Lower Thames Crossing

6.3 Environmental Statement Appendices
Appendix 12.10 – Road Traffic Noise Mitigation and Cost Benefit Analysis

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Lower Thames Crossing

6.3 Environmental Statement Appendices
Appendix 12.10 – Road Traffic Noise Mitigation and Cost Benefit Analysis

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1 Introduction

1.1.1 This document presents an appraisal of options to mitigate the noise effects of the Lower Thames Crossing project (the Project). The Project includes a range of environmental mitigation commitments for noise as outlined in Section 12.5 of the Noise and Vibration Chapter 12 of the Environmental Statement (ES) (Application Document 6.1).

1.1.2 This appendix details the appraisal undertaken and the justification for the conclusions relating to the acoustic mitigation strategy relating to operational road traffic noise considerations in addition to the embedded mitigation presented in Chapter 2 of the ES.

2 Methodology

2.1 Study Area

2.1.1 For each mitigation option a study area has been defined to consider the impacts based upon the guidance contained within the Design Manual for Roads and Bridges Noise and Vibration LA 111 Revision 2 (DMRB LA111) as follows:

a. 1200m from the main alignment for the consideration of different acoustically performing pavement surfaces; and,

b. 600m from each noise barrier options under consideration.

2.2 Road Traffic Noise Predictions

2.2.1 Full details of the methodology used and justification for the implementation of these methodologies are presented within the main text of Chapter 12, section 3.

2.2.2 Operational road traffic noise impacts have been assessed in accordance with the methodology defined in DMRB LA111, implementing the calculation methodology of the CRTN (Department for Transport and Welsh Office, 1988).

2.3 Operational night-time road traffic noise prediction

2.3.1 Night-time operational road traffic noise impacts have also been assessed in accordance with the methodology defined in LA 111; with TRL research report PR/SE/451/02 ‘Converting the UK traffic noise index dB LA10 18 hour to EU noise indices for noise mapping’ Method 3 used within the scope of this appraisal.

2.4 Appraisal Methodology

DMRB LA111

2.4.1 Under the guidance of LA111, the suitability of each potential mitigation measure for use within the project area should be determined based on the following criteria:

a. for residential noise receptors only, a comparison of the monetised noise benefit of a mitigation measure against the cost of the measure over the anticipated design life of the project;

b. the likely perceived benefit of the measure at any noise sensitive receptors;

c. the benefit of a measure in terms of elimination of likely significant effects;

d. practicality of the measure, for example, in terms of safety considerations and engineering constraints;

e. the impact of the measure across other environmental factors, for example the visual impact of a noise barrier.

2.4.2 LA111 further stipulates the cost of mitigation measures should be determined with reference to previously installed similar measures, and include costs of installation and maintenance through its life. Detailed analysis of all of the criteria should only be undertaken where it is considered that that a mitigation measure has the potential to be suitable based on all of the criteria.

TAG

2.4.3 Transport Analysis Guidance (TAG) is the Department for Transport (DfT) transport appraisal guidance and toolkit. It consists of software tools and guidance on transport modelling and appraisal methods that are applicable for highways and public transport interventions. These facilitate the appraisal and development of transport interventions, enabling analysts to build evidence to support business case development, to inform investment funding decisions.

2.4.4 TAG recommends how costs and impacts should be assessed in an appraisal.

2.4.5 Development of analysis using TAG guidance is a requirement for all interventions that require government approval. For interventions that do not require government approval this guidance would serve as a best practice guide.

2.4.6 The Net Present Value (NPV) of noise benefits has been calculated using the appropriate TAG Noise Workbook (TAG Data Book (v1.18)).

2.5 Mitigation Cost

2.5.1 The input parameters and the costs used for the mitigation options are based upon the methodology outlined within Defra report 'NANR 201 – Environmental Noise Valuation – The Costs and Benefits of Remediation Measures' (NANR 201) to determine the whole life cost over 60 a year period.

2.5.2 The specifics of the costs using in the appraisal are set out within:

a. Annex A: Surfacing Costs supplied by the Project Pavement Team; and,

b. Annex B: Noise Barrier Costs supplied by the Project Estimating Team.

2.6 Value for Money

2.6.1 The DfT document Value for Money Framework has been referenced, which outlines the Department's approach to value for money appraisals and provides guidance on how the outputs of these appraisals should be communicated.

2.6.2 The relationship between benefits and costs has been calculated by the division of the value of the monetarised benefit by the cost of the mitigation measure, which allows the consideration of indicative Value for Money (VfM). Consideration of the DfT guidance concludes an indicative VfM of 1 or greater to demonstrate a monetary benefit of the measure, with the measure returning a greater monetised benefit than the cost of implementation.

3 Appraisal of Pavement Surface

3.1 Introduction

3.1.1 Within the scope of the design of the Project, provision of thin surfacing systems is committed to under REAC commitment NV013. Consideration and justification of the performance specifications of this surfacing type along the Project is presented herein.

Thin Surface Systems

3.1.2 Through design a thin surfacing system has a negative texture which reduces the amount of noise generated at the tyre/surface contact, by reducing the air pressures at this tyre/surface interface. At high speed the compression and release of the air trapped under the tyre is a significant component of tyre/surface interface generated noise.

3.1.3 Generally, the use of smaller aggregate sizes and more uniformly shaped aggregate in thin surface systems results in a smother surface and hence increased noise generation.

3.1.4 The noise performance of a road surface is characterised by its 'Road Surface Influence' (RSI) value. This is calculated by using the measurement method within the European Standard BS EN ISO 11819-1:2001 and is referenced within the Highways Authorities Product Approval Scheme (HAPAS) database of available surfaces. The RSI value is quoted in decibels (dB) and expresses the surface's noise performance relative to Hot Rolled Asphalt with 20mm aggregate.

Base Case Scenario: -3.5dB RSI Pavement

3.1.5 Plates 3.1 to 3.5 presents noise change contours of the Project from south to north based upon a thin surface system providing an RSI of -3.5dB.

3.1.6 This is in accordance with the advice of LA111 for the implementation of thin surface systems in situations where speeds are in excess of 75kmph and a HAPAS certificated product is not specifically identified.

3.1.7 This consideration includes all other embedded mitigation (earthworks, false cutting etc) associated with the Project as set out in Chapter 2 of the ES but does not account for any additional Acoustic Mitigation in the form of barriers.

Plate 3.1 Road traffic noise change with -3.5 RSI pavement surface – South of River Thames

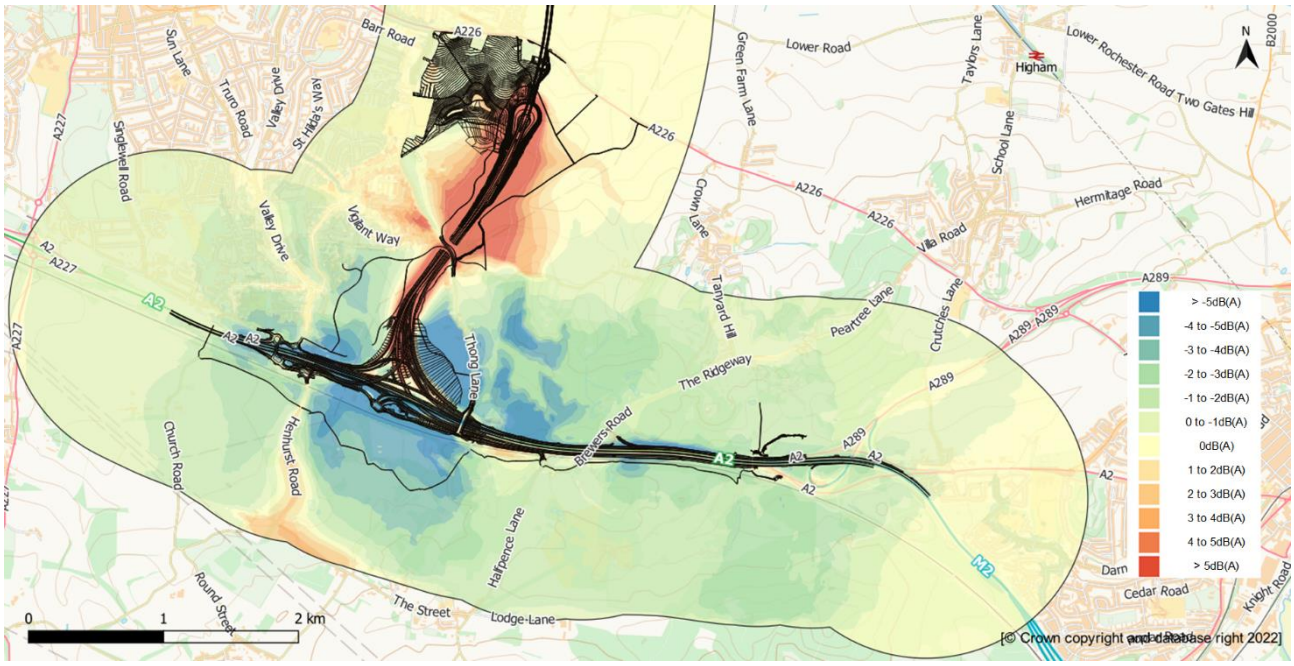


Plate 3.2 Road traffic noise change with -3.5 RSI pavement surface – North of River Thames

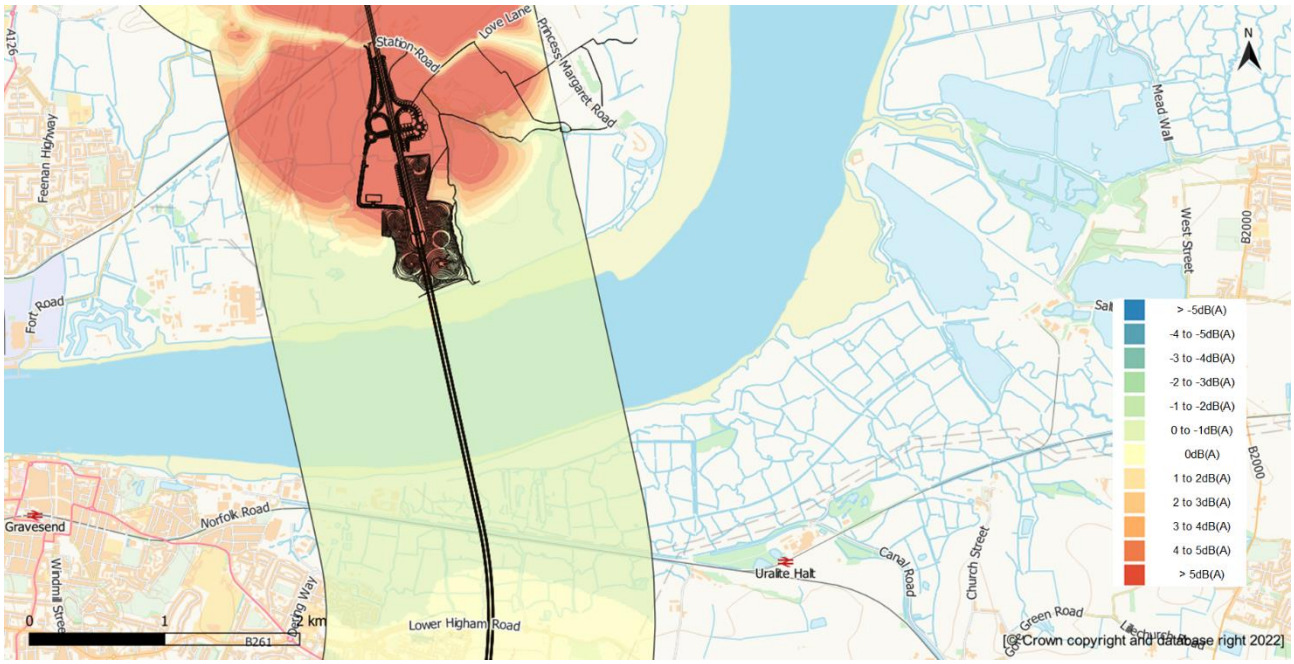


Plate 3.3 Road traffic noise change with -3.5 RSI pavement surface – South of A13

