

Luggie's Knowe

NVC Survey Report

By Andrew Upton

Of

Firth Ecology

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1 Introduction

1.1 Background

The aim of the NVC survey was to identify and map the plant communities within the application boundary and a 250 m buffer (hereafter referred to as the 'study area') in order to identify vegetation of nature conservation interest or areas with potential groundwater dependency.

This report details the findings of the NVC survey together with an evaluation of the communities described.

1.2 The Site

The site measures approximately 160 hectares and is located on a hilly peninsula just north of Lerwick, with a general topography of ridges and slopes lying from south-southwest to north-northeast in line with the underlying geology. The highest point is Hill of Gremista at about 105 m AOD and the land drops to sea-level at the northernmost extent of the study area.

Various data layers available on the Scotland's environment web map (Scotland's environment, undated) provide useful information on the substrate underlying the proposal. The British Geological Survey 1:50,000 Bedrock map classifies most of the underlying rock as metamorphosed former sedimentary rock (probably deep marine sediments), with sedimentary conglomerate at the lower, eastern edge of the survey area. The British Geological Survey 1:50,000 Superficial Deposits map indicates that peat covers the whole of the site.

The depth of peat will be variable, but in places is several metres deep, as indicated by three sinkholes encountered in the upper part of the site. The locations of the sinkholes are indicated on **Drawing 2 (Appendix 2)**.

The vegetation comprises a range of unimproved moorland habitats on the hill ground, with semi-improved grassland running down to the shore at the northern and eastern edges of the study area.

The Loch of Kebister is the largest open water body – otherwise there are numerous small pools and runnels scattered across the flatter areas of peat. There is one small artificial pond within the fence of an adjacent recycling site.

There is extensive sheep grazing on the moorland and associated acid grassland, with more intensive grazing in semi-improved fields on the low ground north of the public road. One wind turbine is already operational on the moorland at the north end of the study area, not far from the public road. On either side of the peninsula there are recent or former quarried areas, now used for rig-decommissioning or as a recycling site; parts of these sites extend into the study area.

2 Methods

2.1 Coverage and timing

The survey was carried out from 13th to 16th August 2021 by Andrew Upton of Firth Ecology, based in Finstown, Orkney.

The full extent of the survey area covered about 160 hectares, or 1.6 km². The survey boundary is shown in **Drawing 1**, covering a 250 m buffer around the defined site boundary. It included the

interior moorland of the peninsula, from Loch of Kebister and the Hill of Gremista, north to the knoll of Luggie's Knowe and the public road. This part of the study area was surveyed in detail.

The 250 m buffer extended beyond the road into semi-improved farmland at its northern and northeastern edge, and here it also reached down to the shore for a few hundred metres on either side of the Vatsland peninsula. This part, including the road verges, was surveyed in somewhat less detail.

Recently quarried and largely bare ground within the boundaries of a rig-decommissioning site (on the west side) and a recycling site (on the east side) were not included in the study area. The vegetated parts of these sites were included in the survey, but could only be viewed from outside the fences.

2.2 Survey and sampling methods

All parts of the detailed study area were walked over at least once; parts of the less detailed study area were viewed from greater distances.

Individual NVC communities and sub-communities were identified and their boundaries marked (with the aid of a GPS) onto large-scale aerial photographs. The aim was to map every clearly distinct vegetation stand, down to about 0.04 hectares in extent (i.e. about 20 m x 20 m), and often considerably smaller.

Much of the vegetation was identified by eye, with quadrat sampling focussed on the major semi-natural vegetation types. Sampling was carried out on a 2m x 2m quadrat basis to confirm or assist with classification. This involved recording the species present, together with their abundances. This data was subsequently compared with the standard NVC tables and classified accordingly.

Vegetation types were classified to sub-community level where possible, although in some cases the vegetation was mapped to community level only, where it did not fit readily within the published sub-communities.

Within the more extensive mapped stands there are usually scattered pockets of other vegetation types, too small to map, forming a low percentage cover.

In places, picking a boundary was a judgment call because the vegetation passed gradually from one type to another e.g. where heather bushes thickened up within the acid grassland areas, causing gradational boundaries from grassland to grassy heath and then from grassy heath to heath proper.

The boundary between dry and wetter blanket bog types was often clear, but became less so on the shallow, higher slopes; here, not only were there gradations between the two types, but numerous islands of one within the other at small scales – this boundary is therefore often very approximate.

2.3 Presentation methods

A list of the NVC communities and sub-communities identified in the survey area is given in **Table 2** in section 3.2 below. A list of plant species noted during the survey is provided in **Tables F and G, Appendix 1**.

Colour-coded NVC maps are presented in **Appendix 2** – the vegetation blocks shown are predominantly of a single vegetation sub-community, but some may be a mosaic of different types, coded to that with the highest ground cover. All the vegetation boundaries on the map are shown

by narrow dotted lines and there has been no attempt to distinguish between those boundaries that were clearly demarcated in the field and those that were more gradational or diffuse.

In **Appendix 2** maps are also produced that indicate the conservation value of the vegetation and groundwater dependency.

Tables **A to E** in **Appendix 1** show the results of the quadrat sampling. The analysis of quadrat data involves scores for 'frequency' and 'cover' for each species in a given vegetation type. Frequency is determined by the proportion of quadrat samples in which a species occurs, as follows:

- Constant 81 – 100 % of samples score V
- Constant 61 – 80 % of samples score IV
- Frequent 41 – 60 % of samples score III
- Occasional 21 – 40 % of samples score II
- Scarce 1 – 20 % of samples score I

Note that species occurring at frequencies covered by both scores IV and V are referred to as 'constants' in the vegetation.

A species' cover values refer to the proportion of ground covered within each quadrat sample, as estimated by eye; these are usually a range of scores in each vegetation type, since it is unusual for a species to be at the same cover in every quadrat. The scores are:

1. <4 % cover, few individuals
2. <4 % cover, several individuals
3. <4 % cover, many individuals
4. 4 – 10 % cover
5. 11 – 25 % cover
6. 26 – 33 % cover
7. 34 – 50 % cover
8. 51 – 75 % cover
9. 76 – 90 % cover
10. 91 – 100 % cover

Thus, the tabulated score for each species is made up of a frequency and a range of cover values e.g.

- *Festuca rubra*, IV (2-5): a constant in the vegetation, occurring in 61 – 80 % of samples, at cover values of <4 % - 25%.
- *Agrostis stolonifera*, II (4-8): only occasional in the vegetation but may be of high local cover, up to 75 %, where it occurs.

The published NVC tables themselves are only a sample of the range of variability in each vegetation type across Britain. Some sub-community tables may be based on only a small number of quadrats and many were not sampled from Shetland, or indeed the north of Scotland. Therefore, it is not surprising that there is considerable variation from the published tables in most cases.

Various software packages exist that can make comparisons from field quadrat data to the published NVC tables; these typically produce a list of possible sub-communities, each with a calculated percentage of 'fit'. Due to the wide variability of actual vegetation, and the limitations of the published NVC tables mentioned above, most field samples come out as only low or moderate fits,

sometimes for a surprisingly disparate range of different sub-communities. However, such software has not been used here, rather the detailed community descriptions in Rodwell (1991), Rodwell (1992) and Rodwell (2000) and the subsequent JNCC Guide to British Upland Vegetation (Averis *et al*, 2004) have been consulted, in addition to the NVC tables. The discussions within these descriptions can shed light on some untabulated, and otherwise unexpected, variation that the authors consider can be accommodated within a community or sub-community.

Thus, rather than relying on a computer programme that simply analyses numbers, an attempt has been made here to make more reasoned decisions in the allocation of the field data to NVC classes.

In addition, there are gaps within the NVC coverage that have subsequently come to light and new vegetation types have been proposed in a more comprehensive review (Rodwell *et al*, 2000) and additional commentary (Averis and Averis, 2020). Two such common upland communities were identified within the study area and have been given suitable codes, shown in inverted commas.

Detailed results from individual quadrat samples are shown in **Tables A to E, Appendix 1**.

2.4 Nomenclature

Plant nomenclature follows the fourth edition of Stace (Stace, 2019) for vascular plants and the British Bryological Society field guide (Atherton *et al*, 2010) for mosses and liverworts.

Nomenclature for NVC communities has been updated in line with the JNCC guide (Averis *et al*, 2004) with some further alterations due to more recent changes in plant names.

2.5 Survey Limitations

The NVC surveys were undertaken at a prime time for identifying the vascular plant species present. However, any small leafy liverworts were not identified during quadrat sampling – this omission will have had little effect on the determination of vegetation communities.

Given the time available and the prime importance of properly locating and mapping the most important vegetation types within the site boundary itself, the less important communities which occurred in only a few small stands, or only in the 250 m buffer, were not looked at in detail. Most were simply identified by eye with a brief note of the typical species present. Where it was not easy to assign a vegetation class or sub-community in these circumstances, it was not felt necessary to spend a great deal of time attempting to do so, and some have been noted as ‘related’ to a particular NVC community or have been given more general descriptive titles.

The use of non-NVC classes should not affect the understanding of the vegetation and will not impair the vegetation impact assessment. The impact assessment relies on broader categories set out in different frameworks at the EU, UK and more local scales. All of the vegetation types, whether NVC or not, can be readily fitted into these.

3 Results

3.1 Vegetation Overview

The immediately obvious human influence on the vegetation within the survey area is the installation of the existing wind turbine and its access road on moorland/acid grassland not far from the public road.

Otherwise the moorland area has been affected by sheep grazing, although this does not appear to be at high density.

There are no other roads or unvegetated tracks within the moorland and little or no evidence of peat cutting or drainage attempts.

Scrub and trees are absent within the survey area.

Other than the Loch of Kebister and the Burn of Kebister, open water is restricted to variably seasonal pools and runnels. There is very little bare peat within the study area.

3.2 Summary of NVC and other vegetation types found at Luggie's Knowe

Categories of vegetation within the study area include the following NVC communities and related non-NVC categories:

- Blanket mire: M18-related, M19
- Bog pool and runnel vegetation: M2, M3, M29
- Flushes, mires and rush-pasture: M6, 'MCx', M28, M23, 'UJe'
- Heaths: H12, M15
- Acid grasslands: U4, U5, U6
- Maritime vegetation: MC2-related, MC9
- Disturbed vegetation: OV27

Three further disturbed habitats are described briefly, rather than being assigned or linked to an NVC class – these are recolonising peat, recolonising subsoil and the public road verge.

All of the vegetation types identified from the study area are listed in **Table 2** below, with a brief indication of their occurrence; they are discussed in more detail in the paragraphs following, with quadrat data referred to in **Tables A to E, Appendix 1**.

