Rigare
Groundwater and Wetland Science

Technical Memorandum

Rigare project #: 1747	Project: Proposed Mynydd Maen Wind Farm, Newbridge
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Subject: **E-H impact assessment & remediation on GWDTEs & peat, proposed Mynydd Maen Wind Farm (Rigare 1747_r1.5 June 2024)**	

1. Introduction

1.1 Overarching principle of hydrological neutrality

The aim of the wind farm design relating to construction, operation and de-commissioning will be, as far as possible, to achieve environmental hydrological neutrality in terms of water quantity and quality. This principle will apply in relation to all classes of potential hydrological impact receptor, including water resources (groundwater and surface water), ecohydrology (i.e., Groundwater-Dependent Terrestrial Ecosystems [GWDTEs] identified by BSG Ecology) and peat.

The approach has two elements:

1. Designing the wind farm to avoid/minimise hydrological impacts where possible. Necessary care has been exercised in designing the wind farm infrastructure to avoid and minimise ecohydrological impacts on sensitive receptors, through a number of design iterations.
2. Where hydrological impacts are possible, designing and emplacing mitigation measures which will reproduce upslope hydrological processes downslope of the infrastructure, through:
    a. Excavation of necessary upslope drainage ditches, including upslope interception ditches at construction sites and upslope trackside drains where needed.
    b. Routing intercepted runoff and seepage from the above beneath the wind farm infrastructure in regular culverts.
    c. Excavation of downslope, contour-parallel recharge trenches as close to the wind farm infrastructure as possible. The intercepted water will flow into and pond evenly along the recharge trench, and either infiltrate into the ground downslope or overtop diffusely during significant rainfall events. The result will be to reproduce the cross-slope distribution and nature of the hillslope hydrology downslope of the wind farm infrastructure, thus achieving hydrological neutrality.

    It is important to note that under this approach, the previous practice of point discharge of intercepted clean water, into nearby streams or at discrete points on the downslope hillside, will not be used.

    d. Designing, excavating and maintaining a dirty water system, with appropriate treatment, within the infrastructure hydrological envelope, between a-c above.

1.2 Appropriate hydrological training

Relevant personnel would be fully trained in relation to relevant hydrological principles and practice. Trainees would include excavator drivers, ecological clerks of works and long-term operators. From this training they will:

- Understand relevant hillslope hydrology, and the nature and location of, and need to avoid impacts at, receptors.

- Understand the principle of hydrological neutrality laid out in Section 1.1 above.
- Be able to implement, diagnose operational problems with, and develop remedial measures for, the resulting systems.

2. Potential hydrology-related impact receptors

2.1 On-site water-dependent ecological features & habitats (GWDTEs)

On-site water-dependent ecological features and habitats were identified by BSG Ecology ecological consultants from the results of their ecological survey of the site (see Chapter 6 Ecology). The locations of these features are shown in Figures 6.9 a, b & c. They comprise:

- Acid/neutral spring/flush habitat (M23b with Sphagnum fallax).
- Marsh/marshy grassland (M23b).
- Ponds.
- Wet dwarf shrub heath (M25a).

The occurrence of these GWDTEs is not extensive across the site, but each stand has been taken into consideration in the impact assessment (Section 3).

The possible impacts on the water supply to, water retention within, and water discharge from, the GWDTEs was considered initially, with the intention that more detailed analysis would be undertaken if any potential impacts were identified (see Section 3).

2.2 Peat

Peat has been considered as a primary potential receptor for hydrological impacts. In good ecohydrological condition, peatlands can deliver a range of important ecosystem services, including carbon storage and reduced greenhouse gas emission, biodiversity, natural flood management, and natural capital and human wellbeing.

An extensive peat survey has been carried out by SLR (see Technical Appendix 9.3: Soil and Peat Management Plan), taking in over 3900 points within the red line boundary. The raw peat thickness data have been contoured and presented in the following classes in Section 3:

- 0-0.3 m.
- 0.3-0.4 m.
- 0.4-0.5 m.
- 0.5-0.75 m.
- 0.75-1.0 m.
- 1.0-1.6 m.

It is firstly worth noting that there is relatively little peat within the site, compared with other sites further north and west in Wales and the rest of the UK. There is no obvious evidence of historical peat mining on the site, and the likely explanation for the limited amount of peat is that the site has been climatically marginal for blanket mire development through the Holocene. The rainfall is relatively low because of its rain-shadow location to the east of higher ground in South Wales, and its southerly location means that evapotranspiration is relatively high because of warmer temperatures. These two factors will have combined to result in relatively low water tables, which in turn mean that decomposition of organic matter is relatively high, but on balance slightly lower than the rate of accumulation of dead plant matter where peat has developed. South Wales is, in general, at the southerly margin of maps of blanket mire occurrence in Wales, and relatively thin peats also exist further west across the Heads of the Valleys watershed.

It is also worth noting that, unfortunately, the site is very likely to become more climatically marginal for blanket mire development and security under most climate change projections (e.g., the UK Meteorological Office's UKCP18 projections).