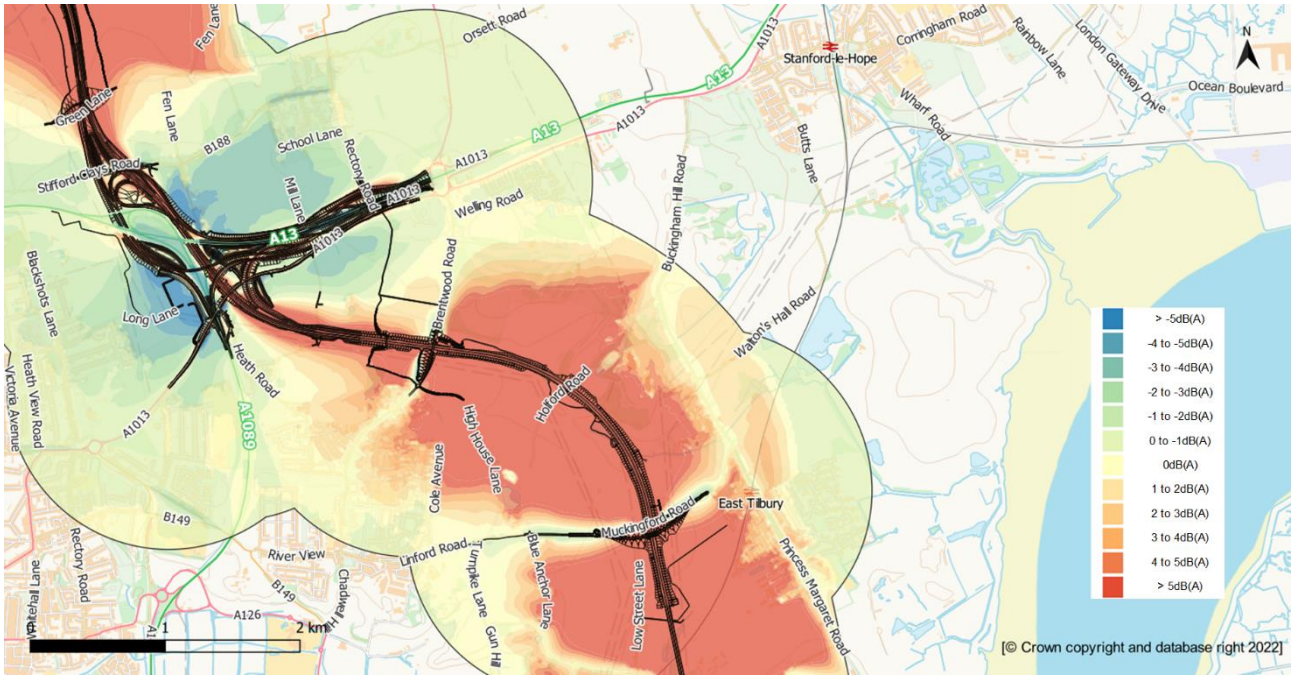


Plate 3.4 Road traffic noise change with -3.5 RSI pavement surface – North of A13 and M25

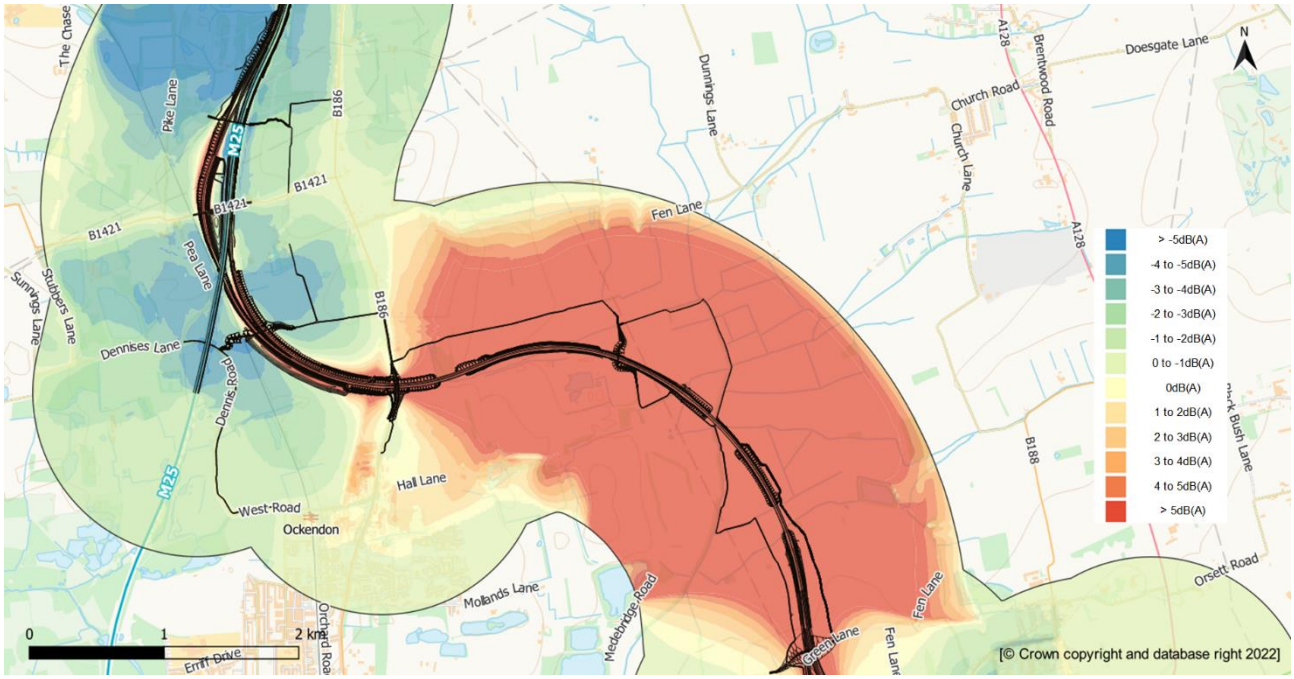
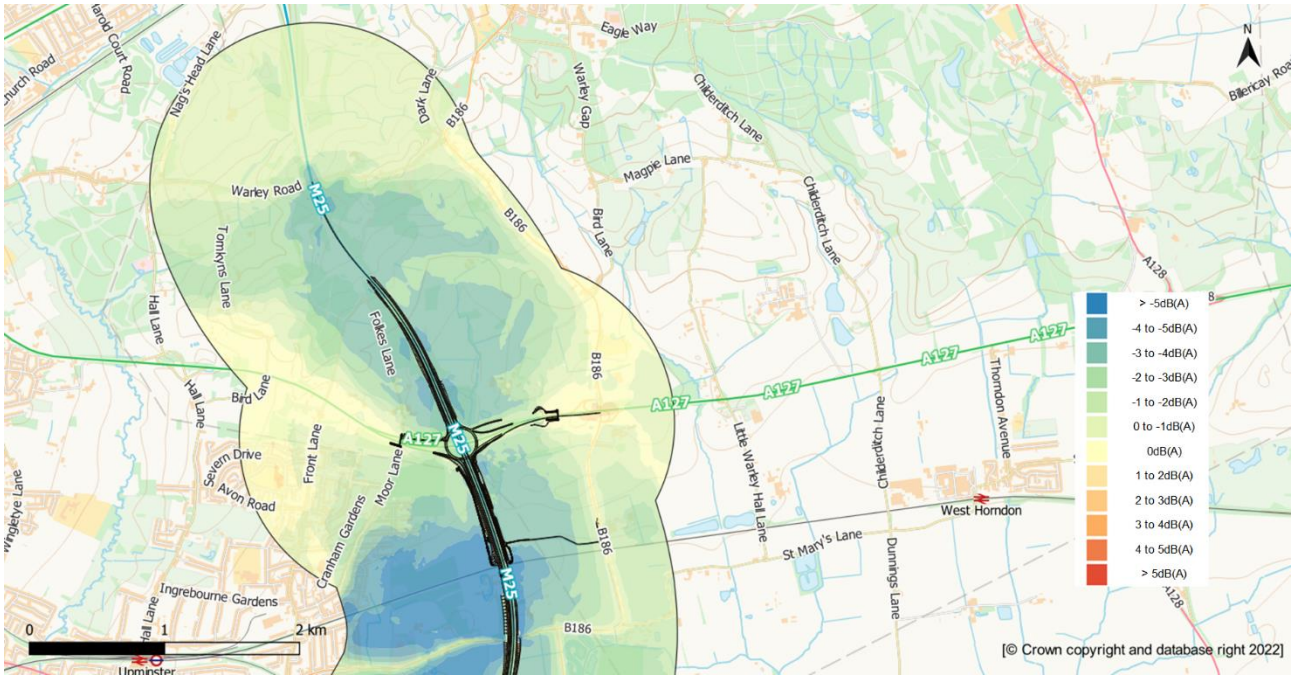


Plate 3.5 Road traffic noise change with -3.5 RSI pavement surface – Along M25



3.1.8 With reference to Plates 3.1 to 3.5, it is apparent that with the implementation of a thin surfacing system with a maximum RSI of -3.5dB, there is a potential for operational road traffic noise impacts as a result of the Project to remain. The locations have been identified as follows:

a. South of the River Thames

   i. 400m South of Thong Lane Bridge to Southern Tunnel Portal, northbound and southbound carriageways; 1,655m in length.

b. North of the River Thames

   i. Northern Tunnel Portal to A1013, northbound and southbound carriageways; 6,320m in length

c. North of the A13 Junction

   i. 270m south of Green Lane to Footbridge (FP252) over LTC, northbound and southbound carriageways; 5,870m in length

3.1.9 LA111 requires the investigation of additional mitigation above the base case proposed pavement surface.

3.2 DMRB Road Traffic Noise Assessment

3.2.1 In order to consider the effectiveness of the current suite of thin surfacing pavements available to the Project, a review of the Highways Authorities Product Approval Scheme (HAPAS) database has been undertaken.

3.2.2 The review of the HAPAS database has shown that there are available pavement surfaces with a Road Surface Influence (RSI) of greater than the base case -3.5dB RSI, up to a maximum of an of -7.5dB RSI being currently approved.

3.2.3 The following options, which have different HAPAS product performance levels, have been appraised:

a. Option 1: HAPAS approved product at RSI -3.5dB (base design);

b. Option 2: HAPAS approved product at RSI -5.0dB; and,

c. Option 3: HAPAS approved product at RSI -7.5dB;

3.2.4 Short term DMRB assessments of changes in road traffic noise have been undertaken for each option in the Tables below (comparison of 2030 opening year do minimum to the 2030 opening year do something). This has been undertaken within the study areas defined specifically for the consideration of the viability of each pavement surface option.

Table 3.1 Surface Option 1: -3.5 dB RSI

Change in noise level		Daytime	Night-time
		Number of dwellings	Number of dwellings
Increase in noise level, $L_{A10, 18hr}/L_{night}$	<1.0	1,639	1,644
	1.0–2.9	551	578
	3.0–4.9	275	254
	>5.0	252	189
No change	0	5,658	5,740
Decrease in noise level, $L_{A10, 18hr}/L_{night}$	<1.0	3,819	4,282
	1.0–2.9	3,293	3,367
	3.0–4.9	1,731	1,455
	>5.0	1,340	1,049

Table 3.2 Surface Option 2: -5.0 dB RSI

Change in noise level		Daytime	Night-time
		Number of dwellings	Number of dwellings
Increase in noise level, $L_{A10, 18hr}/L_{night}$	<1.0	1,672	1,691
	1.0–2.9	486	472
	3.0–4.9	175	151
	>5.0	152	120
No change	0	5,830	5,911

Change in noise level		Daytime	Night-time
		Number of dwellings	Number of dwellings
Decrease in noise level, $L_{A10, 18hr}/L_{night}$	<1.0	3,870	4,332
	1.0–2.9	3,298	3,371
	3.0–4.9	1,730	1,457
	>5.0	1,345	1,053

Table 3.3 Surface Option 3: -7.5 dB RSI

Change in noise level		Daytime	Night-time
		Number of dwellings	Number of dwellings
Increase in noise level, $L_{A10, 18hr}/L_{night}$	<1.0	1,658	1,665
	1.0–2.9	390	367
	3.0–4.9	88	75
	>5.0	116	94
No change	0	6,011	6,093
Decrease in noise level, $L_{A10, 18hr}/L_{night}$	<1.0	3,903	4,364
	1.0–2.9	3,316	3,388
	3.0–4.9	1,726	1,455
	>5.0	1,350	1,057

3.2.5 Within Table 3.4 and Table 3.5, the change in the numbers of dwellings affected by the Project with each pavement surface is considered within the study area defined specifically for the consideration of the viability of each pavement surface option.

Table 3.4 Daytime Appraisal

Change in noise level	Number of Dwellings with -3.5 RSI	Number of Dwellings with -5 RSI	Number of Dwellings with -7.5 RSI	Comparison of -5 RSI v – -3.5 RSI	Comparison of -7.5 RSI v -3.5 RSI
Increase in Road Traffic Noise Level	2,717	2,485	2,252	232 less	465 less
No Change in Road Traffic Noise Level	5,658	5,830	6,011	172 more	353 more
Decrease in Road Traffic Noise Level	10,183	10,243	10,295	60 more	112 more
Total Net Gain (Sum of all beneficial gains, no change and adverse reductions)				+464	+930

Table 3.5 Night-time Appraisal

Change in noise level	Number of Dwellings with -3.5 RSI	Number of Dwellings with -5 RSI	Number of Dwellings with -7.5 RSI	Comparison of -5 RSI v –-3.5 RSI	Comparison of -7.5 RSI v -3.5 RSI
Increase in Road Traffic Noise Level	2,665	2,434	2,201	231 less	464 less
No Change in Road Traffic Noise Level	5,740	5,911	6,093	171 more	353 more
Decrease in Road Traffic Noise Level	10,153	10,213	10,264	60 more	111 more
Total Net Gain (Sum of all beneficial gains, no change and adverse reductions)				+462	+928

3.3 Pavement Surface - Conclusion

3.3.1 An economic appraisal of each pavement surface type has been assessed and is presented in Table 3.6 based upon the 60 year life cost. Within the method, unit values for noise impacts from TAG have been applied to the change in the number of dwellings in order to calculate the benefits for each of the option.

