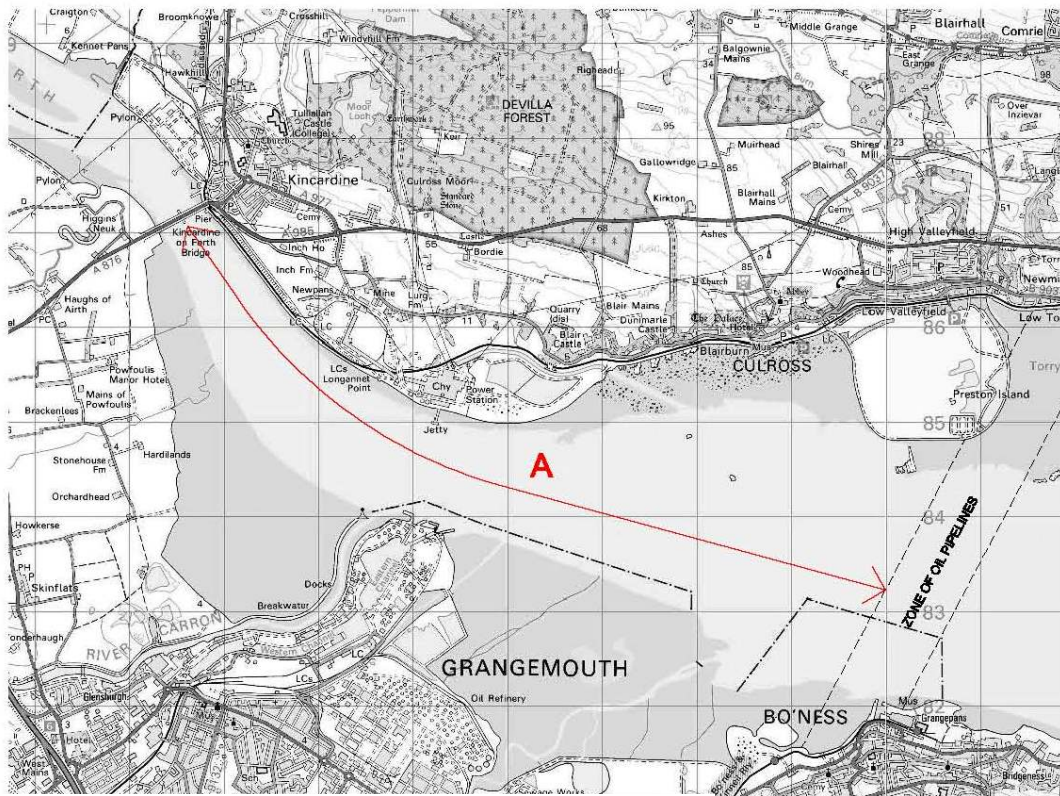


APPENDIX B - ASSESSMENT OF CORRIDOR A

B1 DESCRIPTION OF CORRIDOR

Corridor A is the most westerly of the five options under consideration. It is shown on Drawing Number 49550/G/02 and an extract is given below showing the corridor. Its west boundary is formed by the existing Kincardine Bridge and its east boundary is formed by the oil pipeline which crosses the Firth between Bo'ness and Torry Bay.



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B2 INFLUENCE OF GEOLOGY

In order to understand the underlying geology, the Planning Map for Heavy Structures in the British Geological Society Report 16, No 8: "Engineering Geology of the Upper Forth" has been used as a reference. This report indicates that potentially poor founding strata are present across the full width of the Firth in this corridor. The presumed depths to rockhead in the Firth are at their deepest in Corridor A. From the information available, it is anticipated that the rockhead lies at a depth in excess of 150m below water level, approximately midway between the shores. The depth to rockhead is expected to be of the order of 100m at the most probable main pier positions on either side of the navigation channel.

