



Proposed Residential Development at North Staney Hill, Lerwick

Preliminary Peat Management Plan

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Comments

A02 Revised for site boundary



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1. Summary

- 1.1. This document is a Preliminary Peat Management Plan (PMP) for the proposed housing development at North Stoney Hill, Lerwick on Shetland.
- 1.2. No finalised layout of roads or housing is available but, in order to provide an indicative quantitative assessment, some form of layout is required on which to base calculations. A Feasibility Study for Hjaltsland Housing Association, dated February 2014 contains a conceptual scheme for 240 semi-detached houses covering an area of approximately 14.5 ha. The hypothetical configuration used in the following assessment does not represent the maximum number of house units (possibly up to 400) that the site may potentially be able to accommodate. When a finalised Masterplan is available, the quantities and assumptions made in this Preliminary Peat Management Plan will require to be updated.
- 1.3. Following a desk study, fieldwork to confirm the physical geography and ascertain peat depths was undertaken between the 15th to 17th April 2014 across the 28.94ha site. The underlying bedrock is the Lerwick Sandstone Formation of the Mid Devonian era. The bedrock dips to the west/south-west and is exposed in a series of small scarps trending north-west/south-east. The site ranges in altitude from approximately 10m to 85m AOD, is oriented to the south-east and generally quite steep with a median slope of 11 degrees.
- 1.4. The vegetation is predominantly dry heathland in the upper areas giving way to acid grassland at lower levels. Some small flushes coincide with the narrow valleys formed by the scarps and, occasional small hollows may have ephemeral pools. Also observed to coincide with two of these valleys were 'peat pipes', which in one case has partial collapses.
- 1.5. The peat survey was undertaken on a grid pattern with a typical inter-point spacing of 30m. Of the 338 sample points, the median depth was in the range 0.3m to 0.4m with only 9 points exceeding 1.0m in depth. There was no discernable pattern to these depths and changes could occur over short distances. An exposed section through the soil in an adjacent road cutting showed a thin soil horizon over coarse angular glacial till with a significant cobble and boulder fraction. Thus, approximately two-thirds of the site is technically not peat, as the depth is less than 0.5m and may be described as a thin, but locally variable depth, organic soil.
- 1.6. The provisional calculations have estimated the quantities of topsoil and peat that would be stripped during construction. To comply with SEPA's requirement for a detailed component based assessment, the development 'footprint' is partitioned into four types of component. These comprise roads and footpaths, cut slopes, fill slopes and housing plots. The housing plots are subdivided into 'hard' and 'soft' areas – to distinguish the property and paths from the garden areas. With respect to the peat, this has been split into the acrotelmic (upper) and catotelmic (lower) layers.
- 1.7. This detailed component based analysis gives rise to a large matrix of numbers, which in the context of this site, must be regarded as theoretical and, in the absence of a final layout, speculative. A simplified model that takes cognisance of the practicalities of topsoil stripping on this site was developed and this gives reasonable correspondence with the detailed model. The estimate from the detailed model suggests that approximately 28,800m³ of peat and 35,800m³ of non-peat / organic soil would be excavated. The simplified model gives 50,700m³ of a peat / organic soil mix.
- 1.8. The principal strategy put forward for organic soil and peat management is that stripped material should be re-used locally to the source of origin, having first been stockpiled while construction takes place. This can be applied to the housing plot areas and other 'soft' landscaped areas, but

not for roads and associated footpaths. The latter volume, from the detailed model is estimated to be 17,500m³ (peat and non-peat) requires a destination – either on-site or off-site.

- 1.9. The on-site options would involve incorporating this material into glacial till to improved garden topsoil. The off-site uses could be directed towards a variety of purposes such as infilling / restoration of former peat workings in the vicinity of Lerwick or, capping on landfill sites and other projects. Final mitigation measures for the re-use or disposal of peat off-site will require further study (once a Masterplan has been developed for the site and final volumes of peat can be accurately calculated), and consultation with the Shetland Islands Council.

2. Introduction

Consultation

- 2.1. In response to a pre-planning enquiry in relation to North Stoney Hill, Lerwick, (Ref: PCS/131007, 22nd January 2014), SEPA set out a number of requirements in relation to the water environment including a suggested scope of study in relation to peat on the site.
- 2.2. In SEPA's letter of the 22nd January 2014, Section 6 covers **disruption to wetlands including peatlands** and Section 7 **disturbance and re-use of excavated peat**. These are the elements that are addressed in this Peat Management Plan (PMP). The PMP presents a qualitative and quantitative assessment of the likely impacts on the peatland of the development.
- 2.3. SEPA's letter of the 22nd January 2014 also cites a number of planning guidance references and position statements which are addressed where applicable. It should however be noted that a number of these documents, including the attached appendix to their letter, relate specifically to windfarm developments and not housing. However, where possible, this PMP takes cognisance of these documents and provides a description of the methods used in the assessment. This is followed by a description of the relevant baseline conditions of the site and the quantities of peat for a theoretical development layout.

Legislation

- 2.4. Under the Water Framework Directive, certain types of habitat such as wetlands and groundwater dependent terrestrial ecosystems (GWDTES) are protected. These do not necessarily constitute peat and, a definitive demarcation may be species dependent. In practical terms, and particularly in relation to peat, a number of guideline documents have been developed by SEPA, SNH and the Scottish Government. However, from their contents, it is clear that the driver is often windfarm related.
- 2.5. Where peat has been excavated and cannot be re-used, then it may be regarded as waste and be subject to national legislation principally:
 - Environmental Protection Act 1990 (as amended)
 - Landfill (Scotland) Regulations 2003 (as amended)
 - The Waste Management Licensing (Scotland) Regulations 2011
- 2.6. In the case of the re-use of peat, there may be a range of possibilities that have both a temporal and spatial dimension and, the criteria for re-use is not always clear-cut. This can lead to debate on whether or not a specific proposal constitutes waste or not.

Planning Policy Guidance

- 2.7. SEPA in their letter of 22nd January 2014 cite a number of guidance documents and for convenience these and others considered relevant to this project are listed below:
 - **Planning guidance on windfarm developments.** In the context of this proposed housing development, there may be some relevance to the potential impacts on GWDTES – should any such habitat exist on the site. However, there is mention of access tracks to turbine bases, borrow pits, cable trenches and other forms of windfarm infrastructure, which in terms of scale and characteristics are not directly applicable to housing.

- **Development on Peatland: Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and Minimisation of Waste.** This document opens with the statement that the principles apply to all forms of development. However, all the examples used are taken from wind farms.
 - **Regulatory Position Statement – Developments on Peat.** SEPA's position is that peatlands hold large stocks of carbon and their disturbance may lead to significant releases of CO₂ to the atmosphere. Thus developments on peatland should be avoided or minimised and that peat that cannot be reused will be regarded as waste.
 - **Floating Roads on Peat.** This is a substantial document with an engineering orientation relating to the design and specification of floating roads in peat. These are generally used where the peat depth exceeds approximately 1.2m or where it is economically advantageous to use the technique on shallower peat. It is most unlikely that floating road construction will be used for this development.
 - **Good practice during windfarm construction.** This is a substantial document and covers virtually all stages of windfarm planning and construction. The emphasis is almost entirely on habitat and pollution management. Many of the specific details do not apply to a housing development and only generalisations such as a requirement for various surveys, construction method statements, sediment control measures etc apply.
 - **Developments on Peatland: Site Surveys.** This document proposes a two phase peat depth survey. First, a low resolution pass on a coarse grid of about 100m spacing and then, closer probing at possibly 10m – 50m interval spacing associated with infrastructure locations. It cites the Scottish Peat Surveys of the 1960's which were undertaken on selected peat bogs primarily with the objective of industrial scale extraction of peat for thermal power stations and other purposes. The sites selected in the 1960's were known to have deep peat and the techniques employed were not applicable to current technology (eg GPS), nor the methods particularly appropriate to the mixed ground and topographical conditions for a housing development.
- 2.8. It is clear that a number of these publications are not directly relevant to a housing development on the periphery of existing habitation and infrastructure. However, where possible, some general concepts have been applied in the fieldwork and assessment process.

