MOORS FOR THE FUTURE PARTNERSHIP

THE DESIGN AND EFFECT OF BLOCKING DEEP, MINERAL-BASED PEAT PIPES ON A DEGRADED BLANKET BOG

ANNEX 2

MoorLIFE 2020

Prepared by:

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Preparation and construction of dams for blocking mineral-based peat pipes on Arnfield

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1. Characteristics of pipes on Arnfield moor

- Mineral base
- Pipes have varying diameter – up to 1 m
- Depth of peat 1–2 m
- Collapsed sections (gullies) are of varying lengths
- Collapsed sections follow the original line of the peat pipe,
- Collapsed sections are heavily vegetated with bare peat on steep sides

In some cases the collapsed section is a vertical hole in the ground:

2. Diagrams used in the report

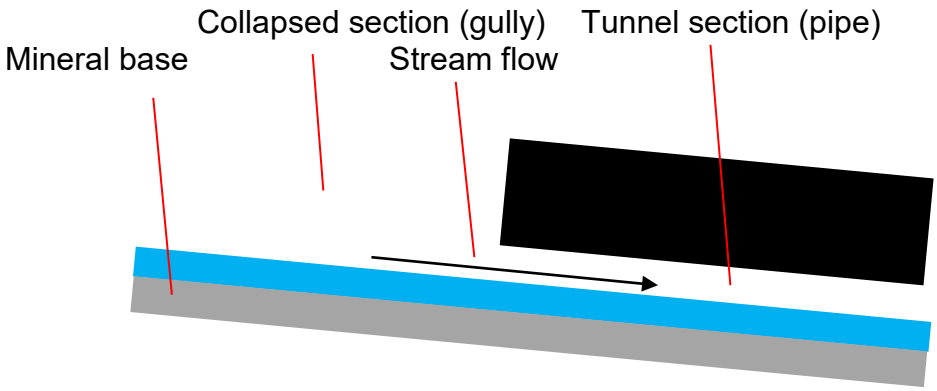

Fig. 1. **Side elevation of peat pipe**

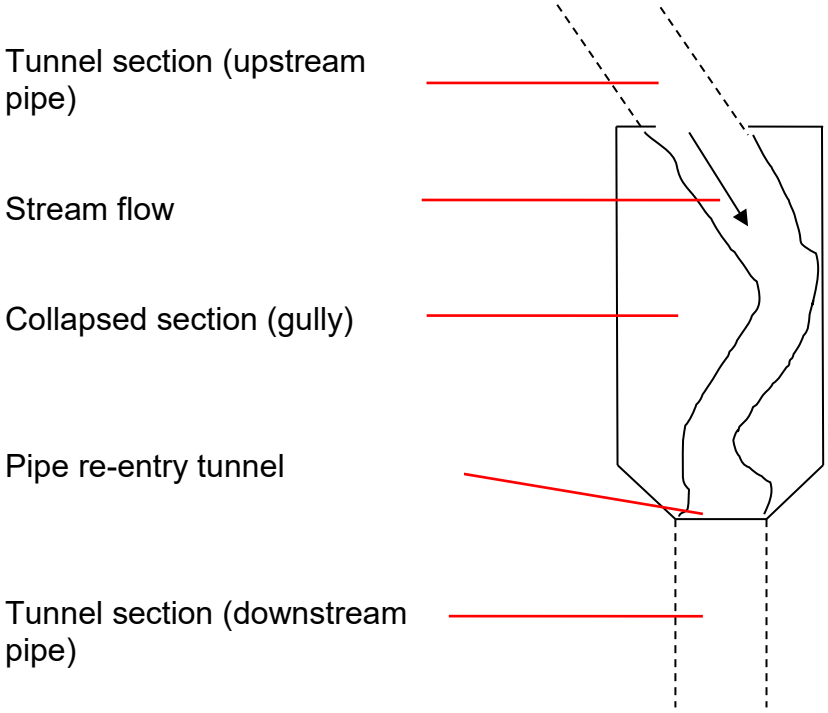

Fig. 2. **Plan (view from top) of peat pipe**

3. Summary work specifications

3.1. Preparation work (stone/peat dams only)

- Excavate downstream from the pipe entrance by minimum 1m, removing pipe roof and widening the area around the pipe mouth by 60 cm on each side of the pipe entrance, making clean
- Excavate upstream (6 m for stone dams; 7 m for peat dams), removing boulders, vegetation (with intact root zone) and peat in separate piles

