Peat depth and condition across the moorlands within the Bamford water treatment works catchment.

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Prepared by

Moors for the Future Partnership
The Moorland Centre, Edale, Hope Valley, Derbyshire, S33 7ZA, UK

T: 01629 816 579
M: 0792 049 5265
E: jonathan.walker@peakdistrict.gov.uk
W: www.moorsforthefuture.org.uk

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Contents

1. Introduction

Peat is an organic material that has accumulated in waterlogged conditions over thousands of years (Natural England, 2010; Ramsar, 1971). Ecosystems with peat deposits are known as peatlands, and represent an important store of terrestrial carbon, with England's peatlands estimated to contain 584 million tonnes of carbon (Natural England, 2010).

Peat has a very low mineral content; therefore, it is much less dense than other soil materials and most of its volume is occupied by water when wet. The organic matter content of peat is very high, ranging from anything above 20-25% for 'peaty' soil, to more than 50-60% for 'peat'. Soils with peat layers generally have dry bulk densities ranging from 0.06g cm^{-3} to 0.4g cm^{-3} depending on the level of humification, compaction or mineral content (JNCC, 2011). The typical carbon content of peat is approximately 52% carbon by dry weight (Lindsay, 2010).

In an undamaged state peatlands can accumulate between 0.1 – 0.2 tonnes of carbon per hectare per year (Natural England, 2010); however, according to Natural England (2010) only 1% of England's deep peats are in an undamaged state where they remain waterlogged and actively continue to form peat and therefore sequester carbon.

In addition to storing carbon, peatlands provide a number of other ecosystem services which can be grouped into four broad categories: provisioning (food, fresh water, wood and fibre, fuel); regulating (climate, flood, disease, water), cultural (aesthetic, spiritual, educational, recreational); and supporting services (nutrient cycling, soil formation, primary production) (Millennium Assessment, 2005). Peatlands also provide unique habitats and biodiversity which are recognised under national and international legislation (JNCC, 2011; Natural England 2010). It is therefore important to understand the extent and location of peatlands within the UK.

In England peatlands cover 1,418,544 ha (10.9%) of the land area, of which 679,926 ha (5.2%) are classified as deep peaty soils; 527,193 ha (4.0%) as shallow peaty soils; and 211,425 ha (1.6%) as soils with peaty pockets (JNCC, 2011). In England and Wales shallow peaty soils are identified as being between 10 and 40 cm deep, and deep peaty soils as greater than 40cm deep; both should contain at least 20% organic matter. This is different to the identification criteria used in both Scotland and Northern Ireland (JNCC, 2011). Deep peaty soils form in three broad habitat types; blanket bog and upland valley mires, raised bogs and lowland fens. Blanket bog is the most extensive peatland type in England and is found mainly across the uplands of the Pennines, Dartmoor, Exmoor and the North York Moors (JNCC, 2011; Natural England 2010).

Recent publications recommend that more detailed and comprehensive data is required on peat depth and organic matter content to inform our understanding of the function, and particularly the carbon stored in our remaining peatlands. These data need to be coordinated and consistent and it is suggested that the possibility of a national peat survey be explored (JNCC, 2011; Natural England, 2010).

2. Aims and Objectives

There are four aims of this report;

1) To collect data on peat depth and condition / status across the moorlands within the Bamford water treatment works (WTW) catchment;
2) To collect the data in such a way that it may contribute to Natural England's Mapping Peat Depth and Carbon Storage in England Project[1];
3) To compare the data collected with existing data on the location of blanket / deep peat;
4) To produce a model of peat depth across the moorlands within the Bamford WTW catchment from the point data collected.

[1] **Mapping Peat Depth and Carbon Storage in England (RP0437) Natural England.**
This project, run by the North Pennines AONB Partnership's Peatscapes initiative, will: i) collate and analyse all available peat depth/C data ii) develop a survey methodology to assess peat depth/C iii) conduct some new targeted peat surveys iv) coordinate with NPAs, NGOs etc. on new surveys v) produce an improved and easily updateable peat depth/C storage map for England vi) supply a report, database & licence-free map.

3. Study site

The Bamford WTW catchment is located in north Derbyshire, within the Peak District National Park, southern Pennines, UK (Figure 3.1). The catchment is 20,159 ha in area of which 12,302 ha (61%) is classified as moorland. Peat soils cover 12,677 ha (63 %) of the Bamford WTW catchment, of which deep peat soils (blanket peat and seasonally wet deep peat to loam) represent 6,700 ha (33 %) and shallow peat (peat to loam over sandstone and shallow peat over sandstone) represent 5,977 ha (30 %) (based on The National Soil Resources Institute (NSRI) geographic database (accessible through LandIS[2])). We do not hold comprehensive NSRI soils data for the entire Bamford WTW Catchment; although we are confident we hold data on all deep peat areas within the catchment – see Figure 4.2.

Figure 3.1: Location of the Bamford Water Treatment Works within the Peak District National Park.