Assessment Methodology and Significance Criteria

Assessment Methodology

- 2.9. SEPA require a quantitative assessment of the quantity of peat disturbed by the development. This has to consider the aerial extent as well as volumetric quantities, and the latter sub-divided into acrotelmic and catotelmic peat.
- 2.10. Where the organic soil depth exceeds 0.5m, it is considered as peat and the acrotelmic peat is the upper more fibrous layer, the base of which is generally taken to be close to the average water table or permanently saturated level in the soil. In fairly uniform blanket bog, this conceptual demarcation may be fairly distinct. However, that is unlikely to be the case at North Stoney Hill. **Figure 11** shows that the soil horizons are far from uniform and the underlying permeability variable from granular till to solid bedrock. Given this situation and where applicable, a general figure of 0.2m has been taken as the acrotelmic depth.
- 2.11. A peat depth survey across the site is required and thereafter to make these quantitative

assessments, the indicative development footprint has been superimposed upon the baseline data and, using the GIS functionality, areas and peat depths are computed and ultimately presented in tabular form.

- 2.12. At this time, the final layout of the development has not been decided. This will be developed through a Masterplan process. However, in order to provide an indicative quantitative assessment, some form of layout is required on which to base calculations. A Feasibility Study for Hjaltland Housing Association, dated February 2014 contains an initial concept based on 240 semi-detached properties and associated roads. This indicative layout has been used for the basis of this assessment in order for a 'broad-brush assessment to be completed. However, following the development of a Masterplan for the site, this assessment of impacts upon peat will require to be re-assessed in order for an accurate assessment of the impacts to be presented. It should however be noted that the methodology followed throughout this assessment will remain as set-out within this PMP.
- 2.13. An example of how the component based calculations are undertaken is shown in **Figure 1**. This shows four types of area – (1) roads and footpaths, (2) housing plot areas, (3) cut slope areas and (4) fill slope areas. Each of these areas is an assemblage of small polygons within which the figure is the assigned probing depth. The allocation of depths to each element is through the Voronoi polygon process which is an algorithm for assigning point data (probed depths) to neighbouring areas. The process is run within the Quantum GIS.

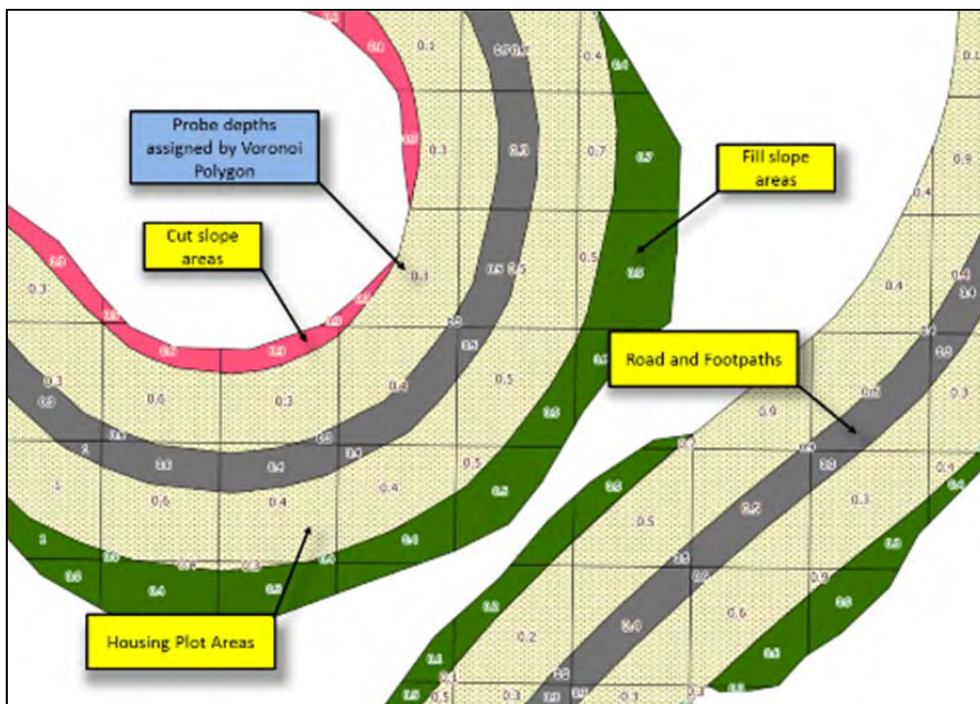


Figure 1 Detail of area / volume computation model

- 2.14. The sub-division of the conceptual development footprint has been done on the basis of offset distances from the road centre line. The road and associated footpath has been taken as 5m either side of the centre line and the back of the housing plots as 25m from the centre line. The latter has been trimmed where this would put the housing outwith the site. The exact distribution and orientation of buildings within plots is not particularly relevant, thus the housing area has been sub-divided into 'hard' areas (house and driveway) and 'soft' (garden) on the basis of a 20:80

percentage split.

- 2.15. The cut / fill areas that abut the housing plot areas are a function of the topography of the site. In order to have acceptable gradients on roads and housing plots, considerable volumes of cut and fill may be required. This increases the footprint of the development, therefore it is prudent to take some account of this in the calculations.
- 2.16. In any numerical calculations of this nature it is important to be aware of the achievable accuracy in the derived figures. As an example, the probing rod is calibrated and read to the nearest 0.1m in what is generally coarse undulating terrain. For this site, the median and mode depths are both 0.3m, thus 0.1 represents a third of the value. Across all samples the random 'error' in the readings should be free of any bias, but not necessarily so for any individual or small number of points. Therefore, when material volumes are presented, it is meaningless to dispute small percentage differences. Furthermore, given the generally shallow and variable nature of the soil, the theoretical demarcation of this into non-peat, acrotelm and catotelm is easy to do in a calculation, but far less so with an excavator.

3. Baseline Conditions

Geographical and Geological Context of North Staney Hill

- 3.1. North Staney Hill is located on the north-western periphery of Lerwick, Shetland. The site area is approximately 28.94ha and ranges in elevation from approximately 10m to 85m above Ordnance Datum (sea level). From the highest location the site falls in all directions but is predominately orientated to the south-east. There are several areas where the gradient exceeds 10 degrees. A general aerial view of the site is shown in **Figure 2** below where the contours are at 5m intervals.
- 3.2. Within the aerial image, the darker areas of vegetation above an elevation of approximately 30m are heather / heathland and below this level there is coarse grassland. However, it should be noted, particularly around the western margin of the site, that this vegetation change is coincident with dykes and fence boundaries. It is therefore likely to be a function of land management rather than elevation alone.