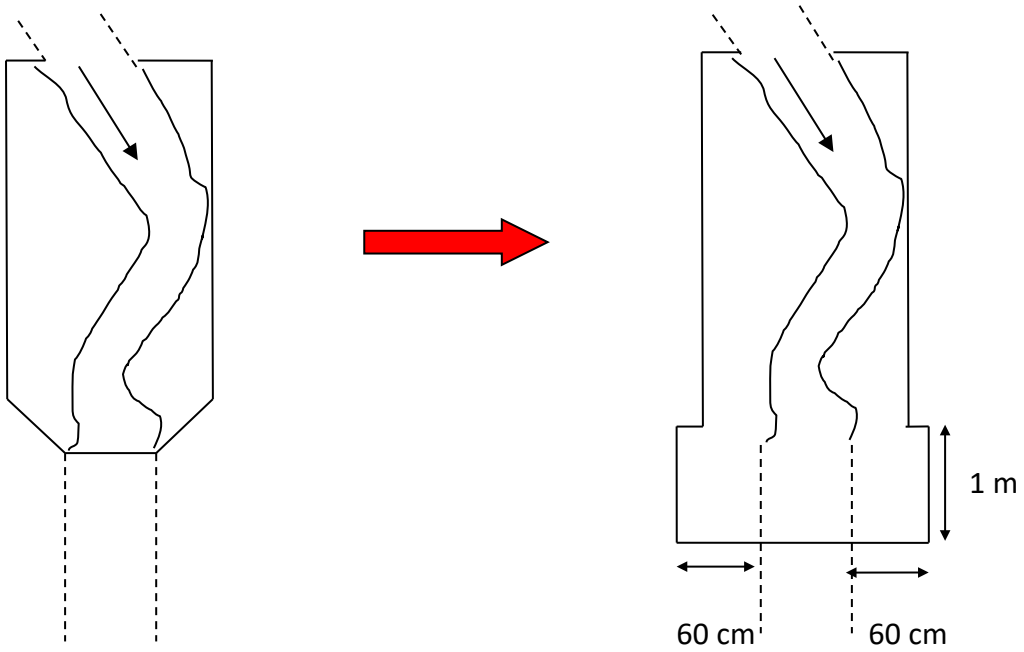

Fig. 3. Plan showing excavation downstream and upstream of pipe entrance

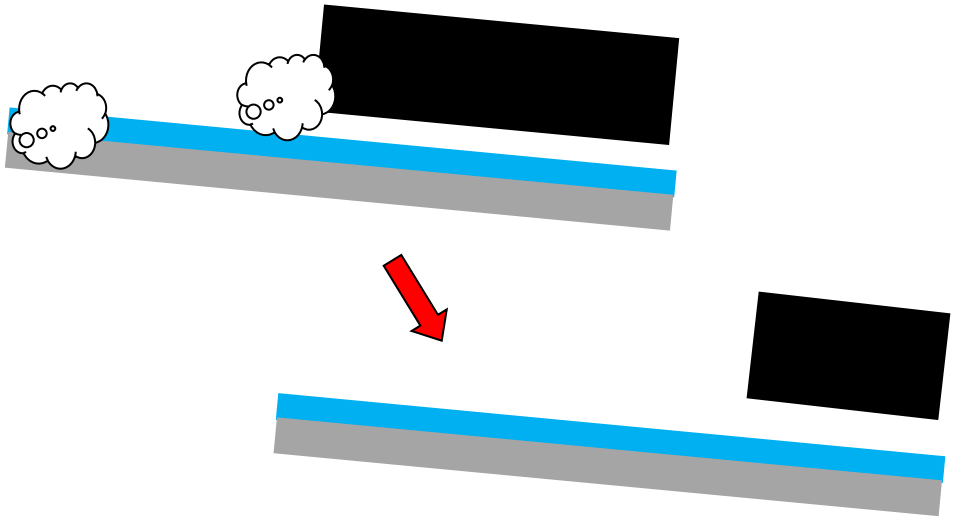

Fig. 4. Elevation showing removal of boulders and debris from gully floor upstream of pipe entrance

3.2. Peat dams

- Construct peat dam using intact peat
- Construct peat dam 1 m upstream of prepared pipe entrance
- Re-profile with peat upstream/downstream and on top of peat dam using peat from preparation phase
- Top-fill with turves, proud of surface, to shed water

