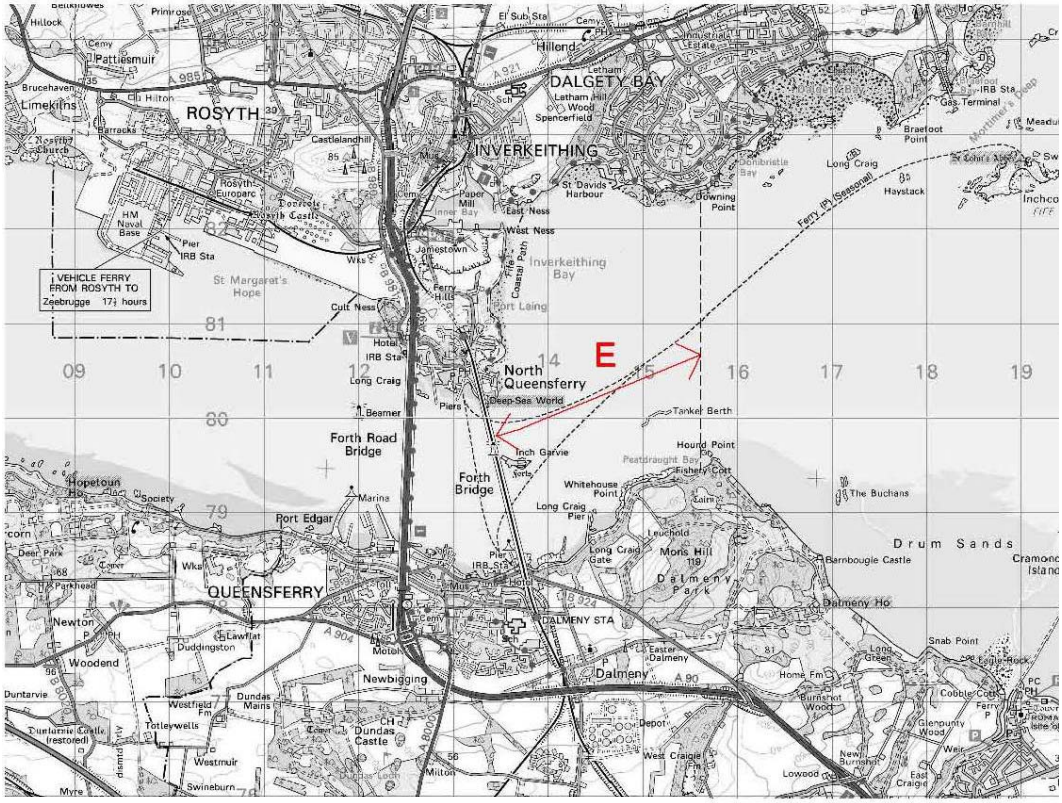
APPENDIX F - ASSESSMENT OF CORRIDOR E

F1 DESCRIPTION OF CORRIDOR

Corridor E is the most easterly of the options to be assessed. As shown on Drawing Number. 49550/G/02, Corridor E is defined by the western edge of the Forth Bridge. No routes were considered east of Hound Point within this corridor. An extract from this drawing is given below.



F2 INFLUENCE OF GEOLOGY

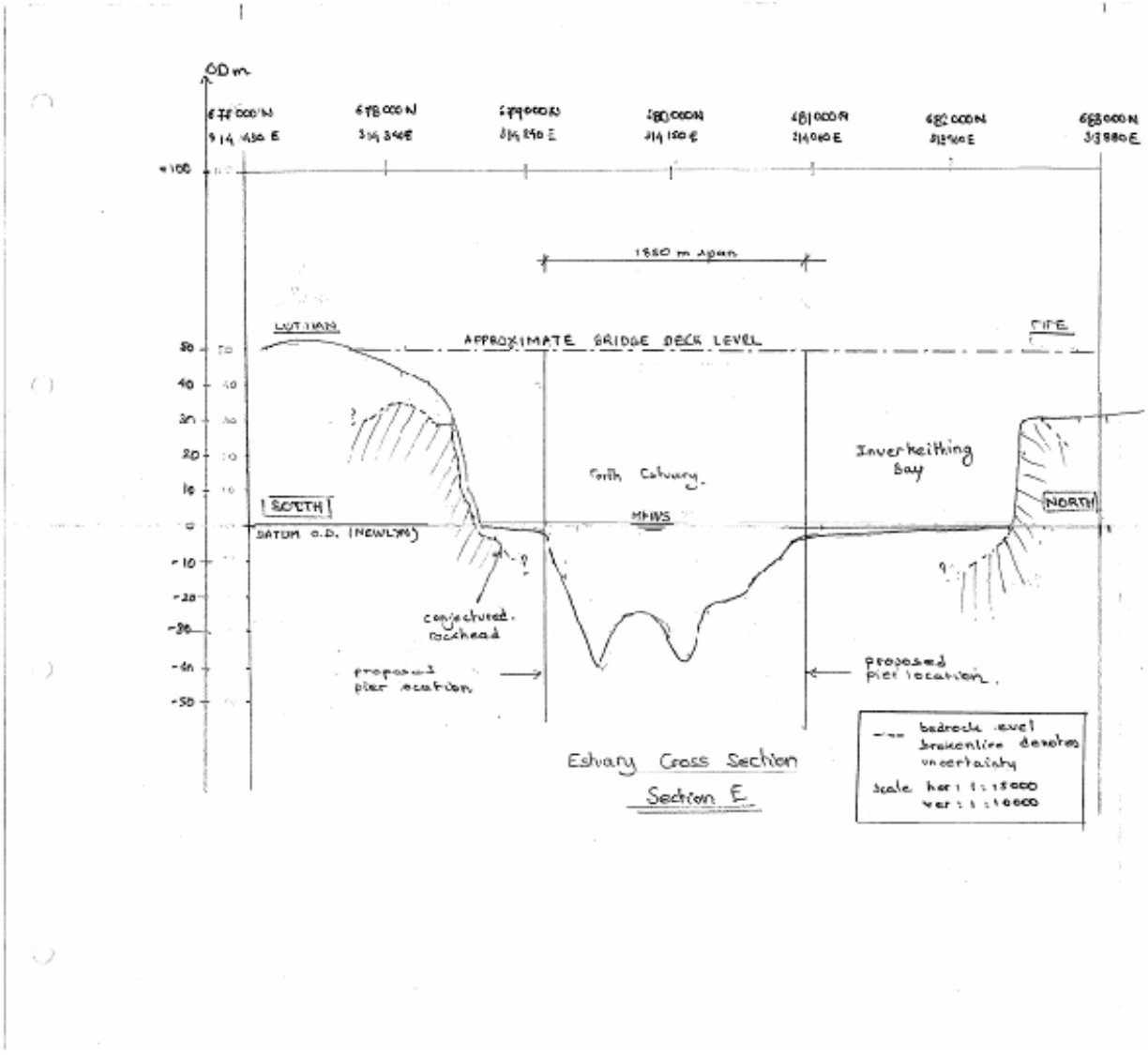
In contrast to Corridor D, the geology of Corridor E is relatively unrecorded. The zone is beyond the study area included in the British Geological Study Report on “Engineering Geology of the Upper Forth Firth”. Consequently, there is no information relating to rockhead levels in the Firth.