Figure 2 Aerial view of Site with 5m interval contours

- 3.3. The orientation of the site is shown graphically in **Figure 3**, which quantifies the proportion of the site orientated in particular directions. This highlights the marked aspect to the south-east and east.

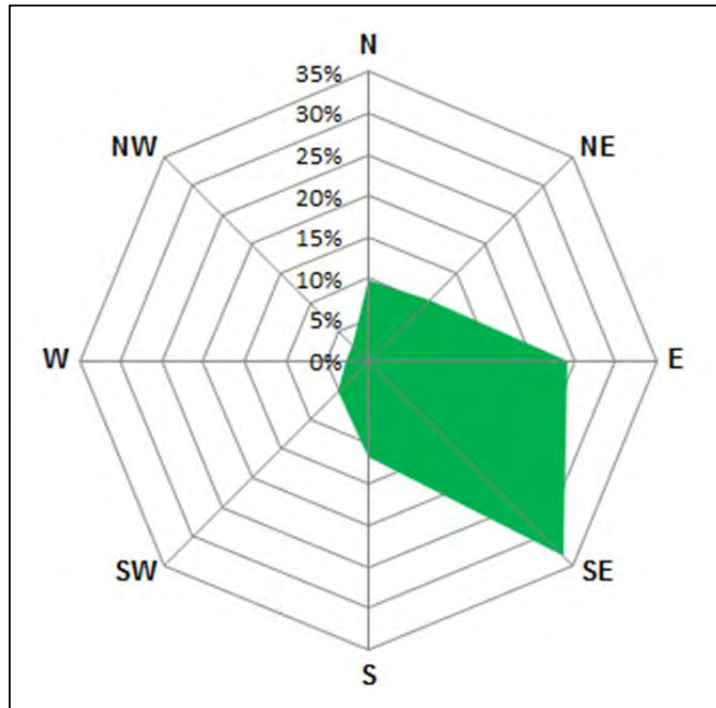


Figure 3 Site aspect

- 3.4. The depth and distribution of peat is often related to topography. A morphological analysis of the site has been undertaken using Ordnance Survey Terrain 5 digital elevation data (OST5) which was loaded into Quantum – a Geographical Information System (GIS).
- 3.5. The OST5 data was processed to generate elevation, slope and aspect layers and these were then sampled on a 10m interval grid across the site. At each sample point, the above attributes were extracted and have been summarised in the following figures.
- 3.6. A histogram of the distribution of elevations within the site is shown in **Figure 4**. With the exception of a small proportion of the site which lies in the south-east, a significant proportion of the site is above 50m in elevation and, when considered in conjunction with aspect (see **Figure 3**), has exposure to south-easterly weather.

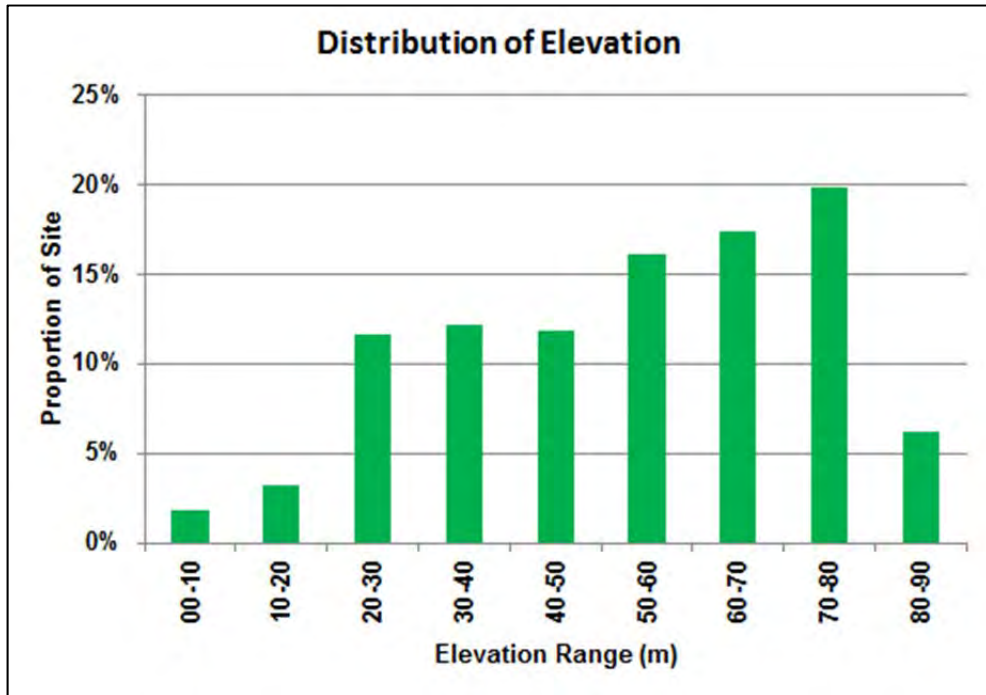


Figure 4 Range of elevations within site

3.7. A histogram of the distribution of slopes within the site is shown in **Figure 5**. This shows that over 60% of the site has slopes in excess of 10 degrees and confirms the impression gained from the contours that this is generally a steep and fairly rugged site. From many studies across Scotland, it has been found that as a general rule, deep peat does not occur on steep slopes. The subsequent fieldwork which is described later in this PMP demonstrates that to be the case.