Table 2. *List of NVC communities & sub-communities and non-NVC vegetation found within the study area. Codes in inverted commas are non-NVC codes used for this site. 'Not assigned' means that the vegetation was not identified beyond community level, although sub-communities are described in the NVC.*

NVC code	Community	NVC sub-community title	Occurrence in the Luggie's Knowe study area
M2	<i>Sphagnum cuspidatum/fallax</i> bog pool community	Not assigned (species-poor northern type)	Scattered patchily across the wetter bog
M3	<i>Eriophorum angustifolium</i> bog pool community	-	Fringe of one dried-out pool
M6c	<i>Carex echinata-Sphagnum fallax/denticulatum</i> mire	<i>Juncus effusus</i> sub-community	Patches up to 1 ha on the lower slopes and up alongside Burn of Kebister
M6	<i>Carex echinata-Sphagnum fallax/denticulatum</i> mire	Not assigned (with abundant <i>Juncus articulatus</i>)	Three flushed areas on NW slope of study area
'MCx'	Neutral small-sedge mire	-	One flush on NW slope
M15a	<i>Trichophorum germanicum-Erica tetralix</i> wet heath	<i>Carex panicea</i> sub-community	One flushed stand on the lower eastern slope
M15b	<i>Trichophorum germanicum-Erica tetralix</i> wet heath	Typical sub-community	Occasional small stands on raised peat adjacent to bog pools
M18-related	<i>Erica tetralix-Sphagnum papillosum</i> wet mire	-	Shallow depressions in the main blanket mire
M19a	<i>Calluna vulgaris-Eriophorum vaginatum</i> blanket mire	<i>Erica tetralix</i> sub-community	Extensive on the flatter areas of hill ground

NVC code	Community	NVC sub-community title	Occurrence in the Luggie's Knowe study area
M19b	<i>Calluna vulgaris</i> - <i>Eriophorum vaginatum</i> blanket mire	<i>Empetrum nigrum nigrum</i> sub-community	Extensive on the highest ground and on moderate slopes
M23b	<i>Juncus effusus/acutiflorus-Galium palustre</i> rush-pasture	<i>Juncus effusus</i> sub-community	Along old ditches within the semi-improved fields
M28	<i>Iris pseudacorus-Filipendula ulmaria</i> mire	Not assigned	Alongside the lower stretch of the Burn of Kebister
M29	<i>Hypericum elodes-Potamogeton polygonifolius</i> soakway	(impoverished northern type)	Within runnels over peat at the very south of the study area
H12a	<i>Calluna vulgaris-Vaccinium myrtillus</i> heath	<i>Calluna vulgaris</i> sub-community	On the steeper moorland slopes
H12c	<i>Calluna vulgaris-Vaccinium myrtillus</i> heath	<i>Galium saxatile-Festuca ovina</i> sub-community	In wide intergrades between H12a and U6d
U4a	<i>Festuca ovina-Agrostis capillaris-Galium saxatile</i> grassland	Typical sub-community	Small well-grazed stands around Luggie's Knowe
U4b	<i>Festuca ovina-Agrostis capillaris-Galium saxatile</i> grassland	<i>Holcus lanatus-Trifolium repens</i> sub-community	Extensive in semi-improved fields to the north and east of the public road
U5	<i>Nardus stricta-Galium saxatile</i> grassland	Not assigned	Scattered small stands within more extensive U6
U6a	<i>Juncus squarrosus-Festuca ovina</i> grassland	<i>Sphagnum</i> sub-community	On lower slopes and adjacent to rush patches
U6d	<i>Juncus squarrosus-Festuca ovina</i> grassland	<i>Agrostis capillaris-Luzula multiflora</i> sub-community	Extensive on eastern slopes of study area
'UJe'	Acid rush-pasture	-	Scattered small patches on the hillside and larger areas within the decommissioning and recycling sites – associated with disturbance
MC2-related	<i>Armeria maritima-Ligusticum scoticum</i> maritime rock-crevice community	-	On cliffs on either side of the Vatsland peninsula
MC9	<i>Festuca rubra-Holcus lanatus</i> maritime grassland	Not assigned	A narrow strip of cliff-top grassland on the west side of the Vatsland peninsula
OV27a	<i>Chamaenerion angustifolium</i> community	<i>Holcus lanatus-Festuca ovina</i> sub-community	Disturbed ground within the fence of the recycling site
Recolonising peat	-	-	Around the existing turbine infrastructure
Recolonising subsoil	-	-	By track within recycling site
Road verge gravel	-	-	Intermittently alongside the public road

The following sections describe the flora, structure and habitat of these communities within the study area.

3.3 Blanket mire

3.3.1 M19a *Calluna vulgaris-Eriophorum vaginatum* blanket mire, *Erica tetralix* sub-community

Virtually all of the blanket mire within the study area can be classed as M19 *Calluna vulgaris-Eriophorum vaginatum* blanket mire and this community covered the bulk of the moorland area, particularly on the higher ground.

Of the two sub-communities present, M19a the *Erica tetralix* sub-community, is found in the flatter areas and is generally wetter, with frequent pools and runnels scattered patchily across it. Seven quadrat samples were taken in this vegetation from across the study area, including the lowest, flattest parts, and the results are shown on **Table C, Appendix 1**; the location of these quadrats is indicated on **Drawing 2, Appendix 2**.

Visually it could be distinguished from much of the adjacent M19b *Empetrum nigrum nigrum* sub-community (see 3.3.2) by its smoother texture and less green overall colouration, both of these factors due to the much lower abundance of Hare's-tail Cottongrass *Eriophorum vaginatum* tussocks. As well as occurring less constantly throughout, Hare's-tail Cottongrass is also at much lower cover levels, often with only scattered, young plants. In some areas, e.g. at the northward extent of M19a close to the existing turbine, Hare's-tail Cottongrass was almost absent, but here as elsewhere, its place was taken by Common Cottongrass *Eriophorum angustifolium* at high cover, lending the vegetation a reddish tinge as the leaves were beginning to turn to their autumnal red.

Species typical of wetter ground that further distinguish the M19a from M19b are seen in the quadrat data, particularly the constant Cross-leaved Heath *Erica tetralix* and frequent Deer-grass *Trichophorum germanicum* and Bog Asphodel *Narthecium ossifragum*.

In places the overall difference in appearance between M19a and M19b is less striking, the vegetation being somewhat tussocky, but with plenty of Common Cottongrass; the boundary between the two types is therefore not always obvious and some areas might be equally, or more correctly, assigned to the other sub-community.

Even the wettest areas of blanket mire (quadrats 1 and 2) are readily seen as M19a rather than the wetter M17a *Trichophorum germanicum-Eriophorum vaginatum* blanket mire (*Drosera rotundifolia-Sphagnum* sub-community) due to the absence of *Sphagnum papillosum*, Purple Moor-grass *Molina caerulea* and Tormentil *Potentilla erecta* (despite the last being frequent in the nearby heath). The presence of a variety of mosses (other than *Sphagna*) in these two quadrats are also indicators of M19a rather than M17a, e.g. *Plagiothecium undulatum*, *Dicranum scoparium* and *Rhytidiadelphus loreus*.

3.3.2 M19b *Calluna vulgaris-Eriophorum vaginatum* blanket mire, *Empetrum nigrum nigrum* sub-community

This is a dry blanket mire with a typically tussocky cover dominated by Heather *Calluna vulgaris* and the green leaves of Hare's-tail Cottongrass. Five quadrat samples were taken and are detailed on **Table D, Appendix 1**; the location of these quadrats is indicated on **Drawing 2, Appendix 2**.

M19b generally occurs on deeper peat than heath and is readily distinguished from it by the constancy of the Hare's-tail Cottongrass.

Compared to the wetter M19a (see 3.3.1) it lacks various wet species, such as Cross-leaved Heath, and is mossier (note the high covers of *Hylocomium splendens* in the quadrats), but with fewer *Sphagna*. Constant Wavy Hair-grass *Deschampsia flexuosa*, Sweet Vernal-grass *Anthoxanthum odoratum* and Heath Woodrush *Luzula multiflora*, albeit at quite low covers, further distinguish M19b from M19a at the Luggie's Knowe site. Despite the sub-community's name, Crowberry *Empetrum nigrum* is no more frequent or abundant in M19b than in M19a and is not a useful distinguishing species.

Compared to the published tables (Rodwell, 1991) there is less Bilberry *Vaccinium myrtillus* and the mosses *Pleurozium schreberi* and *Dicranum scoparium* than might be expected, and more Wavy Hair-grass, Sweet Vernal-grass, Heath Woodrush and *Hylocomium splendens*. Some of these may be regional effects e.g. Heath Woodrush and *Hylocomium* are also noted at higher-than-expected frequencies in various vegetation types in Orkney¹.

A flat area just north of the Loch of Kebister has unusual vegetation – it is a background of M19b (Heather, Hare's-tail Cottongrass, Common Cottongrass and *Sphagna*), but with acid grasses and herbs growing through. These include abundant Yorkshire-fog *Holcus lanatus* and Heath Woodrush along with Common Bent *Agrostis capillaris*, Sweet Vernal-grass, Spreading Meadow-grass *Poa humilis*, Green-ribbed Sedge *Carex binervis*, Tormentil and Heath Bedstraw *Galium saxatile*. It is likely that this was a former gull colony and the grassland that would have been encouraged when the birds were present is now reverting to the original mire. This area is mapped as a composite vegetation type on the NVC map (**Drawings 1 to 3, Appendix 2**) and treated as blanket mire on the vegetation valuation map (**Drawing 3, Appendix 2**).

3.3.3 M18-related *Erica tetralix-Sphagnum papillosum* wet mire

Within the wide expanse of blanket mire there are scattered shallow depressions and channels, sometimes associated with bog pools and runnels, where the vegetation is clearly wetter. In these the cover of Heather is lower and the cover of *Sphagnum* mosses higher (and with more variety) than in the surrounding mire. Five quadrat samples were taken and are detailed in **Table B, Appendix 1**; the location of these quadrats is indicated on **Drawing 2, Appendix 2**.

The constant presence of shrubs (Crowberry is particularly noticeable) and of *Sphagnum papillosum* means that this is not bog pool vegetation, although it sometimes occurs in locations that might imply some sort of successional stage from bog pools/runnels to wet mire.

Although the alignment with the overall M18 NVC tables (Rodwell, 1991) is fairly close, M18 is usually an extensive vegetation type of raised bogs, or as part of the main body of blanket or basin mires, rather than confined to small patches as found here. The main vegetation differences from the published M18 tables are the lack of Deer-grass and *Sphagnum tenellum*, with less Hare's-tail Cottongrass and Bog Asphodel than expected. Crowberry is much more abundant than shown for M18, but this may be a regional effect in which it is generally more common in various moorland types in the Northern Isles than elsewhere.

3.4 Bog pools and runnels

3.4.1 M2 *Sphagnum cuspidatum/fallax* bog pool community

¹ Andrew Upton – personal observation.

A total of 20 bog pools were sampled and a brief note of the constituents of each was made, scoring cover as dominant, abundant, frequent or occasional for all species present. The results are shown in **Table A, Appendix 1**; the location of these pools is indicated on **Drawing 2, Appendix 2**.

The great majority of the pools were dominated by *Sphagnum cuspidatum*, which indicates that they fall within the M2, *Sphagnum cuspidatum/fallax* bog pool community, although not conforming well to the published tables (Rodwell, 1991). Most had few associated species, of which Bulbous Rush *Juncus bulbosus* was by far the most frequent and sometimes co-dominant. Common Cottongrass was also constant at low cover and Common Sedge *Carex nigra* and *Sphagnum denticulatum* were frequent. Otherwise a variety of expected, and unexpected, species were found in just one–three pools each, usually at low covers.

