Oxford to Cambridge Expressway

Corridor Assessment Report

Appendix C: Growth and Economic Assessment Report

PCF Stage 1

June 2018

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Contents

Executive Summary

This Growth and Economic Assessment Appendix presents the findings of the enabled development and economic growth modelling for the Oxford to Cambridge Expressway to inform the Stage 1A corridor selection process. This includes an assessment of the potential role of the Project in enabling new homes, new employment space and new jobs.

The analysis has also carried out sensitivity tests to illustrate how the Oxford to Cambridge Expressway in combination with East West Rail (EWR) and other public transport could enable higher development densities, reduced land take (for the same scale of development), and give the potential for modal shift towards non-car transport to in effect increase capacity and enable further development.

No decisions have been made by government at this stage on if, how much and where extra growth is planned in the corridor. Consequently, this analysis focuses on considering how much growth could by enabled by the Project if it were to go ahead. The scale of growth potentially enabled only takes in to account the potential ability of the Oxford to Cambridge Expressway to accommodate traffic associated with the growth. The potential scale of development does not take in to account other factors such as environmental constraints. Further work would be needed to consider to what degree they influence the scale of potential growth.

Overall the assessment has identified the following:

- All corridor options have the potential to enable significant amounts of new housing and employment if it were decided to plan for and allocate such growth.
- Corridor C2/C3, followed by B2/B3, will potentially enable the most new homes. This is due to the assessed greater spare capacity of the Oxford to Cambridge Expressway junctions for these corridors. Higher spare capacity is a result of less existing or future planned development in these areas and therefore less traffic flow. Enabled development is less along corridors which are already more heavily developed, such as Corridor A.
- Partly as a consequence of the higher level of enabled development, Corridors C2/C3 and B2/B3 are also modelled to have the greatest impact in terms of the number of workers and jobs enabled. However, productivity and economic growth impacts are estimated to be greater along Corridor B than C. This is due to the improved connectivity, travel time savings, and improved linkages to existing clusters of high value knowledge economy for Corridor B options.
- Corridors B1 and C1, to the north and west of Oxford, are most closely aligned with EWR and its stations, and are consequently modelled to benefit the most from the multi-modal corridor in terms of providing the potential for increased density and reduced land take.
- This assessment is heavily dependent on the modelled capacity and the number and location of the junctions on the Oxford to Cambridge Expressway. Junction capacity could change, and greater capacity delivered in locations to enable new town development for example. Also the Oxford to Cambridge Expressway could free up capacity on other roads, and therefore enable wider growth, and this could be relevant in existing congested areas. However, this impact has not been modelled at this stage. As such these figures provide a high level review of development enabled based on the assumed conditions modelled.

In summary while the enabled development impacts are fairly similar for Corridor C2/C3 and B2/B3, the additional productivity and economic benefits along Corridor B2/B3 suggest that in the longer term this corridor could provide the greatest growth benefits.

The main CAR details how the findings of this growth modelling has been applied to the relevant Strategic and Intervention Objectives set by Highways England and the Department for Transport.

1. Introduction

1.1 Background

Highways England (HE) is preparing an assessment of the overall case for investment in the Oxford to Cambridge Expressway and appraisal of corridor and route options. Assessment of the enabled development and economic growth potential is required to support the appraisal.

The enabled development and economic growth potential analysis will feed into a sifting process which will include traffic and transport, environmental (relating to the road), engineering, highway design and cost considerations and support in the identification of a preferred corridor and route alignment for the Oxford to Cambridge Expressway. The analysis will also inform the wider economic impact assessment for the investment. It will be used by HE to plan for the development of the new route.

The project is progressing through Highways England Project Control Framework (PCF) at Stage 1.

1.2 This Appendix

The Corridor Assessment Report (CAR) presents the findings of Stage 1A of the PCF process and presents a comparative analysis of each corridor to identify an optimal corridor option for the Oxford to Cambridge Expressway, which will be progressed to Stage 1B assessment (route analysis).

This Growth and Economic Assessment Appendix sets out the results of the enabled development and economic growth modelling. This report includes the following sections:

- Methodology
- Growth modelling results
- Econometric modelling results
- Conclusions and next steps.

2. Enabled Development Methodology

2.1 Introduction

This section provides a high-level overview of the methodology applied at this stage to support the corridor selection process. This includes an overview of the various stages of the assessment, approach to modelling enabled development, scenarios tested, core assumptions, and caveats and limitations of the assessment which should be considered when interpreting the results.

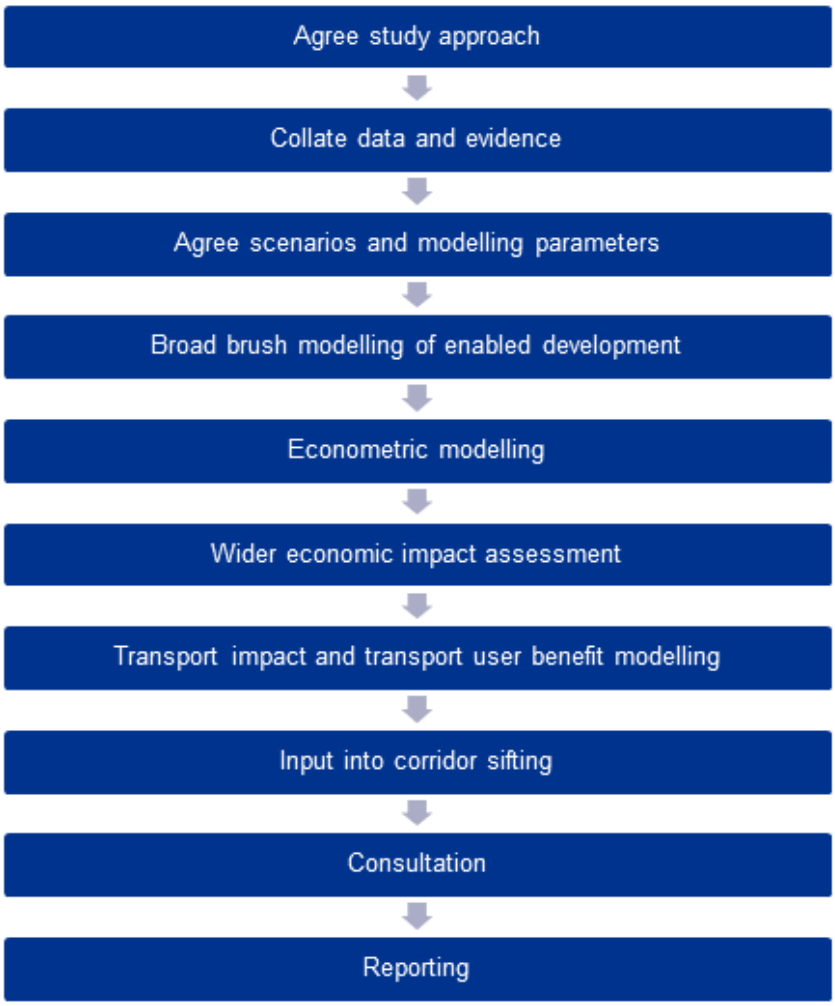
The method applied to inform the corridor decision making process is focused on reviewing the potential of each corridor option to unlock new homes, create new jobs, and have productivity impacts on the economy. Broad assumptions are used to provide a high level order of magnitude assessment for each corridor. There are inherent uncertainties and margins of error. Sensitivity testing has been undertaken to provide a further level of analysis on key factors which could alter development and growth (e.g. alignment with EWR).

Analysis and research is ongoing for each corridor to inform the Value For Money (VfM) assessment and align with the WebTAG guidance. This will be progressed during Stage 1B.

2.2 Method Overview

The enabled development and economic growth modelling has two main purposes. In Stage 1A this focuses on a high-level assessment of the enabled development and economic growth potential of the Project to inform the corridor selection process. At Stage 1B this will be developed further to prepare a WebTAG compliant assessment of the wider economic benefits of the preferred corridor which will be used to develop the business case for investment in the Project. **Figure 2.1** presents the key stages and tasks which have been undertaken at Stage 1A to inform the corridor selection process.

Figure 2.1 Method Overview Key Stages



2.3 Growth Assumptions

This section provides a high-level overview of the key assumptions used in the modelling of enabled development and economic growth. The following presents the main assumptions of the modelling:

- Development could be enabled by the Oxford to Cambridge Expressway in one of two ways:
  - Development could be intensified and delivered at higher densities on Draft Allocated local plan sites within proximity to a junction on the Oxford to Cambridge Expressway.
  - Development could be unlocked on unallocated and currently unidentified development sites due to the greater traffic capacity provided by a junction on the Oxford to Cambridge Expressway.
- The scale of development potentially enabled by the Project is assumed to be directly related to the amount of spare capacity for vehicle trips at each junction on the Oxford to Cambridge Expressway typically assuming a dual 2 road configuration.
- Development in the study area is generally assumed to be supply constrained and not demand constrained, i.e. in overall terms if development comes forward there will generally be the demand for it. The NIC suggests there may be demand for 1 million new homes in the area by 2050. This is therefore the theoretical upper limit on development enabled by the Project.