Nevertheless, if the supposed reduction of depth to rockhead eastwards from Bo'ness to the existing bridges continues downstream of the Forth Bridge, this may be indicative of generally similar geological conditions in Corridor E to those in Corridor D. It is noted, for instance, that downstream of Inch Garvie, there are three areas of relatively shallow water. These may be shoals, or may conceal bedrock at shallow depth. If this is the case, a bridge with multiple spans of about 700m may be achievable. However, further consideration has indicated issues surrounding navigation clearances. This option has not been developed, therefore, due to proximity to these navigation channels.

Within Corridor E, two main navigation channels appear on the admiralty charts, each of the order of 40m deep. They are separated by an area of shallower water which has a bed level of about 25m below OD. This area is immediately downstream of the island of Inch Garvie and may be the result of reduced erosional activity of the bedrock, or the accumulation of sediments due to the slower currents.

There is a minimal amount of site investigation information available for this Corridor and hence it is difficult to establish the bedrock profile and nature of the sediments. This is of particular concern at the proposed main tower locations. However, a cross section of the Firth within this Corridor has been prepared to illustrate the approximate geology and this is presented in Figure F.1 below.

Figure: F.1 Geological Cross Section at Alignment EB1



F3 TRANSPORT PLANNING

A test of the operational performance of Corridor E has been run using the TMfS. This test is representative of both the tunnel and bridge options in this Corridor. In this test the crossing is connected to the A8000/M9 Spur Extension (which is currently under construction) and sweeps across the A90 near Dalmeny. On the north side it connects to the M90 either at a remodelled Junction 2 (Masterton) or further north at a new junction.

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 all vehicles. This test has been run for the forecast years of 2012, 2017, 2022.

This Corridor is the second closest of the five being assessed to the existing Forth Road Bridge. Consequently, it performs relatively well in accommodating trips of the type currently crossing the Forth. In the first model scenario around 20 per cent of peak hour traffic diverts from the existing Forth Road Bridge to a new crossing. Between 25 and 30 per cent of traffic diverts during the day when given free choice of the two crossings.

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

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.

Given the volume of traffic utilising this crossing it is clear that this corridor caters better for both the northern and southern traffic origins and destinations than the previous four corridors.

With both crossings available (the first scenario) the daily traffic flow on the Forth Road Bridge is envisaged to be around 54,000 in 2012 rising to 58,000 by 2022. This is significantly less than current levels and, therefore, it can be concluded that the objective of maintaining cross-Forth transport links to at least the level of service offered in 2006 is likely to be met. The figures suggest that a crossing on this corridor is the most successful in meeting this objective.

In the scenario when only this new corridor is available for cross Forth trips, there is a two per cent increase total distance travelled. This indicates that a replacement crossing in Corridor E would not minimise the impacts of maintenance on the effective operation of the transport network when compared to other corridor options. There would be additional economic costs incurred as a consequence of the

additional mileage driven. In addition, there would also be environmental impacts from the additional distances travelled.

It is considered that this corridor would provide better flexibility during periods of major maintenance at the Forth Road Bridge purely as a consequence of its proximity. The operation of the new crossing as a high wind diversion route when closures are imposed on wind susceptible vehicles makes Corridor E a better prospect compared with A, B and C. There is little difference when compared with D.

There are similar opportunities to Corridor D for introducing public transport into this corridor. Extensions to the proposed Edinburgh Tram Network across into Fife or the expansion of Express Bus services serving a variety of destinations including Dunfermline to West Lothian could be incorporated. The Forth Road Bridge could also provide the priority route for public transport.

In summary, Corridor E performs well against the transport planning objectives for this study. On balance it is the best performing of the five corridors in transport planning terms.

F4 BRIDGE CROSSING OPTIONS

F4.1 Detailed Summary of Constraints

Along the north shore, the designated areas are generally narrow stretches of SSSI and SPA. An inlet, Inner Bay, separates Inverkeithing and North Queensferry. There is a narrow stretch between Inverkeithing and Dalgety Bay which has relatively little urban development.

Along the south shore the areas are again dominated by narrow stretches of SSSI and SPA areas. Immediately south of the shore rises Mons Hill comprising gardens and designed landscape areas.

East of the Forth Bridge the water depths generally decrease but as the width of the Firth increases the width of deeper water also increases. Immediately east of the rail bridge is the island of Inch Garvie.

At Hound Point a tanker berth terminal is located and oil pipelines feed from the berth towards the south shore.

Several bridge alignments and structural forms have been studied to determine if it is possible to construct a bridge crossing through this corridor. These alternatives have been reviewed as follows.

F4.2 Alignment EB1 (Refer to Drawing 49550/B/06)

The area of relatively little urban development between Inverkeithing and Dalgety Bay forms a natural landfall. The south landfall would be located east of Long Craig Pier. In order to found bridge piers in relatively shallow water a suspension bridge with a main span of approximately 1850m, with side spans of approximately 550m, would be required. As stated above, information on bedrock level is extremely limited and a site investigation would be required to provide the necessary

information should this option be taken forward. This option would also involve long stretches of approach viaducts built across the mudflats.

F4.2.1 Risks Associated with Bridge Crossing EB1

In addition to the generic risks associated with design and construction of long span bridges the risks associated with this option are as follows:

- The depth to bedrock level has not been established from site investigation. The information used (set out in section 2.3 of the main report) allows the inference of data. It is possible that the rockhead is at a level which would allow the construction of feasible, cost effective foundations for a large span suspension bridge. Assumptions have been made regarding the depth to bedrock. These assumptions have been used in establishing the cost of the envisaged structure. In order to mitigate the risk and uncertainty associated with this, ground investigation would be required to establish the actual level of bedrock.
- Aerodynamic stability of the main span. This risk could be eliminated at the design stage through wind tunnel testing and analysis. There is a small risk that the design would lead to an increase in the width of the bridge deck and hence an increase in the cost.
- Proximity to Hounds Point Oil Facility. The south landfall has been sited to avoid the oil facility and its pipelines. There is a risk that the pipeline between Hound Point and Dalmeny Storage Tank may conflict with the locations of foundations or anchorages. In order to mitigate this risk, a detailed review of the as-built drawings of the pipelines is required. However, it should be assumed that the pipeline would have to be protected against all envisaged loads arising, both during and after construction. There is also the issue of having the crossing located so close to the facility.

