



Goss Moor National Nature Reserve, Cornwall

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SUMMARY

Natural England undertook two excavations ahead of a project to divert the River Fal from an over-deepened channel. Eleven environmental bulk samples, including one sample of less than one litre in volume, and one monolith sample were taken during the excavation from the western trench (SW 95420 60136). The trench revealed a sequence of stratified organic-rich, clay, and gravel deposits. Five of the bulk samples were sequential and the remaining six were more general ones from deposits. These samples were submitted to Oxford Archaeology North to be assessed for palaeo-environmental remains.

The eleven bulk samples were processed and assessed for plant and insect remains. The monolith sample was processed and assessed for pollen, fungal spores, diatoms and phytoliths. The results for all the material types are presented in this report.

The assessment of the plant and insect remains indicated that these types of remains had been poorly preserved in the deposits possibly because of the high level of humification. Both pollen and fungal spores were present and suggest that changes were taking place in the landscape when the deposits were accumulating. The pollen recorded in the basal pollen sample at a depth of 0.40-0.41m suggested that willow was growing locally but the pollen in the upper samples suggest that the willow was replaced by more open grassland with some stands of hazel and heather scrub and towards the top of the stratigraphy areas of open water. Diatoms and plant phytoliths were also recorded in the upper samples and support the presence of grasses and sedges with areas of open water.

Recommendations are made for further analysis of the pollen but of no other palaeo-environmental material. This analysis should further refine the possible environmental changes suggested by the assessment of a transition from potential willow wetland to open grassy meadows with heather and hazel scrub environments and then to a more open, wet and possibly grazed landscape. It may also be able to confirm the identification of the cereal-type pollen recorded which could be related to possible cultivation. These changes may be related to local mining and quarrying activities.

ACKNOWLEDGEMENTS

OA North would like to thank Natural England for commissioning the palaeo-environmental assessment of the samples from Goss Moor National Nature Reserve, Cornwall (TRURI 2011:19). We would also like to thank the Geography Department of the University of Lancaster for use of their laboratories.

The insect remains were processed, assessed and reported on by David Smith and his colleagues at Birmingham University. The diatoms and phytoliths samples were processed and assessed by Philip Barker of Lancaster University. The environmental bulk samples were processed in house by Sandra Bonsall. Sandra and Denise Druce assessed the waterlogged plant remains and Denise wrote the report on the plant remains. The pollen samples were prepared by Sandra and the pollen and fungal spores were assessed by Mairead Rutherford, who wrote the pollen report. The palaeo-environmental report was compiled by Elizabeth Huckerby.

1. INTRODUCTION

1.1 CIRCUMSTANCES OF THE PROJECT

- 1.1.1 Natural England commissioned Oxford Archaeology North (OA North) to undertake a palaeo-environmental assessment of environmental samples taken during two excavations ahead of a project to divert the River Fal from an over-deepened channel, which was created in the 1970s to prevent the threat of pollution episodes from the China Clay industry upstream. The two excavation trenches were at both ends of this channel.
- 1.1.2 The lower, western trench exposed a sequence of stratified deposits of mainly gravels and clays with a more organic looking layer towards the base. The deposits are thought to have been laid down naturally and are described as possibly water-lain in a flood plain. A single archaeological feature was identified in this trench.
- 1.1.3 The eastern trench and the deposits are described as being disturbed possibly as the result of tin-streaming and more recently by gravel extraction. Goss Moor was extensively disturbed by tin and gravel extraction in the 19th and 20th centuries although this may have commenced in the Bronze Age.
- 1.1.4 The scope of the assessment was laid out in the paleo-environmental assessment Project Design (*Appendix 1*). It included the assessment of the plant remains, the insect remains, pollen, fungal spores and diatoms.
- 1.1.5 The different environmental material types assessed are reported on individually. The reports are drawn together in a discussion about the palaeo-environmental assessment for the Goss Moor National Nature Reserve (NNR).

1.2 SITE BACKGROUND

- 1.2.1 Goss Moor NNR, Cornwall is situated in a broad relatively flat, valley basin which forms the headwaters of the River Fal. The following information about the nature reserve has been obtained from the Natural England web site for Goss Moor NNR. The extensive mining of alluvial tin deposits since the Bronze Age, and in the more recent past gravel extraction, has resulted in the formation of wetland habitats. No industrial activity has taken place since the 1960s.
- 1.2.2 The vegetation today includes areas of heath on the site, which support heather and bell heather with bristle bent and purple moor grass, while wetter areas support lesser butterfly orchid, hemlock water dropwort and the scarce yellow centaury. More acidic areas are home to bog plants like heath spotted orchid, marsh St John's wort and the scarce marsh clubmoss.
- 1.2.3 Eleven bulk samples (including one sample that was less than one litre in volume) and one monolith sample were taken by Natural England and submitted to Oxford Archaeology North for the assessment of plant macrofossils, insects, and diatoms. The samples came from the western trench

(SW 95420 60136) dug as part of the project to divert the River Fal. The trench revealed a sequence of stratified organic-rich, clay, and gravel deposits.

1.3 ARCHIVE

- 1.3.1 A full archive of the work undertaken has been produced to a professional standard in accordance with current English Heritage guidelines (English Heritage 1991). The archive will be submitted to Natural England.

2. PLANT REMAINS

2.1 ASSESSMENT OF THE PLANT MACROFOSSILS:

Denise Druce and Sandra Bonsall

- 2.1.1 **Quantification and methodology:** This report outlines the results of the plant macrofossil assessment of the eleven bulk samples, which was carried out by a team of OA North palaeo-environmental specialists. The samples from the western trench revealed a sequence of stratified organic-rich, clay, and gravel deposits. As the deposits are believed to be naturally accumulated and water-lain, there was the potential for the survival of plant remains by waterlogging. Plant remains are good indicators of the local flora and can be used as proxy indicators of climate change and hydrological conditions (Barber and Charman 2003).
- 2.1.2 The bulk samples came from the stratigraphic units visible in the western trench, and include five 0.05-0.08m thick series samples (samples 3-4), a single 0.01m sample, and two 'bulk' samples were taken from an organic 'peat' deposit revealed towards the base of the trench. Two bulk samples came from the overlying black gravel (sample 2) and brown humic layer (sample 1) and one bulk sample was taken from the lower fill of a linear feature visible in the trench.
- 2.1.3 Ten bulk samples of between six and ten litres in volume and one sample equal or less than one litre were washed through a 250 micron mesh, retained wet and examined under a low-powered binocular microscope at up to x40 magnification. Any plant remains were provisionally identified and quantified on a scale of 1-4, where 1 is rare (<5 items) and 4 is abundant (>100 items). Identification was aided by comparison with the modern reference collection held at OA North. The components of the matrix, such as amorphous organic remains, wood, roots, insect remains, stones, and charcoal were also quantified. The suitability of the samples for further analysis was also noted and presented in table 1 (*Appendix 1*). Plant nomenclature follows Stace (2010).
- 2.1.4 **Assessment results:** All of the samples described as peat in the field contained abundant organic material, however, high levels of humification meant that very little could be identified. The frequent to common wood fragments recorded in the peat samples indicate the presence of a woody environment during their accumulation. Rare to frequent seeds preserved through waterlogging were recorded in only a few of the samples, and these include *Rumex acetosella* (sheep's sorrel), common on cultivated land, grassland and heathy open ground, and *Carex* sp (sedge), which grows in damp/wet locations. Most of the samples contained common stones, which are likely to derive from the layers of over/underlying gravel deposits. Rare charcoal fragments were recorded in the 'peat' samples, which may come from nearby burning activity/events.