[2] LandIS is the 'Land Information System', a substantial environmental information system operated by Cranfield University, UK. http://www.landis.org.uk

4. Methods

The methods described below were determined by the spatial extent and resolution of the survey, as well as the resources available. Areas of blanket / deep peat were prioritised. NATMAP (National soil Map of England and Wales) was used to identify the extent of blanket / deep peat in the Bamford WTW catchment. A buffer of 20 m was then generated around the blanket / deep peat soils, in order to capture the transition from peat to other soil types. The blanket / deep peat soils together with the 20 m buffer constituted the survey area. The spatial design of the survey was developed in discussion with Penny Anderson Associates (PAA) who is working with Peatscapes to deliver Natural England's Mapping Peat Depth and Carbon Storage in England Project. PAA recommended a triangular grid configuration as it provides a more efficient design in terms of sampling cost, and provides better spatial predictive results. The decision to align this survey with a contemporaneous project that is developing a national peat depth monitoring protocol meant that greater value would be derived from the data, and peat depths across the Bamford WTW catchment would be contextualised in the national map. A number of triangular grids of different resolutions were created. The 400 m resolution grid was selected as the finest resolution that could be used to survey all blanket / deep peat soils in the Bamford WTW catchment with the available resources. The triangular grid of survey points was generated within MapInfo Professional 10.5 using the GRIDS.mbx tool. This created a 400 m x 400 m equilateral triangular grid, consisting of 513 peat depth sampling points (Figure 4.2). The sampling grid was uploaded to a differential GPS which surveyors used in the field to navigate to the survey points. The survey was carried out in autumn / winter 2011. In terms of fieldwork this represented over 206 km of surveys, excluding daily walks onto and off the moors. At each sampling point peat depth was measured by pushing a metal peat rod into the peat until the mineral base was reached; this was easy to identify using metal peat depth rods given the distinctive noise they make when hitting the bedrock. Additionally, at each sampling location the condition / status of the peat was recorded in terms of (Figure 4.1):

a) intact vegetation
b) intact bare peat
c) gully side
d) gully bottom
e) peat dome top, vegetated
f) peat dome top, bare peat
g) peat dome bottom, vegetated
h) peat dome bottom, bare peat
i) hag
j) mineral/rock, vegetated
k) mineral/rock, bare peat
l) mineral/rock, mineral base

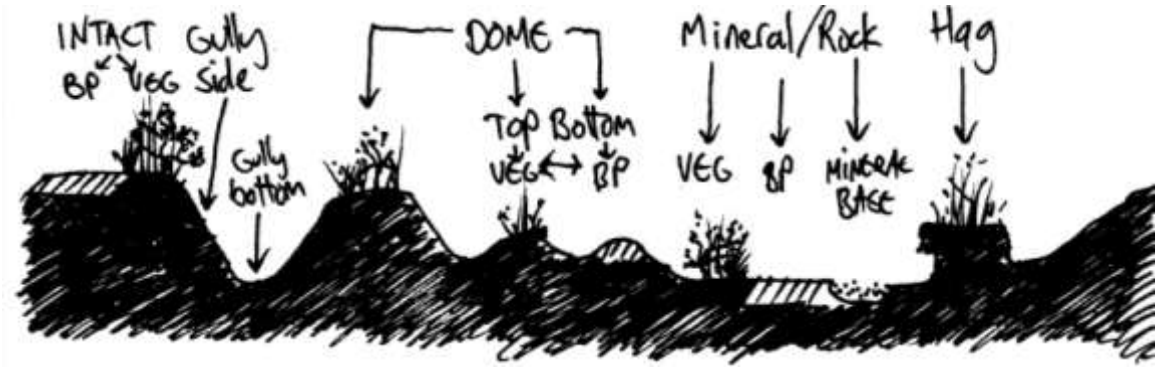

Figure 4.1: Diagram illustrating the status of the peat

4.1 Data analysis

To produce the peat depth model (Figure 5.4) peat depth measurements were imported into MapInfo Professional 11.0. Using VerticalMapper 3.1 (VerticalMapper > create grid) the peat depth point data were interpolated, using the natural neighbour method, to produce a continuous raster grid. Based on this grid, cross sections of peat depth (Figure 5.5 and Figure 5.6) were produced using VerticalMapper 3.1 (VerticalMapper > Grid Manager).