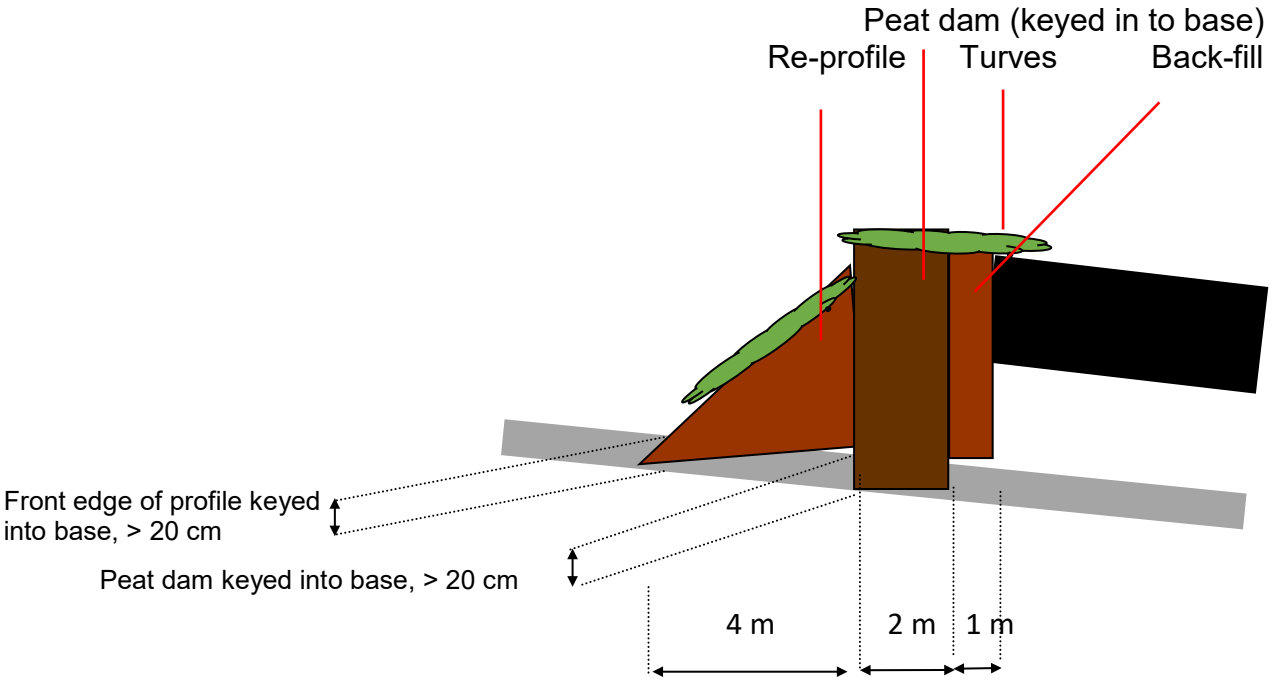

Fig. 5. Elevation view of peat dam

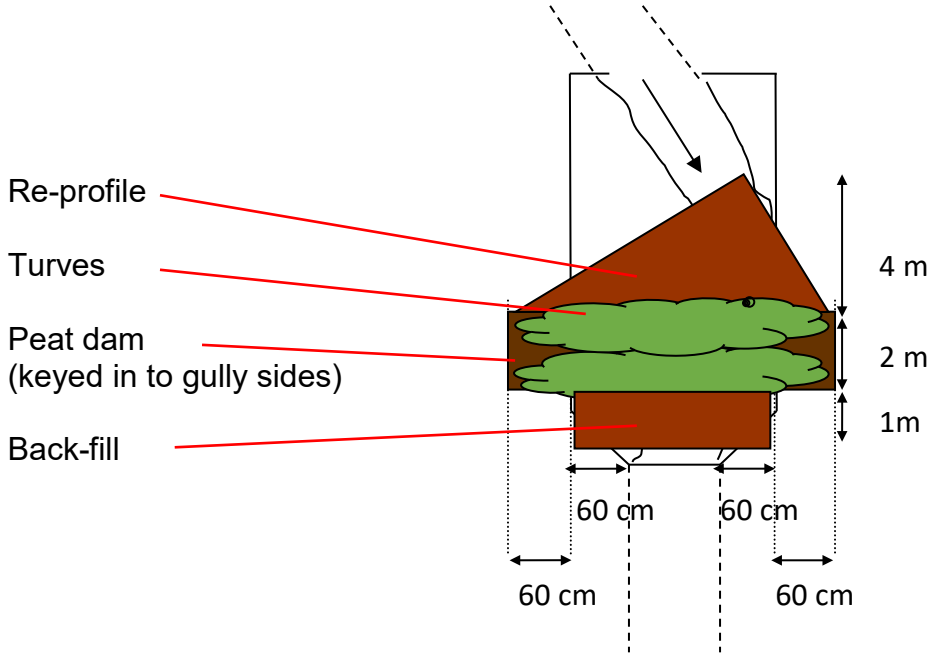

Fig. 6. Plan view of peat dam

3.3. Stone dams

- Heap stones directly at pipe entrance
- Stones to fill up above pipe roof by at least 1 m and 60 cm into sides
- Stones to span entire width of gully
- Re-profile peat upstream and on top of stones using peat from preparation phase
- Top-fill with turves, proud of surface, to shed water

