Norfolk County Council

GREAT YARMOUTH THIRD RIVER CROSSING FULL BUSINESS CASE

Economic Appraisal Report

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1 STUDY OVERVIEW

1.1 INTRODUCTION

1.1.1. This report details an economic appraisal of the Great Yarmouth Third River Crossing (GYTRC) proposals. The Scheme will provide a third crossing over the River Yare, creating a new, more direct link between the western and eastern parts of Great Yarmouth. Specifically, it will provide a connection between the Strategic Road Network (A47) and the South Denes Business Park, Enterprise Zone, Great Yarmouth Energy Park and the Outer Harbour, all of which are located on the South Denes peninsula.

1.1.2. The purpose of this report is to outline the economic evidence used and the key assumptions made, in line with DfT Transport Analysis Guidance (TAG), to determine the economic benefits and costs of the Scheme. The report assesses the Value for Money (VfM) of the Scheme and details how the effects of the Scheme have been monetised and combined with the construction and maintenance costs to give an indication of the economic value of the Scheme over a 60-year appraisal period. The outputs of this economic appraisal inform the GYTRC Full Business Case (FBC), due for submission in September 2020.

1.1.3. The economic appraisal of the Scheme follows the guidance outlined by the relevant TAG modules to ensure that a robust assessment is made. The cost benefit analysis was undertaken on the following categories:

- Transport User Benefits
- Accident Benefits
- Environmental Benefits
- Reliability Benefits
- Wider Benefits
- Active Mode Benefits

1.2 STRUCTURE OF REPORT

1.2.1. This Economic Appraisal Report (EAR) is structured to include the following sections:

- Study Overview
- Economic Appraisal Approach
- Estimation of Costs
- Estimation of Benefits
- Economic Appraisal Results
- Summary and Conclusions

1.3 SCHEME OBJECTIVES

1.3.1. The objectives for the Scheme were initially developed in the Outline Business Case[1] (OBC) and have been further refined to more clearly reflect the Scheme's role in addressing the transport and regeneration needs. The Scheme objectives are detailed in the FBC, and are as follows:

- To support Great Yarmouth as a centre for both offshore renewable energy and the offshore oil and gas industry, enabling the delivery of renewable energy NSIPs and enhancing the Port's role as an international gateway;
- To improve access and strategic connectivity between Great Yarmouth port and the national road network thereby supporting and promoting economic and employment growth (particularly in the Enterprise Zone);
- To support the regeneration of Great Yarmouth, including the town centre and seafront, helping the visitor and retail economy;
- To improve regional and local access by enhancing the resilience of the local road network, reducing congestion and improving journey time reliability;
- To improve safety and to reduce road casualties and accidents, in part by reducing heavy traffic from unsuitable routes within the town centre;
- To improve access to and from the Great Yarmouth peninsula for pedestrians, cyclists and buses, encouraging more sustainable modes of transport and also reducing community severance; and
- To protect and enhance the environment by reducing emissions of greenhouse gases and minimising the environmental impact of the Scheme.

1.4 SCHEME DESCRIPTION

1.4.1. The Scheme involves the construction, operation and maintenance of a new crossing of the River Yare in Great Yarmouth. It consists of a new dual carriageway road across the river, linking the A47 at Harfrey's Roundabout on the western side to the A1243 South Denes Road on the eastern side. It features an opening span Double Leaf Bascule Bridge across the river, which will involve the construction of two "knuckles" that extend the quay wall into the river. The new dual carriageway will also have a clear span over Southtown Road on the western side of the river, as it rises to the centre of the new crossing.

1.4.2. The Scheme will create a new, direct link between the western and eastern parts of the town. It will substantially improve connectivity between the A47 (part of the SRN) and significant destinations on the South Denes peninsula, including the South Denes Business Park, Great Yarmouth Energy Park, the Port and Outer Harbour, including part of the Great Yarmouth and Lowestoft (New Anglia) Enterprise Zone.

Plate 1.1 shows the scheme masterplan.

[1] Great Yarmouth Third River Crossing 2017 Outline Business Case https://www.norfolk.gov.uk/roads-and-transport/major-projects-and-improvement-plans/great-yarmouth/third-river-crossing/further-information-and-documents/outline-business-case-submission

Plate 1.1: Scheme Masterplan

1.5 PREVIOUS ECONOMIC APPRAISALS

1.5.1. A Stage 2 Traffic and Economic Assessment report[2] was produced in October 2009 by Mott MacDonald and which included detailed information on traffic modelling, forecast traffic flows and journey times for three scheme options (two bridge options and one tunnel option). Results showed that all scheme options produced high levels of benefits, with the two bridge options producing the highest levels with a BCR ranging from 4.5 to 4.8. The report concluded that the tunnel option provided a low value for money and should therefore be discounted from further analysis.

[2] Great Yarmouth Third River Crossing – Stage 2 Scheme Assessment Report, September 2009. Mott Macdonald for Norfolk County Council

1.5.2. The OBC was submitted to DfT in March 2017. This included an Economic Case and supporting documentation which presented a BCR of 3.5 for the core scenario[3], and a range of 2.5 to 4.6 under sensitivity testing. The core scenario provided high value for money under DfT categorisation.[4]

1.5.3. Following the OBC submission, the DfT were contacted in November 2017 to request any comments on the traffic modelling and economic appraisal. The purpose of this was to ascertain what the DfT requirements would be for Full Business Case (FBC) approval, and to ensure there was sufficient time in which to address their comments.

1.5.4. The DfT responded with a request for further information on six areas of the appraisal. A formal response was issued to the DfT in October 2018[5].

1.5.5. The DfT comments included requests that the model be updated to reflect the latest scheme design, uncertainty log, TAG guidance, and NTEM / RTF guidance. Thus, the model has been updated since the submission of the OBC. The main changes are:

- The Scheme design has been updated and the forecast opening schedule for the bridge openings has been amended (this results in a minor change to signal timings in the SATURN model);
- The SATURN model has been updated to produce a new 2018 base year to inform the Transport Assessment. This was carried out with reference to new traffic survey data from 2018. Further details of the SATURN model update are given in the Local Model Validation Report Addendum[6];
- The uncertainty log has been updated and used to produce new forecast models for the opening year of 2023 and future years of 2038 and 2051. Details of the uncertainty log and committed developments modelled are given in the Traffic Forecasting Report[7];
- The forecast networks now include committed Highways England (HE) schemes and Vauxhall and Gapton roundabouts, details of which are given in the Traffic Forecasting Report;
- An updated version of TUBA has been used (v1.9.13) which incorporates new values of time from the TAG databook v1.9.2 (May 2019);

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[3] The core scenario is a forecast scenario based on the most unbiased and realistic set of assumptions that will form the central case that is presented in the appraisal summary table (AST). This is defined in WebTAG M4 (May 2018).

[4] The DfT's Value for Money Framework, Section 5.6, Box 5.1 (July 2017) categorises the VfM based upon the value of the BCR. The categories are:

- Very High – BCR greater than or equal to 4
- High – BCR between 2 and 4
- Medium – BCR between 1.5 and 2
- Low – BCR between 1 and 1.5
- Poor – BCR between 0 and 1
- Very Poor – BCR less than or equal to 0

[5] Great Yarmouth Third River Crossing Response to DfT Queries DCO Document 7.6 Economic Appraisal Report Appendix H https://www.norfolk.gov.uk/roads-and-transport/major-projects-and-improvement-plans/great-yarmouth/third-river-crossing/further-information-and-documents/development-consent-application

[6] Great Yarmouth Third River Crossing Local Model Validation Report Addendum (SATURN) DCO Document 7.6 Economic Appraisal Report Appendix A https://www.norfolk.gov.uk/roads-and-transport/major-projects-and-improvement-plans/great-yarmouth/third-river-crossing/further-information-and-documents/development-consent-application

[7] Great Yarmouth Third River Crossing Traffic Forecasting Report (SATURN) DCO Document 7.6 Economic Appraisal Report Appendix B https://www.norfolk.gov.uk/roads-and-transport/major-projects-and-improvement-plans/great-yarmouth/third-river-crossing/further-information-and-documents/development-consent-application

- Updated calculation of reliability benefits using updated reliability ratio parameter from DfT TAG Unit A1.3 (March 2017); and
- A more comprehensive estimate of wider impacts has been undertaken. Full details are given in Wider Impacts Benefits Technical Note (Supporting Document 4).

2 ECONOMIC APPRAISAL APPROACH

2.1 TRANSPORT MODEL

2.1.1. The traffic data used in the economic appraisal for the OBC was derived from a 2016 SATURN model built by WSP and formed a fully TAG compliant update of the earlier work by consultant Mott MacDonald (MM). This model has been updated to 2018 base year to inform the Transport Assessment (TA) and it is forecasts from the 2018 base year that now inform the economic appraisal. An addendum[8] to the OBC Local Model Validation Report has been produced.

2.1.2. The Fixed and Variable Demand SATURN models have been developed for the following time periods[9]:

- AM peak (08:00 – 09:00)
- Average interpeak (10:00 – 15:30)
- PM peak (16:30 – 17:30)

2.1.3. This is consistent with advice presented in DfT TAG Unit M3.1, Section 2.5 (May 2020).

2.1.4. The traffic assignments were carried out with the following vehicle and user classes:

- UC1: Car – Commuting
- UC2: Car – Employer's Business
- UC3: Car – Other
- UC4: LGV
- UC5: HGV

2.1.5. The model forecast years are 2023 (assumed scheme Opening Year), 2038 (Design Year) and 2051 (Horizon Year). Full details of forecasting process are detailed in the Traffic Forecasting Report which can be found in sperate document Appendix B – Traffic Forecasting Report.

TRAVEL DEMAND SCENARIOS

2.1.6. The principal requirement of the traffic model was the provision of traffic forecasts for the Scheme Opening year (2023), Design year (2038) and Horizon year (2051). Future travel demands take into account the existing traffic flows together with the effects of traffic growth and the additional traffic that is expected to arise from new development activity in the town.

2.2 ECONOMIC APPRAISAL PROCESS

2.2.1. The process of economic appraisal for the Scheme consists of several steps, as follows.

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[8] Great Yarmouth Third River Crossing Local Model Validation Report Addendum (SATURN) DCO Document 7.6 Economic Appraisal Report Appendix A https://www.norfolk.gov.uk/roads-and-transport/major-projects-and-improvement-plans/great-yarmouth/third-river-crossing/further-information-and-documents/development-consent-application

[9] The time periods are defined based both on guidance given in WebTAG M3.1, Section 2.5 (January 2014), and traffic count data collected in 2016. The demand profile showed two clear peak hours for AM (08:00-09:00) and PM (16:30-17:30), and a period of relatively consistent flow between these peaks, beginning at 10:00 and finishing at 15:30. An average hour of this period was taken to represent the inter-peak period.

USER BENEFITS (TUBA)

2.2.2. User benefits including time savings, fuel-related vehicle operating costs (VOC), non-fuel VOC, and operator and Government revenues typically form the major element of benefit attributable to highway schemes. The appraisal detailed within this report uses the Department for Transport's (DfT) Transport Users Benefit Appraisal tool (TUBA) Version 1.9.13.

2.2.3. The software provides the DfT standard approach to appraising changes in demand, travel time and operating costs. Demand, average time and average distance matrix skims from the Do Minimum and Do Something tests for the opening and design years are fed into TUBA generating the following economic outputs:

- Time savings
- Vehicle Cost Operating savings
- Greenhouse gases
- Taxes

2.2.4. Analysis of the benefits has been carried out:

- By year, over the 60-year appraisal period
- By trip purpose/ vehicle type/by time period (AM/IP/PM periods)
- By sector of origin and destination

2.2.5. The appraisal area for estimating user benefits includes the full SATURN model area (as detailed in the Local Model Validation Report Addendum[10]), and analysis at an aggregated sector level provides a summary of the findings.

SAFETY BENEFITS (COBA-LT)

2.2.6. Benefits associated with accident savings were calculated using the DfT's Cost and Benefit to Accidents – Light Touch Programme (COBA-LT) which assesses the safety impacts of schemes using detailed inputs of link and junction accident rates and traffic flow forecasts from the traffic model. Accident benefits were calculated over a 60-year period for a limited subset of the model.

OTHER BENEFITS

2.2.7. In addition to the benefits calculated by TUBA and COBA-LT, monetised benefits were also calculated for the following:

- Environmental (Noise and Air Quality);
- Reliability;
- Wider Impacts; and
- Active Modes.