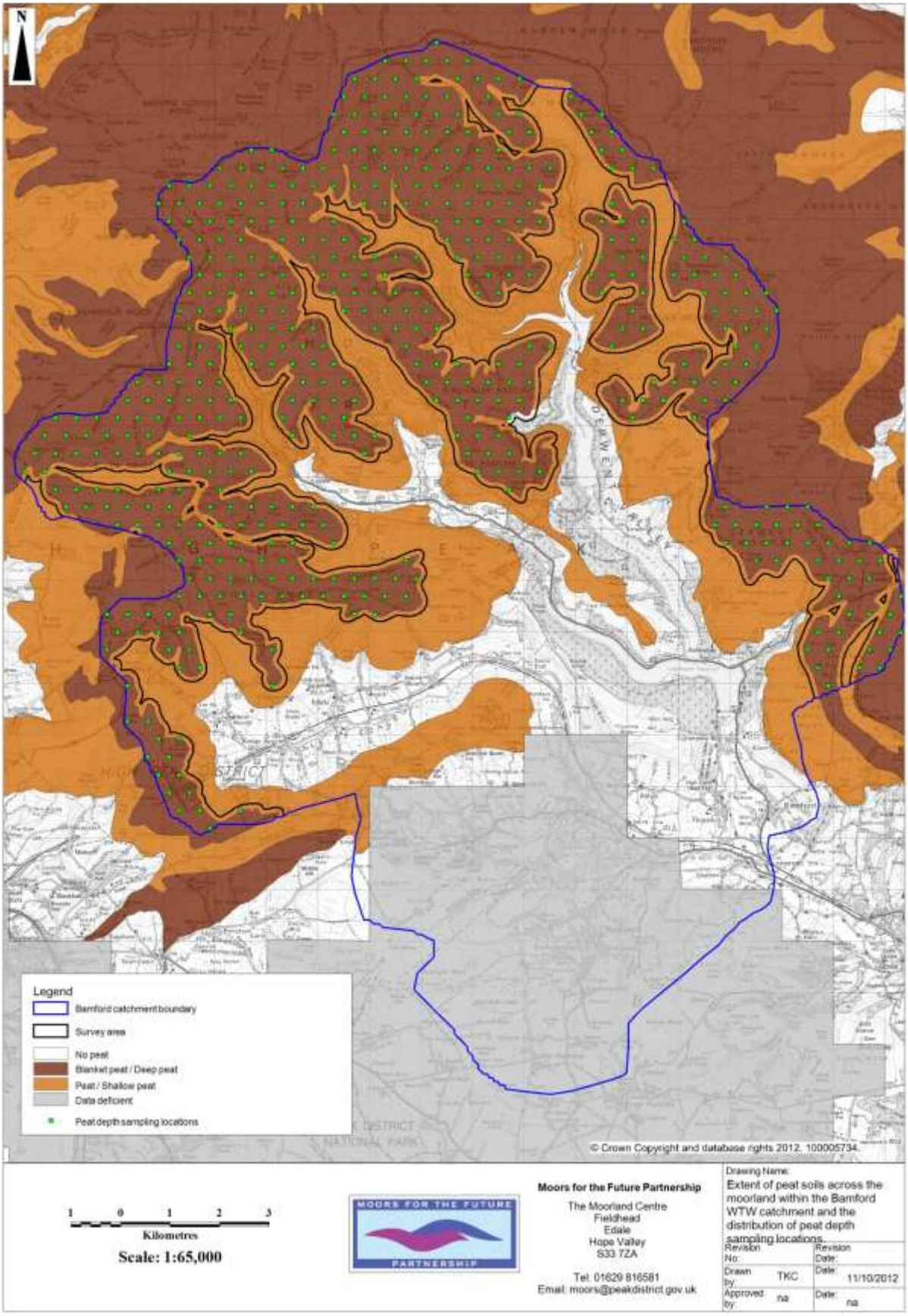

Figure 4.2: Extent of blanket peat soils across the moorlands of the Bamford WTW catchment and the distribution of the 513 proposed peat depth sampling locations (a database licence agreement between Cranfield University and Severn Trent Water (Data lease code: L0096/00599) permits the reproduction of this Map).

5. Results, Analysis and Discussion

5.1 Peat depth and condition

In total 513 peat depth measurements were taken across the peatlands of the Bamford WTW catchment. The mean peat depth recorded was 1.37 m (±0.08 95%CI). The distribution of the peat depth measurements are presented in Figure 5.1; 75 % of measurements recorded peat depths between 0 and 2 m, the rest (25%) recorded depths >2 m. Based on a survey area of 82.67 km² and a mean peat depth of 1.37 m; it can be estimated that there is 0.11 km³ of peat across the moorlands within the Bamford WTW catchment (Table 5.1).

