NR Foxton Level Crossing Closure

GRIP 2 Feasibility Study Report

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May 2013

Network Rail

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Report Control Sheet		
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Abbreviations

AFC	Approved for construction
DNO	Distribution network operator
EA 2010	Equality Act 2010
ELR	Engineers line reference
GRIP	Governance in railway investment projects
LV	Low voltage
OLE	Overhead line equipment
TOC	Train Operating Companies
OSR	Option Selection Report
RAM	Route asset manager
DMRB	Design Manual for Roads and Bridges
NR	Network Rail
ROR	Rules of Route
OC	Overhead Cables
DCO	Development Consent Order
BGS	British Geological Survey
OS	Ordnance Survey
SWOT	Strength, Weaknesses, Opportunity & Threats

Executive Summary

Mott MacDonald Ltd has been appointed by Network Rail to undertake a GRIP-2 feasibility study to review options to close the existing railway level crossing at Foxton, Cambridgeshire, and provide a suitable replacement infrastructure to cross the railway safely. The existing level crossing accommodates traffic using the A10, pedestrians, cyclists and equestrians. This report discusses the impact of closing the existing rail crossing on the local community and the A10 road user and identifies options investigated to close the crossing.

The rail level crossing at Foxton is on the Up and Down main Cambridge line which intersects with the A10 Cambridge Road adjacent to the station and is located approximately 7.6miles south of Cambridge City Centre and 2.2 miles west of junction 11 of the M11 motorway. Foxton's population is currently approximately 1300 with the village bisected by the A10 and the railway line.

Option Study

The options considered mainly fall into three categories,

1. Route options (Route A, B and C).
2. Structural Options (Overbridge or Underbridge).
3. Pedestrian/cyclist and equestrians crossing (footbridge or subway adjacent to the existing level crossing designed in compliance to the Equality Act (EA) 2010).

Route Options

The option study evaluated a number of routes and types of construction which would be feasible. The online option (Route A) was dismissed due to the likely disruption caused to the A10 users and local network, and the option of a route to the south of the A10 (Route B) was not developed due to the presence of existing dwellings and statutory undertakers services. The area to the north of the A10 consists of large areas of farm land which can be utilised for the scheme development. The four sub-routes considered on the north of existing crossing (Route C) have been identified for further development and considered in the feasibility assessment. Each route is considered with the option of an overbridge and underbridge at the proposed crossing location, with approach embankments or cuttings of 1 vertical to 3 horizontal, with this stable slope dictating the acquisition of land for the scheme development. The speed limit on the existing highway is 50mph which is maintained in all the options considered with all routes allowing A10 traffic to flow freely without any disruption and is designed to minimise the impact on the local community.

Sub-Route C1: Highway alignment is designed to maintain the current design speed of 50mph for both horizontal and vertical alignment in accordance with TD 9/93 Highway Link Design.

Sub-Route C2: This Route is designed to consider a relatively smaller curve radius as compared to route C1. The route is designed to maintain 40mph design speed for the vertical and 50mph for the horizontal alignment. The 40mph design speed is below the desirable limit but falls within the acceptable range of TD 9/93.

Sub-Route C3: This route was developed to avoid land take to the Network Rail Depot on the north/west of the existing level crossing. This is the largest curve radius compared to other routes which leads to a significantly large structural span (54m) increasing the area of land take. The route is designed to maintain 40mph design speed for vertical and horizontal alignment.

Sub-Route C4: Similar to route C3, this alignment is designed based on 40mph design speed for both vertical and horizontal with a minimum curve radius. This route would require demolition of the existing Network Rail depot.

Bridge Options

Each by-pass route considers an option of an underpass and an overpass at the proposed crossing point. Numerous forms of construction were studied based on the cost, constructability in a railway environment and environmental impact. In this option study, attention is given to limit the amount of work and time on site by considering a solution which involves as much prefabrication as possible.

The existing level crossing at Foxton is a highway crossing with full pedestrian, cycle and equestrians rights of way. Once the existing level crossing is closed, pedestrian, cyclist and equestrian access must be provided over the existing level crossing to maintain the connectivity between neighbourhoods and link between the station platforms. To achieve this, the report discusses options of providing a footbridge or subway at or adjacent to the existing level crossing location. The options would comply with the Equality Act 2010 and provide full disabled access either by ramps or provision of lifts. This report also illustrates the provision of providing bridle route over the main bridge crossing and at the existing level crossing.

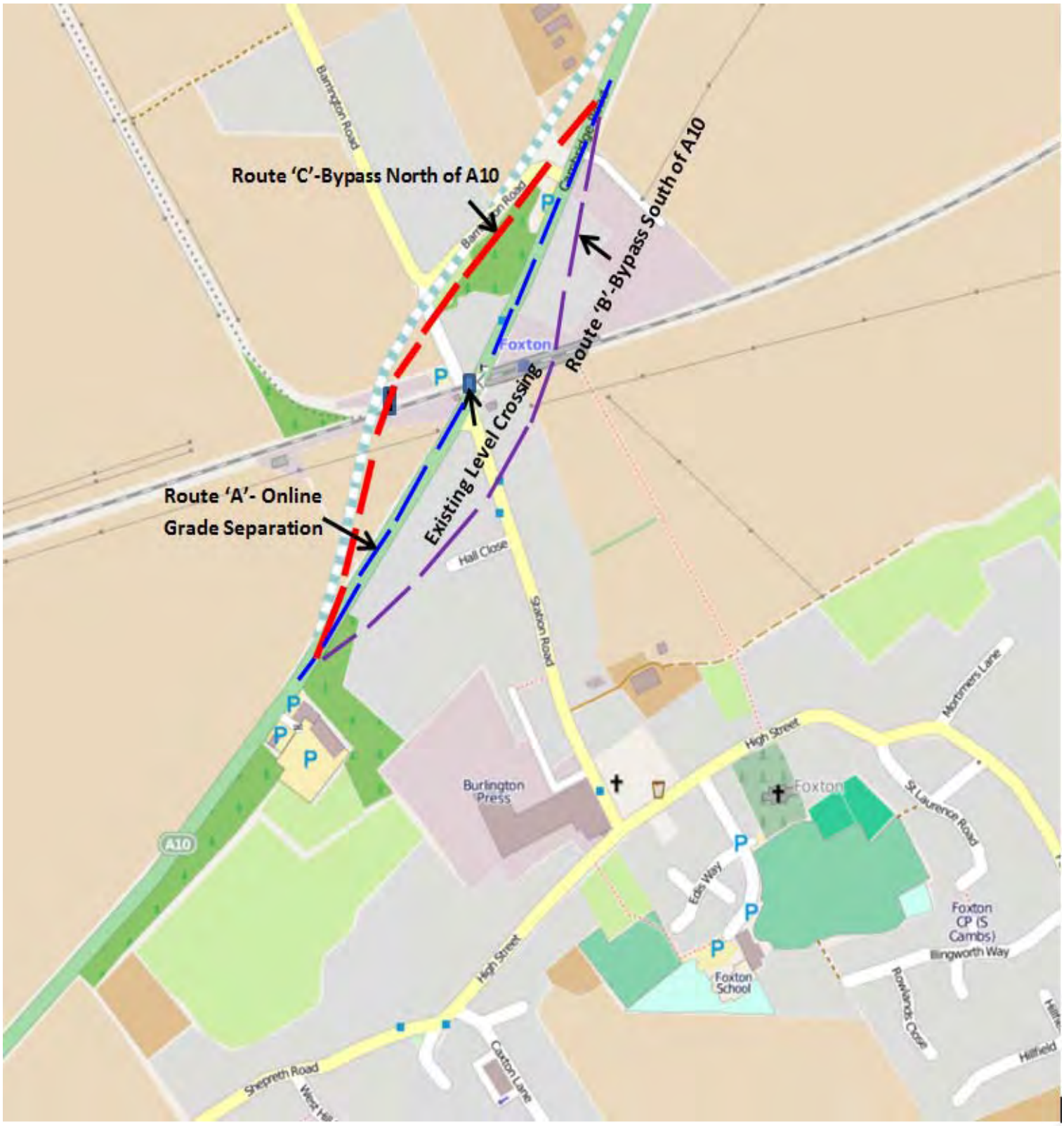
Preferred Options

Taking into account the capital cost, the advantages and disadvantages of the respective options, and the opportunities for minimising risks; it is recommended that route option C4 with a road overbridge proposal is developed as the preferred solution. This is the shortest of all the routes which has an advantage of minimum land acquisition and improves site safety by limiting the construction period. This route offers a minimum structure span over the new level crossing thus minimising the disruption to rail movement and impact on the local community. The overbridge option limits the requirement for possessions when compared to an underpass option. The capital cost estimate of this option is **£11,650,000** which is the cheapest of all options and is one of the key factors in preferring this route.