Cable stayed bridge options were also considered for this alignment. The central tower would require foundations in water approximately 25m deep. Again with little information on the bedrock level, some form of site investigation would be required if this option were to be taken forward.

F4.3 Alignment EB2 (Refer to Drawing 49550/B/07)

Alternative alignments to those discussed above have been examined in order to determine if it is possible to introduce a north landfall near North Queensferry. However, the proximity of the Forth (rail) Bridge and its approaches dictated that any landfall would need to be north of Port Lang.

Several alternative locations for the south landfall have also been considered. The location of the Hound Point Marine Terminal oil pipelines provides a constraint. The steep landscaped Mons Hill and Dalmeny Park also dictate that the landfall would need to be moved towards Whitehouse Point.

In spite of these constraints, it has been concluded that it is possible to bridge the potentially narrow crossing between Whitehouse Point and North Queensferry as part of a longer cross Forth route. In order to found the main towers of a bridge on

this alignment in relatively shallow water, it would be necessary to provide a suspension bridge with a main span of 1650m, with side spans of 500m. Approach viaducts would be required to link the bridge to the north landfall. A further bridge would be required across Inner Bay between West Ness and East Ness.

F4.3.1 Risks associated with Bridge Crossing EB2

In addition to the generic risks associated with design and construction of long span bridges, the risks associated with this bridge option are as follows:

- The depth to bedrock level has not been established from site investigation. The information used (set out in section 2.3 of the main report) allows the inference of data. It is possible that the rockhead is at a level which will allow the construction of feasible, cost effective foundations for a large span suspension bridge. Assumptions have been made regarding the depth to bedrock. These assumptions have been used in establishing the cost of the envisaged structure. In order to mitigate the risk and uncertainty associated with this, ground investigation would be required to establish the actual level of bedrock.
- Aerodynamic stability of the main span. This risk can be eliminated at the design stage through wind tunnel testing and analysis. There is a small risk that the design would lead to an increase in the width of the bridge deck and hence an increase in the cost.
- Proximity to Hounds Point Oil Facility. The south landfall has been sited to avoid the oil facility and its pipelines. There is a risk that the pipeline between Hound Point and Dalmeny Storage Tank may conflict with the locations of foundations or anchorages. In order to mitigate this risk, a detailed review of the as-built drawings of the pipelines is required. However, it should be assumed that the pipeline would have to be protected against all envisaged loads arising both during and after construction. There is also the issue of having the crossing located so close to the facility.

F4.4 Costings

Preliminary comparative costings of suspension bridges on Alignments EB1 and EB2 have been prepared. The former was 1.7 times the cheapest option and the latter was 1.5 times.

F5 TUNNEL CROSSING OPTION

F5.1 Crossing Option (Refer to Drawing 49550/T/03)

Tunnelling could commence between Junction 2A of the M90 and Balgougie on the north shore. The tunnel would cross the northern shoreline at approximately St. Davids Harbour. It would then pass to the east of Inch Garvie, making landfall on the south shore at Lone Craig Gate. It would then rise to a portal between Dalmeny and the M9.

The geological information east of the existing road bridge is limited. The ground conditions through the river section may include dolerite dykes. The tunnel cross section and design would be critical to allow successful tunnelling through the range of ground conditions that could be encountered. These restrictions may limit the size of TBM practicable for a bored tunnel and could dictate the use of cross connections every 500m. This may, in turn, introduce extra costs where cross passages are tunnelled within sands and gravels.

As an alternative construction method, an immersed tube could be constructed through the deep channel at this point. This may reduce the overall tunnel length and avoid some of the geological risk associated with a bored tunnel crossing. The deep, narrow channel and strong tidal flow through this area may have produced a different depositional environment than the shallower areas of the Firth west of the existing bridges. This could indicate that the environmental impact from the immersed tunnel construction would be reduced, as potentially fewer sediments might be released. As it would not be practical to extend the immersed tube tunnel under the banks of the Firth and to facilitate the 3 per cent recommended gradient, it will be necessary to utilise lengths of bored tunnels through these areas. Further investigation would be required to assess this impact.

As further investigation is required to establish the validity of either tunnelling method, it is concluded that both should be retained for this phase of the study.

Work sites could be positioned on either end of the alignment. However, it is likely that new road connections would be required to facilitate a toll plaza to the south end of the tunnel. Additional worksites may also be required on either shoreline to allow tunnelling to be separated into discreet contract packages. If a combined bored /immersed tube tunnel were constructed an additional worksite would be required for the large casting facilities required for the immersed tunnel sections.

The tunnel would pass beneath a number of transport routes, notably the A921, the A90 and the rail lines at Dalgety Bay and Dalmeny. The position of any on-shore buried oil pipelines feeding the Dalmeny Depot would have to be established to ensure tunnelling did not intersect them.

The length of bored tunnel for this alignment would be approximately 7.5km. however, if a combined bored / immersed tube solution were used, this may be reduced to approximately 7km.

F5.2 Costings

A preliminary comparative costing exercise has been carried out for this tunnel option. This crossing will be approximately 3.0 times the cheapest option.

F6 NETWORK LINKAGES

F6.1 Bridge Crossing Option (Refer to Drawing 49550/N/06)

The southern tie-in for a Bridge on Corridor E (alignment EB1 has been assumed for this work) presents a number of challenges. The southern bridgehead lies approximately 500m to the east of the existing Forth (rail) Bridge. The new link road would pass to the east of Dalmeny Station and cross the existing railway line just north of where it passes beneath the A90. It would then have to be elevated to cross the A90 to the west of Dalmeny before connecting into the M9 Spur Extension which is currently under construction.

Motorway traffic could continue directly onto the M9 Spur Extension, but, at present, this only allows traffic to and from the M9 eastbound at Junction 1A of the M9. There is no existing provision for movement to and from the M9 westbound. However, there would appear to be no great impediment to reconstructing the existing Junction 1A to allow all movements.

Non-motorway traffic poses a greater difficulty in operational terms. Providing a connection from the new link road back to the existing non-motorway network would prove difficult if all movements had to be catered for.

A link could be provided for vehicles heading south over the new bridge to head east onto the A90. This would also cater for vehicles which travel westbound on the A90 to access the new bridge heading north. Meeting the needs of vehicles to and from the west would be very difficult given the need to maintain the integrity of the existing rail lines and the A90. The oil storage depot and the layout of the railway lines, as well as the proposed Edinburgh Airport Rail Link, means that the link cannot feasibly by realigned further to the east of the line currently proposed. The proximity of the railway line to the M9 Spur Extension means that realistically no construction works can be undertaken to the east of the M9 Spur Extension.

Further complications are the presence of a shallow oil pipeline running west from the oil depot and the presence of heavily worked mineworkings to both the north and south of the A90 at Dalmeny. Some of these mineworkings were recently grouted as part of the M9 Spur Extension contract. The condition of the remaining workings is unknown.