2.1.5 **Potential:** It is obvious from the stratigraphic sequence that hydrological changes took place on Goss Moor, which is manifest in the shift from gravel deposition to peat accumulation, and then back to gravel deposition once more. Although the waterlogged seeds recorded in a couple of the samples would provide suitable material for radiocarbon dating, their general paucity in the remaining samples, coupled with high levels of organic humification, means that further study of the plant remains would not add significantly to existing knowledge. Accordingly, there are no recommendations for further analysis.

3. INSECT REMAINS

3.1 AN ASSESSMENT OF THE INSECT REMAINS

David Smith

- 3.1.1 **Introduction:** ten samples of material were presented for assessment for insect remains from the western trench excavation at Goss Moor NNR. Four samples come from a sequence of stratified sands, clays, gravels with more organic 'peat' development towards the base. A single sample came from an associated trench feature.
- 3.1.2 This assessment was carried out to establish the following:
- Are insect remains present? And if so, are they of interpretative value?
 - Do the insect remains from these samples provide information on the nature of local water conditions?
 - Do the insect remains provide information on the nature of the surrounding landscape?
- 3.1.3 **Methodology:** The samples were processed using the standard method of paraffin flotation as outlined by Kenward *et al* (1980). The weights and volumes of the individual samples are included in Table 2 (*Appendix 1*). Insect remains were sorted from the flot and examined under a low-power binocular microscope. The system for 'scanning' faunas as outlined by Kenward *et al.* (1985) was initially followed in this assessment. However, since the faunas recovered were so small it has been possible to identify all taxa that were present as far as possible. The nature of the preservation and the potential for archaeological interpretation is outlined in Table 3.
- 3.1.4 **Results:** The insect taxa recovered from the flots are listed in Table 2. The taxonomy used for the Coleoptera (beetles) follows that of Lucht (1987). The numbers of individual insects present is estimated using the following scale: + = 1-2 individuals ++ = 2-5 individuals +++ = 5-10 individuals ++++ = 10+ individuals +++++ = 20+ individuals ++++++ = 100s of individuals.
- 3.1.5 **Discussion:** The insect faunas recovered were very small, eroded and fragmented suggesting that preservation is poor. Many of the taxa recovered are not indicative of specific water conditions or landscapes. Unfortunately, this suggests that these insect faunas have a very limited potential for landscape reconstruction.
- 3.1.6 Only a few of the taxa recovered are indicative of the nature of the surrounding landscape. Given the poorly preserved nature of the insect faunas recovered, and their small size these results should not be over emphasised. Several specimens of the Aphodius 'dung beetles' were recovered from all four samples that produced insect remains. The recovery of these taxa probably indicate that herbivores, possibly cattle, were grazing in the area since they are commonly associated with animal dung lying in pasture (Jessop 1986). The single individual of the 'leaf beetle' *Hydrothassa marginella* is

normally associated with marsh marigold and indicates that this species of plant was present in the area. Similarly, the weevil *Orobitis cyaneus* is associated with violets.

3.1.7 **Recommendations and Conclusions:** There is no need for any further identification of the insect remains from these contexts. Unless other material from this site is recovered, which is clearly better preserved, there seems to be no reason to undertake further archaeological insect work at this location.

3.1.8 If the pollen or the plant macrofossils from this site are published the information from the insect remains can be included as additional notes.

Sample number	Degree of preservation	Comparative size of faunas	Water conditions	landscape	Overall potential
Top of peat, brown layer	Very fragmented Poor preservation	moderate/ Small	no information	<i>Aphodius</i> dung beetle might suggest grassland or pasture	Very low
Top of peat, Black/brown gravel	Very fragmented Very poor preservation	very small	no information	Single <i>Aphodius</i> dung beetle <u>may</u> suggest grassland or pasture.	Very low
Top of peat dark gravel	Very fragmented Very poor preservation	very small	no information	Single <i>Aphodius</i> dung beetle <u>may</u> suggest grassland or pasture.	Very low
Top of peat 0.05m	No preservation	-	-	-	none
Top of peat, 0.06-0.10 m	Very fragmented Very poor preservation	very small	No information	<i>Aphodius</i> dung beetle <u>may</u> suggest grassland or pasture.	Very low
Peat 0.10 m-0.15 m	Very fragmented Very poor preservation	very small	No information	<i>Aphodius</i> dung beetle <u>may</u> suggest grassland or pasture.	Very low
Peat 0.15-0.20 m	No preservation	-	-	-	none
Above gravel peat 0.20-0.28 m	Very fragmented Very poor preservation	very small	No information	Single <i>Aphodius</i> dung beetle <u>may</u> suggest grassland or pasture.	Very low
Bottom of peat	No preservation	-	-	-	none
Bottom of Feature	no preservation	-	-	-	none