In addition to the main road overbridge option, to facilitate pedestrians and cyclists at the existing level crossing, a footbridge will be provided with lift access. The provision of this additional pedestrian route will require a minimum land take and will limit the impact on local community during construction. The capital cost estimate of this option is **£2,300,000**. The preferred route for equestrians is the bypass route over the main road bridge crossing. This route will be more convenient for the riders compared to a combined footbridge for pedestrians and equestrians over the existing level crossing.

In order to progress the work we recommend the review of the following key issues in the next GRIP stage,

- Undertake detail ground investigation and prepare a factual report based on the investigation.
- Carry out a topographic survey of areas where the proposed works impact on existing infrastructure or external land owners.
- Investigate the existing buried services and negotiate with the land owners.
- Carry out an outline design of the structure, to facilitate early acceptance from key stakeholders.
- Consult with the local community.



Indicative Route Plan – Figure 1

1 Introduction

1.1 General

There are approximately 9,000 level crossings in Great Britain and of these, around 7,700 are on the national rail network. Within Cambridgeshire, Network Rail has 176 level crossings (on the Anglia Route), 72 carry public vehicular rights, 51 carry public footpath or bridleway rights, and 53 carry private vehicular rights.

Almost half of all rail related accidents occur at level crossings and the number of incidents of near misses and misuse of level crossings is increasing steadily. Network Rail (NR) is committed to reduce this risk by closing level crossings where reasonably practicable, to improve safety for the general public (refer to NR policy statement in Appendix 'U').

The level crossing at Foxton crosses the A10 Royston to Cambridge Road. The NR assessment score for this level crossing is within tolerable limits as no major accidents have been reported, but there have been a number of recorded instances of misuse and threatening behaviour by members of the public impatient to cross the line.

1.2 Foxton Level Crossing

The level crossing is currently carrying the A10 Royston to Cambridge Road (indicated as 2 in figure below) across the Up Cambridge and Down Cambridge line at a skew.

The level crossing at Foxton is a highway crossing with full pedestrian, cyclist and equestrian right of way. Currently, the crossing is controlled from the adjacent gate box located to the west of Foxton station. The crossing has an electronic barrier across the full width of the road which stops the A10 traffic passing. There is no footbridge at the crossing but there are two pedestrian/cycle and bridleway points at the intersection (indicated as 1 & 3 in figure below). These points are secured by steel gates on either side of the crossing and are locked remotely using electromagnets during train crossings to prevent pedestrian or equestrian movements. The risks associated with the level crossing are discussed in section 2.1 of this report.

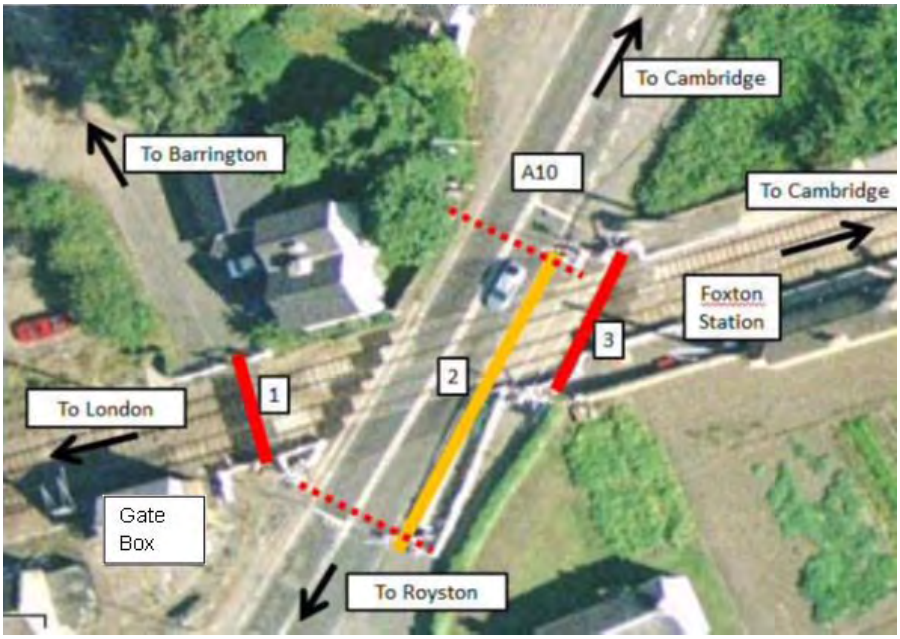


Figure 1.1: Plan of existing crossing

1.3 Report Objectives

The aim of this GRIP 2 Feasibility report is to assess engineering options for replacing the level crossing with a grade separated solution, which would comprise either an overbridge over the railway or an underbridge which allows the A10 vehicular traffic to go under the existing railway lines.

A separate pedestrian facility to link the existing platforms and to maintain the existing public rights of ways for pedestrians, cyclist and equestrians will be considered local to the existing level crossing. The facility must be in full compliance with the Equality Act 2010. The fundamental design goals of this scheme are to:

- Promote efficient operation of railway and highway and aims to reduce risk of accidents/collision;
- Promotes village amenity;
- Provide neighbourhood connectivity;

- Facilitates pedestrian/cyclist and bridleway safety and
- Provide a parking facility for the railway station.

The scheme will relieve A10 traffic congestion and delays from barrier closure due to frequent train movements. It will also allow the local highway and railway network to develop in the future, if required.

The report identifies the options to close the existing Foxton level crossing and adjacent Barrington Road foot crossing, including the removal /alteration of associated signalling equipment and the provision of suitable fencing/vehicle incursion restraint systems at the site of the crossing.

The proposal highlighted in this study must ensure that Network Rail's plan to improve the platform lengthening in the future is safeguarded.

This report considers the following:

- It discusses the options to provide relief from traffic congestion and improve the road safety of the A10 traffic, and convenience for the community using the level crossing;
- It summarise the forms of construction and discusses structural alternatives based on the existing constraints, buildability, associated risks, traffic management, track possession, cost estimation, maintenance and sustainability;
- It lists the technical studies and analysis that have been prepared as part of this study;
- It lists the estimated construction time and cost of considered options;
- It lists the advantages and disadvantages of the options studied and
- It recommends a preferred option, which will require further design development during the GRIP 3 stage.

This report describes the evolution of the project from the original scope of works, describing the key decisions taken and the reasoning behind them.

This report forms the preliminary stage of the Technical Approval process with the preferred option being taken forward to the next GRIP stage.

1.4 Geographical Boundaries

The geographical scope of this work covers the Foxton Level crossing and interface infrastructure.

The Engineering Line Reference of the crossing is SBR. Shepreth Branch: Hitchin, Cambridge Jn-Shepreth Branch Jn. Mileage is 50 miles 74 chains Grid Reference TL408407.

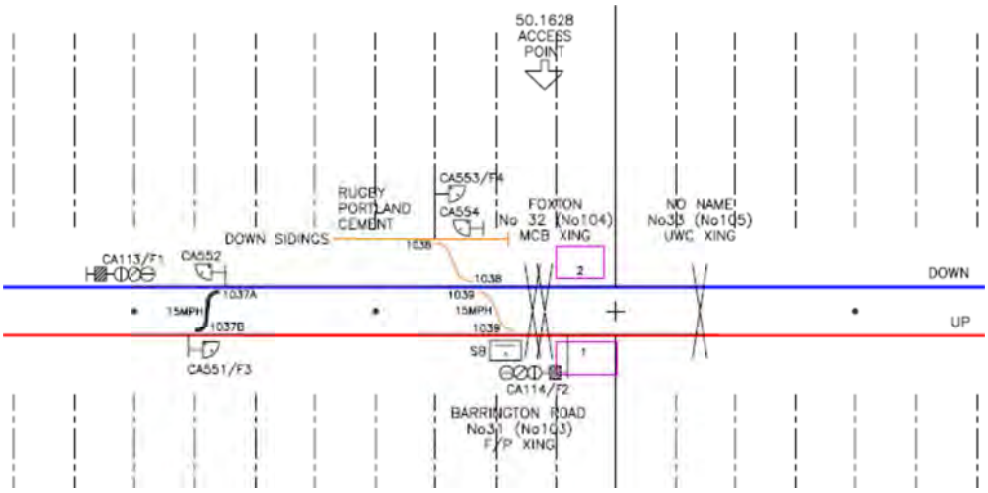


Figure 1.2: Extract from the 5 mile Plan

Figure 1.3: Foxton OS extract (Crown copyright and database rights 2012 (0100040692)

Photo 1.1: Foxton Level Crossing looking west

Photo 1.2: Foxton Level crossing looking north-east

2 Objectives and Considerations

2.1 Description of the challenges

The A10 is a main route which links the Greater London Boroughs with Cambridge and Royston. A traffic survey was carried out by WS Atkins in 2001 to establish the existing traffic levels on the A10. The manual traffic count (12 hours) survey revealed approximately 11,800 vehicles crossing the junction every day.

