

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:
 - 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

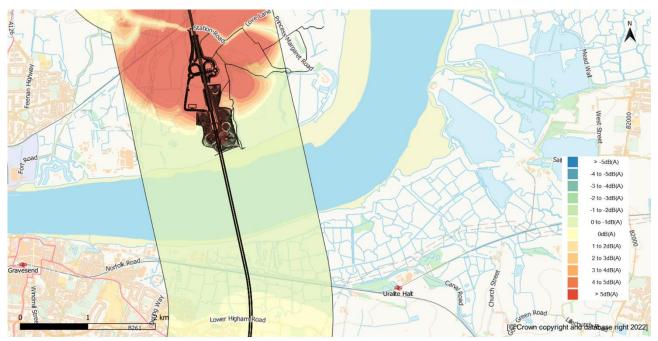


Plate 3.3 Road traffic noise change with -3.5 RSI pavement surface - South of A13

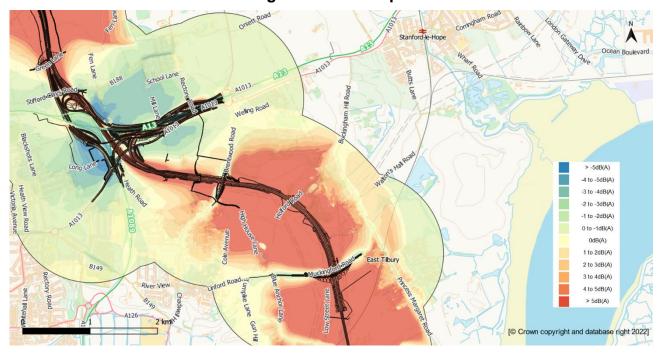


Plate 3.4 Road traffic noise change with -3.5 RSI pavement surface – North of A13 and M25



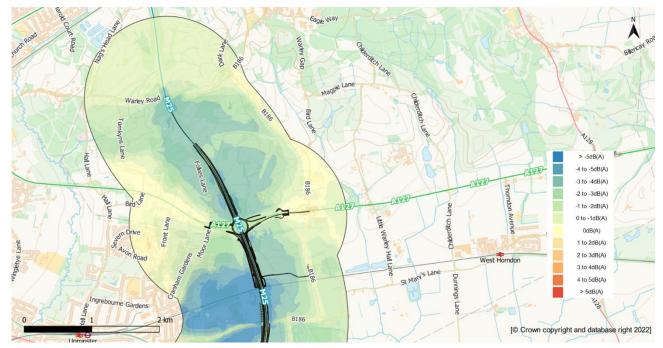


Plate 3.5 Road traffic noise change with -3.5 RSI pavement surface – Along M25

- 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
 - 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 lev	el	Daytime	Night-time		
		Number of dwellings	Number of dwellings		
Increase in noise	<1.0	1,639	1,644		
level, L _{A10, 18hr} /L _{night}	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	<1.0	3,819	4,282		
level, L _{A10, 18hr} /L _{night}	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 lev	el	Daytime	Night-time		
		Number of dwellings	Number of dwellings		
Increase in noise	<1.0	1,672	1,691		
level, L _{A10, 18hr} /L _{night}	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 lev	el	Daytime	Night-time		
		Number of dwellings	Number of dwellings		
Decrease in noise	<1.0	3,870	4,332		
level, L _{A10, 18hr} /L _{night}	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 lev	el	Daytime	Night-time		
		Number of dwellings	Number of dwellings		
Increase in noise	<1.0	1,658	1,665		
level, L _{A10, 18hr} /L _{night}	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	<1.0	3,903	4,364		
level, L _{A10, 18hr} /L _{night}	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 v3.5 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 adverse reducti	•	+464	+930		

Table 3.5 Night-time Appraisal

Change in noise level	Number of Dwellings with -3.5 RSI	wellings Dwellings with -5		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		10,213	10,264	60 more	111 more				
Total Net Gain (Sum of all beneficial gains, no change and +462 +928 adverse reductions)									

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	В	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