Table 3. Summary of the nature of the insect faunas from Goss Moor NNR, Cornwall

4. POLLEN

4.1 AN ASSESSMENT OF THE POLLEN

Mairead Rutherford

- 4.1.1 Five sub-samples from the western trench excavation have been assessed for pollen and non-pollen palynomorphs (NPP) (including fungal spores). The western trench exposed a sequence of stratified deposits of mainly gravels and clays with a more organic layer towards the base. The deposits may represent flood-plain water-lain deposits (Natural England, *pers comm*).
- 4.1.2 The vegetation history of Dartmoor (Caseldine and Hatton 1996) refers to clearances of woodlands by tinnners who used alder woodlands that survived on valley floors (after upland areas had already been cleared of woodland). The nature, extent and timing of human settlement and landuse on Bodmin Moor has been examined by Gearey and Charman (1996) and by Gearey, Charman and Kent (2000a, 2000b). Mighall and Chambers (1993) described declining oak (*Quercus*) and hazel (*Corylus*) pollen as potential evidence that such wood may have been used for firesetting and mining operations at copper mines in Wales.
- 4.1.3 Druce (Druce and Verrill forthcoming) recorded pollen data from a palaeochannel deposit near Indian Queens (A30) that suggested a relatively long period of settlement or farming activity from the early/middle Bronze Age, with a mixed economy of relatively non-intensive pastoralism and possible small-scale arable cultivation.
- 4.1.4 **Methodology:** the monolith was cleaned and the lithology described. Five sub-samples were assessed for pollen from a single monolith representing a total deposit thickness of 0.50m. The sub-samples were chosen on the basis of suitability of the lithologies; details are presented in the Table 4:

Lithology (m)	Sub-samples (m)
0-0.05 Yellow/brown/grey silty clay/ orange mottling (Fe-staining), firm, compact, wet. Band of grit/small stones at 0.05.	-
0.05 - 0.12 Dark brown organic rich silty clay and rootlets. Firm, wet.	0.07-0.08
0.12-0.15 Layer of grit/small stones (0.05m)	-
0.15-0.19 Dark brown organic rich silt clay becoming slightly crumbly; orange mottling (Fe-staining).	0.15-0.16
0.19-0.26 Larger band of coarser stones (0.01m) in silt/clay matrix	-
0.26-0.39 Dark brown /black organic peaty silt/clay with common plant debris.	0.28-0.29 0.36-0.37
0.39-0.45 Light brown sticky silty clay, orange mottling (Fe)	0.40-0.41

0.45-0.50 Yellow green sticky silty clay and stones (10 mm+) Fe-staining.	-
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Table 4: Western trench: sub-sampling for pollen, NPP and lithological descriptions.

- 4.1.5 **Pollen:** the sub-samples were processed for pollen using standard procedures (Method B of Berglund & Ralska-Jasiewiczowa 1986) and mounted in silicone oil. The pollen slides were examined using a Leitz Orthomat microscope using x400 magnifications routinely. Counting was carried out over two cover slips and continued until a sum of at least one hundred land pollen grains was achieved, or until 10 traverses of the cover slip were reached. Pollen identification was carried out using the standard keys of Faegri and Iverson (1989) and Moore *et al* (1991). Microscopic charcoal fragments were quantified, where present, following Peglar (1993). Non-pollen palynomorphs (NPP) (including fungal spores) were identified and quantified, where present. NPP nomenclature followed van Geel (1978) and Blackford *et al* (in press) and plant nomenclature followed Stace (2010).
- 4.1.6 **Results and Discussion:** The raw pollen counts and counts for NPP are presented on Table 5 (*Appendix 1*). All sub-samples proved productive for pollen. Rare fungal spores were recorded in the uppermost sub-sample. Palynomorph preservation was generally good but mineral matter obscured some grains. Palynomorphs are present in abundance in all sub-samples. Assessment suggests a landscape largely cleared of wood, apart from hazel (*Corylus avellana* - type), which includes hazel and bog-myrtle (*Myrica gale*) and heather (*Calluna*) scrub. Open environments with damp meadows may be inferred from the pollen record.
- 4.1.7 The deepest sub-sample at 0.40m suggests local vegetation was dominated by willow (*Salix*), known to grow in damp, wet areas. Herbs of meadow / hedgerow habitats, such as daisies (*Aster*-type), dandelions (*Taraxacum*-type), Devil's Bit Scabious (*Succisa pratensis*) and members of the mint family (*Mentha*-type), are recorded along with ferns indicative of disturbed or rough ground. Evidence for clumps of hazel (*Corylus*) and heather (*Calluna*) in the vicinity are also noted. Regionally, there is evidence to suggest small stands of mixed woodland supporting birch (*Betula*), oak (*Quercus*), alder (*Alnus*). Small quantities of microscopic charcoal are present.
- 4.1.8 The three sub-samples from 0.36m to 0.16m reveal similar pollen assemblages to each other. Among the tree and shrub taxa, hazel in particular and then heather, are the most commonly recorded pollen types, suggesting the area supported a scrub-like vegetation during the time the organic-rich sediments were being deposited. The presence of open areas supporting herb communities is indicated by common grass (Poaceae) pollen, buttercups (Ranunculaceae) and cinquefoil (*Potentilla*-type) and in addition to those Taxa outlined above, suggests possible damp meadow / hedgerow environments. Low counts of possible cereal-type pollen (which could also be a wild grass pollen, Andersen 1979) at 0.36m and the continued presence of low numbers of the disturbance indicator, ribwort plantain (*Plantago lanceolata*) may indicate some small-scale cultivation nearby. Pollen evidence also suggests

regional stands of oak and birch. An increase in the numbers of alder pollen may reflect increased colonisation of alder trees in wetter areas. *Sphagnum* (bog-moss) spores are common within these three samples, indicating perhaps slightly more acidic conditions suitable for the growth of mosses. Microscopic charcoal is present in all sub-samples.

- 4.1.9 The uppermost sample at 0.08m is similar in pollen composition to that described for three samples from 0.36m to 0.16m but with evidence of larger open areas and much reduced hazel and heather coverage. Grass pollen is the dominant herb pollen type recorded but sedge (*Cyperaceae*) pollen is also commonly present, suggesting locally wet areas. The open areas are seen to support a greater variety of herb pollen, including meadowsweet (*Filipendula*), mugwort (*Artemisia*), andampions (*Silene*-type), as well as possible cereal-type pollen (which could also be a wild grass pollen, Andersen 1979) and the disturbance indicator ribwort plantain (*Plantago lanceolata*). Ribwort plantain is associated with weeds of cultivation and, together with the potential cereal-type record, may suggest that some cultivation was taking place nearby. Small quantities of microscopic charcoal are present.
- 4.1.10 Fungal spores are present in the topmost sample at 0.08m. Of significance among the relatively low numbers seen during assessment are specimens of *Podospora* spp. and *Sporomiella* spp. *Podospora* spp. are associated with animals and man. *Podospora* spores are considered reliable coprophilous indicators of herbivore dung, especially when in combination with taxa such as *Sporomiella* by van Geel *et al* (2003). The spores of *Sporomiella* only occur in present day surface samples where grazing herbivores are locally abundant (Davis 1987) and come from obligate coprophilous fungi.
- 4.1.11 The pollen assessment data support the idea that the older sediments may have been deposited within damp, possibly wet environments. The extent to which mining may have impacted on the vegetational record is difficult to assess. Tin mining utilised both wood and water and may therefore have resulted in both reduction of tree pollen and in the presence of pollen indicative of wetter environments in the pollen profile. It may be that the changes in the pollen assemblage in the samples from 0.36-0.08m suggest the transition to more open environments and was coincident with the end of mining and consequent re-adjustment of the vegetation following industrial exploitation.
- 4.1.12 **Recommendations:** Detailed analysis is recommended to further refine the possible environmental changes suggested by the assessment (ie the transition from potential willow wetland to open grassy meadows with heather and hazel scrub environments to a more open, wet and possibly grazed and/or cultivated landscape).
- 4.1.13 Radiocarbon dates would place the vegetational record within an archaeological context, aiding interpretation. A minimum of two dates is recommended, one at the base of the organic section and one at the topmost organic interval. The data could then be integrated with previous work for the area between Bodmin Moor and Indian Queens (Druce and Verrill forthcoming) and compared with regional pollen data for Bodmin Moor (Gearey 2000a, 2000b). If analysis further supports a transition from wetter

