at the point of being overtopped by the slide material.
2) Following remote consultation with geotechnical consultant Ionic Consulting and with the information from the initial drone survey of the area it was evident that this was the only location where it would be safe to gain immediate access to initiate the CEMP measures.

Works commenced at the roadway to T9 (referred to as Wall 1 in Figure 1 above) on the afternoon of the 12th November 2020 as soon as an inspection had been conducted to ensure it was safe for personnel to work in the area. It was not possible to produce a detailed design in this timeframe given the need for immediate action however the proposed works were reviewed and progressed in consultation with the Designer Ionic Consulting. The initial aim was to raise the berm by 1.5m-2m for a length of approximately 100m along the area retaining the slide, this was further raised over the following days by up to 3.8m from the original design level.

The primary aim of Wall 1 was to limit or prevent the flow of liquefied peat into watercourses beyond the site. The existing pipe was largely blocked due to the deposited peat, and though water continued to flow through and around the wall, including seepage through the existing pipe, the majority of the peat slurry and solid clumps of peat were retained.

Step 2 -Assessment:

Before progressing works at any other points on site, more detailed geotechnical assessment was required in order to:

a) Establish safe areas for access on site and to identify unsafe or potentially unstable areas on site
b) Assess what additional emergency measures were necessary to prevent further movement of peat or material

Close monitoring of the slide area by drone continued on a daily basis. Upcoming weather forecasts were reviewed to consider additional rainfall events and potential impact on stability of the area. Ionic Consulting have a site engineer with daily presence on site, and engineers visited the site on 13th Nov 2020 and on six further occasions in the first 2 weeks for the purpose of this assessment.

In addition to the geotechnical assessment it is noted that MKO the environmental and ecological consultant appointed for the project attended site to assess both the Shruhangarave Stream and Mourne Beg River from the 13th Nov 2020 and a new monitoring programme was developed, with support from HES, for these two watercourses including laboratory analysis and visual checks implemented daily.

Step 3 Additional Emergency Measures:

Following further assessment a detailed design for 'Wall 1' was developed by Ionic Consulting. This consisted of a large stone berm raised from original road level of 217.2mOD to 221.0mOD to provide additional containment for deposited peat. A design risk assessment and detailed design are appended for reference. Please refer to drawing MNBG d021.9.1 - Wall 1 Berm (T9 Spur)_RevB and MNBG hs004.5 Design Risk Assessment - T7 Peat Slide Stabilisation RevC. Following initial emergency works carried out on 12th November works continued to implement the final detailed design and were completed by 21st Nov 2020.

The detailed geotechnical assessment undertaken in step 2 identified the risk of further peat movement upslope of the slide initiation point in the peatland area (refer to point S1 in Figure 1) was still significant. Two other points for further check barrages were identified, denoted as 'Wall 2' and 'Wall 3' in Figure 1 to mitigate against this potential risk. Access for construction of Wall 2 would be from the hardstanding at T9 and access for Wall 3 would be from the last section of road constructed to solid formation on the approach to the turbine 7 (T7) location. Wall 3 was prioritised for the following reasons:

a) Wall 3 was located immediately downslope of an area of unstable peat where significant volumes of water or liquefied peat was released, and given the visual signs of further propagating cracks from aerial drone footage it was considered a priority to stabilise this upslope material.
b) Wall 3 is an 'on-land' check barrage as opposed to Wall 2 which is located 'in-stream' which was considered to present a lesser risk to pollution of watercourses
c) The construction of Wall 2 could not safely commence until Wall 1 was complete whereas access was immediately available to Wall 3 prior to the completion of works at Wall 1.

As there was a short section of floating road approaching T7 remaining following the peat slide, the Designer and geotechnical consultant Ionic Consulting Ltd advised that this check barrage be installed upslope of the existing roadway. Again, a detailed design was developed prior to the commencement of the works. Consideration was given to drainage through the check barrage for geotechnical purposes. A design risk assessment and detailed design are also appended for these works for reference. Please refer to drawing MNBG d021.7.4 T7 Slide Berm Details_Rev B and MNBG hs004.5 Design Risk Assessment - T7 Peat Slide Stabilisation RevC.

Works commenced as soon as a geotechnical assessment could be completed and an appropriate civil works design could be developed. Construction of this berm referred to as 'Wall 3' commenced on 17th Nov 2020.

MKO continued to fulfil the Environmental Clerk of Works (ECoW) role during the emergency works and expanded the water quality monitoring programme that was already underway.

As soon as Wall 1 was completed and safe access and egress could be maintained to T9 via the access road, and also the section of Wall 3 past the slide affected area was constructed, construction of Wall 2 was considered. Due to increased rainfall it was observed that an excessive amount of water was flowing towards Wall 1. A decision was taken at this time to prioritise drainage of the area and strategic pumping of clean water away from the area affected by the slide. Clean water was intercepted and diverted from upstream of the slide area and discharged to the North of Wall 1. Soiled water was also removed via pumping from the area adjacent to T9. These works commenced on 25th November.

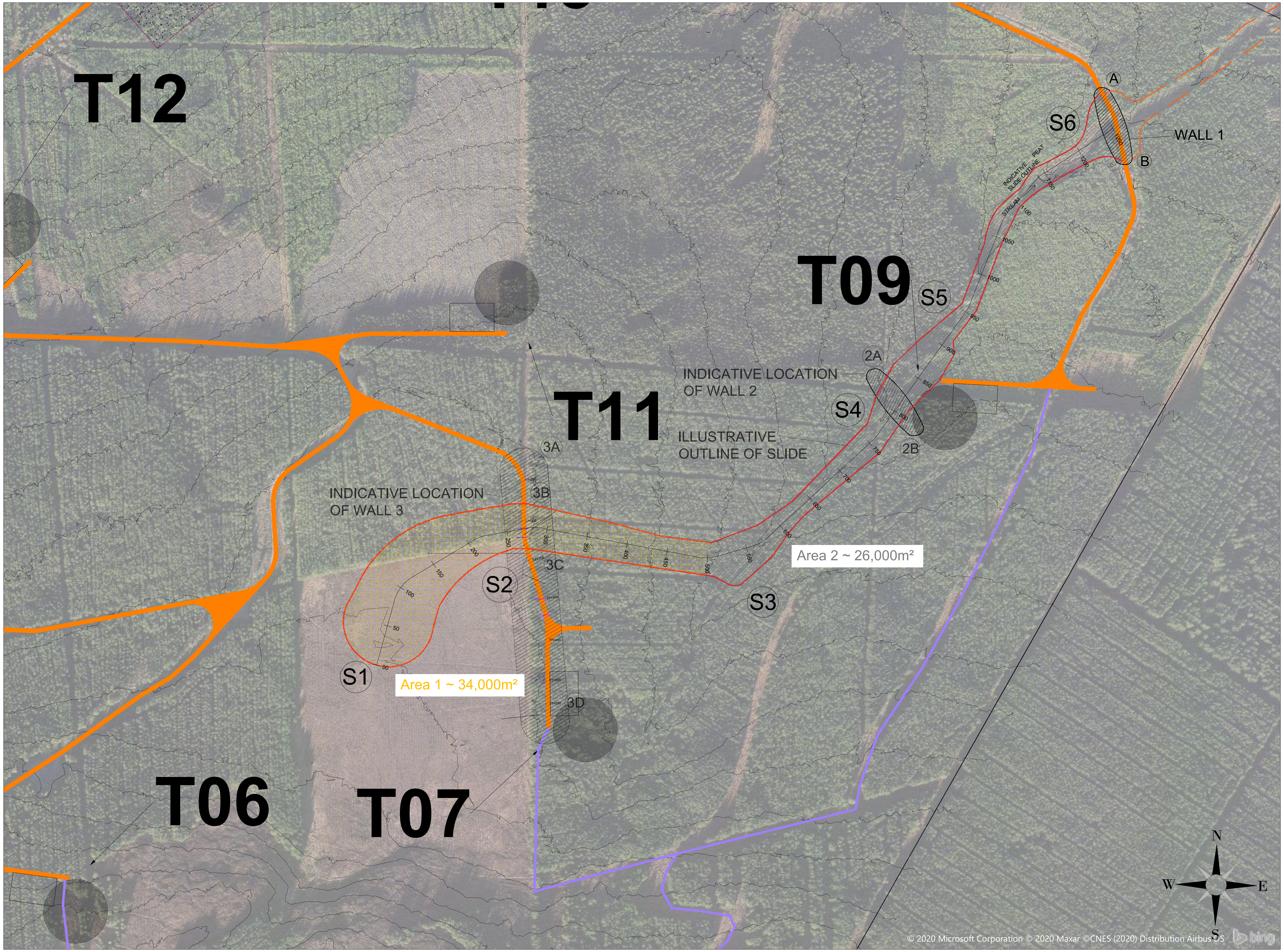
Current situation:

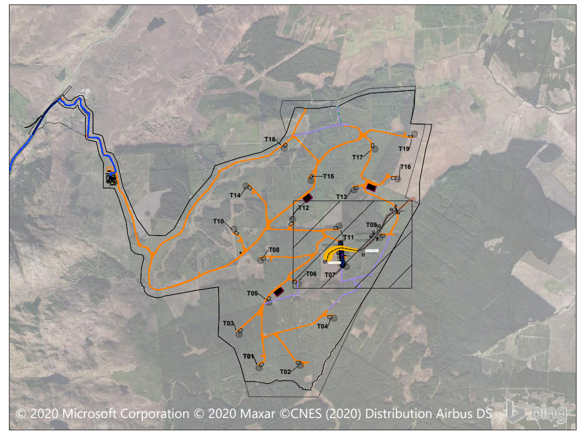
As of today, Wall 1 has been constructed and Wall 3 is nearing completion, and these works are deemed to have largely stabilised the area. A drainage and pumping arrangement has been implemented which combined has substantially reduced the level of water flowing towards Wall 1. Wall 2 is under construction and it is expected no further check barrages will be necessary.

It is noted that is was neither practical nor safe to implement immediate measures downstream of Wall 1 where it is noted a quantity of material has been deposited to either side of the watercourse leading to the Shruhangarve river prior to this time. As referenced above, a monitoring programme has been implemented. It is anticipated that further mitigation measures will be required to address this material downstream of Wall 1 in the short to medium term.

APPENDIX 2

IONIC CONSULTING LTD. DRAWINGS AND DESIGN RISK ASSESSMENTS





NOTES

REV	DATE	DRAWN BY	CHECKED BY	DETAILS
B	23/11/2020	E.A.	J.S.	SLIDE AREA AND CHAINAGE
A	16/11/2020	E.A.	J.S.	FIRST ISSUE

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CLIENT

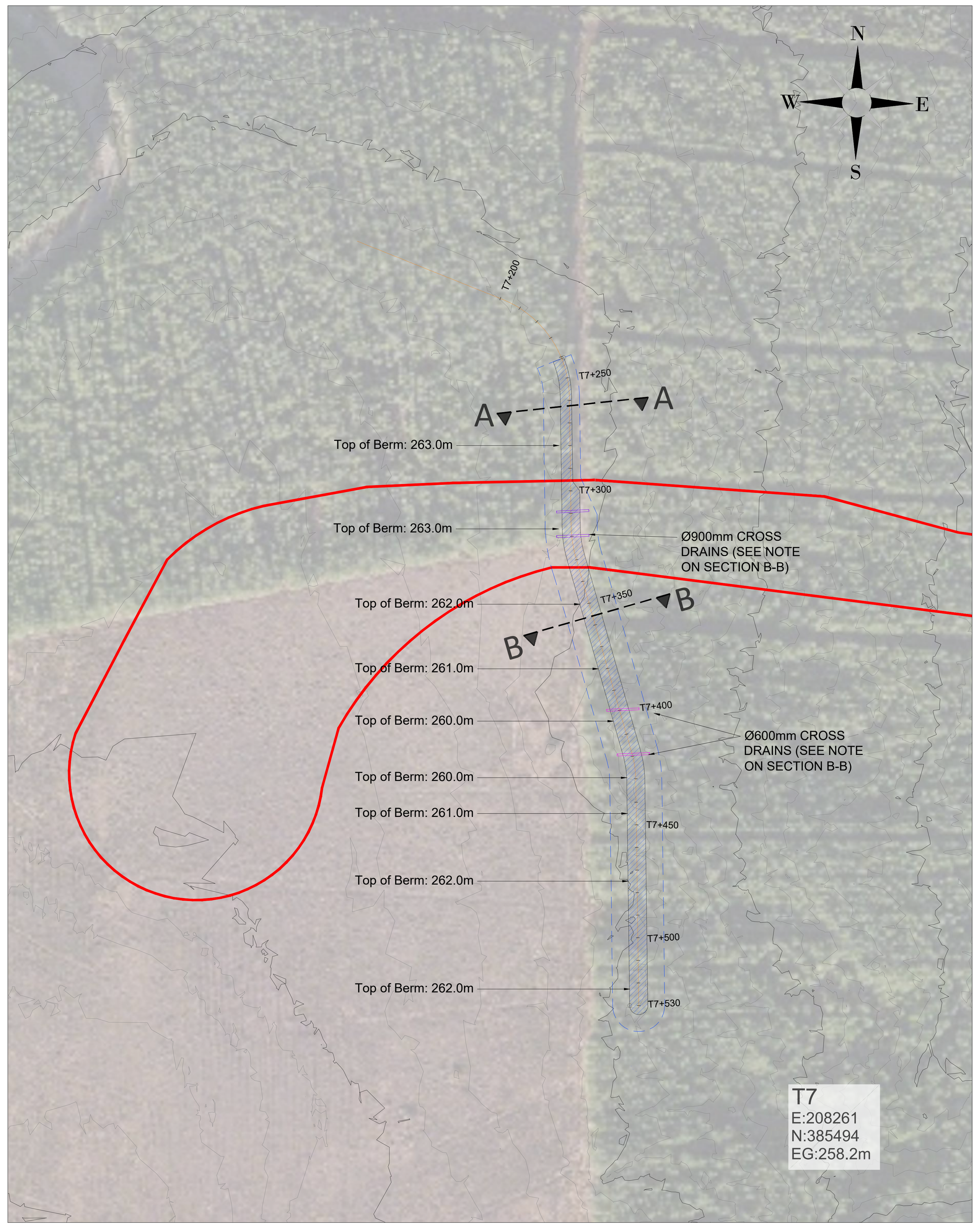
PROJECT: MEENBOG WIND FARM

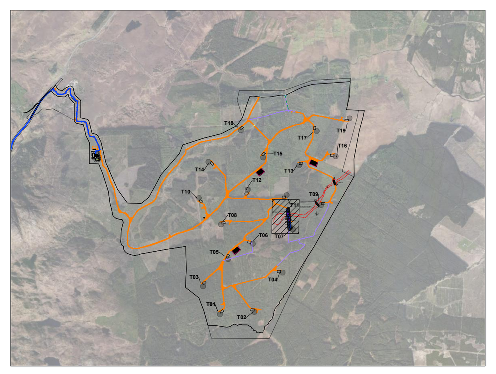
TITLE: T7 SLIDE OVERALL MAP

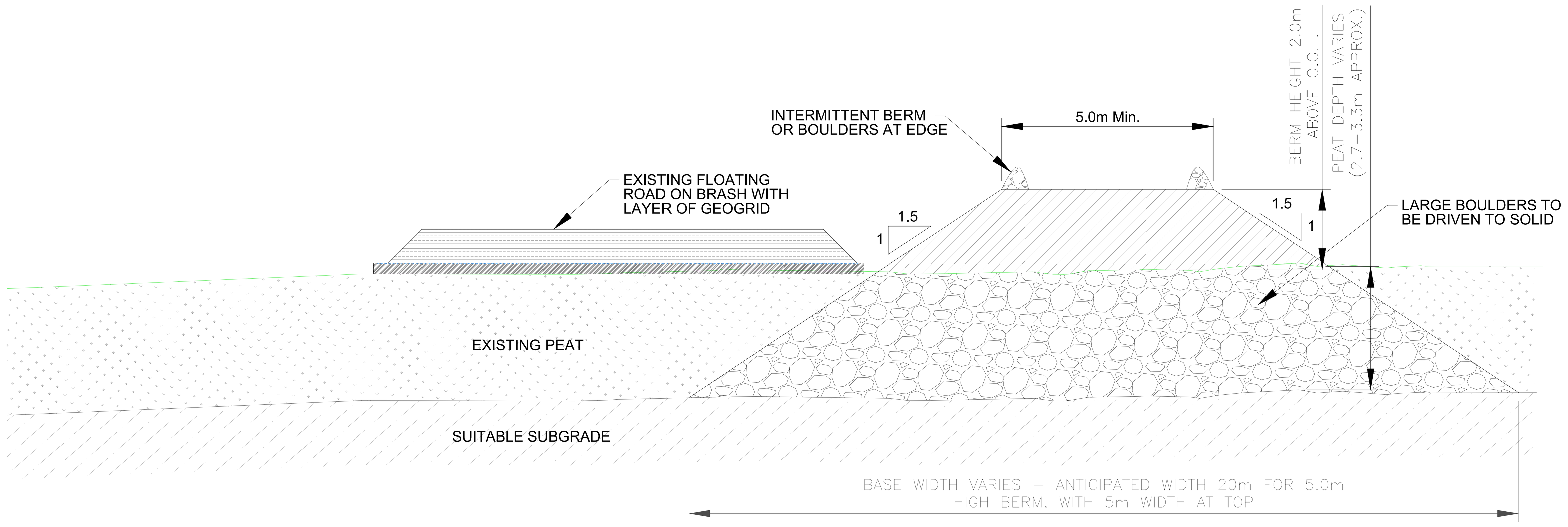
REVISION: B

DRAWN BY	DATE	PAPER SIZE	SCALE
E. ANDRADE	16/11/2020	A3	1:5.000

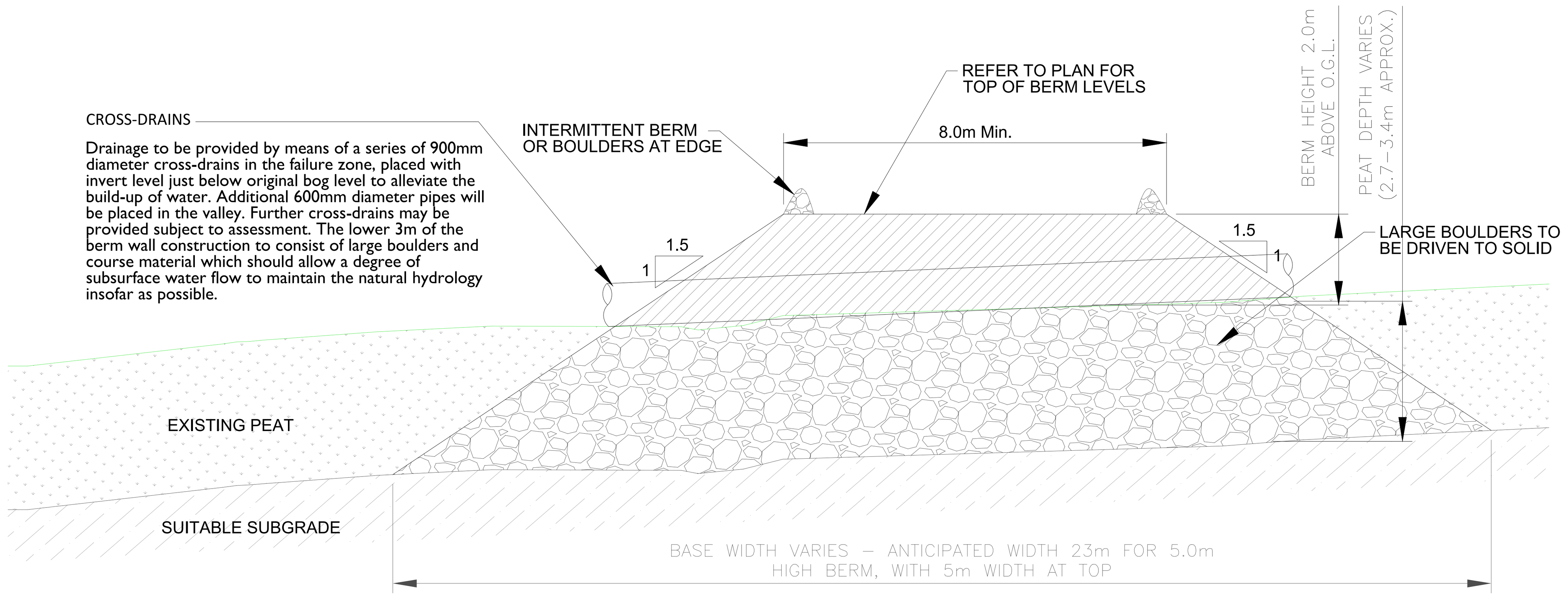
CHECKED AND APPROVED	DATE	STATUS	DRAWING NUMBER
J. SHANAHAN	16/11/2020	INFORMATION	MNBG d021.7.3







SECTION A-A THROUGH "WALL 3" PEAT BERM @ T7 SPUR
Scale 1:100



CROSS-DRAINS

Drainage to be provided by means of a series of 900mm diameter cross-drains in the failure zone, placed with invert level just below original bog level to alleviate the build-up of water. Additional 600mm diameter pipes will be placed in the valley. Further cross-drains may be provided subject to assessment. The lower 3m of the berm wall construction to consist of large boulders and course material which should allow a degree of subsurface water flow to maintain the natural hydrology insofar as possible.

SECTION B-B THROUGH "WALL 3" PEAT BERM @ T7 SPUR
Scale 1:100

NOTES:

1. **Exclusion zone** - an exclusion zone should be enforced downhill during the works. No access or works permitted to any site infrastructure downslope from Wall 3 including at T9 spur road, foundation, Wall 2 or Wall 1.
2. Following stabilisation of the immediate peat failure area at Wall 3 it is recommended that **ongoing assessment** is carried out of the stability of up-slope peat in order to assess the downstream risks, including at T9, Wall 1 and beyond at the public road at Toragh.
3. Continuous **monitoring regime** to be put in place to watch for any peat movements in or around the slide area during the works. The level of the peat on the upslope side of the berm to be assessed regularly.
4. Regular **geotechnical inspections** to be carried out to assess stability of this peat stabilisation area.
5. Works should be programmed taking account of **weather**. Water ingress to the works area or peat slide area could result in destabilisation following heavy rainfall.
6. **Excavate and replace** method to be adopted to construct and move the original and displaced peat insofar as possible to construct the berm. The depth and behaviour of the peat shall be assessed during works to ensure the construction method is appropriate. The berm is to begin at the bend along the west side upslope of the initial section of the T7 floating road that remains intact. The berm will be built using an **incremental approach**, dig and replace in 3m intervals. Placement of large boulders using the **displacement method** will be required where the peat is liquefied. Beyond the existing floating road the berm will be constructed to a level 2m above the original bog level, with an 8m width at the top, up to 23m width at the base of peat is anticipated.
7. All berm construction to be on **solid sub-formation.**
8. **Access and egress**: Workers should only access the work area within their vehicles, and a safe egress should always be maintained in case of movement. The machinery should be operated from the advancing berm, above the level of the slide peat on the upslope side.
9. Works to **cease immediately** if movement is noted and a risk assessment carried out before works can resume.
10. Construction methodology and **RAMS** to be reviewed by Ionic prior to construction by the Contractor.
11. Any peat that may potentially be extracted during the construction of Wall 3 is to be deposited in a **designated peat storage area**, no side-casting or temporary storage of peat permitted elsewhere.

NOTES

REV	DATE	DRAWN BY	CHECKED BY	DETAILS
B	20/11/2020	J.S.	C.OD	GENERAL REVISION
A	18/11/2020	M.B.	J.S.	FIRST ISSUE

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CLIENT

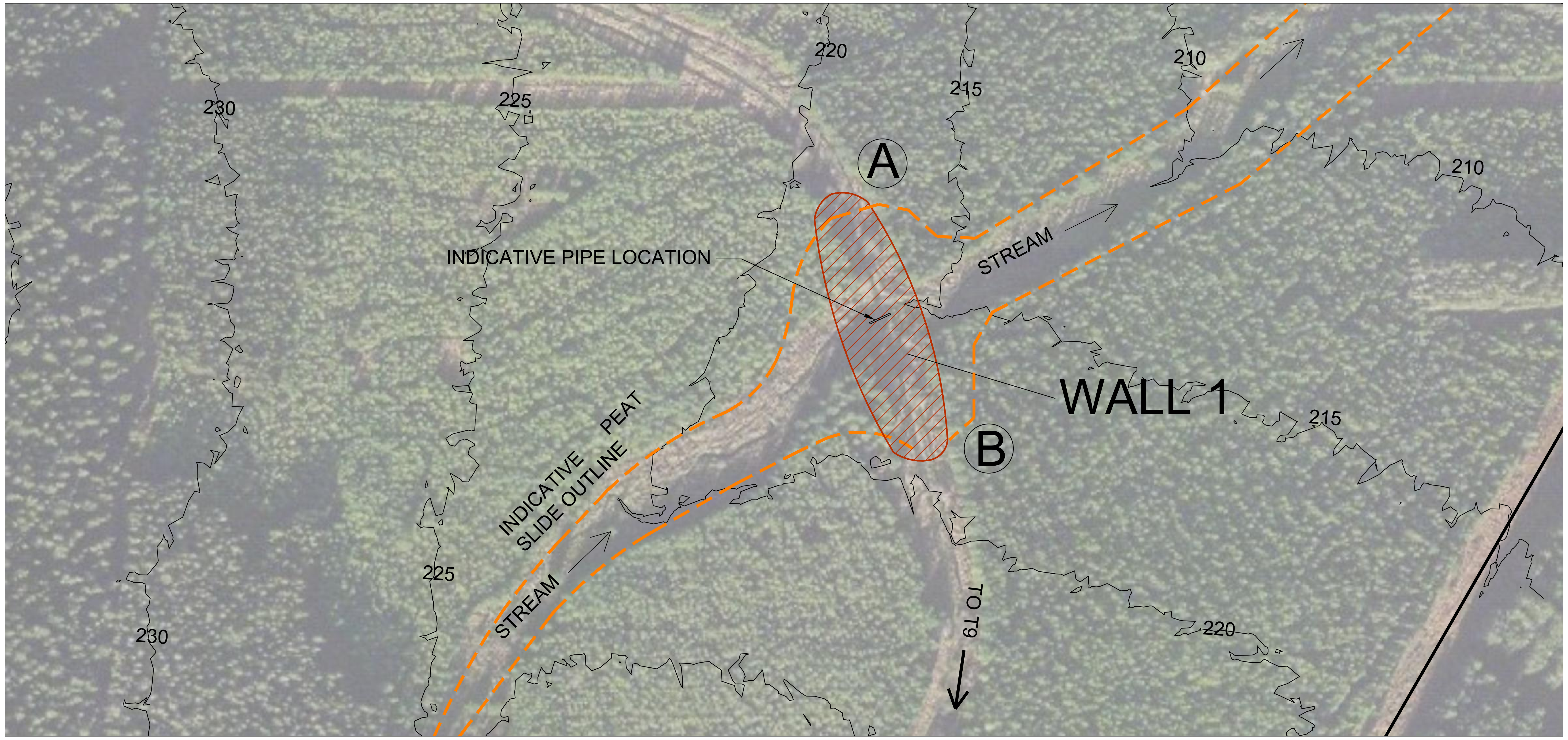
PROJECT: MEENBOG WIND FARM

TITLE: WALL 3 PEAT BERM DETAILS @ T7 SPUR

REVISION: B

DRAWN BY	DATE	PAPER SIZE	SCALE
M. BROWNE	18/11/2020	A1	AS SHOWN

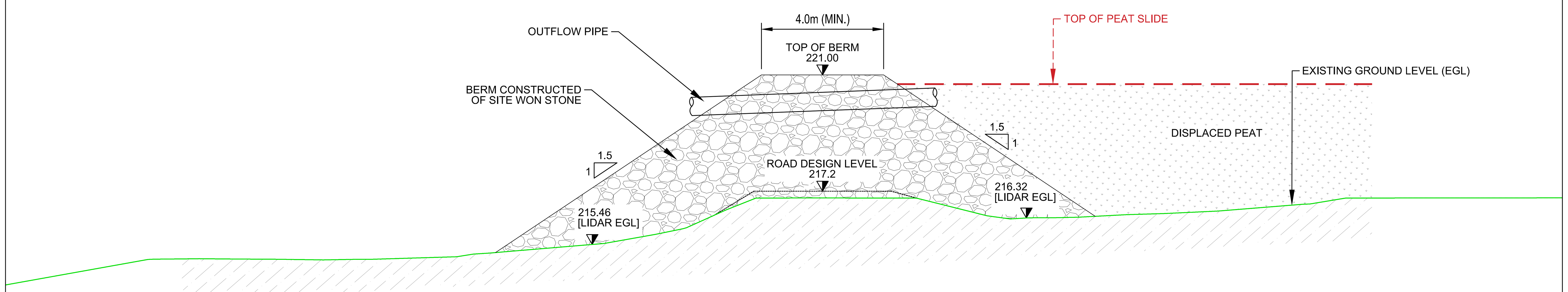
CHECKED AND APPROVED	DATE	STATUS	DRAWING NUMBER
J. SHANAHAN	18/11/2020	CONSTRUCTION	MNBG d021.7.4



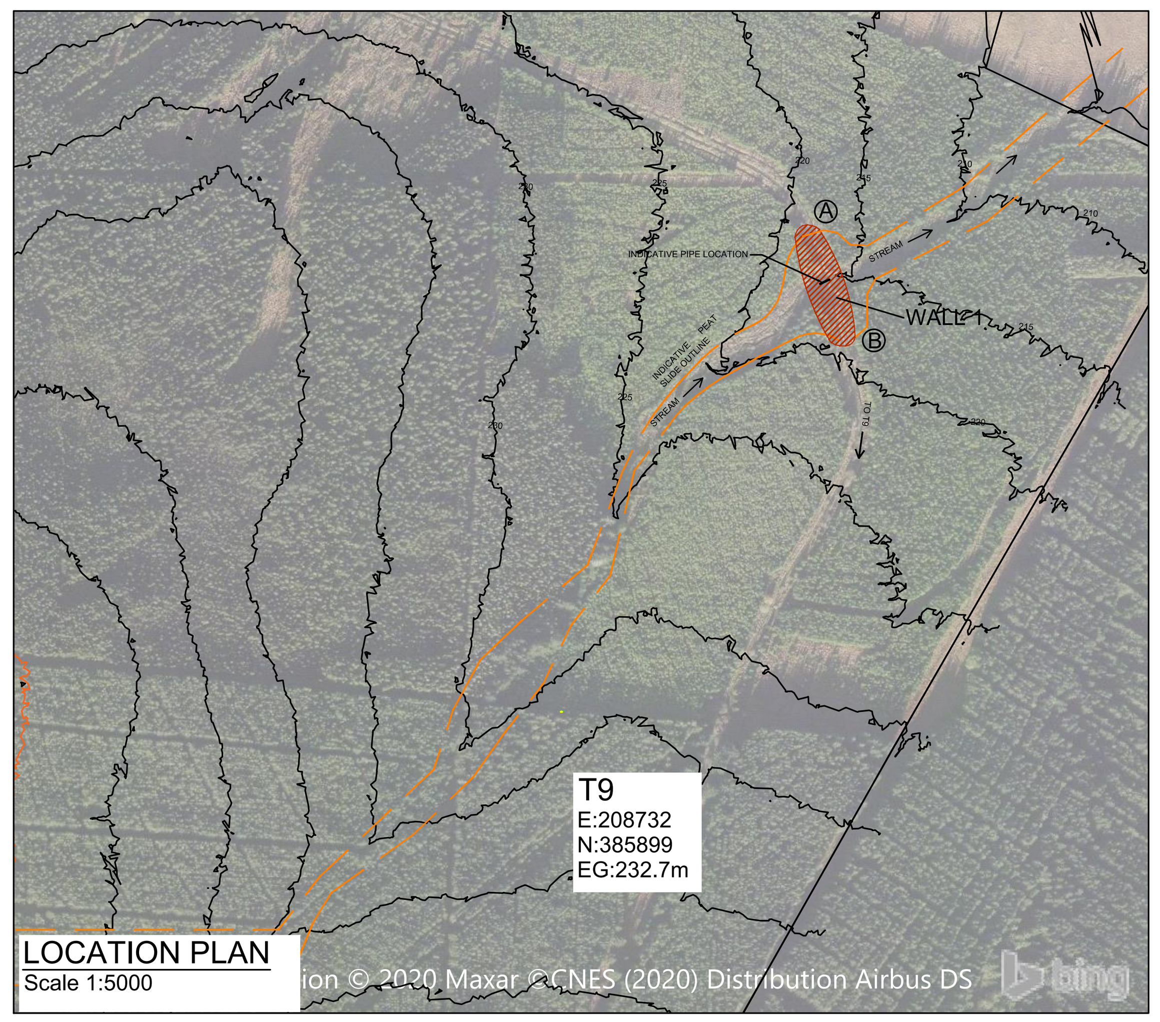
NOTES:

1. WALL 1 CAN ONLY RETAIN THE VOLUME OF PEAT UP TO THE TOP OF THE WALL, ADDITIONAL PEAT FROM ABOVE WILL FLOW ABOVE OR AROUND THE WALL.
2. EXCLUSION ZONE - AN AGREED EXCLUSION ZONE SHOULD BE ENFORCED DOWNHILL DURING THE WORKS.
3. NO-WORK AREAS SHOULD BE ENFORCED UPHILL OF WALL 1 DURING WORKS TO CONSTRUCT THE WALL.
4. CONTINUOUS MONITORING REGIME TO BE PUT IN PLACE TO WATCH FOR ANY PEAT MOVEMENTS IN OR AROUND THE SLIDE AREA DURING THE WORKS.
5. REGULAR GEOTECHNICAL INSPECTIONS TO BE CARRIED OUT TO ASSESS STABILITY OF THIS PEAT STABILISATION AREA.
6. ALL BERM CONSTRUCTION TO BE ON SOLID SUB-FORMATION.
7. ACCESS TO T9 SHALL BE RESTRICTED AND A SAFE EGRESS SHOULD ALWAYS BE MAINTAINED IN CASE OF MOVEMENT. THE MACHINERY SHOULD BE OPERATED FROM THE ADVANCING BERM, ABOVE THE LEVEL OF THE PEAT ON THE UPSLOPE SIDE.
8. WORKS TO CEASE IMMEDIATELY IF MOVEMENT IS NOTED A RISK ASSESSMENT CARRIED OUT BEFORE WORKS CAN RESUME.
9. ANY PEAT TO BE EXTRACTED SHALL BE MOVED TO A DESIGNATED PEAT STORAGE AREA AGREED WITH THE ENGINEER.

NOTE: WALL 1 CAN ONLY RETAIN THE VOLUME OF PEAT UP TO THE TOP OF THE WALL, ADDITIONAL PEAT FROM ABOVE WILL FLOW ABOVE OR AROUND THE WALL.



SECTION THROUGH WALL 1 (PEAT BERM @ SPUR TO T9)
Scale 1:100



LOCATION PLAN
Scale 1:5000

NOTES

REV	DATE	DRAWN BY	CHECKED BY	DETAILS
B	27/11/2020	M.B.	C.ÓD.	PIPE ADDED THROUGH BERM
A	17/11/2020	M.B.	J.S.	FIRST ISSUE

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Formerly known as WIND PROSPECT IRELAND

CLIENT

PROJECT: MEENBOG WIND FARM

TITLE: PEAT BERM DETAILS @ SPUR TO T9 WALL 1

REVISION: B

DRAWN BY	DATE	PAPER SIZE	SCALE
M. BROWNE	17/11/2020	A1	AS SHOWN

CHECKED AND APPROVED	DATE	STATUS	DRAWING NUMBER
J. SHANAHAN	17/11/2020	CONSTRUCTION	MNBG d021.9.1

DESIGN RISK ASSESSMENT

Project Name & Address	Meenbog Wind Farm, Co. Donegal	**Assessment Date**	17 November 2020
Risk Assessor Name	John Shanahan, Cormac O Dubhthaigh	**Review Date**	20 November 2020

Risk Assessment Scope	**Risk Assessment Methodology**
Wind Farm Peat Stabilisation for Meenbog Wind Farm comprising 19 turbines, substation and borrow pits.	Assessment based on site visits & desk study. Detailed LIDAR topographical survey information was available which enabled accurate slope assessments to be carried out. Drone surveys carried out by Ionic to assess peat slide and proposed stabilisation areas. Earlier peat probing, shear vane testing and visual inspection allowed a risk analysis to be carried out and factors of safety to be determined.

Comment (list project constraints, previous design risk assessments etc.)	This DRA is prepared for emergency construction works of the peat retention berm at **Wall 1** on the spur road to T9, and at **Wall 3** at the T7 spur road where the slide occurred. These berms are being constructed to prevent peat continuing to move downstream toward the Mourne Beg River. This DRA will form part of a larger package of design and emergency construction works related to the T7 peat movement. Constraints on the design and works include potential ground instability, time, weather and safety considerations.

Hazard/ Consequence	**People At Risk**	**Risk Rating**			**Risk Reduction Measures**	**Residual Risk**		
		H **1 - 5**	**L** **1 - 5**	**R** **1 - 25**		**H** **1 - 5**	**L** **1 - 5**	**R** **1 - 25**
Geotechnical instability of Peat Stabilisation Area (**Berm Wall 1 T9 Spur)** Moderate original peat depths of 1.5m at the location of this berm. Road upgraded to a solid road for turbine access to T9 prior to the slide at T7. Road level raised immediately to contain the peat insofar as possible coming from T7, thereby creating the berm. Displaced peat of up to 3.5m, accumulating on the upslope side of the berm. Road level raised from design level 217.2mOD to current top of berm level 221.0mOD (at time of writing), it is	Any site operatives, most likely heavy vehicle drivers /operatives (construction, forestry vehicles). Public road users at Toragh north of the site boundary.	5	5	25	Entire area to be initially stabilised with one large berm along the T9 Spur, referred to as Wall 1. This will be followed by an additional berm near T9 foundation (Wall 2) and at the T7 Spur road (Wall 3) where the failure occurred. While the berm will reduce the risk of a slide developing, it may not retain the entire volume of liquified peat that may slide downslope. **Monitoring regime** to be put in place to watch for any peat movements in or around the slide area.	5	3	15

proposed to increase this to approximately 222.0mOD over the coming days.					Regular **geotechnical inspections** to be carried out to assess stability of this peat stabilisation area. The berm designs are provided in drawing **MNBG d021.9.1** for Wall 1. **Works to cease** immediately if movement is noted a risk assessment carried out before works can resume. **Exclusion zone** to be put in place downslope of the berm. **No works zone** to be implemented upslope of the berm.			
Instability during construction of Berm Wall 1 – T9 Spur Road Peat slide initiated during works to build Berm Wall 1	Any site operatives, most likely heavy vehicle drivers /operatives (construction, forestry vehicles). Public road users at Toragh north of the site boundary.	5	5	25	**Exclusion zone** – an exclusion zone should be enforced downhill during the works. There is no site infrastructure downslope from Wall 1 on the T9 spur road, the stream flows outside the site boundary. The **public road** at Toragh downstream from the site boundary should be closed until stability of upslope peat is confirmed and an assessment of downstream risks is carried out. **No-work areas** should be enforced above T9 Spur i.e. no works at T7 Spur road (Wall 3) or near T9 foundation (Wall 2), until construction of the berm is complete. Continuous **monitoring regime** to be put in place to watch for any peat movements in or around the slide area during the works. The level of the peat on the upslope side of the berm to be assessed regularly. Regular **geotechnical inspections** to be carried out to assess stability of this peat stabilisation area. Works should be programmed taking account of **weather**. Water ingress to the works area or peat slide area could result in destabilisation.	5	3	15

					Original T9 access road built from solid sub-formation. Widening of berm on the downslope side will involve the displacement method to reach solid, direct excavation of peat will not be possible but dead weight of in excess of 6m of stone fill on low side will ensure berm is on solid sub-formation. **Access and egress**: Workers should only access the work area within their vehicles, and a safe egress should always be maintained in case of movement. Works to **cease immediately** if movement is noted a risk assessment carried out before works can resume. Construction methodology and **RAMS** to be reviewed by Ionic prior to construction by the Contractor. Any peat that may potentially be extracted upslope from Wall 1 is to be deposited in a **designated peat storage area**, no side-casting or temporary storage of peat permitted elsewhere.			
Instability after construction of Wall 1 T9 Spur road berm While the berm will reduce the risk of a further slide occurring, it will not retain liquified peat beyond the level of the top of the berm.	Any site operatives, most likely heavy vehicle drivers /operatives (construction, forestry vehicles). Public road users at Toragh north of the site boundary.	5	5	25	**Monitoring regime** to be put in place to watch for any peat movements in or around the slide area. Visual inspections along with regular drone flights to assess the extent of the peat slide and potential movement and cracking of peat upslope from the T7 Spur Road. Regular **geotechnical inspections** to be carried out to assess stability of this peat stabilisation area. Once the Wall 1 stabilising berm has been completed a further assessment will be completed of the slide area upslope. Further berms are proposed; Wall 2 at T9 foundation and Wall 3 at the T7 spur road where failure occurred. Sequencing of construction will depend on the volume of displaced peat accumulating and potentially approaching Wall 1.	5	3	15

					A drainage plan is also being developed to alleviate the pressure at Wall 1 and to divert water in order to bypass this location.			
Drop-off raised edges adjacent to peat berms. Vehicle accidentally travels off edge of raised berm embankment. Pedestrian or operative suffers fall due to sudden drop in level.	Any operatives (on foot or in vehicle), most likely heavy vehicle drivers/operatives (berm construction vehicles)	5	3	15	High level embankment shoulder slopes should be at inclinations no more than 34° (1 in 1.5) to provide a stable lateral support to the berm. A minimum width of 4.0m is to be maintained at the top of the berm, width to be increased therefore by a minimum of 1.5m for every 1m vertical increase in berm height. • The structural/useable width of the berm should be clearly demarked to highlight to operatives where vehicles should be positioned and to reduce the risk of vehicle wheels running off the edge or onto soft edges. Reflective marker posts should be positioned every 20m upon completion of the berm. • Warning signs should be provided to indicate potentially deep peat, deep water and a significant drop. • The start and end points of berms should be clearly marked with reflective posts upon completion. Operational controls (limited working times, restricted access, vehicle speed restrictions) should also be considered. • Drivers to be instructed not to travel too close to edges and position tracked machines and vehicles in the centre of the berm.	5	2	10
Drowning Ponding of water around impermeable berms.	Site workers, members of the public	5	3	15	Ponding or accumulation of water behind berms to be avoided by providing drainage pipes or boulders or coarse drawing stone to allow the water to filter through. Ponding water in designated areas to be fenced to mitigate against falls and drowning. Buoyancy aides, peat rescue kits and warning signs should be provided at temporary settlement ponds or other areas of standing water.	4	2	8
Berm failure under lateral load	Any road user (on foot or in vehicle), most	5	5	25	The Wall 1 berm is sized to contain a defined area and volume of peat based upon the slopes,	5	3	15

	likely heavy vehicle drivers/operatives (delivery, haulage, forestry vehicles). Public road users at Toragh north of the site boundary.				contours of the valley and the upper elevation of the berm, currently at 221.0mOD. A suitable factor of safety against failure has been confirmed for this quantity of material that can be retained, however additional material that rises above, over or around the berm cannot be retained. The berm will remain intact but ultimately if peat levels rise the volume of material may exceed the capacity of the berm to retain this additional peat.			
Geotechnical instability of Peat Stabilisation Area (**Berm Wall 3 T7 Spur)** Peat depth between 2.7m and 3.3m along the initial alignment of this berm, peat depths reducing to 1.7m near the turbine location. Floating road that was under construction will be replaced with a solid berm across the entire length of the peat slide risk area. The berm wall will be built to a minimum width of 8m at the top, and to a level of 2m above the original bog level, with shoulders at 1 in 1.5. Top of berm level varies from 260 to 262mOD to maintain the required 2m level above original bog.	Any site operatives, most likely heavy vehicle drivers /operatives (construction, forestry vehicles) along the T9 spur road and turbine location. Public road users at Toragh north of the site boundary.	5	5	25	Entire area within the biodiversity area that slopes to the east is to be stabilised with a large berm along the previously proposed T7 spur road, referred to as Wall 3. This is being constructed after the completion of Wall 1 (T9 spur road) and may be followed by an additional berm Wall 2 (near T9 foundation). The intention with this berm wall is to contain the entire volume of peat within the catchment that is sloping east towards the proposed berm wall. The western part of the biodiversity area slopes west, just beyond the crest of the hill which is approximately 140m west of the proposed berm wall. **Monitoring regime** to be put in place to watch for any peat movements in or around the slide area. Regular **geotechnical inspections** to be carried out to assess stability of this peat stabilisation area. The berm design plan and sections are provided in drawing **MNBG d021.7.4** for Wall 3. **Works to cease** immediately if movement is noted a risk assessment carried out before works can resume. **Exclusion zone** to be put in place downslope of the berm at T9 foundation and Wall 1. There is no wind farm infrastructure upslope of Wall 3.	5	2	10

Instability during construction of Berm Wall 3 (alignment of T7 Spur Road) Risk of additional peat slide being initiated during works to build Berm Wall 3.	Any site operatives, most likely heavy vehicle drivers /operatives (construction, forestry vehicles) along the T9 spur road and turbine location. Public road users at Toragh north of the site boundary.	5	5	25	**Exclusion zone** – an exclusion zone should be enforced downhill during the works. No access or works permitted to any site infrastructure downslope from Wall 3 including at T9 foundation, Wall 2 or Wall 1. Following stabilisation of the immediate peat failure area at Wall 3 it is recommended that **ongoing assessment** is carried out of the stability of upslope peat in order to assess the downstream risks, including at T9, Wall 1 and beyond at the public road at Toragh. Continuous **monitoring regime** to be put in place to watch for any peat movements in or around the slide area during the works. The level of the peat on the upslope side of the berm to be assessed regularly. Regular **geotechnical inspections** to be carried out to assess stability of this peat stabilisation area. Works should be programmed taking account of **weather**. Water ingress to the works area or peat slide area could result in destabilisation following heavy rainfall. **Excavate and replace** method to be adopted to construct and move the original and displaced peat insofar as possible to construct the berm. The depth and behaviour of the peat shall be assessed during works to ensure the construction method is appropriate. The berm is to begin at the bend along the west side upslope of the initial section of the T7 floating road that remains intact. The berm will be built using an **incremental approach**, dig and replace in 3m intervals. Placement of large boulders using the **displacement method** will be required where the peat is liquefied, and at lower depth. Beyond the existing floating road the berm will be constructed to a level 2m above the original bog level, with an 8m width at the top, up to 23m width at the base of peat is anticipated.	5	3	15

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					All berm construction to be on **solid sub-formation.** **Access and egress**: Workers should only access the work area within their vehicles, and a safe egress should always be maintained in case of movement. The machinery should be operated from the advancing berm, above the level of the slide peat on the upslope side. Works to **cease immediately** if movement is noted and a risk assessment carried out before works can resume. Construction methodology and **RAMS** to be reviewed prior to construction by the Contractor. Any peat that may potentially be extracted during the construction of Wall 3 is to be deposited in a **designated peat storage area**, no side-casting or temporary storage of peat permitted elsewhere.			
Instability after construction of Wall 3 (alignment of T7 spur road) The berm is designed to retain the entire volume of peat sloping east towards the berm wall.	Any site operatives, most likely heavy vehicle drivers /operatives (construction, forestry vehicles) along the T9 spur road and turbine location. Operatives along the berm wall post-construction. Public road users at Toragh north of the site boundary.	5	5	25	**Monitoring regime** to be put in place to watch for any peat movements in or around the slide area. Visual inspections along with regular drone flights to assess the extent of the peat slide and potential movement and cracking of peat upslope from Wall 3. Regular **geotechnical inspections** to be carried out to assess stability of this peat stabilisation area. Drainage to be provided by means of a series of 900mm diameter **cross-drains** in the failure zone, placed with invert level just below original bog level to alleviate the build-up of water. Additional 600mm diameter pipes will be placed in the valley from Chainage 380-440. Further cross-drains may be provided subject to assessment. The lower 3m of the berm wall construction to consist of large boulders and course material which should allow a degree of subsurface water flow to maintain the natural hydrology insofar as possible.	5	2	10

Risk Factor

		Hazard/ Consequence				
		1	2	3	4	5
Likelihood	1	1	2	3	4	5
	2	2	4	6	8	10
	3	3	6	9	12	15
	4	4	8	12	16	20
	5	5	10	15	20	25

Risk Rating Key

Hazard Score	**Description**	**Likelihood Score**	**Description**
5	Multiple fatalities or risk to non – employees	5	Extremely likely at any stage during the lifecycle of the site
4	Fatality/ career threatening injury for contractors or maintenance	4	Likely to occur to personnel during construction or maintenance
3	Reportable accident/ broken bones/ permanent scarring	3	Foreseeable that it may occur but not thought to be imminent
2	Medical treatment/ lost time injuries during the lifecycle of the site	2	Unlikely to occur at any stage during the lifecycle of the wind farm
1	Minor Injury or illness resulting in cuts or bruising	1	Extremely Unlikely at any stage for contractors or maintenance

Colour Code	Acceptable approach
15 - 25	Review the design intent and re-design so that the level of risk is reduced to at least a medium and continue to review. Do not proceed with design.
6 - 12	Review the design intent and examine the possibility for designing in additional controls. Communicate residual hazards to PSDP and designers.
1 - 5	Communicate residual hazards to the PSDP and other designers so that they can be kept under review and communicated to the PSCS.

Guidance for completing design risk assessments

1. ***Risk Assessment Scope* –** Details of what aspects of the project are being risk assessed e.g. the electrical element of the substation or the foundation design for the turbine base;

2. ***Risk Assessment Methodology* –** This element is intended to outline what form the scoping exercise for the risk assessment took e.g. desktop review of existing drawings and surveys, a meeting with all design team members or a survey of the site;

3. ***Hazard/ consequence* –** Identifying the hazards which are the situations or items which could foreseeably cause and injury or illness. On a windfarm project this would include;

   - An overhead 38Kv line crossing the proposed access route to the windfarm. The foreseeable injury would be a fatality through electrocution for an operator where their machine would come into contact with the overhead line. ***The Ionic risk assessment should consider this and should consider how this hazard can be eliminated through re-routing or removal. If this isn't possible the Preliminary Plan prepared by Ionic as PSDP should highlight the presence of this presence to the tendering PSCSs. Ionic risk assessments should not outline construction stage precautions as a competent PSCS will determine what these are***;

   - An unprotected leading edge at the side of a borrow pit where someone could fall 1.2m. The foreseeable injury in this case might be a broken leg or arm where the person would strike the ground or put his/ her arm out to break their fall. ***Ionic as PSDP should highlight this in the Construction Stage Plan to all tendering PSCSs and the contractor should in turn risk assess this and implement suitable precautions to be taken during construction***;

   - An un-propped thin concrete slab (hollow-core would be the normal type used) where the foreseeable injury would be fatality for an operative pouring concrete from the combination of a 4.5m fall and being struck by a collapsing structure ***(this example is used as it is important to risk assess anything outside of the norm, if Ionic weren't specifying which type of slab was to be used and it was for the contractor or those doing detailed design to specify the party specifying the particular type of slab would be responsible for risk assessing);***

   - A larger than normal transformer on the back of a truck. The foreseeable injury would be a fatality from crushing where the ground would fail under the weight of a larger than normal crane lifting a heavier than typical type of transformer. The Ionic risk assessment should alert other designers and contractors that there is something out of the ordinary with this particular design. ***The Ionic risk assessment should not need to communicate generic/ normal hazards onto detailed designers or contractors, it should however attempted to reduce risk during the design stage they are involved in. The control measures should highlight the actual measures Ionic has taken to reduce the risk during their design input period;***

   - A large water pond in the vicinity of the substation with stagnant water. If the site of the substation is a significant distance from any residential areas the foreseeable injury wouldn't be high (fatalities through drowning) as the hazard isn't made more significant through the construction project. It may also not be reasonable to consider or implement measures, above and beyond those which would be implemented for any construction project, to protect against Weil's disease as the risk isn't heightened by this hazard. ***The Ionic design risk assessment doesn't need to consider the risks associated with this hazard, the Preliminary Safety Plan prepared by Ionic should however highlight the hazard to the tendering Project Supervisors for the Construction Stage (PSCS);***

4. ***People at Risk –*** This section should consider all people at risk including contractors, maintenance personnel for the full lifecycle of the project, those decommissioning or demolishing the site, members of the public, adjoining landowners and trespassers;

5. ***Risk Rating –*** This section is aimed at enabling the person carrying out the risk assessment to prioritise action. For Ionic the important elements is that design doesn't proceed until all unacceptable risk issues (scored 15 – 25) are reduced to at least medium (scored 6 – 12). All medium and low residual hazards should be communicated to the PSDP for inclusion in the Preliminary Safety Plan where they are brought to the attention of all tendering Project Supervisors for the Construction Stage (PSCS). The competent Ionic Designer is responsible for ensuring that measures they specify are implemented.

   Where Ionic is tasked with preparing conceptual designs a hazard register should be prepared for future designers. These designers in turn are responsible for risk assessing their design inputs and those carrying out detailed drawings should submit permanent works design certificates and design risk assessments to be included in the client safety file;

6. ***Risk Reduction Measures –*** All risk assessments should consider the General Principles of Prevention which is a hierarchy of measures ranging from elimination, through engineering controls and administrative controls to the use of personal protective equipment (PPE). Ionic design risk assessments would be expected to concentrate on preventative measures which would focus on elimination and engineering controls. Within the engineering controls there is also a hierarchy ranging from fixed guarding which require the use of a special tool to overcome through to exhaust ventilation which requires a stringent maintenance regime to ensure that they remain effective – ***in summary the more human intervention that is required to make a measure effective or the more chance there is of it failing the lower it appears on the hierarchy;***

   On the projects where Ionic are engaged the administrative controls and personal protective equipment would be considered in the PSCS/ contractor's risk assessment.

   A typical hierarchy to be considered by Ionic might be as follows (considering measures from top to bottom);

   - Elimination of a hazard – diverting or removing an overhead or underground service or relocating a wind turbine away from a hazard;
   - A fixed guard – switchgear in a cabinet which would require a key to access or a solid barrier which would need a special tool to remove;
   - Interlocks – where a circuit is broken e.g. a gate leading to dangerous plant or equipment has an interlock and when this gate is opened the circuit is broken and the dangerous plant or equipment is isolated;
   - Emergency cut outs – where an operator can strike/ hit an emergency stop in the event of a malfunction;

7. ***Residual Risk –*** A review of the risk rating with the effect of the additional control measures being considered.

APPENDIX 3

COIR-MESH & TERRASTOP SILT FENCE SPECIFICATIONS AND INSTALLATION GUIDES

Hy-Tex **Terrastop™** Silt Fences for Stormwater Run-Off Control

Hy-Tex Terrastop silt fence in use on National Grid's Milford Haven to Aberdulais gas pipeline project

Hy-Tex Terrastop silt fence in use on National Grid's Felindre to Brecon gas pipeline project

News: Terrastop HighFlow trapped approx. 5 tonnes of silt per 10m fence run over 1 month on potato field trials in Scotland

Terrastop™ Premium (GR180)

CE

1137-CPR-0613/29

Sand bags in both grades also available for no-dig solutions. Call for further details

Many construction, forestry and farming activities result in disturbed or bare ground that is vulnerable to weather erosion. The silt laden run-off, plus site debris and other pollutants, often contaminates surrounding land, watercourses, lakes and drains - resulting in significant environmental diffuse pollution and potentially costly fines.

However, due to the on-going nature of such work, it is generally not possible to protect exposed surfaces until the project is complete. So stormwater from such sites represents a major non-point source of diffuse water pollution in the UK.

Solution: Hy-Tex *Terrastop™ Premium,* and *HighFlow* silt fences, offer a proven, practical, economic and effective method to reduce stormwater run-off pollution from such locations. They are special, high quality, permeable, technical filter fabrics, that can be installed as an entrenched vertical barrier fence, and are designed to intercept and detain run-off - trapping harmful silt through settlement and filtration before it leaves the site.

Performance: The benefits of silt fences are increasingly becoming recognised in Britain: The Environment Agency/SEPA Pollution Prevention Guidelines (PPG5) now recommend the use of silt fences to reduce silt transport from exposed ground and stock piles; and research at The James Hutton Institute, with Terrastop Mono 60 silt fencing, showed that even after post-harvest contour grubbing of potato fields roughly 80 tonnes of soil containing 60-70 kg phosphate-P contaminants was trapped from a 17ha field [Dr Andy Vinten].

> Kirsty Liddon's Edinburgh University Dissertation "Prevention of Diffuse Pollution from Active Forestry Harvesting Sites:" concluded **"the Hy-Tex [Terrastop Premium] material appears to be the most suitable material for use as sediment retention as it has the most consistent performance between differing soil types retaining the highest volumes of sediment for both gley and peat solutions."**

While in other countries where silt fences have been used extensively for many years, their proven performance (Intercepting up to 86% of suspended solids [Horner et al. 1990]) has made them a standard *Best Management Practice* on a diverse range of projects.

From this in-depth research, and practical experience, Hy-Tex *Terrastop™ Premium* and *HighFlow* were developed to exceed the highest standards, with many unique features for ease of use, reliability and effective results.

Key Features: General purpose non-woven and woven geotextiles are unsuitable for silt fence use as they clog, overtop and inadequately filter sediment due to poor hydraulic properties (typically less than 10 l/m²/sec) and often fail: tearing and fraying (as they are too weak to withstand the forces of stormwater/silt build-up without costly additional wire support fences) or becoming brittle quickly (due to lack of UV protection). *Terrastop™ Premium* and *HighFlow* are manufactured specifically as silt fences so have high tensile and burst strengths, premium UV stabilisation, woven structures with tear resistant non-fraying reinforced edges, that are durable and self supporting between fixing posts for reliability, as well as having a visually pleasing subtle green colour.

The CE Mark certified *Terrastop Premium* also has an special fibrous weft yarn, combined with a high quality weave, to enhance filtration, maintain flow and minimise clogging.

Installation Aids: Silt fences also often fail through poor installation or aftercare, therefore *Terrastop™ Premium* incorporates pre-marked lines for burial depth and maximum silt accumulation level to ensure correct set-up and maintenance; as well as a top ribbon strip to simplify post attachment and tensioning.

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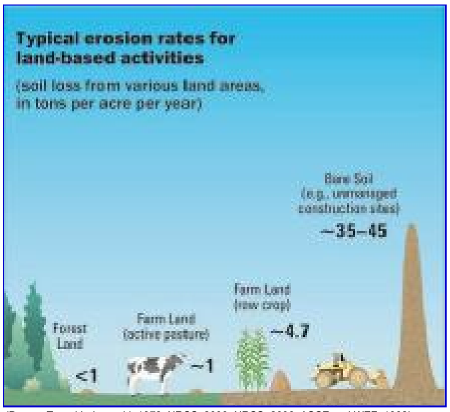
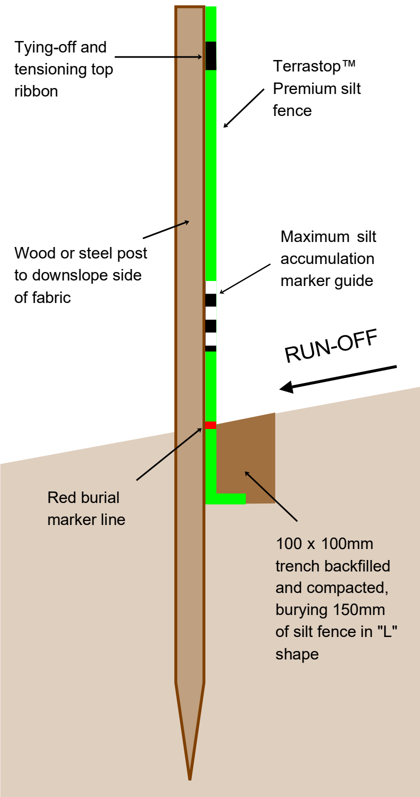
Hy-Tex (UK) Limited
Committed to Quality, Value & Service

Hy-Tex **Terrastop™** Silt Fences for Stormwater Run-Off Control



(Dunne, T. and L. Leopold, 1978; NRCS, 2000; NRCS, 2006; ASCE and WEF, 1992)



The Problem

- Construction activities disturb or expose vulnerable soil
- Erosion up to 150 times greater than before works
- Sediment run-off typically 10 times greater than agricultural lands
- 2.5 cm of rainfall per hour produces 25,000 litres of water for every 1,000m² of land
- Silt laden storm water run-off contaminates surrounding land, roadways, watercourses, lakes and drainage systems
- In a short period more sediment may be deposited in waterways than would normally accumulate over several decades
- Increased public spending on maintenance of drainage systems, waterways and reservoirs
- Serious environmental harm to aquatic habitats

The Solution

Purpose made, properly installed and well maintained silt fences can remove*:

70% of average total suspended solids

80 to 90% of sand

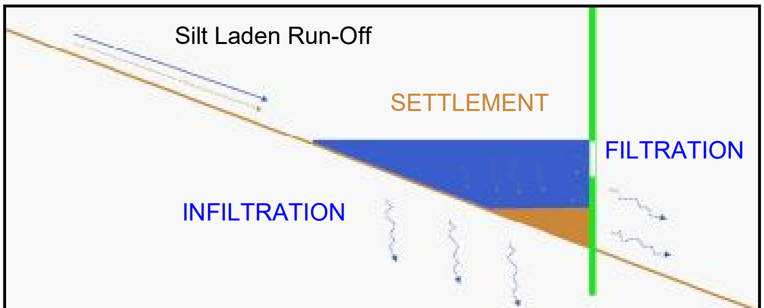
50 to 80% of silt-loam

0 to 20% of silt-clay-loam

*United States Environmental Protection Agency

Key Requirements

- High tensile strength (Minimum 20kN/m), UV stabilised, woven structure
- Tear resistant non-fraying reinforced edges
- Self supporting between fixing posts
- Special weave to enhance filtration, maintain high flow rates (Minimum 20 l/m².sec) and be less prone to clogging
- Ideal exposed fence height of 0.60m (Higher fences often fail due to excess wind and run-off loading) or 1.00m for high flow fences (Greater than 100 l/m².sec)
- Visually pleasing subtle green colour



How Terrastop silt fence works

Specification	Terrastop™ Premium (Terrasilt GR180)	Terrastop™ HighFlow
Tensile Strength	22kN/m	32kN/m
Puncture Resistance (CBR)	3,500N	3,700N
Permeability (ISO 11058)	21 l/m².s (45 l/m².s to AS 3706.9)	190 l/m².s
Opening Size (ISO 11058)	180µm	320µm
Weight	200g/m²	145g/m²
Material	1000µ thick, green/black, 400kLy UV stabilised, polypropylene, tear resistant non-fraying edges.	500µ thick, green/black, 450kLy UV stabilised, polyethylene, tear resistant non-fraying edges.
Roll Size	0.75 x 100m	1.00 x 100m
Other Key Features:	Fibrous weft yarn, burial depth and max silt height marker lines, top tying-off + tensioning ribbon.	

"Basic" grade also available for less stringent applications

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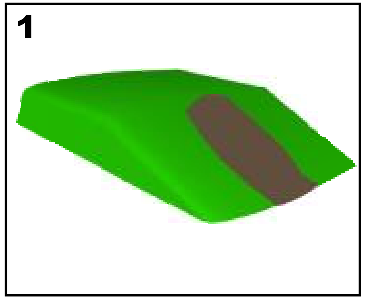
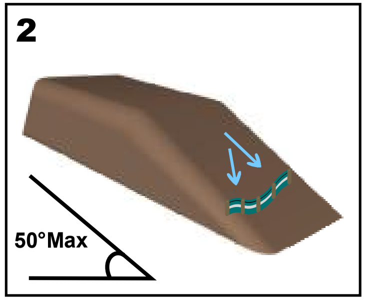
Hy-Tex **Terrastop™** - Silt Fences for Stormwater Run-Off Control

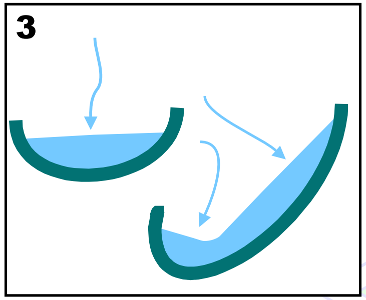


- Find where erosion may occur.
- Look for areas where soil has been disturbed or vegetation removed.

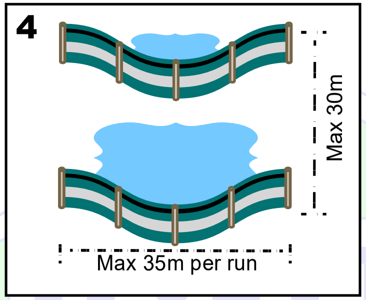


- Maximum 50° slope angle
- Not suitable for channels or ditches

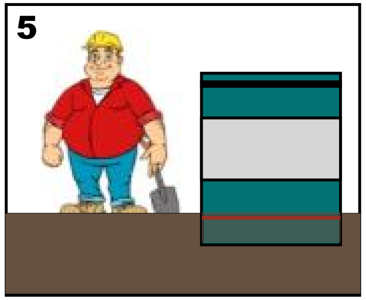
Use Ultra Erosion Guards for steeper slopes



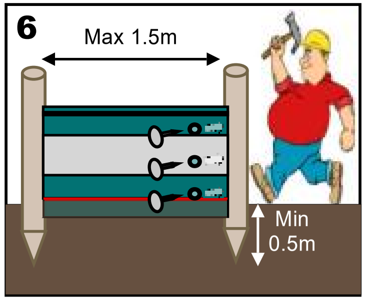
- Check where water is running
- Position fence central and at right angles to flow
- Curve fence ends up slope to form 'smiles' or 'J' shapes so water ponds behind fence



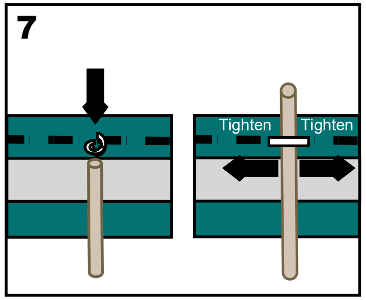
- Maximum 35m fence runs
- Maximum 30m between fence rows
- Add extra fences above and to the side for larger areas



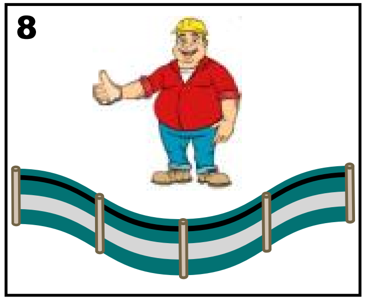
- Dig 100mm trench or use a trenching machine.
- Bury fence up to the red line.
- Make sure backfill is on upslope side of fence.
- Firmly compact.



- Position posts on downslope side of fence
- Max 1.50m post spacing
- Min 0.50m in ground.
- Secure with 3 nails and washers per post or use cable ties
- Post size minimum 1.20m long and 50mm diameter

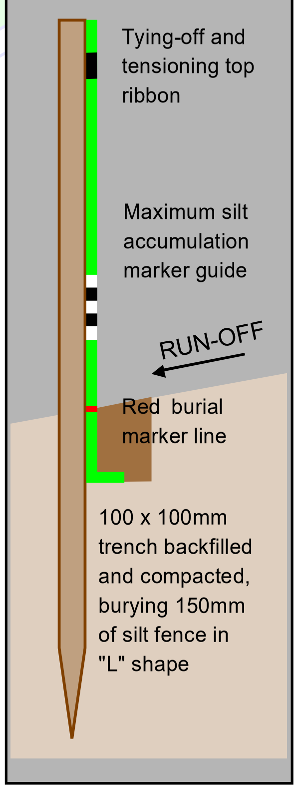


- Tension top edge by looping ribbon band over post.
- Add additional bracing posts for poor ground conditions



- Regularly check site
- Reassess for new areas of erosion and add extra fences as needed
- Repair any damage.
- Remove trapped silt when reaches top of white band or install additional fences.