If the link to the new crossing could cater for motorway traffic only, these issues would be resolved as the new road and hence new bridge would effectively become an extension to the M9 Spur Extension. However, if the existing bridge were to close in the future and the new bridge was forced to cater for non-motorway traffic, the constraints in the area would make this option problematic.

It is also likely that the constraints associated with ground conditions and pipelines would impose the requirement that a length of the link road (potentially from north of Dalmeny to approximately 500m south of the A90) would need to be on a bridge structure rather than high embankment. This has additional economic implications especially over a heavily mineworked area. There are also potential environmental and social implications associated with the construction of such a structure so close to the settlements of Dalmeny and Queensferry. The demolition of at least one property to the north of Main Street in Dalmeny would appear to be unavoidable.

The northern bridgehead lies approximately midway between Inverkeithing to the west and Dalgety Bay to the east. There are two possible tie-in points to the existing motorway network:

- A remodelled Junction 2 of the M90 at Masterton; and
- A new interchange between Junctions 2 and 2A of the M90.

With either option, non-motorway traffic could be served by the provision of a new grade separated junction where the new link road crosses the A921. This would serve traffic from both east and west.

If the option to tie-in at Junction 2 was chosen, the existing layout would have to be altered to cater for the additional movements required. There appear to be few constraints to facilitate this. However, the distance between the new interchange and the adjacent junctions 2 and 2a would be substandard, particularly in terms of the available weaving lengths.

Either option would likely result in the closure of the B981 where the new link crosses. It is concluded that there are adequate alternative routes to avoid this being a significant issue.

Estimated construction cost includes new junctions on the M9 Spur, A921 and M90.

F6.2 Tunnel Crossing Option (Refer to Drawing 49550/N/07)

At the southern end of Corridor E, the tunnel would be required to pass beneath the existing railway line just to the north of the A90 and the A90 itself. This area has been subject to extensive mineworking in the past. The area immediately to the south of the A90 and west of the existing railway line has recently been grouted (to a depth of approximately 60m) as part of the construction of the M9 Spur Extension.

A tunnel on this corridor could emerge approximately 1km to the north of the existing Humbie roundabout (currently being removed). The M9 Spur Extension would effectively be realigned vertically to access this tunnel directly, with the remainder of the M9 Spur being declassified to provide access for non-motorway traffic.

Non-motorway traffic would access and egress the tunnel from the A8000. New slip roads would have to be constructed to allow vehicles to make this manoeuvre. Motorway traffic would access and egress the tunnel directly from the M9 by travelling along the existing M9 Spur and the remaining length of the new M9 Spur Extension. It would be necessary to reconstruct Junction 1A of the M9 to cater for movements to and from the west.

Two options were examined to connect the tunnel into the existing road network to the north of the Forth.

- A new grade separated interchange between Junction 2 and 2a of the M90, and;.
- A remodelled Junction 2 which would allow all movements.

For the first option, a tunnel could emerge to the south of the existing railway line and bridge over it. This alignment would then continue to the north. The M90 rises from Junction 2 to 2a, which would result in a relatively long and steep gradient for the link. Providing a new junction at this location would, however, result in junction spacing and weaving lengths which are less than the desirable minimum. Furthermore, the linkage to the local road network for non-motorway traffic would result in the need for a 3km improvement of the B981 back to its junction with the A921.

If it were practical to provide a new link road connecting into a remodelled Junction 2 at Masterton, many of the issues described above would disappear. However, it is considered that the topography in the area may render this impossible, as the new tunnel may not be able to rise quickly enough to achieve a suitable connection. Linking to the local road network for non-motorway traffic would also be problematic. However, it may be practical to provide a new arrangement at Junction 2 which would allow traffic to access the B981, which would be upgraded to cater for the additional traffic, although this a complex and difficult solution.

For the reasons stated above, it is considered that the first option is preferable, although both would require further detailed investigation to confirm their viability.

Estimated construction cost includes a remodelled junction on the M9, a new junction on the M9 spur and M90 and upgrading of the B981 to the south.

Corridor E is east of the existing rail bridge. The alignment of this corridor would be between the bridge and the oil pipelines off Hound Point. It would connect to the M90 at Junction 2A and the M9 at the A8000 junction.

F7 ENVIRONMENT

F7.1 Introduction

This section identifies the environmental constraints based on international, national and local designations for each route. These are shown in Figures F.2 to F.4. In addition, potential environmental effects that are not related to statutory designations, 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. These various designations are listed within Tables F.1 to F.9.

Each option in this corridor has been assessed for its impact on each of:

- ecology;
- landscape;
- archaeology and cultural heritage;
- communities;
- air quality; and

- planning designations.

F7.2 Ecology - Bridge Option EB1

The Bridge option EB1 for Corridor E crosses the Forth of Forth SPA (SSSI and Ramsar site) on the southern shore of the Firth. The SPA on the southern shore is narrow which suggests a small direct impact. However, the significance of any indirect impacts cannot be determined at this stage, particularly with reference to deep water bird species which may be more common in this corridor than the other corridors.

Carlingnose SSSI lies on the western margin of the corridor, in Fife. This is a small area of species rich calcareous grassland and heathland on a hill-top plateau which supports the vulnerable field gentian (*Gentianella campestris*) and the locally rare dropwort (*Filipendula vulgaris*). Direct impacts on this site could be avoided, but there may be indirect impacts, particularly during construction. However, it should be possible to reduce these to a minimal level.

Non-statutory sites are present in the corridor surrounding connecting roads. The sites are all listed Ancient Woodlands, namely the long established plantations of Fordell Castle and Letham Hill Wood in Fife and the woodlands of the Dalmeny Estate. The habitat within these wooded areas suggests protected species issues may arise that need to be considered. Badger, otter and bats may occur along the southern connecting corridor with the addition of red squirrel to the north. Underpasses, wildlife bridges, habitat creation and appropriate bridge design may be used to mitigate any impact.

F7.3 Landscape – Bridge Option EB1

Nationally Protected Sites

This option passes through the western end of the Dalmeny GDL. In addition, it passes close to the Fordell Castle GDL in Fife and the Dundas Castle GDL located to the south of South Queensferry.

Locally Protected Sites

This option does not pass through or close to any AGLVs / AOLQs. However, it crosses the centre of the West Edinburgh Greenbelt.

F7.4 Archaeology and Cultural Heritage – Bridge Option EB1

Scheduled Ancient Monuments

There are a number of SAMs within the corridor and these are listed in Table F.1 below.

Table F.1: Corridor E1 (Bridge OptionEB1) - Scheduled Ancient Monuments

Council Area	Scheduled Ancient Monuments
Fife	Carlingnose Battery
Fife	St James' Chapel
Edinburgh	Firth of Forth, defensive installations on Inch Garvie
Edinburgh	Craigie Hill Fort

Listed Buildings
In the vicinity of Corridor E1 there are over 100 listed buildings, and there are two listed buildings that lie close to the centreline of the route corridor. These are shown in Table F.2.