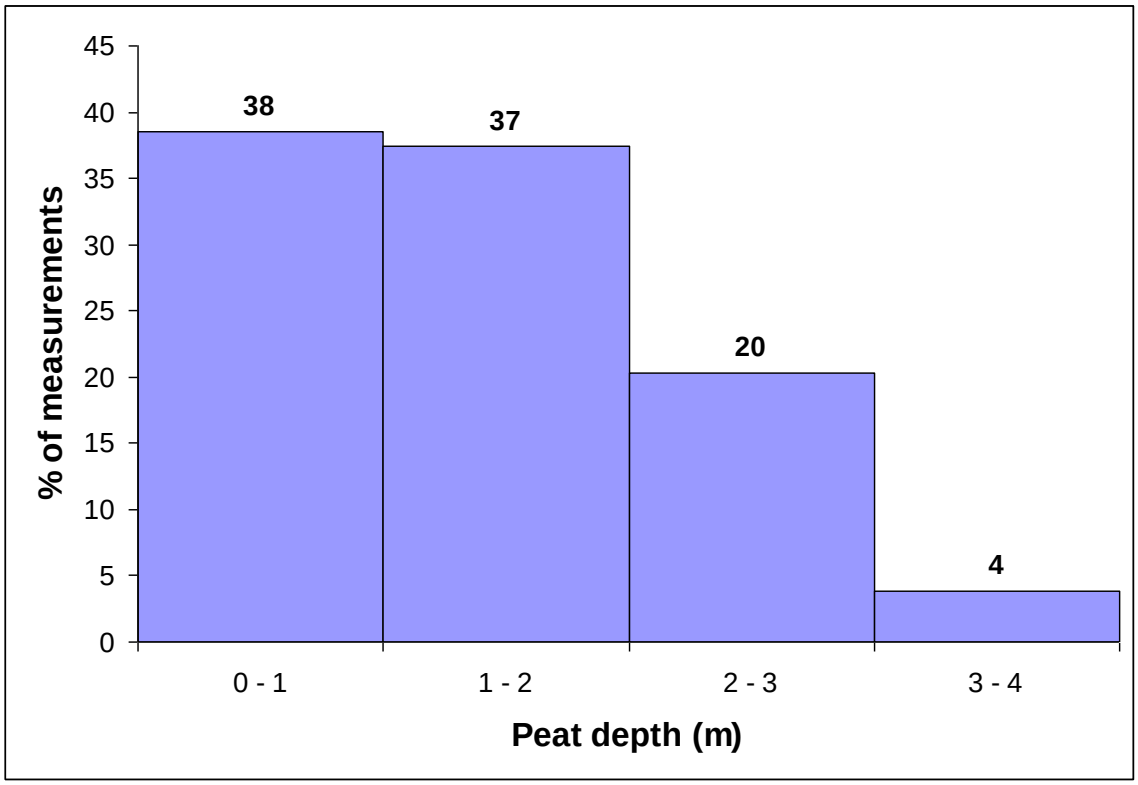

Figure 5.1: Distribution of the 513 peat depth measurements taken across the peatlands of the Bamford WTW Catchment (Values above bars represent percentage of measurements recorded within the peat depth bands).

The number of measurements and the mean peat depth recorded for each landscape location type is presented in Table 5.2. The most frequent landscape location is intact vegetation with 78% of the measurements; the mean peat depth recorded for measurements taken on 'intact vegetation' was also 1.37 m. The next most frequent landscape location is 'peat dome top vegetation' with just 6% of measurements recorded on this location type. The mean peat depth for 'peat dome top vegetation' is similar to that for 'intact vegetation' at 1.29 m. The difference in mean peat depth between both gully side and bottom and peat dome top and bottom is approximately 0.6m; therefore, this could be used as an estimate for the depth of peat lost from these degraded locations. See Figure 5.2 for the distribution of landscape location type across the peatlands within the Bamford WTW catchment.

Table 5.1: Peat volume calculations.

Area of peat survey area	km²	82.67
Average depth of peat	m	1.37
Volume of peat	m³	113,251,650
Volume of peat	km³	0.11

Table 5.2: Mean peat depth for each landscape location category.

Landscape location	No. measurements	Mean peat depth (m)	Standard error
Gully bottom	23	0.67	0.16
Gully side	19	1.21	0.16
Hag	24	2.25	0.17
Intact bare peat	2	2.50	0.23
Intact vegetation	399	1.37	0.04
Mineral/rock bare peat	1	0.11	
Mineral/rock mineral base	3	0.00	0.00
Mineral/rock vegetation	3	0.33	0.05
Peat dome bottom vegetation	3	0.62	0.34
Peat dome top bare peat	5	1.28	0.38
Peat dome top vegetation	31	1.29	0.16