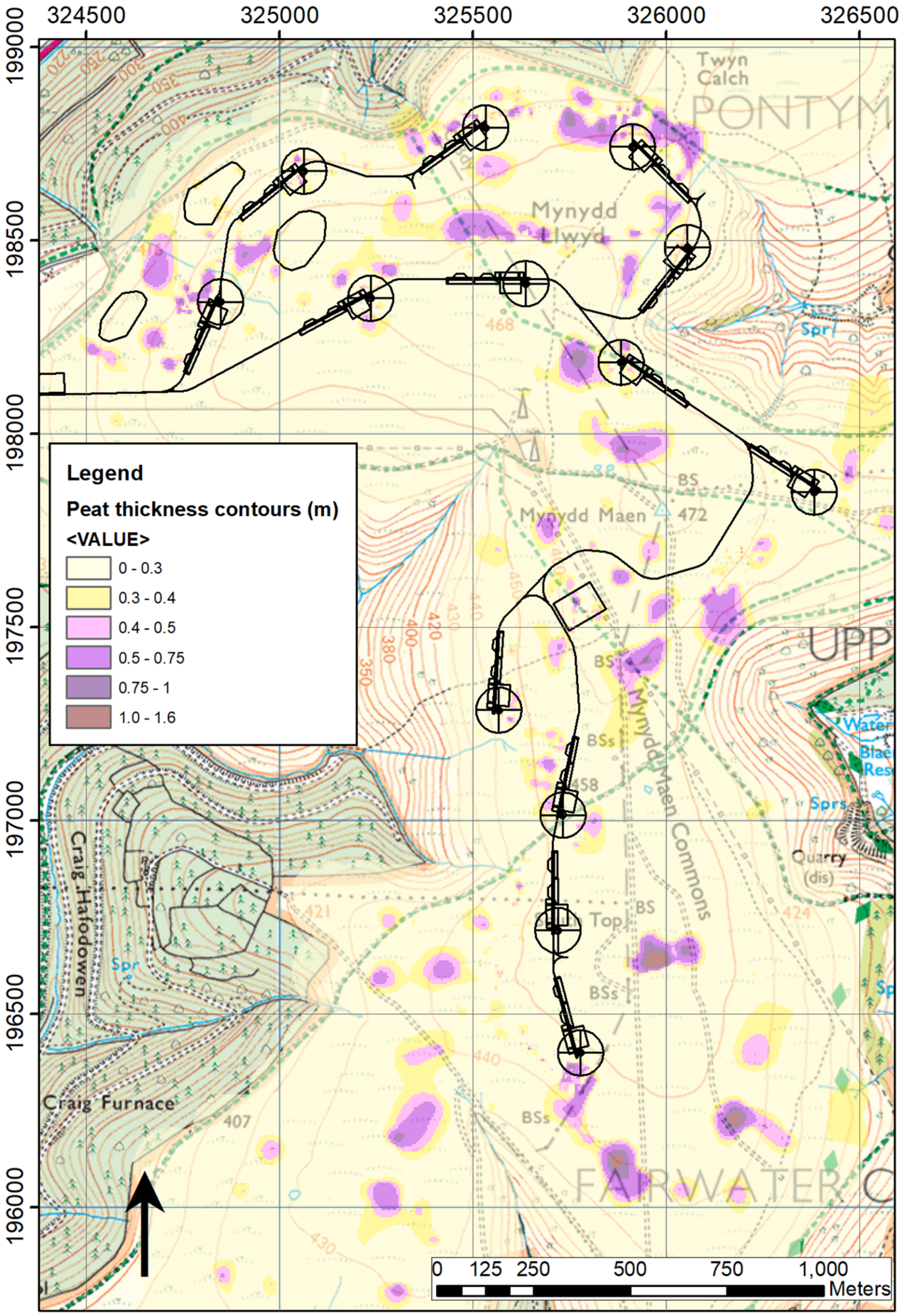

Figure 1. Overall distribution of peat thickness within the site.

Figure 1 shows the overall distribution of peat over the OS 1:25,000-scale survey. In general, it occurs in two topographic settings:

- Across the highest flat ground which forms the tops of Mynydd Llwyd (to the north), Mynydd Twyn-glas (central) and Mynydd Maen (to the south). The main driving factor here is likely to be slow lateral drainage because of the low imposed hydraulic gradients of the flat ground. These peatlands are very likely to be mostly ombrogenous (i.e., dependent on rainfall for water supply).

- On the flanks of the plateau, immediately upslope of where the ground falls away more steeply. The main driving factors here are relatively flat ground, which impedes drainage, but also receipt of runoff from upslope. These peatlands are likely to be somewhat terrigenous, i.e., partly sustained by surface runoff and shallow groundwater flow for water supply, but still significantly dependent of direct rainfall for water supply.

A critical peat thickness of 0.4 m has been adopted to define *deep peat* for this assessment, but smaller thicknesses have been taken into account in Section 3, as appropriate.

Based on the definitions of peat detailed within Section 3.6 of Technical Appendix 9.3: Soil and Peat Management Plan and review of the available site specific investigation data, a depth of 0.4m is considered appropriate for use in classifying peat soils at the Proposed Development due to the presence of silt, sands and clays and clear and established soil structure underlying the 'peaty' soils and peat.