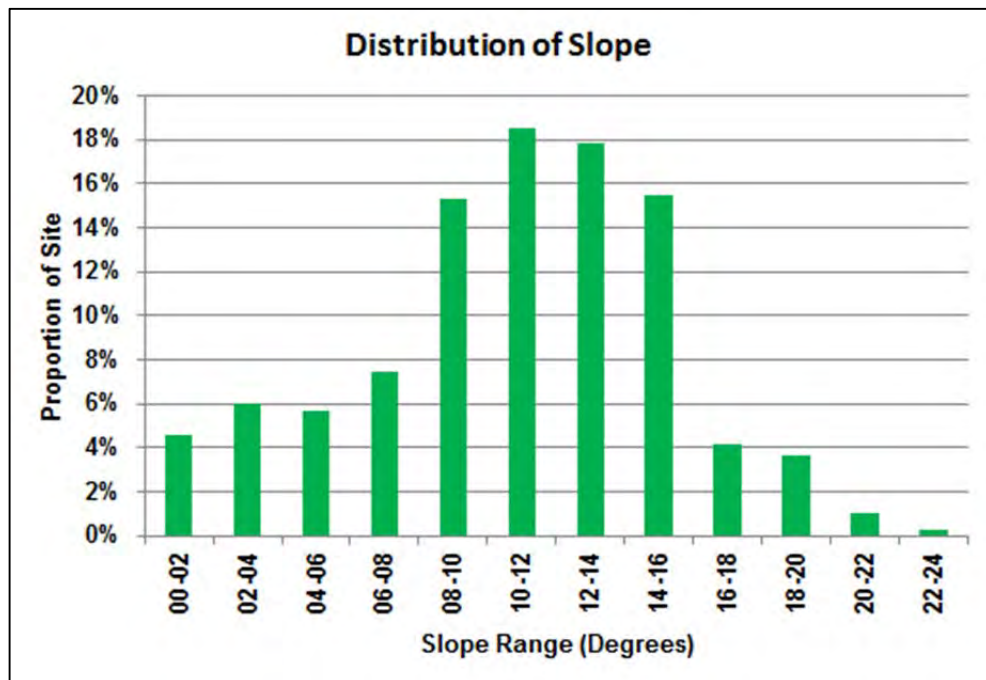


Figure 5 Range of slopes within the site

- 3.8. The underlying bedrock geology of the site is the Lerwick Sandstone Formation of the Mid Devonian era. These sedimentary rocks were formed from rivers depositing mainly sand and gravel detrital material in channels to form river terrace deposits and may also include estuarine and coastal plain deposits.
- 3.9. Within the site the bedding planes dip to the west/south-west at an angle of approximately 40 degrees which is illustrated in **Figure 6**. Perpendicular to the dip orientation and fairly evenly distributed across the site are four minor scarp ridges which can be distinguished by the shadows in the aerial photograph in **Figure 2** above.
- 3.10. A characteristic of these scarps and minor fractures, which are perpendicular to the bedding planes, is a steep rock face as illustrated in **Figure 7**. Across many parts of the site, the scarp lines have fragmented with wreathing and frost action to leave large boulders that have rolled to lower elevations. Some of these boulders provide good illustrations of the original sedimentary depositional processes where the fluvial forces have transported larger stones and cobbles, which are now embedded in distinct layers within the finer grained sandstone. One such example is shown in **Figure 8**.



Figure 6 Bedrock (Sandstone) exposure showing dip angle to W/SW



Figure 7 Exposed rock on steep scarp face



Figure 8 Isolated boulder that has fractured along a layer displaying cobbles

- 3.11. With the exception of two short lengths of ditching adjacent to the southern boundary of the site, there are no other open water bodies or water courses shown on the Ordnance Survey 1:25,000 scale map. This was confirmed during the fieldwork.
- 3.12. However, in two locations there was evidence of 'peat pipes' as illustrated in **Figure 9**. These locations coincided with the lower reaches of the narrow valleys formed by the rock scarps. In the case of the right hand image, this lead into an open ditch as it exited the site.



Figure 9 Illustration of 'Peat Pipes'

- 3.13. The only other water related feature of note on the OS map is a 'Spring' located at NGR: 446704, 1141970 which is towards the eastern margin of the site. During the site visit there was no obvious sign of the spring on the ground surface and, as shown in **Figure 10**, there is no vegetation change or other indication of the presence of a spring visible in the aerial photograph. The annotated points shown in this image relate to the peat probing (described below), thus this area was extensively walked over.



Figure 10 Aerial image of spring position marked on the OS 1:25,000 map

- 3.14. The conclusion that may be drawn from these observations is that precipitation must leave the site through a combination of two mechanisms. When the infiltration capacity of the soil is exceeded, overland flow will occur and this would be intercepted by existing ditches around the periphery. At other times and lower rainfall rates, the subterranean 'peat pipe' flow would convey the run-off to the site boundary.

Peat Survey

- 3.15. Preparation for the peat survey fieldwork commenced with a desk study principally based on the digital terrain model, soil mapping and aerial imagery. From this, it was decided that a regular 30m interval grid pattern within the site would provide sufficient data to characterise the site. In addition to the sample points within the site permission was sought to undertake probing in some of the peripheral areas particularly where these were downhill from the site.
- 3.16. The sampling strategy was generated within the Quantum GIS and easting / northings transferred into a Garmin eTrex 20 GPS. In addition to the sample points themselves, three spatial reference points to readily identifiable features around the site were also loaded into the GPS. These latter points provided on-site confirmation that the GPS was correctly configured and operating to a satisfactory level of accuracy. Throughout the fieldwork the GPS was indicating a positional accuracy of approximately 5m to 8m.
- 3.17. The fieldwork was undertaken with a two person team in clear weather during the period 15th to 17th April 2014. The work was undertaken to Waterman's peat probing task procedures, which in some respects are more rigorous than the *Developments on Peatland: Site Surveys* document cited by SEPA. For example, in addition to the probed depth, other meta-data relating to the substrate encountered by the probe, is recorded and where possible designated as 'rock', 'granular / gravel' or 'clay'. Furthermore, on some test areas of the site close interval probing at 2m intervals was undertaken to establish the typical variability that may be expected.

- 3.18. From the desk study and past experience of this type of terrain, it was anticipated that the site would have a thin cover of organic soil with either glacial till or bedrock below. A road cutting exposure at the north-west of the site confirmed this hypothesis and is illustrated in **Figure 11**. There was also ample evidence of exposed bedrock across the site.



Figure 11 Soil horizons at north-west of site

- 3.19. **Figure 11** illustrates some important factors that must be recognised when undertaking probing fieldwork in this type of terrain. At the point where the probe is placed, a thin organic soil would be penetrated and then possibly a further 0.2m of till before the probe encountered a large stone or boulder. Thus a reading of 0.3m may have been obtained with the base type (based on sound and feel) being recorded as 'granular / gravel'. A short distance to the left of the probe position, a reading of only 0.1m may have been recorded and the base type 'rock'. Although both readings have to be regarded as valid, it is probable that 'granular' base terminations may over-estimate the depth of 'peat'.
- 3.20. At three locations on the site, close interval probing at approximately 2m centres was undertaken to ascertain the magnitude of this type of variability. This is discussed in more detail in subsequent sections, but a range of 0.2m is not uncommon.
- 3.21. The main probing exercise resulted in 338 points being sampled, the locations of which are shown in **Figure 14** appended.
- 3.22. The distribution of probed depths is shown in **Figure 12**, where it should be noted that the term 'probed depth' is deliberate because not all of the material can or should be classified as peat.
- 3.23. In Scotland peat is defined¹ as land where the soil has an organic surface horizon over 0.5m. In the context of that definition, 98 probed locations (29% of the total) could be classified as peat. However, of those 98 points, 58 terminated in granular or soft material thus, as discussed above,

¹ Developments on Peatland: Site Surveys, Scottish Government et al

the reading probably overestimated the depth of the organic layer. It could therefore be that the actual proportion of probed points that are peat is closer to 20%.