environments (which may be linked to the cessation of tin mining in the area) to more open land (perhaps used for agricultural purposes), a further date to identify the age of this change may be important to confirm whether it is related to the cessation of tin mining.

- 4.1.14 A further five sub-samples in addition to those selected at assessment stage (5) would be appropriate for analysis, allowing a 0.04m sampling interval between 0.05m and 0.45m.

5. DIATOMS AND PHYTOLITHS

5.1 DIATOMS AND PHYTOLITHS

Philip Barker

- 5.1.1 **Methods:** Five samples were provided by OA North for diatom analysis. These were prepared using standard procedures. Approximately 1g of material was placed in a beaker with 50ml of hydrogen peroxide and heated for 2h to oxidise organic matter. The samples were then filled with deionised water and allowed to settle for 24h before replacing the water. This was repeated three times to effectively dilute the residual hydrogen peroxide. Following the final wash, the samples were dispersed in 200ml of water and the concentration of sediment in each beaker was assessed. An aliquot of 0.2ml of the suspension was taken and pipetted onto a coverslip, this was dispersed in 0.2ml of deionised water. The coverslips were dried and permanent slides were made using Naphrax high resolution diatom mountant. All the slides were scanned for diatoms. Diatom remains were found in three samples. Concentrations were very low in all but one sample and enumeration was made of those occurring in two traverses of each coverslip rather than setting a minimum count size. This method revealed between 0 and 250 diatoms for each sample. Identifications were made from standard texts, mainly drawn from Krammer and Lange-Bertalot (1986-1991). In addition to diatoms, the remains of phytoliths were also recorded. A separate aliquot of the sediment was dried to establish the water content and from this was used to calculate the dry weight of the sediment used in the diatom analysis.
- 5.1.2 **Results and interpretation:** The two lowest samples analysed (0.47-0.48m and 0.40-0.41m) were entirely devoid of diatoms. Instead, these contained silicate minerals and clay-like complexes. The presence of phytoliths, especially in the 0.40-0.41m sample, suggests a soil deposit. These phytoliths were mainly of the dumb-bell shape associated with grasses and sedges.
- 5.1.3 Samples 0.36-0.37m and 0.15-0.16m contained very few diatom remains and a full count was not possible. Those that were present suggest a moist fluctuating habitat, possibly an ephemeral wetland. Some of the diatoms were partly dissolved but the abundance of phytoliths, which are chemically similar, suggests that diatoms were largely absent. The sample at 0.15-0.16m is very rich in phytoliths derived from grasses or sedges. These data point to a moist habitat within a meadow.
- 5.1.4 The uppermost sample analysed contains a rich diatom flora. More than 28 taxa were identified and diversity was very large. The diversity suggests a radiation in the number of niches available to the diatoms. Grass phytoliths are also abundant. The dominant diatom groups were the *Fragilaria* spp., indicative of disturbed, turbid environments and aerophilous taxa, such as *Eunotia*. *Gomphonema parvulum* might indicate some nutrient availability. The presence of *Aulacoseira distans* suggests an open water pool, as this diatom is typically associated with shallow water ponds covered by

macrophytes. The pH represented by the flora is likely to be weakly acid to circumneutral. Overall this represents a typical wetland flora with some open water pools.

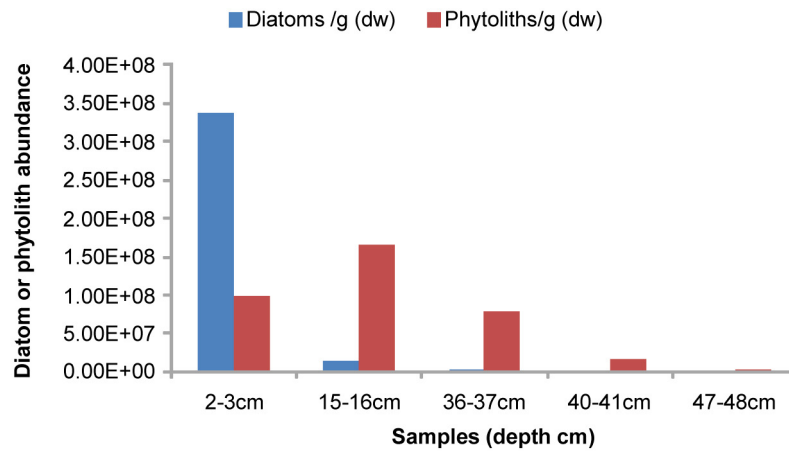


Figure 1: the concentrations of diatoms and phytoliths per gram dry weight from Goss Moor.

