Viking Energy Partnership

Viking Wind Farm

Technical Appendix 14.3
Stream Crossing Guidance

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1 INTRODUCTION

This report forms a Technical Appendix to Chapter 14 (Soil and Water) of the Environmental Statement for Viking Wind Farm (Mouchel, 2009) and should be read with reference to this chapter.

Viking Energy Partnership are currently progressing proposals for a wind farm on North Mainland in the Shetland Islands. The proposed wind farm site is located approximately 27km north of Lerwick and is roughly centred on the settlement of Voe (grid reference HU 4077 6320). The area of interest is divided into four quadrants, with two quadrants to either side of the main A970/A968 route which runs north–south across the island. The quadrants are known as; Delting, Collafirth, Kergord and Nesting. All four quadrants of the proposed 150-turbine wind farm comprise areas of open moorland used mainly for rough grazing.

In addition to requiring planning consent the ***Water Framework Directive*** (WFD) represents a significant piece of environmental legislation which has implications for the proposed development. The WFD has been transposed into Scottish legislation as the ***Water Environment and Water Services (Scotland) Act 2003*** (or WEWS) and has given Scottish ministers powers to introduce regulatory controls over activities in order to protect and improve Scotland's water environment. The water environment includes wetlands, rivers, lochs, transitional waters (estuaries), coastal waters and groundwater. These regulatory controls, the ***Water Environment (Controlled Activities) (Scotland) Regulations 2005*** (known as CAR), were passed by the Scottish Parliament on 1 June 2005. The Regulations mean that it is an offence to undertake the following activities without a CAR authorisation:

- discharges to all wetlands, surface waters and groundwaters (replacing the ***Control of Pollution Act 1974*** (CoPA));
- disposal to land (replacing the ***Groundwater Regulations 1998***);
- abstractions from all wetlands, surface waters and groundwaters;
- impoundments (dams and weirs) of rivers, lochs, wetlands and transitional waters;
- engineering works in inland waters and wetlands.

With respect to stream crossings it is the final point that is relevant and comes under Section E of CAR. Three different types of authorisation under CAR allow for proportionate and risk-based regulation. The authorisation process operates at three levels which are:

- General Binding Rules;
- Registration;
- Licence.

These levels cover activities with increasing levels of potential impact upon the environment. In the case of the Viking Wind Farm development, some of the watercourse crossings will require licensing. Minor, additional, watercourses which do not feature on the 1:50,000 scale Ordnance Survey mapping do not come within the CAR process. We have, however, also taken account of these minor crossings (known as additional crossings) within this report.

The Scottish Environment Protection Agency (SEPA) has produced a Controlled Activity Regulations internal guideline - Regulatory Method WAT-RM-02 (SEPA, 2006a), this lists four types of test that will be applied when determining a licence application. The most significant of these is ‘best practice’ and, in the case of Viking Wind Farm, this test will be applied to the geometry of the access tracks linking up the turbine locations. The best approach to assimilating the rules is to consult the document - Water Environment (Controlled Activities) (Scotland) Regulations 2005: A Practical Guide (SEPA, 2006b).

2 ROUTE SELECTION

Before considering stream crossings in detail SEPA will wish to satisfy themselves that 'best practice' has been followed, which in their terms means avoidance or minimisation of the number of crossings. The number of crossings is a function of the access route to link up the turbines (and other infrastructure) for construction and operational purposes. The main factors that would be considered in determining a route include:

- Maximum track gradient suitable for the type of traffic and loads;
- Other track geometry factors such as bends and junction layouts;
- Stability and bearing capacity of the ground and adjacent slopes;
- The volumes of 'cut' and 'fill' to ensure a suitable track alignment;
- Land take (primarily determined by route length);
- The type and nature of bridging structures;
- Sensitivity (flora, fauna, soils, water, human, etc.);
- Whole life costs (construction and maintenance).

Given this non-exhaustive list, an optimum track geometry has been determined to link up the turbines and other development infrastructure. The development of access tracks is inevitably a compromise between several constraints. The desire to site turbines on areas of stable and or shallow peatland, a series of environmental constraints and the aim of routing access tracks away from difficult terrain means that the track geometry is constrained by ecological and topographical features. Cost is also a pertinent constraint and when taken in conjunction with physical factors results in an access network which is 'optimum'.

There is not a direct link between that 'optimum' and 'best practice' in the WFD context, which is oriented towards the water environment; however, there are should not be obvious redundant crossings or crossings that are readily avoidable.

3 ACCESS TRACK DESIGN

Input was provided as an integral part of the iterative design process to ensure minimal stream crossings, crossings will only occur where there is a demonstrable access requirement.

The site for the Viking Wind Farm consists mainly of open heather and grass moorland with an extensive network of small water bodies. A small proportion of the site is served by existing tracks at entry locations, these would be expected to require upgrade for development purposes. Developing the windfarm will necessitate the construction/upgrade of approximately 118km of site access tracks, including several entry routes from the existing public roads to reach the development site - 3 for both Delting and Nesting, a single route for Collafirth and 5 for Kergord. Figure 14.3.SC01 (in Volume 4b) provides maps of the northern and southern areas of development.

An objective of the scheme was to try to ensure crossings were perpendicular to the associated stream, thereby reducing the disturbance both at the crossing location and in the riparian corridor. Where feasible the tracks have been sited along higher ground and outwith the 50m hydrological feature buffer zone applied as standard across the site in order to avoid water bodies. Stream crossing locations are in upland areas of site catchments, thereby avoiding positions where stream migration (such as meandering) would be more likely to occur. There are a number of open water bodies across the site, particularly in Kergord and Nesting, care has been taken to route the tracks at a suitable distance from these.

At a small number of locations there are crossings which have been identified at the planning stage but which may not be built if deemed surplus at detailed design stage for construction/operational purposes.

Wherever it can be accommodated within the construction programme, track crossing structures on double-width track sections will be limited to single-width dimensions to minimise disturbance.

General site construction activities are anticipated as primarily occurring during 6 month 'summer' periods, this avoidance of 'winter' periods reduces construction activity around streams during periods with more likely heavy/frequent rainfall events and high flows. Further, the construction of crossing structures will take account of the fish spawning season; September to March. These items combine to result in an overall objective to conduct stream crossing construction activities between April and August. However, this will necessarily be subject to construction programme requirements with crossing works to be considered on a case-by-case basis. In all cases the Environmental Manager will be involved in the pre-construction crossing assessment, agreeing method statements, pre-requisite construction conditions (such as particular rainfall/flow conditions) and empowered to immediately halt any construction works that are raising concerns.

3.1 Site Entry Access Tracks

Site entry tracks are discussed below, with descriptions provided from north to south of each quadrant.

In Delting quadrant there are 3 proposed access points to the wind farm infrastructure. The first is from the B9076 opposite Houb of Scatsa. From there, the track travels south-east for 0.9km to turbine D1. The second access track is off the A968 near the Hill of Swinister, heading west and then south-west for roughly 3km to turbine D16. The third access route involves the upgrading of an existing track to enable borrow pit access, opposite the campsite at Otervik, south of Brae on the A970 and travels north-east for about 1.3km to the provisional construction compound location and then north and east for a further 1.4km to turbine D31.

The proposed access route into Collafirth is via a small unclassified road at HU413661, close to the A970 between Garth of Susetter and Souther House. The track heads roughly east for 1.2km before it splits, one track heads east for 0.3km to turbine C34 and the other south for around 0.8km to turbine C38.

For the Kergord quadrant of the wind farm there are 5 proposed site access points. One operational site access track leaves the B9071 at the northern end of Peta Vale, west of Voe, the proposed track heads south roughly following the West Kame for about 2.7km to turbine K42. The second access route is located off the A970 at the north-east end of the site, the track leaves the public road and heads west for approximately 0.5km to turbine K78. The third access is from the B9075 at Lamba Scord and the southern end of Mid Kame, the track runs north upslope for approximately 1km to turbine K88. The fourth access track leaves from the B9075 at Weisdale and heads north for about 1.4km before it divides and the eastern track heads north for a further 1km to the proposed convertor station location. The western track heads NNE for about 1.25km to turbine K52. The fifth, most southerly, access point is from the A971 at the Scord of Sound, here the track heads over low ground for roughly 2.2 km to turbine K76.

At Nesting, there are 3 planned site access tracks. The first is from the A970 adjacent to the access track to the Kergord quadrant. The track follows the contour of the land and skirts south before turning east and then north, this route avoids the need for the construction of

several water crossings over the head waters of Wester Filla Burn. The second proposed access route is also from the A970 at the southerly end of East Kame, the track will head north, avoiding the flood plain of the Burn of Crookdale, for just over 1.5km to turbine N110. The third access point is from the B9075, just south of Newing, this commences with an existing track to be upgraded for borrow pit access which then heads north-west and west around Loch of Skellister for approximately 1.5km to turbine N150.

3.2 On-Site Access Tracks

In the Delting quadrant the main arterial track runs north-west to south-east through the site and incorporates 18 of the 30 turbines proposed for Delting. From the main tracks, spurs give direct access to turbines in other areas. Once again the route has been designed to limit the number of required crossings as far as possible.

In Collafirth the extent of the site has been restricted by the ground conditions (expanses of deep peat) and other constraints. The site tracks have been designed to minimise the number of crossings of the main watercourse in the area; the Seggie Burn.

In the Kergord quadrant the main arterial route runs from north to south through the site. The only major spur leaves the arterial route at K63 and avoids crossing the main watercourses with exception of one crossing over the main outflow stream from Truggles Water. There are a number other small branch tracks from the main arterial route and these have been sited wherever possible to avoid crossing any water bodies. The other major route in Kergord climbs to and runs along Mid Kame ridge, this track incorporates 11 turbines and does not require any stream crossings.

The Nesting quadrant is split into two areas; north and south. The northern part of the site has one arterial track with one main spur sited wherever possible along the slightly higher ground to avoid water bodies. The southern, larger, part of the site has again been designed to avoid the larger water bodies.

3.3 Removal of Existing Structures

Where a proposed new crossing is located adjacent to an existing crossing it will be considered best practice to remove the redundant structure (SEPA, 2008).

In addition, where historic watercourse obstructions are identified in catchments associated with the development, consideration will be given to the removal of such structures. The Fish Survey Technical Appendix (Waterside Ecology, 2009) provides further information on such structures.

Prior to removal of any structure, discussions will be held with SEPA, SNH and other identified stakeholders to ensure this is agreed as a beneficial action.

3.4 Cable Crossing Locations

As cables shall generally be laid alongside access tracks, cable crossings will normally be incorporated as part of track crossing structures.

Where cables are required to cross streams shown on Ordnance Survey 1:50,000 scale map, at locations without any associated track crossing structure, directional drilling techniques shall be employed to enable cable crossing below the stream bed in order to minimise disruption.

4 METHODOLOGY OF WATERCOURSE CROSSING ASSESSMENT

The catchment-based approach in this assessment follows that discussed in the associated Environmental Statement (Mouchel, 2009), with reference made to site hydrological catchment identification numbers as defined in that document.

The project involved a desk study and a walkover survey. The methodology for selection of appropriate stream crossing type is included as Appendix A.

4.1 Desk Study

The desk study consisted of a review of the information regarding Viking Wind Farm, principally involving an examination of the proposed track layout and the identification of watercourses marked on the OS 1:50,000 scale maps (Ordnance Survey, 2003) which will require crossings (known as regulated crossings).

4.2 Walkover Survey

Subsequent to the initial desk study, a walkover survey of the site was conducted, during which the identified crossings were visited to obtain specific information about each location. This fieldwork was conducted between November 2007 and December 2008 as the design phase progressed. Photographs and detailed field notes were taken reporting dimensions of the watercourse channel and flood channel, where apparent, the type of substrate and type of crossing needed. A hand-held GPS unit was used to obtain locations to at least 30m accuracy.

4.3 SEPA Waterbody Risk Category Definitions

Under the terms of the Water Framework Directive, all river basin districts are required to be characterised. The characterisation process required SEPA to produce an initial assessment of the impact of all significant pressures acting on the water environment (SEPA, 2007).

Surface water bodies are defined as being whole or parts of rivers, canals, lochs, estuaries or coastal waters. The main purpose of identifying water bodies is so that their status can be described accurately and compared with environmental objectives.

The WFD applies to all surface waters, but for practical purposes SEPA have defined a size threshold above which a river or loch must be to qualify automatically for characterisation. For lochs, the threshold is a surface area of 0.5km^2, rivers must have a catchment area of 10km^2 or more. In addition to these larger water bodies, smaller waters have been characterised where there is justification by environmental concerns and to meet the requirements of regulatory legislation such as for drinking water supplies.

Each identified water body has been assigned a risk class indicating whether the water body is likely to meet the WFD's objectives. Table 1 provides the risk categories.

Table 1 SEPA Risk Categories used in Water Body Characterisation and Action

WFD reporting category	UK reporting category	Action
At Risk	(1a) Water bodies at significant risk	Consideration of appropriate measures can start as soon as possible
	(1b) Water bodies probably at significant risk but further information is needed to make sure this view is correct	Focus for more detailed risk assessments to determine whether or not the water bodies in this category are at similar risk in time for the interim overview of significant water management issues in 2007
Not At Risk	(2a) Water bodies probably not at significant risk	Focus on improving quality of information in time for second pressure and impact analysis report in 2013
	(2b) Water bodies not at significant risk	Review for next pressure and impact analysis report in 2013 to identify any significant changes in the situation

4.4 Ecological Provisions

For each crossing, there is an indication of the likelihood the stream is used by mammals, (principally otters) and migratory fish (principally Atlantic salmon and trout).

The data on mammals was provided by Celtic Ecology (2009) who conducted a survey of otter signs and activity throughout the site. In relation to otter passage, recognition is made to the 'Design Manual for Roads and Bridges' (Highways Agency, 2008). Tracks have avoided parallel construction alongside streams and the 50m hydrological buffer zone, as previously discussed, is a best practice measure for otter protection, although inevitably crossing locations necessitate entry into this zone. Where otter presence is suspected canalisation will be avoided and ledges/passages will be incorporated into design to enable otters to pass below crossing locations, including during high flow periods.

The data for migratory fish presence throughout the watercourses was provided by Waterside Ecology (2009). A survey was conducted to determine the presence and abundance of five species identified; european eel, atlantic salmon, brown and sea trout, three-spined stickleback and flounder and this information was used to produce a baseline assessment of fish populations. Along with the survey information provided by Waterside Ecology, the given stream crossing indication is based on the size and apparent quality of the stream and the nature of the substrate, knowing that salmonid fish need shallow fast-flowing water with gravel substrate for breeding redds and good access from the sea without significant waterfalls. Where there has not been a survey near the watercourse the indication is inevitably subjective but will provide some basis with which to work. Some watercourses are clearly inappropriate habitat, as fish are unlikely to pass through peat pipes or live in extremely heavily vegetated or ephemeral watercourses. Others are much harder to classify. In all cases, a conservative approach has been used, assuming that there are likely to be fish unless evidence is found to demonstrate this is unlikely.

5 STREAM CROSSING ASSESSMENT

5.1 1:50,000 (Regulated) Stream Crossings

With the final track layout there are a total of 53 crossings identified on the OS 1:50,000 scale mapping (Ordnance Survey, 2003) and therefore CAR-applicable (known as regulated crossings). These locations are shown on Figure 14.3.SC02 (in Volume 4b).

Detailed information about each regulated stream crossing is provided in the Individual Stream Crossing Description section within Appendix B. The regulated stream crossings have been numbered by quadrant identifier prefix (Delting - D, Collafirth - C, Kergord - K and Nesting - N) and have then been numbered from north to south, e.g. in Delting the most northerly stream crossing is DS01, then DS02 and so forth. Note that there is no KS04 due to a layout amendment.

Table 2 provides a summary of these regulated watercourse crossings, enumerating the stream sizes and different types of crossing required across the site. Stream sizes are defined in Appendix A (Section A1.8).

Table 2 Summary of Types and Sizes of 1:50,000 Watercourse Crossings

Crossing Type	**Stream Size (Defined in Appendix A)**			
	Large	**Medium**	**Small**	**Total**
Bridge	3			**3**
Rectangular culvert / arch		10	9	**19**
Rectangular culvert /arch with mammal passage		1	1	**2**
Circular culvert		3	11	**14**
Multiple circular culverts		3	2	**5**
Circular pipe			1	**1**
Multiple circular pipes				
Circular pipe with mammal passage				
Drainage layer (narrow crossing)				
Drainage layer and pipes (broad crossing)		4		**4**
Total new crossings	**3**	**21**	**24**	**48**
Existing crossing structures, with probable upgrade requirement		***2***	***3***	***5***
TOTAL (new + upgraded existing)	**3**	**23**	**27**	**53**

5.2 SEPA Risk Categories for Site Waterbodies

Within the hydrological catchments related to the Viking Wind Farm there are six characterised water bodies; shown on Figure 14.3.SC01 (in Volume 4b). These are all watercourses, as there are no lochs with surface area of 0.5km^2 or greater. Table 3 provides a summary of risk assessment of these water bodies and pressure types exerted on that waterbody (as applicable).

Table 3 Summary of Viking Water Body Risk Categorisation

Catchment ID	Waterbody	Risk Assessment	Pressure on Waterbody?	Pressure Type	Pressure Cause
1	Laxo Burn / Gossawater Burn	2b	None	-	-
2	Burn of Lunklet / South Burn of Burrafirth	2b	None	-	-
3	Burn of Sandwater / Burn of Pettawater	2b	None	-	-
4	Burn of Weisdale	1b	Yes	Morphological Alterations	Impounding - weir/dam at HU396531
5	Burn of Laxobigging	1a	Yes	Morphological Alterations	Mixed farming Impounding - dam at HU417726
6	Burn of Grunnafirth	2b	None	-	-

The largest catchment Laxo Burn/Gossawater Burn in Nesting/Collafirth has been classified as '**2b: Not at significant risk'**. The catchments associated with Burn of Lunklet/South Burn of Burrafirth, Burn of Sandwater/Burn of Pettawater and Burn of Grunnafirth share this classification.

Burn of Weisdale in Kergord/Nesting has been classified '**1b: Probably at risk**', this catchment is pressured due to the Weisdale weir at HU396531, this morphological alteration will influence flow regime in the catchment (Mouchel, 2009).

Burn of Laxobigging in Delting has been classified '**1a: At risk**'. There is a redundant dam at Graven on the Laxobigging Burn at HU417726 and, similarly to Burn of Weisdale, this morphological alteration will influence flow regime. Also, this watercourse has a high ecological and chemical water quality (Mouchel, 2009), with pressure due to local farming practices, this may logically lead to an escalation of risk categorisation in relation to loss of current (high water quality) status.

5.3 Additional (Non-Regulated) Stream Crossings

In addition to assessing the regulated 1:50,000 scale map stream crossings, other stream crossings were recorded, as found on OS 1:10,000 scale digital mapping (Ordnance Survey, 2006) and during field surveys, to inform the track design and construction process.

A further 44 crossings were identified and locations are shown in Figure 14.3.SC03 (in Volume 4b), with an accompanying table of details for these additional watercourse crossings in Appendix C (Table 5). The additional stream crossings in Appendix C give a representative coverage but cannot be comprehensive as these include ephemeral watercourses with size dependent on seasonality and recent weather patterns.

The additional stream crossings have also been numbered by quadrant, e.g. DX01. Note that references for the additional crossings are not sequential and are not numbered from north to south.

5.4 Limitations of Assessment

Following the final modification of the track layout, fieldwork was carried in November 2008, however, owing to inclement weather conditions, it was not possible to undertake the intended survey work at 5 of the additional (i.e. non-CAR) stream crossing locations. Results have been extrapolated for these locations using professional judgement based on nearby crossing sites and watercourses.

Three of the additional stream crossings identified during the desk study of the 1:10,000 scale Ordnance Survey mapping were not found at or close to the mapped locations at the time of field survey and it is probable that these streams are ephemeral. Although there was no flow at the time of survey it is important that any seasonal flow is not restricted by the wind farm infrastructure. Therefore an estimate of the size of these streams during flow conditions has been extrapolated based on information for nearby watercourses and a crossing type recommended accordingly.

Due to the very boggy nature of the site, there are areas where there is effectively sheet flow; these have not been specifically mentioned but will need to have appropriate drainage installed during construction to prevent disruption to surface flows and damage to the track.

6 SUMMARY OF RESULTS

The combined total of identified stream crossings is 97; representing 53 crossings shown on the OS 1:50,000 map and the additional 44 crossings identified from OS 1:10,000 map and during walkover. Table 4 shows the representation of stream crossings per hydrological catchment. Figure 14.3.SC04 (in Volume 4b) shows the combined watercourse crossing locations.

It is expected that detailed design stage will require additional data to that provided in this indicative study, e.g. in relation to dimensions of specific structures, CAR licencing and specialist otter passage advice.

7 REFERENCES

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Waterside Ecology (2009) Viking Wind Farm Environmental Statement - Ecology (Chapter 10): Technical Appendix 10.6 Fish Survey Data

We have used our reasonable endeavours to provide information that is correct and accurate and have discussed above the reasonable conclusions that can be reached on the basis of the information available.

Table 4 Summary of Stream Crossings per Site Hydrological Catchment

Catchment ID	Catchment Name	Area (km^2)	Site Quadrant	1:50,000 Stream Crossings	Additional Stream Crossings
1	Laxo Burn / Gossawater Burn	20.86	Collafirth/Nesting	CS01,CS02, CS03,NS03, NS04,NS05, NS06,NS07, NS08,NS09	CX01,CX02, CX03,CX04, CX05,CX06, CX07,CX08
2	Burn of Lunklet / South Burn of Burrafirth	18.47	Kergord	KS03,KS08, KS09,KS10, KS11,KS12, KS13,KS14, KS15	KX07,KX08, KX10,KX11, KX12,KX13, KX14,KX15, KX16
3	Burn of Sandwater / Burn of Pettawater	14.69	Kergord/Nesting		
4	Burn of Weisdale	13.17	Kergord	KS05,KS06, KS07	KX02,KX03, KX04,KX05, KX06
5	Burn of Laxobigging	11.33	Delting	DS01,DS02, DS03,DS04, DS05,DS06, DS07,DS08, DS09	DX01,DX03, DX04,DX05, DX06,DX08, DX18,DX19
6	Burn of Grunnafirth	10.60	Nesting	NS10,NS11, NS12,NS13	NX07,NX09
7	Catfirth	6.79	Nesting	NS19,NS20	NX08
8	Burn of Kirkhouse	5.88	Kergord	KS01,KS02	
9	Burn of Skelladale	4.82	Delting	DS10,DS11, DS12,DS13, DS14	DX09
10	Burn of Helligill / Trondavoe	4.72	Delting		
11	Burn of Wester Filla / Daal	4.46	Collafirth/Nesting/ Kergord	NS01,NS02	NX04,NX05
12	Scatsta	4.27	Delting		DX12,DX13, DX14,DX15
13	Burn of Sandgarth	4.04	Delting/Collafirth		
14	Burn of Susetter	3.95	Delting/Collafirth		
15	Burn of Voxter	3.26	Kergord		
16	Burn of Gonfirth	2.90	Kergord		
17	Burn of Quoys	2.91	Nesting	NS17,NS18	NX10
18	Burn of Firth	2.69	Delting		DX02
19	Burn of Laxfirth	2.61	Nesting		
20	Burn of Tactigill	2.69	Kergord		
21	Burn of the Dale	2.13	Nesting		
22	Burn of Valayre	2.01	Delting		
23	Mill Burn	1.66	Delting		
24	Loch of Skellister	1.69	Nesting	NS14,NS15, NS16	
25	Atler Burn	1.73	Nesting		
26	Burn of Foulawick	1.34	Delting	DS15	DX10
27	Burn of Grunnawater	0.93	Nesting		
28	Burn of Scudillswick	0.51	Nesting		
29	West Hill of Graven	0.43	Delting		DX17
30	Scord of Sound	0.36	Kergord	KS16	

Note KS04 crossing removed due to late layout amendment, locations shown on Figure 14.3.SC02 (Volume 4)

Appendix A

Watercourse Crossing Selection Guidelines
(Revised January 2009)

A1.1 Introduction

Wind farm developments have been proposed and constructed in a wide range of landscapes which have varying forms of topography, land use and habitat. In any new development there is the likelihood of new access roads being constructed which will require crossing water courses, ditches and other features, such as peat haggs. In some instances there may also be existing crossings that require to be upgraded. Clearly some of the features may only intermittently convey water.