- We assume that Expressway junctions will be located at key intersections with the existing strategic road network and close to existing settlements.
- Enabled housing development is assumed to generally take place within 4km (5-10 minute drive time on local roads) to each Expressway junction. Enabled employment development can also take place in this area but is also anticipated to take place in a wider area (e.g. nearby town centres).
- The amount and location of development enabled is assumed not to be constrained by existing planning policy for the purposes of estimating the Oxford to Cambridge Expressway related enabled capacity. There could though be other constraints, e.g. environmental, that it is decided do limit capacity. These have not been considered in this exercise.
- We assume that sufficient investment in essential local and non-transport strategic infrastructure will be available so that the development potential associated with the Project is not limited by these factors. (We assume that funds such as Community Infrastructure Levy (CIL), S106, Housing Infrastructure Fund (HIF), the Oxfordshire Housing Deal and their successors can contribute to this investment).
- EWR could also enable new development, and the scale of this impact is being reviewed by a separate commission. Where EWR stations and Expressway Junctions are within proximity there could be a combined impact which could enable development in two ways:
    - EWR could enable higher density development. If a set amount of land could be developed then the scenario with EWR could enable more development than the scenario without EWR
    - EWR could enable a modal shift to more use of public transport/cycling/walking which would allow more development for a given junction capacity (assuming this constraint comes in to effect before any constraint on rail capacity)
- Both of these effects of EWR combined with the Oxford to Cambridge Expressway are tested and presented as sensitivity analysis on the overall results for each corridor.

2.4 Growth Modelling Approach

The following presents the key stages and tasks involved in the modelling of the amount of development enabled by the Project:

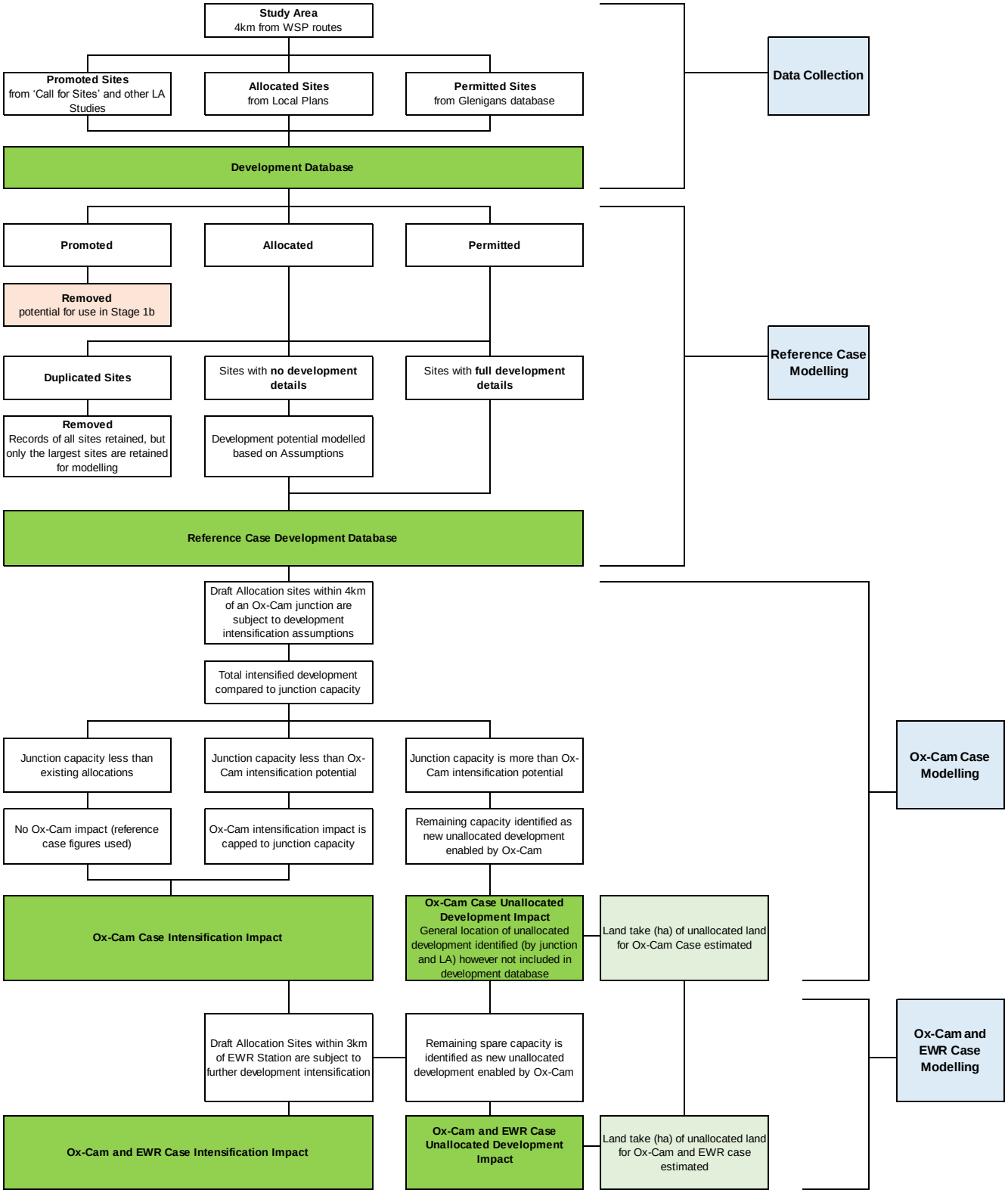
- A development database was prepared of all known planned, promoted and allocated development sites within the enabled growth areas of each Oxford to Cambridge Expressway corridor.
- Promoted sites are removed, duplicated sites combined (assuming largest site areas, and largest development potential is retained, and smaller sites removed), under construction development discounted where likely to be complete in 2018, and gaps in the development database filled. This provides the ‘Reference Case’ for the development potential in each corridor.
- Draft Allocated sites within 4km of each Expressway junction are then treated with development intensification assumptions. This provides an indication of the potential intensification impact of the Oxford to Cambridge Expressway.

- We have carried out a broad-brush initial assessment of junction capacity and spare capacity. Spare capacity is taken to be the difference between total indicative capacity and capacity net of wider assumed traffic demand and data from the National Trip End Model (NTEM) on assumed development. We assume that NTEM accounts for 75% of the growth identified in the development database (reference case) i.e. this development does not require additional capacity provided by the Oxford to Cambridge Expressway. The remaining 25% reference case growth is counted against the overall Oxford to Cambridge Expressway junction capacity figures.
- The growth potentially enabled by the Project is assumed to broadly be constrained by the spare capacity of each junction. This is based on the number of journeys during peak time which can enter and exit the junction, with a conversion factor to provide an estimate for number of homes, and an allowance to achieve 85% of total capacity to ensure the normal functioning of the junction.
- The capacity of each junction to accommodate new homes is broadly assumed to be independent of the capacity of each junction to accommodate new jobs. Specifics will depend on locations and commuting patterns.
- The spare capacity of each junction has only very broadly been estimated and actual spare capacity could vary substantially from the figures used in this initial analysis. Results could vary for example if it is concluded that the Project generates more traffic travelling through the region from and to locations outside the region on the road than current assumed.
- The difference in capacity between the different corridors are largely a consequence of the underlying assumptions on how the different locations of the junctions will impact on capacity. These assumptions could vary significantly in the light of further work.
- Growth potential should be considered in the context of the property market and economic development potential of each corridor though given the scale of development and long time frames there is significant potential for new property market and economic development characteristics to emerge.
- Intensified development is compared to junction capacity in each area. Where junction capacity is less than the 'Reference Case' then no impacts are expected. Where junction capacity is less than the total intensification impact of the Oxford to Cambridge Expressway then the intensification impact is capped to junction capacity. When junction capacity is higher than the intensification impact of the Oxford to Cambridge Expressway, the remaining junction capacity is identified as new unallocated development enabled by Oxford to Cambridge Expressway. This provides the 'Oxford to Cambridge Expressway Case' as both intensification on existing sites, and as new unallocated development (e.g. unplanned new towns or settlements).
- Once we have identified the number of existing planned, intensified, and new unallocated dwellings proposed for each junction we then estimate the equivalent number of population and workers which will be accommodated. From this we estimate the number of jobs which would be required to support this incoming population, and then convert this number of jobs into the employment floorspace required to deliver jobs growth.
- The land take of the modelled unplanned growth is then estimated based on the density and floorspace assumptions. This identifies the total land required for development under each corridor option and each scenario.
- All growth modelling is undertaken for each junction, before being aggregated up and summarised at the overall corridor level. Section 3 of this report presents the summary results for each corridor.

- A ‘EWR and Oxford to Cambridge Expressway Case’ scenario has been run which considers the additional intensification which could be enabled on sites which are within 3km of the EWR stations and 4km from an Oxford to Cambridge Expressway junction. This follows a similar approach as outlined above, but with higher development densities (+60% for residential density, and +20% for employment land density).
- Sensitivity testing is also undertaken to assess the impact of modal shift from road to rail where the Oxford to Cambridge Expressway junctions and EWR align. This is based on the assumption that there could be 20% increase in spare capacity at Oxford to Cambridge Expressway Junctions when aligned with EWR, resulting in an increased scale of development.

Figure 2.2 provides a summary of the various stages and tasks undertaken in the enabled development growth modelling.

Figure 2.2 Enabled Development Growth Modelling Overview



2.5 Scenarios Tested

This Appendix presents results for three scenarios, seven potential Oxford to Cambridge Expressway routes and sensitivity testing of the possible impact East West Rail (EWR) could have on growth enabled by the Project. **Table 2.1** below presents the growth scenarios tested.