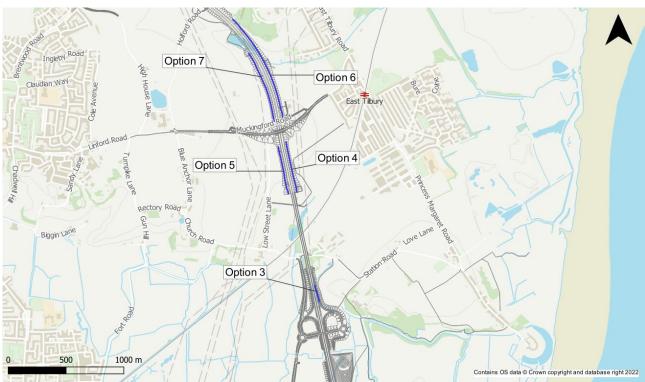
- 4.1.1 The Project has been designed to use earthworks to keep the road low in the surrounding landscape. This is the primary way the Project has sought to control environmental impacts from noise. The secondary measure of the implementation of a pavement surface with an RSI of 7.5dB (specified and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

Option 1

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Plate 4.1 Barrier Options 1 and 2 Locations





Option 14

Option 14

Option 15

Option 15

Option 15

Option 15

Option 15

Option 16

Option 16

Option 17

Option 18

Option 18

Option 18

Option 18

Option 19

Option 10

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



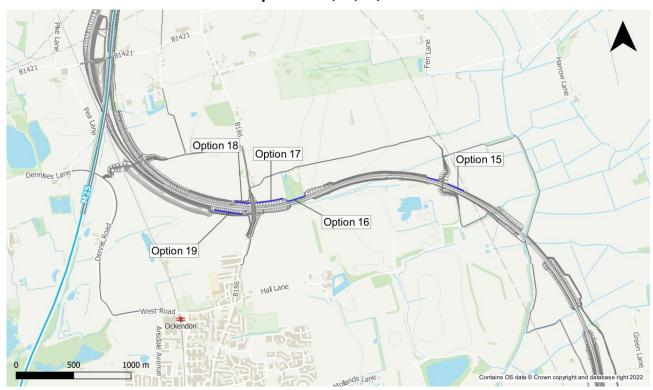


Table 4.1 Barrier Option 1 Appraisal

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

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

Table 4.2 Barrier Option 2 Appraisal

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

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

Table 4.3 Barrier Option 3 Appraisal

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

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

Table 4.4 Barrier Option 4 Appraisal

Barrier Option	Further	Noise impact a	nd benefit			TAG Value	Mitigation	Indicative	Acoustic	Eng. / Env issues	Justification
	Mitigation Option description	Change in Impa	acts				Cost	VfM	Summary		
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
Option 4 at 1m	1m Noise	Daytime	_			£20,580	£221,382	0.09	Daytime - Measure removes	Landscape:	Cost of mitigation measure
Height	barrier	Major Adverse	13	9	-4				three significant effect	Fence would	exceeds monetised acoustic
	adjacent to the LTC Southbound	Moderate Adverse	36	37	1	-			occurring below a SOAEL. Measure does not change	introduce a further urbanising feature into	benefit by a factor of approximately 11 times and returns an indicative VfM of
	carriageway,	Minor Adverse	39	36	-3				number of dwellings above a SOAEL.	the open landscape. A 4m high false cutting	less than 1.
	immediately	Negligible	378	384	6				007.122	screens most traffic	Option presents no material
	north of	Above LOAEL	20	20	0					and highway	acoustic benefit over base
	Tilbury Viaduct to	Above SOAEL	0	0	0					infrastructure in this location therefore	case design when considered in relation to
	Muckingford	Night-time	•						Night-time - Measure reduces	limited vegetation	SOAEL
	Road	Major Adverse	1	1	0				six dwellings (major to	proposed to maintain	Height unacceptable for
	overbridge. Extending 441m on the	Moderate Adverse	40	34	-6				moderate) occurring below a SOAEL, but significant effects still remain.	open landscape (with no/minimal screening	Cultural Heritage constraints
		Minor Adverse	42	41	-1					for fence).	