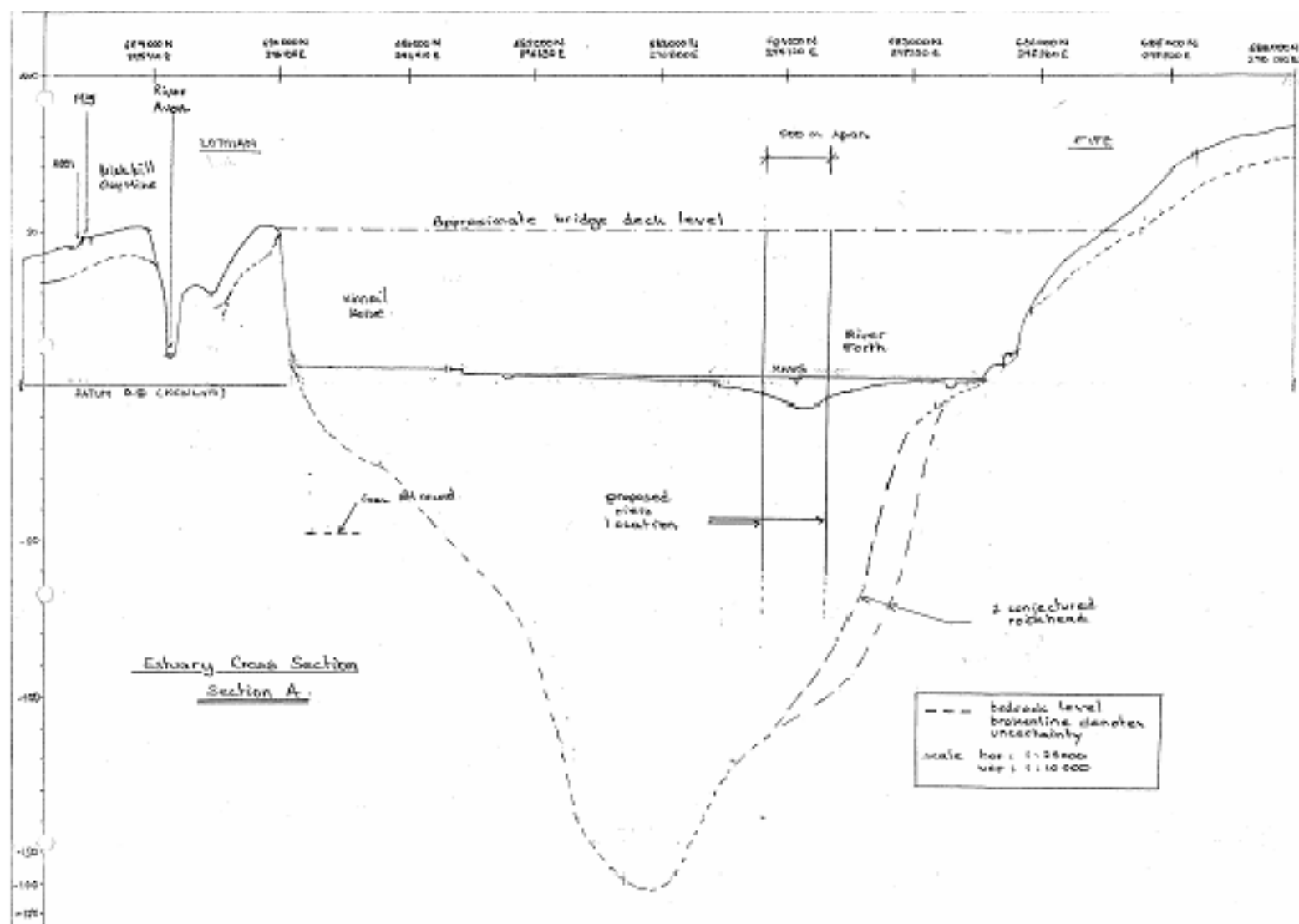
The sediments in this area are thought to consist of granular (non-cohesive) deposits extending from the northern shore to beyond the potential location for the northern pier foundation. These sediments may be absent beneath the potential location for the southern main pier. Normally, granular materials are suitable for supporting heavy foundations, but in this instance, they may be relatively thin as they reduce in thickness southwards. This could limit their potential as a foundation support.

Additionally, according to the available classification, the sediments are indicated as comprising loose to medium dense sands. These are considered to have a poor to medium bearing capacity. The presence of relatively poor founding strata is not limited to the Firth. The depth to bedrock is recorded as being about 60m at the southern shoreline, and outcropping a further 2km to the south. Northwards from the midpoint of the Firth, the depth to bedrock becomes progressively shallower, outcropping at the shore at Longannet.