Table 2.1 Growth Scenarios Tested

Scenario	Oxford to Cambridge Expressway	EWR Western Section
1. Reference Case	X	X
2. Impact on Allocated Growth Sites	✓	X
	✓	✓
3. Impact on Allocated and Aspirational Growth	✓	X
	✓	✓

The three scenarios are:

- Reference Case – Under this scenario the Project is assumed not to proceed. Existing planned development sites (e.g. those with planning permission) and allocated sites (e.g. those development sites which have been identified and adopted in local plans) are assumed to come forward for development up to their planned capacity as per the local plans. Where development details have not been made available the potential capacity of the site has been estimated based on a series of assumptions.
- Oxford to Cambridge Expressway Case allocated sites – Under this scenario the Oxford to Cambridge Expressway will come forward along one of seven corridors. We assume that the Project could have the impact of increasing the capacity and density of development on 'Draft Allocated' sites (e.g. development sites identified for growth in draft local plans) within 4km of each new Oxford to Cambridge Expressway junction.
- Oxford to Cambridge Expressway Case allocated and aspirational growth – Under this scenario the Oxford to Cambridge Expressway will come forward along one of seven corridors, and in addition to intensifying 'Draft Allocated' sites, the spare capacity for vehicle trips at each junction will enable new development to come forward on unallocated (not currently identified or planned for) sites generally within 4km of the new Oxford to Cambridge Expressway junction.

2.6 Junction Capacity

The Project is a proposed nationally significant piece of infrastructure which can facilitate and improve east west travel demand movements. When introduced the Oxford to Cambridge Expressway is expected to become an attractive route for existing users, as well as future users, of the highway network.

To inform Stage 1A Corridor Option Selection within the wider HE PCF, traffic modelling is undertaken to understand the potential impacts of the introduction of the Project. The modelling exercise is carried out within Highways England's South East Regional Transport Model (SERTM) Design Freeze v3.

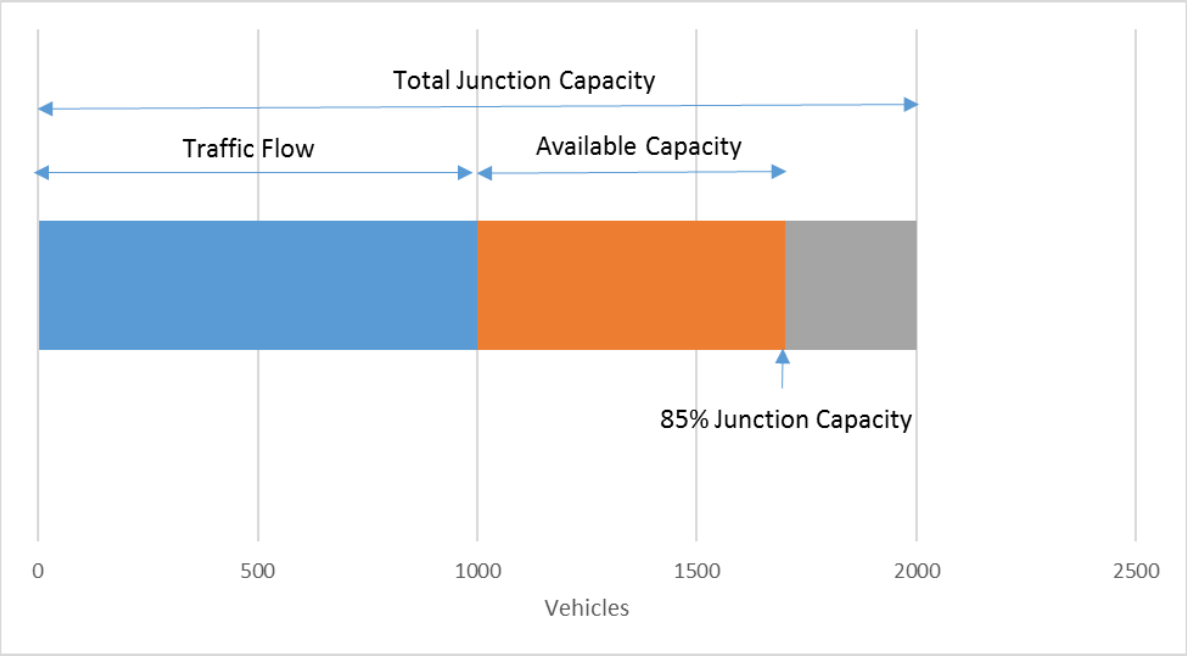
One of the impacts to be understood is the differentiation of how each proposed corridor will enable additional housing and jobs growth above the current national forecasts. The current national forecasts are provided by the Trip End Modelling PROgram (TEMPRO) V7.2. TEMPRO is updated at various points in the cycle of local authority planning periods and as such includes the most relevant planning forecasts for each authority, based upon published documentation such as the Strategic Housing Land Availability Assessment (SHLAA) and if available local plans. The national forecasts for future traffic conditions have been applied to the entire extents of SERTM and are assumed to be inclusive of committed and allocated sites at a local authority level. That is to say that traffic impacts in the forecast years are reflective of a growth scenario which does not specifically account for a development that is dependent (unlocked) on the introduction of the Project.

To determine the additional development enabled by the Project a high level junction assessment is carried out for each corridor. This assessment introduces junctions at various locations within each corridor, dependent on a set of previously agreed criteria. For example, intersection of Oxford to Cambridge Expressway with existing major roads (typically A road and above in hierarchy) or known interactions with existing urban conurbations.

At each of the junctions introduced, within each of the specific corridor options, vehicle capacity is calculated and compared against the forecast numbers of vehicles through each junction. This allows for a Volume to Capacity (VoC) ratio to be determined for each junction within each corridor option.

Available capacity is then calculated for each junction, up to a total VoC of 0.85. This figure is generally accepted as being the threshold for 'approaching capacity' and it is at this point that performance of the junction may start to deteriorate. It assumed that any additional vehicles at a junction as a result of dependent development should not take that junction to a state of deteriorating performance. Figure 2.3 shows an example diagram for the calculation of available junction capacity.

Figure 2.3 Spare Junction Capacity Calculation Diagram



The total available capacity at each junction is summed over each corridor. This spare capacity in vehicles by corridor is then used to determine the likely number of dwellings that would produce the equivalent number of vehicles. The trip rate to convert from traffic flow to dwellings was extracted from observed count data which is stored in a database called Trip Rate Information Computer System (TRICS), and an average rate of areas with similar properties as the area of interest was used to include more development trip information and to provide a more accurate trip rate. This rate of production is assumed to be consistent across corridors so as to not bias any assessment.

The estimated increase in number of dwellings per local authority in the future, and potential users of the Oxford to Cambridge Expressway junctions, was calculated using a combination of TEMPRO and TRICS. TEMPRO determined the number of trips, and TRICS was used to convert this into the number of dwellings. These figures could then be compared with the estimated available capacity to determine whether there would be enough capacity at each of the junctions to accommodate the predicted number of dwellings.

While TEMPRO includes the majority of the allocated growth anticipated to come forward in the future it is understand that it may not include all growth in the corridor areas. In addition it may not consider permitted or planned developments which have been submitted and may come forward in these areas. When the enabled development impacts of the Project are being considered the spare junction capacity is reduced further taking into account 25% of the Permitted and Allocated growth estimated in the Reference Case for each junction.

There are several assumptions associated with this methodology, more specifically:

- Junctions are treated in isolation and as such, vehicle impacts on capacity of movement through multiple junctions is not captured
- Junction capacity is the modelled capacity of each junction, meaning that under certain operational conditions, the overall capacity for any one junction may change slightly from corridor to corridor option
- Junction capacity is based on typical design standards. There is potential for larger capacity junctions to be designed for and delivered in areas where new towns are proposed, or additional junctions to be developed in these areas. This could significantly change the amount of spare capacity for any given corridor
- Dwelling production rates of vehicles is assumed to be the same, irrespective of geography
- Expressway junctions were modelled to provide all movements to minimise the delays and they could differ from the actual designs
- For residential trip rates, privately owned houses and flats with select locations of Edge of Town Centre and Suburban area was collected and used to determine a residential weekday trip rate
- Due to the proximity of sub-options 2 and 3 the junction capacity for these corridor options are considered to be the same.
- The assessment does not consider the additional loading and requirements of aspiration employment and jobs growth trips.

2.7 Reference Case Growth

Work on the assessed Reference Case growth (that which would occur independent of the Project) is still on-going. Further steps and caveats on accuracy include:

- The Reference Case growth relates to the permitted and allocated development within a 4km corridor study area and is therefore different for each corridor. This is a smaller study area than used in the 2016 NIC work.

- The Reference Case is defined as allocated development capacity and development from 2018 onwards. As all local plans do not run through to 2050 this does not cover all capacity that could come forward between now and 2050 without the Project.
- The work does not yet take full account of feedback from consultations with the local authorities and their latest information. For example, there may be further sites where development is complete and will should be taken out of our database.
- The figures do not include an allowance for development on sites of less than 100 units. This will tend to increase numbers.
- The figures are not directly comparable with other assessment of baseline capacity as for example work for the National Infrastructure Commission (NIC) and England's Economic Heartland (EEH) assess baseline for the full area of the local authorities in the Oxford to Cambridge Expressway corridor whereas the figures presented here are for the area of influence within these local authorities.
- Our understanding is that the figures for the EEH work project forward rates of development through to 2050 and so present higher numbers and are also not comparable with this work which focuses on allocations rather than rates of development.
- Future revisions to our estimates are likely to differ from our latest estimate.