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

Table 4.5 Barrier Option 5 Appraisal

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

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

Table 4.6 Barrier Option 6 Appraisal

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

Barrier Option	Further	Noi	ise impact an	nd benefit		TAG Value	Mitigation	Indicative	Acoustic	Eng. / Env issues	Justification
	Mitigation Option description		Change in In	npacts			Cost	VfM	Summary		
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
	Road	Above SOAEL	0	0	0					the east, so would be considered a potentially	Measure not viable at this height and not implemented into
	overbridge. Extending		Night-tim	ne					Night-time - Measure removes seven significant	prominent feature;	design.
	984m on the top of the	Major Adverse	0	0	0				effects occurring below a	however, could be mitigated if limited to 1m.	
	embankment.	Moderate Adverse	8	1	-7				SOAEL. Measure does not change number of dwellings above	Northern end of fence near existing watercourse would be more contained	
		Minor Adverse	100	86	-14				the SOAEL.	by existing and proposed	
		Negligible	242	263	21					vegetation Water Commentary	
		Above LOAEL	349	349	0					looks to cross the Gobions Sewer water course	
		Above SOAEL	0	0	0						
			Daytime	е					Daytime - Measure removes 15 significant effects		Cost of mitigation measure exceeds monetised acoustic
		Major Adverse	1	0	-1				occurring below a SOAEL. Measure does not change		benefit by a factor of approximately 7 times and returns an indicative
	2m Noise barrier	Moderate Adverse	15	1	-14				number of dwellings above the SOAEL.		VfM of less than 1.
	adjacent to the	Minor Adverse	115	76	-39						Option presents no material acoustic benefit over base case
	LTC Southbound	Negligible	219	273	54						design when considered in relation to SOAEL
	carriageway,	Above LOAEL	5	3	-2						Height unacceptable for
Option 6 at 2m	immediately north of	Above SOAEL	1	1	0	£101,888	£705,528	0.14			Landscape constraints Measure not viable at this height
Height	Muckingford		Night-tim	ne	T	2101,000	2700,020	0.11	Night-time - Measure removes seven significant		and not implemented into design.
	Road overbridge.	Major Adverse	0	0	0				effects occurring below a SOAEL.		ucsign.
	Extending 984m on the	Moderate Adverse	8	1	-7				Measure does not change number of dwellings above		
	top of the embankment.	Minor Adverse	100	59	-41				the SOAEL.		
	ornbarmariona.	Negligible	242	290	48						
		Above LOAEL	349	349	0						
		Above SOAEL	0	0	0						
	3m Noise		Daytime	е	ı				Daytime - Measure removes 16 significant effects		Cost of mitigation measure exceeds monetised acoustic
Option 6 at 3m	barrier adjacent to the	Major Adverse	1	0	-1				occurring below a SOAEL.		benefit by a factor of approximately
Height	LTC Southbound	Moderate Adverse	15	0	-15	£126,743	£918,072	0.14	Measure does not change number of dwellings above the SOAEL.		7 times and returns an indicative VfM of less than 1. Option presents no material
	carriageway,	Minor Adverse	109	53	-56						acoustic benefit over base case

Barrier Option	Further Mitigation		se impact an			TAG Value	Mitigation Cost	Indicative VfM	Acoustic	Eng. / Env issues	Justification
	Option description		Change in Im	npacts			0031	VIIVI	Summary		
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
	immediately	Negligible	194	266	72						design when considered in relation to SOAEL
	north of Muckingford	Above LOAEL	5	3	-2						Height unacceptable for
	Road overbridge.	Above SOAEL	1	1	0						Landscape constraints Measure not viable at this height
	Extending		Night-tim	ne					Night-time - Measure removes eight significant		and not implemented into design.
	98m on the	Major Adverse	0	0	0				effects occurring below a		design.
	top of the embankment.	Moderate Adverse	8	0	-8				SOAEL. Measure does not change number of dwellings above		
		Minor Adverse	100	38	-62				the SOAEL.		
		Negligible	242	312	70						
		Above LOAEL	349	349	0						
		Above SOAEL	0	0	0						