3.3.2 As there are no options for a “no surface” option to compare against, the indicative VfM has been calculated for the additional costs of the enhanced measures above the costs for the base case -3.5 dB RSI thin surfacing system (Table 3.6), which would be installed as a standard on the Project as a result of the main alignment running speed.

Table 3.6 Indicative VfM of Option 2 and Option 3

Option /RSI	Additional cost of Surface	Additional Monetised Benefit	Ratio benefit to cost	Conclusion
	A	B	C (=B/A)	
Option 2 -5 dB RSI	£497,469	£2,832,965	5.7	Positive value indicates that there is expected to be an overall benefit with an indicative VfM of >1
Option 3 -7.5 dB RSI	£1,846,241	£5,930,922	3.2	Positive value indicates that there is expected to be an overall benefit with an indicative VfM of >1

3.3.3 As can been seen from Table 3.6 the additional costs associated with both pavement surfaces provide indicative Value for Money greater than 1, indicating a monetised benefit of the measure. However, with reference to Tables 3.4 and 3.5 Option 3 reduces noise at approximately double the number of receptors than Option 2.

3.3.4 As a result of this, and in order to comply with Table E/1.3 NN-NPS Aims and Associated Actions of the England National Application Annex to LA111; Noise and Vibration, Option 3 with an RSI of -7.5dB has been implemented within the design of the Project.

4 Acoustic Barriers Appraisals

4.1.1 The Project has been designed to use earthworks to keep the road low in the surrounding landscape. This is the primary way the Project has sought to control environmental impacts from noise. The secondary measure of the implementation of a pavement surface with an RSI of - 7.5dB (specified and justified within Section 3 of this Appendix) was then considered.

4.1.2 Therefore, the iterative approach used in the noise appraisal only required to consider where additional acoustic mitigation could be deemed beneficial, in addition to the earthworks and pavement measures already included within the design.

4.1.3 Within the scope of the appraisal 19 barrier locations (options) have been considered at varying barrier heights. These have been individually assessed and considered in line with DMRB LA111 and a representative VfM concluded for each barrier Option. This was coupled with further consideration of wider environmental impacts to conclude the overall viability of each Option, with barriers concluded to be eligible presented in Table 12.29 of Chapter 12 (Application Document 6.1) and on Figure 12.6 (Application Document 6.2).

4.1.4 Plates 4.1 to 4.4 present the geographic location of the Options considered, with the detailed objective and subjective consideration of each option presented in Table 4.1 to 4.19 and a conclusion drawn as to whether the Option is viable or not.

4.1.5 The indicative VfM and the consideration of other environmental factors are presented for each barrier option within Tables 4.1 to 4.19. These tables present the information to conclude which noise barrier options should be taken forward into the design of the Project.

4.1.6 Based upon this consideration the following noise barriers have been implemented into the design of the Project:

a. Barrier Option 3 at 2.0m; and,

b. Barrier Option 9 at 3.0m.