Terrastop Silt Fence Installation Guidelines



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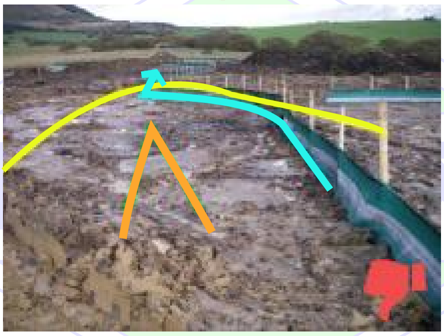
Unrivalled Quality

Hy-Tex **Terrastop™** - Silt Fences for Stormwater Run-Off Control

Position Fence

Fence is centred and at right angles to flow.



Runoff follows the fence line making erosion worse.

Orange lines highlight the slope direction.

Yellow line depicts the correct positioning.

Blue line is the water runoff direction.

Join Fences

Fold edges on one another several times & then fixed.

Gaps allow sediment to pass through.

Trench In

Bottom buried up to red line & backfill firmly compacted.

Not buried deep enough & ground poorly compacted.

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Hy-Tex CoirMesh™ Woven Coconut Fibre Erosion Control Meshes

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Hy-Tex CoirMesh™ Woven Coconut Fibre Erosion Control Meshes

CoirMesh™ woven coconut fibre meshes protect seed and soil on bare surfaces vulnerable to erosion by weather, water and general abrasion, and promote vegetation restoration. These exceptionally tough, durable and hard wearing meshes are particularly beneficial on sites where erosion forces are harsh (such as waterways and exposed uplands) or plants slow to develop.

Furthermore, the high tensile strengths of the fabrics can be utilised in bioengineering solutions to provide temporary soil reinforcement and retention.

EROSION ONTROL EATURES

S rface Ero ion ontrol Like our *Soil Saver™* jute meshes, the woven yarn structure and hairy fibres, of the *CoirMesh™* range effectively protect bare surfaces from weather erosion by sheltering the ground from rainsplash and wind scour damage dissipate the energy of overland water flow and trap silts from runoff.

In addition, these hard wearing fabrics also effective protect against abrasion erosion caused by pedestrians and wildlife (School playing fields, footpaths and deer parks are good examples).

aterwa Ero ion rotection Shoreline and bank erosion is caused by a variety of conditions including scour from flowing water wind, motorboat, and jet ski generated waves ice heave groundwater seepage water level fluctuation runoff from adjacent uplands and human and wildlife use of the waterfront.

The tough, durable, close woven structures of *CoirMesh™* fabrics are ideal suited to such harsh conditions, protecting and supporting the ground and promoting sedimentation and encouraging the restoration of bank and wetland fringe vegetation.

IOENGINEERING EATURES

i D ra ilit Coir is a strong cellulose fibre, obtained from coconut husks, that has a high lignin content - resulting in excellent naturally resistant to rot, moulds and moisture.

Field trials, combined with laboratory testing (See opposite), have shown that woven coir is an extremely durable material, and maintains it s structural integrity for many years.

CoirMesh™ meshes are therefore recommended on sites where conditions will accelerate decomposition, such as uplands or waterways, or where vegetation may be slow to establish, such as shady sites.

i Stren t Woven coir meshes are very strong and hard wearing, having higher wet tensile strengths and functional longevity (5-10 years) than other organic erosion control fabrics. They therefore withstand harsher erosion forces and higher shear stresses than alternative natural fibre erosion products.

Geote tile ro ertie The strength, durability and weave densities of the *CoirMesh™* range allow specifiers to go beyond the design limits of other organic erosion control blankets, and offer great scope for use in as geotextiles in ground engineering applications - to provide initial structural stability until sustainable vegetation and reinforcing root matrix establishes.

The meshes have successfully been used as temporary soil retention envelopes on steep slopes, as stabilisation geotextiles for access tracks and as filtration and retention layers on riverbanks.

Furthermore, because the load bearing capacity of soil increases as it consolidates, the fabrics are also useful for temporary soil reinforcement applications.

ide Ran e of e Den itie Hy-Tex supply *CoirMesh™* in a comprehensive range of mesh si es, and weave patterns, to satisfy demands for a wide range of applications and vegetation types.

A special *CoirMesh™ Loop* grade is also available which incorporates a raised loop pile for enhanced sediment entrapment and erosion energy dissipation in extremely harsh environments. This makes it particularly beneficial on sites with high overland, or along waterway margins, as the loop pile traps and preserves a fertile surface crust essential to successful ecological development.

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Hy-Tex CoirMesh™ Woven Coconut Fibre Erosion Control Meshes

LA ORATOR TRIALS A

To test the life and strength of various natural fibre woven materials the BAM German Testing Institute placed samples in incubators simulating extreme conditions designed to rapidly accelerate decomposition. Cotton fully degraded after weeks, and jute within weeks, while after a full year coir still retained over 20 of its original tensile strength.

Other fabric samples were put in a shower room and kept wet for 1 7 days with a weight at each end to simulate traction in flood conditions. Both the jute and cotton samples fell apart before the trial was complete. However, the coir was undamaged and maintained its physical structure without any change except slight elongation.

IELD TRIALS ELS U LAND IG A S

"...Coir based geotextiles have been shown to persist in UK upland conditions for at least 3 years and to retain their erosion control function The non-coir biodegradable products tested initially performed well but did not last much longer than one year *. The heavier coir-based products, when well seated on the soil, provide physical protection for the young seedlings against desiccation and wind rock, as well as erosion control and moisture retention. These are of much benefit on upland sites..."*

"...Coir based geotextiles are of particular use because of their longevity which allows slow growing plants to establish well before the geotextile biodegrades. This is of great value where climatic conditions may result in slow plant establishment, where construction difficulties may delay sowing until late in the season, or where slow growing native plants need to be established to match nearby vegetation..."

ichards, Moorehead and Laing Ltd
Extracts from the 1 2 Coir Geotextile Seminar

EGETATION RESTORATION EATURES

e etation ro otion In addition to providing stable ground conditions for growth, *CoirMesh*™ fabrics create a beneficial environment for the promotion of effective vegetation restoration. The grid like construction retains seed, moisture and nutrients encourages water infiltration into the underlying soil provides shade and insulation and protects emerging seedlings against wind rock and rain impact damage.

The coconut fibre also absorbs and retains large amounts of moisture to maintain humid conditions.

Finally a wide range of mesh densities are available to cater for differing vegetation requirements.

rolon ed rotection ative plant species and wildflowers often take much longer to develop that common vegetation. Consequently, the slower decomposition rates of the *CoirMesh*™ range are ideally suited to protecting such sites - allowing ample time for such flora to successfully develop (e.g. heather heathland).

EN IRON ENTAL EATURES

ildlife riendl The open weave structure of *CoirMesh*™ fabrics consist of freely movable intersecting yarn threads. This feature significantly increases wildlife friendliness compared to synthetic net stitched organic blankets and plastic mats, as there are many instances where fish, birds, and reptiles may potentially get entangled in such synthetic nets.

CoirMesh™ fabrics are made purely from coconut fibre so pose minimal risk to gra ing animals if accidentally ingested.

En iron entall De ira le The meshes fully decompose, and integrate with the soil, over time to leave no future problems for land maintenance or wildlife habitats.

CoirMesh™ fabrics are made from freshwater retted coconut fibre husks, without bleaching or chemical treatment, so contain no pollutants that may harm the ecosystem.

Coir is an abundant, natural, renewable resource so satisfies important environmental concerns regarding sustainability.

Neat A earance The discrete natural faun colour, and ability to readily stain to the soil colour, combined with the tidy finished appearance, are visually pleasing.

Te a De art ent of Tran ort Slo e and annel Ero ion ontrol Trial

SEDI ENT LOSS TRIALS
<u>Slope Protection Application</u>
1:2 Clay
700g Coir Mesh0 2201 kg/10m
00g Coir Mesh0 2 50 kg/10m
Control2.05 kg/10m
1:2 Sand
700g Coir Mesh10 3 kg/10m
00g Coir Mesh27 05 kg/10m
Control53 210 kg/10m

<u>Channel Liner Application</u> (Grade 3)
Shear Stress Flow 96 Pascal
(Velocity l/m /sec, depth 32. 1 cm)
7 0g Coir Mesh0 1 cm
Control 2 2 50 cm
Shear Stress Flow 192 Pascal
(Velocity 5. l/m /sec, depth .01 cm)
7 0g Coir Mesh0 350 cm
Control 0 37 cm

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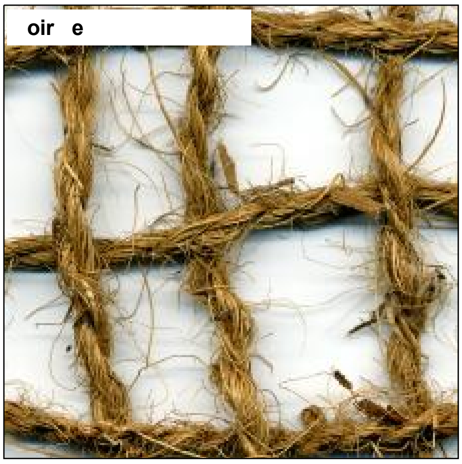
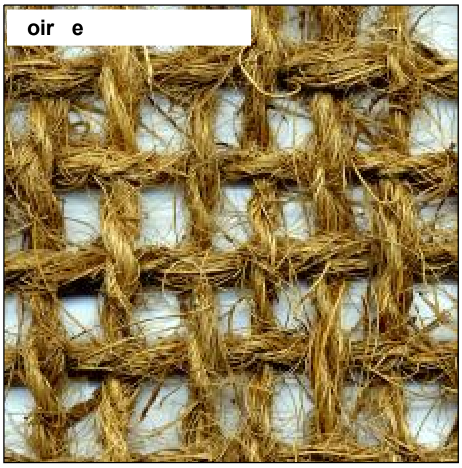
Hy-Tex Coir Mesh™ Woven Coconut Fibre Erosion Control Meshes





alit For bioengineering designs it is critical to have reliable strength retention and durability properties. Therefore the entire CoirMesh range are made using the superior processes of freshwater retted and properly graded coconut fibre, then are spun and woven to well defined specifications.

Furthermore, Hy-Tex are the only British supplier to import directly from India, and work exclusively with the highly regarded manufacturer Brothers Coir Mills.

Consequently, consistent quality, and traceability of manufacturing source, can be assured.

S ecification In addition to the standard grades detailed below, Hy-Tex offer a comprehensive range of mesh densities (from 205 to 2,500g/m) to satisfy any site conditions or vegetation requirements.

on-standard 1.00 to .00m wide roll widths can also optionally be supplied for installation convenience.

S ecification	Te oir e			
				Loo
Weight	00g/m	700g/m	00g/m	1, 00g/m
arn Thickness	mm	mm	mm	mm
Warp Threads	/m	110/m	130/m	1 0/m
Weft Threads	0/m	70/m	70/m	0/m
Warp Loops	-	-	-	5/m
Weft Loops	-	-	-	3 /m
Open Area	5	0	35	20
Material	Pure, freshwater retted, woven coir fibre yarn			
Warp uality	Vycome	Anjengo	Anjengo	Vycome
Weft uality	Vycome	Aratory	Aratory	Vycome
Manufacturer	Brothers Coir Mills, India			
Pack si e	2m x 25m			

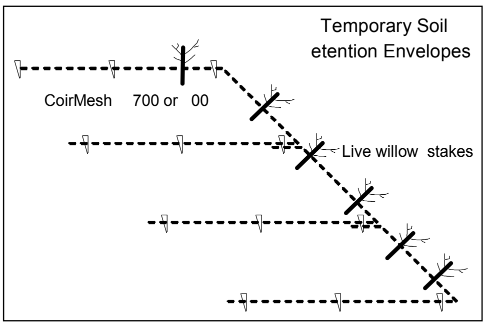
An en o - Long and medium staple, well cleaned fibre from well retted husks. Fairly hairy and relatively smooth and stiff.
Arator - Long and medium staple fibre, less combed fibre from retted husks. Hairy, less regular spinning slightly pithy.
co e - Medium and short staple fibre, less combed fibre from retted husks. Hairy, less regular spinning slightly pithy with rough texture. Very flexible.

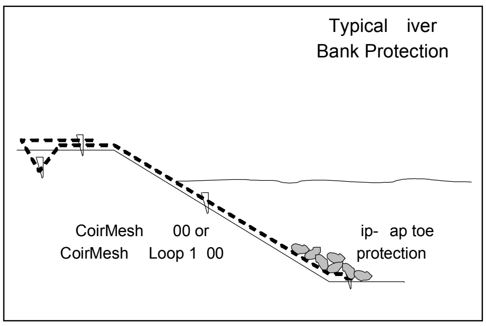
Further specification details, and full installation guides available on request.

I ortant Additional S ecifier Infor ation

1). equest an Indian G.S.P. Certificate of Origin - this will help confirm source and original destination of material.
2). Do not accept non-Indian material - other countries also manufacture coir meshes but generally the standard is not as high.
3). Do not accept lower yarn qualities - they are weaker and degrade sooner.
). Due to the high general demand for coir fibre, some manufacturers use cheaper mechanical, or chemical, processing methods which can produce poorly graded, weaker, and potentially contaminated yarn fibre.

For reliable performance coir geotextile yarns should be made using the traditional method of retting ripe coconut husks in freshwater for up to six months. This retting process cures the coconut fibre - increasing UV resistance, durability, water retention and flexibility without causing deterioration. The fibre is then separated from the husks and sorted into grades by skilled labour.





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GENERAL INSTALLATION GUIDELINES

Preparation

- Work sub-grade and topsoil free of clods, rubbish and large stones to a depth of at least 75mm.
- Smoothly grade (but do not compact) soil surface, to eliminate ruts, footprints and other depressions as far as possible.

Installation

- Bury the top edge of the coir in a narrow slit trenches 300mm deep. Use staples/pegs at 300mm centres to secure edges. Fill trench and tamp firmly closed.
- Unroll the coir down the slope (or, if suitable, parallel to the contours on short straight slopes), ensuring it lies smoothly but loosely on the surface without tension.
- Fix with staples/pegs at maximum 1.00m centres - fastening rows down each overlap, and at maximum 1.00m intervals across each strip.
- Where two or more widths are applied side by side, an overlap of at least 200mm must be made, lapping **in direction of water flow** to avoid lift by the current.
- Where more than one length is required down the slope, the top piece should overlap the second by at least 500mm, and the top edge must also be folded under by 150mm. Secure the lap with staples at 300mm centres along the fold.
- Bury bottom edge in a narrow slit trench 300mm deep, or fold under by 150mm. Use staples/pegs at 300mm centres to secure edges. Fill trench and tamp firmly closed.
- Bury extreme outside edges of the coir covered area in narrow slit trenches 300mm deep. Use staples/pegs at 300mm centres to secure edges. Fill trenches and tamp firmly closed.
- On soft/sandy soil, or windy areas, apply staples in alternate slanting positions. For extremely arduous situations double pin, or reduce spacing, for extra hold.
- Studies and experience have shown that a two-man team is the most efficient way to install staples. One man drives the staples just below ground level with a wooden mallet. The other walks ahead, carrying a supply of staples, pushing them into the soil as far as possible by hand at the correct intervals.
- Workers should avoid unnecessary walking directly on the prepared area both before and after the coir is applied.
- Where required, coir can be easily cut using scissors or a sharp knife, taking care not to stretch or distort the material excessively.

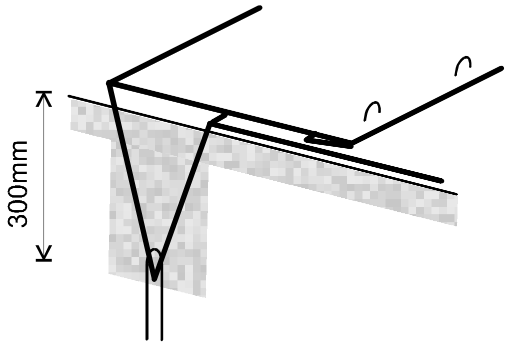
Finishing

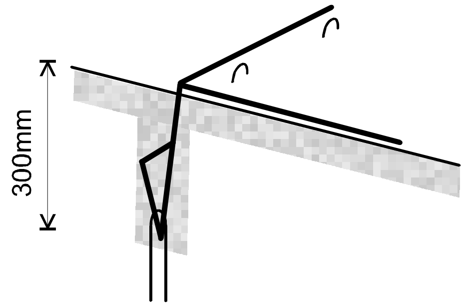
- If site conditions permit, the entire coir area should be rolled with a smooth roller. For best results the roller should weigh approximately 100 kg per metre length.
- Plants or saplings may be planted through the coir by cutting a 'V' shaped slit, folding the flap back during planting then pinning back in place with sufficient staples fixed around the opening to prevent lift. To avoid disturbing the coir when planting, it is recommended that work be executed from a long lightweight plank or ladder.

Inspection

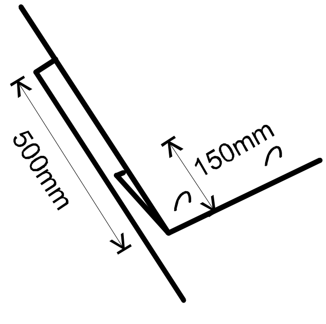
- The coir covered area should undergo a final inspection. Any clods etc. which hold the material off the ground should be stamped into the soil. Push the coir mesh down into any depressions and secure with staples.
- Ensure the coir mesh completely covers all areas to be protected from erosion. Overlaps must be ample and well stapled so that no gapping can occur. The material should be in intimate contact with soil surface at all points.

TERMINATION DETAILS

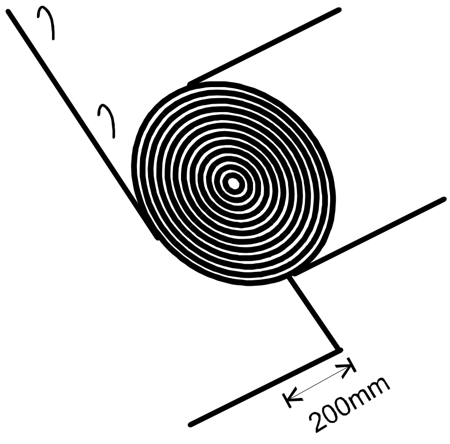




JUNCTION OVERLAP DETAIL



SIDE OVERLAP DETAIL



HY-TEX

Specialists in Biodegradables

APPENDIX 4

SEDIMAT SPECIFICATION AND INSTALLATION GUIDE

Hy-Tex **Sedimat™** Sediment Entrapment Mats


Sedimat™ installed using stones


Sedimat™ prior to installation


Silt laden Sedimat™ being removed


Trapped silt in Sedimat™

International Erosion Control Association Award Winner

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Hy-Tex **Sedimat™** Sediment Entrapment Mats


Sedimat™ installed using stones


Sedimat™ installed using stakes


Disturbed sediment entering Sedimat™


Used Sedimats™ fixed to bank


Grass roots binding to soil

Waterway Sedimentation Downstream sedimentation of waterways is a significant problem common to a wide range of in-stream activities, and from site run-off.

Civil engineering projects, drainage works, ditch maintenance, temporary fords and flood alleviation schemes can all release large pulses of sediment which drift downstream.

Impact on Waterways Sediments can reduce, or destabilise, channel cross-sections, interfere with drainage, blocks culvert, and upset natural or desired hydrology.

Impact on the Environment Sediments can smother fish spawning areas, choke out aquatic insects, reduce pool volumes, and harm aquatic vegetation.

The Solution *Sedimat*™, a *patented* product, is a simple, yet effective, mat designed to trap harmful disturbed sediment by promoting settlement.

Sedimats™ are flat 1.20 x 3.00m pads which are fixed on the stream bed immediately downstream of the site about to be disturbed.

They are constructed from layers of biodegradable materials, secured to wooden stays to help maintain their form in the current and facilitate removal.

Trap Harmful Disturbed Sediment During in-stream activities, disturbed sediment is pushed along the stream bed by the current until it reaches the mats. Sediment then filters down through the mat layers and is trapped inside.

Each *Sedimat*™ is capable of trapping in excess of 250kg of sediment. Because they lay flat on the bed the mats are not affected by the current and do not cause back up of water.

Easy to Handle, Install and Remove The mats are packaged individually in rolls which are simple to store, handle and transport.

They are secured flat on the stream bed, with either stones or driven-in stakes. Placed immediately downstream of the area to be disturbed, arranged in sufficient numbers to cover the stream bed, just before work begins.

Provide Useful Bank Stabilisation When the mats are full, or construction activities complete, they can easily be removed either by rolling them into a machinery bucket or dragging them onto the bank.

The fully biodegradable, sediment laden mats can then be unrolled, fixed to the embankment and seeded to provide instant bank stabilisation, a rich seedbed for vegetation restoration, and avoid disposal problems.

Field Trials *Sedimats*™ were developed by fisheries biologists at the New York State Electric and Gas Corporation, and put through an extensive set of field trials under the review of the New York State environmental and transport agencies.

These trials were conducted in a wide variety of streams across the State, from tiny, slow running rivulets less than 1.50m wide to swift and turbulent streams more than 24.00m across.

Regardless of conditions, the result was the same. Sediment mats effectively trapped large volumes of sediment, on average more than 80% of the amount disturbed.

In a State noted for stringent environmental protection standards, *Sedimats*™ are now fully approved and in some situations are mandatory.

In 1996 Sedimats™ won an International Erosion Control Association award.

Since their introduction into Britain they have gained wide acceptance by environmental consultants, and are now extensively used by the Environment Agency and many contractors on a variety of waterway related projects.

Please consult installation guidelines for further assistance.

FURTHER INFORMATION, AND A VIDEO/DVD, AVAILABLE ON REQUEST

Sedimat™ technology is protected throughout Europe
under patent no. 93114 349.9-1255.
Hy-Tex (UK) Limited are the sole European licensee

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Hy-Tex **Sedimat™** Sediment Entrapment Mats

COVERAGE GUIDELINES

TheBrandNameforQuality
Hy-Tex **Sedimat™**
Sediment Entrapment Matting

MAT SIZE 1.20 x 3.00m

Sedimats™ are easy to apply in a variety of situations in both natural and artificial channels once their guidelines for use are understood.

Firstly, for maximum effectiveness, mats should be installed across the full width of the stream. Faster moving water requires a greater length of coverage than slower moving water, especially if the flow is turbulent. Also stream beds with a preponderance of silt and clay require a greater length of coverage than if the sediment is primarily sand and gravel. The number of mats needed for a particular location is also directly proportional to how invasive the project there will be.

Minimum Length of Down Stream Coverage Suggested

Water Velocity	0-0.3m/s	0.3-0.6m/s	0.6-0.9m/s	>0.9m/s
Fines mostly sand	1.20m	2.40m	3.60m	>5.00m
Fines mostly silt and clay	2.40m	4.80m	7.20m	>10.00m

FIG: 1

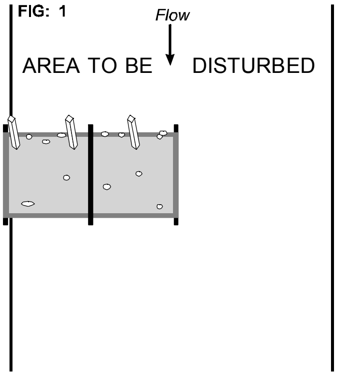


FIG: 2

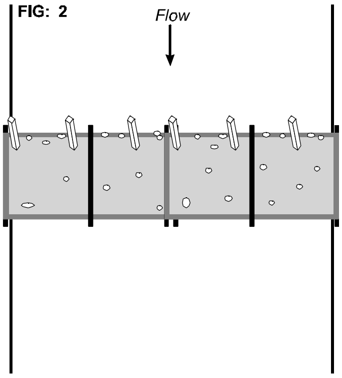
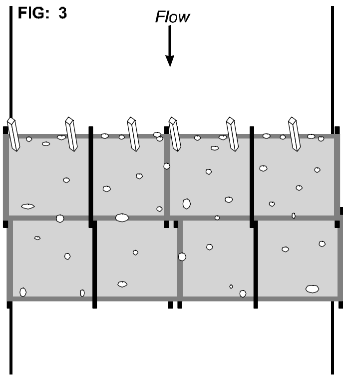


FIG: 3



	Guidelines	Comments
LOCATION	a). The mats must be installed downstream of the area to be disturbed, and should be placed as close as possible to the works area without causing disruption.	*The mats are at their most effective when encountering sediment directly after it is disturbed - as the sediment travels downstream it becomes more dispersed in the water. However, if the current immediately below the work area is so fast and turbulent that sediment may be transported right over the mats then they can be positioned downstream at the first slow spot.*
INSTALLATION	a). Before works begin, and starting at the position furthest up-stream, unroll and stretch out the mats then submerge them in the water at right angles to the flow.	*The mats can be unrolled across or down the channel to provide any length/width of coverage.*
	b). Secure up-stream edges with sufficient stones/stakes to prevent lift by the current. If required, add further stones/stakes to ensure the mats lay flat on the stream bed and will not be displaced (Fig: 1)	*Were currents are/may be strong, or if the mats will be installed for a long time, it is advisable to use stakes.* *It is important the current is not allowed to flow under the mats. Avoid covering too much of the mat with stones (accumulating silt will act as an anchor).*
	c). Where several mats are required to cover the channel width, lap the sides (Fig: 2)	*The full width of the channel should be protected unless there is a specific reason.*
	d). Where more than one row is required, tuck the up-stream edges under the preceding mats (Fig:3)	*Refer to coverage guidelines*
REMOVAL	a). It is important to regularly check if the mats are full. Feel/Look for the presence of sediment lying on top of the downstream edge of the mat.	*When the mats are full they must be replaced or more added to the downstream end of the existing mats.*
	b). When construction activities are complete, or the mats full, they can easily be removed either by rolling them into a machinery bucket or dragging them onto the bank.	*The mats are capable of trapping in excess of 250kg of sediment so will require machinery removal when heavily laden.* *When being removed there is often slight leakage, if this is not acceptable then mats should be temporarily installed downstream to trap this.*
	c). If required, the mats can then be unrolled, secured to the bank (with fixing pins or stakes) and seeded.	*The sediment laden biodegradable mats provide instant surface stabilisation and a rich seedbed for vegetation restoration, thereby avoiding disposal problems.* *If desired the support stays can easily be cut free for re-use or disposal.*

WARNING - ENSURE YOU PLAN AHEAD FOR REMOVAL OF MATS AS THEY WILL BE HEAVILY LADEN WITH SILT

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APPENDIX D

ACTION PLAN – VERSION 2.0

Peat Slide Action Plan – Version 2.0

Meenbog Wind Farm

DOCUMENT DETAILS

Client:	**Planree Limited**
Project Title:	**Meenbog Wind Farm**
Project Number:	**201174**
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01	Draft	11/03/2021	BK; TB; PR; MW; MG; SC	BK / MW
02	Final	08/03/2021	BK; TB; PR; MW; MG; SC	BK/WOC

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1. INTRODUCTION

1.1 Background

McCarthy Keville O'Sullivan Ltd. (MKO) have been requested by Planree Limited (Planree) to provide technical assistance and prepare an Action Plan following a peat slide incident at the Meenbog Wind Farm construction site on the 12th November. Since the appointment by Planree, MKO have been coordinating a team of ecologists, hydrologists, environmental scientists, environmental engineers and aquatic ecologists to prepare an Action Plan that would make recommendations to mitigate the effects of the incident.

Version 1.0 of this Action Plan was prepared specifically to inform Planree's response to a notice issued by Donegal County Council (DCC) dated 17th November issued under Sections 10(5), 12(1) and 23(1) of the Local Government (Water Pollution) Acts, relating to the discharge of peat, sediment and heavily soiled water from the wind farm site under construction at Meenbog, Ballybofey, Co. Donegal to the Shruhangarve stream and Mourne Beg River commencing on the 12th and 13th November 2020.

This version of the Action Plan (Version 2.0) updates and expands upon the recommendations provided in Action Plan Version 1.0. In particular, additional detail is provided on the phasing of, and specific measures proposed for, the restoration of the Shruhangarve Stream. These measures are set out in Section 5.2 of this plan.

1.2 Scope of Action Plan

DCC's letter of 17th November requested Action Plan, in the form of a written report, by submitted to Donegal County Council detailing the engineering measures identified and considered necessary to:

> *(a) eliminate or limit the release of further polluting matter from the area where the landslide occurred, from areas up gradient of the land slide and from areas down gradient of the landslide where material has been deposited,*
>
> *(b) prevent the catastrophic release of material built up behind the existing improvised impoundment structure on site, (taking into consideration projected rainfall amounts) and,*
>
> *(c) mitigate against the further dispersal of peat and sediment, deposited along the banks of the Shruhangarve, by the watercourse through and beyond the confines of the site.*

This Action Plan has been prepared by MKO for Planree Limited in response to the DCC requests outlined above. The description of emergency engineering works undertaken to date which address Point (a) and (b) above has been compiled by Ionic Consulting and is set out in Section 2.

The MKO proposals are included herein as a series of recommendations for Planree Limited or their contractors to implement on-site.

MKO has prepared this action plan to allow Planree Limited present it and the recommendations contained herein as Planree Limited's proposals to Donegal County Council along with the necessary commitments to their effective implementation.

MKO is not responsible for the implementation of the proposed measures contained herein on-site, but will monitor the implementation of any measures that might be proposed by Planree as part of an expanded role for the on-site Environmental Clerk of Works.

This Action Plan has been prepared as a "Version 2.0" document and is by no means exhaustive or limited. This version of the Action Plan provides additional detail on the phasing of, and specific measures proposed for, the restoration of the Shruhangarve Stream. Action Plan Version 2.0 focuses on immediately implementable measures for the stabilisation of deposited peat in the slip scar and downstream of Wall 1. It is anticipated that future versions of the Action Plan will be forthcoming and will address in further detail the proposed restoration of the Shruhangarve Stream upstream of Wall 1. Further recommendations are likely to be brought forward to address the situation on-site and in the downstream watercourses as a result of ongoing water monitoring efforts, ecological surveys, seasonal factors, the trialling of certain recommendations on site and the contributions from other stakeholders and regulatory authorities whose input will be very much welcomed and carefully considered.

1.3 Contributors

The following people contributed to the preparation of the Action Plan and the recommendations contained herein.

Brian Keville – MKO (Environmental Director)

Brian has over 20 years' professional experience as an environmental consultant having graduated from the National University of Ireland, Galway with a first class honours degree in Environmental Science. Brian's professional experience has focused on project and environmental management, and environmental impact assessments. Brian has acted as project manager and lead-consultant on numerous environmental impact assessments, across various Irish counties and planning authority areas. These projects have included large infrastructural projects such as roads, ports and municipal services projects, through to commercial, mixed-use, industrial and renewable energy projects. The majority of this work has required liaison and co-ordination with government agencies and bodies, technical project teams, sub-consultants and clients.

Michael Watson – MKO (Environment Team Project Director)

Michael is Project Director and head of the Environment Team in McCarthy Keville O'Sullivan (MKO). Michael has over 18 years' experience in the environmental sector. Following the completion of his Master's Degree in Environmental Resource Management, Geography, from National University of Ireland, Maynooth he worked for the Geological Survey of Ireland and then a prominent private environmental & hydrogeological consultancy prior to joining MKO in 2014. Michael's professional experience includes managing Environmental Impact Assessments, EPA License applications, hydrogeological assessments, environmental due diligence and general environmental assessment on behalf of clients in the wind farm, waste management, public sector, commercial and industrial sectors nationally. Michael also has a Bachelor of Arts Degree in Geography and Economics from NUI Maynooth, is a Member of IEMA, a Chartered Environmentalist (CEnv) and Professional Geologist (PGeo).

Thomas Blackwell – MKO (Senior Environmental Consultant)

Thomas is a Senior Environmental Consultant with MKO with over 15 years of progressive experience in environmental consulting. Thomas holds a BA (Hons) in Geography from Trinity College Dublin and a M.Sc. in Environmental Resource Management from University College Dublin. Prior to taking up his position with MKO in August 2019, Thomas worked as a Senior Environmental Scientist with HDR, Inc. in the United States and held previous posts with private consulting firms in both the USA and Ireland. Thomas is a registered Professional Wetland Scientist with the Society of Wetland Scientists with specialist knowledge in wetland assessment and delineation, mitigation planning and design, stream geomorphic assessment, and stream and wetland restoration design. Thomas' key areas of expertise include fluvial geomorphology and stream restoration design. Thomas has provided stream restoration design, and construction oversight for numerous private and publicly funded projects in multiple jurisdictions.

Pat Roberts – MKO (Principal Ecologist)

Pat joined MKO (then Keville & O'Sullivan Associates) in 2005 following completion of a B.Sc. in Environmental Science. He has extensive experience of providing ecological services in relation to a wide range of developments at the planning, construction and monitoring stages. He has wide experience of large scale industrial and civil engineering projects. He is highly experienced in the completion of ecological baseline surveys and impact assessment at the planning stage. He has worked closely with construction personnel at the set-up stage of numerous construction sites to implement and monitor any prescribed best practice measures. He has designed numerous Environmental Operating Plans and prepared many environmental method statements in close conjunction with project teams and contractors. He has worked extensively on the identification, control and management of invasive species on numerous construction sites.

John Hynes – MKO (Ecology Team Project Director)

John Hynes is a Senior Ecologist with McCarthy O'Sullivan Ltd. with over 7 years of experience in both private practice and local authorities. John holds a B.SC in Environmental Science and a M.Sc. in Applied Ecology. John has specialist knowledge in Flora and Fauna field surveys. Geographic Information Systems, data analysis, Appropriate Assessment, Ecological Impact Assessment and Environmental Impact Assessment. Since joining MKO John has been involved as a Senior Ecologist on a significant range of energy infrastructure, commercial, national roads and private/public development projects. John has project managed a range of strategic infrastructure and development projects across the Ireland and holds CIEEM membership.

Owen Cahill – MKO (Project Environmental Engineer)

Owen is an Environmental Engineer with McCarthy O'Sullivan Ltd. with over 11 years of experience in the environmental management and construction industries. Owen holds BSc. (Hons) and MSc. in Construction Management and a Masters in Environmental Engineering. Owen has project managed the Environmental Impact Assessment of a range of development projects across the Ireland and holds Full Membership with the Institute of Environmental Management & Assessment and is a Chartered Environmentalist.

Michael Gill – Hydro-Environmental Services

Michael Gill is an Environmental Engineer with over 18 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms in Ireland. He has also managed EIA/EIS assessments for infrastructure projects and private residential and commercial developments. In addition, he has substantial experience in wastewater engineering and site suitability assessments, contaminated land investigation and assessment, wetland hydrology/hydrogeology, water resource assessments, surface water drainage design and SUDs design, water quality protection, water treatment systems and surface water/groundwater interactions.

Cormac Ó Dubhthaigh – Ionic Consulting Limited

Cormac is the Civil Engineering Manager at Ionic Consulting and joined the company in 2009. He holds a first class honours B.E. Civil Engineering degree from UCD and also completed an M.Eng.Sc. masters degree in Structural Engineering in UCD in 1996. He has considerable experience in the design of wind farm infrastructure including roads, hardstandings, wind turbine foundations, substations, bridges and associated works, with design experience on over 30 wind farms. He has previous experience in Ireland and Australia working with leading civil engineering consultancies including ARUP and Roughan & O'Donovan. He is a chartered member of Engineers Ireland (CEng MIEI).

Claire Looney – Ionic Consulting Limited

Claire is a Senior Project Manager with Ionic Consulting and has more than 14 years' experience in the energy sector, both in Ireland and internationally. She leads a team focussing on the delivery of onshore windfarms in Ireland, from pre-construction through to operational takeover with specific focus on Health & Safety, contract administration and programme delivery. She acts as the PSDP and Project Manager for a number of windfarms in Ireland. She is a chartered engineer and holds an honours degree in Electrical Engineering from UCC.

2. BACKGROUND (WORKS COMPLETED TO DATE)

2.1 Emergency Works

The following summary of emergency works undertaken on site has been prepared by Ionic Consulting (Ionic), and the Ionic briefing note from which this content was taken is included in full in Appendix 1. The emergency works set out in this section have now been completed. This section has been retained in Version 2.0 of the action plan for completeness and for ease of reference for the reader.

As set out in the notice and in line with section 6.1.5 of the project Construction and Environmental Management Plan ("CEMP"), we can confirm that following the peat slide on 12th Nov 2020, all construction works were ceased on the wind farm site as soon as notice of the incident was provided to site management. The only activities undertaken were those works required to ensure construction areas were left in a safe condition. Once all personnel on site had been safely accounted for, available resources were then immediately re-directed towards mitigating against further discharges to watercourses. The response to the peat slide can be split into stages which are set out below.

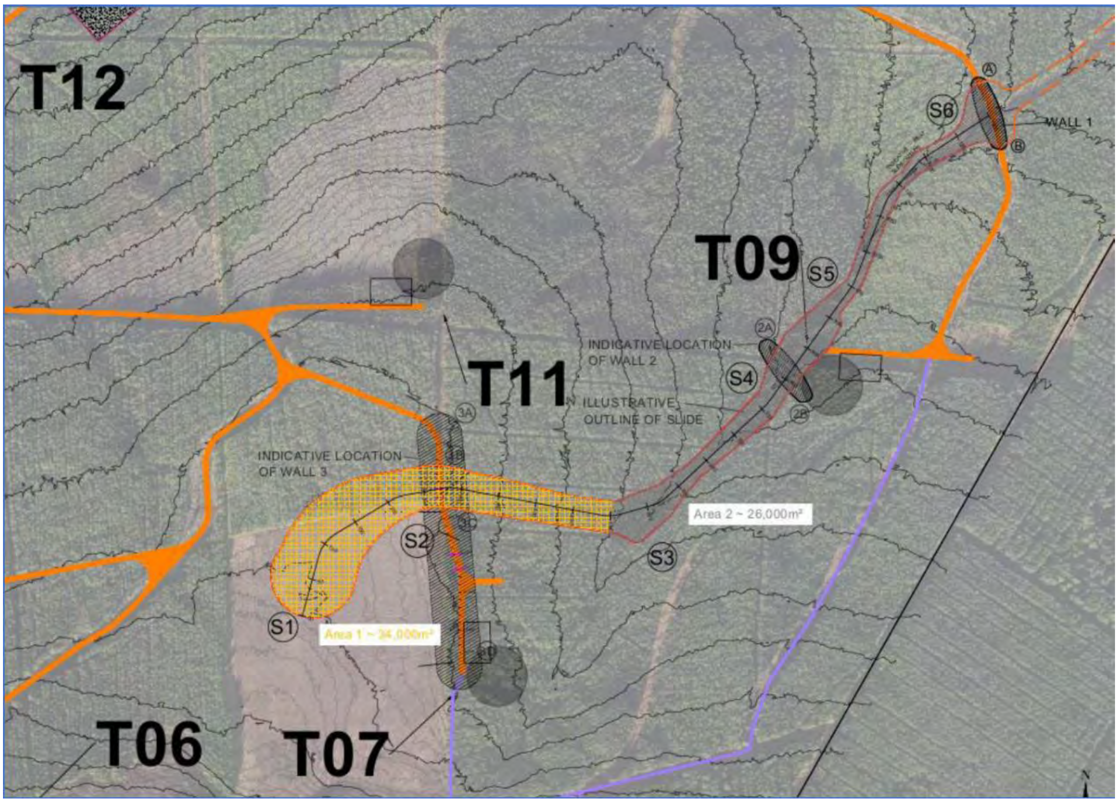


Figure 2.1 Overview map of works area

2.1.1 Step 1 - Immediate actions

The first stage was the immediate response within the first 24-72hours which consisted of emergency measures to prevent further material from entering local watercourses. Ionic Consulting who are the Designer and Geotechnical Engineers for the works were consulted. It was possible to undertake a drone survey relatively quickly following the incident as a drone was available on site. Based on the available information the slide path could be determined and an assessment of safe access points was undertaken.

It was evident that majority of the material that slid was deposited between points S3 and S6 shown on Figure 2.1 above, largely because of the shallower gradient and also by the existing roadway leading to turbine no. 9 (T9). This unstable, water-laden material presented the most immediate risk in terms of pollution of watercourses with the concern that the roadway could be overtopped by material being retained to the South. This risk was exacerbated by the fact that the slide material had entered the local stream (at approximately point 'S3' in Figure 2.1) and water from the surrounding catchment entering the stream would be retained behind the roadway (identified as 'Wall 1' in Figure 2.1). A secondary risk in terms of immediate further pollution of watercourses was the risk of additional movement of material from the area upslope of the slide initiation point (to the South and west of point 'S1' in Figure 2.1.

To mitigate against the risks above, the immediate aim was to introduce check barrages to prevent the slide from reaching any watercourses in line with the CEMP. Immediate action was taken to reinforce and increase the height of the accessible roadway leading to T9. The reason works commenced at this point was two-fold:

1) This road was already acting as a check barrage, retaining some of the slide material to the South however it was at the point of being overtopped by the slide material.

2) Following remote consultation with geotechnical consultant Ionic Consulting and with the information from the initial drone survey of the area it was evident that this was the only location where it would be safe to gain immediate access to initiate the CEMP measures.

Works commenced at the roadway to T9 (referred to as Wall 1 in Figure 2.1 above) on the afternoon of the 12th November 2020 as soon as an inspection had been conducted to ensure it was safe for personnel to work in the area. It was not possible to produce a detailed design in this timeframe given the need for immediate action however the proposed works were reviewed and progressed in consultation with the Designer Ionic Consulting. The initial aim was to raise the berm by 1.5m-2m for a length of approximately 100m along the area retaining the slide, this was further raised over the following days by up to 3.8m from the original design level.

The primary aim of Wall 1 was to limit or prevent the flow of liquefied peat into watercourses beyond the site. The existing pipe was largely blocked due to the deposited peat, and though water continued to flow through and around the wall, including seepage through the existing pipe, the majority of the peat slurry and solid clumps of peat were retained.

2.1.2 Step 2 -Assessment

Before progressing works at any other points on site, more detailed geotechnical assessment was required in order to:

a) Establish safe areas for access on site and to identify unsafe or potentially unstable areas on site

b) Assess what additional emergency measures were necessary to prevent further movement of peat or material

Close monitoring of the slide area by drone continued on a daily basis. Upcoming weather forecasts were reviewed to consider additional rainfall events and potential impact on stability of the area. Ionic Consulting have a site engineer with daily presence on site, and engineers visited the site on 13th Nov 2020 and on six further occasions in the first 2 weeks for the purpose of this assessment.

In addition to the geotechnical assessment it is noted that MKO the environmental and ecological consultant appointed for the project attended site to assess both the Shruhangarave Stream and Mourne Beg River from the 13th Nov 2020 and a new monitoring programme was developed, with support from HES, for these two watercourses including laboratory analysis and visual checks implemented daily.

2.1.3 Step 3 - Additional Emergency Measures

Following further assessment a detailed design for 'Wall 1' was developed by Ionic Consulting. This consisted of a large stone berm raised from original road level of 217.2mOD to 221.0mOD to provide additional containment for deposited peat. A design risk assessment and detailed design are appended for reference. Please refer to drawing MNBG d021.9.1 - Wall 1 Berm (T9 Spur)_RevB and MNBG hs004.5 Design Risk Assessment - T7 Peat Slide Stabilisation RevC *(included in Appendix 2 of this Action Plan).* Following initial emergency works carried out on 12th November works continued to implement the final detailed design and were completed by 21st Nov 2020.

The detailed geotechnical assessment undertaken in step 2 identified the risk of further peat movement upslope of the slide initiation point in the peatland area (refer to point S1 in Figure 2.1) was still significant. Two other points for further check barrages were identified, denoted as 'Wall 2' and 'Wall 3' in Figure 2.1 to mitigate against this potential risk. Access for construction of Wall 2 would be from the hardstanding at T9 and access for Wall 3 would be from the last section of road constructed to solid formation on the approach to the turbine 7 (T7) location. Wall 3 was prioritised for the following reasons:

> a) Wall 3 was located immediately downslope of an area of unstable peat where significant volumes of water or liquefied peat was released, and given the visual signs of further propagating cracks from aerial drone footage it was considered a priority to stabilise this upslope material.
>
> b) Wall 3 is an 'on-land' check barrage as opposed to Wall 2 which is located 'in-stream' which was considered to present a lesser risk to pollution of watercourses
>
> c) The construction of Wall 2 could not safely commence until Wall 1 was complete whereas access was immediately available to Wall 3 prior to the completion of works at Wall 1.

As there was a short section of floating road approaching T7 remaining following the peat slide, the Designer and geotechnical consultant Ionic Consulting Ltd advised that this check barrage be installed upslope of the existing roadway. Again, a detailed design was developed prior to the commencement of the works. Consideration was given to drainage through the check barrage for geotechnical purposes. A design risk assessment and detailed design are also appended for these works for reference. Please refer to drawing MNBG d021.7.4 T7 Slide Berm Details_Rev B and MNBG hs004.5 Design Risk Assessment - T7 Peat Slide Stabilisation RevC *(included in Appendix 2 of this Action Plan)*..

Works commenced as soon as a geotechnical assessment could be completed and an appropriate civil works design could be developed. Construction of this berm referred to as 'Wall 3' commenced on 17th Nov 2020.

MKO continued to fulfil the Environmental Clerk of Works (ECoW) role during the emergency works and expanded the water quality monitoring programme that was already underway.

As soon as Wall 1 was completed and safe access and egress could be maintained to T9 via the access road, and also the section of Wall 3 past the slide affected area was constructed, construction of Wall 2 was considered. Due to increased rainfall it was observed that an excessive amount of water was flowing towards Wall 1. A decision was taken at this time to prioritise drainage of the area and strategic pumping of clean water away from the area affected by the slide. Clean water was intercepted and diverted from upstream of the slide area and discharged to the North of Wall 1. Soiled water was also removed via pumping from the area adjacent to T9. These works commenced on 25th November.

2.1.4 Measure 1 - Impound water and sediment behind Wall 1 (Complete)

Large volumes of sediment have been successfully impounded behind Wall 1 and prevented from entering downstream watercourses, as evident in Figures 2.1 and 2.2 below. The volumetric measurement of these sediment volumes is presently underway and will be reported in future iterations of the Action Plan. Approximately 79% of water flows entering the Shruhangarve catchment upstream of Wall 1 have been intercepted upstream of the impounded sediment and diverted away from the sediment impounded behind Wall 1, thereby minimising the re-mobilisation of the impounded sediment, but larger volumes of water are likely to continue to reach the upstream side of Wall 1 in periods of heavier and prolonged rainfall.

There currently appears to be minimal seepage of water through Wall 1, likely because any void spaces have become plugged with suspended peat and the bypass flows already in place around Wall 1.

Figure 2.1 Water and sediment impoundment area upstream of Wall 1 showing stabilised situation and deposits of peat up to surface of water

Figure 2.2 Aerial image of water and peat impoundment area upstream of Wall 1 showing large volums of impounded peat and clearly identifiable channel for water reaching Wall 1

Objectives of recommendations

1. *Eliminate or limit the release of further polluting matter from the area where the landslide occurred.*
2. *Eliminate or limit the release of further polluting matter from areas up gradient of the land slide.*
3. *Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.*
4. *Prevent the catastrophic release of material built up behind the existing improvised impoundment structure on site.*

Recommended measures

1. *Continue to intercept as much water as possible upstream of Wall 1 and overpump it to the downstream site of Wall 1 to minimise the amount of water reaching the upstream side of Wall 1.*
2. *Keep existing overflow pipe clear to be able to release any excess build-up of water behind Wall 1 in order to maintain the structural integrity of Wall 1.*
3. *Maintain overflow pipe at existing level and install flow meter in pipe.*
4. *Prevent any overflow of water around sides of Wall 1 by building up level of wall/road.*
5. *Continue to assess rate of seepage through Wall 1, and if necessary, seal upstream side of Wall 1 to minimise seepage through wall (using vertical timbers, peat plug etc.).*

2.1.5 Measure 2 – Intercept clean water (Complete)

Large volumes of clean water are already being successfully intercepted upstream of the peat slide area on the Shruhangarve stream as a result of the emergency works now completed on site, and are being prevented from reaching the peat slide area and becoming entrained with sediment, see Figure 2.3 below. Further volumes of clean water are being intercepted as overland flow, and prevented from reaching the peat slide area and becoming entrained with sediment. The more "clean" water that can be intercepted upstream or upgradient of the peat slide area, the less water will become soiled. Intercepting as much clean water as possible and diverting or pumping it to the downstream side of Wall 1 keeps that clean water clean and prevents that water mobilising further sediment or deposited peat sludge it might otherwise encounter.

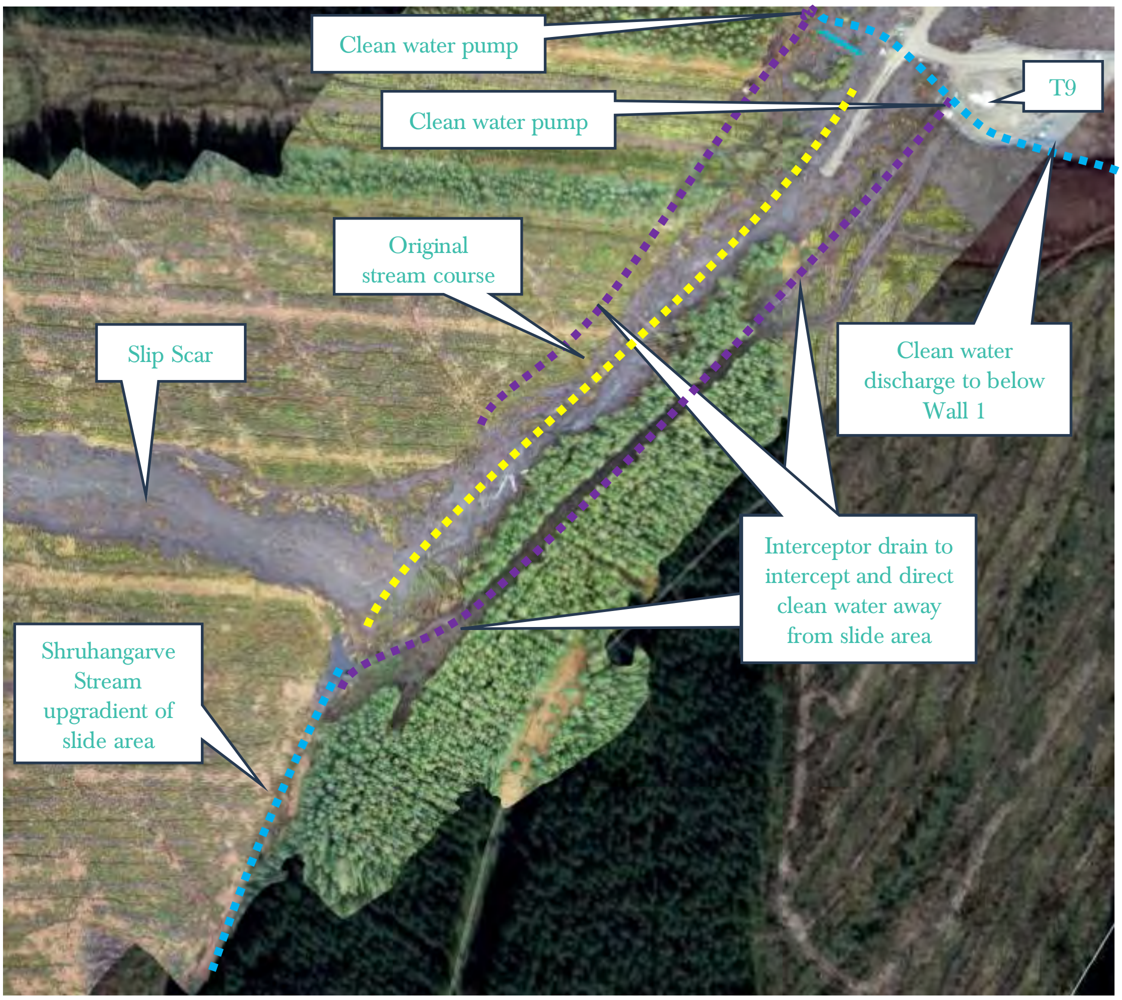


Figure 2.3 Aerial view of Stream Reach 1, showing interceptor drains collecting clear water for pumping around peat slide area

Analysis of the Shruhangarve catchment topography upstream of Wall 1 undertaken since the peat slide has divided it into "clean" and "soiled" sub-catchment areas, as detailed on HES Figure No. P1249-5_D101 included above. Clean water is being intercepted from the sub-catchment areas labelled as "upstream_clean", "T9_west_clean", and "upstream_east_clean" on HES Figure No. P1249-5_D101. Further efforts are considered likely to yield diminishing returns and may not be justifiable given the extent of further works required. Objectives of recommendations

1. *Eliminate or limit the release of further polluting matter from the area where the landslide occurred.*
2. *Eliminate or limit the release of further polluting matter from areas up gradient of the land slide.*

3. *Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.*
4. *Mitigate against the further dispersal of peat and sediment, deposited along the banks of the Shruhangarve, by the watercourse through and beyond the confines of the site.*

Recommended measures

1. *Continue to analyse catchment topography and forestry drainage features to identify other routes of clean water interceptor drains/sumps.*
2. *Specifically target area west of T9, west of stream (labelled "T9_west_clean" on HES Figure No. P1249-5_D101) for further interception of clean water. Possible interception/pumping arrangement shown in Figure 2.4 below to be developed further and approved by ecologist, hydrologist and geotechnical engineer before implementation. This has now been completed and no further works are proposed in this area.*
3. *Minimise the need for pumping, using gravity flows wherever possible.*
4. *Where necessary, identify safe pumping locations at the end of interceptor drain.*
5. *Ensure all pumps and fuels bowsers are bunded or double-skinned.*
6. *Pump and/or pipe intercepted clean water to downstream side of Wall 1.*

Discharge all intercepted and piped clean water onto rock armour downstream of Wall 1 to minimise further erosion from channel bed/bank and all diffuse dispersed flow to naturally reconcentrate in existing stream channel.

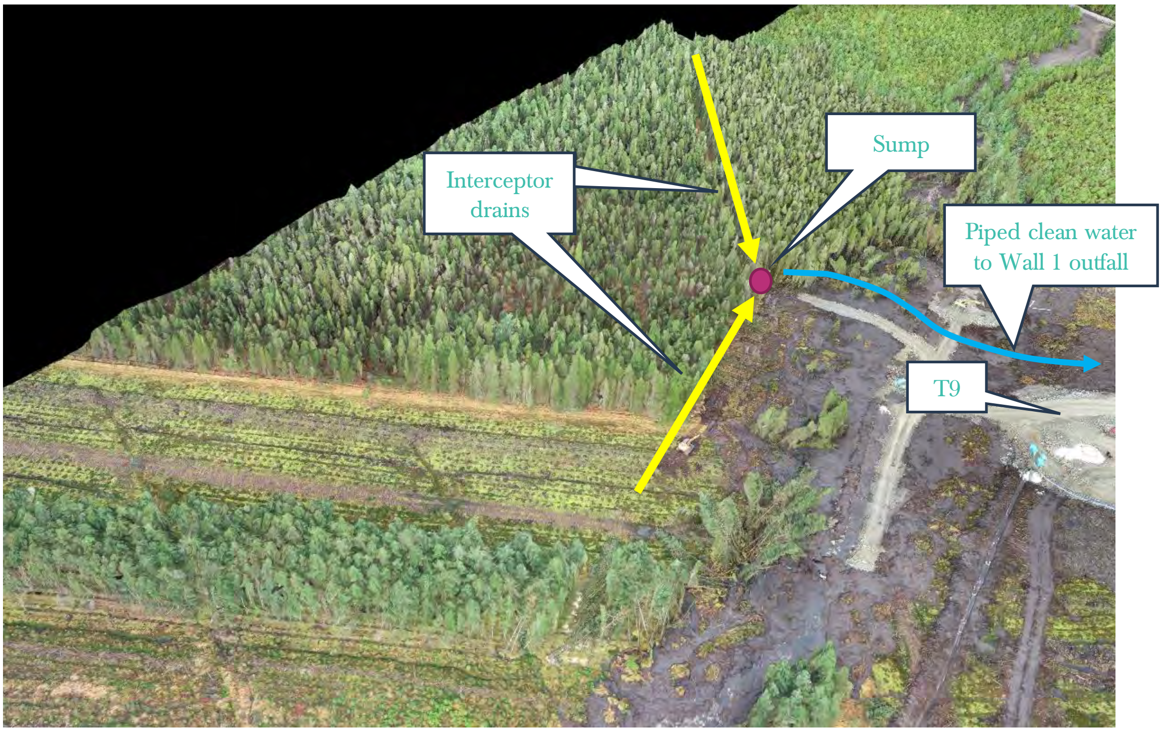


Figure 2.4 Clean water interceptor drains and pumping arrangement for area west of T9 (for illustrative purposes only)

Current situation

As of March 2021, Walls 1, 2 and 3 remain in place and are effective. These works are deemed to have largely stabilised the area. A drainage and pumping arrangement has been implemented which combined has substantially reduced the level of water flowing towards Wall 1.

Some initial measures (installation of coir matting and silt fence) were commenced downstream of Wall 1 but have been suspended pending further assessment. As referenced above, a monitoring programme has been implemented.

3. CURRENT SITE HYDROLOGY

Upstream of Wall 1 a series of emergency works have been completed to a) stabilise the ground to prevent further peat movement, and b) to manage surface water and protect downstream water quality.

The catchment upstream of Wall 1 is ~0.85km^2 in area. Surface water flows from this catchment will vary with preceding rainfall and catchment wetness. In the spring and summer months there will be increased evapotranspiration. Catchment area maps have been prepared for the Shruhangarve sub-catchment in which the peat slide occurred, and one is included as HES Figure No. P1249-5_D101 below.

3 no. stone structures have been constructed to stabilise the peat, Wall 1, Wall 2 and Wall 3. Wall 3 is the furthest up the catchment and is located along the T7 (turbine 7) access track. Wall 1 is the lower structure and is constructed perpendicular to the Shruhangarve stream along the line of the T9 access track. Wall 2 is the intermediate structure and is located west of T9 (turbine 9).

Following the peat slide event (12th November), and after the initial geotechnical stabilisation works, one of the focuses on site was to attempt to divert as much clean water as possible around Wall 1, and back into the Shruhangarve stream. The purpose here was to prevent flow through the pond behind Wall 1 as this holds significant volumes of loose peat and sludge which will be mobilised by larger throughflows. Based on initial estimations, HES determined that ~59% (Upstream clean and Upstream_east_clean) of the total catchment upstream of the slide could be diverted around Wall1. In order to implement this, a diversion drain and two sumps (initial settlement sump to capture any large solids, and second pump sump from which water is pumped) were created to the southwest of T9. An 8" pump and backup 6" pump are operational, and pumping water from this clean water area around Wall 1 (Discharge 1). Additional clean water (~10-18%) has been diverted from the western side of the catchment (T9_west_clean).

At Wall 2 a series of linear attenuation/settlement ponds (2 no.), and sumps (2 no.) have been created. These capture soiled water coming from the upstream slip area and currently from the catchment to the west of the slip area. This soiled water is pumped from the second sump (again, an initial settlement sump to capture any large solids, and second pump sump were installed) from which water is pumped and diverted around Wall1. This water is treated via a settlement tank and silt bags (Discharge 2).

At Wall 3 a temporary pumping arrangement was established to divert water away from downstream of Wall 3 to the north. The purpose of this pumping was to prevent significant water flows down through the slip area and reduce the risk of further destabilisation. The catchment upstream of Wall 3 is relatively small and as such pumping flows were also relatively small (Discharge 5). Pumping at this location has now been suspended and water is currently flowing downs the slip scar. Monitoring of discharge water has shown that this is not leading to an increase in turbidity at downstream monitoring locations.

At Wall 1, there are two further discharges. The first is overflow from the pond behind Wall 1, and this overflow occurs through 2 no. 600mm pipes (Discharge 2). As outlined above much of the runoff water from the catchment is being diverted around the pond upstream of Wall 1. The second discharge at Wall 1 is seepage flow through the southern (lower) end of Wall 1. This flow is captured in a sump downstream of Wall 1 and pumped laterally into the main channel of the Shruhangarve (Discharge 3). The purpose here is to prevent flows down through the forestry which could destabilise the peat there, and also remobilise some of the loose peat/sludge that coats the ground following the peat slide.

Figure 3.1 below shows a flow diagram of the current water flow and pumping arrangements on-site.

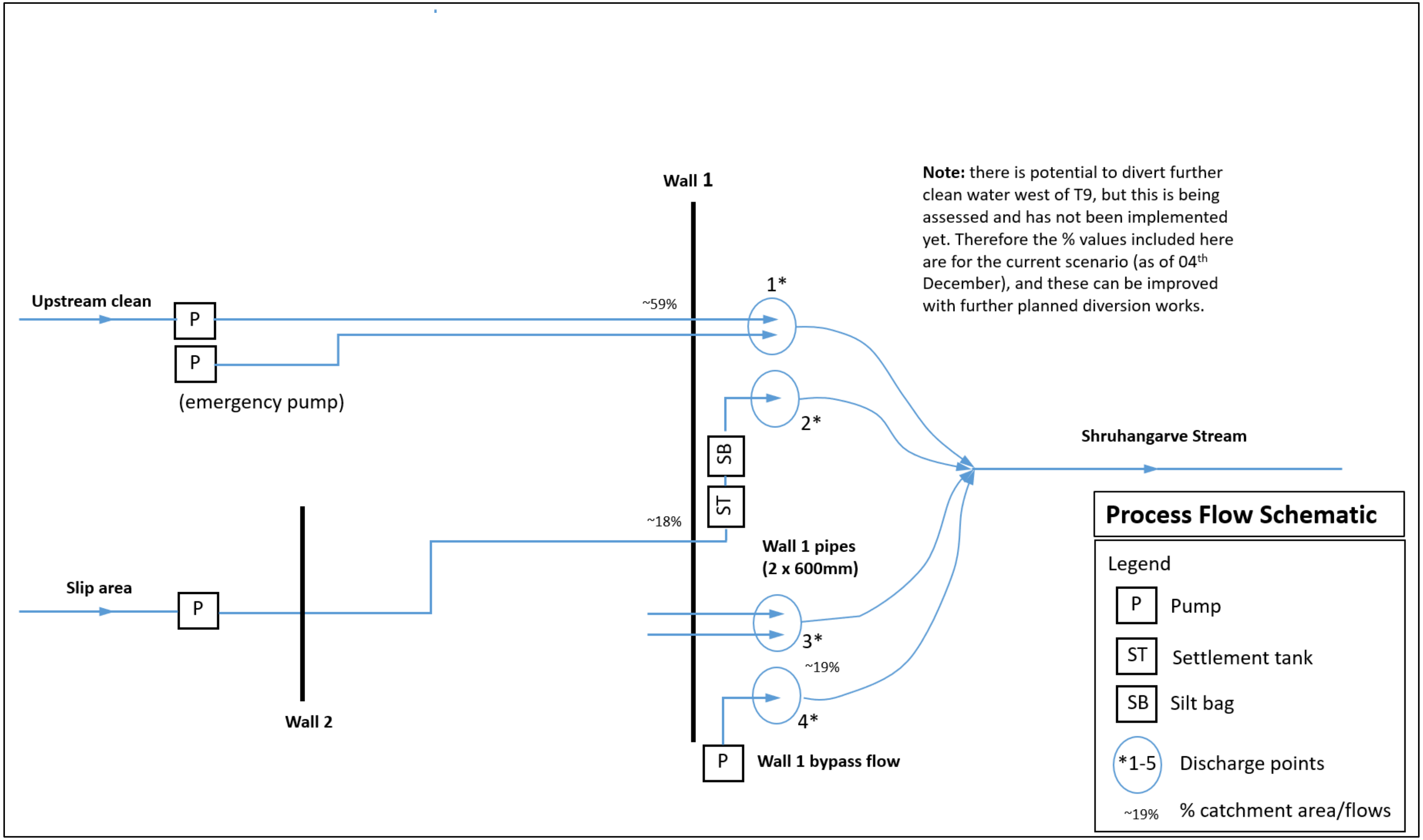


Figure 3.1 Flow diagram of current water flows and pumping arrangements on-site

4. RECOMMENDED FUTURE PHILOSOPHY

The emergency works undertaken and now completed on site since the original peat slide on the 12th/13th November have stabilised the situation on the ground to allow a considered view now be taken on future recommendations and measures that will further improve water quality and eventually restore and reinstate the river channel to the greatest extent possible.

Following the completion of the emergency works, it was determined to be better to do nothing else in the short term during the wetter winter months. However, at the time of writing (mid March 2021) it is approaching the optimum time of year for the implementation of additional restoration works Over the coming months it is anticipated that warmer weather, commencement of the growing season, and lower rainfall will result in drier ground conditions. It is therefore important to commence additional restoration works as quickly as possible in order to avail of these favourable conditions over the spring and summer.

Some fundamental principles are recommended for any works being considered and implemented in this and future Action Plans:

1. Do not do anything that makes the current improving situation worse from a water quality, habitats or protected species perspective, <u>even on a temporary basis</u>, until the proposed measures have been considered and recommended from an ecological, hydrological and geotechnical perspective to have longer term benefits, and detailed method statements are developed to minimise any potential for negative effects.
2. Do not consciously do anything that causes a soiled discharge to a natural watercourse, even if only temporary.

There will be very limited or no entirely risk-free options. However, any option recommended and selected will have to be justifiable and demonstrated to be the optimal option out of a number that will have been considered.

Any works will require continuous turbidity monitoring and will have to cease and be further modified if causing increased turbidity levels.

5. ACTION PLAN PROPOSALS

5.1 Introduction

Proposals are set out in the below section of the Action Plan under three categories:

1. *Water quality protection measures*
    - *Phase 1A – Detailed proposals presented below*
    - *Phase 1B – Detailed proposals being prepared*
    - *Phase 2 – Detailed proposals being prepared*
2. *Water quality monitoring – currently underway*
3. *Ecological surveys – scheduled*

The recommendations for water quality protection measures have been made by way of this Action Plan to Planree.

The recommendations for water quality monitoring have been made previously to Planree and MKO are currently undertaking this monitoring.

The recommended ecological surveys have been proposed to Planree by MKO (with input from Triturus Environmental Ltd), have been accepted by Planree, but have not yet commenced.

5.2 Water Quality Protection Measures

A series of recommendations to protect water quality are outlined in this section of the Action Plan.