6. DISCUSSION

6.1 CONCLUSIONS:

- 6.1.1 The assessment of the palaeo-environmental remains from Goss Moor NNR, Cornwall from the western excavation trench has demonstrated that although both plant and insect remains were present they were poorly preserved. In contrast, pollen was plentiful and well preserved. Diatoms were absent from the two samples taken from the lower clay deposit (0.47-0.48m and 0.40-0.40m) but were identified in the more organic material and in the upper clay deposit (0.02-0.03m), where a rich diatom assemblage was identified. Significant numbers of phytoliths, silicate remains from some plants, were recorded in all but the lowest sample (0.47-0.48m).
- 6.1.2 The plant and insect remains are such that little can be inferred about the condition or development of the local landscape. The paucity of these remains may be the result of the high degree of humification of the organic material in the samples. However, the frequent to common wood fragments do suggest the presence of some woodland and the insect fragments indicate possible evidence for grazing animals. Grazing is also suggested by the fungal spores recorded in the pollen samples. One insect species is host specific to marsh-marigolds and another to violets suggesting that both these plants were to be found growing nearby.
- 6.1.3 The pollen, fungal spores, diatoms and plant phytoliths have provided more evidence of the palaeo-environmental conditions and of the local landscape than either the plant or insect remains. The assessment of the various strands of microfossil evidence suggest that for most of the profile, which was sampled by the monolith, the landscape was open with plant communities rich in sedges and grasses. The pollen assemblage from the lowest sample (0.46m) differs from those higher up in the profile and suggests that the local landscape was dominated by willow. The diatom assemblage recorded, at a depth of 0.02-0.03m, in the upper yellow, brown grey silty clay (0-0.05m) suggest there was a typical wetland flora with some open water pools when the deposit was laid down. Just below this the pollen recorded in dark brown organic-rich silty clay (at 0.07-0.08m) also points towards locally wet areas.

6.2 POTENTIAL AND RECOMMENDATIONS:

- 6.2.1 Pollen is the only palaeo-environmental material type where there is any potential for further analysis. It is recommended that further analysis should be undertaken to further refine the possible environmental changes suggested in the assessment (ie the transition from potential willow wetland to open grassy meadows with heather and hazel scrub environments and then to a more open, wet and possibly grazed and/or cultivated landscape). These changes may be related to local mining and quarrying activities.
- 6.2.2 Scientific dating of the deposits will be used to allow the data to be correlated with previous work for the area between Bodmin Moor and Indian Queens (Druce and Verrill forthcoming) and compared with regional pollen data for

Bodmin Moor (Gearey 2000a, 2000b). If analysis further supports a transition from wetter environments (which may be linked to tin mining in the area) to more open land (perhaps used for agricultural purposes), a further date to identify the age of this change may be appropriate.

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APPENDIX 1: TABLES

Sample no	Sample description	Flot vol (ml)	Flot description	Plant remains (seeds)	Potential
1	Brown humic layer above peat	200	Amorphous organic (4), insects (1), stones (3)	-	None
2	Black gravel overlying peat	200	Stones (4)	-	None
3	Peat: 0-0.05m	200	Amorphous organic (4), wood fragments (3), roots (3), insect eggs (4), stones (4), charcoal (1)	-	None
na	Peat 0.05-0.06m	150	Amorphous organic (4), wood fragments (3), roots (3), insect eggs (4), stones (3), charcoal (1)	-	None
4	Peat: 0.06-0.1m	200	Amorphous organic (4), earthworm eggs (1), charcoal (1)	WPR (1) <i>Rumex acetosella</i>	None
5	Peat: 0.1-0.15m	200	Amorphous organic (4), roots (3), insect eggs (3), stones (2), charcoal (1)	WPR (2) <i>Carex</i>	None
6	Peat: 0.15-0.20m	200	Amorphous organic (4), wood fragments (2), roots (4), stones (3), sand (2)	-	None
7	Peat 0.20-0.28m (above gravel)	200	Amorphous organic (4), roots (3), stones (3), charcoal (1)	-	None
na	Bulk sample from upper half of peat. Contains black gravel and small inclusions. Above linear feature	200	Amorphous organic (4), wood fragments (2), roots (3), insect eggs (3), stones (3), charcoal (1)	WPR (1) indeterminate	None
na	Bulk sample from lower half of peat	200	Amorphous organic (4), wood fragments (2), roots (3), insect eggs (1), earthworm eggs (1), stones (3), charcoal (1)	-	None
na	Lower half of linear feature	200	Stones (4)	-	None

Table 1 Assessment results of the plant remains from Goss Moor, Cornwall. Material scored on a scale of 1-4 where 1 is rare (up to 5 items) and 4 is abundant (>100 items). WPR = waterlogged plant remains

Sample no.	Ecological codes	Top of peat Brown layer	Top of peat black/brown gravel	Top of peat dark gravel	Top of peat 0.6-0.10m	Peat 0.10-0.15	Above gravel peat 0.20-0.22m	Host plant
Sample volume (L.)		2	2		2	4	2	
Sample weight (Kg.)		2.5	4.6		1.6	5	1.6	
COLEOPTERA								
Carabidae								
<i>Notiophilus spp.</i>		-	+	-	-	-	-	
<i>Clivina fossor (L.)</i>		-	-	-	-	-	+	
<i>Dyschirius globosus (Hbst.)</i>		+	++	-	+++	-	-	
<i>Trechus spp.</i>		+	-	-	-	-	-	
<i>Bembidion spp.</i>		+	-	-	+	-	-	
<i>Pterostichus spp.</i>		-	-	-	++	-	-	
Hydrophilidae								
<i>Cercyon spp.</i>		+	-	-	+	-	-	
<i>Cryptopleurum minutum (F.)</i>	df	-	-	-	+	-	-	
<i>Chaetarthria seminulum (Hbst.)</i>	a	+	-	-	++	-	-	
Staphylinidae								
<i>Oxytelus rugosus (F.)</i>		+	-	-	-	-	-	
<i>Oxytelus spp.</i>		+	-	-	+	-	-	
<i>Stenus spp.</i>		+	-	-	-	-	-	
<i>Lathrobium spp.</i>	oa	+	-	-	-	-	+	
<i>Xantholinus spp.</i>		+	-	-	+	-	-	
<i>Philonthus spp.</i>		+	-	-	-	-	-	
Aleocharinidae Genus & spp. Indet.		-	+	+	-	-	-	
Scarabaeidae								
<i>Aphodius spp.</i>	df	+++	+	+	++	+	+	
Chrysomelidae								
<i>Plateumaris sericea (L.)</i>	ws	+	-	-	-	-	-	Usually on <i>Carex</i> spp. (sedges)
<i>Donacia/ Plateumaris spp.</i>	ws	+	-	-	-	-	-	
<i>Hydrothassa marginella (L.)</i>	ws	-	+	-	-	-	-	Often <i>Caltha palustris</i> L. (Marsh marigold)
Curculionidae								
<i>Orobitis cyaneus (L.)</i>	p	-	-	-	+	-	-	<i>Viola</i> spp. (violets)

Table 2: Assessment results for the insect remains from Goss Moor NNR, Cornwall

Samples that produced no insect remains

Peat top 0.05m, peat 0.15-0.20m, Bottom of peat, bottom of feature.