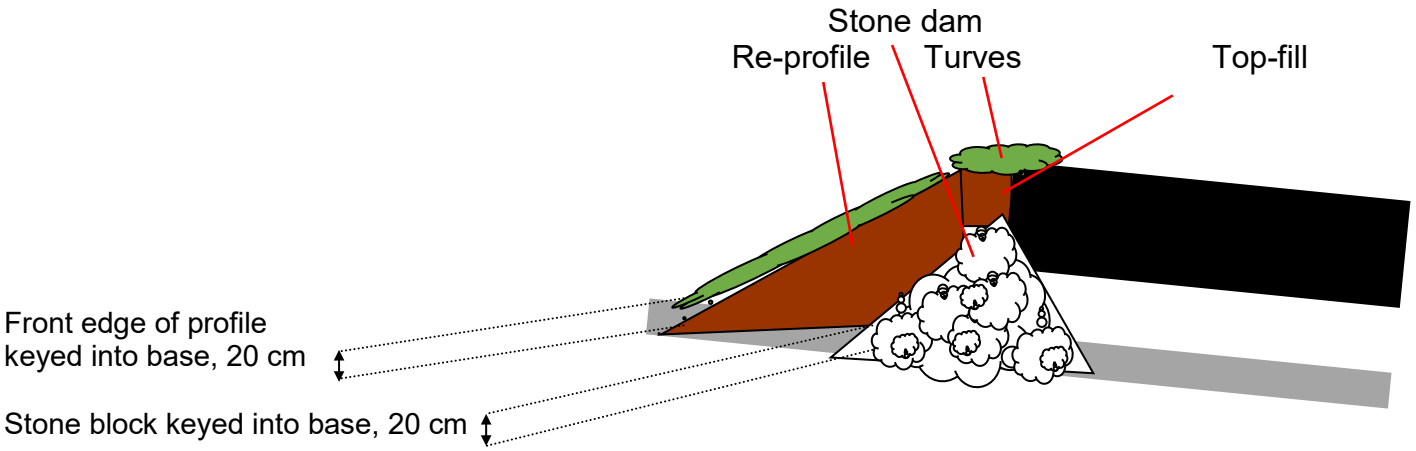

Fig. 7. Elevation view of stone dam

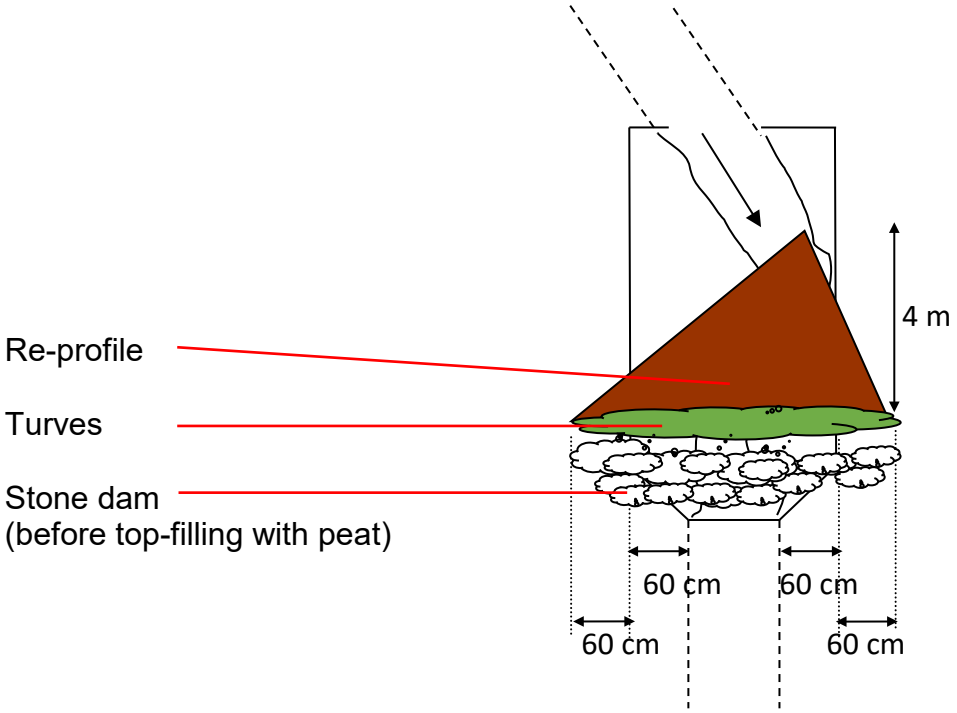

Fig. 8. Plan view of stone dam

3.4. Heather bale dams

- Dismantle bale material and construct blockage inside the pipe entrance
- Re-profile upstream using peat from preparation phase
- Insert non-living stakes through roof of pipe to stabilise block in position

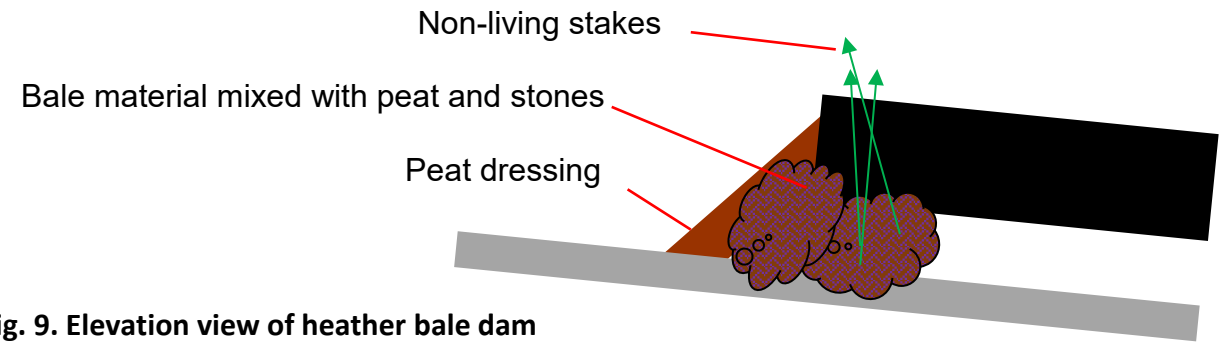

Fig. 9. Elevation view of heather bale dam

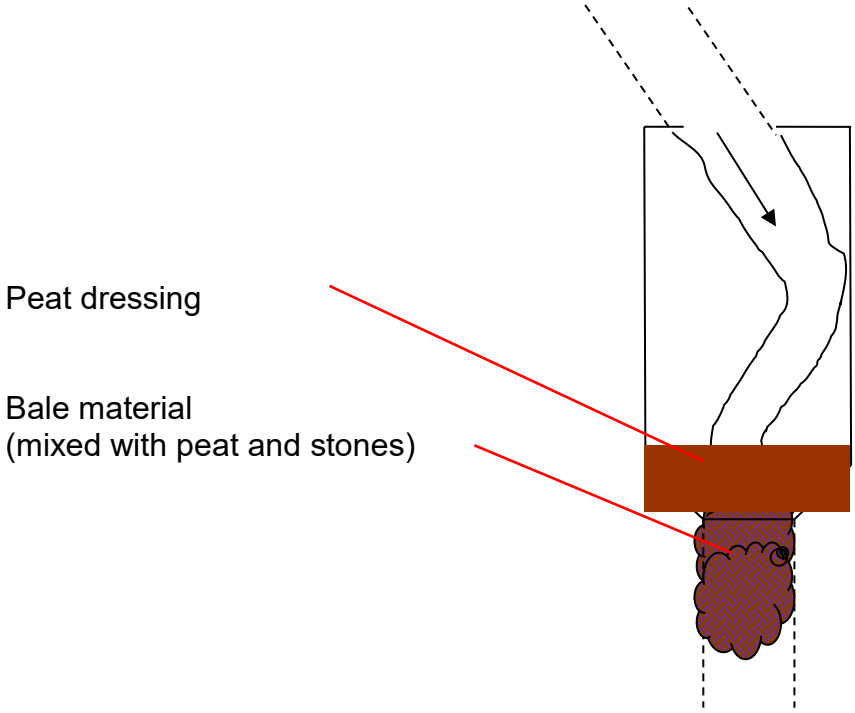

Fig. 10. Plan view of heather bale dam

4. Access routes to work site from Arnfield farm

No access during the main bird nesting season 1st April to 31st July.