Plate 4.1 Barrier Options 1 and 2 Locations

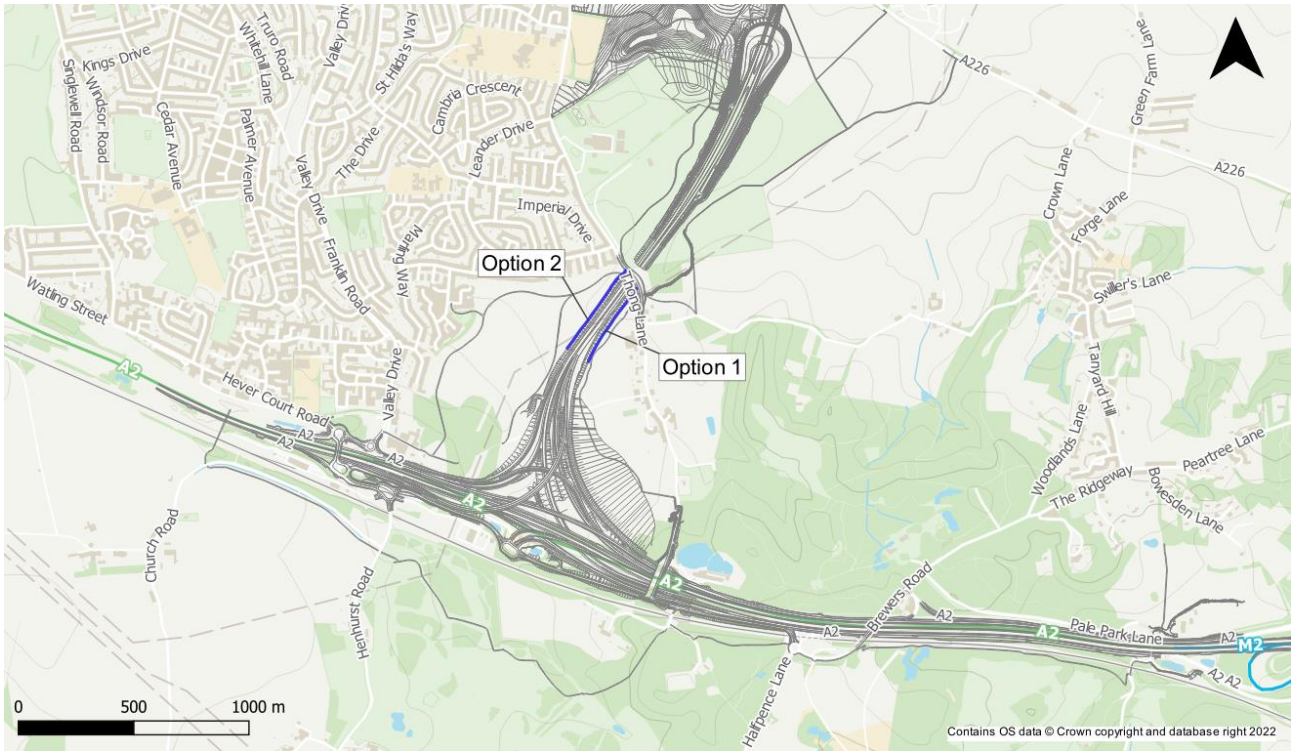


Plate 4.2 Barrier Options 3,4,5,6 and 7 Locations

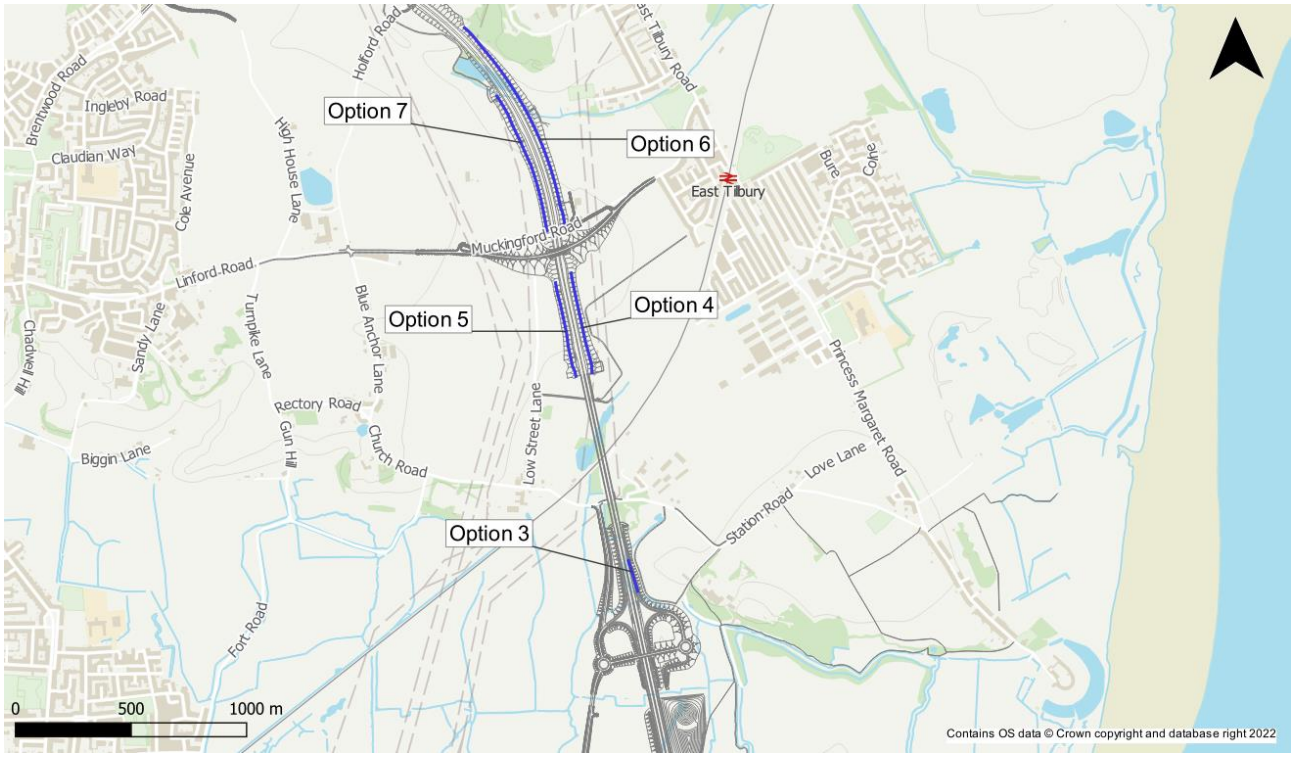


Plate 4.3 Barrier Options 8,9,10,11,12,13 and 14 Locations

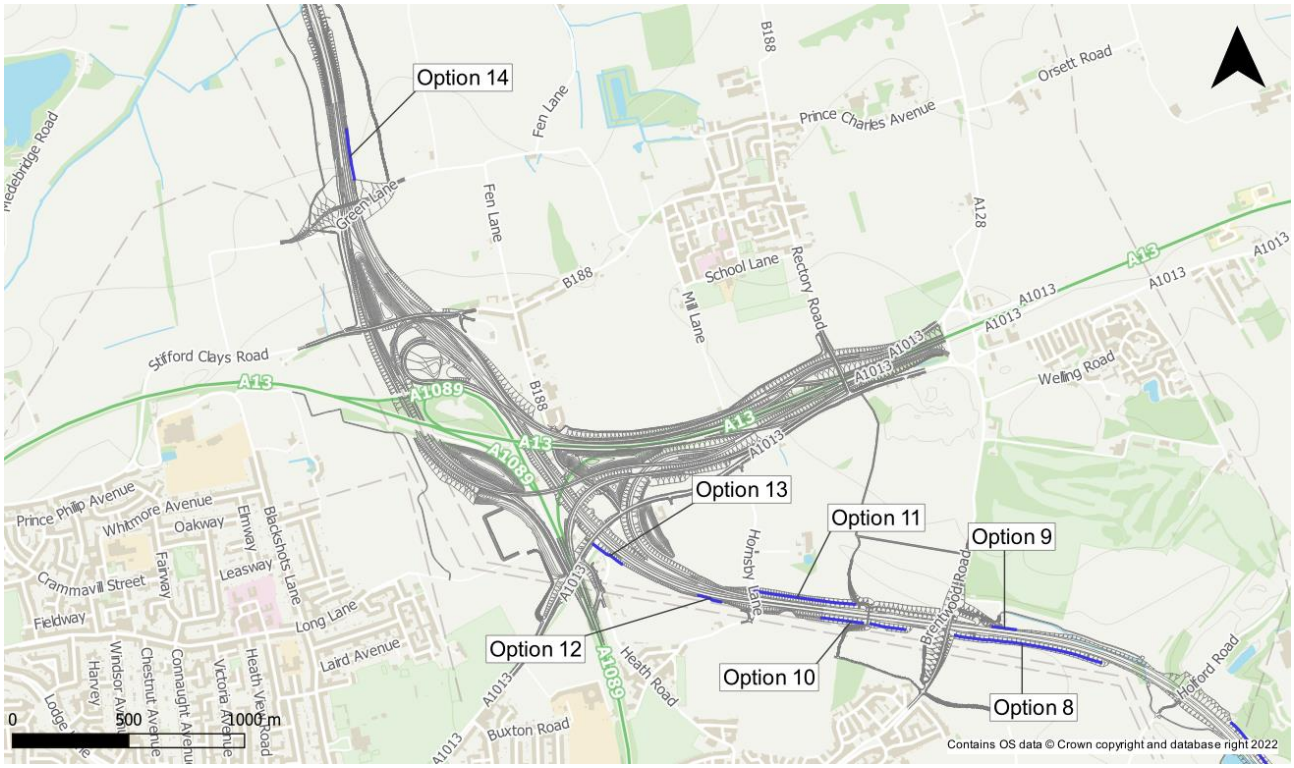


Plate 4.4 Barrier Options 15,16,17,18 and 19 Locations

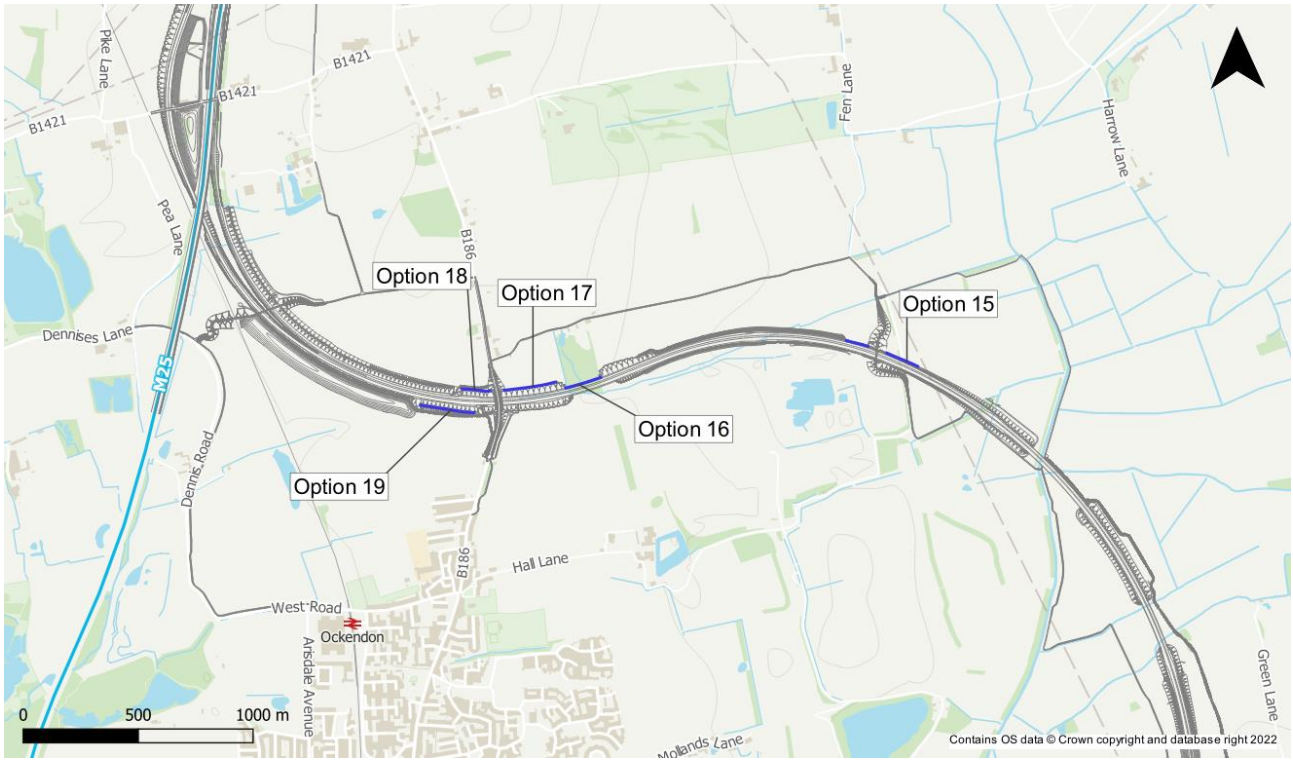


Table 4.1 Barrier Option 1 Appraisal

Barrier Option	Further Mitigation Option description	Noise impact and benefit Change in Impactswithin 600m Study Area				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
Option 1 at 1m Height	1m Noise barrier adjacent to the LTC Southbound carriageway on top of cutting. Extending 378m south from the Thong Lane Green Bridge	Daytime				£4,818	£189,756	0.03	Daytime - Measure removes one significant effect occurring below a SOAEL. Measure does not change number of dwellings above a SOAEL.	Landscape: Measure would be visible from new WCH route and properties in Thong. Fence could potentially help disguise new cutting (most traffic and highway infrastructure would be screened in the cutting, although fence would introduce a new urbanising element. Limited vegetation proposed so not much visual screening of fence. If fence is required, limit height to 1m to not create a dominating element Cultural Heritage: Potential impacts on Thong conservation area to the east which could be reduced by planting, however predominantly rock and scree habitat may affect this. Limiting height to 1m to not create a dominating element.	Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 39 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design. **Measure not viable at this height and not implemented into design.**
		Major Adverse	12	11	-1						
		Moderate Adverse	4	4	0						
		Minor Adverse	7	8	1						
		Negligible	3	3	0						
		Above LOAEL	2	2	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure reduces the impact at two dwellings (major to moderate) occurring below a SOAEL, but significant effects still remain. Measure doL		
		Major Adverse	7	5	-2						
		Moderate Adverse	8	10	2						
		Minor Adverse	8	8	0						
		Negligible	3	3	0						
		Above LOAEL	32	32	0						
		Above SOAEL	0	0	0						
Option 1 at 2m Height	2m Noise barrier adjacent to the LTC Southbound carriageway on top of cutting. Extending 378m south from the Thong Lane Green Bridge	Daytime				£13,421	£271,026	0.05	Daytime - Measure removes one significant effect occurring below a SOAEL. Measure does not change number of dwellings above a SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 20 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design. Height not acceptable for Landscape and Cultural Heritage constraints **Measure not viable at this height and not implemented into design.**
		Major Adverse	12	9	-3						
		Moderate Adverse	4	6	2						
		Minor Adverse	7	8	1						
		Negligible	3	3	0						
		Above LOAEL	2	2	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure reduces the impact at two dwellings (major to moderate) occurring below a SOAEL, but significant effects still remain. Measure does not change number of dwellings above a SOAEL		
		Major Adverse	7	5	-2						
		Moderate Adverse	8	10	2						
		Minor Adverse	8	8	0						
		Negligible	3	3	0						
		Above LOAEL	32	32	0						
		Above SOAEL	0	0	0						
Option 1 at 3m Height	3m Noise barrier	Daytime				£20,437	£352,674	0.06	Daytime - Measure removes one significant		Cost of mitigation measure exceeds monetised acoustic
		Major Adverse	12	8	-4						

Barrier Option	Further Mitigation Option description	Noise impact and benefit Change in Impactswithin 600m Study Area				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
	adjacent to the LTC Southbound carriageway on top of cutting. Extending 378m south from the Thong Lane Green Bridge	Moderate Adverse	4	7	3				effect occurring below a SOAEL. Measure does not change number of dwellings above a SOAEL.		benefit by a factor of approximately 17 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design. Height not acceptable for Landscape and Cultural Heritage constraints **Measure not viable at this height and not implemented into design.**
		Minor Adverse	7	8	1						
		Negligible	3	3	0						
		Above LOAEL	2	2	0						
		Above SOAEL	0	0	0						
		Night-time									
		Major Adverse	7	5	-2				Night-time - Measure reduces the impact at two dwellings (major to moderate) occurring below a SOAEL, but significant effects still remain. Measure does not change number of dwellings above a SOAEL		
		Moderate Adverse	8	10	2						
		Minor Adverse	8	8	0						
		Negligible	3	3	0						
		Above LOAEL	32	32	0						
		Above SOAEL	0	0	0						

Table 4.2 Barrier Option 2 Appraisal

Barrier Option	Further Mitigation Option description	Noise impact and benefit Change in Impacts				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
Option 2 at 1m Height	1m Noise barrier adjacent to the LTC Northbound carriageway on top of cutting. Extending 422m south from the Thong Lane Green Bridge.	Daytime				£92,607	£211,844	0.44	Daytime - Measure removes 11 significant effects occurring below a SOAEL. Measure does not change number of dwellings above a SOAEL.	Landscape: Measure would be visible from some properties in Gravesend and new WCH routes/Chalk Park. Majority of properties in Gravesend are likely to be screened by year 15 due to ancient woodland mitigation planting, therefore unlikely to be visible. Cultural Heritage:	Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 2 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL **Measure not viable at this height and not implemented into design.**
		Major Adverse	66	59	-7						
		Moderate Adverse	69	65	-4						
		Minor Adverse	130	125	-5						
		Negligible	409	425	16						
		Above LOAEL	3	0	-3						
		Above SOAEL	0	0	0						
		Night-time									
		Major Adverse	55	49	-6				Night-time - Measure removes seven significant effects occurring below a SOAEL. Measure does not change number of dwellings above a SOAEL.		
		Moderate Adverse	61	60	-1						
		Minor Adverse	137	128	-9						
		Negligible	421	437	16						
		Above LOAEL	674	674	0						

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
		Above SOAEL	0	0	0					Potential impacts limiting height to 1m to not create a dominating element.	
Option 2 at 2m Height	2m Noise barrier adjacent to the LTC Northbound carriageway on top of cutting. Extending 422m south from the Thong Lane Green Bridge.	Daytime				£177,630	£302,574	0.59	Daytime - Measure removes 18 significant effects occurring below a SOAEL. Measure does not change number of dwellings above a SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 1.7 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL Height not acceptable for Cultural Heritage constraints **Measure not viable at this height and not implemented into design.**
		Major Adverse	66	58	-8						
		Moderate Adverse	69	59	-10						
		Minor Adverse	130	115	-15						
		Negligible	409	442	33						
		Above LOAEL	3	0	-3						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure removes 13 significant effects occurring below a SOAEL. Measure does not change number of dwellings above a SOAEL.		
		Major Adverse	55	44	-11						
		Moderate Adverse	61	59	-2						
		Minor Adverse	137	124	-13						
		Negligible	421	447	26						
		Above LOAEL	674	674	0						
		Above SOAEL	0	0	0						
Option 2 at 3m Height	3m Noise barrier adjacent to the LTC Northbound carriageway on top of cutting. Extending 422m south from the Thong Lane Green Bridge.	Daytime				£238,152	£393,726	0.60	Daytime - Measure removes 25 significant effects occurring below a SOAEL. Measure does not change number of dwellings above a SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 1.7 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL Height not acceptable for Cultural Heritage constraints **Measure not viable at this height and not implemented into design.**
		Major Adverse	66	55	-11						
		Moderate Adverse	69	55	-14						
		Minor Adverse	130	111	-19						
		Negligible	409	453	44						
		Above LOAEL	3	0	-3						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure removes 20 significant effects occurring below a SOAEL. Measure does not change number of dwellings above a SOAEL.		
		Major Adverse	55	29	-26						
		Moderate Adverse	61	67	6						
		Minor Adverse	137	118	-19						
		Negligible	421	460	39						
		Above LOAEL	674	674	0						
		Above SOAEL	0	0	0						

Table 4.3 Barrier Option 3 Appraisal

Barrier Option	Further Mitigation Option description	Noise impact and benefit – Change in Impacts				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
Option 3 at 1m Height	1m high barrier adjacent to south bound carriageway Extending 137m	Daytime				£4,121	£68,774	0.06	Daytime - Measure removes no significant effects. Measure does not change number of dwellings above a SOAEL.	Landscape: Visible from WCH routes to east, with glimpses likely from some residential properties. Fence would help screen some views of traffic on embankment. Fence likely to be screened in year 15 by planting on embankment. Would introduce additional urbanising element, but character of this area already influenced by landfill activities etc. Up to 2m height in this location would be acceptable. Cultural Heritage: Large junction is proposed, height of barrier of no concern and would not create any additional impacts. Water Commentary Potentially in the floodplain of the West Tilbury Main and directly impacting on a watercourse.	Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 17 times and returns an indicative VfM of less than 1. Option presents a material acoustic benefit over base case design with one dwelling predicted to reduce to below a SOAEL during the night-time. **Measure not implemented due to Option at 2m height presenting better VfM.**
		Major Adverse	4	4	0						
		Moderate Adverse	3	3	0						
		Minor Adverse	3	3	0						
		Negligible	1	1	0						
		Above LOAEL	2	2	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure reduces one dwelling from major to moderate below a SOAEL which remains a significant effect. Option removes one impact from above a SOAEL		
		Major Adverse	4	3	-1						
		Moderate Adverse	3	4	1						
		Minor Adverse	3	3	0						
		Negligible	1	1	0						
		Above LOAEL	10	11	1						
		Above SOAEL	1	0	-1						
Option 3 at 2m Height	2m high barrier adjacent to south bound carriageway Extending 137m	Daytime				£6,938	£98,229	0.07	Daytime - Measure removes no significant effects. Measure does not change number of dwellings above a SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 14 times and whilst returns an indicative VfM of less than 1, is better than 1m option Option presents a material acoustic benefit over base case design with one dwelling predicted to reduce to below a SOAEL during the night-time. **Measure implemented at 2m height**
		Major Adverse	4	4	0						
		Moderate Adverse	3	3	0						
		Minor Adverse	3	3	0						
		Negligible	1	1	0						
		Above LOAEL	2	2	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure reduces one dwelling from major to moderate below a SOAEL which remains a significant effect. Option removes one impact from above a SOAEL		
		Major Adverse	4	3	-1						
		Moderate Adverse	3	4	1						
		Minor Adverse	3	3	0						
		Negligible	1	1	0						
		Above LOAEL	10	11	1						
		Above SOAEL	1	0	-1						
Option 3 at 3m Height	3m high barrier adjacent to south	Daytime				£11,945	£127,821	0.09	Daytime - Measure removes no significant effects.		Cost of mitigation measure exceeds monetised acoustic
		Major Adverse	4	3	-1						