Table F.2: Corridor E (Bridge Option EB1) - Listed Buildings

Council Area	Listed Building	Category
Fife	Spencerfield House	Category B
Fife	Spencerfield House, Gate Piers	Category B

Conservation Areas / Heritage Conservation
Provision for Conservation Areas is defined by the Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997. The centre line of the corridor as proposed appears to cross through the Dalmeny Conservation Area in Dalmeny village, as well as a number of listed buildings in this area.

F7.5 Community Impacts – Bridge Option EB1

Effects on communities and scattered dwellings could take the form of impacts on visual amenity, noise impacts and changes in land use or land take. This section identifies the settlements and dwellings that are located on the centre line of Corridor E1 and any other significant settlements or properties within the Corridor.

On the southern shore this option encompasses a number of scattered dwellings located between the A90 and Kirkliston. It crosses the Firth the east of the existing Forth Rail Bridge passing Dalmeny and the eastern outskirts of South Queensferry.

On the north shore the route passes through North Queensferry and passes by the outer fringes of Inverkeithing and Dalgety Bay, to the west and east of the route respectively. Further north, the route takes in scattered dwellings at Duloch and Balbougie.

There are large populations associated with the settlements on both the northern and southern sides of the route. As a result, there a large number of potential receptors for visual and noise related impacts. It is possible that if the route joins the A90 north of junction 2 it would result in significant visual and landscape impacts. These would result for its introducing a road that, due to the railway line and the topography would have to be on a viaduct or embankment across the floor of the valley. The road would then rise up and cut through the top a hill, thus adding to its visual impact.

It should also be noted that the location of the bridge to the east of the Forth Rail Bridge would adversely impact on the setting of the rail Bridge resulting in a significant impact on visual amenity.

F7.6 Air Quality – Bridge Option E1

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. Furthermore, as this option is close to the existing transport corridor the additive effect of emissions in some locations may be significant. In addition, by construction of an additional crossing is likely to encourage increased road travel which is likely to lead to an increase in global CO_2 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.

F7.7 Planning Designations – Bridge Option EB1

Housing

In the Edinburgh and Fife Council Local Plans there are various planning designations that fall within the study area. These are summarised in Table 10.3 below

Table F.3: Corridor E (Bridge OptionEB1) - Planning Designations

Description	Name	Location
Housing Supply (2006)	E Dunfermline North E1	Dunfermline
Housing Supply (2006)	E Dunfermline North H	Dunfermline (Fife)
Housing Supply (2006)	Kingdom Gateway H	Dunfermline (Fife)
Housing Supply (2006)	Kingdom Gateway F	Dunfermline (Fife)
Housing Supply (2006)	Kingdom Gateway E	Dunfermline (Fife)
Housing Supply (2006)	Kingdom Gateway I	Dunfermline (Fife)
Housing Supply (2006)	Kingdom Gateway G	Dunfermline (Fife)
Housing Supply (2006)	Borelands Reservoir	Inverkeithing (Fife)
Housing Supply (2006)	King Street B	Inverkeithing (Fife)
Housing Supply (2006)	Service Station Chapel Place	Inverkeithing (Fife)
Housing Supply (2006)	Port Street	Inverkeithing (Fife)
Housing Supply (2006)	Roman Road	Inverkeithing (Fife)
Strategic Housing Allocation Proposals	North Kirkliston - HSP 1 (located in Chapter 5 of the Rural West Edinburgh Local plan)	Edinburgh

F7.8 Environmental Conclusions – Bridge Option EB1

The baseline study has found a wide variety of designations, some of which pose more of a constraint to the proposed crossing than others. The Firth of Forth SPA (which is also a Ramsar site and SSSI) and the Forth Islands SPA represent the over riding constraints on the southern fringes of the Firth. They are afforded the highest level of protection in the UK and there is a presumption against causing adverse impact unless the development is of over riding public interest and there are no alternatives. In addition, any impacts to the qualifying bird species using the Firth out with the SPA may impact on the ecological integrity of the SPA itself.

However, for this option, the SPA is only crossed on the southern side of Firth. It is avoided on the northern bank.

Other significant constraints for this option comprise the Dalmeny GDLs and the Dalmeny Conservation Area. In addition, some areas of Ancient Woodland with the potential for European protected species as well as listed buildings would be affected by this alignment.

Construction of a bridge in this area would impact on local communities and on visual amenity and landscape. It would also introduce a new noise source to the area, which may be significant depending on the proximity of sensitive receptors within dwellings, etc. A bridge is also likely to reduce local air quality, which may exacerbate the existing air quality situation, as well as contributing to increased global CO_2 due to overall increases in traffic across the Forth.

F7.9 Ecology – Bridge Option EB2

Corridor E2 crosses the Forth of Forth SPA (SSSI and Ramsar site) on both landfalls. The Firth of Forth designations reflect its international and national importance for wader and wildfowl populations. The corridor also crosses open water spanning the Forth Islands SPA. This is designated at an international level for its breeding tern and seabird colonies. Sea ducks and divers feed, loaf and roost outside the SPA in the open waters of the Firth and salmon migrate upstream to spawn in the River Teith Special Area for Conservation (SAC). Impacts could therefore occur outwith the immediate boundaries of the SPAs but may still affect the integrity of these designated areas. Carlingnose SSSI lies on the western margin of the corridor and may be susceptible to indirect effects.

Non statutory sites are present in the 1km zone of potential impact of the road connections to the bridge. The sites are all listed Ancient Woodlands, namely the long established plantations of Fordell Castle and Letham Hill Wood in Fife and the woodlands of the Dalmeny Estate in the City of Edinburgh. The habitat associated with these wooded areas indicates protected species issues could arise that would need to be considered. Badger, otter and bats may be present along the southern connecting section of the route of red squirrels to the north. Underpasses, wildlife bridges, habitat creation and appropriate bridge design may be used to mitigate some of these impacts.

The longer connecting roads required for option EB2 indicate greater potential impact on the general countryside than those for other routes. For this option, these roads increase the potential for direct impact on the Dalmeny Estate woodlands.

F7.10 Landscape – Bridge Option EB2

Nationally Protected Sites

Bridge Option EB2 passes through the western end of the Dalmeny GDL. In addition, it passes close to the Fordell Castle GDL in Fife and the Dundas Castle GDL located to the south of South Queensferry.

Locally Protected Sites

This route does not pass through or close to any AGLVs. However it crosses the centre of the West Edinburgh Greenbelt.

F7.11 Archaeology and Cultural Heritage – Bridge Option EB2

Scheduled Ancient Monuments

There are a number of SAMs within the route corridor and these are listed in Table 1F.4 below.