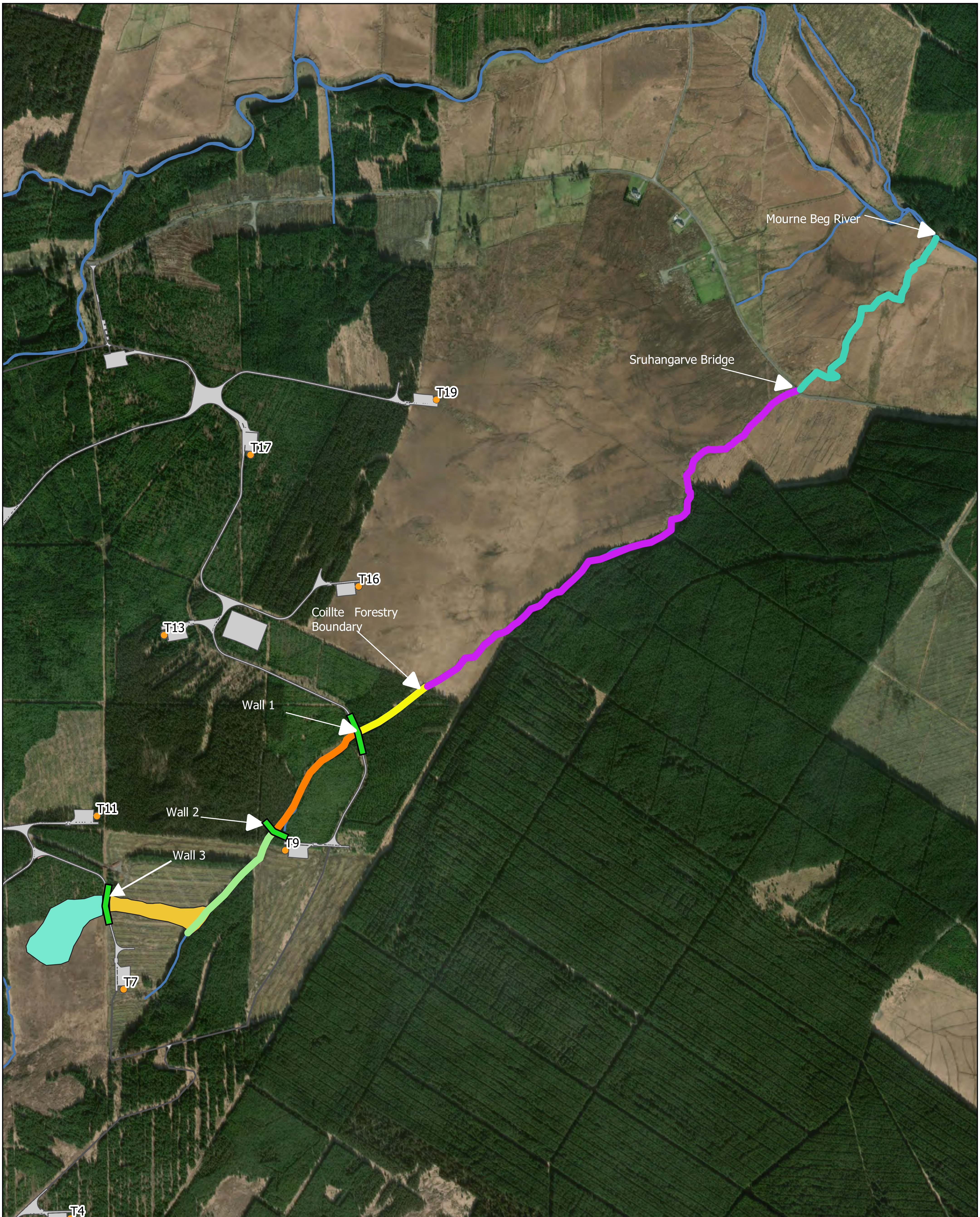
MKO has prepared this action plan and the recommendations contained herein to allow Planree Limited present their proposals to Donegal County Council along with the necessary commitments to the effective implementation of the proposals.

MKO is not responsible for the implementation of the proposed measures contained herein on-site, but will monitor the implementation of any measures that might be proposed by Planree as part of an expanded role for the on-site Environmental Clerk of Works.

The objectives of each of the water quality protection measures proposed below are described in terms of the required measures outlined in Donegal County Council's notice dated 17th November, as follows:

- *Eliminate or limit the release of further polluting matter from the area where the landslide occurred.*
- *Eliminate or limit the release of further polluting matter from areas up gradient of the land slide.*
- *Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.*
- *Prevent the catastrophic release of material built up behind the existing improvised impoundment structure on site.*
- *Mitigate against the further dispersal of peat and sediment, deposited along the banks of the Shruhangarve, by the watercourse through and beyond the confines of the site.*

For the purposes of describing the recommended water quality protection measures, Figure 5.1 has been prepared which divides the Shruhangarve stream into five sections or reaches, and these reaches will be referred to further below. The proposed water quality protection measures have been divided into two phases of work to allow for the implementation of some works while necessary studies and assessments are conducted for the future phases.



Map Legend

Peatslip

- Upper Scar
- Slip Scar

Stream Reaches

- Stream Reach 1
- Stream Reach 2
- Stream Reach 3
- Stream Reach 4
- Stream Reach 5
- Rivers/Streams
- Proposed Permanent Development Footprint
- Proposed Turbine Locations

N

Drawing Title	
Meenbog Peatslide Restoration Areas	
Project Title	
Meenbog Windfarm	
Drawn By: TJB	Checked By: BK
Project No.: 201174	Drawing No.: Figure 5.1
Scale: 1:10000	Date: 12/03/2021

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5.2.1 Phase 1 A – Works Now Proposed

The peat slide resulted in the formation of a wide slip scar (as shown on Figure 5.1) downstream of Wall 3 and significant impacts on the Shruhangarve stream channel between the base of the slip scar and Wall 2. Whilst further works are required in following phases to restore the Shruhangarve stream channel, Phase 1A includes works that will assist in the stabilisation of the slip scar and the banks of the upstream of Wall 2.

In addition, large volumes of peat mobilised during the peat slide were deposited along the downstream reaches of the Shruhangarve stream during the peat slide event. The spatial and volumetric measurement of these peat deposits is presently underway and will be reported in future iterations of the Action Plan. The deposits extend to varying widths along the banks Shruhangarve stream for a distance of approximately 2.4 kilometres downstream of Wall 1 as far as the Mourne Beg River.

The Shruhangarve stream downstream of Wall 1 continues to flow within the original natural stream channel, but larger flows during and after large rainfall events have caused some secondary mobilisation of the peat that would have been originally deposited on the stream banks. While the majority of the streambank peat deposits appear relatively stable, overland flows from the adjacent bog habitat towards the stream have caused some further mobilisation of the deposited peat in particular locations. It is not considered justifiable to leave the peat deposits in place without taking action to minimise run off, as to do so would result in further secondary mobilisation of the deposited peat into the adjacent stream. The Shruhangarve Stream with associated peat deposits is shown in Figure 5.2

Figure 5.2 Peat deposited on stream bank downstream of Wall 1, with intact vegetation partially visible and larger deposits of peat further back from stream edge

The works proposed in Phase 1A relate to the following restoration areas as shown in Figure 5.1:

1. *Slip Scar from Wall 3 to Shruhangarve Stream*
2. *Stream Reach 1: Slip Scar to Wall 2*

3. *Stream Reach 3: Wall 1 to Coillte Forestry Boundary*
4. *Stream Reach 4: Coillte Forestry Boundary to Shruhangarve Bridge*
5. *Stream Reach 5: Shruhangarve Bridge to Mourne Beg River*

Objectives of Works

The objectives of the restoration measures outlined in this phasee are to protect the water quality in the Shruhangarve Stream, avoid damage to sensitive habitats and ecosystems, and accelerate the recovery of this portion of the Shruhangarve Stream to its pre-event condition.

1. *Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.*
2. *Mitigate against the further dispersal of peat and sediment, deposited along the banks of the Shruhangarve, by the watercourse through and beyond the confines of the site.*

In order to achieve these objectives a number of measures are proposed and discussed below. These measures include the following:

1. *Stabilising peat deposits in place by seeding and mulching.*
2. *Installation of silt fencing in selected locations.*
3. *Installation of coir fibre matting in selected locations.*
4. *Promoting bank stability by installation of live stakes to promote bank stability. Live stakes are dormant cuttings native willow (Salix sp.) that are approximately 0.9 metres in length and are pushed into the soil of the stream bank approximately 0.6 metres. These cuttings will then grow and develop a root mass that helps bind the stream bank together.*
5. *Seeding and planting areas of denuded peat in the slip scar.*

The following sections set out the measures proposed for each stream reach and restoration area.

5.2.1.1 Slip Scar: Wall 3 to the Shruhangarve Stream

The slip scar downstream of Wall 3 is approximately 240 metres in length and between 45 and 60 metres wide. It covers at total of approximately 1.15 hectares. The majority of the peat that was in the slip scar was displaced during the 12th November peat slide event. As a result, there is now a relatively shallow layer of peat remaining in this area underlain by rock and mineral subsoil. There is currently water discharging through Wall 3 and flowing down the slip scar to the Shruhangarve Stream. The discharge is concentrated and is now flowing in a channel down the slip scar. It is not currently clear what the long term discharge rate of the water in this area will be. Future discharge rates may depend in part on any bog rehabilitation measures undertaken upstream of Wall 3. It is therefore proposed to allow the discharging water to continue to flow in the recently formed channel and to monitor the condition of the area over the coming months to determine whether further action is warranted or if the area continues to stabilise naturally.

In order to stabilise the remaining peat and soil in the slip scar area and to aid in the revegetation of the area the following measures are proposed. None of these measures will involve in-stream works or the use of mechanised equipment. For the purposes of this plan the slip scar area has been divided into 2 Zones as follows:

- Zone 1 comprises of wetter areas immediately adjacent to the discharge channel and has an area of approximately 3,575 m2.
- Zone 2 comprises the remainder of the slip scar outside of Zone 1 and has an area of approximately 7,765 m2.

See Figure 5.3 below for the location of the Planting Zones 1 and 2. Proposed seeding and planting rates for Zones 1 and 2 are provided in Tables 5.1 and 5.2 below.

Map Legend

Slip Planting Plan

Zone 1 (3,575 sq. metres)

Zone 2 (7,765 sq. metres)

Stream Reaches

Stream Reach 1

Drawing Title: Slip Scar Planting Plan	
Project Title: Meenbog WF	
Drawn By: TJB	Checked By: BK
Project No.: 201174	Drawing No.: Figure 5.3
Scale: 1:1500	Date: 10.03.2021

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5.2.1.1.1 Seeding

The entire slip scar area (Zones 1 and 2) will be seeded with peatland grass seed mix. Seeding will be accomplished manually with a handheld broadcast seeder. The proposed seed mix and seeding rates are provided in Table 5.1. Substitutions may be made to the proposed seed mix depending on availability. Suitability of substituted species must be confirmed and approved by the project ecology and environmental consultant.

Table 5.1 Proposed Seeding Rates

Species	Percentage of Mix	Seed Quantity per Ha (Kg)	Zones 1 & 2 Total Seeding Area (HA)	Total Kg of Seed
Yorkshire fog	30%	11.25	1.13	12.75
Highland Bent	30%	11.25	1.13	12.75
Red fescue	40%	15.0	1.13	17
Totals	100%	37.5	1.13	42.5

5.2.1.1.2 Live staking

Live willow cuttings (live stakes) shall be installed along both sides of the existing channel (Zone 1) within the slip scar area. The purpose of the live cuttings is to provide stability through the establishment of fast-growing native willows.

- Cuttings shall be between 60cm and 90cm in length, and between 3cm and 8cm in diameter. They will be cut in the dormant season, i.e. between Nov and Mar. Cuttings will have an angled cut at the bottom end of the stake and a flat cut at the top of the stake to aid with installation.
- Cuttings shall be installed in a triangular grid pattern at 1m on centre (o.c.). The first row shall be located on the side of the existing channel.
- Cuttings shall be fashioned from live, dormant native willow species (*Salix cinerea*, *Salix caprea* and *Salix aurita*).
- Cuttings shall be sourced locally on-site (or within 20km max of the establishment site if necessary)
- The following methodology will be implemented for the handling, preparation, and installation of cuttings to ensure the highest possible survival rate:
    - Cuttings shall be cut and installed on the same day where possible.
    - If same-day installation is not possible, cuttings shall be stored for no more than 1 week with the bottom end of each stake fully submerged in water to prevent drying out of the material.
    - All lateral branches shall be carefully removed from the woody cuttings prior to installation.
    - Cuttings shall be driven into the ground using a "dead blow" plastic hammer.
    - Peat shall be firmly packed around the hole after installation, where required.
    - Cuttings shall be tamped in at a right angle to the ground with between 70%-80% of the stake installed below the ground surface.
    - Between 20%-30% and two buds (or pruned, lateral branch locations) on the cutting shall be above the ground surface
    - Split or otherwise damaged cuttings shall not be used.

Figure 5.4 Example of live cutting along drain in planting trial on deep peat.

5.2.1.1.3 Planting with bare root plants

Zone 2 will be planted with bare root saplings at a density of approximately 800 stems per acre. A mix of the following species is proposed for planting:

- Downy Birch (*Betula pubescens*)
- Scots pine (*Pinus sylvestris*)
- Alder (*Alnus glutinosa*)

Planting will be carried out manually. The main forms of planting rooted material are set out as below. A combination of all the planting methods described below, or other appropriate methods, may be used on the site as conditions dictate. All planting should be to root collar depth or slightly deeper, and trees should be firm and upright with their roots hanging vertically and well spread out.

Areas selected for planting of bare root saplings shall be planted at a density of 800 stems per hectare. Trees will be planted in single species groups or mixed where appropriate, i.e. alder and birch).

Slit Planting

The spade is used to make a vertical slit in the ground. The tree roots are carefully positioned into the slit by hand to ensure that roots are equally spaced in the vertical slit created. The slit is closed by foot and firmed up, ensuring the tree is vertical and upright. It is important to ensure that roots are not bent over, as this can lead to poor development, e.g. J-shaped root. This form of planting can be suitable for ribbons, mounds and ripped ground.

Angle Notch Planting: L notch or T notch

A double slot is made using a suitable planting spade. The slots can either be "L" or "T" shaped and should be approx. 15cm deep as illustrated in Figure 5.5 below. The purpose of the double slot is to lift up the peat and create space to allow the roots to be distributed evenly. Once the tree has been positioned in the slot and the roots have been pushed in fully by hand, then slightly pull up the plant to allow the roots to hang down and to ensure correct planting depth. Then the spade is removed and the soil is firmed with the ball of the foot. The angle notch planting methodology is illustrated in Figure 5.6, below.

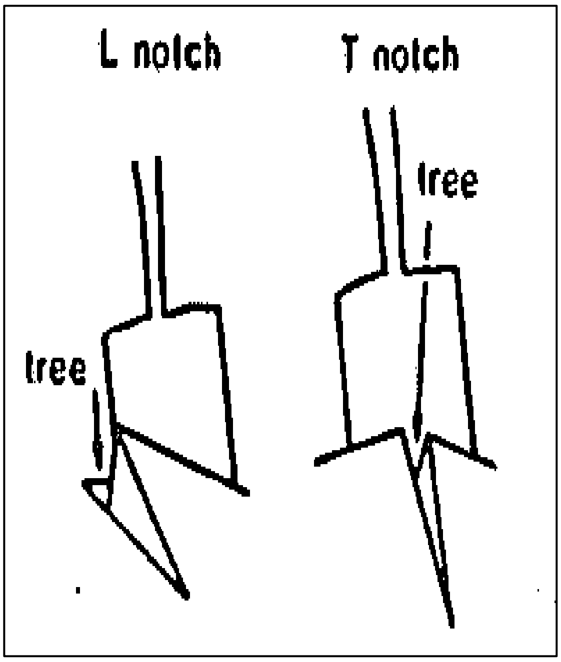


Figure 5.5 L" and "T" Planting Notches

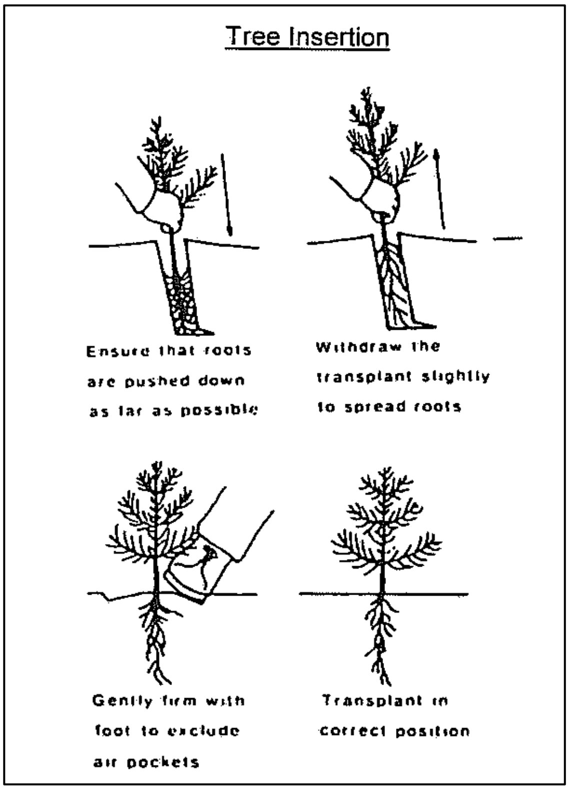


Figure 5.6 Angle Notch Planting Steps

5.2.1.1.4 Planting Schedule

Zones 1 and 2 will be planted according the schedule provided in Table 5.2 below. Other suitable native species may be substituted at the discretion of the project ecologist.

Table 5.2 Proposed Plant Numbers

Species	Size	Number of plants - Zone 1	Number of plants - Zone 2	Total	Spacing (metres o.c.)
Downy birch (*Betula pubescens*)	Bare Root	0	300	300	3.5
Alder (*Alnus glutionosa*)	Bare Root	0	300	300	3.5
Scots pine (*Pinus sylvestris*)	Bare Root	0	150	150	3.5
Willow (*Salix* spp.)	Live Stake	4,250	0	4,250	1

5.2.1.2 Stream Reach 1: Shruhangarve Stream from Slip Scar to Wall 2

This stream reach is approximately 390 metres in length. There is significant peat deposition throughout the reach and the original stream channel has been extensively damaged by the peat slide (Figure 5.7). A full restoration of this reach will be required and will be detailed in later phases of this action plan. For the purposes of Phase 1A of this action plan it is proposed to seed all bare peat areas adjacent to Stream Reach 1. This is intended as a temporary measure to promote stability and minimise loss of peat while further design and analysis work is undertaken. There are no in-stream works proposed at this time.

Figure 5.7 View of peat deposits at Reach 1, facing upstream.

5.2.1.2.1 *Seeding*

Bare peat adjacent to Stream Reach will be seeded per the seeding schedule in Table 5.3 below. There is approximately 8,700 m^2 of bare peat on the left bank of the stream and approximately 6,400 m^2 of bare peat on the right bank of the stream that will be seeded. Substitutions may be made to the proposed seed mix depending on availability. Suitability of substituted species must be confirmed and approved by the project ecology and environmental consultant.

Table 5.3 Proposed Seeding Rates – Reach 1

Species	Percentage of Mix	Seed Quantity per Ha (Kg)	Total Seeding Area Ha	Total Kg of Seed
Yorkshire fog	30%	11.25	1.51	17
Highland Bent	30%	11.25	1.51	17

Red fescue	40%	15.0	1.51	22.7
Totals	100%	37.5	1.51	56.7

5.2.1.3 Stream Reach 3: Wall 1 to Coillte Forestry Boundary

This stream reach is approximately 225 metres in length. There is significant peat deposition throughout this reach as well as a number of debris blockages. Access to this reach is difficult due to the existing forestry and steep slopes adjacent to the stream. Coir fibre matting has been installed on both stream banks for approximately 100 metres downstream of Wall 1. Given the higher level of impact to the stream channel in this reach it is proposed to install coir fibre matting and live stakes along both banks of the stream throughout this entire reach. Where debris is encountered in the channel this shall be removed by hand if possible.

Taking into account the conditions discussed above, the following measures are recommended for this reach.

5.2.1.3.1 *Installation of Coir Fibre Matting.*

Coir fibre matting shall be installed in a single row on both sides of the stream in Reach 3. The installation of the coir fibre matting shall be accomplished by hand using the following methodology.

- Coir fibre matting shall be at least 700 grams/m2 weight.
- Matting shall be anchored in a trench at top of the stream bank. Stout stakes (38mm x 38mm minimum) shall be used to secure the matting into the toe and top of bank trench.
- The stream bank shall be prepared by smoothing with shovels to remove large clumps of deposited peat, seeded, and mulched with straw prior to the placement of the matting.
- The matting shall be installed so as to not be in tension, but be placed neatly, flush against the soil, and with no gaps or wrinkles.
- Matting overlaps shall be 0.6m in width, and overlaps shall be oriented in a down-slope direction, downstream direction, or otherwise "shingle-style" in accordance with the direction of the dominant erosive action so that the matting end is protected against movement.
- The field of the matting over the surface of the stream bank shall be secured with hardwood matting stakes of at least 0.3 cm in length. Matting stakes shall be installed in a triangular grid pattern at 0.6m OC.
- Matting shall be neatly secured around any projecting stream structures or rocks to prevent any loose or frayed edges.
- There shall be no loose ends or unsecured matting on the completed work.
- No matting will be placed on the bed of the channel.

5.2.1.3.2 *Installation of Live Stakes*

Live willow cuttings (live stakes) shall be installed through the coir fibre matting along both sides of the stream channel following the installation of coir fibre matting. Details of the required spacing and number required are provided in Table 5.4 below. The purpose of the live cuttings is to provide bank stability through the establishment of fast-growing native willows. The live stakes will be installed using the following methodology

- Cuttings shall be between 60cm and 90cm in length, and between 2cm and 8cm in diameter. They will be cut in the dormant season, i.e. between Nov and Mar.

Cuttings will have an angled cut at the bottom end of the stake and a flat cut at the top of the stake to aid with installation.

- Cuttings shall be installed in a two-row triangular grid pattern at 75cm on centre (o.c.). The first row shall be located on the side of the existing channel with the second row being located on the flat adjacent to the channel.
- Cuttings shall be fashioned from live, dormant native willow species (*Salix cinerea, Salix caprea* and *Salix aurita*).
- Cuttings shall be sourced locally on-site (or within 20km max of the establishment site if necessary)
- The following methodology will be implemented for the handling, preparation, and installation of cuttings to ensure the highest possible survival rate:
    - Cuttings shall be cut and installed on the same day where possible.
    - If same-day installation is not possible, cuttings shall be stored for no more than 1 week with the bottom end of each stake fully submerged in water to prevent drying out of the material.
    - All lateral branches shall be carefully removed from the woody cuttings prior to installation.
    - Cuttings shall be driven into the ground using a "dead blow" plastic hammer.
    - Peat shall be firmly packed around the hole after installation, where required.
    - Cuttings shall be tamped in at a right angle to the ground with between 70%-80% of the stake installed below the ground surface.
    - Between 20%-30% and two buds (or pruned, lateral branch locations) on the cutting shall be above the ground surface
    - Split or otherwise damaged cuttings shall not be used.

Table 5.4 Proposed Live Stake Numbers and Spacing

Species	Size	Number of plants	Spacing (metres o.c.)
Willow (*Salix* spp.)	Live Stake	1,200	0.75

5.2.1.3.3 Stabilisation of Peat Deposits on Top of Bank

- All areas of peat deposition at top of bank to stabilised in place by seeding with an appropriate peatland grass seed mix. Seed mid and seeding rate are provided in Table 5.4 below. Substitutions may be made to the proposed seed mix depending on availability. Suitability of substituted species must be confirmed and approved by the project ecology and environmental consultant.
- Seeding will be accomplished manually with a handheld broadcast seeder.
- Straw mulch to be applied to seeded areas to promote germination of seed.

Table 5.5 Proposed Seeding Rates – Reach 3

Species	Percentage of Mix	Seed Quantity per Ha (Kg)	Total Seeding Area Ha	Total Kg of Seed
Yorkshire fog	30%	11.25	0.57	6.4
Highland Bent	30%	11.25	0.57	6.4
Red fescue	40%	15.0	0.57	8.6

Totals	100%	37.5	0.57	21.4

5.2.1.4 Stream Reach 4: Coillte Forestry Boundary to Shruhangarve Bridge

The levels of peat deposition on the top of the stream banks in Reach 4 are variable, ranging from very light (<0.1m) to moderate (0.4 m) in discrete pockets. The total area of peat deposition in Reach 4 is approximately 3.83 hectares. There is evidence of vegetation recovery throughout this reach as shown in Figure 5.8 below. There is some evidence of some localised bank instability in the upper section of this reach, however this is not widespread and in general the channel geomorphology remains intact. A field inspection of this stream reach on 25th February 2021 revealed a number of blockages in the stream channel in the upper section of this reach. Where debris is encountered in the channel this shall be removed by hand if possible.

Figure 5.8 Riparian vegetation recovering in Reach 4

Figure 5.9 Area of heavier peat deposits in Reach 4 (facing upstream) where temporary silt fencing is recommended. Immediate streamside zone is largely free of peat.

Taking into account the conditions discussed above, the following measures are recommended for this reach:

5.2.1.4.1 Stabilisation of Peat Deposits on Top of Bank

- All areas of peat deposition at top of bank to stabilised in place by seeding with an appropriate peatland grass seed mix.
- Seed mix and seeding rate are provided in Table 5.5 below. Substitutions may be made to the proposed seed mix depending on availability. Suitability of substituted species must be confirmed and approved by the project ecology and environmental consultant.
- Seeding will be accomplished manually with a handheld broadcast seeder.
- Straw mulch to be applied to seeded areas to promote germination of seed.

Table 5.6 Proposed Seeding Rates – Reach 4

Species	Percentage of Mix	Seed Quantity per Ha (Kg)	Total Seeding Area (HA)	Total Kg of Seed
Yorkshire fog	30%	11.25	3.83	43
Highland Bent	30%	11.25	3.83	43
Red fescue	40%	15.0	3.83	57.5
Totals	100%	37.5	3.83	143.5

5.2.1.4.2 Installation of Silt Fencing

- Areas of peat deposition greater than 0.3m in depth to be surrounded by silt fence on the streamward side.
- Using manual labour, access the stream bank on foot where peat deposits are low, and clear a working area of approx. 1.5-metres along the stream bank of all excess peat deposits sitting on the surface. Peat removed from surface of stream bank to be placed further back from stream bank.
- Install silt fencing along cleared path on stream bank, taking care to follow manufacture's specifications and ensure bottom of fence is property buried into ground surfacer and adequate fencing stakes are installed are regular intervals to support fence and the silt that will build up behind it. Specification for Terrastop silt fencing is included in Appendix 3.
- Maintain silt fence in place for as long as necessary until all bare peat has reseeded and demonstrated to have well-establish root system of surface vegetation, capable or binding material together. Silt fence only to be removed with approval of supervising ecologist.

Figure 5.10 Silt fence Installed on Reach 4

5.2.1.4.3 Installation of Coir Fibre Matting.

The extensive use of coir fibre matting is not anticipated in Reach 4. Where areas of bank instability are identified during the peat stabilisation and silt fence installation process these shall be assessed by the project environmental team and if necessary coir fibre matting shall be installed per the methodology described below. Coir fibre matting shall be installed in a single row either side of the stream in Reach

4 where necessary. The installation of the coir fibre matting shall be accomplished by hand using the following methodology.

- Coir fibre matting shall be at least 700 grams/m2 weight.
- Matting shall be anchored in a trench at top of the stream bank. Stout stakes (38mm x 38mm minimum) shall be used to secure the matting into the toe and top of bank trench.
- The stream bank shall be prepared by smoothing with shovels to remove large clumps of deposited peat, seeded, and mulched with straw prior to the placement of the matting.
- The matting shall be installed so as to not be in tension, but be placed neatly, flush against the soil, and with no gaps or wrinkles.
- Matting overlaps shall be 0.6m in width, and overlaps shall be oriented in a down-slope direction, downstream direction, or otherwise "shingle-style" in accordance with the direction of the dominant erosive action so that the matting end is protected against movement.
- The field of the matting over the surface of the stream bank shall be secured with hardwood matting stakes of at least 0.3 cm in length. Matting stakes shall be installed in a triangular grid pattern at 0.6m OC.
- Matting shall be neatly secured around any projecting stream structures or rocks to prevent any loose or frayed edges.
- There shall be no loose ends or unsecured matting on the completed work.
- No matting will be placed on the bed of the channel.

5.2.1.4.4 *Installation of Live Stakes*

In any areas where coir fibre matting is installed, live willow cuttings (live stakes) shall be installed through the coir fibre matting along the stream channel. The purpose of the live cuttings is to provide bank stability through the establishment of fast-growing native willows. The live stakes will be installed using the following methodology

- Cuttings shall be between 60cm and 90cm in length, and between 2cm and 8cm in diameter. They will be cut in the dormant season, i.e. between Nov and Mar. Cuttings will have an angled cut at the bottom end of the stake and a flat cut at the top of the stake to aid with installation.
- Cuttings shall be installed in a two-row triangular grid pattern at 75cm on centre (o.c.). The first row shall be located on the side of the existing channel with the second row being located on the flat adjacent to the channel.
- Cuttings shall be fashioned from live, dormant native willow species (*Salix cinerea, Salix caprea* and *Salix aurita*).
- Cuttings shall be sourced locally on-site (or within 20km max of the establishment site if necessary)
- The following methodology will be implemented for the handling, preparation, and installation of cuttings to ensure the highest possible survival rate:
    - Cuttings shall be cut and installed on the same day where possible.
    - If same-day installation is not possible, cuttings shall be stored for no more than 1 week with the bottom end of each stake fully submerged in water to prevent drying out of the material.
    - All lateral branches shall be carefully removed from the woody cuttings prior to installation.
    - Cuttings shall be driven into the ground using a "dead blow" plastic hammer.
    - Peat shall be firmly packed around the hole after installation, where required.
    - Cuttings shall be tamped in at a right angle to the ground with between 70%-80% of the stake installed below the ground surface.

- Between 20%-30% and two buds (or pruned, lateral branch locations) on the cutting shall be above the ground surface
- Split or otherwise damaged cuttings shall not be used.

5.2.1.5 Stream Reach 5: Shruhangarve Bridge to Mourne Beg River

A field inspection of this stream reach on 25th February 2021 revealed no blockages in the stream channel and relatively light levels of peat deposition on the top of the stream banks. The Shruhangarve stream is generally more incised in this reach than further upstream and this, in conjunction with the greater distance from the original peat slide, may have contributed to generally lighter levers of peat deposition. There is evidence of vegetation recovery throughout this reach as shown in Figure 5.11 below. Furthermore, there is no evidence of extensive channel instability in this reach.

Figure 5.11 View of typical peat deposits in Reach 5, facing downstream.

Taking into account the conditions discussed above, the following measures are recommended for Reach 5.

5.2.1.5.1 Peat Deposits on Top of Bank

- All areas of peat deposition at top of bank to stabilised in place by seeding with an appropriate peatland grass seed mix. Substitutions may be made to the proposed seed mix depending on availability. Suitability of substituted species must be confirmed and approved by the project ecology and environmental consultant.
    - Total Area for Seeding: 38,323m^2
- Straw mulch to be applied to seeded areas to promote germination of seed.
- No silt fencing is recommended in this reach.

Table 5.7 Proposed Seeding Rates – Reach 5

Species	Percentage of Mix	Seed Quantity per Ha (Kg)	Total Seeding Area Ha	Total Kg of Seed
Yorkshire fog	30%	11.25	1.7	19.1
Highland Bent	30%	11.25	1.7	19.1
Red fescue	40%	15.0	1.7	25.5
Totals	100%	37.5	1.7	63.7

5.2.2 Phase 1B – Works Not Yet Proposed

5.2.2.1 Assessment and Implementation of Bog Rehabilitation Measures upstream of Wall 3 (Upper Scar)

In Phase 1B an assessment of the upper scar will be undertaken. The purpose of the assessment is to determine what actions can be taken to support the rehabilitation of the bog from an ecological perspective. The following actions are recommended:

1. *Pedestrian survey by ecologists and hydrologist.*
2. *Establishment of goals for the bog from an ecological perspective and consider options of how they might be achieved.*
3. *Determine what additional ecological/hydrological and geotechnical surveys may be required.*
4. *Propose a strategy for restoration works and monitoring*
5. *Set up ecological monitoring stations*
6. *Oversee the implementation of any necessary works*
7. *Ongoing monitoring of effectiveness*

5.2.2.2 Removal of Heavy Peat Deposits from Stream Banks (Reach 1)

Present situation informing recommendations

Large volumes of peat were deposited on the banks of the Shruhangarve stream during the peat slide. Upstream from Wall 1 and T9 along stream reaches 1 and 2, these deposits will need to be removed or stabilised and every effort made to prevent them being gradually washed into the stream channel before normal water flows can be restored in the Shruhangarve stream.

Peat sludge is deposited along the entire length of Reach 1, up to distances of 35 metres from the stream channel.

Access to certain areas in these stream reaches will be by forestry and ground conditions limited, and while it might be possible to get machinery into locations, it is impractical to expect to be able to remove all the deposited peat material without causing further damage to the peatland habitats or constructing further access roads.

Objectives of recommendations

1. *Eliminate or limit the release of further polluting matter from the area where the landslide occurred.*
2. *Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.*
3. *Mitigate against the further dispersal of peat and sediment, deposited along the banks of the Shruhangarve, by the watercourse through and beyond the confines of the site.*

Recommended measures

1. *Inspect stream banks to identify nature and depth of deposited peat, access options, ground conditions, etc to assess safety of work areas, safe work methods, means of handling and delivering materials, etc.*
2. *Quantify distances, areas and volumes of deposited peat from drone imagery, including larger deposition areas, to prioritise areas for work.*

3. *Where machine access is possible and practical, use low-pressure excavators to remove excessive depths of deposited peat and spread out on surrounding ground to prevent future slumping of peat deposits. Then stabilise spread material.*
4. *Utilise stabilisation methods and materials proven to be effective on the section of the Shruhangarve downstream of Wall 1.*
5. *Installation techniques and timing may have to be adjusted based on water flows in stream linked to rainfall.*
6. *Divide works areas into sections and assign installation crews to sections.*
7. *Seed the peat sludge deposits in Spring/Summer 2021 with appropriate seed mix (to be selected).*
8. *More detailed recommendations for the removal of the peat and stabilisation of the unvegetated surfaces that remain will be developed in future iterations of the Action Plan when access options to the areas in question have been further investigated.*

5.2.3 Phase 2 – Works Not Yet Proposed

Phase 2 recommendations relate to the dewatering of the accumulated peat upstream of Wall 1 and the restoration of Stream Reaches 1 and 2. These recommendations will be expanded upon in the coming weeks and are presented below as high level proposals to show the intended approach to the restoration of Reaches 1 and 2.

5.2.3.1 Reach 1 Stream Restoration

Present situation informing recommendations

Approximately 850 metres of the Shruhangarve Stream upstream of Wall 1 have been impacted by the peat slide (Stream Reaches 1 and 2). Mass movement and deposition of peat in this area has substantially damaged the original stream channel resulting in a loss of instream habitat in this area.

It is proposed to use natural channel design techniques to re-establish a functional stream channel in these reaches. The restoration design process will focus on the development of a stream design that is appropriate in terms of channel cross-sectional dimension, plan, and profile, and that will therefore be stable in the long term. In addition, the design will incorporate design elements to provide appropriate in-stream aquatic habitat. Stream banks and the riparian zone will be revegetated with native species with a view to enhancing bank stability in the new channel and reducing potential soil erosion in the riparian area.

It is proposed to start the design and implementation of the restoration of Reach 1 (approximately 390 metres) in advance of Reach 2. Reach 2 cannot be adequately assessed until the area upstream of Wall 1 has been dewatered and the accumulated peat removed. However, due to the topography of the site, there is nothing to prevent the design and implementation of the Reach 1 restoration plan in advance of that work.

Objectives of recommendations

1. *Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.*
2. *Mitigate against the further dispersal of peat and sediment, deposited along the banks of the Shruhangarve, by the watercourse through and beyond the confines of the site.*
3. *Return Reach 1 to a natural, stable condition.*

Recommended measures

1. *Conduct a limited geomorphological survey of Reach 1 of the Shruhangarve Stream. Survey will be limited due to the poor condition of the remaining stream channel. Survey will include the following:*
    - *detailed cross sections*
    - *long profile*
2. *Conduct a geomorphological survey of a 100 metre long stable section of Reach 4 of the Shruhangarve Stream. Survey will include the following:*
    - *Bankfull identification*
    - *Detailed cross sections*
    - *Long profile*
    - *Wolman reachwide pebble count*
    - *Radius of curvature in meander bends*
3. *Conduct desktop analysis of Reach 1 along with field survey of impacted reaches to attempt to classify the likely character of the lost stream channel.*

4. *Identify and conduct geomorphological survey of suitable reference reach stream channel. Reference reach survey will include:*
    - *Bankfull identification*
    - *Detailed cross sections*
    - *Long profile*
    - *Wolman reachwide pebble count*
    - *Radius of curvature in meander bends*
5. *Use reference reach data, survey of unimpacted and/or moderately impacted stream reaches, to develop dimensionless ratios to inform the conceptual design of new channel for Reaches 1 and 2.*
6. *Design will include in-stream structures and a detailed planting plan utilising appropriate native species.*
7. *Once the proposed restoration design has been finalised and approved work should commence at the upstream end and work down.*
8. *All work will be conducted in the dry, therefore pump arounds will be necessary.*
9. *More detailed recommendations for the restoration of the stream will be developed in future iterations of the Action Plan.*

5.2.3.2 Install Water Treatment System

Present situation informing recommendations

While the water quality situation on-site and in the downstream catchments has stabilised since the completion of the emergency works and suspension of all other works within the Shruhangarve catchment, a portion (currently 21%) of the rainfall entering the upper reaches of the Shruhangarve catchment is still coming into contact with the peat slippage area, disturbed ground and deposited peat, and there is currently no effective means of treating this soiled water prior to its discharge to the downstream side of Wall 1. This is not recommended beyond the immediate short term and should be rectified as soon as possible.

Over the medium to long term it will also be necessary to carry out works in the catchment to manage and remove residual peat deposited upstream of Wall 1 and eventually restore and reinstate the Shruhangarve stream to the greatest extent possible. These works have the potential to mobilise and release peat sediment into downstream in the absence of mitigation. A water treatment system is recommended as the only realistic means of preventing the uncontrolled release of sediment during future phases of remedial works upstream of Wall 1, but more details are required before a definitive set of recommendations can be made.

Discussion are ongoing with a number of water treatment system providers to provide water treatment proposals, both in the short term and in the longer term, during future remedial works phases. Outlined below is a summary of the outcome of tests completed by Siltbuster, and some information relating to the use of a similar system on the Corrib Gas Pipeline project, where discharge occurred to an SAC receiving waterbody.

Please note, the system outlined below is provided for information purposes only and as an indication of what can be provided, but no commercial arrangement has been initiated to date. The intention here is to provide information regarding what can be achieved and the general setup of such a system. Further detail will be provided once discussions advance with the treatment system providers and a more firm proposal is available, following further engagement with stakeholders and regulatory authorities.

Objectives of recommendations

1. *Eliminate or limit the release of further polluting matter from the area where the landslide occurred.*
2. *Eliminate or limit the release of further polluting matter from areas up gradient of the land slide.*
3. *Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.*
4. *Prevent the catastrophic release of material built up behind the existing improvised impoundment structure on site.*

Further information

Laboratory Test Results

A 5-litre raw sample water (untreated, unsettled sample from upstream of Wall 1) was sent to Siltbuster1 on the 20th November 2020 for analysis which is summarised below. The output of the analysis determines the appropriate treatment proposals.

Initial analysis of the as received sample indicated a TSS of 4,570 mg/L and pH of 5.2 [H+]. The raw sample also contained a large amount of organic matter in the form of roots, twigs and vegetation.

The received sample was allowed to settle for 30 minutes to replicate intended onsite primary attenuation lagoon and pH remained the same, and TSS was reduced by 57% to 1,975 mg/L. The intended primary settlement pond will help remove any heavier large peat particles and other organic detritus.

A series of secondary settlement tests were then completed without the aid of pre-treatment chemicals and these results are shown in Table 5.1 below.

These tests confirmed that the remaining particles in suspension exhibited very slow and/or non-settling characterises within water, and that that the typical target discharge level of <60mg/l could not be achieved using a purely gravity based system due to their particle size and subsequently low settling velocity.

Table 5.8 Gravity Settlement Test results (without chemical treatment)

Time (minutes)	Settling Velocity (m/h)	Total Suspended Solids TSS (mg/L)
3	2	1,948
6	1	1,930
12	0.5	1,947
30	0.2	1,923
60	0.1	1,753
120	0.05	1,750

1 Siltbuster Limited, Kingswood Gate, Monmouth, Monmouthshire, UK https://www.siltbuster.co.uk

Improved settling characteristics was then achieved using a three-stage chemical pre-treatment and the results are shown in Table 5.2 below.

- Ferric Chloride,
- Sodium hydroxide
- Anionic polymer

Table 5.9 Settlement Test results (with chemical pre-treatment)

Time (minutes)	Rise Rate (m/hr)	TSS (mg/L)	% Removal TSS	pH
15	0.4	19	99.04	6.87
30	0.2	17	99.63	6.87

Based upon the sample provided; it is was determined that a total suspended solids (TSS) content of <60mg/l can only be viably achieved through the use of pre-treatment water chemicals to enhance the settling velocity of the solids you intend to capture.

Treatment System Proposal

One proposed treatment system being considered is a Siltbuster MT30, chemical dosing system & 4 No. HB50s which has a typical operating range of between 8-120m^3/hr. The system will consist of the following:

- Feed pond, primary settlement lagoon
- Feed pumps (diesel with fuel bowsers)
- Electrical supply (generator and fuel bowser)
- Clean water supply by bowser (2/3 m^3 every couple of days for Polymer make up, and feed supply for the safety showers)
- Bunded chemical storage area (e.g. bunded 20' container)
- Siltbuster MT30 Chemical Pre-Treatment System
  - Inlet magnetic flow meter, to record the volume of water treated
  - pH adjustment system
  - Siltbuster Mix Tank (MT30) to allow the controlled mixing of the treatment chemicals
  - Flow proportional control system for coagulant and flocculant polymer dosing
  - Coagulant dosing pump
  - Flocculant make-up system
  - 1 No IBC spill stand/containment bunds for the temporary storage of chemicals.
  - Siltbuster HB50 Gravity Operated Settlement Units (Recovery of Suspended Solids): 4 No Siltbuster Lamella Clarifier Units to separate the suspended solids from the treated water.
- Safety showers, fed from the clean water supply
- Sludge pond/sump (gravity drainage from HB50hoppers, and sludge is transferred to sludge disposal area (remote peat storage area)
- Monitoring/sampling of treated water
- Discharge pipework

Treatment System Layout and Configuration

A photographic example of the system layout is shown in Figure 5.12 below. The total plan area of the core water treatment system is approximately 50-60 m^2.

- MT30 – 3.5mW x 6.1mL = 21.35m2
- HB50 – 1.7mW x 3.8mL x 4 no. = 25.84m^2

Figure 5.12: MT30 Chemical Pre-Treatment system with 4 No Lamella clarifiers

Treatment System Controls

Power requirements include a minimum 20KVA generator, 3-phase, 415V earth plus neutral, adjustable earth leakage or minimum 300 mA RCD.

There will be a flow proportional control system for coagulant and flocculant polymer dosing. The use of flow proportional dosing system minimises the risk associated with the overdosing of the treatment chemicals, and any potential for carry over into the discharge. The minimum amount of chemical additives are dosed at all times.

A coagulant dosing pump and associated pipe-work will allow the automatic flow proportional addition of the coagulant.

The pumped raw waters will be delivered to the Treatment Plant at a steady continuous rate so as to reduce the total suspended solids content prior to discharge, and to maximise the efficiency of the treatment process.

Use of Siltbuster Systems

Standard settlement or coarse filtration alone will not clean peat water to a standard suitable for discharge to a salmonid river.

The reason we have proposed Siltbuster with chemical treatment is that this type of system is an industry standard in the UK and is one that is recommended by the Environment Agency and planning authorities for all kinds of sites, including sites with sensitive downstream watercourses. It is this sensitivity that is the driver for use of such systems, i.e. the approach is that it is better to treat the water on site to the highest standard available.

There is a perception that chemical treatment is too risky as such chemicals are toxic. The reality is that chemicals (flocculants and coagulants) are used in almost every water treatment plant across the country. Furthermore, dosing rates of chemical to initiate settlement is small, being in the order of 2-10 mg/L. Any perception of vast quantities of chemicals being used is incorrect, as dosing rates are small, and all dosing is completed on a flow proportioned basis.

Consultant hydrologist Michael Gill has direct experience of using Siltbsuter systems on the Corrib Onshore Pipeline construction works in Co. Mayo, and based on observation and operation of the system over some 5000 hours in 2012 and 2013 two things are known:

1. *Lamella plate clarifier system such as Siltbusters work very well in peatland environments when used in combination with 3-stage chemical treatment*
2. *Monitoring data indicate no carry-over of treatment chemicals in the post treatment discharge.*

An example of treatment capability of Siltbuster systems from Corrib is provided in Figure 5.13. This is a duration curve of downstream water quality data post Siltbuster treatment. The system was setup so that any water not meeting discharge criteria was recycled back to the settlement ponds. The graph shows all data, and only 24 treated water (discharge water) data points out of 1194 records were above 20 mg/L (i.e. recycling occurred at these times).

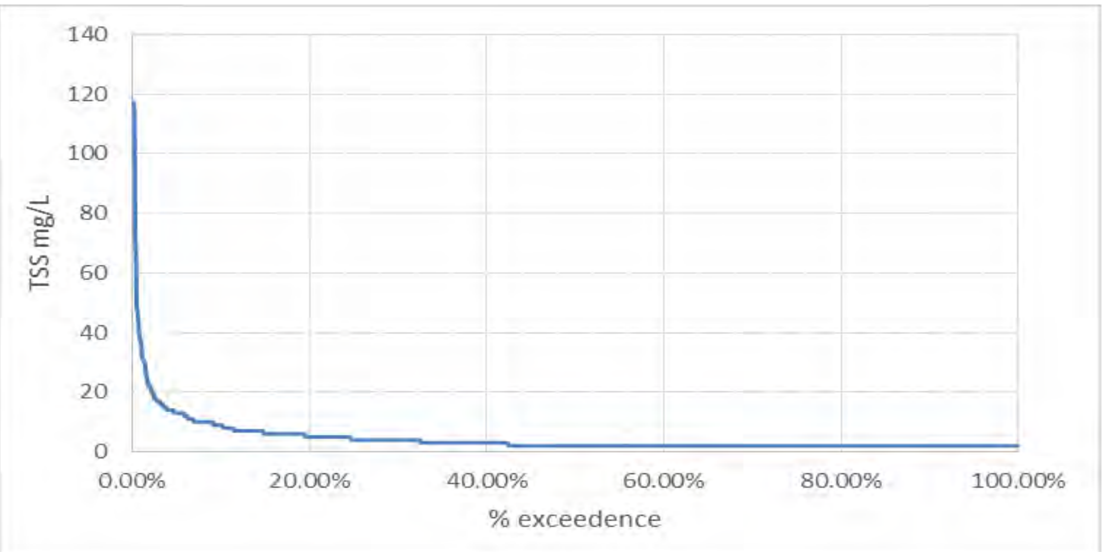


Figure 5.13 TSS treatment data using Siltbuster systems (with 3 stage chemical dosing).

5.2.3.3 Remove Deposited Peat from Impoundment Area Upstream of Wall 1

Present situation informing recommendations

Large volumes of silt have been successfully impounded behind Wall 1 and prevented from entering downstream watercourses. The volumetric measurement of these silt volumes is presently underway and will be reported in future iterations of the Action Plan. Water flows have been largely intercepted upstream of the impounded silt and diverted away from the silt impounded behind Wall 1, thereby minimising the re-mobilisation of the impounded silt.

The long-term recommendation is to restore the natural water flows in the Shruhangarve stream and reinstate the stream to the greatest extent possible. To do so will require the silt and sediment that has accumulated behind Wall 1 to be removed and the area stabilised before normal flows can be restored in the channel and through a culvert under Wall 1 which was originally intended as a access road to Turbine 9.

Objectives of recommendations

1. *Eliminate or limit the release of further polluting matter from the area where the landslide occurred.*
2. *Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.*
3. *Prevent the catastrophic release of material built up behind the existing improvised impoundment structure on site.*

Recommended measures

1. *Complete volumetric calculations of silt and sediment volumes impounded upstream of Wall 1.*
2. *In Spring/Summer 2021, after having allowed time for water levels behind Wall 1 to decrease and the material to partially dry out, begin to recover as much deposited peat as possible from the upstream side of Wall 1, using long reach excavators working from the top of Wall 1.*
3. *With further engineering input, investigate feasibility of creating cells behind Wall 1 as water levels lowers and material dries out to assist recovering further volumes.*
4. *Transport recovered peat sludge to on-site treatment/management area. Consider treatment/management options further over coming period, including:*
    - Using existing on-site peat storage areas, with enhanced Siltbuster-type water treatment at outfall.
    - Lined settlement lagoon with centrifuge, sludge treatment and water treatment.
5. *Selected treatment/management option to determine other actions.*
6. *After all recoverable peat has been removed from the area upstream of Wall 1, an assessment and survey of the conditions in Reach 2 will be conducted.*
7. *Information gathered in this survey will contribute to the development of a stream restoration design for Reach 2.*

5.2.3.4 Reach 2 Stream Restoration

Present situation informing recommendations

It is proposed to use natural channel design techniques to re-establish a functional stream channel in Reach 2. The restoration design process will focus on the development of a stream design that is appropriate in terms of channel cross-sectional dimension, plan, and profile, and that will therefore be stable in the long term. In addition, the design will incorporate design elements to provide appropriate in-stream aquatic habitat. Stream banks and the riparian zone will be revegetated with native species with a view to enhancing bank stability in the new channel and reducing potential soil erosion in the riparian area. Once the area upstream of Wall 1 has been dewatered and the accumulated peat removed Reach 2 will be surveyed to establish a baseline for the development of the stream restoration plan for the reach.

Objectives of recommendations

1. *Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.*
2. *Mitigate against the further dispersal of peat and sediment, deposited along the banks of the Shruhangarve, by the watercourse through and beyond the confines of the site.*
3. *Return Reach 2 to a natural, stable condition.*

Recommended measures

1. *Conduct a limited geomorphological survey of Reach 2.. Survey will include the following:*
    - *detailed cross sections*
    - *long profile*
2. *The reference reach data and survey of unimpacted and/or moderately impacted stream reaches that was conducted in Phase 2 will be used to develop dimensionless ratios to inform the conceptual design of new channel for Reaches 2.*
3. *Design will include in-stream structures and a detailed planting plan utilising appropriate native species.*
4. *Once the proposed restoration design has been finalised and approved work should commence at the upstream end and work down.*
5. *All work will be conducted in the dry, therefore pump arounds will be necessary.*
6. *More detailed recommendations for the restoration of the stream will be developed in future iterations of the Action Plan.*

5.2.3.5 Further Recommendations

The recommendations outlined above are not by no means exhaustive or limited.

Further recommendations are currently and will continue to be developed to deal with the various reaches of the affected Shruhangarve stream. These will be detailed in future iterations of the Action Plan to further address the situation on-site and in the downstream watercourses as a result of ongoing water monitoring efforts, ecological surveys, seasonal factors, the trialling of certain recommendations on site and the contributions from other stakeholders and regulatory authorities whose input will be very much welcomed and carefully considered.

5.3 Water Quality Monitoring

5.3.1 Introduction

The following surface water quality monitoring programme of the Shruhangarve, Mourne Beg and Derg rivers has been implemented to monitor water quality downstream of the Meenbog Wind Farm. This monitoring programme is being undertaken in addition to the monitoring proposal for the construction phase of the Meenbog Wind Farm as set out in Section 5.2 of the Construction and Environmental Management Plan (CEMP). This supplementary monitoring programme combines the use of laboratory analysis, water quality monitoring instrumentation and visual inspection to develop a comprehensive schedule of monitoring of all watercourses that exist both at the site and the surrounding area.

This water monitoring programme is the subject of independent review by the supervising hydrologist who will provide the necessary guidance on the monitoring requirements. The water monitoring programme is outlined in the following sections.

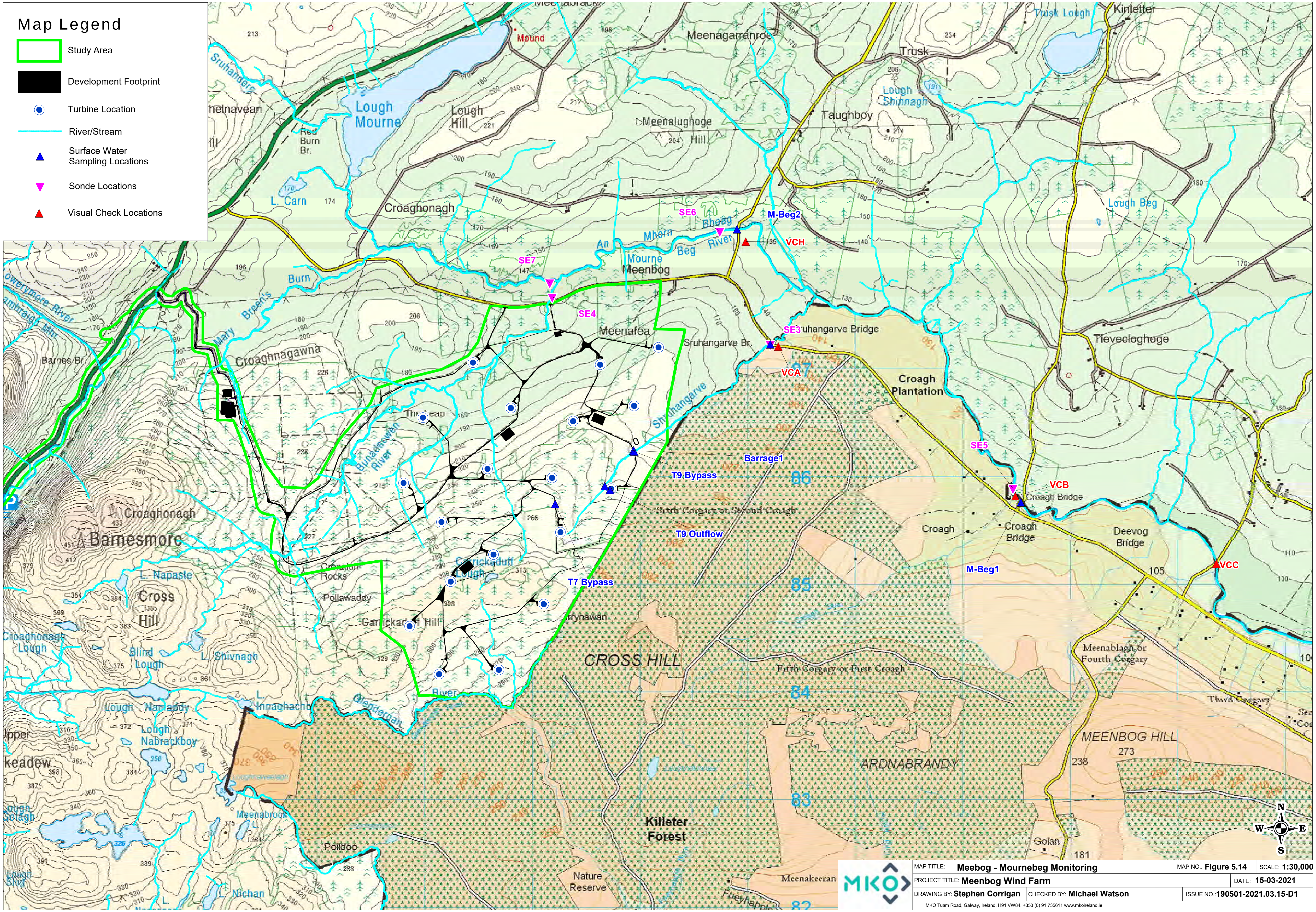
5.3.2 Drainage Inspection and Monitoring

In addition to the daily visual inspections carried out at the wind farm site (CEMP Section 5.2), daily visual inspections of watercourses are being undertaken at various locations adjacent to Turbine no. 7 and 9 and along the Shruhangarve, Mourne Beg and Derg rivers. The details of the visual check locations are set out in Table 5.10 and mapped in Figure 5.14.

Table 5.10 Visual Inspection Locations

ID	Easting (IG)	Northing (IG)	Analysis	Frequency	Task
VC-A	210286	387213	Visual Inspection to determine water quality	Daily	The visual inspection carried out at each Visual Check (VC) location is undertaken to determine the quality of water within a watercourse in terms of its visual appearance and checking for the presence of suspended sediment or a turbid complexion in the water. As outlined on the Daily Visual Inspection sheets, a scoring system has been devised to rate water quality at each VC in terms of: 1. Water clear – no issues 2. Water turbid with a visible peaty tinge (naturally occurring in waters drained from peatlands and not related to the wind farm works) 3. Water silty as a result of works NOT associated with the wind farm works 4. Water silty as a result of works associated with the wind farm works.
VC-B	212491	385822		Daily	
VC-C	214359	385195		Daily	
VC-D	220693	383782		Daily	
VC-E	222878	382954		Daily	
VC-F	226104	384388		Daily	
VC-G	228689	384662		Daily	
VC-H	209984	388188		Daily	
VC-I	222735	382563		Daily	

The visual inspection sheets and photographic records are being kept in the environmental file on site. Inspection points also include the additional laboratory analysis sampling points and the sonde locations as outlined in Figure 5.14


Map Legend
Study Area
Development Footprint
Turbine Location
River/Stream
Surface Water Sampling Locations
Sonde Locations
Visual Check Locations
Lough Mourne
Lough Hill
Meenagarranroe
Trusk
Trusk Lough
Kinletter
Lough Shinnagh
Taughboy
Meenalughoge
Hill
Croaghonagh
L. Carn
Red Burn Br.
Mound
Lough Beg
SE6
M-Beg2
VCH
SE7
An Mhorn Bheag
Mourne Beg River
Meenbog
Burn
Mary Breen's
SE4
Meenafea
SE3
Sruhangarve Bridge
Sruhangarve Br.
VCA
Tievecloghoge
Croaghnagawna
Barnes Br.
The Leap
Bunadaowen River
Sruhangarve
Croagh Plantation
Barrage1
SE5
T9 Bypass
VCB
Croagh Bridge
Croaghonagh
Barnesmore
Sixth Corgary or Second Croagh
Croagh
T9 Outflow
Deevog Bridge
M-Beg1
VCC
Carrickadutt Lough
T7 Bypass
Pollawaddy
Carrickadutt Hill
Cross Hill
L. Napasle
Blind Lough
L. Shivnagh
CROSS HILL
Fifth Corgary or First Croagh
Meenablagh or Fourth Corgary
Third Corgary
MEENBOG HILL
ARDNABRANDY
Lough Nabrackboy
Lough Namaboy
Glenderan River
Killeter Forest
Nature Reserve
Meenakeeran
Golan
Polldoo
L. Nichan
Meenabrock
MAP TITLE: Meebog - Mournebeg Monitoring
MAP NO.: Figure 5.14
SCALE: 1:30,000
PROJECT TITLE: Meenbog Wind Farm
DATE: 15-03-2021
DRAWING BY: Stephen Corrigan
CHECKED BY: Michael Watson
ISSUE NO.: 190501-2021.03.15-D1
MKO
MKO Tuam Road, Galway, Ireland, H91 VW84. +353 (0) 91 735611 www.mkoireland.ie

5.3.3 Monitoring Parameters

The analytical determinants of the monitoring programme (including limits of detection and frequency of analysis) will be as per S.I. No. 272 of 2009 European Communities Environmental Objectives (Surface Waters) Regulations, S.I. No. 722 of 2003 European Communities (Water Policy) Regulations and European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009. The suites of parameters will include:

Suite 1

- Total Suspended Solids (mg/l)
- Ammoniacal Nitrogen as NH3 (mg/l)
- Ammoniacal Nitrogen as NH4 (mg/l)
- Nitrite (NO2) (mg/l)
- Ortho-Phosphate (P) (mg/l)
- Nitrate (NO3) (mg/l)
- Phosphorus (unfiltered) (mg/l)
- Chloride (mg/l)
- Biochemical Oxygen Demand (BOD) (mg/l)
- pH
- Electrical Conductivity
- Temperature
- Dissolved Oxygen

Suite 2

- Turbidity (NTU) (hand held turbidity meter)

Suite 3

- Turbidity (NTU) (sonde measured)

Suite 4

- Arsenic Dissolved filtered
- Cadmium Dissolved filtered
- Calcium Dissolved filtered
- Chromium Dissolved filtered
- Copper Dissolved filtered
- Lead Dissolved filtered
- Iron Dissolved filtered
- Magnesium Dissolved filtered
- Mercury Dissolved filtered
- Nickel Dissolved filtered
- Potassium Dissolved filtered
- Sodium Dissolved filtered
- Zinc Dissolved filtered
- Phosphorus Dissolved filtered
- Total Petroleum Hydrocarbons CWG (Speciated)
- Gasoline Range Organics (Aliphatic/Aromatic Split)
- VOCs
- Total Phenols
- BTEX
- Chlorophenols
- Sulphate
- Chloride

- Nitrate
- Nitrite
- Molybdate Reactive Phosphorus (MRP unfltered)
- Ortho Phosphate
- Ammonia Low Level
- Ammoniacial Nitrogen
- Total Alkalinity
- BOD
- COD
- Conductivity
- pH
- TOC
- Suspended Solids
- Hardness

5.3.4 Laboratory Analysis Sampling

Laboratory analysis of a range of parameters with relevant regulatory limits and Environmental Quality Standards (EQSs) was being undertaken on a daily basis but this was reduced to a weekly basis in February 2021 following a sustained period of stable results. The sample locations are located at bypass drains and outflows at Turbines no's 7 and 9 and Wall 1 all within the wind farm site as well as locations along the Shruhangarve, Mourne Beg and Derg rivers. The details of the surface water sampling locations are as outlined in Table 5.11 and mapped in Figure 5.14. All samples will be sent for analysis to an independent laboratory.

In addition, turbidity readings using a hand held turbidity meter are being taken at all surface water monitoring points which are the subject of the independent laboratory analysis as outlined in Figure 5.14. These daily turbidity readings will provide site management with current readings on water quality for these watercourses in advance of the results for each locations being received from the testing laboratory, which has a minimum five day turnaround for results.

Table 5.11 Sample Locations for Laboratory Analysis

ID	Easting (IG)	Northing (IG)	Testing Parameters	Frequency	Task
Sample locations on the wind farm site from discharges from behind the Barrage to the Shruhangarve and water that is pumped to the Bunadaowen river					
T7 Bypass	208213	385750	Suite 1 Suite 2	Daily	Sampling to be undertaken on a daily basis for laboratory analysis to provide trends on water quality for the parameters being tested. Each sample location is photograph as record of the appearance of the watercourse during the sampling. Sampling frequency reduced to weekly sampling in February 2021 following a sustained period of stable readings.
Barrage (Wall) 1	208940	386246		Daily	
T9 Bypass	208946	386238		Daily	
T9 Outflow	208722	385883		Daily	
Sample location on the Shruhangarve river upstream of the confluence with the Mourne Beg river					
SE3	210212	387234	Suite 1 Suite 2	Daily	Sampling to be undertaken on a daily basis for laboratory analysis to provide trends on water quality for the parameters being tested. Each sample location is photograph as record of the appearance of the watercourse during the sampling Sampling frequency reduced to weekly sampling in February 2021 following a sustained period of stable readings.
Sample location on the Mourne Beg river upstream of the confluence with the Shruhangarve					
M-Beg 2	209903	388303	Suite 1 Suite 2	Daily	Sampling to be undertaken on a daily basis for laboratory analysis to provide trends on water quality for the parameters being tested. Each sample location is photograph as record of the appearance of the watercourse during the sampling Sampling frequency reduced to weekly sampling in February 2021 following a sustained period of stable readings.
Sample location on the Mourne Beg river downstream of the confluence with the Shruhangarve					
M-Beg 1	212542	385764	Suite 1 Suite 2	Daily	Sampling to be undertaken on a daily basis for laboratory analysis to provide trends on water quality for the parameters being tested. Each sample location is photograph as record of the appearance of the watercourse during the sampling

ID	Easting (IG)	Northing (IG)	Testing Parameters	Frequency	Task
					Sampling frequency reduced to weekly sampling in February 2021 following a sustained period of stable readings.
Sample locations on the Derg River downstream of the confluence with the Mourne Beg river					
Derg 1	226189	384383	Suite 1 Suite 2	Daily	Sampling to be undertaken on a daily basis for laboratory analysis to provide trends on water quality for the parameters being tested. Each sample location is photograph as record of the appearance of the watercourse during the sampling. Sampling frequency reduced to weekly sampling in February 2021 following a sustained period of stable readings.
Derg 2	228852	384793		Daily	

5.3.5 Continuous Turbidity Monitoring

Turbidity monitors or sondes are installed at locations surrounding the wind farm site as outlined in Figure 5.14. The sondes provide continuous readings for turbidity levels at two new locations both upstream and downstream of the Mourne Beg river. This equipment is supplemented by daily visual inspections at their locations as outlined in Table 5.12 and mapped in Figure 5.14.

Table 5.12 Continuous Turbidity Monitoring (Sonde) Locations

ID	Easting (IG)	Northing (IG)	Testing Parameters	Frequency	Summary
SE1	202046	384649	Suite 3	Continuous	Sonde has been recording turbidity continuously since September 2019 in the Lowreymore river south of the Barnesmore Gap
SE3	210212	387234		Continuous	Sonde had been recording turbidity in the Shruhangarve since September 2019 until it was taken away by material from the peat slippage. The continuous turbidity monitor at Shruhangarve Bridge was reinstalled on 18th December 2020 and has been operational since that date.
SE4	208185	387675		Continuous	Sonde has been recording turbidity continuously since September 2019 in the Bunadaowen river north of the Meenbog WF site
SE5	212530	385761		Continuous	Sonde has been recording turbidity continuously since 19/11/20 in the Mourne Beg river downstream of the confluence with the Shruhangarve to provide water quality data downstream from the Shruhangarve
SE6	209915	388320		Continuous	Sonde has been recording turbidity continuously since 26/11/20 in the Mourne Beg river upstream of the confluence with the Shruhangarve to provide water quality data upstream from the Shruhangarve.
SE7	209742	388286		Continuous	Sonde has been recording turbidity continuously since 08/02/21 in the Mourne Beg River upstream of the confluence with the Bunadaowen river to provide quality upstream of the Bunadaowen and Shruhangarve.

5.3.6 Aquatic Ecology Baseline Monitoring

It is proposed to undertake surface water sampling to establish baseline conditions as part of an aquatic ecology assessment of the Shrunhangarve stream and Mourne Beg rivers. Two rounds of sampling, in spring and summer at 10 no. sample locations will be carried out. The approximate locations of these sample points has to be determined in consultation with the project ecologists. Surface water samples will be sent to an independent testing laboratory for analysis for the parameters listed under Suite 4 below.

5.3.7 Surface Water Monitoring Reporting

Visual inspection, turbidity monitoring data and laboratory analysis results of water quality monitoring will be used to further inform future recommendations that are made or revised in subsequent iterations of this Action Plan.

All water monitoring reports will be available to Donegal County Council on request at any time.

5.4 Ecological Surveys

5.4.1 Introduction

A comprehensive schedule and scope of aquatic ecology surveys is planned, coordinated by MKO ecologists with the assistance of Triturus Environmental Ltd. Using Triturus's experience of similar schemes and aquatic studies within Ireland, a 'best practise approach' for the selection of the monitoring techniques has been compiled.

The scope and purpose of the aquatic surveys planned are to:

1. *Establish baseline conditions in the river.*
2. *Assess the damage caused as a result of the peat slide.*
3. *Consider measures that could be employed to ameliorate any impacts.*
4. *Monitor conditions within the river in the long term.*

MKO ecologists will also be completing a detailed assessment of the potential impacts that the peat slide may have had on bird species, known from the Meenbog wind farm site and surrounding area. This assessment will include a study of all known ornithological data including the location of roosts, nest sites and foraging areas for sensitive species. Potential habitat loss and disturbance displacement impacts were assessed for hen harrier and merlin in January 2021. No significant habitat loss or disturbance displacement effect on hen harrier or merlin were identified resulting from the November 2020 peat slide at the Meenbog Wind Farm. Both species will be subject to continued construction phase monitoring as per planning permission conditions within the wind farm site.

MKO ecologists will be completing detailed botanical surveys of the peatlands within the Meenbog wind farm site and along the banks of the Shruhangarve, to assess the impact of the peat slide on them, to evaluate their condition and to advise on any measures that may be employed to enhance their conservation.

To establish baseline conditions in the river, the following aquatic surveys outlined below are proposed.

5.4.2 River Invertebrates (Q values and RICT)

Macro-invertebrate samples will be collected from 10 sampling locations by kick sampling to calculate Q-ratings/RICT (NOTE: the catchment is cross border and two river invertebrate status calculations are required for Water Framework Directive (WFD) in order to comply with EPA/NIEA guidance. Sampling will follow 'Guidelines for the selection of sampling methods and devices for benthic macroinvertebrates in fresh waters' (ISO 10870:2012).