A minimum off peak traffic count was undertaken in November 2012 by Network Rail, which provides a more up to date data on volume of traffic using the level crossing. See Appendix 'M' for details.

The volume of through traffic using this crossing point is expected to grow in line with national trends and due to the future development of local housing. The existing railway level crossing stops the road traffic frequently due to the busy nature of the main railway route into London via Royston, therefore causing traffic delays and inconvenience to the road users. The existence of the level crossing also presents a possible weakness to the operation of the Train Operating Companies (TOC) services and safety to their staff.

2.1.1 Risks Involved

The level crossing at Foxton does pose a safety risk to road and rail users. The particular risks involved at the existing level crossing(s) are highlighted below:

- If the gates for the pedestrian crossing are locked of use, then pedestrians, cyclists and equestrians have to use the route under the main barrier, sharing this with the high speed (50 mph) traffic on the A10;
- If the crossing is not used correctly (i.e. 'misuse'), there is a significant risk of an accident and injury;
- There is a risk of slips, trips and falls while crossing the railway line;
- Equipment may be damaged due to vandalism.

In order to eliminate these risks, this study discusses different options for the removal of this level crossing.

It must be noted that the crossing in its current form is safe if used correctly, and is fully compliant with Network Rail's Level Crossings Standards.

2.2 Key Challenges in the scheme development

The key issues relevant to this feasibility study are summarised below:

1. Local community;
2. Network Rail;
3. Statutory Undertakers';
4. Land ownership;
5. Geography and general site condition;
6. Ground data and groundwater condition.

2.2.1 Local community

The impacts on local residents are considered to take a key issue during the scheme development. The route options selection will be developed to minimise the potential social effects on the local community by providing easy access as part of the preferred option. Where possible conflict between the through traffic and local village traffic will be minimised. The options have been assessed to meet the importance of providing continuous emergency and police service access to the village of Foxton.

Construction traffic movements and noise during construction will have a detrimental impact on the community. Construction stages and techniques that minimise the disruption to rail traffic and noise impact on the local community are considered in this feasibility study.

All route options have to ensure considered by ensuring that the existing public right of way and bridleway is facilitated. This can be incorporated into Network Rail's passengers' requirement to link platform 1 and platform 2.

2.2.2 Network Rail

Network Rail is keen to ensure that the continuous operation of the network is maintained. Therefore, in any option selected, the effects on

the operational railway operation must be kept to a minimum, and any proposed structural options must be constructible during any rule of the route (ROR) possession, and or within reasonable blockade duration.

Network Rail requires a direct link between platforms 1 and 2 to be maintained to ensure passenger connectivity and operational flexibility of their network.

An existing Network Rail Depot is located to the northwest of the level crossing, adjacent to Barrington Road. It is understood that this Depot is of a non-critical operational nature, and the land can be considered as non-essential during the options study.

Due to the presence of the level crossing, the overhead line equipment (OLE) adjacent to the crossing is set at a higher level than desirable. Where possible, the OLE is to be lowered to meet Network Rail standards.

It is understood that the level crossing signal/gate box building is not listed. Therefore it can be demolished as part of the proposal, if considered necessary. However, the interlocking building to the west of the signal/gate box must be maintained to allow the continuous operation of the line.

2.2.3 Statutory Undertakers

Based on the data provided by the Network Rail, various statutory undertakers' apparatus have apparatus present in the area of the level crossing, along the A10, Station Road and Barrington Road.

A medium pressure gas main, BT and virgin media cables run underneath the existing level crossing location. Electricity and telecom cables supporting the railway operation run at the ground level. Drawing records also indicate the presence of a 3" diameter water main crossing the track from the existing bridleway crossing point. These services are would require diversion if an underpass online option is considered.

A pumping station is located to the northwest of the level crossing together with an associated foul sewer (6" rising main) crossing the A10 carriageway from north and south of the existing crossing point.

Diversion of this foul sewer will need to be considered for any underpass route option.

A number of overhead cables (OC), supported on timber posts were observed during the initial site visit on 15th Jan 2013. The overhead cables run from the village of Foxton, crossing the A10 to the west of Station Road, and the farm field before running almost parallel to the railway. The cable location will need to be reviewed, for any route options to the north of the railway.

The service information provided by Network Rail is a guide indicating the approximate location of the existing services. It will be necessary to investigate these further with Statutory Undertakers' to determine the exact location and any other allocated apparatus. If there is a clash with a proposed option, then this will need to be discussed with affected Statutory Undertaker and costs for relocation or protection will need to be included. This will be undertaken in the next GRIP stages.

2.2.4 Land ownership

Bypass options will require a large area of land (approx. 45,000 m^2) to be purchased. The land width will have to be wide enough to allow for future maintenance. The route options developed are based on the availability and ownership of land, attention is given to limit the level of land acquisition and optimise the land readily available. The majority of the site area for the new routes proposed consists of undeveloped farmland. Where the use or the permanent acquisition of land is required, Network Rail will seek to acquire the land or rights of land through negotiations. However, if this is not possible to reach an agreement with the current land owner, then a compulsorily purchase of the land may be required, which will be obtained through the Development Consent Order (DCO) process.

Based on the information provided by the Land Registry Department, the primary land owners affected by this project are indicated in the plan of land ownership attached to Appendix 'O'.

2.2.5 Geography and general site condition

The area of the study includes land within the village of Foxton. The proposed route options will commence approximately 220m along the A10 from the level crossing in both directions. The total length of any proposed by-pass will be approximately 500m.

The approximate National Grid Reference co-ordinates of the proposed level crossing are 540862 Easting and 248752 Northing. The terrain of the site area is generally flat comprising undeveloped farm land to the northwest and southeast, with domestic properties and small farm holdings to the northeast and southwest.

Based on the Environment Agency's website information, the site is located within Flood Zone 1, which is defined as land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year. Therefore the site is located in an area of lowest flood risk.

In the absence of any topographic information, the topography of the site is considered to be flat, based on observation from the initial site visit.

2.2.6 Ground data and groundwater conditions

The British Geological Survey (BGS) records have been searched to ascertain the ground data records adjacent to the proposed site. Records of a number of exploratory boreholes in close vicinity of the site were available as follows:

- BGS Ref TL44NW11- a borehole located towards the eastern end of the route options, less than 50m from the site near the existing petrol filling station on the A10 (see figure 2.1 below).
- BGS Ref TL4NW7- a borehole located less than 200m from the site, at the junction of Station Road and Hall Close (see figure 2.1 below).

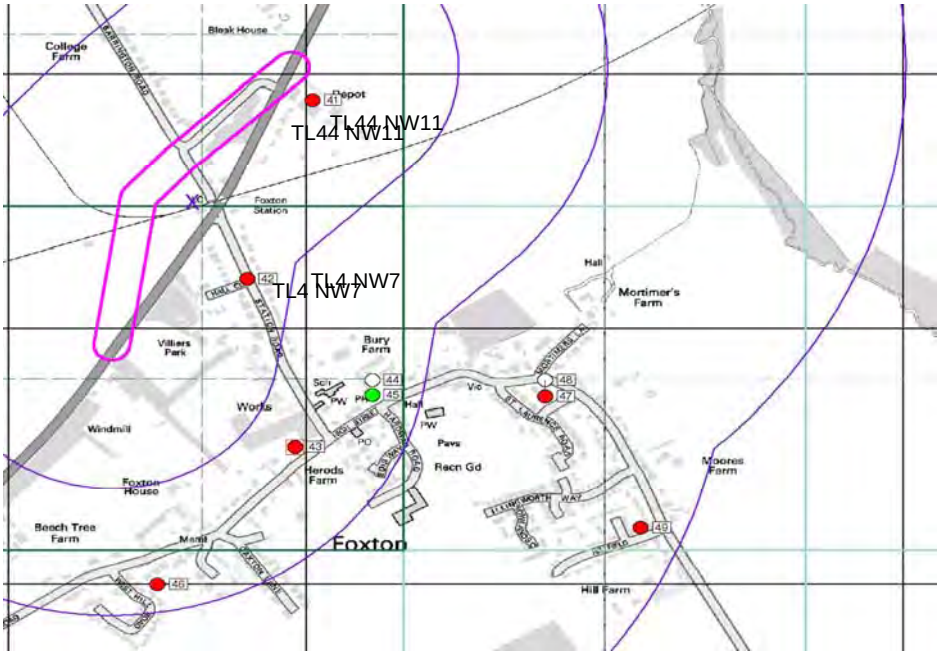


Figure 1.4: Borehole Locations

The borehole records indicate the following strata in the vicinity of site:

The bore hole record TL44NW11 indicates:

FROM	TO	MATERIAL
EGL	0.3m	Topsoil
0.3m	2.8m	River gravels (Gravels and sand)
2.8m	21.4m	Chalk Marl and Cambridge Greensand

The bore hole record TL4NW7 indicates:

FROM	TO	MATERIAL
EGL	0.3m	Topsoil
0.3m	3.0m	River gravels (Gravels and sand)
3m	18.3m	Chalk Marl and Cambridge Greensand

Ground water levels were encountered at 2.4m bgl in borehole TL44NW11 and 1.8m bgl in borehole TL4NW7. Based on this information, the water table will have a significant impact on the structural form, so a detailed ground investigation and preparation of factual and interpretation reports are recommended in the next GRIP stage to justify the options discussed.

