Appendix TA - C

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London Resort Staff Distribution Note

London Resort Company Holdings

A note by Volterra Partners, June 2020

Volterra

1 Introduction

1.1 This note describes the method used to estimate the trip distribution of staff employed at the proposed London Resort. The analysis makes use of the journey to work data available by small geographic area (MSOA) from the 2011 Census. The census trip distribution for the existing site is adjusted based on comparable sites to account for the characteristics of major leisure attractions.

1.2 Since there are only 500 car parking spaces available for London Resort staff, the number of commutes made by car is capped. This impacts the expected distribution of staff as the car and public transport catchment areas are different. This analysis considers commuting patterns for both car and public transport and aggregates the patterns, capping the number of car journeys.

1.3 There will be a desire to retain as many jobs locally as possible, and to ensure opportunities are made available and accessible to those who need them most. As the project progresses, it will be important to refine the job types and distributions further to account for this, although we believe the geographical distribution presented in this note is appropriate for modelling purposes at this stage.

2 Existing Distribution and Comparator Sites

Immediate Area journey to work distribution

2.1 The Immediate Impact Area is defined by the three Middle Layer Super Output Areas[1] (MSOAs) that surround the proposed London Resort site.

2.2 The 2011 Census *Location of usual residence and place of work by method of travel to work (MSOA level*) dataset was used to ascertain the geographical distribution of commuting trips to the Immediate Area. The number of trips from each MSOA in England and Wales to the Immediate Area was found. This gave a total of 4,750 trips over the 690 origin MSOAs for which there was at least one trip made. In other words, a total of 4,750 people commute to the Immediate Area from 690 different MSOAs.

2.3 Aggregating the trips to local authority level, Table 1 shows that a large number of commuting trips had their origin in Gravesham or Dartford, making up a combined 57% of all trips. Despite the Project Site being in Dartford, the majority of commute trips according to the census originated in Gravesham. This is likely because Dartford is better connected to other employment locations and London, with Ebbsfleet International station for example lying in the borough and close to the site, making Dartford residents more likely to commute outside of the borough.

Table 1: % of trips to the Immediate Area by local authority

County	Origin local authority	% trips to Immediate Area
Kent	Gravesham	34%
Kent	Dartford	23%
Kent	Medway	12%
London	Bexley	5%
Kent	Sevenoaks	4%
Kent	Maidstone	3%
Kent	Tonbridge and Malling	2%
London	Greenwich	2%
London	Bromley	2%
Kent	Swale	2%
London	Lewisham	1%
Essex	Thurrock	1%
Kent	Canterbury	1%
Kent	Ashford	1%
Kent	Tunbridge Wells	1%
-	*Other*	*8%*

Source: ONS Crown Copyright Reserved [from Nomis on 23 January 2020]

2.4 An alternative aggregation is made by splitting the MSOA origins into travel time bands based on the AM peak travel time between MSOA centroids. For each MSOA, the travel time (network car/transit travel time in AM peak traffic) to the Immediate Area is calculated[2] and the MSOAs are grouped into broad travel time bands. These travel time

[1] Middle Super Output areas are small areas designed to improve the reporting of small area statistics in England and Wales. They are fixed boundaries drawn such that the minimum population in any MSOA is 5,000 with a mean of 7,200 people.
[2] Travel time data for car and transit modes of travel are sourced from the Google Maps distance matrix API.

bands represent how long a worker working in the Immediate Area commutes for and is a better representation of how far workers travel than 'as the crow flies' distance.

2.5 The distribution of trips from each travel time band is shown in Table 2 and shows that 29% of car commute trips are made locally, within a 15-minute drive time of the Immediate Area. Most car trips (69%) are made from within 30 minutes of the Immediate Area. There is a clear difference between the trips made by car and by public transport within each time band, reflecting the fact that car travel times are generally quicker, allowing more people to access the site within shorter times.

Table 2: Proportion of trips to the Immediate Area by travel time band

Travel time band (from worker home origin)	% of car trips to the IIA	% of public transport trips to the IIA
Less than 15 minutes	29%	0%[3]
Between 15 and 30 minutes	40%	57%
Between 30 and 60 minutes	26%	23%
Between 60 and 90 minutes	3%	9%
Between 90 and 120 minutes	0%	5%
More than 120 minutes	1%	6%

Source: Google distance matrix API

3 Travel times are taken from MSOA (population weighted) centroids. Due to the way the MSOAs are drawn around the IIA, no centroid is within a 15minute walk or public transport journey of the site.

3 London Resort Staff Distribution

3.1 The census journey to work distribution for trips to the existing Immediate Area represents a good estimate of the likely trip distribution for the site area. It implicitly accounts for a number of factors that affect the propensity to commute including competing travel times, competing employment locations and population characteristics.

3.2 Once the London Resort is operational, however, the characteristics of the area will fundamentally change. Employment opportunities provided at the London Resort will be more attractive than existing opportunities and there will be many additional jobs available, meaning that people are likely to travel from further than they do currently to take advantage of these opportunities. To take account of the relative differences between the existing and proposed land uses, trip distributions of comparable sites have been analysed so that the census trips can be scaled up/down.

3.3 The census trip distribution exercise has been conducted for the MSOAs containing Thorpe Park, Westfield London, and Bluewater Shopping Centre (refer to Appendix A for more detail). These sites were chosen due to the similarity of land uses and/or locations to the London Resort. The difference in characteristics between the existing Immediate Area and the chosen comparison sites is clear. Tables 3 and 4 summarise the worker trip distribution of the Immediate Area compared to the comparator areas. It shows that a much higher proportion of trips to the Immediate Area by car are less than 15 minutes.

Table 3: Car trip distribution of comparators by distance band

Distance band	Immediate Area	Bluewater	Westfield London	Thorpe Park
Less than 15 minutes	29%	16%	6%	19%
Between 15 and 30 minutes	40%	32%	12%	32%
Between 30 and 60 minutes	26%	20%	34%	35%
Between 60 and 90 minutes	3%	4%	28%	8%
Between 90 and 120 minutes	0%	1%	10%	3%
More than 120 minutes	1%	3%	10%	3%
Average time	*26min*	*26min*	*40min*	*33min*
Average distance	*22km*	*24km*	*13km*	*24km*

Source: Google maps

3.4 There is also a much more local distribution of public transport trips (57% within 30 minutes compared with an average of 17% among the comparator sites). This suggests that when there is a large employment site, it attracts staff from a much wider catchment.