The Blue line in the map below indicates a hard rocky farm track for which 4WD vehicles or quad bikes are a minimum requirement because of steep slopes and the need for high ground clearance in places (Fig. 3).

The Green line indicates a further degradation in the road surface; at first the hard rocky farm track becomes steeper, and then, higher up, becomes a soft peaty track with some boggy sections and occasional steep inclines. In wet or even slightly wet conditions, low pressure-bearing, tracked vehicles or quad bikes with studded tyres are required to minimise the risk of damage.

The Black dotted line indicates a very rough “semi” track which skirts a fence line. The route then turns off the semi-track to cross rough gullied moorland. Access to or egress from the work site is a possibility here, especially egress where the descent will help minimise damage. Low pressure-bearing, tracked vehicles or quad bikes with studded tyres only

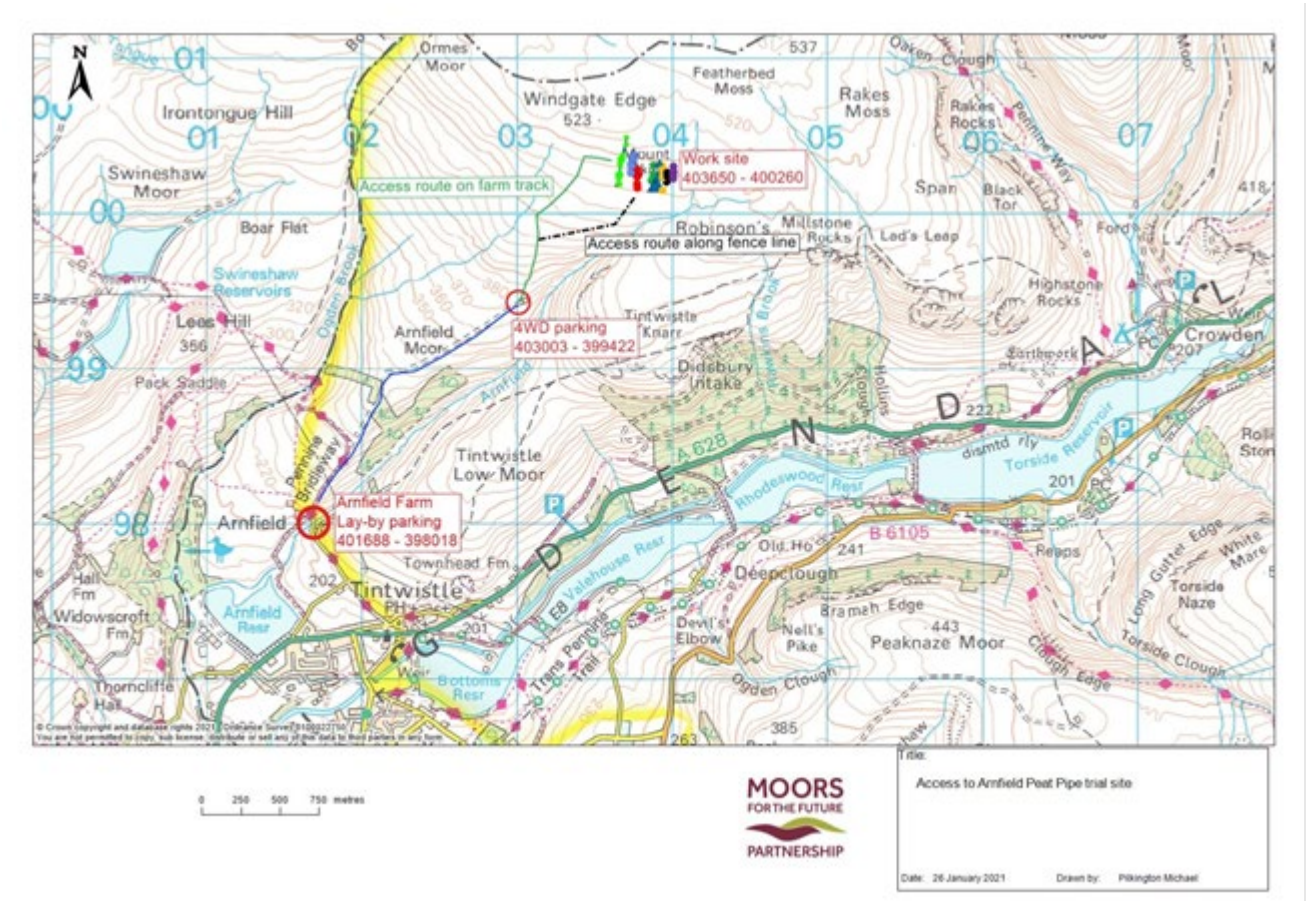

Fig. 11. Map of access/egress routes from Arnfield Farm

5. Movement and use of machinery

No work will be undertaken during the main bird nesting season 1st April to 31st July.