Table 4.7 Barrier Option 7 Appraisal

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

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

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

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

Table 4.9 Barrier Option 9 Appraisal

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

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

Table 4.10 Barrier Option 10 Appraisal

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

Barrier	Further	Noise impact a	nd benefit			TAG Value	Mitigation	Indicative	Acoustic	Eng. / Env issues	Justification
Option	Mitigation Option description	Change in Impa	acts				Cost	VfM	Summary		
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)	-					
		Negligible	61	79	18				Measure does not change number of		
		Above LOAEL	201	201	0	_			dwellings above the		
		Above SOAEL	6	6	0	_			SOAEL.		
Option 10 at	3m Noise	Daytime		1		£74,620	£302,292	0.25	Daytime - Measure	-	Cost of mitigation measure
9	barrier adjacent to	Major Adverse	4	2	-2				removes six significant effect		exceeds monetised acoustic benefit by a factor of
	the LTC Northbound	Moderate Adverse	8	4	-4				occurring below a SOAEL. Measure does not change number of dwellings above the		approximately 4 times and returns an indicative VfM of
	carriageway, north of	Minor Adverse	154	128	-26						less than 1. Option presents no material acoustic benefit over
	Brentwood	Negligible	41	73	32						base case design when considered in relation to SOAEL
	Road overbridge.	Above LOAEL	14	14	0				SOAEL.		Height unacceptable for
	Extending	Above SOAEL	2	2	0						Landscape and Cultural Heritage constraints
	324m on the top of the	Night-time	•		·				Night-time - Measure		Measure not viable at this
	embankment	Major Adverse	3	2	-1				removes one significant effect		height and not implemented into design
		Moderate Adverse	4	4	0				occurring below a SOAEL.		implemented into design
		Minor Adverse	139	112	-27				Measure does not		
		Negligible	61	89	28	7			change number of dwellings above the SOAEL.		
		Above LOAEL	201	201	0						
İ		Above SOAEL	6	6	0	1					

Table 4.11 Barrier Option 11 Appraisal

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

Barrier	Further	Noise impact a	nd benefit			TAG Value		t Indicative VfM	e Acoustic Summary	Eng. / Env issues	Justification
Option	Mitigation Option description	Change in Imp	acts								
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)	-					
	to the LTC Southbound	Moderate Adverse	0	0	0				Daytime - Measure does not change	Would be visible from WCH route	benefit by a factor of approximately 32 times and
	carriageway, on top of	Minor Adverse	1	1	0				significant effects.	and residential properties to south. Fence would potentially provide screening of tops of high-sided	returns an indicative VfM of less than 1. Option presents
	embankment	Negligible	0	0	0				Measure does not change number of		no material acoustic benefit
	south of	Above LOAEL	0	0	0	1			dwellings above the		over base case design.
	Hornsby Lane. Extending	Above SOAEL	0	0	0	1			SOAEL		Measure not viable at this height and not
	433m to	Night-time	-1	1		1			Night-time - Measure	vehicles, however	implemented into design.
	footbridge FP79	Major Adverse	1	0	-1	1			reduces one dwelling	it would also introduce a further	
		Moderate Adverse	0	1	1				(major to moderate) occurring below a SOAEL, but significant effects still remain.	urbanising feature into the open	
		Minor Adverse	1	1	0	1				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	
		Negligible	0	0	0	7			Measure does not		
		Above LOAEL	2	2	0	1			change number of dwellings above a SOAEL Daytime - Measure does not change significant effects. Measure does not change number of		
	otion 11 at 2m Noise	Above SOAEL	0	0	0						
Option 11 at		Daytime		<u> </u>		£2,634	£310,461	0.01			Cost of mitigation measure
2m Height	barrier adjacent	Major Adverse	1	1	0		2010,101				exceeds monetised acoustic
	to the LTC Southbound carriageway, on	Moderate Adverse	0	0	0						benefit by a factor of approximately 27 times and returns an indicative VfM of
	top of	Minor Adverse	1	1	0	1			dwellings above the		less than 1. Option presents
	embankment south of	Negligible	0	0	0	1			SOAEL		no material acoustic benefit over base case design when
	Hornsby Lane.	Above LOAEL	0	0	0	7					considered in relation to
	Extending 433m to	Above SOAEL	0	0	0	7					SOAEL Height unacceptable for
	footbridge FP79	Night-time		•	•]			Night-time - Measure		Landscape and Cultural
		Major Adverse	1	0	-1				reduces one dwelling (major to moderate)		Heritage constraints
		Moderate Adverse	0	1	1				occurring below a SOAEL, but		Measure not viable at this height and not implemented into design
		Minor Adverse	1	1	0]			significant effects still		implemented into design
		Negligible	0	0	0				remain. Measure does not		
		Above LOAEL	2	2	0				change number of		
		Above SOAEL	0	0	0				dwellings above a SOAEL		
Option 11 at	3m Noise	Daytime	• 	·		£3,740	£403,989	0.01	Daytime - Measure		Cost of mitigation measure
3m Height	barrier adjacent	Major Adverse	1	0	-1		<u> </u>		reduces one dwelling		exceeds monetised acoustic