2.8 Caveats and Limitations

In addition to above points the following provides an overview of other caveats and limitations of this enabled development and economic growth modelling that should be considered when interpreting the results:

- The assessment does not consider, or test, the scale of aspirational development envisaged by NIC (i.e. 1 million new home). This is not yet an adopted policy position, and it is unlikely that the Project alone will deliver this scale of growth.
- The scale of development which could be enabled by the Project would require a substantial increase in the construction and delivery of new homes if to be achieved by 2050. The realism of this requirement has not been tested at this stage.
- The assessment does not consider the additional capacity which will be freed up on other roads as a result of the Oxford to Cambridge Expressway. This additional capacity could enable development along other road networks as a result of spare capacity.
- Environmental constraints on enabled development have not been assessed at this stage.
- The modelled junction capacity is a key driver in the scale of development which can be enabled by the Project. At present spare junction capacity has been assessed based on a range of assumptions regarding the type of junction needed, likely location, and potential existing and future traffic loading. The junction capacity could change significantly and can be designed to be larger or smaller if required. For example, if a new town was proposed a larger junction with greater capacity could be developed to service this new settlement. At Stage 1A all junctions are modelled to be of similar scale, with the key differentiator in capacity being the existing and future traffic flows.

3. Enabled Development Results

3.1 Introduction

The following section presents the results of the enabled development and economic growth modelling for Stage 1A. This section presents a comparative analysis between each corridor for a series of key growth indicators including the number of homes enabled, amount of employment floorspace, number of workers, jobs, productivity, and land take. We also present sensitivity testing on the potential impact of EWR in terms of land take and modal shift impacts.

In summary the results of the growth modelling indicate that the Project can provide improved accessibility that could enable a substantial number of new homes across all corridors, with the most enabled development observed along corridors which have the lowest current traffic flow levels, including Corridor C2/C3 and Corridor B2/3. Partly due to these higher levels of development these corridors will also have the greatest impact in terms of the number of workers and jobs. However greater economic and productivity impacts could be observed in Corridor B2/B3.

Corridors B1 and C1, to the north and west of Oxford, are most aligned with EWR stations, and could therefore benefit the most from the multi-modal corridor, providing increased density and reduced land take. The corridor that benefits the most from EWR could though be influenced by decisions on if and where to locate new settlements and the relation of these settlements to the Oxford to Cambridge Expressway junctions and EWR stations.

This assessment is heavily dependent on the modelled capacity and location of the Oxford to Cambridge Expressway junctions. Junction capacity could change, and greater capacity delivered in locations to enable new town development.

3.2 Housing Growth

The Project can enable development through intensification of draft allocated sites, and by unlocking new unallocated sites for development. This effect will not be universal across the entire corridor, but focused around the main Oxford to Cambridge Expressway junctions due to the improved accessibility.

Table 3.1 and **Figure 3.1** below presents our analysis of the homes potentially enabled by the Project for each corridor option under each scenario. This shows an estimate of the homes which the Project could enable. These figures include the Reference Case growth.

This assessment shows that overall the Project is estimated to have the potential to enable between 295,000 and 355,000 new homes in addition to the Reference Case. Corridors C2/C3 are assessed to have the most capacity to generate new homes, equivalent to 355,000 new homes on unallocated sites, and 360,000 homes in total. This is closely followed by Corridor B2/B3 which could enable 345,000 new homes on unallocated sites, and deliver 350,000 homes in total. This should be observed in the context that Corridor C includes one extra junction compared to the other corridor options.

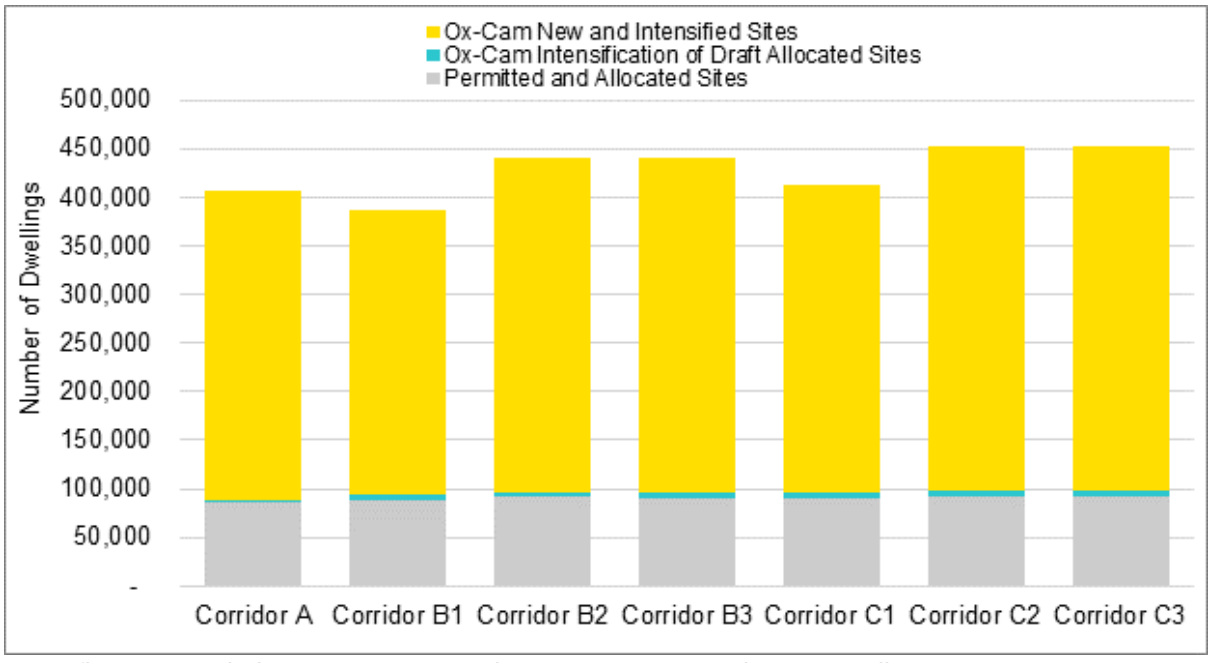
Table 3.1 Assumed Development Enabled Under Each Scenario: Homes

Scenario	Corridor A	Corridor B1	Corridor B2	Corridor B3	Corridor C1	Corridor C2	Corridor C3
Reference Case	85,000	90,000	90,000	90,000	90,000	90,000	90,000

Scenario	Corridor A	Corridor B1	Corridor B2	Corridor B3	Corridor C1	Corridor C2	Corridor C3
Oxford to Cambridge Expressway Intensification Impact (Inc. Ref Case)	90,000	95,000	95,000	95,000	95,000	100,000	100,000
Oxford to Cambridge Expressway Case Intensification and Aspirational Growth (Inc. Ref Case)	405,000	390,000	440,000	440,000	410,000	455,000	455,000
Total Oxford to Cambridge Expressway Additional Growth Impact (Exc. Ref Case)	**320,000**	**300,000**	**350,000**	**350,000**	**320,000**	**360,000**	**360,000**

Note: figures rounded to nearest 5,000. Figures may not sum due to rounding

Figure 3.1 Assumed Development Enabled Under Each Scenario: Homes



Note: figures rounded to nearest 5,000. Figures may not sum due to rounding.

Comparing this growth with the NIC's vision for delivery of 1 million new homes suggests that the Oxford to Cambridge Expressway and associated local infrastructure could enable between 30-35% of this growth. When taken alongside Reference Case growth, this could enable closer to 45% of the required growth.

The Reference Case growth is based on a more confined study area for the Project compared to the overall Oxford Cambridge corridor area used as a basis for the NIC's vision and so are likely to under-estimate total growth.

3.3 Workers and Jobs

We estimate the potential incoming population and number of workers which could be accommodated at development enabled by the Project. This is based on a broad assumption of 2.33 people per dwelling and 1.27 workers per dwelling.

The number of forecast jobs in the wider study area (i.e. full local authority areas) under the corridor options has been estimated by Cambridge Econometrics using their Local Economic Forecasting Model (LEFM), presented in Section 4.

The resulting ratios of workplace to resident workforce is shown in **Table 3.2** below.

Table 3.2 Oxford to Cambridge Expressway Jobs to Resident Workforce Ratios

	2020	2050, Reference Case	2050, Scenario A	2050, Scenario B1	2050, Scenario B2/3	2050, Scenario C1	2050, Scenario C2/3
Ratio of Workplace to Resident Employment	1.12	1.09	1.06	1.07	1.06	1.06	1.06

The wider study area current experiences net in-commuting, with 12% more people employed within the area than there are employed people who live in the area. The construction of a significant number of new homes is expected to have a direct impact on this ratio as if workers within the study area are more easily able to find homes also located within the area then the net inward commuting effect should decrease, and the ratio of resident and workplace employment will move closer to parity. We see that the Reference Case scenario reduces the workplace/resident employment ratio to 1.09, whereas the five Expressway scenarios all produce a ratio of around 1.06 to 1.07. The ratio is not anticipated to vary significantly between the Expressway scenarios.

3.4 Land Take Assessment

The Project will increase the capacity and provide access to allow development to come forward. Some of this development will take place on previously undeveloped land and may be planned to achieve higher densities in response to the changing growth agenda in these areas. In additional, where the Oxford to Cambridge Expressway junctions and EWR stations are suitably close to each other there could be the potential for higher densities of development, delivering more homes and job opportunities over the same spaces due to the improved access and connectivity. This could result in more efficient use of development land. While land take will be large due to large scale of growth, higher densities will mean less land is required to deliver the same amount of growth.

The following analysis considers the amount of land which would be required to deliver the development enabled by the Project and compares this to the existing amount of greenfield land available. This also considers the potential impact that EWR will have in conjunction with the Oxford to Cambridge Expressway to increase density and make more efficient use of land.

This assessment does not consider environmental and utilities capacity constraints as this analysis has not yet been undertaken.

Table 3.3 and **Figure 3.2** below present the existing urban area around each Oxford to Cambridge Expressway junction location, the amount of greenfield land (including land with environmental constraints) and the potential land take required to deliver the number of homes and jobs enabled by the Oxford to Cambridge Expressway only (not including EWR).