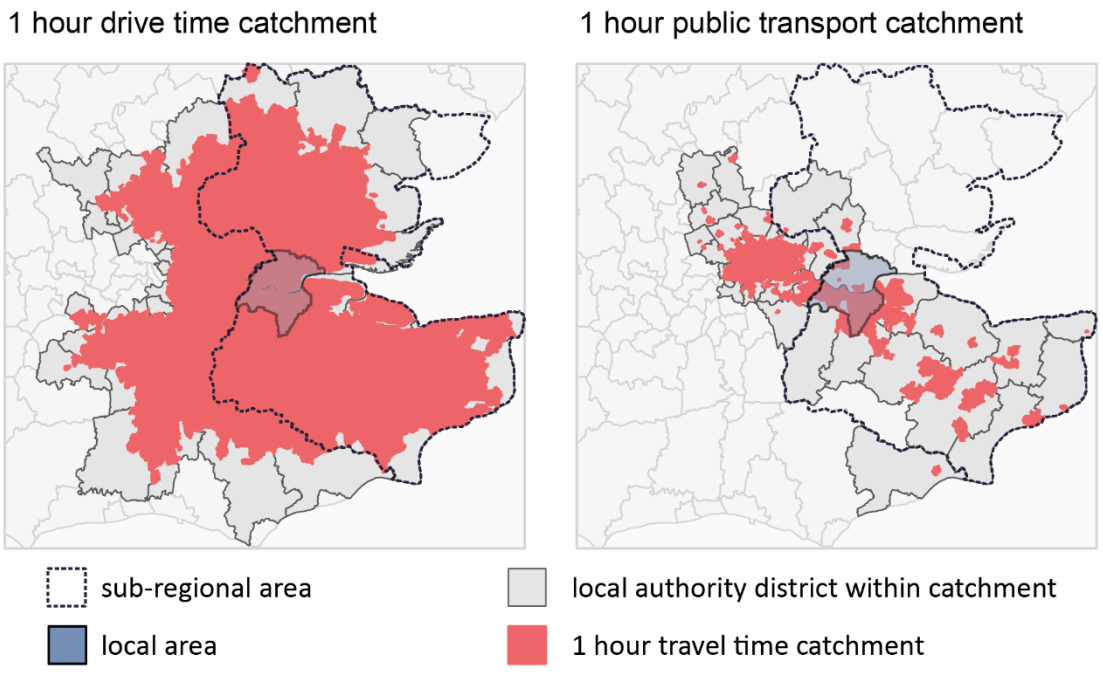
Table 4: Public transport trip distribution of comparators by distance band

Distance band	Immediate Area	Bluewater	Westfield London	Thorpe Park
Less than 15 minutes	0%	0%	2%	18%
Between 15 and 30 minutes	57%	3%	17%	10%
Between 30 and 60 minutes	23%	14%	50%	31%
Between 60 and 90 minutes	9%	8%	23%	24%
Between 90 and 120 minutes	5%	3%	4%	10%
More than 120 minutes	6%	2%	4%	6%
Average time	*45min*	*53min*	*43min*	*53min*
Average distance	*17km*	*15km*	*12km*	*17km*

Source: Google maps

3.5 Figure 1 illustrates the difference in areas accessible within 60 minutes of the Immediate Area. The 1 hour drive time catchment reaches a much wider area than the public transport catchment which is concentrated near public transport nodes.

Figure 1: MSOAs accessible within one hour of London Resort



Adjusting the existing trip distribution

3.6 The distribution of trips at London Resort is estimated by averaging the existing distribution of trips to the Immediate Area and trips to the comparator areas by distance band and by mode of transport. This is due to the fact that the characteristics of London Resort are considered to be a blend of those at each of the comparator sites in terms of accessibility, similarity of location and similarity of attraction. The averaged distribution is given in Tables 5 and 6.

3.7 The result is that workers are expected to commute from slightly further away. Currently, 29% of workers in the Immediate Area live within a 15 minute car commute. This will reduce to 18% based on the new distribution.

Table 5: Average car distribution of trips to comparator sites

Distance band	Immediate Area	Bluewater	Westfield	Thorpe Park	**Average**
< 15 minutes	29%	16%	6%	19%	**18%**
15 - 30 minutes	40%	32%	12%	32%	**29%**
30 - 60 minutes	26%	20%	34%	35%	**29%**
60 - 90 minutes	3%	4%	28%	8%	**11%**
90 - 120 minutes	0%	1%	10%	3%	**3%**
> 120 minutes	1%	3%	10%	3%	**4%**

Table 6: Average public transport distribution of trips to comparator sites

Distance band	Immediate Area	Bluewater	Westfield	Thorpe Park	**Average**
< 15 minutes	0%	0%	2%	18%	**5%**
15 - 30 minutes	57%	3%	17%	10%	**22%**
30 - 60 minutes	23%	14%	50%	31%	**30%**
60 - 90 minutes	9%	8%	23%	24%	**16%**
90 - 120 minutes	5%	3%	4%	10%	**5%**
> 120 minutes	6%	2%	4%	6%	**5%**

3.8 The average distribution of trips among comparator sites is applied to local MSOAs in proportion to their existing propensity to commute to the Immediate Area. For example, trips from each MSOA in the 15 minute catchment of the Immediate Area by car are reduced by a factor of 0.61 reflecting the 61% lower average propensity to commute compared to the current situation (18% vs 29%).

3.9 The updated trips to the various MSOAs are then aggregated to the local authority level to give a new trip distribution. The comparison between the two distributions is shown in Tables 7 and 8.

Table 7: Comparison of trips made to Immediate Area by local authority (car)

Origin Local Authority	% trips to Immediate Area	% trips adjusted for average comparator area
Gravesham	32%	23%
Dartford	20%	14%
Medway	14%	15%
Bexley	5%	4%
Sevenoaks	5%	4%
Maidstone	3%	4%
Tonbridge and Malling	3%	3%
Greenwich	2%	2%
Bromley	2%	2%
Swale	2%	2%
Lewisham	1%	1%
Thurrock	1%	1%
Canterbury	1%	1%
Ashford	1%	3%

Origin Local Authority	% trips to Immediate Area	% trips adjusted for average comparator area
Tunbridge Wells	1%	1%
Other	*7%*	*21%*

Table 8: Comparison of trips made to Immediate area by local authority (PT)

Origin Local Authority	% trips to Immediate Area	% trips adjusted for average comparator area
Gravesham	40%	35%
Dartford	36%	23%
Medway	4%	8%
Bexley	5%	10%
Sevenoaks	1%	1%
Maidstone	0%	1%
Tonbridge and Malling	0%	0%
Greenwich	3%	7%
Bromley	1%	2%
Swale	0%	1%
Lewisham	1%	1%
Thurrock	0%	1%
Canterbury	1%	1%
Ashford	0%	0%
Tunbridge Wells	0%	0%
Other	*8%*	*10%*

Adjusting the distribution for Tilbury

3.10 The first adjustment to the census journey to work data was to factor the existing distributions by the travel patterns of comparable sites. This led to 1% of trips still being assigned to Thurrock for both the PT and car distributions (Tables 7 and 8). Thurrock MSOAs are currently between 19 and 42 minutes drive time from London Resort, and a 60 to 120+ minute public transport journey. At present, just 8% of commute trips to the Immediate Area from Thurrock are made by public transport due to poor public transport links between the north and south of the river at Thurrock. By contrast, 28% of trips from Dartford and Gravesham to the Immediate Area are made by public transport.