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

Table 4.12 Barrier Option 12 Appraisal

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

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

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

Table 4.13 Barrier Option 13 Appraisal

	urther	Noise impact a	nd benefit			TAG Value	Mitigation	Indicative VfM	Acoustic	Eng. / Env	Justification
. 0	Mitigation Option description	Change in Imp	acts				Cost		Summary	issues	
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
•	Im Noise	Daytime				£1,548	£74,798	0.02	Daytime - Measure	Landscape:	Cost of mitigation
•	parrier adjacent to	Major Adverse	0	0	0				does not change significant effects.	This fence would	measure exceeds monetised acoustic
tl	he LTC Northbound	Moderate Adverse	0	0	0				Measure does not change number of	likely help screen the Project from the nearby	benefit by a factor of approximately 48 times
	carriageway,	Minor Adverse	0	0	0				dwellings above the	residential	and returns an indicative
	south of A1013	Negligible	2	1	-1				SOAEL.	properties and would be	VfM of less than 1. Option presents no
	Stamford	Above LOAEL	3	3	0					contained within	material acoustic benefit
	Road	Above SOAEL	0	0	0					proposed	over base case design.
	overbridge. Extending	Night-time			•				Night-time - Measure	planting.	Measure not viable at
	150m on the	Major Adverse	0	0	0				does not change	Up to 2m is acceptable.	this height and not implemented into
	cutting ,	Moderate Adverse	0	0	0				significant effects. Measure does not change number of	Cultural Heritage: No concerns	design.
		Minor Adverse	0	0	0				dwellings above the		
		Negligible	2	2	0				SOAEL.		
		Above LOAEL	0	0	0	05.400	£106,833				
		Above SOAEL	3	3	0						
•	2m Noise	Daytime				£5,423		0.05	Daytime - Measure		Cost of mitigation
	parrier adjacent to	Major Adverse	0	0	0				does not change significant effects.		measure exceeds monetised acoustic
tl	he LTC Northbound	Moderate Adverse	0	0	0				Measure does not change number of		benefit by a factor of approximately 20 times
	carriageway,	Minor Adverse	0	0	0				dwellings above the		and returns an indicative
	south of A1013	Negligible	2	1	-1				SOAEL.		VfM of less than 1. Option presents no
	Stamford	Above LOAEL	3	3	0						material acoustic benefit
	Road	Above SOAEL	0	0	0						over base case design
	overbridge. Extending	Night-time							Night-time - Measure		when considered in relation to SOAEL
	150m on the	Major Adverse	0	0	0				does not change significant effects.		Measure not viable at
	op of the cutting	Moderate Adverse	0	0	0				Measure does not change number of		this height and not implemented into
		Minor Adverse	0	0	0				dwellings above the		design
		Negligible	2	1	-1				SOAEL.		
		Above LOAEL	0	0	0						
		Above SOAEL	3	3	0						
•	Bm Noise	Daytime				£7,958	£139,017	0.06			Cost of mitigation
3m Height b	oarrier	Major Adverse	0	0	0						measure exceeds