Bulbous Rush is not listed as a constituent of M2 in the NVC tables, neither are Common Sedge or *Sphagnum denticulatum*, but the clear dominance of *Sphagnum cuspidatum* makes it difficult to place these pools in any other category.

The JNCC guide (Averis *et al*, 2004) suggests that northern forms of M2 bog pool were under-sampled for the original NVC and that a better sub-community distinction for these is between species-poor and species-rich forms. The pools at Luggie’s Knowe are clearly species-poor.

Very occasional pools did not have *Sphagnum cuspidatum*, e.g. one that was bare apart from a little Jointed Rush *Juncus articulatus* and one that had abundant Carnation Sedge *Carex panicea* with Common Cottongrass and *Sphagnum denticulatum*. Nevertheless, these were all also species-poor and all have been coded the same on the NVC maps, as ‘M2 and related’ bog pools.

There are also numerous linear channels, usually very gently sloping, in which the vegetation is essentially the same as the bog pools, being dominated by *Sphagnum cuspidatum* and lacking any shrubs or an obvious sedge or rush layer. However, they tend to have a somewhat wider range of associated species than the small pools. Sample number 18 in **Table A, Appendix 1** was a channel like this. They have been coded on the NVC maps in the same colour as the bog pools.

3.4.2 M3 *Eriophorum angustifolium* bog pool community

This is a community that is usually dominated by Common Cottongrass, often without any other species. Such single-species stands are often found on bare peat where the cottongrass is the first coloniser. Such was the case here, where one bare peat depression has a fringe of Common Cottongrass growing in from the edge.

Despite the abundance of this species in various other vegetation types within the study area, no other instances of M3 were encountered.

3.4.3 M29 *Hypericum elodes*-*Potamogeton polygonifolius* soakway

M29 is a community of often narrow trickles over peat, usually with a thick covering of Bog Pondweed *Potamogeton polygonifolius* leaves. At Luggie’s Knowe it was found within two wider runnels at the very southern edge of the study area, in a wide expanse of flat blanket mire.

Northern examples such as this are beyond the range of Marsh St. John’s-wort *Hypericum elodes* but may be regarded as an impoverished form of M29. Although lacking the St. John’s-wort, the trickles here held a good selection of the expected associates, such as Lesser Spearwort *Ranunculus flammula*, Star Sedge *Carex echinata*, Common Yellow-sedge *Carex demissa*, Carnation Sedge, Jointed Rush and Marsh Violet *Viola palustris*.

3.5 Flushes, mires and rush-pasture

3.5.1 M6c *Carex echinata*-*Sphagnum fallax/denticulatum* mire, *Juncus effusus* sub-community

Soft Rush *Juncus effusus* commonly forms patches and strips of taller vegetation along drainage flows on the lower slopes. In the moorland area the majority of these also held abundant *Sphagnum* mosses beneath the rushes, making them easy to identify as the M6c *Juncus effusus* sub-community.

3.5.2 M6 *Carex echinata*-*Sphagnum fallax/denticulatum* mire (with abundant *Juncus articulatus*)

Four areas close together on the northwest slope are a form of acid flush that clearly falls within the M6 community, but does not closely fit any of the four published sub-communities. The key features that indicate M6 are the abundance of rushes (here mainly Jointed Rush) with sedges (Common Sedge and occasional Star Sedge) and frequent *Sphagnum* species (*S. palustre*, *S. denticulatum*, *S. subnitens* and *S. fimbriatum*). Other species typical of the community as a whole are Tormentil, Marsh Violet, Velvet Bent *Agrostis canina* and Purple Moor-grass.

The abundance of Jointed Rush suggests that these flushes are similar to the other rush-dominated sub-communities M6c (*Juncus effusus*) and M6d (*Juncus acutiflorus*), but with a different species featuring here.

3.5.3 'MCx' neutral small-sedge mire

One flushed area on the northwest slopes was distinctly less acidic than the surrounding vegetation, likely due to more neutral or basic groundwater influence. This held a selection of sedges and is clearly related to the M6 community, but lacking *Sphagnum* and with various species indicative of more neutral conditions. Jointed Rush was present here too, with sedges represented by Star Sedge, Common Sedge, Carnation Sedge and the more basiphilous Flea Sedge *Carex pulicaris* and Dioecious Sedge *Carex dioica*. Most of the herbs of the nearby M6 (with Jointed Rush) were present; in addition the following were also noted: Autumn Hawkbit *Scorzoneroides autumnalis*, Devil's-bit Scabious *Succisa pratensis* and an Eyebright *Euphrasia* species.

3.5.4 M28 *Iris pseudacorus*-*Filipendula ulmaria* mire

This is vegetation in which Yellow Iris *Iris pseudacorus* is dominant. There are three recognised sub-communities, typical of different ecological settings (Rodwell, 1991), but the M28 stand found along the lower Burn of Kebister did not conform to any of them. This is because the Iris is so strongly dominant that there is little room for more than straggly individuals of a few species typical of the community as a whole – these are Common Sorrel *Rumex acetosa*, Rough Meadow-grass *Poa trivialis*, Creeping Bent *Agrostis stolonifera* and Yorkshire-fog.

3.5.4 M23b *Juncus effusus/acutiflorus*-*Galium palustre* rush-pasture, *Juncus effusus* sub-community

This is rushy vegetation with an underlying rather grassy flora incorporating various 'poor-fen' (marsh) species. It was identified along one old ditch system within the semi-improved fields, where brief inspection revealed typical associated species such as Common Sorrel, Marsh Willowherb *Epilobium palustre* and Lesser Spearwort.

3.5.5 'UJe' acid rush-pasture

Soft Rush growing over acid grassland is not included within the NVC, but is a common vegetation type in the uplands (Averis *et al*, 2004), frequently on previously disturbed ground on peat. Within the study area there are scattered small patches within the wider acid grassland where sheep-

trampling has opened up the grass cover, allowing the rushes to invade over the U6 grassland species (see 3.7.5).

There is more variable and extensive rushy vegetation inside the fences of the adjacent decommissioning and recycling sites. In the former, the rushes are in a weedy but still essentially acidic grassland, probably on soil spread from the adjacent working area. In the latter, rushes are colonising over what appears to be former blanket mire, with patchy Common Cottongrass and occasional Heather bushes among the grasses beneath. Access to both of these areas was restricted and they were not examined closely.

3.6 Heaths

3.6.1 M15a *Trichophorum germanicum-Erica tetralix* wet heath, *Carex panicea* sub-community

There is very little wet heath within the study area, probably because the depth of peat favours blanket mire across most of the flatter parts.

Two small, flushed patches of heath hold an array of sedges, making them M15a, the *Carex panicea* wet heath sub-community. On the west slope this vegetation is associated with M6 acid flushes (see 3.5.2 above) and there is Jointed Rush growing with the sedges beneath tussocky Heather. On the lower east slope, this vegetation has Cross-leaved Heath and Purple Moor-grass with the Heather and is flushed by neutral or basic groundwater. It is a particularly species-rich example and holds a good selection of sedges and broad-leaved herbs, including Carnation and Flea Sedges, Lesser Clubmoss *Selaginella selaginoides*, Alpine Meadow-rue *Thalictrum alpinum*, Sea Plantain *Plantago maritima*, Round-leaved Sundew *Drosera rotundifolia*, Common Butterwort *Pinguicula vulgaris* and an Eyebright.

3.6.2 M15b *Trichophorum germanicum-Erica tetralix* wet heath, Typical sub-community

In four places around pool and runnel systems the adjacent peat was distinctly raised up and therefore drier than in the surrounding mire expanse. Here Deer-grass was much more obvious amongst the Heather, with a noticeably thinner cover of Common Cottongrass. These small areas were not investigated closely, but did not appear particularly diverse – they have been taken to fall within the somewhat catch-all wet heath Typical sub-community, M15b.

This is heath vegetation occurring on deep peat, due to the very localised drier soil conditions. However, in the context of the valuation of the vegetation and its treatment in terms of potential mitigation, the M15b here is best included as part of the blanket mire within which it sits.

3.6.3 H12a *Calluna vulgaris-Vaccinium myrtillus* heath, *Calluna vulgaris* sub-community

H12 is a dry heath type, found on steeper slopes throughout the study area. It is also present in smaller patches on areas of raised ground and on some raised banks alongside channels and runnels (both wet and dry) – these are locations where the peat is either shallower, or is more freely draining.

In H12a, the *Calluna vulgaris* sub-community, the Heather is very strongly dominant as shown in the five quadrat samples taken here (**Table E, Appendix 1**, their locations shown on **Drawing 2, Appendix 2**). It is typically associated with Bilberry *Vaccinium myrtillus*, but this species was scarce within the study area and featured in only one of the quadrats. The other likely heath community would be H10 *Calluna vulgaris-Erica cinerea* heath, but Bell Heather *Erica cinerea* was even scarcer and not found in any of the quadrats. Of the associated species, the constant presence of Wavy Hair-grass *Deschampsia flexuosa* and the abundance of mosses both point towards H12. The main

moss is *Hylocomium splendens* rather than the *Pleurozium schreberi* indicated in the NVC tables (Rodwell 1991) and this may be a regional effect, since *Hylocomium* is found at greater abundances than expected in various vegetation types in Orkney².

3.6.4 H12c *Calluna vulgaris*-*Vaccinium myrtillus* heath, *Galium saxatile*-*Festuca ovina* sub-community

Where grasses thicken up within the Heather, or where grassy gaps appear between the Heather bushes, the dry heath falls into the H12c *Galium saxatile*-*Festuca ovina* sub-community. This occurs widely on the north-eastern slopes of the study area where acid grassland and heath interleave with each other.

The boundary between U6d grassland and H12c grassy heath was notionally set where the shrubs comprise 25% or more of the cover, and between H12c and H12a where patches of grass became small and no more than occasional. However, given the complexities of the vegetation patterning over the slopes, the mapped boundaries are necessarily rather approximate. Also, some of the main heath slopes mapped as H12a may have grassier edges, but these are generally not distinguished on the NVC map.

3.7 Acid grasslands

3.7.1 U4a *Festuca ovina*-*Agrostis capillaris*-*Galium saxatile* grassland, Typical sub-community

This sub-community is present within the study area as a few small patches, mainly around the existing wind turbine. It is comprised of soft leaved grasses such as Red Fescue *Festuca rubra*, bent-grasses *Agrostis* spp., and Sweet Vernal-grass and is well-grazed. Tormentil is typically present but usually only a few other forbs and mosses. These small areas were not looked at in any detail.

3.7.2 U4b *Festuca ovina*-*Agrostis capillaris*-*Galium saxatile* grassland, *Holcus lanatus*-*Trifolium repens* sub-community

This is a semi-improved grassland and is the main vegetation of the enclosed fields to the north and east of the public road. It contains most of the species in U4a (see 3.7.1 above), although Tormentil is only occasional, with higher abundances of Yorkshire-fog as well as several very common species indicating less acid conditions such as White Clover *Trifolium repens*, Common Mouse-ear *Cerastium fontanum* and, in particular, Perennial Ryegrass *Lolium perenne*. This is a common community of the upland edges, with no species of particular interest, and was not looked at in any further detail.