3.11 It is expected that Tilbury in Thurrock will be a key location for London Resort staff arriving by public transport, with a ferry service to London Resort available. To account for the improved linkages and reduced travel time between Thurrock and London Resort, a predictive model is used to estimate the 'expected' trips for areas north of the river. This analysis considers those MSOAs for which it is quicker to go via Tilbury than directly to London Resort and adjusts the journey time on that basis. This allows us to see how trips might be distributed if current transport constraints are lifted. No adjustment is made for improved linkages by car as no car parking spaces for staff will be provided on the Essex project site.

3.12 The approach used to predict these trips from Thurrock is set out in Appendix B. The model assigns an increased 11% of public transport trips to Thurrock, compared with just 1% before the adjustments were made. The updated distribution by local authority is set out in Table 9.

Table 9: Distribution by local authority after Tilbury adjustment (PT)

Origin local authority	Existing distribution	Adjusted trip distribution
Gravesham	35%	31%
Dartford	23%	21%
Thurrock	1%	11%
Medway	8%	8%
Bexley	10%	8%
Sevenoaks	1%	1%
Maidstone	1%	1%
Tonbridge and Malling	0%	0%
Swale	7%	6%
Bromley	2%	2%
Ashford	1%	0%
Lewisham	1%	1%
Canterbury	1%	1%
Greenwich	0%	0%
Tunbridge Wells	0%	0%
Other	*10%*	8%

Accounting for staff accommodated on site and capping car trips

3.13 There are proposed to be only 500 car parking spaces available for operational staff so most staff will be expected to commute via public transport. Two main options for staff will be to either arrive at Ebbsfleet International station where they can get an onward shuttle to London Resort, or to arrive at Tilbury and get a short ferry to complete the journey.

3.14 Two separate trip distributions are derived – one for car and one for public transport, both using the method described to this point. The staff using the 500 car parking spaces available are distributed according to the car distribution, with the remaining staff either arriving by public transport or accommodated on-site. The various commuting patterns to Tilbury area or the IIA by public transport or by car are applied as follows for the year 2025 at peak:

- **1,800 staff**[4] are accommodated on site and **not expected to commute**.
- **1,900 staff** are expected to commute by car directly to London Resort[5]. These staff are distributed using the distribution of **car journeys to the Immediate Area**.
- The remaining **staff** are expected to commute by public transport. This remainder varies by assessment year and time of year as shown in the table below. These staff are distributed according to **public transport journeys to the Immediate Area**.

[4] There are expected to be accommodation for 2,000 staff members on site. An occupancy rate of 90% is assumed to be conservative.

[5] 500 staff during the day at an occupancy of 2 people per car (WSP assumption). The car park is also assumed to be used at a capacity of 0.9 for a further 500 night time staff, again at an occupancy of 2 (WSP assumption).

Table 10: Employment by year and season

Season	Low			Peak		
Year	2025	2029	2037	2025	2029	2037
Staff	7,638	10,981	11,395	11,084	14,847	15,494
Living onsite	1,800	1,800	1,800	1,800	1,800	1,800
Travel by car	1,900	1,900	1,900	1,900	1,900	1,900
Travel by PT	3,938	7,281	7,695	7,384	11,147	11,794

3.15 The job numbers in this note are different to the numbers presented in other parts of the DCO application (chapter 7: land use and socio-economics, Employment and Skills Strategy, and the Economic and Regeneration Statement) as they are different estimates for different purposes. The estimates presented in this technical note are the appropriate job estimates for the transport modelling. These estimates specifically relate to people movement to the site and are conservative from that point of view. They reflect likely shift patterns and maximum numbers on site at any given time. The job estimates presented in the other documents referred to above are based on the actual number of job opportunities available. At any given time (even the peak) the whole workforce will not be onsite at the same time, due to shift patterns, holidays, and different working arrangements. The two sets of numbers are derived from a consistent set of base workforce assumptions.

4 Summary

4.1 Existing commuting patterns to the site ignore the attractiveness of the London Resort as an employment location, the improved accessibility that will be provided from the north of the river, and the cap on the number of car parking spaces for staff.

4.2 To adjust the existing commuting patterns, the number of commutes was factored up or down to be in line with patterns observed at other similar land uses (Thorpe Park, Westfield, Bluewater).

4.3 London Resort is expecting a high number of trips made by public transport due to a lack of parking options on site. Separate distributions are made for public transport and car trips using the same method to distribute the staff arriving by car and public transport in turn.

4.4 Further adjustments were made to the number of commute trips from Thurrock. Since in the future park and ride options will be available from Tilbury, this will make commutes from Thurrock and some parts of Havering more likely than at present. We predict the number of trips from Thurrock origins by the expected commute time and the relationship between commutes and travel time.

Table 11: Staff trip distribution to London Resort

Origin	Low season			Peak season		
	2025	2029	2037	2025	2029	2037
On site accommodation	24%	16%	16%	16%	12%	12%
Gravesham	22%	24%	25%	24%	26%	26%
Dartford	14%	16%	16%	16%	17%	18%
Thurrock	6%	8%	8%	8%	9%	9%
Medway	8%	8%	8%	8%	8%	8%
Bexley	5%	6%	6%	6%	7%	7%
Greenwich	4%	4%	4%	4%	5%	5%
Bromley	2%	2%	2%	2%	2%	2%
Southwark	1%	1%	1%	1%	1%	1%
Maidstone	1%	1%	1%	1%	1%	1%
Sevenoaks	1%	1%	1%	1%	1%	1%
Lewisham	1%	1%	1%	1%	1%	1%
Croydon	1%	1%	1%	1%	1%	1%
Canterbury	1%	1%	1%	1%	1%	1%
Lambeth	0%	1%	1%	1%	1%	1%
Swale	1%	1%	1%	1%	1%	1%
Other	10%	8%	8%	8%	8%	8%

5 Appendix A: Comparator Distributions

Bluewater worker distribution

5.1 The Bluewater site is in the local authority of Dartford, and the site is bounded entirely by the MSOA *Dartford 006*. Figure 2 shows the Bluewater site and its location within the MSOA and local authority.