Key to ecological coding

a= aquatic water beetles

ws = water side taxa often associated with emergent vegetation

df = taxa often associated with dung

p= taxa associated with grassland and open areas

l= taxa associated with trees

m= taxa associated with moorland

key to numbers of individuals

+ = 1-2 individuals

++ = 2-5 individuals

+++ = 5-10 individuals

Western Trench						
Preservation		Good	Good	Good	Good	Good
Potential		Good	Good	Good	Good	Good
Depth (m)		0.08	0.16	0.28	0.36	0.40
Trees and shrubs						
<i>Alnus</i>	Alder	7	8	13	12	2
<i>Betula</i>	Birch	2	5	4	5	2
<i>Ulmus</i>	Elm	1		1		
<i>Quercus</i>	Oak			4	3	2
<i>Fraxinus</i>	Ash	1				
<i>Corylus</i>	Hazel	23	46	64	65	10
<i>Salix</i>	Willow				1	57
<i>Ilex</i>	Holly	1				
<i>Calluna</i>	Heather	8	15	26	13	11
Crops						
Cereal-type		1			1	
Herbs						
<i>Artemisia</i>	Mugwort	1				
<i>Aster</i> -type	Daisy-type	1	2	1	1	4
<i>Centaurea nigra</i>	Knapweed			1		
Cyperaceae	Sedges	13	2	1	1	
Fabaceae	Pea family	1				
<i>Filipendula</i>	Meadowsweet	1				
<i>Hypericum</i> -type	St. John's Wort		1			
<i>Mentha</i> -type	Mints					1
<i>Plantago lanceolata</i>	Ribwort Plantain	3	1	1	2	
Poaceae	Grass family	39	20	24	21	3
<i>Potentilla</i> -type	Cinquefoil	4	6	2		
Ranunculaceae	Buttercup family	1	1	1		
Rubiaceae	Bedstraw family	1	1			
<i>Silene</i> -type	Pinks	2				
<i>Succisa pratensis</i>	Devil's Bit Scabious	1	1	1	1	5
<i>Taraxacum</i> -type	Dandelions	5	1	4	1	1
Unknown herbs		5	4	4	0	5
Total land pollen		124	114	152	127	101
Number of traverses		1	1	1	1	3
Ferns and mosses						
<i>Polypodium</i>	Polypodies	2	8	5	2	10
<i>Pteridium</i>	Bracken	1	3	2	3	
<i>Pteropsida</i> (monolete)	Fern spores (monolete)	1	1		2	1
<i>Pteridophyta</i> (undiff.)	Fern spores (trilete)		3			
<i>Sphagnum</i>	Bog moss spores	1	4	8	10	
Indeterminate pollen						
Broken grains		4	2	1	2	7
Concealed grains				8	3	7
Corroded grains						
Crumpled grains		2	4	8	11	20
Aquatics						
<i>Potamogeton</i>	Pondweeds	1	1			
Microscopic charcoal		+	++	++	++	+
Fungal spores						
Type 18		1		1		
Podospora		1				
<i>Sporomiella</i>		1				
Undiff. Fungal spores		2		1		

Table 5: Western trench: pollen and fungal spores, raw counts.

	0.02- 0.03m	0.15- 0.16m	0.36- 0.37m	0.40- 0.41m	0.47- 0.48m	0.02- 0.03m (%)
Phytoliths	73	103	95	12	3	
<i>Aulacoseira distans</i>	7					2.8
<i>Brachysira serians</i>	8					3.2
<i>Cymbella amphicephala</i>	2					0.8
<i>Cymbella silesiaca</i>	3	4				1.2
<i>Diatoma mesodon</i>	1					0.4
<i>Eunotia curvata</i>	1					0.4
<i>Eunotia minima</i>	14					5.6
<i>Eunotia pectinalis</i>	27		2			10.8
<i>Eunotia spp</i>	2					0.8
<i>Fragilaria capucina</i>	15					6
<i>Fragilaria construens</i>	54					21.6
<i>Fragilaria virescens</i>	9					3.6
<i>Frustulia vulgare</i>	6					2.4
<i>Gomphonema olivaceum</i>			1			0
<i>Gomphonema parvulum</i>	33	2				13.2
<i>Hantzschia amphioxys</i>	1					0.4
<i>Meridion circulare</i>	3					1.2
<i>Navicula cryptocephala</i>	6					2.4
<i>Navicula lanceolata</i>	7					2.8
<i>Navicula mutica</i>	2					0.8
<i>Navicula spp.</i>	7					2.8
<i>Nitzschia sp</i>	5					2
<i>Pinnularia borealis</i>	4		1			1.6
<i>Pinnularia microstauron</i>	5					2
<i>Pinnularia viridis</i>	8	3				3.2
<i>Synedra acus</i>	4					1.6
<i>Synedra ulna</i>	8					3.2
<i>Tabellaria flocculosa</i>	8					3.2
Total diatoms counted	250	9	4	0	0	
Diatoms /g (dry)	337,126,0 01	14,441,04 3	3,330,28 2	0	0	
Phytoliths/g	98,440,79 2	165,269,7 18	79,094,1 86	15,973,8 13	1,512,4 52	

Table 6: Assessment results for the diatoms and phytoliths from Goss Moor, Cornwall

APPENDIX 2: PROJECT DESIGN

EXECUTIVE SUMMARY

Oxford Archaeology North (OA North) received a brief from Natural England to design a costed project design for the palaeo-environmental assessment of samples taken during two excavations on the Goss Moor National Nature Reserve, Cornwall. The brief stated that the samples were to be assessed for pollen, plant macrofossils and insect remains but if the assessment of other remains was thought to be desirable a case should be made for their inclusion. OA North has suggested that fungal spores and diatoms should also be assessed for the following reasons:

- fungal spores may help in our understanding of the nature of the local environment, animal and anthropogenic activity for example some fungal spores are associated with damaged trees. There is no additional cost implication in undertaking this assessment.
- diatoms are habitat specific and are therefore good indicators of such characteristics as minerals, salinity and water quality which may be of considerable importance from a site that is known to have been influenced by tin and gravel extraction. There is an additional cost implication in undertaking this assessment.

STAFFING

The pollen, fungal spores and plant macrofossils will be assessed in house by the OA North environmental team. The insects and diatoms will be assessed by external specialists.

1. INTRODUCTION

1.1 PROJECT BACKGROUND

- 1.1.1 Natural England (hereafter the 'client') has requested that Oxford Archaeology North (OA North) submit a costed Project Design describing a Palaeo-environmental Assessment of environmental samples taken during two excavations ahead of a project to divert the River Fal from an over-deepened channel, which was created in the 1970s to prevent the threat of pollution episodes from the China Clay industry upstream. The two excavation trenches were at both ends of this channel.
- 1.1.2 The lower, western trench exposed a sequence of stratified deposits of mainly gravels and clays with a more organic looking layer towards the base. The deposits are thought to have been laid down naturally and are described as

possibly water-lain in a flood plain. A single archaeological feature was identified in this trench.