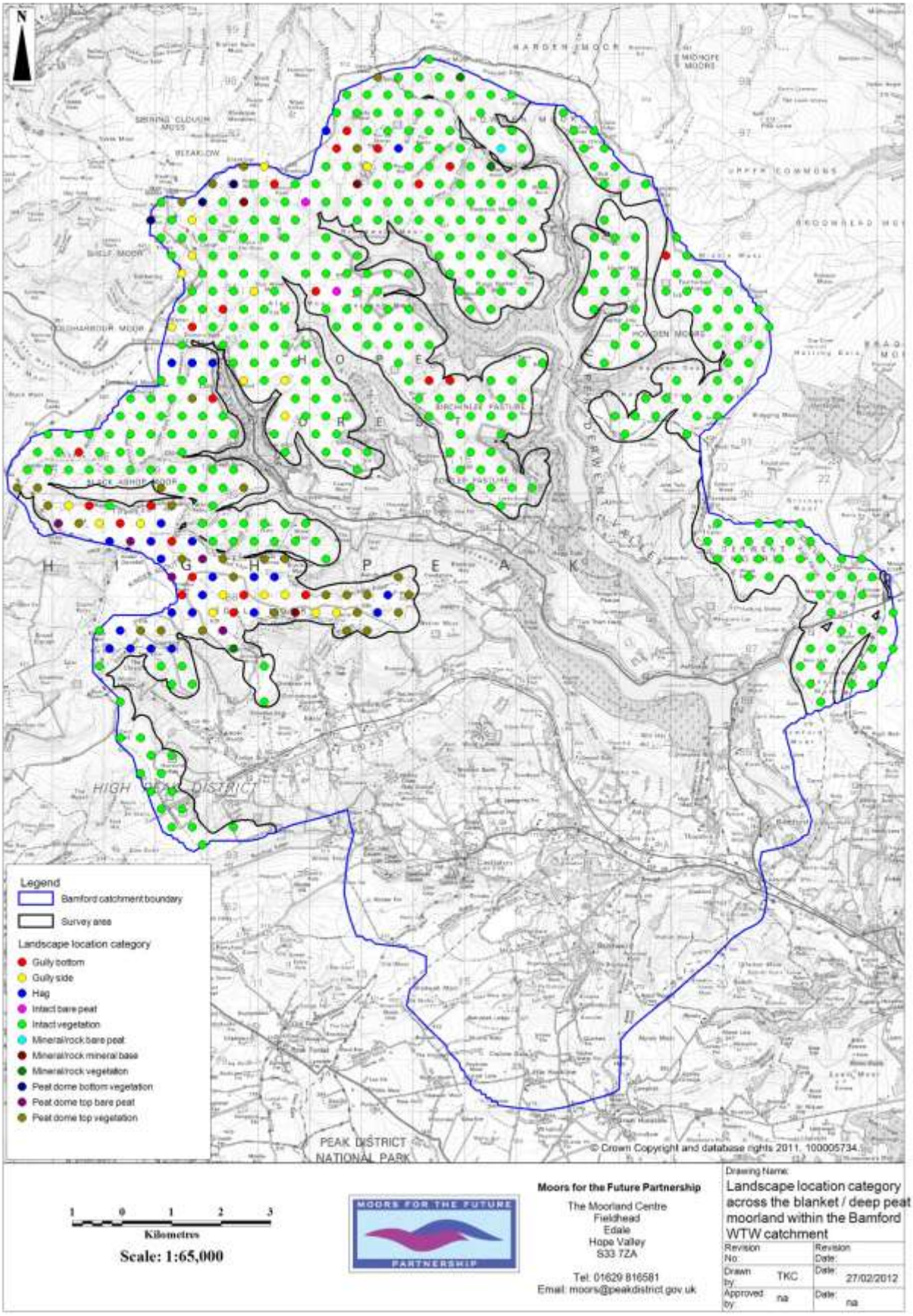

Figure 5.2: Model of landscape location category across the deep peat soil moorland areas within the Bamford WTW catchment.

5.2 Comparison of data with existing data

Shallow peaty soils are between 10 and 40 cm deep and deep peaty soils are greater than 40 cm. Across the peatlands within the Bamford catchment 18.3% of the peat depth measurements recorded shallow peaty soils and 81.7% recorded deep peaty soils (Table 5.3); however, approximately 40% of the measurements that recorded shallow peaty soils occurred close to or within the 20 m buffer that was applied around the deep peat in order to capture this transition. Therefore, the peat depth data is generally very representative of the NATMAP data and vice versa. Figure 5.3 shows the peat depth data (grouped into shallow and deep peaty soils) overlying the NATMAP generated map.

Table 5.3: Number and percentage of peat depth samples between 0-40 cm and >40 cm for each landscape location.

Landscape location	No. of peat depth samples 0-40 cm	Percentage of peat depth samples 0-40 cm	No. of peat depth samples > 40 cm	Percentage of peat depth samples > 40 cm
Intact vegetation	68	13.3	331	64.5
Intact bare peat	0	0	2	0.4
Gully side	0	0	19	3.7
Gully bottom	10	1.9	12	2.3
Peat dome top vegetation	7	1.4	25	4.9
Peat dome top bare peat	1	0.2	4	0.8
Peat dome bottom vegetation	1	0.2	2	0.4
Peat dome bottom bare peat	0	0	0	0
Mineral/rock vegetation	2	0.4	1	0.2
Mineral/rock bare peat	1	0.2	0	0
Mineral/rock mineral base	3	0.6	0	0
Hag	1	0.2	23	4.5
Total	94	18.3	419	81.7