5.2 Bluewater represents a good comparison site in that it is a large-scale employment attractor within an area in relatively close proximity to London Resort. Public transport accessibility is considered to be lower at Bluewater due to poorer connections to central London.

Figure 2: Bluewater Shopping Centre

5.3 The distribution of trips from each MSOA in England and Wales to the MSOA containing Bluewater was gathered from the Census (2011) data and split into distance bands as shown in Table 12.

Table 12: % of trips to Bluewater by distance band

Distance band	% of trips to Bluewater
Less than 15 minutes	24%
Between 15 and 30 minutes	42%
Between 30 and 60 minutes	25%
Between 60 and 90 minutes	5%
Between 90 and 120 minutes	1%
More than 120 minutes	4%

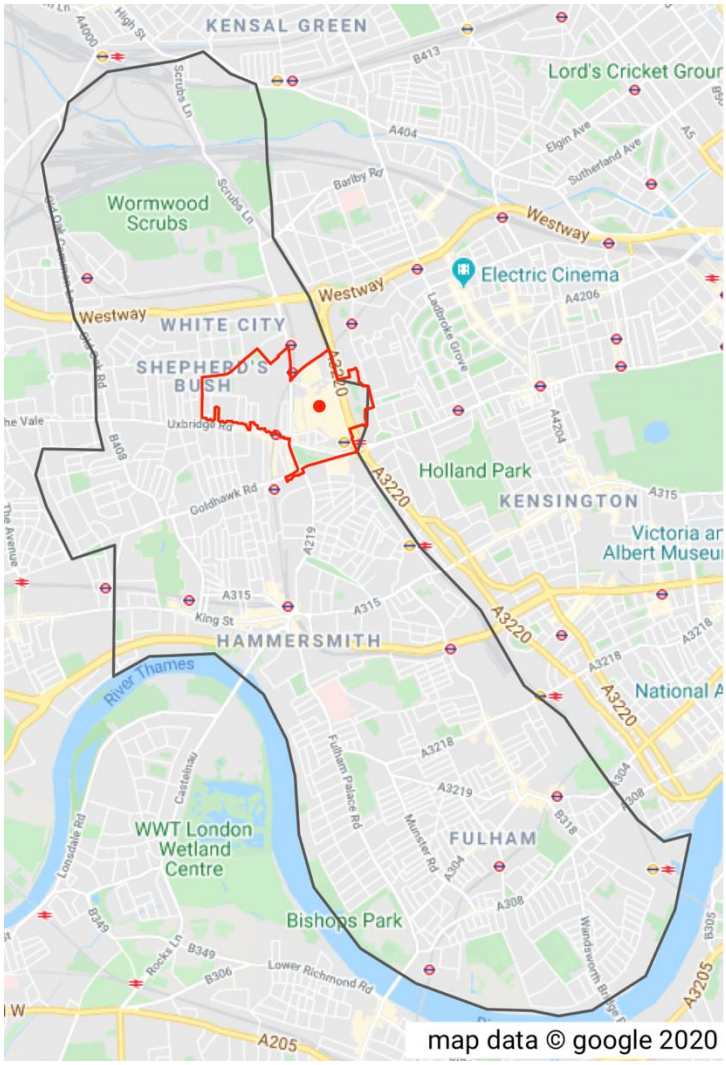
5.4 Trips made to Bluewater are relatively less local (within 15 minutes) with notably more people commuting from beyond 60 minutes away (10%) when compared the Immediate Area (4%).

Westfield London worker distribution

5.5 Westfield London is in the London Borough of Hammersmith and Fulham, and the site is bounded entirely by the MSOA *Hammersmith and Fulham 004*. Figure 3 shows the Westfield site and its location within the MSOA and local authority.

5.6 Westfield is a comparator site with a high level of accessibility due to its inner London location and strong public transport links. Similarities exist with London Resort due in the scale of the attraction and its connectivity to London.

Figure 3: Westfield London



5.7 Table 13 shows an even wider trip dispersion than Bluewater, with 27% of trips made over an hour in length. The increased willingness to travel further to work is likely influenced by the availability of public transport links. The majority (86%) of all trips made to the Westfield MSOA are made by public transport, compared with 25% to Bluewater and 21% to the Immediate Area.

Table 13: % of trips to Westfield London by distance band

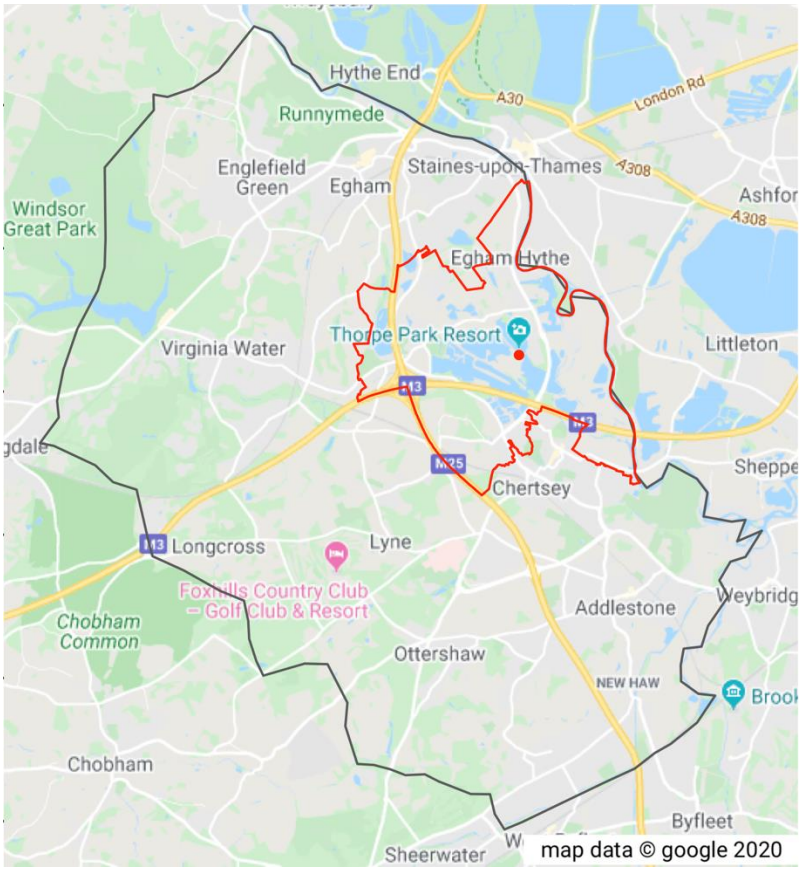
Distance band	% of trips to Westfield London
Less than 15 minutes	14%
Between 15 and 30 minutes	15%
Between 30 and 60 minutes	43%
Between 60 and 90 minutes	18%
Between 90 and 120 minutes	4%
More than 120 minutes	5%