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

Table 4.14 Barrier Option 14 Appraisal

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

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

Table 4.15 Barrier Option 15 Appraisal

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

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

Table 4.16 Barrier Option 16 Appraisal

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

Barrier	Further Mitigation	Noise impact a	nd benefit			TAG Value	Mitigation Cost	Indicative VfM	Acoustic	Eng. / Env	Justification
Option	Option description	Change in Impa	acts						Summary	issues	
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
	retaining structure	Above LOAEL	0	0	0					as well as some	base case design when
	tying into earthworks	Above SOAEL	0	0	0	_				proposed planting to the	considered in relation to SOAEL
	features on either	Night-time				_			Night-time - Measure	south of the	Measure not viable at
	side. Extending a total of 159m at	Major Adverse	3	3	0				does not change significant effects.	Project.	this height and not
	carriageway edge	Moderate Adverse	0	0	0				Measure does not change number of	from properties and WCH route	implemented into design.
		Minor Adverse	0	0	0	_			dwellings above the	to south until	
		Negligible	0	0	0				SOAEL.	vegetation is established.	
		Above LOAEL	3	3	0					Maximum height	
		Above SOAEL	0	0	0					of 2m would be	
Option 16 at 2m	2m Noise barrier	Daytime			T	£97	£113,286	0	I	acceptable.	Cost of mitigation
Height	adjacent to the LTC Southbound	Major Adverse	3	3	0	_			significant effects.	Cultural Heritage:	measure exceeds monetised acoustic
	carriageway, south of the B186 North	Moderate Adverse	0	0	0				Measure does not change number of	Same comments as Landscape	benefit and returns a very poor VfM. Option
	Road overbridge	Minor Adverse	0	0	0	_			dwellings above the	Water	presents no material
	on top of a retaining structure	Negligible	0	0	0				SOAEL.	Commentary	acoustic benefit over base case design when
	tying into	Above LOAEL	0	0	0					Looks to cross/directly	considered in relation to
	earthworks features on either	Above SOAEL	0	0	0					impact a	SOAEL
	side. Extending a	Night-time	1	T					Night-time - Measure	watercourse	Measure not viable at this height and not
	total of 159m at	Major Adverse	3	3	0				does not change significant effects.		implemented into
	carriageway edge	Moderate Adverse	0	0	0				Measure does not change number of		design.
		Minor Adverse	0	0	0	_			dwellings above the		
		Negligible	0	0	0				SOAEL.		
		Above LOAEL	3	3	0						
		Above SOAEL	0	0	0						
Option 16	3m Noise barrier	Daytime	T	Г	T	£97	£147,414	0	Daytime - Measure		Cost of mitigation
at 3m Height	adjacent to the LTC Southbound	Major Adverse	3	3	0	_			does not change significant effects.		measure exceeds monetised acoustic
	carriageway, south of the B186 North	Moderate Adverse	0	0	0				Measure does not change number of		benefit and returns a very poor VfM. Option
	Road overbridge	Minor Adverse	0	0	0				dwellings above the		presents no material
	on top of a retaining structure	Negligible	0	0	0				SOAEL.		acoustic benefit over base case design when
	tying into	Above LOAEL	0	0	0						considered in relation to
	earthworks	Above SOAEL	0	0	0						SOAEL

Barrier	Further Mitigation	Noise impact a	nd benefit			TAG Value	Mitigation Cost	Indicative VfM	Acoustic	Eng. / Env	Justification
Option	Option description	Change in Impacts							Summary	issues	
	footures on either	Impact	Mitigation	Barrier Option Design	Change ("-" indicates benefit)						
		Night-time							Night-time - Measure		Height unacceptable for
	side. Extending a total of 159m at carriageway edge	Major Adverse	3	3	0				does not change		Landscape constraints Measure not viable at
		Moderate Adverse	0	0	0				significant effects. Measure does not change number of		this height and not implemented into
		Minor Adverse	0	0	0				dwellings above the		design.
		Negligible	0	0	0	<u></u>			SOAEL.		
		Above LOAEL	3	3	0						
		Above SOAEL	0	0	0]					