This indicates that Corridor C1 is currently the most densely developed corridor, with over 8,900ha of existing urban area, while Corridor B2/B3 are the leased developed with 7,900ha of urban area. The amount of greenfield land along each corridor is significant. This includes land which is contained and could not come forward for development including protected environmentally sensitive areas. Corridor C2/C3 has the largest amount of greenfield land, totalling 52,500ha.

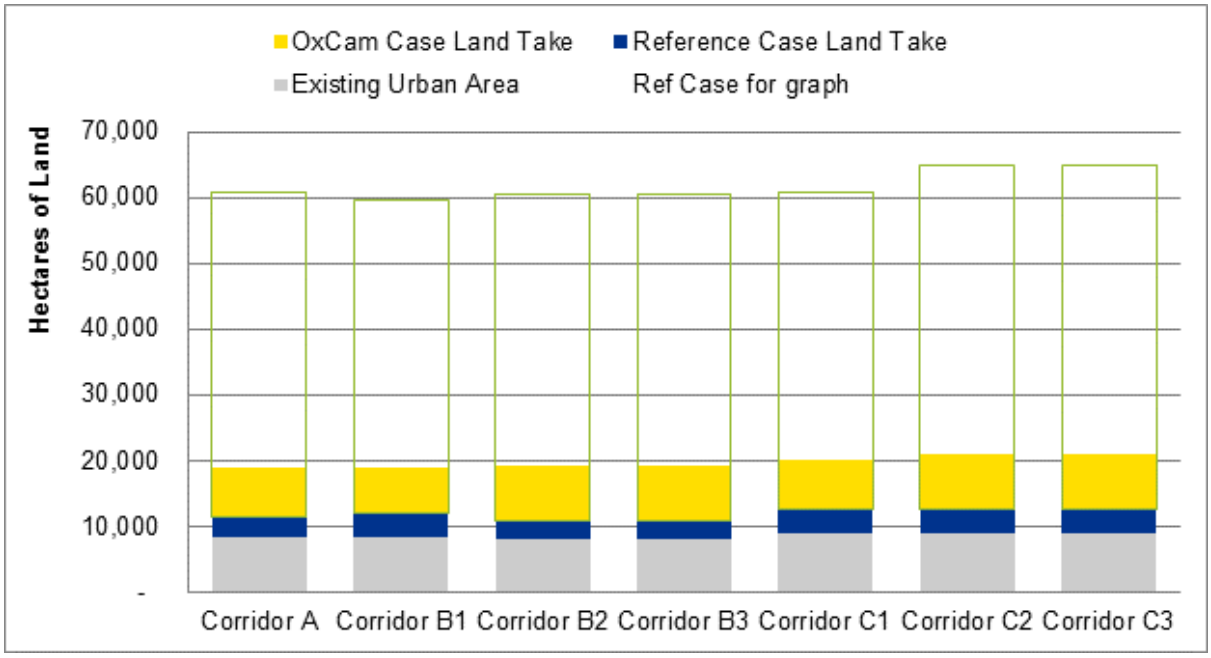
Growth enabled by the Project is estimated to require between 7,000ha to 8,500ha for Corridor B1 and C2/C3 respectively. This level of growth will have different impacts on greenfield land, with Corridor B2/B3 requiring 17% of the greenfield land capacity, and Corridor B1 requiring 15% of the greenfield land capacity based upon the growth and density assumptions used for this modelling.

Table 3.3 Oxford to Cambridge Expressway Land Take Assessment

	Corridor A	Corridor B1	Corridor B2	Corridor B3	Corridor C1	Corridor C2	Corridor C3
Existing Urban Area	8,500	8,500	8,000	8,000	9,000	9,000	9,000
Ref Case Land Take	3,000	3,500	3,000	3,000	3,500	3,500	3,500
Oxford to Cambridge Expressway Enabled Development Land Take	7,500	7,000	8,000	8,000	7,500	8,500	8,500
Total Urban Land Take	**19,000**	**19,000**	**19,000**	**19,000**	**20,000**	**21,000**	**21,000**
Unallocated Greenfield Land	49,500	47,500	49,500	49,500	48,000	52,500	52,500
Proportion of Greenfield land required to deliver Oxford to Cambridge Expressway enabled development	15.3%	14.7%	16.6%	16.6%	15.7%	16.1%	16.1%

Note: Figures rounded to nearest 5,000. Figures may not sum due to rounding.

Figure 3.2 Oxford to Cambridge Expressway Land Take Assessment



Note: Figures rounded to nearest 500ha.

Table 3.4 and **Figure 3.3** presents the proportion of the total area around each Oxford to Cambridge Expressway junction which is currently urban, would be developed during the Reference Case, would be developed during the Oxford to Cambridge Expressway case, and then demonstrates the impact EWR could have in reducing land take requirements by increasing densities.

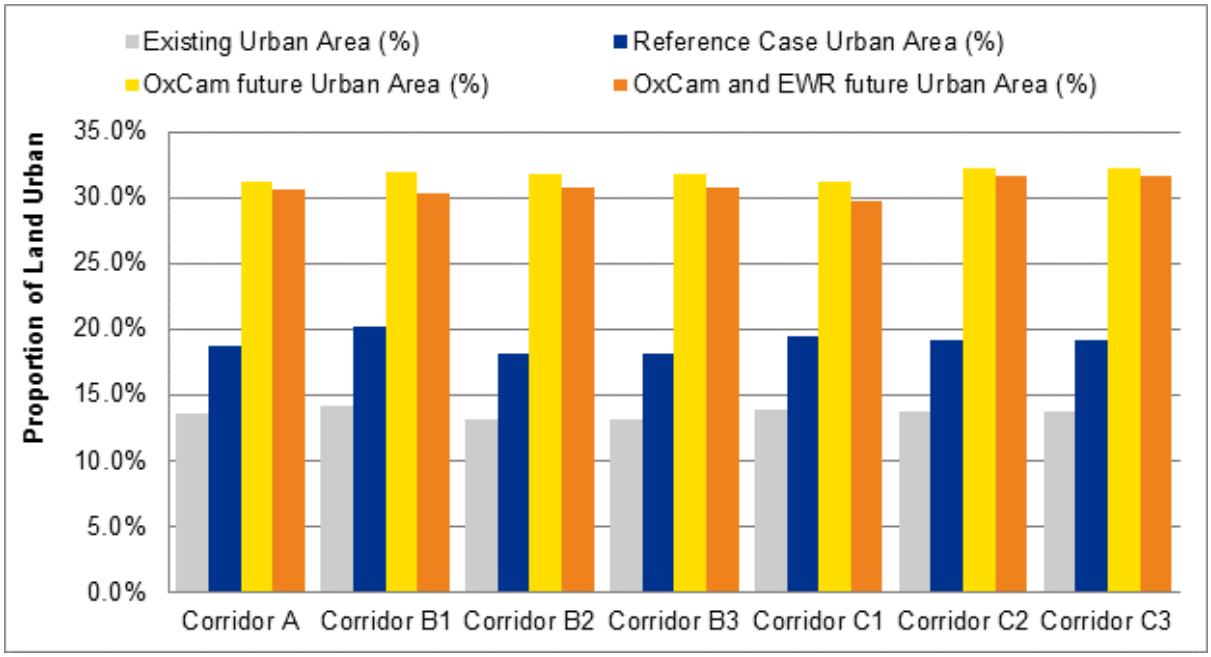
This indicates that under the Reference Case and Oxford to Cambridge Expressway the proportion of land around each junction which may be required for development would double compared to existing conditions. The proportion of urban area around each junction would increase from between 13% and 14%, to between 31% for Corridor A and C1, and 32% for Corridor C2/C3. This impact will be from both the Reference Case and Oxford to Cambridge Expressway scale growth.

With the changes in densities assumed in this modelling EWR could decrease the amount of urban areas by a modest volume, with the smallest impact of 0.6% for Corridor A, and largest impact of 1.7% and 1.5% for Corridor B1 and C1 respectively. That is due to the greater alignment of these two corridors with EWR.

Table 3.4 Comparison of the Proportion of Urban Land by Scenario

	Corridor A	Corridor B1	Corridor B2	Corridor B3	Corridor C1	Corridor C2	Corridor C3
Existing Urban Area	13.6%	14.1%	13.2%	13.2%	13.8%	13.7%	13.7%
Reference Case Urban Area (inc. existing)	18.8%	20.2%	18.1%	18.1%	19.5%	19.2%	19.2%
Oxford to Cambridge Expressway future Urban Area (inc. existing and Ref. case)	31.2%	32.0%	31.7%	31.7%	31.2%	32.2%	32.2%
Oxford to Cambridge Expressway and EWR future Urban Area (inc. existing and Ref. case)	30.6%	30.3%	30.8%	30.8%	29.7%	31.6%	31.6%
Impact of EWR on land take	**-0.6%**	**-1.7%**	**-0.9%**	**-0.9%**	**-1.5%**	**-0.7%**	**-0.7%**