- 1.1.3 The eastern trench and the deposits are described as being disturbed possibly as the result of tin-streaming and more recently by gravel extraction. Goss Moor was extensively disturbed by tin and gravel extraction in the 19th and 20th centuries although this may have commenced in the Bronze Age.
- 1.1.4 Both bulk and monolith environmental samples were taken from the western trench. The bulk samples were taken during machine excavation, which curtailed the available time for sampling. A preliminary assessment needs to be undertaken on these samples.

1.2 SITE BACKGROUND

- 1.2.1 Goss Moor NNR, Cornwall is situated in a broad relatively flat, valley basin which forms the headwaters of the River Fal. The extensive mining of alluvial tin deposits since the Bronze Age, and in the more recent past gravel extraction has resulted in the formation of wetland habitats. No industrial activity has taken place since the 1960s.

1.3 OXFORD ARCHAEOLOGY NORTH

- 1.3.1 The company, both as Oxford Archaeology North, and under the former guise of Lancaster University Archaeological Unit (LUAU), has considerable experience of sites of all periods, having undertaken a great number of small and large scale projects throughout Northern England during the past 25 years and latterly in Southern England. Evaluations, assessments, watching briefs and excavations have taken place within the planning process, to fulfil the requirements of clients and planning authorities, to very rigorous timetables.
- 1.3.2 OA North has the professional expertise and resources to undertake the project detailed below to a high level of quality and efficiency. OA North is an Institute of Field Archaeologists (IFA) registered organisation, registration number 17, and all its members of staff operate subject to the IFA Code of Conduct.

2 OBJECTIVES

- 2.1 The following programme has been designed following the brief (TRURI 2011:19) received by OA North from Natural England.
 - Stage 1: Assessment of pollen, fungal spores and diatoms
 - Stage 2: Assessment of plant macrofossils
 - Stage 3: Assessment of insect remains
 - Stage 4: Reporting
 - Analysis and dating.

- 2.2 **Stage 1: Assessment of pollen, fungal spores and diatoms:** small sub-samples will be taken from the monolith sample and processed for pollen, fungal spores and diatoms.
- 2.3 The prepared samples will be assessed by the individual specialists. The pollen and fungal spores will be assessed in house and the diatom will be submitted to the relevant specialist.
- 2.4 **Stage 2: Assessment of plant macrofossils:** a one litre sub-sample will be taken from each bulk sample will be processed and assessed for plant macrofossils. The plant macrofossils will be assessed in house
- 2.5 **Stage 3: Assessment of insect remains:** : the remaining volume from each bulk sample will be processed and assessed for insect remains. The insect remains will be assessed by the relevant specialist.
- 2.6 **Stage 4: Reporting:** A written report will be produced giving the results of the assessment, an outline of the archaeological implications of the combined work and an indication if any Stage 4 work is warranted.
- 2.7 **Stage 5: Analysis and dating:** This stage will comprise full analysis of pollen, fungal spores, plant macrofossils, insects and diatoms and it will be supported by a programme of scientific dating. An account of successive environments and an outline of archaeological implications will be given. If the results are of sufficient merit they may be published in an appropriate academic journal.
- 2.8 **Report and archive:** a written report will be produced at Stage 3 to assess the significance of the data generated by the programme within a local and regional context. It will present the results of the assessments from each stage. The data will be entered into OASIS, the Online Access to the Index of archaeological investigations.

3 METHOD STATEMENT

3.1 Palaeo-environmental Assessment

- 3.1.1 **Stage 1: Pollen, fungal spores and diatoms:** Samples for pollen and fungal spores will be processed in house by the OA North environmental team but samples for diatom assessment will be submitted to the relevant specialist.
- 3.1.2 The pollen in the sediment will be assessed to help understand the nature and processes of accumulation of the waterlogged deposits and also the local environment. The pollen assessment method to be used is in the following paragraphs.
- 3.1.3 The monolith sample will be cleaned and recorded on *pro-forma* sheets following the standard guidelines for Geoarchaeology (English Heritage 2004). A description of the deposits using standard quaternary (Late Devensian and Holocene) terminology (colour texture, compaction and inclusions) will be compiled.
- 3.1.4 Five small sub-samples will be taken from the monolith for the assessment of pollen and fungal spores. A further five samples will be taken for the assessment of diatoms.
- 3.1.5 **Pollen and fungal spores:** five sub-samples, 10-20ml in volume, will be prepared for pollen analysis using a standard chemical procedure (method B of Berglund & Ralska – Jasiewiczowa (1986), using HCl, NaOH, sieving, HF, and Erdtman's acetolysis, to remove carbonates, humic acids, particles > 170 microns, silicates, and cellulose, respectively. The samples will be stained with safranin, dehydrated in tertiary butyl alcohol, and the residues mounted in 2000 cs silicone oil. Slides will be examined at a magnification of 400x (1000x for critical examination) by ten equally-spaced traverses or a total 100 land pollen and spores if fewer transects are needed across two slides to reduce the possible effects of differential dispersal on the slide (Brooks & Thomas, 1967). *Lycopodium* tablets (Stockmarr, 1971) will be added to a known volume of sediment at the beginning of the preparation so that pollen concentrations could be calculated. Pollen identification will be made using the keys of Moore *et al.* (1991), Faegri & Iversen (1989), and a small modern pollen reference collection. Andersen (1979) will be followed for identification of cereal-type grains. Indeterminable grains will also be recorded as an indication of the state of the pollen preservation. Plant nomenclature will follow Stace, 1997. Fungal spore identification and interpretation will follow van Geel (1978) and Blackford, J.J. (*et al.* 2010) (in press).
- 3.1.6 The data will be presented in tables as either percentage values or actual numbers of pollen grains and spores. The interpretation of the data may help in our understanding of the nature in which the waterlogged deposits accumulated and also of the local and regional environment.