5.1. Risk Assessment Method Statement (RAMS)

The Contractor will provide a RAMS with its Tender which will include methods for

1. tracking Machinery and Equipment to and from Sites
2. choosing access/egress routes to and from Sites
3. maintaining mechanical condition and functioning of equipment
4. ensuring skilled and efficient operation of machinery
5. tracking Machinery on Sites with very wet, boggy ground; use of bog mats
6. avoiding Machinery bogging down when accessing/egressing or on Sites
7. recovering Machinery bogged down when accessing/egressing or on Sites
8. avoiding damage to peat surfaces on Sites
9. repairing damaged peat surfaces on Sites during general movement or recovery of bogged down Machinery
10. minimising fuel spills during re-fuelling, including the use of spill kits
11. minimising disturbance to wildlife

5.2. Access and egress routes for Machinery and Equipment

1. All access/egress and alternative Routes (see map above), will minimise impact on the ground and will
2. be agreed with the Nominated Officer prior to the Works Commencement Date.
3. choose the least sensitive route across the moor, while avoiding or minimising features such as walls, fences, pastures etc
4. avoid very wet areas, flushes and stream channels
5. be reassessed at the time of Works based on current ground conditions

5.3. Operating Machinery

1. The contractor shall ensure that suitably experienced machine operators will always be used for all aspects of the work, including checking and maintaining machinery and vehicles and ensuring that machinery and vehicles are fit for purpose
2. All Machinery accessing the Works Sites will be strictly low ground pressure vehicles (< 3 psi (0.2 kg cm^{-2}), when fully laden.
3. However, specification and capability of equipment and machinery suitable for the Works shall be the responsibility of the Contractor.

5.4. Minimising damage

Machinery and Equipment movement on the Works Sites should be kept to the minimum that might reasonably be expected to complete the Works.

1. There should be no visible signs of the formation of informal tracks – if it is necessary to cross wet sensitive areas, bog mats will be used to minimise risk of damage.
2. Repeat vehicle movements along the same route will be avoided (exception of recognised tracks).
3. Excavator operators will restrict access to periods where it can be anticipated that the ground is dry, firm or frozen, and avoiding periods of wet weather. Thus avoiding damage to the surrounding habitat.

4. If adverse weather conditions occur, or if the weather is forecasted to deteriorate so that ATV or other machinery access is not possible without ground disturbance, work will be suspended.
5. If in the opinion of the Nominated Officer ground conditions deteriorate to the point where significant damage could occur or is occurring, the Contractor must halt work
6. Excavator operators will access/depart from their excavators at the start and end of consecutive days on foot. This will minimise unnecessary movement of machinery on and off site and avoid damage to the supporting habitat

5.5. Repairing damage

1. Fence sections, stiles and gates that have been cut or removed to gain access should promptly be replaced by the Contractor with an appropriate length of new wire and posts and a new gate, if necessary, to the Nominated Officer's satisfaction.
2. In the unlikely event that turves become lifted by the turning and movement of tracked and/or wheeled machinery, this must promptly be reported to the Nominated Officer. Contractors must provide site specific RAMS, and outline plans for replacing and distributing turves to cover and repair the damaged area on award of contract (in advance of the work).
3. The Works Site must be returned to pre-Works condition as close as possible and as soon as practicable after the completion of the Works and to the satisfaction of the Nominated Officer

5.6. Fuel

1. Transporting of fuel to the Works Sites may be undertaken by appropriate vehicle for the terrain. All access routes for the transport of fuel for the excavator Machinery must be agreed with the Nominated Officer and detailed in the Method Statement.
2. Transporting of fuel must be kept to a minimum throughout the Works.
3. Re-fuelling of excavators in the field should be to a maximum of 85% capacity, using double-bunded containers and away from water courses.
4. The Contractor shall ensure it has at all times on the Sites spill kits for fuels and oils, and shall immediately use the same in the event of such spillage in accordance with the manufacturer's instructions.

5.7. Bogging down

1. Reference will be made to the site-specific RAMS for recovery of equipment/machinery that has become bogged down or stuck,.
2. The operator must stop all attempts at self-recovery immediately, make the machine safe (e.g. drain fuel if necessary) and inform the MFFP nominated officer.
3. A recovery plan will then be agreed to ensure further damage is minimised.
4. Subsequent plans to "make good"/ remediation etc, the resulting damage caused will be developed and agreed with relevant stakeholders prior to implementation. This may include work to make-good ruts, seeding with nurse crops and/or planting moorland plants to aid stabilisation and revegetation
5. In particular, damage that involves ruts and track lines are likely to result in erosion should be a first priority for repair. Works to rectify these should be agreed by the Nominated Officer prior to being undertaken

5.8. Ecological Watching Brief

The Nominated Officer may provide an “Ecological Watching Brief” during tracking activities. The Contractor shall comply (and ensure that any sub-contractor complies) with the requirements and conditions of the Specification.

6. Detailed work specifications

6.1. Preparation work (stone/peat dams only)

1. Preparation work is only required for blocking locations that are ear-marked for construction of either peat dams or stone dams (not for heather bale dams). These will be clearly marked and discussed in the pre-works and work site meetings.
2. Excavate downstream (approx. 1 m) from the existing tunnel entrance in order to obtain clean and sound walls and tunnel face. Make a clean vertical face around the pipe entrance, extending at least 60 cm on each side of the pipe entrance at base level (Fig. 3 and Fig. 4).
3. When moving large boulders and vegetation from the bottom of the gully the root zone will be left intact in the turves that are removed.
4. Carefully remove large boulders and vegetation from along the bottom of the gully to a distance of approximately 6 metres (stone dams) or 7 metres (peat dams) upstream of the excavated pipe entrance, ensuring the root zone is left intact in the turves that are removed, and lay the turves and the peat in separate piles to one side. The peat will be used for constructing peat dams and for profiling upstream of peat and stone dams and the turves will be used for covering bare peat surfaces of the peat dam and re-profiled areas. Flatten this area as much as possible. Extend 1 m up the sides of the gully.
5. Rocks and mineral scrapings can be used to plug the pipe entrance as much as possible.
6. The excavation work may require the removal of part of the roof of the peat pipe, especially where the blocking location consists of a vertical hole leading down to the pipe and the requirement is for a peat or stone dam.