The main favourable hydrological condition for peatlands is a high water table relative to the ground surface for the majority of the time. Any net hydrological impacts (i.e. after mitigation) which could lower the peatland water table should be avoided.

2.3 Other water features

Assessment of impacts on off-site water features, including water abstractions, are reported elsewhere (Chapter 9: Hydrology and Hydrogeology).

3. Ecohydrological impact assessment

An important general principle for the following impact assessments is that hydrological impacts tend only to extend a short distance (generally <10 m, and usually less) upslope, but can extend for greater distances downslope (20-30+ m) without mitigation.

3.1 Turbines 1-4 and associated infrastructure

Turbines T1, T2 , T3 and T4 would be located on the flat top of (T4) and on the gently-sloping, upper northern and eastern flanks of Mynydd Llwyd, in the north-eastern sector of the proposed wind farm (Figure 2[1]).

3.1.1 GWDTEs

The only area of GWDTE within the possible zone of hydrological influence of these turbines is the area of M25a wet dwarf shrub heath immediately south of T4 (#1 in Figure 2). The northern edge of this area of wet heath is located c. 15 m south of the turbine base. The ground here is flat, but the presence of the 468 mAOD spot-height within the area of wet heath suggests that it is slightly higher than the turbine base. There is potential for marginal, temporary lowering of the water table in the area of wet heath during construction, but there would be no hydrological impacts during operation.

3.1.2 Peat

Turbine T1 is located immediately upslope of one of the more extensive areas of deep peat within the study area; direct loss of deep peat and associated habitat has been avoided through turbine positioning.

The areas of deep peat west-north-west (#2) and south (#3) are cross-slope from the proposed turbine; their upslope hillside catchments would not be affected by the development, and therefore they would not be affected hydrologically.

The area of deep peat north-east of T1 (#4) is immediately downslope of the proposed turbine location. Ecohydrological mitigation, as described in Section 1.1, would need to be carefully designed to avoid hydrological impacts on this area of peat. It is likely that hillslope runoff collected to the south-west of the turbine would be routed around the north-western tip of the turbine base, and/or through the crane-pad area, into recharge trenches upslope of the peat.

[1] This and subsequent figures are included at the end of the document.

This area is recognized as more critical for potential ecohydrological impacts, and so water table monitoring (dipwells and automatic water level recorders [AWLRs]) will be installed at the earliest opportunity post consent.

Turbine T2 and associated infrastructure are immediately downslope of local peat deposits, and therefore there are unlikely to be any significant hydrological impacts on the peat.

Turbine T3 is located within an area of discontinuous peat. The ground here slopes downwards to the north-west, so the deep peat c. 40 m south-west of the turbine (#5) would not be affected hydrologically by the proposed turbine.

Careful mitigation would be implemented to safeguard the hydrological condition of the small areas of deep peat (e.g., #6) immediately north-west of the proposed turbine and hard-standing.

Turbine T4 is located c. 95 m upslope and south of a large area of deep peat (#7). T4 is located close to the highest point of Mynydd Llwyd, meaning that it would intercept downslope flows from a relatively small part of the hillside catchment for the area of peat. It is considered very unlikely that the turbine would have any significant hydrological effect on the area of deep peat, but pre-emptive mitigation measures would be considered.

None of the proposed tracks between these turbines are upslope of any areas of deep peat, and therefore they would not cause any ecohydrological impacts.

3.2 Turbines 5-7 and associated infrastructure

Turbine T5 would be located within a flat area which forms the east ridge of Mynydd Llwyd.

Turbines T6 and T7 would be located on the gently-sloping ground to the north-west of the plateau ridge of Mynydd Llwyd.

3.2.1 GWDTEs

There is a very small pond equidistant between T5 and T7 (#1 in Figure 3). The proposed infrastructure (T5) is aligned approximately along the ridge (i.e., the watershed), and therefore it would not reduce the hydrological catchment to the pond; there would be no ecohydrological impact.

3.2.2 Peat

Turbine T5 would be located between three small areas of deep peat. The small area of peat to the north-west of the turbine (#2) is partially downslope of the turbine base, but it is considered very unlikely that it would be affected hydrologically by the construction. The other small areas of deep peat are cross-slope from T5, and would not be affected hydrologically.

There is relatively little deep peat in the vicinity of Turbine T6. A very small area of deep peat would be removed for the construction. Hydrological mitigation would be considered for the small area of deep peat immediately north of the turbine base (#3).

Turbine T7 and a small part of the access track to T6 are immediately upslope of a significant area of deep peat (#4). Carefully designed hydrological mitigation would be required here to ensure that the ecohydrological condition of the peat was not damaged.

There is a proposed borrow pit (#5) immediately east and partially upslope of an area of deep peat (#6). Hydrological mitigation would be considered here, with routing of hillside runoff around the south-western side of the borrow pit, to maintain the hydrological integrity of the area of peat.

There is very little peat in the vicinity of the other borrow pits (#7 and #8)

3.3 Turbines 8 & 9, and associated infrastructure

Turbine T8 is on ground which gently slopes to the north-east, on the high saddle between Mynydd Llwyd and Mynydd Maen (Figure 4). Turbine T9 is located on the topographic ridge between Mynydd Maen and Mynydd Twyn-glas, on relatively flat ground.