From this description, it can be seen that foundations of a bridge would be very problematic in Corridor A. The depth of the bedrock would lead to very deep and potentially uneconomic foundations. Hence it is considered that an alignment in this corridor would be difficult to justify in terms of the study objectives. It would also be questionable whether the risks and potential costs associated with this corridor make it suitable for further assessment when compared to other corridors in the study.

A cross section of the Firth of Forth within Corridor A has been prepared to illustrate the approximate geology and is shown in Figure B.1 below.

Figure: B.1 Geological Cross-Section at Alignment AB1



B3 TRANSPORT PLANNING

A test of Corridor A's operational performance has been undertaken using the TMfS. This test is representative of both potential tunnel and bridge options in this corridor. In this test, the crossing is connected to the M9 at or around Junction 4. On the north side it connects to the A985 to the west of Culross. The section of the A985 eastwards to the A823(M) is upgraded to dual 2 lane carriageway standard.

This test has been run in two different scenarios. The first assumes that the new crossing is simply added to the existing network and there are therefore two crossings available to the motorist. This test has been run for the forecast years of 2012, 2017 and 2022.

Clearly this corridor is some distance from the existing Forth Road Bridge and the results from the TMfS reflect this. In the first model scenario around five per cent of traffic diverts from the existing Forth Road Bridge in all three forecast years.

The second scenario modelled assumes that the existing Forth Road Bridge is closed to all traffic and therefore only the new crossing is available. This latter case is representative of the situation that might exist when the existing bridge has to be closed for maintenance purposes. This test has been run for 2012 only.

In this scenario, there is an increase of one per cent in total daily travel time and a 6 per cent increase in the daily distance travelled. This increase is unsurprising given the extra distance that all vehicles are forced to travel and the additional time incurred as a consequence.

It is concluded that this corridor would have little value in providing support to the Forth Road Bridge during periods of major maintenance. Also, the distance from the existing Forth Road Bridge would mean that this corridor would have little advantage over the Kincardine crossings as a high winds diversion route.

The origins of southbound peak hour traffic on the existing bridge showed that 19 per cent came from the M90 north of Junction 3 (Halbeath) 23 per cent came from the A92 East Fife Distributor Road, 29 per cent came from Dunfermline town, 20 per cent came from the south Fife coastal routes and five per cent from Rosyth. More importantly the destinations of this traffic saw only three per cent heading for the M9 corridor and 19 per cent for the M8 corridor. It is therefore not surprising that this corridor does not adequately cater for traffic movements.

With both crossings available, the daily traffic flow on the Forth Road Bridge is envisaged to be around 68,000 in 2012, growing to 75,000 in 2022. This is an increase over the flows currently experienced. It is concluded that the objective of maintaining cross-Forth transport links to at least the level of service offered in 2006 will not be met by a crossing in Corridor A.

The increase in total distance travelled and extra travel time incurred during closure of the Forth Road Bridge would result in additional economic costs. In addition, there would be consequential environmental impacts resulting from the additional distance travelled.

Furthermore, this corridor is remote from the main public transport cross Forth corridors and the ability to integrate enhanced public transport services into a new crossing will be remote. There would be little prospect of new LRT modes being usefully incorporated into a crossing in this corridor. However new modes could be given priority on the existing Forth Road Bridge.

In summary, Corridor A performs poorly against the transport planning objectives for this study and it is concluded that the location of this corridor is unsuitable for the provision of a replacement crossing. However, for illustrative purposes, a possible example of a bridge crossing follows in section B.4.

B4 BRIDGE CROSSING OPTIONS

B4.1 Detailed Summary of Constraints

Along the north shore, the area is dominated by large areas of mudflats extending from Longannet Point to Preston Island. This area is a SSSI and a SPA. These environmental features represent major constraints to construction within Corridor A. Also located on the north shore are Longannet Power Station and the village of Culross. These developments also represent major constraints to construction.

Along the south shore are expansive areas of mudflats which are designated as SSSI and SPA, and the petrochemical complex at Grangemouth. This combination of urban, environmental and industrial developments represents a major constraint to construction in the area.