Thorpe Park worker distribution

5.8 The Thorpe Park site is in the London Borough of Runnymede, and the site is bounded entirely by the MSOA *Runnymede 004*. Figure 4 shows the Thorpe Park site and its location within the MSOA and local authority.

5.9 Thorpe Park is a comparator site that offers a similar leisure attraction to that of London Resort. While the travel patterns may differ due to its quite different location and proximity to transport, the type and characteristics of workers are likely to be more comparable.

Figure 4: Thorpe Park



5.10 Table 14 shows that 53% of workers live within 30 minutes of Thorpe Park, less than Bluewater and the Immediate area, but more than Westfield. A relatively low proportion of workers (17%) use public transport to access the site. The fact that 13% of workers still commute from beyond 60 minutes shows that the Immediate Area's existing distribution is likely to get wider with the introduction of a large-scale attraction.

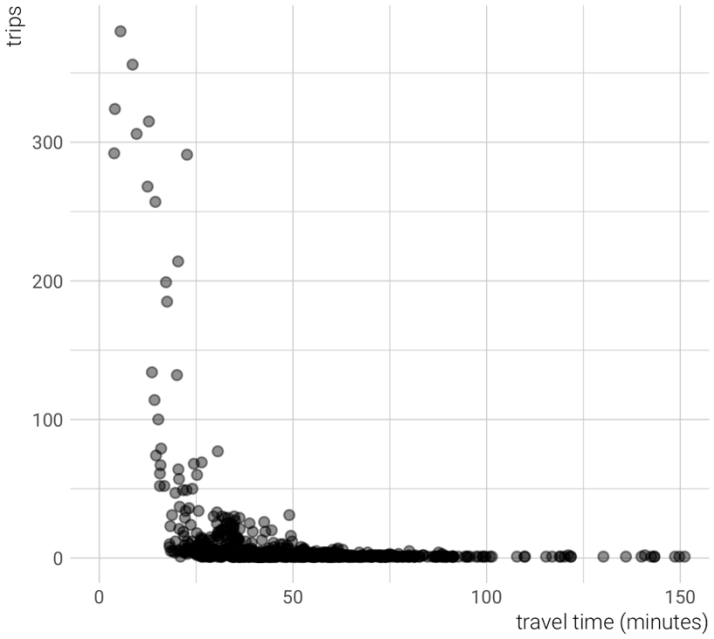
Table 14: % of trips to Thorpe Park by distance band

Distance band	% of trips to Thorpe Park
Less than 15 minutes	22%
Between 15 and 30 minutes	31%
Between 30 and 60 minutes	33%
Between 60 and 90 minutes	8%
Between 90 and 120 minutes	3%
More than 120 minutes	2%

7 Appendix B: Predicting Trips from North of the Thames

7.1 The trip distribution from MSOAs to London Resort was taken as a starting point. This is the trip distribution from Section 3, adjusted to be in line with comparator site commute patterns. The relationship between this initial trip distribution and travel time is shown in Figure 5.

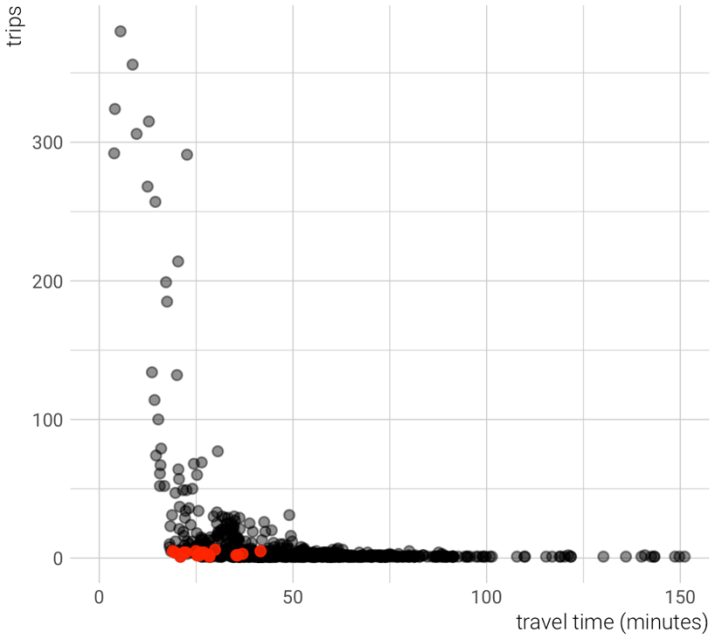
Figure 5: Travel time vs trips for commutes to the Immediate Area



7.2 Based on the relationship between trips and travel time, this analysis aims to predict the impact on the number of trips from Thurrock, highlighted in red in Figure 6. It is hypothesised that Thurrock trips are below their 'expected' level of trips due to poor public transport linkages – people currently commute predominantly by car.

7.3 Travel times have been calculated from each MSOA to London resort going via Tilbury (Google distance matrix travel time to Tilbury + 10 minute ferry to resort). This analysis considers those MSOAs for which it is quicker to go via Tilbury than directly to London Resort and adjusts the journey time on that basis.

Figure 6: Travel time vs trips (Thurrock highlighted)



Modelling approach

7.4 From the data it is clear that there is a non-linear relationship between the number of trips and travel time. The approaches considered to model the non-linear relationship were narrowed down to:

- Support Vector Machine (SVM)
- K-nearest Neighbours (KNN)
- Multivariate Adaptive Regression Splines (MARS)
- Elastic Net

7.5 Models such as linear regression with polynomial or log specifications were discounted as poorly fitting. The Elastic Net specification used was log(commutes) ~ log(travel time) + log(travel time) * houseprice + log(travel time) * working age population. This is a special case of linear regression where parameters are balanced between ridge and lasso regression.