[10] Great Yarmouth Third River Crossing Local Model Validation Report Addendum (SATURN) DCO Document 7.6 Economic Appraisal Report Appendix A https://www.norfolk.gov.uk/roads-and-transport/major-projects-and-improvement-plans/great-yarmouth/third-river-crossing/further-information-and-documents/development-consent-application

ANNUALISATION OF BENEFITS

2.2.8. Benefits of the Scheme have been converted from the weekday traffic model period outputs to annual totals over a 60-year appraisal period. Annualisation factors for conversion of period model outputs are explained in detail in Supporting Document 5.

APPRAISAL PERIOD

2.2.9. The economic appraisal was carried out for a 60-year period, from 2023 (Opening Year), in accordance with DfT guidance. The final year in which benefits were calculated was 2082.

VALUE FOR MONEY ASSESSMENT

2.2.10. A full cost benefit appraisal was undertaken to assess the Scheme's value for money. The results from TUBA, COBA-LT and other benefits were combined to calculate the overall economic benefits of the Scheme. By comparing the construction, operation and maintenance costs with the traffic benefits of the Scheme over a 60-year appraisal period, a BCR was calculated, which represents the value for money afforded by the Scheme.

SENSITIVITY TESTS

2.2.11. As recommended in DfT TAG Unit M4, Section 4 (May 2019), sensitivity tests have been carried out whereby high and low growth projections are applied in addition to the core scenario forecast.

2.2.12. Additional sensitivity tests have been carried out with alternative economic growth projections and carbon valuations applied.

2.3 NON-STANDARD PROCEDURES AND ECONOMIC PARAMETERS

2.3.1. The economic appraisal has adopted procedures, economic parameters and values recommended in current DfT and HE guidance.

3 ESTIMATION OF COSTS

3.1 OVERVIEW

3.1.1. The estimation of costs for the Scheme has been carried out following the principles set out in DfT TAG Unit A1.2 (July 2017). The costs have been estimated under three broad headings – investment, operating and maintenance costs.

3.1.2. The base cost of the Scheme is made up of investment, maintenance and operating costs, for a given price base. This includes estimates for construction, land, preparation, supervision. It incorporates a realistic assumption of changes in real costs over time (e.g. cost increases or reductions relative to the rate of general inflation). The base cost also takes into account the cost of land compensation.

3.1.3. The Scheme costs presented are the final costs that have been agreed with the contractor.

3.2 INVESTMENT COST

WORKS COST

3.2.1. Costs have been estimated using a Quarter 2, 2020 price base for 2020-2024 costs and actual prices for 2017-2020 and are detailed in Table 3.1. The total cost exclusive of risk and inflation amounts to £102.0 million.

Table 3.1: Great Yarmouth Third River Crossing Scheme Cost Estimate (£000)

Cost Area	Costs (up to and including 2019-20) Actual prices	Estimated costs (from 2020-21 onwards) 2020 Q2 prices	Costs (£000)
Construction	6,042	63,174	69,215
Utilities	21	1,483	1,505
Land	1,279	14,973	16,253
Fees	9,613	5,343	14,956
Total work cost (exclusive of risk)	16,955	84,974	101,929

ADJUSTMENT FOR RISK

3.2.2. Prior to the submission of the OBC a Risk Management Workshop was held on 30th January 2017 to consider risks associated with the preferred scheme at the time.

3.2.3. A structured and systematic process for identifying, assessing and managing risk has been established for the Scheme. A risk log has been generated which identifies risks that may occur during the planning, design and construction phases and outlines any unrealised issues that have the potential to adversely impact on the Scheme delivery, programme or cost. The Risk Register and Quantified Risk Assessment (QRA) can be found in separate document Appendix E to the FBC.

3.2.4. The scheme risks will be managed in line with the risk management strategy set out in the FBC Financial Case.

3.2.5. Table 3.2 shows the Scheme costs inclusive of risk. The total work cost including risk amounts to £120.0 million.

Table 3.2: Scheme Cost Estimate including risk (£000)

Cost Area	Cost (£000)
Base Cost	101,929
Quantified Risk (most likely)	17,545
Risk-adjusted Base Cost	**119,467**

SCHEME COST PROFILE

3.2.6. The Scheme cost profile based on the current scheme programme is set out in Table 3.3 and adjusted for risk.

Table 3.3: Scheme Cost Profile (£000)

Scheme Element	2017-18 Costs (Actual Prices)	2018-19 Costs (Actual Prices)	2019-20 Costs (Actual Prices)	2020-21 Estimated Costs (2020 Q2 Prices)	2021-22 Estimated Costs (2020 Q2 Prices)	2022-23 Estimated Costs (2020 Q2 Prices)	2023-24 Estimated Costs (2020 Q2 Prices)	Total Cost
Construction	136	-10	5,916	5,360	36,994	20,379	440	69,215
Utilities	0	0	21	1,130	354	0	0	1,505
Land	39	236	1,004	11,444	3,889	736	-1,095	16,253
Fees	1,714	5,031	2,867	2,754	1,242	1,139	209	14,956
Base Cost	**1,888**	**5,257**	**9,809**	**20,687**	**42,480**	**22,253**	**-447**	**101,929**
QRA	0	0	0	5,528	8,828	2,557	632	17,545
Risk Adjusted Base Cost	**1,888**	**5,257**	**9,809**	**26,215**	**51,309**	**24,810**	**186**	**119,474**

INFLATION – FINANCIAL CASE

3.2.7. The 2020 prices have been inflated through the delivery and construction period based on historic trend analysis of the inflationary indices applicable and a nominal allowance for the effects of coronavirus (COVID-19), as set out in Table 3-4 below:

Table 3-4: Inflation (based on Bank of England CPI forecasts of general inflation)

Factors applied to 2020 Q1 to give out-turn prices	2020-2021	2021-2022	2022-2023	2023-2024
Stage One (Design) included on 2020 base cost, no further inflation to be applied as Stage One completion before the next annual adjustment of the Prices.	n/a	n/a	n/a	n/a

Stage Two (Fees).	n/a	2.50%	2.50%	2.50%
Stage Two (Construction).	2.50%	3.50%	3.50%	n/a

3.2.8. It is recognised that the coronavirus (COVID-19) outbreak combined with Brexit (trade deals and a reducing migrant workforce) and a desire to 'kick start' the economy through the delivery of major infrastructure projects could introduce a shortage of resource which introduces uncertainty when considering the inflationary factors used. This continues to be monitored.

OUTTURN COST ESTIMATE

3.2.9. The £121,164k "scheme cost" as defined by DfT, is the out-turn capital cost of the scheme excluding costs incurred prior to completion of the OBC. The inflation factors in Table 3-4 have been applied to the appropriate elements of the forecast costs shown in Table 3.3 to produce the total scheme out-turn spend profile given in Table 3.5.

Table 3.5: Outturn Spending Profile (£000)

Scheme Element	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	Cost
Construction	136	-10	5,916	5,404	37,517	20,927	440	70,330
Utilities	0	0	21	1,130	354	0	0	1,505
Land	39	236	1,004	11,444	3,889	736	-1,095	16,253
Fees	1,714	5,031	2,867	2,754	1,263	1,174	214	15,017
Base Cost	**1,888**	**5,257**	**9,809**	**20,731**	**43,023**	**22,837**	**-441**	**103,105**
QRA	0	0	0	5,733	9,013	2,682	632	18,060
Risk adjusted Base Cost	**1,888**	**5,257**	**9,809**	**26,464**	**52,036**	**25,519**	**191**	**121,164**

3.2.10. The funding request is given in Table 3.6.

Table 3.6: Funding Request and Profile (£000)

Source	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	Cost
DfT funding requested	0	3,941	6,668	26,070	45,129	16,280	0	98,088
LA (NCC) contribution	206	998	3,141	394	6,907	9,239	191	21,076
LEP contribution	1,682	318	0	0	0	0	0	2,000

Total	**1,888**	**5,257**	**9,809**	**26,464**	**52,036**	**25,519**	**191**	**121,164**

3.3 OPERATING AND MAINTENANCE COSTS

3.3.1. The assessment of traffic related maintenance costs focuses on the plan for non-routine reconstruction and resurfacing of the carriageway. The aim of the process is to calculate the net maintenance and operating cost impact of the Scheme to ensure that this is robustly captured in the present value of costs.

3.3.2. It is assumed that major maintenance would take place every few years for resurfacing of the new built sections of carriageway and for reconstruction works.

3.3.3. Operating costs of the Bridge structure are known, and professional experience of similar infrastructure has informed the costs associated with the operation and maintenance activities. For these reasons an additional 'risk' factor has not been applied to the Operation and Maintenance tasks.

3.3.4. All maintenance and operation costs have been estimated at 2016 Q3 prices for the same reasons as given above.

3.3.5. Inflation over and above GDP deflator has not been applied to maintenance and operation costs due to the uncertainty in forecasting economic conditions far in the future.

BRIDGE MAINTENANCE COST

3.3.6. The through-life maintenance cost of the bridge has been calculated at a 2016 Q3 price base. The maintenance cost is based on a 40 year cycle to repeat throughout the life of the structure. The elements included within this cost are:

- Routine servicing costs;
- Exceptional repairs and maintenance; and
- Re-painting and refurbishment.

3.3.7. Routine servicing costs include weekly, monthly and six monthly servicing. There is also a cost estimated for consumable parts.

3.3.8. Exceptional repairs and maintenance costs include allowances for hydraulic oil replacement and changing of filters on a five year cycle. A cost is included to refurbish the hydraulic cylinders every 10 years.

3.3.9. Re-painting and refurbishment of the bridge occurs every 25 years. The hydraulic cylinders are replaced every 40 years.

3.3.10. The total cost over a 60-year appraisal period amounts to £5,565,406 (2016 Q3 prices). Note that maintenance costs are not applied in the opening year of appraisal.

3.3.11. A full breakdown of the cost calculation can be found in separate document Appendix A.

BRIDGE OPERATING COST

3.3.12. The operating cost for 24/7 operation of the bridge has been calculated to be £102,523 per annum for 24/7 staffing. This gives a total cost of £6,048,857 (2016 Q3 prices) over a 60-year appraisal period.

ROAD OPERATING AND MAINTENANCE COST

3.3.13. The operating and maintenance cost for the road sections of the Scheme has been calculated to be £66,672 per annum (2016 Q3 prices). Included within this cost are the following:

- Highways maintenance liabilities including communications equipment, drainage clearance, road and street lighting operation, winter maintenance (i.e. application of salt and snow clearance) and infrastructural and safety inspections.
- Longer term highways renewals, including re-surfacing and renewing the new bridge approaches and bridge surface (included in the annual average cost)

3.3.14. The total cost amounts to £3,933,648 (2016 Q3 prices) over a 60-year appraisal period.

3.4 DELAYS DURING CONSTRUCTION AND MAINTENANCE

3.4.1. The construction of the bridge is mostly offline with tie-ins at either end. The impact on existing traffic is limited to vehicles on South Denes and William Adams Way / Suffolk Road. Given the relatively short construction programme it is anticipated that the impact will be minimal relative to the overall scheme costs and benefits. As such no monetised delay values have been calculated.

3.4.2. The scheduled maintenance will be carried out with minimal impact to traffic using the scheme. This will mean carrying out the maintenance tasks in the off-peak periods as much as possible. When assessing delays, a comparison needs to be made on a network wide basis between the Do Minimum and Do Something scenarios. The impact of maintenance delays on the existing network will be improved due to the presence of the Scheme itself, as this provides an additional river crossing when the other key links (e.g. Breydon Bridge and Haven Bridge) are being maintained.

3.4.3. Thus, delay values due to maintenance have not been calculated as it is anticipated that the impact will be minimal relative to the overall scheme costs and benefits.

3.5 PRESENT VALUE COST (PVC)

OVERVIEW

3.5.1. In line with DfT TAG Unit A1.1 Cost Benefit Analysis (May 2018) and Unit A1.2 Scheme Costs (July 2017), all future investment and operating costs, estimated over the appraisal period, should be converted to Present Value Cost (PVC).

3.5.2. This involves three key steps:

- Re-basing to the DfT's Base Year;
- Discounting to the DfT's Base year; and
- Converting to Market Prices.