Figure 3.3 Comparison of the Proportion of Urban Land by Scenario



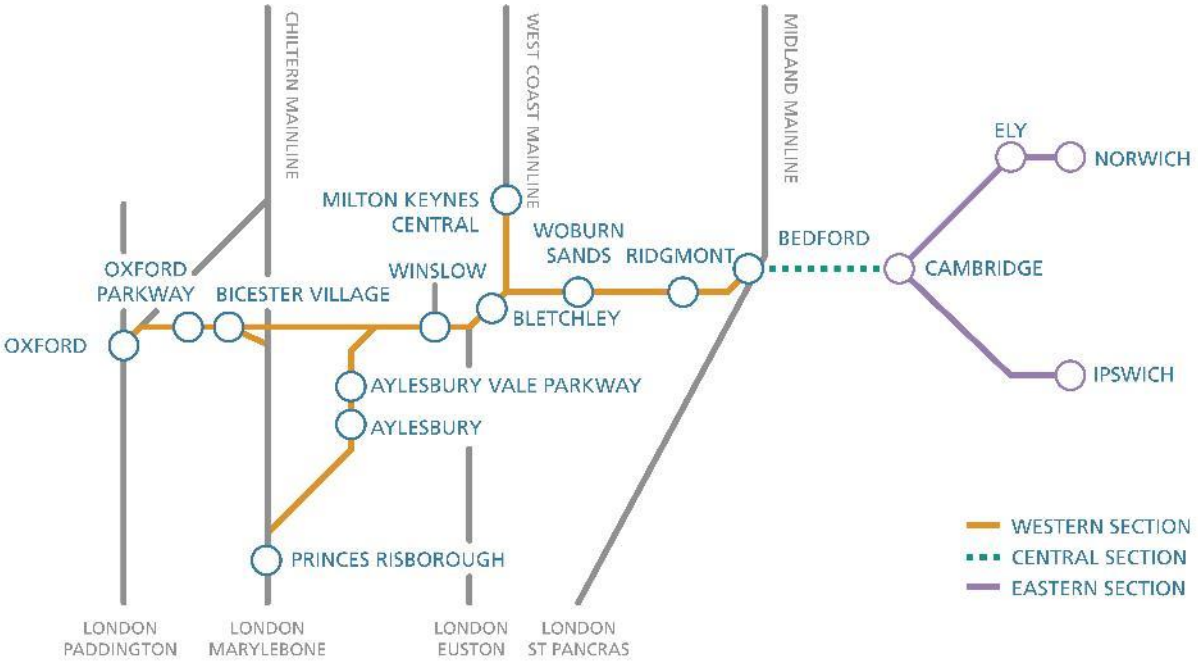
3.4.1 Modal Split Sensitivity Test

Where the Project aligns with EWR commuters will have a choice of transport options. This could have the effect of reducing the number of trips by residents via the Oxford to Cambridge Expressway, and in effect increase the spare capacity of the Oxford to Cambridge Expressway junction, as people choose to use non-car modes and in particular rail as their preferred mode of transport. This modal shift impact has not yet been modelled through detailed traffic modelling but is presented here as a high-level sensitivity test.

The following analysis considers the potential for modal shift of up to 20% of trips from Oxford to Cambridge Expressway to EWR. This will effectively increase the spare capacity on Oxford to Cambridge Expressway Junctions by 20% and allow for more development to come forward in these areas. This impact is only tested at junctions which are near proposed EWR stations.

Figure 3.4 presents the current proposed route for EWR and **Table 3.5** below presents the alignment of the Oxford to Cambridge Expressway Junctions and EWR Stations which has been used in this sensitivity testing. This indicates that Corridors B1 and C1 are most closely aligned to EWR Stations.

Figure 3.4 EWR Stations



Source: EastWestRail, http://www.eastwestrail.org.uk/east-west-rail-route/, 2018

Table 3.5 Tested Alignment of Oxford to Cambridge Expressway Junctions and EWR Stations

Oxford to Cambridge Expressway Junction		EWR Station	Oxford to Cambridge Expressway Corridor effected
1A, 1B, 1C	West of Didcot	-	-
2A, 2B, 2C	Abingdon	-	-
3A	North of Great Milton	-	-
3B	East of Oxford	-	-
3C	North Oxford	Oxford Oxford Parkway	Corridor B1 Corridor C1
4A	North of Thame	-	-
4B	East of Oakley	-	-
4C	Wendlebury	Bicester Village	Corridor B1 Corridor C1
5C	South of Bicester	Bicester Village	Corridor B1 Corridor B2 Corridor B3 Corridor C1 Corridor C2 Corridor C3
5A	Northwest of Aylesbury	Aylesbury Vale Parkway	Corridor A
5B	Twyford	Winslow	Corridor B1 Corridor B2 Corridor B3
6C	Buckingham	-	-

Oxford to Cambridge Expressway Junction		EWR Station	Oxford to Cambridge Expressway Corridor effected
7B, 7C	South of Bletchley	Bletchley	Corridor B1 Corridor B2 Corridor B3 Corridor C1 Corridor C2 Corridor C3
6A	North of Leighton Buzzard	No differentiation between corridors and therefore no impact modelled.	
8A, 8B, 8C	Brogborough		
9A, 9B, 9C	Southwest of Kempston		
10A, 10B, 10C	South of Kempston		
11A, 11B, 11C	East of Bedford		
12A, 12B, 12C	South of St Neots		
13A, 13B, 13C	West of Cambourne		
14A, 14B, 14C	West Cambridge		

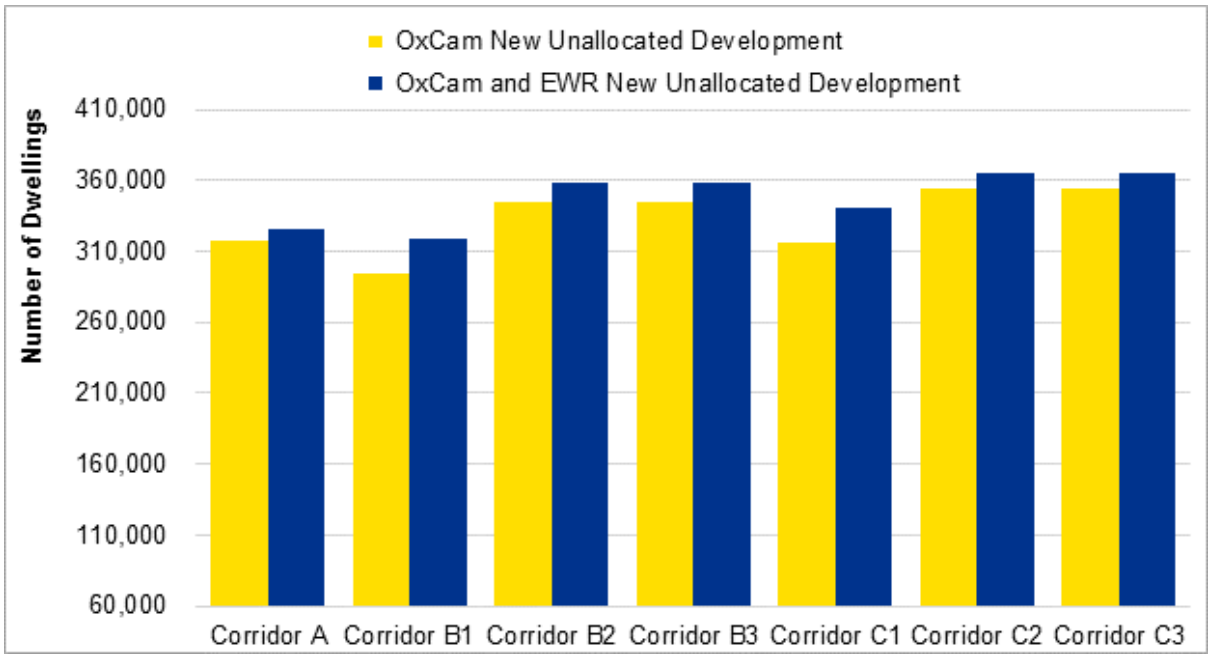
Table 3.6 and **Figure 3.5** below presents the potential impact of modal shift to EWR on the enabled development capacity of the Oxford to Cambridge Expressway. This indicates that the greatest impact from EWR could be in Corridor B1 with 8% more development, and Corridor C1 with 7% more development enabled. However, despite this increase, Corridor C2/C3, followed by B2/B3 would still have the largest enabled development under the assumptions used. These figures do not include Reference Case growth, and only consider new unallocated development, not intensification of allocated sites.

Table 3.6 Spare Oxford to Cambridge Expressway Capacity and Impact of EWR from Modal Shift: Dwellings Enabled

	Corridor A	Corridor B1	Corridor B2	Corridor B3	Corridor C1	Corridor C2	Corridor C3
Project Only New Unallocated Development	315,000	295,000	345,000	345,000	315,000	355,000	355,000
Project and EWR New Unallocated Development	325,000	320,000	360,000	360,000	340,000	365,000	365,000
EWR Impact on Enabled Development	3%	8%	4%	4%	7%	3%	3%

Note: Figures rounded to nearest 5,000.

Figure 3.5 Spare Oxford to Cambridge Expressway Capacity and Impact of EWR from Modal Shift: Dwellings Enabled



Note: Figures rounded to nearest 5,000.

4. Econometric Modelling

4.1 Introduction

This section presents the approach and key findings of the econometric growth modelling undertaken to inform the corridor sifting process.

4.2 Approach to Modelling

The econometric modelling was carried out using Cambridge Econometrics (CE)'s Local Economic Forecasting Model (LEFM) and its associated scenario analysis tool in order to quantify the relative wider economic benefits that could accrue from each of the short-listed corridor options.

WebTAG M5.3 guidance states that in addition to straightforward wider economic analysis using a simple tailor made tool such as Wider Impacts and Transport Appraisal (WITA), *'…in some circumstances it may be relevant to adopt more sophisticated economic principles in the appraisal'*[1]. The use of LEFM in this appraisal is intended to provide that additional analysis.

The purpose of the econometric modelling exercise was to identify the corresponding sectoral outcomes that would correspond to the potential enabled development physical growth scenarios and what implications this would have for employment, wages and GVA on both the local and national scale.