Acid grassland similar to U4b is colonising roadside cuttings below the moorland edge and has been mapped as that sub-community. It occurs along much of the slope below the moorland fence down to the level of the road. Again this grassland was not looked at in any detail.

3.7.3 U5 *Nardus stricta*-*Galium saxatile* grassland

Acid grassland with abundant Mat-grass *Nardus stricta* falls within the U5 community. It usually indicates more acid conditions than U4 and may occur over large expanses where sheep grazing has been heavy and prolonged. However, in the study area this community is present only as rather small patches within the wider U6 grassland (see 3.7.5 below), easily picked out by the local dominance of the Mat-grass. Again, most of these small areas were not looked at in detail and no sub-community has been assigned.

² Andrew Upton, personal observation

One strip between rushes at the base of the eastern slope is mossier and richer than the higher stands and was investigated briefly. It contains species not usually associated with this community, such as plentiful Marsh Violet, *Sphagnum denticulatum* and *Sphagnum fimbriatum* as well as several others that are rather scarce within U5 as a whole, including Heath Grass *Danthonia decumbens*, Tufted Hair-grass *Deschampsia cespitosa* and Bog Asphodel. Although clearly U5, given the abundance of Mat-grass, this stand did not fit any of the published sub-communities (Rodwell, 1992); it is likely closest to the damper U5b *Agrostis canina-Polytrichum commune* sub-community and has been marked as such on the vegetation map.

3.7.4 U6a *Juncus squarrosus-Festuca ovina* grassland, *Sphagnum* sub-community

Most of the acid grassland on the moorland area belongs to the U6 *Juncus squarrosus-Festuca ovina* community, with abundant Heath Rush *Juncus squarrosus*.

Towards the bottom of the eastern slopes, particularly where adjacent to rushy M6c vegetation (see 3.5.1 above), there is much *Sphagnum* in this grassland, implying that it is U6a, the *Sphagnum* sub-community. However, these peripheral areas were not looked at in such detail and no attempt was made to define boundaries for this sub-community – the NVC map simply shows all of the U6 as one colour code.

3.7.5 U6d *Juncus squarrosus-Festuca ovina* grassland, *Agrostis capillaris-Luzula multiflora* sub-community

The main areas of U6 grassland on the upper northern and eastern slopes are quite uniform in appearance, with abundant Heath Rush in a short, grassy sward. Although no quadrat samples were taken, notes of the main species present were made in a representative area, which clearly indicated the grassy U6d *Agrostis capillaris-Luzula multiflora* sub-community. Typical associated species present abundantly throughout are Heath Bedstraw *Galium saxatile*, Sweet Vernal-grass, bent-grasses *Agrostis* spp., Tormentil and *Hylocomium splendens*. Wavy Hair-grass, Mat-grass, a woodrush *Luzula* sp. and the moss *Rhytidiadelphus squarrosus* were found more thinly through the sward and are also expected species from this sub-community.

3.8 Maritime vegetation

3.8.1 MC2-related Maritime cliff community

Maritime vegetation is present in a very narrow strip along either side of the Vatsland peninsula at the northern end of the study area. Here there are low rocky cliffs and steep banks down to the sea with more or less scattered plants on ledges and in crevices. The options for such vegetation in the NVC are between a southern community (MC1) and a northern community (MC2) (Rodwell, 2000). MC2 is the *Armeria maritima-Ligusticum scoticum* maritime rock crevice community, characterised by Scots Lovage *Ligusticum scoticum*. The cliff vegetation within the study area is clearly related to MC2, being formed of scattered plant cushions on rocky cliffs, but has no Scots Lovage. On the west side it is more species-poor, comprising just three of the constant/frequent species of the community: Thrift *Armeria maritima*, Red Fescue *Festuca rubra* and Sea Plantain. The taller cliffs on the east side, at the southern extent of the study area there, are richer and additionally hold Sea campion *Silene uniflora*, Sheep'-bit *Jasione montana* and docks including Northern Dock *Rumex longifolia*.

This vegetation is too narrow to be mapped but occurs more or less intermittently along the cliffy sections of both shorelines within the study area.

3.8.2 MC9 *Festuca rubra*-*Holcus lanatus* maritime grassland

Along the western clifftops the grassland has a maritime character, particularly so where it is able to continue down the slopes towards the shore. A simple note was made of the main species here, ranging from the bottom of the slopes where there was little or no grazing to the open transition to semi-improved grassland at the top.

It is clear that this is primarily MC9 *Festuca rubra*-*Holcus lanatus* maritime grassland, with both of these grass species present, plus Spreading Meadow-grass and Tufted Hair-grass. Of these, the meadow-grass is expected in MC9 (preferential for the MC9e *Anthoxanthum odoratum* sub-community) whilst the hair-grass is a regular clifftop species in Orkney³, although not listed in the MC9 tables (Rodwell, 2000).

More specifically maritime species on the west side of Vatsland, as expected in MC9, are Thrift, Sea Plantain, Sea Campion and Bird's-foot Trefoil *Lotus corniculatus*, primarily on the steeper slopes. Others include Ribwort Plantain *Plantago lanceolata* and Wild Thyme *Thymus polytrichus*, which are particularly indicative of the MC9 community as a whole, while Common Dog-violet *Viola riviniana* and Primrose *Primula vulgaris* are preferential for MC9d, the *Primula vulgaris* sub-community. Buck's-horn Plantain *Plantago coronopus*, an Eyebright, Daisy *Bellis perennis* and Devil's-bit Scabious were also noted.

It is likely that more than one sub-community of MC9 is present, but this narrow maritime grassland is indicated on the NVC map as a single unassigned MC9 category along the west shore.

On the east side of the peninsula the cliffs are generally steeper and higher with grazed semi-improved acid grassland extending right to the edge – there may be strips of more maritime grassland in places, but these were not searched for and none are mapped.

3.9 Disturbed vegetation

3.9.1 OV27 *Chamaenerion angustifolium* community

Rosebay Willowherb *Chamaenerion angustifolium* is a species that colonises disturbed or burnt ground and can form dominant stands. In the study area it is present in one place inside the recycling site fence, where the willowherb grows on spoil beside a ditch, with adjacent disturbed acid rush-pasture and grassland over former heath. Although not looked at closely, this is taken to be the OV27a *Holcus lanatus*-*Festuca ovina* sub-community found in grassy and heathy situations on acid soils.

3.9.2 Recolonising peat

A patchily open cover of blanket mire and heath plants, along with various pioneer species is present alongside the hardstanding and track for the existing wind turbine, where peat was re-laid following construction. Bare peat now forms the minority of the area, with a varied mix of Soft Rush, Heath Rush, Hare's-tail Cottongrass, Common Cottongrass, Green-ribbed Sedge, Annual Meadow-grass *Poa annua*, Early Hair-grass *Aira praecox*, Procumbent Pearlwort *Sagina procumbens*, Heath Bedstraw and the moss *Polytrichum juniperum*. At the current stage of colonisation it is not realistic to assign an NVC class, although most of this area seems likely to become a form of blanket mire or rush-mire.

Similar vegetation is present on small stretches of ditch and roadside bank.

³ Andrew Upton, personal observation

3.9.3 Recolonising subsoil

Alongside one track inside the recycling site fence, dumped subsoil is being recolonised in various phases, with a patchy cover of Soft Rush, grasses, thistles, scattered Rosebay Willowherb and thick stands of Coltsfoot *Tussilago farfara*.

3.9.4 Road verges and cuttings

The verges of the public road were variable. In places the vegetation behind the moorland fence continued through it down to the level of the road. Elsewhere cuttings have resulted in colonisation by a form of secondary acid grassland, appearing similar to the semi-improved U4b sub-community (see 3.7.2 above). One small stretch of cutting is a vertical face of stone with patchy vegetation cover including Sheep's-bit, elsewhere found only on the eastern sea-cliffs.

Down at the level of the road, an island of grass at a lay-by beside sheep-pens is a mixture of tall species such as False Oat-grass *Arrhenatherum elatius*, Cocksfoot *Dactylis glomerata*, Reed Canary-grass *Phalaris arundinacea* and Common Couch *Elymus repens*, with tall herbs such as Gound-elder *Aegopodium podagraria* and a Bindweed *Calystegium* species. This clearly disturbed vegetation is limited in extent and, although more neutral and apparently related to MG1 *Arrhenatherum elatius* grassland, it is included within the general U4b colour code on the NVC map.

More interestingly, there are stretches of level gravelly ground adjacent to the carriageway which hold an open, low vegetation of a calcareous nature with similarities to some southern limestone grasslands. This was not investigated in detail, but holds patches of Autumn Gentian *Gentianella amarella* subsp. *septentrionalis*, Wild Thyme, Sea Plantain and an eyebright species. In Phase 1 terms this would be coded as 'J1.3', 'short perennial' vegetation, typically found on free-draining and shallow, stony soil. It is too narrow to show on the vegetation map.

3.10 Rare, scarce and declining species

No nationally rare or nationally scarce plant species at a GB level were identified from this survey work.

There is one subspecies listed on the most recent (2005) vascular plant Red List for Great Britain (Cheffings and Farrell, 2005) as other than of 'Least Concern' this is:

- Autumn Gentian *Gentianella amarella* subsp. *septentrionalis* classed as 'Near Threatened' having declined by 20% or more between the two date classes 1930-69 and 1987-1999 (i.e. it does not qualify for 'Critically Endangered', 'Endangered' or 'Vulnerable' now, but is close to qualifying for, or is likely to qualify for one of these threatened categories in the near future).

This Autumn Gentian subspecies is endemic to Britain and the UK therefore has an international responsibility to ensure its conservation.

Within the study area it occurs on gravelly verges of the public road rather than in pristine semi-natural habitats.

4 Evaluation

4.1 Reference lists

The NVC vegetation types at Luggie’s Knowe fall within broader habitats that have been recognised as important at different regional scales – European, UK and Scottish – and have been listed in various biodiversity documents produced by different bodies. These listings are:

- Annex I of the EC Habitats Directive (European Council, 1992) – as habitat types of ‘Community Interest’ requiring the designation of special areas;
- the UK Biodiversity Action Plan, UKBAP (JNCC, 2019) – as ‘priority’ habitats, and
- the Scottish Biodiversity List, SBL (NatureScot, 2020) – including those placed on a ‘watching brief’.

The definitions within each list are not identical and JNCC have drawn up a spreadsheet of ‘correspondences’ including how they relate to the NVC classes (JNCC, 2008). The listed habitats are nested within this hierarchy so that Annex I habitats are also important at each of the more local levels.

There is no current version of a Shetland Local Biodiversity Action Plan and the original version is no longer available on the Shetland Islands Council website. A number of specific Biodiversity Action Plan Documents are still extant (Shetland Islands Council, undated), but these do not relate to any of the habitats found within the study area.

4.2 Evaluation

Table 3 below shows the listed habitat types that occur within the study area, with the relevant NVC communities indicated. It should be noted that various acid grasslands and disturbed or recent habitats are not regarded as important or priority at any of these levels.