3.3.1 GWDTEs

There is a significant area of wet dwarf shrub heath immediately west of T8 (#1 in Figure 4), which is approximately coincident with an area of deep peat. The proposed turbine location lies downslope of, and is therefore very unlikely to cause any significant hydrological impacts within, this area of GWDTE. Similarly, T8 is significantly downslope of, and would not cause any hydrological impact upon, the small pond to its south-west (#2).

There are no GWDTEs in the vicinity of T9.

3.3.2 Peat

Turbine T8 would be located immediately east and downslope of a significant area of deep peat (#3). Since the turbine base would be c. 60 m downslope of the peat, it would not cause any ecohydrological impact.

The only area of deep peat in the vicinity of T9 lies c. 75m east of the turbine base (#4). The turbine construction would not be within the hillslope catchment of this area of peat, and therefore the hydrological integrity of the peat would be maintained.

3.4 Turbines 10 & 11, and associated infrastructure

Turbine T10 is located on westwards-sloping ground, west of the north-south-oriented ridge between Mynydd Twyn-glas and Mynydd Maen, whilst T11 is located on ground which slopes only gently westward, on the central plateau of the same ridge (Figure 5).

The main access track to T11-T13 runs south immediately west of the highest ground of the ridge.

3.4.1 GWDTEs

GWDTEs in this area are limited to a small pond (#1 in Figure 5) on the opposite, eastern side of the summit ridge and existing track, and therefore in a different hydrological catchment. Hydrological impacts on this pond caused by the proposed wind farm can be ruled out.

3.4.2 Peat

There is discontinuous peat across the ridge plateau, with some extending downslope to the west.

Turbine T10 would be located immediately west and downslope of a small area of patchy deep peat (#2). It is possible that the water table in this peat will be drawn down slightly during construction, but it would be restored to its current condition during operation, with no significant ecohydrological impact.

Turbine T11 and associated crane pads, etc, would be located immediately east and upslope of areas of deep peat (#3). Hydrological mitigation would be deployed here to ensure that the upslope water supply to these peats was maintained. It is possible that this will require one or more culverts to transfer intercepted upslope flow through the turbine infrastructure, with a recharge trench immediately upslope of the peat.

The area of deep peat (#4) upslope and cross-slope from T11 would not be affected hydrologically by the development.

A small amount of peat would be relocated from within the footprint of the excavation north-east of T10 (#5). There is a small area of deep peat (#6) immediately south-west of this excavation, and immediately west and downslope of the proposed access track to the southern part of the wind farm. Hydrological mitigation would be employed to ensure maintenance of the water supply to this peat, most likely via a culvert beneath the track.

It is worth noting that the largest area of deep peat in this vicinity (#7) is on the eastern side of the Mynydd Maen ridge, and therefore any ecohydrological impacts from the development can be ruled out.

3.5 Turbines 12 & 13, and associated infrastructure

The proposed locations for T12 and T13 are both on the west side of the southern end of the Mynydd Maen ridge (Figure 6).

3.5.1 GWDTEs

There is a relatively large area of wet dwarf shrub heath (M25a) and ephemeral ponds (#1 in Figure 6), coincident with an area of deep peat, around 200 m east of T12 and T13. This feature lies to the east of the Mynydd Maen ridge and is therefore in a separate hydrological catchment to the proposed turbines; ecohydrological impacts from the turbines on the wet heath and peat can be ruled out.

There are some small acid flushes (#2) c. 250 m west and downslope of T13; this large spatial displacement means that ecohydrological impacts can be ruled out. The large area of wet dwarf shrub heath (and deep peat) to the west of these flushes (#3) is on the other side of a shallow valley to the turbines so therefore, again, any ecohydrological impacts can be ruled out.

3.5.2 Peat

As noted above, hydrological impacts on the large area of deep peat to the east of the proposed turbine locations (#1) can be ruled out.

There is very patchy deep peat to the west and downslope of T12; it is considered very unlikely that this peat would be significantly ecohydrologically affected by turbine construction.

There is a large area of deep peat (#4) immediately south of the proposed location for T13. The turbine foundation is likely to interrupt some of the upslope catchment to this area of peat, so hydrological mitigation would be required. This would probably consist of an interception ditch upstream of the construction, feeding into a ditch around its eastern side, in turn feeding into a recharge trench upslope of the peat.

4. Ecohydrological impact assessment on GWDTEs & peat: Summary

The wind farm has been designed, and would be constructed, under the overarching principle of hydrological, and by extension ecohydrological, neutrality. The overall design of the wind farm is aimed at minimizing hydrological impacts by placing infrastructure on topographic ridges (i.e. no-flow boundaries) and higher, flat areas. The most recent iteration of the infrastructure layout largely avoids direct removal/relocation of deep peat, and minimizes ecohydrological impacts on GWDTEs and deep peat.