LEFM has been designed to project economic indicators for a local area by explaining the output of local industries through an explicit representation of expenditure flows in the area and their links with the world outside the local area. In this it differs from other methods of local economy modelling which typically link local output or employment (by sector) directly to national or regional output or employment. Such methods include shift-share or econometrically estimated equations. While these methods allow a user to derive projections for local output or employment growth from national or regional projections, they offer little scope for introducing an explanation of local performance relative to these higher levels, and they are typically not suitable for analysing the indirect effects on the local economy arising from the opening of a new enterprise or the closure of an existing one.

LEFM is also distinguished from other approaches by its sectoral detail. It identifies 45 sectors[2] (defined on SIC07), allowing (for example) electronics to be distinguished from electrical equipment, and IT services from other business support services. Detailed disaggregation by sector is usually valuable because different sectors have different prospects (e.g. technological change is driving much faster growth in electronics and computing than in the other sectors with which they are commonly combined), because they have different employment characteristics, and also because it allows local knowledge about specific firms to be more easily incorporated in the forecast. One of the consequences of working in such detail is that most variables in the model have to be disaggregated by sector (or a similar classification: see below for more details).

In order the estimate the wider sectoral and economic impacts of the corridor scenarios the LEFM scenario modelling tool is used. This tool takes the existing sectoral projections for each area generated by the main LEFM model and simulates their progression over time under a variety of different scenarios. The exogenous inputs into this tool are:

[1] WebTAG M5.3. p7

- The peak commuting travel times between districts under each corridor option, using the Stage 0 traffic modelling. This allows us to calculate the expansion of labour and product markets and estimate the increased likelihood of collaborative activity due to increased effective economic mass of each district.
- The physical growth that could be released in each scenario, as set out in the preceding chapters of this Appendix. Significant additional housing stock feeds directly into estimates for future population growth, which in turn drives growth in labour supply and demand for local services.

The growth in employment by sector is calculated by a combination of two mechanisms, the strength of which depends on the sector in question: the increase in demand for local services both within the district and in neighbouring districts is driven by growth in population; whilst the growth of existing clusters is driven by improvements to local sectoral productivity and the increase in national and international competitiveness this implies.

Localisation agglomeration benefits are calculated on a sector-by-sector and district-by-district basis, and informed by both the existing spatial distribution of sectoral clusters and the effects of the increased access to sectoral economic mass in neighbouring districts provided by the improved connectivity.

Feedback mechanisms between productivity and employment growth are incorporated into the model on a spatial-sectoral basis, along with employment and productivity spill-over impacts both between sectors and between local areas, based around empirically derived input/output tables.

The implications for occupational structure are calculated using the sectoral/occupational conversion projections produced by CE as part of the *Working Futures* project. Wage levels are assumed to grow as a set proportion of productivity growth by sector.

The model has produced 5-yearly projections of the following variables between 2030 and 2050:

- Employment (by 45 sectors)
- Productivity (by 45 sectors)
- GVA (by 45 sectors)
- Occupation (by 25 occupations)
- Mean Wage level

For the following local authority districts, as well as for the UK as a whole:

- Oxford
- South Oxfordshire
- Vale of White Horse
- Cherwell
- West Oxfordshire
- West Berkshire
- Aylesbury Vale
- Milton Keynes
- Bedford
- Huntingdonshire
- South Cambridgeshire
- Cambridge
- East Cambridgeshire

We have also considered the problems of additionality and displacement using the following assumptions:

- The proportion of external migration into the study area is assumed to remain constant at the rate of the past decade at 15% of all inward migration, and is considered a net addition to UK population
- Any employment and GVA generated by the proportion of the growth in demand for services generated by external migrants into the study area is considered a net addition to UK employment and GVA
- Any productivity and GVA growth generated by additional agglomeration benefits due to improved connectivity and/or increased economic density within the study area is considered a net addition to UK productivity and GVA
- Any employment and GVA growth generated by an increase in productivity that leads to a growth in the UK's market share of internationally tradable sectors is considered a net addition to UK employment and GVA.

By comparing the outputs for different scenarios it is possible to quantify the net benefit of different schemes above the Reference Case across a range of different economic indicators, including labour productivity, total employment, GVA/capita, average real wage, and % of employment in high-value or knowledge sector jobs.

4.3 Econometric Modelling Results

The results of the scenario modelling exercise are shown in the figures below. On a district-by-district level sub-options 2 and 3 are identical and are thus presented together.

Figure 4.1 shows the total additional employment estimated to be generated by 2050 in each corridor option compared to the Reference Case. Employment growth is partly driven by additional service demand due to population growth and partly by growth of existing sectoral clusters. We see that all corridor options produce additional employment for between 250,000 and 350,000 additional workers, with the more direct routes (A and B) producing the highest levels of employment growth.

Figure 4.1 Estimated Total Additional Employment over Reference Case

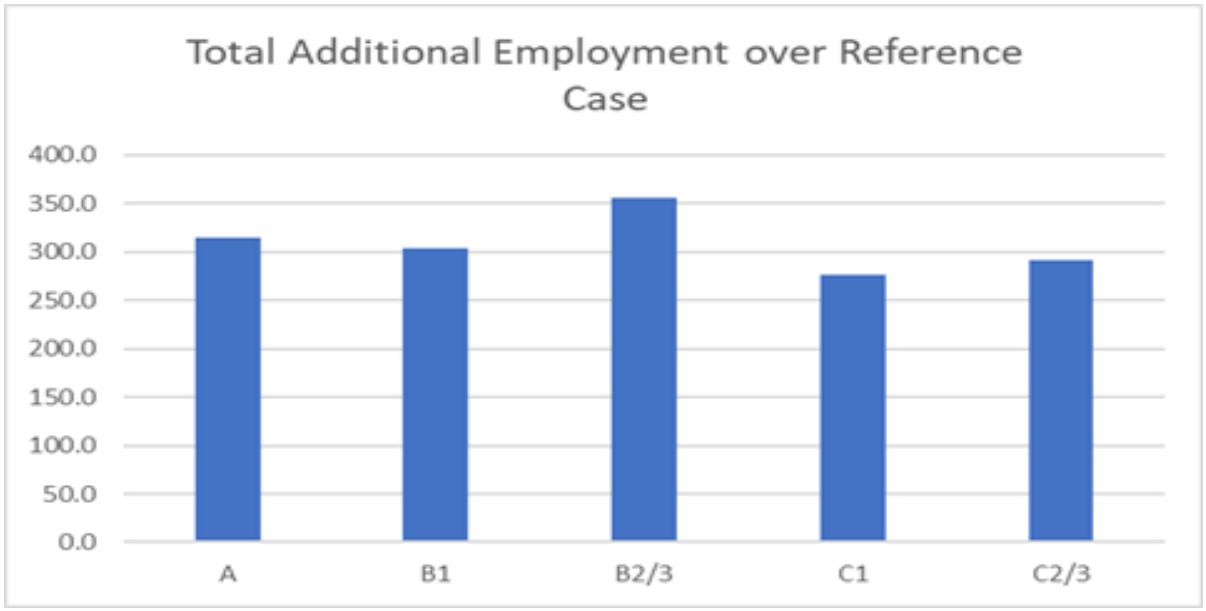


Figure 4.2 shows the estimated growth in high skill and knowledge sector employment. Growth in these sectors is largely driven by the assessed impact of the Expressway in facilitating greater productivity and employment growth in existing sectoral clusters. Again we see that the greater growth occurs in the more direct routes that best link the three main knowledge sector clusters in the 'missing link' area centred around of Oxford, Milton Keynes and Science Vale.