Table F.4: Scheduled Ancient Monuments: Corridor E (Bridge Option EB2)

Council Area	Schedules Ancient Monuments
Fife	Enclosed settlement 310m NNE of Balbougie
Fife	Souterrain 370m ENE of Middlebank House
Fife	Carlingnose Battery
Fife	St James' Chapel
Edinburgh	Firth of Forth, defensive installations on Inch Garvie
Edinburgh	Craigie Hill Fort

Listed Buildings

In the vicinity of option EB2 there are over 300 listed buildings (mainly clustered in Inverkeithing, North Queensferry and Dalmeny) Two listed buildings lie close to the centreline of the route . These are shown on Table F.5.

Table F.5 Listed Buildings: Corridor E (Bridge Option EB2)

Council Area	Listed Building	Category
Edinburgh	Easter Dalmeny, Farmhouse	Category C(s)
Edinburgh	Carlowrie Cottages, Railway Bridge	Category C(s)

In addition, the route lies parallel to the Forth Bridge, which is a Category A listed structure.

Conservation Areas / Heritage Conservation

Provision for Conservation Areas is defined by the Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997 and although there are Conservation Areas in the vicinity (e.g. at South Queensferry, Dalmeny and Kirkliston) there are none within the route corridor.

F7.12 Community Impacts – Bridge Option EB2

Effects on communities and scattered dwellings could take the form of impacts on visual amenity, noise levels and changes in land use or land take. This section identifies the settlements and dwellings that are located on the centre line of this option EB2 and any other significant settlements or properties within the Corridor.

On the southern shore the corridor encompasses a number of scattered dwellings to the south of Dalmeny including Almondhill and Craigiebrae Farm. The alignment passes Easter Dalmeny and crosses the Forth in a north westerly direction.

North Queensferry is located on the western side of the corridor. On the northern shore the alignment is fringed to the east by the outskirts of Dalgety Bay and to the west by Inverkeithing.

There are large populations associated with the settlements on both the northern and southern sides of the corridor. As a result, there a large number of potential receptors for visual and noise related impacts. It is possible that if the route joins the A90 north of junction 2 it would have significant visual and landscape impacts. These would arise for its introducing a road that, due to the railway line and the existing topography would have to be on a viaduct or embankment across the floor of the valley. The road would then rise up and cut through the top a hill, thus adding to its visual impact.

It should also be noted that the location of the bridge to the east of the Forth Rail Bridge could adversely impact on the setting of the Rail Bridge and could be a significant impact on visual amenity.

F7.13 Air Quality – Bridge Option EB2

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. As this option is close to the existing transport corridor the additive effect of emissions in some locations may be significant. In addition, construction of an additional crossing is likely to encourage increased road travel which will likely lead to an increase in global CO_2 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.

F7.14 Planning Designations – Bridge Option EB2

Housing

In the Edinburgh and Fife Council Local Plans there are various planning designation that fall within the study area. These are summarised in Table F.6 below

Table F.6 Planning Designations

Description	Name	Location
Housing Supply (2006)	E Dunfermline North E1	Dunfermline
Housing Supply (2006)	E Dunfermline North H	Dunfermline (Fife)
Housing Supply (2006)	Kingdom Gateway H	Dunfermline (Fife)
Housing Supply (2006)	Kingdom Gateway F	Dunfermline (Fife)
Housing Supply (2006)	Kingdom Gateway E	Dunfermline (Fife)
Housing Supply (2006)	Kingdom Gateway I	Dunfermline (Fife)
Housing Supply (2006)	Kingdom Gateway G	Dunfermline (Fife)
Housing Supply (2006)	Borelands Reservoir	Inverkeithing (Fife)
Housing Supply (2006)	King Street B	Inverkeithing (Fife)
Housing Supply (2006)	Service Station Chapel Place	Inverkeithing (Fife)
Housing Supply (2006)	Port Street	Inverkeithing (Fife)
Housing Supply (2006)	Roman Road	Inverkeithing (Fife)
Strategic Housing Allocation Proposals	North Kirkliston - HSP 1 (located in Chapter 5 of the Rural West Edinburgh Local plan)	Edinburgh

F7.15 Environmental Conclusions – Bridge Option EB2

This section of the report summarises the potential environmental constraints present within Corridor E: Bridge Option EB2. The baseline study has found a wide variety of designations, some of which pose more of a constraint to the proposed crossing than others. The Firth of Forth SPA (which is also a Ramsar site and SSSI) and the Forth Islands SPA represent the over riding constraints on the intertidal habitats of the Firth. They are afforded the highest level of protection in the UK and there is a presumption against causing adverse impact unless the development is of over riding public interest and there are no alternatives. There will be a direct impact on the Firth of Forth SPA on the northern and southern shore. In addition, any impacts to the qualifying bird species outwith the two SPAs may also impact on the ecological integrity of the SPA's themselves.

Some areas of Ancient Woodland may be affected by this alignment.

Other significant constraints comprise the GDL at Dalmeny and some listed buildings, particularly south of the Firth. In addition, the setting of the Forth Bridge in terms of visual impact would be affected by this alignment.

Construction of a bridge in this area would impact on local communities and would significantly impact on visual amenity and landscape. It would also introduce a new noise source to the area, which may be a significant source depending on the proximity of sensitive receptors within dwellings, etc. The bridge is also likely to reduce local air quality, which may exacerbate the existing air quality situation, as well as contributing to increased global CO_2 due to overall increases in traffic across the Forth.

F7.16 Ecology – Tunnel Option

This tunnel option would avoid direct impact on the Firth of Forth SPA (Ramsar and SSSI). Indirect impacts would depend upon the final placement and design of the route.

Carlingnose and Ferry Hills SSSIs lie on the western margin of the corridor. There may be some indirect impact on these sites, although this cannot be assessed until the route is known.

Non-statutory sites within the corridor of the connecting road include areas listed on the Ancient Woodland Inventory, namely the long established plantations of Fordell Castle in Fife and Dundas Castle in the City of Edinburgh. In Fife there are a number of such woodlands, including Calais Muir wood which is also a Scottish Wildlife Trust Wildlife Site, are Jamestown Pond and Inverkeithing Bay. These sites indicate potential issues relating to protected species.

F7.17 Landscape – Tunnel Option

Nationally Protected Sites

Corridor E Tunnel Option passes beneath the western end of the Dalmeny GDL. In addition, it passes close to the Fordell Castle GDL in Fife at its northern end and the Dundas Castle GDL located to the south of South Queensferry. Depending on the alignment, it is possible that none of these landscapes will be directly impacted by this option.

Locally Protected Sites

This option does not pass through or close to any AGLVs / AOLQs. However, it crosses the centre of the West Edinburgh Greenbelt.

F7.18 Archaeology and Cultural Heritage – Tunnel Option

Scheduled Ancient Monuments

There are a number of SAMs within the route corridor and these are listed in Table F.7 below.