Samples collected and associated data will provide a WFD classification according to Toner et al., 2005 for Ireland and standard UK River Prediction and Classification System (RIVPACS) and river assessment method benthic invertebrate fauna invertebrates (General Degradation): Whalley, Hawkes, Paisley & Trigg (WHPT) metric in River Invertebrate Classification Tool (RICT).

5.4.3 Specialist river electrofishing

Fish monitoring will be guided by CEN - EN 14962 Water quality - Guidance on the scope and selection of fish sampling methods. Sampling methods within rivers have been categorised and in order to evaluate the fish population parameters such as species composition, abundance and age structure. These include, site specific backpack electrofishing at the 10 sites to be identified for water quality and invertebrate sampling.

5.4.4 River Habitat Survey (RHS) and Fish Habitat Survey

Approximately 20 km of downstream river channel to be surveyed, which would include the 10-water quality/river invertebrate sites. The fisheries habitat is assessed using the Life Cycle Unit Method (LCUM) developed in Northern Ireland by Kennedy[2] which is currently used by the Loughs Agency and the optimal survey period for field study is during low river flow which enables visual habitat observation[3]. River Habitat Survey (RHS) follows standard methodology developed within the UK[4].

Any potential areas of lamprey habitat (potential breeding and juvenile habitat i.e. sediment banks will also be identified during this survey. Standard lamprey habitat assessment would follow guidance by the European Commission's LIFE Nature programme (Maitland, 2003) and the Scottish Fisheries Coordination Centre (Marine Scotland, 2007).

5.4.5 Aquatic Vegetation

Aquatic vegetation would be recorded on a 'presence absence' basis at each of the 10 sites identified for water quality and invertebrate sampling (four riverine sites and six sampling stations within the estuary). Monitoring would be guided by Common Standards Monitoring Guidance for Rivers (JNCC 2016). This survey would also record the aquatic vegetation (emergent and floating vegetation) and would be carried out in conjunction with macro-invertebrate and fish surveys.

5.4.6 Hydromorphology Assessment

The hydromorphology assessment would be guided by the River Hydromorphology Assessment Technique (RHAT) Training Manual (NIEA 2014). It would be conducted over the 10 sites identified for water quality and invertebrate sampling (four riverine sites and six sampling stations within the estuary) and would be carried out in conjunction with macro-invertebrate and fish surveys.

5.4.7 Future phases

Future phases of surveys and assessment will be detailed and developed further as the results of the baseline surveys become available and will be included in future iterations of the Action Plan.

2 Kennedy GJA (1984). Evaluation of Techniques for Classifying Habitats for Juvenile Salmon (Salmo salar L.). Proceedings of the Atlantic Salmon Trust Workshop on Stock Enhancement
3 Department of Agriculture Northern Ireland (2005). The Evaluation of Habitat for Salmon and Trout. Advisory Leaflet No. 1. Fisheries Division, Stormont, Belfast.
4 Environment Agency (2003). River Habitat Survey in Britain and Ireland – Field Survey Guidance Manual: 2003 version, Environment Agency, Scottish Environmental Protection Agency (SEPA) & Environment & Heritage Service (NI).

APPENDIX E

ACTION PLAN – VERSION 3.0

Peat Slide Action Plan – Version 3.0

Meenbog Wind Farm

DOCUMENT DETAILS

Client: **Planree Limited**

Project Title: **Meenbog Wind Farm**

Project Number: **201174**

Document Title: **Peat Slide Action Plan – Version 3.0**

Document File Name: **201174 - Action Plan Version 3.0 F 2021.05.06**

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Planning and Environmental Consultants

Rev	Status	Date	Author(s)	Approved By
01	Draft	12/05/2021	BK; TB; PR; MW; MG; SC	PR
02	Final	18/05/2021	BK; TB; PR; MW; MG; SC	WOC, BK

Table of Contents

1. INTRODUCTION

1.1 Background

McCarthy Keville O'Sullivan Ltd. (MKO) have been requested by Planree Limited (Planree) to provide technical assistance and prepare an Action Plan following a peat slide incident at the Meenbog Wind Farm construction site on the 12th November. Since the appointment by Planree, MKO have been coordinating a team of ecologists, hydrologists, environmental scientists, environmental engineers and aquatic ecologists to prepare an Action Plan that would make recommendations to mitigate the effects of the incident.

Version 1.0 of this Action Plan was prepared specifically to inform Planree's response to a notice issued by Donegal County Council (DCC) dated 17th November issued under Sections 10(5), 12(1) and 23(1) of the Local Government (Water Pollution) Acts, relating to the discharge of peat, sediment and heavily soiled water from the wind farm site under construction at Meenbog, Ballybofey, Co. Donegal to the Shruhangarve stream and Mourne Beg River commencing on the 12th and 13th November 2020.

Action Plan (Version 2.0) updated and expanded upon the recommendations provided in Action Plan Version 1.0. In particular, additional detail was provided on the phasing of, and specific measures proposed for, the restoration of the Shruhangarve Stream.

This version of the Action Plan (Version 3.0) further updates and expands upon the recommendations provided in Action Plan Version 2.0. In particular, additional detail is provided on the next phase (Phase 1B) of measures proposed for the restoration of the Shruhangarve Stream. These measures are set out in Section 5.2 of this plan.

1.2 Scope of Action Plan

DCC's letter of 17th November requested Action Plan, in the form of a written report, by submitted to Donegal County Council detailing the engineering measures identified and considered necessary to:

> *(a) eliminate or limit the release of further polluting matter from the area where the landslide occurred, from areas up gradient of the land slide and from areas down gradient of the landslide where material has been deposited,*
>
> *(b) prevent the catastrophic release of material built up behind the existing improvised impoundment structure on site, (taking into consideration projected rainfall amounts) and,*
>
> *(c) mitigate against the further dispersal of peat and sediment, deposited along the banks of the Shruhangarve, by the watercourse through and beyond the confines of the site.*

This Action Plan has been prepared by MKO for Planree Limited in response to the DCC requests outlined above. The description of emergency engineering works undertaken to date which address Point (a) and (b) above has been compiled by Ionic Consulting and is set out in Section 2.

The MKO proposals are included herein as a series of recommendations for Planree Limited or their contractors to implement on-site.

MKO has prepared this action plan to allow Planree Limited present it and the recommendations contained herein as Planree Limited's proposals to Donegal County Council along with the necessary commitments to their effective implementation.

MKO is not responsible for the implementation of the proposed measures contained herein on-site, but will monitor the implementation of any measures that might be proposed by Planree as part of an expanded role for the on-site Environmental Clerk of Works.

This Action Plan has been prepared as a "Version 3.0" document and is by no means exhaustive or limited. Action Plan Version 3.0 focuses on immediately implementable rehabilitation measures for the upper scar, stabilisation of deposited peats in the central portion of Stream Reach 2, and the graduated removal of accumulated peat from the impounded area upstream of Wall 1. It is anticipated that future versions of the Action Plan will be forthcoming and will address in further detail the proposed restoration of the Shruhangarve Stream upstream of Wall 1. Further recommendations are likely to be brought forward to address the situation on-site and in the downstream watercourses as a result of ongoing water monitoring efforts, ecological surveys, seasonal factors, the trialling of certain recommendations on site and the contributions from other stakeholders and regulatory authorities whose input will be very much welcomed and carefully considered.

1.3 Contributors

The following people contributed to the preparation of the Action Plan and the recommendations contained herein.

Brian Keville – MKO (Environmental Director)

Brian has over 20 years' professional experience as an environmental consultant having graduated from the National University of Ireland, Galway with a first class honours degree in Environmental Science. Brian's professional experience has focused on project and environmental management, and environmental impact assessments. Brian has acted as project manager and lead-consultant on numerous environmental impact assessments, across various Irish counties and planning authority areas. These projects have included large infrastructural projects such as roads, ports and municipal services projects, through to commercial, mixed-use, industrial and renewable energy projects. The majority of this work has required liaison and co-ordination with government agencies and bodies, technical project teams, sub-consultants and clients.

Michael Watson – MKO (Environment Team Project Director)

Michael is Project Director and head of the Environment Team in McCarthy Keville O'Sullivan (MKO). Michael has over 18 years' experience in the environmental sector. Following the completion of his Master's Degree in Environmental Resource Management, Geography, from National University of Ireland, Maynooth he worked for the Geological Survey of Ireland and then a prominent private environmental & hydrogeological consultancy prior to joining MKO in 2014. Michael's professional experience includes managing Environmental Impact Assessments, EPA License applications, hydrogeological assessments, environmental due diligence and general environmental assessment on behalf of clients in the wind farm, waste management, public sector, commercial and industrial sectors nationally. Michael also has a Bachelor of Arts Degree in Geography and Economics from NUI Maynooth, is a Member of IEMA, a Chartered Environmentalist (CEnv) and Professional Geologist (PGeo).

Thomas Blackwell – MKO (Senior Environmental Consultant)

Thomas is a Senior Environmental Consultant with MKO with over 15 years of progressive experience in environmental consulting. Thomas holds a BA (Hons) in Geography from Trinity College Dublin and a M.Sc. in Environmental Resource Management from University College Dublin. Prior to taking up his position with MKO in August 2019, Thomas worked as a Senior Environmental Scientist with HDR, Inc. in the United States and held previous posts with private consulting firms in both the USA and Ireland. Thomas is a registered Professional Wetland Scientist with the Society of Wetland

Scientists with specialist knowledge in wetland assessment and delineation, mitigation planning and design, stream geomorphic assessment, and stream and wetland restoration design. Thomas' key areas of expertise include fluvial geomorphology and stream restoration design. Thomas has provided stream restoration design, and construction oversight for numerous private and publicly funded projects in multiple jurisdictions.

Pat Roberts – MKO (Principal Ecologist)

Pat joined MKO (then Keville & O'Sullivan Associates) in 2005 following completion of a B.Sc. in Environmental Science. He has extensive experience of providing ecological services in relation to a wide range of developments at the planning, construction and monitoring stages. He has wide experience of large scale industrial and civil engineering projects. He is highly experienced in the completion of ecological baseline surveys and impact assessment at the planning stage. He has worked closely with construction personnel at the set-up stage of numerous construction sites to implement and monitor any prescribed best practice measures. He has designed numerous Environmental Operating Plans and prepared many environmental method statements in close conjunction with project teams and contractors. He has worked extensively on the identification, control and management of invasive species on numerous construction sites.

John Hynes – MKO (Ecology Team Project Director)

John Hynes is a Senior Ecologist with McCarthy O'Sullivan Ltd. with over 7 years of experience in both private practice and local authorities. John holds a B.SC in Environmental Science and a M.Sc. in Applied Ecology. John has specialist knowledge in Flora and Fauna field surveys. Geographic Information Systems, data analysis, Appropriate Assessment, Ecological Impact Assessment and Environmental Impact Assessment. Since joining MKO John has been involved as a Senior Ecologist on a significant range of energy infrastructure, commercial, national roads and private/public development projects. John has project managed a range of strategic infrastructure and development projects across the Ireland and holds CIEEM membership.

David McNicholas – MKO (Senior Ecologist

David McNicholas is a Senior Ecologist at MKO. David holds a BSc (First Class Hons) Environmental Science and an MSc (Hons) Environmental, Health and Safety Management. David has over 10 years professional ecological consultancy experience. David specialises in the preparation of EIAs, EcIAs and NISs including ecological surveys and monitoring. David has worked on all phases of wind farm development from feasibility/ scoping, ecological surveys, preparation of full EIS chapters, construction phase environmental monitoring and post-construction ecological monitoring. David has worked as an Ecological Clerk of Works (ECoW) during the construction phase of ten large scale wind farms in Ireland and Northern Ireland, gained significant experience on the implementation of the environmental and ecological measures. David is a full member of the Chartered Institute of Ecology and Environmental Management (MCIEEM).

Owen Cahill – MKO (Project Environmental Engineer)

Owen is an Environmental Engineer with McCarthy O'Sullivan Ltd. with over 11 years of experience in the environmental management and construction industries. Owen holds BSc. (Hons) and MSc. in Construction Management and a Masters in Environmental Engineering. Owen has project managed the Environmental Impact Assessment of a range of development projects across the Ireland and holds Full Membership with the Institute of Environmental Management & Assessment and is a Chartered Environmentalist.

Michael Gill – Hydro-Environmental Services

Michael Gill is an Environmental Engineer with over 18 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms in Ireland. He has also managed EIA/EIS assessments for infrastructure projects and private residential and commercial developments. In addition, he has substantial experience in wastewater engineering and site suitability assessments, contaminated land investigation and assessment, wetland hydrology/hydrogeology, water resource assessments, surface water drainage design and SUDs design, water quality protection, water treatment systems and surface water/groundwater interactions.

Cormac Ó Dubhthaigh – Ionic Consulting Limited

Cormac is the Civil Engineering Manager at Ionic Consulting and joined the company in 2009. He holds a first class honours B.E. Civil Engineering degree from UCD and also completed an M.Eng.Sc. masters degree in Structural Engineering in UCD in 1996. He has considerable experience in the design of wind farm infrastructure including roads, hardstandings, wind turbine foundations, substations, bridges and associated works, with design experience on over 30 wind farms. He has previous experience in Ireland and Australia working with leading civil engineering consultancies including ARUP and Roughan & O'Donovan. He is a chartered member of Engineers Ireland (CEng MIEI).

Claire Looney – Ionic Consulting Limited

Claire is a Senior Project Manager with Ionic Consulting and has more than 14 years' experience in the energy sector, both in Ireland and internationally. She leads a team focussing on the delivery of onshore windfarms in Ireland, from pre-construction through to operational takeover with specific focus on Health & Safety, contract administration and programme delivery. She acts as the PSDP and Project Manager for a number of windfarms in Ireland. She is a chartered engineer and holds an honours degree in Electrical Engineering from UCC.

2. BACKGROUND (WORKS COMPLETED TO DATE)

2.1 Emergency Works

The following summary of emergency works undertaken on site has been prepared by Ionic Consulting (Ionic), and the Ionic briefing note from which this content was taken is included in full in Appendix 1. The emergency works set out in this section have now been completed. This section has been retained in Version 2.0 of the action plan for completeness and for ease of reference for the reader.

As set out in the notice and in line with section 6.1.5 of the project Construction and Environmental Management Plan ("CEMP"), we can confirm that following the peat slide on 12th Nov 2020, all construction works were ceased on the wind farm site as soon as notice of the incident was provided to site management. The only activities undertaken were those works required to ensure construction areas were left in a safe condition. Once all personnel on site had been safely accounted for, available resources were then immediately re-directed towards mitigating against further discharges to watercourses. The response to the peat slide can be split into stages which are set out below.

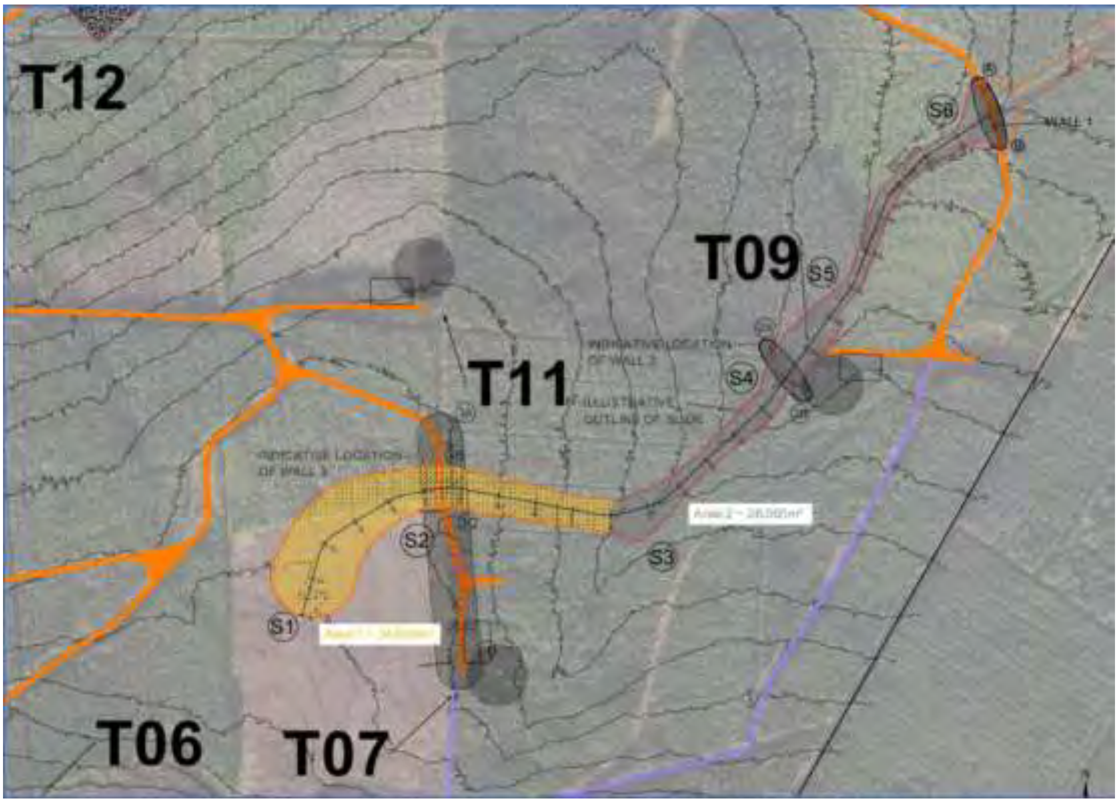


Figure 2.1 Overview map of works area

2.1.1 Step 1 - Immediate actions

The first stage was the immediate response within the first 24-72hours which consisted of emergency measures to prevent further material from entering local watercourses. Ionic Consulting who are the Designer and Geotechnical Engineers for the works were consulted. It was possible to undertake a drone survey relatively quickly following the incident as a drone was available on site. Based on the available information the slide path could be determined and an assessment of safe access points was undertaken.

It was evident that majority of the material that slid was deposited between points S3 and S6 shown on Figure 2.1 above, largely because of the shallower gradient and also by the existing roadway leading to turbine no. 9 (T9). This unstable, water-laden material presented the most immediate risk in terms of pollution of watercourses with the concern that the roadway could be overtopped by material being retained to the South. This risk was exacerbated by the fact that the slide material had entered the local stream (at approximately point 'S3' in Figure 2.1) and water from the surrounding catchment entering the stream would be retained behind the roadway (identified as 'Wall 1' in Figure 2.1). A secondary risk in terms of immediate further pollution of watercourses was the risk of additional movement of material from the area upslope of the slide initiation point (to the South and west of point 'S1' in Figure 2.1.

To mitigate against the risks above, the immediate aim was to introduce check barrages to prevent the slide from reaching any watercourses in line with the CEMP. Immediate action was taken to reinforce and increase the height of the accessible roadway leading to T9. The reason works commenced at this point was two-fold:

1) This road was already acting as a check barrage, retaining some of the slide material to the South however it was at the point of being overtopped by the slide material.

2) Following remote consultation with geotechnical consultant Ionic Consulting and with the information from the initial drone survey of the area it was evident that this was the only location where it would be safe to gain immediate access to initiate the CEMP measures.

Works commenced at the roadway to T9 (referred to as Wall 1 in Figure 2.1 above) on the afternoon of the 12th November 2020 as soon as an inspection had been conducted to ensure it was safe for personnel to work in the area. It was not possible to produce a detailed design in this timeframe given the need for immediate action however the proposed works were reviewed and progressed in consultation with the Designer Ionic Consulting. The initial aim was to raise the berm by 1.5m-2m for a length of approximately 100m along the area retaining the slide, this was further raised over the following days by up to 3.8m from the original design level.

The primary aim of Wall 1 was to limit or prevent the flow of liquefied peat into watercourses beyond the site. The existing pipe was largely blocked due to the deposited peat, and though water continued to flow through and around the wall, including seepage through the existing pipe, the majority of the peat slurry and solid clumps of peat were retained.

2.1.2 Step 2 -Assessment

Before progressing works at any other points on site, more detailed geotechnical assessment was required in order to:

a) Establish safe areas for access on site and to identify unsafe or potentially unstable areas on site

b) Assess what additional emergency measures were necessary to prevent further movement of peat or material

Close monitoring of the slide area by drone continued on a daily basis. Upcoming weather forecasts were reviewed to consider additional rainfall events and potential impact on stability of the area. Ionic Consulting have a site engineer with daily presence on site, and engineers visited the site on 13th Nov 2020 and on six further occasions in the first 2 weeks for the purpose of this assessment.

In addition to the geotechnical assessment it is noted that MKO the environmental and ecological consultant appointed for the project attended site to assess both the Shruhangarave Stream and Mourne Beg River from the 13th Nov 2020 and a new monitoring programme was developed, with support from HES, for these two watercourses including laboratory analysis and visual checks implemented daily.

2.1.3 Step 3 - Additional Emergency Measures

Following further assessment a detailed design for 'Wall 1' was developed by Ionic Consulting. This consisted of a large stone berm raised from original road level of 217.2mOD to 221.0mOD to provide additional containment for deposited peat. A design risk assessment and detailed design are appended for reference. Please refer to drawing MNBG d021.9.1 - Wall 1 Berm (T9 Spur)_RevB and MNBG hs004.5 Design Risk Assessment - T7 Peat Slide Stabilisation RevC *(included in Appendix 2 of this Action Plan).* Following initial emergency works carried out on 12th November works continued to implement the final detailed design and were completed by 21st Nov 2020.

The detailed geotechnical assessment undertaken in step 2 identified the risk of further peat movement upslope of the slide initiation point in the peatland area (refer to point S1 in Figure 2.1) was still significant. Two other points for further check barrages were identified, denoted as 'Wall 2' and 'Wall 3' in Figure 2.1 to mitigate against this potential risk. Access for construction of Wall 2 would be from the hardstanding at T9 and access for Wall 3 would be from the last section of road constructed to solid formation on the approach to the turbine 7 (T7) location. Wall 3 was prioritised for the following reasons:

a) Wall 3 was located immediately downslope of an area of unstable peat where significant volumes of water or liquefied peat was released, and given the visual signs of further propagating cracks from aerial drone footage it was considered a priority to stabilise this upslope material.

b) Wall 3 is an 'on-land' check barrage as opposed to Wall 2 which is located 'in-stream' which was considered to present a lesser risk to pollution of watercourses

c) The construction of Wall 2 could not safely commence until Wall 1 was complete whereas access was immediately available to Wall 3 prior to the completion of works at Wall 1.

As there was a short section of floating road approaching T7 remaining following the peat slide, the Designer and geotechnical consultant Ionic Consulting Ltd advised that this check barrage be installed upslope of the existing roadway. Again, a detailed design was developed prior to the commencement of the works. Consideration was given to drainage through the check barrage for geotechnical purposes. A design risk assessment and detailed design are also appended for these works for reference. Please refer to drawing MNBG d021.7.4 T7 Slide Berm Details_Rev B and MNBG hs004.5 Design Risk Assessment - T7 Peat Slide Stabilisation RevC *(included in Appendix 2 of this Action Plan)*..

Works commenced as soon as a geotechnical assessment could be completed and an appropriate civil works design could be developed. Construction of this berm referred to as 'Wall 3' commenced on 17th Nov 2020.

MKO continued to fulfil the Environmental Clerk of Works (ECoW) role during the emergency works and expanded the water quality monitoring programme that was already underway.

As soon as Wall 1 was completed and safe access and egress could be maintained to T9 via the access road, and also the section of Wall 3 past the slide affected area was constructed, construction of Wall 2 was considered. Due to increased rainfall it was observed that an excessive amount of water was flowing towards Wall 1. A decision was taken at this time to prioritise drainage of the area and strategic pumping of clean water away from the area affected by the slide. Clean water was intercepted and diverted from upstream of the slide area and discharged to the North of Wall 1. Soiled water was also removed via pumping from the area adjacent to T9. These works commenced on 25th November.

2.1.4 Measure 1 - Impound water and sediment behind Wall 1 (Complete)

Large volumes of sediment have been successfully impounded behind Wall 1 and prevented from entering downstream watercourses, as evident in Figures 2.2 and 2.3 below. The volumetric measurement of these sediment volumes is presently underway and will be reported in future iterations of the Action Plan. Approximately 79% of water flows entering the Shruhangarve catchment upstream of Wall 1 have been intercepted upstream of the impounded sediment and diverted away from the sediment impounded behind Wall 1, thereby minimising the re-mobilisation of the impounded sediment, but larger volumes of water are likely to continue to reach the upstream side of Wall 1 in periods of heavier and prolonged rainfall.

There currently appears to be minimal seepage of water through Wall 1, likely because any void spaces have become plugged with suspended peat and the bypass flows already in place around Wall 1.

Figure 2.2 Water and sediment impoundment area upstream of Wall 1 showing stabilised situation and deposits of peat up to surface of water

Figure 2.3 Aerial image of water and peat impoundment area upstream of Wall 1 showing large volums of impounded peat and clearly identifiable channel for water reaching Wall 1

Objectives of recommendations

1. *Eliminate or limit the release of further polluting matter from the area where the landslide occurred.*
2. *Eliminate or limit the release of further polluting matter from areas up gradient of the land slide.*
3. *Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.*
4. *Prevent the catastrophic release of material built up behind the existing improvised impoundment structure on site.*

Recommended measures

1. *Continue to intercept as much water as possible upstream of Wall 1 and overpump it to the downstream site of Wall 1 to minimise the amount of water reaching the upstream side of Wall 1.*
2. *Keep existing overflow pipe clear to be able to release any excess build-up of water behind Wall 1 in order to maintain the structural integrity of Wall 1.*
3. *Maintain overflow pipe at existing level and install flow meter in pipe.*
4. *Prevent any overflow of water around sides of Wall 1 by building up level of wall/road.*
5. *Continue to assess rate of seepage through Wall 1, and if necessary, seal upstream side of Wall 1 to minimise seepage through wall (using vertical timbers, peat plug etc.).*

2.1.5 Measure 2 – Intercept clean water (Complete)

Large volumes of clean water are already being successfully intercepted upstream of the peat slide area on the Shruhangarve stream as a result of the emergency works now completed on site, and are being prevented from reaching the peat slide area and becoming entrained with sediment, see Figure 2.4 below. Further volumes of clean water are being intercepted as overland flow, and prevented from reaching the peat slide area and becoming entrained with sediment. The more "clean" water that can be intercepted upstream or upgradient of the peat slide area, the less water will become soiled. Intercepting as much clean water as possible and diverting or pumping it to the downstream side of Wall 1 keeps that clean water clean and prevents that water mobilising further sediment or deposited peat sludge it might otherwise encounter.

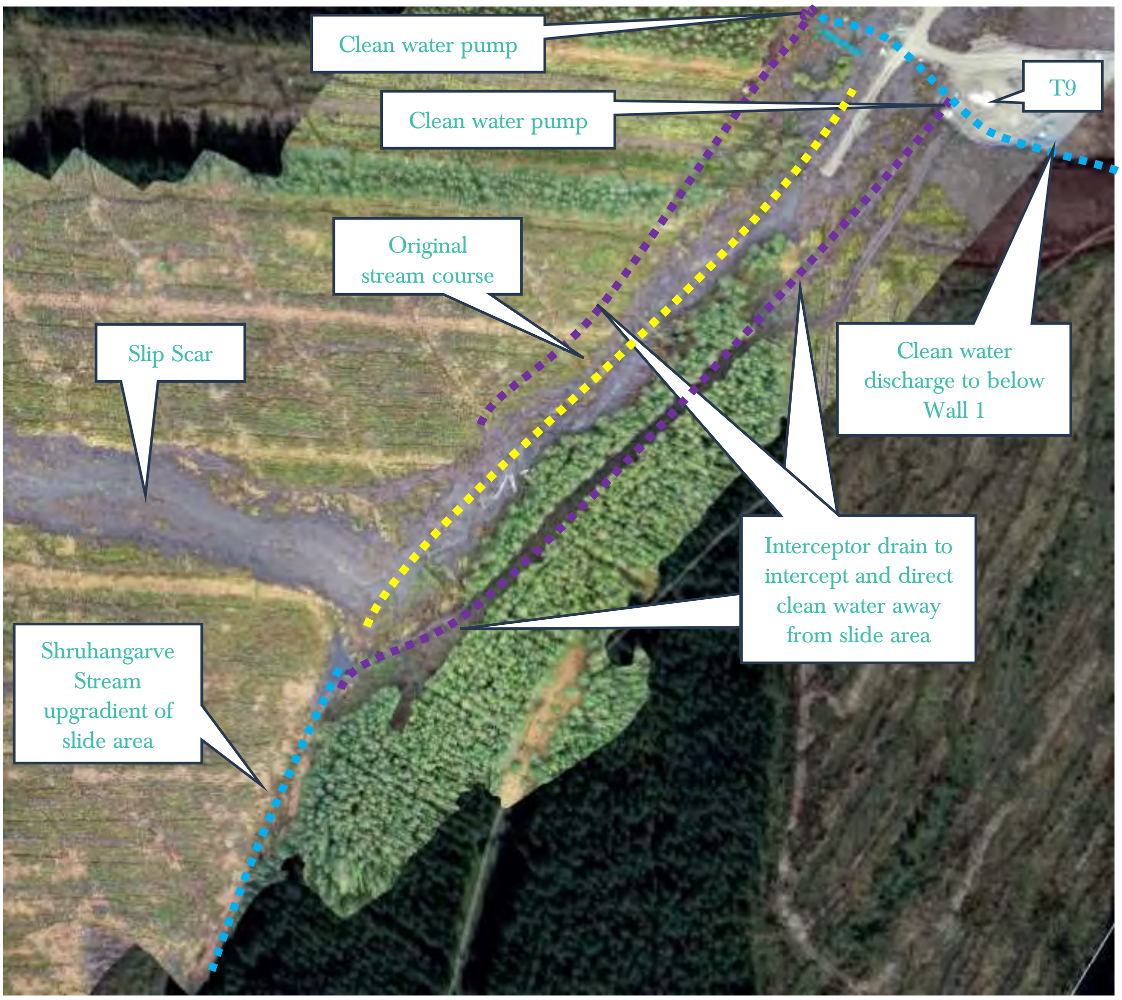


Figure 2.4 Aerial view of Stream Reach 1, showing interceptor drains collecting clear water for pumping around peat slide area

Analysis of the Shruhangarve catchment topography upstream of Wall 1 undertaken since the peat slide has divided it into "clean" and "soiled" sub-catchment areas, as detailed on HES Figure No. P1249-5_D101 included above. Clean water is being intercepted from the sub-catchment areas labelled as "upstream_clean", "T9_west_clean", and "upstream_east_clean" on HES Figure No. P1249-5_D101. Further efforts are considered likely to yield diminishing returns and may not be justifiable given the extent of further works required. Objectives of recommendations

1. *Eliminate or limit the release of further polluting matter from the area where the landslide occurred.*
2. *Eliminate or limit the release of further polluting matter from areas up gradient of the land slide.*

3. *Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.*
4. *Mitigate against the further dispersal of peat and sediment, deposited along the banks of the Shruhangarve, by the watercourse through and beyond the confines of the site.*

Recommended measures

1. *Continue to analyse catchment topography and forestry drainage features to identify other routes of clean water interceptor drains/sumps.*
2. *Specifically target area west of T9, west of stream (labelled "T9_west_clean" on HES Figure No. P1249-5_D101) for further interception of clean water. Possible interception/pumping arrangement shown in Figure 2.5 below to be developed further and approved by ecologist, hydrologist and geotechnical engineer before implementation. This has now been completed and no further works are proposed in this area.*
3. *Minimise the need for pumping, using gravity flows wherever possible.*
4. *Where necessary, identify safe pumping locations at the end of interceptor drain.*
5. *Ensure all pumps and fuels bowsers are bunded or double-skinned.*
6. *Pump and/or pipe intercepted clean water to downstream side of Wall 1.*

Discharge all intercepted and piped clean water onto rock armour downstream of Wall 1 to minimise further erosion from channel bed/bank and all diffuse dispersed flow to naturally reconcentrate in existing stream channel.

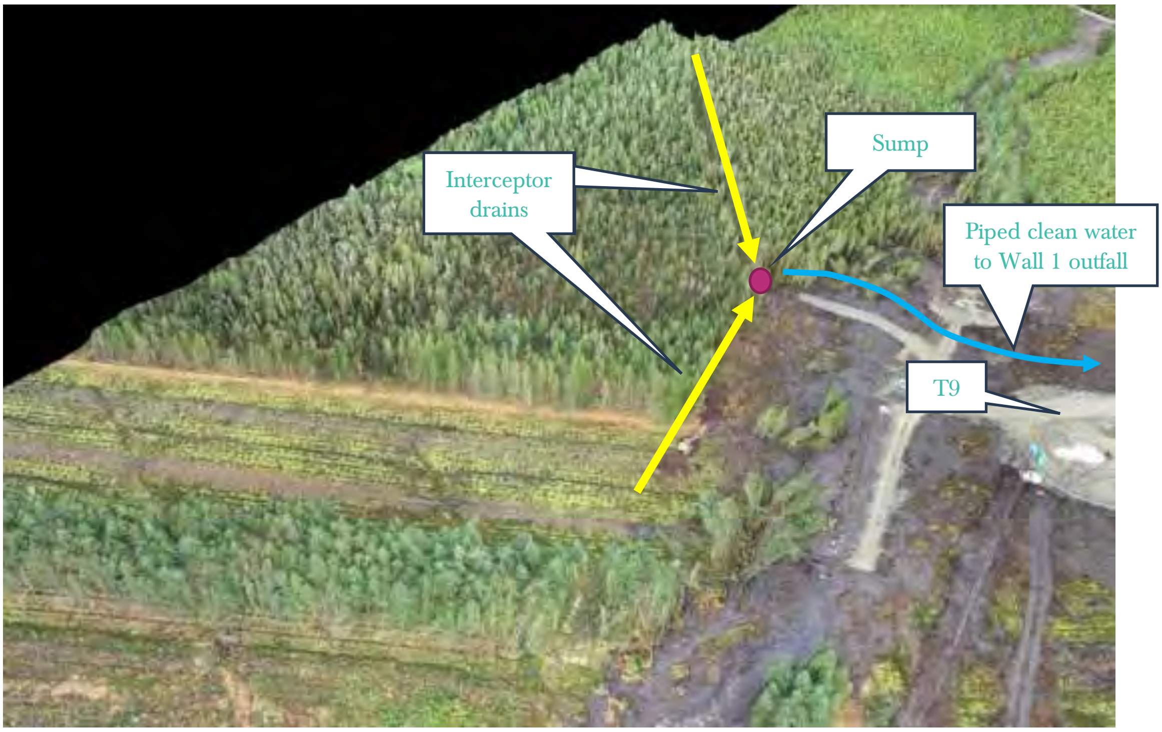


Figure 2.5 Clean water interceptor drains and pumping arrangement for area west of T9 (for illustrative purposes only)

Current situation

As of March 2021, Walls 1, 2 and 3 remain in place and are effective. These works are deemed to have largely stabilised the area. A drainage and pumping arrangement has been implemented which combined has substantially reduced the level of water flowing towards Wall 1.

Some initial measures (installation of coir matting and silt fence) were commenced downstream of Wall 1 but have been suspended pending further assessment. As referenced above, a monitoring programme has been implemented.

3. CURRENT SITE HYDROLOGY

Upstream of Wall 1 a series of emergency works have been completed to a) stabilise the ground to prevent further peat movement, and b) to manage surface water and protect downstream water quality.

The catchment upstream of Wall 1 is ~0.85km^2 in area. Surface water flows from this catchment will vary with preceding rainfall and catchment wetness. In the spring and summer months there will be increased evapotranspiration. Catchment area maps have been prepared for the Shruhangarve sub-catchment in which the peat slide occurred, and one is included as HES Figure No. P1249-5_D101 below.

3 no. stone structures have been constructed to stabilise the peat, Wall 1, Wall 2 and Wall 3. Wall 3 is the furthest up the catchment and is located along the T7 (turbine 7) access track. Wall 1 is the lower structure and is constructed perpendicular to the Shruhangarve stream along the line of the T9 access track. Wall 2 is the intermediate structure and is located west of T9 (turbine 9).

Following the peat slide event (12th November), and after the initial geotechnical stabilisation works, one of the focuses on site was to attempt to divert as much clean water as possible around Wall 1, and back into the Shruhangarve stream. The purpose here was to prevent flow through the pond behind Wall 1 as this holds significant volumes of loose peat and sludge which will be mobilised by larger throughflows. Based on initial estimations, HES determined that ~59% (Upstream clean and Upstream_east_clean) of the total catchment upstream of the slide could be diverted around Wall1. In order to implement this, a diversion drain and two sumps (initial settlement sump to capture any large solids, and second pump sump from which water is pumped) were created to the southwest of T9. An 8" pump and backup 6" pump are operational, and pumping water from this clean water area around Wall 1 (Discharge 1). Additional clean water (~10-18%) has been diverted from the western side of the catchment (T9_west_clean).

At Wall 2 a series of linear attenuation/settlement ponds (2 no.), and sumps (2 no.) have been created. These capture soiled water coming from the upstream slip area and currently from the catchment to the west of the slip area. This soiled water is pumped from the second sump (again, an initial settlement sump to capture any large solids, and second pump sump were installed) from which water is pumped and diverted around Wall1. This water is treated via a settlement tank and silt bags (Discharge 2).

At Wall 3 a temporary pumping arrangement was established to divert water away from downstream of Wall 3 to the north. The purpose of this pumping was to prevent significant water flows down through the slip area and reduce the risk of further destabilisation. The catchment upstream of Wall 3 is relatively small and as such pumping flows were also relatively small (Discharge 5). Pumping at this location has now been suspended and water is currently flowing downs the slip scar. Monitoring of discharge water has shown that this is not leading to an increase in turbidity at downstream monitoring locations.

At Wall 1, there are two further discharges. The first is overflow from the pond behind Wall 1, and this overflow occurs through 2 no. 600mm pipes (Discharge 2). As outlined above much of the runoff water from the catchment is being diverted around the pond upstream of Wall 1. The second discharge at Wall 1 is seepage flow through the southern (lower) end of Wall 1. This flow is captured in a sump downstream of Wall 1 and pumped laterally into the main channel of the Shruhangarve (Discharge 3). The purpose here is to prevent flows down through the forestry which could destabilise the peat there, and also remobilise some of the loose peat/sludge that coats the ground following the peat slide.

Figure 3.1 below shows a flow diagram of the current water flow and pumping arrangements on-site.

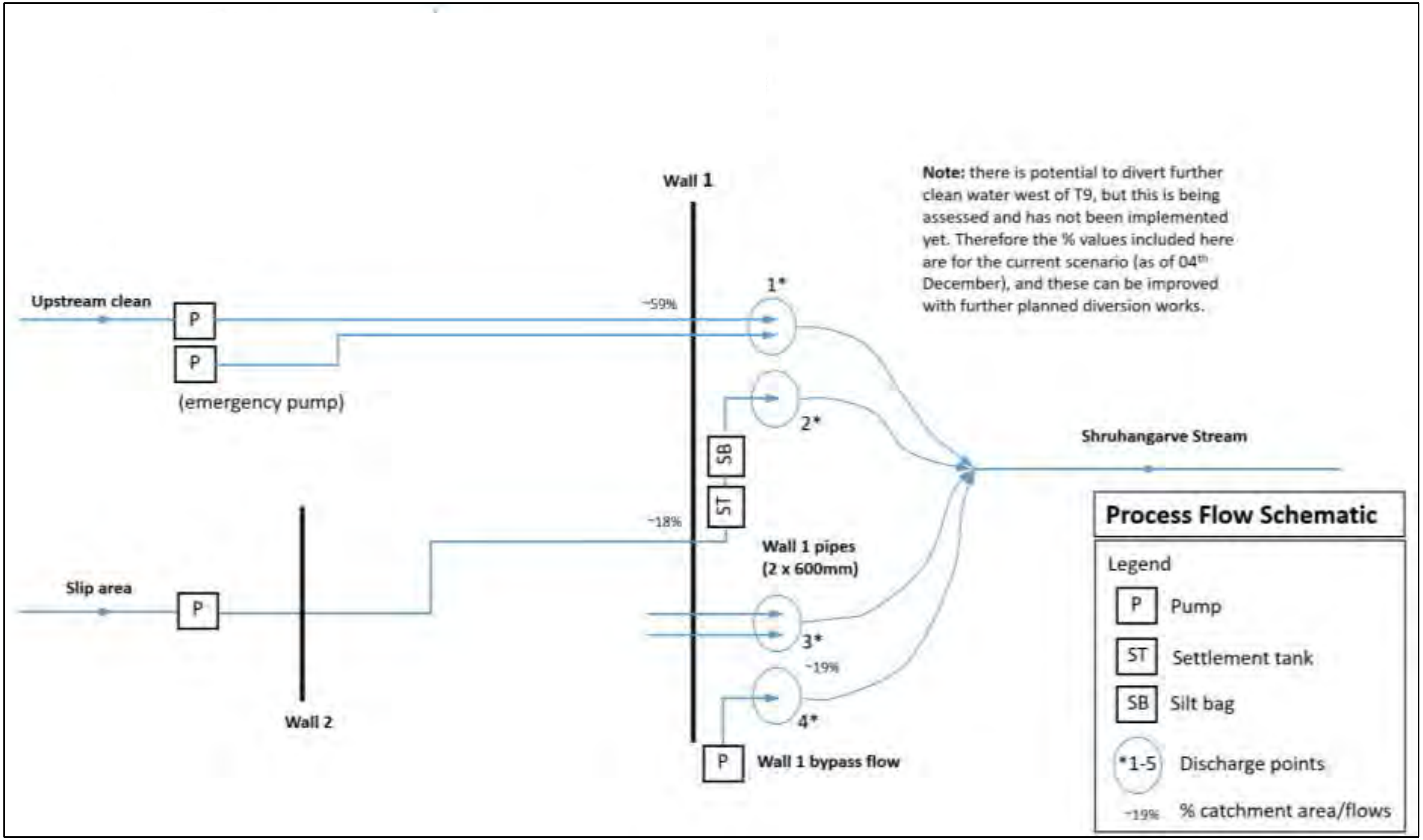


Figure 3.1 Flow diagram of current water flows and pumping arrangements on-site

4. RECOMMENDED FUTURE PHILOSOPHY

The emergency works undertaken and now completed on site since the original peat slide on the 12th/13th November have stabilised the situation on the ground to allow a considered view now be taken on future recommendations and measures that will further improve water quality and eventually restore and reinstate the river channel to the greatest extent possible.

Following the completion of the emergency works, it was determined to be better to do nothing else in the short term during the wetter winter months. However, at the time of writing (mid March 2021) it is approaching the optimum time of year for the implementation of additional restoration works Over the coming months it is anticipated that warmer weather, commencement of the growing season, and lower rainfall will result in drier ground conditions. It is therefore important to commence additional restoration works as quickly as possible in order to avail of these favourable conditions over the spring and summer.

Some fundamental principles are recommended for any works being considered and implemented in this and future Action Plans:

1. Do not do anything that makes the current improving situation worse from a water quality, habitats or protected species perspective, even on a temporary basis, until the proposed measures have been considered and recommended from an ecological, hydrological and geotechnical perspective to have longer term benefits, and detailed method statements are developed to minimise any potential for negative effects.
2. Do not consciously do anything that causes a soiled discharge to a natural watercourse, even if only temporary.

There will be very limited or no entirely risk-free options. However, any option recommended and selected will have to be justifiable and demonstrated to be the optimal option out of a number that will have been considered.

Any works will require continuous turbidity monitoring and will have to cease and be further modified if causing increased turbidity levels.

5. ACTION PLAN PROPOSALS

5.1 Introduction

Proposals are set out in the below section of the Action Plan under three categories:

1. *Water quality protection measures*
    - *Phase 1A – Works currently underway*
    - *Phase 1B – Detailed proposals presented below*
    - *Phase 2 – Detailed proposals being prepared*
2. *Water quality monitoring – currently underway*
3. *Ecological surveys – scheduled*

The recommendations for water quality protection measures have been made by way of this Action Plan to Planree.

The recommendations for water quality monitoring have been made previously to Planree and MKO are currently undertaking this monitoring.

The recommended ecological surveys have been proposed to Planree by MKO (with input from Triturus Environmental Ltd), have been accepted by Planree, but have not yet commenced.

5.2 Water Quality Protection Measures

A series of recommendations to protect water quality are outlined in this section of the Action Plan.

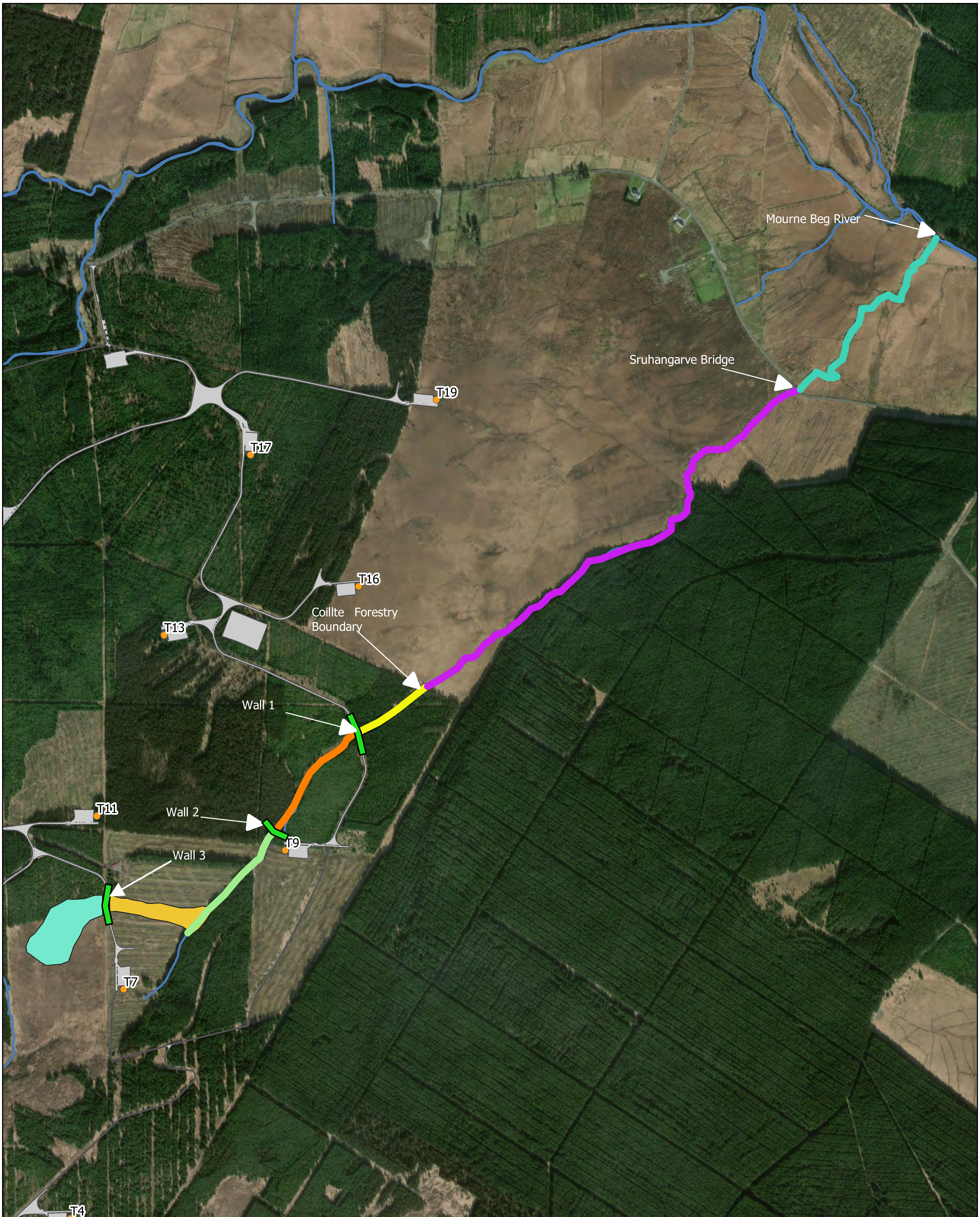
MKO has prepared this action plan and the recommendations contained herein to allow Planree Limited present their proposals to Donegal County Council along with the necessary commitments to the effective implementation of the proposals.

MKO is not responsible for the implementation of the proposed measures contained herein on-site, but will monitor the implementation of any measures that might be proposed by Planree as part of an expanded role for the on-site Environmental Clerk of Works.

The objectives of each of the water quality protection measures proposed below are described in terms of the required measures outlined in Donegal County Council's notice dated 17th November, as follows:

- *Eliminate or limit the release of further polluting matter from the area where the landslide occurred.*
- *Eliminate or limit the release of further polluting matter from areas up gradient of the land slide.*
- *Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.*
- *Prevent the catastrophic release of material built up behind the existing improvised impoundment structure on site.*
- *Mitigate against the further dispersal of peat and sediment, deposited along the banks of the Shruhangarve, by the watercourse through and beyond the confines of the site.*

For the purposes of describing the recommended water quality protection measures, Figure 5.1 has been prepared which divides the Shruhangarve stream into five sections or reaches, and these reaches will be referred to further below. The proposed water quality protection measures have been divided into two phases of work to allow for the implementation of some works while necessary studies and assessments are conducted for the future phases.



Map Legend

Peatslip
- Upper Scar
- Slip Scar

Stream Reaches
- Stream Reach 1
- Stream Reach 2
- Stream Reach 3
- Stream Reach 4
- Stream Reach 5
- Rivers/Streams
- Proposed Permanent Development Footprint
- Proposed Turbine Locations

N

Drawing Title	
Meenbog Peatslide Restoration Areas	
Project Title	
Meenbog Windfarm	
Drawn By: TJB	Checked By: BK
Project No.: 201174	Drawing No.: Figure 5.1
Scale: 1:10000	Date: 12/03/2021

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5.2.1 Phase 1 A – Works Currently Underway

The peat slide resulted in the formation of a wide slip scar (as shown on Figure 5.1) downstream of Wall 3 and significant impacts on the Shruhangarve stream channel between the base of the slip scar and Wall 2. Whilst further works are required in following phases to restore the Shruhangarve stream channel, Phase 1A includes works that will assist in the stabilisation of the slip scar and the banks of the upstream of Wall 2.

In addition, large volumes of peat mobilised during the peat slide were deposited along the downstream reaches of the Shruhangarve stream during the peat slide event. The spatial and volumetric measurement of these peat deposits is presently underway and will be reported in future iterations of the Action Plan. The deposits extend to varying widths along the banks Shruhangarve stream for a distance of approximately 2.4 kilometres downstream of Wall 1 as far as the Mourne Beg River.

The Shruhangarve stream downstream of Wall 1 continues to flow within the original natural stream channel, but larger flows during and after large rainfall events have caused some secondary mobilisation of the peat that would have been originally deposited on the stream banks. While the majority of the streambank peat deposits appear relatively stable, overland flows from the adjacent bog habitat towards the stream have caused some further mobilisation of the deposited peat in particular locations. It is not considered justifiable to leave the peat deposits in place without taking action to minimise run off, as to do so would result in further secondary mobilisation of the deposited peat into the adjacent stream. The Shruhangarve Stream with associated peat deposits is shown in Figure 5.2

Figure 5.2 Peat deposited on stream bank downstream of Wall 1, with intact vegetation partially visible and larger deposits of peat further back from stream edge

The works proposed in Phase 1A relate to the following restoration areas as shown in Figure 5.1:

1. *Slip Scar from Wall 3 to Shruhangarve Stream*
2. *Stream Reach 1: Slip Scar to Wall 2*

3. *Stream Reach 3: Wall 1 to Coillte Forestry Boundary*
4. *Stream Reach 4: Coillte Forestry Boundary to Shruhangarve Bridge*
5. *Stream Reach 5: Shruhangarve Bridge to Mourne Beg River*

Objectives of Works

The objectives of the restoration measures outlined in this phasee are to protect the water quality in the Shruhangarve Stream, avoid damage to sensitive habitats and ecosystems, and accelerate the recovery of this portion of the Shruhangarve Stream to its pre-event condition.

1. *Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.*
2. *Mitigate against the further dispersal of peat and sediment, deposited along the banks of the Shruhangarve, by the watercourse through and beyond the confines of the site.*

In order to achieve these objectives a number of measures are proposed and discussed below. These measures include the following:

1. *Stabilising peat deposits in place by seeding and mulching.*
2. *Installation of silt fencing in selected locations.*
3. *Installation of coir fibre matting in selected locations.*
4. *Promoting bank stability by installation of live stakes to promote bank stability. Live stakes are dormant cuttings native willow (Salix sp.) that are approximately 0.9 metres in length and are pushed into the soil of the stream bank approximately 0.6 metres. These cuttings will then grow and develop a root mass that helps bind the stream bank together.*
5. *Seeding and planting areas of denuded peat in the slip scar.*

The following sections set out the measures proposed for each stream reach and restoration area.

5.2.1.1 Slip Scar: Wall 3 to the Shruhangarve Stream

The slip scar downstream of Wall 3 is approximately 240 metres in length and between 45 and 60 metres wide. It covers at total of approximately 1.15 hectares. The majority of the peat that was in the slip scar was displaced during the 12th November peat slide event. As a result, there is now a relatively shallow layer of peat remaining in this area underlain by rock and mineral subsoil. There is currently water discharging through Wall 3 and flowing down the slip scar to the Shruhangarve Stream. The discharge is concentrated and is now flowing in a channel down the slip scar. It is not currently clear what the long term discharge rate of the water in this area will be. Future discharge rates may depend in part on any bog rehabilitation measures undertaken upstream of Wall 3. It is therefore proposed to allow the discharging water to continue to flow in the recently formed channel and to monitor the condition of the area over the coming months to determine whether further action is warranted or if the area continues to stabilise naturally.

In order to stabilise the remaining peat and soil in the slip scar area and to aid in the revegetation of the area the following measures are proposed. None of these measures will involve in-stream works or the use of mechanised equipment. For the purposes of this plan the slip scar area has been divided into 2 Zones as follows:

- Zone 1 comprises of wetter areas immediately adjacent to the discharge channel and has an area of approximately 3,575 m2.
- Zone 2 comprises the remainder of the slip scar outside of Zone 1 and has an area of approximately 7,765 m2.

See Figure 5.3 below for the location of the Planting Zones 1 and 2. Proposed seeding and planting rates for Zones 1 and 2 are provided in Tables 5.1 and 5.2 below.

Map Legend

Slip Planting Plan

Zone 1 (3,575 sq. metres)

Zone 2 (7,765 sq. metres)

Stream Reaches

Stream Reach 1

N

Drawing Title Slip Scar Planting Plan	
Project Title Meenbog WF	
Drawn By TJB	Checked By BK
Project No. 201174	Drawing No. Figure 5.3
Scale 1:1500	Date 10.03.2021

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5.2.1.1.1 Seeding

The entire slip scar area (Zones 1 and 2) will be seeded with peatland grass seed mix. Seeding will be accomplished manually with a handheld broadcast seeder. The proposed seed mix and seeding rates are provided in Table 5.1. Substitutions may be made to the proposed seed mix depending on availability. Suitability of substituted species must be confirmed and approved by the project ecology and environmental consultant.

Table 5.1 Proposed Seeding Rates

Species	Percentage of Mix	Seed Quantity per Ha (Kg)	Zones 1 & 2 Total Seeding Area (HA)	Total Kg of Seed
Yorkshire fog	30%	11.25	1.13	12.75
Highland Bent	30%	11.25	1.13	12.75
Red fescue	40%	15.0	1.13	17
Totals	100%	37.5	1.13	42.5

5.2.1.1.2 Live staking

Live willow cuttings (live stakes) shall be installed along both sides of the existing channel (Zone 1) within the slip scar area. The purpose of the live cuttings is to provide stability through the establishment of fast-growing native willows.

- Cuttings shall be between 60cm and 90cm in length, and between 3cm and 8cm in diameter. They will be cut in the dormant season, i.e. between Nov and Mar. Cuttings will have an angled cut at the bottom end of the stake and a flat cut at the top of the stake to aid with installation.
- Cuttings shall be installed in a triangular grid pattern at 1m on centre (o.c.). The first row shall be located on the side of the existing channel.
- Cuttings shall be fashioned from live, dormant native willow species (*Salix cinerea, Salix caprea* and *Salix aurita*).
- Cuttings shall be sourced locally on-site (or within 20km max of the establishment site if necessary)
- The following methodology will be implemented for the handling, preparation, and installation of cuttings to ensure the highest possible survival rate:
  - Cuttings shall be cut and installed on the same day where possible.
  - If same-day installation is not possible, cuttings shall be stored for no more than 1 week with the bottom end of each stake fully submerged in water to prevent drying out of the material.
  - All lateral branches shall be carefully removed from the woody cuttings prior to installation.
  - Cuttings shall be driven into the ground using a “dead blow” plastic hammer.
  - Peat shall be firmly packed around the hole after installation, where required.
  - Cuttings shall be tamped in at a right angle to the ground with between 70%-80% of the stake installed below the ground surface.
  - Between 20%-30% and two buds (or pruned, lateral branch locations) on the cutting shall be above the ground surface
  - Split or otherwise damaged cuttings shall not be used.

Figure 5.4 Example of live cutting along drain in planting trial on deep peat.

5.2.1.1.3 Planting with bare root plants

Zone 2 will be planted with bare root saplings at a density of approximately 800 stems per acre. A mix of the following species is proposed for planting:

- Downy Birch (*Betula pubescens*)
- Scots pine (*Pinus sylvestris*)
- Alder (*Alnus glutinosa*)

Planting will be carried out manually. The main forms of planting rooted material are set out as below. A combination of all the planting methods described below, or other appropriate methods, may be used on the site as conditions dictate. All planting should be to root collar depth or slightly deeper, and trees should be firm and upright with their roots hanging vertically and well spread out.

Areas selected for planting of bare root saplings shall be planted at a density of 800 stems per hectare. Trees will be planted in single species groups or mixed where appropriate, i.e. alder and birch).

Slit Planting

The spade is used to make a vertical slit in the ground. The tree roots are carefully positioned into the slit by hand to ensure that roots are equally spaced in the vertical slit created. The slit is closed by foot and firmed up, ensuring the tree is vertical and upright. It is important to ensure that roots are not bent over, as this can lead to poor development, e.g. J-shaped root. This form of planting can be suitable for ribbons, mounds and ripped ground.

Angle Notch Planting: L notch or T notch

A double slot is made using a suitable planting spade. The slots can either be "L" or "T" shaped and should be approx. 15cm deep as illustrated in Figure 5.5 below. The purpose of the double slot is to lift up the peat and create space to allow the roots to be distributed evenly. Once the tree has been positioned in the slot and the roots have been pushed in fully by hand, then slightly pull up the plant to allow the roots to hang down and to ensure correct planting depth. Then the spade is removed and the soil is firmed with the ball of the foot. The angle notch planting methodology is illustrated in Figure 5.6, below.

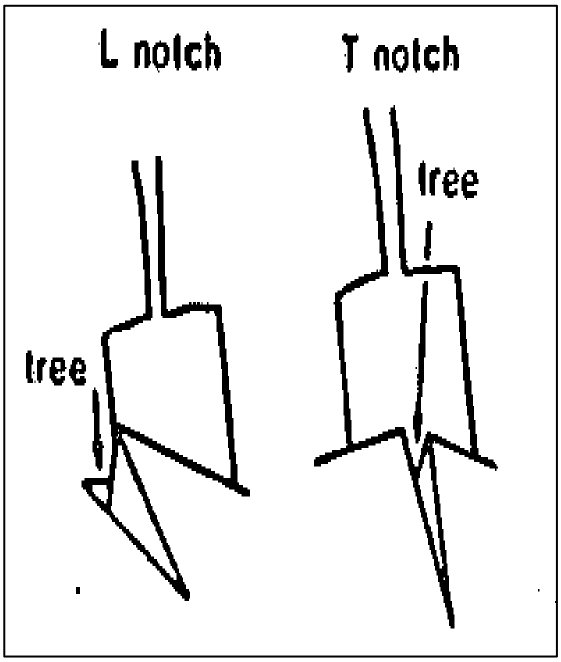


Figure 5.5 L" and "T" Planting Notches

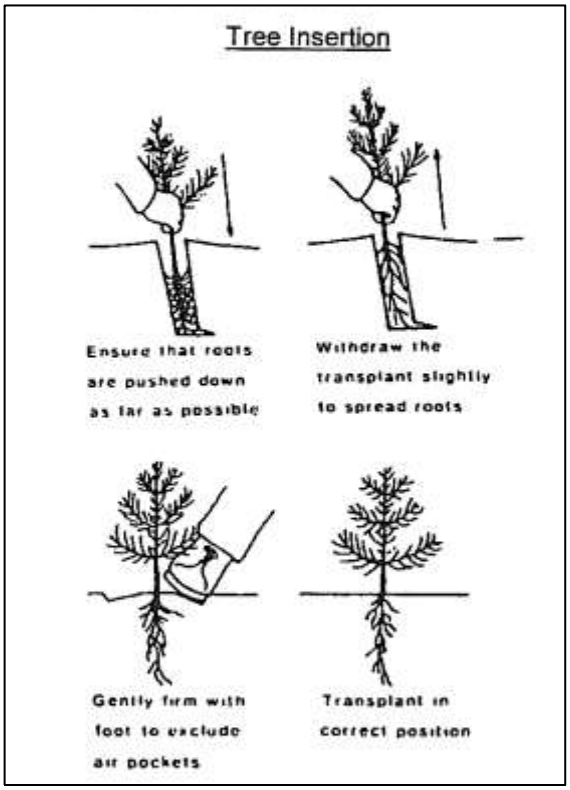


Figure 5.6 Angle Notch Planting Steps

5.2.1.1.4 Planting Schedule

Zones 1 and 2 will be planted according the schedule provided in Table 5.2 below. Other suitable native species may be substituted at the discretion of the project ecologist.

Table 5.2 Proposed Plant Numbers

Species	Size	Number of plants - Zone 1	Number of plants - Zone 2	Total	Spacing (metres o.c.)
Downy birch (*Betula pubescens*)	Bare Root	0	300	300	3.5
Alder (*Alnus glutionosa*)	Bare Root	0	300	300	3.5
Scots pine (*Pinus sylvestris*)	Bare Root	0	150	150	3.5
Willow (*Salix* spp.)	Live Stake	4,250	0	4,250	1

5.2.1.2 Stream Reach 1: Shruhangarve Stream from Slip Scar to Wall 2

This stream reach is approximately 390 metres in length. There is significant peat deposition throughout the reach and the original stream channel has been extensively damaged by the peat slide (Figure 5.7). A full restoration of this reach will be required and will be detailed in later phases of this action plan. For the purposes of Phase 1A of this action plan it is proposed to seed all bare peat areas adjacent to Stream Reach 1. This is intended as a temporary measure to promote stability and minimise loss of peat while further design and analysis work is undertaken. There are no in-stream works proposed at this time.

Figure 5.7 View of peat deposits at Reach 1, facing upstream.

5.2.1.2.1 Seeding

Bare peat adjacent to Stream Reach will be seeded per the seeding schedule in Table 5.3 below. There is approximately 8,700 m^2 of bare peat on the left bank of the stream and approximately 6,400 m^2 of bare peat on the right bank of the stream that will be seeded. Substitutions may be made to the proposed seed mix depending on availability. Suitability of substituted species must be confirmed and approved by the project ecology and environmental consultant.

Table 5.3 Proposed Seeding Rates – Reach 1

Species	Percentage of Mix	Seed Quantity per Ha (Kg)	Total Seeding Area Ha	Total Kg of Seed
Yorkshire fog	30%	11.25	1.51	17
Highland Bent	30%	11.25	1.51	17

Red fescue	40%	15.0	1.51	22.7
Totals	100%	37.5	1.51	56.7

5.2.1.3 Stream Reach 3: Wall 1 to Coillte Forestry Boundary

This stream reach is approximately 225 metres in length. There is significant peat deposition throughout this reach as well as a number of debris blockages. Access to this reach is difficult due to the existing forestry and steep slopes adjacent to the stream. Coir fibre matting has been installed on both stream banks for approximately 100 metres downstream of Wall 1. Given the higher level of impact to the stream channel in this reach it is proposed to install coir fibre matting and live stakes along both banks of the stream throughout this entire reach. Where debris is encountered in the channel this shall be removed by hand if possible.

Taking into account the conditions discussed above, the following measures are recommended for this reach.

5.2.1.3.1 *Installation of Coir Fibre Matting.*

Coir fibre matting shall be installed in a single row on both sides of the stream in Reach 3. The installation of the coir fibre matting shall be accomplished by hand using the following methodology.

- Coir fibre matting shall be at least 700 grams/m2 weight.
- Matting shall be anchored in a trench at top of the stream bank. Stout stakes (38mm x 38mm minimum) shall be used to secure the matting into the toe and top of bank trench.
- The stream bank shall be prepared by smoothing with shovels to remove large clumps of deposited peat, seeded, and mulched with straw prior to the placement of the matting.
- The matting shall be installed so as to not be in tension, but be placed neatly, flush against the soil, and with no gaps or wrinkles.
- Matting overlaps shall be 0.6m in width, and overlaps shall be oriented in a down-slope direction, downstream direction, or otherwise “shingle-style” in accordance with the direction of the dominant erosive action so that the matting end is protected against movement.
- The field of the matting over the surface of the stream bank shall be secured with hardwood matting stakes of at least 0.3 cm in length. Matting stakes shall be installed in a triangular grid pattern at 0.6m OC.
- Matting shall be neatly secured around any projecting stream structures or rocks to prevent any loose or frayed edges.
- There shall be no loose ends or unsecured matting on the completed work.
- No matting will be placed on the bed of the channel.

5.2.1.3.2 *Installation of Live Stakes*

Live willow cuttings (live stakes) shall be installed through the coir fibre matting along both sides of the stream channel following the installation of coir fibre matting. Details of the required spacing and number required are provided in Table 5.4 below. The purpose of the live cuttings is to provide bank stability through the establishment of fast-growing native willows. The live stakes will be installed using the following methodology

- Cuttings shall be between 60cm and 90cm in length, and between 2cm and 8cm in diameter. They will be cut in the dormant season, i.e. between Nov and Mar.

Cuttings will have an angled cut at the bottom end of the stake and a flat cut at the top of the stake to aid with installation.

- Cuttings shall be installed in a two-row triangular grid pattern at 75cm on centre (o.c.). The first row shall be located on the side of the existing channel with the second row being located on the flat adjacent to the channel.
- Cuttings shall be fashioned from live, dormant native willow species (*Salix cinerea, Salix caprea* and *Salix aurita*).
- Cuttings shall be sourced locally on-site (or within 20km max of the establishment site if necessary)
- The following methodology will be implemented for the handling, preparation, and installation of cuttings to ensure the highest possible survival rate:
    - Cuttings shall be cut and installed on the same day where possible.
    - If same-day installation is not possible, cuttings shall be stored for no more than 1 week with the bottom end of each stake fully submerged in water to prevent drying out of the material.
    - All lateral branches shall be carefully removed from the woody cuttings prior to installation.
    - Cuttings shall be driven into the ground using a "dead blow" plastic hammer.
    - Peat shall be firmly packed around the hole after installation, where required.
    - Cuttings shall be tamped in at a right angle to the ground with between 70%-80% of the stake installed below the ground surface.
    - Between 20%-30% and two buds (or pruned, lateral branch locations) on the cutting shall be above the ground surface
    - Split or otherwise damaged cuttings shall not be used.

Table 5.4 Proposed Live Stake Numbers and Spacing

Species	Size	Number of plants	Spacing (metres o.c.)
Willow (*Salix* spp.)	Live Stake	1,200	0.75

5.2.1.3.3 Stabilisation of Peat Deposits on Top of Bank

- All areas of peat deposition at top of bank to stabilised in place by seeding with an appropriate peatland grass seed mix. Seed mid and seeding rate are provided in Table 5.5 below. Substitutions may be made to the proposed seed mix depending on availability. Suitability of substituted species must be confirmed and approved by the project ecology and environmental consultant.
- Seeding will be accomplished manually with a handheld broadcast seeder.
- Straw mulch to be applied to seeded areas to promote germination of seed.