The oil pipelines associated with Grangemouth also provide a constraint to construction. The approximate location of these pipelines has been determined using the current admiralty charts. However, it has been assumed that constructing foundations close to the pipeline zones would not be permitted and the risks associated with damage to the pipelines would be high.

Within the Firth, the main navigational channel for shipping is located closer to the north shore. Information received from the Forth Ports PLC indicates that the width of the channel is 450m. The depth of the water is generally less than 5m and the depth of the navigation channel into Grangemouth is maintained at 6.5m. Several bridge alignments have been reviewed to determine if it is possible to construct a bridge crossing in this area.

B4.2 Bridge Options (Refer to Drawing 49550/B/01)

It is considered that this corridor would be unlikely to provide sufficient relief to the Forth Road Bridge due to its proximity to the existing and developing crossings at Kincardine. Consequently, the area of the Forth between Grangemouth and Kincardine has not been assessed for potential crossings.

It is also considered that construction of a bridge through the port and town of Grangemouth would be too disruptive. Therefore, the alignment considered for this corridor has a south landfall to the east of Grangemouth, with the north landfall being sited between Culross and Blair Castle.

Possible schemes for the bridge superstructure were considered on the assumption that ground conditions would be adequate to support foundations and other structural elements.

One possible construction form for this alignment would consist of a cable stayed bridge with a main span of 500m spanning the navigation channel. The remainder of the crossing would consist of multi-span approach viaducts built over the mudflats. However, the soft ground conditions and low lying bedrock outlined in section B2 above, indicate that foundations would be extremely complex and costly.

This option has not been progressed any further due to its distance from the Forth Road Bridge and the combination of environmental and structural reasons outlined above.

B4.3 Risks associated with Bridge in Corridor A

The risks associated with bridge option in Corridor A are as follows:

- The depth to bedrock level has not been established from site investigation. The information used is set out in section 2.3 of the main report. It is likely that the bedrock level is excessively deep and the overlying sediments too soft to permit the construction of a large span cable-stayed bridge.
- The presence of the oil pipeline on the south shore between Kinneil and Dalmeny represents a major risk to construction. The exact location of this pipeline needs to be determined and adequately protected on site for all envisaged loads during and after construction.

B4.4 Costings

This option has not been costed due to the degree of its failure to achieve the stated objectives (as outlined in section B2)

B5 TUNNEL CROSSING OPTIONS

There are a number of potential tunnel crossing points within Corridor A that could connect the M9 with the A985:

The shortest bored tunnel crossing would be close to the Kincardine Bridge. It would have a length of approximately 3 to 5 km, depending on the interchange position. This area has fairly low lying shorelines, particularly on the southern shore. This allows flexibility in portal position and there appear to be opportunities for work sites on the south shore.

Tunnelling under Grangemouth or Bo'ness on the south shore and the power station on the north would not be desirable. A tunnel alignment between Grangemouth and Bo'ness of approximately 8km may be possible. However, the steep banks of the Firth at this point would require additional tunnelling or an increase in tunnel gradients to bring the tunnel up to a suitable tie in. There appears to be potential for work sites on the south shore around Junction 4 of the M9.

There is limited potential for a worksite on the north shore close to the A985 due to the local topography. However, there may be suitable land adjacent to the A985 to the north of Culross. Tunnelling could therefore be possible from either end of this alignment.

Careful design and management of the alignment would be required to minimise impacts. This would be particularly important to the south where tunnelling may impact the River Avon, The Antonine Wall and The Bo'ness rail spur line.

B6 NETWORK LINKAGES

Due to the inability of this corridor to achieve the stated objectives (as outlined in 6.2) further work in developing this corridor in terms of network linkages has not been undertaken.

B7 ENVIRONMENT

B7.1 Introduction

This section identifies the environmental constraints based on international, national and local designations for this corridor. These are shown in Figure B.2. In addition, potential environmental effects that are not related to statutory designations in this area, such as air quality and community impacts are discussed briefly. Comparisons between corridors have been undertaken on a qualitative basis, concentrating mainly on whether any designated sites are likely to be affected by the proposals. The corridor is assessed for its impact on:

- ecology;
- landscape;
- archaeology and cultural heritage;
- communities;
- air quality; and
- planning designations.