7.6 It was hypothesised that other factors such as working age population in the origin MSOA and house price would also be good predictors of the number of trips made to the Immediate Area. In most cases these additional variables did not add predictive power. The final specifications of the respective models were to include working age population in the MARS model only and to exclude house price in all models.

7.7 To choose between the models, 10-fold cross validation was used to test the model performance on out-of-sample data on 10 different hold-out samples. The performance of each model (R-squared and mean absolute error) are shown in Tables 15 and 16.

7.8 The R-squared is a measure of the proportion of the variance in trips made that can be explained by our model. Mean Absolute Error (MAE) is a measure of the average error – it differs from R-squared by not penalising more heavily those points that are further away from the prediction. R-squared is the more 'meaningful' of the two-evaluation metrics as it is scale-free, whereas MAE can only be judged relative to the other values but is more robust to outliers. Seeing that R-Squared and MAE is highest for the MARS model, MARS is selected for use in prediction.

7.9 The relationship was modelled separately for trips made by PT and by car. In both relationships, the MARS model was chosen as the best performing model.

Table 15: Car model comparisons (cross validated errors)

Model	R-squared	MAE
SVM	0.56	10.3
KNN	0.51	8.49
MARS	0.67	8.0
Elastic Net	0.48	-

Table 16: PT model comparisons (cross validated errors)

Model	R-squared	MAE
SVM	0.55	1.83
KNN	0.62	1.43
MARS	0.67	1.50
Elastic Net	0.52	-

Final model

7.10 The final model specification chosen was the MARS model. The model was chosen for its highest cross-validated R-Squared value (0.67). This model splits the non-linear dataset into segments where change points are found in the data. Using travel time and working age population as predictors, the model finds two change points, or 'knots' in the relationship. The relationship found between travel time and trips is shown in Figures 7 and 8, with Thurrock MSOAs highlighted in green.

Figure 7: MARS model fit (Car trips)

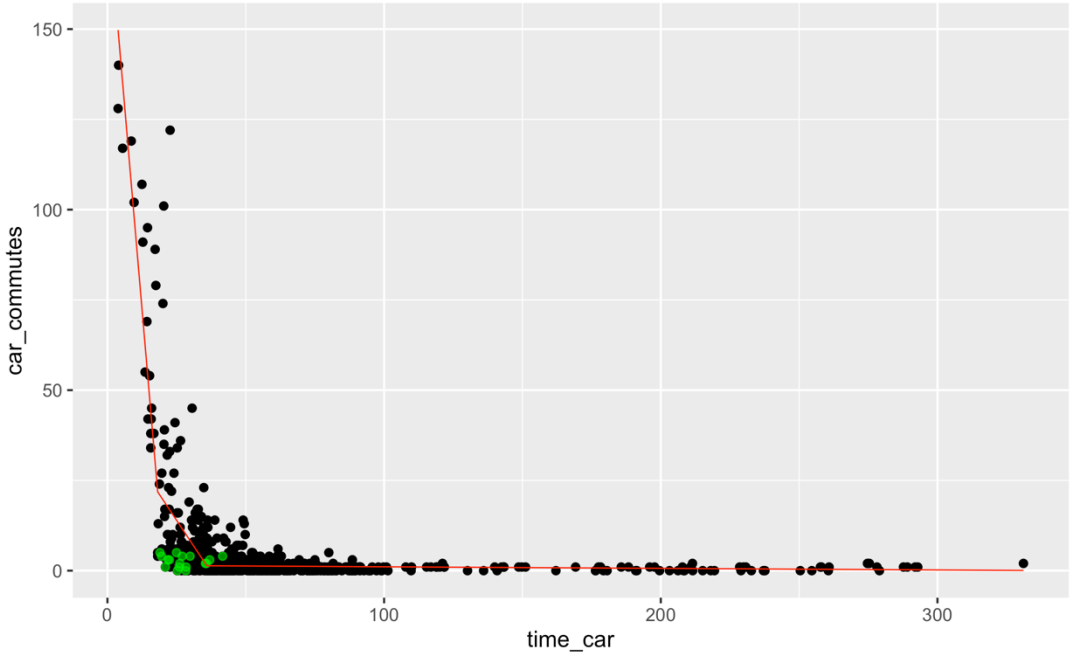
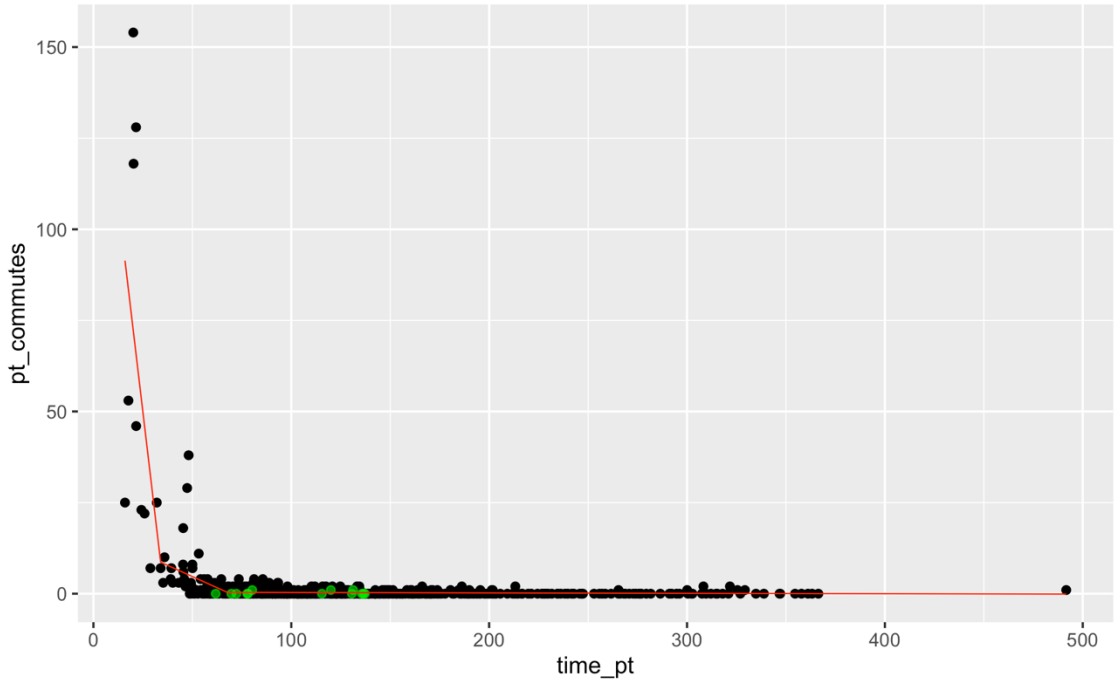


Figure 8: MARS model fit (PT trips)



7.11 The model is used to estimate the number of commuters from Thurrock based on the (adjusted) travel time to the Immediate Area. These predicted commutes are used in preference to the actual observed census data since it is expected that transport constraints on trips from Thurrock will be overcome once London Resort is operational.