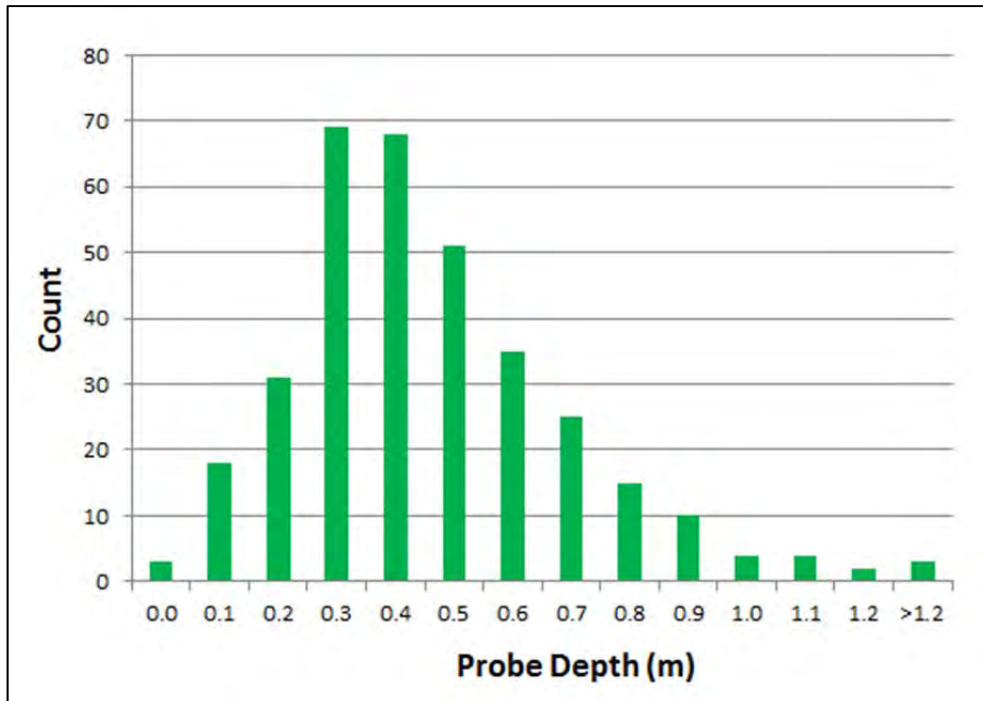


Figure 12 Histogram of probed depths

- 3.24. The definition of 'deep' peat used by SEPA is peat which is greater than 1.0m in depth, although in engineering and earthworks terms, this is not particularly deep. There are 9 points with a depth greater than 1.0m which represents less than 3% of the survey. Of these 9 locations, there were 3 points where the probe did not bottom out, but it is believed that these are isolated pockets of limited extent because the average depths of the immediately surrounding points range from 0.3m to 0.5m.
- 3.25. An illustration of the limited extent of a 'deep' peat pocket is shown in **Figure 13**. In this figure the main points (two showing) that are on a regular grid at a 30m spacing are part of the peat survey for the site as a whole. At point B19 of the main peat survey, a depth of 1.2+m was recorded and, to establish the extent of the deeper peat four radial transects (N,S,E and W) were undertaken. These transects used close interval probing at approximately 2m centres. The probed depths demonstrated that the 'deep' peat was limited to no more than about 4m in any direction.



Figure 13 Close interval probing around 'deep' peat

- 3.26. In order to assess the extent and volumes of peat, Voronoi polygons were generated to enclose the probing points. This process allocates a representative area to each point. The central part of the study area was surveyed on a regular grid thus the generated areas are square, but around the periphery, the probing locations are less regular resulting in multi-sided polygons. On the basis of the probed depth, the polygons have been categorised into 'Peat' (depth greater than 0.5m) and 'non-Peat'.
- 3.27. The 'Peat' and 'non-Peat' polygons have been rendered accordingly and are displayed in (appended) which shows that depth values of many of the polygons are only marginally into the category of 'Peat'.
- 3.28. This is also apparent from the histogram in **Figure 12** above. However, the map puts this into a spatial context. There is no obvious pattern to the distribution of those areas that have been categorised as peat.
- 3.29. The conclusion that can be drawn from the fieldwork and baseline survey is that areas that may be designated as peat are patchy and generally shallow except for three points with deeper peat, but there is good evidence that these are localised.

Development Constraints

- 3.30. The median probing depth is 0.3m and therefore can be classified as an organic topsoil and not peat. As shown in **Figure 15**, the distribution of those areas that may be classified as peat shows no particular pattern or concentration of locations with deeper peat.
- 3.31. Thus, nothing has been identified in the peat survey fieldwork that would constitute a constraint on the layout of the development.

4. Planning and Design Measures

Hierarchy of Measures

- 4.1. When developing a Peat Management Plan it is possible to identify a hierarchy of measures through which the effectiveness of the approach to peat management is optimised and would, in general, constitute the steps set out below, each of which is discussed in more detail.
- Site Selection;
 - Site layout considerations;
 - Assessment of peat volumes;
 - Engineering design measures; and,
 - Application of methods.
- 4.2. When developing a project there is interplay between many disciplines such as hydrology, visual impact, ornithology, ecology and others but, in addition, one must also consider the constructability of the scheme. Given the multiple objectives of these disciplines, the design process is one of constrained optimisation – or compromise.
- 4.3. The degree to which any particular ideal can be achieved will vary from one site to another. In developing the Preliminary PMP cognisance has been taken of documents such as *Developments on Peatland: Guidance on the assessment of peat volumes, reuse of excavated peat and the minimisation of waste (Scottish Renewables, SEPA 2012)*. This document sets out the disposal of peat from the waste hierarchy perspective of prevention, re-use / recycle or as a last resort disposal. It is closely aligned to SEPA's *Regulatory Position Statement – Developments on Peat (2010)* in which it states that “developments on peat should seek to minimise peat excavation and disturbance to prevent the unnecessary production of waste soils and peat”.
- 4.4. This report examines the volume of peat likely to be excavated during the construction process and the potential for minimising excavation and identifying areas for re-use.

Site Selection

- 4.5. There is a recognised demand for housing in Shetland and in particular around Lerwick. However, in the context of this report, site selection is beyond the scope of this study where the objective is restricted to an assessment of North Staney Hill alone.

Layout Considerations

- 4.6. As stated in the **Development Constraints** section the distribution of peat across the site is patchy and generally shallow so no particular constraints are imposed by those conditions. Within the Phase I Habitat Study (refer to Chapter 6 the ES document) some small areas of active blanket bog were observed. These patches may be avoidable but if not, are unlikely to be of any major significance.
- 4.7. The actual layout of the road infrastructure and housing has yet to be determined, but the primary drivers for this are likely to be visual / architectural considerations closely aligned with engineering factors due to the topography. A Masterplan will be developed which will set out the location and distribution of housing and road layouts across the site.
- 4.8. It is possible that the design will undergo a series of iterations and the construction undertaken in

phases. Although it is possible to make some generalised assessments at this stage, the quantitative elements set out in the **Assessment of Peat Volumes** section will require to be revisited when the project layout is more clearly defined.

Assessment of Peat Volumes

- 4.9. In order to quantify the impacts of the proposed development, an indicative footprint that has been utilised for the purposes of this assessment and has been superimposed upon the baseline study of the site. The impact assessment which follows in the subsequent sections is a tentative quantification of those areas that are directly or indirectly affected by the development based upon this indicative site layout.

Demolition Works

- 4.10. Within the site there are a number of small structures dating from World War II, and possibly earlier, the most prominent of which is a reinforced concrete bunker located near the top of the hill (GR: 446415, 1141990) and also hut bases near the east margin of the site (GR: 446745, 1142000). It may be that these and similar features are considered to be of archaeological interest and therefore retained. However, even if the decision was that they should be removed, their physical extent is very small thus, their demolition would be insignificant in terms of disturbance to the peat.

Construction Works

- 4.11. The component base methodology for determining the quantities of peat impacted by the development has been set out in Section 2.9 of this report. The results, based on a tentative conceptual layout as described earlier, of undertaking the calculations to establish the quantities stripped are as in **Table 1**.