- 3.1.7 **Fungal spores:** the data will be presented in tables as either percentage values or actual numbers of fungal spores. The interpretation of the data may help in our understanding of the nature of the local environment, animal and anthropogenic activity for example some fungal spores are associated with damaged trees (Innes *et al* 2006) .
- 3.1.8 **Diatoms:** five small sub-samples of the sediment samples will be submitted to the relevant specialist (Dr Philip Barker), who will prepare 10ml samples following the standard hydrogen peroxide and hydrochloric acid procedure (Batterbee 1986). The sediments will be processed and assessed for the presence and absence of diatoms. If present the diatoms will be identified and quantified.
- 3.1.9 Diatoms are freshwater or marine algae with a silica frustule or chamber, which is resistant to decay. They are habitat specific and are therefore a good indicators of such characteristics as minerals, salinity and water quality (English Heritage, 2002). As it is recorded that Goss Moor has been influenced by tin and gravel extraction information about the water quality and mineral content of the deposits will be a very important indicator of biological conditions.
- 3.1.10 **Stage 2: Assessment of plant macrofossils:** the bulk samples will be processed and assessed for the presence or absence of plant macrofossils by the OA North in house environmental team. The brief states that the deposits are thought to have been water-lain and therefore it is anticipated that the plant remains will have been preserved by water logging and the processing methodology is based on this assumption. A one litre sample of each bulk sample will be washed through 250 micron mesh, retained wet and examined under a low powered binocular microscope. If present the plant macrofossils will be identified, where possible, quantified and the potential for further analysis will be recorded.
- 3.1.11 Waterlogged plant remains are good indicators of the local flora. They can be used as proxy indicators of climate change and hydrological conditions (Barber and Charman, 2003).
- 3.1.12 **Stage 3: Assessment of insect remains:** The remainder of the bulk samples will be submitted to the relevant specialist, who would process them by paraffin flotation techniques and assess the flots for the presence of insect remains. If these are present they are invaluable to our understanding of the nature of the deposits, possible urban habitation conditions and the economy of the sites.
- 3.1.13 **Stage 4: Reporting:** The data from the pollen, fungal spores, diatoms, plant macrofossil and insect assessment will be presented in a written report with an outline of the archaeological implications. Proposals will be made for further analysis if warranted and the methodology for this analysis will also be included.
- 3.1.14 **Stage 5: analysis and dating:** if the environmental assessment demonstrates the potential for further research of the pollen, fungal spores, diatoms, plant

macrofossils and insects, a programme of full analysis for all or some of the samples will be recommended. The details of the methodology will be outlined in the Stage 3 report. This programme of analysis will be supported by a programme of scientific dating and the advice of the Scottish Universities Environmental Research Centre will be sought.

3.2 REPORT

3.2.1 **Report:** three bound and one unbound copy of the final report will be submitted to the client within two months following the commissioning of the project. The report will include:

- a site location plan related to the national grid;
- a front cover to include the planning application number and the NGR;
- the dates on which each phase of the programme of work was undertaken;
- a concise, non-technical summary of the results;
- an explanation to any agreed variations to the brief, including any justification for any analyses not undertaken;
- a description of the methodology employed, work undertaken and results obtained;
- a description of the pollen, fungal spores, plant macrofossil and insect assessments undertaken and the results obtained;
- a summary of the impact of the development on any archaeological remains and, where possible, a model of potential archaeological deposits within as-yet unexplored areas of the development site;
- a copy of this project design, and indications of any agreed departure from that design;
- Recommendations for further works
- the report will also include a complete bibliography of sources from which data has been derived.

3.2.2 This report will be in the same basic format as this project design; a copy of the report can be provided on CD, if required.

3.2.3 **Confidentiality:** all internal reports to the client are designed as documents for the specific use of the client, for the particular purpose as defined in the project brief and project design, and should be treated as such. They are not suitable for publication as academic documents or otherwise without amendment or revision.

- 3.2.4 **Archive:** the results of all environmental archaeology work carried out will form the basis for a full archive to professional standards, in accordance with current standard guidelines (English Heritage 1991; 2002; 2004). The project archive will include summary processing and analysis of all features, finds, or palaeo-environmental data recovered during fieldwork, which will be catalogued by context.

4. HEALTH AND SAFETY

- 4.1 OA North provides a Health and Safety Statement for all projects and maintains a Unit Safety policy. All site procedures are in accordance with the guidance set out in the Health and Safety Manual compiled by the Standing Conference of Archaeological Unit Managers (1997). A written risk assessment will be undertaken in advance of project commencement and copies will be made available on request to all interested parties.

5. PROJECT MONITORING

- 5.1 Whilst the work is undertaken for the client, J Joy Ede the SW Historic Environment Specialist Archaeologist, for Natural England will be kept fully informed of the work and its results. Any proposed changes to the Written Scheme of Investigation will be agreed with Joy Ede in consultation with the client.

6. TIMING, STAFFING AND AVAILABILITY

- 6.1 **Timing:** The final report will be submitted to the client within two months following the commissioning of the project by the client .
- 6.2 **Staffing:** All staff participating in the project should be suitably qualified and appropriate experience in this type of project. If OA North are successful the project will be under the direct management of **Murray Cook MA, MIFA, FSA Scot**, OA North Post-Excavation Manager.
- 6.3 All environmental sub-sampling and assessment will be undertaken under the auspices of **Elizabeth Huckerby BA, MSc, MIFA** (OA North Environmental Manager) who has experience of palaeoenvironmental work in the North West England having worked on the North West Wetlands Survey and the Upland Peat Project both English Heritage funded Projects and who heads a team of environmental archaeologists. **Elizabeth** has experience of sites, in Southern and Eastern Britain, France and Ireland. **Denise Druce BA, PhD** who has considerable experience of working in the North West England on the Upland

Peat Project and many other projects in North West England. She also has experience of working on the Severn Estuary, Cornwall, Central and Southern Wales and Southern and Eastern Britain. Denise has previously analysed the pollen from the lower palaeochannel sequence identified in the stream valley south-west of Belowda Lane on Goss Moor (Druce and Verrill forthcoming). **Mairead Rutherford BA, MSc**, an experienced pollen analyst, has worked on sites throughout the British Isles, including several sites in West and North West Scotland, the Pennines and North Cumbria will assess the pollen and fungal spores. **Elizabeth Huckerby**, an experienced waterlogged plant remains and pollen specialist will assess the waterlogged plant remains. Curricula Vitae are to be found in Appendix 1.

6.4 The insects will be assessed by either **David Smith, MA(CANTAB), MA, PhD, FRES Birmingham University** or **Enid Allison, B Sc, D Phil, Canterbury Archaeological Trust** depending on their availability. Both are very experienced insect specialists. The diatoms will be assessed by **Philip Barker** at the University of Lancaster, a very experienced diatom specialist. Curricula Vitae are available on request.

6.5 *Availability:* OA North has availability to undertake and complete this work within two months following the commissioning of the project by the client.

7 INSURANCE

7.1 The successful contractor shall provide professional indemnity cover to a value of £2,000,000; proof of which to be supplied.

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