3.5.3. Before these three steps, inflation, risk and Optimism Bias were applied to the total scheme cost.

INFLATION- ECONOMIC CASE

3.5.4. The cost of the Scheme should include the effect of forecast construction inflation relative to general inflation as measured by the GDP deflator. Table 3.7 summarises the inflation rates given by TAG data book v1.13 (May 2020) and the Office for National Statistics (ONS) construction output price indices (2020 Q2 release, August 2020). These rates were subsequently used to calculate the inflation factors listed in Table 3.8, to account for the difference between construction inflation and general inflation. The construction inflation rate for April 2019 to March 2020 is applied for all the forecast years. (note construction output price indices for April to June 2020 were excluded from inflation projection due to COVID19 related uncertainty). The factors shown in Table 3.8 have been applied to the construction cost of the Scheme in line with the spend profile.

Table 3.7: General Inflation Rates – Economic Case

Index	2020/21	2021/22	2022/23	2023/24
GDP deflator	1.8%	1.9%	2.0%	2.0%
Construction Inflation Rate	3.0%	3.0%	3.0%	3.0%

Table 3.8: Inflation Factors – Economic Case

Index	2020/21	2021/22	2022/23	2023/24
Construction Inflation Factor	1.012	1.022	1.033	1.044

3.5.5. Inflation has not been applied to the non-construction elements of the Scheme costs. The change per annum in forecast GDP deflator is higher than the Real GDP growth per annum (TAG Databook v1.13 (May 2020)). It is therefore assumed that all other costs of the Scheme are not subject to any inflation above the GDP deflator. The inflation factors given Table 3.8 have been applied to the construction and utilities costs in Table 3.3 to give a pre-risk adjusted cost profile in Table 3.9.

Table 3.9: Inflation Adjusted Sub-Total Cost Profile (£000, 2020 Q2 prices from 2020-21)

Scheme Element	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	Cost
Construction	136	-10	5,916	5,422	37,823	21,053	459	70,799
Utilities	0	0	21	1,143	362	0	0	1,526
Land	39	236	1,004	11,444	3,889	736	-1,095	16,253
Fees	1,714	5,031	2,867	2,754	1,242	1,139	209	14,956
Inflation Adjusted Sub-Total	**1,888**	**5,257**	**9,809**	**20,762**	**43,317**	**22,927**	**-428**	**103,533**

3.5.6. The inflation adjustment applied per year is given in Table 3.10.

Table 3.10: Inflation Adjustment Applied (£000, 2020 Q2 prices from 2020-21)

Scheme Element	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	Cost
Sub-Total	1,888	5,257	9,809	20,687	42,480	22,253	-447	**101,929**
Inflation	0	0	0	75	837	674	19	**1,605**
Inflation Adjusted Sub-Total	**1,888**	**5,257**	**9,809**	**20,762**	**43,317**	**22,927**	**-428**	**103,533**

RISK

3.5.7. As outlined above, a structured and systematic process for identifying, assessing and managing risk has been established for the Scheme. The total risk associated cost of the Scheme is £17.5 million as shown in Table 3.11.

Table 3.11: Risk Adjustment Applied (£000, 2020 Q2 prices from 2020-21)

Scheme Element	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	Cost
Inflation Adjusted Sub-Total	1,888	5,257	9,809	20,762	43,317	22,927	-428	**103,533**
Risk	0	0	0	5,528	8,828	2,557	632	**17,545**
Risk Adjusted Sub-Total	**1,888**	**5,257**	**9,809**	**26,290**	**52,145**	**25,484**	**205**	**121,079**

OPTIMISM BIAS

3.5.8. An Optimism Bias was applied to costs to reflect the uncertainty of the current cost estimates, based on guidance in DfT TAG Unit A1-2, Section 3.5, Table 8 (July 2017). This figure is derived from a weighted average, calculated, based on the proportions of bridge and road costs (66:34) giving an overall optimism bias allowance of 5% which is applied to the total risk-adjusted costs as shown in Table 3.12.

Table 3.12: Scheme Cost with Optimism Bias (£000, 2020 Q2 prices from 2020-21)

Scheme Element	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	Cost
Risk Adjusted Sub-Total	1,888	5,257	9,809	26,290	52,145	25,484	205	**121,079**
Optimism Bias	0	0	0	1,309	2,597	1,269	10	**5,185**
Total	**1,888**	**5,257**	**9,809**	**27,599**	**54,742**	**26,753**	**215**	**126,264**

RE-BASING

3.5.9. DfT TAG Unit A1.1 (May 2018) explains that, when applying monetary values to impacts over a long appraisal period, it is very important to take the effects of inflation into account. Failure to do so, would distort the results by placing too much weight on future impacts, where values would be higher simply because of inflation.

3.5.10. For Cost Benefit Analysis purposes, all values should be in real prices (including inflation) to stop the effects of inflation distorting the results. To convert nominal prices (not including inflation) to real prices, a price base year and an inflation index are needed.

3.5.11. The real price in any given year is then the nominal price deflated by the change in the inflation index between that year and the Base year (2010).

3.5.12. The GDP price deflator contained in the TAG databook v1.13 (May 2020) has been used to convert prices from the 2020 price year base to 2010 costs (2010 index = 100, 2020 = 119.51).

Table 3.13: Scheme Cost deflated to 2010 prices (£000)

Scheme Element	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	Cost
Scheme Cost	1,888	5,257	9,809	27,599	54,742	26,753	215	**126,264**
Rebasing Factor	0.837	0.837	0.837	0.837	0.837	0.837	0.837	
Total (2010 prices)	**1,580**	**4,399**	**8,207**	**23,093**	**45,804**	**22,385**	**180**	**105,648**

DISCOUNTING

3.5.13. DfT TAG Unit A1.1 (May 2018) outlines that all monetised costs (and benefits) arising in the future need to be adjusted to take account of 'social time preference', that is peoples preference to consume goods and services now, rather than in the future. The technique used to perform this adjustment is known as discounting.

3.5.14. A Discount Rate which represents the extent to which people prefer current over future consumption, is applied to convert future costs (and benefits) to their present value which is the equivalent value of a cost (or benefit) in the future occurring today.

3.5.15. As such, the cost estimate has been discounted to the DfT's Base year (2010) using the discount rates outlined in TAG databook v1.13, (May 2020) summarised in Table 3.14.

Table 3.14: Discount Rates

Years from Current Year	Discount Rate
0-30	3.50%
31-75	3.00%
76-125	2.50%

Table 3.15: Scheme Cost discounted to 2010 prices (£000)

Scheme Element	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	Cost
Total (2010 prices)	1,580	4,399	8,207	23,093	45,804	22,385	180	**105,648**
Discount Factor	0.786	0.759	0.734	0.709	0.685	0.662	0.639	-
Total (2010 prices, discounted to 2010)	**1,242**	**3,341**	**6,022**	**16,371**	**31,373**	**14,814**	**115**	**73,278**

MARKET PRICES

3.5.16. The final stage in preparing the package cost for appraisal is to convert the cost to the 'market price' using the indirect tax correction factor of 1.19, which reflects the average rate of indirect taxation in the economy. The application of indirect tax correction is shown in Table 3.16.

Table 3.16: Scheme Cost adjusted for Indirect Taxation (£000, 2010 prices discounted to 2010)

Scheme Element	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	Cost
Total	1,242	3,341	6,022	16,371	31,373	14,814	115	**73,278**
Indirect Tax Correction	1.190	1.190	1.190	1.190	1.190	1.190	1.190	-
Total adj for Indirect Taxation	**1,478**	**3,975**	**7,166**	**19,481**	**37,334**	**17,629**	**137**	**87,200**

SUNK COSTS

3.5.17. In accordance with DfT TAG Unit A1.2 July 2017, only the cost that will be incurred after the time of economic appraisal and decision to go ahead with the scheme should be considered. Therefore the cost incurred for 2017/18, 2018/19 and 2019/20 are removed from the economic appraisal process. Sunk costs amount to **£12.6m** at 2010 prices discounted to 2010.

3.5.18. The cost profile with sunk costs removed is given in Table 3.17.

Table 3.17: Cost profile with sunk costs removed (£000, 2010 prices discounted to 2010)

Scheme Element	2020-21	2021-22	2022-23	2023-24	Cost
Construction	4,018	27,080	14,563	307	45,968
Utilities	847	259	0	0	1,106

Land	8,480	2,785	509	-732	11,042
Fees	2,041	889	788	139	3,857
QRA	4,096	6,321	1,769	422	12,608
Total with sunk costs removed	**19,482**	**37,334**	**17,629**	**137**	**74,581**

PRESENT VALUE COST SUMMARY

3.5.19. Table 3.18 summarises the investment and operating costs which have been adjusted to 2010 prices and values. It demonstrates that the total PVC estimate over the 60-year appraisal period for the Scheme is £78.7 million.

Table 3.18: Summary of Scheme Costs (£000)

Cost Categories	Reference	Costs £000
Investment Cost (2020 Prices inc Optimism Bias)	Table 3.12	126,264
Investment Cost deflated to 2010 prices	Table 3.13	105,648
Investment Cost discounted to 2010 base year	Table 3.15	73,278
Present Value of Investment Cost (2010 Market Prices)	Table 3.16	87,200
Present Value of Investment Cost with sunk costs removed (2010 Market Prices) #1	**Table 3.17**	**74,581**
Operation and Maintenance Costs (2016 Prices)	Section 3.3, Appendix A	15,547
Present Value of Operation and Maintenance Costs (2010 Market Prices) #2	**Appendix A**	**4,172**
Total Present Value of Costs (2010 Market Prices)	**(#1 + #2)**	**78,753**

4 ESTIMATION OF BENEFITS

4.1 INTRODUCTION

4.1.1. The following scheme benefits were calculated for the Core Scenario forecast and the Low and High Growth Scenarios:

- User Benefits (time, vehicle operating cost and tax savings);
- Accident Cost Savings; and
- Other Benefits (environment, reliability, wider impacts, regeneration, and active mode appraisal)

4.2 USER BENEFITS

4.2.1. The following section provides an overview of the TUBA economic appraisal, including the key inputs and parameters used within the appraisal and the outputs and results.

4.2.2. TUBA 1.9.13 was used to carry out an appraisal of the 'user benefits' for the Scheme.

4.2.3. The Transport Economic Efficiency (TEE) benefits arise from time and vehicle operating cost savings over the 60-year appraisal period and are evaluated from the difference in costs between the Do Minimum and Do Something forecasts.

SCHEME PARAMETERS

4.2.4. Table 4.1 shows the main parameters that have been used in the TUBA scheme file.

Table 4.1: Scheme Parameters

Parameter	Option
TUBA Version	v1.9.13
Opening Year	2023
Design Year	2038
Horizon Year	2051 (final NTEM forecast year)
Final Appraisal Year	2082
Modelled Years	2023, 2038 and 2051

TIME SLICES

4.2.5. TUBA is able to provide user benefits for up to 8,760 hours within a year and it allocates each hour into one of five time slices as shown in Table 4.2.

Table 4.2: TUBA Time Slices

Period	Time
Weekday AM Period	(07:00-10:00)
Weekday Inter-Peak Period	(10:00-16:00)
Weekday PM Period	(16:00-19:00)
Weekday Off-Peak Period	(19:00-07:00)
Weekend + Bank Holiday	(24-hours)

4.2.6. The traffic models developed for the Scheme, consists of the three distinct time periods: AM peak hour (08:00-09:00), Inter-peak (average of 10:00-15:30), and PM Peak (16:30-17:30). Non-modelled hours should therefore be included in the TUBA analysis either by expanding the modelled hour to the relevant period or by adopting “donor” models. (Detail of the method of annualisation is provided in Supporting Document 5). The TUBA analysis periods and the corresponding modelled hours are summarised in Table 4.3.