3 Options

3.1 Route Options

This section provides an outline evaluation of the route options considered to eliminate the Foxton level crossing. The route options are developed based on the Ordnance Survey (OS) mapping available. The following sections discuss each Route option considered and the reasoning behind its continued development or discounting from the process. Following the completion of evaluation, recommendations will be made as to which options are not viable and which proposal should be taken forward into the next GRIP stage. A summary of the strengths, weaknesses, opportunities and threats (SWOT) of each option is provided which can be found in Appendix 'A' of this report.

This study considers the Do-nothing option as well as the following road route options:

- Route A – On-line Option Grade Separation
- Route B – By-pass South of the A10
- Route C – By-pass North of the A10

While considering the options, reference was made to the previous study undertaken by WS Atkins on behalf of Cambridgeshire County Council (CCC) in 2002.

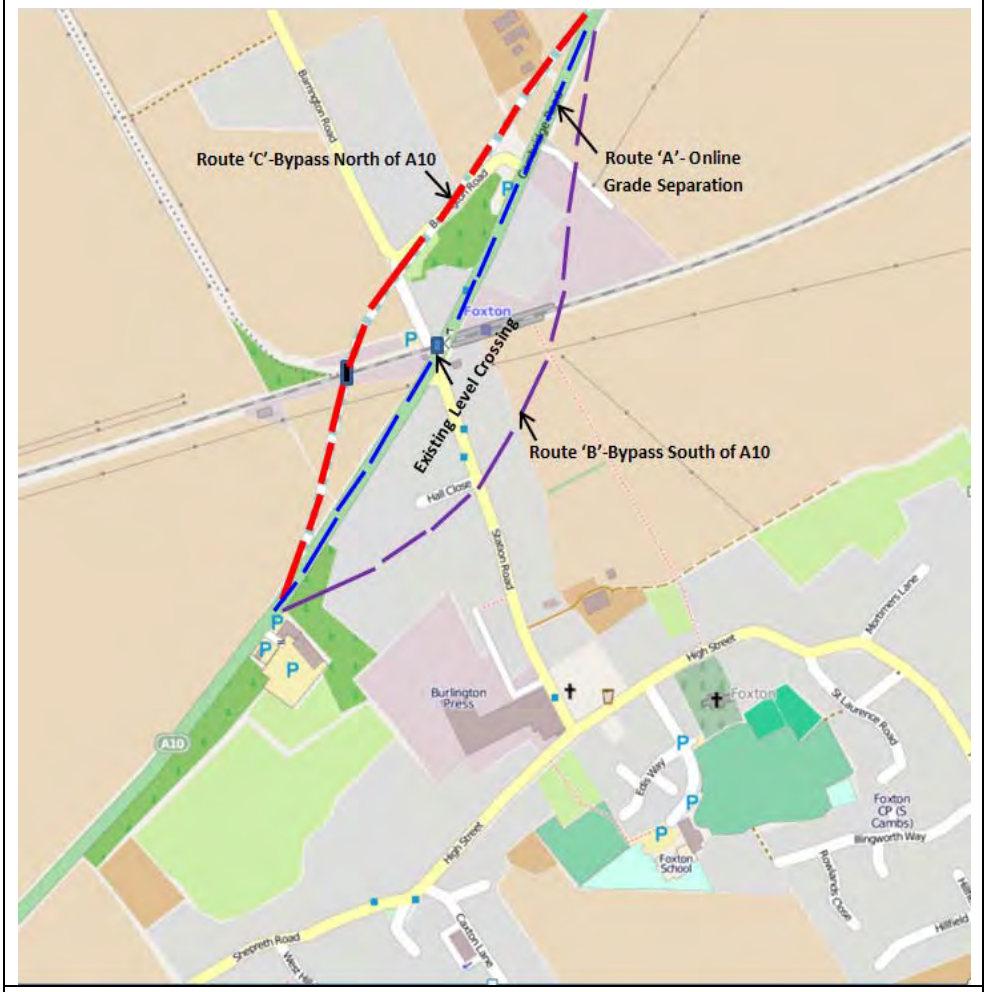


Figure 1.5: Indicative Route Plan

3.1.1 Do-Nothing Option

The Do-nothing scenario considers no change from the existing situation at the level crossing. Whilst the level crossing is currently in compliant with Network Rail's requirement, the safety/security risks and highway congestion remain unresolved, which was the primary driver of this study. Furthermore, the Do-Nothing Option does not meet the aspiration of Network Rail's current policy statement with regards to level crossings, (see Appendix 'U' for NR's Approach to level crossing

safety), therefore the Do-nothing Option will not be taken forward at this stage for further consideration, but may be revisited once all other options have been exhausted.

Photo 1.3: Existing Level Crossing

3.1.2 Route A: On-line Grade Separation

On-line grade separation option utilises the existing A10 corridor. This proposal maintains the railway line on its current alignment and level:

- Option A1 - is the construction of a new underpass to take the A10 below the railway line.
- Option A2 - is the construction of a new flyover to take the A10 above the railway line.

The underpass option A1 will require the construction of a railway underbridge to carry the existing railway lines and OLE. This will require a substantial length of approach retaining walls on either approaches to

the railway, approximately 220m long and up to 6.5m in height, to support the existing ground and adjacent properties.

The flyover option A2 will consist of a bridge constructed over the existing railway line to carry the A10 with a series of approach structures on either side of the railway line supported on piers. An alternative option is to support the approaches to the flyover on solid earth embankments with retaining walls, or with a standard 1 in 3 sloped embankment. This option will require a significant land take outside the current A10 footprint and has been discounted for this reason.

Issues cited as reasons to favour or not favour this option are listed in section 10 of this report.

Due to the significant traffic disruption envisaged on the A10, the disruption to Foxton Railway Station, the permanent closure of Station Road, the significant adverse effects to the residences immediate to the A10, together with the other Route option available, the On-line grade separation option is consider in practicable, hence will not be considered further in this report.

3.1.3 Route B: By-Pass South Side

The Route B option is to construct a by-pass for the A10 to the south of the existing route as indicated in fig 1.5.

This route option will have a significant impact on the local environment and population. This route option will have direct impact on the residential dwellings immediately to the south of the A10 which will make selection of this route difficult. Up to 10 houses will be affected by this route, located on both the east and west side of the level crossing and would have to be demolished. Noise and dust emission levels during construction would be high directly affecting the residents of the community in the short term. This route option is likely to receive strong opposition from local residents, resulting in a public inquiry.

Station Road is a main route to Foxton Village Centre; this route option will require a closure of Station Road with a provision of either an alternate route or an overbridge over the road which would significantly increase the cost of the scheme. This route will interface with existing utility services (water mains and sewer). The diversion of these services is unavoidable and will have significant cost implications. Moreover, the presence of the station platform on the south side is unavoidable and would require a long span crossing over the existing platform. The route to avoid station platform is not advisable as it would restrict future extension of platforms in that direction.

3.1.4 Route C: By-Pass North Side

Unlike the area to the south of the A10, the area to the north comprises of open farm land which allows several sub-routes to be developed without having, as a severe direct impact on residential properties, as Route B.

Cambridgeshire County Council's (CCC) current requirement for the by-pass is to accommodate a 7.3m wide two lane carriageway with a 1m grass verge to accommodate equestrian use and a further 3m for a combined pedestrian footway and cycleway on one or both sides of the carriageway. During the next stage of this scheme development, the detail of this will be agreed.