Barrier Option	Further Mitigation Option description	Noise impact and benefit Change in Impacts Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)	TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
	bound carriageway Extending 137m	Moderate Adverse	3	4	1				Measure does not change number of dwellings above a SOAEL.		benefit by a factor of approximately 11 times and and whilst returns an indicative VfM of less than 1, is better than 1m and 2m options. Option presents a material acoustic benefit over base case design with one dwelling predicted to reduce to below a SOAEL during the night-time. Height not acceptable for Landscape constraints **Measure not implemented in favour of 2m option due to Landscape constraints.**
		Minor Adverse	3	3	0						
		Negligible	1	1	0						
		Above LOAEL	2	2	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure reduces one dwelling from major to moderate below a SOAEL which remains a significant effect. Option removes one impact from above a SOAEL		
		Major Adverse	4	3	-1						
		Moderate Adverse	3	4	1						
		Minor Adverse	3	3	0						
		Negligible	1	1	0						
		Above LOAEL	10	11	1						
		Above SOAEL	1	0	-1						

Table 4.4 Barrier Option 4 Appraisal

Barrier Option	Further Mitigation Option description	Noise impact and benefit Change in Impacts Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)	TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
Option 4 at 1m Height	1m Noise barrier adjacent to the LTC Southbound carriageway, immediately north of Tilbury Viaduct to Muckingford Road overbridge. Extending 441m on the	Daytime				£20,580	£221,382	0.09	Daytime - Measure removes three significant effect occurring below a SOAEL. Measure does not change number of dwellings above a SOAEL.	Landscape: Fence would introduce a further urbanising feature into the open landscape. A 4m high false cutting screens most traffic and highway infrastructure in this location therefore limited vegetation proposed to maintain open landscape (with no/minimal screening for fence).	Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 11 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL Height unacceptable for Cultural Heritage constraints
		Major Adverse	13	9	-4						
		Moderate Adverse	36	37	1						
		Minor Adverse	39	36	-3						
		Negligible	378	384	6						
		Above LOAEL	20	20	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure reduces six dwellings (major to moderate) occurring below a SOAEL, but significant effects still remain.		
		Major Adverse	1	1	0						
		Moderate Adverse	40	34	-6						
		Minor Adverse	42	41	-1						

Barrier Option	Further Mitigation Option description	Noise impact and benefit Change in Impacts				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
	top of the embankment.	Negligible	383	390	7				Measure does not change number of dwellings above a SOAEL	Fence likely to be visible on the skyline from properties to the east, so would be considered a potentially prominent feature. If fence is required, limit height to 1m to not create a dominating element. Cultural Heritage: Better from cultural heritage perspective not to have Option in any form.	**Measure not viable at this height and not implemented into design**.
		Above LOAEL	466	466	0						
		Above SOAEL	0	0	0						
Option 4 at 2m Height	2m Noise barrier adjacent to the LTC Southbound carriageway, immediately north of Tilbury Viaduct to Muckingford Road overbridge. Extending 441m on the top of the embankment.	Daytime				£36,206	£316,197	0.11	Daytime - Measure removes eight significant effect occurring below a SOAEL. Measure does not change number of dwellings a SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 9 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL Height unacceptable for Cultural Heritage constraints **Measure not viable at this height and not implemented into design.**
		Major Adverse	13	6	-7						
		Moderate Adverse	36	35	-1						
		Minor Adverse	39	37	-2						
		Negligible	378	388	10						
		Above LOAEL	20	20	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure reduces nine dwellings (major to moderate) occurring below a SOAEL, but significant effects still remain. Measure does not change number of dwellings above the LOAEL and SOAEL		
		Major Adverse	1	1	0						
		Moderate Adverse	40	31	-9						
		Minor Adverse	42	40	-2						
		Negligible	383	394	11						
		Above LOAEL	466	466	0						
		Above SOAEL	0	0	0						
Option 4 at 3m Height	3m Noise barrier adjacent to the LTC Southbound carriageway, immediately north of Tilbury Viaduct to Muckingford Road overbridge. Extending 441m on the top of the embankment.	Daytime				£48,983	£411,453	0.12	Daytime - Measure removes 11 significant effect occurring below a SOAEL. Measure does not change number of dwellings above a SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 8 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL Height unacceptable for Cultural Heritage constraints **Measure not viable at this height and not implemented into design.**
		Major Adverse	13	6	-7						
		Moderate Adverse	36	32	-4						
		Minor Adverse	39	33	-6						
		Negligible	378	395	17						
		Above LOAEL	20	20	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure reduces 11 dwellings (major to moderate) occurring below a SOAEL, but significant effects still remain. Measure does not change number of dwellings above a SOAEL		
		Major Adverse	1	1	0						
		Moderate Adverse	40	29	-11						
		Minor Adverse	42	41	-1						
		Negligible	383	395	12						
		Above LOAEL	466	466	0						
		Above SOAEL	0	0	0						

Table 4.5 Barrier Option 5 Appraisal

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
Option 5 at 1m Height	1m Noise barrier adjacent to the LTC Northbound carriageway, immediately north of Tilbury Viaduct to Muckingford Road overbridge. Extending 414m on the top of the embankment.	Daytime				£1,381	£207,828	0.01	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above a SOAEL.	Landscape: Option would introduce a further urbanising feature into the open landscape, with limited vegetation proposed to maintain open landscape (no/minimal screening for fence). Likely to be visible on the skyline from properties to the east, so would be considered a potentially prominent feature; however, could be mitigated if limited to 1m. Cultural Heritage: Better from cultural heritage perspective not to have Option in any form.	Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 150 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL Height unacceptable for Cultural Heritage constraints Measure not viable at this height and not implemented into design.
		Major Adverse	0	0	0						
		Moderate Adverse	1	1	0						
		Minor Adverse	2	1	-1						
		Negligible	8	8	0						
		Above LOAEL	0	0	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the LOAEL and SOAEL.		
		Major Adverse	0	0	0						
		Moderate Adverse	1	1	0						
		Minor Adverse	1	1	0						
		Negligible	9	9	0						
		Above LOAEL	14	14	0						
		Above SOAEL	0	0	0						
Option 5 at 2m Height	2m Noise barrier adjacent to the LTC Northbound carriageway, immediately north of Tilbury Viaduct to Muckingford Road overbridge. Extending 414m on the top of the embankment.	Daytime				£2,155	£296,838	0.01	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above a SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 137 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL Height unacceptable for Cultural Heritage and Landscape constraints **Measure not viable at this height and not implemented into design.**
		Major Adverse	0	0	0						
		Moderate Adverse	1	1	0						
		Minor Adverse	2	1	-1						
		Negligible	8	8	0						
		Above LOAEL	0	0	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure removes one significant effect occurring below a SOAEL. Measure does not change number of dwellings above a SOAEL.		
		Major Adverse	0	0	0						
		Moderate Adverse	1	0	-1						
		Minor Adverse	1	2	1						
		Negligible	9	8	-1						
		Above LOAEL	14	14	0						
		Above SOAEL	0	0	0						

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
Option 5 at 3m Height	3m Noise barrier adjacent to the LTC Northbound carriageway, immediately north of Tilbury Viaduct to Muckingford Road overbridge. Extending 414m on the top of the embankment.	Daytime				£2,833	£386,262	0.01	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above a SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 136 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL Height unacceptable for Cultural Heritage and Landscape constraints **Measure not viable at this height and not implemented into design.**
		Major Adverse	0	0	0						
		Moderate Adverse	1	1	0						
		Minor Adverse	2	1	-1						
		Negligible	8	8	0						
		Above LOAEL	0	0	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure removes one significant effect occurring below a SOAEL. Measure does not change number of dwellings above a SOAEL.		
		Major Adverse	0	0	0						
		Moderate Adverse	1	0	-1						
		Minor Adverse	1	2	1						
		Negligible	9	8	-1						
		Above LOAEL	14	14	0						
		Above SOAEL	0	0	0						

Table 4.6 Barrier Option 6 Appraisal

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
Option 6 at 1m Height	1m Noise barrier adjacent to the LTC Southbound carriageway, immediately north of Muckingford	Daytime				£59,753	£493,968	0.12	Daytime - Measure removes 12 significant effects occurring below a SOAEL. Measure does not change number of dwellings above the SOAEL.	Landscape: Option would introduce a further urbanising feature into the open landscape, with limited vegetation proposed to maintain open landscape (no/minimal screening for fence). Likely to be visible on the skyline from properties to	Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 8 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL
		Major Adverse	1	0	-1						
		Moderate Adverse	15	4	-11						
		Minor Adverse	115	97	-18						
		Negligible	219	249	30						
		Above LOAEL	5	4	-1						

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
	Road overbridge. Extending 984m on the top of the embankment.	Above SOAEL	0	0	0					the east, so would be considered a potentially prominent feature; however, could be mitigated if limited to 1m. Northern end of fence near existing watercourse would be more contained by existing and proposed vegetation Water Commentary looks to cross the Gobions Sewer water course	**Measure not viable at this height and not implemented into design.**
		Night-time							Night-time - Measure removes seven significant effects occurring below a SOAEL. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	0	0	0						
		Moderate Adverse	8	1	-7						
		Minor Adverse	100	86	-14						
		Negligible	242	263	21						
		Above LOAEL	349	349	0						
		Above SOAEL	0	0	0						
Option 6 at 2m Height	2m Noise barrier adjacent to the LTC Southbound carriageway, immediately north of Muckingford Road overbridge. Extending 984m on the top of the embankment.	Daytime				£101,888	£705,528	0.14	Daytime - Measure removes 15 significant effects occurring below a SOAEL. Measure does not change number of dwellings above the SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 7 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL Height unacceptable for Landscape constraints **Measure not viable at this height and not implemented into design.**
		Major Adverse	1	0	-1						
		Moderate Adverse	15	1	-14						
		Minor Adverse	115	76	-39						
		Negligible	219	273	54						
		Above LOAEL	5	3	-2						
		Above SOAEL	1	1	0						
		Night-time							Night-time - Measure removes seven significant effects occurring below a SOAEL. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	0	0	0						
		Moderate Adverse	8	1	-7						
		Minor Adverse	100	59	-41						
		Negligible	242	290	48						
		Above LOAEL	349	349	0						
		Above SOAEL	0	0	0						
Option 6 at 3m Height	3m Noise barrier adjacent to the LTC Southbound carriageway,	Daytime				£126,743	£918,072	0.14	Daytime - Measure removes 16 significant effects occurring below a SOAEL. Measure does not change number of dwellings above the SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 7 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case
		Major Adverse	1	0	-1						
		Moderate Adverse	15	0	-15						
		Minor Adverse	109	53	-56						

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
	immediately north of Muckingford Road overbridge. Extending 98m on the top of the embankment.	Negligible	194	266	72						design when considered in relation to SOAEL Height unacceptable for Landscape constraints **Measure not viable at this height and not implemented into design.**
		Above LOAEL	5	3	-2						
		Above SOAEL	1	1	0						
		Night-time							Night-time - Measure removes eight significant effects occurring below a SOAEL. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	0	0	0						
		Moderate Adverse	8	0	-8						
		Minor Adverse	100	38	-62						
		Negligible	242	312	70						
		Above LOAEL	349	349	0						
		Above SOAEL	0	0	0						

Table 4.7 Barrier Option 7 Appraisal

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
Option 7 at 1m Height	1m Noise barrier adjacent to the LTC Northbound carriageway, immediately north of Muckingford Road overbridge. Extending 624m on the top of the embankment.	Daytime				£2,157	£313,248	0.01	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.	Landscape: Option would introduce a further urbanising feature into the open landscape, with limited vegetation proposed to maintain open landscape (no/minimal screening for fence). Likely to be visible on the skyline from properties to the east, so would be considered a potentially prominent	Cost of mitigation measure significantly exceeds monetised acoustic benefit and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL **Measure not viable at this height and not implemented into design**.
		Major Adverse	1	1	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	1	1	0						
		Negligible	4	3	-1						
		Above LOAEL	2	1	-1						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure does not change significant effects.		
		Major Adverse	1	1	0						
		Moderate Adverse	0	0	0						

Barrier Option	Further Mitigation Option description	Noise impact and benefit Change in Impacts				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
		Minor Adverse	1	0	-1				Measure does not change number of dwellings above the SOAEL.	feature; however, could be mitigated if limited to 1m.	
		Negligible	4	4	0						
		Above LOAEL	7	7	0						
		Above SOAEL	0	0	0						
Option 7 at 2m Height	2m Noise barrier adjacent to the LTC Northbound carriageway, immediately north of Muckingford Road overbridge. Extending 624m on the top of the embankment.	Daytime				£2,264	£447,408	0.01	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		Cost of mitigation measure significantly exceeds monetised acoustic benefit and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL Height unacceptable for Landscape constraints **Measure not viable at this height and not implemented into design**.
		Major Adverse	1	1	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	1	1	0						
		Negligible	4	3	-1						
		Above LOAEL	2	1	-1						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	1	1	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	1	0	-1						
		Negligible	4	4	0						
		Above LOAEL	7	7	0						
		Above SOAEL	0	0	0						
Option 7 at 3m Height	3m Noise barrier adjacent to the LTC Northbound carriageway, immediately north of Muckingford Road overbridge. Extending 624m on the top of the embankment.	Daytime				£3,351	£582,192	0.01	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		Cost of mitigation measure significantly exceeds monetised acoustic benefit and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL Height unacceptable for Landscape constraints **Measure not viable at this height and not implemented into design**.
		Major Adverse	1	1	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	1	0	-1						
		Negligible	4	4	0						
		Above LOAEL	2	1	-1						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	1	1	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	1	0	-1						
		Negligible	4	4	0						