Table F.7: Corridor E (Tunnel Option) - Scheduled Ancient Monuments:

Council Area	Scheduled Ancient Monuments
Fife	Enclosed settlement 310m NNE of Balbougie
Fife	Souterrain 370m ENE of Middlebank House
Fife	Carlingnose Battery
Fife	St James' Chapel
Edinburgh	Firth of Forth, defensive installations on Inch Garvie
Edinburgh	Craigie Hill Fort

Listed Buildings

In the vicinity of route Corridor E Tunnel Option there are over 140 listed buildings (mainly clustered in Inverkeithing, North Queensferry and Dalmeny). Two listed buildings lie close to the centreline of the route corridor. These are shown on Table F.8.

Table F.8: Corridor E (Tunnel Option) - Listed Buildings

Council Area	Listed Building	Category
Edinburgh	Wester Dalmeny	Category C(s)
Edinburgh	Wester Dalmeny, Farmhouse	Category C(s)
Fife	Spencerfield House	Category B
Fife	Spencerfield House, Gate Piers	Category B

In addition, the corridor lies parallel to the Forth Bridge, which is a Category A listed structure.

F7.19 Community Impacts – Tunnel Option

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

On the southern shore the corridor takes in scattered dwellings including Craigiebrae Farm and Milton. South Queensferry and Dalmeny are located to the west and east of the centre alignment respectively.

On the northern shore the landfall is flanked to the west by the outskirts of Inverkeithing and to the east by Dalgety Bay. Further northwards the scattered dwellings at Duloch and Balbougie are located within the route.

As this corridor is based on the development of a tunnel the impacts associated with visual amenity would be limited to the effects resulting from the network tie-ins on the southern and northern shores. These would be significantly less than the Route E Bridge Options. There is however, the potential for locally significant effects as a result of traffic related noise, although again this would be confined to the sections of the route outwith the tunnel.

F7.20 Air Quality – Tunnel Option

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. However, there are good opportunities to control local air quality through filtering, ventilation and other measures associated with the tunnel. Nevertheless, construction of an additional crossing of the Forth is likely to encourage increased road travel, which is likely to lead to an increase in global CO_2 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.

F7.21 Planning Designation – Tunnel Option

Housing

In the Edinburgh and Fife Council Local Plans there are various planning designation that fall within the study area. These are summarised in Table F.9 below

Table F.9: Corridor E (Tunnel Option) - Planning Designations

Description	Name	Location
Housing Supply (2006)	E Dunfermline North E1	Dunfermline
Housing Supply (2006)	E Dunfermline North H	Dunfermline (Fife)
Housing Supply (2006)	Kingdom Gateway H	Dunfermline (Fife)
Housing Supply (2006)	Kingdom Gateway F	Dunfermline (Fife)
Housing Supply (2006)	Kingdom Gateway E	Dunfermline (Fife)
Housing Supply (2006)	Kingdom Gateway I	Dunfermline (Fife)
Housing Supply (2006)	Kingdom Gateway G	Dunfermline (Fife)
Housing Supply (2006)	Borelands Reservoir	Inverkeithing (Fife)
Housing Supply (2006)	King Street B	Inverkeithing (Fife)
Housing Supply (2006)	Service Station Chapel Place	Inverkeithing (Fife)
Housing Supply (2006)	Port Street	Inverkeithing (Fife)

Description	Name	Location
Housing Supply (2006)	Roman Road	Inverkeithing (Fife)
Strategic Housing Allocation Proposals	North Kirkliston- HSP 1 (located in Chap 5 of the Rural West Edinburgh Local plan)	Edinburgh

F7.22 Environmental Conclusions – Tunnel Option

The Firth of Forth SPA (which is also a Ramsar site and SSSI) and the Forth Islands SPA represent the main constraints being the highest level of ecological designation. However, the locations of the SPAs, when considered in relation to the likely alignment and geometry of the tunnel mean that the tunnel option should avoid direct impacts on these areas. Other possible constraints comprise the GDL at Dalmeny although again this may be avoided by the tunnel design. However, some areas of Ancient Woodland and listed buildings may be affected by this alignment, particularly where these lie within the route of any surface infrastructure such as access roads and toll plaza(s).

Construction techniques may have differing impacts on these designated sites. For example a bored tunnel would be likely to have less impact than a immersed tube design that would require removal of sediments.

However, construction of a tunnel in this area would impact on local communities less than a bridge option with reduced visual impacts and noise. In addition there are opportunities to control local air quality although any new crossing of the Forth would be likely to increase global CO_2 due to overall growth in traffic across the Forth.

F8 CONCLUSION

It is concluded that two bridge crossing options are feasible for Corridor E. One would result in a suspension bridge with a main span of 1850m and the other a span of 1650m. The former would be one of the longest bridges of its type in the world. The costs of these two crossing options would be between 1.5 and 1.7 times the cost of the cheapest crossing option considered within this study.

A tunnel option measuring 9km in length would be required for this corridor. As with Corridor D, the use of a bored tunnel would be limited in places due to the presence of the dolerite intrusion. The cost of this option would be approximately 3 times the cost of the cheapest crossing option.

Corridor E performs in a similar manner to Corridor D in terms of the Transport Planning objectives. However the separation of the two crossings by the Forth Bridge would mean that network integration for flexibility during maintenance operations would not be as straightforward as it could be with Corridor D.

In terms of environmental impact, one of the bridge options (EB1) would cross the SPA on the south side only whereas the other (EB2) would cross the SPA on both shores. The tunnel option would avoid any direct impacts on the SPA through intrusion of piers, etc., and through disturbance of sediments during construction. In

addition, in terms of impacts on cultural heritage, landscape, visual impact, noise and local air quality a tunnel is likely to perform better than the bridge options proposed.