Table 1 Organic soil volumes for detailed component model

Features	Area (m ²)			Volume (m ³)			
	NP	P	Total	NP	A	C	AC_Total
Road & Footpaths	21689	8101	29790	7366	1620	4645	6265
Housing Plots	<i>70804</i>	<i>24670</i>	<i>95474</i>	<i>23160</i>	<i>4934</i>	<i>14387</i>	<i>19321</i>
'hard' (20%):	14161	4934	19095	4632	987	2877	3864
'soft' (80%) :	56643	19736	76379	18528	3947	11510	15457
Cut slopes	7110	2538	9648	2193	508	1161	1669
Fill slopes	7640	2395	10035	3065	479	1073	1552
Totals:	107243	37704	144947	35784	7541	21266	28807

Note abbreviations: **NP** - Non-peat, **P** – Peat, **A** – Acrotelm, **C** - Catotelm

- 4.12. The Housing Plots have been partitioned into 'hard' and 'soft' elements. The 'hard' elements relate to the building, driveway and paths and are surfaces from which soil is stripped and not replaced. The 'soft' element relates to the garden where it is likely that soil will be stripped and the area landscaped and improved soil reinstated. The percentage splits are estimates based on a conceptual configuration of housing.
- 4.13. The 'Cut slopes' and 'Fill slopes' relate to those parts of the site that are outwith the footprint of the road and housing plots but are necessary to achieve road gradients or reasonably level housing plots. It has been assumed that the cut slopes will be in rock and relatively steep, thus soil will be

stripped but not replaced. In the fill slope areas it has been assumed that the soil will be stripped, the fill material placed and compacted and the surface reinstated.

- 4.14. Each of these features has an area and volume dimension and these are further subdivided into non-peat and peat components. The volumetric peat component itself is then partitioned into acrotelmic (upper) and catotelmic (lower) peat.
- 4.15. This detailed component based analysis generates a large array of figures as above, however the overall characteristics of the scheme are possibly best assimilated by considering aggregations of these figures. The key features (based upon the indicative layout) are:
 1. The total development area is approximately 14.49 ha which is approx. 50% of the 28.94ha site.
 2. Of the development area, 3.77 ha (26%) may be considered to be on peat and 10.72 ha on non-peat areas.
 3. The 'fill slope' and housing plot 'soft' areas account for 7.64 ha (53%) of the development area. These areas will have topsoil and vegetation reinstated and they have some potential for the reuse of peat that has been stripped from elsewhere on the site.
 4. In terms of volumes, 64,591m³ of superficial material will be stripped of which 28,807m³ (45%) may be considered as peat. However, of this, 17,009m³ arises from the 'fill slope' and housing plot 'soft' areas and it would be reasonable to expect that a significant proportion of that material can be reinstated to those locations.
 5. The volume of material stripped from the roads and footpaths, housing plot 'hard' and 'cut slope' areas is 25,989m³ of which 11,789m³ (45%) may be considered as peat. None of this material can be reinstated to its point of origin and none is suitable for engineering purposes; thus alternative reuse and disposal paths must be considered.
- 4.16. It is important to note that the above volume figures relate only to the organic horizons on the site and exclude the excavation of glacial till and rock necessarily incurred in the construction of the roads and housing. Those volumes cannot be derived until a 3D road and housing layout is developed. However, it is clear from the topography of the site that engineering related excavations may be significant. A refined layout design should try and achieve a reasonable balance between cut and fill, but the proportion of engineering unsuitable material is an unknown. Alternative reuse and disposal paths must be considered for this material.

Material Use Strategy

- 4.17. A plausible strategy for managing these components is reinstatement to point of origin where possible, otherwise alternative reuse and disposal paths must be considered. Under this scenario the following actions would apply:
 1. All superficial material would be stripped from the housing plot areas ('hard' and 'soft'), but not necessarily concurrently, and stockpiled until landscape reinstatement.
 2. Following possible plot grading, both the non-peat and peat arising in the housing plot areas would go back into the 'soft' landscaped component. As the 'hard' component volumes are relatively small this would not add substantially to the depths when redistributed into the 'soft' areas.
 3. All superficial material would be stripped from the fill slope areas and stockpiled until reinstatement. Following the engineering compaction of the fill slopes both the non-peat

and peat would be reinstated back on top of the fill slope.

4. All superficial material would be stripped from the road, footpaths and cut slope areas and stockpiled. If it was beneficial for additional material for actions (2) and (3) above then some of this material could be used. However, it cannot be reused at the point of origin and therefore the majority is likely to be surplus to the needs of the development site. Summating the relevant components in **Table 1** gives a possible volume of 17,493m³ to be reused or for disposal.
- 4.18. The reuse options for surplus material (of any sort) within the site boundary are limited; this is not due to a lack of open space, but rather from the re-use of excavated material onto existing natural habitat.
 - 4.19. If on-site reuse or disposal is not practical or favoured then alternatives would need to be considered. A number of possibilities may exist such as transporting the surplus to areas of former peat workings or habitat restoration and capping / landscaping on other works elsewhere. The quantities of materials are such that they may provide 2-3 ha of restoration / capping potential, however all such possibilities would require further detailed studies and consultation with Shetland Islands Council.
 - 4.20. The above analysis is presented in the component format requested by SEPA and is based on the best assessment possible at present. However, it is important to note that the calculations incorporate several theoretical idealisations. With reference to **Figure 11**, it will be difficult to strip soil with precision into non-peat, acrotelm and catotelm. With the exception of some localised areas, the practical reality may be that there is a top-soil strip of 0.3m-0.4m across the development site as a whole. Below this level excavation will generally be in till or rock. This would result in two grades of material, (a) organically rich soil with some fine till, cobbles and occasional boulders and (b) predominantly till with a significant grading of cobbles and boulders. Note that in this context cobbles are taken to be between 63mm-200mm and boulders larger than 200mm (BS 5930).
 - 4.21. On the basis of a simplified model using the same feature descriptions and areas as in **Table 1**, but considering layer (a) above stripped to a mean depth of 0.35m, then the volumes of an organically rich soil are as given in **Table 2**.

Table 2 Organic soil volumes for simplified model

Feature	Area (m²)	Volume (m³)
Road & Footpaths	29790	10427
Housing Plots	95474	33416
'hard' (20%):	19095	6683
'soft' (80%) :	76379	26733
Cut slopes	9648	3377
Fill slopes	10035	3512
Totals:	144947	50731

- 4.22. Using the same strategy as outlined above where the stripped organic layer from the roads, footpaths and cut slope areas cannot be reinstated to the source of origin results in a slightly different quantity of surplus organic soil. It may be that a percentage of this could be reused in the housing landscaped and fill slope areas, however if not then 13,803m³ of surplus arises.
- 4.23. Considering both the detailed and simplified model it may be concluded that with respect to organic

soils a possible surplus of between 13,800m³ and 17,500m³ may arise.

Engineering Design

- 4.24. Detailed design issues, such as road geometry and gradients are linked to the housing layout. Both require to be informed by intrusive ground investigations. We understand that a series of trial pits has been undertaken along the eastern margin of the site. However the interior may require investigation if the development extends across the whole of North Staney Hill.
- 4.25. In the case of North Staney Hill where there are steep slopes, a rigorous approach is required to the geometrical road design in order to have confidence in the computed areas and volumes of material and to ensure that road geometry and gradient constraints are not exceeded. This requires 3D modelling software (such as Civil 3D) and a detailed topographic survey in order to generate the cut / fill profiles and material volumes.