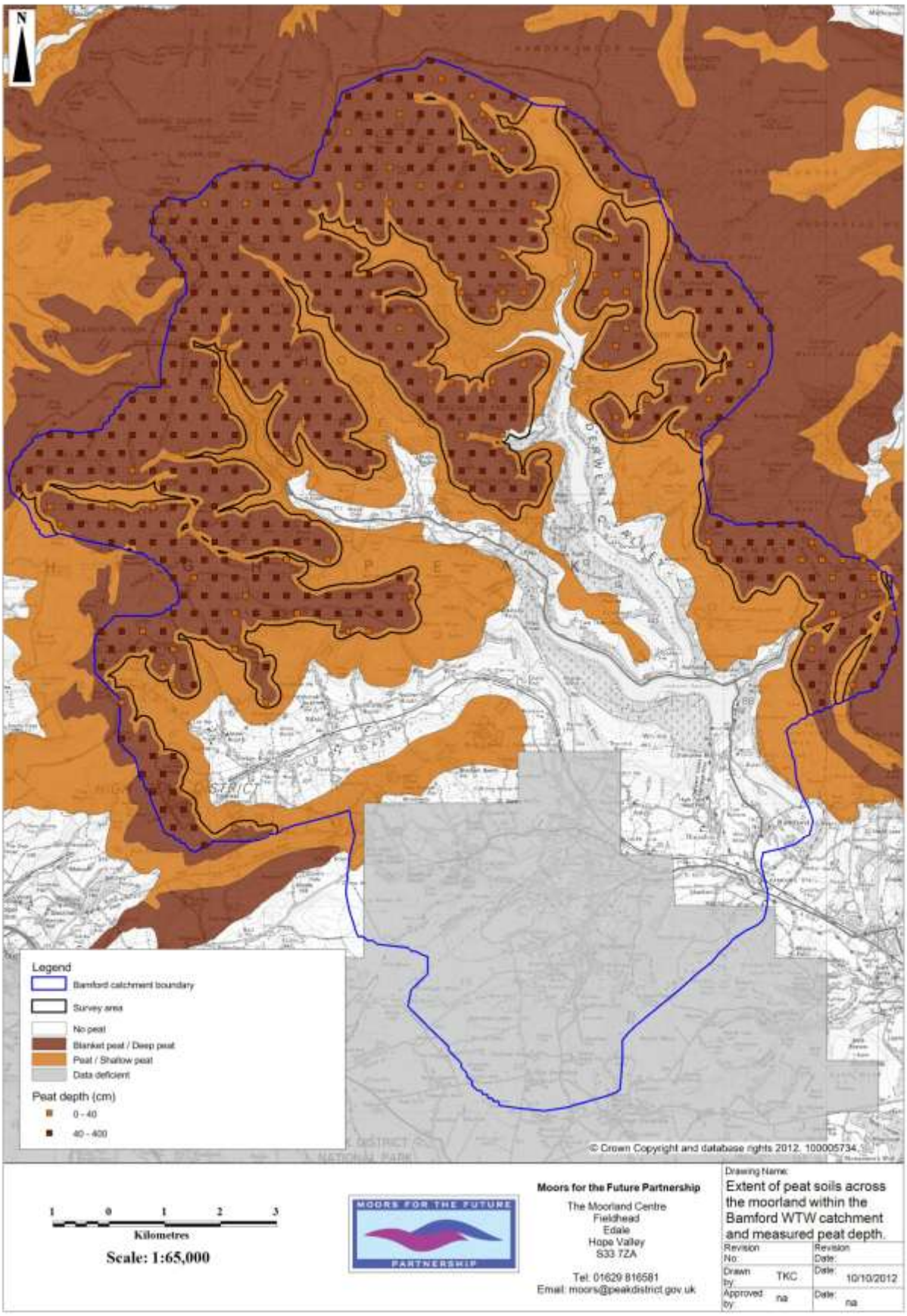

Figure 5.3: Extent of blanket peat soils across the moorlands of the Bamford WTW catchment and measured peat depth (a database licence agreement between Cranfield University and Severn Trent Water (Data lease code: L0096/00599) permits the reproduction of this Map).

5.3 Model of peat depth

A model of peat depth across the peatlands within the Bamford catchment is presented in Figure 5.4. Based on this model a north-south and east-west cross section of peat depth was plotted (Figure 5.5 and Figure 5.6). The locations of these cross sections are shown on the peat depth model (Figure 5.4).