Table 4.3: TUBA Analysis Periods and Corresponding Model Input Hours

TUBA Analysis Periods	Model Input Periods
AM Peak Period (0700-1000)	AM Peak Hour (08:00-09:00)
Inter-Peak Period (1000-1600)	Average Inter-Peak Hour (10:00-15:30)
PM Peak Period (1600-1900)	PM Peak Hour (16:30-17:30)
Off-Peak Period (1900-0700)	Average Inter-Peak Hour (1000-1600)
Weekend + Bank Holiday	Average Inter-Peak Hour (1000-1600)

VEHICLE TYPE AND TRIP PURPOSE

4.2.7. In accordance with the DfT TAG Unit A1.3, Section 4 (March 2017), TUBA benefits are required to be assessed with disaggregation to vehicle type and journey purposes. Seven user classes are defined in the TUBA standard economic file, representing 3 distinct trips purposes for car, two for LGV’s and two for HGV’s that is based on different values of time (VoT), vehicle occupancies and fuel consumptions for each vehicle types and purposes:

- Car – Employer Business;
- Car – Commuting;
- Car – Other;
- LGV – Personal;
- LGV – Freight;

- OGV 1; and
- OGV 2.

4.2.8. The traffic models developed for the Scheme however consist of five user classes:

- UC1 Car – Employer Business;
- UC2 Car – Commuting;
- UC3 Car – Other;
- UC4 LGV; and
- UC5 HGV.

4.2.9. The user classes from the Great Yarmouth traffic forecast variable demand models were therefore converted to the standard TUBA user classes, using the adjustment factors applied for each modelled user class as provided in Table 4.4.

Table 4.4: Modelled User Classes to TUBA User Classes

Model User Class	TUBA User Class	TUBA Vehicle / Submode	TUBA Trip Purpose	TUBA Demand Factor
1	1	1 (Car)	1 (Business)	1.00
2	2	1 (Car)	2 (Commuting)	1.00
3	3	1 (Car)	3 (Other)	1.00
4	4	2 (LGV personal)	0 (Commuting and Other)	0.12
4	5	3 (LGV freight)	0 (Business)	0.88
5	6	4 (OGV1)	0 (Business)	0.17
5	7	5 (OGV2)	0 (Business)	0.26

4.2.10. The split between LGV personal and LGV freight is given in TAG databook v1.11, A1.3.4 (November 2018). The demand adjustment factors for HGVs are based upon the vehicle split assumed for the OBC, and include an additional factor to convert from PCUs to vehicles.

4.2.11. A TUBA appraisal was then undertaken using the parameters described above, with demand and skimmed time and distances for Do Minimum and Do Something forecast models to produce the user benefits for the 60-year appraisal period.

ANALYSIS OF USER BENEFITS

4.2.12. User benefits including time savings, fuel-related vehicle operating costs (VOC), non-fuel VOC, and operator and Government revenues, typically form the major element of benefit attributable to highway schemes. The appraisal reported here uses TUBA Version 1.9.13.

4.2.13. The software provides the DfT standard approach to appraising changes in demand, travel time and operating costs. Demand, average time and average distance matrix skims from the Do Minimum (DM) and Do Something (DS) tests for the Opening and Design years are fed into TUBA, generating the following types of economic outputs:

- User Time Savings

- Vehicle Operating Cost Savings
- Greenhouse Gases
- Indirect Taxes

4.2.14. Analysis of the benefits has been carried out:

- By year, over the 60-year appraisal period
- By trip purpose/ vehicle type/ by time period (AM/ IP/ PM periods); and
- By sector of origin and destination

4.2.15. The appraisal area for estimating user benefits includes the full model area, although analysis at sector level provides the facility to assess benefits within only part of the modelled area.

ANNUALISATION FACTORS AND NON-MODELLED HOURS

4.2.16. The forecast model consists of three distinct peak hours: AM peak hour (08:00-09:00), average inter-peak hour (10:00-15:30), and PM peak hour (16:30-17:30). TUBA analysis is, however, required to be carried out for all the hours for the whole year.

4.2.17. For non-modelled hours (i.e. AM Peak shoulders (07:00-08:00 and 09:00-10:00), PM peak shoulders (15:30-16:30 and 17:30-18:30), off-peak and weekend and Bank Holidays), it is only appropriate to calculate benefits for hours in which traffic levels are similar to the modelled hours.

4.2.18. For example, in the appraisal it would not be appropriate to expand the AM peak hour to the AM period in the event that observed traffic was significantly lower in the peak shoulders. In reality, this would result in significantly less actual delays caused by traffic in the peak shoulders as opposed to the peak hour, thus resulting in overestimating the modelled benefits of the Scheme if the peak shoulders were included in the calculation of benefits.

4.2.19. TUBA guidance suggests that a conservative approach should be used to identify benefits/dis-benefits for non-modelled periods so that it would represent as close as possible the changes in travel time between Do Minimum and Do Something compared to the changes in the modelled hours.

4.2.20. It is often considered good practice that the peak shoulder traffic exceeding 90% of that in the peak hour should be included in the derivation of the annualisation factors as the change in travel time between the Do Minimum and Do Something in the peak shoulders would be close to the changes experienced in the peak hour. The 90% threshold was used in the initial analysis.

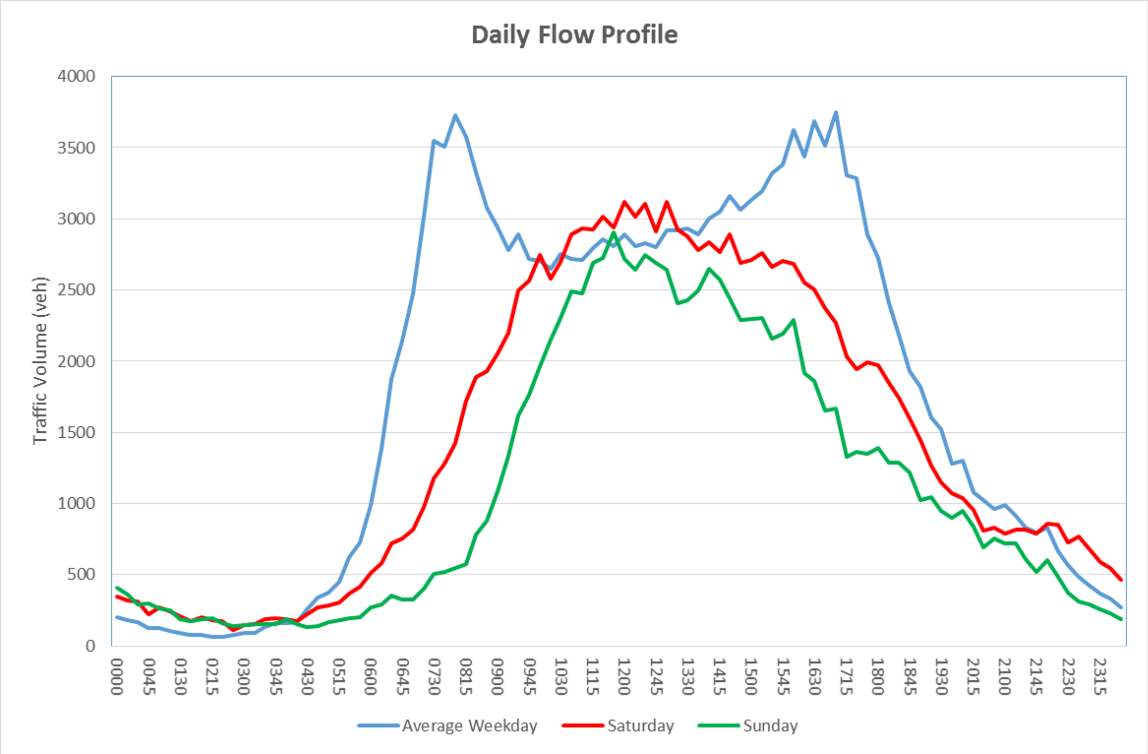
4.2.21. Observed traffic counts from nine Automatic Traffic Counts (ATC) at the RSI locations in Great Yarmouth that were collected over two weeks in November 2016, for the purpose of the base year model validation, were used to identify this profile.

4.2.22. The locations of the nine ATC counts can be found within Supporting Document 5.

4.2.23. Additional ATC and MCC data was collected in 2018 for the purpose of constructing a micro-simulation model for operational assessment of the Scheme. Examination of the 2018 ATC data, the 2016 ATC data and long term traffic counts along the A47, showed that traffic flow profiles have remained fairly static from 2016. As such this annualisation analysis is still applicable and provides consistency with the OBC submission.

4.2.24. Plate 4.1 provides a summary of the daily traffic flow profile that was produced from the ATC sites.

Plate 4.1: Traffic Flow Profile



4.2.25. As can be seen from Plate 4.1, weekday traffic volume peaks between 08:00-09:00 before reducing significantly to the inter-peak. Peak conditions re-emerge at 15:30 and continue to 17:30 before receding into the off-peak period. During weekend, the traffic volume shows similarly to the inter-peak period on Saturday with slightly lower flow on Sunday. It is therefore suggested that only about 1.5 hours for the AM and just over 2 hours for the PM period that will be used for the calculation of the benefits of the Scheme. This was based on the assumption that traffic volume in the peak shoulders of more than 90% of the peak hour volume is deemed to be appropriate to be included in the derivation of the annualisation factors. Further detail on the annualisation and non-modelled hours is provided in Supporting Document 5.

4.2.26. The following factors were applied to the relevant modelled hours to include the non-modelled hours in the calculation of the TUBA benefits, and to derive the annualisation factors as provided in Table 4.5. The source of these calculations can be found in Tables 3-3 to 3-5 in Supporting Document 5.

Table 4.5: Annualisation Factors

No	Time Slice	Duration (min)	Traffic Model	Annualisation Factor
1	Weekday AM Period	60	AM Peak Hour Model	1.51 x 253 = 383
2	Weekday Inter-Peak Period	60	Inter-Peak Hour Model	7.23 x 253 = 1,828
3	Weekday PM Period	60	PM Peak Hour model	2.20 x 253 = 556
4	Weekday Off-Peak period	60	Inter-Peak hour model	0.00 x 253 = 0
5	Weekend	60	Inter-Peak hour model	8.06 x 52 = 419
			Total Annual Hours	3,186 hours

4.2.27. Around 36% of annual hours are reflected in the annualisation. It is noted that the ATC counts were collected for two weeks during November 2016. They therefore do not represent the whole year of traffic travelling within the area, particularly during the summer seasons where weekend traffic volumes are likely to be higher than those in November.

4.2.28. Furthermore, the ATC counts during November do not include any Bank Holidays, therefore these benefits are also excluded. The annualisation factors derived for the weekends using November are therefore considered conservative in the calculation of the benefits for the Scheme.

BENEFITS AT SECTOR LEVEL

4.2.29. The geographic distribution of benefits has been assessed through an analysis of sector-based cost changes. A 10 by 10 sector system was defined for the study area to provide an overview of the distribution of benefits derived from the transport model. These sectors are illustrated in Plate 4.2 and listed in Table 4.6 below.

Plate 4.2: Sector Locations

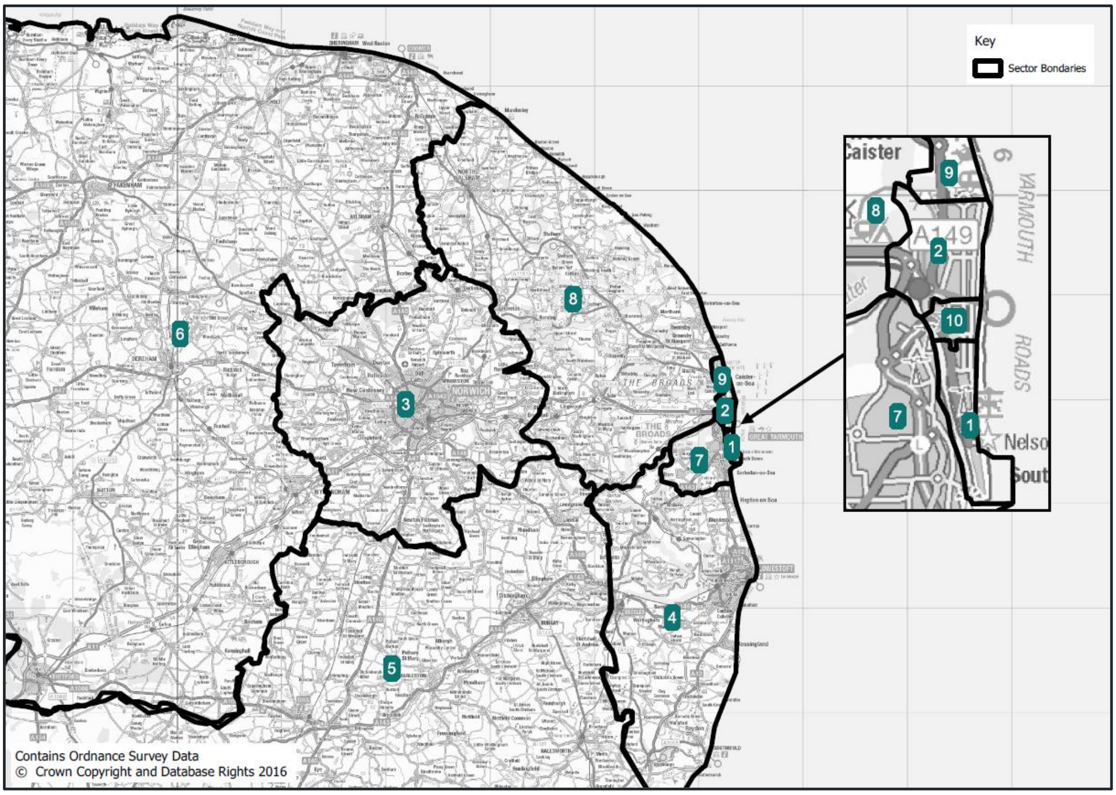


Table 4.6: Sector System

Sector	Description
Sector 1	Great Yarmouth Peninsula
Sector 2	Great Yarmouth north town
Sector 3	Norwich
Sector 4	Lowestoft
Sector 5	South (London, Ipswich, etc.)
Sector 6	North/West (Midlands, Northwest, Northeast, etc.)
Sector 7	Rural areas south of Great Yarmouth
Sector 8	North of Great Yarmouth (Winterton-on-Sea, Horsey Corner, North Walsham)
Sector 9	Caister-on-Sea
Sector 10	Great Yarmouth mid-town

4.3 ACCIDENT SAVINGS

4.3.1. The anticipated number of accidents and casualties saved as a result of the introduction of the Scheme were calculated using the DfT's software Cost and Benefit to Accidents – Light Touch (v2013_02COBA-LT).