5. Material Management

- 5.1. Following the detailed earthworks and civils design and prior to construction commencing, the contractor will provide a plan detailing potential locations for temporary storage and an outline programme and method statement indicating the duration and quantity of stored peat and other excavated material. These plans will include measures to mitigate sediment runoff from all forms of stored material. The plans provided by the contractor shall be consistent with other relevant documents such as a Construction Environmental Management Plan and Site Waste Management Plan.
- 5.2. The length of time and volume of temporary storage of peat should be minimised to prevent sedimentation of any watercourse or waterbody. Where practical, excavated peat shall immediately be used locally for reinstatement and/or landscaping. Good practice methods would include careful removal of vegetated turves, short timescales between lifting and replacement of turves (8 week limit) and ensuring stored turves are kept in good condition (including watering when weather conditions could lead to desiccation). Re-vegetation of bare soil with native vegetation would be encouraged.
- 5.3. During the construction phase of the project there will be a need to cover areas of peat and also excavate peat, soil and rock for infrastructure such as roads and foundations. Where there is not a defined use for this material during the construction process, excess material will be waste and will require to be disposed of in accordance with good practice or regulatory requirements.
- 5.4. It is possible to consider five types of activity associated with peat, soil and rock during the construction process, as described below:
 - **Covered** – on a temporary basis below stockpiled material or construction compounds where the original surface will subsequently be re-exposed. This would also apply to floating road construction, although it is unlikely in the case of North Stoney Hill.
 - **Excavation** – at the location of on-site infrastructure, such as roads, footpaths, house foundations, landscaped areas and garden areas within housing plots as well as site compounds on a temporary basis.
 - **Re-use** – including backfilling adjacent to roads and footpaths and with housing plots as well as restoration of temporary construction compounds, laydown areas etc. In addition to on-site re-use of excavated material there may potentially be off-site applications.
 - **Storage** – generally this applies to the short term storage of excavated material before re-use. As decommissioning of housing is not pertinent to this study longer term storage for this purpose is not considered.
 - **Disposal** – where there is an excess of excavated material over reasonable opportunities for re-use in line with good practice, there may be a need for disposal of that material to a licensed waste facility.

Covered

- 5.5. Stockpiled material arising from excavations may be placed upon peat, but subsequently removed when used elsewhere on the site during the construction process. In this case, the peat may be covered for periods ranging between a few days to virtually the duration of the earthworks construction period.
- 5.6. Peat may be covered on a temporary basis in the establishment of a construction compound where

fill material such as rock or suitable glacial till would be used to create a relatively level and uniform area. This compound will likely be in use for the duration of the contract and then the superficial material removed to expose the original surface.

- 5.7. In both of these cases, the construction method statement will likely stipulate a geo-textile membrane over the in-situ surface prior to the deposition of the stockpiled or temporary construction material.
- 5.8. The distribution of peat at North Staney Hill is patchy, thus it may be possible to locate construction compounds and stockpiles in areas that are devoid of peat.

Excavation

- 5.9. Peat excavation should be minimised where possible. However, it is an unavoidable consequence of constructing roads and housing at North Staney Hill. As the estimates in the **Construction Works** section demonstrate, a significant quantity of the surface material that is excavated is not peat and also a high proportion of the excavated material can be reused.
- 5.10. Significant quantities of glacial till and rock will also be excavated. It is anticipated that following grading and classification most of this material will be used either for engineering purposes, such as for road and embankment construction or landscaping within the housing plots.
- 5.11. The processing of excavated glacial till which, is likely to include a significant proportion of cobbles and boulders, will require screening and crushing plant. To minimise transportation and double handling this plant may be located on site.

Re-use

- 5.12. A detailed and realistic evaluation of the re-use of excavated material is an important element of the peat management plan. Area and volume calculations of the excavation / re-use balance of acrotelmic and catotelmic peat has been undertaken in the style required by SEPA for all major components for the development. Given the possible practical difficulties of distinguishing and separately excavating these layers in the thin soil horizons at North Staney Hill a simplified volumetric model has also been considered.
- 5.13. The results of these calculations suggest that there may be a surplus of stripped organic material that would require disposal if other on-site uses cannot be identified. One such option would be to enrich the glacial till with the peat / organic soil to improve the quality of the topsoil reinstated within the housing plots. Exploring this option would require inputs from other soil science disciplines and the views of other stakeholders.
- 5.14. Off-site reuse of material surplus to the development would be a further possibility. In generic terms, the obvious applications would be towards habitat schemes associated with former peat working in the areas surrounding Lerwick or capping / landscaping on other works. This would require further studies to be undertaken to identify potential locations, land ownership in consultation with Shetland Islands Council.

Storage

- 5.15. As noted above, various elements of the construction process involve storage of peat and other excavated material for widely varying periods. With respect to peat at all times the volume and duration of storage must be minimised particularly where the viability of the peat has to be maintained for immediate or longer term re-use.

- 5.16. Candidate locations for the temporary storage of peat and other excavated materials have not been identified at present. Unless any planning conditions are imposed, then it is the responsibility of the contractor to plan the best logistical sequence of works and stockpile locations with due regard to sediment management. An important factor, where applicable, is that the acrotelmic peat and catotelmic peat should be separately managed and in the case of the former is stored turf side up and kept moist.

Disposal

- 5.17. As discussed under the **Re-use** section there is the possibility of a surplus of material, which would then require off-site disposal. In addition to the identification of suitable location(s), this would probably be subject to the waste disposal legislation and require discussions with SEPA.

6. Conclusions

- 6.1. North Stoney Hill is a generally steep rocky hillside with the main topographic features being a series of small scarps orientated to the north-west – south-east. The sandstone bedrock is exposed in a number of locations and numerous large boulders are scattered across the site.
- 6.2. Three main conclusions can be determined from the fieldwork. First, the general depth of probing was shallow with a median value of between 0.3m to 0.4m, which represents an organic soil which by definition is not peat. Secondly, the proportion of points where the depth exceeded 0.5m (peat) was less than a third, but there was no pattern to the distribution of these locations across the site. Thirdly, from an exposure of the soil horizons it was clear that the material underlying the thin organic soil comprised a glacial till which had a significant proportion of cobbles and boulders.
- 6.3. Given the generally thin cover of organic soil and the patchy distribution of the peat, neither of these impose any obvious constraints. Thus nothing has been identified in the peat survey fieldwork that would constitute a constraint on the layout of the development.
- 6.4. Some constraints relating to road geometry and housing plot layout may arise from the steep topography, but these are of little significance in the context of peat management. To satisfy road design, gradients may require somewhat more land take, and hence potential loss of peatland, than a similar number of houses on a flat site, but the difference is likely to be marginal.
- 6.5. The total topsoil quantities that require to be stripped have been estimated from the component based model required by SEPA and give 35,800m³ of non-peat soils and 28,800m³ of peat over a conceptual area of 14.5 ha which is approximately 50% of the 28.94ha site.
- 6.6. Based on a strategy of reuse at source of origin, the calculations suggest that a surplus of 17,500m³ of mixed organic soils and peat may arise based upon the indicative layout utilised within the Preliminary PMP. Further discussion and possible studies may be required to arrive at an acceptable solution for this balance of material.
- 6.7. Further assessment of the impacts on peat will be required following the development of a detailed Masterplan for the site.