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
		Above LOAEL	7	7	0						
		Above SOAEL	0	0	0						

Table 4.8 Barrier Option 8 Appraisal

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
Option 8 at 1m Height	1m Noise barrier adjacent to the LTC Northbound carriageway, immediately south of Brentwood Road overbridge. Extending 640m on the top of the embankment.	Daytime				£38,565	£321,280	0.12	Daytime - Measure removes seven significant effects occurring below a SOAEL. Measure does not change number of dwellings above the SOAEL.	Landscape: Option would introduce a further urbanising feature into the open landscape, with limited vegetation proposed to maintain open landscape (no/minimal screening for fence). Likely to be visible on the skyline from properties to the east, so would be considered a potentially prominent feature; however, could be mitigated if limited to 1m.	Cost of mitigation measure exceeds monetised acoustic benefit and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL **Measure not viable at this height and not implemented into design**.
		Major Adverse	7	7	0						
		Moderate Adverse	34	27	-7						
		Minor Adverse	134	132	-2						
		Negligible	553	562	9						
		Above LOAEL	9	9	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure removes six significant effect occurring below a SOAEL. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	7	4	-3						
		Moderate Adverse	19	16	-3						
		Minor Adverse	134	129	-5						
		Negligible	568	579	11						
		Above LOAEL	723	723	0						
		Above SOAEL	5	5	0						
Option 8 at 2m Height	2m Noise barrier adjacent to the LTC Northbound carriageway, immediately south of	Daytime				£70,544	£458,880	0.15	Daytime - Measure removes 19 significant effect occurring below a SOAEL. Measure does not change number of		Cost of mitigation measure exceeds monetised acoustic benefit and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL
		Major Adverse	7	7	0						
		Moderate Adverse	34	15	-19						
		Minor Adverse	134	135	1						
		Negligible	553	571	18						
		Above LOAEL	9	9	0						

Barrier Option	Further Mitigation Option description	Noise impact and benefit Change in Impacts Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)	TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
	Brentwood Road overbridge. Extending 640m on the top of the embankment.	Above SOAEL	0	0	0				dwellings above the SOAEL.		Height unacceptable for Landscape constraints **Measure not viable at this height and not implemented into design.**
		Night-time							Night-time - Measure removes 13 significant effect occurring below a SOAEL. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	7	3	-4						
		Moderate Adverse	19	10	-9						
		Minor Adverse	134	128	-6						
		Negligible	568	587	19						
		Above LOAEL	723	723	0						
		Above SOAEL	5	5	0						
Option 8 at 3m Height	3m Noise barrier adjacent to the LTC Northbound carriageway, immediately south of Brentwood Road overbridge. Extending 640m on the top of the embankment.	Daytime				£101,479	£597,120	0.17	Daytime - Measure removes 25 significant effect occurring below a SOAEL. Measure does not change number of dwellings above the SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL Height unacceptable for Landscape constraints **Measure not viable at this height and not implemented into design.**
		Major Adverse	7	6	-1						
		Moderate Adverse	34	10	-24						
		Minor Adverse	134	132	-2						
		Negligible	553	580	27						
		Above LOAEL	9	9	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure removes 15 significant effect occurring below a SOAEL. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	7	3	-4						
		Moderate Adverse	19	8	-11						
		Minor Adverse	134	122	-12						
		Negligible	568	595	27						
		Above LOAEL	723	723	0						
		Above SOAEL	5	5	0						

Table 4.9 Barrier Option 9 Appraisal

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
Option 9 at 1m Height	1m Noise barrier adjacent to the LTC Southbound carriageway, adjacent to Brook Farm Houses. At carriageway edge extending 96m between earthworks features.	Daytime				£6,909	£48,192	0.14	Daytime – Measure does not remove any significant effects. Measure does not change number of dwellings above the SOAEL.	Landscape: This fence would likely help screen the Project from the nearby residential property. Above 3m, it will be a huge fence, advise 2 to 3m height max Cultural Heritage: 3m height would be acceptable, above 3m height would need reviewing	Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 7 times and returns an indicative VfM of less than 1. Option presents a material acoustic benefit over base case design with one dwelling predicted to reduce to below a SOAEL during the night-time. **Measure not implemented due to Option at 3m height presented better VfM.**
		Major Adverse	2	2	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	0	0	0						
		Above LOAEL	0	0	0						
		Above SOAEL	2	2	0						
		Night-time							Night-time - Measure does not remove any significant effects. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	2	2	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	0	0	0						
		Above LOAEL	0	0	0						
		Above SOAEL	2	2	0						
Option 9 at 2m Height	2m Noise barrier adjacent to the LTC Southbound carriageway, adjacent to Brook Farm Houses. At carriageway edge extending 96m between earthworks features.	Daytime				£15,053	£68,832	0.22	Daytime- Measure does not remove any significant effects but removes two impact from above a SOAEL		Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 5 times and whilst still returns an indicative VfM of less than 1, does present a material acoustic benefit over the base case design with two dwelling predicted to reduce to below a SOAEL during the daytime. **Measure not implemented due to Option at 3m height presented better VfM.**
		Major Adverse	2	2	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	0	0	0						
		Above LOAEL	0	2	2						
		Above SOAEL	2	0	-2						
		Night-time							Night-time - Measure does not remove any significant effects. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	2	2	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	0	0	0						
		Above LOAEL	0	0	0						

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
		Above SOAEL	2	2	0						
Option 9 at 3m Height	3m Noise barrier adjacent to the LTC Southbound carriageway, adjacent to Brook Farm Houses. At carriageway edge extending 96m between earthworks features.	Daytime				£21,119	£89,568	0.24	Daytime- Measure does not remove any significant effects but removes two impacts from above a SOAEL		Cost of mitigation measure exceeds monetised acoustic benefit and returns an indicative VfM of less than 1, does present a material acoustic benefit over the base case design with two dwelling predicted to reduce to below a SOAEL during the daytime. In addition, the measure reduces the noise increase at the properties by a greater amount than the 2m option, thus representing as far as reasonably possible accounting for other constraints including Landscape. **Measure implemented at 3m height to reduce noise as far as is reasonably possible.**
		Major Adverse	2	2	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	0	0	0						
		Above LOAEL	0	2	2						
		Above SOAEL	2	0	-2						
		Night-time							Night-time - Measure does not remove any significant effects. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	2	2	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	0	0	0						
		Above LOAEL	0	0	0						
		Above SOAEL	2	2	0						

Table 4.10 Barrier Option 10 Appraisal

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
Option 10 at 1m Height	1m Noise barrier adjacent to the LTC Northbound carriageway, north of Brentwood Road overbridge. Extending 324m on the top of the embankment	Daytime				£30,292	£162,648	0.19	Daytime - Measure removes five significant effects occurring below a SOAEL. Measure does not change number of dwellings above the SOAEL.	Landscape: Would be visible from WCH route and residential properties to south. Fence would potentially provide screening of tops of high-sided vehicles, however it would also introduce a further urbanising feature into the open landscape (although in context of WCH bridge and partially contained by Old House Wood). Height of fence should be limited to 1m Cultural Heritage: Up to 1m in height, as landscape should be kept as open as possible	Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 5 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design. **Measure not viable at this height and not implemented into design.**
		Major Adverse	4	3	-1						
		Moderate Adverse	8	4	-4						
		Minor Adverse	154	145	-9						
		Negligible	41	55	14						
		Above LOAEL	14	14	0						
		Above SOAEL	2	2	0						
		Night-time							Night-time - Measure removes one significant effect occurring below a SOAEL. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	3	2	-1						
		Moderate Adverse	4	4	0						
		Minor Adverse	139	130	-9						
		Negligible	61	71	10						
		Above LOAEL	201	201	0						
		Above SOAEL	6	6	0						
Option 10 at 2m Height	2m Noise barrier adjacent to the LTC Northbound carriageway, north of Brentwood Road overbridge. Extending 324m on the top of the embankment	Daytime				£51,899	£232,308	0.22	Daytime - Measure removes six significant effect occurring below a SOAEL. Measure does not change number of dwellings above the SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 4 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL Height unacceptable for Landscape and Cultural Heritage constraints **Measure not viable at this height and not implemented into design**
		Major Adverse	4	3	-1						
		Moderate Adverse	8	3	-5						
		Minor Adverse	154	134	-20						
		Negligible	41	67	26						
		Above LOAEL	14	14	0						
		Above SOAEL	2	2	0						
		Night-time							Night-time - Measure removes one significant effect occurring below a SOAEL.		
		Major Adverse	3	2	-1						
		Moderate Adverse	4	4	0						
		Minor Adverse	139	122	-17						

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
		Negligible	61	79	18				Measure does not change number of dwellings above the SOAEL.		
		Above LOAEL	201	201	0						
		Above SOAEL	6	6	0						
Option 10 at 3m Height	3m Noise barrier adjacent to the LTC Northbound carriageway, north of Brentwood Road overbridge. Extending 324m on the top of the embankment	Daytime				£74,620	£302,292	0.25	Daytime - Measure removes six significant effect occurring below a SOAEL. Measure does not change number of dwellings above the SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 4 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL Height unacceptable for Landscape and Cultural Heritage constraints **Measure not viable at this height and not implemented into design**
		Major Adverse	4	2	-2						
		Moderate Adverse	8	4	-4						
		Minor Adverse	154	128	-26						
		Negligible	41	73	32						
		Above LOAEL	14	14	0						
		Above SOAEL	2	2	0						
		Night-time							Night-time - Measure removes one significant effect occurring below a SOAEL. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	3	2	-1						
		Moderate Adverse	4	4	0						
		Minor Adverse	139	112	-27						
		Negligible	61	89	28						
		Above LOAEL	201	201	0						
		Above SOAEL	6	6	0						

Table 4.11 Barrier Option 11 Appraisal

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
Option 11 at 1m Height	1m Noise barrier adjacent	Daytime				£1,592	£217,366	0.01		Landscape:	Cost of mitigation measure exceeds monetised acoustic
		Major Adverse	1	1	0						

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
	to the LTC Southbound carriageway, on top of embankment south of Hornsby Lane. Extending 433m to footbridge FP79	Moderate Adverse	0	0	0				Daytime - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL	Would be visible from WCH route and residential properties to south. Fence would potentially provide screening of tops of high-sided vehicles, however it would also introduce a further urbanising feature into the open landscape. Height of fence should be limited to 1m Cultural Heritage: Up to 1m in height, as landscape should be kept as open as possible	benefit by a factor of approximately 32 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design. **Measure not viable at this height and not implemented into design.**
		Minor Adverse	1	1	0						
		Negligible	0	0	0						
		Above LOAEL	0	0	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure reduces one dwelling (major to moderate) occurring below a SOAEL, but significant effects still remain. Measure does not change number of dwellings above a SOAEL		
		Major Adverse	1	0	-1						
		Moderate Adverse	0	1	1						
		Minor Adverse	1	1	0						
		Negligible	0	0	0						
		Above LOAEL	2	2	0						
		Above SOAEL	0	0	0						
Option 11 at 2m Height	2m Noise barrier adjacent to the LTC Southbound carriageway, on top of embankment south of Hornsby Lane. Extending 433m to footbridge FP79	Daytime				£2,634	£310,461	0.01	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL		Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 27 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL Height unacceptable for Landscape and Cultural Heritage constraints **Measure not viable at this height and not implemented into design**
		Major Adverse	1	1	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	1	1	0						
		Negligible	0	0	0						
		Above LOAEL	0	0	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure reduces one dwelling (major to moderate) occurring below a SOAEL, but significant effects still remain. Measure does not change number of dwellings above a SOAEL		
		Major Adverse	1	0	-1						
		Moderate Adverse	0	1	1						
		Minor Adverse	1	1	0						
		Negligible	0	0	0						
		Above LOAEL	2	2	0						
		Above SOAEL	0	0	0						
Option 11 at 3m Height	3m Noise barrier adjacent	Daytime				£3,740	£403,989	0.01	Daytime - Measure reduces one dwelling		Cost of mitigation measure exceeds monetised acoustic
		Major Adverse	1	0	-1						

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
	to the LTC Southbound carriageway, on top of embankment south of Hornsby Lane. Extending 433m to footbridge FP79	Moderate Adverse	0	1	1				(major to moderate) occurring below a SOAEL, but significant effects still remain. Measure does not change number of dwellings above a SOAEL		benefit by a factor of approximately 25 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL Height unacceptable for Landscape and Cultural Heritage constraints **Measure not viable at this height and not implemented into design**
		Minor Adverse	1	1	0						
		Negligible	0	0	0						
		Above LOAEL	0	0	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure reduces one dwelling (major to moderate) occurring below a SOAEL, but significant effects still remain. Measure does not change number of dwellings above a SOAEL		
		Major Adverse	1	0	-1						
		Moderate Adverse	0	1	1						
		Minor Adverse	1	1	0						
		Negligible	0	0	0						
		Above LOAEL	2	2	0						
		Above SOAEL	0	0	0						