Where primary hydrological impacts are likely, careful design and implementation of mitigation measures would ensure that impacts are avoided or minimized. The main mitigation technique would be to route water which is intercepted upslope of the infrastructure under tracks, via frequent culverts, and then to redistribute it across the slope below the infrastructure using recharge trenches. The aim is to reproduce, downslope, the hillslope hydrology upslope of the infrastructure.

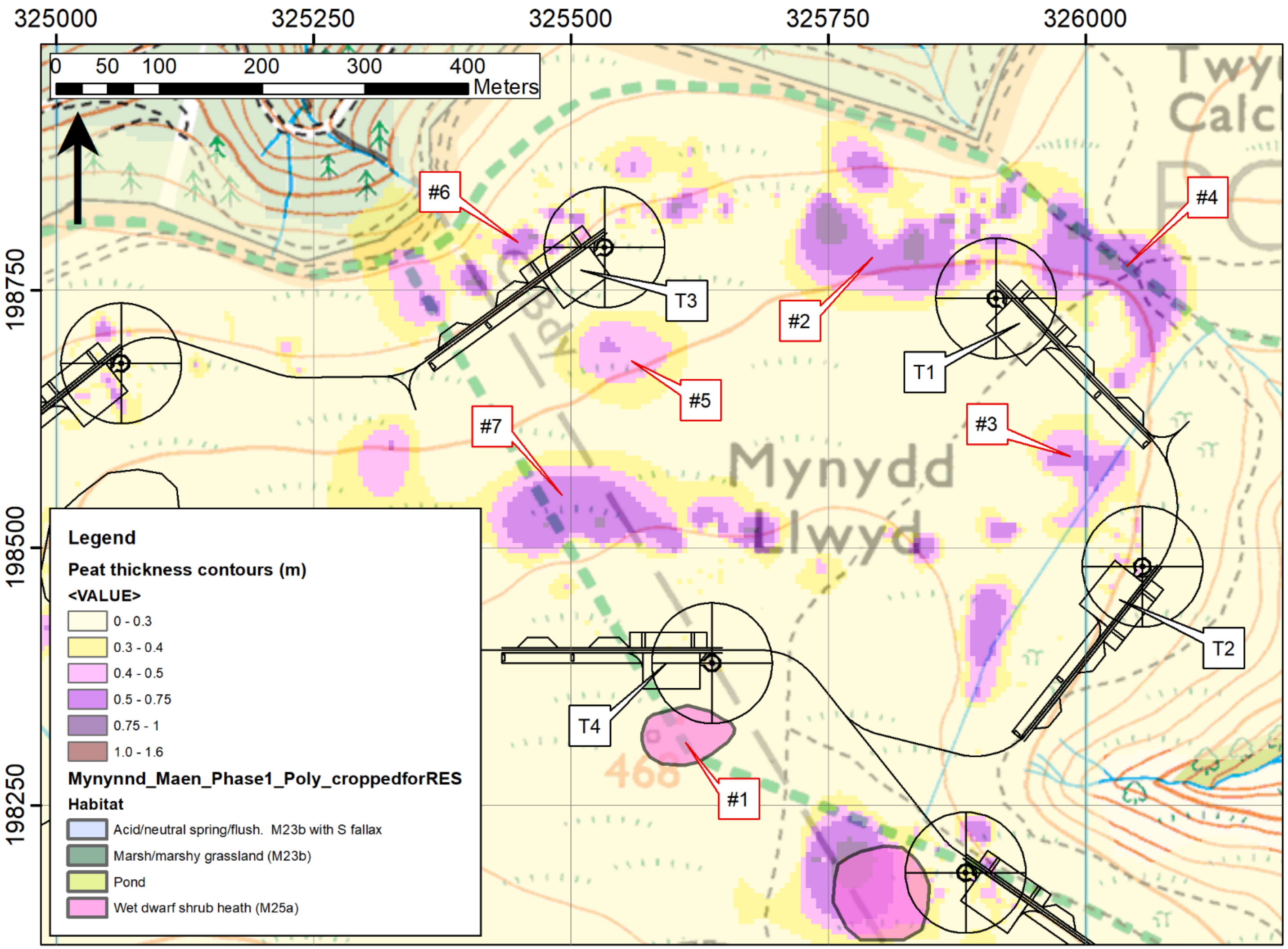

Figure 2. Annotated plan showing peat thickness and occurrence of GWDTEs in the vicinity of proposed Turbines T1-4.