Table 17: Predicted commutes from Thurrock (PT trips)

MSOA	Commute time	Commute time via Tilbury + ferry	Current commutes to site	Expected commutes to site
Thurrock 018	62	32	0	20
Thurrock 017	70	40	0	7
Thurrock 016	72	42	0	7
Thurrock 019	80	50	1	5
Thurrock 014	78	48	0	5
Thurrock 013	78	48	0	5
Thurrock 006	120	56	1	3
Havering 022	103	58	0	3
Basildon 022	121	61	2	2
Medway 002	63	62	0	2
Thurrock 015	137	63	0	2
Thurrock 007	131	66	1	1
Havering 030	103	64	0	1
Havering 023	106	65	0	1
Basildon 019	124	67	0	1
Thurrock 009	131	65	0	1
Thurrock 002	136	64	0	1

7.12 Table 17 shows how the MSOAs in Thurrock are expected to have many more commutes made to the London Resort site if the commute time and accessibility is improved. By removing the existing barriers to access the site (poor public transport options) and reducing the travel time (river crossing), the model predicts that Thurrock MSOAs will become much more attractive options to commute from.

Disclaimer

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London Resort: Hotel Distribution Note

London Resort Company Holdings

A report by Volterra Partners, December 2020

Volterra

1 Introduction

1.1 This note sets out the methodology and assumptions used to determine the number and distribution of off-site hotel rooms required to accommodate visitors to London Resort.

1.2 The note is split into four parts:

- Overnight stays;
- Hotel distribution by broad area;
- Hotel distribution by local authority district; and
- Scenario testing hotel distributions

1.3 The first section estimates the number of overnight stays by visitor type. Different types of visitor (primary resident, secondary resident, domestic tourist, and international tourist) will have different trip purposes and different preferences on where they wish to stay. For example, some may be linking a trip with London, of whom some may wish to stay within London rather than closer to Dartford or Gravesham. LDP has supplied estimates of the number of visitors to London Resort. Volterra apply a set of assumptions to convert these into estimates of those visitors who will stay overnight.

1.4 The second section makes assumptions about the typical trip purposes of the different types of visitor (primary resident, secondary resident, domestic tourist, and international tourist) to estimate the distribution of hotel demand. This is based on evidence from Disneyland Paris. Based on trip purpose, a further set of assumptions are used to distribute the overnight stays between the areas of Dartford and Gravesham, within 1 hour of London resort, or London.

1.5 The third section then describes how the hotel rooms are distributed into individual local authority districts.

1.6 It should be noted that a number of assumptions are required, for which comparator empirical evidence is often not available. Common sense assumptions have therefore had to be made in several places. Wherever this is the case, the assumptions and our basis for them has been transparently described.

2 Overnight Stays

Key inputs:

- Attendance at Main Gate, Second Gate, RDE, MICE and Waterpark in each assessment year (provided by LDP)
- Number of hotel rooms on site (provided by LDP)
- Average occupancy of on-site hotel rooms for each year (provided by LDP for on site hotels. Off site hotel occupancy provided by Visit Britain)

Key assumptions:

- Some visitors will visit both the main gate and second gate generating two visits. LDP expect these 'park hoppers' to be 15% of main gate attendance and are removed from the visitor numbers so as not to double count.
- Visitors to the waterpark do not also visit the theme park on the same day. A visit to the waterpark on the same day would not be feasible. All waterpark visitors (both on-site at the hotel and off-site) are therefore additional.
- The proportion of visitors who stay overnight is estimated for each home origin:
    - We assume that 0% of people within a one hour drive of London Resort (primary residents) stay overnight – all are assumed make day trips;
    - 10% of people within 1-2 hours of London resort (secondary residents) require overnight accommodation;
    - 50% of domestic tourists wish to stay in overnight accommodation; and
    - 100% of international tourists require overnight accommodation as it would be too far to make a day trip.
- Some visitor groups are assumed to make only day visits and not require overnight accommodation, these are:
    - Day theme park visitors;
    - Day MICE delegates;
    - Offsite RDE visitors; and
    - Offsite Waterpark visitors (all are primary residents so live within 1hour).

Method

2.1 The number of visitors differs from the number of visits to London Resort. Some people will visit both the main gate and second gate in a single day, generating two visits but representing just one visitor. Similarly, a large proportion of visits to RDE will be made by visitors already on site.

2.2 As set out in the assumptions, park hoppers are estimated to be 15% of main gate attendance. The off-site and on-site RDE attendance is estimated separately to avoid double counting visitors who are already on-site visiting the theme park or at hotels. The double-counted guests (park hoppers and on-site RDE visits) are subtracted from the total attendance to give the number of distinct visitors.

2.3 When considering the number of overnight stays, it is visitors and not visits that are relevant. While a visitor may be counted as multiple visits if they park-hop, for example, they will only require at most one bed night/overnight stay. To estimate the number of visitors staying overnight, the analysis adjusts visitors by also removing those people who only visit for the day.

Day theme park visits

2.4 The first adjustment to get from visitors to overnight stays is to remove those people who only visit the theme park for the day and return home the same day. This analysis assumes how the proportion of day visits relates to the visitor's home origin.

2.5 Primary residents (living within 60 minutes) are all assumed to make day trips. Secondary residents (60-120 mins) are largely assumed to make day trips, with 90% frequency. Domestic tourists (staying in tourist accommodation within 0-60 mins drive of the site but residing beyond the two hours' drive) are assumed to visit for the day at a frequency of 50%. This is because this includes many who would have come to the catchment area anyway and visit the attraction as a day trip as well as those who would extend the stay (whether stay where they are based or move to the onsite accommodation). No international tourists are expected to make day trips as a return home after visiting the theme park would not be feasible. These assumptions are outlined in Table 1.[1]

Table 1: Proportion of day trips by visitor home origin

Segment	% day visits
Primary residential	100%
Secondary residential	90%
Domestic tourism	50%
International tourism	0%

2.6 Applying the assumptions of day trip propensities to our visitor numbers allows us to estimate the number of day trips made by visitors to the site. These day trips are removed from the total number of visitors.