It is uncertain what type(s) of vegetation will result from the recolonisation of the bare peat around the existing turbine infrastructure, which is currently being led by rushes and cottongrasses with few shrubs or mosses; it has not been included in the table below.

Table 3. *Vegetation types at Luggie’s Knowe which are included in legislative and biodiversity lists.*

NVC and non-NVC communities	Habitats Directive Annex I	UKBAP Priority list	Scottish Biodiversity List
M2, M3, M15b, M18-related, M19a, M19b, M29	Blanket Bog (‘active’ – a priority habitat)	Blanket Bog	Blanket Bog
M15a	Northern Atlantic wet heaths with <i>Erica tetralix</i>	Upland heathland	Upland heathland
H12a, H12c	European dry heaths	Upland heathland	Upland heathland
MC2-related, MC9	Vegetated sea-cliffs of the Atlantic and Baltic coasts	Maritime cliff & slopes	Maritime cliff & slopes
M6c, M6, ‘MCx’, M28	-	Upland flushes, fens and swamps	Upland flushes, fens and swamps
U6a, U6d	-	-	U6 Acid Grassland
U5	-	-	U5 Acid Grassland

Some notes may be made on the biodiversity listing categories in **Table 3** as follows:

- The M29 is here included within the broader blanket bog within which it is set, rather than the UKBAP and SBL 'Upland flushes, fens and swamps' that the UKBAP description suggests.
- Both U5 and U6 acid grassland are included in the Scottish Biodiversity List under the heading 'watching brief only' i.e. they are of 'less concern' (NatureScot, 2020).

The various listings in **Table 3** give an accepted judgement on the biodiversity value of each habitat, as a whole. This does not necessarily translate to a habitat's importance or value at the site level – for instance blanket bog is classed as a European Priority Habitat under the Habitats Directive, implying that it is important at the European level, but every individual stand is not treated as internationally important in ecological impact assessment. However, these habitats and their constituent vegetation types may be considered as priorities for biodiversity conservation at the level of the legislation or plan in which they feature. The wordings of the UKBAP objectives clearly imply that a no-net-loss scenario is a prime target for each UKBAP habitat, and they are therefore high conservation priorities wherever they occur. The majority of these habitats are in favourable condition within the Luggie's Knowe survey area.

Drawing 3, Appendix 2 shows the study area vegetation by its relative value within the above listings.

4.3 Groundwater dependent terrestrial ecosystems (GWDTE)

Since the implementation of the EU Water Framework Directive (WFD), SEPA has drawn attention to the requirement to consider habitats that are dependent on groundwater within impact assessments. Such habitats are termed 'groundwater dependent terrestrial ecosystems' (GWDTE) and a list of the relevant NVC communities considered likely to be highly or moderately groundwater dependent has been compiled by SEPA (SEPA, 2017). The occurrence of these communities is detailed in **Table 4** along with information regarding their setting at the study area which indicates the extent to which they occur in situations indicative of potential groundwater dependence.

Drawing 4, Appendix 2 shows the location of potentially groundwater dependent vegetation, based on the NVC classes and SEPA's NVC table.

In line with the large-scale approach taken by the Water Framework Directive, groundwater is here taken as the body of water (aquifer) in the underlying rock i.e. it does not include shallow subsurface water in the soil which is separated from the rock aquifer by impermeable soil or subsoil layers.

The clearest evidence of groundwater is where flushed vegetation on the slopes shows neutral or calcareous traits, whilst being surrounded by acidic vegetation types. It is assumed that the water feeding these areas has been in contact with the underlying rock and is therefore at least partially groundwater dependent.

Where there are wet acidic habitats set within the mire and heath, it is most likely that the water feeding them emanates from the wet peat body itself, rather than groundwater. This applies to most of the NVC communities classed as potentially groundwater dependent by SEPA, as noted in the final column of **Table 4**.

Table 4. Occurrence of SEPA-defined NVC communities likely to be highly or moderately groundwater dependent (depending on the hydrogeological setting). The two highlighted rows indicate likely groundwater dependent vegetation.

NVC community	NVC Community Name (per SEPA's table)	Per SEPA as likely to be highly or moderately groundwater dependent	Occurrence of habitat at the Luggie's Knowe site in the context of the hydrogeological setting
M6, no sub-community assigned	<i>Carex echinata</i> - <i>Sphagnum recurvum</i> mire	Highly	These flushes are set within blanket mire, receiving acidic water at the top of the slope where its source is most likely to be from the blanket peat rather than from groundwater.
M6c, <i>Juncus effusus</i> sub-community	<i>Carex echinata</i> - <i>Sphagnum recurvum</i> mire	Highly	Set within dry heath and grassland on the lower slopes, or at their base; most likely to be receiving acidic water from run-off and through the adjacent peat rather than from groundwater.
'MCx', non-NVC neutral small-sedge mire	(not on SEPA's table, but treated as M6)	Highly	One flush emerging mid-way down the northwest slope where it is surrounded by acidic vegetation; its neutral status implies that at least part of its water source is from the underlying rock, offsetting the surface acidity.
M15a, <i>Carex panicea</i> sub-community	<i>Scirpus cespitosus</i> – <i>Erica tetralix</i> wet heath	Moderately	The flushed heath area on the western slope is set within blanket mire, receiving acidic water at the top of the slope where its source is most likely to be from the blanket peat.
M15a, <i>Carex panicea</i> sub-community	<i>Scirpus cespitosus</i> – <i>Erica tetralix</i> wet heath	Moderately	The flushed heath area at the bottom of the eastern slope contains several species indicative of calcareous influence. It is surrounded by acidic vegetation, implying that at least part of its water source is from the underlying rock, offsetting the surface acidity.
M15b, Typical sub-community	<i>Scirpus cespitosus</i> – <i>Erica tetralix</i> wet heath	Moderately	Three small areas set within the blanket mire and perched on raised peat hummocks around pools and runnels; clearly not connected to the groundwater in these locations.
M23b, <i>Juncus effusus</i> sub-community	<i>Juncus effusus/acutiflorus</i> - <i>Galium palustre</i> rush-pasture	Highly	One area along old, dry ditches in semi-improved grassland to the north of the public road. Unlikely to be connected to groundwater here.
'UJe' non-NVC rushes over acid grassland	(not on SEPA's table, but treated as MG10)	Moderately	'UJe' occurs in sheep-disturbed areas within acid grassland and where groundworks have taken place in the neighbouring working sites; these are all locations not connected to groundwater.
M28, no sub-community assigned	<i>Iris Pseudacorus</i> - <i>Filipendula ulmaria</i> mire	Moderately	One stand alongside the lower Burn of Kebister; most likely kept damp due to surface run-off from the slopes on either side as well as the influence of the burn.
M29	<i>Hypericum elodes</i> - <i>Potamogeton polygonifolius</i> soakway	Highly	Occurs in two soakways set within blanket mire and associated runnels; the water source is clearly from the mire peat rather than groundwater.

NVC community	NVC Community Name (per SEPA's table)	Per SEPA as likely to be highly or moderately groundwater dependent	Occurrence of habitat at the Luggie's Knowe site in the context of the hydrogeological setting
U6a, <i>Sphagnum</i> sub-community	<i>Juncus squarrosus</i> - <i>Festuca ovina</i> grassland	Moderately	Found adjacent to rush patches on the lower slopes, particularly M6c (see above); most likely to be receiving acidic water from run-off and through the adjacent peat rather than from the ground.
U6d, <i>Agrostis capillaris</i> - <i>Luzula multiflora</i> sub-community	<i>Juncus squarrosus</i> - <i>Festuca ovina</i> grassland	Moderately	Found extensively on the tops of ridges and on the steeper eastern slopes – locations that would not be connected to groundwater; this is not particularly damp vegetation.

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Appendix 1 – Vegetation Tables and Species Lists

Tables A – E NVC Tables

Tables F & G Species Lists

***Cover score:**

1	<4% cover, few individual plants	6	26 – 33% cover
2	<4% cover, several individuals	7	34 – 49% cover
3	<4% cover, many individuals	8	50 – 75% cover
4	5 – 10% cover	9	76 – 90% cover
5	11 – 25% cover	10	91 – 100% cover

Frequency values:

V	81 – 100% of samples	II	21 - 40% of samples
IV	61 – 80% of samples	I	1 – 20% of samples
III	41 – 60% of samples		

TABLE A.

Bog pools: M2 bog pool community and related
Pool numbers 1 – 20 marked on NVC map, from north to south

	Approximate cover scores: D – dominant; A = abundant; f = frequent; o = occasional																				Frequency & cover range
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
<i>Sphagnum cuspidatum</i>	D	D		D		f	D	f	A	A	D	D	D	D	D	D	D	D	D	D	V (f-D)
<i>Juncus bulbosus</i>	D			D		D	A	f	f	A	A	A		A	A	o		f	A	A	IV (o-D)
<i>Eriophorum angustifolium</i>	f	f			f	o	f				o	f	o	o		f	f	A	f		IV (o-A)
<i>Carex nigra</i>	A											f	A		f		f		A	A	II (f-A)
<i>Sphagnum denticulatum</i>					o		o	f	o	o				f	A	o					II (o-A)
<i>Sphagnum papillosum</i>	o												o			o		f			I (o-f)
<i>Sphagnum capillifolium</i>		f														o		f			I (o-f)
<i>Drosera rotundifolia</i>	o															o			o		I (o)
<i>Anthoxanthum odoratum</i>	o																	o	o		I (o)
<i>Warnstorffia fluitans</i>														A						o	I (o-A)
<i>Eriophorum vaginatum</i>														f		f					I (f)
<i>Juncus articulatus</i>			o	A											o						I (o-A)
<i>Agrostis canina</i>	o																	o			I (o)
<i>Sphagnum palustre</i>										o											I (o)
<i>Polytrichum commune</i>																		o			I (o)
<i>Erica tetralix</i>																o					I (o)
<i>Juncus squarrosus</i>																		o			I (o)
<i>Carex panicea</i>					A																I (A)
<i>Holcus lanatus</i>																			o		I (o)
<i>Ranunculus flammula</i>															o						I (o)
<i>Potamogeton polygonifolius</i>															o						I (o)
<i>Potentilla erecta</i>																		o			I (o)
<i>Pinguicula vulgaris</i>																			o		I (o)
<i>Callitriche stagnalis</i>															f						I (f)

TABLE B – M18-related wet mire at Luggie’s Knowe

Wetter depressions in blanket mire: M18-related wet mire					
Quad	Date	GPS ref	Elev.	Gradient	Comment
A	15/08/21	HU 46087 / 44442	104m	<10° NE	Set within M19a
B	15/08/21	HU 45908 / 44669	95m	+/- level	Flat area between pools
C	15/08/21	HU 45943 / 44737	95m	+/- level	Middle of a larger depression
D	16/08/21	HU 46424 / 45517	50m	10° NW	
E	16/08/21	HU 46106 / 45204	68m	+/- level	More <i>E. vaginatum</i> at edge of depression