Table 5.5 Proposed Seeding Rates – Reach 3

Species	Percentage of Mix	Seed Quantity per Ha (Kg)	Total Seeding Area Ha	Total Kg of Seed
Yorkshire fog	30%	11.25	0.57	6.4
Highland Bent	30%	11.25	0.57	6.4
Red fescue	40%	15.0	0.57	8.6

Totals	100%	37.5	0.57	21.4

5.2.1.4 Stream Reach 4: Coillte Forestry Boundary to Shruhangarve Bridge

The levels of peat deposition on the top of the stream banks in Reach 4 are variable, ranging from very light (<0.1m) to moderate (0.4 m) in discrete pockets. The total area of peat deposition in Reach 4 is approximately 3.83 hectares. There is evidence of vegetation recovery throughout this reach as shown in Figure 5.8 below. There is some evidence of some localised bank instability in the upper section of this reach, however this is not widespread and in general the channel geomorphology remains intact. A field inspection of this stream reach on 25th February 2021 revealed a number of blockages in the stream channel in the upper section of this reach. Where debris is encountered in the channel this shall be removed by hand if possible.

Figure 5.8 Riparian vegetation recovering in Reach 4

Figure 5.9 Area of heavier peat deposits in Reach 4 (facing upstream) where temporary silt fencing is recommended. Immediate streamside zone is largely free of peat.

Taking into account the conditions discussed above, the following measures are recommended for this reach:

5.2.1.4.1 Stabilisation of Peat Deposits on Top of Bank

- All areas of peat deposition at top of bank to stabilised in place by seeding with an appropriate peatland grass seed mix.
- Seed mix and seeding rate are provided in Table 5.6 below. Substitutions may be made to the proposed seed mix depending on availability. Suitability of substituted species must be confirmed and approved by the project ecology and environmental consultant.
- Seeding will be accomplished manually with a handheld broadcast seeder.
- Straw mulch to be applied to seeded areas to promote germination of seed.

Table 5.6 Proposed Seeding Rates – Reach 4

Species	Percentage of Mix	Seed Quantity per Ha (Kg)	Total Seeding Area (HA)	Total Kg of Seed
Yorkshire fog	30%	11.25	3.83	43
Highland Bent	30%	11.25	3.83	43
Red fescue	40%	15.0	3.83	57.5
Totals	100%	37.5	3.83	143.5

5.2.1.4.2 Installation of Silt Fencing

- Areas of peat deposition greater than 0.3m in depth to be surrounded by silt fence on the streamward side.
- Using manual labour, access the stream bank on foot where peat deposits are low, and clear a working area of approx. 1.5-metres along the stream bank of all excess peat deposits sitting on the surface. Peat removed from surface of stream bank to be placed further back from stream bank.
- Install silt fencing along cleared path on stream bank, taking care to follow manufacture's specifications and ensure bottom of fence is property buried into ground surfacer and adequate fencing stakes are installed are regular intervals to support fence and the silt that will build up behind it. Specification for Terrastop silt fencing is included in Appendix 3.
- Maintain silt fence in place for as long as necessary until all bare peat has reseeded and demonstrated to have well-establish root system of surface vegetation, capable or binding material together. Silt fence only to be removed with approval of supervising ecologist.

Figure 5.10 Silt fence Installed on Reach 4

5.2.1.4.3 Installation of Coir Fibre Matting.

The extensive use of coir fibre matting is not anticipated in Reach 4. Where areas of bank instability are identified during the peat stabilisation and silt fence installation process these shall be assessed by the project environmental team and if necessary coir fibre matting shall be installed per the methodology described below. Coir fibre matting shall be installed in a single row either side of the stream in Reach

4 where necessary. The installation of the coir fibre matting shall be accomplished by hand using the following methodology.

- Coir fibre matting shall be at least 700 grams/m2 weight.
- Matting shall be anchored in a trench at top of the stream bank. Stout stakes (38mm x 38mm minimum) shall be used to secure the matting into the toe and top of bank trench.
- The stream bank shall be prepared by smoothing with shovels to remove large clumps of deposited peat, seeded, and mulched with straw prior to the placement of the matting.
- The matting shall be installed so as to not be in tension, but be placed neatly, flush against the soil, and with no gaps or wrinkles.
- Matting overlaps shall be 0.6m in width, and overlaps shall be oriented in a down-slope direction, downstream direction, or otherwise "shingle-style" in accordance with the direction of the dominant erosive action so that the matting end is protected against movement.
- The field of the matting over the surface of the stream bank shall be secured with hardwood matting stakes of at least 0.3 cm in length. Matting stakes shall be installed in a triangular grid pattern at 0.6m OC.
- Matting shall be neatly secured around any projecting stream structures or rocks to prevent any loose or frayed edges.
- There shall be no loose ends or unsecured matting on the completed work.
- No matting will be placed on the bed of the channel.

5.2.1.4.4 Installation of Live Stakes

In any areas where coir fibre matting is installed, live willow cuttings (live stakes) shall be installed through the coir fibre matting along the stream channel. The purpose of the live cuttings is to provide bank stability through the establishment of fast-growing native willows. The live stakes will be installed using the following methodology

- Cuttings shall be between 60cm and 90cm in length, and between 2cm and 8cm in diameter. They will be cut in the dormant season, i.e. between Nov and Mar. Cuttings will have an angled cut at the bottom end of the stake and a flat cut at the top of the stake to aid with installation.
- Cuttings shall be installed in a two-row triangular grid pattern at 75cm on centre (o.c.). The first row shall be located on the side of the existing channel with the second row being located on the flat adjacent to the channel.
- Cuttings shall be fashioned from live, dormant native willow species (*Salix cinerea, Salix caprea* and *Salix aurita*).
- Cuttings shall be sourced locally on-site (or within 20km max of the establishment site if necessary)
- The following methodology will be implemented for the handling, preparation, and installation of cuttings to ensure the highest possible survival rate:
    - Cuttings shall be cut and installed on the same day where possible.
    - If same-day installation is not possible, cuttings shall be stored for no more than 1 week with the bottom end of each stake fully submerged in water to prevent drying out of the material.
    - All lateral branches shall be carefully removed from the woody cuttings prior to installation.
    - Cuttings shall be driven into the ground using a "dead blow" plastic hammer.
    - Peat shall be firmly packed around the hole after installation, where required.
    - Cuttings shall be tamped in at a right angle to the ground with between 70%-80% of the stake installed below the ground surface.

- Between 20%-30% and two buds (or pruned, lateral branch locations) on the cutting shall be above the ground surface
- Split or otherwise damaged cuttings shall not be used.

5.2.1.5 Stream Reach 5: Shruhangarve Bridge to Mourne Beg River

A field inspection of this stream reach on 25th February 2021 revealed no blockages in the stream channel and relatively light levels of peat deposition on the top of the stream banks. The Shruhangarve stream is generally more incised in this reach than further upstream and this, in conjunction with the greater distance from the original peat slide, may have contributed to generally lighter levers of peat deposition. There is evidence of vegetation recovery throughout this reach as shown in Figure 5.11 below. Furthermore, there is no evidence of extensive channel instability in this reach.

Figure 5.11 View of typical peat deposits in Reach 5, facing downstream.

Taking into account the conditions discussed above, the following measures are recommended for Reach 5.

5.2.1.5.1 *Peat Deposits on Top of Bank*

- All areas of peat deposition at top of bank to stabilised in place by seeding with an appropriate peatland grass seed mix. Substitutions may be made to the proposed seed mix depending on availability. Suitability of substituted species must be confirmed and approved by the project ecology and environmental consultant.
    - Total Area for Seeding: 38,323m^2
- Straw mulch to be applied to seeded areas to promote germination of seed.
- No silt fencing is recommended in this reach.

Table 5.7 Proposed Seeding Rates – Reach 5

Species	Percentage of Mix	Seed Quantity per Ha (Kg)	Total Seeding Area Ha	Total Kg of Seed
Yorkshire fog	30%	11.25	1.7	19.1
Highland Bent	30%	11.25	1.7	19.1
Red fescue	40%	15.0	1.7	25.5
Totals	100%	37.5	1.7	63.7

5.2.2 Phase 1B – Works Currently Proposed

5.2.2.1 Bog Rehabilitation Measures upstream of Wall 3 (Upper Scar)

A botanical assessment of the habitats within the study area was undertaken on the 31st of March 2021. A total of five detailed relevés were undertaken, on both the habitats occurring within area where the peat slide occurred and within the adjacent intact peatland habitat. The assessment included a botanical assessment of habitats by ecologists from MKO. The purpose of the assessment was to determine what actions can be taken to support the rehabilitation of the bog from an ecological perspective. Based on this assessment a Peatland Restoration Plan has been developed, a copy of which is included as Appendix 4 to this Action Plan. The following actions, taken from the Peatland Restoration Plan are recommended and are proposed for implementation as part of the Phase 1B restoration works:

5.2.2.1.1 *Management of revegetating bare peat*

The areas of bare peat will likely revegetate over time from the natural seed source of the adjacent peatland. It is therefore initially proposed to set up 6 permanent monitoring plots within the peat slide area to determine the likely rate of natural recolonization between summer 2021 and summer 2022. The natural colonization of this bare peat would ensure a native, locally sourced, species mix establishing within the area. It is also proposed to establish a further three vegetation monitoring plots outside of the peat slide for comparison. The location of these monitoring plots are shown in Appendix 4, Figure 3-1.

Active Reseeding and Sphagnum Mulch Inoculation

Reseeding

Following the initial two-summer natural recolonisation evaluation described above, should the natural revegetation be deemed too slow or patchy, it is proposed to add a nurse crop. This would comprise of sheep's fescue (*Festuca ovina*) which would then speed up revegetation of the bare peat. In addition, alternative species, depending on availability, as recommended by YPP (2018a) are provided in Table 5.8.

The grass roots bind the peat surface into a stable turf that then forms the basis for other moorland species to colonise into and recolonize over time. Such sewing and associated revegetation would be subject to further monitoring for the lifetime of the project as described in detail in Section 3.4 of Appendix 4.

A reseeding rate of 10kg/ha is recommended (YPT, 2018a[1]). It also states that "*Peat is naturally very nutrient poor and damaged peat even more so. In order to establish the grass sward and provide favourable conditions for initial dwarf-shrub growth it is necessary to provide a short-lived low dose of nutrients using artificial fertiliser applied in July once the grasses are actively growing". "Phosphate fertiliser (P2O5) should be applied at a rate of 20kg/ha*".

[1] *Yorkshire Peat Partnership, 2018a, Online, available at: https://www.yppartnership.org.uk/sites/default/files/2018-07/171011%20Technical%20Specification%203%20Flat%20or%20gently%20sloping%20bare%20peat%20stabilisation%20%26%20re-vegetation%20TT.pdf, Accessed 13.04.2021*

Table 5.8 Moorland grass mix species composition (Source; YPP, 2018a)

Species (Latin)	Species (English)	% of seed mix
Agrostis capillaris	Common bent	20
Festuca ovina	Sheep's fescue	20
Deschampsia flexuosa	Wavy hair grass	30
Eriophorum vaginatum	Hare's-tail cotton-grass	30

<u>Sphagnum mulch inoculation</u>

As described in the Yorkshire Peat Partnership Technical *Specification 4* (YPP, 2018[2]).

- "*Where appropriate donor sites are available, Sphagnum clumps can be harvested and transported to the restoration site for planting.*
- *Clumps of Sphagnum are harvested (preferably by hand) from a suitable donor site*
- *The donor site must not suffer long-term damage as a result of harvesting"*
- YPP *"recommends that less than 10% of the donor site should be harvested".*
- *"The donor site is surveyed by a suitably experienced botanist prior to cutting to determine the species composition which should be as close as possible to the ideal mix" outlined in Table 3.2.*
- *"There is currently no evidence-based information on the best times to plant the clumps".* YPP proposes *"planting in late winter spring to give them a full growing season before the next winter".*
- *"Clumps are heeled into the bare peat surface in wetter areas at a rate of 1 clump per m²"*.

Table 5.9 Recommended Sphagnum mix (Source; YPP, 2018)

	Species	%
Base composition	*S. capillifolium*	*30*
	S. papillosum	*30*
	S. palustre	*30*
	S. subnitens	*10*

[2] *Yorkshire Peat Partnership (YPP), 2018, Technical Specification 4, Online, Available at: https://www.yppartnership.org.uk/sites/default/files/2018-07/171011%20Technical%20Specification%204%20Introducing%20Sphagnum%20into%20existing%20degraded%20vegetation%20TT.pdf, Accessed. 13.04.2021*

Additional species depending on conditions (adjust base composition % accordingly)	*S. inundatum* *(S. tenellum**)* *(S. magellanicum***)*	*5* *10* *5*

***bare peat only. Adjust the content of other species to accommodate it.*
****not for general use but may be worth adding in specific circumstances where it has been found on nearby moors. Adjust the content of other species to accommodate it.*

5.2.2.1.2 Measures for the control of surface water flow rates entering the Upper Scar

Existing/historic drainage channels occurring within the wider area to the south of the area where the peat slide occurred provide some surface contribution to the affected area. Therefore, following advice from the project hydrologist Michael Gill, a number of plastic dams will be installed at a number of targeted areas to slow the rate of flow entering the area of the peat slide following periods of heavy rainfall. This will assist in avoiding or reducing erosion during periods of heavy rainfall by decreasing through flow. Therefore, the dams will be installed within the drains partly below the surface level. This will allow surface water runoff to continue to discharge from this small catchment at a controlled rate without creating any significant water retention at this location. Drains will be blocked, where appropriate, using plastic dams, see Plate 5.12. These will be installed by hand with no vehicular access permitted to the area at any stage of the works. The indicative location of the dams is provided in Figure 3.2 of the Peatland Restoration Plan (Appendix 4, attached). The methodology for dam installation is also set out in Mackin et, al., (2017).

Figure 5.12 Example of plastic dams to be used for on-site drain blocking.

5.2.2.1.3 Monitoring

To confirm that habitat restoration has been successful, all areas of restored vegetation will be subject to a specific monitoring plan. Monitoring results will be reported within an *Annual Environmental Report* with any notable actions required identified and implemented following agreement with the project stakeholders.

Prior to the commencement of the habitat management measures, permanent vegetation monitoring plots will be established within the management areas. The monitoring plot locations will be selected using stratified random sampling. This will allow the monitoring plots to be representative of microtopography and vegetation cover sampling areas. Monitoring plots will be surveyed and classified using the relevé method as per the *National Survey of Upland Habitats* (Perrin et al., 2014) with plot sizes being 2m x 2m. Biotic and abiotic parameters that form baseline indicators of ecological and hydrological condition of the bog will be recorded. Monitoring plots will be marked out permanently using posts and their location recorded using GIS. It is envisaged that a minimum of six 2m x 2m monitoring plots will be established across the enhanced areas. Visual inspections of restored areas will be carried out biannually during the first two years to check for potential peat erosion or movement and natural revegetation. Results will be analysed and a report of the findings will be produced. The enhancement plan will be regularly updated and amended where necessary to improve the efficacy of the enhancement work. Monitoring will involve the following:

Surface peat assessment

An assessment of the physical state of the surface peat with regard to:

- Percentage bare peat not covered by vegetation (via the establishment of a number of fixed point relevés);
- Moisture status (qualitative);
- Intactness (e.g. presence of visible cracking in surface peat; and
- General stability (e.g. presence of peat erosion).

Vegetation sampling

- A number of fixed relevé sites (i.e. permanent quadrats) will be set up in areas where active management is proposed of previously forested areas. Baseline data will be recorded prior to the commencement of habitat management activities set out in this outline plan. The character of each relevé will be recorded (e.g. species proportions present, vegetation structure and height) and photographs will be taken of each relevé from a fixed point. These relevés will then be re-examined during each year in order to establish the extent of revegetation/ habitat improvement resulting from management practices.
- In addition to the above, drone imagery will also be taken of the slip scar and used to estimate the rate and extent of revegetation.

Hydrological monitoring

- Water levels within areas where drains are blocked will be recorded bi-annually during the first five years.
- The area covered by standing surface water, i.e. the newly formed “bog pools” will also be estimated using drone imagery, as these features may be important in promoting the establishment of Sphagnum moss and thus active peat formation conditions.

The efficacy of the habitat rehabilitation and enhancement measures employed will be reviewed after the first and second year i.e. 2022 and 2023, following commencement of the plan on the basis of the results of vegetation sampling from the managed areas. Analysis of the data collected will be the basis for a review of the measures and techniques employed.

5.2.2.1.4 *Reporting*

Reports detailing the monitoring works carried out, the results obtained and a review of their success, along with any suggestions for amendments to the plan will be prepared in years 1 & 2 with the results subject to a revised monitoring plan.

5.2.2.2 Stream Reach 2: Stabilisation of Area Upstream of Impoundment

Drone inspections and a field visit on the 30th of March 2021 have identified an approximately 100 metre section of Stream Reach 2 immediately upstream of the impounded area where the original stream channel is intact and largely free of obstructions. The levels of peat deposition on the top of the stream banks immediately adjacent to the stream in this section are generally light (0.1 to 0.2 m) and natural riparian vegetation is evident.   However, there are several areas where large sections of brown, fibrous peat has been deposited in the riparian area. Figure 5.13 is representative of typical conditions within this section of Reach 2.

Figure 5.13 Area of heavier peat deposits in Reach 4 (facing upstream) where temporary silt fencing is recommended. Immediate streamside zone is largely free of peat.

Taking into account the conditions discussed above it is proposed to use hand tools to clear heavy deposits from a 2 metre wide strip on either side of the stream. Silt fence will then be installed along both sides of the stream at 2 metres from the top of bank. All exposed residual peat with will be seeded with a native seed mix to promote revegetation. The following methods will be utilised:

5.2.2.2.1 *Installation of Silt Fencing*

- Silt fence will be installed on both sides of the stream.
- Using manual labour, access the stream bank on foot where peat deposits are low, and clear a working area of approx. 2-metres along the stream bank of all excess peat

deposits sitting on the surface. Peat removed from surface of stream bank to be placed further back from stream bank.

- Install silt fencing along cleared path on stream bank, taking care to follow manufacture's specifications and ensure bottom of fence is property buried into ground surfacer and adequate fencing stakes are installed are regular intervals to support fence and the silt that will build up behind it. Specification for Terrastop silt fencing is included in Appendix 3.
- Maintain silt fence in place for as long as necessary until all bare peat has reseeded and demonstrated to have well-establish root system of surface vegetation, capable or binding material together. Silt fence only to be removed with approval of supervising ecologist.
-

5.2.2.2.2 Stabilisation of Peat Deposits on Top of Bank

- Hand tools will be used to clear heavy peat deposits from a 2 metre wide strip on either side of the stream channel
- All areas of peat deposition at top of bank to stabilised in place by seeding with an appropriate peatland grass seed mix.
- Seed mix and seeding rate are provided in Table 5.10 below. Substitutions may be made to the proposed seed mix depending on availability. Suitability of substituted species must be confirmed and approved by the project ecology and environmental consultant.
- Seeding will be accomplished manually with a handheld broadcast seeder.
- Straw mulch to be applied to seeded areas to promote germination of seed.

Table 5.10 Proposed Seeding Rates – Reach 2

Species	Percentage of Mix	Seed Quantity per Ha (Kg)	Total Seeding Area (HA)	Total Kg of Seed
Yorkshire fog	30%	11.25	0.4	4.5
Highland Bent	30%	11.25	0.4	4.5
Red fescue	40%	15.0	0.4	6
Totals	100%	37.5	0.4	15

5.2.2.3 Reach 2: Remove Deposited Peat from Impoundment Area Upstream of Wall 1.

Large volumes of silt have been successfully impounded behind Wall 1 and prevented from entering downstream watercourses. Water flows have been largely intercepted upstream of the impounded silt and diverted away from the silt impounded behind Wall 1, thereby minimising the re-mobilisation of the impounded silt.

The long-term recommendation is to restore the natural water flows in the Shruhangarve stream and reinstate the stream to the greatest extent possible. To do so will require the peat sludge that has accumulated behind Wall 1 to be removed and the area stabilised before normal flows can be restored in the channel and through a culvert under Wall 1 which was originally intended as an access road to Turbine 9.

In order to ensure the long term stability of the site, and to facilitate the restoration of the Shruhangarve stream it is necessary to remove this accumulated peat sludge for safe, permanent storage elsewhere on the site. The proposed works involve the removal of peat sludge from upstream of Wall1 to on-site permanent peat storage areas. It is proposed to slowly dry and remove peat sludge accumulated behind Wall1 and transport to the existing on-site permanent peat storage areas.

The works will be completed during a period of optimum conditions (dry period of low river flow where there is no discharge through the existing 600mm pipes crossing Wall1 and when there is at least 300mm between the water surface upstream of Wall 1 and the invert of the pipes) and it is proposed that these works will be completed slowly over a period of 8-12 weeks. All works will be fully supervised and observed by the Ecological Clerk of Work and the Project Hydrologist. If there is any observed change in water quality in the Shruhangarve Stream below Wall1, all works will cease immediately under instruction from the Project Ecologist or the Project Hydrologist. The following methodology is proposed for the safe drying, removal, and permanent storage of the accumulated peat sludge. All removed peat will be permanently stored in the authorised on-site peat storage areas.

5.2.2.3.1 *Objectives of recommendations*

1. *Eliminate or limit the release of further polluting matter from the area where the landslide occurred.*
2. *Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.*
3. *Prevent the catastrophic release of material built up behind the existing improvised impoundment structure (Wall 1) on site.*

5.2.2.3.2 *Proposed Methodology*

Preparation Works (already largely complete as part of Emergency Works)

- Clean water diversion pumping upstream of Wall1 is already in situ and operation.
- There is an existing set of 600mm pipe crossing Wall1, but there is no discharge through these pipes.

Creation of outer drying cells (refer to Figure 5.14)

- Create vertical barriers/berm on pond side of Cell 1 and Cell 2 using rock.
- Dig peat material from Cell 1 and Cell 2 and remove to peat storage area
- Fill empty Cell 1 and Cell 2 with material from source 1 and source 2 areas
- Allow material in Cell 1 and Cell 2 to dry
- Once dry, remove material in Cell 1 and Cell 2 to authorised on-site peat storage area.

Figure 5.14 Creation of outer drying cells

Creation of intermediate drying cells (refer to Figure 5.15)

- Create vertical barriers/berm on pond side of Cell 3 and Cell 4.
- Fill the empty Cell 1/Cell 3 and Cell 2/Cell 4 with material from source 3 and source 4 areas
- Allow material in Cell 1/Cell 3 and Cell 2/Cell 4 to dry
- Once dry, remove material in Cell 1/Cell 3 and Cell 2/Cell 4 to authorised on-site peat storage area.

Figure 5.15 Creation of intermediate drying cells

Creation of Inner drying cells (refer to Figure 5.16)

- Create vertical barriers/berm on pond side of Cell 5 and Cell 6.
- Fill the empty Cell 1/Cell 3/Cell 5 and Cell 2/Cell 4/Cell 6 with material from source 5 area.
- Once material in all cells is dry, remove material in Cell 1/Cell 3/Cell 5 and Cell 2/Cell 4/Cell 6 to authorised on-site peat storage area.
- Repeat this process until all material in Source Area 5 is removed.

Figure 5.16 Creation of Inner drying cells

Equipment Required

- 34t excavator
- Dump trucks
- Tracked Excavators
- Tree stumps
- Rock to construct cell barriers

5.2.3 Phase 2 – Works Not Yet Proposed

Phase 2 recommendations relate to the dewatering of the accumulated peat upstream of Wall 1 and the restoration of Stream Reaches 1 and 2. These recommendations will be expanded upon in the coming weeks and are presented below as high level proposals to show the intended approach to the restoration of Reaches 1 and 2.

5.2.3.1 Reach 1 Stream Restoration

Present situation informing recommendations

Approximately 850 metres of the Shruhangarve Stream upstream of Wall 1 have been impacted by the peat slide (Stream Reaches 1 and 2). Mass movement and deposition of peat in this area has substantially damaged the original stream channel resulting in a loss of instream habitat in this area.

It is proposed to use natural channel design techniques to re-establish a functional stream channel in these reaches. The restoration design process will focus on the development of a stream design that is appropriate in terms of channel cross-sectional dimension, plan, and profile, and that will therefore be stable in the long term. In addition, the design will incorporate design elements to provide appropriate in-stream aquatic habitat. Stream banks and the riparian zone will be revegetated with native species with a view to enhancing bank stability in the new channel and reducing potential soil erosion in the riparian area.

It is proposed to start the design and implementation of the restoration of Reach 1 (approximately 390 metres) in advance of Reach 2. Reach 2 cannot be adequately assessed until the area upstream of Wall 1 has been dewatered and the accumulated peat removed. However, due to the topography of the site, there is nothing to prevent the design and implementation of the Reach 1 restoration plan in advance of that work.

Objectives of recommendations

1. *Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.*
2. *Mitigate against the further dispersal of peat and sediment, deposited along the banks of the Shruhangarve, by the watercourse through and beyond the confines of the site.*
3. *Return Reach 1 to a natural, stable condition.*

Recommended measures

1. *Conduct a limited geomorphological survey of Reach 1 of the Shruhangarve Stream. Survey will be limited due to the poor condition of the remaining stream channel. Survey will include the following:*
    - *detailed cross sections*
    - *long profile*
2. *Conduct a geomorphological survey of a 100 metre long stable section of Reach 4 of the Shruhangarve Stream. Survey will include the following:*
    - *Bankfull identification*
    - *Detailed cross sections*
    - *Long profile*
    - *Wolman reachwide pebble count*
    - *Radius of curvature in meander bends*
3. *Conduct desktop analysis of Reach 1 along with field survey of impacted reaches to attempt to classify the likely character of the lost stream channel.*
4. *Identify and conduct geomorphological survey of suitable reference reach stream channel. Reference reach survey will include:*
    - *Bankfull identification*
    - *Detailed cross sections*
    - *Long profile*
    - *Wolman reachwide pebble count*
    - *Radius of curvature in meander bends*

5. *Use reference reach data, survey of unimpacted and/or moderately impacted stream reaches, to develop dimensionless ratios to inform the conceptual design of new channel for Reaches 1 and 2.*
6. *Design will include in-stream structures and a detailed planting plan utilising appropriate native species.*
7. *Once the proposed restoration design has been finalised and approved work should commence at the upstream end and work down.*
8. *All work will be conducted in the dry, therefore pump arounds will be necessary.*
9. *More detailed recommendations for the restoration of the stream will be developed in future iterations of the Action Plan.*

5.2.3.2 Install Water Treatment System

Over the medium to long term it will be necessary to carry out works to restore and reinstate the Shruhangarve stream to the greatest extent possible. Some of these works may have the potential to mobilise and release peat sediment into downstream in the absence of mitigation. Depending on the nature of the works proposed, a water treatment system may be the only realistic means of preventing the uncontrolled release of sediment during future phases of remedial works upstream of Wall 1, but more details are required before a definitive set of recommendations can be made.

Discussion are ongoing with a number of water treatment system providers to provide water treatment proposals, both in the short term and in the longer term, during future remedial works phases. Outlined below is a summary of the outcome of tests completed by Siltbuster, and some information relating to the use of a similar system on the Corrib Gas Pipeline project, where discharge occurred to an SAC receiving waterbody.

Please note, the system outlined below is provided for information purposes only and as an indication of what can be provided, but no commercial arrangement has been initiated to date. The intention here is to provide information regarding what can be achieved and the general setup of such a system. Further detail will be provided once discussions advance with the treatment system providers and a more firm proposal is available, following further engagement with stakeholders and regulatory authorities.

Objectives of recommendations

1. *Eliminate or limit the release of further polluting matter from the area where the landslide occurred.*
2. *Eliminate or limit the release of further polluting matter from areas up gradient of the land slide.*
3. *Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.*
4. *Prevent the catastrophic release of material built up behind the existing improvised impoundment structure on site.*

Further information

Laboratory Test Results

A 5-litre raw sample water (untreated, unsettled sample from upstream of Wall 1) was sent to Siltbuster3 on the 20th November 2020 for analysis which is summarised below. The output of the analysis determines the appropriate treatment proposals.

Initial analysis of the as received sample indicated a TSS of 4,570 mg/L and pH of 5.2 [H+]. The raw sample also contained a large amount of organic matter in the form of roots, twigs and vegetation.

The received sample was allowed to settle for 30 minutes to replicate intended onsite primary attenuation lagoon and pH remained the same, and TSS was reduced by 57% to 1,975 mg/L. The intended primary settlement pond will help remove any heavier large peat particles and other organic detritus.

A series of secondary settlement tests were then completed without the aid of pre-treatment chemicals and these results are shown in Table 5.11 below.

These tests confirmed that the remaining particles in suspension exhibited very slow and/or non-settling characterises within water, and that that the typical target discharge level of <60mg/l could not be achieved using a purely gravity based system due to their particle size and subsequently low settling velocity.

Table 5.11 Gravity Settlement Test results (without chemical treatment)

Time (minutes)	Settling Velocity (m/h)	Total Suspended Solids TSS (mg/L)
3	2	1,948
6	1	1,930
12	0.5	1,947
30	0.2	1,923
60	0.1	1,753
120	0.05	1,750

Improved settling characteristics was then achieved using a three-stage chemical pre-treatment and the results are shown in Table 5.12 below.

- Ferric Chloride,
- Sodium hydroxide
- Anionic polymer

3 Siltbuster Limited, Kingswood Gate, Monmouth, Monmouthshire, UK https://www.siltbuster.co.uk

Table 5.12 Settlement Test results (with chemical pre-treatment)

Time (minutes)	Rise Rate (m/hr)	TSS (mg/L)	% Removal TSS	pH
15	0.4	19	99.04	6.87
30	0.2	17	99.63	6.87

Based upon the sample provided; it is was determined that a total suspended solids (TSS) content of <60mg/l can only be viably achieved through the use of pre-treatment water chemicals to enhance the settling velocity of the solids you intend to capture.

Treatment System Proposal

One proposed treatment system being considered is a Siltbuster MT30, chemical dosing system & 4 No. HB50s which has a typical operating range of between 8-120m^3/hr. The system will consist of the following:

- Feed pond, primary settlement lagoon
- Feed pumps (diesel with fuel bowsers)
- Electrical supply (generator and fuel bowser)
- Clean water supply by bowser (2/3 m^3 every couple of days for Polymer make up, and feed supply for the safety showers)
- Bunded chemical storage area (e.g. bunded 20' container)
- Siltbuster MT30 Chemical Pre-Treatment System
  - Inlet magnetic flow meter, to record the volume of water treated
  - pH adjustment system
  - Siltbuster Mix Tank (MT30) to allow the controlled mixing of the treatment chemicals
  - Flow proportional control system for coagulant and flocculant polymer dosing
  - Coagulant dosing pump
  - Flocculant make-up system
  - 1 No IBC spill stand/containment bunds for the temporary storage of chemicals.
  - Siltbuster HB50 Gravity Operated Settlement Units (Recovery of Suspended Solids): 4 No Siltbuster Lamella Clarifier Units to separate the suspended solids from the treated water.
- Safety showers, fed from the clean water supply
- Sludge pond/sump (gravity drainage from HB50hoppers, and sludge is transferred to sludge disposal area (remote peat storage area)
- Monitoring/sampling of treated water
- Discharge pipework

Treatment System Layout and Configuration

A photographic example of the system layout is shown in Figure 5.17 below. The total plan area of the core water treatment system is approximately 50-60 m^2.

- MT30 – 3.5mW x 6.1mL = 21.35m2
- HB50 – 1.7mW x 3.8mL x 4 no. = 25.84m^2

Figure 5.17: MT30 Chemical Pre-Treatment system with 4 No Lamella clarifiers

Treatment System Controls

Power requirements include a minimum 20KVA generator, 3-phase, 415V earth plus neutral, adjustable earth leakage or minimum 300 mA RCD.

There will be a flow proportional control system for coagulant and flocculant polymer dosing. The use of flow proportional dosing system minimises the risk associated with the overdosing of the treatment chemicals, and any potential for carry over into the discharge. The minimum amount of chemical additives are dosed at all times.

A coagulant dosing pump and associated pipe-work will allow the automatic flow proportional addition of the coagulant.

The pumped raw waters will be delivered to the Treatment Plant at a steady continuous rate so as to reduce the total suspended solids content prior to discharge, and to maximise the efficiency of the treatment process.

Use of Siltbuster Systems

Standard settlement or coarse filtration alone will not clean peat water to a standard suitable for discharge to a salmonid river.

The reason we have proposed Siltbuster with chemical treatment is that this type of system is an industry standard in the UK and is one that is recommended by the Environment Agency and planning authorities for all kinds of sites, including sites with sensitive downstream watercourses. It is this sensitivity that is the driver for use of such systems, i.e. the approach is that it is better to treat the water on site to the highest standard available.

There is a perception that chemical treatment is too risky as such chemicals are toxic. The reality is that chemicals (flocculants and coagulants) are used in almost every water treatment plant across the country. Furthermore, dosing rates of chemical to initiate settlement is small, being in the order of 2-10 mg/L. Any perception of vast quantities of chemicals being used is incorrect, as dosing rates are small, and all dosing is completed on a flow proportioned basis.

Consultant hydrologist Michael Gill has direct experience of using Siltbsuter systems on the Corrib Onshore Pipeline construction works in Co. Mayo, and based on observation and operation of the system over some 5000 hours in 2012 and 2013 two things are known:

1. *Lamella plate clarifier system such as Siltbusters work very well in peatland environments when used in combination with 3-stage chemical treatment*
2. *Monitoring data indicate no carry-over of treatment chemicals in the post treatment discharge.*

An example of treatment capability of Siltbuster systems from Corrib is provided in Figure 5.18. This is a duration curve of downstream water quality data post Siltbuster treatment. The system was setup so that any water not meeting discharge criteria was recycled back to the settlement ponds. The graph shows all data, and only 24 treated water (discharge water) data points out of 1194 records were above 20 mg/L (i.e. recycling occurred at these times).

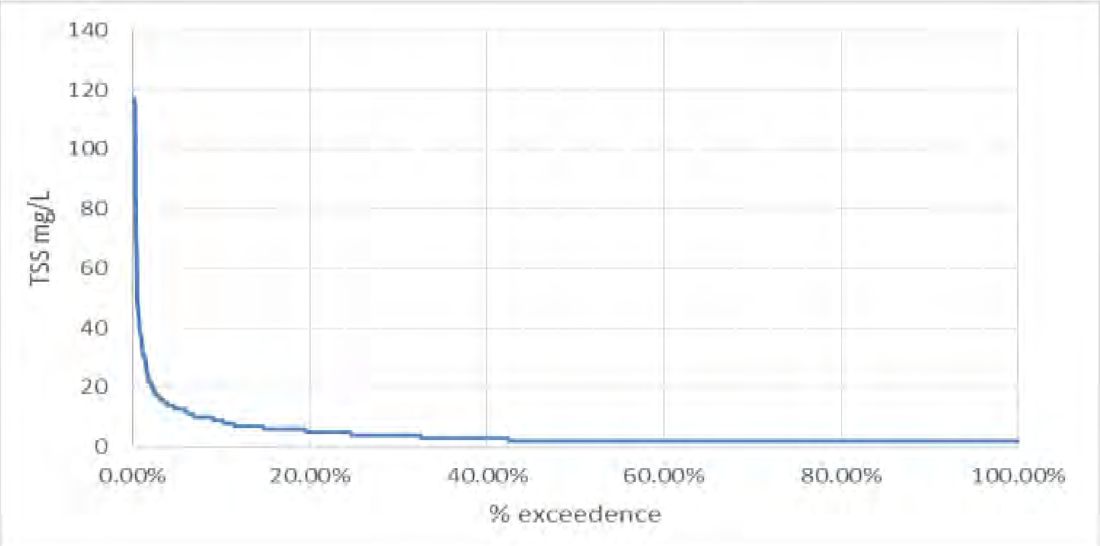


Figure 5.18 TSS treatment data using Siltbuster systems (with 3 stage chemical dosing).

5.2.3.3 Reach 2 Stream Restoration

Present situation informing recommendations

It is proposed to use natural channel design techniques to re-establish a functional stream channel in Reach 2. The restoration design process will focus on the development of a stream design that is appropriate in terms of channel cross-sectional dimension, plan, and profile, and that will therefore be stable in the long term. In addition, the design will incorporate design elements to provide appropriate in-stream aquatic habitat. Stream banks and the riparian zone will be revegetated with native species with a view to enhancing bank stability in the new channel and reducing potential soil erosion in the riparian area. Once the area upstream of Wall 1 has been dewatered and the accumulated peat removed Reach 2 will be surveyed to establish a baseline for the development of the stream restoration plan for the reach.

Objectives of recommendations

1. *Eliminate or limit the release of further polluting matter from areas down gradient of the landslide where material has been deposited.*
2. *Mitigate against the further dispersal of peat and sediment, deposited along the banks of the Shruhangarve, by the watercourse through and beyond the confines of the site.*
3. *Return Reach 2 to a natural, stable condition.*

Recommended measures

1. *Conduct a limited geomorphological survey of Reach 2.. Survey will include the following:*
   - *detailed cross sections*
   - *long profile*
2. *The reference reach data and survey of unimpacted and/or moderately impacted stream reaches that was conducted in Phase 2 will be used to develop dimensionless ratios to inform the conceptual design of new channel for Reaches 2.*
3. *Design will include in-stream structures and a detailed planting plan utilising appropriate native species.*
4. *Once the proposed restoration design has been finalised and approved work should commence at the upstream end and work down.*
5. *All work will be conducted in the dry, therefore pump arounds will be necessary.*
6. *More detailed recommendations for the restoration of the stream will be developed in future iterations of the Action Plan.*

5.2.3.4 Further Recommendations

The recommendations outlined above are not by no means exhaustive or limited.

Further recommendations are currently and will continue to be developed to deal with the various reaches of the affected Shruhangarve stream. These will be detailed in future iterations of the Action Plan to further address the situation on-site and in the downstream watercourses as a result of ongoing water monitoring efforts, ecological surveys, seasonal factors, the trialling of certain recommendations on site and the contributions from other stakeholders and regulatory authorities whose input will be very much welcomed and carefully considered.

5.3 Water Quality Monitoring

5.3.1 Introduction

The following surface water quality monitoring programme of the Shruhangarve, Mourne Beg and Derg rivers has been implemented to monitor water quality downstream of the Meenbog Wind Farm. This monitoring programme is being undertaken in addition to the monitoring proposal for the construction phase of the Meenbog Wind Farm as set out in Section 5.2 of the Construction and Environmental Management Plan (CEMP). This supplementary monitoring programme combines the use of laboratory analysis, water quality monitoring instrumentation and visual inspection to develop a comprehensive schedule of monitoring of all watercourses that exist both at the site and the surrounding area.

This water monitoring programme is the subject of independent review by the supervising hydrologist who will provide the necessary guidance on the monitoring requirements. The water monitoring programme is outlined in the following sections.

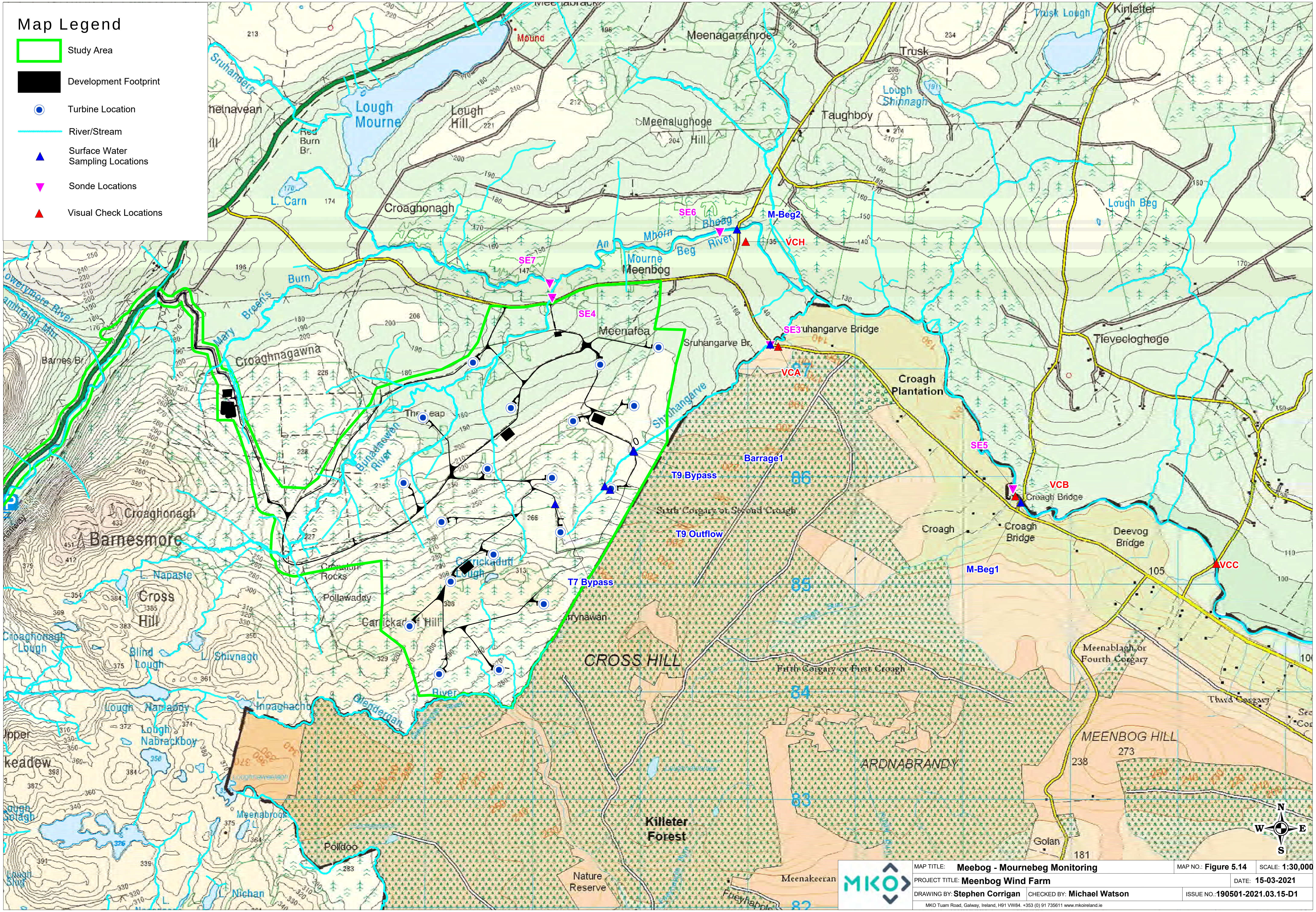
5.3.2 Drainage Inspection and Monitoring

In addition to the daily visual inspections carried out at the wind farm site (CEMP Section 5.2), daily visual inspections of watercourses are being undertaken at various locations adjacent to Turbine no. 7 and 9 and along the Shruhangarve, Mourne Beg and Derg rivers. The details of the visual check locations are set out in Table 5.13 and mapped in Figure 5.19.

Table 5.13 Visual Inspection Locations

ID	Easting (IG)	Northing (IG)	Analysis	Frequency	Task
VC-A	210286	387213	Visual Inspection to determine water quality	Daily	The visual inspection carried out at each Visual Check (VC) location is undertaken to determine the quality of water within a watercourse in terms of its visual appearance and checking for the presence of suspended sediment or a turbid complexion in the water. As outlined on the Daily Visual Inspection sheets, a scoring system has been devised to rate water quality at each VC in terms of: 1. Water clear – no issues 2. Water turbid with a visible peaty tinge (naturally occurring in waters drained from peatlands and not related to the wind farm works) 3. Water silty as a result of works NOT associated with the wind farm works 4. Water silty as a result of works associated with the wind farm works.
VC-B	212491	385822		Daily	
VC-C	214359	385195		Daily	
VC-D	220693	383782		Daily	
VC-E	222878	382954		Daily	
VC-F	226104	384388		Daily	
VC-G	228689	384662		Daily	
VC-H	209984	388188		Daily	
VC-I	222735	382563		Daily	

The visual inspection sheets and photographic records are being kept in the environmental file on site. Inspection points also include the additional laboratory analysis sampling points and the sonde locations as outlined in Figure 5.19



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5.3.3 Monitoring Parameters

The analytical determinants of the monitoring programme (including limits of detection and frequency of analysis) will be as per S.I. No. 272 of 2009 European Communities Environmental Objectives (Surface Waters) Regulations, S.I. No. 722 of 2003 European Communities (Water Policy) Regulations and European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009. The suites of parameters will include:

Suite 1

- Total Suspended Solids (mg/l)
- Ammoniacal Nitrogen as NH3 (mg/l)
- Ammoniacal Nitrogen as NH4 (mg/l)
- Nitrite (NO2) (mg/l)
- Ortho-Phosphate (P) (mg/l)
- Nitrate (NO3) (mg/l)
- Phosphorus (unfiltered) (mg/l)
- Chloride (mg/l)
- Biochemical Oxygen Demand (BOD) (mg/l)
- pH
- Electrical Conductivity
- Temperature
- Dissolved Oxygen

Suite 2

- Turbidity (NTU) (hand held turbidity meter)

Suite 3

- Turbidity (NTU) (sonde measured)

Suite 4

- Arsenic Dissolved filtered
- Cadmium Dissolved filtered
- Calcium Dissolved filtered
- Chromium Dissolved filtered
- Copper Dissolved filtered
- Lead Dissolved filtered
- Iron Dissolved filtered
- Magnesium Dissolved filtered
- Mercury Dissolved filtered
- Nickel Dissolved filtered
- Potassium Dissolved filtered
- Sodium Dissolved filtered
- Zinc Dissolved filtered
- Phosphorus Dissolved filtered
- Total Petroleum Hydrocarbons CWG (Speciated)
- Gasoline Range Organics (Aliphatic/Aromatic Split)
- VOCs
- Total Phenols
- BTEX
- Chlorophenols
- Sulphate
- Chloride

- Nitrate
- Nitrite
- Molybdate Reactive Phosphorus (MRP unfltered)
- Ortho Phosphate
- Ammonia Low Level
- Ammoniacial Nitrogen
- Total Alkalinity
- BOD
- COD
- Conductivity
- pH
- TOC
- Suspended Solids
- Hardness

5.3.4 Laboratory Analysis Sampling

Laboratory analysis of a range of parameters with relevant regulatory limits and Environmental Quality Standards (EQSs) was being undertaken on a daily basis but this was reduced to a weekly basis in February 2021 following a sustained period of stable results. The sample locations are located at bypass drains and outflows at Turbines no's 7 and 9 and Wall 1 all within the wind farm site as well as locations along the Shruhangarve, Mourne Beg and Derg rivers. The details of the surface water sampling locations are as outlined in Table 5.14 and mapped in Figure 5.19. All samples will be sent for analysis to an independent laboratory.

In addition, turbidity readings using a hand held turbidity meter are being taken at all surface water monitoring points which are the subject of the independent laboratory analysis as outlined in Figure 5.19. These daily turbidity readings will provide site management with current readings on water quality for these watercourses in advance of the results for each locations being received from the testing laboratory, which has a minimum five day turnaround for results.

Table 5.14 Sample Locations for Laboratory Analysis

ID	Easting (IG)	Northing (IG)	Testing Parameters	Frequency	Task
Sample locations on the wind farm site from discharges from behind the Barrage to the Shruhangarve and water that is pumped to the Bunadaowen river					
T7 Bypass	208213	385750	Suite 1 Suite 2	Daily	Sampling to be undertaken on a daily basis for laboratory analysis to provide trends on water quality for the parameters being tested. Each sample location is photograph as record of the appearance of the watercourse during the sampling. Sampling frequency reduced to weekly sampling in February 2021 following a sustained period of stable readings.
Barrage (Wall) 1	208940	386246		Daily	
T9 Bypass	208946	386238		Daily	
T9 Outflow	208722	385883		Daily	
Sample location on the Shruhangarve river upstream of the confluence with the Mourne Beg river					
SE3	210212	387234	Suite 1 Suite 2	Daily	Sampling to be undertaken on a daily basis for laboratory analysis to provide trends on water quality for the parameters being tested. Each sample location is photograph as record of the appearance of the watercourse during the sampling Sampling frequency reduced to weekly sampling in February 2021 following a sustained period of stable readings.
Sample location on the Mourne Beg river upstream of the confluence with the Shruhangarve					
M-Beg 2	209903	388303	Suite 1 Suite 2	Daily	Sampling to be undertaken on a daily basis for laboratory analysis to provide trends on water quality for the parameters being tested. Each sample location is photograph as record of the appearance of the watercourse during the sampling Sampling frequency reduced to weekly sampling in February 2021 following a sustained period of stable readings.
Sample location on the Mourne Beg river downstream of the confluence with the Shruhangarve					
M-Beg 1	212542	385764	Suite 1 Suite 2	Daily	Sampling to be undertaken on a daily basis for laboratory analysis to provide trends on water quality for the parameters being tested. Each sample location is photograph as record of the appearance of the watercourse during the sampling

ID	Easting (IG)	Northing (IG)	Testing Parameters	Frequency	Task
					Sampling frequency reduced to weekly sampling in February 2021 following a sustained period of stable readings.
Sample locations on the Derg River downstream of the confluence with the Mourne Beg river					
Derg 1	226189	384383	Suite 1 Suite 2	Daily	Sampling to be undertaken on a daily basis for laboratory analysis to provide trends on water quality for the parameters being tested. Each sample location is photograph as record of the appearance of the watercourse during the sampling. Sampling frequency reduced to weekly sampling in February 2021 following a sustained period of stable readings.
Derg 2	228852	384793		Daily	

5.3.5 Continuous Turbidity Monitoring

Turbidity monitors or sondes are installed at locations surrounding the wind farm site as outlined in Figure 5.14. The sondes provide continuous readings for turbidity levels at two new locations both upstream and downstream of the Mourne Beg river. This equipment is supplemented by daily visual inspections at their locations as outlined in Table 5.15 and mapped in Figure 5.19.

Table 5.15 Continuous Turbidity Monitoring (Sonde) Locations

ID	Easting (IG)	Northing (IG)	Testing Parameters	Frequency	Summary
SE1	202046	384649	Suite 3	Continuous	Sonde has been recording turbidity continuously since September 2019 in the Lowreymore river south of the Barnesmore Gap
SE3	210212	387234		Continuous	Sonde had been recording turbidity in the Shruhangarve since September 2019 until it was taken away by material from the peat slippage. The continuous turbidity monitor at Shruhangarve Bridge was reinstalled on 18th December 2020 and has been operational since that date.
SE4	208185	387675		Continuous	Sonde has been recording turbidity continuously since September 2019 in the Bunadaowen river north of the Meenbog WF site
SE5	212530	385761		Continuous	Sonde has been recording turbidity continuously since 19/11/20 in the Mourne Beg river downstream of the confluence with the Shruhangarve to provide water quality data downstream from the Shruhangarve
SE6	209915	388320		Continuous	Sonde has been recording turbidity continuously since 26/11/20 in the Mourne Beg river upstream of the confluence with the Shruhangarve to provide water quality data upstream from the Shruhangarve.
SE7	209742	388286		Continuous	Sonde has been recording turbidity continuously since 08/02/21 in the Mourne Beg River upstream of the confluence with the Bunadaowen river to provide quality upstream of the Bunadaowen and Shruhangarve.

5.3.6 Aquatic Ecology Baseline Monitoring

It is proposed to undertake surface water sampling to establish baseline conditions as part of an aquatic ecology assessment of the Shrunhangarve stream and Mourne Beg rivers. Two rounds of sampling, in spring and summer at 10 no. sample locations will be carried out. The approximate locations of these sample points has to be determined in consultation with the project ecologists. Surface water samples will be sent to an independent testing laboratory for analysis for the parameters listed under Suite 4 below.

5.3.7 Surface Water Monitoring Reporting

Visual inspection, turbidity monitoring data and laboratory analysis results of water quality monitoring will be used to further inform future recommendations that are made or revised in subsequent iterations of this Action Plan.

All water monitoring reports will be available to Donegal County Council on request at any time.

5.4 Ecological Surveys

5.4.1 Introduction

A comprehensive schedule and scope of aquatic ecology surveys is planned, coordinated by MKO ecologists with the assistance of Triturus Environmental Ltd. Using Triturus's experience of similar schemes and aquatic studies within Ireland, a 'best practise approach' for the selection of the monitoring techniques has been compiled.

The scope and purpose of the aquatic surveys planned are to:

1. *Establish baseline conditions in the river.*
2. *Assess the damage caused as a result of the peat slide.*
3. *Consider measures that could be employed to ameliorate any impacts.*
4. *Monitor conditions within the river in the long term.*

MKO ecologists will also be completing a detailed assessment of the potential impacts that the peat slide may have had on bird species, known from the Meenbog wind farm site and surrounding area. This assessment will include a study of all known ornithological data including the location of roosts, nest sites and foraging areas for sensitive species. Potential habitat loss and disturbance displacement impacts were assessed for hen harrier and merlin in January 2021. No significant habitat loss or disturbance displacement effect on hen harrier or merlin were identified resulting from the November 2020 peat slide at the Meenbog Wind Farm. Both species will be subject to continued construction phase monitoring as per planning permission conditions within the wind farm site.

MKO ecologists will be completing detailed botanical surveys of the peatlands within the Meenbog wind farm site and along the banks of the Shruhangarve, to assess the impact of the peat slide on them, to evaluate their condition and to advise on any measures that may be employed to enhance their conservation.

To establish baseline conditions in the river, the following aquatic surveys outlined below are proposed.

5.4.2 River Invertebrates (Q values and RICT)

Macro-invertebrate samples will be collected from 10 sampling locations by kick sampling to calculate Q-ratings/RICT (NOTE: the catchment is cross border and two river invertebrate status calculations are required for Water Framework Directive (WFD) in order to comply with EPA/NIEA guidance. Sampling will follow 'Guidelines for the selection of sampling methods and devices for benthic macroinvertebrates in fresh waters' (ISO 10870:2012).

Samples collected and associated data will provide a WFD classification according to Toner et al., 2005 for Ireland and standard UK River Prediction and Classification System (RIVPACS) and river assessment method benthic invertebrate fauna invertebrates (General Degradation): Whalley, Hawkes, Paisley & Trigg (WHPT) metric in River Invertebrate Classification Tool (RICT).

5.4.3 Specialist river electrofishing

Fish monitoring will be guided by CEN - EN 14962 Water quality - Guidance on the scope and selection of fish sampling methods. Sampling methods within rivers have been categorised and in order to evaluate the fish population parameters such as species composition, abundance and age structure. These include, site specific backpack electrofishing at the 10 sites to be identified for water quality and invertebrate sampling.

5.4.4 River Habitat Survey (RHS) and Fish Habitat Survey

Approximately 20 km of downstream river channel to be surveyed, which would include the 10-water quality/river invertebrate sites. The fisheries habitat is assessed using the Life Cycle Unit Method (LCUM) developed in Northern Ireland by Kennedy[4] which is currently used by the Loughs Agency and the optimal survey period for field study is during low river flow which enables visual habitat observation[5]. River Habitat Survey (RHS) follows standard methodology developed within the UK[6].

Any potential areas of lamprey habitat (potential breeding and juvenile habitat i.e. sediment banks will also be identified during this survey. Standard lamprey habitat assessment would follow guidance by the European Commission's LIFE Nature programme (Maitland, 2003) and the Scottish Fisheries Coordination Centre (Marine Scotland, 2007).

5.4.5 Aquatic Vegetation

Aquatic vegetation would be recorded on a 'presence absence' basis at each of the 10 sites identified for water quality and invertebrate sampling (four riverine sites and six sampling stations within the estuary). Monitoring would be guided by Common Standards Monitoring Guidance for Rivers (JNCC 2016). This survey would also record the aquatic vegetation (emergent and floating vegetation) and would be carried out in conjunction with macro-invertebrate and fish surveys.

5.4.6 Hydromorphology Assessment

The hydromorphology assessment would be guided by the River Hydromorphology Assessment Technique (RHAT) Training Manual (NIEA 2014). It would be conducted over the 10 sites identified for water quality and invertebrate sampling (four riverine sites and six sampling stations within the estuary) and would be carried out in conjunction with macro-invertebrate and fish surveys.

5.4.7 Future phases

Future phases of surveys and assessment will be detailed and developed further as the results of the baseline surveys become available and will be included in future iterations of the Action Plan.

4 Kennedy GJA (1984). Evaluation of Techniques for Classifying Habitats for Juvenile Salmon (Salmo salar L.). Proceedings of the Atlantic Salmon Trust Workshop on Stock Enhancement
5 Department of Agriculture Northern Ireland (2005). The Evaluation of Habitat for Salmon and Trout. Advisory Leaflet No. 1. Fisheries Division, Stormont, Belfast.
6 Environment Agency (2003). River Habitat Survey in Britain and Ireland – Field Survey Guidance Manual: 2003 version, Environment Agency, Scottish Environmental Protection Agency (SEPA) & Environment & Heritage Service (NI).

APPENDIX 4

PEATLAND RESTORATION PLAN

Peatland Restoration Plan

Meenbog Peat Slide Remediation, Co. Donegal

DOCUMENT DETAILS

Client: Planree Ltd.

Project Title: Meenbog Peat Slide Remediation, Co. Donegal

Project Number: 201174

Document Title: Peatland Replacement and Enhancement Plan

Document File Name: PMP F – 2021.05.12 - 201174

Prepared By: MKO
Tuam Road
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Rev	Status	Date	Author(s)	Approved By
01	Draft	12/04/2021	DMN/JOS	PR
02	Final	12/05/2021	DMN/JOS	PR

Table of Contents

1. INTRODUCTION

1.1 Background

Following a peat slippage at the permitted Meenbog Windfarm, Co Donegal, this Peatland Restoration Plan has been prepared to describe the measures that will be employed to stabilise, restore and monitor peatland habitats in the area where the peat slippage occurred (Upper Slip Scar - above Wall Three). The study area is shown in Figure 1.1 and Plate 1.1.

The following sections initially describe the upland blanket bog vegetation occurring within and adjacent to the area where the slip occurred (Upper Slip Scar – above Wall Three) as well as a review of the current hydrological conditions on the site. This is followed by a description of the proposed management actions to assist in the restoration of this peatland and the proposed monitoring programme.

Plate 1.1 Example of the fragmented blanket bog habitat occurring where the slip occurred.

The Bog Restoration Plan will be implemented in accordance with the published guidelines and best practice such as the guidelines arising from the EU–LIFE/Coillte '*Irish Blanket Bog Restoration Project*' (2002-2007)', Scottish Natural Heritage (SNH)'s guidance note Planning for development: *What to consider and include in Habitat Management Plans* (Version 2, January 2014).

1.1.1 Statement of Authority

This report has been prepared by David McNicholas (BSc., MSc., MCIEEM), Julie O'Sullivan (BSc., MSc) and reviewed by Pat Roberts (B.Sc. Environmental Science, MCIEEM). David McNicholas has over 10 years' professional ecological consultancy experience and is a full member of the Chartered Institute of Ecology and Environmental Management. Julie has over 5 years professional ecological experience. Pat has over 15 years' experience in ecological management and assessment. The baseline ecological surveys were undertaken by David McNicholas and Julie O'Sullivan on 31st March 2021.

Map Legend
Study area
Wall 3
Microsoft product screen shots reprinted with permission from Microsoft Corporation
N
Drawing Title
Study area
Project Title
Meenbog Peatland Restoration Plan
Drawn By
DMN
Checked By
PR
Project No.
201174
Drawing No.
Figure 1-1
Scale
1:1450
Date
12.04.2021
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+353 (0) 91 735611
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2. DESCRIPTION OF THE BASELINE ENVIRONMENT

2.1 Survey Methodology

A botanical assessment of the habitats within the study area was undertaken on the 31st of March 2021. A total of five detailed relevés were undertaken, on both the habitats occurring within area where the peat slide occurred and within the adjacent intact peatland habitat. The location of each relevé is provided in Figure 2.1 and described in full in Appendix 1.

Relevés that were undertaken in peatland habitats followed the survey methodology and assessment criteria set out in the following document:

- *Perrin, P.M, Martin, J.R., Barron, J.R., Roche & O' Hanrahan, B. (2014) Guidelines for a national survey and conservation assessment of upland vegetation and habitats in Ireland. Version 2.0. Irish Wildlife Manuals, No. 79. National Parks and Wildlife Service.*

All species were readily identifiable during the survey. Plant nomenclature for vascular plants follows '*New Flora of the British Isles*' (Stace, 2010), while mosses and liverworts nomenclature follows '*Mosses and Liverworts of Britain and Ireland - a field guide'* (British Bryological Society, 2010).

A total of five 2m x 2m relevés were recorded. For each relevé, a 12-figure grid reference was obtained using a GPS unit. Relevés were taken within a representative sample in homogeneous stands of vegetation. Cover in vertical projection for each vascular and bryophyte species was recorded in percentage cover, as were other general parameters: bare soil and peat depth.

Vegetation relevé data recorded during the field survey (2m x 2m) was analysed using the Irish Vegetation Classification (IVC) Engine for Relevés to Irish Communities Assignment (ERICA) online application. This programme assesses the data against a reference database of vegetation communities and assigns the relevé data a community classification. This is a robust assessment allowing for accurate vegetation community assignment.

2.2 Description of the baseline habitats

The habitats within area where the peat slide occurred, comprise predominantly of upland blanket bog (PB2) and a small area of conifer plantation forestry (WD4), see Plate 2.1. The vegetation community occurring within the area affected by the peat slide, see Plate 2.2, and within the adjacent intact peatland habitat, see Plate 2.3, were assessed by undertaking releves as described in Section 2.1. The results of the releve data found that the vegetation composition was uniform throughout the survey area, with all quadrats conforming to the BG2C community i.e. Cross-leaved Heath – Purple Moor-grass – Reindeer Lichen bog/heath (*Erica tetralix – Molinia caerulea – Cladonia portentosa* bog/heath).

As shown in Plate 1.1, the area where the peat slide occurred now comprises some areas of exposed peat. In order to estimate the area of bare peat and bare peat areas now retaining surface water within the peat slide, the study area was surveyed using a drone. The imagery was then used to produce contour data and high-resolution imagery from which the following areas for each feature within the peat slide have been determined:

1. Vegetated area: 2,163m^2.
2. Peat area: 8,963m^2 (~50/50 peat and water),
3. Bare peat not retaining surface water: 1,0310m^2.

Map Legend

- Study area
- Relevé locations
- Wall 3

Drawing Title	Relevé Locations
Project Title	Meenbog Peatland Restoration Plan
Drawn By: DMN	Checked By: PR
Project No.: 201174	Drawing No.: Figure 2-1
Scale: 1:1500	Date: 12.04.2021

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Plate 2.1 Example of blanket bog (PB2) and coniferous plantation forestry (WD4) occurring within the study area.


Plate 2.2 Example of the fragmented blanket bog habitat occurring within the area where the slip occurred. Note the amount of surface water retention within the newly formed "bog pools", providing suitable features for Sphagnum moss establishment.

Plate 2.3 Example of the blanket bog habitat occurring adjacent to the area where the peat slide occurred.

2.3 Description of local hydrology

The area of peatland in which the peat slide occurred is located was historically subject to drainage associated with the afforestation of the surrounding lands. These drains run in south to north direction with "interceptor" drains located to the east (River Waterbody code: UKGBNI1NW010102066) and west (River Waterbody code: IE_NW_01B010100) of the bog directing much of this water to the adjacent watercourses that ultimately drain the lands. Given the localized topography and the interceptor drains described previously, the area of land that is "contributing" surface water runoff to the slip scar below Wall Three is relatively small. The contribution of direct rainfall and local surface water runoff towards the peat slide has resulted in the formation of a small surface water flow path through the peat slide area that runs generally from southwest to northeast. Therefore, following periods of heavy rainfall, the flow rate through this area increases as it would have prior to the peat slide. However, small pools have begun to establish as a result of rainwater accumulation within the peat slide area within newly formed depressions, and these appear to store and release water following rainfall events.

3. MANAGEMENT PRESCRIPTIONS

3.1 Management of revegetating bare peat

The areas of bare peat will likely revegetate over time from the natural seed source of the adjacent peatland. It is therefore initially proposed to set up 6 permanent monitoring plots within the peat slide area to determine the likely rate of natural recolonization between summer 2021 and summer 2022. The natural colonization of this bare peat would ensure a native, locally sourced, species mix establishing within the area. It is also proposed to establish a further three vegetation monitoring plots outside of the peat slide for comparison. The location of the indicative proposed permanent monitoring plots are shown in Figure 3-1.

3.1.1 Active Reseeding and Sphagnum Mulch Inoculation

3.1.1.1 Reseeding

Following the initial two summer natural recolonization evaluation described above, should the natural revegetation be deemed too slow or patchy, it is proposed to add a nurse crop. This would comprise of sheep's fescue (*Festuca ovina*) which would then speed up revegetation of the bare peat. In addition, alternative species, depending on availability, as recommended by YPP (2018a) are provided in Table 3.1.

The grass roots bind the peat surface into a stable turf that then form the basis for other moorland species to colonise into and recolonize over time. Such sowing and associated revegetation would be subject to further monitoring as described in detail in Section 3.4 of this report.

A reseeding rate of 10kg/ha is recommended (YPT, 2018a[1]). It also states that "*Peat is naturally very nutrient poor and damaged peat even more so. In order to establish the grass sward and provide favourable conditions for initial dwarf-shrub growth it is necessary to provide a short-lived low dose of nutrients using artificial fertiliser applied in July once the grasses are actively growing". "Phosphate fertiliser (P2O5) should be applied at a rate of 20kg/ha*".

Table 3.1 Moorland grass mix species composition (Source; YPP, 2018a)

Species (Latin)	Species (English)	% of seed mix
Agrostis capillaris	Common bent	20
Festuca ovina	Sheep's fescue	20
Deschampsia flexuosa	Wavy hair grass	30
Eriophorum vaginatum	Hare's-tail cotton-grass	30

3.1.1.2 Sphagnum mulch inoculation

As described in the Yorkshire Peat Partnership Technical *Specification 4* (YPP, 2018[2]).

[1] *Yorkshire Peat Partnership, 2018a, Online, available at: https://www.yppartnership.org.uk/sites/default/files/2018-07/171011%20Technical%20Specification%203%20Flat%20or%20gently%20sloping%20bare%20peat%20stabilisation%20%26%20re-vegetation%20TT.pdf, Accessed 13.04.2021*

Map Legend

- Study area
- Wall 3
- Indicative Permanent Monitoring Relevés
- Proposed Tree Removal

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Drawing Title: Indicative Permanent Monitoring Relevés	
Project Title: Meenbog Peatland Restoration Plan	
Drawn By: DMN	Checked By: PR
Project No.: 201174	Drawing No.: Figure 3-1
Scale: 1:1500	Date: 12.04.2021

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- "*Where appropriate donor sites are available, Sphagnum clumps can be harvested and transported to the restoration site for planting.*
- *Clumps of Sphagnum are harvested (preferably by hand) from a suitable donor site*
- *The donor site must not suffer long-term damage as a result of harvesting"*
- YPP *"recommends that less than 10% of the donor site should be harvested".*
- *"The donor site is surveyed by a suitably experienced botanist prior to cutting to determine the species composition which should be as close as possible to the ideal mix" outlined in Table 3.2.*
- *"There is currently no evidence-based information on the best times to plant the clumps".* YPP proposes *"planting in late winter spring to give them a full growing season before the next winter".*
- *"Clumps are heeled into the bare peat surface in wetter areas at a rate of 1 clump per m*[2]".