4.3.2. As defined in the COBA-LT manual, the total cost of accidents on a network is calculated by multiplying the number of accidents predicted to occur on the network by the cost per accident. The number of accidents on a given length of road is expressed by accident rates, defined as the number of Personal Injury Accidents (PIA) per million vehicle kilometres travelled. The outputs are expressed as the change in the number of accidents and casualties when a scheme is introduced, and the economic cost implications of these changes.

4.3.3. The savings in the number of accidents / casualties as a result of the Scheme were calculated from the difference between accident and casualty costs in the Do Minimum and Do Something. The accident benefits were calculated over a 60-year appraisal period and discounted to 2010 base prices and values.

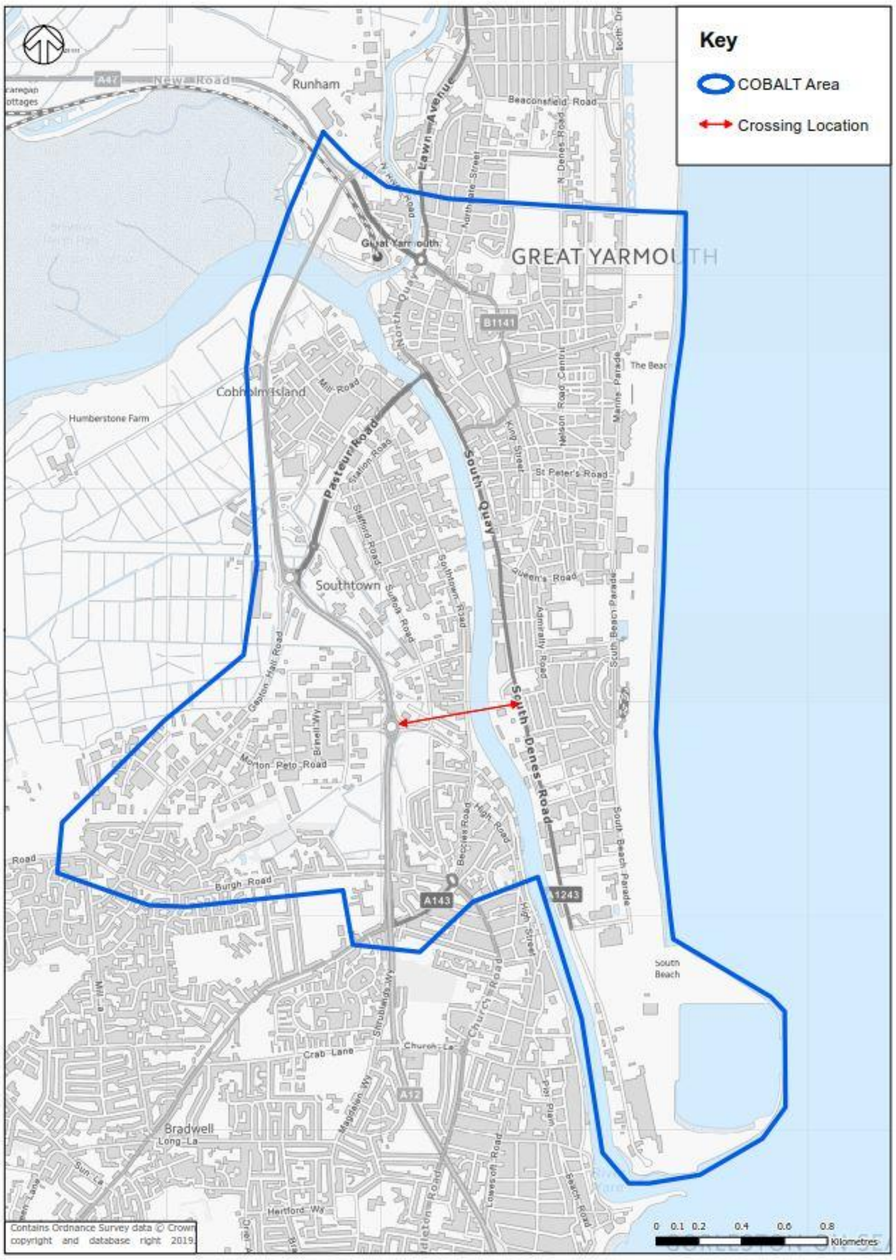
4.3.4. The latest standard economic parameter file was used which contains a series of data tables of standard parameters required to calculate accident impacts in line with TAG guidance. These data tables provide the inputs required to calculate accident and casualty numbers and costs by year using:

- Costs per accident type
- Rates of accidents and casualties of different severities by link type; and
- Junction class and allowance for changes in accident and casualty rates through time using change factors (known as beta factors).

4.3.5. Alongside the economic parameter file, the Scheme specific input file is used to produce the output file. This contains comparable information for links and junctions, setting out the classification of types, traffic flows and historical accident data.

4.3.6. The extent of the study area was based on links with differences in AADT flow of over 5% between the Do Minimum and Do Something scenarios. The resulting study area is illustrated in Plate 4.3.

Plate 4.3: COBA-LT Study Area



4.3.7. COBA-LT has the ability to run the analysis using two different modes as summarised as follows:

- Separate mode – accident benefits are calculated separately for links and junctions (defined as those accidents occurring within 20m of a junction); or
- Combined mode – accident benefits are calculated for links in such a way that the junction accidents are included.

4.3.8. The Scheme is likely to result in a considerable redistribution of traffic thus impacting flows on a number of links and junctions. It is considered appropriate to assess links and junctions separately within COBA-LT. Default accident rates were used across the COBA-LT network.

4.3.9. For each link within the study area (for both the Do Minimum and Do Something scenarios), a COBA link type was assigned from the default set of 15 available within COBA-LT. Link lengths, speed limits and AADT flows were also extracted for each link from the forecast models.

4.3.10. The COBA-LT study area includes a considerable number of junctions, including a number of minor junctions where safety is unlikely to be impacted by the Scheme. The junctions included in the assessment were selected using the following methodology:

- All junctions where at least one Personal Injury Accident (PIA) was recorded in the 6-year period between 2010 and 2015 were included. This assessment of observed accidents was undertaken for selection purposes only. No observed accidents were included in the COBA-LT input file;
- Any other major junctions likely to be impacted by the Scheme;
- The existing priority junction at Sutton Road/South Denes Road on the Peninsula (to be replaced by the new signalised junction) was included with flows in the Do Minimum scenario only; and
- The new roundabout and traffic signal junctions on the west and eastern side of the new bridge respectively were included with flows in the Do Something scenario only.

4.3.11. The locations of the junctions that were included in the COBA-LT assessment can be found in sperate document Appendix B.

4.3.12. For each junction a COBA-LT junction type was assigned from the default set of eight available. The AADT flows for each approach arm were extracted from the forecast models.

4.3.13. A summary of the COBA-LT parameters is presented in Table 4.7.

Table 4.7: Accident Benefits Calculation General Parameters

Parameter	Value
First Year of Appraisal	2023
Evaluation Period	60 Years
Traffic Flow Input Format	AADT
Type of Accident Calculations	Link and Junction Separate (SEP)
Traffic Flow Input Year	2023, 2038, 2051
Traffic Growth Assumption	Default Central (DEFC)
Economic Growth Assumption	Default Central (DEFC)
Fuel Cost Growth Assumption	Default Central (DEFC)

4.4 OTHER BENEFITS

ENVIRONMENT

4.4.1. The Environmental Appraisal of the Scheme, alongside the Noise and Air Quality impacts which informed the Distributional Impact assessment, were initially developed on a qualitative basis for OBC. These have been updated for the FBC and include quantified, qualitative and monetised assessments where required by DfT TAG Unit A3. Monetised benefits are presented for both Noise and Air Quality, and are included in the BCR calculation.

4.4.2. Greenhouse gas benefits arising from the scheme have been monetised within the TUBA appraisal and are also included in the BCR calculation.

RELIABILITY BENEFITS

4.4.3. The term reliability refers to variation in journey times that individual drivers are unable to predict (journey time variability). Such variation could come from recurring congestion at the same period each day (day-to-day variability), or from non-recurring events such as incidents. It however excludes predictable variation relating to varying levels of demand by time of day, day of week, and seasonal effects which travellers are assumed to be aware of.

4.4.4. Different methods to estimate reliability impacts have been developed for public transport and private vehicle trips on inter urban motorways and dual carriageways, urban roads, and other roads. All require a unit to measure travel time variability and this is generally the standard deviation of travel time (for private travel) or lateness (for public transport).

4.4.5. For inter-urban motorways and dual carriageways, impacts of journey time variability and incident delays is estimated using the HE's bespoke tool namely Motorways Reliability and Incident Delays (MyRIAD). For motorways and dual carriageways, alternative routes avoiding particular sections usually have limited capacity making it difficult for large number of drivers to divert if they encounter delays due to an incident, therefore, in the absence of significant demand exceeding capacity, it may be sufficient to assume that incidents are the main source of unpredictable variability.

4.4.6. For urban areas, alternative routes are more readily available than on the motorways and there are many ways for drivers to divert away from incidents which reduce capacity on a particular route.

4.4.7. Building on previous research, a model has been developed to forecast changes in the standard deviation of travel time from changes in journey time and distance, as provided in the DfT TAG Unit A1.3, Section 6 (March 2017):

$$\Delta\sigma_{ij} = 0.0018({t_{ij2}}^{2.02} - {t_{ij1}}^{2.02}){d_{ij}}^{-1.41}$$

where:

$\Delta\sigma_{ij}$ is the change in standard deviation of journey time from i to j (seconds)

t_{ij1} and t_{ij2} are the journey times, before and after the change, from i to j (seconds)

d_{ij} is the journey distance from i to j (km).

4.4.8. To estimate the monetised benefits of changes in journey time variability, monetary values are needed. The reliability ratio enables changes in variability of journey time to be expressed in monetary terms. The reliability ratio is defined as:

Reliability Ratio = Value of SD of travel time / Value of travel time

4.4.9. The recommended value for the reliability ratio for all journey purposes by car, based on evidence compiled, is 0.4 as stated in the DfT TAG Unit A1.3, Section 6.3.4 (March 2017). The reliability benefits are then can be estimated using the "rule of half" formula:

$$Benefit = -\frac{1}{2}\sum_{ij}\Delta\sigma_{ij} * (T_{ij}^{0} + T_{ij}^{1}) * VOR$$

Note that the value of reliability (VOR) is obtained by multiplying the value of time by the reliability ratio and T_{ij}^{0} and T_{ij}^{1} are number of trips before and after the change.