Table 4.17 Barrier Option 17 Appraisal

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

Barrier Option	Further	Noise impact and benefit			TAG	Mitigation	Indicative VfM	Acoustic	Eng. / Env	Justification	
	Mitigation Option description	Change in Imp	acts			Value	Cost		Summary	issues	
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
Option 17 at	2m Noise	Major Adverse	1	1	0				Daytime - Measure	should be	Cost of mitigation
2m Height	barrier adjacent to the LTC	Moderate Adverse	2	1	-1				removes one significant effect occurring below a	limited to 1m Cultural Heritage:	measure exceeds monetised acoustic benefit and returns an
	southbound	Minor Adverse	2	3	1				SOAEL.	Same comments as	indicative VfM of less
	carriageway, north of the	Negligible	4	4	0				Measure does not		than 1. Option presents no material acoustic
	B186 North	Above LOAEL	2	2	0				change number of dwellings above a	Landscape	benefit over base case
	Road overbridge on	Above SOAEL	1	1	0				SOAEL.		design when considered
	top of the embankment. Extending a total of 224m	Night-time							Night-time - Measure		in relation to SOAEL Measure not viable at
		Major Adverse	1	0	-1				reduces one dwelling (major to moderate)		this height and not
		Moderate Adverse	0	1	1				occurring below a SOAEL, but		implemented into design.
		Minor Adverse	4	4	0				significant effects still remain.		
		Negligible	4	4	0	_			Measure does not		
		Above LOAEL	6	6	0				change number of		
		Above SOAEL	3	3	0				dwellings above a SOAEL		
Option 17 at 3m	3m Noise	Daytime	1			£4,012	£208,992	0.02	Daytime - Measure		Cost of mitigation
Height	barrier adjacent to the	Major Adverse	1	1	0				removes two significant effects		measure exceeds monetised acoustic
	LTC southbound	Moderate Adverse	2	0	-2				occurring below a SOAEL.		benefit and returns an indicative VfM of less
	carriageway, north of the	Minor Adverse	2	4	2]			Measure does not		than 1. Option presents no material acoustic
	B186 North	Negligible	4	4	0				change number of dwellings above a		benefit over base case
	Road	Above LOAEL	2	2	0				SOAEL.		design when considered
	overbridge on top of the	Above SOAEL	1	1	0						in relation to SOAEL Height unacceptable for
	embankment.	Night-time							Night-time - Measure		Landscape constraints
	Extending a total of 224m	Major Adverse	1	0	-1				reduces one dwelling (major to moderate)		Measure not viable at
	10101 01 22 1111	Moderate Adverse	0	1	1				occurring below a SOAEL, but		this height and not implemented into design.
		Minor Adverse	4	4	0				significant effects still remain.		
		Negligible	4	4	0				Measure does not		
		Above LOAEL	6	6	0				change number of		
		Above SOAEL	3	3	0				dwellings above a SOAEL		

Table 4.18 Barrier Option 18 Appraisal

Barrier	Further	Noise impact a	nd benefit			TAG Value	Mitigation	Indicative	Acoustic	Eng. / Env	Justification
Option	Mitigation Option description	Change in Imp					Cost	VfM	Summary	issues	
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
Option 18 at	1m Noise	Daytime				£0	£60,240	0	Daytime - Measure does not	Landscape:	Cost of mitigation
1m Height	barrier	Major Adverse	0	0	0				change significant effects.	Similar as for	measure exceeds
	adjacent to the LTC southbound	Moderate Adverse	0	0	0				Measure does not change number of dwellings above the SOAEL.	option 17, although less	monetised acoustic benefit and returns a very poor VfM. Option
	carriageway,	Minor Adverse	0	0	0				SOAEL.	apparent to properties to the north due to angle of views	presents no material
	north of the	Negligible	1	1	0						acoustic benefit over
	B186 North	Above LOAEL	1	1	0						base case design when
	Road	Above SOAEL	0	0	0					and North	considered in relation to
	overbridge on top of the	Night-time							Night-time - Measure does not change significant effects. Measure does not change number of dwellings above the	Road green	SOAEL Management winds at
	embankment.	Major Adverse	0	0	0					bridge earthworks. If definitely required height should be limited to 1m Cultural	Measure not viable at this height and not
	Extending a total of 120m	Moderate Adverse	0	0	0						implemented into design.
		Minor Adverse	0	0	0	7			SOAEL.		doorgin
		Negligible	1	1	0	7					
		Above LOAEL	0	0	0						
		Above SOAEL	1	1	0					Heritage:	
Option 18 at	2m Noise	Daytime				£0	£86,040	0	Daytime - Measure does not	Same comments as	Cost of mitigation
2m Height	barrier	Major Adverse	0	0	0				change significant effects.	Landscape	measure exceeds
	adjacent to the LTC	Moderate Adverse	0	0	0				Measure does not change number of dwellings above the SOAEL.	· ·	monetised acoustic benefit and returns a
	southbound carriageway,	Minor Adverse	0	0	0	1					very poor VfM. Option presents no material
	north of the	Negligible	1	1	0	1					acoustic benefit over
	B186 North	Above LOAEL	1	1	0	1					base case design when
	Road	Above SOAEL	0	0	0	7					considered in relation to
	overbridge on	Night-time			•	7			Night-time - Measure does not]	SOAEL
	top of the embankment.	Major Adverse	0	0	0				change significant effects.		Height unacceptable for Landscape constraints
	Extending a total of 120m	Moderate Adverse	0	0	0				number of dwellings above the		Measure not viable at this height and not
	101011 01 120111	Minor Adverse	0	0	0	1			SOAEL.		implemented into
		Negligible	1	1	0	1					design.
		Above LOAEL	0	0	0	7					
		Above SOAEL	1	1	0	1					
Option 18 at	3m Noise	Daytime		•		£0	£111,960	0	Daytime - Measure does not]	Cost of mitigation
3m Height	barrier	Major Adverse	0	0	0]			change significant effects.		measure exceeds
	adjacent to the LTC	Moderate Adverse	0	0	0				number of dwellings above the		monetised acoustic benefit and returns a
	southbound	Minor Adverse	0	0	0	\dashv			change significant effects. Measure does not change number of dwellings above th SOAEL. Daytime - Measure does not change significant effects. Measure does not change		very poor VfM. Option