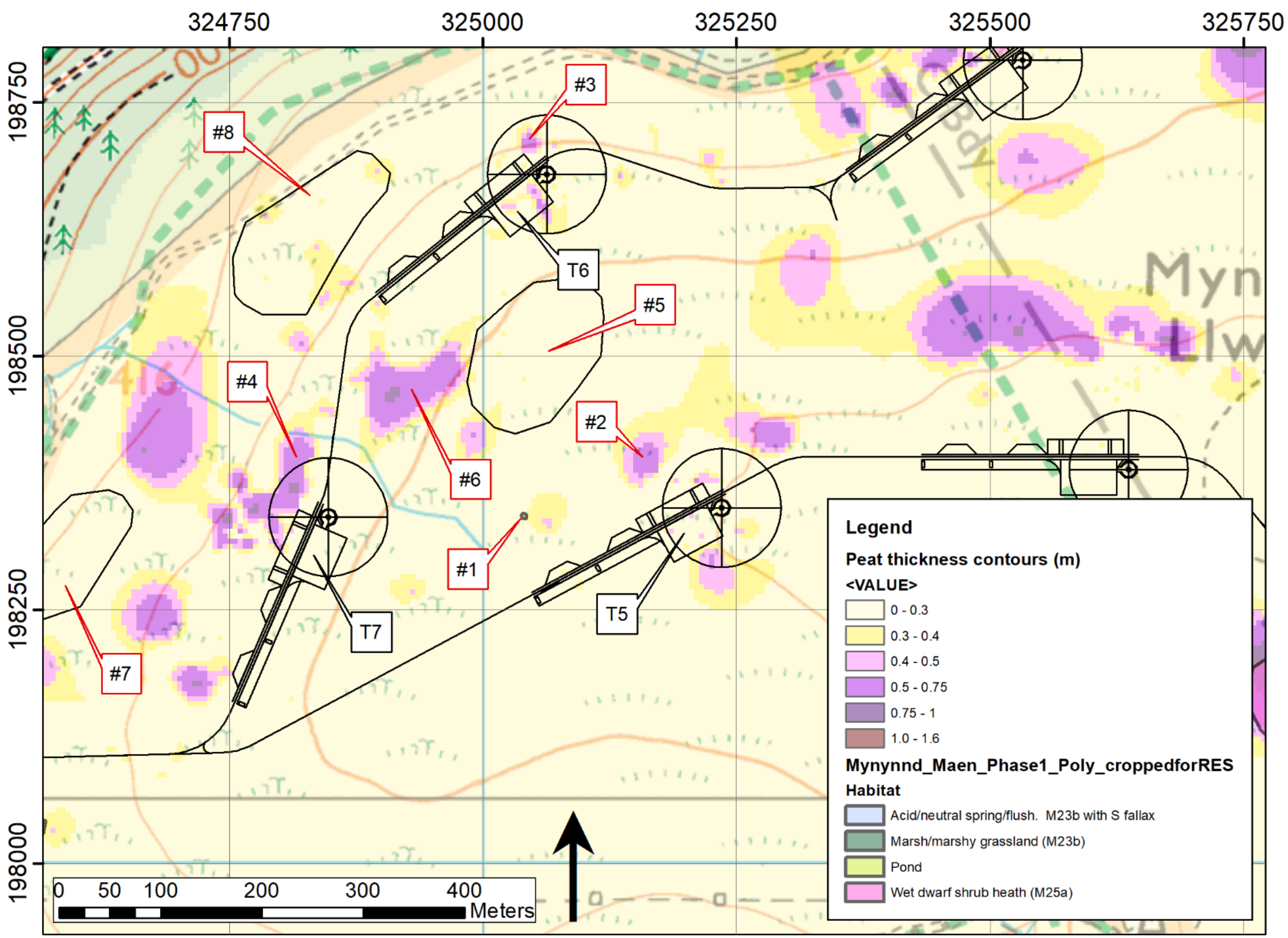

Figure 3. Annotated plan showing peat thickness and occurrence of GWDTEs in the vicinity of proposed Turbines T5-7.