WIDER IMPACTS

4.4.10. Wider Impacts, as defined in DfT guidance, are the economic impacts of transport that are additional to transport user benefits. Transportation costs are intrinsically linked with regional economic performance. They impact on companies and residents acting in labour and product markets.

4.4.11. In perfectly competitive markets, these impacts would be fully captured by a properly specified appraisal. But in practice, most markets are not perfectly competitive and as a result, wider impacts may result as direct user impacts that are amplified through the economy. Previous schemes across the country have demonstrated that these impacts can be large, and can therefore be an important part of the overall appraisal of a transport scheme.

4.4.12. The types of wider impacts considered are:

- WI1 – Agglomeration;
- WI2 – Output change in perfectly competitive markets; and
- WI3 – Tax revenues arising from labour market impacts (from labour supply impacts and from moves to more or less productive jobs)

4.4.13. The Wider Impacts for the Scheme have been calculated using WSP's Wider Impacts in Transport Appraisal (WITA) emulation tool. The emulation tool, a macro-embedded spreadsheet that applies the methodology set out in DfT TAG Unit A2.1 (May 2018) has previously been accepted for use by HE, Transport for the North and the DfT for appraisal of wider impact benefits for the Trans-Pennine Tunnel and the M60 North West Quadrant. The WITA tool assesses all three types of Wider Impacts discussed above.

4.4.14. The Wider Impacts above are referenced as Level 2 benefits, based on travel cost changes impacting the existing regional economy in a "static" manner. Land use is not expected to be impacted.

4.4.15. The likely "dynamic" impact of wider impacts and regeneration in Great Yarmouth has been reported by consultant Regeneris in "Assessment of Wider Economic and Regeneration Benefits", 2017. Their appraisal of benefits and impacts is largely qualitative but quantification is also outlined with the focus of the appraisal being on the impacts on employment land and existing sites and premises, as well as on town centre regeneration and the visitor economy. There is also a commentary on demographic change and how increased investment and development activity in Great Yarmouth will lead to requirements for, and supply of, a skilled labour market. The analysis represents additional gain to the Great Yarmouth economy based on changes to land use, primarily earlier realisation of development sites related to the availability of the Third River Crossing. This report is discussed further in the Case for The Scheme. The quantified outputs are not included in this report.

Regeneration

4.4.16. Regeneration benefits (as defined by DfT) are not included in the calculation of the adjusted BCR, and are reported here as qualitative benefits as part of the Strategic Case. This is because there is no "dependent development" associated with the Scheme, and therefore no calculable land value uplift (planning gain) that is directly attributable. It is likely that the regeneration benefits form a component of potential Level 3 “dynamic clustering” impacts, although the levels of assurance around such benefits are necessarily lower than those lodged under Level 1 (transport economic) and Level 3 (wider impact) benefits. Hence the exclusion of monetised regeneration impacts is considered a conservative approach to the calculation of scheme benefits.

ACTIVE MODE BENEFITS

4.4.17. As a result of the Scheme, pedestrians and cyclists will have better access to the Great Yarmouth peninsula and a more pleasant environment. Dedicated facilities on the new bridge will improve journey quality and encourage more people to walk or cycle. These impacts are expected to produce economic benefits due to:

- Increased physical activity leading to lower healthcare costs;
- Less absenteeism and fewer working days lost;
- The value placed on improved journey quality and ambience; and
- Time savings for cyclists and pedestrians.

4.4.18. To quantify these benefits, an active mode appraisal has been conducted over a 30-year appraisal period in line with TAG guidance. Benefits for physical activity, absenteeism and journey quality and ambience has been assessed using the DfT’s Active Mode Appraisal Toolkit (May 2019).

4.4.19. Benefits for time savings for cyclists and pedestrians have been calculated using the rule of a half.

4.4.20. The benefits have been calculated over a 30-year appraisal period. All benefits have been calculated in 2010 prices, discounted to 2010. The benefits calculation also allows for real growth in line with forecast GDP/capita.

4.4.21. A full report on the calculation of active modes benefits is contained in the Active Modes Appraisal Report (Supporting Document 2).

4.5 SOCIAL AND DISTRIBUTIONAL IMPACT (SDI) ANALYSIS

4.5.1. The analysis of distributional impacts is mandatory in the appraisal process and is a key component of the Appraisal Summary Table (AST). The Distributional Impacts Appraisal compares the distribution of benefits arising from a transport intervention against the different social groups to assess the extent to which benefits are experienced by those groups and compared nationally.

4.5.2. Distributional impacts consider the benefits and disbenefits that transport interventions have across different social groups. For example, people with access to a car may experience less benefits to those without a car for an intervention that improves local public transport services. It is important to consider vulnerable groups and that they are not disadvantaged further by receiving a disproportionately low share of the benefits provided by the intervention, or a disproportionately high share of the disbenefits.

4.5.3. Within DfT TAG Unit A4.2 (December 2015), there are eight transport benefit indicators that are assessed as part of the Distributional Impacts Appraisal:

- User benefits;
- Noise;
- Air quality;
- Accidents;
- Security;
- Severance;

- Accessibility; and
- Personal affordability.

4.5.4. The appraisal approach consists of the following three steps:

- Step 1 – Screening Process:
  - Identification of likely impacts for each indicator.
- Step 2 – Assessment:
  - Confirmation of the area impacted by the transport intervention (impact area)
  - Identification of social groups in the impact area; and
  - Identification of amenities in the impact area.
- Step 3 – Appraisal of Impacts:
  - Core analysis of the impacts; and
  - Full appraisal of DIs and input into AST.

4.5.5. A full report on the methodology and outputs of the SDI analysis which has been updated from its original OBC submission for the purposes of this FBC application is contained in Supporting Document 3.

5 ECONOMIC APPRAISAL RESULTS

5.1 INTRODUCTION

5.1.1. This section of this report provides the results of the appraisal of user benefits and accident cost savings.

5.2 USER BENEFITS (TUBA)

5.2.1. The user benefits derived from the Scheme in the core scenario appraisal are summarised in Table 5.1.

Table 5.1: TUBA Benefits (£000, 2010 prices discounted to 2010)

Cost and Benefits	Core Scenario (£,000)
Consumer User (Commute)	42,125
Consumer User (Other)	95,815
Business User and Provider	77,213
Indirect Tax Revenue	-5,747
Greenhouse Gases	2,951
Present Value of Benefits (PVB)	212,357

Benefits by Time Period

5.2.2. The contribution by type of benefit and by time period is summarised in Table 5.2 and Plate 5.1.

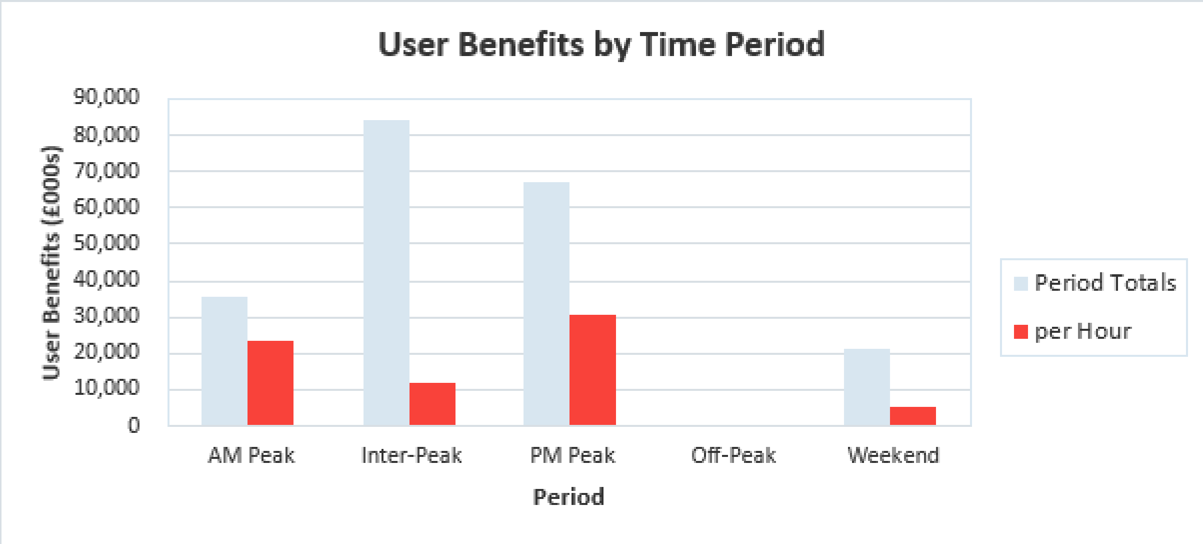
5.2.3. User Benefits (excluding costs associated with non-fuel Vehicle Operating Costs (VOC), greenhouse gases and indirect tax revenue) across the 60-year appraisal period are £208 million, of which 93% are made up of time savings, with the other 7% being made up of fuel based VOCs. It is noted that there is a significantly larger contribution in total benefits from the PM period than the AM period in years 2038, 2051 and over the appraisal period as a whole.

Table 5.2: User Benefits by Types and Time Period (£000, 2010 prices discounted to 2010)

Period	Type	2023	2038	2051	60 Years
AM Period	Time Savings	420	485	689	33,491
AM Period	VOC (fuel only)	65	44	39	2,224
AM Period	**Total**	**485**	**529**	**728**	**35,715**
AM Period	*per Hour*	*320*	*349*	*481*	*23,592*
Inter-Peak Period	Time Savings	1,071	1,096	1,576	77,204
Inter-Peak Period	VOC (fuel only)	209	138	113	6,726
Inter-Peak Period	**Total**	**1,280**	**1,234**	**1,689**	**83,930**
Inter-Peak Period	*per Hour*	*177*	*171*	*234*	*11,616*
PM Period	Time Savings	590	925	1,356	63,740
PM Period	VOC (fuel only)	81	66	62	3,328
PM Period	**Total**	**671**	**991**	**1,418**	**67,068**
PM Period	*per Hour*	*305*	*451*	*645*	*30,518*
Weekend	Time Savings	273	280	403	19,733
Weekend	VOC (fuel only)	48	32	26	1,542
Weekend	**Total**	**321**	**312**	**429**	**21,275**
Weekend	*per Hour*	*80*	*77*	*106*	*5,281*
Total	**Time Savings**	**2,354**	**2,786**	**4,024**	**194,168**
Total	**VOC (fuel only)**	**403**	**280**	**240**	**13,820**
Total	**Total**	**2,757**	**3,066**	**4,264**	**207,988**

Note: All values are abstracted from TUBA outputs and may contain rounding discrepancies.

Plate 5.1: User Benefits by Time Period



5.2.4. Further to the aforementioned, it can be seen that user benefits increase over the forecast years consistently across all the time periods. The order of magnitude of benefits by time periods are plausible with the highest benefits per hour attributed to the AM and PM periods. The levels of delay in the AM and PM period hours are significantly higher than those in the Inter-peak or weekend periods.

Benefits by Trip Purpose

5.2.5. Table 5.3 summarises travel time benefits by journey purpose. Some 30% of these savings are realised by freight movements whereas 44% of benefits are accrued by 'others' journey purposes. This is expected given the nature of the area (i.e. to serve as a major attraction for tourism and as a port for freight). Around 19% of benefits are attributed to commuters and 7% to business users (car).

Table 5.3:Travel Time Savings by Trip Purpose (£000, 2010 prices discounted to 2010)

Purpose	Travel Time	Vehicle Operating Cost	Total	Proportion
Commuting	41,191	934	42,125	19.6%
Other	88,640	7,175	95,815	44.5%
Business (Car)	12,890	1,836	14,726	6.8%
Business (Freight)	51,447	11,040	62,487	29.0%
Total	**194,168**	**20,985**	**215,153**	**100.0%**

Note: All values are abstracted from TUBA outputs and may contain rounding discrepancies.

User Benefits by Vehicle Type and Magnitude of Time Savings

5.2.6. Table 5.4 provides a breakdown of travel time savings by car, LGV and OGV and the size of the time savings accrued by each vehicle type.