The sub-route options consider alternatives for a fly-over and an underpass. The sub-route alignments are designed based on the appropriate vertical and horizontal alignment curve to comply with the relevant design speed, in accordance with TD 9/93 Highway Link Design. The highway alignment will be designed to:

- To keep the connectivity of local streets to the A10 Cambridge Road, particularly to a number of dwellings in Barrington Road.
- To provide turning facilities for the vehicles due to the closure of the main road at the existing level crossing.
- To create a new car parking facility in between the bypass route junction on the south side and existing level crossing. The proposal will create upto 85 car parking spaces which will encourage further train usage.

The alignments are developed using the geometric requirements contained within TD9/93. Cambridge County Council as the local Highway Authority has stipulated a 50mph design speed limit for the by-pass; therefore in accordance with TD 9/93, the vertical and horizontal design curves appropriate to 50mph will be preferred. However, TD 9/93 also accepts design curves for 40mph.

The following sub-routes are considered for Route C.

1. Sub-Route C1: 50mph road design speed for vertical and horizontal alignment ;
2. Sub-Route C2: 40mph road design speed for vertical and 50mph design speed for the horizontal alignment ;
3. Sub-Route C3: 40mph road design speed for vertical and horizontal alignment avoiding the existing Network Rail depot.
4. Sub-Route C4: 40mph road design speed for vertical and horizontal alignment (min land take).

3.1.4.1 Route C1 – Highway Alignment with 50V & 50H Curves

This option proposes to provide a by-pass route north of the A10, and crosses the railway line with an option of an overbridge or underbridge to the west of the Foxton station. In this option, the highway alignment is designed to meet the desirable minimum vertical and horizontal

curves, appropriate for a design speed of 50mph. The slope of approach embankments or cutting considered for the highway alignment is generally 1 in 3. This slope is chosen to check the design feasibility of routes, although embankment slopes can be varied to limit the level of land take if necessary. The route leads to larger curve radius resulting in a 32m span bridge span. The route will require a small retaining structure at Barrington Road (as shown on the scheme plan). The main drawback of this route is that it clashes with the rear garden of a residential property located on the Barrington road. This route clashes with Network Rail depot car park.

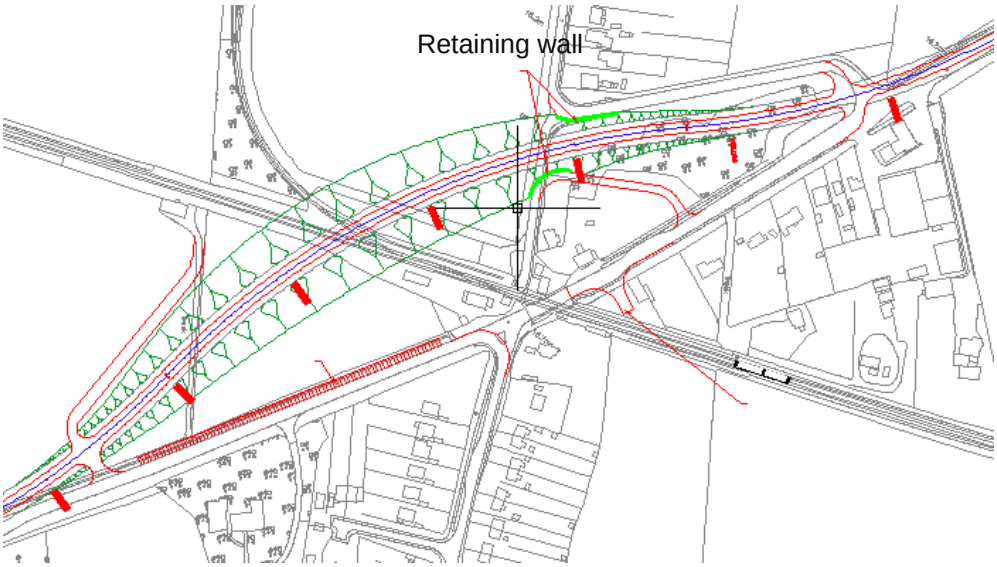


Figure 1.6: Route C1 Layout

Route C1 Structure Configurations

An overbridge/flyover at this location will comprise a single span bridge, approximately 32.6m clear skew span, with a 40 degrees skew between the abutments and the deck. The width of the structure will be approximately 22.6m.

An underbridge/underpass at this location will comprise a single span bridge, approximately 20.1m clear skew span, with a 42 degrees skew between the abutments and the deck. The width of the structure will be approximately 26.6m.

3.1.4.2 Route C2 – Highway Alignment with 40V & 50H Curves

This option is similar to the Route C1; the highway alignment is designed to maintain a vertical alignment suitable for a design speed of 50mph and a horizontal alignment suitable for a design speed of 40mph. Although the horizontal design speed is less than the desirable limit it still lies within the acceptable standard of TD 9/93. This route option has slightly smaller curve radius compared to route C1, resulting in reduction to the total length of the by-pass. Similar to Route C1, this route clashes with Network Rail depot car park.

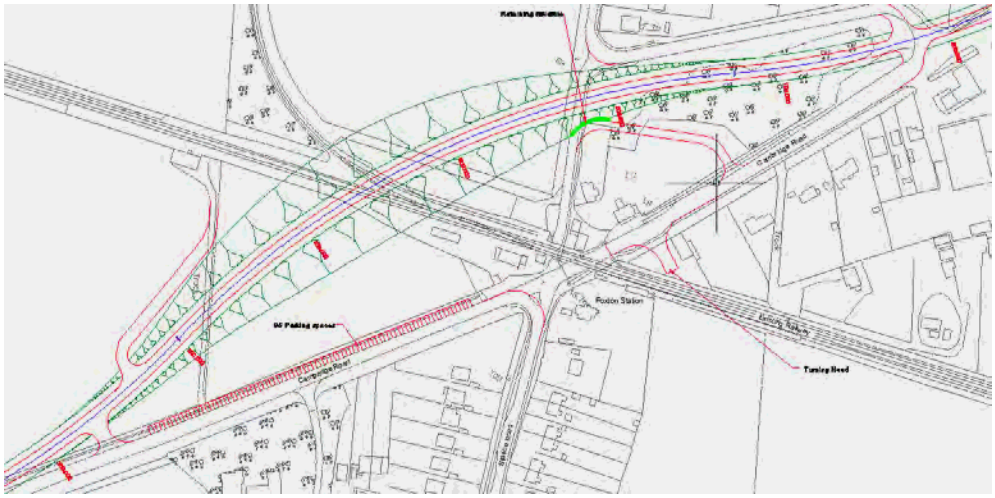


Figure 1.7: Route C2 Layout

Structure Configurations

The proposed overbridge/flyover at this location will comprise of a single span bridge, approximately 31.5m clear skew span, with a 42 degrees skew between the abutments and the deck. The width of the structure is approximately 22.5m.

The proposed underbridge/underpass at this location will comprise a single span bridge, approximately 19.8m clear skew span, with a 43 degrees skew between the abutments and the deck. The width of the structure is approximately 26.6m.

3.1.4.3 Route C3 – Highway Alignment with 40V & 40H Curves (Avoiding the existing depot)

For this route, the highway alignment design is based on the design speed of 40mph for both horizontal and vertical alignment, which is less than desirable but within the acceptable standard of TD 9/93. The option is proposed to limit the effects to the existing Network Rail Depot located northwest of the existing level crossing. As illustrated below, this option has largely avoided the Depot and also eliminates the need for retaining walls at Barrington Road, but has increased land take substantially, as well as increase in the size of the over or under bridge.

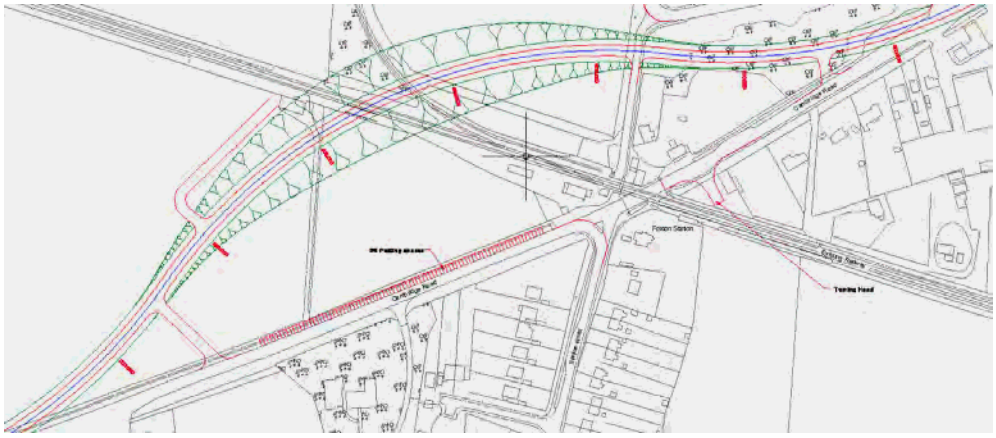


Figure 1.8: Route C3 Layout

Structure Configurations

The proposed overbridge/flyover at this location will comprise a two or three span bridge, of overall length of approximately 50m clear skew span, with a 40 degrees skew between the abutments and the deck. The width of the structure is approximately 22.8m. The increase in bridge span (compared to Routes C1 and C2) is necessary to support the railway track on the branch line.