6.2. Sourcing peat for dam construction and re-profiling

1. All peat to be used for the construction of the peat dam or the profiling of all dam types is to be taken primarily from the material removed in the Preparation phase, or, if this source proves to be insufficient, taken from further upstream where for example spare peat remains from a previous block.
2. In circumstances where there is insufficient peat within the gully itself, peat will be sought from a donor site elsewhere only when it is the only technique that will succeed to achieve the required structural integrity of the dam, not leave dams vulnerable to structural failure and accordingly, essential to achieve the restoration objective of the trial.
3. The location and use of such donor sites will follow an assessment of the integrity/stability of the peat mass, and will be:
    a. Within range of the excavator arm
    b. Limited in size and depth to supply peat for a maximum of two peat dams
    c. Avoided in areas where pits might create a hydrological link or structural weakness between existing erosion features, and areas with developing erosion features
    d. Avoided if there is a risk of linear patterns of disturbance (e.g. a line of pits perpendicular with the slope)
    e. Avoided where there are important sensitive habitat features such as Sphagnum hummocks and bog pools

f. Remove the turves ensuring the root zone is left intact, and lay the turves to one side. Then remove the peat for constructing peat dams and for profiling upstream of peat and stone dams.
g. Before moving on, the sides of the donor site will be re-profiled using reserved turves with intact roots so as to create a revegetated shallow depression that will be no deeper than pools created by adjacent grip blocking and will not exceed 1m deep

6.3. Sourcing vegetative turves for covering bare peat surfaces

1. All bare peat surfaces (top of peat dams and re-profiled surfaces of all dams) will be covered with turves taken from the piles made during the preparation phase in order to prevent oxidation and erosion of the peat (see for example, Fig. 6, Fig. 7)
2. In circumstances where there is insufficient vegetation collected from the preparation phase, or from a donor peat site, vegetation will be sought from a donor site elsewhere only when it is the only technique that will succeed in minimising bare peat surfaces that will be vulnerable to erosion and accordingly, essential to achieve the restoration objective of the trial
3. The location and use of such donor sites will follow an assessment of the integrity/stability of the vegetation, as follows:
    a. The donor site location should contain intact and healthy vegetation within range of the excavator arm but not adjacent to the top of the re-profiled slope
    b. The length and width of turves removed from a donor area shall not exceed the width of the excavator bucket
    c. The turf and root structure remains intact
4. Before moving on, the sides of the donor site will be re-profiled using reserved turves with intact roots so as to create a revegetated shallow depression that will be no deeper than pools created by adjacent grip blocking and will not exceed 1m deep

6.4. Peat dams

6.4.1. Number and location of peat dams

1. The number of peat pipes to be blocked using peat is known and mapped
2. The trial has been designed so that the “peat dam” method will only be used on pipes where the amount of peat removed during the preparation phase is likely to be sufficient without the requirement of peat donor sites

6.4.2. Peat dam construction

1. Functioning and fully-vegetated Peat Dams of good construction will be built within collapsed sections of the pipe, 1 m upstream of a clean, excavated peat pipe entry tunnel. The Peat Dams will have a natural finish and a high degree of integration with the surrounding habitat.
2. The peat to be used for the construction of the dam must be sourced in accordance with sections 6.1 and 6.2 above, and must be intact and well-humified so that it is sufficiently robust and impermeable
3. Although the Nominated officer may give guidance on the construction of the Peat Dams, the Contractor remains responsible for the standard of construction.
4. The construction of Peat Dams will follow the construction process below

a. Locate the area for Peat Dam construction in the collapsed area approximately 1 m upstream of the prepared pipe entrance tunnel (Fig. 3, Fig. 4)
b. Excavate into the sides of the gully parallel with the intended line of the Peat Dam wall (approximately 1 m from the excavated pipe entrance. The resulting ditches should cut at least 0.6 metres into the gully sides and 0.2 metres below the original depth of the gully (see Fig. 2 and 3.). This is done to ensure the Peat Dam will be fully keyed-in to the landscape and thereby prevent erosion at the gully edges.
c. Construct the base for the Peat Dam wall and the base of the upstream Re-profile area, using plugs of wet, "putty-like" peat. These are placed along the base of the gully where the peat dam is to be built (2 m from front to back) and also upstream for approximately 4 metres to take the Re-profile part of the Peat Dam. This is done across the entire width of the gully and 1 m up the sides
d. Tamp down on these "base layer" plugs using the heel of the excavator bucket to make a water tight seal onto the mineral layer
e. Use additional plugs of peat to build up the Peat Dam which will be constructed two metres deep (front to back), in order to ensure its structural integrity. The whole Peat Dam is then firmed down using the excavator bucket to make a watertight seal
f. Build up the Peat Dam to be sufficiently higher than the surrounding ground level (where possible and allowing for settlement of the peat) to allow water to overflow laterally away from the pool behind Peat Dam and soak into the bog surface (see Fig. 5).