Table 5.4: Travel Time Savings by Vehicle Type (£000, 2010 prices discounted to 2010)

Veh. Type	Purpose	< -5min	-5 to -2min	-2 to 0min	0 to 2min	2 to 5min	> 5min	Total
Car	Business	-13	-5	-691	5,582	4,528	3,490	12,891
Car	Commuting	0	-1	-2,106	13,032	15,283	14,982	41,190
Car	Other	-2	-18	-6,346	36,883	32,777	22,666	85,960
LGV	Personal	-2	-2	-171	898	961	996	2,680
LGV	Freight	-30	-27	-2,667	13,987	15,134	15,556	41,953
OGV1	Business	-2	-5	-340	1,092	1,048	2,004	3,797
OGV2	Business	-2	-7	-510	1,638	1,572	3,006	5,697
All	All	-51	-65	-12,831	73,112	71,303	62,700	194,168

5.2.7. Table 5.4 shows that the majority of time savings are realised by those driving cars (72%). LGV's make up around 23% of savings whereas 5% of overall travel time savings are enjoyed by OGVs.

5.2.8. Benefits arise across all the time saving bands, which is expected as the objectives of the new bridge are to shorten travel time and distances for traffic to/from the Peninsula and also to relieve congestion. It is noted that a small proportion of dis-benefits are forecast and this is also expected as some of the local traffic would suffer delays as increases in traffic in the peninsula arise from traffic re-assignment.

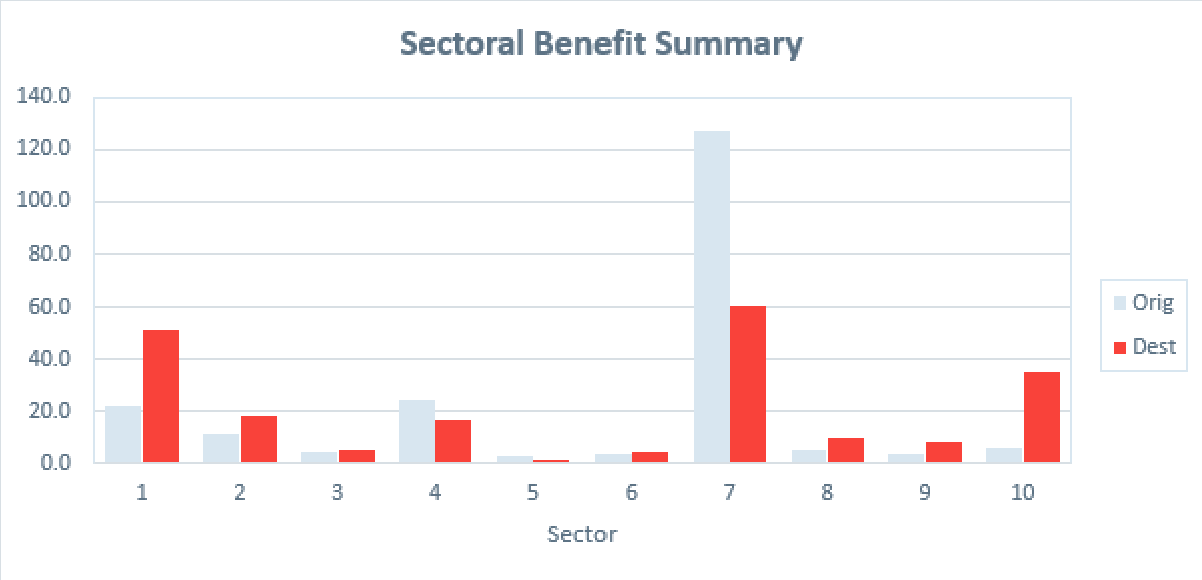
Geographical Distribution of Time Benefits

5.2.9. Guidance recommends that an aggregation of modelled zones into different geographical areas should be used in the TUBA analysis. This is to ensure that the benefits produced by the Scheme are geographically proportionate given the scale and location of the Scheme.

5.2.10. The distribution of benefits has the same sector system as described in section 4.2 of this report.

5.2.11. Plate 5.2 shows the majority of the benefits are between sector 7 (south of Great Yarmouth), and the Peninsula (sectors 1 and 10). It is noted that the benefits are not proportional and that there are larger benefits associated with northbound movements as opposed to southbound movements.

Plate 5.2: User Benefits by Sector



5.2.12. It is also noted that greenhouse gas benefits are not included in Plate 5.2.

5.3 SAFETY BENEFIT ASSESSMENT

5.3.1. Table 5.5 summarises the accident benefits generated by the Scheme over the 60-year appraisal period, discounted to 2010 prices. The Scheme is forecast to save 20 accidents with a resultant benefit of £0.9 million.

Table 5.5: Scheme Accident Benefits

	DM	DS	Saving
Number of Accidents	5,174	5,154	20
Cost of Accidents (£000)	187,885	186,938	947

5.3.2. Table 5.6 summarises the savings in casualties. The Scheme is forecast to result in a saving of 54 casualties over the 60-year appraisal period.

Table 5.6: Scheme Casualty Benefit

Severity	DM	DS	Saving
Fatal	30	30	0
Serious	437	436	1
Slight	6,770	6,717	53
Total	**7,237**	**7,183**	**54**

5.3.3. Accident savings are broken down by links and junctions in Table 5.7. It can be seen that the accident savings are largely associated with savings at junctions. This can be attributed to the removal of trips from a number of junctions, resulting in a reduction in collisions, due to the reassignment of trips.

Table 5.7: Accident Savings over 60 Years (£000, 2010 prices discounted to 2010)

Location	DM
Links Only	52
Junction Only	895
Total	**947**

5.3.4. Over the 60-year appraisal period, the overall impact of accident cost savings is £0.9m, with accidents making up just under 1% of total scheme benefits.

5.4 ENVIRONMENTAL BENEFITS

NOISE

5.4.1. Noise increases occur in the area immediately surrounding the Scheme and along routes to the north east, at receptors on and around Nelson Road Central, Nelson Road South and Blackfriars' Road. Noise increases also occur at receptors on Beccles Road south of the Scheme. Noise decreases are concentrated in the residentials areas to the east and west of the existing Haven Bridge.

5.4.2. The net present value of change in noise for a 60-year appraisal period is given in Table 5-8.

Table 5-8 – Net Present Value of Change in Noise (£000, 2010 prices discounted to 2010)

Category	NPV (£000)
Net present value of impact on sleep disturbance (£):	-721
Net present value of impact on amenity (£):	-450
Net present value of impact on AMI (£):	-144
Net present value of impact on stroke (£):	-37
Net present value of impact on dementia (£):	-56
Net present value of change in noise (£):	**-1,408**

5.4.3. The TAG worksheets for noise assessment can be found in separate document Appendix C of the FBC Submission. Plots showing the change in noise are included in the Social and Distributional Impacts Report (Supporting Document 3).

AIR QUALITY

5.4.4. Air quality deteriorates in the areas around Beccles Road, Southtown Road (near the Scheme) and on the peninsula immediately to the north of the Scheme tie in. Air quality improves in the areas around Gapton Hall Road, Pasteur Road / Haven Bridge, Southtown Road (north of the Scheme), east of A47 approach to Breydon Bridge, and on the peninsula around the town centre and Haven Bridge.

5.4.5. The net present value of change in air quality for a 60 year appraisal period is given in Table 5-9.

Table 5-9 – Net Present Value of Change in Air Quality (£000, 2010 prices discounted to 2010)

Category	NPV (£000)
Present value of change in NO_2 concentrations	-117
Present value of change in $PM_{2.5}$ concentrations	-269
Net present value of impact on AMI (£):	-386

5.4.6. The TAG worksheets for air quality assessment can be found in separate document Appendix C of the FBC Submission. Plots showing the change in air quality are included in the Social and Distributional Impacts Report (Supporting Document 3).

5.5 RELIABILITY BENEFITS

5.5.1. Table 5.10 provides a summary of the reliability benefits of the Scheme from the core scenario for each appraisal year and the total over 60 years.

5.5.2. It is calculated that the present value of the reliability benefits for the Great Yarmouth Third River Crossing over the 60-year appraisal period is £11.3 million (2010 prices).

Table 5.10: Reliability Benefits –Core Scenario (£000, 2010 prices discounted to 2010)

Purpose	2023	2038	2051	Total (60 years)
Business	17	20	32	1,497
Non-Business	89	111	222	9,796
Total	**106**	**130**	**253**	**11,292**

5.6 WIDER IMPACT BENEFITS

5.6.1. Wider Impacts have been calculated using WSP's Wider Impacts in Transport Appraisal (WITA) emulation tool which applies the methodology set out in DfT TAG Unit A2.1 (May 2018). The initial WITA benefit was £96.5 million, of which £89.4 million was attributable to agglomeration benefits, equivalent to 42% of the TUBA benefits.

5.6.2. Census Journey to Work information was used to scale the agglomeration benefits to reflect the proportion of commute trips from each local authority that would reasonably be affected by the Scheme. Using this method, it is calculated that the present value of these wider benefits for the Great Yarmouth Third River Crossing over the 60-year appraisal period is £68.3 million, of which £61.2 million is due to agglomeration, equivalent to 28% of the TUBA benefits.

5.6.3. All values are in 2010 prices discounted to 2010.

5.6.4. Full details are given in Supporting Document 4.

5.7 ACTIVE MODE BENEFITS

5.7.1. The Present Value of Benefits for each active mode impact are summarised in Table 5.11 It is calculated that the present value of the active modes benefits for the Scheme, over a 30 year appraisal period, is £12.7 million (2010 prices).

Table 5.11: Present Value of Active Mode Impacts over 30 Year Appraisal Period (£000, 2010 prices discounted to 2010)

Impact	Pedestrian	Cycle user	Total
Physical Activity (Health)	2,698	2,662	5,361
Absenteeism	849	609	1,459
Journey Quality/Ambience	984	788	1,772
Journey Time	3,489	226	3,715
Total	**8,021**	**4,286**	**12,307**

5.7.2. A full report is included in Supporting Document 2.

5.8 SOCIAL AND DISTRIBUTIONAL IMPACT BENEFITS

5.8.1. The social and distributional impact assessment has been updated, where it has been possible to do so, in line with the state of development of the Scheme. The indicators and their respective assessments can be found in separate document Appendix E – Social and Distributional Impacts and are summarised as follows:

- User Benefits – Large Beneficial;
- Noise – Large Beneficial;
- Air Quality – Moderate Adverse;
- Accidents – Slight Adverse;
- Severance – Slight Beneficial; and
- Personal Affordability – Large Beneficial.

5.8.2. The following indicators were considered to be out of scope during the initial screening proforma:

- Security; and
- Accessibility.

5.8.3. Further details are given in the Social and Distributional Impacts report (Supporting Document 3).

5.9 TRANSPORT ECONOMIC EFFICIENCY (TEE)

5.9.1. The results of the appraisal in terms of user costs and benefits are summarised in the Transport Economic Efficiency (TEE) table, reproduced in Table 5.12. This can be found in separate document Appendix G of the FBC submission.

Table 5.12: Transport Economic Efficiency (TEE)

	ALL MODES		ROAD		BUS and COACH	RAIL		OTHER
Non-business: Commuting								
User benefits	TOTAL		Private Cars and LGVs		Passengers	Passengers		
Travel time	£ 41,191		41,191					
Vehicle operating costs	£ 934		934					
User charges	£ -		0					
During Construction & Maintenance	£ -		0					
NET NON-BUSINESS BENEFITS: COMMUTING	£ 42,125	(1a)	**42,125**					
Non-business: Other	ALL MODES		ROAD		BUS and COACH	RAIL		OTHER
User benefits	TOTAL		Private Cars and LGVs		Passengers	Passengers		
Travel time	£ 88,640		88,640					
Vehicle operating costs	£ 7,175		7,175					
User charges	£ -		0					
During Construction & Maintenance	£ -		0					
NET NON-BUSINESS BENEFITS: OTHER	£ 95,815	(1b)	**95,815**					
Business								
User benefits			Good Vehicles	Business Cars/LGVs	Passengers	Freight	Passengers	
Travel time	£ 64,337		51,447	12,890				
Vehicle operating costs	£ 12,876		11,040	1,836				
User charges	£ -		0	0				
During Construction & Maintenance	£ -		0	0				
Subtotal	£ 77,213	(2)	**62,487**	**14,726**				
Private sector provider impacts						Freight	Passengers	
Revenue	£ -							
Operating costs	£ -							
Investment costs	£ -							
Grant/subsidy	£ -							
Subtotal	£ -	(3)						
Other business impacts								
Developer contributions		(4)						
NET BUSINESS IMPACT	£ 77,213	(5) = (2) + (3) + (4)						
TOTAL								
Present Value of Transport Economic Efficiency Benefits (TEE)	£ 215,153	(6) = (1a) + (1b) + (5)						

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2010 prices and values

5.10 PUBLIC ACCOUNTS

5.10.1. A summary of the Scheme costs and their allocation between providers is accounted for in the Public Accounts (PA) table, shown in Table 5.13. The apportionment of funding between local and central government is detailed further in the FBC Financial Case. The Local Authority contribution is approximately 21%. This can also be found in separate document Appendix F of the FBC submission.