In Scotland many of the developments are on hilltops thus the majority of the crossings are over small headwater burns or minor watercourses. In engineering terms the usual approach has been to place circular culverts into the stream bed and build the road on an embankment above the culvert. This approach, and associated good practice as given in The Forests and Water Guidelines (Forestry Commission, 2004), has been used for over 30 years in the construction of forestry access roads. Where a single circular culvert would be inadequate twin or triple culverts have been used or, as streams become even wider, rectangular culverts or conventional abutment bridges may be employed.

Although wind farm developments may be located in areas of similar terrain to forestry plantations the expected standards for watercourse crossings are changing. In part this is because some proposed developments are in areas where forestry would not have been considered in the past and there is a limited history of practical engineering solutions. But the main driver for a change from past practice is the introduction of the Water Framework Directive and its associated Regulations. Under these regulations it is ecological status that has primacy over engineering and the conveyance of flows.

From April 2006 nearly all proposals which will involve engineering activity in the vicinity of water have to be submitted to SEPA for appraisal and, depending on the scale of the work and sensitivity of the waters, may require registration or licensing.

In order to avoid a proliferation of ad-hoc approaches to the design of crossings it is considered that a set of guidelines would be of benefit to the developer and to SEPA. Following these guidelines would show commitment and provide comfort that a consistent best practice is being taken. A scheme of characterisation of water courses along with the potential means of spanning these will provide the developer and SEPA with a tool for evaluating the numbers, types and potential impacts of the crossing. It is intended that full cognisance should still be taken of the Forest and Water Guidelines as well as the CIRIA Culvert Design Guide (CIRIA, 1997) which focuses mainly on engineering features.

A1.2 Methodology

There are a limited number of watercourse morphologies or, more specifically, cross sectional shapes of channel, bank and flood plain. There are a limited number of engineering possibilities, namely fords, circular and rectangular culverts, arches and abutment supported bridges. Put simply, the objective of these guidelines is to ‘map’ watercourse characteristics to crossing mechanisms taking into account ecological issues. Thus the focus of this guide is to address hydrology and ecology and not detailed engineering design.

It is considered that ecological issues should consider not only the end result and possible requirement for features such as continuity of stream bed (to avoid significant negative local effects on aquatic ecological and fishery receptors) or the passage of mammals, but also the risks and duration of constructing the structure.

A1.3 Watercourses

Wind farm developments may potentially cross many types of water conveying features. Thus in the context of this document 'watercourse' needs to be seen in a broader sense than a burn or stream alone and needs to encompass the following:

- Natural burns and streams as normally perceived;
- Ditches and drains as encountered alongside roads, in moor gripping or forested areas;
- Incised channels in peat (also known as haggs or gullies);
- Peat pipes;
- Flushes.

Of these features it is the natural streams that perhaps display the greatest variety of sizes and cross-sectional profile. They may also be regarded as being the highest on the ecological agenda as they typically tend to support the most valuable assemblages of aquatic flora and fauna with high individual nature conservation and fishery value. However, it must be recognised that this guideline is not intended to cover major river crossings where many other factors would come into play.

In cross-section ditches and drains tend to be fairly regular and trapezoidal (at least when originally constructed) and have a flow regime which may be transient. Nevertheless they provide 'cover', corridors for movement and frequently a damp habitat for certain creatures, such as frogs.

Haggs and peat pipes are natural features within areas of blanket bog. Gullies between haggs are formed where water forces have eroded the peat and could be up to 5m deep and frequently take the form of an narrow irregular 'V' or broad 'U' shape. They act as drainage channels following periods of prolonged rainfall. The formation of peat pipes is not well understood, but these often occur at the peat / mineral soil interface and could be 0.5m diameter, but are usually significantly smaller.

Flushes usually occur at the headwaters of streams where flow is predominantly sub-surface interflow with perhaps some overland flow during wetter periods. Although perhaps located in a concave part of the hillside there is no defined channel and the width of the flush may vary considerably depending on terrain.

Within streams a large range of channel bed and bank materials may be encountered including organic soils, clays, gravels, boulders and bedrock.

It is clear from this definition that some of these channels only convey water intermittently. Furthermore aquatic ecology, in terms of fish, is confined to burns and streams although amphibians clearly have a more widespread habitat and may utilise the wet and damp conditions of ephemeral watercourses.

A1.4 Structures

The envisaged structural components of the crossing may comprise circular or rectangular culverts, segmental arch sections or a bridge deck set upon abutments. Construction may use a variety of techniques and materials – steel, precast and insitu concrete, plastics and timber. Table A1.1 sets out the generally available sizes and materials in which these elements may be procured.

Table A1.1 Structural Elements

Type	Materials	Size Range (mm)		Comments
Circular Culvert	Precast concrete	200[1]	2400	High strength and durable
	Corrugated metal	300	6000	
	Plastic	100	600	
Rectangular Culvert	Precast concrete	1000x600	4800x3000	Large range of widths and heights
Segmental Arch	Pre-cast concrete	2000	10000	No interference with stream bed
	Corrugated metal			
Bridge Decking	Pre-cast concrete	4000	10000	Standard Beam with in-situ deck
	Steel & Concrete			Steel Beam with in-situ deck
	Timber	2000	4000	Limited life / load capacity
Abutments	In-situ concrete	-	-	Conventional construction
	Pre-cast sections	-	-	Reinforced earth techniques
	Masonry	-	-	May be in the form of gabions

The suggested range of diameters or spans for which these different structures may be applied should be regarded as indicative. Clearly, particular manufacturers of pipes, box culverts and arch systems have a greater or lesser range and bespoke solutions such as bridges can be almost of any size.

A1.5 Ecological Provisions

Ecological provision for fish and mammals need only be provided where there is reasonable evidence that these animals occupy or migrate through the locus of the proposed crossing. For example fish may be entirely absent upstream of a natural barrier such as a waterfall or a reach with a non-navigable gradient and high flow velocities. Similarly field surveys may have failed to establish the presence of any of the designated mammals and that habitats are such as to be unlikely to attract inward migration.

Conversely, if the need for ecological provision has been established then this should take an appropriate form which will depend on the species being provided for and the physical nature of the crossing. In general the provisions at burns and streams may encompass:

- Mammal ledges within the crossing and at top of bank elevation;
- Mammal tunnels adjacent to the stream and accessible from bank level;
- Continuity of stream bed comprising natural indigenous material;
- Absence of a step in the water levels in excess of 300mm;
- No reduction in overall width or natural fluctuation of depth;
- Reinstatement of natural vegetation to provide ‘cover’.

This guideline does not provide any methodology for assessing the ecology of the site in general, or the specific location of the proposed watercourse crossing. Those matters are for other specialists; the only necessary information required is whether ecological provision is required or not at the candidate crossing locations.

[1] Although pipes may be available in these smaller sizes the CIRIA minimum recommended diameter for any circular culvert is 450mm.

A1.6 Hydraulic Sizing

The CIRIA Guidelines provide recommendations on calculation methods for the design flood to be passed through a culvert without risk of structural damage. In the absence of a historically significant period of actual flow records (which is often the case) the suggestion is to use the Flood Studies Report (Institute of Hydrology, 1993). Although valid at the time the guidelines were produced, the normal method now would be to use the Flood Estimation Handbook (Centre for Ecology and Hydrology, 2006) and the associated digital model of channel networks.

The design standard in terms of flood severity is normally expressed as a return period. Wind farms are typically located in rural areas with access tracks generally conforming to forestry type roads where bridging culverts have been designed to a 1:50 year return period. Due to climate change it is suggested that a 1:100 year standard is now adopted. For information, on the basis of the Flood Studies Report the approximate growth factors on Qbar (about 2 a year return period) for Region 1 (Scotland) for various return periods is set out in Table A1.2.

Table A1.2 Return Period Growth Factors

Return Period	Growth Factor
15	1.7
25	1.9
50	2.2
100	2.5
200	2.8
300	3.0
400	3.1
500	3.2

This shows that going from the 1:50 yr to 1:100 yr return period is in effect a 14% increase in flood flow (i.e. (2.5-2.2) / 2.2 = 0.14). This seems an adequate uplift for bridges or culverts where a small amount of transient upstream ponding would be of no consequence.

Furthermore, in terms of sizing rectangular culverts where there is a need to re-establish a natural stream bed, it is proposed that an additional 450mm is added to the vertical dimension so that the structure may be inserted into the stream bed.

Note, however, that the digitised channel network is based on the watercourses visible on a 1:25,000 scale Ordnance Survey map. It may be that many of the smaller crossings in a particular development do not feature at this scale, nor would other features such as drainage ditches or moor gripping. Thus, a pragmatic approach along with hydrological judgement may be required where definitive calculations are not practical. Thus, the range of options may comprise:

- Comprehensive use of FEH featuring the actual stream to be crossed;
- Utilise surrogate streams to calculate unit flow rates per hectare and then pro-rata to the specific crossing;
- Consider stream morphology to estimate 1-2 year return period flow based on bank full condition and then scale to design return period;
- Consider stream / channel morphology and ‘match’ conveyance capacity of existing channel so that crossing unlikely to form a restriction.

Although these may appear to be in decreasing order of sophistication it should be borne in mind that the regression equations for Mean Annual Flood (MAF) are not precise and may under or over estimate actual values. The error in the estimate does not improve when scaled up to the design return period. The channel morphology has been shaped by actual flow characteristics and taking cognisance of that can provide useful insight to past flood levels. Both calculation and observation have a role to play.

Where the crossing has to take regard of migratory fish the Scottish Executive (as was) issued guidelines (Scottish Executive, 2000) which provide important design criteria such a minimum width and depth of water, maximum velocity of flow and provision of rest pools. These parameters are species and culvert length dependant.

A1.7 Selection Process

The process of 'mapping' watercourse characteristics to a suitable form of crossing is conceptually fairly simple. It is a case of matching several physical / ecological criteria to the most appropriate crossing type.

In practice there are a large number of permutations of watercourse, topography, bed materials etc that can be considered although some are of unlikely combinations. The number of categories of each attribute is set out in Table A1.3.

Table A1.3 Description of Watercourse Attributes

Type of Attribute	Options	Cases
Watercourse types	5	Stream, Ditch, Peat Hagg, Peat Pipe, Flush
Setting / Context	6	Incised, Broad, Road drain, Land drain, Buried, Surface
Size	3	Small, Medium, Large (predominantly as in width)
Ecological Provision	2	Yes, No

If every one of these attributes were permutated without regard to feasibility there would be 180 permutations, however this reduces to 47 if anomalous physical combinations such as buried streams, surface peat pipes and the like are discounted.

The number of options can be further reduced to 25 by considering only those that make environmental sense - thus fish migration up peat pipes is not a recognised phenomenon for which provision needs to be made. The reduction in numbers has been based on removing 22 hypothetical cases of Ecological Provision where it is believed that the case for mammal ledges / passes and natural bed reinstatement either do not make sense or cannot be justified. Of these 6 relate to road side ditches or small land drains, 8 to peat haggs, 4 to peat pipes and 4 to flushes. In all of these cases fish are neither present nor mammals likely to be impeded.

The selection process can be reduced to a decision table, Table A1.5, provided at the rear of the report, where by working from left to right across the columns a watercourse crossing type is determined. This table is also available as a spreadsheet and, with auto-filtering, allows a rapid check to be made of alternatives where a classification is marginal. A summary count of the options is given in Table A1.4.

Table A1.4 Summary of crossing options

Water feature	Number of options	Arch / Bridge	Culvert/ Pipe	Comments
Streams	12	4	8	All large streams crossed by bridge / arch
Ditches	5		5	Only massive ditches would justify bridges
Peat Haggs	4		4	
Peat Pipes	2		2	Pipes ensure continuity of subsurface flows
Flush	2		2	
Total:	25			

A1.8 Decision Rationale

In drawing up the choice of crossing type and the form of ecological provision a number of assumptions have been made. In effect these are embedded in the table and the rationale for making certain choices is explained below.

Small, Medium and Large Crossings

Within the crossing type selection table watercourse size is expressed in terms of small / medium / large but without actual dimensions being stated. In part this is due to the fact that the table covers a range of features such as peat haggs, ditches and streams where “large” in one context may not be “large” in another. However, within the category of streams and for the following dimensions are proposed:

- Small - less that 1 metre;
- Medium - between 1 and 3 metres;
- Large - greater than 3 metres.

For other features such as haggs, flushes, etc the size differentiation is not significant in determining crossing type; it merely governs the diameter or number of circular conduits to ensure drainage is unimpeded.

Bridges

Where the watercourse is of significant width or the stream is within a deeply incised valley then a conventional abutment bridge may offer the best practical engineering solution whether or not ecological provision has to be made. In some cases the bridge may be multi-span with one of more supports required within the watercourse. Where technically possible the abutments would be set back by at least 1 metre from the banks of the watercourse, if these are well defined. However, over the passage of time erosion / deposition could change this marginal strip between the abutment and watercourse, unless “hard” engineering is employed, which may not be desirable.

Rectangular Culverts / Arches

Rectangular culverts and arches can be used where there are watercourses narrower than those appropriate for bridge construction but which have a requirement to provide mammal and/or fish passage and ensure sufficient hydraulic capacity during peak flow periods. Arches

minimise disruption to stream base. Rectangular culverts may incorporate mammal ledges and can be buried below stream bed level to enable bed material replacement.

Circular Culverts
In all cases where there are no ecological provisions to be made it is assumed that neither natural bed material, or water velocity nor depth are critical other than in the purely hydraulic sense. Thus, circular culverts provide an economic and viable solution.

Multiple Culverts (Circular)
None of these cases has ecological implications, so the rationale above for singular circular culverts still applies. Multiple (usually twin) culverts have been considered a viable option where the crossing is wide and the use of a single circular culvert would require a disproportionately large diameter which would also raise the height of the crossing.

In the case of deeply incised streams culvert height may not be so much of an issue as it may be accommodated without the need to raise the road level. However, it has been assumed that in engineering terms handling two smaller pipes would be preferable to one large pipe – but that decision can be left to the engineer / contractor.

Multiple Culverts (Rectangular)
Multiple (usually twin) culverts have been considered a viable option where the crossing is wide. Although there is a reasonable range of width to depth ratios available for off-the-shelf precast units there may be occasions where the topography and channel morphology would favour multiple culverts.

The decision table includes cases where ecological provision needs to be made and this can be designed into rectangular box culverts. The fact that there are multiple culverts means that there will be one or more piers within the watercourse, but the culvert sizing can be such as to ensure the original cross-sectional width is maintained. With twin culverts it is also possible to set one at a lower elevation to act as a low flow channel.

'Flashy' streams, particularly within incised channels, may lend themselves to rectangular culverts as a large height to width ratio can be employed to accommodate larger water level changes than would a circular culvert.

Omega Culverts
There has been discussion on the feasibility of using a variation on rectangular culverts where instead of a lower slab the culvert has outward projecting footings (hence omega: Ω). This precast unit would be used in a similar manner to conventional culverts, but the stream bed would be left relatively undisturbed. However, as no such commercially available units have been identified in manufacturers' literature this crossing type has not been illustrated in Table A1.6.

Ecological Provision
This document does not aim to provide any means of determining the requirement for ecological provision as that discipline resides elsewhere. However, it is recognised that migratory fish may not be the only drivers as native resident species may also be present. Where ecological provision is required for fish the first priority is that a natural bed profile should remain, which can be accomplished by the use of rectangular deep culverts. Where preservation of the bank is also deemed essential the crossing type may be either a bridge or an arch so as to not interfere with the edge of the stream. Experience shows that in most cases the ground below a bridge or arch is unlikely to retain the former vegetation.

Where provision has to be made for the passage of mammals this can be accomplished by incorporating ledges, at bank level, within a rectangular culvert. Alternatively, a tunnel may be provided to one side of the watercourse.

The assumption has been made that wider crossings would be undertaken with a bridge resting on abutments which are clear of the stream edge. The smaller crossings may be constructed from segmental arches or similar – although small span bridges would be equally serviceable.

Inevitably, there will be some disturbance in the vicinity of the crossing during the construction period. The Environmental Management Plan / Pollution Prevention Plan (EMP / PPP) will address risk elimination and mitigation, particularly during the construction period. However, in addition to engineering, the reinstatement of vegetation must be integral to the design to provide 'rest / cover' areas.

Construction

As a rule, the more ***in situ*** construction, the more complex the task and the longer the duration of activity in the vicinity of a watercourse crossing; the greater is the risk of a hazardous or pollution incident arising. Thus, "constructability" is a relevant factor to consider when selecting the type of stream crossing solution.

For example it may be possible to span a 3m stream using either a rectangular culvert or conventional abutment bridge. A bridge may take weeks to construct and involve in-situ concrete pours and also require a temporary crossing to facilitate work at both sides. A bridging culvert could be put in place within days and with bed reinstatement it would appear no different from the bridge option. Thus, where there are competing options it would be prudent to evaluate all forms of risk during the construction and operational phase of the structure and not just the status of the structure when completed.

In addition to the cross-sectional geometry of the watercourse geotechnical factors also have an influence on constructability. The practicalities of excavation for foundations or bed preparation will depend upon the surrounding material being 'hard' and 'soft'. If the bed or banks would require heavy percussion hammering, drilling, blasting etc then the material is 'hard'. Where the bed can be excavated by hand or excavator then the material is 'soft', which may include rock that is weathered or weak. In either case it is assumed that the bed rock can be broken out to a depth sufficient to allow the normal 200mm of granular bedding on which to lay precast concrete units where this is the chosen option.

In the schedule of individual stream crossings an indication has been given as to what is considered to be the most appropriate crossing type. This is generally based on the selection matrix in Table A1.5 however this is intended as guidance only. On occasions specific channel characteristics or local morphology may suggest some variation on the selection table is more appropriate. For example, the table may suggest a single circular culvert, but due to topographic considerations multiple circular culvers may be more appropriate.

A particular issue that may arise with small / ephemeral water courses is that the channel is ill-defined and on the day of the site inspection an optimum position for the culvert is unclear. These conditions are most likely to arise on small headwater streams that are unmarked on the OS 1:50,000 scale maps or in peat hagged areas. In these cases it is anticipated that further observations will be available closer to the construction period. Also some ditching or realignment immediately upstream may be necessary to convey flows towards the culvert to minimise ponding upstream of the crossing point.

A further issue to consider, in some instances, will be the provision of temporary crossings, perhaps to facilitate the construction of the permanent crossing or for some other purpose of

limited duration. In these circumstances ecological provision to a lower standard may be inevitable although, as this will be temporary and perhaps seasonally phased, the actual impact may be negligible.

A1.9 Diagrams

A selection of schematic diagrams has been produced to illustrate some of the watercourse crossings that may arise. These are shown in Table A1.6 and although not every permutation has been drawn, the selection attempts to cover the most frequent situations and at the same time show a variety of key design features.

In the majority of cases these diagrams only show cross-sections of the crossings, however it will be self evident that the length of culverts and arches will depend on the depth of the embankment material above the soffit of the pipe or crown of the arch and the arrangement of any entrance and exit structures. A single longitudinal section is given as a general illustration.

For example if the face of the embankment is at 45º and the road width (W), the fill material height above the soffit is F and the height of the opening is H then the length of the culvert will be; W + 2x(F + H) approximately. This excludes possible entrance and exit wing walls or pools.

Thus for a 6 metre wide road with 1.5 metres of fill on top of a 2 metre high rectangular culvert the length would be approximately 6 + 2x(1.5 + 2); giving 13 metres.

The situation is somewhat different for bridges as there is no fill placed above the stream, only the bridge deck which will be marginally wider than the road. However, the base of the abutments will be wider and this again depends on the height of the road embankment and the side slope.

A1.10 References

Centre for Ecology and Hydrology (2006), ***Flood Estimation Handbook*** (version 2), CD-ROM.

CIRIA (1997), ***CIRIA Report 168 - Culvert Design Guide***, published by CIRIA.

Institute for Hydrology (1993), ***Flood Studies Report***.

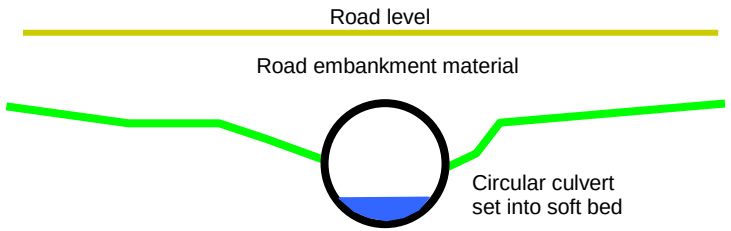
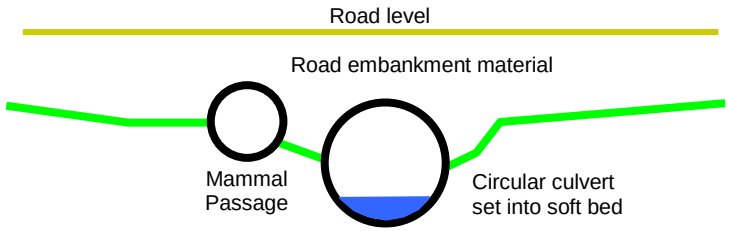
Forestry Commission (2004), ***Forests and Water Guidelines***, Fourth Edition, published by the Forestry Commission.