6.4.3. Peat dam re-profiling

1. The Contractor shall ensure that suitably experienced machine operators will always be used to complete profiling Works.
2. The peat to be used for the re-profiling works must be sourced in accordance with sections 6.1 and 6.2
3. Extend the re-profile area for approximately 4 m upstream of the Peat Dam wall (Fig. 5, Fig. 6)
4. Use the excavator bucket to tamp down onto the first layer to make a firm water-tight contact.
5. Key the upstream leading edge (of the Re-profile section) into the mineral layer and replace rocks and finer mineral layer material on top of the upstream leading edge of the peat Re-profile section
6. Back-fill the space between the downstream side of the Peat Dam and the excavated pipe entrance.

6.4.4. Peat dam vegetation translocation

1. The turves to be used in the vegetation translocation works must be sourced in accordance with sections 6.1 and 6.3 above.
2. Lay turves on to the recipient bare peat area in a chequerboard pattern. Beginning at the bottom of the slope,
3. Once in place, press down the turves using the excavator, taking care not to break up the turf.

4. After a minimum settling-in period of 6 months, these translocation areas will be considered for plug planting with both vascular and Sphagnum species.

6.5. Stone dams

6.5.1. Supply and delivery of stone

1. All stone delivered will be clean millstone grit which is (a) compatible with local geology and pH range and (b) of a size between 150 mm and 250 mm in any dimension.
2. All stone will be flown into the site by helicopter

6.5.2. Stone dam construction

1. These stone dams will generally be much larger than those normally used in gullies. They should completely obscure the pipe entrance.
2. A single Dam Unit consists of 750kg of Stone – it will often be necessary to use many Dam Units (up to 10 units in some cases) at the entrance to the peat pipe – information will be provided as the projected number of units that will be required at each location
3. Locate the area for Stone Dam construction right up against the cleaned pipe entrance (Fig. 7, Fig. 8).
4. Sufficient stones are required to completely fill the pipe entrance, and overtopping it, piled against the face of the pipe entrance, by at least 1 m and extending at least 60 cm into the gully side (see Fig. 7, Fig. 8).
5. Stone Dams should have a steep face (approximately 60 degrees) on the upstream side.
6. There will be some hand movement of stone required by the Contractor after the Dam Unit(s) have been dropped into place to ensure that the Dam conforms to the Specification as set out above. These activities will minimise the requirement for vehicle access and thus reduce the impact to the ground from soil compaction
7. In the event of uncertainty over the method of construction of Stone Dam required that is required, the Contractor must obtain prior clarification and instruction from the Nominated Officer.

6.5.3. Stone dam re-profiling

1. The peat to be used in the re-profiling works must be sourced in accordance with sections 6.1 and 6.2 above.
2. The Contractor shall ensure that suitably experienced machine operators will be used at all times to complete the profiling Works.
3. Extend the Re-profile area for approximately 4 m upstream of the Stone Dam (Fig. 7, Fig. 8)
4. Key the upstream leading edge (of the Re-profile section) into the mineral layer and replace rocks and finer mineral layer material on top of the upstream leading edge of the peat Re-profile section.
5. Cover the top of the constructed Stone dam with a thick layer of peat and firm this down well. It is especially important to maintain peat saturation when it is profiled over the stone dams, because of the drying effect of the underlying stone

6.5.4. Stone dam vegetation translocation

1. The turves to be used in the vegetation translocation works must be sourced in accordance with sections 6.1 and 6.3 above.
2. Covering bare peat areas with vegetated turves is especially important over stone dams, because of the drying effect of the underlying stone.
3. Follow the guidelines in 6.4.4. Peat dam vegetation translocation and consult Fig. 7, Fig. 8

6.6. Heather bale dams

6.6.1. Supply and delivery of Heather bales and other materials

1. Heather bales will be delivered to the work site by helicopter, airlifting operations previously consented, and will avoid the impact of delivery by vehicle
2. Non-living stakes will be derived from untreated Sweet Chestnut

6.6.2. Heather bale dam construction (by hand)

1. All work will be manually undertaken by RSPB volunteers, no machinery will be involved in heather bale construction or re-profiling
2. Avoid installation during poor ground/weather conditions to minimise soil compaction
3. All non-heather bale materials to be used in the construction of heather bale dams must be sourced in accordance with sections 6.1 and 6.2 above.
4. Construct Heather Bale Dams inside the entrance to the pipe re-entry tunnel (Fig. 9, Fig. 10)
5. Where there are large diameter pipes it may be necessary to construct Dams out of material taken from more than one Heather Bale.
6. Non-living stakes will be used to stabilise the block in position by penetrating down from the pipe roof into the blockage.

6.6.3. Heather bale dam re-profiling (by hand)

1. All peat to be used in the re-profiling works must be sourced in accordance with sections 6.1 and 6.2 above.
2. Tamp down onto the first layer to make a firm water-tight contact.
3. Extend the re-profile area for approximately 1 m upstream of the Dam (Fig. 9, Fig. 10)
4. Key the upstream leading edge (of the re-profile section) into the mineral layer and replace rocks and finer mineral layer material on top of the upstream leading edge of the peat re-profile section.
5. Peat should be backfilled and compacted around each dam to ensure a snug fit. It is especially important that peat should be packed in tightly along the upstream face of the dam but also packed in beside and amongst the bale material

6.6.4. Heather bale dam vegetation translocation (by hand)

1. All turves to be used in vegetation translocation of heather bale dams must be sourced in accordance with sections 6.1 and 6.3 above
2. Covering bare peat areas with vegetated turves prevents oxidation and erosion of the peat (see Fig. 9, Fig. 10).
3. Follow the guidelines in 6.4.4. Peat dam vegetation translocation, bearing in mind that, in the context of heather bale dams, this action will be carried out manually.

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