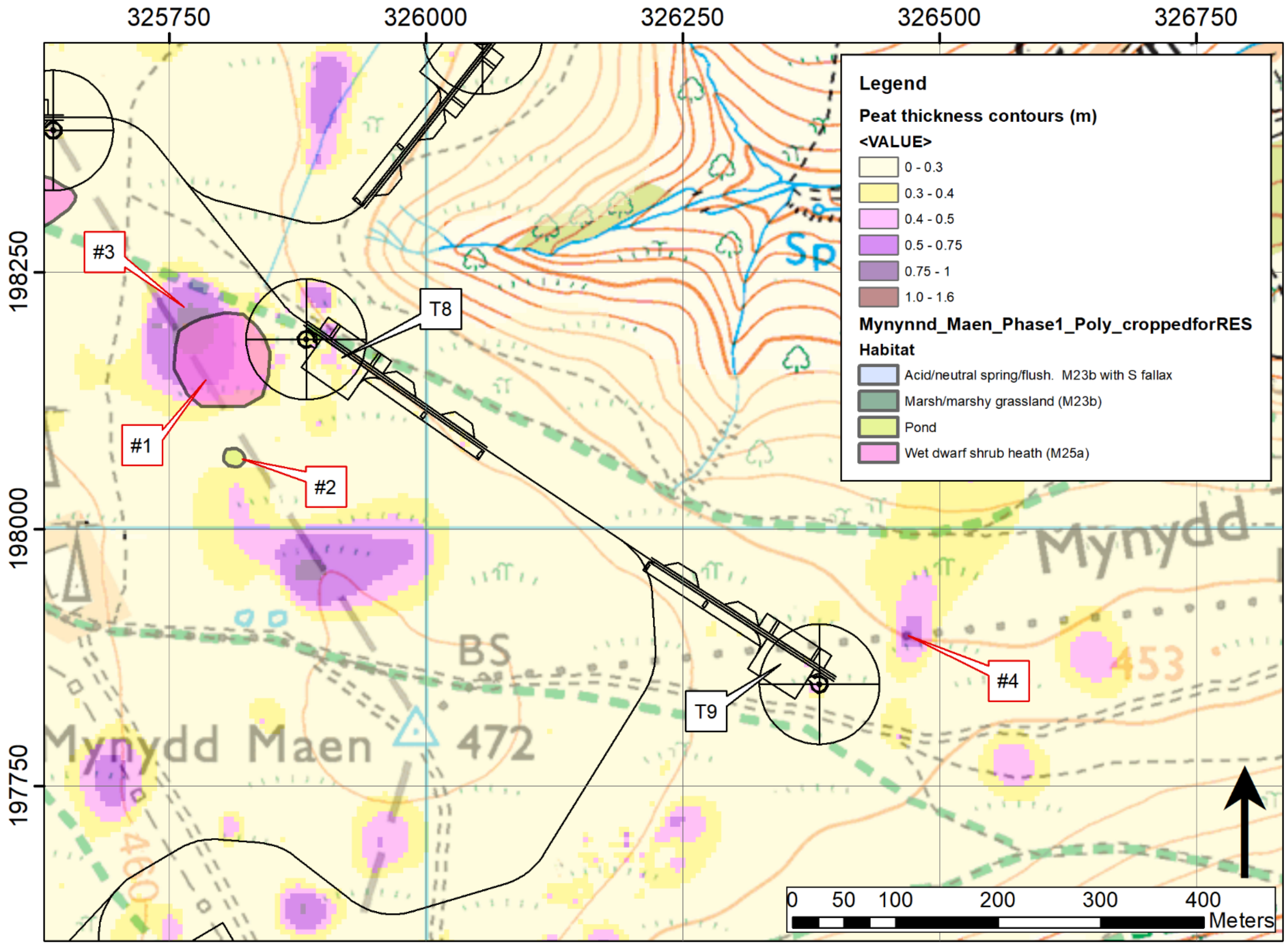

Figure 4. Annotated plan showing peat thickness and occurrence of GWDTEs in the vicinity of proposed Turbines T8 & 9.