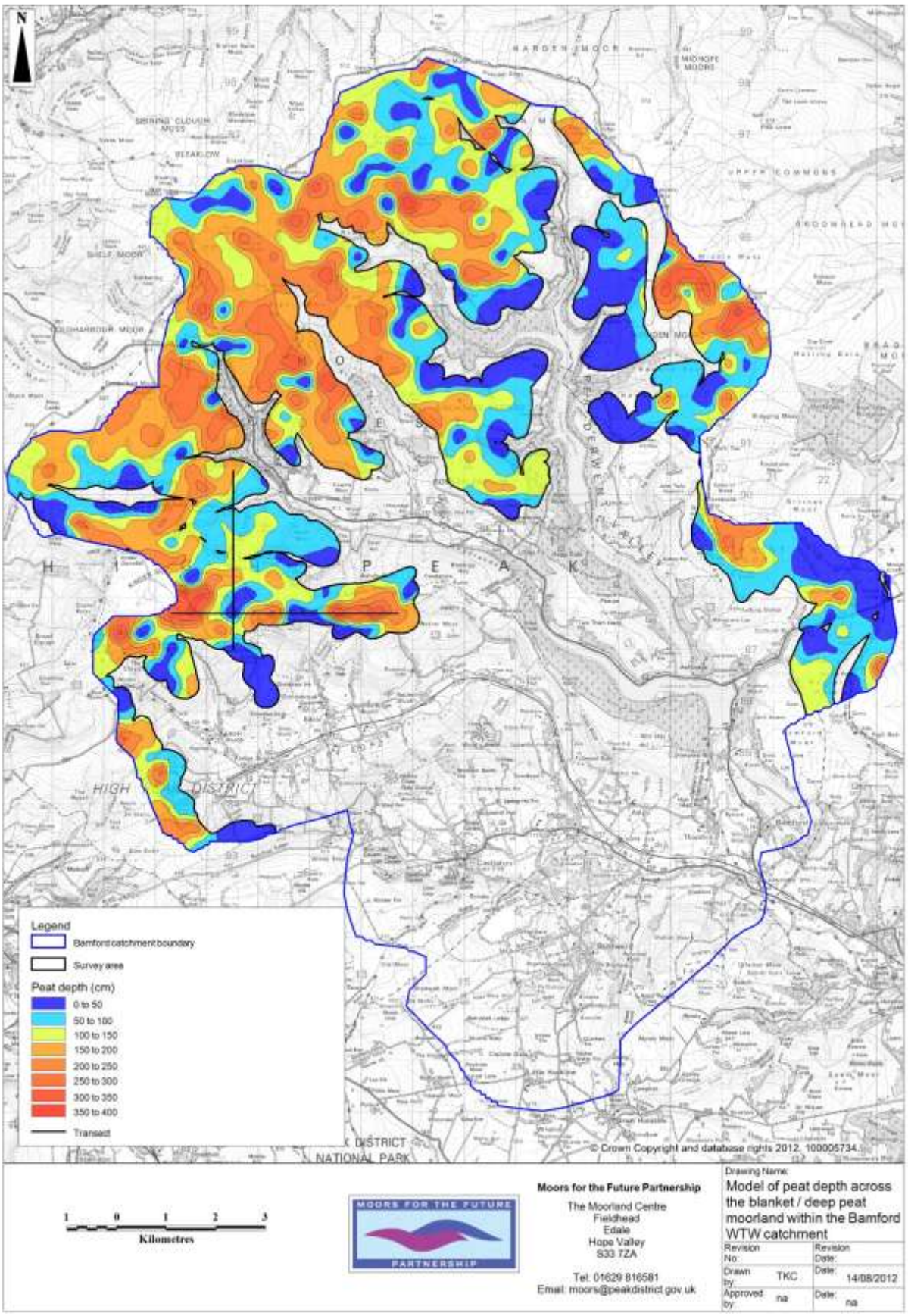

Figure 5.4: Model of peat depth across the blanket / deep peat moorland within Bamford WTW catchment.