Table 3.2 Recommended Sphagnum mix (Source; YPP, 2018)

	Species	%
Base composition	*S. capillifolium*	*30*
	S. papillosum	*30*
	S. palustre	*30*
	S. subnitens	*10*
Additional species depending on conditions (adjust base composition % accordingly)	*S. inundatum*	*5*
	*(S. tenellum**)*	*10*
	*(S. magellanicum***)*	*5*

***bare peat only. Adjust the content of other species to accommodate it.*
****not for general use but may be worth adding in specific circumstances where it has been found on nearby moors. Adjust the content of other species to accommodate it.*

3.2 Measures for the control of surface water flow rates entering the Study Area

As described above, existing/historic drainage channels occurring within the wider area to the south of the area where the peat slide occurred provide some surface contribution to the affected area. Therefore, following advice with the project hydrologist Michael Gill, a number of plastic dams will be installed at a number of targeted areas to slow the rate of flow entering the area of the peat slide following periods of heavy rainfall. This will assist in avoiding or reducing erosion during periods of heavy rainfall by decreasing through flow. Therefore, the dams will be installed within the drains partly below the surface level. This will allow surface water runoff to continue to discharge from this small catchment at a controlled rate without creating any significant water retention at this location. Drains will be blocked, where appropriate, using plastic dams, see Plate 3.1. These will be installed by hand with no vehicular access permitted to the area at any stage of the works. The indicative location of the dams is provided in Figure 3.2. The methodology for dam installation is also set out in Mackin et, al., (2017).

[2] *Yorkshire Peat Partnership (YPP), 2018, Technical Specification 4, Online, Available at: https://www.yppartnership.org.uk/sites/default/files/2018-07/171011%20Technical%20Specification%204%20Introducing%20Sphagnum%20into%20existing%20degraded%20vegetation%20TT.pdf, Accessed. 13.04.2021*

Map Legend

- Proposed drain blocking locations
- Proposed tree removal area
- Wall 3
- Study area

N

Drawing Title	
Management Actions	
Project Title	
Meenbog Peatland Restoration Plan	
Drawn By	Checked By
DMN	PR
Project No.	Drawing No.
201174	Figure 3.2
Scale	Date
1:1450	12.04.2021

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Plate 3.1 Example of plastic dams to be used for on-site drain blocking.

3.3 Tree Felling

The area where the peat slide occurred (above Wall Three) encompasses a number of trees that currently located on isolated raised sections of peat i.e. “peat rafts”, held together by the root system. In this area, the surrounding peat has lowered in elevation, see Plate 3.2 and Figure 3.2.

As part of the monitoring programme, the trees within this area will be subject to monitoring to see if there are any signs that they may be knocked over during high winds (known as windblow). If the trees do fall and result in any additional vegetation disturbance, it is proposed to fell these individual trees by hand. Any such vegetation clearance will be undertaken under the provisions of the Wildlife Acts 1976 to 2018.

Plate 3.2 Example of forestry occurring at the northern extent of the study area with notable peat rafts.

3.4 Monitoring

To confirm that habitat restoration has been successful, all areas of restored vegetation will be subject to a specific monitoring plan. Monitoring results will be reported within an *Annual Environmental Report* with any notable actions required identified and implemented following agreement with the project stakeholders.

Prior to the commencement of the habitat management measures, permanent vegetation monitoring plots will be established within the management areas. The monitoring plot locations will be selected using stratified random sampling. Indicative areas are shown Figure 3-1. This will allow the monitoring plots to be representative of microtopography and vegetation cover sampling areas. Monitoring plots will be surveyed and classified using the relevé method as per the *National Survey of Upland Habitats* (Perrin et al., 2014) with plot sizes being 2m x 2m. Biotic and abiotic parameters that form baseline indicators of ecological and hydrological condition of the bog will be recorded. Monitoring plots will be marked out permanently using posts and their location recorded using GIS. A minimum of six 2m x 2m monitoring plots will be established across the restoration area. Visual inspections of restoration area will be carried out twice per year during the first two years to check for potential peat erosion or movement and natural revegetation. The initial inspection, early in the year, will aim to identify any additional actions that could be taken to reduce erosion or promote revegetation. The second survey will aim to determine the amount of vegetation growth over the summer period. Results will be analysed and the annual environmental report will include the findings of the monitoring. Following the initial two years of monitoring, should natural revegetation be determined to be too slow and additional actions required to promote revegetation, additional measures will be implemented as described in Section 3.1. The restoration plan will be regularly updated and amended where necessary to improve the efficacy of the restoration work. Monitoring will involve the following:

<u>Surface peat assessment</u>

An assessment of the physical state of the surface peat with regard to:

- Percentage bare peat not covered by vegetation (via the establishment of a number of fixed point relevés);
- Intactness (e.g. presence of visible cracking in surface peat; and
- General stability (e.g. presence of peat erosion).

<u>Vegetation sampling</u>

- A number of fixed relevé sites (i.e. permanent quadrats) will be set up.
- Baseline vegetation data will be recorded prior to the commencement of habitat management activities set out in this plan. The character of each relevé will be recorded (e.g. species proportions present, vegetation structure and height) and photographs will be taken of each relevé from a fixed point.
- These relevés will then be re-examined twice per year as described above with a single yearly Annual Environmental Report (AER) prepared. This will establish and document the extent of revegetation/ habitat improvement resulting from management practices.
- In addition to the above, drone imagery will also be taken of the study area and used to estimate the rate and extent of revegetation.

<u>Hydrological monitoring</u>

- Water levels within areas where drains are blocked will be recorded by installing piezometers which will be subject to monitoring using dataloggers.
- The area covered by standing surface water, i.e. the newly formed "bog pools" will also be estimated using drone imagery, as these features may be important in promoting the establishment of Sphagnum moss and thus active peat formation conditions.

The efficacy of the habitat rehabilitation and enhancement measures employed will be reviewed after the first and second year i.e. 2022 and 2023, following commencement of the plan on the basis of the results of vegetation sampling from the managed areas. Analysis of the data collected will be the basis for a review of the measures and techniques employed.

3.5 Reporting

As described above, biannual monitoring will be undertaken for the first 2 years to determine if there is any erosion occurring within the areas of bare peat and if additional drain blocking measures may be required. In addition, the natural revegetation will also be monitored and it will be determined whether reseeding is required.

Annual reports will be prepared in the form of an Annual Environmental Reports thereafter for a period of 10 years. Following this, monitoring and subsequent reporting will be undertaken in years 15 and 20. These surveys and associated reports will document the revegetation and make any necessary recommendations required to vary the management prescription and monitoring frequency at any time, should it be required.

4. CONCLUSION

This Peatland Restoration Plan sets out measures for the stabilisation and revegetation of the peatland vegetation at the area where the peat slide occurred (Upper Slip Scar - above Wall 3) at Meenbog, Co. Donegal. The following actions have been proposed:

- Initially undertake monitoring of the natural revegetation from local seed sources,
- Following the initial 24 month monitoring, should natural regeneration be considered too slow or patchy. active reseeding and sphagnum mulch inoculation is proposed as the secondary approach.
- In order to reduce any scouring that may hinder revegetation of the bare peat as a result of increased water conveyance through the study area, measures for the control of surface water flow rates entering area where the peat slide occurred have been proposed in the form of drain blocking.
- Trees occurring within the effected area will be subject to monitoring in order to determine if felling may be necessary to prevent any future ground disturbance.

These measures will be fully assessed through a detailed monitoring and reporting programme as described in Section 3.5. Following the implementation of the measures outlined in this report, it is envisaged that the peatland vegetation will recover, and the areas of bare peat will be fully revegetated.

5. BIBLIOGRAPHY

Mackin, F., Barr, A., Rath, P., Eakin, M., Ryan, J., Jeffrey, R. & Fernandez Valverde, F. (2017) Best practice in raised bog restoration in Ireland. Irish Wildlife Manuals, No. 99. National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht, Ireland.

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APPENDIX 1

RELEVE DATA

Planning and Environmental Consultants

Botanical Study - Appendix 6-1

Meenbog Peatslide Remediation

DOCUMENT DETAILS

Client: **Enerco**

Project Title: **Meenbog Peatslide Remediation**

Project Number: **201174**

Document Title: **Botanical Survey**

Document File Name: **BS F – 201174 – 2021.04.12**

Prepared By:

MKO
Tuam Road
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MKO Planning and Environmental Consultants

Rev	Status	Date	Author(s)	Approved By
01	Final	12/04/2021	JOS	PR

Table of Contents

1. HABITAT ASESSMENT

1.1 Survey Methodology

A botanical assessment of the habitats within the study area was undertaken on the 31st of March 2021 by David McNicholas (BSc., MSc., MCIEEM) and Julie O'Sullivan (B.Sc, M.Sc). A total of five detailed relevés were undertaken on the 31st of March 2021, focussing on the peatland habitats surrounding the peat slide area. The location of each relevé is provided in Figure 1.1.

Relevés that were undertaken in peatland habitats followed the survey methodology and assessment criteria set out in the following document:

- *Perrin, P.M, Martin, J.R., Barron, J.R., Roche & O' Hanrahan, B. (2014) Guidelines for a national survey and conservation assessment of upland vegetation and habitats in Ireland. Version 2.0. Irish Wildlife Manuals, No. 79. National Parks and Wildlife Service.*

All species were readily identifiable during the survey. Plant nomenclature for vascular plants follows '*New Flora of the British Isles*' (Stace, 2010), while mosses and liverworts nomenclature follows '*Mosses and Liverworts of Britain and Ireland - a field guide*' (British Bryological Society, 2010).
An initial walkover survey of the entire site was undertaken at the outset of each survey. Although the survey was not undertaken within the optimal survey period for peatland habitats, all species were identifiable at the time of survey.

A total of five 2m x 2m relevés were recorded. For each relevé, a 12-figure grid reference was obtained using a GPS unit. Relevés were taken within a representative sample in homogeneous stands of vegetation. Cover in vertical projection for each vascular and bryophyte species was recorded in percentage cover, as were other general parameters: bare soil, peat depth.

Vegetation relevé data recorded during the field survey (2m x 2m) was analysed using the IVC ERICA database. This programme assesses the data against a reference database of vegetation communities and assigns the relevé data a community classification. This is a robust assessment allowing for accurate vegetation community assignment.

1.1.1 Best Practice and Guidance

The habitat assessment surveys described in this report have been undertaken with reference to the following guidelines and resources:

- Perrin, P.M, Martin, J.R., Barron, J.R., Roche & O' Hanrahan, B. (2014) Guidelines for a national survey and conservation assessment of upland vegetation and habitats in Ireland. Version 2.0. Irish Wildlife Manuals, No. 79. National Parks and Wildlife Service.
- European Commission (2013) Interpretation Manual of European Union Habitats – EU27.
- NPWS (2013) The Status of EU Protected Habitats and Species in Ireland. Habitat Assessments Volume 2. Unpublished Report, National Parks & Wildlife Services. Department of Arts, Heritage and the Gaeltacht, Dublin, Ireland.
- NPWS (2019) The Status of EU Protected Habitats and Species in Ireland. Habitat Assessments Volume 2. Habitat Assessments. Unpublished Report, National Parks & Wildlife Services. Department of Arts, Heritage and the Gaeltacht, Dublin, Ireland.

2. RESULTS OF HABITAT SURVEY

The habitats within the study area comprise Upland Blanket Bog (PB2) and Eroding Blanket Bog (PB5) where the original peat mass has been lost during the landslide.

The Upland Blanket Bog (PB2) habitat is located on gently sloping land on an area of deep peat (1.4m - 2m) and is dominated by a mixture of heather (*Calluna vulgaris*) and purple moor grass (*Molinia caerulea*) (Plate 2.1 & 2.2). Cross leaved heath (*Erica tetralix*), common cotton grass (*Eriophorum angustifolium*) and hare's-tail cottongrass (*Eriophorum vaginatum*) are also frequent within the vegetation with Tormentil (*Potentilla erecta*), bog asphodel (*Narthecium ossifragum*), lousewort (*Pedicularis sylvatica*) and heath bed straw (*Galium saxatile)* also present. *Sphagnum capillifolium*, *Racomitrium lanuginosum* are the dominant species within the bryophyte layer with frequent *Hypnum jutlandicum, Odontoschisma sphagni*, *Sphagnum palustre and Sphagnum cuspidatum.* Revegetated drainages ditches (FW4) run through this area of upland blanket bog (Plate 2.3).

Vegetation relevé data recorded during the field survey (2m x 2m) was analysed using the IVC ERICA database. The relevés recorded in the upland blanket bog (PB2) habitat were assigned to bog/heath communities, based on analysis of the vegetation alone. However, given that the relevé's were all recorded on deep peat, all relevés can be best classified as bog habitat, rather than heath. The Upland Blanket Bog (PB2) habitat corresponds to Cross-leaved Heath – Purple Moor-grass – Reindeer Lichen bog/heath (*Erica tetralix – Molinia caerulea – Cladonia portentosa* bog/heath) BG2C in the Irish Vegetation Classification. This vegetation community qualifies as EU HD Annex I habitat 7130 Blanket bog (active)*.

Plate 2-1 Eroding gullies formed within the blanket bog habitat.

Plate 2-2 Upland Blanket Bog (PB2), view looking north-east

Plate 2-3 Upland Blanket Bog (PB2) and revegetated drainage ditches (FW4) (view looking south).

2.1 Relevé data

2.1.1 Relevé 1

Table 2-1 Relevé 1 Botanical Survey Results

Relevé 1	Grid reference: ITM 0608135 0885697	Date: 31/03/2021
Species	Common Name	% Cover
Vascular Plants		
Calluna vulgaris	Heather	15
Eriophorum angustifolium	Common Cottongrass	3
Eriophorum vaginatum	Hare's-tail Cottongrass	2
Narthecium ossifragum	Bog Asphodel	0.5
Molinia caerulea	Purple moor grass	20
Erica tetralix	Cross leaved heath	0.5
Potentilla erecta	Tormentil	0.5
Pedicularis sylvatica	Lousewort	0.5
Non-vascular Plants		
Cladonia portentosa	Reindeer lichen	0.5
Racomitrium lanuginosum	Woolly fringe moss	0.5
Sphagnum capillifolium	Acute-leaved/Red Bog-moss	20
Sphagnum palustre	Blunt leaved bog moss	5
Hypnum jutlandicum	Heath plait moss	0.5
Bare peat		20
Fossitt (2000) Habitat Classification - Upland blanket bog PB2 **IVC Community** - BG2C Cross-leaved Heath – Purple Moor-grass – Reindeer Lichen bog/heath (*Erica tetralix – Molinia caerulea – Cladonia portentosa* bog/heath)		


Plate 2-4 Relevé 1

2.1.2 Relevé 2

Table 2-2 Relevé 2 Botanical Survey Results

Relevé 2	Grid reference: ITM 0608130 0885682	Date: 31/03/2021
Species	Common Name	% Cover
Vascular Plants		
Calluna vulgaris	Heather	10
Eriophorum angustifolium	Common Cottongrass	0.5
Eriophorum vaginatum	Hare's-tail Cottongrass	0.5
Molinia caerulea	Purple moor grass	20
Erica tetralix	Cross leaved heath	2
Potentilla erecta	Tormentil	0.5
Galium saxatile	Heath bedstraw	+
Non-vascular Plants		
Cladonia portentosa	Reindeer lichen	1
Racomitrium lanuginosum	Woolly fringe moss	35
Sphagnum capillifolium	Acute-leaved/Red Bog-moss	3
Odontoschisma sphagni	Bog moss flapwort	0.5
Fossitt (2000) Habitat Classification - Upland blanket bog PB2 **IVC Community** - BG2C Cross-leaved Heath – Purple Moor-grass – Reindeer Lichen bog/heath (*Erica tetralix – Molinia caerulea – Cladonia portentosa* bog/heath)		

Plate 2-5 Relevé 2

2.1.3 Relevé 3

Table 2-3 Relevé 3 Botanical Survey Results

Relevé 3	Grid reference: ITM 0608003 0885555	Date: 31/03/2021
Species	Common Name	% Cover
Vascular Plants		
Calluna vulgaris	Heather	20
Eriophorum vaginatum	Hare's-tail Cottongrass	10
Molinia caerulea	Purple moor grass	10
Erica tetralix	Cross leaved heath	2
Potentilla erecta	Tormentil	0.5
Non-vascular Plants		
Cladonia portentosa	Reindeer lichen	5
Cladonia spp.	Lichen	0.5
Racomitrium lanuginosum	Woolly fringe moss	20
Sphagnum capillifolium	Acute-leaved/Red Bog-moss	30
Odontoschisma sphagni	Bog moss flapwort	0.5
Fossitt (2000) Habitat Classification - Upland blanket bog PB2 **IVC Community** - BG2C Cross-leaved Heath – Purple Moor-grass – Reindeer Lichen bog/heath (*Erica tetralix – Molinia caerulea – Cladonia portentosa* bog/heath)		

Plate 2-6 Relevé 3

2.1.4 Relevé 4

Table 2-4 Relevé 4 Botanical Survey Results

Relevé 4	Grid reference: ITM 0608035 0885530	Date: 31/03/2021
Species	Common Name	% Cover
Vascular Plants		
Calluna vulgaris	Heather	50
Eriophorum vaginatum	Hare's-tail Cottongrass	2
Molinia caerulea	Purple moor grass	30
Erica tetralix	Cross leaved heath	1
Potentilla erecta	Tormentil	+
Non-vascular Plants		
Cladonia portentosa	Reindeer lichen	7
Racomitrium lanuginosum	Woolly fringe moss	15
Sphagnum capillifolium	Acute-leaved/Red Bog-moss	7
Hypnum jutlandicum	Heath plait moss	+
Fossitt (2000) Habitat Classification - Upland blanket bog PB2 **IVC Community** - BG2C Cross-leaved Heath – Purple Moor-grass – Reindeer Lichen bog/heath (*Erica tetralix – Molinia caerulea – Cladonia portentosa* bog/heath)		

Plate 2-7 Relevé 4

2.1.5 Relevé 5

Table 2-5 Relevé 5 Botanical Survey Results

Relevé 5	Grid reference: ITM 0608055 0885579	Date: 31/03/2021
Species	Common Name	% Cover
Vascular Plants		
Calluna vulgaris	Heather	30
Eriophorum angustifolium	Common Cottongrass	1
Eriophorum vaginatum	Hare's-tail Cottongrass	2
Narthecium ossifragum	Bog Asphodel	+
Erica tetralix	Cross leaved heath	+
Potentilla erecta	Tormentil	+
Non-vascular Plants		
Cladonia portentosa	Reindeer lichen	1
Racomitrium lanuginosum	Woolly fringe moss	35
Sphagnum capillifolium	Acute-leaved/Red Bog-moss	5
Sphagnum cuspidatum	Feathery bog moss	3
Bare peat		3
Fossitt (2000) Habitat Classification - Upland blanket bog PB2 **IVC Community** - BG2C Cross-leaved Heath – Purple Moor-grass – Reindeer Lichen bog/heath (*Erica tetralix – Molinia caerulea – Cladonia portentosa* bog/heath)		

Plate 2-8 Relevé 5

3. BIBLIOGRAPHY

Perrin, P.M, Martin, J.R., Barron, J.R., Roche & O' Hanrahan, B. (2014) Guidelines for a national survey and conservation assessment of upland vegetation and habitats in Ireland. Version 2.0. Irish Wildlife Manuals, No. 79. National Parks and Wildlife Service

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APPENDIX F

ACTION PLAN – VERSION 4.0

Peat Slide Action Plan – Version 4.0

Meenbog Wind Farm

DOCUMENT DETAILS

Client: **Planree Limited**

Project Title: **Meenbog Wind Farm**

Project Number: **201174**

Document Title: **Peat Slide Action Plan – Version 4.0**

Document File Name: **201174 - Action Plan Version 4.0 F 2021.09.27**

Prepared By: **MKO**
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MKO Planning and Environmental Consultants

Rev	Status	Date	Author(s)	Approved By
01	Draft	17/09/2021	TB; PR	MW
02	Final	27/09/2021	TB; PR	BK

Table of Contents

1. INTRODUCTION

1.1 Background

McCarthy Keville O'Sullivan Ltd. (MKO) have been requested by Planree Limited (Planree) to provide technical assistance and prepare an Action Plan following a peat slide incident at the Meenbog Wind Farm construction site on the 12th of November 2020. Since the appointment by Planree, MKO have been coordinating a team of ecologists, hydrologists, environmental scientists, environmental engineers, and aquatic ecologists to prepare an Action Plan that would make recommendations to mitigate the effects of the incident.

Version 1.0 of this Action Plan was prepared specifically to inform Planree's response to a notice issued by Donegal County Council (DCC) dated 17th November issued under Sections 10(5), 12(1) and 23(1) of the Local Government (Water Pollution) Acts, relating to the discharge of peat, sediment, and heavily soiled water from the wind farm site under construction at Meenbog, Ballybofey, Co. Donegal to the Shruhangarve stream and Mourne Beg River commencing on the 12th and 13th November 2020.

Action Plan (Version 2.0) updated and expanded upon the recommendations provided in Action Plan Version 1.0. In particular, additional detail was provided on the phasing of, and specific measures proposed for, the restoration of the Shruhangarve Stream.

Action Plan (Version 3.0) further updated and expanded upon the recommendations provided in Action Plan Version 2.0. In particular, additional detail was provided on Phase 1B of measures proposed for the restoration of the Shruhangarve Stream.

1.2 Scope of Action Plan Version 4.0

This Action Plan has been prepared as a "Version 4.0" document and is by no means exhaustive or limited. Action Plan Version 4.0 focuses exclusively on immediately implementable rehabilitation measures for Stream Reach 1 and 2.

MKO has prepared this action plan to allow Planree Limited present it and the recommendations contained herein as Planree Limited's proposals to Donegal County Council along with the necessary commitments to their effective implementation.

MKO is not responsible for the implementation of the proposed measures contained herein on-site, but will monitor the implementation of any measures that might be proposed by Planree as part of an expanded role for the on-site Environmental Clerk of Works.

1.3 Contributors

The following people contributed to the preparation of the Action Plan and the recommendations contained herein.

Thomas Blackwell – MKO (Senior Environmental Consultant)

Thomas is a Senior Environmental Consultant with MKO with over 15 years of progressive experience in environmental consulting. Thomas holds a BA (Hons) in Geography from Trinity College Dublin and a M.Sc. in Environmental Resource Management from University College Dublin. Prior to taking up his position with MKO in August 2019, Thomas worked as a Senior Environmental Scientist with HDR, Inc. in the United States and held previous posts with private consulting firms in both the USA and Ireland. Thomas is a registered Professional Wetland Scientist with the Society of Wetland

Scientists with specialist knowledge in wetland assessment and delineation, mitigation planning and design, stream geomorphic assessment, and stream and wetland restoration design. Thomas' key areas of expertise include fluvial geomorphology and stream restoration design. Thomas has provided stream restoration design, and construction oversight for numerous private and publicly funded projects in multiple jurisdictions.

Pat Roberts – MKO (Principal Ecologist)

Pat joined MKO (then Keville & O'Sullivan Associates) in 2005 following completion of a B.Sc. in Environmental Science. He has extensive experience of providing ecological services in relation to a wide range of developments at the planning, construction, and monitoring stages. He has wide experience of large scale industrial and civil engineering projects. He is highly experienced in the completion of ecological baseline surveys and impact assessment at the planning stage. He has worked closely with construction personnel at the set-up stage of numerous construction sites to implement and monitor any prescribed best practice measures. He has designed numerous Environmental Operating Plans and prepared many environmental method statements in close conjunction with project teams and contractors. He has worked extensively on the identification, control, and management of invasive species on numerous construction sites.

Brian Keville – MKO (Environmental Director)

Brian has over 20 years' professional experience as an environmental consultant having graduated from the National University of Ireland, Galway with a first-class honours degree in Environmental Science. Brian's professional experience has focused on project and environmental management, and environmental impact assessments. Brian has acted as project manager and lead-consultant on numerous environmental impact assessments, across various Irish counties and planning authority areas. These projects have included large infrastructural projects such as roads, ports, and municipal services projects, through to commercial, mixed-use, industrial, and renewable energy projects. The majority of this work has required liaison and co-ordination with government agencies and bodies, technical project teams, sub-consultants and clients.

Michael Watson – MKO (Environment Team Project Director)

Michael is Project Director and head of the Environment Team in McCarthy Keville O'Sullivan (MKO). Michael has over 18 years' experience in the environmental sector. Following the completion of his Master's Degree in Environmental Resource Management, Geography, from National University of Ireland, Maynooth he worked for the Geological Survey of Ireland and then a prominent private environmental & hydrogeological consultancy prior to joining MKO in 2014. Michael's professional experience includes managing Environmental Impact Assessments, EPA License applications, hydrogeological assessments, environmental due diligence and general environmental assessment on behalf of clients in the wind farm, waste management, public sector, commercial and industrial sectors nationally. Michael also has a Bachelor of Arts Degree in Geography and Economics from NUI Maynooth, is a Member of IEMA, a Chartered Environmentalist (CEnv) and Professional Geologist (PGeo).

2. RESTORATION WORKS ON THE SHRUHANGARVE STREAM COMPLETED TO DATE (PHASE 1A AND 1B WORKS)

For the purposes of describing the completed and proposed restoration works on the Shruhangarve Stream, the effected stream has been divided into five sections or reaches, and these reaches will be referred to further below. Figure 2.1 shows the location of each of these stream reaches.

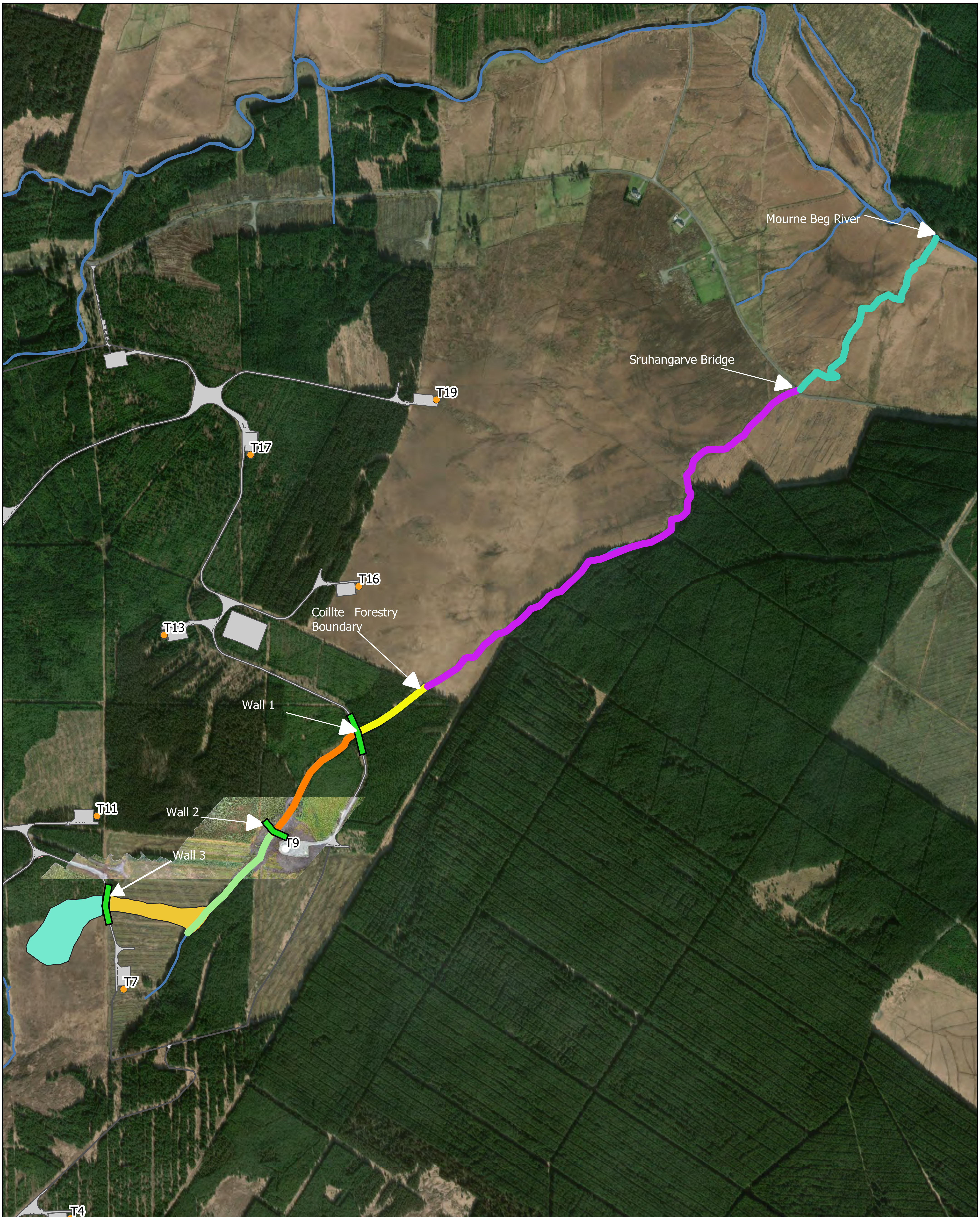
This section describes the restoration works that have been completed to date on the Shruhangarve Stream and the current condition of the various stream reaches. The works completed to date were previously described and authorised under Phase 1A and Phase 1B of the Actions Plan (Action Plan Versions 2.0 and 3.0).

2.1 Stream Reach 1: Slip Scar to Wall 2

There have been very limited works conducted in Reach 1 to date. As of the time of writing the following works have been undertaken:

- Fallen trees and other large debris have been mostly cleared from the banks of the reach in order to facilitate safe access.
- A brash road has been constructed along both sides of the reach in order to allow equipment to move up and down the reach. This is essential in order to allow any restoration work to occur. Without the brash road it would be impossible to bring any equipment into the area.
- Areas of bare peat have been seeded with a temporary seed mix in order to reduce the potential for erosion

There has been no in-stream works undertaken in this reach to date. The removal of debris from this reach has facilitated the gathering of survey data that was previously obscured. This has allowed the development of the restoration plan set out in Section 3 of this document.



Map Legend

Peatslip
- Upper Scar
- Slip Scar

Stream Reaches
- Stream Reach 1
- Stream Reach 2
- Stream Reach 3
- Stream Reach 4
- Stream Reach 5
- Rivers/Streams
- Proposed Permanent Development Footprint
- Proposed Turbine Locations

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Drawing Title	
Meenbog Peatslide Restoration Areas	
Project Title	
Meenbog Windfarm	
Drawn By: TJB	Checked By: BK
Project No.: 201174	Drawing No.: Figure 2.1
Scale: 1:10000	Date: 12/03/2021

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2.2 Stream Reach 2: Wall 2 to Wall 1

For the purposes of discussion Reach 2 has been divided into three sub-reaches (Upper, Middle, and Lower). Discrete restoration activities have occurred in these sub-reaches and are discussed below.

2.2.1 Reach 2 (Upper)

The upper portion of Stream Reach 2 (approximately 160m immediately downstream of Wall 2) was obstructed by numerous fallen and/or unstable trees that had been damaged in the initial peat slide. Plate 2.1 is representative of the dangerous trees in Reach 2. These trees posed a serious health and safety risk to workers implementing the restoration works on the Shruhangarve Stream. Therefore, to facilitate the approved Phase 1B works on the central portion of Reach 2 these trees were removed and the area made safe for accessing Stream Reach 2. The removal of these trees has also facilitated access to the upper portions of Stream Reach 2 and will allow safe access for the restoration of this reach.

Plate 2.1 View of damaged trees at Reach 2, facing downstream.

The removal of debris, fallen and unsafe trees from this reach has allowed a geomorphic survey of the stream reach to be conducted. The survey included the following:

- detailed cross sections of the channel at approximately 25 metre intervals
- long profile of channel thalweg and banks

A photograph of Reach 2 following the removal of the unsafe trees is provided below (Plate 2.2). Once the trees and debris were removed, it became apparent that much of the stream channel was relatively intact. Since all flow in the upper portion of Reach 2 had been bypassed by the pumps located at Wall 2, and in order to take advantage of an extended period of dry weather, blockages in the channel were removed using hand tools. The banks were seeded, and coir matting was installed along the stream banks.

Plate 2.2 View of Reach 2 (Upper) following removal of dangerous trees, facing upstream.

2.2.2 Reach 2 (Central)

The central portion of Reach 2 is approximately 90 metres in length. The original stream channel in this area was intact and largely free of obstructions. The levels of peat deposition on the top of the stream banks immediately adjacent to the stream in this section are generally light (0.1 to 0.2 m) and natural riparian vegetation is evident. However, there are several areas where large sections of brown, fibrous peat had been deposited in the riparian area.

Minimal works were required in this area. Heavy peat deposits were removed from the immediate stream side and the riparian zone was seeded with a native grass seed mix to reduce the potential for erosion. Large woody debris was removed by hand and any minor channel obstructions were also removed using hand tools. Coir fibre matting was utilised in limited areas to provide bank surface protection while vegetation becomes re-established.

2.2.3 Reach 2 (Lower)

The lower portion of Reach 2 was formerly inundated with water and peat sludge that was impounded upstream of Wall 1. This impoundment prevented the movement of additional material downstream. Action Plan Version 3.0 provided a methodology for the removal of the accumulated peat/sediment upstream of Wall 1. This sub-reach is approximately 130 metres in length.

Per the methodology set out in Action Plan Version 3.0 a number of peat drying cells were constructed adjacent to Wall 1. Tracked excavators were used to remove accumulated peat and place it in the drying cells to drain. The material was then moved to the authorised borrow pits for permanent storage. As the work progressed it became evident that in order to remove all the accumulated peat additional measures would be required. Slurry tankers were used to pump liquified peat from the impoundment and safely transport it to the peat cells in the borrow pits. This allowed a further lowering of the water upstream of Wall 1 and facilitated access for the excavators to remove further peat accumulations within the impoundment.

Plate 2.3 below is representative of the impounded area upstream of Wall 1 before the commencement of restoration works.

Plate 2.3 View of impounded area prior to commencement of sediment removal works, facing downstream

As the water level in the impoundment dropped the original course of the stream channel became apparent. The channel had been much degraded and was clogged with accumulated peat deposits. Plate 2.4 was taken during the sediment removal process. The course of the original stream channel is apparent in the foreground. The deposited peat was removed from the channel and the stream banks have been matted with coir fibre matting to reduce the risk of erosion. A total of approximately 93 metres of stream channel has now been re-established in the formerly impounded area.

Plate 2.4 View of impounded area during sediment removal works, facing downstream

Plate 2.5 View of impounded area following sediment removal works, taken from Wall 1, facing upstream

Plate 2.6 View of coir matting installed on re-established stream channel, facing upstream

All significant peat deposits have now been removed from the lower portion of Reach 2 down to the level of the native ground. The area has been seeded with a native grass seed mix to provide surface protection from erosion. An area approximately 30 metres long by 15 metres wide, immediately upstream of Wall 1 has been left to provide attenuation for high flows and to continue to act as a silt trap to prevent any sediment that might arise from upstream works from proceeding further downstream. This area will remain in this condition until all upstream works are completed. Plates 2.5 and 2.6 are representative of the current condition of this reach

Following the removal of the accumulated peat and sediments upstream of Wall 1 the two existing 600mm overflow pipes in Wall 1 were removed and replaced with a 900mm pipe with an invert elevation of 217.922m. The lowing of the pipe was required in order to protect the restored sections of Reach 2 from prolonged inundation during the winter season and to ensure that the progress made to date is not lost. The lowering of the pipe will prevent the area upstream of Wall 1 from becoming completely inundated during heavy rainfall. As discussed above, an area approximately 30 metres by 15 metres will be maintained for attenuation purposes until all upstream works are completed.

The lowering of the overflow pipe at Wall 1 occurred when there was no potential for release of sediment downstream of Wall 1. The work occurred during dry weather when there was a minimum of 300mm between the water surface and the invert of the new, lower pipe invert as set out in Action Plan Version 3.0. This ensured that there was no opportunity for sediment to enter the Shruhangarve stream below Wall 1. Water quality monitoring during the works period confirmed that there was no effect on downstream waters quality.

The pumps located at T9, along with the Wall 1 bypass pump will remain in-situ to provide additional attenuation as needed.

2.3 Stream Reach 3: Wall 1 to Coillte Forestry Boundary

This stream reach is approximately 225 metres in length. There was significant peat deposition throughout this reach as well as a number of debris blockages. Access to this reach was difficult due to the existing forestry and steep slopes adjacent to the stream. Coir fibre matting has been installed on both stream banks for approximately 100 metres downstream of Wall 1, the entire area has been seeded, and live stakes have been installed along both banks of the channel. Minor debris blockages were removed from the channel by hand. Vegetation recovery has been excellent in this reach. This reach should be monitored for stability, but no further measures are recommended at this time. Plate 2.7 is representative of current conditions in Reach 3.

Plate 2.7 View of current conditions in Stream Reach 3, facing downstream.

2.4 Stream Reach 4: Coillte Forestry Boundary to Shruhangarve Bridge

The levels of peat deposition on the top of the stream banks in Reach 4 are variable, ranging from very light (<0.1m) to moderate (0.4 m) in discrete pockets. The total area of peat deposition in Reach 4 is approximately 3.83 hectares. Areas of deeper peat deposits near the upper end of the reach were surrounded by silt fence and the immediate bank side area was cleared using shovels. All bare peat areas were seeded with a native grass seed mix per the recommendations in Action Plan Version 2.0. Minor stream obstructions were removed by hand.

In general, vegetation recovery has been excellent throughout the reach. Recovery of vegetation has been slower in areas where peat deposits were heaviest. These areas are protected by silt fence and there is evidence of vegetation recovery in these areas as the peat has dried out. A photograph of recovered riparian vegetation in Reach 4 is provided below.

Plate 2.8 Riparian vegetation recovering in lower portion of Reach 4, facing upstream

Plate 2.9 Riparian vegetation recovering in upper portion of Reach 4, facing downstream

2.5 Stream Reach 5: Shruhangarve Bridge to Mourne Beg River

Heavy peat deposits in localised areas along the banks of the Shruhangarve in Reach 5 were removed and the entire riparian area was seeded with native seed mix per the recommendations in Action Plan Version 2.0. Vegetation recovery has been excellent throughout this reach. A typical photograph of current site conditions in Reach 5 is provided below.

Figure 2.2 View of recovering riparian vegetation in Reach 5, facing downstream.

2.6 Slip Scar: Wall 3 to Shruhangarve Stream

The slip scar has been planted with live willow stakes and bare-root saplings of downy birch, alder, and Scott's pine per the recommendations in Action Plan Version 2.0. The entire area was also seeded with native grass seed.

To date the survival of the willow live stakes, downy birch bare roots, and alder bare-roots appears to be good. Scott's pine survival appears to be lower due to browsing by deer. Continued monitoring of this area will be required to determine if further remediation measures are required.

3. PROPOSED WORKS (PHASE 2)

3.1 Reach 1 Stream Restoration Proposals

Reach 1 has been heavily impacted by the peat slide. Mass movement and deposition of peat in this area has substantially damaged the original stream channel resulting in a loss of instream habitat in this area.

It is proposed to use natural channel design techniques to re-establish a stable stream channel in Reach 1. The restoration design process is focused on the development of a stream design that is appropriate in terms of channel cross-sectional dimension and profile, and that will therefore be stable in the long term. Based on the most recent survey of the reach it is proposed to largely maintain the current pattern of the channel. Significant changes to the channel pattern are not practical due to the constraints present within the reach. In addition, the design will incorporate elements to provide appropriate in-stream aquatic habitat. Stream banks and the riparian zone will be revegetated with native species with a view to enhancing bank stability in the new channel and reducing potential soil erosion in the riparian area.

3.1.1 Stream Design Parameters

A stream design was developed for Reach 1 based on the drainage area, the existing conditions of the stream in combination with data gathered from intact portions of the Shruhangarve Stream. Figures 3.1 and 3.2, below, show typical cross sections for riffle and pool sections of the proposed restored stream channel. The dimensions of the proposed channel are given in Table 3.1. For reference, the proposed channel cross section overlaid on cross section of the existing channel is provided in Figure 3.3.

The stream design was developed by Thomas Blackwell with MKO. Thomas has over 14 years of experience in the design and implementation of stream restoration projects and has worked on stream and river restoration projects of a variety of scales in multiple jurisdictions.

Table 3.1 Proposed Channel Dimensions in Metres.

Feature	Rosgen Stream Type	Width of Floodprone area	Bankfull Width	Mean Bankfull Depth	Width/Depth Ratio	Bankfull Area	Max Depth	Entrenchment Ratio
Riffle	B4	4	2	0.16	12.31	0.33	0.25	2.0
Pool	B4	–	4	–	–	1.2	0.5	–

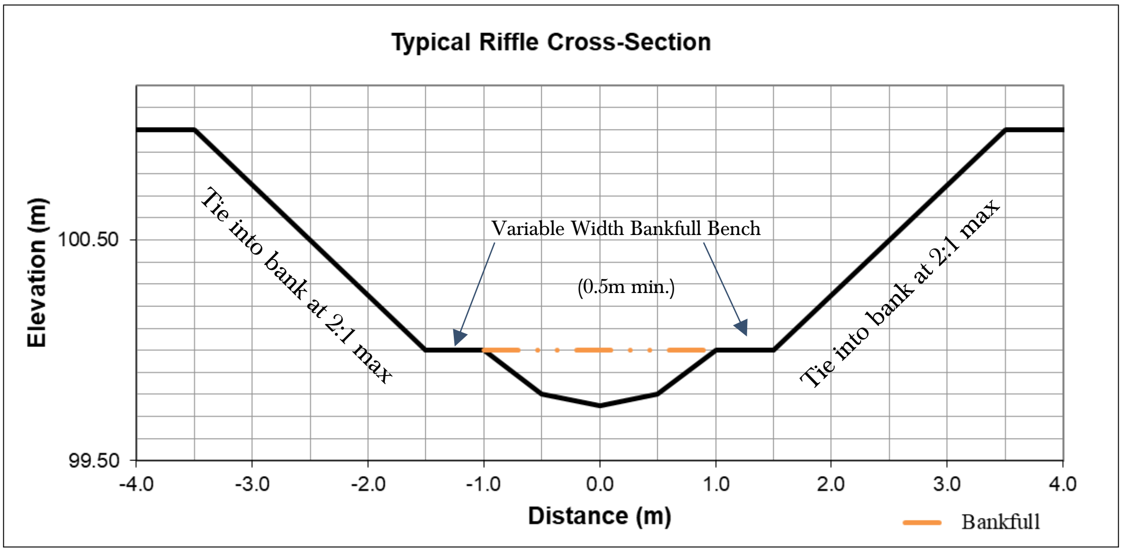


Figure 3.1 Proposed Typical Riffle Cross Section

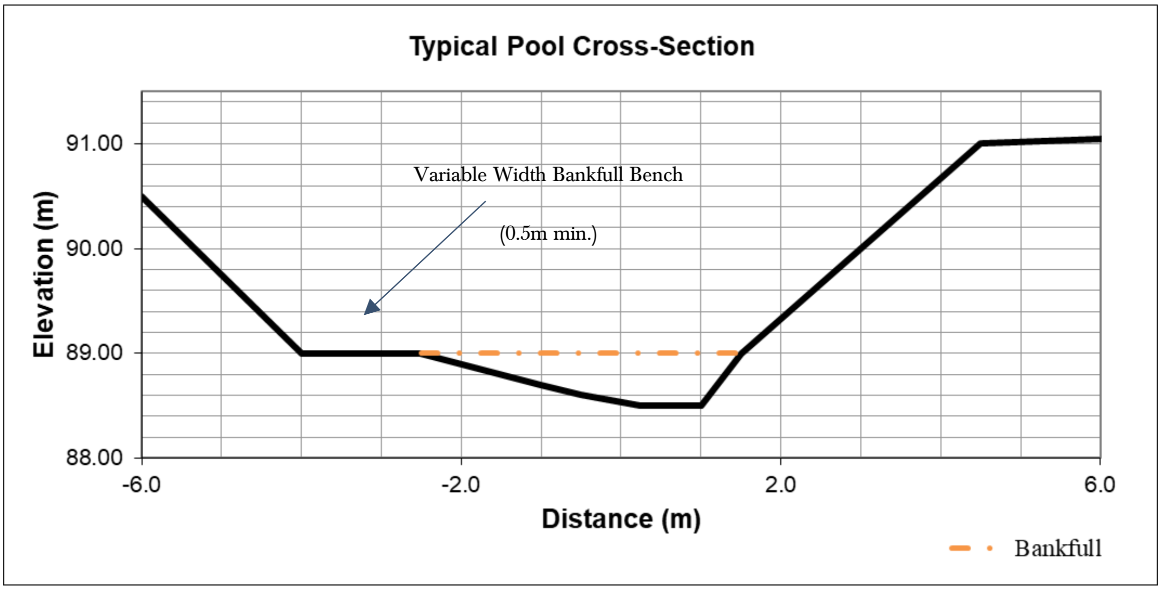


Figure 3.2 Proposed Typical Pool Cross Section

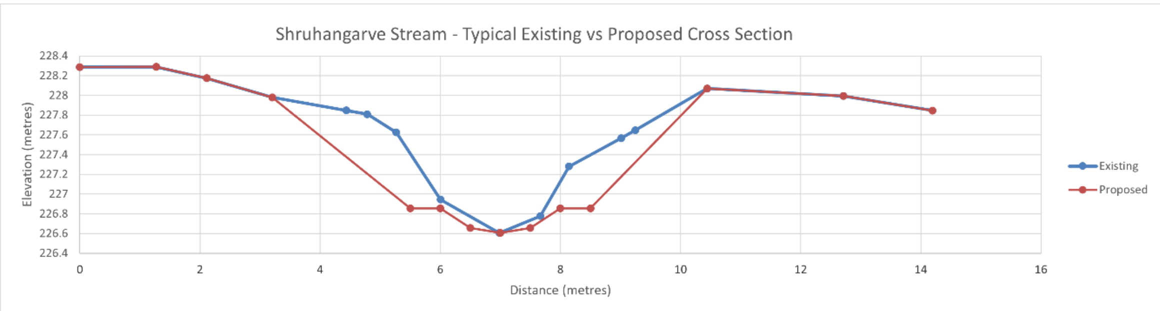


Figure 3.3 Example of Existing vs. Proposed Stream Cross Section

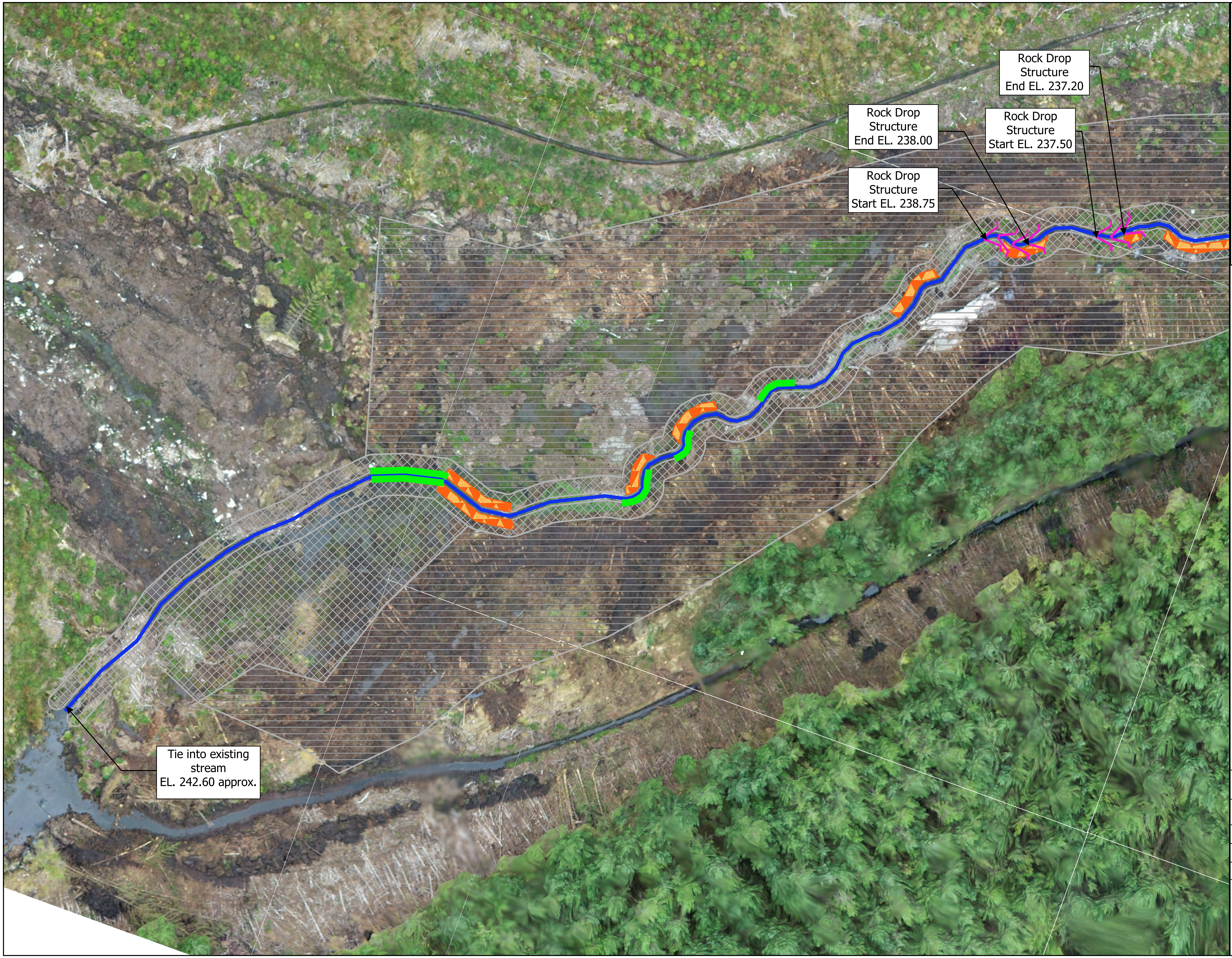
3.1.2 Proposed Restoration Approach

Site conditions along Stream Reach 1 are a limiting factor in the use of heavy machinery, and by extension to the restoration techniques that can be practically implemented. Given these limits, the restoration approach for Reach 1 is focused in the first instance on the enhancement of all relatively intact sections of stream channel within the reach. This will be achieved by the removal of minor blockages, recontouring banks as necessary, installation of coir fibre matting, and the use of bioengineering techniques such as live staking and the installation of live willow fascines in strategic locations.

Secondly, where the existing channel is poorly defined a new channel shall be constructed to the dimensions set out in Section 3.1.1. This will be achieved through a mixture of excavation and reconstruction of lost stream banks using vegetated geogrids. These techniques are discussed in detail below.

The third priority will be the installation of a limited number of grade control measures (cross vanes and rock drop structures). These will be installed in areas where the gradient of the channel is especially steep and are designed to ensure the vertical stability of the channel in the long term. These grade control measures are designed to replace the natural rock grade controls that likely existed in the channel prior to the peat slide. The entire reach will be heavily planted with native willows to promote stability through root development, and to provide shade to the channel in the longer term.

The locations of the various proposed measures are shown on Figures 3.4 to 3.8. Given the variability inherent in natural systems it is highly likely that field adjustments in the location and elevation of proposed structures and measures. The stream designer will have the flexibility to make changes in the field as conditions dictate within the overall intent of the proposed plan. Once the restoration of the stream channel has been completed flow will be restored to the new channel. Any residual sediment will be washed out of the channel and captured at Wall 2 and Wall 1 to protect downstream water quality.



Map Legend

- Reach 1 - Proposed Centreline

Instream Structures

- Rock Drop Structure
- Rock Step Pool
- Vegetated Geolift
- Live Fascine
- Constructed Riffle

Planting Zones

- Zone 1
- Zone 2

Drawing Title: Reach 1	
Project Title: Shruhangarve Restoration	
Drawn By: TB	Checked By: PR
Project No.: 201174	Drawing No.: Figure 3-4
Scale: 1:400	Date: 2021-09-27

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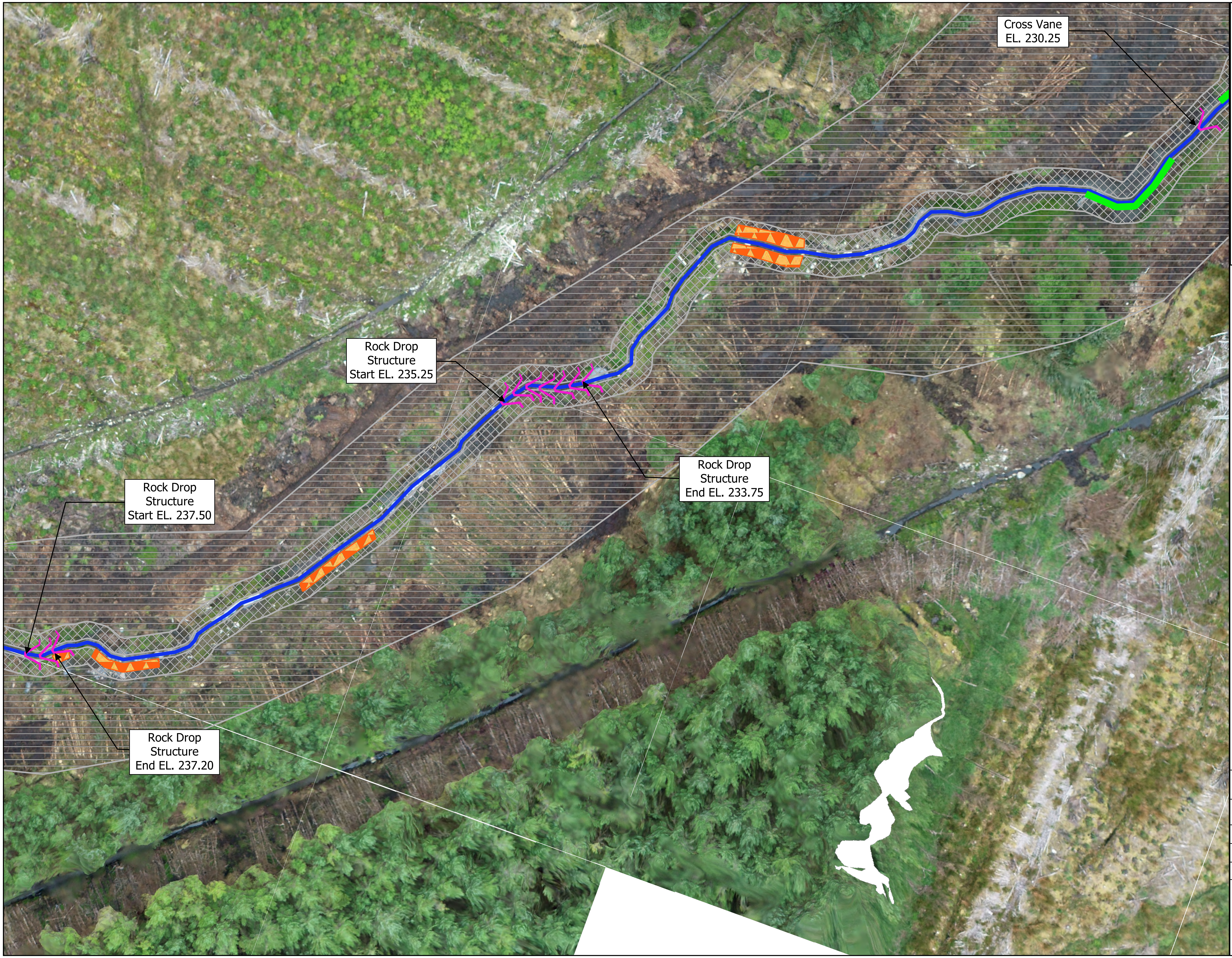

Map Legend

- Reach 1 - Proposed Centreline

Instream Structures

- Cross-Vane/Rock Drop Structure
- Rock Step Pool
- Vegetated Geolift
- Live Fascine
- Constructed Riffle

Planting Zones

- Zone 1
- Zone 2

Drawing Title: Reach 1	
Project Title: Shruhangarve Restoration	
Drawn By: TB	Checked By: PR
Project No.: 201174	Drawing No.: Figure 3-5
Scale: 1:400	Date: 2021-09-27

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Map Legend

- Reach 1 - Proposed Centreline

Instream Structures

- Cross-Vane
- Rock Step Pool
- Live Fascine
- Constructed Riffle

Planting Zones

- Zone 1
- Zone 2

N

Drawing Title	
Reach 1	
Project Title	
Shruhangarve Restoration	
Drawn By: TB	Checked By: PR
Project No.: 201174	Drawing No.: Figure 3-6
Scale: 1:400	Date: 2021-09-27

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Map Legend

Instream Structures

- Cross Vane
- Live Fascine
- Constructed Riffle

Planting Zones

- Zone 1
- Zone 2
- Reach 1 Proposed Centreline

Drawing Title

Reach 2 Upper

Project Title	
Shruhangarve Restoration	
Drawn By: TB	Checked By: PR
Project No.: 201174	Drawing No.: Figure 3-7
Scale: 1:400	Date: 2021-09-27

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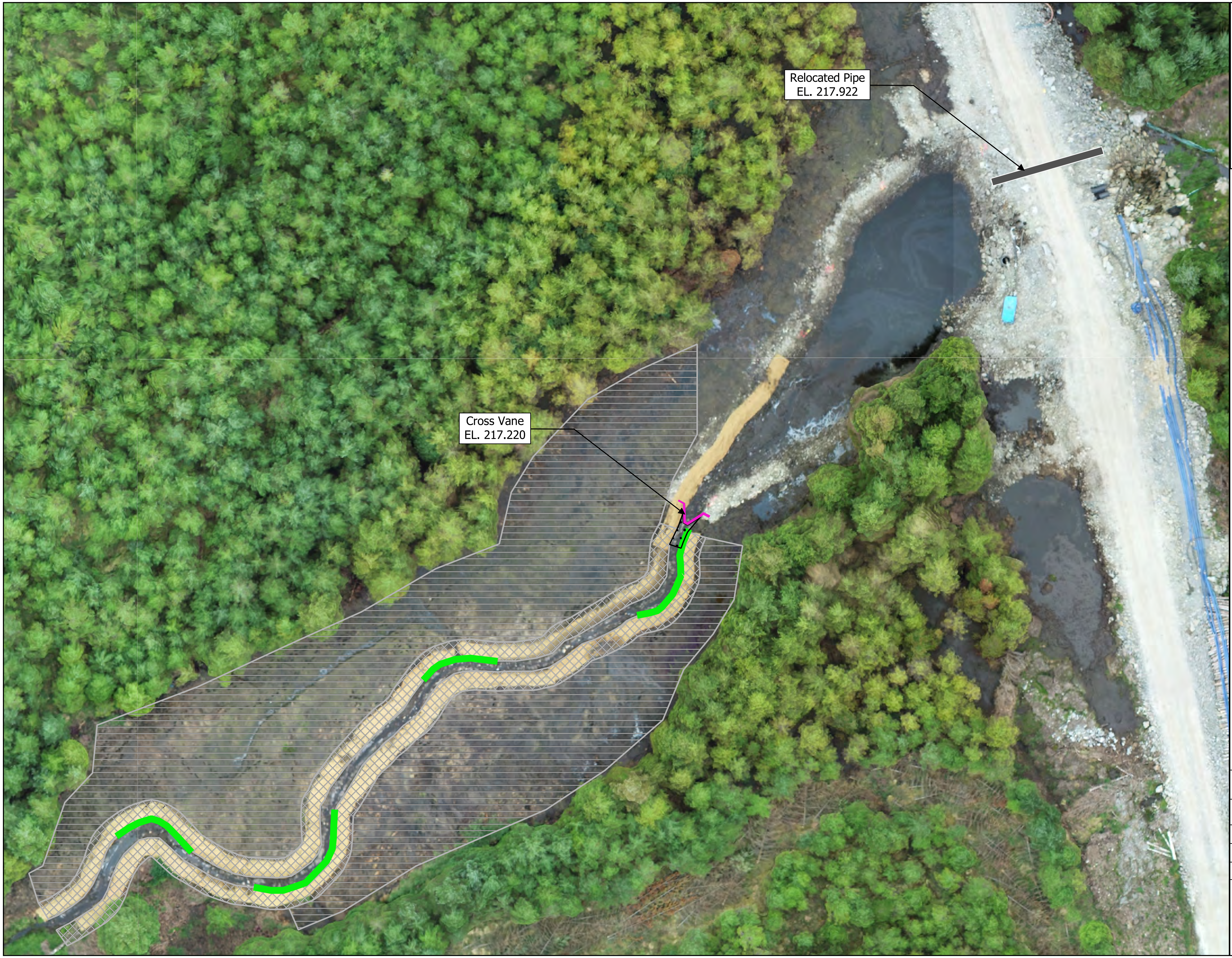

Map Legend

- Cross Vane
- Fascine
- Constructed Riffle

Planting Zones

- Zone 1
- Zone 2

Drawing Title	
Reach 2 Lower	
Project Title	
Shruhangarve Restoration	
Drawn By: TB	Checked By: PR
Project No.: 201174	Drawing No.: Figure 3-8
Scale: 1:350	Date: 2021-09-27

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Rock Step Pools

From Wall 2 upstream for approximately 140 metres the stream channel will be restored using a series of rock step pools (Figure 3.6). The existing rock berms on either side of this section of stream channel will remain in-situ as they provide protection against potential slumping of the adjacent peat material. The top of the berms will be lowered to match the grade of the adjacent ground, covered with a thin layer of soil, and seeded with native peatland grass seed. The rock step pools will provide a good mix of in-stream habitat (pools and cascades) and will help in providing oxygenation to the stream. Although the existing channel is not particularly steep in this section, the horizontal constraints limit the ability to re-establish natural sinuosity to the channel. Therefore, the channel design for this section was focused on energy dissipation and habitat creation through the creation of rock step pools.

Rock step pools will also be used as drop structures at three additional locations in Reach 1 where there is potential for vertical instability due to the slop of the channel. The locations of these drop structures are shown on Figures 3.4 and 3.5. Plate 3.1 provides an example of a constructed rock step pool structure.

Plate 3.1 Example of Rock Step Pool Structure

Vegetated Geogrid

There are a number of areas where the original stream bank on one or both sides of the channel has been washed away. In these areas the stream bank will be reconstructed using vegetated geogrids. The vegetated geogrid consists of live cuttings of willow placed between soil lifts wrapped with coir fibre matting. The matting provides short term surface protection from erosion, while the roots that will develop from the willow cuttings will provide long term stability. Plate 3.2 below shows an example of a vegetated geogrid under construction. The locations where vegetated geogrids are proposed are shown on Figures 3.4 and 3.5.

Plate 3.2 Example of Vegetated Geogrid

Cross Vanes

A cross vane is made up of a set of upstream angled lines of boulders, connected by a section of smaller rocks upstream. While water usually covers the lower section during normal flows, the higher sections deflect flow away from the banks of the stream. Flow is diverted over the rock walls and concentrated down the centre of the channel. The scouring associated with high flow velocities in the centre of the channel and the "waterfalling" over the structure itself creates a deep, elongated pool.

The purpose of the cross vane is to protect the banks downstream of the vane and to provide grade control to reduce the potential for headcutting in the channel. Cross vanes are proposed for two locations in Reach 1 (Figures 3.4 and 3.5).

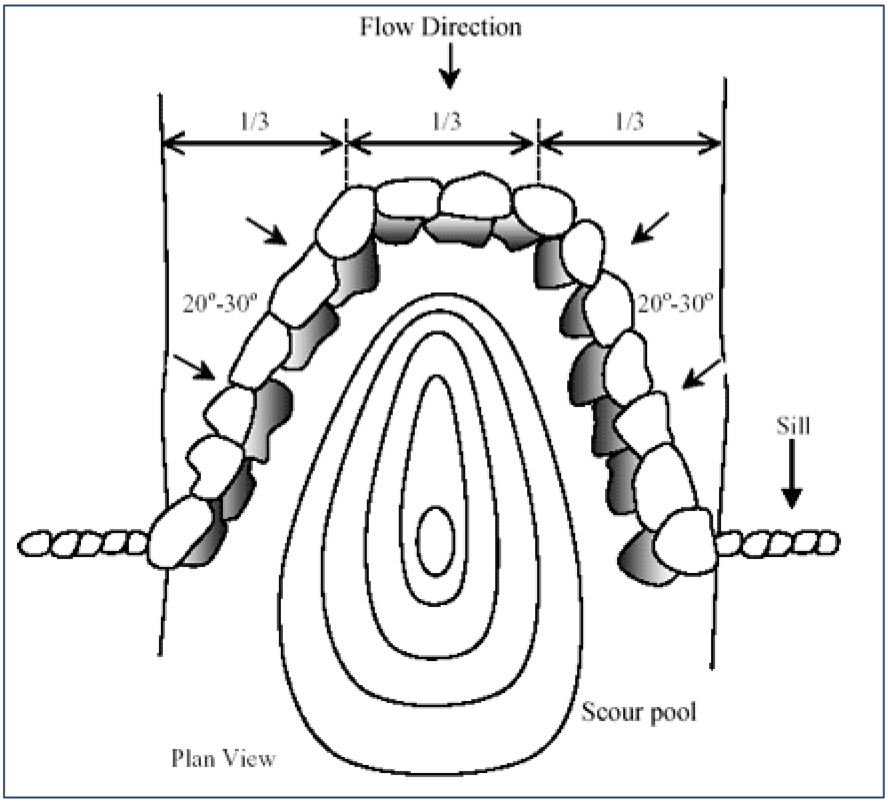

Figure 3.9 Typical plan view of cross vane.

Plate 3.3 Example of cross vane on a restored stream

The following methodology shall be used to install cross vanes:

1. *A boulder cross vane is a grade control, in-stream structure that directs stream flow away from the stream banks and in toward the centre of the channel.*
2. *Elevation control points shall be designated at the upstream invert (centre) of the Cross vane to establish part of the profile. Pool elevation control points or excavation to a specified maximum pool depth shall be designated to establish the remaining profile. Survey of control points shall be required to establish accurate cross vane installation within the tolerance specified by the designer.*
3. *The vane arm shall intercept the stream bank at a height equal to between ½ bankfull Stage and bankfull stage. Elevation control points may be established at the left and Right stream bank/vane arm intercept points. Bankfull is not necessarily the top of the stream bank slope.*
4. *The cross vane shall be constructed with flat-sided boulders of a size (750mm x 500mm x 500mm approx.)*
5. *Non-woven filter fabric shall be used to seal the gaps Between the boulders and under the coarse backfill material. There shall be no filter Fabric visible in the finished work; edges shall be folded, tucked, or trimmed as needed.*
6. *Coarse backfill of the boulder cross vane shall be of a type, size, and gradation as specified by the designer (804 stone). Coarse backfill shall be placed to a thickness equal to the Depth of the header and footer boulders and shall extend out from the vane arms to the Stream bank and upstream a distance specified by the designer.*
7. *The invert (centre) of the boulder cross vane shall be constructed first, followed by One vane arm and then the other vane arm. The floodplain sills shall be constructed Last.*
8. *Boulder cross vane shall be built typically as follows:*
    - *Over-excavate stream bed to a depth equal to the total thickness of the header and footer boulders.*
    - *Place footer boulders. There shall be no gaps between boulders.*
    - *Install filter fabric.*
    - *Place coarse backfill behind the footer boulders.*
    - *Install header boulders on top of and set slightly back from the footer boulders (such that part of the header boulder is resting on the coarse backfill). Header Boulders shall span the seams of the footer boulders. There shall be no gaps Between boulders. The slope of the vane arm is measured along the vane arm which Is installed at an angle to the stream bank and profile.*
    - *Place coarse backfill behind header boulders ensuring that any voids between the Boulders are filled.*
9. *If any erosion control matting is specified for use in the vicinity of the vane arm Intercept points and floodplain sills all matting edges shall be neatly secured around the boulders.*

Live Staking

Live willow cuttings (live stakes) shall be installed along both sides of the existing channel (Zone 1) within the slip scar area. The purpose of the live cuttings is to provide stability through the establishment of fast-growing native willows. The method for installation of live stakes, including spacing and quantities, is provided in Appendix 1.

Live Fascines

Approximately 51 metres of live willow fascines will be installed on the outside of meander bends. The purpose of the live willow fascine is to minimise the risk of scour and erosion at the stream bend. Once established the willow will create a dense root mat that will provide long term stability. The following methodology shall be used to install the live fascines.