	Species	M18-related cover score by quadrat (see p 1)					M18-related frequency & cover range
		A	B	C	D	E	
Constant in Luggies M18-related	<i>Calluna vulgaris</i>	7	6	6	6	5	V (5-7)
	<i>Empetrum nigrum</i>	3	8	7	7	6	V (3-8)
	<i>Erica tetralix</i>	2	2	1	1	3	V (1-3)
	<i>Eriophorum angustifolium</i>	9	8	5	8	8	V (5-9)
	<i>Sphagnum papillosum</i>	4	1	-	5	6	IV (1-6)
	<i>Sphagnum capillifolium</i>	6	4	4	4	4	V (4-6)
	<i>Drosera rotundifolia</i>	3	1	1	3	3	V (1-3)
	<i>Aulacomnium palustre</i>	2	1	-	2	3	IV (1-3)
	<i>Mnium hornum</i>	2	1	1	2	2	V (1-2)
	<i>Plagiothecium undulatum</i>	2	4	1	1	-	IV (1-4)
Freq in M18-related	<i>Sphagnum denticulatum</i>	-	-	1	3	3	III (1-3)
	<i>Sphagnum fallax</i>	-	-	4	2	2	III (2-4)
	<i>Rhytidiadelphus loreus</i>	3	3	-	3	-	III (3)
Occasional in M18-related	<i>Eriophorum vaginatum</i>	-	-	7	-	2	II (2-7)
	<i>Sphagnum magellanicum</i>	-	3	4	-	-	II (3-4)
	<i>Luzula multiflora</i>	1	2	-	-	-	II (1-2)
	<i>Holcus lanatus</i>	-	1	1	-	-	II (1)
	<i>Neottia cordata</i>	3	-	1	-	-	II (1-3)
	<i>Hylocomium splendens</i>	2	-	-	1	-	II (1-2)
Scarce in M18-related	<i>Juncus squarrosus</i>	-	-	-	4	-	I (4)
	<i>Anthoxanthum odoratum</i>	-	-	1	-	-	I (1)
	<i>Potentilla erecta</i>	-	-	-	4	-	I (4)
	<i>Dicranum scoparium</i>	-	-	-	2	-	I (2)
	<i>Racomitrium lanuginosum</i>	-	-	-	1	-	I (1)
	<i>Hypnum jutlandicum</i>	-	-	-	1	-	I (1)

TABLE D – M19b at Luggie’s Knowe

Extensive tussocky blanket mire: M19b <i>Calluna vulgaris</i>-<i>Eriophorum vaginatum</i> blanket mire, <i>Empetrum nigrum nigrum</i> sub-community					
Quad	Date	GPS ref	Elev.	Gradient	Comment
A	15/08/21	HU 46102 / 44338	92m	10° E	Not very tussocky
B	15/08/21	HU 46001 / 44581	113m	<10° SW	Not very tussocky
C	15/08/21	HU 46036 / 44800	104m	<10° NW	Not very tussocky
D	16/08/21	HU 46112 / 45376	62m	+/- level	Tussocky
E	16/08/21	HU 46212 / 45198	90m	<10° W	Not very tussocky

	Species	M19b cover score by quadrat (see p 1)					M19b frequency & cover range
		A	B	C	D	E	
Constant in Luggies M19b	<i>Calluna vulgaris</i>	9	9	9	9	9	V (9)
	<i>Eriophorum vaginatum</i>	5	6	6	2	8	V (2-8)
	<i>Empetrum nigrum</i>	2	3	3	-	4	IV (2-4)
	<i>Eriophorum angustifolium</i>	3	5	3	3	1	V (1-5)
	<i>Luzula multiflora</i>	3	3	3	3	2	V (2-3)
	<i>Deschampsia flexuosa</i>	4	1	1	3	1	V (1-4)
	<i>Anthoxanthum odoratum</i>	3	2	3	4	-	IV (2-4)
	<i>Rhynchospora alba</i>	4	3	1	4	3	V (1-4)
	<i>Hypnum jutlandicum</i>	2	1	1	3	1	V (1-3)
	<i>Hylocomium splendens</i>	8	4	6	6	4	V (4-8)
Frequent in M19b	<i>Plagiothecium undulatum</i>	-	2	-	2	1	III (1-2)
	<i>Kindbergia praelonga</i>	1	1	-	-	3	III (1-3)
Occasional in M19b	<i>Sphagnum capillifolium</i>	-	4	1	-	-	II (1-4)
	<i>Neottia cordata</i>	-	2	-	1	-	II (1-2)
	<i>Pleurozium schreberi</i>	2	1	-	-	-	II (1-2)
	<i>Rhynchospora alba</i>	-	-	-	2	2	II (2)
Scarce in 19b	<i>Vaccinium myrtillus</i>	-	-	3	-	-	I (3)
	<i>Erica tetralix</i>	-	1	-	-	-	I (1)
	<i>Juncus squarrosus</i>	-	-	1	-	-	I (1)
	<i>Carex nigra</i>	-	-	-	4	-	I (4)
	<i>Sphagnum papillosum</i>	-	1	-	-	-	I (1)
	<i>Potentilla erecta</i>	-	-	-	2	-	I (2)
	<i>Dicranum scoparium</i>	-	1	-	-	-	I (1)
	<i>Mnium hornum</i>	-	-	-	2	-	I (2)
<i>Cladonia portentosa</i>	-	1	-	-	-	I (1)	

TABLE E – H12a at Luggie’s Knowe

Dry heath:					
H12a <i>Calluna vulgaris</i>-<i>Vaccinium myrtillus</i> heath, <i>Calluna vulgaris</i> sub-community					
Quad	Date	GPS ref	Elev.	Gradient	Comment
A	15/08/21	HU 46123 / 44389	99m	20-30° E	
B	15/08/21	HU 46061 / 44546	110m	30° E	A patchy, more grassy edge
C	16/08/21	HU 46299 / 45253	82m	30° NW	
D	16/08/21	HU 46368 / 45539	54m	20-30° E	
E	06/08/21	HU 46177 / 45199	76m	30° W	

	Species	H12a cover score by quadrat (see p 1)					H12a frequency & cover range
		A	B	C	D	E	
Constant in Luggies H12a	<i>Calluna vulgaris</i>	10	9	9	10	10	V (9-10)
	<i>Deschampsia flexuosa</i>	4	2	1	2	4	V (1-4)
	<i>Hylocomium splendens</i>	7	3	8	7	6	V (3-8)
	<i>Potentilla erecta</i>	1	3	2	-	3	IV (1-34)
	<i>Carex nigra</i>	4	3	2	1	-	V (1-4)
	<i>Luzula multiflora</i>	-	3	2	1	2	IV (1-3)
	<i>Anthoxanthum odoratum</i>	-	3	3	2	1	V (2-3)
	<i>Rhynchospora loreus</i>	-	2	3	1	4	V (3-8)
	<i>Rhynchospora squarrosus</i>	3	1	1	-	1	IV (1-3)
Freq in H12a	<i>Agrostis canina</i>	2	-	2	-	3	III (2-3)
	<i>Rumex acetosa</i>	-	2	1	1	-	III (1-2)
	<i>Hypnum jutlandicum</i>	-	-	1	1	3	III (1-3)
Occasional in H12a	<i>Empetrum nigrum</i>	-	1	2	-	-	II (1-2)
	<i>Polytrichum sp.</i>	-	1	1	-	-	II (1)
	<i>Kindbergia praelonga</i>	-	-	-	1	3	II (1-3)
Scarce in H12a	<i>Vaccinium myrtillus</i>	-	-	2	-	-	I (2)
	<i>Eriophorum angustifolium</i>	-	-	-	2	-	I (2)
	<i>Galium saxatile</i>	-	3	-	-	-	I (3)
	<i>Cerastium fontanum</i>	-	2	-	-	-	I (2)
	<i>Rhynchospora triquetrus</i>	-	-	1	-	-	I (1)
	<i>Pleurozium schreberi</i>	-	-	1	-	-	I (1)

TABLE F – Luggie’s Knowe Vascular Plant Species

Scientific name	English name
<i>Aegopodium podagraria</i>	Ground-elder
<i>Agrostis canina</i> agg.	Velvet Bent
<i>Agrostis capillaris</i>	Common Bent
<i>Agrostis stolonifera</i>	Creeping Bent
<i>Aira praecox</i>	Early Hair-grass
<i>Angelica sylvestris</i>	Wild Angelica
<i>Anthoxanthum odoratum</i>	Sweet Vernal-grass
<i>Armeria maritima</i>	Thrift
<i>Arrhenatherum elatius</i>	False Oat-grass
<i>Bellis perennis</i>	Daisy
<i>Blechnum spicant</i>	Hard Fern
<i>Callitriche stagnalis</i>	Common Water-starwort
<i>Calluna vulgaris</i>	Heather
<i>Carex binervis</i>	Green-ribbed Sedge
<i>Carex demissa</i>	Common Yellow Sedge
<i>Carex dioica</i>	Dioecious Sedge
<i>Carex echinata</i>	Star Sedge
<i>Carex nigra</i>	Common Sedge
<i>Carex panicea</i>	Carnation Sedge
<i>Carex pulicaris</i>	Flea Sedge
<i>Cerastium fontanum</i>	Common Mouse-ear
<i>Chamaenerion angustifolium</i>	Rosebay Willowherb
<i>Cirsium palustre</i>	Marsh Thistle
<i>Cirsium vulgare</i>	Spear Thistle
<i>Cynosurus cristatus</i>	Crested Dog's-tail
<i>Dactylis glomerata</i>	Cocksfoot
<i>Danthonia decumbens</i>	Heath Grass
<i>Deschampsia cespitosa</i>	Tufted Hair-grass
<i>Deschampsia flexuosa</i>	Wavy Hair-grass
<i>Drosera rotundifolia</i>	Round-leaved Sundew
<i>Dryopteris dilatata</i>	Broad Buckler Fern
<i>Elymus repens</i>	Common Couch
<i>Empetrum nigrum</i>	Crowberry
<i>Epilobium brunnescens</i>	New Zealand Willowherb
<i>Epilobium palustre</i>	Marsh Willowherb
<i>Equisetum arvense</i>	Field Horsetail
<i>Equisetum fluitans</i>	Water Horsetail
<i>Erica cinerea</i>	Bell Heather
<i>Erica tetralix</i>	Cross-leaved Heath
<i>Eriophorum angustifolium</i>	Common Cottongrass
<i>Eriophorum vaginatum</i>	Hare's-tail Cottongrass