B7.2 Ecology

Corridor A crosses the extensive mudflats of the Firth of Forth SPA and SSSI at Kinneil on the southern shore and Torry Bay on the northern shore. Kinneil Kerse is recognised for its importance in autumn and winter to the qualifying wildfowl interest of the SPA and Ramsar site.

Torry Bay Local Nature Reserve (LNR) stretches from Longannet Point in the west to Crombie Point in the east. Corridor A lies on the mudflat habitat used by the waterfowl for feeding and roosting and which also supports extensive eelgrass (*Zostera* spp.) beds growing on the soft mud. Shelduck and great-crested grebe regularly occur in this LNR during winter in significant numbers.

However, although there are potential impacts from a bridge alignment, there are opportunities to mitigate some of the impacts, particularly by control of the construction activities. Nevertheless, the low level viaduct approach proposed across the mudflats would result in significant impacts, particularly the loss of habitat and disruption to bird movements, both of which would be permanent.

The Avon Gorge SSSI lies beyond the southern shore of the Forth. It comprises a semi-natural, ancient woodland with a rich ground flora and rare beetle fauna. These landscapes are situated within the corridor. The connecting route from the crossing to the M9 would have to cross this steep gorge, possibly by connecting in with any possible upgrade of the A801.

Non-statutory sites within the corridor comprise linear woodlands listed on the Ancient Woodland Inventory. It is likely that there will be some habitat loss associated with these in view of their distribution within the corridor. This has implications of disruption to protected species such as bats, otters, red squirrels and badgers, although individually such impacts can often be mitigated.

B7.3 Landscape

This section considers the landscape character and value of the area within Corridor A. The level of protection afforded to sites of landscape value and importance varies according to the level of designation.

Nationally Protected Sites

The proposed alignment crosses through the centre of the Dunimarle Castle GDL located just to the west of the Royal Burgh of Culross.

Locally Protected Sites

Areas of Greenbelt are under considerable pressure as economic growth demands more land to be released for housing and out of town office and business park developments. The southern end of Corridor A crosses the area of Greenbelt between Grangemouth and Bo'ness.

B7.4 Archaeology and Cultural Heritage

Archaeology is the study of the past through the material remains of human activities left behind, be they visible monuments, buried sites or portable antiquities. Cultural heritage is a more encompassing concept embracing historic buildings, townscapes and landscapes, which combine to characterise the historic environment. Heritage resources potentially include features dating from the earliest Holocene human occupation, approximately 10,000 years ago, through to 21st century buildings and townscapes.

Scheduled Ancient Monuments

There are a number of SAMs within route Corridor A and these are listed in Table B.1 below.

Table B.1: Route Corridor A - Scheduled Ancient Monuments

Council Area	Scheduled Ancient Monuments
Fife	Culross Old Parish Church
Fife	Culross Palace, palace and gardens
Falkirk	Nether Kinneil, shell middens 400m ene of Inveravon
Falkirk	Antonine Wall, Nether Kinneil-Inveravon, rampart and ditch
Falkirk	Antonine Wall, Dean Burn –Upper Kinneil, Nether Kinneil Road Junction
Falkirk	Antonine Wall, Inveravon – River Avon, rampart ditch and Roman Fortlet
Falkirk	Antonine Wall, Roman Camps 420m and 730m se of Inveravon

Listed Buildings

Within Corridor A there are 37 listed buildings, most of which are within urban centres although there are some spread throughout the countryside. The listed buildings closest to the centre of the route corridor are stated in Table B.2 below.

Table B.2: Corridor A - Listed Buildings

Council Area	Listed Building	Category
Fife	Ashes House	Category C(s)
Fife	Culross, West Church and Churchyard	Category (A)
Fife	Culross, West Church, Dalglish Mausoleum	Category B

Fife	Dunimarle Castle, Blairburn Cottage	Category-C(s)
Fife	Dunimarle Castle, St Serf's Church	Category B
Fife	Dunimarle Castle	Category A
Fife	Old Dunimarle Castle	Category B
Fife	Culross, Balgownie House, Inchkeith School	Category B
Fife	Culross, Balgownie House, Boat House	Category B
Fife	Culross, Balgownie House, Ruined Building	Category C(s)
Fife	Culross, Balgownie House, Boundary Walls And Gate Piers	Category B
Fife	Culross, West Green, Undercliffe	Category B
Fife	Culross, West Green, Caldervale	Category B
Fife	Culross, West Green, Clifton	Category B
Fife	Culross, West Green, Westerlea	Category B
Fife	Culross, West Green, The Old School House	Category C(s)
Fife	Culross, West Green, Weaver's Cottage	Category C(s)
Fife	Culross, West Green, Muir's House	Category B
Fife	Culross, West Green, Leitch's House	Category B