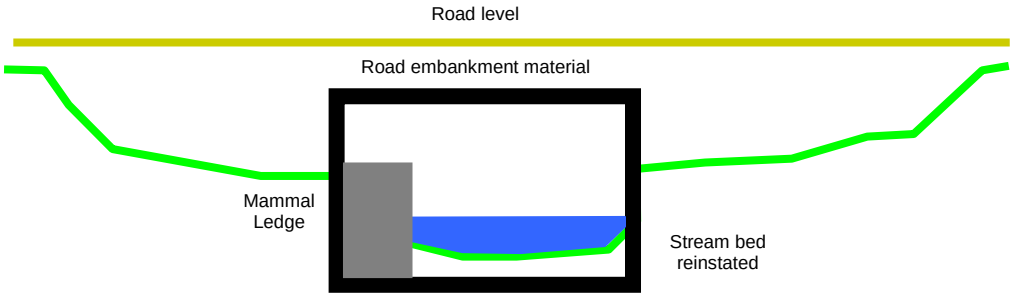
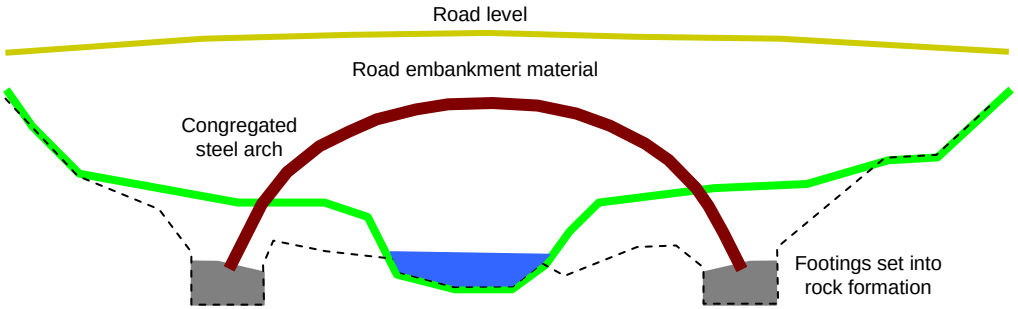
Scottish Executive (2000), ***River Crossings and Migratory Fish: Design Guidance***, published by the Scottish Executive.

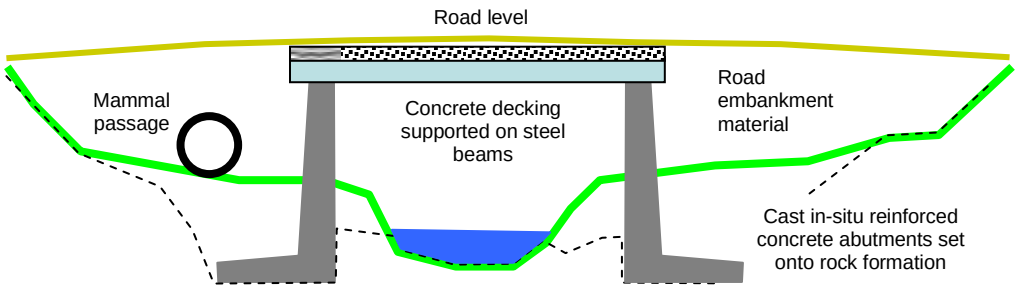
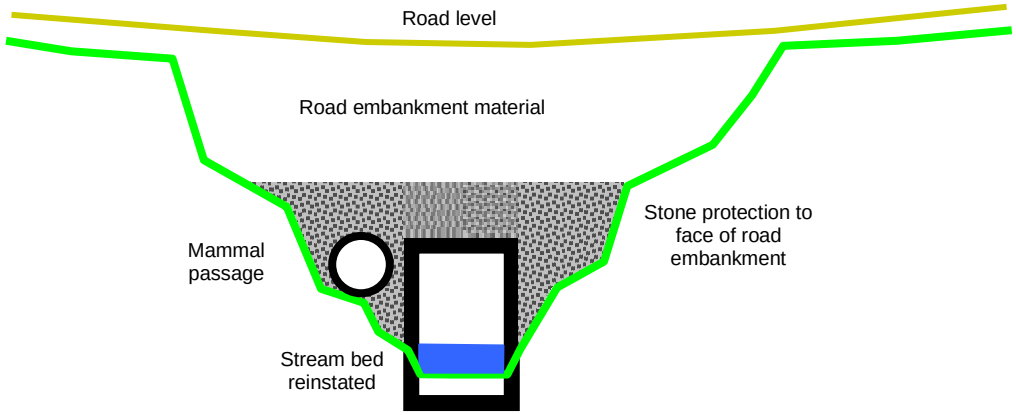
Table A1.5 Crossing Type Selection Table

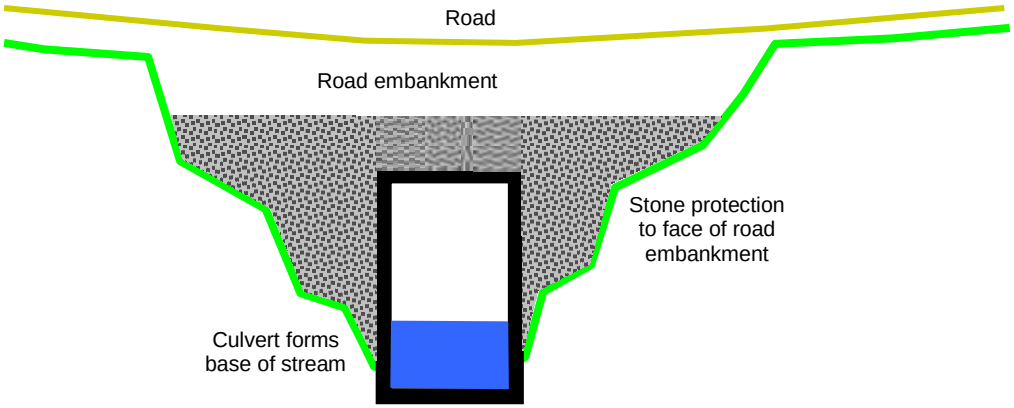
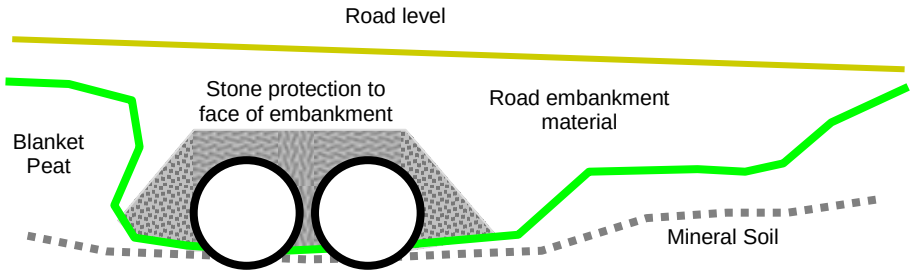
Code	Watercourse	Context	Size	Eco	Structure	Eco Provisions
S_IS_SN	Stream	Incised	Small	No	circular culvert	-
S_IS_SY	Stream	Incised	Small	Yes	rectangular culvert	Tunnel / Natural Bed / Velocity constraints
S_IM_SN	Stream	Incised	Medium	No	circular culvert	-
S_IM_SY	Stream	Incised	Medium	Yes	rectangular culvert	Tunnel / Natural Bed / Velocity constraints
S_IL_HN	Stream	Incised	Large	No	Bridge / Segmental arch	-
S_IL_HY	Stream	Incised	Large	Yes	Bridge / Segmental arch	Natural bank margin ~1m each side
S_BS_SN	Stream	Broad	Small	No	circular culvert	-
S_BS_SY	Stream	Broad	Small	Yes	rectangular culvert	Ledges / Natural Bed / Velocity constraints
S_BM_SN	Stream	Broad	Medium	No	circular culvert	-
S_BM_SY	Stream	Broad	Medium	Yes	rectangular culvert	Ledges / Natural Bed / Velocity constraints
S_BL_HN	Stream	Broad	Large	No	Bridge / Segmental arch	-
S_BL_HY	Stream	Broad	Large	Yes	Bridge / Segmental arch	Natural bank margin ~1m each side
D_RS_SN	Ditch	Road drain	Small	No	circular culvert	-
D_RL_SN	Ditch	Road drain	Large	No	circular culvert	-
D_LS_SN	Ditch (Grip)	Land drain	Small	No	circular culvert	-
D_LL_SN	Ditch	Land drain	Large	No	circular culvert	-
D_LL_SY	Ditch	Land drain	Large	Yes	rectangular culvert	Ledges / Natural Bed / Velocity constraints
P_IS_SN	Peat Hagg	Incised	Small	No	circular culvert	-
P_IL_SN	Peat Hagg	Incised	Large	No	circular culvert (multiple)	-
P_BS_SN	Peat Hagg	Broad	Small	No	circular culvert	-
P_BL_SN	Peat Hagg	Broad	Large	No	circular culvert (multiple)	-
P_BS_SN	Peat Pipe	Buried	Small	No	circular pipe	-
P_BL_SN	Peat Pipe	Buried	Large	No	circular pipe	-
F_SN_SN	Flush	Surface	Narrow	No	drainage layer	-
F_SB_SN	Flush	Surface	Broad	No	drainage layer & pipes	-

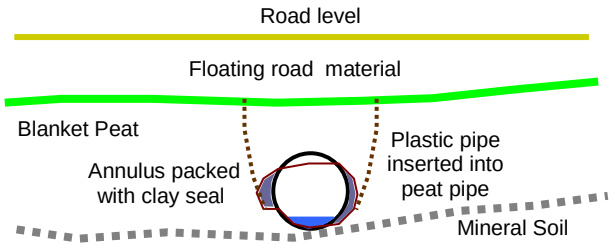
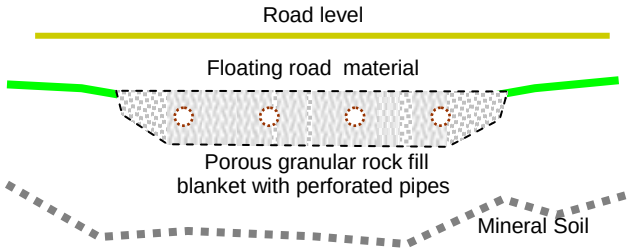
Table A1.6 Illustration of Watercourse Crossings

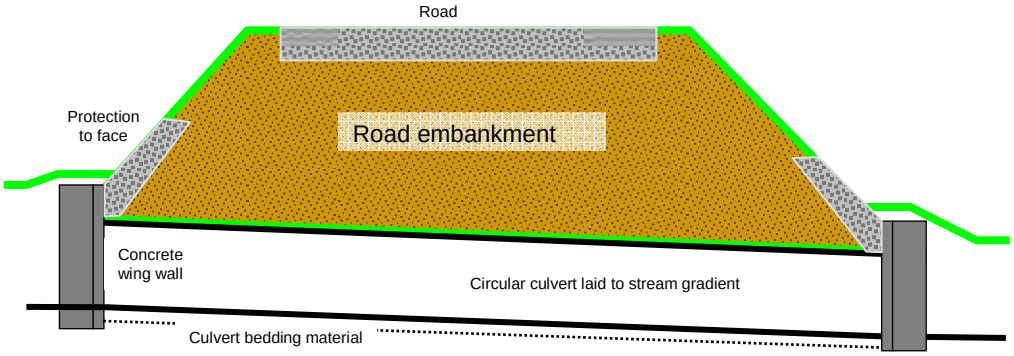
	Sketch of Channel Cross-Section / Longitudinal Section	Comments
1	**Stream: Broad valley, Small channel, No Eco provision** 	Typical of small headwater burns on rolling topography, perhaps before slopes become steeper and streams gather volume and energy and are more incised. Altitude or downstream topographic features exclude the possibility of fish being present. A circular precast concrete or plastic pipe can be placed on bedding material so that the invert is aligned with the original bed level. The pipe diameter is sized by inspection of stream morphology because calculations alone may only provide the illusion of precision.
2	**Stream: Broad valley, Small channel, Eco provision** 	Typical of small burns on rolling topography, similar to (1) above but where there is a requirement for mammals to pass along the watercourse. A circular precast concrete or plastic pipe can be placed on bedding material so that the invert is aligned with the original bed level. The mammal passage should be at top of bank level and comply with minimum diameter requirements.

	Sketch of Channel Cross-Section / Longitudinal Section	Comments
3	**Stream: Broad valley, Medium channel, Eco provision** 	Typical of mid reach 'Highland' streams with granular and cobbled beds. The habitat is well suited to resident and migratory fish. Aquatic mammals are present. The rectangular box culvert structure contains a reinstated natural bed and the width allows for the provision of mammal ledges aligned with the banks. The freeboard provides passage for the design flood flows.
4	**Stream: Broad valley, Large channel, Eco provision (or not)** 	Typical of mid reach streams where superficial drift deposits are shallow. The stream has cut to the rock and the bed consists of boulders and intact rock. Placing rectangular box culvert(s) would require bedrock to be broken and excavated. An alternative to (5) using corrugated metal arch set into concrete footings which are clear of the stream banks. This also allows passage for mammals. The height of the arch will pass the design flood without surcharging.

	Sketch of Channel Cross-Section / Longitudinal Section	Comments
5	**Stream: Broad valley, Large channel, Eco provision (or not)** 	Typical of mid reach streams where superficial drift deposits are shallow. The stream has cut to the rock and the bed consists of boulders and intact rock. Placing rectangular box culvert(s) would require bedrock to be broken and excavated. An alternative to (4) using concrete abutments and steel / concrete composite decking. Passage for mammals where necessary. The height of the bridge soffit will pass the design flood without surcharging.
6	**Stream: Incised valley, Medium channel, Eco provision** 	Typically found on energetic streams which have cut into deep clay or glacial deposits. As flood flows cannot spread latterly depth fluctuations may be considerable. The rectangular box culvert structure contains a reinstated natural bed. As an alternative to mammal ledges a higher level circular pipe allows mammal passage. This would act as a high flow relief if required, but be above the majority of minor floods.

	Sketch of Channel Cross-Section / Longitudinal Section	Comments
7	**Stream: Incised valley, Large channel, No Eco provision** 	Typically found on energetic streams which have cut through superficial deposits and into the rock formation. Depth fluctuations may be considerable, as flood flows cannot spread laterally. The bedrock has been broken out to facilitate the placing of large rectangular box culvert which will pass the design flow without surcharging.
8	**Peat Hagg: Broad, Large (deep) channel, No Eco provision** 	Typically found in deep blanket peat where the gulley has bottomed out at the mineral soil / rock interface. Normally flows are small arising from seepage out of the peat, with intermittent large storm flows which may carry blocky peat fragments. The soil / bedrock has been excavated to allow for bedding and twin circular culverts set at a level which will avoid upstream ponding. The pipe diameter is sized by inspection of the gully morphology because calculations alone may only provide the illusion of precision.

	Sketch of Channel Cross-Section / Longitudinal Section	Comments
9	**Peat Pipe: Buried, Large size** 	These are encountered at random in blanket peat (and some may go un-noticed). Ensuring continuity of the bog hydrology is important. The section of peat pipe which will be below the road should be excavated and a 'best fit' plastic pipe should be inserted into the irregular ends. The space between the drainage pipe and the peat pipe requires to be sealed with natural material such as clay. The trench should be refilled with the excavated peat.
10	**Flushes: Various widths** 	Within the area of the flush there is no clearly defined channel, other than perhaps a broad concave area. Flow is predominantly by sub-surface interflow and it is important to ensure this continuity and avoid compaction of the flush by the road. A drainage blanket wrapped in geotextile placed below the road construction will provide flow continuity without concentrating the discharges into a narrow channel.

	Sketch of Channel Cross-Section / Longitudinal Section	Comments
11	**Longitudinal Section: Circular culvert, no Eco provision**  	In the case of crossings which have no need for particular ecological provision a circular culvert may be the preferred choice. This is generally laid to the stream gradient on prepared bedding material. The entrance and exit to the culvert require wing walls to locally stabilise the stream banks and the toe of the road embankment. Depending on the size of the opening various forms of wing wall construction may be used - concrete, gabions, stone. If there is a risk of surcharge then the embankment face may require protection.

Appendix B

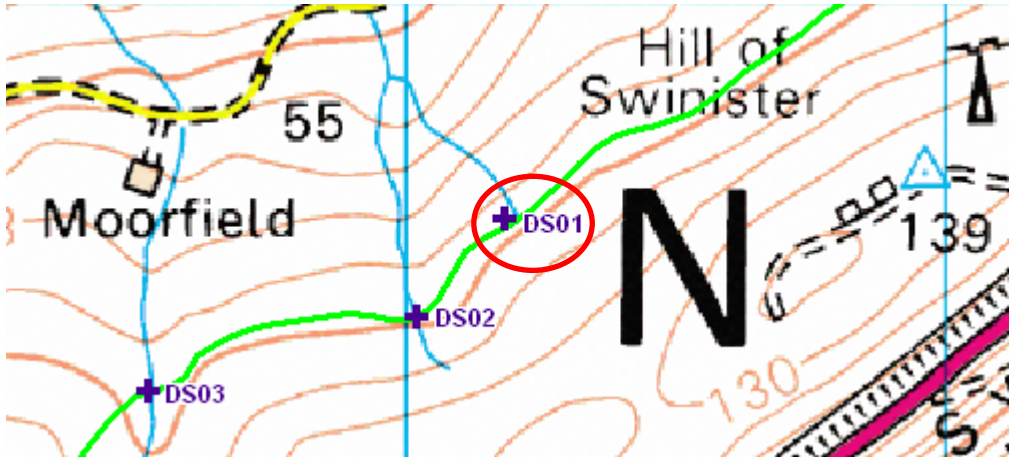
Watercourse Crossings Identified at 1:50,000 Scale

Individual Stream Crossing Descriptions:

DS01	CS01	KS01	NS01
DS02	CS02	KS02	NS02
DS03	CS03	KS03	NS03
DS04		KS05	NS04
DS05		KS06	NS05
DS06		KS07	NS06
DS07		KS08	NS07
DS08		KS09	NS08
DS09		KS10	NS09
DS10		KS11	NS10
DS11		KS12	NS11
DS12		KS13	NS12
DS13		KS14	NS13
DS14		KS15	NS14
DS15		KS16	NS15
			NS16
			NS17
			NS18
			NS19
			NS20

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS01
Route:	Access track between A968 & D16
Catchment ID:	5
Watercourse:	Stenswall Burn - feeder burn to North Burn
NGR:	HU 43186 72598
Description:	Small stream 0.3m wide in overgrown gully up to 2.5m wide by 1.2m deep with a water depth of 0.06m. Peat bed with some medium sized cobbles and peat banking.
CAR Category:	Small
Catchment Area:	0.15 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert



 Not to Scale

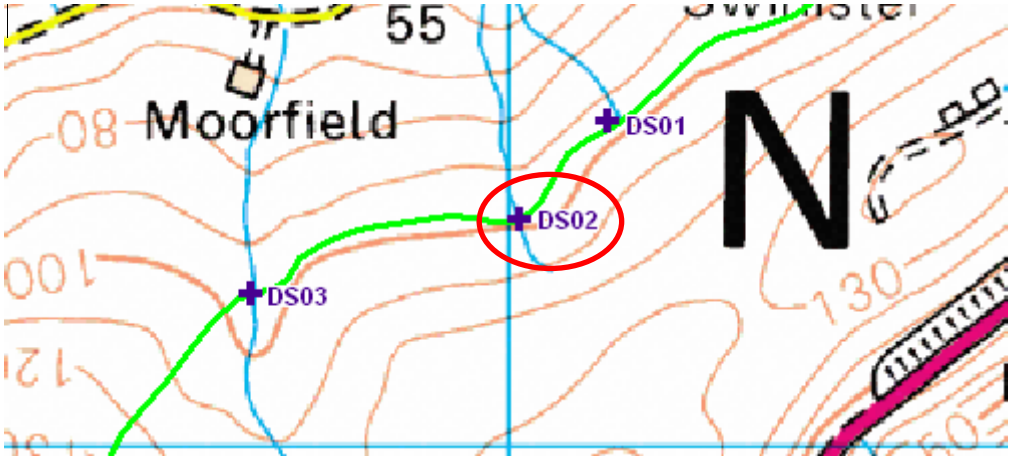
Looking across stream Viking DS01 across 1.jpg

Looking downstream Viking DS01 down.jpg

Looking upstream Viking DS01 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS02
Route:	Access track between A968 & D16
Catchment ID:	5
Watercourse:	Stenswall Burn feeder burn to North Burn
NGR:	HU 43021 72418
Description:	Small stream 0.5m wide with a water depth of 0.1m in a boggy area up to 10m wide by 1.8m deep. Peat bed & vegetated peat banks. Peat slightly undercut in places. No distinct channel.
CAR Category:	Small
Catchment Area:	0.21 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert



 Not to Scale

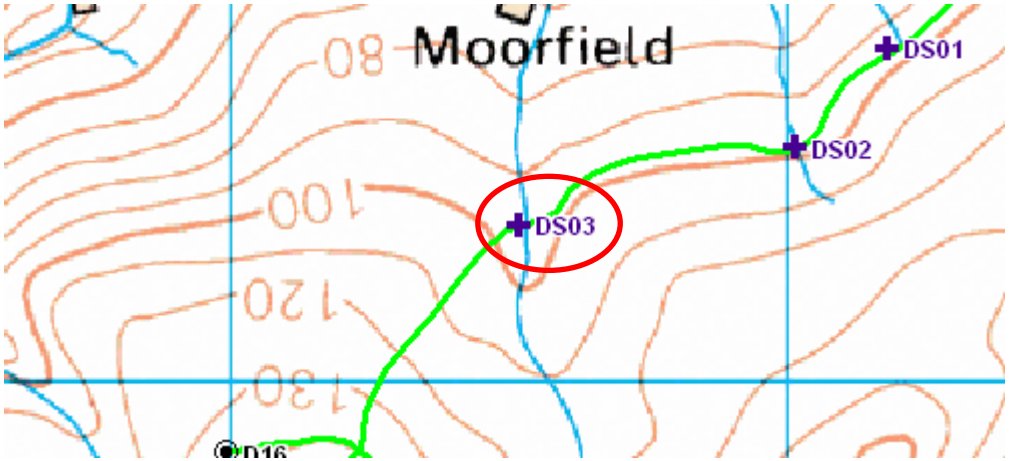
Looking across stream Viking DS02 across 1.jpg

Looking downstream Viking DS02 down.jpg

Looking upstream Viking DS02 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS03
Route:	Access track between A968 & D16
Catchment ID:	5
Watercourse:	Burn of Moorfield, tributary burn to North Burn
NGR:	HU 42524 72280
Description:	Small stream around 0.5m wide within broad flood channel 20m wide by 5m deep with a water depth of 0.3m. Peat bed with cobbles and boulders.
CAR Category:	Small
Catchment Area:	0.53 km^2 (upstream of crossing location)
Ecology:	Migratory fish, unlikely. Mammals, none
Crossing Type:	New crossing: Rectangular culvert.