Table 5.13: Public Accounts (PA)

	ALL MODES TOTAL		ROAD INFRASTRUCTURE	BUS and COACH	RAIL	OTHER
Local Government Funding						
Revenue						
Operating Costs	£ 4,172		£ 4,172			
Investment Costs	£ 11,974		£ 11,974			
Developer and Other Contributions						
Grant/Subsidy Payments						
NET IMPACT	£ 16,146	*(7)*	£ 16,146			
Central Government Funding: Transport						
Revenue						
Operating costs						
Investment Costs	£ 62,607		£ 62,607			
Developer and Other Contributions						
Grant/Subsidy Payments						
NET IMPACT	£ 62,607	*(8)*	£ 62,607			
Central Government Funding: Non-Transport						
Indirect Tax Revenues	£ 5,747	*(9)*	£ 5,747			
TOTALS						
Broad Transport Budget	£ 78,753	*(10) = (7) + (8)*				
Wider Public Finances	£ 5,747	*(11) = (9)*				

Notes: Costs appear as positive numbers, w hile revenues and 'Developer and Other Contributions' appear as negative numbers.

All entries are discounted present values in 2010 prices and values.

5.11 SUMMARY OF MONETISED COSTS AND BENEFITS

5.11.1. A summary of all costs and benefits, providing an overall BCR for the Scheme is provided in Table 5.14 (also can be found in separate document Appendix H of the FBC submission). The total monetised benefits exceed the costs by £145.1 million. The initial BCR of the Scheme is 2.8. This means that the value for money category is high.

5.11.2. This initial value of BCR includes monetised benefits of noise and air quality impact, accident savings, greenhouse gas reductions and indirect taxation impacts, but does not include benefits accruing from reliability or wider impacts.

Table 5.14: Analysis of Monetised Costs and Benefits (AMCB)

Analysis of Monetised Costs and Benefits			
Noise	-£	1,408	*(12)*
Local Air Quality	-£	386	*(13)*
Greenhouse Gases	£	2,951	*(14)*
Journey Quality	£	5,488	*(15)*
Physical Activity	£	6,819	*(16)*
Accidents	£	947	*(17)*
Economic Efficiency: Consumer Users (Commuting)	£	42,125	*(1a)*
Economic Efficiency: Consumer Users (Other)	£	95,815	*(1b)*
Economic Efficiency: Business Users and Providers	£	77,213	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	£	5,747	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Present Value of Benefits (see notes) (PVB)	£	223,817	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)*
Broad Transport Budget	£	78,753	*(10)*
Present Value of Costs (see notes) (PVC)	£	78,753	*(PVC) = (10)*
OVERALL IMPACTS			
Net Present Value (NPV)	£	145,064	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)		2.84	BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

5.11.3. Table 5.15 demonstrates that the inclusion of reliability benefits and wider economic impacts gives an adjusted BCR of 3.9. Businesses will benefit from reduced congestion, faster journeys and improved journey time reliability, with reduced costs and better access to markets, whilst commuters will similarly benefit from shorter, more reliable, journeys to work. These benefits, which are included in the BCR calculations will support local development and the regeneration of the Great Yarmouth economy.

Table 5.15: Adjusted BCR (£000, 2010 prices discounted to 2010)

Adjusted BCR	**2010 prices £000**
Initial Present Value of Benefits (PVB)	223,817
Wider Impacts – Reliability	11,292

Wider Impacts – Economic	68,338
Adjusted Present Value of Benefits (PVB)	303,448
Present Value of Costs (PVC)	78,753
Net Present Value (NPV)	224,695
Adjusted BCR	3.9

5.11.4. The Scheme is expected to lead to a reduction in greenhouse gas emissions based upon the TUBA output; these have been monetised and included in the BCR.

5.12 SENSITIVITY TESTS

5.12.1. In order to understand how sensitive the benefits are to a range of alternative parameters, a number of tests have been performed:

- Alternative growth scenarios – low and high growth as defined by DfT guidance (DfT TAG Unit M4 Forecasting and Uncertainty (May 2018));
- Alternative economic growth projection; and
- Alternative carbon valuation

Alternative Growth Scenarios

5.12.2. The results of the appraisal for the low and high growth sensitivity tests are shown in Table 5.16.

5.12.3. The results show that benefits are much larger in the high growth scenario with a value for money categorisation of very high. Even the low growth scenario has significant benefits and a value for money categorisation of high.

Table 5.16: Alternative Growth Scenario TUBA Benefit Sensitivity Tests (£000, 2010 prices discounted to 2010)

Benefits	Low Growth	Core	High Growth
Noise#	-1,408	-1,408	-1,408
Local Air Quality#	-386	-386	-386
TUBA: Consumer –Commuting user benefits	29,597	42,125	55,666
TUBA: Consumer – other user benefits	67,557	95,815	132,940
TUBA: Business benefits	56,452	77,213	104,043
TUBA: Indirect Tax Revenue	-4,785	-5,747	-6,798
TUBA: Greenhouse Gases	2,400	2,951	3,533
COBA-LT Accident Benefits	3,006	947	-2,150
Active Mode Appraisal	8,688	12,307	15,919

Initial Present Value of Benefits (PVB)	**161,121**	**223,817**	**301,359**
Initial BCR	**2.0**	**2.8**	**3.8**
Additional Benefits: Reliability Benefits	6,228	11,292	18,317
Additional Benefits: Wider Impacts	57,250	68,338	78,918
Final Present Value of Benefits (PVB)	**224,600**	**303,448**	**398,595**
PVC	**78,753**	**78,753**	**78,753**
BCR	**2.9**	**3.9**	**5.1**
VfM	**High**	**High**	**Very High**

Low and High Growth Noise and Air Quality Impacts assumed to be same as Core

Alternative Economic Growth Projection

5.12.4. A sensitivity test has been undertaken to establish the impact that changes to long-term economic projections would have on the benefits of the Scheme. This has been undertaken using a sensitivity test version of TUBA, COBA-LT and WITA dataset that accounts for updated long-term economic projections published by the Office of Budget Responsibility in March 2020. The results are compared to the core scenario in Table 5.17 below.

Table 5.17: Core and Alternative Economic Growth TUBA benefits sensitivity tests (£,000s, 2010 prices, discounted to 2010)

Benefits	**Core**	**Alternative Economic Growth**
Noise	-1,408	1,408
Local Air Quality	-386	-386
TUBA: Consumer –Commuting user benefits	42,125	35,382
TUBA: Consumer – other user benefits	95,815	80,892
TUBA: Business benefits	77,213	66,380
TUBA: Indirect Tax Revenue	-5,747	-5,531
TUBA: Greenhouse Gases	2,951	2,785
COBA-LT: Accident Benefits	947	969
Active Mode Appraisal	12,307	12,307
Initial Present Value of Benefits (PVB)	**223,817**	**191,390**
Initial BCR	**2.8**	**2.4**

Additional Benefits: Reliability Benefits	11,292	11,292
Additional Benefits: Wider Impacts	68,338	58,497
Final Present Value of Benefits (PVB)	**303,448**	**261,179**
PVC	**78,753**	**78,753**
BCR	**3.9**	**3.3**
VfM	**High**	**High**

Alternative Carbon Valuation

5.12.5. Where the carbon impacts of a proposed scheme are monetised using published carbon values, a high carbon values sensitivity test is now required. This requirement reflects recent changes in the UK's domestic and international targets for reducing GHG emissions as well as an ongoing cross-government review of carbon valuation.

5.12.6. The sensitivity test is conducted by extracting the high value carbon from the TUBA output and noting how that affects the overall scheme Value for Money. The core and other sensitivity tests use the central valuation of carbon. The results are shown in Table 5.18 below.

Table 5.18: Core Scenario vs Core with Additional Weekend and Bank Holiday Hours (£000)

Benefits	**Core**	**Core with High Carbon**
Noise	-1,408	-1,408
Local Air Quality	-386	-386
TUBA: Consumer – Commuting user benefits	42,125	42,125
TUBA: Consumer – other user benefits	95,815	95,815
TUBA: Business benefits	77,213	77,213
TUBA: Indirect Tax Revenue	-5,747	-5,747
TUBA: Greenhouse Gases	2,951	4,554
COBA-LT: Accident Benefits	947	947
Active Mode Appraisal	12,307	12,307
Initial Present Value of Benefits (PVB)	**223,817**	**225,420**
Initial BCR	**2.8**	**2.9**

Additional Benefits: Reliability Benefits	11,292	11,292
Additional Benefits: Wider Impacts	68,338	68,338
Final Present Value of Benefits (PVB)	**303,448**	**305,051**
PVC	**78,753**	**78,753**
BCR	**3.9**	**3.9**
VfM	**High**	**High**

5.12.7. The use of high value carbon in the assessment produces a slight increase in benefits as the scheme reduces the amount of carbon emitted. This does not change the value for money of the scheme.

5.13 APPRAISAL SUMMARY

5.13.1. An Appraisal Summary Table (AST) is a requirement for a TAG compliant business case submission. It records all the impacts which have been assessed and described above – economic, environmental, social and public account impacts – assessed using monetised, quantitative or qualitative information as appropriate.

5.13.2. The AST submitted as part of the FBC can be found in separate document Appendix C.

6 SUMMARY

6.1 PURPOSE

6.1.1. The purpose of this report has been to produce an EAR to support the FBC submission. The report details how the benefits and costs of the Great Yarmouth Third River Crossing scheme have been derived for the economic appraisal and to present the results.

6.2 ECONOMIC APPRAISAL PROCESS

6.2.1. The economic appraisal has been undertaken in accordance with the relevant guidance documents (WebTAG). Industry-standard computer programmes TUBA and COBA-LT have been used to undertake the user benefit and accident appraisals respectively. All other monetised benefits have been calculated in line with the latest TAG guidance at the time.

6.2.2. The study area used for the economic analysis has been based on the study area used for the strategic traffic model. All traffic data used in the economic appraisal is consistent with those presented in the Traffic Forecasting Report.

6.2.3. The economic appraisal has been undertaken over the standard 60-year appraisal period. All costs and benefits have been deflated and discounted to the Present Value Year of 2010.

6.2.4. The different types of benefits which are being assessed as part of the economic analysis, and the methodology used to calculate and monetise them, are as follows:

- Travel time savings which involves multiplying savings by monetary values and user benefits using TUBA;
- Vehicle Operating Costs (VOCs), which is a mixture of increases and decreases, due to changes in fuel consumption and changes in distances travelled was also assessed using TUBA;
- Carbon emissions (both in tonnes and in monetary terms) for the life of the Scheme was estimated using TUBA;
- Accident saving benefits assessed using COBA-LT;
- Noise and Air Quality benefits calculated using TAG workbooks;
- Reliability Benefits calculated manually following TAG;
- Wider Impacts Benefits calculated manually following TAG; and
- Active Model Appraisal Benefits calculated both manually and using TAG Active Mode Appraisal Toolkit.

6.3 RESULTS

6.3.1. The Scheme produces significant time savings, improves safety and reduces carbon emissions.

6.3.2. The total scheme Present Value of Benefits (PVB) is £303.4 million (2010 prices) for the core scenario. The total Present Value of Costs (PVC) of the Scheme is £78.8 million (2010 prices).

6.3.3. The Wider Impacts Benefits produced by the Scheme is £68.3 million (2010 prices).

6.3.4. The BCR for the core scenario is 2.8 with an adjusted BCR of 3.9 (including reliability and wider benefits). The BCR for the core scenario using alternative OBR economic projections is 2.4 with an adjusted BCR of 3.3. The BCR for the low growth scenario is 2.0 with an adjusted BCR of 2.9. Therefore, the Scheme offers high value for money under all scenarios appraised.

6.3.5. In accordance DfT's Value for Money Framework, schemes with a BCR over 2.0 represent a high value for money.

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