Fife	Culross, West Green, The Cottage	Category C (s)
Fife	Culross, Sandhaven, House	Category B

Conservation Areas / Heritage Conservation

Although there are conservation areas in the vicinity (e.g. in Linlithgow), there are none within the route corridor.

B7.5 Community Impacts

Effects on communities and scattered dwellings could take the form of impacts on visual amenity, noise and changes in land use or land take. This section identifies the settlements and dwellings that are located on the centre line of Corridor A and any other significant settlements or properties within the Corridor.

Within Corridor A, Blair Castle, Dunimarle Castle, the Palace Hotel and Kirkton are located either on or adjacent to the centre of the route alignment.

Population levels in the vicinity of Corridor A are quite low and as such there are fewer receptors to experience noise or visual amenity impacts. These comprise mainly individual houses and farms, particularly in Fife. On the southern shore the corridor passes between the Grangemouth petrochemical works to the west and the outskirts of Bo'ness to the east. However, the introduction of a bridge and associated traffic would have a permanent impact on visual amenity for receptors with views of the Firth and would lead to increased levels of noise.

B7.6 Air Quality

Construction of a new crossing of the Firth of Forth would have local and global air quality impacts. Introducing a new road into an area is likely to increase the amount of traffic emissions and therefore cause a localised decrease in air quality. In addition, construction of an additional crossing is likely to encourage increased road travel which is likely to lead to an increase in global CO₂ emissions. However the introduction of complementary measures such as enhanced public transport services and HOV in the overall strategy will help to reduce this increase.

B7.7 Planning Designations

There are no areas designated for housing within the route corridor. However, the corridor does pass through an area currently zoned for development associated with the petrochemical works at Grangemouth. In addition, the corridor passes through the Major Hazard Consultation Zone around Grangemouth as well as Pipeline Consultation Zones.

B7.8 Environmental Conclusions

The Firth of Forth SPA (which is also a Ramsar site and a SSSI) represents the overriding constraint on the northern and southern fringes of the Firth. It is afforded the highest level of protection in the UK and there is a presumption against causing adverse impact unless the development is of overriding public interest and there are no alternatives. In addition, any impacts to the qualifying bird species using the Firth outwith the SPA may impact on the ecological integrity of the SPA. The Avon Gorge SSSI may also be crossed by access roads associated with this route corridor, although this would likely be tied in with any proposed upgrade of the A801.