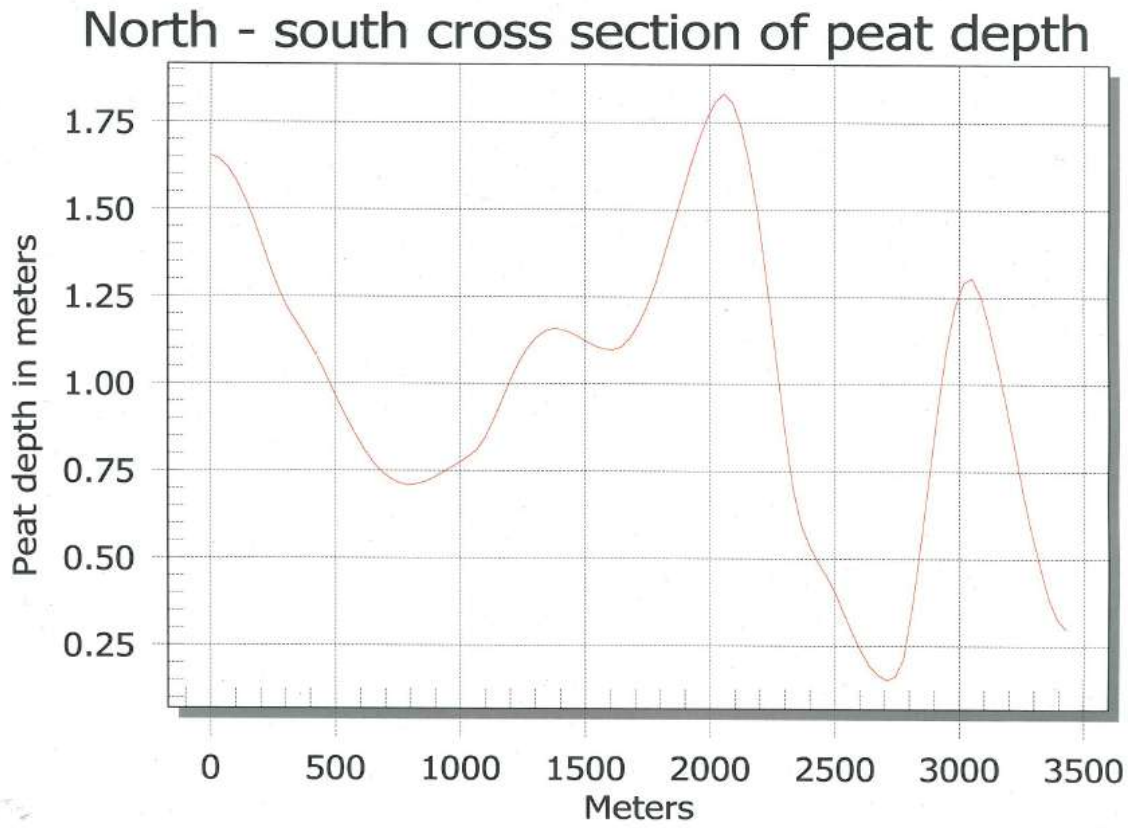

Figure 5.5: North – South cross section of peat depth.

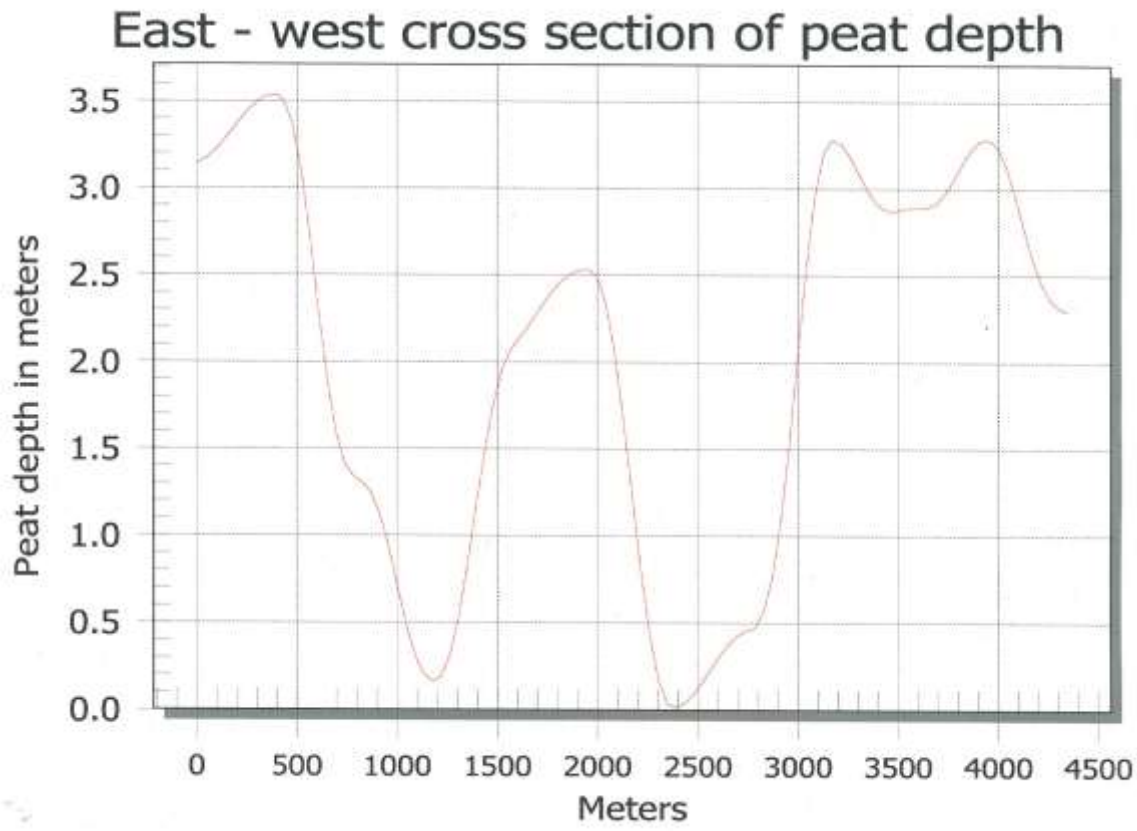

Figure 5.6: East – West cross section of peat depth.

6. Conclusion

The total amount of carbon stored in our peatlands can be estimated by combining information on the area and status of peatlands with estimates of peat carbon content, density and depth (Natural England, 2010). However, many estimates of peat carbon have assumed only 1m depth in England and Wales (Natural England, 2010) and used simple assumptions on peat bulk density (JNCC, 2011) which may have underestimated the importance of English and Welsh soil carbon. This is supported by the results of this report which found average peat depth across the peatlands within the Bamford WTW catchment to be 1.37 m.

7. Future / Other Research

- Undertake surveys along transects between existing peat depth sampling locations to investigate peat depth at a finer scale and to verify the accuracy of interpolated model and cross sections.
- Carry out bulk density analysis in order to calculate the carbon content of the peat within the Bamford WTW catchment.
- For detailed information on peatland land cover and management within the Bamford WTW catchment see Walker, J., Crouch, T, Proctor, S., Brown, M. and Maskill, R. (2011) Land cover and management activities across the moorlands in the Bamford Water Treatment Works Catchment and their implications for water colour and run-off. Moors for the Future Partnership, Edale.

8. References

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