 Not to Scale

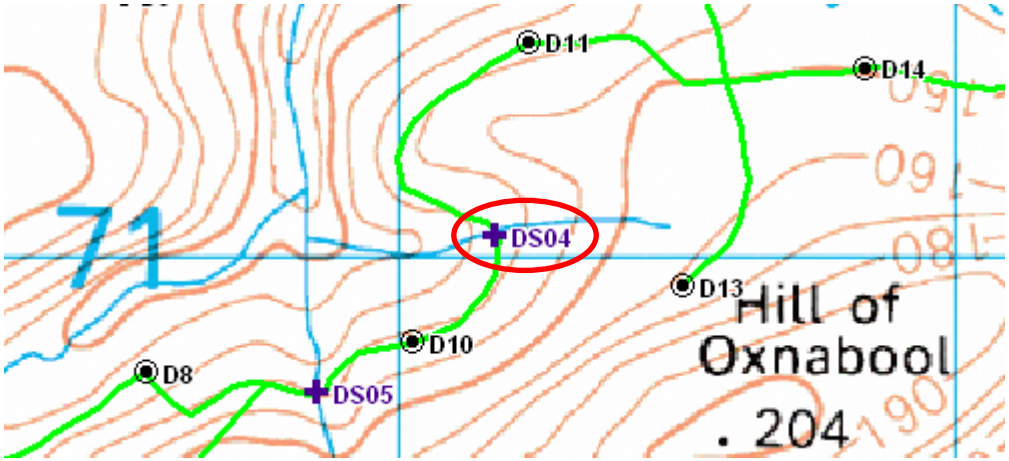
Looking across stream Viking DS03 across.jpg

Looking downstream Viking DS03 down.jpg

Looking upstream Viking DS03 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS04
Route:	Access track between D10 & D11
Catchment ID:	5
Watercourse:	Burn of Laxobigging
NGR:	HU 41173 71040
Description:	Boggy area 20m wide by 5m deep with a water depth of 0.3m. No distinct watercourse, peat bed with some exposed rock.
CAR Category:	Medium
Catchment Area:	0.26 km^2 (upstream of crossing location)
Ecology:	Migratory fish, unlikely. Mammals, none
Crossing Type:	New crossing: Multiple circular culverts.



 Not to Scale

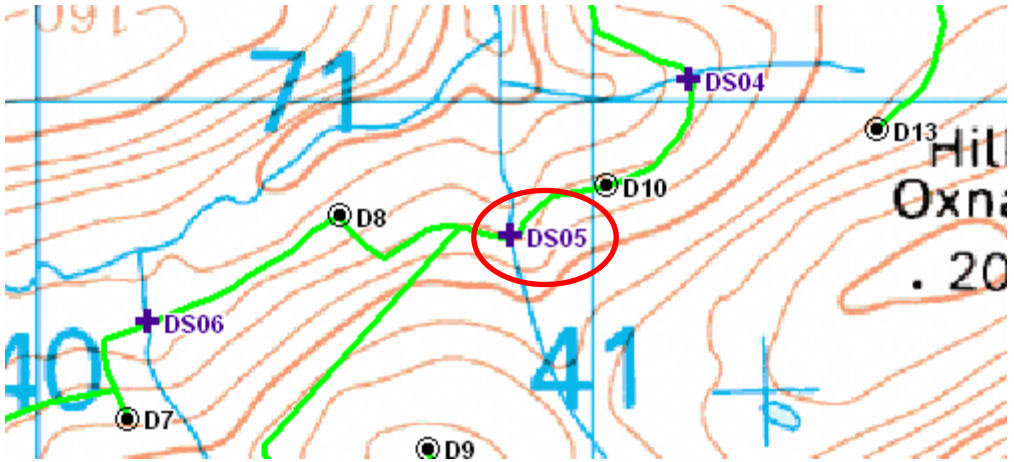
Looking across stream Viking DS04 across.jpg

Looking downstream Viking DS04 down.jpg

Looking upstream Viking DS04 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS05
Route:	Track between D8 & D10
Catchment ID:	5
Watercourse:	Burn of Laxobigging
NGR:	HU 40853 70757
Description:	Small stream in well defined v-shaped channel up to 4m deep and 0.4-1.0m wide. Medium to coarse rock bed and grass and moss banking on flood channel which is up to 14m wide
CAR Category:	Small
Catchment Area:	0.57 km^2 (upstream of crossing location)
Ecology:	Migratory fish, likely. Mammals, none.
Crossing Type:	New crossing: Rectangular culvert.



 Not to Scale

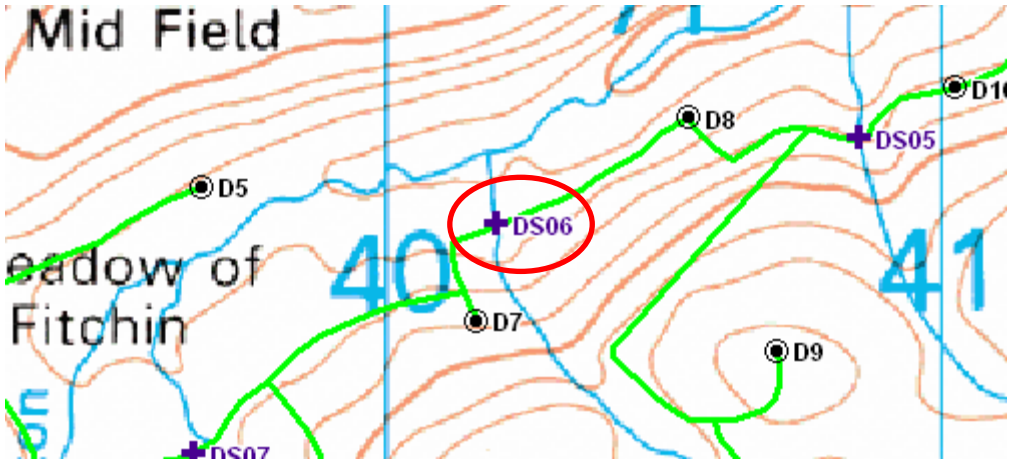
Looking across stream Viking DS05 across.jpg

Looking downstream Viking DS05 down.jpg

Looking downstream Viking DS05 down.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS06
Route:	Track between D7 & D8
Catchment ID:	5
Watercourse:	Burn of Oxnabool feeder burn to Burn of Laxobigging
NGR:	HU 40203 70602
Description:	Small stream 0.4m wide by 1m deep, water level 0.2m. Stream within a larger flood channel about 2-3m wide. Peaty bed with cobbles and large rocks on bed.
CAR Category:	Medium
Catchment Area:	0.51 km^2 (upstream of crossing location)
Ecology:	Migratory fish, unlikely. Mammals, none.
Crossing Type:	New crossing: Rectangular culvert.



 Not to Scale

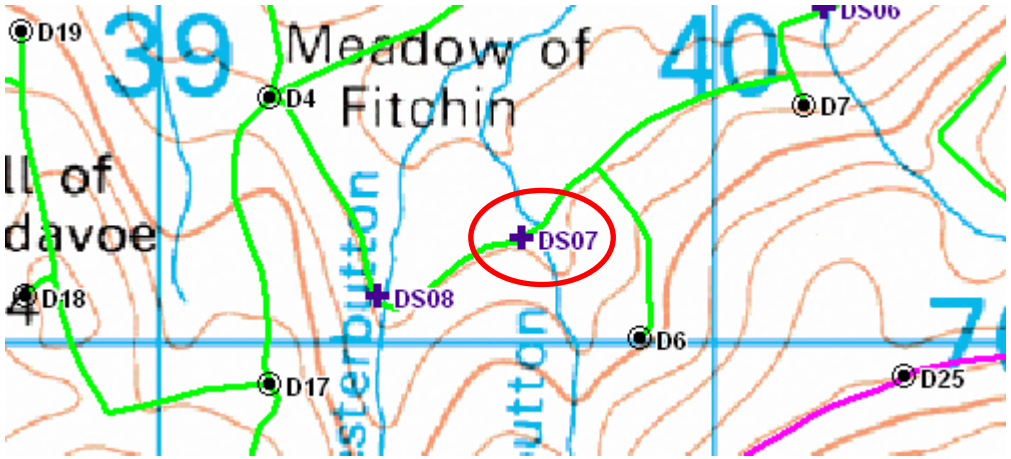
Looking across stream Viking DS06 across.jpg

Looking across stream Viking DS06 across.jpg

Looking upstream Viking DS06 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS07
Route:	Track between D4, D6 & D7
Catchment ID:	5
Watercourse:	Burn of Easterbutton
NGR:	HU 39658 70188
Description:	Channel 1.2m wide by roughly a 1m high with a water depth of 0.7m and a rocky bed. In a valley up 25m in width.
CAR Category:	Medium
Catchment Area:	1.15 km^2 (upstream of crossing location)
Ecology:	Migratory fish, present. Mammals, none.
Crossing Type:	New crossing: Rectangular culvert.



 Not to Scale

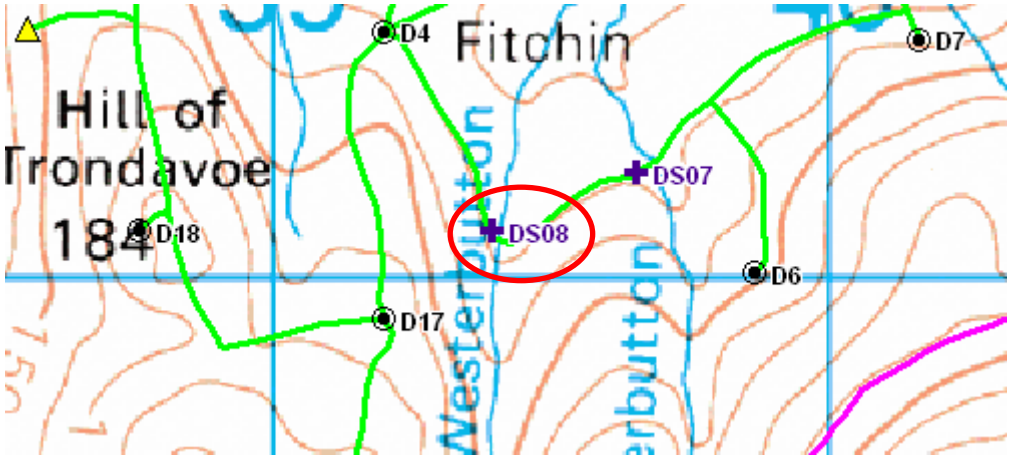
Looking across stream Viking DS07 across.jpg

Looking across stream Viking DS07 across.jp

Looking upstream Viking DS07 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS08
Route:	Track between D4, D6 & D7
Catchment ID:	5
Watercourse:	Burn of Westerbutton
NGR:	HU 39399 70083
Description:	Well defined channel with gently sloping grass banking. 0.8-1.2m wide with a flood channel of 9m. Water depth 0.3 - 0.5m with peat bed and banking.
CAR Category:	Medium
Catchment Area:	0.94 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Rectangular culvert



 Not to Scale

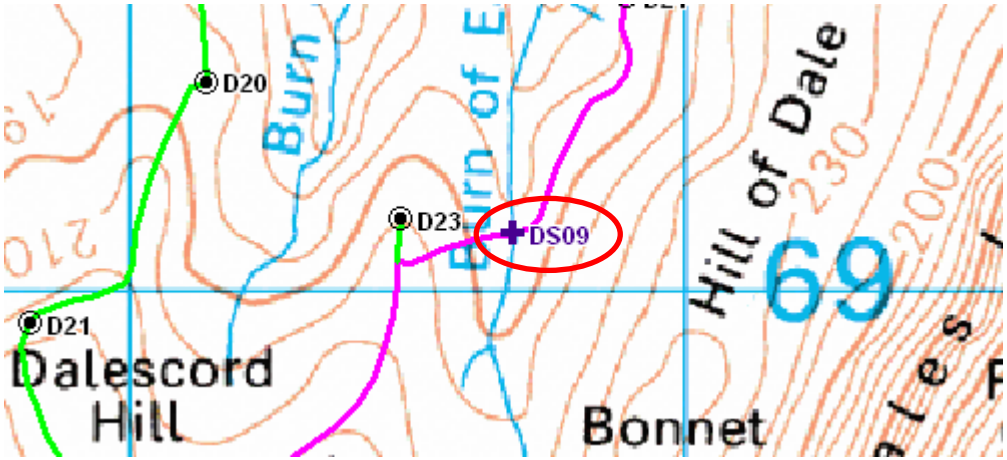
Looking across stream Viking DS08 across.jpg

Looking downstream Viking DS08 down.jpg

Looking upstream Viking DS08 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS09
Route:	Track between D23 & D24
Catchment ID:	5
Watercourse:	Burn of Easterbutton
NGR:	HU 39692 70083
Description:	Small stream in 0.6m wide with a water depth of 0.2m. Medium and coarse stones on peaty bed and peat banking. Stream widens at meanders and points of overground flow.
CAR Category:	Small
Catchment Area:	0.52 km^2 (upstream of crossing location)
Ecology:	Migratory fish, present. Mammals, none
Crossing Type:	New crossing: Rectangular culvert



 Not to Scale

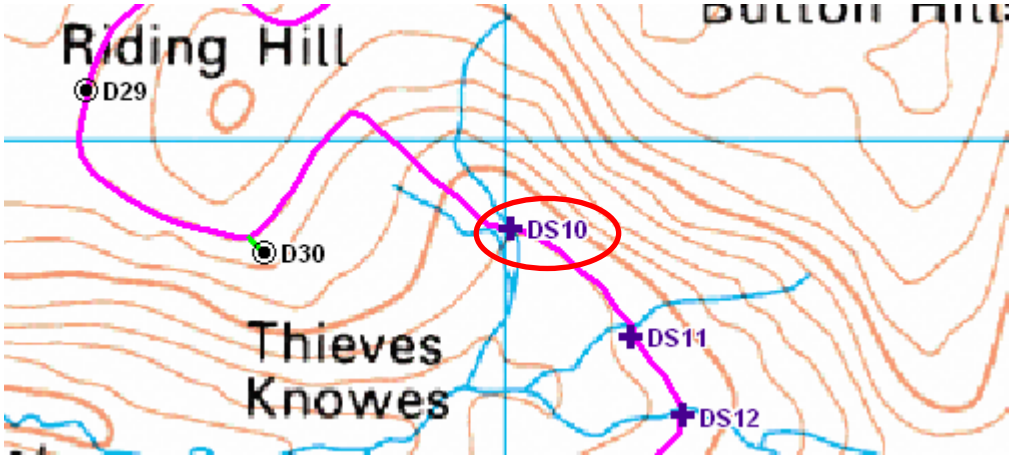
Looking across stream Viking DS09 across 2.jpg

Looking downstream Viking DS09 down.jpg

Looking upstream Viking DS09 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS10
Route:	Track between D30 & D31
Catchment ID:	9
Watercourse:	Unamed tributray to Burn of Skelladale
NGR:	HU 39011 67843
Description:	Small, shallow stream 0.3-0.6m, with a water depth of 0.1m. Peat bed and banking. Channel could dry up on occasion.
CAR Category:	Small
Catchment Area:	0.31 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert



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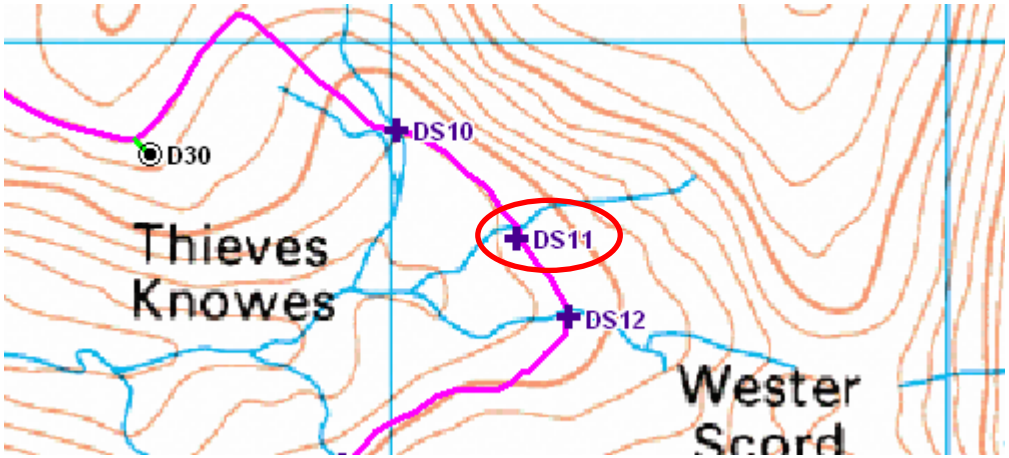
Looking across stream Viking DS10 across 2.jpg

Looking downstream Viking DS10 down.jpg

Looking upstream Viking DS10 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS11
Route:	Track between D30 & D31
Catchment ID:	9
Watercourse:	Unamed tributary to Burn of Skelladale
NGR:	HU 39230 67650
Description:	Small, poorly defined stream, boogy channel rather than a stream in places. Channel up 0.8m wide by 0.2m deep, with a water depth of 0.1m. Medium sized stone bed and grass banks.
CAR Category:	Small
Catchment Area:	0.33 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert



 Not to Scale

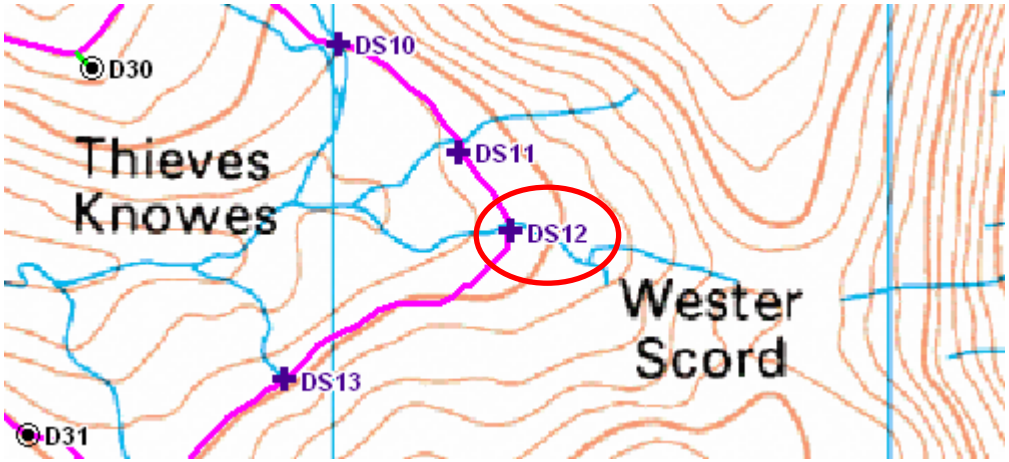
Looking across stream Viking DS11 across 2.jpg

Looking downstream Viking DS11 down.jpg

Looking upstream Viking DS11 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS12
Route:	Track between D30 & D31
Catchment ID:	9
Watercourse:	Unamed tributary burn to Burn of Skelladale
NGR:	HU 39324 67507
Description:	Small stream up to 0.5m wide in well-defined U- shaped channel. Flood channel up to 8m wide and 2.6m high, with a water depth of 0.2m. Peat bed with some cobbles. Peat banking which is slightly undercut in places.
CAR Category:	Small
Catchment Area:	0.25 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Rectangular culvert / arch



 Not to Scale

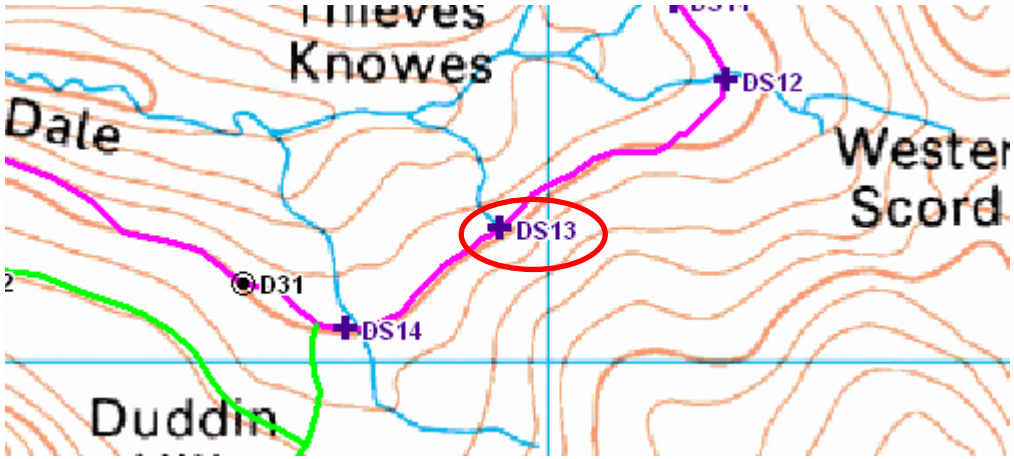
Looking across stream Viking DS12 across 2.jpg

Looking downstream Viking DS12 down.jpg

Looking upstream Viking DS12 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS13
Route:	Track between D30 & D31
Catchment ID:	9
Watercourse:	Unamed tributary burn to Burn of Skelladale
NGR:	HU 38913 67240
Description:	Small stream channel 0.4m wide by 0.4m high with a water depth of 0.2m. Peat bed and peat banking.
CAR Category:	Small
Catchment Area:	0.32 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert.