- Fascines shall be installed in linear trenches at the toe of stream banks.
- Fascines shall be fabricated from live dormant cuttings of willow, at least 2 metres in length, and 1cm in diameter, tied together with biodegradable twine to form a bundle the same length as the cuttings. The bundles should be approximately 20cm in diameter.
- Fascines shall be installed parallel to the water surface.
- Fascine installation trench width shall be such that fascine fits snugly within. Fascine installation trench depth shall allow approximately one quarter of the fascine to protrude above the ground surface.
- Dead stout stakes shall be installed through the live fascines with one stake perpendicular to the slope of the bank and the other perpendicular to the channel bed. The top of the stakes should be flush with the installed bundle.
- Soil should be placed along the side of, over, and pressed into the fascine in the trench to create contact between dormant woody cuttings and soil to promote growth.

Plate 3.4 shows an example of a live willow fascine installed on a stream bank.

Plate 3.4 Live willow fascine installed at toe of bank.

Coir Fibre Matting

Coir fibre matting shall be installed in a single row on both sides of the stream in Reach 1. The installation of the coir fibre matting shall be accomplished by hand using the following methodology.

- Coir fibre matting shall be at least 700 grams/m2 weight.
- Matting shall be anchored in a trench at top of the stream bank. Stout stakes (38mm x 38mm minimum) shall be used to secure the matting into the toe and top of bank trench.
- The stream bank shall be prepared by smoothing with shovels to remove large clumps of deposited peat, seeded, and mulched with straw prior to the placement of the matting.
- The matting shall be installed so as to not be in tension, but be placed neatly, flush against the soil, and with no gaps or wrinkles.
- Matting overlaps shall be 0.6m in width, and overlaps shall be oriented in a down-slope direction, downstream direction, or otherwise "shingle-style" in accordance with the direction of the dominant erosive action so that the matting end is protected against movement.
- The field of the matting over the surface of the stream bank shall be secured with hardwood matting stakes of at least 0.3 cm in length. Matting stakes shall be installed in a triangular grid pattern at 0.6m OC.
- Matting shall be neatly secured around any projecting stream structures or rocks to prevent any loose or frayed edges.
- There shall be no loose ends or unsecured matting on the completed work.
- No matting will be placed on the bed of the channel.

3.2 Stream Reach 2

3.2.1 Reach 2 Lower Restoration Proposals

The lower portion of Reach 2 has been cleared of accumulated peat and the stream channel has been re-established through all but the final approximately 40 metres of the reach. As discussed in Section 2.2.3, this final 40 metres will remain as a silt trap and attenuation basin until such time as all upstream works have been completed. At that time the channel will be restored, wall 1 removed, and a new culvert installed to connect Reach 2 and Reach 3. Specific plans for this final stage of works will be provided in a future version of this Action Plan.

The following measures are currently proposed for Reach 2 Lower:

- Install live stakes (*Salix* sp.) on both banks of the re-established stream channel
- Install approximately 42 metres of live willow fascines on outside of meander bends. The purpose of the live willow fascine is to minimise the risk of scour and erosion at the stream bend. Once established the willow will create a dense root mat that will provide long term stability. See section 3.2.2 for further details on the use of live fascines.
- Plant remaining denuded area with mix of native woody species.
- Install a single grade control structure at the downstream end of the re-established stream channel. This grade control structure is designed to minimise the risk of head-cutting in the channel and will also form the starting point for the final stage of the restoration (reconnection of Reach 2 and Reach 3)

Figure3.8 provides an overview of the proposed restoration measures in the lower portion of Stream Reach 2. Proposed planting details are provided in Appendix 1. Once the restoration of the stream channel has been completed to the satisfaction of the stream designer flow will be restored to the new channel. Any residual sediment will be washed out of the channel and captured at Wall 1 to protect downstream water quality. All pumps will remain in-situ at T9 and Wall 1 until such time as it is deemed appropriate to remove them by the project hydrologist.

3.2.2 Reach 2 Upper Restoration Proposals

As discussed in Section 2.2.1, the upper portion of Reach 2 has been cleared of damaged and dangerous trees, minor channel blockages were removed to re-establish a continuous channel, and the stream banks have been matted with coir fibre matting. The riparian area has also been seeded with a native peatland grass seed mix.

In order to complete the restoration of Reach 2 the following measures are currently proposed for Reach 2 Upper:

- Install live stakes (*Salix* sp.) on both banks of the re-established stream channel
- Install approximately 53 metres of live willow fascines on outside of meander bends
- Plant remaining denuded area with mix of native woody species.
- Install a single grade control structure at the upstream end of the re-established stream channel. This grade control structure is designed to minimise the risk of head-cutting in the channel and will also serve as the link point between Reach 2 and the restoration of Reach 1.

Figure3.7 provides an overview of the proposed restoration measures in the lower portion of Stream Reach 2. Proposed seeding and planting details are provided in Appendix 1. Once the restoration of the stream channel has been completed to the satisfaction of the stream designer flow will be restored to the channel. Any residual sediment will be washed out of the channel and captured at Wall 1 to protect downstream water quality. All pumps will remain in-situ at T9 and Wall 1 until such time as it is deemed appropriate to remove them by the project hydrologist.

APPENDIX 1

PLANTING METHODOLOGY

PLANTING AND SEEDING METHODOLOGY – REACH 1 AND 2

This appendix provides the methodology for seeding and planting associated with the restoration of Stream Reaches 1 and 2. Planting zones are indicated on Figures 3.4 to 3.8 of the main report.

Seeding

The entire planting area (Zones 1 and 2) will be seeded with peatland grass seed mix. Seeding will be accomplished manually with a handheld broadcast seeder. The proposed seed mix and seeding rates are provided in Table 5.1. Substitutions may be made to the proposed seed mix depending on availability. Suitability of substituted species must be confirmed and approved by the project ecology and environmental consultant.

Table 3.2 Proposed Seeding Rates

Species	Percentage of Mix	Seed Quantity per Ha (Kg)	Zones 1 & 2 Total Seeding Area (HA)	Total Kg of Seed
Yorkshire fog	30%	11.25	1.1	12.5
Highland Bent	30%	11.25	1.1	12.5
Red fescue	40%	15.0	1.1	16.5
Totals	100%	37.5	1.1	41.5

Live staking

Live willow cuttings (live stakes) shall be installed through the coir fibre matting along both sides of the stream channel following the installation of coir fibre matting (Zone 1). Details of the required spacing and number required are provided in Table 5.4 below. The purpose of the live cuttings is to provide bank stability through the establishment of fast-growing native willows. The live stakes will be installed using the following methodology

- Cuttings shall be between 60cm and 90cm in length, and between 2cm and 8cm in diameter. They will be cut in the dormant season, i.e., between Nov and Mar. Cuttings will have an angled cut at the bottom end of the stake and a flat cut at the top of the stake to aid with installation.
- Cuttings shall be installed in a two-row triangular grid pattern at 75cm on centre (o.c.). The first row shall be located on the side of the existing channel with the second row being located on the flat adjacent to the channel.
- Cuttings shall be fashioned from live, dormant native willow species (*Salix cinerea, Salix caprea* and *Salix aurita*).
- Cuttings shall be sourced locally on-site (or within 20km max of the establishment site if necessary)
- The following methodology will be implemented for the handling, preparation, and installation of cuttings to ensure the highest possible survival rate:
    - Cuttings shall be cut and installed on the same day where possible.

- If same-day installation is not possible, cuttings shall be stored for no more than 1 week with the bottom end of each stake fully submerged in water to prevent drying out of the material.
- All lateral branches shall be carefully removed from the woody cuttings prior to installation.
- Cuttings shall be driven into the ground using a "dead blow" plastic hammer.
- Peat shall be firmly packed around the hole after installation, where required.
- Cuttings shall be tamped in at a right angle to the ground with between 70%-80% of the stake installed below the ground surface.
- Between 20%-30% and two buds (or pruned, lateral branch locations) on the cutting shall be above the ground surface
- Split or otherwise damaged cuttings shall not be used.

Table 3.3 Proposed Live Stake Numbers and Spacing

Species	Size	Number of plants	Spacing (metres o.c.)
Willow (*Salix* spp.)	Live Stake	3,950	0.75

Figure 3.10 Example of live cutting along drain in planting trial on deep peat.

Planting with bare root plants

Zone 2 will be planted with bare root saplings at a density of approximately 800 stems per acre. A mix of the following species is proposed for planting:

- Downy Birch (*Betula pubescens*)
- Scot's pine (*Pinus sylvestris*)
- Alder (*Alnus glutinosa*)

Planting will be carried out manually. The main forms of planting rooted material are set out as below. A combination of all the planting methods described below, or other appropriate methods, may be used on the site as conditions dictate. All planting should be to root collar depth or slightly deeper, and trees should be firm and upright with their roots hanging vertically and well spread out.

Areas selected for planting of bare root saplings shall be planted at a density of 800 stems per hectare. Trees will be planted in single species groups or mixed where appropriate, i.e., alder and birch).

Slit Planting

The spade is used to make a vertical slit in the ground. The tree roots are carefully positioned into the slit by hand to ensure that roots are equally spaced in the vertical slit created. The slit is closed by foot and firmed up, ensuring the tree is vertical and upright. It is important to ensure that roots are not bent over, as this can lead to poor development, e.g., J-shaped root. This form of planting can be suitable for ribbons, mounds, and ripped ground.

Angle Notch Planting: L notch or T notch

A double slot is made using a suitable planting spade. The slots can either be "L" or "T" shaped and should be approx. 15cm deep as illustrated in Figure 5.5 below. The purpose of the double slot is to lift up the peat and create space to allow the roots to be distributed evenly. Once the tree has been positioned in the slot and the roots have been pushed in fully by hand, then slightly pull up the plant to allow the roots to hang down and to ensure correct planting depth. Then the spade is removed, and the soil is firmed with the ball of the foot. The angle notch planting methodology is illustrated in Figure 5.6, below.

Planting Schedule

Zone 2 will be planted according to the schedule provided in the table below. Other suitable native species may be substituted at the discretion of the project ecologist.

Table 3.4 Proposed Plant Numbers

Species	Size	Number of plants - Zone 1	Number of plants - Zone 2	Total	Spacing (metres o.c.)
Downy birch (*Betula pubescens*)	Bare Root	0	360	300	3.5
Alder (*Alnus glutionosa*)	Bare Root	0	360	300	3.5

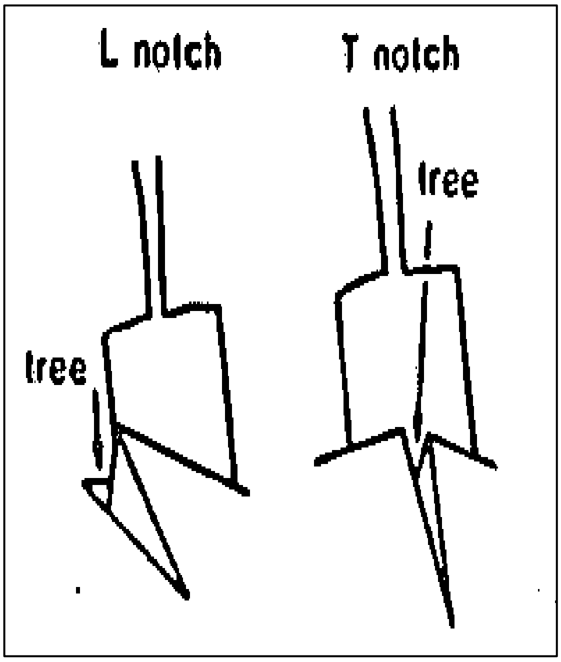

Figure 3.11 L" and "T" Planting Notches

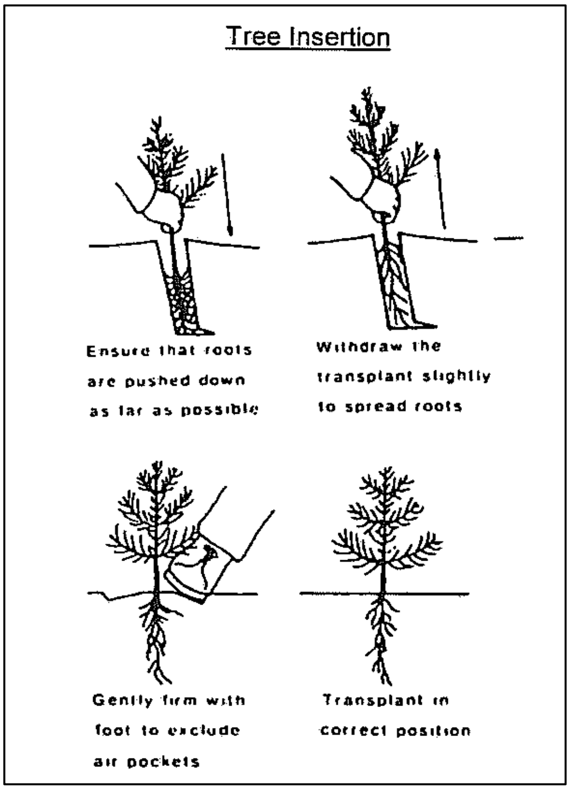

Figure 3.12 Angle Notch Planting Steps

APPENDIX G

DCC CORRESPONDENCE

(25TH JANUARY 2024)

From: JOE FERRY (LAB) <JOE.FERRY@donegalcoco.ie>
Sent: Thursday, January 25, 2024 9:35 AM
To: Thomas Blackwell <tblackwell@mkoireland.ie>
Cc: MICHAEL McGARVEY <mmcgarvey@donegalcoco.ie>; SEAMUS HOPKINS <SHOPKINS@Donegalcoco.ie>; Malena Sara Thren <msthren@mkoireland.ie>
Subject: RE: 220623 Scoping Letter Alterations to Meenbog Windfarm

Some people who received this message don't often get email from joe.ferry@donegalcoco.ie. Learn why this is important

Caution: This is an external email and may be malicious. Please take care when clicking links or opening attachments.

Thomas,
You may recall that we met at Meenbog during the immediate aftermath of the peat slide and during the remedial works subsequently. Bryan Cannon, Senior Engineer, was actively involved also but he has since moved to the Roads Directorate as Director and has been replaced by Seamus Hopkins (cc'd) as Senior Engineer. Any future correspondence for the Water & Environment directorate should be sent to us. I have read through your letter, which I note has been copied to various other sections of Donegal County Council, including Planning, and I am satisfied with the approach taken.

I visited the site on the 31st August last year, with colleagues Patrick Gallagher from Environment and Martin McDermott from Planning, in the company of Chris O'Mahoney, and we were satisfied with the outcome of the remedial and restoration works completed. I think the main scar area will require a bit more time to fully establish complete vegetative cover, ie native grasses & heather, along with the deciduous trees planted already, which should afford good protection in time to the Sruhangarve stream down gradient of the area. There was no evidence during that visit of any sediment loss from that area or ingress to the stream. The other areas downstream of the site and immediately upstream of the confluence with the Mournebeg river have recovered exceptionally well, at least from a visual perspective. I think overall both MKO and Planree have managed the aftermath of this unfortunate incident in a very professional manner and appear to have achieved the best possible environmental outcomes in the circumstances.

Kind regards

Joe Ferry, (Dr),
A/Senior Executive Scientist
Donegal Co. Council
Public Services Centre
Letterkenny
Co. Donegal

F92TNY3
074-9153900

From: SUZANNE BOGAN (TINNEY) LAB LETTERKENNY <SBOGAN@DONEGALCOCO.IE>
Sent: 24 January 2024 16:18
To: SEAMUS HOPKINS <SHOPKINS@Donegalcoco.ie>; JOE FERRY (LAB) <JOE.FERRY@donegalcoco.ie>
Cc: MICHAEL McGARVEY <mmcgarvey@donegalcoco.ie>
Subject: FW: 220623 Scoping Letter Alterations to Meenbog Windfarm

Hi all,

Please see attached and below email I received regarding Meenbog Windfarm.

Kind Regards,

Suzanne

From: Malena Sara Thren <msthren@mkoireland.ie>
Sent: 19 January 2024 17:11
To: SUZANNE BOGAN (TINNEY) LAB LETTERKENNY <SBOGAN@DONEGALCOCO.IE>; DCCINFO <info@Donegalcoco.ie>
Cc: Thomas Blackwell <tblackwell@mkoireland.ie>
Subject: 220623 Scoping Letter Alterations to Meenbog Windfarm

Dear Sir or Madam,
Please find attached the scoping letter regarding a Substitute Consent Application for Alterations to Meenbog Windfarm, Co. Donegal.
As part of the scoping exercise, we would welcome any comments in relation to the Subject Development.
If you have any queries, please do not hesitate to contact me.

Kind regards,
Malena

Malena Sara Thren
Graduate Environmental Scientist

MKO
Tuam Road, Galway, H91 VW84

Offices in Galway and Dublin
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APPENDIX H

BORROW PIT AND PEAT CELL RESTORATION AND REMEDIATION PLAN

Borrow Pit and Peat Cell Restoration and Remediation Plan

Meenbog Wind Farm

DOCUMENT DETAILS

Client: **Planree Ltd**

Project Title: **Meenbog Wind Farm**

Project Number: **201174**

Document Title: **Borrow Pit and Peat Cell Restoration and Remediation Plan**

Document File Name: **2021.02.25 - BP-PC R&R Plan F - 201174**

Prepared By:
MKO
Tuam Road
Galway
Ireland
H91 VW84

Planning and Environmental Consultants

Rev	Status	Date	Author(s)	Approved By
01	Draft	22/02/2021	TB,	BK
02	Final	25/02/2021	TB	BK

Table of Contents

1. INTRODUCTION

This Restoration and Remediation Plan has been prepared by McCarthy Keville O'Sullivan Ltd. (MKO) on behalf of Planree Ltd, to accompany a response to Donegal County Councils letter issued under S.152 of the Planning and Development Act, as amended on the 15th January 2021. The purpose of this plan is to provide a framework for the restoration and remediation of the borrow pits and peat storage cells located on the Meenbog Wind Farm site. Implementation of the plan will ensure the long-term sustainability of these features and minimise any potential for environmental effects associated with them.

There are 3 no. borrow pits and 4 no. peat storage areas located on the Meenbog Windfarm Site. These areas are located as described below.

Borrow Pits:

- Borrow pit located southwest of T12: An existing forestry borrow pit was expanded to win stone on site.
- Borrow pit No. 2 is located approximately 140 metres south of Turbine No. 15
- Borrow pit No. 3 is located approximately 170 metres east of Turbine No. 13

Pet Storage Areas:

- Peat Cells south of Substation
- Peat Cells at T15
- Peat Cell at T17
- Peat Cell at T18

The borrow pits have been used to win stone for the construction of the wind farm infrastructure, including roads, hardstands, turbine bases, and substation. During the construction of the wind farm a significant quantity of peat and spoil has been generated. In order to safely store this material, peat cells have been constructed in the borrow pits once rock extraction has been completed. Additional peat storage cells were also constructed at the locations described above. These locations were selected by the site geotechnical engineer as being suitable for the storage of peat, and make use of existing topographical features to the greatest extent possible.

This peat cell and borrow pit rehabilitation plan sets out the proposed methodology for rehabilitating the borrow pits and peat storage cells at the Meenbog Wind Farm site.

2. METHODOLOGY

Upon removal of the rock from the borrow pits, the pits will be restored using excavated peat and spoil within cells located inside the borrow pit. Cells have been created within the borrow pits for the placement of the excavated peat & spoil. This is to allow for the safe placement and grading of the peat and spoil using dumper trucks and excavators. Similarly, peat cells constructed outside of borrow pits will also be restored by filling with excavated peat and spoil in accordance with the proposals originally set out in the Environmental Impact Assessment Report (EIAR) for the project, now further expanded upon below.

In order to successfully rehabilitate the borrow pits and peat cells the following criteria shall be achieved:

- Removal of all plant machinery.
- Removal of waste material.
- Exposed sections of the rock slopes will be left with irregular faces and declivities to promote re-vegetation and provide a naturalistic appearance.
- Stabilisation of any unstable areas such as cliffs and steep slopes by re-profiling.
- Naturalisation of the site by grading the filled peat cells to approximate the natural topography of the area.
- Enhancement of natural colonisation of vegetation by, wherever possible, placing the acrotelm of excavated peat with the vegetation part of the sod facing the right way up to encourage growth of plants and vegetation at the surface of the re-instated borrow pits.
- Where acrotelm is not available, the finished peat surface will be seeded with a peatland seed mix to promote rapid revegetation. Proposed seed mix is provided in Table 2.1 below. Seeding will occur between April and September.
- Peat storage cells and borrow pits will be filled maximum extent practicable so as to match as closely as possible the level of the surrounding topography. It is acknowledged that it is not possible to exactly match the surrounding topography
- Once the borrow pits and peat cells have been filled the surrounding ground shall be reprofiled to blend in with the filled areas. This will result in a more natural appearance for the peat cells and borrow pits.
- Livestock-proof, post and wire fencing will be installed around all borrow pits and peat cells.
- Safety signage warning of the presence of deep peat will be installed.
- Overflow drainage systems will be installed.

Following an initial application of native seed it is expected that the rehabilitated areas will be allowed to develop naturally in the short-medium term as an area of biodiversity value developing semi-natural habitats.

Table 2.1 Peatland Seed Mix

Species	Percent of Mix
Hard fescue	40%
Yorkshire fog	30%
Highland bent	30%

One, of the most sustainable management options for re-vegetation of the restored borrow pits and filled peat cells is to promote natural re-colonisation of the areas. This means that species present in the surrounding landscape that are already adapted to the various environmental conditions of the site will colonise. Promotion of natural colonisation also increases structural diversity, adding to the biodiversity of the site. Finally, as the main after-use option has been identified as creating semi-natural habitats for biodiversity, then the best option to create these habitats is through natural succession via pioneer habitat development.

Plate 2.1 below shows the borrow pit southwest of T12. This borrow pit has been partially restored with peat. Plate 2.2 shows a peat cell at the same borrow pit that has been filled with peat. The peat surface of the completed peat cells will be allowed to revegetate naturally. Typical cross sections of borrow pits and peat cells are included as Figures 2.1 and 2.2 respectively.

Plate 2.1 Partially restored borrow pit southwest of T12

Plate 2.2 Completed peat cell at borrow pit southwest of T12

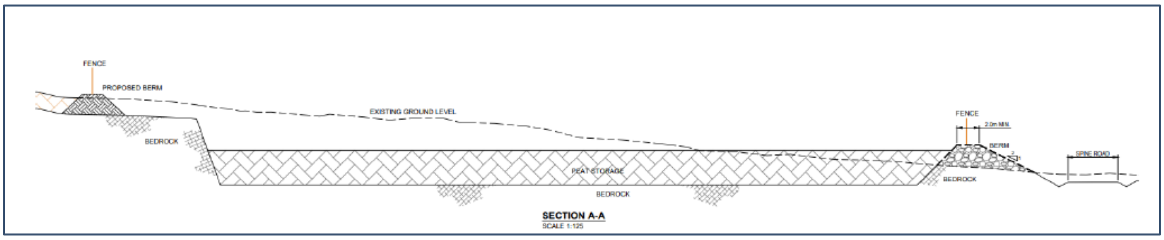

Figure 2.1 Typical borrow pit cross section

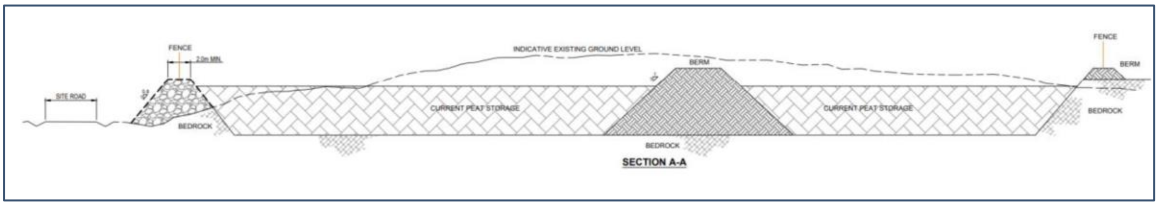

Figure 2.2 Typical peat cell cross section.

3. REHABILITATION PROGRAMME

The rehabilitation programme is divided into a series of initial short-term (Year 1) and medium term (Years 2-5) measures, as outlined below.

Following the initial short-term measures, there will be annual assessments of the site by an ecologist or environmental scientist to determine the progress of the rehabilitation work and requirements for further enhancement measures, until such time as a stable, rehabilitated habitat composition has been established in the restoration areas. It is not expected that there will be any requirement for after-care and maintenance other than ecological monitoring. Annual assessment will continue until the project ecologist is satisfied that the rehabilitated areas are stable and have become adequately naturalised.

3.1 Short-term (Year 1)

- Peat Cells at substation, T15, T17, and T18 to be filled to maximum capacity and seeded to promote revegetation.
- Borrow Pit southwest of T12 to be filled to maximum capacity and graded to approximate the pre-construction topography of the area. Exposed rock wall to the rear of the borrow pit will be left in-situ. Peat surface will be seeded to promote revegetation.
- Borrow Pits 2 and 3 shall be filled to maximum capacity and graded to approximate the pre-construction topography of the area.
- Peat surface in all completed peat cells will be seeded to promote revegetation.
- Post and wire fence to be provided to perimeter of all peat storage cells and borrow pits.
- Warning signs to be erected at suitable locations advising of deep peat.
- During the initial stabilisation period, drainage from borrow pits and peat storage cells will be monitored by the on-site Environmental Clerk of Works (ECoW) on a monthly basis.

3.2 Medium-term (Years 2-5)

- Natural re-colonisation of the rehabilitated areas will be monitored. If natural colonisation is not progressing satisfactorily, then consideration will be given to targeted management such as fertiliser treatment and supplemental seeding to speed up natural re-colonisation.
- There will be annual assessments of the site by an ecologist or environmental scientist to determine the progress of the rehabilitation work and requirements for further enhancement measures, until such time as a stable, rehabilitated habitat composition has been established in the restoration areas. When the habitat has been sufficiently restored and stabilised to the satisfaction of the ecologist, further annual assessments or monitoring will be suspended thereafter.

4. CONCLUSIONS

Rehabilitation of the borrow pits and peat storage cells at Meenbog Wind Farm will stabilise and naturalise the site and enhance its ecological potential. The ecological value of the borrow pits and peat storage cells will be enhanced by the natural revegetation of the peat surfaces which will over time result in a more ecologically diverse vegetative community than the commercial conifer plantation that was present at these sites prior to construction.

APPENDIX I

ASSESSMENT OF IMPACTS ON MERLIN AND HEN HARRIER ARISING FROM PEAT SLIDE

Planning and Environmental Consultants

Assessment of Impacts on Merlin and Hen Harrier arising from November 2020 Peat Slide

Meenbog Wind Farm, Co. Donegal

DOCUMENT DETAILS

Client:	**Planree Ltd.**
Project Title:	**201174 Meenbog Wind Farm**
Project Number:	**201174**
Document Title:	**Assessment of Impacts on Merlin and Hen Harrier arising from November 2020 Peat Slide**
Document File Name:	**AoI F 2021.01.22**
Prepared By:	**MKO** **Tuam Road** **Galway** **Ireland** **H91 VW84**

Planning and Environmental Consultants

Rev	Status	Date	Author(s)	Approved By
01	Draft	15/01/2021	PC/PM	

Table of Contents

1. INTRODUCTION

Following a peat slide at the site of the Meenbog Wind Farm in November 2020, the operator of the wind farm was directed by the Environmental Protection Agency (EPA) to evaluate whether or not environmental damage, as defined in the European Communities (Environmental Liability) Regulations 2008, has occurred. The Direction required an assessment is made of habitats and species that are among the Qualifying Interests of the River Finn SAC. In addition, the provisions of the Environmental Liability Regulations require an assessment of any habitats or species that are listed on the Annex I, II or IV of the EU Habitats Directive (92/43/EEC) and Annex I of the EU Birds Directives (2009/127EC) and had the potential to have been affected by the peat slide.

The species hen harrier (*Circus cyaneus*) and Merlin (*Falco columbarius*) are known from the area surrounding the peat slide and are listed on Annex I of the EU Birds Directive. This report assesses the potential significant effects that the peat slide may have on hen harrier and merlin. Firstly, a brief description of the evaluation criteria and assessment methods is provided. This is followed by a description of the survey methodologies that were followed and the survey results are reported. This is followed by a thorough assessment of the potential effects of the peat slide on hen harrier and merlin.

2. ORNITHOLOGICAL EVALUATION CRITERIA AND IMPACT ASSESSMENT METHODS

2.1 Geographical Framing

This assessment utilises the geographical framework described in *Guidelines for Assessment of Ecological Impact of National Road Schemes* (NRA 2009). The guidelines provide a basis for determination of whether any particular site is of importance on the following scales:

- International
- National
- County
- Local Importance (Higher Value)
- Local Importance (Lower Value)

2.2 Receptor Evaluation and Impact Assessment (Percival 2003)

Percival's (2003) methodology for assessing the effects of wind farms on birds has been applied to assess the sensitivity of a species to the development type, the magnitude of the effect and the significance of the potential impact. The following tables (Table 2-1 - Sensitivity, Table 2-2 – Magnitude of effect, Table 2-3 – Determination of significance) outline the assessment criteria for each stage.

Table 2-1 Determination of Magnitude of Effects (Percival 2003)

Sensitivity	Determining Factor
Very High	Species that form the cited interest of SPA's and other statutorily protected nature conservation areas. Cited means mentioned in the citation text for the site as a species for which the site is designated.

Sensitivity	Determining Factor
High	Species that contribute to the integrity of an SPA but which are not cited as species for which the site is designated. Ecologically sensitive species including the following: divers, common scoter, hen harrier, golden eagle, red necked phalarope, roseate tern and chough. Species present in nationally important numbers (>1% Irish population)
Medium	Species on Annex 1 of the EU Birds Directive. Species present in regionally important numbers (>1% regional (county) population). Other species on BirdWatch Ireland's red list of Birds of Conservation Concern
Low	Any other species of conservation interest, including species on BirdWatch Ireland's amber list of Birds of Conservation Concern not covered above.

Table 2-2 Determination of Magnitude of Effects (Percival 2003)

Sensitivity	Description
Very High	Total loss or very major alteration to key elements/ features of the baseline conditions such that the post development character/ composition/ attributes will be fundamentally changed and may be lost from the site altogether. Guide: < 20% of population / habitat remains
High	Major loss or major alteration to key elements/ features of the baseline (pre-development) conditions such that post development character/ composition/ attributes will be fundamentally changed. Guide: 20-80% of population/ habitat lost
Medium	Loss or alteration to one or more key elements/features of the baseline conditions such that post development character/composition/attributes of baseline will be partially changed. Guide: 5-20% of population/ habitat lost
Low	Minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible but underlying character/composition/attributes of baseline condition will be similar to pre-development circumstances/patterns. Guide: 1-5% of population/ habitat lost
Negligible	Very slight change from baseline condition. Change barely distinguishable, approximating to the "no change" situation. Guide: < 1% population/ habitat lost

Table 2-3 Significance matrix: combining magnitude and sensitivity to assess significance (Percival 2003)

Significance		Sensitivity			
		Very High	High	Medium	Low
Magnitude	Very High	Very High	Very High	High	Medium
	High	Very High	Very High	Medium	Low
	Medium	Very High	High	Low	Very Low
	Low	Medium	Low	Low	Very Low
	Negligible	Low	Very Low	Very Low	Very Low

2.3 Impact Assessment – EPA Criteria (2017 Draft)

The following terms were utilised when quantifying duration and frequency of effects:

- Momentary – effects lasting from seconds to minutes
- Brief – effects lasting less than a day
- Temporary – effects lasting less than a year
- Short-term – effects lasting 1 to 7 years
- Medium term – effects lasting 7 to 15 years
- Long term – effects lasting 15 to 60 years
- Permanent – effects lasting over 60 years
- Reversible – effects that can be undone, for example through remediation or restoration
- Frequency – How often the effect will occur. (once, rarely, occasionally, frequently, constantly – or hourly, daily, weekly, monthly, annually)

Criteria for assessing impact significance and impact quality are provided in Table 2-4 and 2-5.

Table 2-4 Criteria for assessing impact significance based on (EPA, 2017)

Impact Magnitude	Definition
No change	No discernible change in the ecology of the affected feature
Imperceptible Effect	An effect capable of measurement but without significant consequences
Slight Effect	An effect which causes noticeable changes in the character of the environment without affecting its sensitivities
Moderate Effect	An effect that alters the character of the environment that is consistent with existing and emerging baseline trends
Significant Effect	An effect which, by its character, magnitude, duration or intensity significantly alters most of a sensitive aspect of the environment

Impact Magnitude	Definition
Profound Effect	An effect which obliterates sensitive characteristics

Table 2-5 Criteria for assessing impact quality based on (EPA, 2017)

Impact Type	Criteria
Positive	A change which improves the quality of the environment (for example, by increasing species diversity; or the improving reproductive capacity of an ecosystem, or by removing nuisances or improving amenities
Neutral	No effects or effects that are imperceptible, within normal bounds of variation or within the margin of forecasting error
Negative	A change which reduces the quality of the environment (for example, lessening species diversity or diminishing the reproductive capacity of an ecosystem; or damaging health or property or by causing nuisance)

EPA impact assessment criteria have been used in this assessment. Percival (2003) has also been followed in the assessment of potential impacts given its specific focus on the interactions between wind farms and birds. The two assessment criteria have been used to independently characterise impacts to inform a robust assessment of potential impacts resulting from the subject development site on local avian communities.

3. FIELD SURVEY METHODS

This section of the report describes the various survey methods employed.

Pre-planning field surveys were undertaken in line with SNH (2017) between April 2015 and September 2017.

Pre-commencement bird surveys were undertaken to confirm the absence/presence of breeding hen harrier prior to the initiation of construction works at the wind farm site (April 2019 - July 2019). Breeding raptor surveys were undertaken with a particular focus on hen harrier. These surveys were based on Hardey et al., (2013) and included walkovers and vantage point methods. The surveys methods undertaken were sufficient to identify any other breeding raptor species likely present on-site.

Construction phase monitoring were undertaken in accordance with Hardey et al., (2013). These surveys were undertaken between May and July 2020. These surveys were based on Hardey et al., (2013) and included walkovers and vantage point methods. The surveys methods undertaken were sufficient to identify any other breeding raptor species likely present onsite. Following the identification of a hen harrier nest onsite as per Figure 4.1 in Confidential Appendix 1, the survey effort was intensified in June and July.

The survey effort undertaken during both the pre-commencement and construction phase monitoring is provided in Table 3-1 below.

Table 3-1 Summary of survey effort

Month	Survey Type	Hours Conducted
Pre-commencement phase 2019		
April 2019	Breeding Hen Harrier Survey	8
May 2019	Breeding Walkover Survey	6.5
July 2019	Breeding Hen Harrier Survey	6
Construction phase 2020		
May 2020	Breeding Raptor Surveys	24
May 2020	Breeding Walkover Survey	10
June 2020	Breeding Raptor Surveys	48.5
June 2020	Breeding Walkover Survey	14.5
July 2020	Breeding Raptor Surveys	24

4. RESULTS

During the 2015 to 2017 pre-planning surveys hen harrier and merlin were recorded infrequently within the wind farm site. No evidence of breeding or roosting was recorded on-site.

Hen harrier were not recorded during pre-commencement surveys within the wind farm site. In May 2020, a hen harrier nest was identified within the wind farm site. Following the identification of the nest site, construction works were not permitted within 500m of the nest location in accordance with the requirements of the EIAR and agreed monitoring plan. In response to identifying the nest, survey effort was intensified during June and July 2020. The nest site was found to be inactive in July, i.e. no hen harrier activity was recorded on repeat visits during this period. The hen harrier nest is located outside the 500m disturbance distance (970m) from the site of the November 2020 peat slide.

Throughout pre-commencement and construction phase monitoring, merlin were not recorded within the wind farm site. During pre-commencement surveys merlin were recorded on a single occasion outside the site. This observation was not mapped by the surveyor however the merlin was recorded approx. 4km west of the wind farm site. During construction phase monitoring a merlin nest was recorded 3.2km to the west of the wind farm site. Three chicks were successfully fledged. There was no merlin activity recorded within or adjacent to the wind farm site.

The results of pre-commencement and construction phase monitoring are provided in Tables 4-1 and 4-2 respectively. The below results of the pre-commencement and construction phase monitoring are relied upon for the impact assessment, as this data is the most up to date information available.

Table 4-1 Summary of field survey results from pre-commencement phase 2019

Species	Survey Type	No. of Observations	No. of observations within 500m of the wind farm	Activity of note	Breeding Status (Possible, Probable, Confirmed)	Figure
Merlin	Breeding Walkover Survey	1	0	No activity of note.	Individual recorded. No evidence of breeding observed	Not mapped (c.4km from site)

Table 4-2 Summary of field survey results from construction phase 2020

Species	Survey Type	No. of Observations	No. of obsewrvations within 500m of the wind farm	Activity of note	Breeding Status (Possible, Probable, Confirmed)	Figure
Hen Harrier	Breeding Raptor Survey	22	20	Three food passed observed and multiple observations of a pair around a nest site.	One confirmed nest site within the wind farm site.	Figure 4.1

Species	Survey Type	No. of Observations	No. of obsewrvations within 500m of the wind farm	Activity of note	Breeding Status (Possible, Probable, Confirmed)	Figure
						Within Confidential Appendix 1 – Not for public circulation
Merlin	Breeding Raptor Survey	9	0	Nest located and three juveniles recorded at the nest site	One confirmed nest site 3.2km from the wind farm site	Figure 4.2 Within Confidential Appendix 1 – Not for public circulation

5. EVALUATION

A determination of population importance of hen harrier and merlin is provided below following the criteria described in Section 2.

5.1 Hen Harrier

Based on the latest Breeding Hen Harrier Survey (NPWS 2015), the ROI National breeding population is in the range of 108-157 pairs. Therefore, a single breeding pair in Ireland conforms to International Importance as per NRA criteria. In May 2020, a breeding pair of hen harrier were recorded within the wind farm site during the construction phase of the permitted development. This population was assigned **National/International** importance.

5.2 Merlin

As per the latest NPWS Article 12 reporting document, the estimated population of merlin in Ireland is 200 to 400 breeding pairs. Therefore 1% of the ROI National breeding population is two to four breeding pairs. As discussed, a successful merlin nest was recorded approximately 3.2km to the west of the wind farm site and approx. 5km from the site of the November 2020 peat slide. This pair was assigned County Importance (Higher Value) on the basis of a resident/regularly occurring population assessed to be important at the county level.

5.3 Sensitivity Determination

Criteria developed by Percival (2003) is presented in Table 2-1 for assessing bird sensitivity within the study area. Hen harrier and merlin were classified as follows:

- Hen Harrier High Sensitivity (Criteria: ecologically sensitive species)
- Merlin Medium Sensitivity (Criteria: Annex I species)

6. IMPACT ASSESSMENT

6.1 Hen Harrier

Table 6-1 Impact Characterisation for hen harrier based on Percival (2003) & EPA (2017)).

Analysis of potential effects		Magnitude and Significance of potential effect (Percival 2003)	Significance of potential effect (EPA 2017)
Direct Habitat Loss	A peat slide occurred during construction works at the Meenbog Wind Farm in November 2020. The habitats within the impacted area were a combination of peatland and forestry. In May 2020, a hen harrier nest was recorded within the Meenbog Wind Farm, at a distance of greater than 500m (approx. 970m) from the site of the peat slide. Please refer to Figure 4.1 in Confidential Appendix 1 for further details. There was no habitat loss at the nest site. The impacted area is very small area, approx. 3.98ha relative to the total area utilised by this wide-ranging species. Recent work on the ranging behaviour of hen harriers breeding in Scotland (Arroyo et al., 2014) has revealed that, while breeding male hen harriers travelled up to nine kilometres from nests on occasion, they had a home-range size that averaged only eight square kilometres (800 ha). The average home-range size for females was 4.5 square kilometres (450 ha) and it was found that males hunted mostly within two kilometres of the nest and females within one kilometre. The peat slide area therefore constitutes less than 1% of the home range area of a hen harrier. There has been a negligible loss of potentially suitable hen harrier habitat as a result of the peat slide. Furthermore, extensive areas of unaffected foraging habitat will remain and there is an abundance of suitable habitat in the surrounding area.	The magnitude of the effect is assessed as *negligible*. The cross tablature of *High* sensitivity species and *Negligible* Impact corresponds to a ***Very Low*** effect significance	**Long-term Slight to Imperceptible Negative Effect**

	Significant effects have not occurred and are not predicted to occur at any geographical scale.		
Disturbance Displacement	As previously discussed in May 2020, a hen harrier nest was recorded within the Meenbog Wind Farm, approx. 970m from where the peat slide occurred. Disturbance of hen harrier was been reported to occur within 500-750m (Ruddock and Whitfield 2007). Based on the separation distance involved, no disturbance is predicted to have occurred. Significant effects have not occurred and are not predicted to occur at any geographical scale.	No Effect	No Effect

6.2 Merlin

Table 6-2 Impact Characterisation for merlin based on Percival (2003) & EPA (2017)).

Analysis of potential effects		Magnitude and Significance of potential effect (Percival 2003)	Significance of potential effect (EPA 2017)
Direct Habitat Loss	As previously discussed, there was a peat slide within the permitted wind farm in November 2020. This peat slide has the potential to result in localised habitat loss. However, the impacted area is very small area, approx. 3.98ha. No merlin activity was recorded within the wind farm site. The nearest known merlin nest is located, approx. 5km from where the peat slide occurred and outside the wind farm site. Please refer to Figure 4.2 in Confidential Appendix 1 for further details. The core foraging range of merlin is 5km (SNH 2016). Based on the separation distance involved, it would therefore not be expected that merlin from the identified nest would forage at the site of the peat slide with any regularity. Furthermore, no merlin were recorded onsite.	The magnitude of the effect is assessed as *negligible*. The cross tablature of *Medium* sensitivity species and *Negligible* Impact corresponds to a *Very Low* effect significance	**Long-term Imperceptible Negative Effect**

	Significant effects are not anticipated particularly given the lack of activity recorded onsite. Furthermore, extensive areas of unaffected foraging habitat will remain and there is an abundance of suitable habitat in the surrounding area. Significant effects have not occurred and are not predicted to occur at any geographical scale.		
Disturbance Displacement	As previously discussed, no merlin activity was recorded within the wind farm site. The nearest known merlin nest is located, approx. 5km from the site of the peat slide and outside the wind farm site. Please refer to Figure 4.2 for further details. Based on the separation distance involved, no disturbance is predicted to have occurred. Significant effects have not occurred and are not predicted to occur at any geographical scale.	**No Effect**	**No Effect**

7. CONCLUSION

Potential habitat loss and disturbance displacement impacts were assessed for hen harrier and merlin. No significant habitat loss or disturbance displacement effect on hen harrier or merlin were identified resulting from the November 2020 peat slide at the Meenbog Wind Farm. Both species will be subject to continued construction phase monitoring as per planning permission conditions within the wind farm site.

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CONFIDENTIAL APPENDIX 1

(NOT INCLUDED IN 2024 SUBSTITUTE CONSENT APPLICATION TO AN BORD PLEANÁLA. CAN BE PROVIDED TO ABP ON REQUEST)

APPENDIX J

PRELIMINARY SURFACE WATER QUALITY ASSESSMENT

Preliminary Surface Water Quality Assessment

Meenbog Wind Farm

DOCUMENT DETAILS

Client: **Planree Limited**

Project Title: **Meenbog Wind Farm**

Project Number: **201174**

Document Title: **Preliminary Surface Water Quality Assessment**

Document File Name: **201174 - SW Assessment Rpt Version 1.0 D1 2021.01.15.docx**

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MKO Planning and Environmental Consultants

Rev	Status	Date	Author(s)	Approved By
01	Final	20/01/2021	BK; TB; PR; MW; MG; SC	BK / MW

Table of Contents

1. INTRODUCTION

1.1 Background

A peat slide occurred during the construction phase of the Meenbog wind farm (Meenbog, Ballybofey, Co. Donegal) on 12th November 2020. The peat slide occurred on the northeastern side of the wind farm site within the Shruhangarve Stream catchment. The peat slide resulted in the discharge of peat, sediment and heavily soiled water to the Shruhangarve Stream and the Mourne Beg River. Initial estimates indicate a failure volume of >50,000m^3 (please note the actual slide volume is being determined by ongoing geotechnical analysis).

This report presents background information in respect of the geological, hydrogeological and hydrological setting of the wind farm site, and provides a preliminary assessment of the resulting environmental impacts on surface water quality arising from the peat slide event.

1.2 Scope of Surface Water Assessment

This report provides a partial response to Item 1 of the 3rd December 2020 letter received from the EPA in respect of the peat slide.

Item 1 reads as follows:

1. *Planree Limited shall evaluate impact on surface waters of discharges from the facility. This evaluation shall include an assessment of whether or not environmental damage, as defined in the European Communities (Environmental Liability) Regulations 2008, has occurred as a result of such discharges, individually and cumulatively, taking into account the impact of direct discharges to surface water. Cognisance shall be had of the EPA's "Environmental Liability Regulations Guidance Document" available at https://www.epa.ie/pubs/advice/general/environmentalliabilityregulations.html in completing this evaluation. The evaluation shall include habitats and species for which the River Finn SAC is designated, in particular salmon and lamprey.*

As outlined previously a full assessment will not be available until ecological surveys are complete. Therefore, in in order to respond to the letter in the required timeline, we are submitting our preliminary assessment of surface water quality based on data collection and ongoing monitoring completed in the downstream rivers (Shruhangarve Stream, Mourne Beg River, Derg River, and Mourne River) since the peat slide event. This report relates to data collected between 6th November, 2020 and 6th January 2021. Data collection is ongoing and ongoing assessment of these data will be completed.

1.3 Basic Timeline of Events

To provide some context for this report a brief summary of the situation on site is provided as follows:

- The peat slide occurred on 12th November 2020;
- Following the peat slide a period of stabilisation works were undertaken to prevent further peat movement. This period is called the emergency works phase, and grounds works were completed from 12th November to mid December;
- During the emergency works phase 3 no. stone berms were constructed to stabilise the peat slide scar, these stone berms are referred to as Wall1, Wall2, and Wall3. Wall1 is the lower wall (most downstream) on the Shruhangarve Stream; and,
- During the emergency works phase geotechnical, hydrological and environmental monitoring was undertaken.

1.4 Contributors

The following people contributed to the preparation of this report and the recommendations contained herein.

Brian Keville – MKO (Environmental Director)

Brian has over 20 years' professional experience as an environmental consultant having graduated from the National University of Ireland, Galway with a first class honours degree in Environmental Science. Brian's professional experience has focused on project and environmental management, and environmental impact assessments. Brian has acted as project manager and lead-consultant on numerous environmental impact assessments, across various Irish counties and planning authority areas. These projects have included large infrastructural projects such as roads, ports and municipal services projects, through to commercial, mixed-use, industrial and renewable energy projects. The majority of this work has required liaison and co-ordination with government agencies and bodies, technical project teams, sub-consultants and clients.

Michael Watson – MKO (Environment Team Project Director)

Michael is Project Director and head of the Environment Team in McCarthy Keville O'Sullivan (MKO). Michael has over 18 years' experience in the environmental sector. Following the completion of his Master's Degree in Environmental Resource Management, Geography, from National University of Ireland, Maynooth he worked for the Geological Survey of Ireland and then a prominent private environmental & hydrogeological consultancy prior to joining MKO in 2014. Michael's professional experience includes managing Environmental Impact Assessments, EPA License applications, hydrogeological assessments, environmental due diligence and general environmental assessment on behalf of clients in the wind farm, waste management, public sector, commercial and industrial sectors nationally. Michael also has a Bachelor of Arts Degree in Geography and Economics from NUI Maynooth, is a Member of IEMA, a Chartered Environmentalist (CEnv) and Professional Geologist (PGeo).

Thomas Blackwell – MKO (Senior Environmental Consultant)

Thomas is a Senior Environmental Consultant with MKO with over 15 years of progressive experience in environmental consulting. Thomas holds a BA (Hons) in Geography from Trinity College Dublin and a M.Sc. in Environmental Resource Management from University College Dublin. Prior to taking up his position with MKO in August 2019, Thomas worked as a Senior Environmental Scientist with HDR, Inc. in the United States and held previous posts with private consulting firms in both the USA and Ireland. Thomas is a registered Professional Wetland Scientist with the Society of Wetland Scientists with specialist knowledge in wetland assessment and delineation, mitigation planning and design, stream geomorphic assessment, and stream and wetland restoration design. Thomas' key areas of expertise include fluvial geomorphology and stream restoration design. Thomas has provided stream restoration design, and construction oversight for numerous private and publicly funded projects in multiple jurisdictions.

Owen Cahill – MKO (Project Environmental Engineer)

Owen is an Environmental Engineer with McCarthy O'Sullivan Ltd. with over 11 years of experience in the environmental management and construction industries. Owen holds BSc. (Hons) and MSc. in Construction Management and a Masters in Environmental Engineering. Owen has project managed the Environmental Impact Assessment of a range of development projects across the Ireland and holds Full Membership with the Institute of Environmental Management & Assessment and is a Chartered Environmentalist.

Michael Gill – Hydro-Environmental Services.

Michael Gill is an Environmental Engineer with over 18 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms in Ireland. He has also managed EIA/EIS assessments for infrastructure projects and private residential and commercial developments. In addition, he has substantial experience in wastewater engineering and site suitability assessments, contaminated land investigation and assessment, wetland hydrology/hydrogeology, water resource assessments, surface water drainage design and SUDs design, water quality protection, water treatment systems, and surface water/groundwater interactions.

2. CATCHMENT CHARACTERISTICS

2.1 General wind farm Site Description

The Meenbog wind farm site is located approximately 8.2km to the southwest of the towns of Ballybofey and Stranorlar, Co. Donegal.

The Meenbog wind farm site is ~890ha (8.9km^2) in area. The eastern and southern boundaries of the development study area are defined by the Northern Ireland border. The closest town to the site, in Northern Ireland, is Castlederg which is located approximately 17.1km to the southeast of the site.

The wind farm site is dominated by commercial forestry plantations that have been planted over peat. The elevation of the site ranges between approximately 180 and 300mOD (metres above Ordnance Datum).

2.2 Wind Farm Site Geology

Bedrock mapped at the wind farm site comprises Precambrian quartzites, gneisses and schists. Bedrock is exposed in the borrow pits at the wind farm site, and these exposures generally confirm the mapped geology. The exposed bedrock is typically noted to be massive and very competent with a thin upper weathered zone at some locations.

The published subsoils map (www.epa.ie) for the area shows that blanket peat is almost exclusively across the wind farm site. This is confirmed by site investigations. Peat depths recorded during peat probing investigation ranged from 0 to 5.8m with an average of 1.7m.

Based on site observations made during site investigations, the mineral subsoils that are present on site only occur in localized thin pockets with depths typically less than 0.5m over bedrock. A thin weathered bedrock horizon (if present) at the peat/mineral subsoil occurs and is very thin (0.2 – 0.3m).

CORINE (Co-ORdinated INformation on the Environment) Land Cover 2018, EPA (Environmental Protection Agency) soils and 10 metre contour mapping were used to determine the main landscape features within the catchment. Regarding topography, the wind farm site terrain is mountainous and is characterised by a significant fall in elevation from an altitude from the head of the landslide of approximately 307 m O.D. to its confluence with the Mourne Beg River of approximately 128 m O.D.

2.3 Wind Farm Site Hydrogeology

The Precambrian quartzites, gneisses and schists, which are mapped to underlie the Meenbog wind farm site are classified by the GSI (www.gsi.ie) as a Poor Aquifer, having bedrock which is generally unproductive except for local zones (Pl).

The Precambrian rocks generally have an absence of inter-granular permeability, and most groundwater flow is expected to be in the uppermost part of the aquifer comprising a broken and weathered zone typically less than 3m thick, a zone of interconnected fissuring 10m thick, and a zone of isolated poorly connected fissuring typically less than 150m (GSI, 2004). Based on observations from the bedrock exposures at the existing borrow pits (which were noted to be largely competent and massive) limited groundwater flow will be restricted to the top of the rock or within a very thin weathered zone (0.2 – 03m).

Groundwater flowpaths (where present) are likely to be short (30-300m), with groundwater discharging to nearby streams and small seepages/springs. Groundwater flow directions are expected to follow topography and therefore groundwater directions within the site are expected to be towards the primary streams draining the site (GSI, 2004). Local groundwater flow directions will mimic topography, whereby flowpaths will be from topographic high points to lower elevated discharge areas at local streams (GSI, 2004).

Based on observations at the site, groundwater baseflow contribution to local streams is expected to be very low all year round. Overall, the hydrology of the site will be dominated by surface water runoff on the bog surface and within the existing drainage channels.

2.4 Regional and Local Hydrology

Regionally the Meenbog wind farm site is located in the Mourne River surface water catchment.

The Mourne River, which originates within the Republic of Ireland as the Mourne Beg River (tributary of the Mourne River), flows in a northerly direction approximately 12km to the northeast of the site. The downstream Mourne River / River Derg, which flow to the south of the site (within Northern Ireland), merge with the Strule River approximately 15km east of the proposed site to the form the Mourne River. The Mourne River exists within the regional River Foyle catchment.

Locally, the wind farm site drains via the Bunadowen River, the Glendergan River, and the Shruhangarve Stream to the Mourne Beg River.

The catchment area within which the peat slide occurred is the Shruhangarve Stream. It drains to the Mourne Beg River, which itself is a tributary to the Derg River. The drainage areas of these catchments are outlined in Table 2-1. Standard Average Annual Rainfall in the area is ~1,802mm, but this probably increases with elevation at the Wind Farm site.

The catchment is a mountainous (see S1085 slope in **Table 2-1**), partially forested (coniferous) area, with largely peat soil/subsoils. The elevation at the top of the Shruhangarve catchment is ~307mOD, at Wall1[1] is ~216mOD (original ground), and at the Mourne River Beg confluence is ~128mOD.

[1] Wall1 is a stone berm which has been constructed within the wind farm site to stabalise and impound the peat side.

Table 2-1: Catchment Areas and Soils/Subsoils Type

Catchment Area	Area (km^2)	~Slope (S1085 m/km)	Landuse / Soil Type
Shruhangarve above Wall1	0.85	62.7	Forestry or semi natural, peat and rock outcrop
Shruhangarve Stream	4.38	44.3	Forestry or semi natural, peat and rock outcrop
Mourne Beg upstream of Shruhangarve Stream confluence	34.9	9.8	Forestry or semi natural, peat and rock outcrop

Table *2-2* presents the catchment descriptors from the OPW FSU website for a 1.08km^2 catchment area (with an outlet point just northwest of Wall1, i.e. a slightly larger catchment area, but useful for comparison purposes).

Table 2-2: Approx. Wall1 Catchment descriptors from FSU

Parameter	Value
Location No.	GBNI0100027_1
Contributing Area	1.09 km^2
BFISOIL	0.2846
SAAR	1801.7 mm
FARL	1
DRAIND	1.59 km/km^2
S1085	43.72 m/km
ARTDRAIN2	0
URBEXT	0

Secondly, rainfall depths have been used to estimate the flow at Wall1 for various daily rainfall totals, with discharge being distributed over a 24 hour period. This approach assumes no losses, and all rainfall runs off without recharge, storage or attenuation. Data is presented in Table 2-3.

On site flow measurements have also been recorded, and to date total flows in the order of 30 to 300 L/s (~100 to 1,000 m^3/hr) have been recorded at Wall1. Flows vary depending on preceding rainfall on the catchment.

Flow ratios at the Shruhangarve bridge downstream of the site indicate that Wall1 flows are approximately 30% of the recorded flow at the bridge (on 25th November), and similarly Wall1 flows are <2% of the recorded flow (25th November) at Croagh Bridge on the Mourne Beg River (downstream of Shruhangarve confluence).

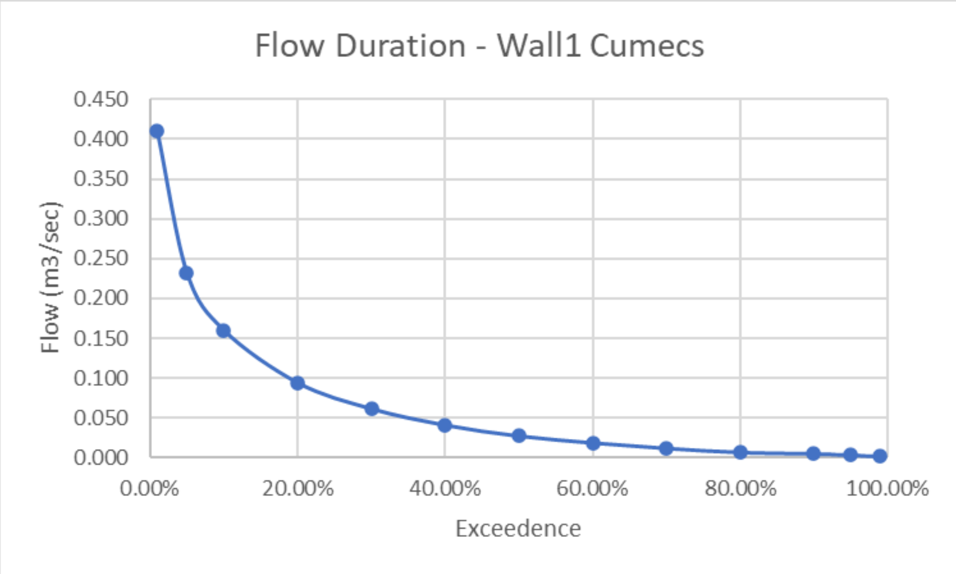

Figure 2-1. Wall1 catchment flow estimations from HydroTool website

Table 2-3: Approx. Wall1 catchment flows from various daily rainfall depths

Daily Rainfall (mm)	Distributed Flow over 24 hrs (full Wall1 catchment) (L/s)	Distributed Flow over 24 hrs (21% of Wall1 catchment) (L/s)
2	20	4
5	49	10
10	99	21
15	148	31
20	198	42
50	494	104
75	741	156

2.5 Designated Sites

A portion of the Meenbog wind farm site drains to the Mourne Beg River, via the Bunadowen River and the Shruhangarve Stream catchments. Downstream of the confluence of the Shruhangarve Stream and the Mourne Beg River, the Mourne Beg River is part of the River Finn SAC (in the Republic of Ireland), and the Mourne Beg River is part of the River Foyle and Tributaries ASSI and SAC (in Northern Ireland).

2.6 Open-Source Climate and Hydrological Data

2.6.1 Lough Mourne ACS

Continuous rainfall monitoring is undertaken at Lough Mourne ACS (Automatic Climate Station). Data since 10th November are plotted below (Figure 2-2). Highest daily total since 10th November was recorded on 26th December at 48mm. Data from Lough Mourne ACS indicates there was 28mm of rainfall on the 11th November, the day before the peat slide occurred.

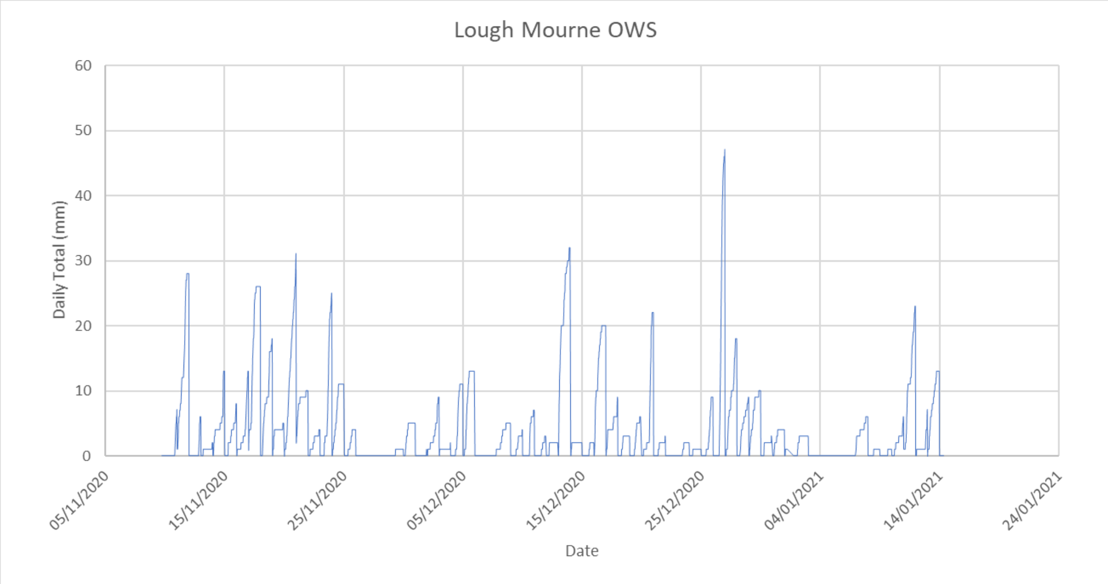

Figure 2-2.Lough Mourne ACS – Daily Rainfall Data (cumulative plot)

2.6.2 On Site Raingauge

Rainfall monitoring has been installed at the wind farm site and has been ongoing since 24th November 2020. Collated data is presented here as Figure 2-3. The highest daily total on site since monitoring began was recorded on 26th December 2020 (36.2mm).

(Please note we have no data included on Figure 2.3 for Dec 11th to Dec 15th, as data downloaded were automated from 15th onwards). Data does exist for those dates, but it has not been downloaded yet). Daily rainfall totals for the site are provided in tabular form as Appendix 1.

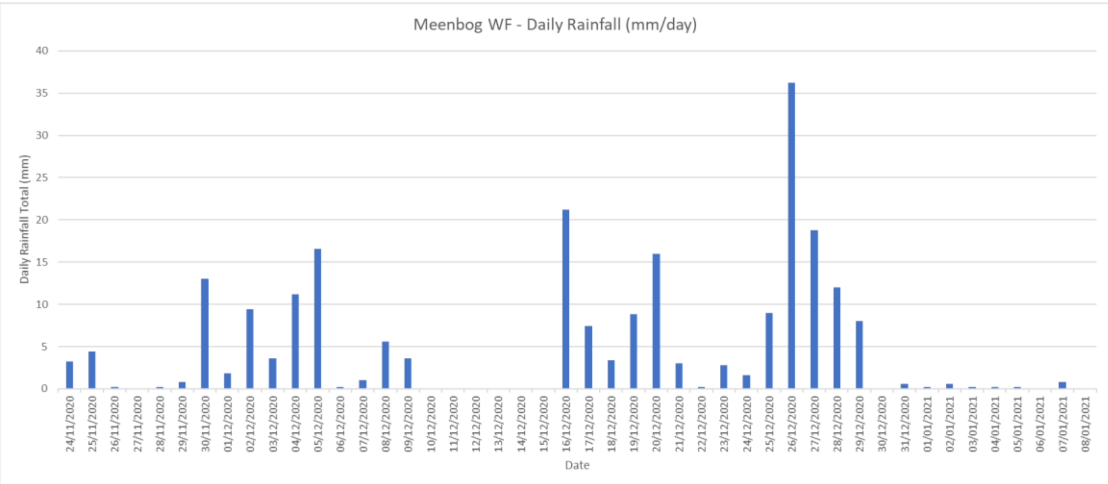

Figure 2-3. Meenbog wind farm – Daily Rainfall Data (daily total plot)

2.6.3 Derg River Water Level Gauge

Automated surface water level monitoring data for Derg River (15min interval data) is available for a gauging station located at Castlederg town (~17km downstream of the Meenbog wind farm site). All available data from January 2020 to January 2021 are plotted on Figure 2-4.

The water level plot shows high flow levels in the Derg River on the 12th of November 2020. The peak water level depth recorded at Castlederg was ~2.8m. The water level was generated by preceding heavy rainfall (28mm recorded at Lough Mourne ACS on 11th November 2020) which fell on the catchment on 10th and 11th November. The water level recorded in the Derg River on the 12th November 2020 was the fourth highest flood event of 2020. This hydrograph shows the natural variability in river flows over an annual cycle. This variability likely results in variations in turbidity across the same cycle.

There were a number of heavy rainfall events in the days following the peat slide, and these are illustrated by the river water level response recorded on Figure 2-5.

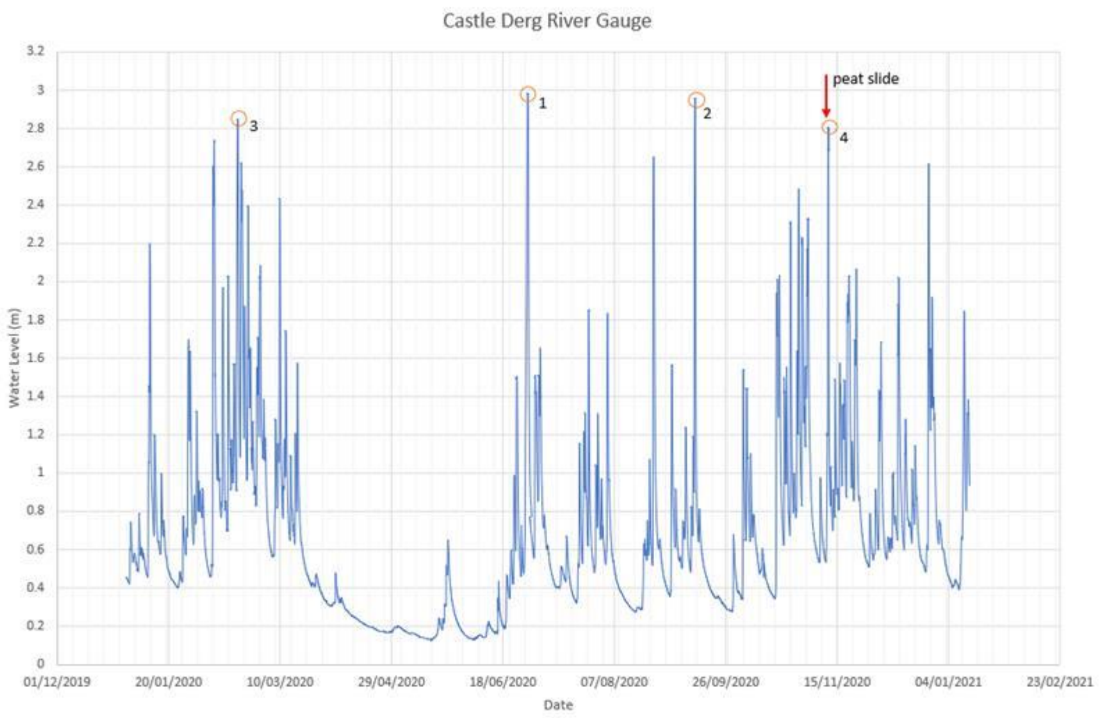

Figure 2-4. Castlederg river level data – Jan 2020 to Jan 2021 (on the Derg River at Castlederg)

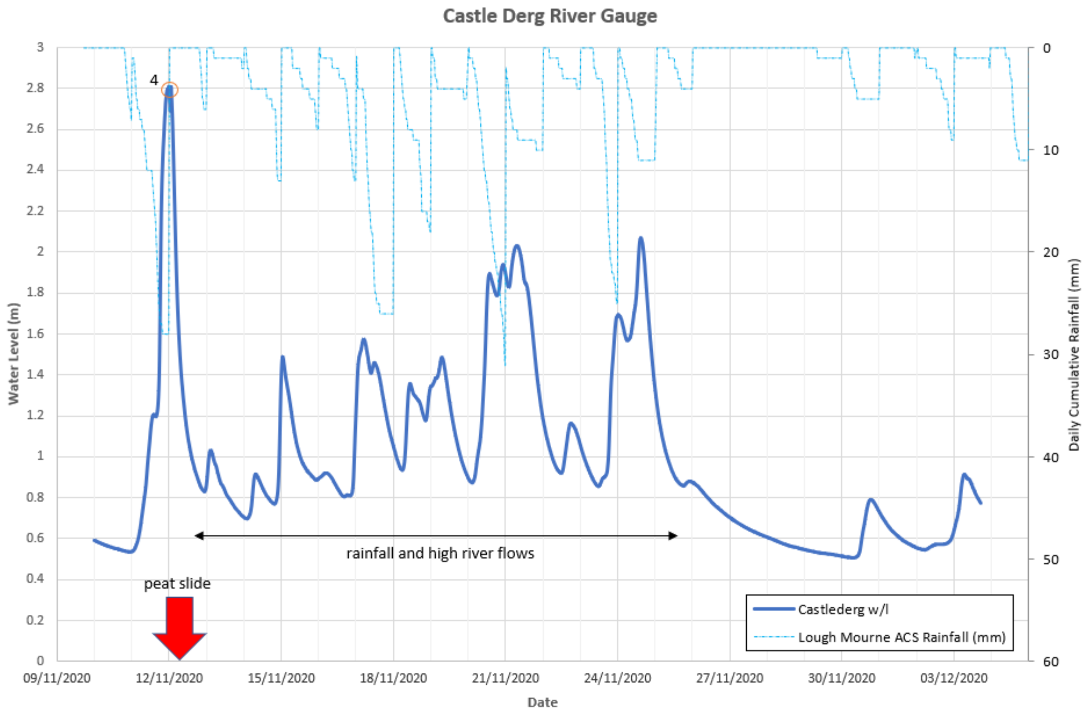

Figure 2-5. Castlederg river level data – Nov 2020 to Dec 2020 (on the Derg River at Castlederg)

2.6.4 Sion Mills Turbidity Monitoring

Continuous turbidity monitoring is completed by the Loughs Agency at Sion Mills, ~41kms downstream of the Shruhangarve/Mourne Bed River confluence. Data from this monitoring device for the month of November is plotted on Figure 2-6. There is a significant recorded peak in turbidity at Sion Mills at 20:30hrs on the 11th November 2020. This peak corresponds with the recorded flood peak in the Derg/Mourne Rivers as illustrated by the water level hydrograph data from Castlederg (on the Derg River, hydrograph data included on Figure 2-4). There are additional smaller spikes in turbidity recorded at Sion Mills for the remainder of November, and these spikes also correspond with higher water levels (i.e. higher river flows in the Derg River being transferred downstream to the Mourne River) recorded at Castlederg.