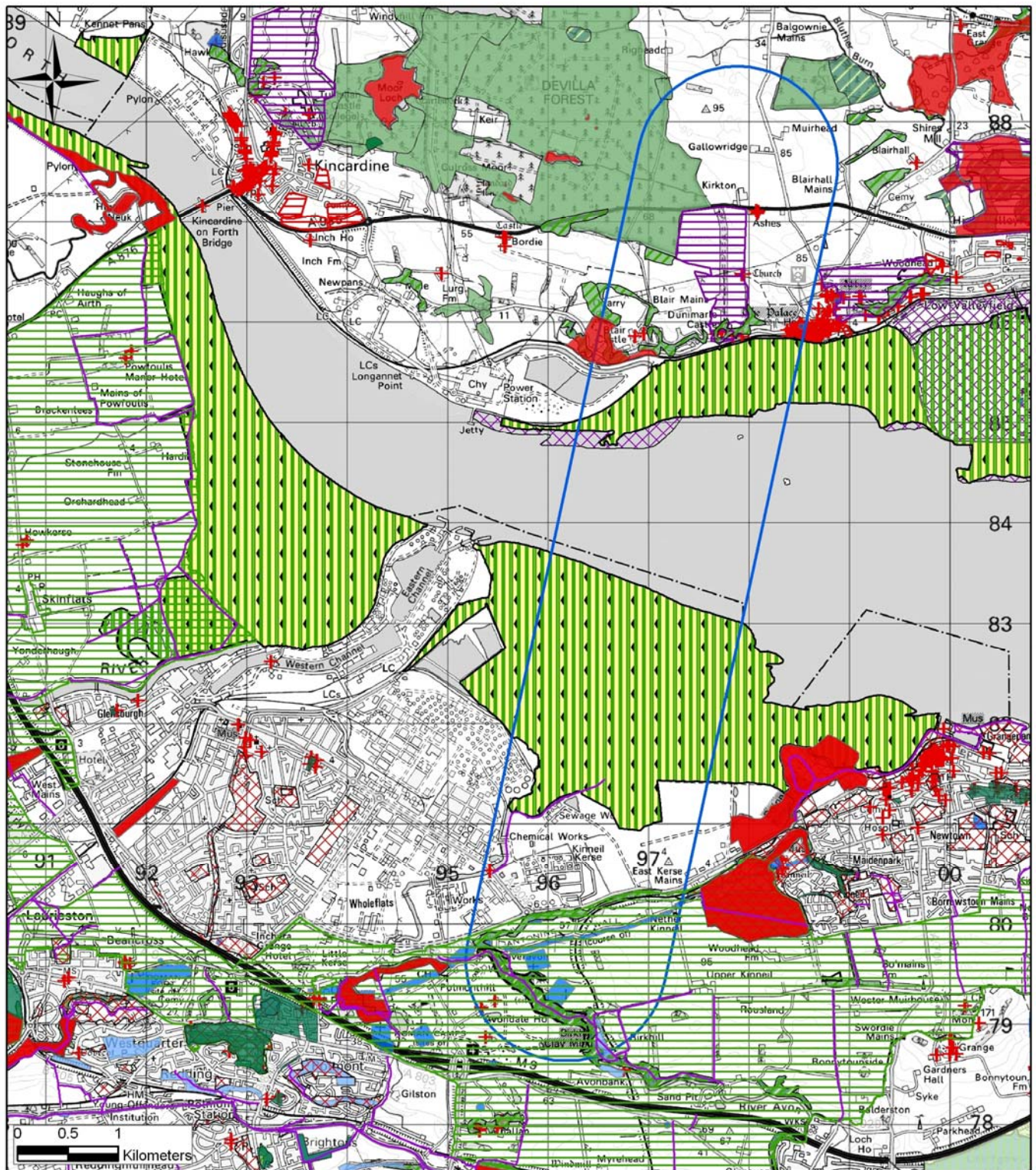
Other significant constraints comprise the SAMs in the vicinity of the Antonine Wall at the southern end of the corridor and the Dunimarle Castle GDL at the northern end. In addition, some areas of Ancient Woodland and listed buildings would be affected by this corridor, depending on the precise details of the route.

Construction of a bridge in this area would impact on local communities and on visual amenity as well as introducing a new noise source to the area. The bridge would also be likely to reduce local air quality as well as contributing to increased global CO₂ due to overall increases in traffic across the Forth.

B8 CONCLUSION

The remote location of this corridor (in terms of distance from the existing Forth Road Bridge) results in this performing poorly against the transport planning objectives. This, combined with the difficulties likely in establishing foundations and other structural elements leads to the conclusion that this corridor should not be pursued further. In addition, this crossing is likely to have significant environmental impacts on people and the natural and built environment.

Figure B.2 – Corridor A – Bridge Option A



Key			
	Corridor For Bridge Option A		Scheduled Ancient Monuments
	Special Scientific Site of Interest (SSSI)		Conservation area
	Special Protection Area (SPA)		Local Nature Reserves
	Ramsar		Country Park
	Listed Buildings		Gardens & Designed Landscape
			Site of importance for nature conservation (SINC)
			Semi-Natural Woodland Inventory Sites
			Ancient (of semi-natural origin) Woodland Inventory
			Long-Established (of plantation origin) Woodland Inventory
			Areas of Great Landscape Value
			Countryside policy area
			Housing Supply for 2006 & Housing Proposals
			Strategic Housing Allocations
			Scottish Wildlife Trust Reserve
			Wildlife Site
			Provisional Wildlife Site
			Greenbelt
			Public Parks
			Tree Preservation Orders
			Environmental proposals