 Not to Scale

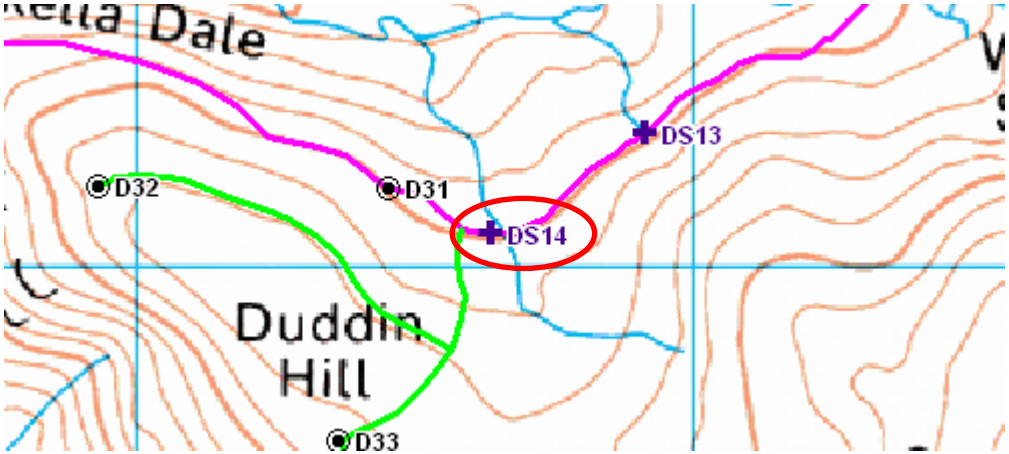
Looking across stream Viking DS13 across 2.jpg

Looking downstream Viking DS13 down.jpg

Looking upstream Viking DS13 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS14
Route:	Track between D30 & D31
Catchment ID:	9
Watercourse:	Unamed tributary burn to Burn of Skelladale
NGR:	HU 38638 67059
Description:	Small stream 0.5m wide in small to medium stream in channel 0.2-2m wide and 0.6-0.8m deep with a water level of 0.2m. Peat bed and banking.
CAR Category:	Small
Catchment Area:	0.31 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert



 Not to Scale

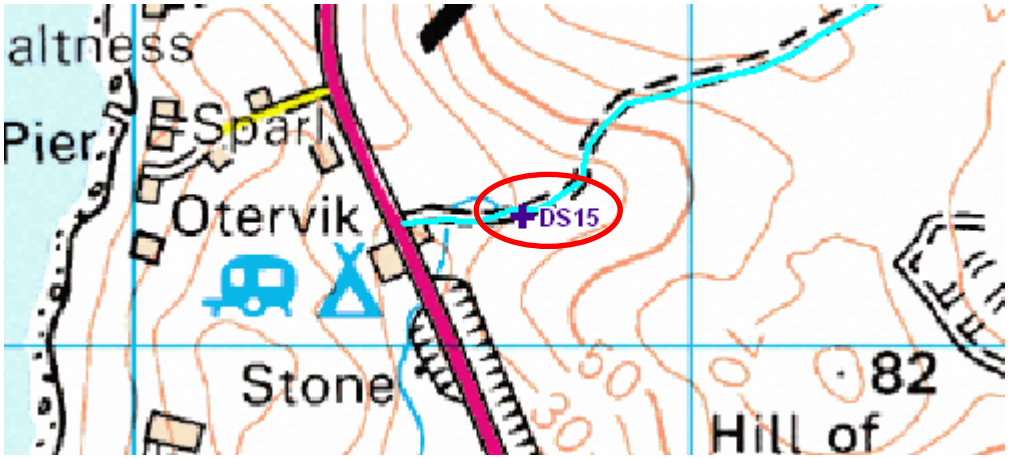
Looking across stream Viking DS14 across 2.jpg

Looking downstream Viking DS14 down.jpg

Looking upstream Viking DS14 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS15
Route:	Site access between A970 and D31
Catchment ID:	26
Watercourse:	Foulawick Burn
NGR:	HU 36700 66229
Description:	Medium stream in well-defined channel up to 2.4 m wide by 1m deep and a water depth of 0.2m. Bare rock bed. The burn culverted under existing road.
CAR Category:	Medium
Catchment Area:	0.50 km^2 (upstream of crossing location)
Ecology:	Migratory fish, likely. Mammals, none
Crossing Type:	Probably requiring upgrade of existing crossing: Rectangular culvert



 Not to Scale

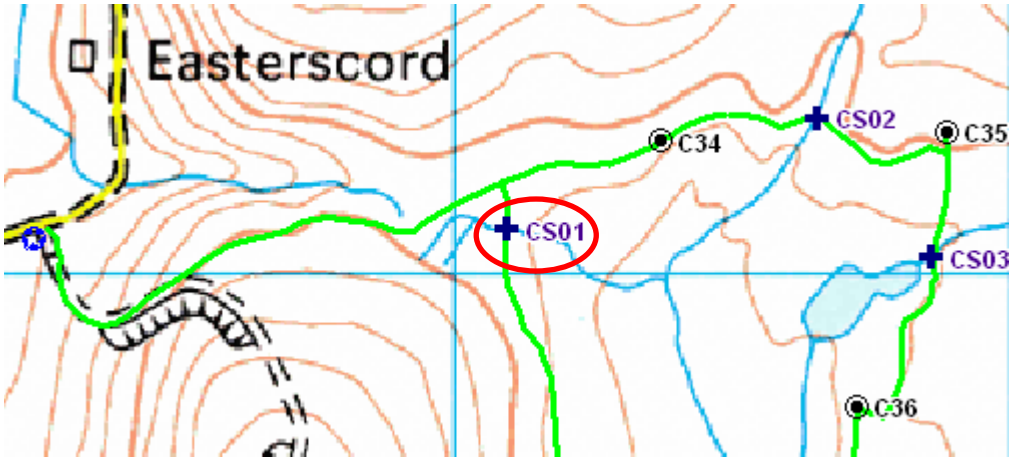
Looking across stream Viking DS15 across 2.jpg

Looking downstream Viking DS15 down.jpg

No Photograph Available

Viking Wind Farm Survey of Stream Crossings

Crossing:	CS01
Route:	Between Access road and C34
Catchment ID:	1
Watercourse:	Unamed tributary burn to Seggie Burn
NGR:	HU 42095 66077
Description:	Small stream 0.5-0.7m wide and 0.9m deep with a water level of 0.1m. Peat bed with some sand and gravel. Vegetated peat banking. Good flow with some undercutting of the peat banking.
CAR Category:	Small
Catchment Area:	0.07 km^2 (upstream of crossing location)
Ecology:	Migratory fish, unlikely. Mammals, none
Crossing Type:	New crossing: Rectangular culvert



 Not to Scale

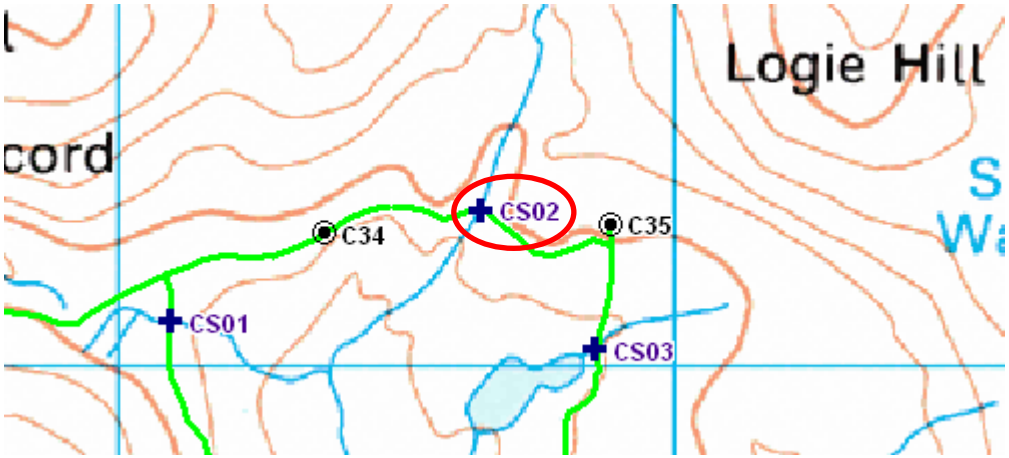
Looking across stream Viking CS01 across 1.jpg

Looking downstream Viking CS01 down.jpg

Looking upstream Viking CS01 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	CS02
Route:	Between C34 & C35
Catchment ID:	1
Watercourse:	Unnamed tributary burn to Seggie Burn
NGR:	HU 42652 66278
Description:	Small channel 0.04-0.08m wide by 1m deep. Water depth 0.2m deep. Fine silt and peat bed and peat banking.
CAR Category:	Small
Catchment Area:	0.56 km^2
Ecology:	Migratory fish, unlikely. Mammals, none
Crossing Type:	New crossing: Rectangular culvert



 Not to Scale

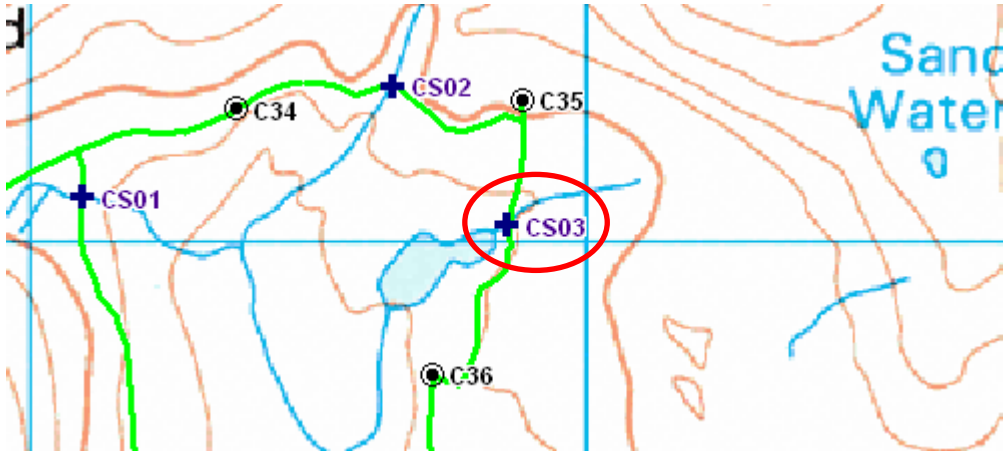
Looking across stream Viking CS02 across 1.jpg

Looking downstream Viking CS02 down.jpg

Looking upstream Viking CS02 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	CS03
Route:	Between C35 & C36
Catchment ID:	1
Watercourse:	Unnamed tributary to Seggie Burn
NGR:	HU 42858 66027
Description:	Small stream/peat pipe. Overground channel 1m wide by 1.5m deep. Flood channel 16m wide. Water depth 0.2m deep. Fine silt, cobble and peat bed and peat banking. Collapsed peat pipe which looks quite unstable.
CAR Category:	Small
Catchment Area:	0.24 km^2
Ecology:	Migratory fish, none. Mammals none
Crossing Type:	New crossing: Circular pipe



 Not to Scale

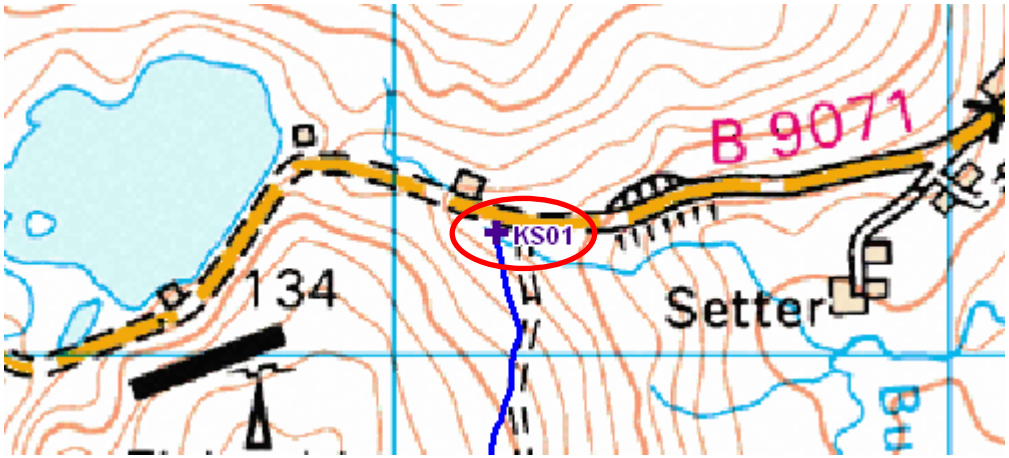
Looking across stream Viking CS03 across 1.jpg

Looking downstream Viking CS03 down.jpg

Looking upstream Viking CS03 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS01
Route:	Site access track just off B9071
Catchment ID:	8
Watercourse:	Unnamed feeder burn to Burn of Kirkhouse
NGR:	HU 39188 62220
Description:	Exiting circular steel culvert 900mm in diameter under existing track. Stream is in a shallow v-shaped channel 1m wide by 0.4-0.5m deep. Peat bed with silt and medium-coarse rock. Peat banking with some exposed rock.
CAR Category:	Small
Catchment Area:	0.19 km^2 (upstream of crossing location)
Ecology:	Migratory fish, unlikely. Mammals, none.
Crossing Type:	Probably requiring upgrade of existing crossing: Circular culvert



 Not to Scale

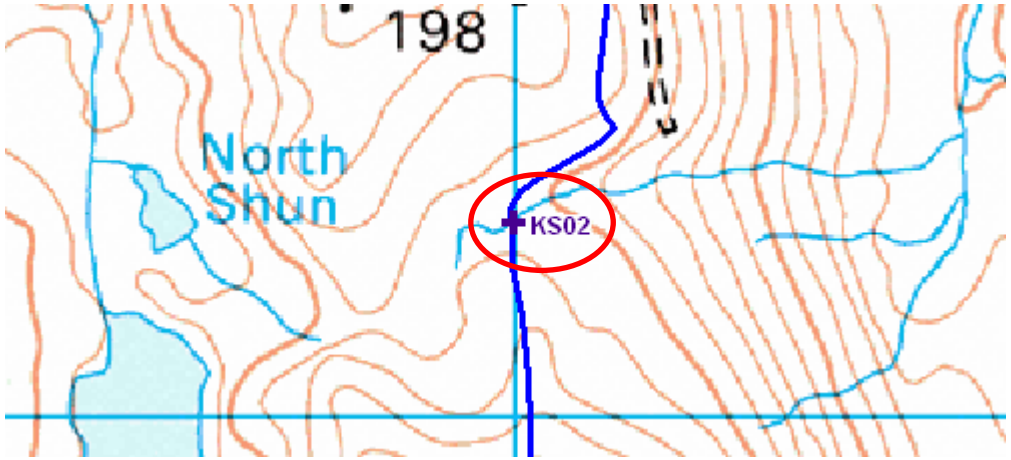
Looking across stream Viking KS01 across 1.jpg

Looking downstream Viking KS01 down.jpg

Looking upstream Viking KS01 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS02
Route:	Site access track between B9071 & K42
Catchment ID:	8
Watercourse:	Tributary to Burn of Kirkhouse
NGR:	HU 39000 61347
Description:	Small stream with good flow, water 0.1m deep. Well defined channel 0.5m wide by 0.6m deep cut into peat. Vegetated bed with some coarse rock exposed. Over hanging vegetated peat banks.
CAR Category:	Small
Catchment Area:	0.21 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none.
Crossing Type:	New crossing: Circular culvert



 Not to Scale

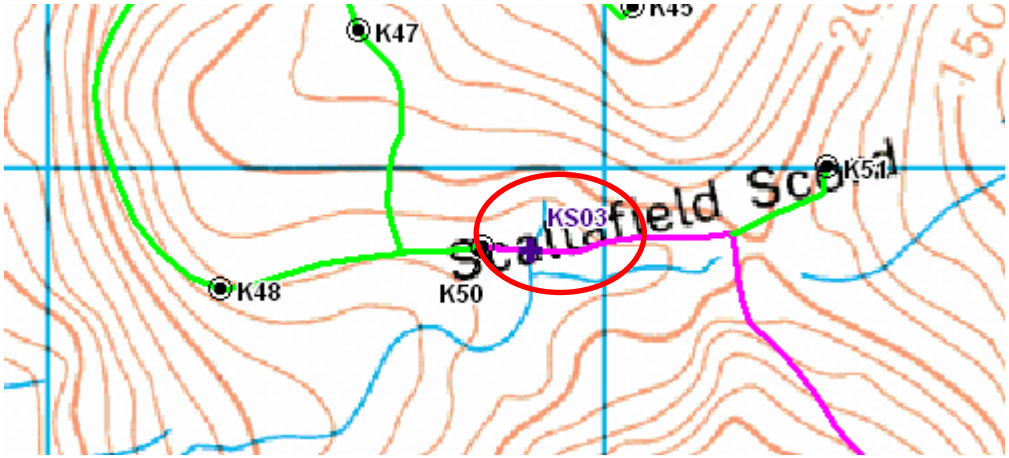
Looking across stream Viking KS02 across 1.jpg

Looking downstream Viking KS02 down.jpg

Looking upstream Viking KS02 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS03
Route:	Site Access Track between K50 & K51
Catchment ID:	2
Watercourse:	Unnamed tributary of Red Burn
NGR:	HU 38870 57849
Description:	Poorly defined stream with diffuse flow. Flush over the surface up to 3m wide. Poor flow.
CAR Category:	Medium
Catchment Area:	0.09 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none.
Crossing Type:	New crossing: Drainage layer and pipes



 Not to Scale

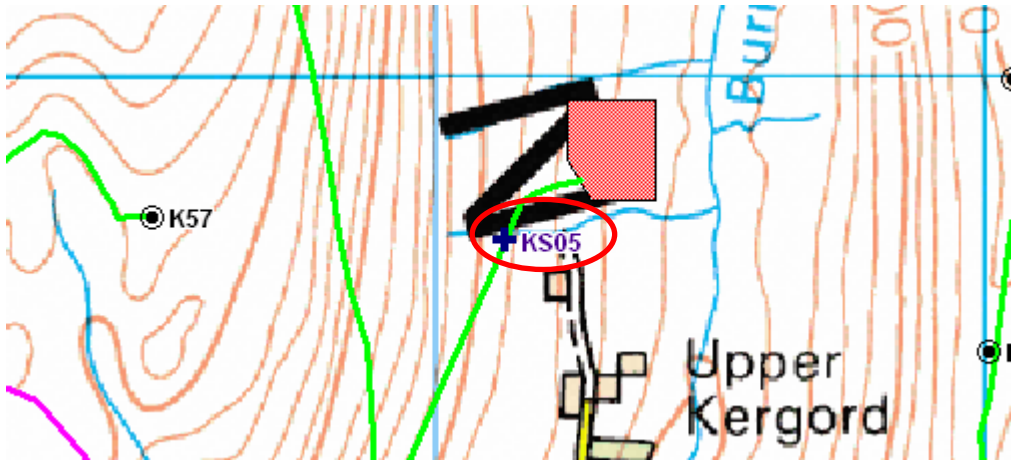
Looking across stream Viking KS03 across 1.jpg

Looking downstream Viking KS03 down.jpg

Looking upstream Viking KS03 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS05
Route:	Access track to convertor station
Catchment ID:	4
Watercourse:	Unnamed feeder burn to Burn of Weisdale
NGR:	HU 40027 56700
Description:	Small ditch, has been straightened and probably deepened. Channel 1.5m wide by 0.5m deep. Peat bed with some exposed rock and peat and vegetated banking. Note surveyed location was 100m W (upstream) of crossing position due to late layout amendment.
CAR Category:	Medium
Catchment Area:	0.06 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert.



Not to Scale

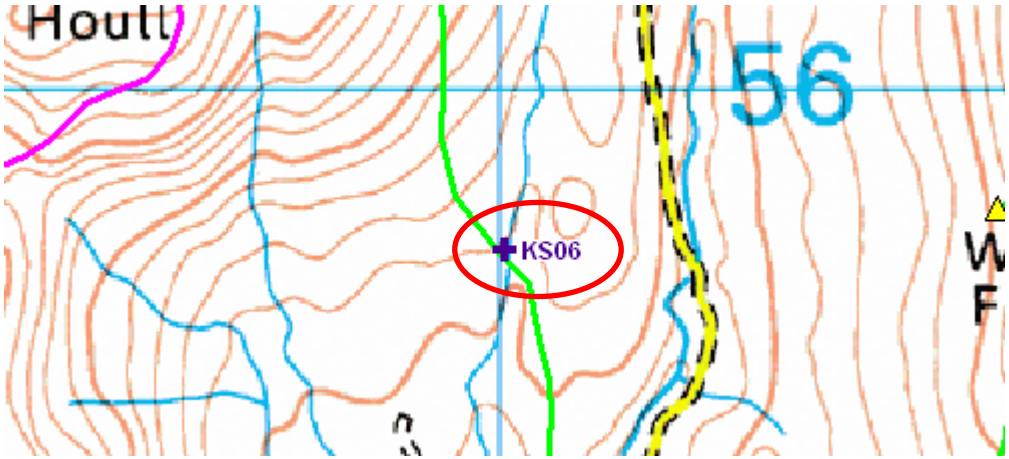
Looking across stream Viking KS05 across.jpg

Looking downstream Viking KS05 down.jp

Looking upstream Viking KS05 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS06
Route:	Site access track between B9075 & K52
Catchment ID:	4
Watercourse:	Burn of Droswall
NGR:	HU 40013 55708
Description:	Small Stream 0.1-0.2m wide, with a water depth of 0.1m. Channel 0.6m wide by 0.6m deep. Flood channel 14m wide by 5.5m high. Peat bed and vegetated peat banks.
CAR Category:	Small
Catchment Area:	0.42 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Rectangular culvert



Not to Scale

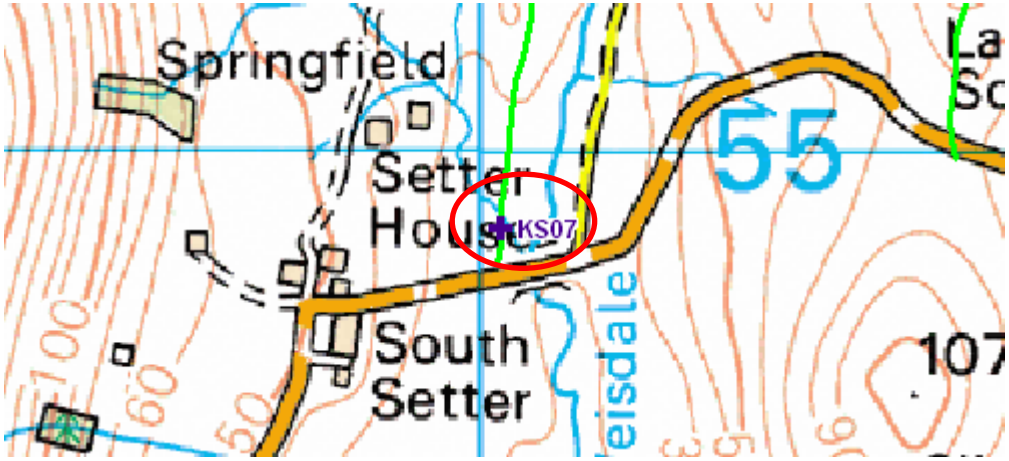
Looking across stream Viking KS06 across 2.jpg

Looking downstream Viking KS06 down.jpg

Looking upstream Viking KS06 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS07
Route:	Access track next to the B9075
Catchment ID:	4
Watercourse:	Burn of Weisdale
NGR:	HU 40039 54862
Description:	Small-Medium stream up to 1m wide in channel 0.5-2.0m wide by 0.5m deep, with a water depth of 0.2m. Peat bed and grass covered peat and mineral banks.
CAR Category:	Medium
Catchment Area:	2.17 km^2 (upstream of crossing location)
Ecology:	Migratory fish, likely. Mammals, none
Crossing Type:	New crossing: Rectangular culvert