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

Table 4.19 Barrier Option 19 Appraisal

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

Barrier	Further	Noise impact and benefit			TAG Value	Mitigation	Indicative VfM	Acoustic	Eng. / Env	Justification	
Option	Mitigation Option description	Change in Imp	acts				Cost		Summary	issues	
		Impact	No Mitigation Design	Barrier Option Design	Change ("-" indicates benefit)						
	adjacent to the LTC	Moderate Adverse	0	0	0				Measure does not change number of dwellings above	Same comments as	monetised acoustic benefit and returns an indicative VfM of less than 1. Option presents no material acoustic benefit over base case design when considered
	northbound	Minor Adverse	78	70	-8				the SOAEL.	SOAEL. Landscape Water: looks to cross/directly	
	carriageway, south of the	Negligible	134	142	8						
	B186 North	Above LOAEL	9	9	0]					
	Road	Above SOAEL	0	0	0					impact a	
	overbridge on	Night-time							Night-time - Measure does	watercourse	in relation to SOAEL
	top of the	Major Adverse	0	0	0	_			not change significant		Measure not viable at
	embankment. Extending a total of 233m	Moderate Adverse	0	0	0				effects. Measure does not change		this height and not implemented into design.
	10181 01 233111	Minor Adverse	67	60	-7				number of dwellings above the SOAEL.		design.
		Negligible	145	152	7				THE SOALL.		
		Above LOAEL	207	207	0						
		Above SOAEL	5	5	0						
Option 19 at	3m Noise	Daytime				£24,907	£217,389	0.11	Daytime - Measure does not		Cost of mitigation
3m Height	barrier	Major Adverse	0	0	0				change significant effects.		measure exceeds
	adjacent to the LTC northbound	Moderate Adverse	0	0	0				Measure does not change number of dwellings above		monetised acoustic benefit and returns an
	carriageway,	Minor Adverse	78	66	-12				the SOAEL.		indicative VfM of less than 1. Option presents
	south of the	Negligible	134	146	12						no material acoustic
	B186 North	Above LOAEL	9	9	0						benefit over base case
	Road	Above SOAEL	0	0	0						design when considered
	overbridge on	Night-time							Night-time - Measure does		in relation to SOAEL
	top of the embankment.	Major Adverse	0	0	0				not change significant		Height unacceptable for Landscape constraints
	Extending a total of 233m	Moderate Adverse	0	0	0				effects. Measure does not change		Measure not viable at this height and not
		Minor Adverse	67	54	-13				number of dwellings above the SOAEL.		implemented into
		Negligible	145	158	13						design.
		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/m²
- b. Surface course is assumed as £6/m²
- 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		Barrier Height (metres)							
Cost Assumption	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		Barrier Height (metres)							
Cost Assumption	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	Barrier Height (metres)						
Cost Assumption	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	Barrier Height (metres)						
Cost Assumption	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	Barrier Height (metres)						
		Rates	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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