The proposed underbridge/underpass at this location will comprise of a single span structure, approximately 22.9m clear skew span, with a 43 degrees skew, between the abutments and the deck. The width of the structure is approximately 50m. Alternatively, the structure can be split

into two small width structures, one to carry the Cambridge Up and Dn line, and the other to carry the branch line.

The merit of these underpass options should be considered further if this sub-route option was selected for further consideration.

3.1.4.4 Route C4 – Highway Alignment with 40V & 40H Curves (Min land take)

The highway alignment of this sub-route option is based on the design speed of 40mph for both horizontal and vertical alignment. The proposed alignment is shown in Figure 1.9 below.

This route is the shortest of proposed options and minimises the area of land take and the structural span of the bridge. This route will require demolition of the existing Network Rail Depot. Unlike other routes, this route protects the access track to the derelict building located to the west of bypass.

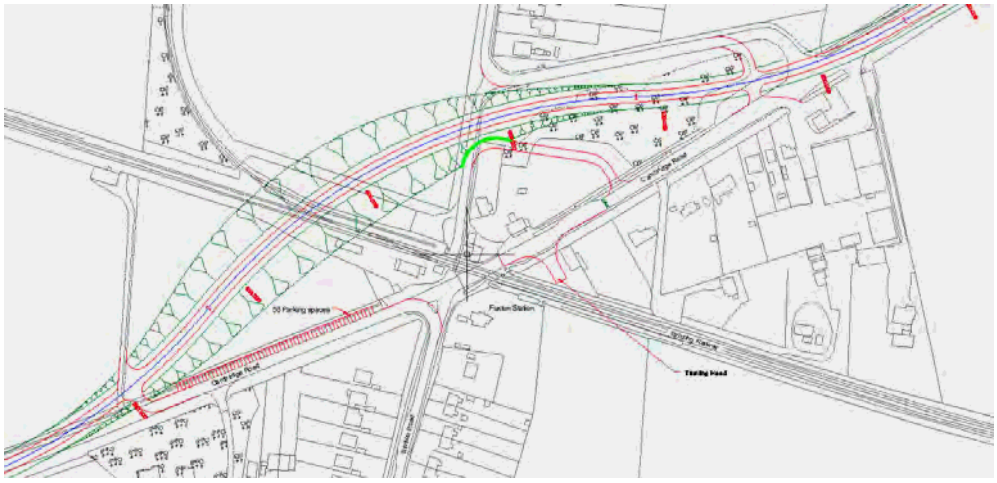


Figure 1.9: Route C4 Layout

Route C4 Structure Configurations

The proposed overbridge/flyover at this location will comprise a single span bridge, approximately 19.7m clear skew span, with a 36 degrees skew between the abutments and the deck. The width of the structure is approximately 26.7m.

The proposed underbridge/underpass at this location will comprise a single span bridge, approximately 20.8m clear skew span with a 36 degrees skew, between the abutments and the deck. The width of the structure is approximately 21.7m.

3.2 Bridge Options

The level crossing is on the main Up and Down Cambridge line which is the main route to London and has been assessed as a high demand route with restricted access. Therefore, in any structure option selection, the option effects on the railway operation must kept to a minimum, and any proposed structural options must be constructible during a 'Rules of the Route' (ROR) possession or within a reasonable blockage duration.

3.2.1 Overbridge Options

For all overbridge options, the substructure will be set 4.5m back from the running edge of the cess rail on either side. This is to ensure that the substructures can be constructed with minimum or no possession. This setback will also eliminate the need to design the substructure for derailment impact, which means the substructure can be more cost-effective.

To minimise the possession requirement for constructing the superstructure, a quick and self-supporting solution should be considered, e.g. beam and slab deck. The beams can be erected during a night-time possession, with permanent shutters spanning between the beams. This would allow the construction of the deck to follow continuously without possession.

The overbridge option should be able to accommodate future widening of the A10 to a dual carriageway with minimal to no demolition.

3.2.1.1 Precast Prestressed Concrete (PPC) Beams on Cantilever abutments (Option 1)

This form of superstructure construction is quick and requires minimum possession time. The bridge will consist of PPC beams simply supported on full height reinforced concrete abutments. An insitu

reinforced concrete deck is designed to act compositely. Permanent formwork will be used to support the wet deck concrete during construction.

PPC beams are heavy and require a bigger crane for lifting when compared to other forms of construction. As the access and space at site is unlikely to be restricted, the lifting requirement for a heavy crane is not considered to be an issue.

A preliminary assessment of the foundation type required for the proposed structure has been undertaken based on the available ground information in the proximity of the level crossing. The assessment concludes that spread foundations are not appropriate for the bridge abutments and a piled solution is required with the piles socketed into Chalk Marl. A detailed investigation of the pile design has not been undertaken at this GRIP stage, but an initial assessment suggests that a CFA piling system will be appropriate due to its vibration free and quick installation. A high groundwater table will require casing for the installation of the CFA piles. Note that full height abutments will generate additional horizontal pressures on the piles but these can be designed accordingly. The piling activity and full height abutments will increase the proportion of wet concreting on site, which will have an impact on health and safety, and will be a risk for the site force working in the close proximity of the live rail traffic.

It is important to mention here that the final choice of foundation should be confirmed following a more detailed site investigation, which is outside the scope of this study.

3.2.1.2 Integral/Semi Integral Bridge on bankseat abutments (Option 2 & 3)

This form of structure will comprise of PPC beams cast integral or semi-integral with insitu reinforced concrete bank-seats and spread footings. Bank seat abutments will comprise of one of the forms of construction discussed below.

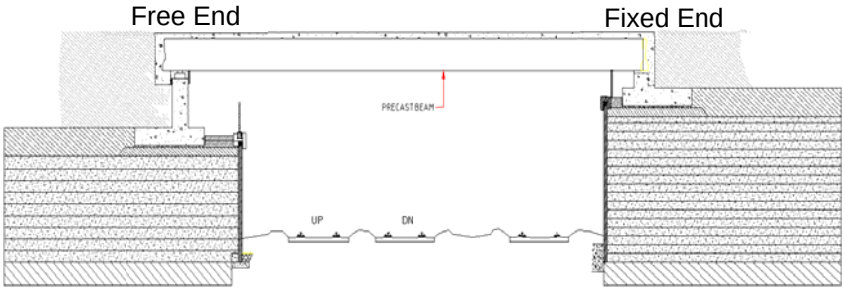


Figure 1.10: Semi-Integral Bridge

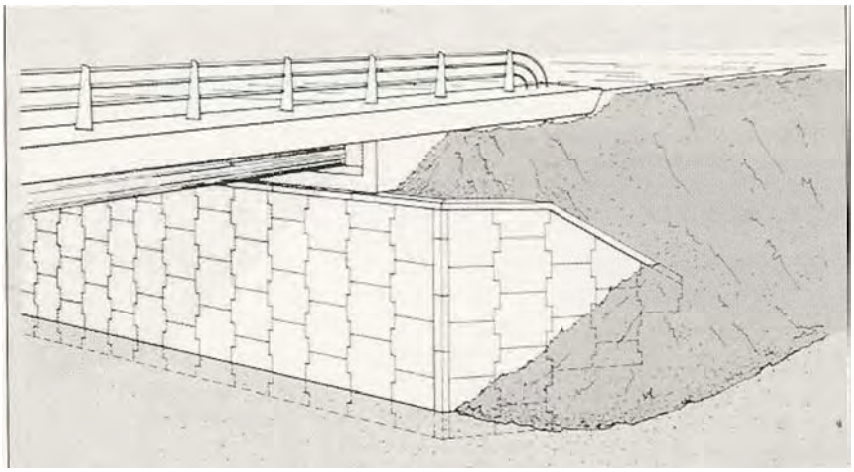


Figure 1.11: Semi-Integral Bridge

Fully Integral Bridge (Option 2)

The use of an integral form negates the need for bearings and movement joints. This will minimise the maintenance requirements and reduce the whole life cost of each structure. In this option, bankseat abutments would be seated on compacted granular fill material normally at 1:2.5. The bankseat would require to be set back at some distance from the track to accommodate slopes of the material and would significantly increase the span of the bridge and the construction cost associated to this when compared to full height abutments.