Not to Scale

Looking across stream — Viking KS07 across 2.jpg

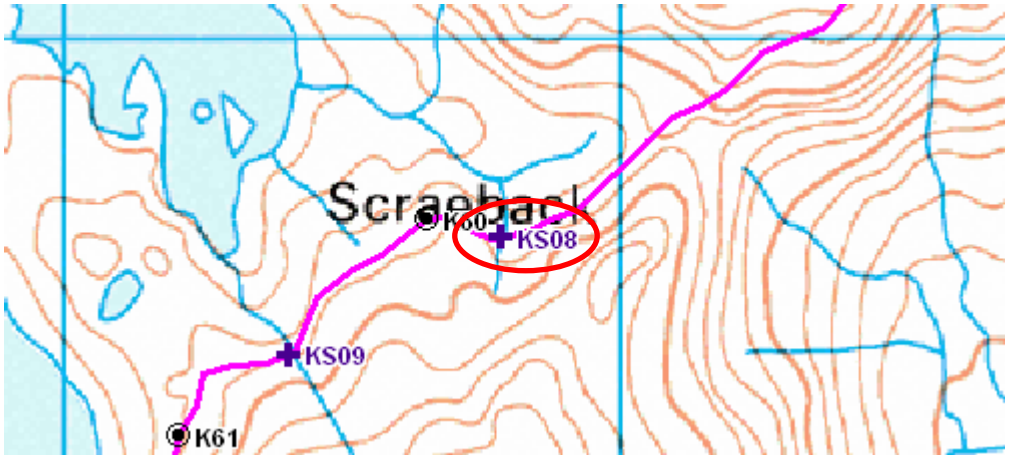
No Photograph Available

Looking downstream — Viking KS07 down.jpg

Looking upstream — Viking KS07 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS08
Route:	Between K59 & K60
Catchment ID:	2
Watercourse:	Unamed inflow burn to Lamba Water
NGR:	HU 38789 55638
Description:	Small poorly defined channel up to 1m wide and 0.1-0.4m deep. Deep peat bed >1m. Channel is boggy with a water depth of 0.1m and is very overgrown with grass, moss and water vegetation.
CAR Category:	Small
Catchment Area:	0.04 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert



 Not to Scale

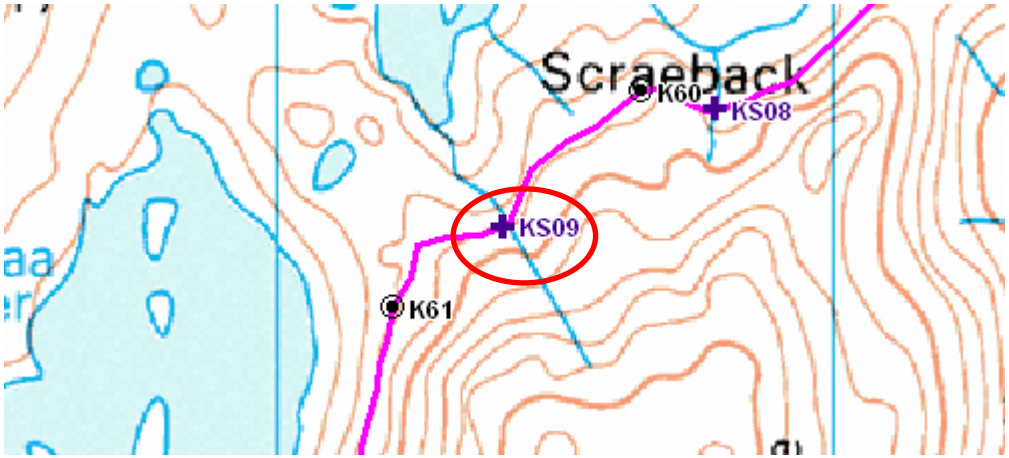
Looking across stream Viking KS08 across 2.jpg

Looking downstream Viking KS08 down.jpg

Looking upstream Viking KS08 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS09
Route:	Access track between K60 & K61
Catchment ID:	2
Watercourse:	Unamed inflow burn to Lamba Water
NGR:	HU 38406 55428
Description:	Poorly defined shallow channel up to 0.05m wide with a water depth of up to 0.01m. Vegetated bed.
CAR Category:	Small
Catchment Area:	0.21 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Multiple circular culverts



 Not to Scale

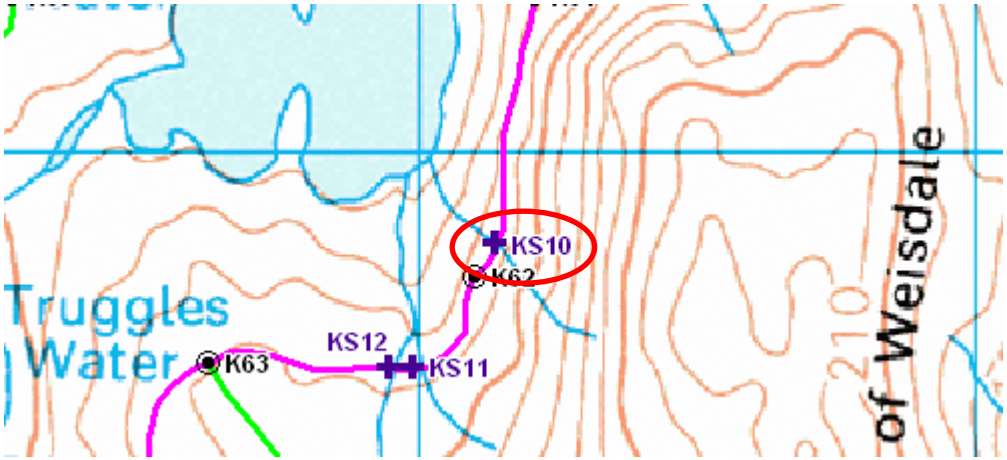
Looking across stream Viking KS09 across 2.jpg

Looking downstream Viking KS09 down.jpg

Looking upstream Viking KS09 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS10
Route:	Access track between K61 & K62
Catchment ID:	2
Watercourse:	Unamed inflow burn to Maa Water
NGR:	HU 37839 50613
Description:	Small stream up to 1m wide with 0.5-1m deep banking. Water 0.5m deep. No clear channel with peat bed and banking.
CAR Category:	Small
Catchment Area:	0.14 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert



 Not to Scale

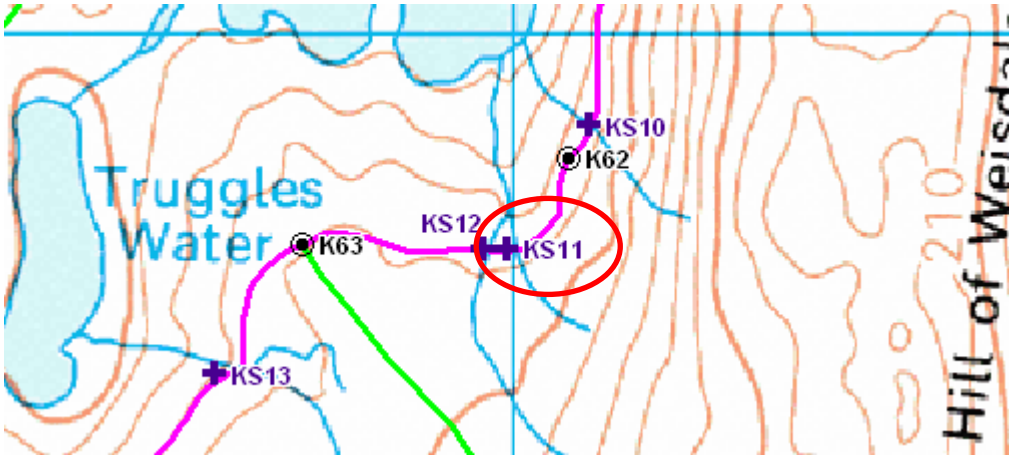
Looking across stream Viking KS10 across 2.jpg

Looking downstream Viking KS10 down.jpg

Looking upstream Viking KS10 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS11
Route:	Site access track between K62 and K63
Catchment ID:	2
Watercourse:	Unnamed inflow burn to Maa Water
NGR:	HU 37990 55428
Description:	Small stream, water 0.2m deep. Defined channel 0.5-1.0m wide by 0.4m deep. Flood channel 12m wide by 1.2m high. Vegetated peat bed with some exposed coarse rock.
CAR Category:	Small
Catchment Area:	0.14 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert



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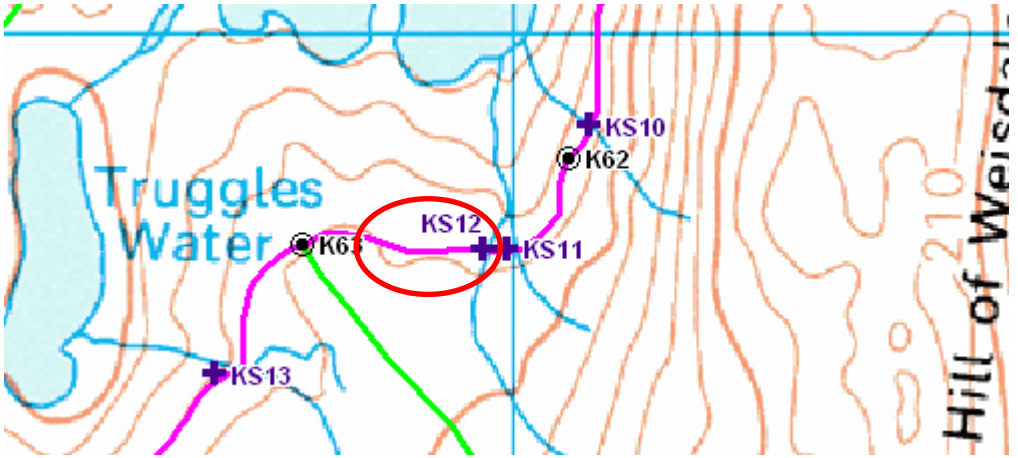
Looking across stream Viking KS11 across 2.jpg

Looking downstream Viking KS11 down.jpg

Looking upstream Viking KS11 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS12
Route:	Site access track between K62 & K63
Catchment ID:	2
Watercourse:	Unnamed inflow burn to Maa Water
NGR:	HU 37945 54611
Description:	Well defined channel 0.5m wide but up to 1.1m wide in places by 0.5-1m deep. Water depth 0.3m. Flood channel 4.5m wide & 3m high. Coarse rock and peat bed with vegetated peat banks.
CAR Category:	Small
Catchment Area:	0.23 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert.



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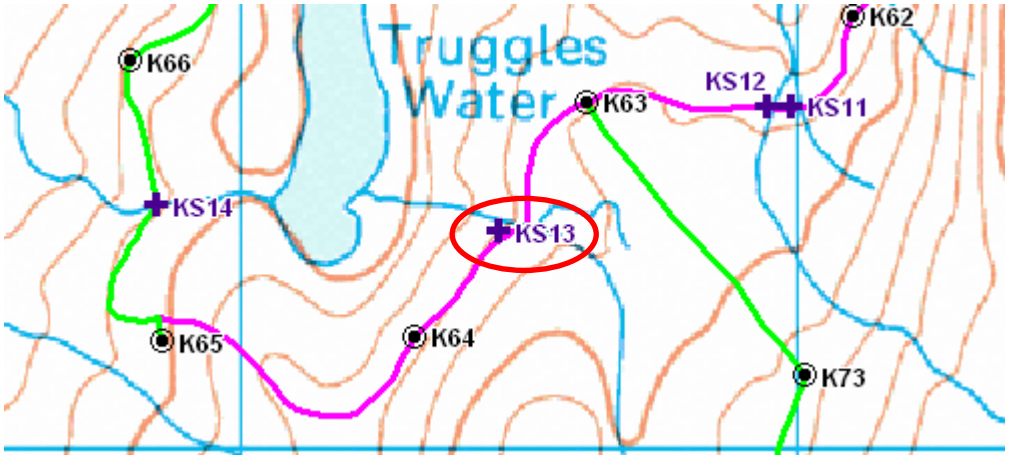
Looking across stream Viking KS12 across 2.jpg

Looking downstream Viking KS12 down.jpg

Looking upstream Viking KS12 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS13
Route:	Between K63 & K64
Catchment ID:	2
Watercourse:	Unnamed inflow burn to Truggles Water
NGR:	HU 37463 54387
Description:	Small to medium stream in V- shaped channel 0.5-1.1m wide by 0.5m deep, with a water depth of 0.2m. Predominantly cobbles and pebbles on stream bed and grass covered peat and mineral banks.
CAR Category:	Medium
Catchment Area:	0.36 km^2 (upstream of crossing location)
Ecology:	Migratory fish, likely. Mammals, none
Crossing Type:	New crossing: Rectangular culvert



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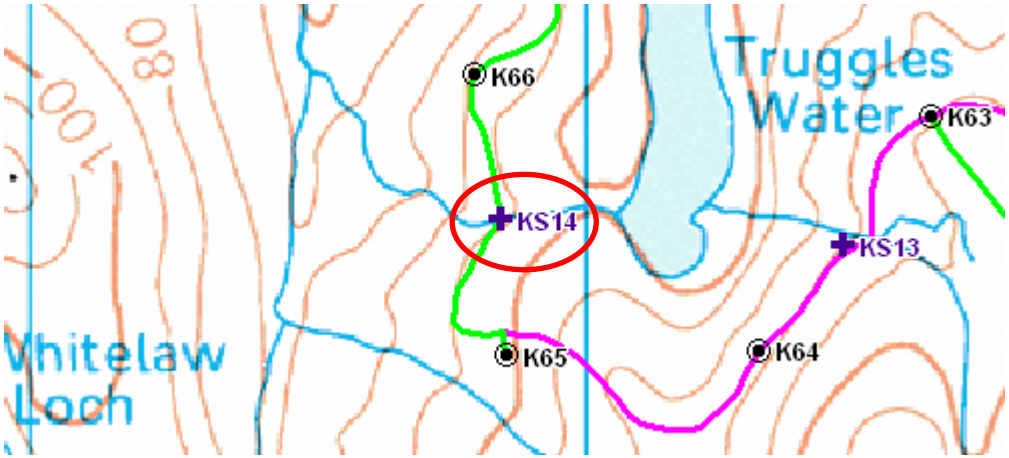
Looking across stream Viking KS13 across 2.jpg

Looking downstream Viking KS13 down.jpg

Looking upstream Viking KS13 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS14
Route:	Between K65 & K66
Catchment ID:	2
Watercourse:	Outflow burn from Truggles Water
NGR:	HU 36844 54434
Description:	Medium stream with good flow in well defined channel 1.5-2m wide by 0.8m deep, with a water depth of 0.2m. Predominantly boulders on stream bed and vegetated, peat and mineral banks. V shaped flood channel
CAR Category:	Medium
Catchment Area:	2.73 km^2 (upstream of crossing location)
Ecology:	Migratory fish, present. Mammals, none
Crossing Type:	New crossing: Rectangular culvert / arch



 Not to Scale

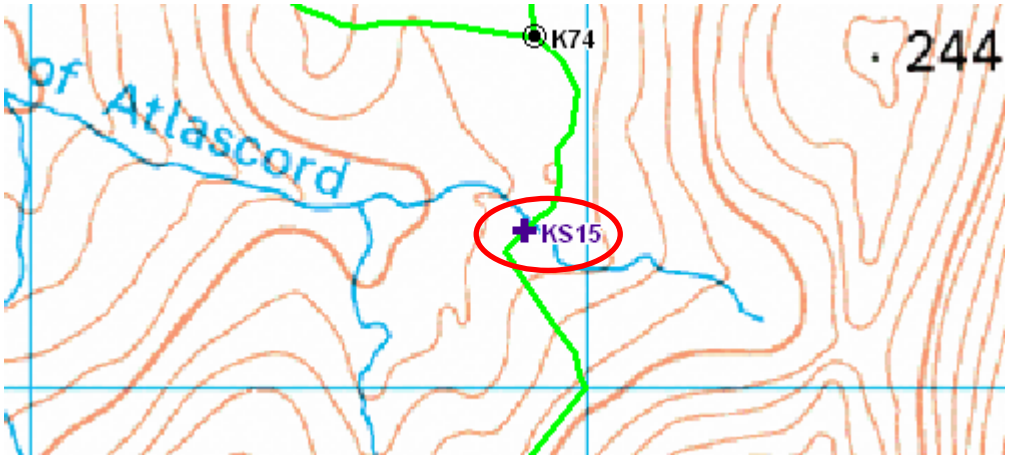
Looking across stream Viking KS14 across 2.jpg

Looking downstream Viking KS14 down.jpg

Looking upstream Viking KS14 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS15
Route:	Between K74 & K76
Catchment ID:	2
Watercourse:	Burn of Atlascord
NGR:	HU 37888 53278
Description:	Medium stream in well-defined channel 1m wide by 1.5m deep, with a water depth of 0.2m. Peat with fine silt/sand and gravel/pebble bed. Steep peat banks.
CAR Category:	Medium
Catchment Area:	0.23 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Rectangular culvert



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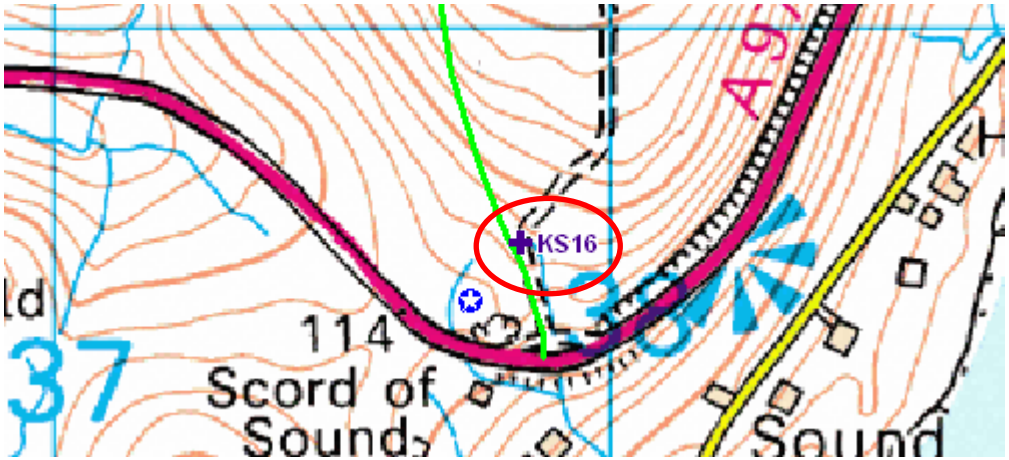
Looking across stream Viking KS15 across 2.jpg

Looking downstream Viking KS15 down.jpg

Looking upstream Viking KS15 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS16
Route:	Site access track south of K76
Catchment ID:	30
Watercourse:	Unamed feeder burn to Weisdale Voe
NGR:	HU 37839 50613
Description:	Small/medium stream in well-defined channel 0.9 -1.2m wide by 0.7 m deep and a water depth of 0.05m. Fine silt/sand and gravel/pebble bed. Burn culverted under existing road.
CAR Category:	Medium
Catchment Area:	0.03 km^2 (upstream of crossing location)
Ecology:	Migratory fish, unlikely. Mammals, none
Crossing Type:	Existing crossing: Possible upgrade with circular culvert



 Not to Scale

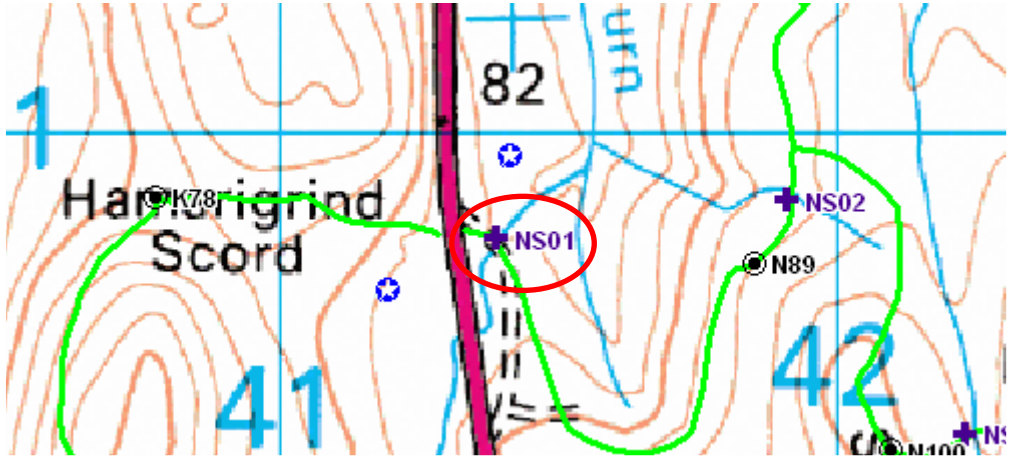
Looking across stream Viking KS16 across 2.jpg

Looking downstream Viking KS16 down.jpg

Looking upstream Viking KS16 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS01
Route:	Between A970 & N89
Catchment ID:	11
Watercourse:	Tributary channel of Wester Filla Burn
NGR:	HU 41389 60808
Description:	Medium stream in defined channel 0.9-1.5m wide by 0.4m deep. Water depth 0.2m. Flood channel 2m wide and up to 2.7m high. Coarse rock bed and mineral banking overlain by peat.
CAR Category:	Medium
Catchment Area:	0.44 km^2 (upstream of crossing location)
Ecology:	Migratory fish, present. Mammals, none
Crossing Type:	New crossing: Rectangular culvert



Not to Scale

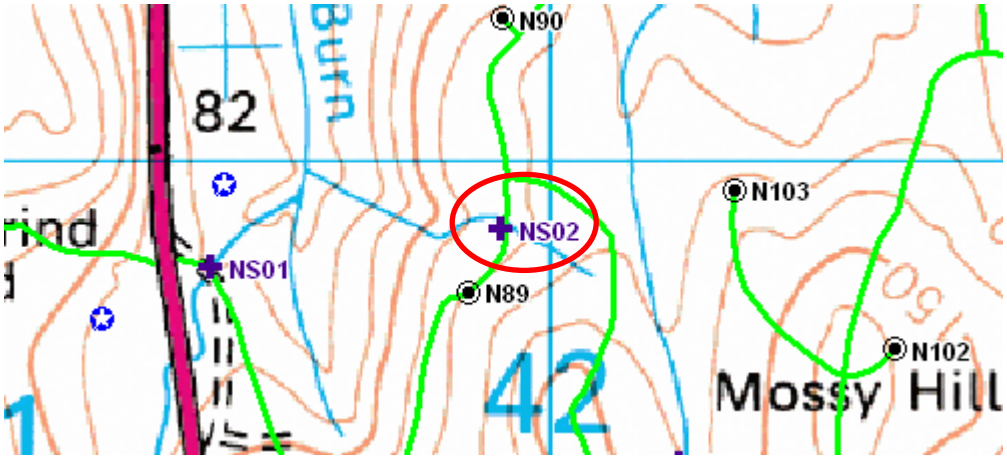
Looking across stream Viking NS01 across 1.jpg