Table 4.12 Barrier Option 12 Appraisal

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
Option 12 at 1m Height	1m Noise barrier adjacent to the LTC Northbound carriageway, north of Hornsby Lane on top of the retaining structure tying	Daytime				£2,109	£50,200	0.04	Daytime - Measure removes one significant effect occurring below a SOAEL. Measure does not change number of dwellings above the SOAEL.	Landscape: This fence would likely help screen the Project from the nearby residential property as this is a short section where the Project is in shallow cutting so would	Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 24 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design.
		Major Adverse	0	0	0						
		Moderate Adverse	2	1	-1						
		Minor Adverse	9	10	1						
		Negligible	55	55	0						
		Above LOAEL	49	49	0						
		Above SOAEL	0	0	0						
		Night-time									

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
	into earthworks features on either side. Extending 100m on the top of the retaining structure	Major Adverse	0	0	0				Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL	help screen car traffic. Up to 2m is acceptable. Cultural Heritage: No concerns	**Measure not viable at this height and not implemented into design.**
		Moderate Adverse	1	1	0						
		Minor Adverse	10	10	0						
		Negligible	55	55	0						
		Above LOAEL	46	46	0						
		Above SOAEL	20	20	0						
Option 12 at 2m Height	2m Noise barrier adjacent to the LTC Northbound carriageway, north of Hornsby Lane on top of the retaining structure tying into earthworks features on either side. Extending 100m on the top of the retaining structure	Daytime				£7,331	£71,700	0.10	Daytime - Measure removes one significant effect occurring below a SOAEL. Measure does not change number of dwellings above the SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 10 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL **Measure not viable at this height and not implemented into design**
		Major Adverse	0	0	0						
		Moderate Adverse	2	1	-1						
		Minor Adverse	9	10	1						
		Negligible	55	55	0						
		Above LOAEL	49	48	-1						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL		
		Major Adverse	0	0	0						
		Moderate Adverse	1	1	0						
		Minor Adverse	10	10	0						
		Negligible	55	55	0						
		Above LOAEL	46	46	0						
		Above SOAEL	20	20	0						
Option 12 at 3m Height	3m Noise barrier adjacent to the LTC Northbound carriageway, north of Hornsby Lane on top of the retaining structure tying into earthworks	Daytime				£8,991	£93,300	0.10	Daytime - Measure removes one significant effect occurring below a SOAEL. Measure does not change number of dwellings above the SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 10 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL
		Major Adverse	0	0	0						
		Moderate Adverse	2	1	-1						
		Minor Adverse	9	10	1						
		Negligible	55	55	0						
		Above LOAEL	49	48	-1						
		Above SOAEL	0	0	0						
		Night-time									
		Major Adverse	0	0	0						

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
	features on either side. Extending 100m on the top of the retaining structure	Moderate Adverse	1	1	0				Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL		Height unacceptable for Landscape and Cultural Heritage constraints **Measure not viable at this height and not implemented into design**
		Minor Adverse	10	10	0						
		Negligible	55	55	0						
		Above LOAEL	46	46	0						
		Above SOAEL	20	20	0						

Table 4.13 Barrier Option 13 Appraisal

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
Option 13 at 1m Height	1m Noise barrier adjacent to the LTC Northbound carriageway, south of A1013 Stamford Road overbridge. Extending 150m on the top of the cutting	Daytime				£1,548	£74,798	0.02	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.	Landscape: This fence would likely help screen the Project from the nearby residential properties and would be contained within proposed planting. Up to 2m is acceptable. Cultural Heritage: No concerns	Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 48 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design. **Measure not viable at this height and not implemented into design.**
		Major Adverse	0	0	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	2	1	-1						
		Above LOAEL	3	3	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	0	0	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	2	2	0						
		Above LOAEL	0	0	0						
		Above SOAEL	3	3	0						
Option 13 at 2m Height	2m Noise barrier adjacent to the LTC Northbound carriageway, south of A1013 Stamford Road overbridge. Extending 150m on the top of the cutting	Daytime				£5,423	£106,833	0.05	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit by a factor of approximately 20 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL **Measure not viable at this height and not implemented into design**
		Major Adverse	0	0	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	2	1	-1						
		Above LOAEL	3	3	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	0	0	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	2	1	-1						
		Above LOAEL	0	0	0						
		Above SOAEL	3	3	0						
Option 13 at 3m Height	3m Noise barrier	Daytime				£7,958	£139,017	0.06			Cost of mitigation measure exceeds
		Major Adverse	0	0	0						

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
	adjacent to the LTC Northbound carriageway, south of A1013 Stamford Road overbridge. Extending 150m on the top of the cutting	Moderate Adverse	0	0	0				Daytime - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		monetised acoustic benefit by a factor of approximately 18 times and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL Height unacceptable for Landscape and Cultural Heritage constraints **Measure not viable at this height and not implemented into design**
		Minor Adverse	0	0	0						
		Negligible	2	1	-1						
		Above LOAEL	3	3	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	0	0	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	2	1	-1						
		Above LOAEL	0	0	0						
		Above SOAEL	3	3	0						

Table 4.14 Barrier Option 14 Appraisal

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
Option 14 at 1m Height	1m Noise barrier adjacent to the southbound A13/LTC slip road, south of A1013 Stamford Road overbridge. Extending 215m on the top of the cutting	Daytime				£0	£107,930	0	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.	Landscape: The fenland landscape is open and rural here, so reducing the number of new urbanising elements would be beneficial. If definitely required, height of fence should be limited to 1m. Cultural Heritage:	Cost of mitigation measure exceeds monetised acoustic benefit and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL **Measure not viable at this height and not implemented into design.**
		Major Adverse	1	1	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	1	1	0						
		Negligible	0	0	0						
		Above LOAEL	0	0	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure does not change significant effects. Measure does not change number of		
		Major Adverse	1	1	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	1	1	0						

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
		Negligible	0	0	0				dwellings above the SOAEL.	Same comments as Landscape	
		Above LOAEL	2	2	0						
		Above SOAEL	0	0	0						
Option 14 at 2m Height	2m Noise barrier adjacent to the southbound A13/LTC slip road, south of A1013 Stamford Road overbridge. Extending 215m on the top of the cutting	Daytime				£241	£154,155	0	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL Height unacceptable for Landscape constraints **Measure not viable at this height and not implemented into design.**
		Major Adverse	1	1	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	1	1	0						
		Negligible	0	0	0						
		Above LOAEL	0	0	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	1	1	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	1	1	0						
		Negligible	0	0	0						
		Above LOAEL	2	2	0						
		Above SOAEL	0	0	0						
Option 14 at 3m Height	3m Noise barrier adjacent to the southbound A13/LTC slip road, south of A1013 Stamford Road overbridge. Extending 215m on the top of the cutting	Daytime				£1,3121	£200,595	0.01	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL Height unacceptable for Landscape constraints **Measure not viable at this height and not implemented into design.**
		Major Adverse	1	1	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	1	1	0						
		Negligible	0	0	0						
		Above LOAEL	0	0	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	1	1	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	1	1	0						
		Negligible	0	0	0						
		Above LOAEL	2	2	0						
		Above SOAEL	0	0	0						

Table 4.15 Barrier Option 15 Appraisal

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
Option 15 at 1m Height	1m Noise barrier adjacent to the LTC Southbound carriageway, extending north and south of Footpath FP136 overbridge tying into earthworks features on either side. Extending a total of 241m at carriageway edge	Daytime				£0	£120,480	0	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.	Landscape: This is within the flat fenland landscape. The Project is also at grade here so possibly help to screen some views of traffic from the north-east. At year 15, proposed planting would also largely screen the fence, apart from the eastern end. Cultural Heritage: Same comments as Landscape Water Commentary Potentially in the floodplain of the Mardyke	Cost of mitigation measure exceeds monetised acoustic benefit and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL **Measure not viable at this height and not implemented into design.**
		Major Adverse	0	0	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	9	9	0						
		Above LOAEL	0	0	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	0	0	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	9	9	0						
		Above LOAEL	9	9	0						
		Above SOAEL	0	0	0						
Option 15 at 2m Height	2m Noise barrier adjacent to the LTC Southbound carriageway, extending north and south of Footpath FP136 overbridge tying into earthworks features on either side. Extending a total of 241m at	Daytime				£0	£172,080	0	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL **Measure not viable at this height and not implemented into design.**
		Major Adverse	0	0	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	9	9	0						
		Above LOAEL	0	0	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	0	0	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	9	9	0						

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
	carriageway edge	Above LOAEL	9	9	0						
		Above SOAEL	0	0	0						
Option 15 at 3m Height	3m Noise barrier adjacent to the LTC Southbound carriageway, extending north and south of Footpath FP136 overbridge tying into earthworks features on either side. Extending a total of 241m at carriageway edge	Daytime				£0	£223,920	0	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL **Measure not viable at this height and not implemented into design.**
		Major Adverse	0	0	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	9	9	0						
		Above LOAEL	0	0	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	0	0	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	9	9	0						
		Above LOAEL	9	9	0						
		Above SOAEL	0	0	0						

Table 4.16 Barrier Option 16 Appraisal

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
Option 16 at 1m Height	1m Noise barrier adjacent to the LTC Southbound carriageway, south of the B186 North Road overbridge on top of a	Daytime				£97	£79,316	0	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.	Landscape Fence would be contained by existing and proposed vegetation at The Wilderness	Cost of mitigation measure exceeds monetised acoustic benefit and returns a very poor VfM. Option presents no material acoustic benefit over
		Major Adverse	3	3	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	0	0	0						

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
	retaining structure tying into earthworks features on either side. Extending a total of 159m at carriageway edge	Above LOAEL	0	0	0					as well as some proposed planting to the south of the Project. Would be visible from properties and WCH route to south until vegetation is established. Maximum height of 2m would be acceptable. Cultural Heritage: Same comments as Landscape Water Commentary Looks to cross/directly impact a watercourse	base case design when considered in relation to SOAEL **Measure not viable at this height and not implemented into design.**
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	3	3	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	0	0	0						
		Above LOAEL	3	3	0						
		Above SOAEL	0	0	0						
Option 16 at 2m Height	2m Noise barrier adjacent to the LTC Southbound carriageway, south of the B186 North Road overbridge on top of a retaining structure tying into earthworks features on either side. Extending a total of 159m at carriageway edge	Daytime				£97	£113,286	0	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit and returns a very poor VfM. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL **Measure not viable at this height and not implemented into design.**
		Major Adverse	3	3	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	0	0	0						
		Above LOAEL	0	0	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	3	3	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	0	0	0						
		Above LOAEL	0	0	0						
		Above SOAEL	0	0	0						
Option 16 at 3m Height	3m Noise barrier adjacent to the LTC Southbound carriageway, south of the B186 North Road overbridge on top of a retaining structure tying into earthworks	Daytime				£97	£147,414	0	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit and returns a very poor VfM. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL
		Major Adverse	3	3	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	0	0	0						
		Above LOAEL	0	0	0						
		Above SOAEL	0	0	0						

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
	features on either side. Extending a total of 159m at carriageway edge	Night-time							Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		Height unacceptable for Landscape constraints **Measure not viable at this height and not implemented into design.**
		Major Adverse	3	3	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	0	0	0						
		Above LOAEL	3	3	0						
		Above SOAEL	0	0	0						

Table 4.17 Barrier Option 17 Appraisal

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
Option 17 at 1m Height	1m Noise barrier adjacent to the LTC southbound carriageway, north of the B186 North Road overbridge on top of the embankment. Extending a total of 224m	Daytime				£1,520	£112,448	0.01	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.	Landscape: This fence would introduce a further urbanising feature into the rural landscape and the line of the Project route would be evident due to the fence in views from the nearby residential properties. A hedgerow would soften the fence by year 15 If definitely required height	Cost of mitigation measure exceeds monetised acoustic benefit and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL **Measure not viable at this height and not implemented into design.**
		Major Adverse	1	1	0						
		Moderate Adverse	2	2	0						
		Minor Adverse	2	2	0						
		Negligible	4	4	0						
		Above LOAEL	2	2	0						
		Above SOAEL	1	1	0						
		Night-time							Night-time - Measure does not change significant effects. Measure does not change number of dwellings above a SOAEL.		
		Major Adverse	1	1	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	4	4	0						
		Negligible	4	4	0						
		Above LOAEL	6	6	0						
		Above SOAEL	3	3	0						
		Daytime				£2,335	£160,608	0.01			