Figure F.2 – Corridor E Bridge Option EB1

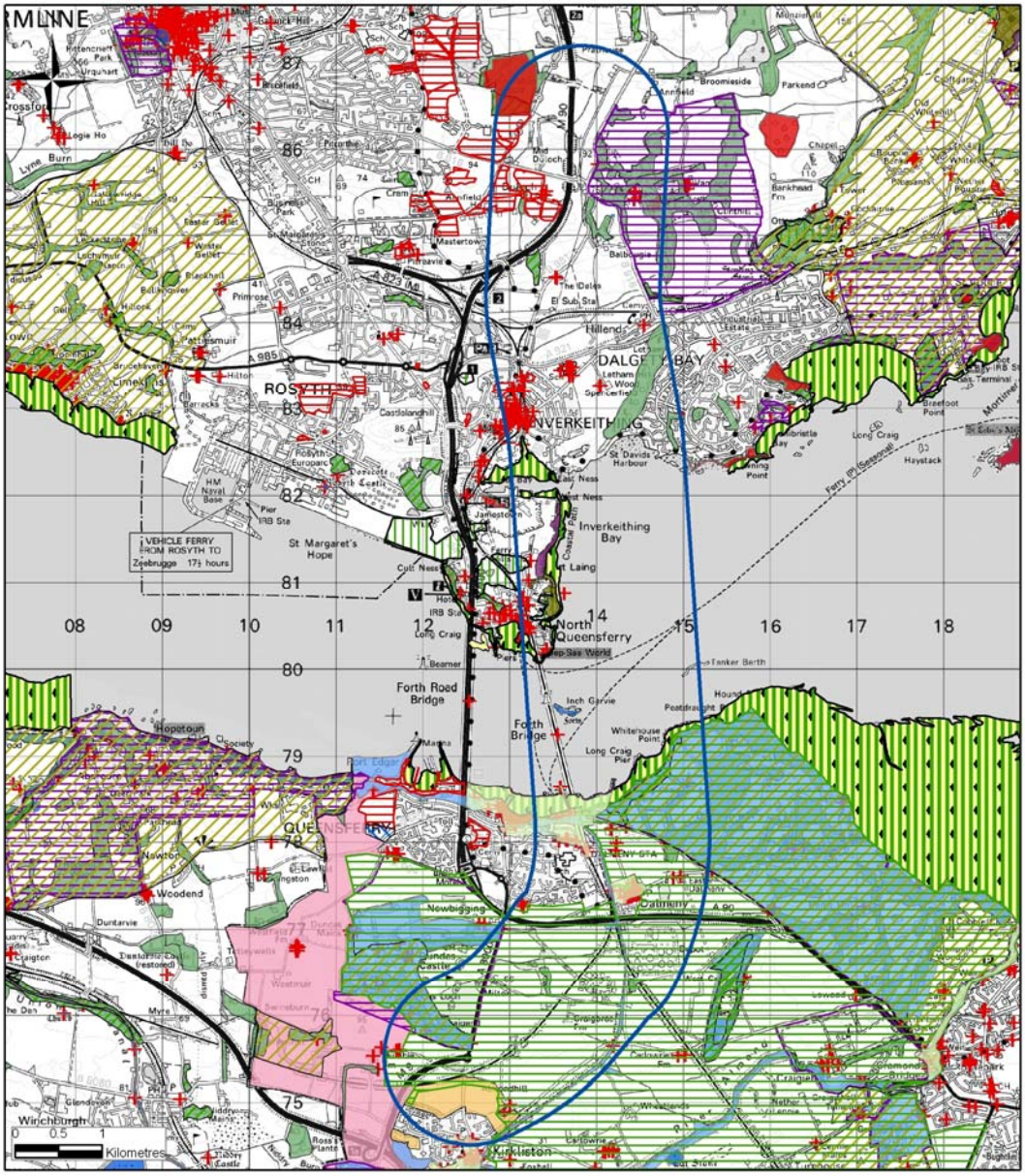


Figure F.3 – Corridor E Bridge Option EB2

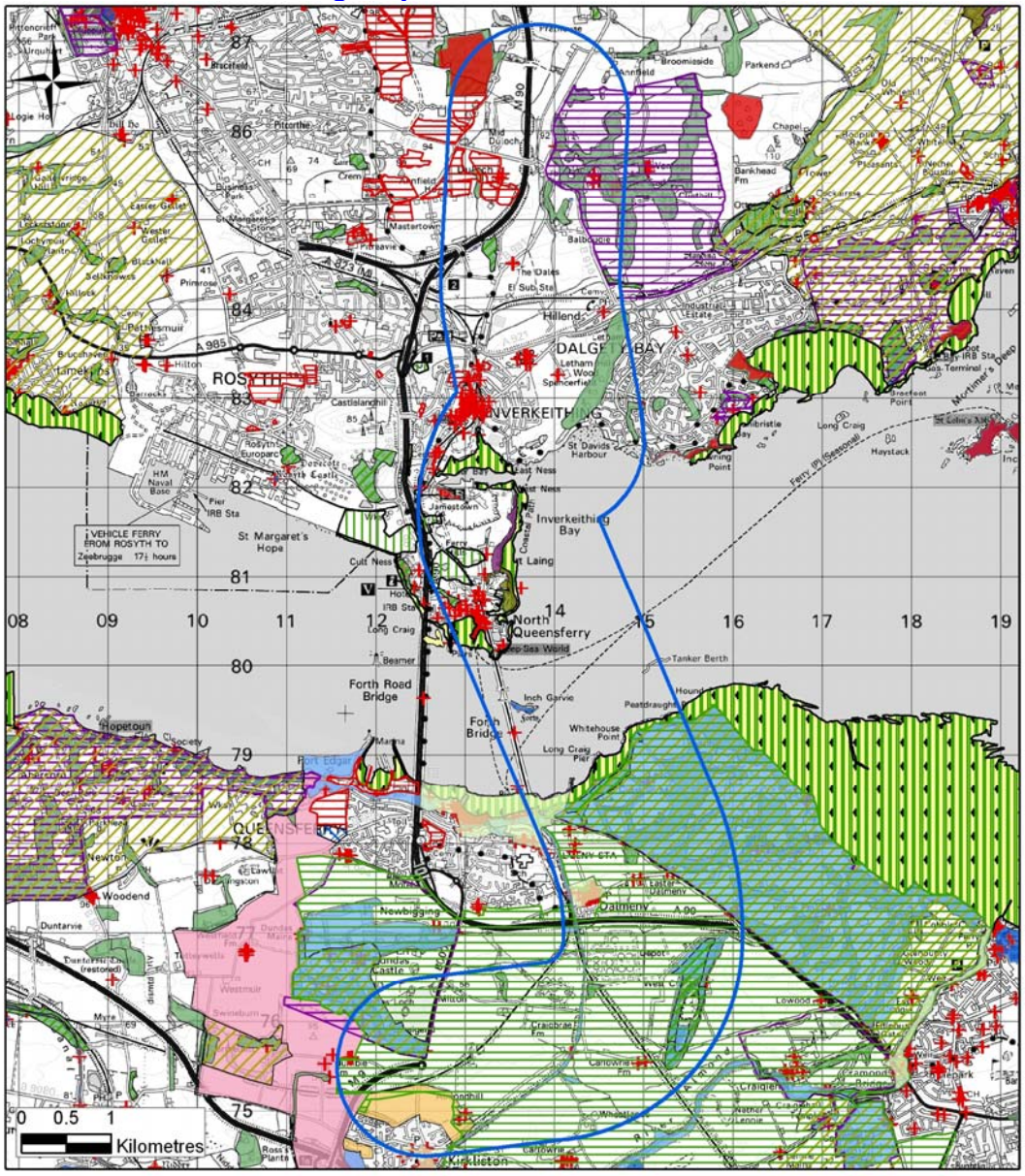


Figure F.4 – Corridor E Tunnel Option