Looking downstream Viking NS01 down.jpg

Looking upstream Viking NS01 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS02
Route:	Between N89 & N90
Catchment ID:	11
Watercourse:	Tributary burn to Wester Filla Burn
NGR:	HU 41912 60877
Description:	Small stream 0.6-0.9m in peat channel 4.5m wide by 1.6m deep. Water 0.02m deep with very little flow. Peaty bed with silt and gravel deposits.
CAR Category:	Small
Catchment Area:	0.04 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Multiple circular culverts



Not to Scale

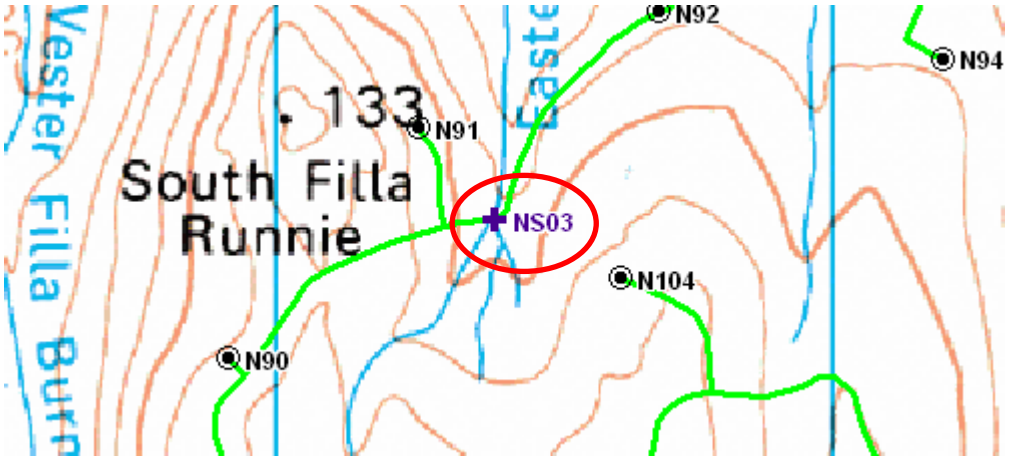
Looking across stream Viking NS02 across 1.jpg

Looking downstream Viking NS02 down.jpg

Looking upstream Viking NS02 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS03
Route:	Between N90 & N92
Catchment ID:	1
Watercourse:	Easter Filla Burn
NGR:	HU 42394 61503
Description:	Small/medium stream in well defined channel 1-2 wide and 0.6-1m high. Water depth 0.2m. Bed of predominantly cobbles & coarse bare rock. Vegetated peat banking.
CAR Category:	Medium
Catchment Area:	0.59 km^2 (upstream of crossing location)
Ecology:	Migratory fish, likely. Mammals, none
Crossing Type:	New crossing: Rectangular culvert / arch



 Not to Scale

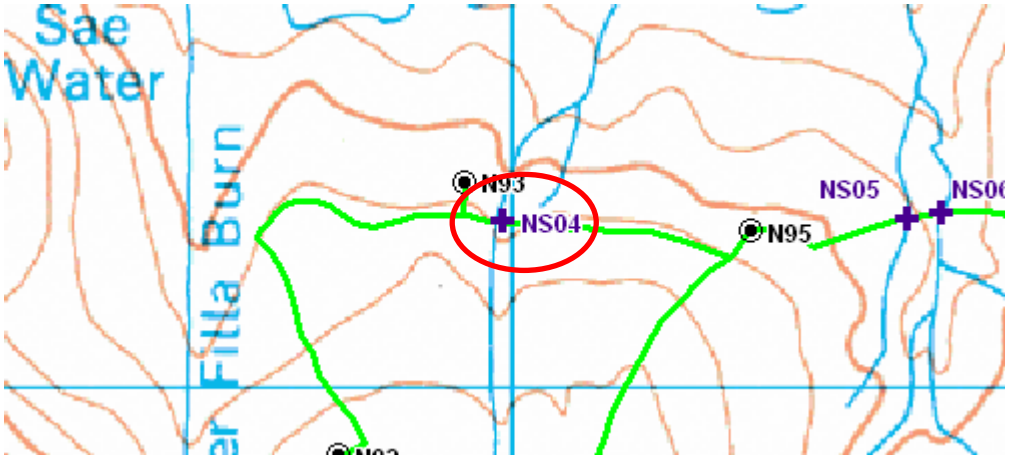
Looking across stream Viking NS03 across 1.jpg

Looking downstream Viking NS03 down.jpg

Looking upstream Viking NS03 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS04
Route:	Between N93 & N95
Catchment ID:	1
Watercourse:	Unnamed feeder burn to Laxo Burn
NGR:	HU 42983 62299
Description:	Small stream in well defined channel. Channel 0.6-1m wide by 0.6m deep. Water depth 0.2m. V-shaped flood channel 5.5m wide by 3m deep. Peat bed with some coarse rock bed. Mineral and peat banking.
CAR Category:	Small
Catchment Area:	0.47 km^2 (upstream of crossing location)
Ecology:	Migratory fish, likely. Mammals, likely.
Crossing Type:	New crossing: Rectangular culvert /arch with mammal passage.



 Not to Scale

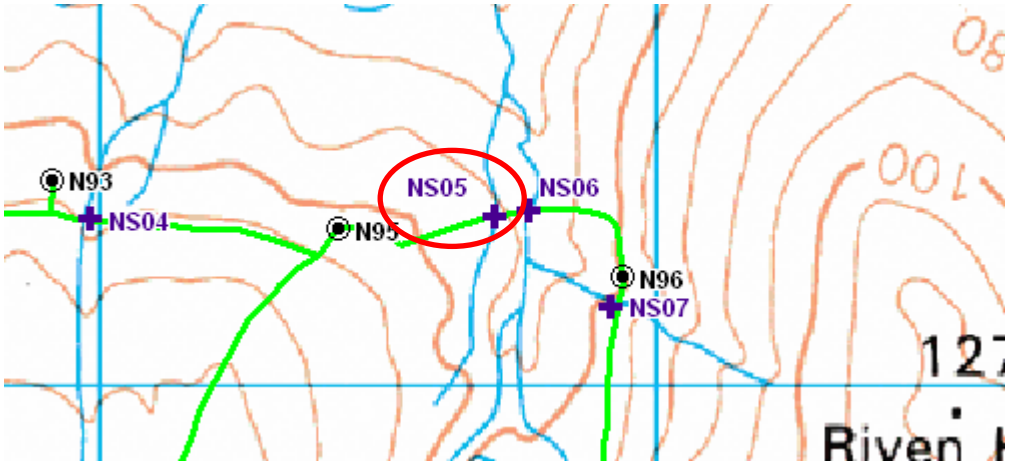
Looking across stream Viking NS04 across 1.jpg

Looking downstream Viking NS04 down.jpg

Looking upstream Viking NS04 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS05
Route:	Between N95 & N96
Catchment ID:	1
Catchment ID:	Unnamed tributary to Gossawater
Watercourse:	HU 43711 62305
NGR:	Small/medium 0.5-1.5m wide stream in flood channel up
Description:	to 5.5m wide and 1.5m high. Water depth 0.05m. Peat and vegetated peat banks.
CAR Category:	Medium
Catchment Area:	0.41 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert



 Not to Scale

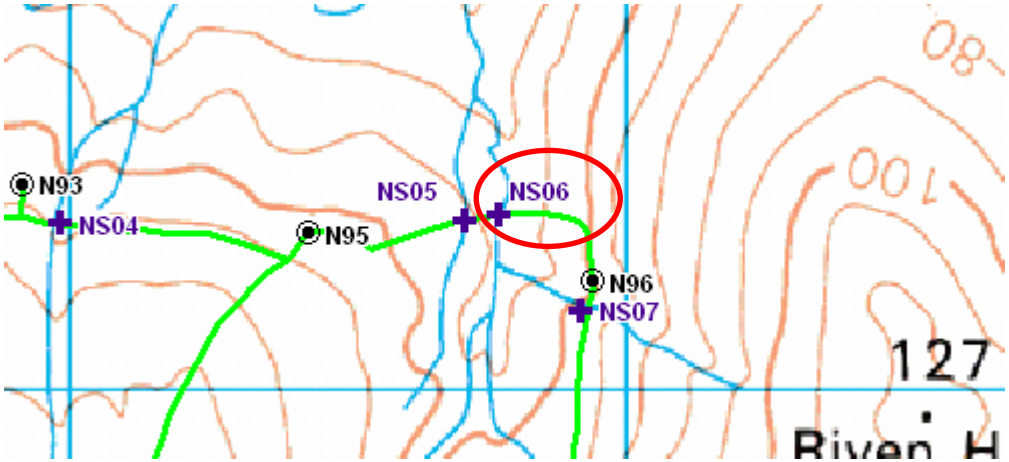
Looking across stream Viking NS05 across 2.jpg

Looking downstream Viking NS05 down.jpg

Looking upstream Viking NS05 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS06
Route:	Between N95 & N96
Catchment ID:	1
Watercourse:	Gossawater Burn feeding to Laxo Burn
NGR:	HU 43775 62316
Description:	Incised medium burn in well-defined channel 3m wide and up to 2.5m high, water 0.2m deep. Stony bed of predominantly cobbles and boulders, peat banking.
CAR Category:	Large
Catchment Area:	5.65 km^2 (upstream of crossing location)
Ecology:	Migratory fish, present. Mammals, present
Crossing Type:	New crossing: Bridge



Not to Scale

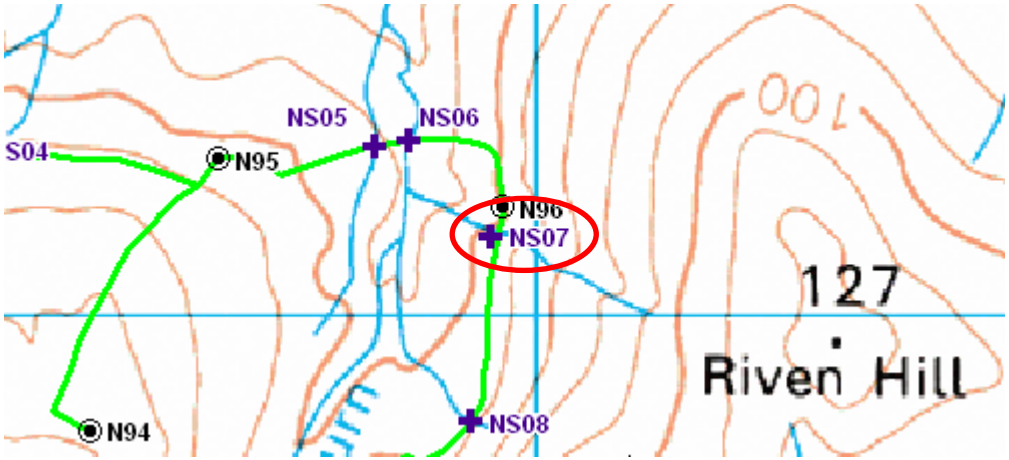
Looking across stream Viking NS06 across 1.jpg

Looking downstream Viking NS06 down.jpg

Looking upstream Viking NS06 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS07
Route:	Between N96 & N97
Catchment ID:	1
Watercourse:	Unnamed feeder burn to Gossawater burn
NGR:	HU 43921 62142
Description:	Very shallow stream in shallow channel 1-2m wide by 0.2m deep. Almost no flow, area around stream very boggy. Vegetated peat bed and banks.
CAR Category:	Medium
Catchment Area:	0.07 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, unlikely
Crossing Type:	New crossing: Drainage layer and pipes



 Not to Scale

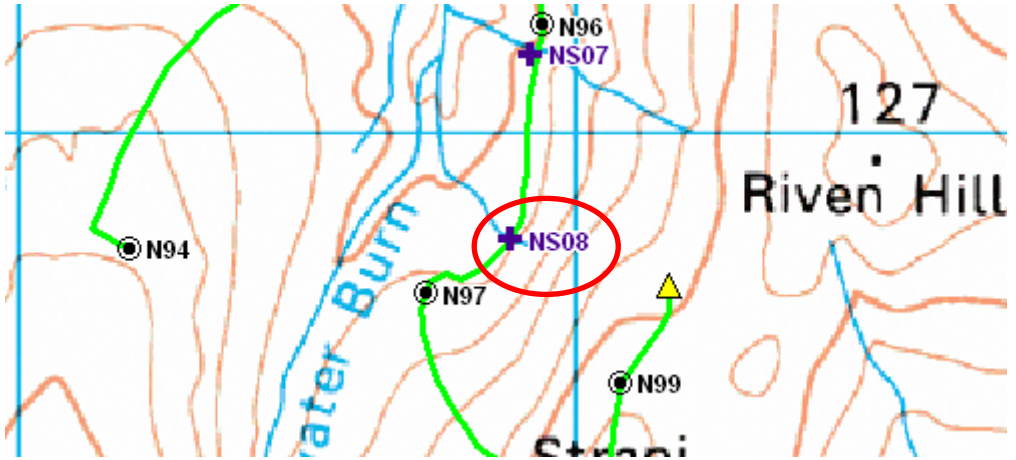
Looking across stream Viking NS07 across 2.jpg

Looking downstream Viking NS07 down.jpg

Looking upstream Viking NS07 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS08
Route:	Between N96 & N97
Catchment ID:	1
Watercourse:	Unnamed feeder burn to Gossawater Burn
NGR:	HU 43885 61810
Description:	Poorly defined stream, flush in places. Channel up to 1.5m wide and up to 0.5m deep. Water 0.05m deep with very little flow. Peat and vegetated bed.
CAR Category:	Medium
Catchment Area:	0.23 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Drainage layer and pipes.



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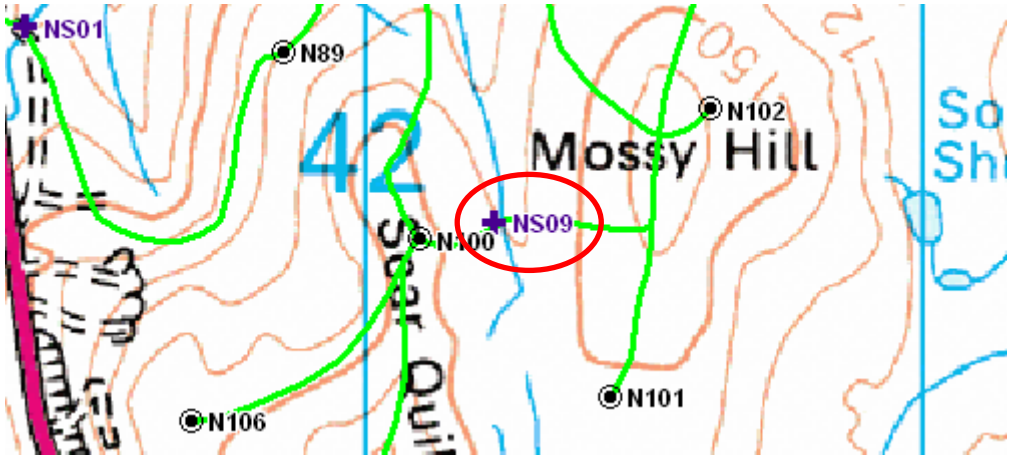
Looking across stream Viking NS08 across 2.jpg

Looking downstream Viking NS08 down.jpg

Looking upstream Viking NS08 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS09
Route:	Between N100, N101 & N102
Catchment ID:	1
Watercourse:	Easter Filla Burn
NGR:	HU 42231 60457
Description:	Broad medium burn in well-defined peat channel 2-4m wide and up to 4m high, water 0.2m deep. Flood channel up to 5m wide. Stony bed with peat banks.
CAR Category:	Medium
Catchment Area:	0.05 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Multiple circular culverts



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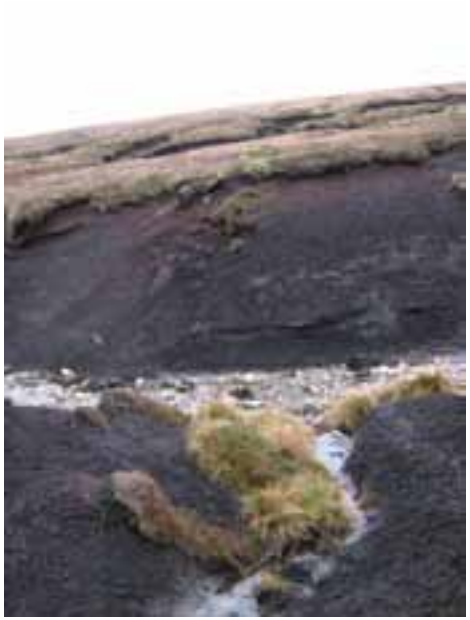


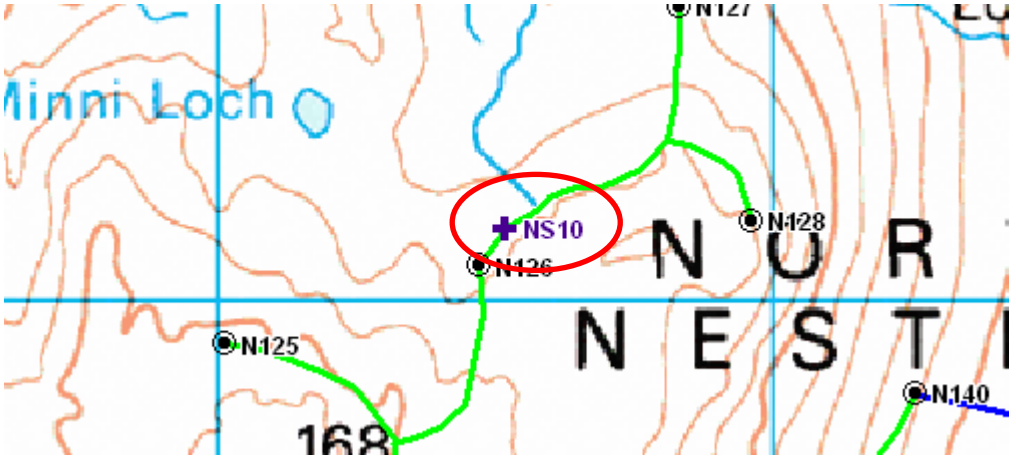
Looking across stream Viking NS09 across.jpg

Looking downstream Viking NS09 down.jpg

Looking upstream Viking NS09 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS10
Route:	Between N126 & N127
Catchment ID:	6
Watercourse:	Unnamed inflow burn to Quinni Loch
NGR:	HU 44517 59127
Description:	Small stream up to 0.5m wide by 2m deep, with a water depth of 0.05m. Flood channel 8m wide by 4m high. Medium sized stone bed and grass covered peat banks.
CAR Category:	Small
Catchment Area:	0.15 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Rectangular culvert



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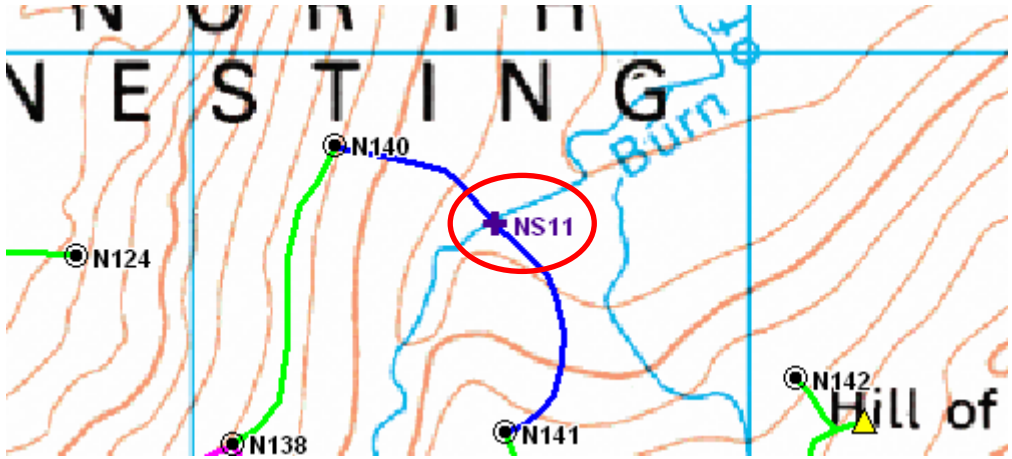
Looking across stream Viking NS10 across 1.jpg

Looking downstream Viking NS10 down.jpg

Looking upstream Viking NS10 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS11
Route:	Site access track between N140 and N141
Catchment ID:	6
Watercourse:	Burn of Grunnafirth
NGR:	HU 45542 58690
Description:	Large well defined channel. Good fast flow. Channel 3m wide and 1m deep. Water depth 0.5m. Large rocks on bed
CAR Category:	Large
Catchment Area:	5.89 km^2 (upstream of crossing location)
Ecology:	Migratory fish, present. Mammals, likely
Crossing Type:	New crossing: Bridge



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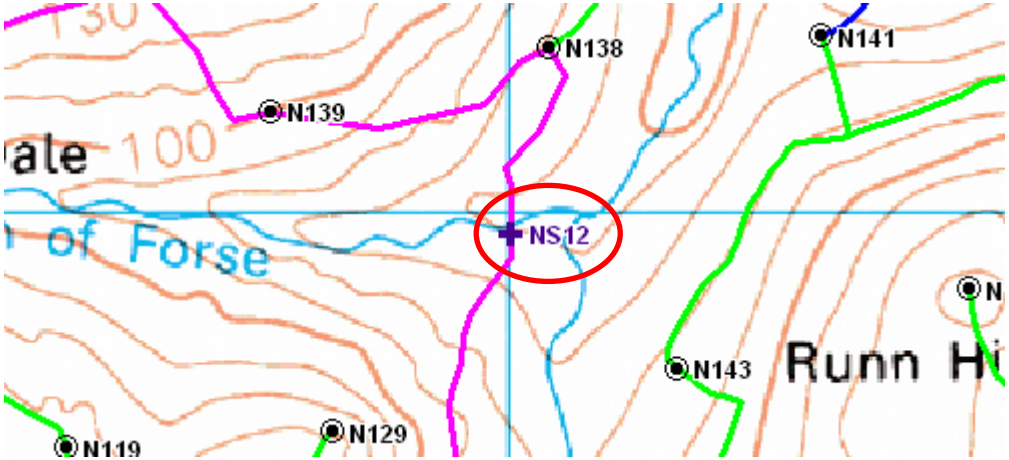
Looking across stream Viking NS11 across 2.jpg

Looking downstream Viking NS11 down.jpg

Looking upstream Viking NS11 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS12
Route:	Between N137 & N150
Catchment ID:	6
Watercourse:	Burn of Forse
NGR:	HU 45002 57960
Description:	Medium stream in well defined channel 3m wide by 1m deep. Water depth 0.5m. Predominantly cobble and pebble bed with some large boulders. No vegetation in channel. Peat banks slightly undercut. Exposed rock on banking.
CAR Category:	Large
Catchment Area:	3.95 km^2 (upstream of crossing location)
Ecology:	Migratory fish, present. Mammals, possible
Crossing Type:	New crossing: Bridge



Not to Scale

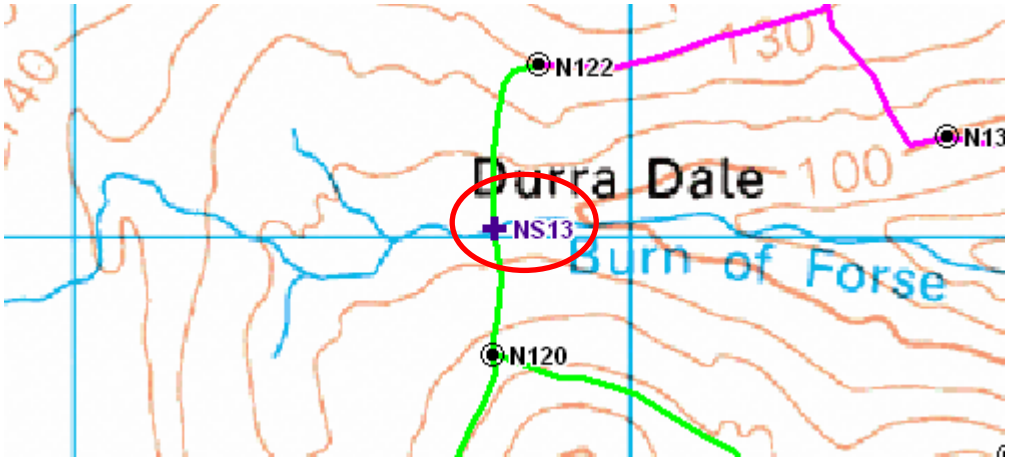
Looking across stream Viking NS12 across 1.jpg

Looking downstream Viking NS12 down.jpg

Looking upstream Viking NS12 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS13
Route:	Between N120 & N122
Catchment ID:	6
Watercourse:	Burn of Forse
NGR:	HU 43755 58013
Description:	Medium stream in channel 2-3m wide and 1-2m deep. Predominantly boulder, cobble and pebble bed. Water level 0.4m. Peat banking.
CAR Category:	Medium
Catchment Area:	2.41 km^2 (upstream of crossing location)
Ecology:	Migratory fish, present. Mammals, possible
Crossing Type:	New crossing: Rectangular culvert / arch with mammal passage.