7. References

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Floating Roads on Peat, Forestry Civil Engineering, SNH, August 2010

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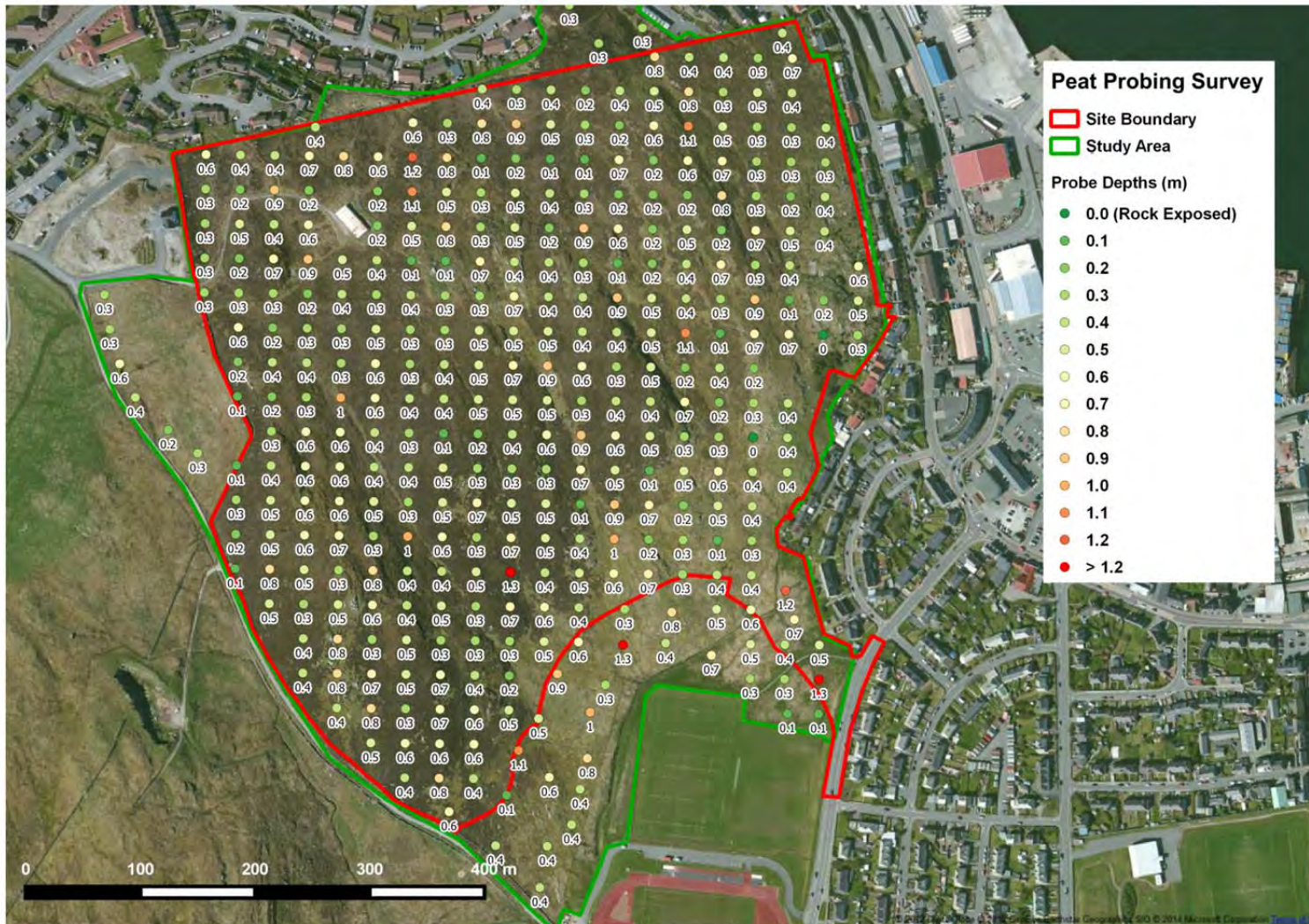


Figure 14 Survey probing locations with depths

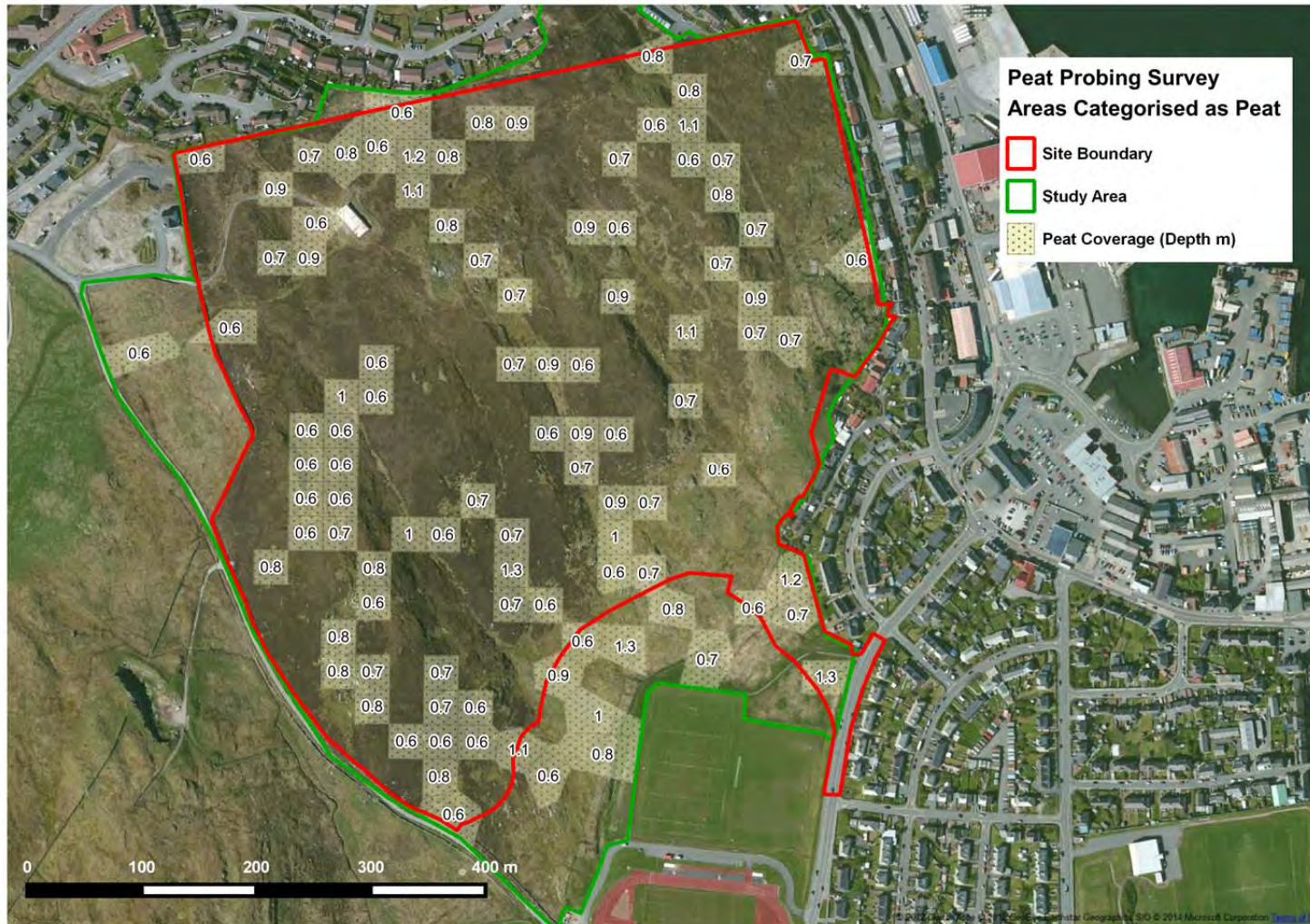


Figure 15 Study Area Categorised as Peat and non-Peat

UK and Ireland Office Locations