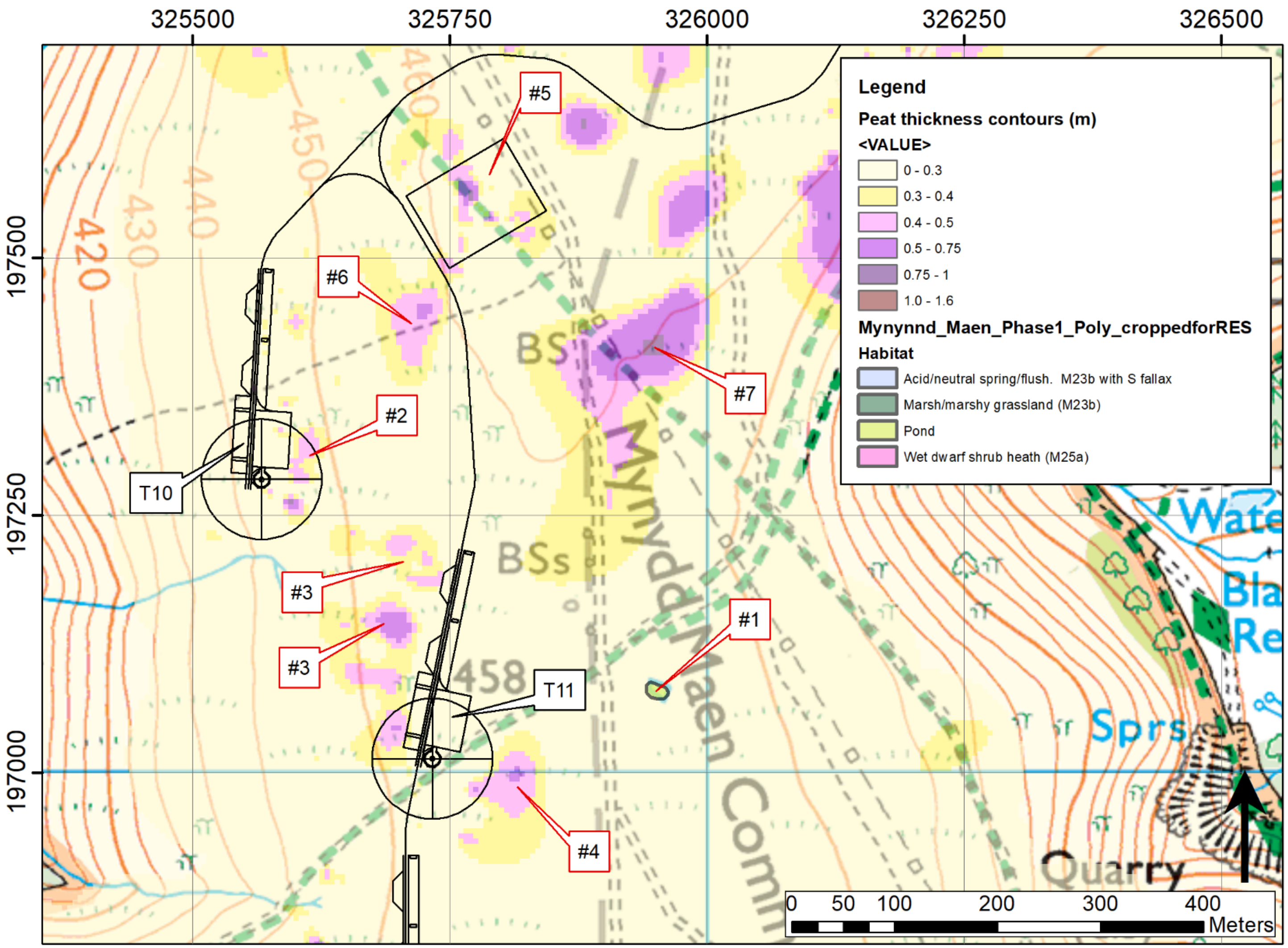

Figure 5. Annotated plan showing peat thickness and occurrence of GWDTEs in the vicinity of proposed Turbines T10 & 11.

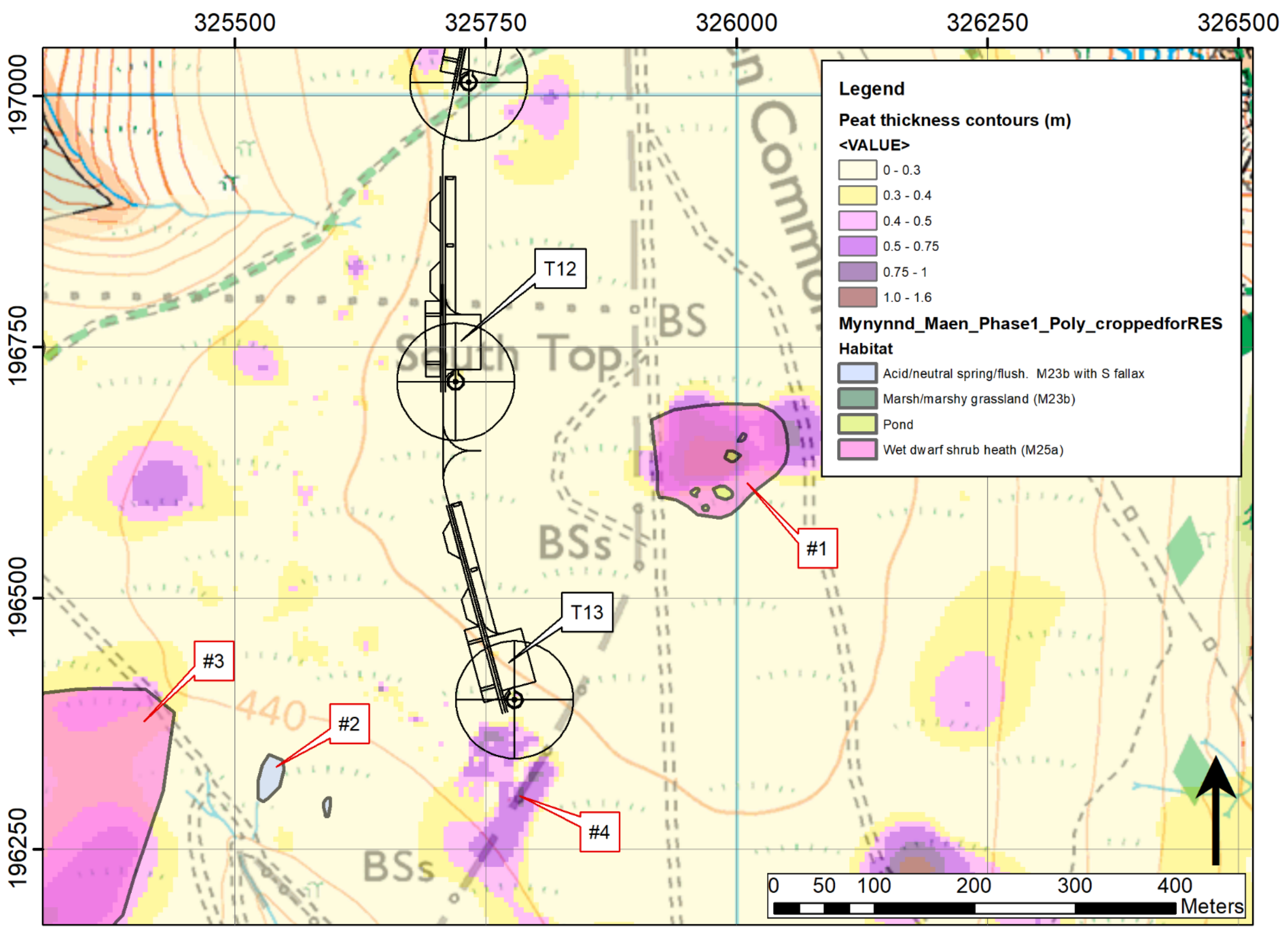

Figure 6. Annotated plan showing peat thickness and occurrence of GWDTEs in the vicinity of proposed Turbines T12 & 13.