A screen capture of the full turbidity dataset at Sion Mills from January 2020 to January 2021 is included as Figure 2-7. The plot shows recorded spikes in turbidity preceding the peat slide event at Meenbog wind farm. Spikes are recorded in May/June and September/October.

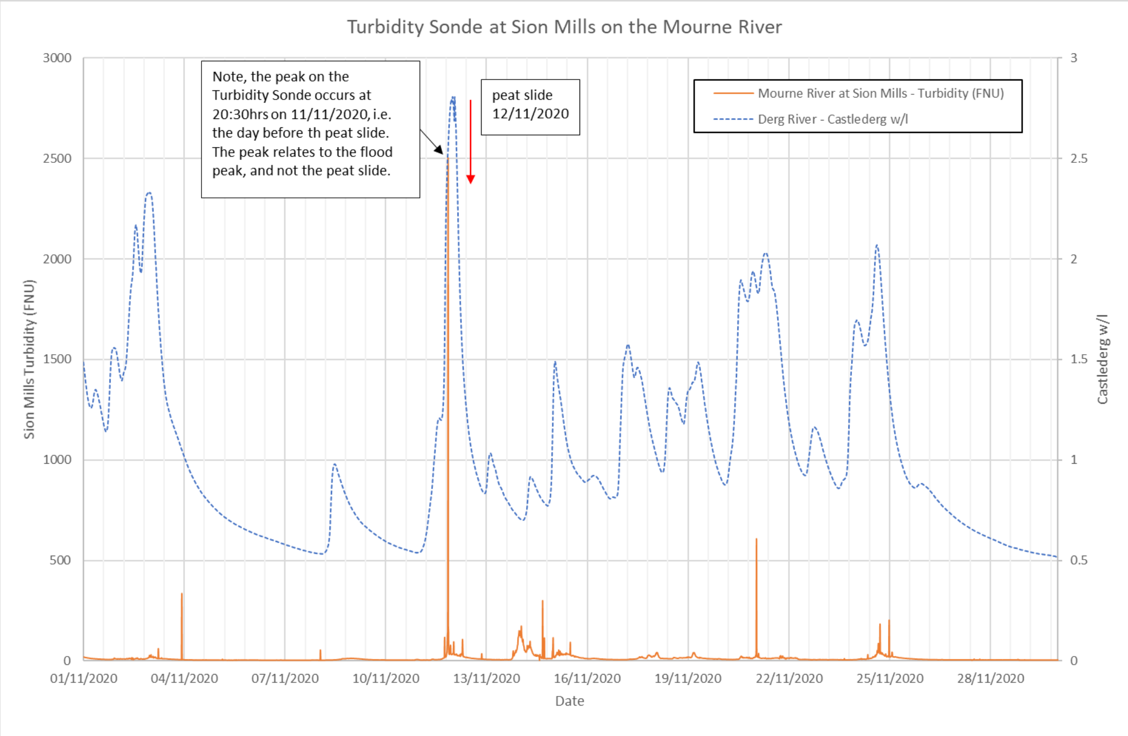

Figure 2-6. Sion Mills Turbidity Monitoring for month of November 2020 (on the Mourne River)

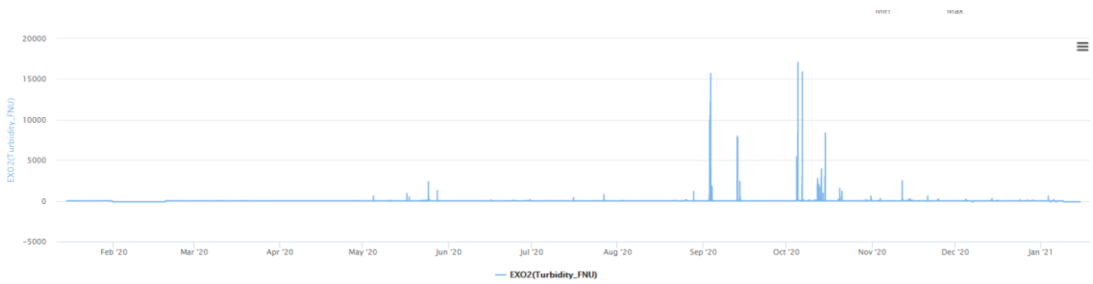

Figure 2-7. Sion Mills Turbidity Monitoring for Jan 2020 to Jan 2021 (on the Mourne River)

3. SURFACE WATER QUALITY ASSESSMENT

3.1 Introduction

The peat slide event at Meenbog wind farm impacted downgradient surface water via a tributary of the Mourne Beg River. This tributary, the Shruhangarve Stream, transferred peat and sediment down the valley to the confluence with the Mourne Beg River and on via the Mourne Beg River to the Derg River, and on into the downstream Mourne River.

Table 3-1sets out the EPA waterbody codes and naming conventions for the watercourses in the area. The discussion on water quality below relates to these downstream streams and rivers. Rivers and monitoring locations are shown on Figure 3-1. Main Rivers and Monitoring Locations (Note: the peat slide occurred in the Shruhangarve catchment).Figure 3-1.

Table 3-1: Downstream Surface Water Body Names and wind farmD Codes and 2018 Status

River Name:	Waterbody Code	2018 Status
Shruhangarve Stream	n/a	none
Mourne Beg River (Mourne Beg_010)	IE_NW_01M010200	Poor
Mourne Beg River (Derrygoonan)	UKGBNI1NW010102066	Moderate
Mourne Beg River (Lisnacloone)	UKGBNI1NW010102064	Moderate
River Derg (Millbrook)	UKGBNI1NW010102095	Moderate
Mourne River	UKGBNI1NW010102074	MEP
Upper Foyle	UKGBNI5NW250030	Moderate

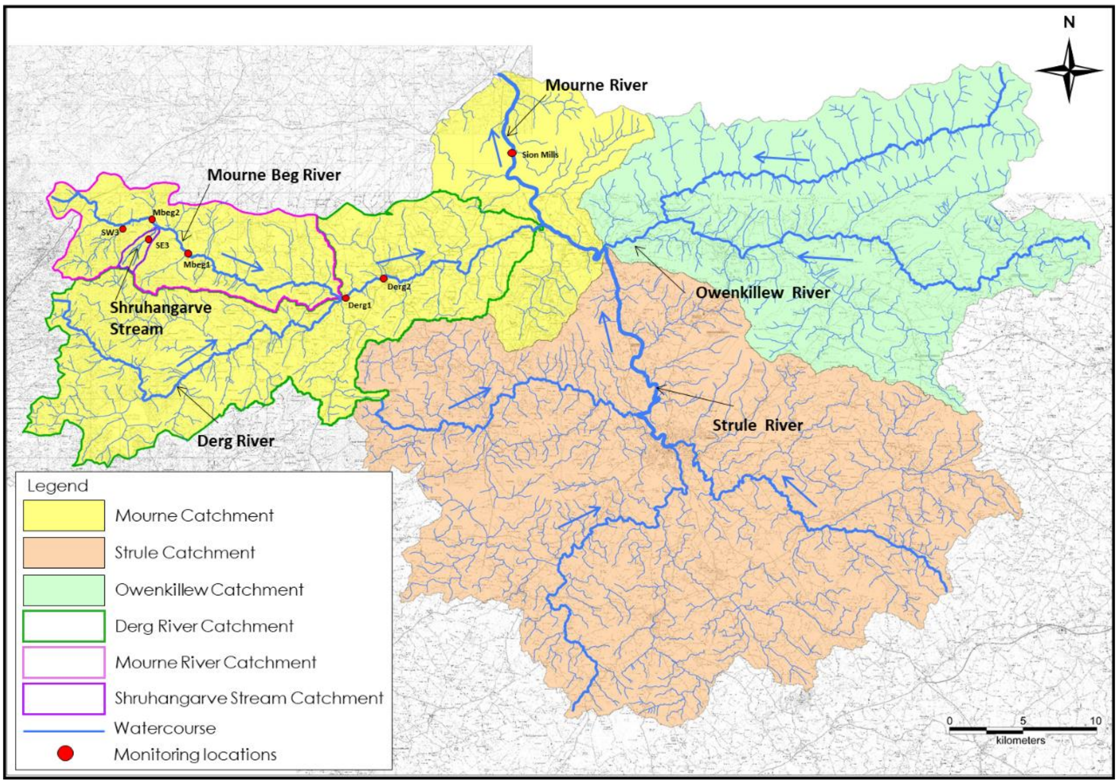

Figure 3-1. Main Rivers and Monitoring Locations (Note: the peat slide occurred in the Shruhangarve catchment).

3.2 Pre-Event Water Quality

Background Q-values at Mbeg2 monitoring point (Bridge S.W. of Tonreagh, EPA Station Code RS01M010200) between 1990 and 2016 varied between Q2/3 and Q4, with the latest Q-value, recorded in 2019, being reported as Q4.

Baseline water quality monitoring completed for the EIAR at SW3 (on the Bunadowen) indicated a TSS of <10 mg/L and ammonia of <0.03 mg/L, and BOD of <1 mg/L, and a slightly elevated ortho-P of 0.05 mg/L.

Based on this background water quality is generally good, with very low TSS/turbidity, with likely small variations during flood events. Nutrients from forestry, and ammonia from (blanket) peatland runoff may also have small seasonal and temporal background variations.

3.3 Post Event Water Quality Data

Three forms of water quality monitoring are being completed downstream of the peat slide area. Monitoring locations, type of monitoring, and data collection periods are summarised in Table 3-2.

Table 3-2: Ongoing Surface Water Quality Monitoring

Monitoring Types	Monitoring Locations	Data periods assessed in this report	Type of Sampling
Daily field turbidity monitoring	SE3, SW3, MBeg1, and MBeg2	24/11/2020 to 05/01/2021	Daily field monitoring
Daily grab surface water sampling	SE3, MBeg1, MBeg2, Derg1 and Derg2	13/1/2020 to 17/12/2020	Grab sampling for lab
Continuous turbidity sonde monitoring	MSe3, MSe4, MSe5, MSe6	6/11/2020 to 06/01/2021	Continuous

Daily grab samples are sent for laboratory analysis, the results of this chemical water quality data are provided up to 17th December 2020. Water quality monitoring is ongoing and future results will be provided when available from the independent laboratories.

The location of these monitoring points are shown in Figure 3-1. A brief description of monitoring locations is provided as follows:

- SE3 - Located on the Shruhangarve at the Shruhangarve Bridge;
- SW3 - Located on the Bunadowen River downstream of the Meenbog wind farm site;
- M-Beg 1 – Located on the Mourne Beg River at Croagh Bridge (downstream of the Shruhangarve confluence);
- M-Beg 2 - Located on the Mourne Beg River between the confluence of the Bunadowen River and the confluence of the Shruhangarve;
- Derg 1 – Located at the main road bridge in Castlederg; and,
- Derg 2 – Located Downstream of Castlederg.
- MSe3 - In the Shruhangarve
- MSe4 - In the Bunadowen river north of the Meenbog wind farm site
- MSe5 - In the Mourne Beg river downstream of the confluence with the Shruhangarve
- MSe6 - In the Mourne Beg river upstream of the confluence with the Shruhangarve

Chemical Analysis Suite

Daily grab sampling is untaken as described above, and the samples are sent for laboratory analysis for the following suite of parameters:

- Total Phosphorus (mg/L)
- Chloride (mg/L)
- Nitrate (NO_3) (mg/L NO_3)
- Nitrite (NO_2) (mg/L NO_2)
- Orthophosphate (mg/L as P)
- Ammonia (NH_3) (mg/L N
- BOD (mg/L)
- DO (%, or mg/L)
- TSS (mg/L)

3.3.2 Surface Water Environmental Quality Standards

Recorded data are assessed against the following surface water environmental data standards(EQS):

Table 3-3: Surface Water Environmental Data Standards(EQS)Parameter	Environmental Quality Standard	Source/Reference
Total Phosphorus	No available SW EQS	-
Chloride	No available SW EQS	-
Nitrate (NO_3)	There are currently no environmental quality standards for nitrate, however, average nitrate concentration values <4 mg/l NO_3 (0.9mg/l N) and less than 8 mg/l NO_3 (1.8mg/l N) are considered by the EPA to be indicative of high and good quality respectively.	Water Quality in 2019 – An Indicators Report (EPA, Dec 2020)
Nitrite (NO_2)	No available SW EQS	-
Orthophosphate	High status ≤0.025 (mean) or ≤0.045 (95%ile) Good status ≤0.035 (mean) or ≤0.075 (95%ile)	SW Regs (SI272 of 2009 as amended)
Ammonia (NH_3)	High status ≤0.040 (mean) or ≤0.090 (95%ile) Good status ≤0.065 (mean) or ≤0.140 (95%ile)	SW Regs (SI272 of 2009 as amended)
BOD	High status ≤1.3 (mean) or ≤2.2 (95%ile) Good status ≤1.3 (mean) or ≤2.2 (95%ile)	SW Regs (SI272 of 2009 as amended)
Dissolved Oxygen	Lower limit: 95%ile >80% saturation Upper limit: 95%ile <120% saturation	SW Regs (SI272 of 2009 as amended)

Table 3-3: Surface Water Environmental Data Standards(EQS)Parameter	Environmental Quality Standard	Source/Reference
Total Suspended Solids (TSS)	25 mg/L	Salmonid Regs (SI 293 of 1988)

3.3.3 Daily field turbidity monitoring

The collected field turbidity data gives a daily indication of variability in water quality (turbidity being a proxy for Total Suspended Solids (TSS)) downstream of the peat slide event. Data for SE3, SW3, MBeg1, and MBeg2 are plotted on Figure 3-2, and a summary of that data is provided in Table 3-4.

Table 3-4: Summary of field turbidity monitoring data

Monitoring Location	Data Range (NTU)	Observed trends
SE3	81.2 to 1.75	Spikes in data during emergency works period, but decreasing trend from 24th November onwards
SW3	32.1 to 0.93	Background data in the Bunadowen, this location is upstream of the peat slide
MBeg1	8.3 to 0.97	Relatively stable, with minor variability as a result of rainfall and variations in flows
MBeg2	9.25 to 1.15	Relatively stable, with minor variability as a result of rainfall and variations in flows

The turbidity data show a very clear trend of decreasing turbidity on the Shruhangarve and a return to close to normal levels by mid-December. Short-term increases in turbidity can be seen as a result of rainfall events. Daily field turbidity monitoring data are provided in tabular form as Appendix 2

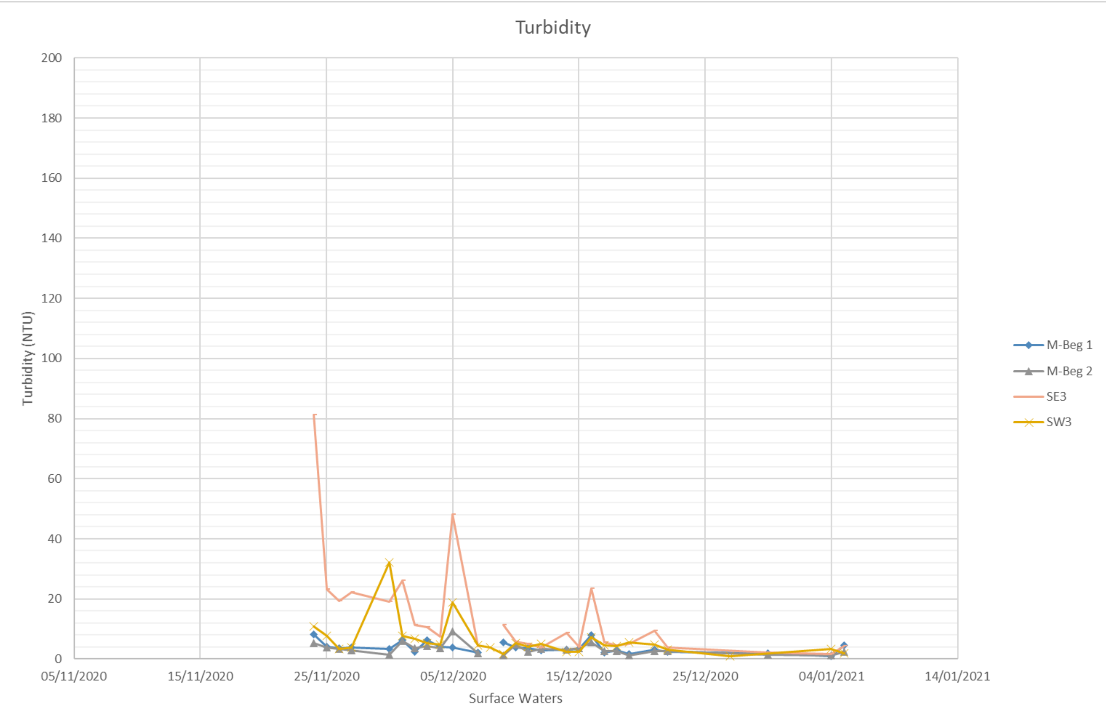

Figure 3-2. Daily field turbidity monitoring data plot

3.3.4 Daily Grab Sampling Data

In general, the collected data indicates little variability for the following parameters: total phosphorous (small spike in SE3, but settled after 1 week), chloride, nitrate, and nitrite (1 elevated record for 15/11/2020, but all subsequent data are stable).

The discussion below focuses on recoded variations of the following parameters: TSS, Ortho-P, Ammonia, and BOD. Daily grab sampling data are provided in tabular form as Appendix 3

Total Suspended Solids

TSS data (lab data) for SE3, MBeg1, MBeg2, Derg 1 and Derg2 are plotted on Figure 3-3, and a summary of that data is provided in Table 3-5.

Table 3-5: Summary of TSS laboratory data

Monitoring Location	TSS Data Range (mg/L)	Observed trends
SE3	4,690 to 6	Initial TSS load was high after the peat slide and during the emergency works period, with a settling down of recorded variations after the 25th November 2020. Only 1 exceedance of 25mg/L EQS occurred between 26th November and 17th December 2020.
MBeg1	875 to 4	Initial TSS load was high after the peat slide, with some further variation during the emergency works period, with a settling down of recorded variations after the 21st November 2020. No exceedance of 25mg/L EQS from 21st November onwards.
MBeg2	<10	(upstream of Shruhangarve confluence) All recorded data below salmonid EQS (25 mg/L).
Derg1	951 to 4	Initial TSS load was evident at Derg 1 after the peat slide, with some further variation up to 17th November 2020. No exceedance of 25mg/L EQS from 17th November onwards, with only 3 recorded exceedances on 13th, 15th, and 17th November.
Derg2	349 to 4	Initial TSS load was evident at Derg 2 after the peat slide, with some further variation up to 23rd November 2020. Only 1 exceedance of 25mg/L EQS from 23rd November onwards, but the recorded data suggests other catchment influences as Derg2 TSS data is higher than the upstream Derg1 data on 11 occasions.

The TSS data show a very clear trend of decreasing solids in the Shruhangarve, Mourne Beg and Derg Rivers following the peat slide event. There are indications from Derg2 data that other anthropogenic activities may be impacting on water quality in the Derg River downstream of Castlederg.

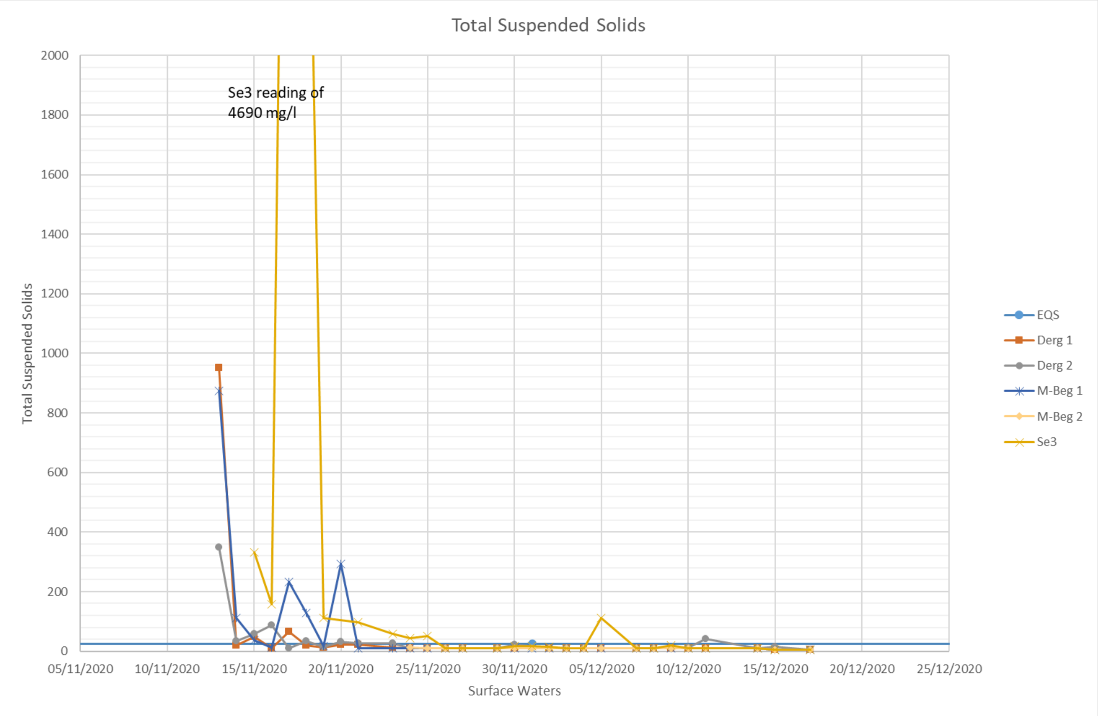

Figure 3-3. TSS (lab) data plot

Ortho-Phosphate

Ortho-P data (lab data) for SE3, MBeg1, MBeg2, Derg 1 and Derg2 are plotted on Figure 3-4, and a summary of that data is provided in Table 3-6.

Table 3-6: Summary of Ortho-P laboratory data

Monitoring Location	Ortho-P Data Range (mg/L)	Observed trends
SE3	0.12 to 0.04 (n = 26, μ = 0.075)	Elevated ortho-P has been recorded since the peat slide and during the emergency works period, but importantly this does not appear to be impacting on downstream water quality at MBeg1 as significant dilution is available after the confluence of the Shruhangarve and the Mourne Beg River.
MBeg1	0.04 to 0.03 (n = 29, μ = 0.03)	Low ortho-P data results, with Good Status (mean of 0.03 mg/L) indication using mean of recorded data.
MBeg2	0.03 (n = 19, μ = 0.03)	Low ortho-P data results, with Good Status (mean of 0.03 mg/L) indication using mean of recorded data.
Derg1	0.09 to 0.03 (n = 27, μ = 0.035)	Low ortho-P data results, with Good Status (mean of 0.03 mg/L) indication achieved using mean of recorded data.
Derg2	0.16 to 0.03 (n = 28, μ = 0.04)	Generally low ortho-P data results, but recorded data suggests other catchment

Monitoring Location	Ortho-P Data Range (mg/L)	Observed trends
		influences as Derg2 data for ortho-P is higher than the upstream Derg1 data on 8 occasions.

The recorded ortho-P data shows elevated trends in the Shruhangarve Stream, but this is not having an impact on water quality in the Mourne Beg River, as data from MBeg1 is consistently meeting the Good Status EQS. There are indications from Derg2 ortho-P data that other anthropogenic activities may be impacting on water quality in the Derg River downstream of Castlederg.

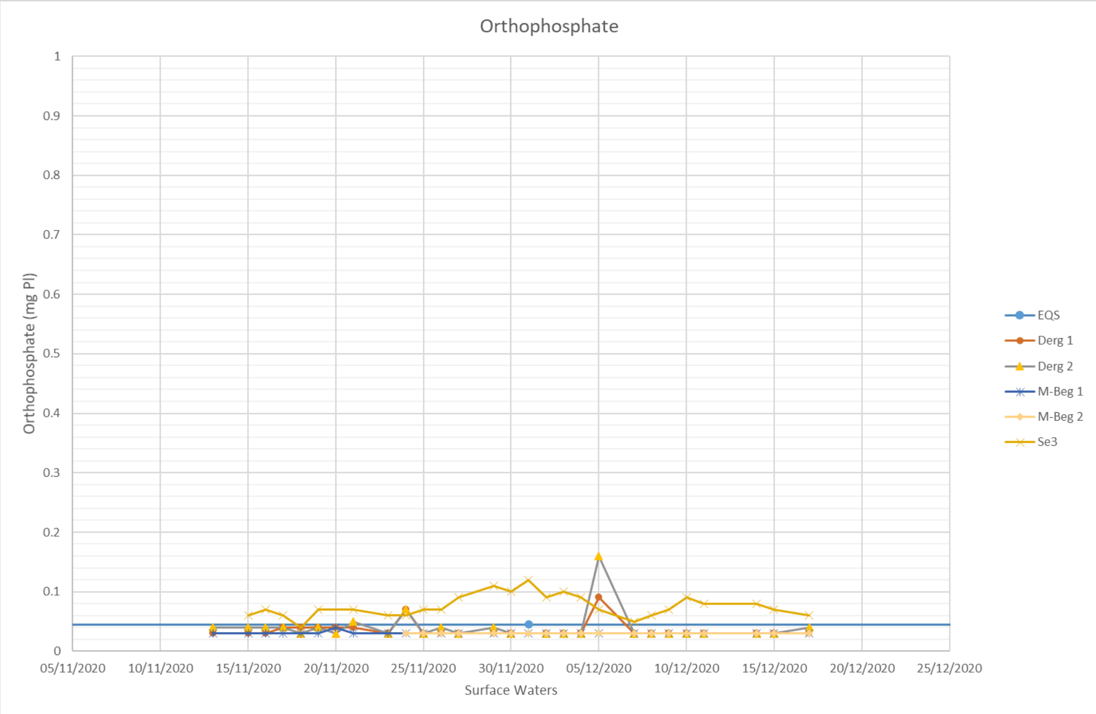

Figure 3-4. Ortho-P (lab) data plot

Ammonia

Ammonia data (lab data, converted to Ammonia-N to compare to EQS) for SE3, MBeg1, MBeg2, Derg 1 and Derg2 are plotted on Figure 3-5, and a summary of that data is provided in Table 3-7.

Table 3-7: Summary of Ammonia laboratory data

Monitoring Location	Ammonia-N Data Range (mg/L)	Observed trends
SE3	0.03 to 1.46 (n = 28, μ = 0.07)	Elevated Ammonia-N was recorded up to 24th November 2020 following the peat slide, with only small temporal variations since then.
MBeg1	0.02 -to 0.38 (n = 29, μ = 0.06)	Elevated Ammonia-N was recorded up to 25th November 2020 following the peat slide, with only small temporal variations since then.
MBeg2	0.02 to 0.08 (n = 19, μ = 0.04)	Low background ammonia-N recorded.

Monitoring Location	Ammonia-N Data Range (mg/L)	Observed trends
Derg1	0.02 to 0.37 (n = 28, µ = 0.07)	Elevated ammonia-N recorded on 13th November 2020, with only small temporal variations since then.
Derg2	0.04 to 0.15 (n = 28, µ = 0.04)	Elevated ammonia-N recorded on 13th November 2020, with only small temporal variations since then. Again, recorded data suggests other catchment influences as Derg2 data for Ammonia-N is higher than the upstream Derg1 data on 12 occasions.

The recorded ortho-P data shows elevated trends in the Shruhangarve Stream, but this is only having a minor effect on downstream water quality in the Mourne Beg River. There are indications from Derg2 ammonia-N data that other anthropogenic activities may be impacting on water quality in the Derg River downstream of Castlederg.

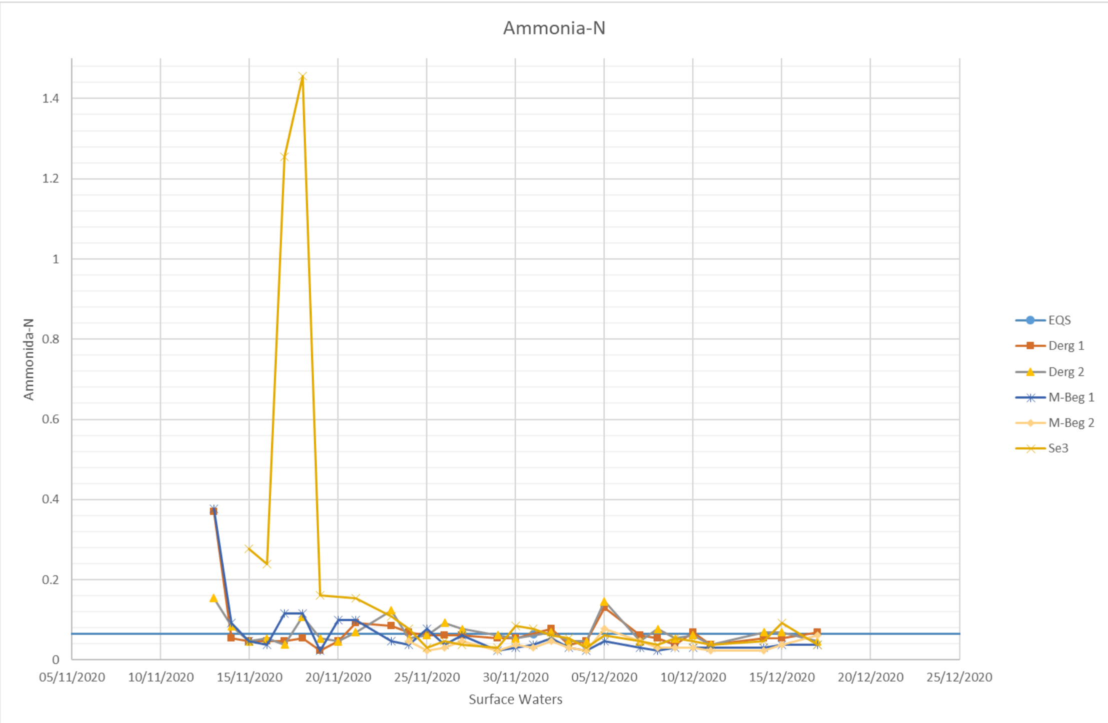

Figure 3-5. Ammonia (lab) data plot

BOD

BOD data (lab data) for SE3, MBeg1, MBeg2, Derg 1 and Derg2 are plotted on Figure 3-6, and a summary of that data is provided in Table 3-8.

Table 3-8: Summary of BOD laboratory data

Monitoring Location	BOD Data Range (mg/L)	Observed trends
SE3	48 to 1 (n = 28, μ = 1.8)	Elevated BOD was recorded up to 19th November 2020 following the peat slide, with only small temporal variations since then.
MBeg1	4-to 1 (n = 29, μ = 1.18)	Elevated BOD was recorded on 13th November 2020 following the peat slide, with only small temporal variations since then.
MBeg2	5 to 1 (n = 19, μ = 1.29)	Low background BOD, with one spike on 11th December 2020 (5mg/L).
Derg1	10 to 1 (n = 28, μ = 1.8)	Elevated BOD was recorded on 13th November 2020 and 20th November following the peat slide, with only small temporal variations since then.
Derg2	2 to 1 (n = 28, μ = 1.03)	In general, low BOD recorded.

The recorded BOD data shows elevated trends in the Shruhangarve Stream, but this has not caused any significant ongoing effect on downstream water quality in the Mourne Beg River.

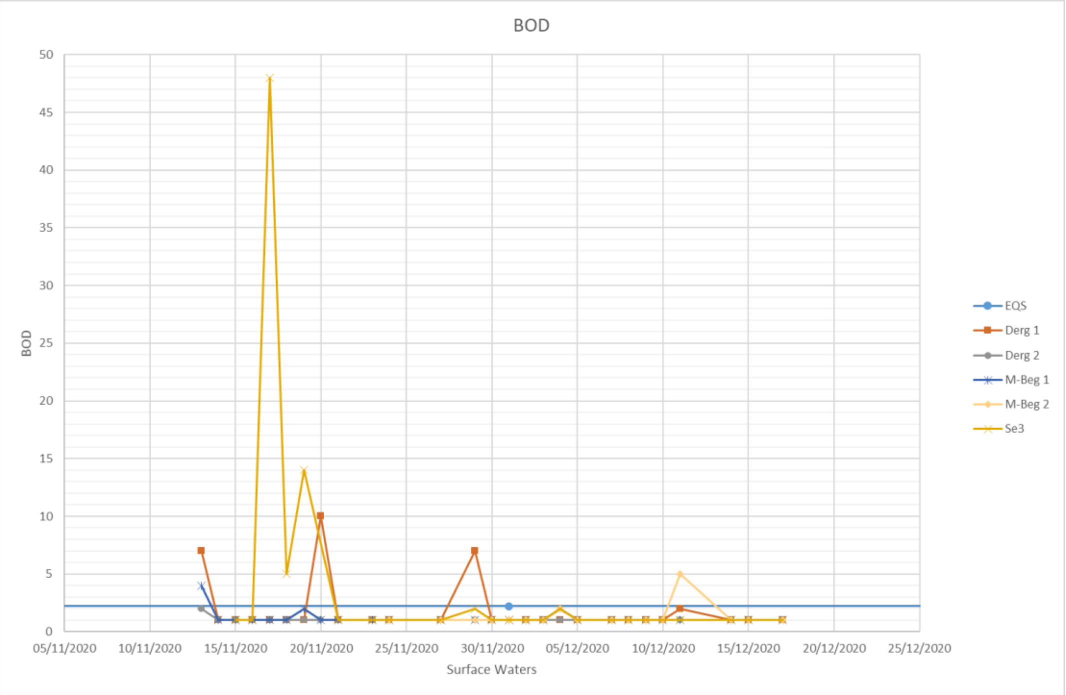

Figure 3-6. BOD (lab) data plot

3.3.5 Continuous Turbidity Monitoring

Continuous turbidity monitoring is ingoing at MSe3, MSe4, MSe5, MSe6. Data plots from between 6th November 2020 and 06th January 2021 have been analysed and a summary of these data plots is provided in

Table 3-9. The locations of Continuous turbidity monitoring points are illustrated on Figure 3-7.

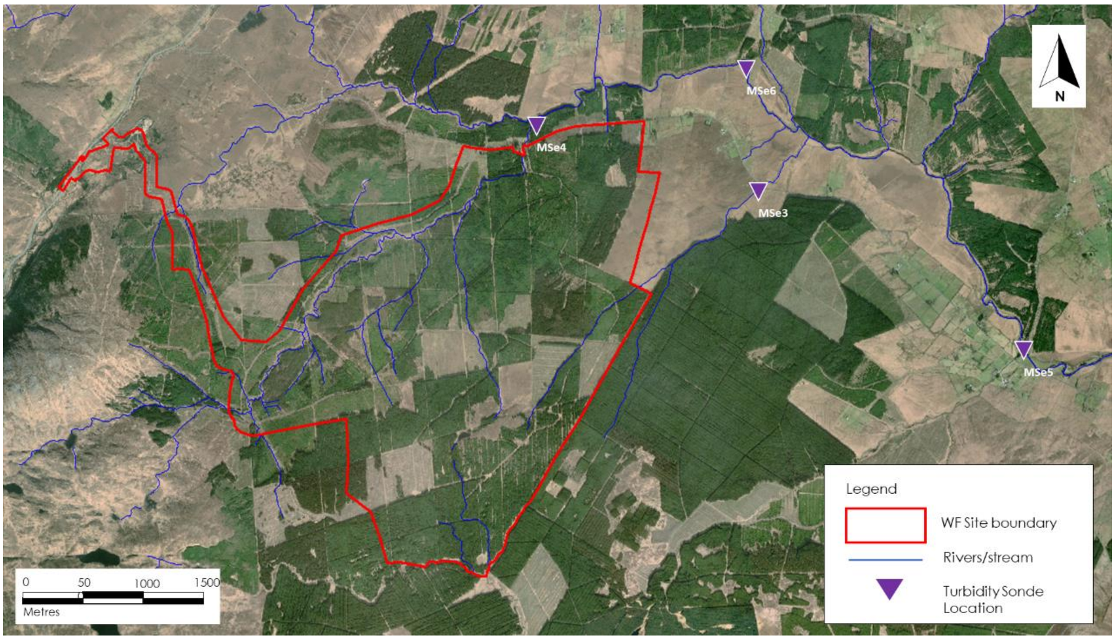

Figure 3-7. Continuous Turbidity Monitoring Locations

Table 3-9: Summary of In-Situ Continuous Turbidity monitoring data

Monitoring Location	Sonde Data Range (NTU)	Observed trends
MSe3	0 to ~5000	Background data before the slide indicated variation of between 3 to 10 NTU. Original sonde had to be replaced following the peat slide. Data shows variation in turbidity following the peat slide with gradual improvement over time back to background concentrations, with recorded spikes likely arising during/following heavy rainfall, and during the emergency works.
MSe4	2.5 to 160	Data shows variation in turbidity in the Bunadowen River north of the wind farm site. With variations and spikes likely arising during heavy rainfall.
MSe5	~1 to ~340	Data shows variation in turbidity following the peat slide with gradual improvement over time back to background concentrations, with recorded spikes likely arising during heavy

Monitoring Location	Sonde Data Range (NTU)	Observed trends
		rainfall, and initially during the emergency works.
MSe6	~1.5 to ~26	Data shows variation in turbidity following the peat slide with gradual improvement over time back to background concentrations, with recorded spikes likely arising during heavy rainfall, and initially during the emergency works.

The continuous turbidity monitoring data indicates that as a result of the mitigation measures put in place to capture peat from the peat slide and to stabilise the affected area, the levels of turbidity in the Shruhangarve, and in the Mournebeg River have returned to normal seasonal levels. Short term increases in turbidity can be seen as a direct response to rainfall events (storms), however this would be typical of peatland streams. A number of extremely high, short duration, spikes in turbidity can be seen in some instances on SE3. These are the result of debris obstructing the optical sensor on the sonde rather than being indicative of generally high turbidity in the stream.

Overall, the continuous turbidity monitoring data illustrates the improving water quality trend following the peat slide event, and these data also illustrate the natural variability of turbidity during high rainfall/flood events, as is also indicated in Section 2.6.4 (Sion Mills data).

3.4 Surface Water Quality Impact Assessment

Based on analysis of the above data, and using relevant EQSs where applicable, it appears that water quality impacts following the peat slide can be summarised as follows:

River Name:	SW Quality Impact Magnitude and Duration
Shruhangarve Stream	Significant effect on water quality for ~2-3 weeks post event (and during emergency works implementation within the wind farm site to stabilise the peat slide area), with improving water quality from early December 2020. Significant volumes of peat sludge remain on banks of the Shruhangarve, and this can be mobilised by flood flows and rainfall runoff until such time as it is stabilised or removed.
Mourne Beg River (Mourne Beg_010) Mourne Beg River (Derrygoonan) Mourne Beg River (Lisnacloone)	Likely significant effect on water quality during initial flush as the peat slide occurred, with Low to Moderate effect on water quality for ~1 week post event, with gradual return to improving water quality from early 20th November 2020 onwards (All TSS monitoring since 21st November at MBeg1 was <10 mg/L). Some pockets of peat sludge and debris remain intermittently along the river, and this can be mobilised by flood flows.
River Derg (Millbrook)	Likely moderate to significant effect on water quality during initial flush as the peat slide occurred, with Low to Moderate effect on water quality for ~1 week post event, with gradual return to improving water quality from early 21st November 2020 onwards. Indications that other anthropogenic activities may be impacting water quality in the Derg River.

The consequences of these variations in water quality on habitats and species within the Shruhangarve Stream, the Mourne Beg, and the Derg and Mourne Rivers can only be determined following ecological assessment which will be completed during summer 2021.

Based on analysis of the collated monitoring data, as outlined above, current water quality in the Shruhangarve Stream has stabilised below TSS EQS, and water quality in the Mourne Beg River and the Derg River appears to have reverted to baseline ranges.

4. ONGOING WATER QUALITY MONITORING

Water quality monitoring is ongoing at the site and at monitoring points downstream of the site, including continuous turbidity monitoring at the locations described in Section 3.3.4, field turbidity monitoring, and grab sampling for laboratory analysis. Additional water quality monitoring data will be provided once available and processed.

5. CONCLUSION

Continuous turbidity monitoring of the Bunadowan River and Shruhangarve Stream has been ongoing throughout the construction phase of the Meenbog wind farm. In response to the peat slide event on the 12th of November 2020 additional Sondes were installed on the Mourne Beg River both upstream and downstream of the confluence of the Shruhangarve Stream. In addition, a robust monitoring programme involving daily grab samples for laboratory analysis and daily field turbidity monitoring was instituted in order to assess the effects of the peat slide on the Shruhangarve Stream, the Mournebeg River, and the Derg River.

In general the turbidity in the Shruhangarve and Mournebeg is now comparable to the pre-event condition. It should be noted that there are significant accumulations of peat on the banks of the Shruhangarve that could be remobilised as the result of a large flood event. This could have the potential to result in short term significant increase in turbidity on the Shruhangarve Stream however it is unlikely that such an event would have significant impacts on the Mournebeg River due to the dilution effect as a result of the larger flows in that river.

As with the continuous turbidity monitoring data, the daily turbidity data show a very clear trend of decreasing turbidity on the Shruhangarve and a return to close to normal levels by mid-December. Short-term increases in turbidity can be seen as a result of rainfall events.

The daily grab sample data show significant negative effects on water quality immediately following the peat slide followed by a rapid improvement in water quality since the event. This is particularly evident at the Shruhangarve and Mournebeg 1 sample locations. The data appear to show a clear trend of stabilising water quality and environmental conditions at the site and in downstream waters.

In general, the surface water quality monitoring data indicate that conditions within the Shruhangarve Stream (downstream of Wall 1 barrage) and the Mournebeg River have significantly improved since the initial event and are now stable from an environmental and water quality perspective. This report does not draw any conclusions on the effect of the peat slide on protected habitats or species. The effects on habitats and species will not be fully know until the conclusion of comprehensive ecological surveys are completed in the summer of 2021.

APPENDIX 1

DAILY RAINFALL TOTALS

Date	Total Rainfall (mm)
24/11/2020	3.2
25/11/2020	4.4
26/11/2020	0.2
27/11/2020	0
28/11/2020	0.2
29/11/2020	0.8
30/11/2020	13
01/12/2020	1.8
02/12/2020	9.4
03/12/2020	3.6
04/12/2020	11.2
05/12/2020	16.6
06/12/2020	0.2
07/12/2020	1
08/12/2020	5.6
09/12/2020	3.6
10/12/2020	No data available yet
11/12/2020	No data available yet
12/12/2020	No data available yet
13/12/2020	No data available yet
14/12/2020	No data available yet
15/12/2020	No data available yet
16/12/2020	21.2
17/12/2020	7.4
18/12/2020	3.4
19/12/2020	8.8
20/12/2020	16
21/12/2020	3
22/12/2020	0.2
23/12/2020	2.8
24/12/2020	1.6
25/12/2020	9
26/12/2020	36.2
27/12/2020	18.8
28/12/2020	12
29/12/2020	8
30/12/2020	0
31/12/2020	0.6
01/01/2021	0.2
02/01/2021	0.6
03/01/2021	0.2
04/01/2021	0.2
05/01/2021	0.2
06/01/2021	0

07/01/2021	0.8
08/01/2021	0

APPENDIX 2

DAILY FIELD TURBIDITY MONITORING DATA

Monitoring Point	Date	Turbidity (NTU)
MBeg1	24/11/2020	8.3
MBeg1	25/11/2020	4.09
MBeg1	26/11/2020	3.71
MBeg1	27/11/2020	3.92
MBeg1	30/11/2020	3.34
MBeg1	01/12/2020	6.25
MBeg1	02/12/2020	2.32
MBeg1	03/12/2020	6.32
MBeg1	04/12/2020	4.06
MBeg1	05/12/2020	3.91
MBeg1	07/12/2020	2.11
MBeg1	08/12/2020	--
MBeg1	09/12/2020	5.49
MBeg1	10/12/2020	3.92
MBeg1	11/12/2020	3.52
MBeg1	12/12/2020	2.81
MBeg1	14/12/2020	3.21
MBeg1	15/12/2020	3.41
MBeg1	16/12/2020	7.89
MBeg1	17/12/2020	2.24
MBeg1	18/12/2020	2.85
MBeg1	19/12/2020	1.67
MBeg1	21/12/2020	3.05
MBeg 1	22/12/2020	2.32
MBeg 1	30/12/2020	1.83
MBeg 1	04/01/2021	0.97
MBeg 1	05/01/2021	4.6
MBeg2	24/11/2020	5.36
MBeg2	25/11/2020	3.934
MBeg2	26/11/2020	3.27
MBeg2	27/11/2020	2.92
MBeg2	30/11/2020	1.35
MBeg2	01/12/2020	6.12
MBeg2	02/12/2020	3.66
MBeg2	03/12/2020	4.31
MBeg2	04/12/2020	3.49
MBeg2	05/12/2020	9.25
MBeg2	07/12/2020	1.84
MBeg2	08/12/2020	
MBeg2	09/12/2020	1.2
MBeg2	10/12/2020	4.71
MBeg2	11/12/2020	2.38

Monitoring Point	Date	Turbidity (NTU)
MBeg2	12/12/2020	3.43
MBeg2	14/12/2020	3.15
MBeg2	15/12/2020	3.64
MBeg2	16/12/2020	5.65
MBeg2	17/12/2020	2.73
MBeg2	18/12/2020	2.61
MBeg2	19/12/2020	1.26
MBeg2	21/12/2020	2.51
MBeg2	22/12/2020	2.67
MBeg2	30/12/2020	1.47
MBeg2	04/01/2021	1.15
MBeg2	05/01/2021	2.45
SE3	24/11/2020	81.2
SE3	25/11/2020	23.2
SE3	26/11/2020	19.43333333
SE3	27/11/2020	22.1
SE3	30/11/2020	19.1
SE3	01/12/2020	26.2
SE3	02/12/2020	11.4
SE3	03/12/2020	10.7
SE3	04/12/2020	7.56
SE3	05/12/2020	48.2
SE3	07/12/2020	4.22
SE3	08/12/2020	
SE3	09/12/2020	11.4
SE3	10/12/2020	5.69
SE3	11/12/2020	5.16
SE3	12/12/2020	3.91
SE3	14/12/2020	8.57
SE3	15/12/2020	4.15
SE3	16/12/2020	23.4
SE3	17/12/2020	5.58
SE3	18/12/2020	4.48
SE3	19/12/2020	5.13
SE3	21/12/2020	9.38
SE3	22/12/2020	3.8
SE3	30/12/2020	2.15
SE3	04/01/2021	1.75
SE3	05/01/2021	4.21
SW3	24/11/2020	10.8
SW3	25/11/2020	7.74

Monitoring Point	Date	Turbidity (NTU)
SW3	26/11/2020	3.47
SW3	27/11/2020	3.84
SW3	30/11/2020	32.1
SW3	01/12/2020	7.71
SW3	02/12/2020	6.67
SW3	03/12/2020	5.19
SW3	04/12/2020	4.77
SW3	05/12/2020	18.9
SW3	07/12/2020	4.66
SW3	08/12/2020	3.8
SW3	09/12/2020	1.58
SW3	10/12/2020	5.24
SW3	11/12/2020	4.15
SW3	12/12/2020	4.94
SW3	14/12/2020	2.3
SW3	15/12/2020	2.28
SW3	16/12/2020	7.32
SW3	17/12/2020	4.66
SW3	18/12/2020	4.27
SW3	19/12/2020	5.43
SW3	21/12/2020	4.79
SW3	22/12/2020	3.1
SW3	27/12/2020	0.93
SW3	04/01/2021	3.33
SW3	05/01/2021	1.94

APPENDIX 3

DAILY GRAB SAMPLE DATA

Year	Month	Date	Location ID	Total Phosphorus	Chloride	Nitrate	Nitrite	Orthophosphate	Unionised Ammonia (NH_3)	Ammonia (NH_4)	BOD	DO	Electrical Con	pH	Total Suspended Solids
				mg P/l	mg Cl-/l	mg NO3/l	mg NO2/l	mg P/l	mg NH3/l	mg NH4/l	mg O2/l	mg/l			mg/l
			EQS	0.4	250	25	0.05	0.045	0.5	0.2	2.2				25
2020	11	13/11/2020	Derg-1	0.209	11.7	1.6	0.02	0.03	0.45	0.48	7		76	5.88	951
2020	11	14/11/2020	Derg-1	NA	NA	NA	NA	NA	0.07	0.07	1		NA	7.01	20
2020	11	15/11/2020	Derg-1	0.067	10.7	1.2	0.02	0.03	0.06	0.06	1		85	6.86	48
2020	11	16/11/2020	Derg-1	0.045	10.5	0.9	0.02	0.03	0.06	0.06	1		88	7.23	10
2020	11	17/11/2020	Derg-1	0.066	9.2	0.4	0.02	0.04	0.06	0.06	1		91	7.23	66
2020	11	18/11/2020	Derg-1	0.078	9.9	1.1	0.02	0.04	0.07	0.07	1		72	6.75	20
2020	11	19/11/2020	Derg-1	0.083	9.3	0.9	0.02	0.04	0.03	0.03	1		64	6.84	13
2020	11	20/11/2020	Derg-1	0.102	8.2	0.6	0.02	0.04	0.06	0.06	10		58	6.74	21
2020	11	21/11/2020	Derg-1	0.056	7.3	0.5	0.02	0.04	0.11	0.12	1		52	6.61	22
2020	11	23/11/2020	Derg-1	0.051	11.2	2.6	0.02	0.03	0.1	0.11	1		99	7.11	12
2020	11	24/11/2020	Derg-1	0.085	7.5	0.7	0.02	0.07	0.08	0.09	1		64	6.66	10
2020	11	25/11/2020	Derg-1	0.062	10.9	2.6	0.02	0.03	0.08	0.08			112	6.85	10
2020	11	26/11/2020	Derg-1	0.046	9.7	1.7	0.02	0.03	0.08	0.08			87	6.8	10
2020	11	27/11/2020	Derg-1	0.039	13.9	4.4	0.02	0.03	0.08	0.08	1		152	7.26	10
2020	11	29/11/2020	Derg-1	0.054	13.4	3.5	0.02	0.03	0.07	0.07	7		135	7	10
2020	11	30/11/2020	Derg-1	0.053	12.2	2.4	0.02	0.03	0.07	0.07	1	9	110	7.18	10
2020	12	02/12/2020	Derg-1	0.038	10.5	1.3	0.02	0.03	0.09	0.1	1	10	92	6.88	10
2020	12	03/12/2020	Derg-1	0.046	10	1.2	0.02	0.03	0.05	0.05	1	10	86	6.82	10
2020	12	04/12/2020	Derg-1	0.037	16.2	2.9	0.02	0.03	0.06	0.06	1	11	133	7.06	10
2020	12	05/12/2020	Derg-1	0.115	13.3	0.8	0.02	0.09	0.16	0.17	1	10	85	6.7	11
2020	12	07/12/2020	Derg-1	0.044	13.1	2.3	0.02	0.03	0.08	0.08	1	10	117	6.99	10
2020	12	08/12/2020	Derg-1	0.072	15.3	3.5	0.02	0.03	0.07	0.07	1	9	141	7.21	10
2020	12	09/12/2020	Derg-1	0.018	13.3	2.6	0.02	0.03	0.05	0.05	1	10	110	6.91	10
2020	12	10/12/2020	Derg-1	0.013	12.3	1.9	0.02	0.03	0.08	0.09	1	10	103	6.83	10
2020	12	11/12/2020	Derg-1	0.034	11.5	1.4	0.02	0.03	0.05	0.05	2	10	92	6.92	10
2020	12	14/12/2020	Derg-1	0.02	12.6	1.9	0.02	0.03	0.07	0.07	1	10	105	6.86	10
2020	12	15/12/2020	Derg-1	0.023	12	2	0.02	0.03	0.07	0.07	1	10	100	7.02	5
2020	12	17/12/2020	Derg-1	0.026	10.3	1.2	0.02	0.03	0.08	0.09	1	10	83	6.91	4

2020	11	13/11/2020	Derg-2	0.113	11.4	1.4	0.02	0.04	0.19	0.2	2		75	6.56	349
2020	11	14/11/2020	Derg-2	NA	NA	NA	NA	NA	0.1	0.11	1		NA	7.43	33
2020	11	15/11/2020	Derg-2	0.083	9.9	0.8	0.02	0.04	0.06	0.06	1		69	6.85	59
2020	11	16/11/2020	Derg-2	0.075	9.3	0.4	0.02	0.04	0.07	0.07	1		64	6.83	87
2020	11	17/11/2020	Derg-2	0.042	12.2	2.1	0.02	0.04	0.05	0.05	1		128	7.31	10
2020	11	18/11/2020	Derg-2	0.098	10.1	1.2	0.02	0.03	0.13	0.14	1		132	6.78	34
2020	11	19/11/2020	Derg-2	0.084	8.9	0.8	0.02	0.04	0.07	0.07	1		74	6.91	15
2020	11	20/11/2020	Derg-2	0.093	8.8	0.7	0.02	0.03	0.06	0.06	1		63	6.92	32
2020	11	21/11/2020	Derg-2	0.087	7.4	0.7	0.02	0.05	0.08	0.09	1		60	6.4	28
2020	11	23/11/2020	Derg-2	0.069	10.2	1.6	0.02	0.03	0.15	0.16	1		89	6.66	26
2020	11	24/11/2020	Derg-2	0.087	7.5	0.8	0.02	0.07	0.07	0.07	1		65	6.86	10
2020	11	25/11/2020	Derg-2	0.065	9.1	1.2	0.02	0.03	0.08	0.08			91	6.82	10
2020	11	26/11/2020	Derg-2	0.046	9.8	1.8	0.02	0.04	0.11	0.12			94	6.79	10
2020	11	27/11/2020	Derg-2	0.044	10.6	1.9	0.02	0.03	0.09	0.1	1		103	6.92	10
2020	11	29/11/2020	Derg-2	0.056	11.4	2.3	0.02	0.04	0.08	0.08	1		117	7.25	10
2020	11	30/11/2020	Derg-2	0.073	12.3	2.8	0.02	0.03	0.07	0.07	1	9	116	6.96	21
2020	12	02/12/2020	Derg-2	0.052	10.5	1.6	0.02	0.03	0.08	0.09	1	10	94	6.81	10
2020	12	03/12/2020	Derg-2	0.06	9.2	0.7	0.02	0.03	0.06	0.06	1	10	79	6.9	10
2020	12	04/12/2020	Derg-2	0.049	10.5	1	0.02	0.03	0.06	0.06	1	11	84	6.77	10
2020	12	05/12/2020	Derg-2	0.153	13.7	1	0.02	0.16	0.18	0.19	1	10	92	6.92	10
2020	12	07/12/2020	Derg-2	0.053	12.3	1.8	0.02	0.03	0.06	0.06	1	10	106	7.08	10
2020	12	08/12/2020	Derg-2	0.074	14.1	2.2	0.02	0.03	0.09	0.1	1	9	119	6.93	10
2020	12	09/12/2020	Derg-2	0.022	12.4	1.7	0.02	0.03	0.07	0.07	1	10	98	7.08	10
2020	12	10/12/2020	Derg-2	0.037	11.8	1.9	0.02	0.03	0.08	0.08	1	10	103	6.77	12
2020	12	11/12/2020	Derg-2	0.044	11.2	0.9	0.02	0.03	0.05	0.05	1	10	77	6.75	41
2020	12	14/12/2020	Derg-2	0.069	11.6	1.1	0.02	0.03	0.08	0.09	1	10	89	6.92	10

2020	12	15/12/2020	Derg-2	0.051	11.6	1.9	0.02	0.03	0.08	0.09	1	10	101	6.91	14
2020	12	17/12/2020	Derg-2	0.029	9.8	1.2	0.02	0.04	0.06	0.06	1	10	137	4.13	4

2020	11	15/11/2020	SE3	0.14	11.1	0.2	0.2	0.06	0.34	0.36	1		74	6.5	333
2020	11	16/11/2020	SE3	0.116	11	0.2	0.02	0.07	0.29	0.31	1		63	5.95	158
2020	11	17/11/2020	SE3	0.77	9.3	0.2	0.02	0.06	1.54	1.63	48		51	4.88	4690
2020	11	18/11/2020	SE3	0.644	8.7	0.2	0.02	0.04	1.78	1.89	5		71	4.72	3287
2020	11	19/11/2020	SE3	0.123	8.7	0.2	0.02	0.07	0.2	0.21	14		48	4.8	111
2020	11	21/11/2020	SE3	0.089	6.9	0.4	0.02	0.07	0.19	0.2	1		40	5.57	96
2020	11	23/11/2020	SE3	0.091	7.6	0.2	0.02	0.06	0.13	0.14	1		57	4.86	58
2020	11	24/11/2020	SE3	0.094	5.9	0.2	0.02	0.06	0.09	0.1	1		42	4.6	44
2020	11	25/11/2020	SE3	0.13	6.8	0.2	0.02	0.07	0.04	0.04			43	4.8	50
2020	11	26/11/2020	SE3	0.087	6.9	0.2	0.02	0.07	0.06	0.06			275	4.87	10
2020	11	27/11/2020	SE3	0.101	7.6	0.2	0.02	0.09	0.05	0.05	1		50	5.2	10
2020	11	29/11/2020	SE3	0.127	8.2	0.2	0.02	0.11	0.04	0.04	2		54	4.73	10
2020	11	30/11/2020	SE3	0.111	7.2	0.3	0.02	0.1	0.1	0.11	1	9	39	5.31	17
2020	12	01/12/2020	SE3	0.124	8.1	0.4	0.02	0.12	0.09	0.1	1	9	45	5.49	16
2020	12	02/12/2020	SE3	0.106	7.8	0.2	0.02	0.09	0.08	0.08	1	10	45	5.08	14
2020	12	03/12/2020	SE3	0.095	7.8	0.2	0.02	0.1	0.07	0.07	1	10	43	5.07	10
2020	12	04/12/2020	SE3	0.092	8.2	0.2	0.02	0.09	0.04	0.04	2	11	47	6.36	10
2020	12	05/12/2020	SE3	0.15	10.8	0.2	0.02	0.07	0.08	0.08	1	10	52	5.27	112
2020	12	07/12/2020	SE3	0.068	11	0.2	0.02	0.05	0.06	0.06	1	10	54	4.83	10
2020	12	08/12/2020	SE3	0.085	10.2	0.2	0.02	0.06	0.05	0.05	1	9	51	5.14	10
2020	12	09/12/2020	SE3	0.061	10.4	0.2	0.02	0.07	0.07	0.07	1	10	49	5.04	20
2020	12	10/12/2020	SE3	0.059	10.3	0.2	0.02	0.09	0.06	0.06	1	10	51	5.38	10
2020	12	11/12/2020	SE3	0.06	10.9	0.2	0.02	0.08	0.05	0.05	1	10	49	4.93	10
2020	12	14/12/2020	SE3	0.046	10.8	0.2	0.02	0.08	0.06	0.06	1	10	50	4.97	10
2020	12	15/12/2020	SE3	0.039	10.7	0.2	0.02	0.07	0.11	0.12	1	10	55	4.86	6
2020	12	17/12/2020	SE3	0.041	10	0.2	0.02	0.06	0.05	0.05	1	10	52	4.92	6

2020	11	13/11/2020	M-Beg 1	0.169	12	0.2	0.02	0.03	0.46	0.49	4		57	4.97	875
2020	11	14/11/2020	M-Beg 1	NA	NA	NA	NA	NA	0.11	0.12	1		NA	5.31	111
2020	11	15/11/2020	M-Beg 1	0.055	10.9	0.2	0.02	0.03	0.06	0.06	1		51	6.11	37
2020	11	16/11/2020	M-Beg 1	0.041	10.6	0.2	0.02	0.03	0.05	0.05	1		55	6.35	13
2020	11	17/11/2020	M-Beg 1	0.074	9.2	0.2	0.02	0.03	0.14	0.15	1		48	5.82	233
2020	11	18/11/2020	M-Beg 1	0.07	9	0.2	0.02	0.03	0.14	0.15	1		44	5.7	129
2020	11	19/11/2020	M-Beg-1	0.049	8.8	0.2	0.02	0.03	0.03	0.03	2		44	5.54	16
2020	11	20/11/2020	M-Beg-1	0.105	8	0.2	0.02	0.04	0.12	0.13	1		42	5.15	293
2020	11	21/11/2020	M-Beg 1	0.043	7.3	0.2	0.02	0.03	0.12	0.13	1		42	5.92	10
2020	11	23/11/2020	M-Beg 1	0.035	8.5	0.5	0.02	0.03	0.06	0.06	1		43	6.32	10
2020	11	24/11/2020	M-Beg 1	0.045	7.5	0.2	0.02	0.03	0.05	0.05	1		40	5.7	11
2020	11	25/11/2020	M-Beg 1	0.036	7.9	0.2	0.02	0.03	0.09	0.1			96	6.22	10
2020	11	26/11/2020	M-Beg 1	0.033	7.6	0.2	0.02	0.03	0.05	0.05			43	6.15	10
2020	11	27/11/2020	M-Beg 1	0.034	8.1	0.2	0.02	0.03	0.08	0.08	1		46	5.69	10
2020	11	29/11/2020	M-Beg 1	0.036	8.3	0.3	0.02	0.03	0.03	0.03	1		50	5.32	10
2020	11	30/11/2020	M-Beg 1	0.038	8.4	0.4	0.02	0.03	0.04	0.04	1	9	46	6.55	10
2020	12	01/12/2020	M-Beg 1	0.037	8.4	0.3	0.02	0.03	0.05	0.05	1	10	45	6.14	10
2020	12	02/12/2020	M-Beg 1	0.03	8.2	0.2	0.02	0.03	0.07	0.07	1	10	47	5.39	10
2020	12	03/12/2020	M-Beg 1	0.035	8.2	0.2	0.02	0.03	0.04	0.04	1	10	43	6.12	10
2020	12	04/12/2020	M-Beg 1	0.034	8.5	0.2	0.02	0.03	0.03	0.03	2	11	43	6.16	10
2020	12	05/12/2020	M-Beg 1	0.053	10.2	0.2	0.02	0.03	0.06	0.06	1	10	48	5.94	10
2020	12	07/12/2020	M-Beg 1	0.039	10.4	0.2	0.02	0.03	0.04	0.04	1	11	61	5.95	10
2020	12	08/12/2020	M-Beg-1	0.044	11.1	0.2	0.02	0.03	0.03	0.03	1	9	54	6.31	10

2020	12	09/12/2020	M-Beg-1	0.015	11	0.2	0.02	0.03	0.04	0.04	1	10	55	6.27	10
2020	12	10/12/2020	M-Beg 1	0.042	11	0.2	0.02	0.03	0.04	0.04	1	10	59	6.92	10
2020	12	11/12/2020	M-Beg 1	0.02	10.5	0.2	0.02	0.03	0.04	0.04	1	10	59	6.77	10
2020	12	14/12/2020	M-Beg 1	0.008	10.5	0.5	0.02	0.03	0.04	0.04	1	10	50	6.28	10
2020	12	15/12/2020	M-Beg 1	0.021	10.2	0.2	0.02	0.03	0.05	0.05	1	10	57	7.14	4
2020	12	17/12/2020	M-Beg 1	0.013	9.3	0.2	0.02	0.03	0.05	0.05	1	10	46	6.21	4

2020	11	24/11/2020	M-Beg 2	0.039	9	0.2	0.02	0.03	0.06	0.06	1		572	5.55	13
2020	11	25/11/2020	M-Beg 2	0.028	7.7	0.2	0.02	0.03	0.03	0.03			60	5.97	10
2020	11	26/11/2020	M-Beg 2	0.036	7.1	0.2	0.02	0.03	0.04	0.04			40	6.38	10
2020	11	27/11/2020	M-Beg 2	0.027	7.9	0.2	0.02	0.03	0.06	0.06	1		44	6.28	10
2020	11	29/11/2020	M-Beg 2	0.033	8.1	0.2	0.02	0.03	0.03	0.03	1		56	5.39	10
2020	11	30/11/2020	M-Beg 2	0.032	8.4	0.4	0.02	0.03	0.05	0.05	1	9	44	7.18	10
2020	12	01/12/2020	M-Beg 2	0.036	8.2	0.4	0.02	0.03	0.04	0.04	1	10	46	6.21	10
2020	12	02/12/2020	M-Beg 2	0.028	8.1	0.2	0.02	0.03	0.06	0.06	1	10	42	6.18	10
2020	12	03/12/2020	M-Beg 2	0.034	7.8	0.2	0.02	0.03	0.04	0.04	1	10	42	6.36	10
2020	12	04/12/2020	M-Beg 2	0.035	8.2	0.2	0.02	0.03	0.03	0.03	2	11	42	6.41	10
2020	12	05/12/2020	M-Beg 2	0.05	11.1	0.3	0.02	0.03	0.09	0.1	1	10	55	6.33	10
2020	12	07/12/2020	M-Beg 2	0.036	10.2	0.2	0.02	0.03	0.06	0.06	1	11	54	6.25	10
2020	12	08/12/2020	M-Beg 2	0.042	10.7	0.3	0.02	0.03	0.04	0.04	1	9	54	6.14	10
2020	12	09/12/2020	M-Beg 2	0.009	10.5	0.2	0.02	0.03	0.04	0.04	1	10	46	6.2	10
2020	12	10/12/2020	M-Beg 2	0.035	10.2	0.2	0.02	0.03	0.04	0.04	1	10	61	6.65	10
2020	12	11/12/2020	M-Beg 2	0.014	10	0.2	0.02	0.03	0.03	0.03	5	10	50	6.17	10
2020	12	14/12/2020	M-Beg 2	0.005	10.3	0.2	0.02	0.03	0.03	0.03	1	10	49	6.23	10
2020	12	15/12/2020	M-Beg 2	0.013	9.8	0.2	0.02	0.03	0.05	0.05	1	10	49	6.71	6
2020	12	17/12/2020	M-Beg 2	0.011	9.1	0.2	0.02	0.03	0.08	0.08	1	11	45	6.54	5