 Not to Scale

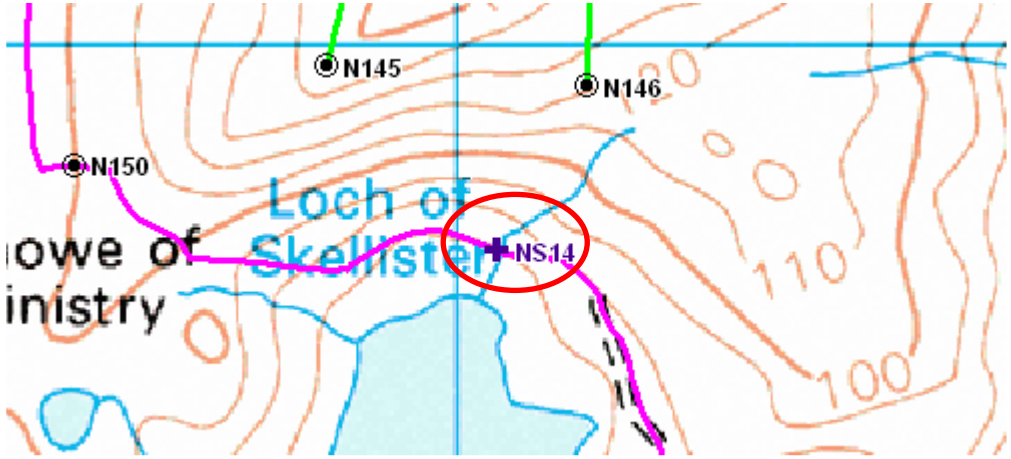
Looking across stream Viking NS13 across 1.jpg

Looking downstream Viking NS13 down.jpg

Looking upstream Viking NS13 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS14
Route:	Track between B9075 and N150
Catchment ID:	24
Watercourse:	Unnamed inflow burn into Loch of Skellister
NGR:	HU 46075 56627
Description:	Peat pipe with some overground flow. Channel 1m wide by 0.15m deep. Flood channel 11m wide by around 2.3m high. Vegetated peat bed and banking.
CAR Category:	Medium
Catchment Area:	0.14 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert



 Not to Scale

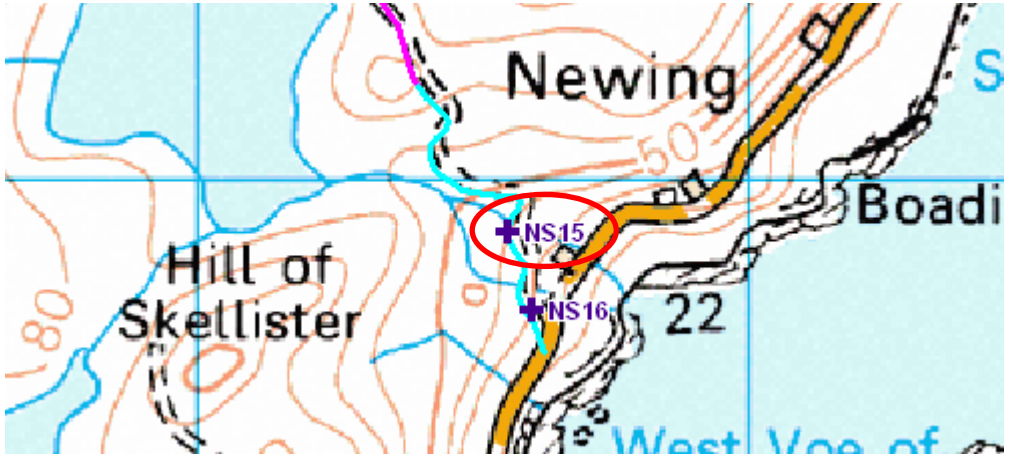
Looking across stream Viking NS14 across 1.jpg

Looking downstream Viking NS14 down.jpg

Looking upstream Viking NS14 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS15
Route:	Site access track between B9075 and N150
Catchment ID:	24
Watercourse:	Unnamed inflow burn into Loch of Skellister
NGR:	HU 46566 55905
Description:	Well defined small stream. Estimated less than 1m wide by 0.5m deep. Flowing over bed rock
CAR Category:	Small
Catchment Area:	1.70 km^2 (upstream of crossing location)
Ecology:	Migratory fish, possible. Mammals, unlikely
Crossing Type:	Probably requiring upgrading of existing crossing: Rectangular culvert.



 Not to Scale

No Photograph Available

Looking across stream Viking NS15 across 1.jpg

Looking downstream Viking NS15 down.jpg

Looking upstream Viking NS15 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS16
Route:	Site access track between B9075 and N150
Catchment ID:	24
Watercourse:	Unamed ouflow from Loch of Skellister
NGR:	HU 46612 55763
Description:	Well defined small stream with good fast flow. 0.4-1m wide by 0.4m deep. Water depth of 0.2m flowing over bed rock. Large exposed bolders on banks. Culverted under existing B9075 road.
CAR Category:	Small
Catchment Area:	1.67 km^2 (upstream of crossing location)
Ecology:	Migratory fish, likely. Mammals, unlikely
Crossing Type:	Probably requiring upgrading of existing crossing: Rectangular culvert.

 Not to Scale

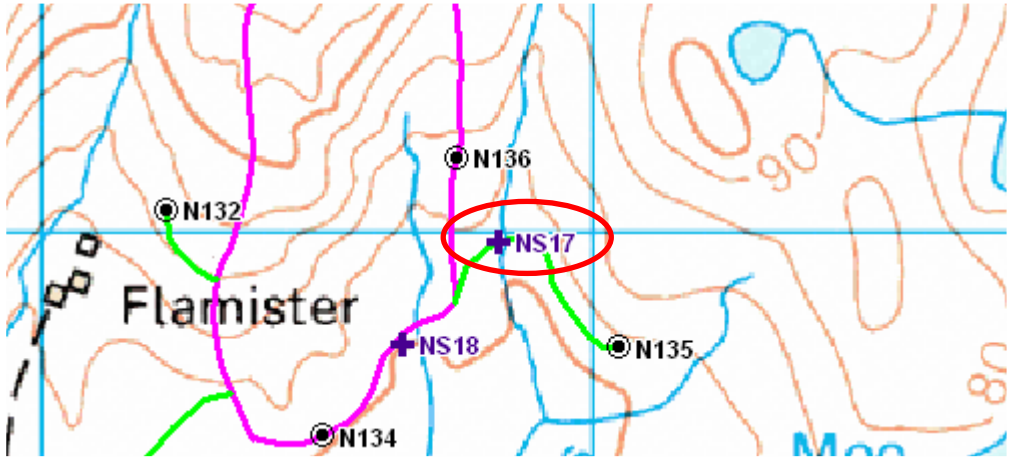
Looking across stream Viking NS16 across.jpg

Looking downstream Viking NS16 down.jpg

Looking upstream Viking NS16 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS17
Route:	Between N134 & N136
Catchment ID:	17
Watercourse:	Burn of Quoys
NGR:	HU 44831 55981
Description:	Small stream, with good flow, channel 0.7m wide by 0.5m deep. Water 0.2m deep. Coarse rocky bed, exposed rock and vegetation on banking.
CAR Category:	Small
Catchment Area:	0.73 km^2 (upstream of crossing location)
Ecology:	Migratory fish, likely. Mammals, none
Crossing Type:	New crossing: Rectangular culvert / arch



 Not to Scale

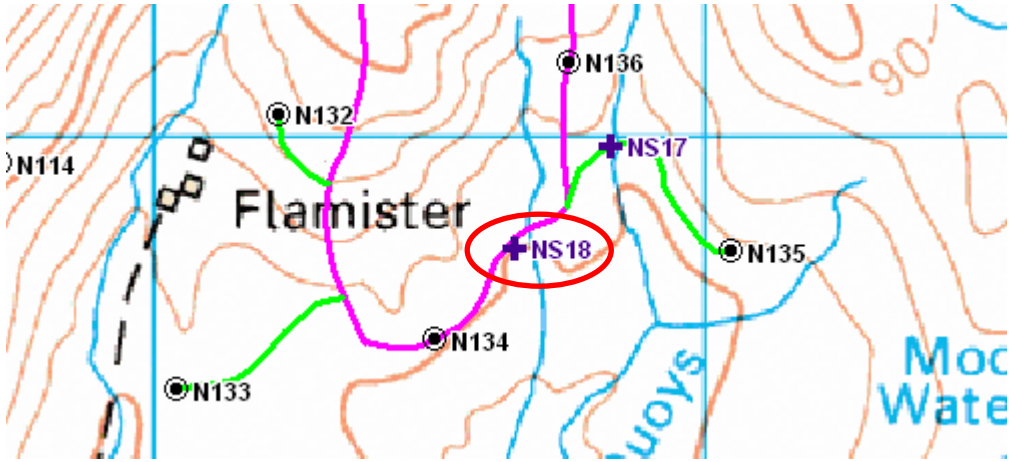
Looking across stream Viking NS17 across.jpg

Looking downstream Viking NS17 down.jpg

Looking upstream Viking NS17 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS18
Route:	Between N134 & N136
Catchment ID:	17
Watercourse:	Unamed tributary to Burn of Quoys
NGR:	HU 44654 55795
Description:	Shallow channel, poorly defined in places. Flow area ~0.2-2m wide in broad valley, water 0.2m depth. Vegetation predominantly grasses.
CAR Category:	Medium
Catchment Area:	0.29 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Drainage layer and pipes



Not to Scale

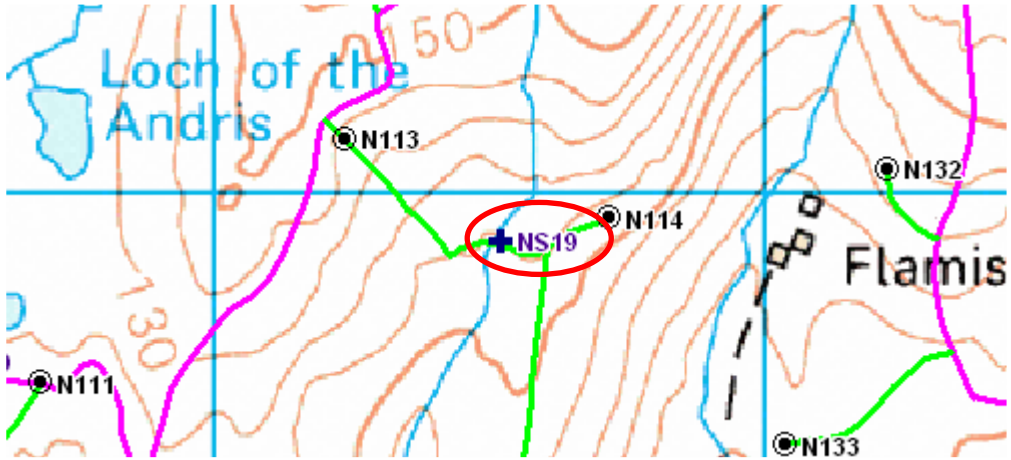
Looking across stream — Viking NS18 across.jpg

Looking downstream — Viking NS18 down.jpg

Looking upstream — Viking NS18 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS19
Route:	Between N113 & N114
Catchment ID:	7
Watercourse:	Gill Burn
NGR:	HU 43524 55909
Description:	Medium stream in 1-1.8m wide by 1.1m deep peat channel. Water level 0.2m deep with good flow. Rocky bed and vegetated peat banks.
CAR Category:	Medium
Catchment Area:	0.20 km^2 (upstream of crossing location)
Ecology:	Migratory fish, unlikely. Mammals, none
Crossing Type:	New crossing: Rectangular culvert



 Not to Scale

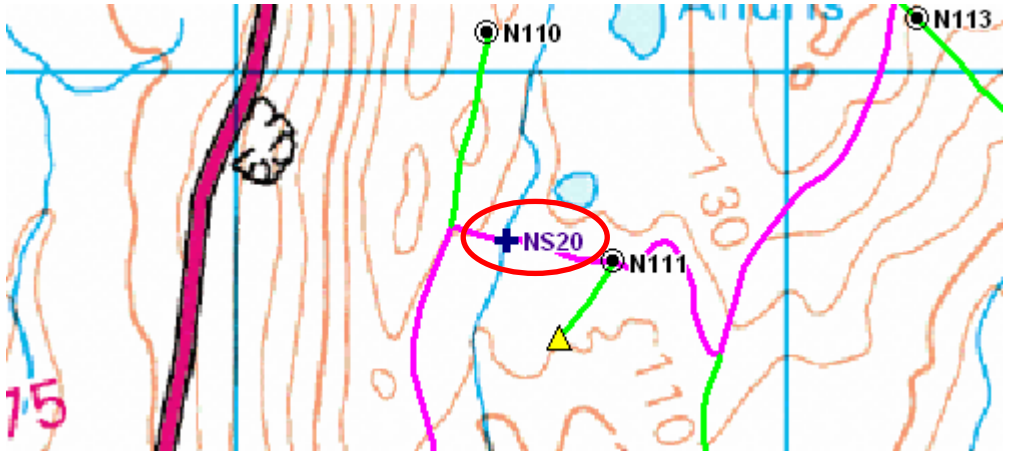
Looking across stream Viking NS19 across.jpg

Looking downstream Viking NS19 down.jpg

Looking upstream Viking NS19 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS20
Route:	Between N110 & N111
Catchment ID:	7
Watercourse:	Burn of Crookdale
NGR:	HU 42494 55690
Description:	Poorly defined channel cut into peat. Up to 5m deep and 2-3m wide. Peaty bed with island areas of peat up to 1m above water level and some large boulders. Water level 0.05m. Peat banking.
CAR Category:	Medium
Catchment Area:	0.93 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Multiple circular culverts



 Not to Scale

Looking across stream Viking NS20 across.jpg

Looking downstream Viking NS20 down.jpg

Looking upstream Viking NS20 up.jpg

Appendix C

Table of Additional Watercourse Crossings

Table 5 Additional (non-CAR) Watercourse Crossing Details

ID	Grid reference	Watercourse type	Width (m)	Depth (m)	Crossing type	Comments
DX01	HU 3988 7004	Stream	1.0-2.0	0.7	Rectangular culvert	Wide and shallow
DX02	HU 3966 6923	Stream	0.6	0.6	Circular culvert	
DX03	HU 4280 7241	Flush	0.5-6	-	Drainage layer	
DX04	HU 4280 7241	Stream	1.2	0.5	Circular culvert	
DX05	HU 4217 7135	Flush	3	-	Drainage layer	
DX06	HU 4206 7130	Stream/Peat Pipe	2	-	Circular pipe	Peat Pipe
DX08	HU 3985 6937	Flush	2-6	-	Drainage layer	Boggy area
DX09	HU 3922 6740	Stream	1.1	1.1	Circular culvert	
DX10	HU 3680 6630	Stream	1.1	1.1	Existing crossing: circular culvert	Existing crossing
DX12	HU 4017 7142	Stream	0.6	0.7	Circular culvert	
DX13	HU 4002 7141	Stream	0.5-1	0.1	Circular culvert	
DX14	HU 3999 7141	Stream	0.4-0.9	1	Circular culvert	
DX15	HU 3955 7122	Stream	0.7	1.0	Circular culvert	
DX17	HU 4063 7225	Flush	6	-	Drainage layer	Boggy
DX18	HU 4236 7166	Wide Flush	Up to 8	-	Drainage layer and pipes	May not be apparent in the summer, braided channels and wetland
DX19	HU 4236 7166	Stream	0.3	0.1	Circular culvert	Not surveyed – see note[1]
CX01	HU 4297 6460	Stream	0.4	1.4	Circular culvert	Very shallow channel
CX02	HU 4223 6463	Stream	0.4	1.4	Circular culvert	
CX03	HU 4211 6516	Wide flush	8.0	-	Drainage layer & pipes	Confluence of 2 small streams, very wet area
CX04	HU 4219 6618	Stream	1.0-3.0	0.7	Circular culvert (multiple)	Top of stream, variable width and v. boggy
CX05	HU 4215 6616	Stream	0.5	0.7-1	Circular pipe	Peat pipes in places
CX06	HU 4272 6551	Stream	0.6-2.0	1.4	Circular pipe	Quite large peat pipe, downstream channel looks a bit collapsed in places
CX07	HU 4218 65520	Stream	0.5-1.0	1.0-1.5	Circular culvert	Probably Ephemeral – see note[*]
CX08	HU 4249 6629	Peat pipe	1.5-2	3	Circular pipe	Peat pipe
KX02	HU 4022 5680	Ditch	1.0-3.0	0.5	Circular culvert	Not surveyed – see note[2]
KX03	HU 4008 5657	Ditch	0.5-0.7	0.1	Circular culvert	Survey position was 60m W (upstream), due to late layout amendment, unlikely to influence crossing type.
KX04	HU 3986 5659	Ditch	0.5-0.7	0.1	Circular culvert	Not Surveyed – see note[3]
KX05	HU 3989 5639	Stream	0.3-0.5	0.5	Circular culvert	
KX06	HU 3998 5637	Stream	1	0.1	Circular culvert	
KX07	HU 3924 5904	Stream	0.5	0.1	Circular culvert	

ID	Grid reference	Watercourse type	Width (m)	Depth (m)	Crossing type	Comments
KX08	HU 3863 5815	Stream	1	0.1	Circular culvert	
KX10	HU 3860 5820	Stream	1	0.5	Circular culvert	
KX11	HU 3897 5880	Stream	0.5	0.2	Circular culvert	
KX12	HU 3808 5470	Flush	4	-	Circular culvert	Probably Ephemeral – see note*
KX13	HU 3853 5558	Flush	4	-	Drainage layer	
KX14	HU 3684 5597	Stream	1	0.5	Circular culvert	
KX15	HU 3719 5563	Stream	0.9	0.4	Circular culvert	Not Surveyed – see note[4]
KX16	HU 3716 5567	Stream	0.9	0.4	Circular culvert	Not Surveyed – see note[5]
NX04	HU 4168 6043	Stream	0.5-1	0.5	Circular culvert	
NX05	HU 4170 6043	Stream	0.6-1	0.2-1	Circular culvert	
NX07	HU 4517 5854	Stream	1.0	0.1-0.5	Circular culvert	Probably Ephemeral – see note*
NX08	HU 4245 5598	Stream	0.4-2	0.5-0.2	Circular culvert (multiple)	Very low flow through wide peat gully
NX09	HU 4518 5864	Stream	0.9	0.1-0.5	Circular culvert	Small stream in shallow channel
NX10	HU 4024 5565	Stream	0.3	0.2	Circular culvert	

Locations shown on Figure 14.3.SC03 (in Volume 4)

Notes

The additional crossings are not in sequential order and some have been removed due to layout amendment.

*Probably Ephemeral - these 3 streams were identified during the desk study of the 1:10,000 scale OS mapping but were not apparent at time of survey. It is likely that these streams are seasonal and therefore stream size has been extrapolated from survey information for nearby streams and a crossing type has been recommended accordingly.

[1] Unable to survey as a result of adverse weather, DX19 crosses (approximately 0.8km upstream) the same watercourse as DS03. Results from DS03 have been used to provide an estimate of the type and size of watercourse and the type of crossing that would be necessary. Note: a conservative estimate has been provided and the watercourse may be smaller.

[2] Unable to find in snow conditions. Results for KX02 have been estimated using information from KX03 (approximately 270m West) which crosses adjacent stream and from examination of the OS mapping looks similar in size and type. Note: a conservative estimate has been provided and the watercourse may be smaller.

[3] Unable to survey as a result of adverse weather, KX04 crosses (approximately 0.5km upstream) the same watercourse as KX03. Results from KX03 have been used to provide an estimate of the type and size of watercourse and the type of crossing that would be necessary. Note: a conservative estimate has been provided and the watercourse may be smaller.

[4] Unable to survey as a result of adverse weather, KX15 crosses (approximately 0.5km upstream) the same watercourse as KX14. Results from KX14 have been used to provide an estimate of the type and size of watercourse and the type of crossing that would be necessary. Note: a conservative estimate has been provided and the watercourse may be smaller.

[5] Unable to survey as a result of adverse weather, KX16 crosses (approximately 0.4km upstream) the same watercourse as KX14. Results from KX14 have been used to provide an estimate of the type and size of watercourse and the type of crossing that would be necessary. Note: a conservative estimate has been provided and the watercourse may be smaller.