Figure 4.2 Additional Estimated Employment in High Skill and Knowledge Sectors

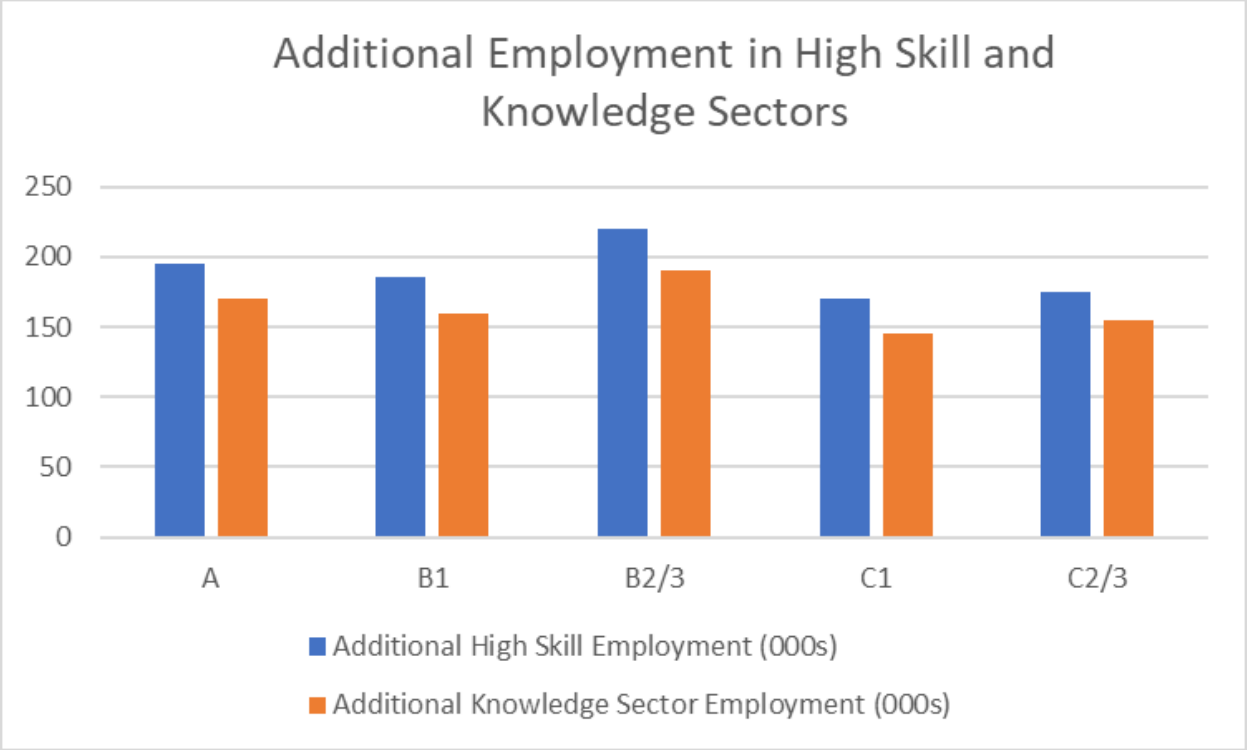
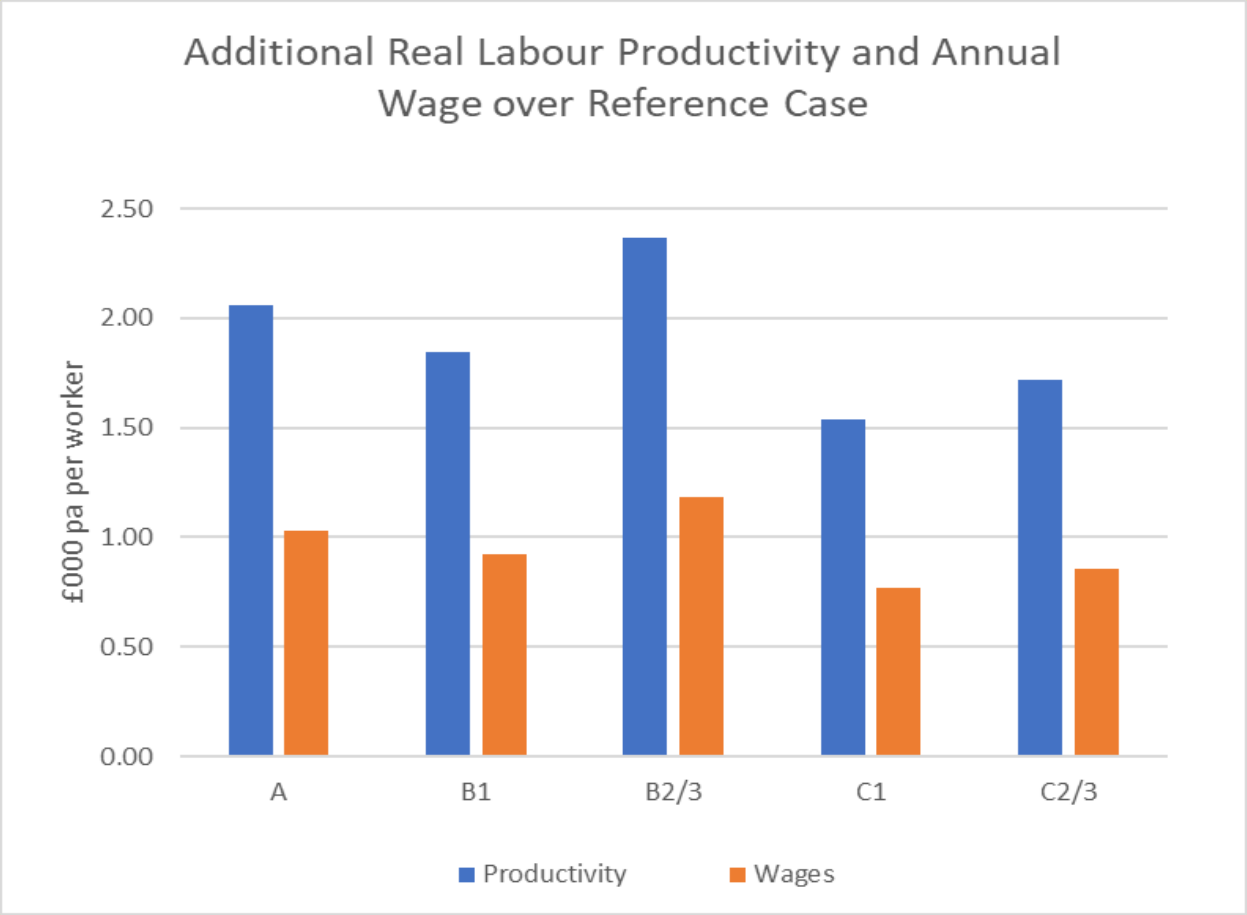


Figure 4.3 shows the estimated growth in productivity and corresponding growth in wages induced by the different corridor options. Productivity growth is driven largely by agglomeration benefits due to increased access to economic mass (including access to labour pools, access to customers, and increased knowledge spill-overs both within and between sectors). We find estimated additional real-terms productivity impacts of between £1,500 and £2,500 per worker per year by 2050. Wages grow at approximately half this level in line with recent historic trends.

Figure 4.3 Additional Real Labour Productivity and Annual Wage over Reference Case



In all of the above analysis the projections only include the impacts that arise endogenously as a result of the implementation of the Expressway options, as manifested by our two modelling factors: additional housing stock; and reduced AM peak travel times. These projections are intended for comparison purposes only and are not intended as a stand-alone forecast, and do not preclude the possibility that additional investment in the area, either in infrastructure or otherwise, produces significantly higher levels of growth. There is also the potential that the clustering effect created by a new economic corridor could lead to new activities, industries, employment and higher growth than shown in the model.

5. Conclusions

This Growth and Economic Assessment Appendix presents the findings of the enabled development and economic growth modelling for the Oxford to Cambridge Expressway to inform the Stage 1A corridor selection process. This includes an assessment of the potential role of the Project in enabling new homes, new employment space and new jobs.

The analysis has also carried out sensitivity tests to illustrate how the Oxford to Cambridge Expressway in combination with EWR and other public transport could enable higher development densities, reduced land take (for the same scale of development), and give the potential for modal shift towards non-car transport to in effect increase capacity and enable further development.

No decisions have been made by government at this stage on if, how much and where extra growth is planned in the corridor. Consequently, this analysis focuses on considering how much growth could by enabled by the Project if it were to go ahead. The scale of growth potentially enabled only takes in to account the potential ability of the Project to accommodate traffic associated with the growth. The potential scale of development does not take in to account other factors such as environmental constraints. Further work would be needed to consider to what degree they influence the scale of potential growth.

Overall the assessment has identified the following:

- All corridor options have the potential to enable significant amounts of new housing and employment if it were decided to plan for and allocate such growth.
- Corridor C2/C3, followed by B2/B3, will potentially enable the most new homes. This is due to the assessed greater spare capacity of the Oxford to Cambridge Expressway junctions for these corridors. Higher spare capacity is a result of less existing or future planned development in these areas and therefore less traffic flow. Enabled development is less along corridors which are already more heavily developed, such as Corridor A.
- Partly as a consequence of the higher level of enabled development, Corridors C2/C3 and B2/B3 are also modelled to have the greatest impact in terms of the number of workers and jobs enabled. However, productivity and economic growth impacts are estimated to be greater along Corridor B than C. This is due to the improved connectivity, travel time savings, and improved linkages to existing clusters of high value knowledge economy for Corridor B options.
- Corridors B1 and C1, to the north and west of Oxford, are most closely aligned with EWR and its stations, and are consequently modelled to benefit the most from the multi-modal corridor in terms of providing the potential for increased density and reduced land take.
- This assessment is heavily dependent on the modelled capacity and location of the Oxford to Cambridge Expressway junctions. Junction capacity could change, and greater capacity delivered in locations to for example enable new town development. Also the Oxford to Cambridge Expressway could free up capacity on other roads, and therefore enable wider growth, and this could be relevant in existing congested areas. However, this impact has not been modelled at this stage. As such these figures provide a high level review of development enabled based on the assumed conditions modelled.

In summary while the enabled development impacts are fairly similar for Corridor C2/C3 and B2/B3, the additional productivity and economic benefits along Corridor B2/B3 suggest that in the longer term this corridor could provide the greatest growth benefits.

The main CAR details how the findings of this growth modelling has been applied to the relevant Strategic and Intervention Objectives set by HE and DfT.

Appendix A. Glossary

ASR	Appraisal Specification Report
BCR	Benefit cost ratio
CBA	Cost benefit assessment
CE	Cambridge Econometrics
CIL	Community Infrastructure Levy
DCLG	Department for Communities and Local Government
DfT	Department for Transport
EWR	East West Rail
FUR	Functional urban region
GIS	Geographic information system
GVA	Gross value added
Ha	Hectare
HE	Highways England
HIF	Housing Infrastructure Fund
JSP	Joint Statutory Plan
NIC	National Infrastructure Commission
LA	Local authority
LEFM	Local Economy Forecasting Model
LUTI	Land Use Transport Interaction
NPPV	Net present public value
OS	Ordinance Survey
PCF	Project Control Framework
PMA	Property market area
pp	pages
PTAL	Public transport accessibility level
RIS	Road Investment Strategy
S106	Section 106 planning obligations agreement
SEM	Supplementary economic model
SERTM	South East Regional Traffic Model
SHMA	Strategic housing market assessment
SHLAA	Strategic housing land availability assessment
SIC	Standard industrial classification
Sq ft	Square feet
Sq m	Square metre
SRN	Strategic road network
TAG	Transport Appraisal Guide
TIEP	Transport Infrastructure and Economic Performance (report)
TIS	Transport investment strategy
TGB	Treasury Green Book
VfM	Value for Money
WITA	Wider Impacts in Transport Appraisal