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
Option 17 at 2m Height	2m Noise barrier adjacent to the LTC southbound carriageway, north of the B186 North Road overbridge on top of the embankment. Extending a total of 224m	Major Adverse	1	1	0				Daytime - Measure removes one significant effect occurring below a SOAEL. Measure does not change number of dwellings above a SOAEL.	should be limited to 1m Cultural Heritage: Same comments as Landscape	Cost of mitigation measure exceeds monetised acoustic benefit and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL **Measure not viable at this height and not implemented into design.**
		Moderate Adverse	2	1	-1						
		Minor Adverse	2	3	1						
		Negligible	4	4	0						
		Above LOAEL	2	2	0						
		Above SOAEL	1	1	0						
		Night-time							Night-time - Measure reduces one dwelling (major to moderate) occurring below a SOAEL, but significant effects still remain. Measure does not change number of dwellings above a SOAEL		
		Major Adverse	1	0	-1						
		Moderate Adverse	0	1	1						
		Minor Adverse	4	4	0						
		Negligible	4	4	0						
		Above LOAEL	6	6	0						
		Above SOAEL	3	3	0						
Option 17 at 3m Height	3m Noise barrier adjacent to the LTC southbound carriageway, north of the B186 North Road overbridge on top of the embankment. Extending a total of 224m	Daytime				£4,012	£208,992	0.02	Daytime - Measure removes two significant effects occurring below a SOAEL. Measure does not change number of dwellings above a SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL Height unacceptable for Landscape constraints **Measure not viable at this height and not implemented into design.**
		Major Adverse	1	1	0						
		Moderate Adverse	2	0	-2						
		Minor Adverse	2	4	2						
		Negligible	4	4	0						
		Above LOAEL	2	2	0						
		Above SOAEL	1	1	0						
		Night-time							Night-time - Measure reduces one dwelling (major to moderate) occurring below a SOAEL, but significant effects still remain. Measure does not change number of dwellings above a SOAEL		
		Major Adverse	1	0	-1						
		Moderate Adverse	0	1	1						
		Minor Adverse	4	4	0						
		Negligible	4	4	0						
		Above LOAEL	6	6	0						
		Above SOAEL	3	3	0						

Table 4.18 Barrier Option 18 Appraisal

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
Option 18 at 1m Height	1m Noise barrier adjacent to the LTC southbound carriageway, north of the B186 North Road overbridge on top of the embankment. Extending a total of 120m	Daytime				£0	£60,240	0	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.	Landscape: Similar as for option 17, although less apparent to properties to the north due to angle of views and North Road green bridge earthworks. If definitely required height should be limited to 1m Cultural Heritage: Same comments as Landscape	Cost of mitigation measure exceeds monetised acoustic benefit and returns a very poor VfM. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL **Measure not viable at this height and not implemented into design.**
		Major Adverse	0	0	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	1	1	0						
		Above LOAEL	1	1	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	0	0	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	1	1	0						
		Above LOAEL	0	0	0						
		Above SOAEL	1	1	0						
Option 18 at 2m Height	2m Noise barrier adjacent to the LTC southbound carriageway, north of the B186 North Road overbridge on top of the embankment. Extending a total of 120m	Daytime				£0	£86,040	0	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit and returns a very poor VfM. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL Height unacceptable for Landscape constraints **Measure not viable at this height and not implemented into design.**
		Major Adverse	0	0	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	1	1	0						
		Above LOAEL	1	1	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	0	0	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	1	1	0						
		Above LOAEL	0	0	0						
		Above SOAEL	1	1	0						
Option 18 at 3m Height	3m Noise barrier adjacent to the LTC southbound	Daytime				£0	£111,960	0	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit and returns a very poor VfM. Option
		Major Adverse	0	0	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
	carriageway, north of the B186 North Road overbridge on top of the embankment. Extending a total of 120m	Negligible	1	1	0						presents no material acoustic benefit over base case design when considered in relation to SOAEL Height unacceptable for Landscape constraints **Measure not viable at this height and not implemented into design.**
		Above LOAEL	1	1	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	0	0	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	0	0	0						
		Negligible	1	1	0						
		Above LOAEL	0	0	0						
		Above SOAEL	1	1	0						

Table 4.19 Barrier Option 19 Appraisal

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
Option 19 at 1m Height	1m Noise barrier adjacent to the LTC northbound carriageway, south of the B186 North Road overbridge on top of the embankment. Extending a total of 233m	Daytime				£11,549	£116,966	0.01	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.	Landscape: Fence would be visible from properties to the south until contained by proposed vegetation. Unlikely to form a dominant element in views due to distance of receptors. Advise max 2m height Cultural Heritage:	Cost of mitigation measure exceeds monetised acoustic benefit and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL **Measure not viable at this height and not implemented into design.**
		Major Adverse	0	0	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	78	75	-3						
		Negligible	134	137	3						
		Above LOAEL	9	9	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	0	0	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	67	64	-3						
		Negligible	145	148	3						
		Above LOAEL	207	207	0						
		Above SOAEL	5	5	0						
Option 19 at 2m Height	2m Noise barrier	Daytime				£19,610	£167,061	0.12	Daytime - Measure does not change significant effects.		Cost of mitigation measure exceeds
		Major Adverse	0	0	0						

Barrier Option	Further Mitigation Option description	Noise impact and benefit				TAG Value	Mitigation Cost	Indicative VfM	Acoustic Summary	Eng. / Env issues	Justification
		Change in Impacts									
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
	adjacent to the LTC northbound carriageway, south of the B186 North Road overbridge on top of the embankment. Extending a total of 233m	Moderate Adverse	0	0	0				Measure does not change number of dwellings above the SOAEL.	Same comments as Landscape Water: looks to cross/directly impact a watercourse	monetised acoustic benefit and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL **Measure not viable at this height and not implemented into design.**
		Minor Adverse	78	70	-8						
		Negligible	134	142	8						
		Above LOAEL	9	9	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	0	0	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	67	60	-7						
		Negligible	145	152	7						
		Above LOAEL	207	207	0						
		Above SOAEL	5	5	0						
Option 19 at 3m Height	3m Noise barrier adjacent to the LTC northbound carriageway, south of the B186 North Road overbridge on top of the embankment. Extending a total of 233m	Daytime				£24,907	£217,389	0.11	Daytime - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		Cost of mitigation measure exceeds monetised acoustic benefit and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered in relation to SOAEL Height unacceptable for Landscape constraints **Measure not viable at this height and not implemented into design.**
		Major Adverse	0	0	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	78	66	-12						
		Negligible	134	146	12						
		Above LOAEL	9	9	0						
		Above SOAEL	0	0	0						
		Night-time							Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the SOAEL.		
		Major Adverse	0	0	0						
		Moderate Adverse	0	0	0						
		Minor Adverse	67	54	-13						
		Negligible	145	158	13						
		Above LOAEL	207	207	0						
		Above SOAEL	5	5	0						

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Annexes

Annex A Pavement Surface Costs

A.1 General

A.1.1 The pavement surface cost has been calculated over a 60-year period from the opening year of the Project, appropriate discount rates taken from the HM Treasury Green Book.

-3.5dB RSI surfacing

a. Binder CAPEX is assumed as £9/m^2

b. Surface course is assumed as £6/m^2

c. Surface course interventions are assumed at years 0, 12, 24, 36, and 48

d. Binder course interventions are assumed at years 0 and 36

-5dB RSI surfacing

a. No additional interventions of either surface or binder course are required for -5dB RSI surfacing relative to -3.5dB RSI surfacing over a 60-year life.

b. Binder CAPEX is assumed as £9.50/m2

c. Surface course is assumed as being 5% more expensive than -3.5dB RSI surfacing. With a -3.5dB RSI surfacing value of £6, this means an -5dB RSI surfacing value of £6.30.

d. Surface course interventions are assumed at years 0, 12, 24, 36, and 48

e. Binder course interventions are assumed at years 0 and 36

-7.5dB RSI surfacing

a. It is assumed that one additional intervention to lay surface course will be required over a 60year life relative to -3.5dB RSI surfacing.

b. Surface course is assumed as £6/m2

c. Binder CAPEX is assumed as £10/m2

d. Surface course interventions are assumed at years 0, 10, 20, 30, 40, and 50

e. Binder course interventions are assumed at years 0, and 30

A.2 Summary

A.2.1 Base cost assumptions, for one square metre of surface are as follows:

a. -3.5dB RSI surfacing: £31.57

b. -5dB RSI surfacing: £32.99

c. -7.5dB RSI surfacing: £36.84

Annex B Acoustic Barrier Costs

B.1 Introduction

B.1.1 Barrier costs have been estimated using the methodology outlined in Defra report 'NANR 201 – Environmental Noise Valuation – The Costs and Benefits of Remediation Measures' (NANR 201)

B.2 Methodology

Base Barrier Cost

B.2.1 The initial specific cost for an Environmental/Noise barrier has been provided by the Project estimating team based on a 2m barrier as presented in Table B.1.

Table B.1 Base Barrier Cost

Description	Cost per Metre
Fencing - Environmental Barriers (Absorptive and Reflective) - Environmental / Noise barriers; All Types - including foundations - 2.0m high	£258.64

B.2.2 The cost of acoustic barriers at different heights has been based upon the guidance contained within Defra report NANR 201 which states '...*on the basis of data obtained from other projects, it would be reasonable to allow a reduction in barrier cost of 15% per half metre reduction from 3m, and an increase in barrier cost of 25% per half metre increase above 3m…'*

B.2.3 The initial barrier cost per metre calculated using this guidance for different barrier heights is presented in Table B.2

Table B.2 Base Barrier Cost per Metre

Barrier Height (metres)	Cost per Metre
1	£181.05
2 (Initial Barrier Cost)	£258.64
3	£336.23
4	£465.55
5	£594.87
6	£724.19

Installation Cost

Table B.3 Barrier Installation Cost per Metre

Item and Percentage of Base Cost Assumption	Barrier Height (metres)					
	1	2	3	4	5	6
Base Cost	£181.05	£258.64	£336.23	£465.55	£594.87	£724.19
Highway Authority Approvals 10%	£18.10	£25.86	£33.62	£46.56	£59.49	£72.42
Design/Consultancy/Professional fees 12%	£21.73	£31.04	£40.35	£55.87	£71.38	£86.90
Traffic Management Costs 0%	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
Protection (safety barriers) 10%	£18.10	£25.86	£33.62	£46.56	£59.49	£72.42
Risk/contingency 10%	£18.10	£25.86	£33.62	£46.56	£59.49	£72.42
Total Barrier Cost	£257.09	£367.27	£477.45	£661.08	£844.72	£1,028.35

Maintenance Cost

Table B.4 Barrier Maintenance Cost per Metre

Item and Percentage of Base Cost Assumption	Barrier Height (metres)					
	1	2	3	4	5	6
Base Cost	£181.05	£258.64	£336.23	£465.55	£594.87	£724.19
Highway Authority Approvals 0%	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
Design/Consultancy/Professional fees 5%	£9.05	£12.93	£16.81	£23.28	£29.74	£36.21
Traffic Management Costs 10%	£18.10	£25.86	£33.62	£46.56	£59.49	£72.42
Protection (safety barriers) 0%	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
Risk/contingency 10%	£18.10	£25.86	£33.62	£46.56	£59.49	£72.42
Total Maintenance Cost	£45.26	£64.66	£84.06	£116.39	£148.72	£181.05

Replacement Cost

Table B.5 Barrier Replacement Cost per Metre

Item and Percentage of Base Cost Assumption	Barrier Height (metres)					
	1	2	3	4	5	6
Base Cost	£181.05	£258.64	£336.23	£465.55	£594.87	£724.19
Highway Authority Approvals 0%	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
Design/Consultancy/Professional fees 5%	£9.05	£12.93	£16.81	£23.28	£29.74	£36.21
Traffic Management Costs 20%	£36.21	£51.73	£67.25	£93.11	£118.97	£144.84

Item and Percentage of Base Cost Assumption	Barrier Height (metres)					
	1	2	3	4	5	6
Protection (safety barriers) 0%	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
Risk/contingency 10%	£18.10	£25.86	£33.62	£46.56	£59.49	£72.42
Total replacement Cost	£244.41	£349.16	£453.91	£628.50	£803.08	£977.66

Year Life Cost

Table B.6 60 Year Life Costs of Barrier per Metre

Year	Activity	Barrier Height (metres)					
		1	2	3	4	5	6
0	New Barrier	£257.09	£367.27	£477.45	£661.08	£844.72	£1,028.35
10	Maintenance	£45.26	£64.66	£84.06	£116.39	£148.72	£181.05
20	Replacement	£244.41	£349.16	£453.91	£628.50	£803.08	£977.66
30	Maintenance	£45.26	£64.66	£84.06	£116.39	£148.72	£181.05
40	Replacement	£244.41	£349.16	£453.91	£628.50	£803.08	£977.66
50	Maintenance	£45.26	£64.66	£84.06	£116.39	£148.72	£181.05

Table B.7 Discounted 60 Year Life Costs of Barrier per Metre

Year	Activity	Discount Rates	Barrier Height (metres)					
			1	2	3	4	5	6
0	New Barrier	1.0000	£257.09	£367.27	£477.45	£661.08	£844.72	1028.35264
10	Maintenance	0.7089	£32.09	£45.84	£59.59	£82.51	£105.43	128.3485482
20	Replacement	0.5026	£122.84	£175.48	£228.12	£315.86	£403.60	491.3421841
30	Maintenance	0.3563	£16.13	£23.04	£29.95	£41.47	£52.99	64.50378144
40	Replacement	0.2651	£64.79	£92.56	£120.33	£166.61	£212.90	259.1774539
50	Maintenance	0.1973	£8.93	£12.75	£16.58	£22.96	£29.34	35.71352848
60 Year whole Life cost			£501.86	£716.94	£932.02	£1,290.50	£1,648.97	£2,007.44
60 Year whole Life cost (Rounded up)			£502.00	£717.00	£933.00	£1,291.00	£1,649.00	£2,008.00

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