The span of the structure can be reduced by supporting the bankseats on vertical reinforced earth walls founded on an unreinforced concrete

levelling pad (as discussed in option 3 below). This option is not viable in this situation due to a significantly larger span of the structure (40m), as the reinforced earth walls are not normally designed to take significant thermal movements occurring from a fully integral connection. The maximum span limit for a fully integral bridge resting on reinforced earth wall is 18m in accordance with BD70/03.

Based on the available ground data, it is difficult to justify the feasibility of this option at this stage. The available ground strata may be too soft to support the fill material and a piled foundation underneath the bankseat footing may be necessary, which would make this option more expensive. A detailed ground investigation is recommended in the next GRIP stage to confirm the viability of this option.

Semi-Integral Bridge (Option 3)

The proposal is similar to the fully integral option. Instead of resting bankseats on granular fill material, the bankseat abutments will be supported on vertical reinforced earth walls founded on an unreinforced concrete levelling pad. Independent reinforced earth wingwalls to retain approach embankments will also form part of the structure.

Reinforced earth walls consist of interlocking precast concrete facing panels tied back to the granular backfill with reinforcing straps. The structure is a standard form of construction and would overcome the issue of an increased span with bankseat abutments as discussed in the integral option above. In this option, one abutment will be cast integral with the superstructure providing full movement continuity. The other abutment will have bearings to accommodate the thermal movements of the deck. An end screen will be provided at the bearing abutment to protect the bearings from the backfill material. The end screen will be separated from the back face of cantilever abutment by means of a compressible joint filler. The joint will cater for the movement of the superstructure arising from thermal, shrinkage and creep effects, and the possibility of deck leakage through expansion joints will be significantly reduced. The maintenance cost of the structure will be higher than fully integral bridge will be lower than a full abutment height option. However there will be significant cost savings in terms of the overall construction cost of the structure.

The construction will be undertaken in phases. In the first phase, reinforced earth abutments will be constructed along with embankment construction using precast concrete facing panels and reinforcing strips. Backfilling activity behind abutments will be carried out in stages as the facing panels progressed towards top. This phase will give programme advantage in terms of construction.

The integral end of the structure will eliminate the need for the inspection of bearings, thus minimising maintenance and inspection costs. The option is economical as the reinforced earth walls use reinforced concrete facing panels as opposed to a full height abutment. Pre-stressed beams are low maintenance and there is also a minimal requirement for insitu concrete, which reduces the health and safety risk on site. The structure can be decommissioned easily and recycled at the end of its serviceable life.

The reinforced earth option minimises the amount of excavation. The inherent flexibility of the reinforced earth solution makes it possible to construct bridge abutments on relatively soft soil. The settlement of compacted reinforced earth material is normally the main risk in this design, which can be controlled with traditional soil improvement techniques.

3.2.1.3 Steel Composite deck (Option 4)

A steel composite deck on cantilever abutment or semi-integral structure on bankseat is another option considered for overbridges. This form of construction will require rail possessions for the installation of the steel beams. The steel beams can be installed in pairs with cross bracing, with the permanent framework already attached, providing the necessary stability during erection and reducing the possession duration. The steel beams are generally spaced between 2.5 to 3.5m apart resulting in fewer girders compared to a PPC beams solution.

Steel beams are lighter compared to PPC and allow for quick installation utilising a smaller crane with minimal possession duration. A steel composite bridge will also benefit the construction by minimising the construction depth and the height of the approach embankments when compared to the PPC option.

However, the long term maintenance cost of steel structure is generally recognised as higher than a PPC beam solution, particularly with regards to the protected paint system. Alternatively, the use of weathering steel should be considered to eliminate the requirement of maintenance painting. A steel bridge will require earth bonding as it will be adjacent to the OLE.

3.2.1.4 Summary of Overbridge Options

A summary of the advantages and disadvantages of overbridge options is shown below.

Ref	Bridge Type	Advantages	Disadvantages
1	PPC Beams-Cantilever abutments	1. Low maintenance cost compared to steel construction but higher than integral form of construction. 2. Horizontal thrust will be sustained by the substructure when compared to integral options.	1. Large amount of crane lifts during erection. 2. High volume of insitu concrete. 3. Maintenance cost due to bearings and movement joints. 4. Prestressed beams are heavier than steel beams. 5. Construction depth will be greater than integral or semi-integral option. 6. Will require longer construction time when compared to the integral form of construction. 7. Substructure cost will be higher than integral or semi-integral options.

2.	PPCs Beams-Semi-integral bridge	1. Can be constructed on soft ground. 2. Low construction depth. 3. Low maintenance cost. 4. Easy to demolish 5. Simple, rapid and safe construction. 6. Reduced need for piles or foundation improvement. 7. Less volume of in-situ concrete when compared to alternatives. 8. Panels can be modified on site to suit geometric constraints.	1. As (1) above 2. Drainage outlets are required to prevent settlement. 3. No cracks or warning of settlement is apparent on the structure. 4. Requires additional cost of ground improvement to limit settlement issues.
3	Steel Composite Deck.	1. Easy to pre-camber during fabrication. 2. Due to its lighter weight, smaller crane may be used during erection. 3. Easy transportation and rapid erection. 4. Shallow construction depth compared to PPC beams. 5. Less number of beams will reduce the possession requirement.	1. Bracing between beams is required for their stability during erection. 2. Higher long term maintenance cost. 3. Bonding require for steel deck, due to close proximity to OLE.

Table 1.1: Bridge Option's Comparison Summary

3.2.2 Underbridge/Underpass Options

The underbridge/underpass option will follow the road geometry similar to the overbridge option and will accommodate a 7.3m wide carriageway and 4.5m wide verges to protect pedestrian/cycleway and equestrian right of ways. The underbridge option will require a significant amount of excavation, which could be an issue due to the high ground water table. The risk of slope instability can be mitigated by considering cutting a slope of 1:3 in the alignment design, but this requires greater land acquisition. The amount of land take could be minimised by providing steeper slopes stabilised by ground anchors or retaining structures. In the absence of sufficient geotechnical information, this report does not consider the feasibility of soil strengthening or retaining wall techniques. Based on the initial assessment, it seems that acquisition of additional land will not be a major problem, but a detailed cost-effective analysis will required in the next GRIP stage.

A lower structure headroom can be achieved with this type of construction. The minimum headroom clearance of 5.3m (from carriageway level to the soffit) will be achieved in accordance with TD 27/01. This minimum headroom will require a structure to be designed for collision loading. Based on the site constraints, the following underpass construction proposals are considered feasible for the scheme.

To meet Network Rail's construction requirements, a reinforced concrete box option is the only feasible underbridge option.

The concrete box can be installed using the following methods:

1. Gradual jacking, under live railway operation;
2. Jacking during a blockade (cut and cover).

In both methods, a reinforced concrete box will be constructed in the approach cutting excavation adjacent to the rail track. No bearings or movement joints would be required for this option, thus significantly reducing the maintenance costs. Both types of construction will require large wingwalls on all four corners of the box, which could consist of steel sheet piles or concrete bored piles construction, and be

constructed prior to the installation to retain any excavation or cutting. The configuration of wingwalls has a huge impact in determining the box length, which ultimately affects the construction cost of the structure. The configuration of the wingwalls parallel or perpendicular to the box will lead to significant larger lengths and is not considered to be an optimum solution. It is appropriate to angle wingwalls and provide battered slopes at the ends, which will minimise the construction cost of wingwalls and visual tunnelling effect of the underbridge. However, the high water table level may affect the decision on the alignment of the wingwalls. This must be investigated further in the next GRIP stage.

The methods considered for the box construction are discussed in the following sections:

3.2.2.1 Gradual Jacking method (Option 5).

This technique provides the benefit of construction with minimal disruption to the rail movement. This method will generally require a deeper road alignment to accommodate more fill over the structure, and constant track monitoring. Train speed over the structure will need to be restricted during the box installation for safety.

In this method, the concrete box will be constructed in an excavation adjacent to the rail track, with a leading cutting shield attached to the front of the box. As the box is jacked into the embankment, the existing ground is excavated carefully from within the box from the cut face. The process will continue until the structure is pushed to its final position.

This non-disruptive nature of the process, together with its safety mitigation measures and simplicity, has been considered as a best possible solution for tunnelling under the busy track. This type of construction requires a high level of precision and accuracy, along with constant track monitoring of track levels during the process, as this could affect the twist and cant of the permanent way.

3.2.2.2 Jacking During a Blockade (Cut and Cover) (Option 6)

In this method, the reinforced concrete box will be constructed adjacent to the railway in the approach cutting excavated for the road alignment

as discussed above. Once the box is constructed the rail track would be closed to remove totally the fill under the track for the positioning of the box. This type of construction will require a possession of approximately 65 hours.