Scientific name	English name
<i>Euphrasia officinalis</i> agg.	Eyebright
<i>Festuca rubra</i>	Red Fescue
<i>Festuca vivipara</i>	Viviparous Fescue
<i>Galium saxatile</i>	Heath Bedstraw
<i>Gentianella amarella</i> subsp. <i>septentrionalis</i>	Autumn Gentian
<i>Holcus lanatus</i>	Yorkshire-fog
<i>Hypochaeris radicata</i>	Cat's-ear
<i>Iris pseudacorus</i>	Yellow Iris
<i>Jacobaea jacobaea</i>	Ragwort
<i>Jasione montana</i>	Sheep's-bit
<i>Juncus articulatus</i>	Jointed Rush
<i>Juncus bulbosus</i>	Bulbous Rush
<i>Juncus conglomeratus</i>	Compact Rush
<i>Juncus effusus</i>	Soft Rush
<i>Juncus squarrosus</i>	Heath Rush
<i>Lolium perenne</i>	Perennial Ryegrass
<i>Lotus corniculatus</i>	Bird's-foot Trefoil
<i>Luzula campestris</i>	Field Woodrush
<i>Luzula multiflora</i>	Heath Woodrush
<i>Luzula sylvatica</i>	Great Woodrush
<i>Molinia caerulea</i>	Purple Moor-grass
<i>Montia fontana</i>	Blinks
<i>Myosotis discolor</i>	Changing Forget-me-not
<i>Nardus stricta</i>	Mat-grass
<i>Narthecium ossifragum</i>	Bog Asphodel
<i>Neottia cordata</i>	Lesser Twayblade
<i>Phalaris arundinacea</i>	Reed Canary-grass
<i>Pinguicula vulgaris</i>	Common Butterwort
<i>Plantago coronopus</i>	Buck's-horn Plantain
<i>Plantago lanceolata</i>	Ribwort Plantain
<i>Plantago maritima</i>	Sea Plantain
<i>Poa annua</i>	Annual Meadow-grass
<i>Poa humilis</i>	Spreading Meadow-grass
<i>Poa trivialis</i>	Rough Meadow-grass
<i>Polygala serpyllifolia</i>	Heath Milkwort
<i>Potamogeton polygonifolius</i>	Bog Pondweed
<i>Potentilla erecta</i>	Tormentil
<i>Primula vulgaris</i>	Primrose
<i>Ranunculus acris</i>	Meadow Buttercup
<i>Ranunculus flammula</i>	Lesser Spearwort
<i>Ranunculus repens</i>	Creeping Buttercup
<i>Rumex acetosa</i>	Common Sorrel
<i>Rumex acetosella</i>	Sheep's Sorrel

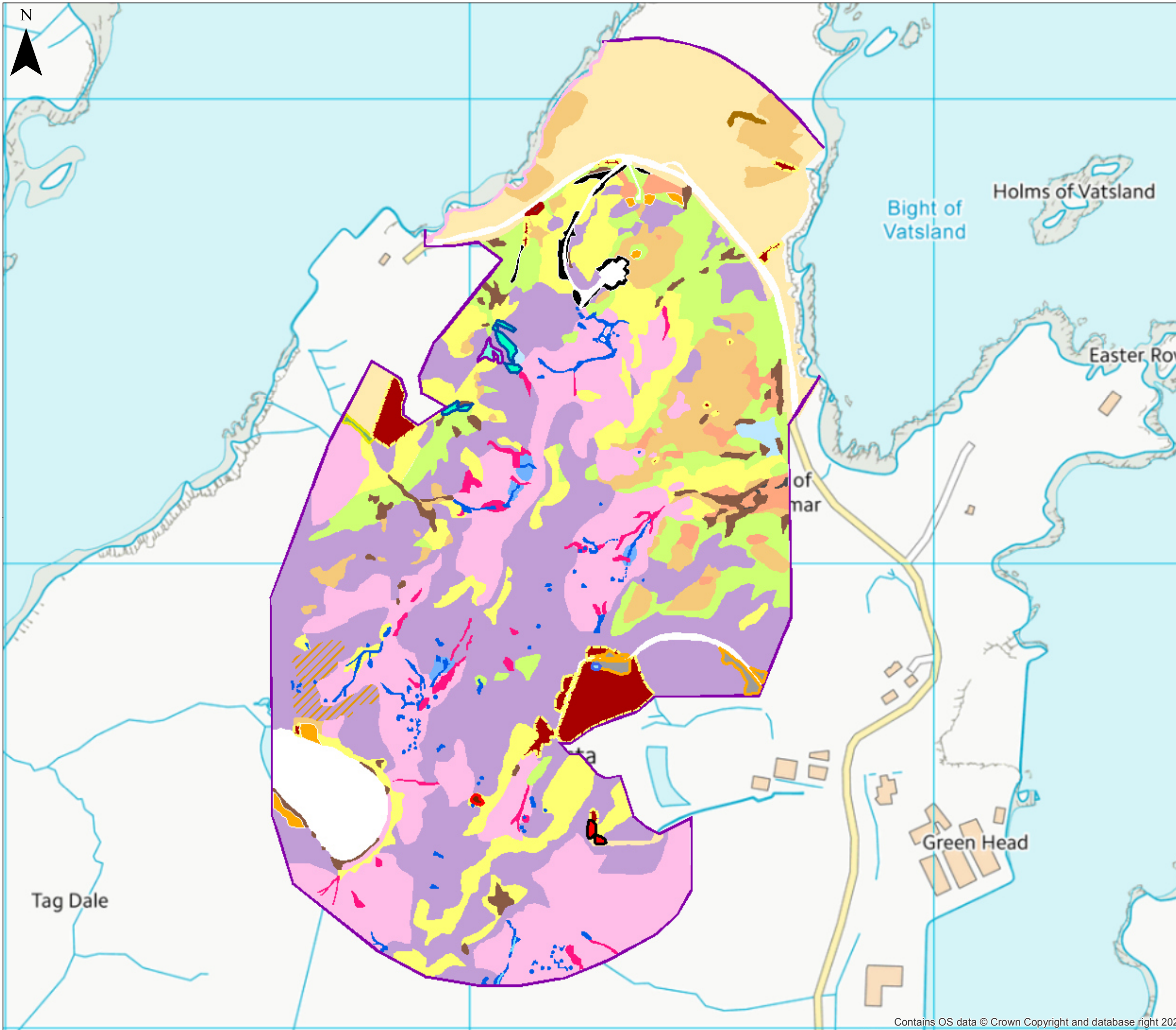
Scientific name	English name
<i>Rumex longifolius</i>	Northern Dock
<i>Rumex obtusifolius</i>	Broad-leaved Dock
<i>Sagina procumbens</i>	Procumbent Pearlwort
<i>Scorzoneroides autumnalis</i>	Autumn Hawkbit
<i>Selaginella selaginoides</i>	Lesser Clubmoss
<i>Silene uniflora</i>	Sea Campion
<i>Stellaria alsine</i>	Bog Stitchwort
<i>Stellaria media</i>	Chickweed
<i>Succisa pratensis</i>	Devil's-bit Scabious
<i>Thalictrum alpinum</i>	Alpine Meadow-rue
<i>Thymus polytrichus</i>	Wild Thyme
<i>Trichophorum germanicum</i>	Common Deergrass
<i>Trifolium pratense</i>	Red Clover
<i>Trifolium repens</i>	White Clover
<i>Tussilago farfara</i>	Coltsfoot
<i>Urtica dioica</i>	Stinging Nettle
<i>Vaccinium myrtillus</i>	Bilberry
<i>Viola palustris</i>	Marsh Violet
<i>Viola riviniana</i>	Common Dog-violet

TABLE G – Luggie’s Knowe Lower Plant Species

Bryophytes
<i>Aulacomnium palustre</i>
<i>Dicranum majus</i>
<i>Dicranum scoparium</i>
<i>Hylocomium splendens</i>
<i>Hypnum jutlandicum</i>
<i>Kindbergia praelonga</i>
<i>Mnium hornum</i>
<i>Plagiothecium undulatum</i>
<i>Pleurozium schreberi</i>
<i>Polytrichum commune</i>
<i>Polytrichum juniperum</i>
<i>Racomitrium lanuginosum</i>
<i>Rhytidiadelphus loreus</i>
<i>Rhytidiadelphus squarrosus</i>
<i>Rhytidiadelphus triquetrus</i>
<i>Sphagnum capillifolium</i>
<i>Sphagnum cuspidatum</i>
<i>Sphagnum denticulatum</i>
<i>Sphagnum fallax</i>
<i>Sphagnum fimbriatum</i>
<i>Sphagnum magellanicum</i>
<i>Sphagnum palustre</i>
<i>Sphagnum papillosum</i>
<i>Sphagnum subnitens</i>
<i>Warnstorffia fluitans</i>
Lichens
<i>Cladonia arbuscula</i>
<i>Cladonia portentosa</i>
<i>Cladonia uncialis</i>
<i>Peltigera</i> sp.

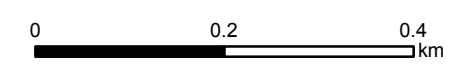
Appendix 2 – Drawings 1 to 4

Drawing 1 – NVC Survey Results



KEY

	M2 bog pools & related pools & runnels
	M3 bog pool
	M6 acid sedge flush
	M6c soft rush mire
	MCx neutral sedge mire
	M15a flushed wet heath
	M15b 'Typical' wet heath
	M18 related wet mire channels and depressions
	M19a blanket mire
	M19b blanket mire
	M19b blanket mire with acid grasses
	M23b Soft Rush rush-pasture
	M28 iris stand
	M29 Bog Pondweed runnel
	H12a dry heath
	H12c grassy dry heath
	U4a Fescue-Agrostis acid grassland
	U4b semi-improved Fescue-Agrostis acid grassland
	U5 Mat-grass acid grassland
	U5b related damp Mat-grass acid grassland
	U6 heath rush acid grassland
	MC9 Fescue-Yorkshire fog maritime grassland
	OV27a Rosebay Willowherb stand
	Recolonising peat,
	Recolonising subsoil,
	U1e soft rush over acid grassland
	Exposed rock cutting,
	Artificial pond,
	Survey boundary,