This technique was adopted for the replacement of Owen Street level crossing in Tipton. A photograph of the underpass showing excavation of the existing railway embankment in readiness for the jacking of the box structure are shown below, together with the completed structure.

Photo 1.4: Owen Street during main possession for installation.

Photo 1.5 – Owen Street Underpass after completion.

When planned and resourced properly, this type of installation can be successful. Unlike the gradual jacking method, this method eliminates the need for track monitoring, the risk of potential unforeseen objects within the excavation, and potential emergency stoppage due to any unacceptable settlement.

This installation technique will require minimum fill material over the structure. Therefore, the approach road alignment design will be shallower, potentially reducing cost for the excavation and retaining wall heights associated to the structure.

Construction Issues for the Underpass Options:

This option will require the use a considerable amount of concrete and reinforcement, not just for the box structure, but also for the jacking slab built beneath the box. The volume of excavation will be an issue for this form of construction due to the existing ground conditions.

The high water table on site may lead to a high risk of flooding during the construction requiring de-watering works. The high water table will also have an great impact on the long term maintenance of the structure and may require constant pumping of water to ensure the structure is not subject to flooding. From a design perspective, the structure will have to be designed to withstand high hydrostatic pressures which will make this option an expensive alternative. The presence of existing 8" diameter Anglian water foul sewer (rising main) is also an obstruction in the development of the underpass, which makes this option expensive and difficult to achieve.

A portal frame structure was considered as an alternative option, but discounted at early stage due to the complex construction requirements, extensive concreting and possession periods involved in building the structure.

3.2.3 Passenger/Public Footbridge-Options

The closure of the existing level crossing at Foxton will require an alternative safe crossing route for the pedestrians, cyclists and equestrians. This section investigates the different options to facilitate the community and provide a link between station platforms after the level crossing has been closed. The following requirements have been identified as critical for the optioneering of the proposals:

- Minimal adverse impact on the local environment, adjacent land and properties;
- Minimal capital cost implications;
- Long term maintenance liabilities;
- Compliance with Network Rail design standard and Equality Act 2010 requirements;
- Constructability;
- Safeguard plan for future extension of the existing platforms;
- Continuous operation of the railway.

The following footbridge options are considered to be reasonable options and are discussed further in the report:

1. Footbridge with approach ramps and stairs;
2. Footbridge with stairway and lift shaft. ;

3. Footbridge with approach ramps to accommodate equestrians;
4. Subway with approach ramps.

3.2.3.1 Footbridge with approach ramps and stairs (MMD-318484-C-DR-BR-103) (Option 7)

In this option, the bridge will be facilitated with stairs and Equality Act 2010 compliant ramps. The ramps will form a U-shape formation in line with station platforms. The footbridge and ramps will be owned and maintenance by Network Rail and the main aim of the footbridge is to provide the link between station platforms. It is preferred to position the bridge over the platforms or as close to the station as possible. The footbridge also serves as a local public right of way over the railway. The provision of using the footbridge for equestrians is considered as a separate option (refer to section 3.2.4.3).

Based on the available information, there were no undue constraints identified that will preclude the construction of a bridge or ramps.

There is an opportunity to minimise the land acquisition by opening the corridor between station platforms and the land owned by Network Rail which is currently being obstructed by a residential property (No. 2 Barrington Road). If this property was acquired, it will not only benefit the construction of proposed footbridge but will also facilitate the future extension of platforms.

The bridge span configuration is derived by positioning the bridge square to the track. An initial assessment suggests that this will provide a span saving of approximately 15% compared to its position in line with the carriageway. The footbridge supports will be set to a minimum of 4.5m away from the nearest rail or constructed at the back of the platforms. The proposed footbridge will be 2m wide, with a span of approximately 16m.

The ramps are located on private land, parallel to and behind the back of the existing station platforms. The approach ramps are designed to comply with Equality Act 2010 requirements for full disabled access with a maximum slope of 1:20, with 2m landings at 6m intervals.

The minimum required width of a bridge is 2m for unsegregated cycle and pedestrian access with a minimum headroom requirement of 5.1m from rail level as specified in NR/L2/TRK/2049. This headroom clearance will dictate a total ramp length of approximately 128m in accordance to Equality Act 2010 requirements. This will require more land acquisition and cause significant problems for people with walking difficulties and wheelchair users. This is not recommended by the 'Code of Practice for Disable People'.

3.2.3.2 Footbridge with stairs and lift shafts (MMD-318484-C-DR-BR- 102 & 104) (Option 8)

In this option, lift shafts will be provided instead of ramps to facilitate disabled access which satisfies the requirement for wheelchair users and other people with disabilities. Stairways can be provided in a form of normal stairs or a wrap round solution which will provide a smaller structural footprint when compared to a normal. This option will comprise of two sets of stairs and lift shafts, located on each side of the footbridge. The configuration of bridge span will remain same as discussed above. Lift lobby areas will have a minimum headroom of 2.3m to canopies and suspended fittings and should accommodate minimum 16 passengers at a time. The main advantage of this option over the ramp is that it minimises the requirement for land acquisition, hence reducing the cost of the option. However, the continuous operational and maintenance cost of this option will also need to be considered in the whole life cost.

As with the previous footbridge option, this option cannot accommodate equestrian use on safety grounds. Therefore, equestrians will be directed to use the path provided by the by-pass.

3.2.3.3 Footbridge with approach ramps to accommodate Equestrians (MMD-318484-C-DR-BR-105) (Option 9)

In this option, a footbridge and access ramps will be provided to accommodate pedestrians, together with a cyclists and equestrian. The minimum width of the footbridge and ramps, for a combined equestrian/ pedestrian access would be 3.5m (BD29/04) with solid side panels/parapets of 1.8m height to accommodate equestrian use. The construction of ramps will be similar to option 7, but they will not be and

suitable for wheel chairs and people with walking difficulties as discussed above in section 2.4.4.1.

A steel deck is unacceptable due to its noise under equestrian use with the clanging noise made by hooves which could frighten the horses. A timber decking over steel deck plate would be adopted on the bridge and ramps to deaden the sound of horses hooves. Small gaps are recommended in between the decking panels to aid drainage. The requirement for equestrian use on the bridge will require regular cleaning and maintenance. This option does not lead to a safe solution, as there is a possibility of horses being startled while crossing the bridge during train movement. However, this option is still viable should be considered in the next GRIP stage for further development. With an alternate route available, it is considered likely that riders would prefer to use a larger bridge (bypass route) rather than small steel pedestrian footbridge.

Footbridge Form and Construction

The bridge construction will require a night closure or a day possession during the weekend. The possession requirement and restricted site access will limit the amount of work and time on site and will require as much prefabrication as possible. A steel bridge is considered to be the best option as it can be installed in a single lift operation in a limited possession time. The Network Rail standard U-frame steel bridge is the preferred option due to its long term success and popularity. The bridge should include a minimum 1.5m high steel clad restraint system for pedestrians or 1.8m high for equestrians.

3.2.3.4 Subway with approach ramps (MMD-318484-C-DR-BR- 101) (Option 10)

An alternative is to construct a subway with approach ramps under the existing platforms and tracks. As the existing level crossing is a designated bridleway route, this underpass option will accommodate equestrians along with pedestrians and cyclists. The structure will be a precast reinforced concrete box with a width and headroom clearance (mounted access) of 5.0m and 3.5m respectively as specified in BD29/04 in compliance with IAN 124/11. It is proposed to provide chamfers at the bottom of subway for pedestrian safety. There is

another option of reducing the headroom of the structure to 2.7m, but this would restrict equestrians to dismounted access. Equality Act 2010 compliant ramps associated with the structure will require approximately 90m long ramps (based on full mounted equestrian access) which will require substantial land acquisition to create the length of path needed for such a height gain and fall.

Construction Issues

The main issues that would be involved in the construction of a subway are:

- The subway will be constructed under the existing tracks, which will stop train movements during the construction period;
- The subway will be constructed under the existing platforms. This option will not be feasible if platforms are founded on piles (not likely);
- The available data shows no presence of existing services but unforeseen obstructions i.e. HV cables could have a great impact on the construction cost and timescale;
- Due to high groundwater table level, other issues involving possible flooding during construction and the high cost of maintenance are similar to an underpass option as already discussed in section 2.4.2 above. These issues will increase financial cost and preclude this from further consideration.

The estimated construction cost of these options is given in section 7.1.

Equestrian Route

Equestrian right of way must be consideration, following the closure of Foxton level crossing. Below is a summary of equestrian route options considered as part of this study.

At the existing level crossing, equestrian have been consider in:

- Option 9 - Footbridge with approach ramps to accommodate equestrian;