Scale 1:8,000 @ A3



Luggie's Knowe
NVC Report

Drawing 1

NVC Map

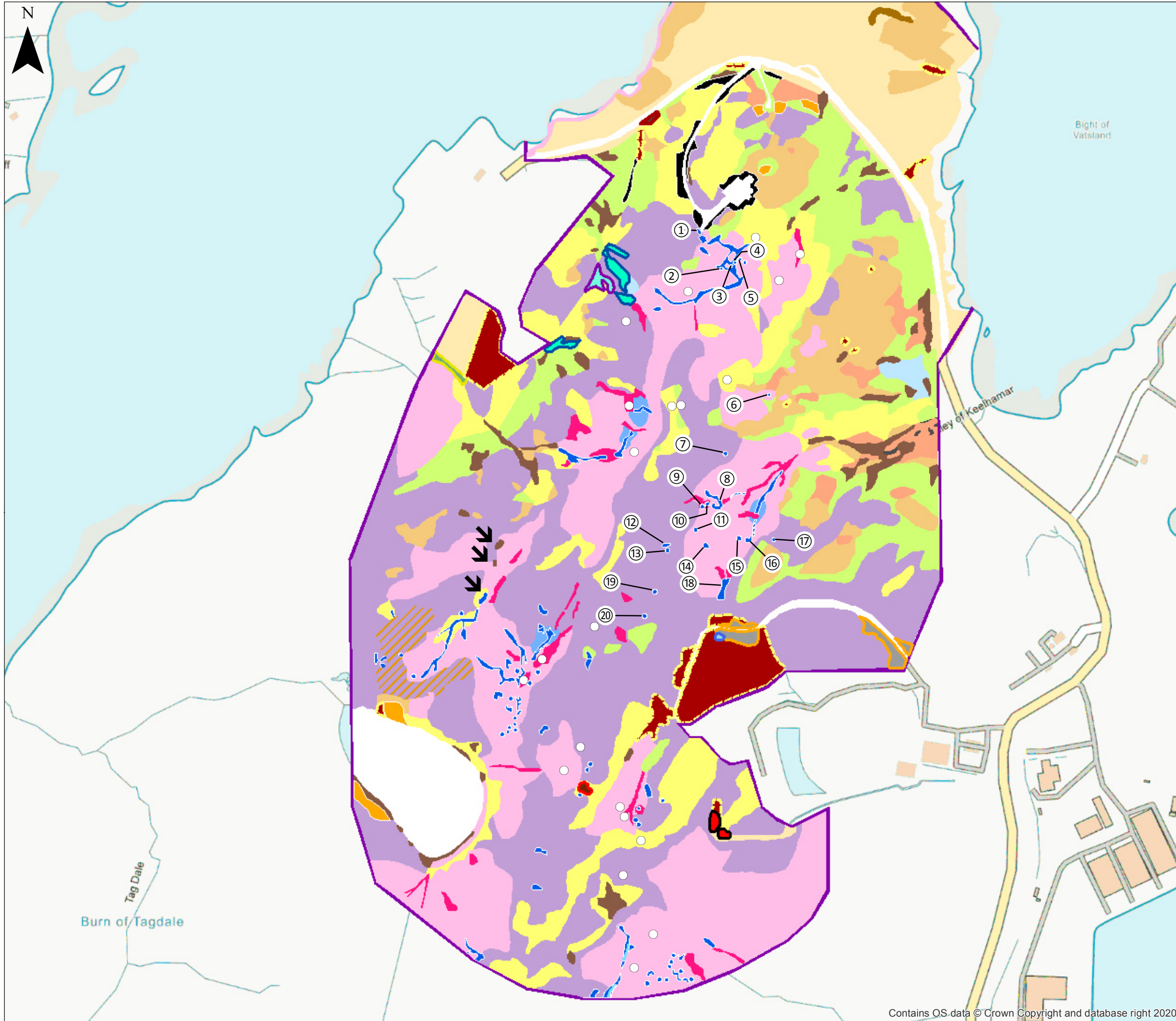
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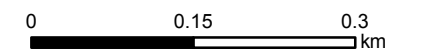
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Drawing 2 – Quadrat Sample Locations and Sinkholes



KEY

- ① Sampled bog pool (with arrow)
- Quadrat sample location
- ↘ Location of sink-hole in peat



Scale 1:7,000 @ A3



Luggie's Knowe
NVC Report

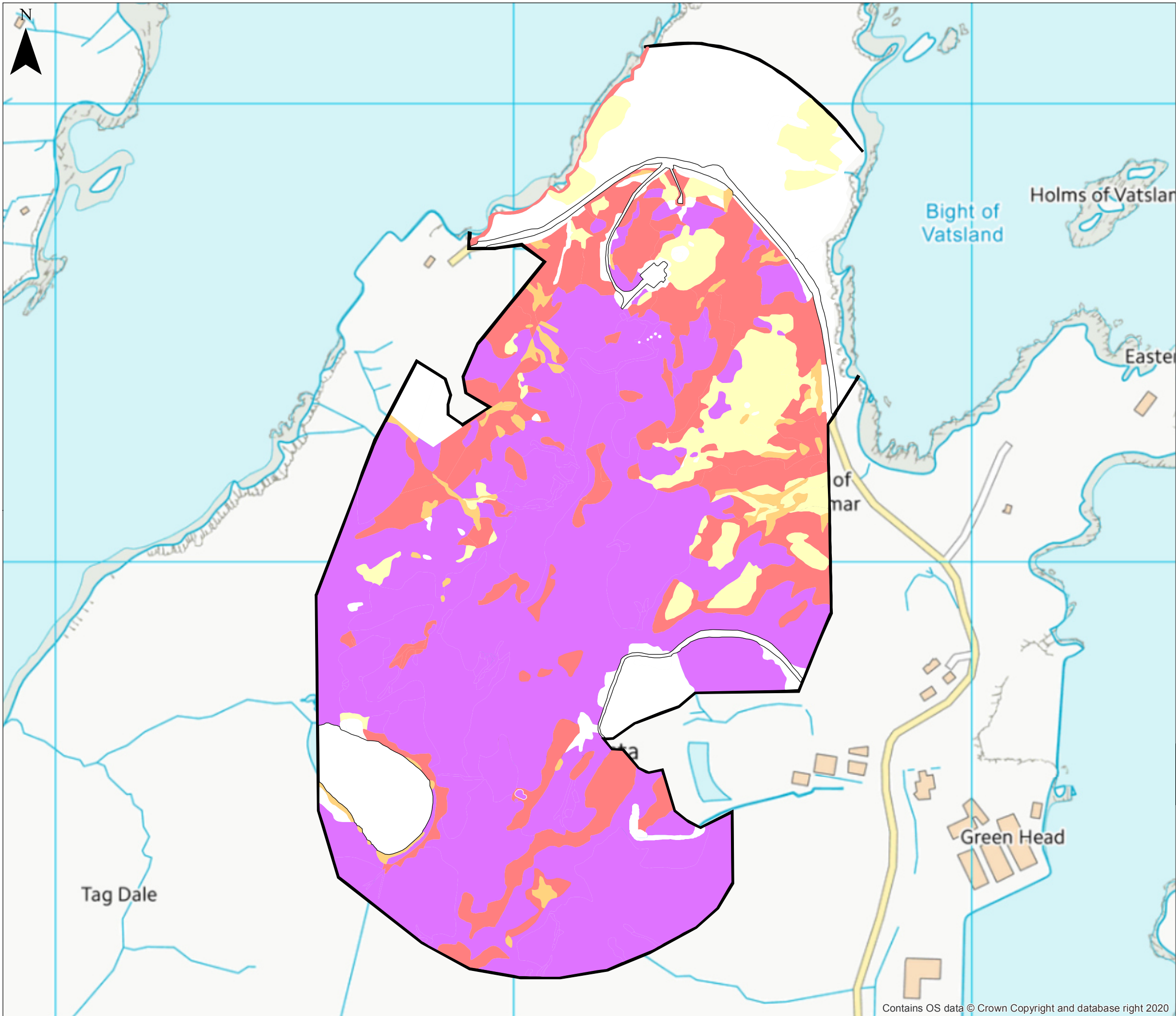
Drawing 2

Sampling Locations and Sink-holes

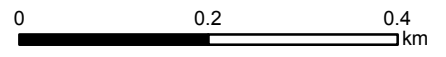
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Drawing 3 – NVC Vegetation Valuation



- KEY**
- EU Annex 1 habitat
 - EU Annex 1 priority habitat
 - SBL watching brief habitat
 - UK BAP/SBL priority habitat



Scale 1:8,000 @ A3



Luggie's Knowe
NVC Report

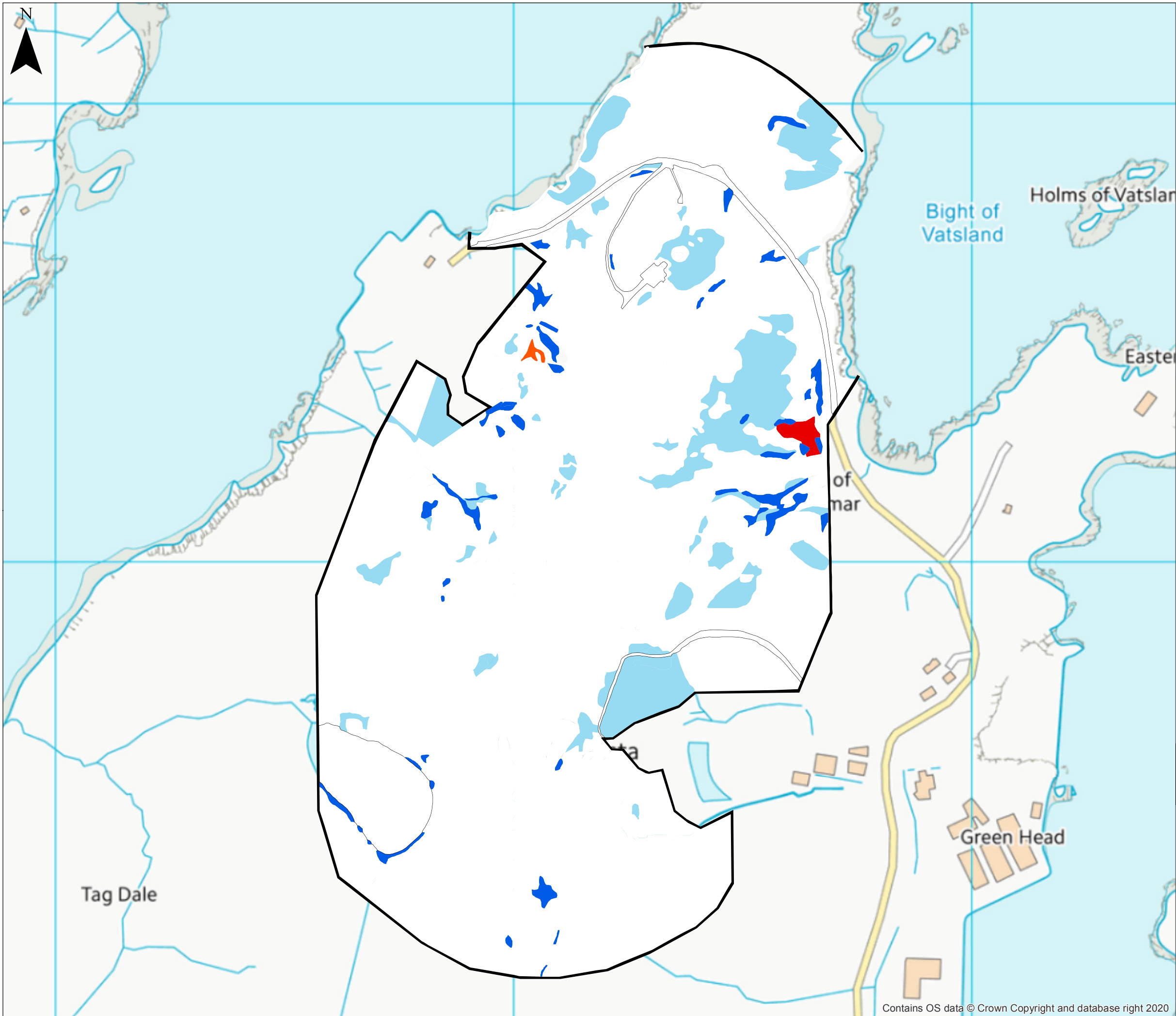
Drawing 3

NVC Vegetation valuation

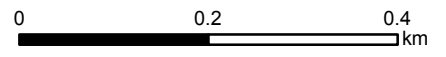
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Project Number: 3515

Drawing 4 – Groundwater Dependant Terrestrial Ecosystem's (GWDTE).



- KEY**
- SEPA 'highly' likely, but not connected here
 - SEPA 'moderately' likely, but not connected here
 - SEPA 'highly' likely and connected here
 - SEPA 'moderately' likely and connected here



Scale 1:8,000 @ A3



Luggie's Knowe
NVC Report
Drawing 4
GWDE map