Day MICE delegates

2.7 Attendance estimates are made separately for day visits to the MICE centre and MICE visits from people staying at hotels on site. It is assumed that the MICE visits from hotels are already counted in the RDE figures. LDP assumes that half of the day MICE delegates are not already counted in RDE and so are additional visitors in for the purposes of this analysis.

2.8 For the overnight visitor calculations, these day MICE delegates are removed as they are assumed not to require an overnight stay. Day MICE visitors are only assumed to visit on weekdays and so are not included in the design day (busy day in high season – roughly 95th percentile level of busyness) or peak day (busiest day of the year) attendance figures. There is therefore only need to remove these day visitors for the annual assessment.

[1] At this stage this analysis does not consider the additionality of these overnight stays. This will be important for assessing the economic impacts, but for the purposes of trip generation is not required at this stage.

Offsite RDE visitors

2.9 The offsite RDE visitors are assumed to be primary residents and domestic tourists who are staying nearby anyway. These were calculated by applying penetration rates to the primary and domestic tourist catchments and were calculated separately from onsite RDE visitors.

2.10 These offsite visits are likely to be short day trips and not to create any additional overnight stays. Offsite RDE visitors are therefore removed from our visitor figures as they do not stay overnight.

Offsite Waterpark visitors

2.11 Offsite Waterpark visitors are assumed to be captured from primary residents who live within 60minutes. These residents are therefore assumed not to require an overnight stay and are removed from the visitor figures.

Overnight stays

2.12 Table 2 shows the elements that combine to calculate total visitors, and then the visitors that are removed to arrive at total overnight visitors.

Table 2: Annual visitors and overnight visitors (000s)

Land use	Annual visitors (000s)		
	2024	2029	2038
TOTAL VISITORS	**6,500**	**8,500**	**12,500**
LESS theme day visits	*-60%*	*-50%*	*-46%*
Less day MICE delegates	*-0%*	*-0%*	*-0%*
Less offsite RDE	*-6%*	*-10%*	*-10%*
Less offsite Waterpark	*-6%*	*-3%*	*-2%*

2.13 Table 3 shows the breakdown of overnight visitors by home origin.

Table 3: Annual overnight stays by home origin (000s)

Land use	Annual visitors (000s)		
	2024	2029	2038
Secondary residents	14%	10%	8%
Domestic tourists	24%	24%	19%
International tourists	62%	66%	73%
TOTAL OVERNIGHT VISITORS	**100%**	**100%**	**100%**

2.14 The number of overnight visitors in each assessment year gives the total number of bednights required to accommodate those who wish to stay overnight. The number of bednights makes no assumptions about where these hotel rooms will be located. The following sections provide the methodology for estimating the distribution of hotel rooms for resort guests in the local authorities surrounding the site.

3 Hotel Distribution by Broad Area

Key inputs:

- Overnight stays by secondary residents (previous section output)
- Overnight stays by domestic tourists (previous section output)
- Overnight stays by international tourists (previous section output)
- Preferences for overnight stay locations based on trip purpose (evidence from Disneyland Paris)

Key assumptions:

- 100% of day trips (non-overnight stays) are made for the sole motivation of visiting the theme park (and 0% are on linked trips).
- 85% of 'sole motivated' visitors want to stay in resort hotels, with the other 15% prefer to stay locally in Dartford and Gravesham.
- 50% of those visitors on linked trips to London want to stay in London (the remaining 50% are distributed 85% on resort and 15% locally as per the sole motivated assumption)
- 50% of those visitors on linked trips to within one hour (outside London) of London resort want to stay within that one-hour catchment. The other 50% are distributed as per the sole motivated trip preferences.

Method

3.1 Evidence from Disneyland Paris[2] (DLP) shows the trip motivations of visitors to the theme park based on where those visitors live. Table 4 shows the trip purposes of DLP visitors by visitor home origin.

Table 4: Disneyland Paris trip purposes by home origin

Trip purpose	Local area (Seine-et-Marne area)	Domestic tourist (French Provinces)	Overseas
Theme park sole motivation	98.7%	77%	41%
Linked trip with Paris	1.2%	17.1%	33.9%
Linked trip other	0%	5.9%	25.1%

3.2 The numbers in Table 4 don't account for the fact that the distribution will change depending on whether you are an overnight stayer or on a day trip. Day trips will all be for the sole motivation of visiting the theme park. Since 77% of all domestic tourists are sole-motivated, and we know that those who visit just for the day and are all sole motivated, we can work out the proportion of overnight domestic tourists who are sole motivated.

3.3 The trip purposes for just the overnight visitors are adjusted and calculated on the basis that 100% of non-overnight visitors are sole motivated. Table 5 presents the trip purposes of just the overnight visitors based on the proportions in 2038.

[2]https://www.marketscreener.com/EURO-DISNEY-67837/news/EURO-DISNEY-Press-Kit-Disneyland-Paris-Economic-and-Social-Impact-Study-14216747/

Table 5: Trip purposes of overnight visitors by home origin (2038)

Trip purpose	Local area (no overnights)	Domestic tourist + secondary residential	Overseas
Theme park sole motivation	-	25%	41%
Linked trip with London	-	56%	33.9%
Linked trip other	-	19%	25%

3.4 A set of assumptions is used to map from trip motivations to where visitors wish to stay:

- It is assumed that 85% of visitors with the theme park as the sole motivation wish to stay at resort hotels, with the remaining 15% wanting to stay locally in Dartford and Gravesham. The assumption is that these visitors will want to stay on or near the site, since that is their sole reason for coming; and
- Half of visitors making linked trips are assumed to want to stay in the area of their linked trip (one-hour radius or London). The other half of linked-trip visitors are assumed to stay either at resort (85%) or in Dartford/Gravesham (15%) as per the sole-motivated trip assumption.

Table 6: Assumptions mapping trip purposes to stay preferences

Trip purpose	Where visitors wish to stay			
	Resort	Dartford & Gravesham	1 hr of resort	London
Theme park sole motivation	**85%**	**15%**	0%	0%
Linked trip with London	43%	8%	0%	**50%**
Linked trip with other	43%	8%	**50%**	0%

3.5 Combining this set of assumptions (Table 6) with the overnight visitors by trip purpose table (Table 5) results a set of preferences of where visitors to London Resort will wish to stay by broad area (Table 7).

Table 7: Overnight stay preferences by broad area

	2024	2029	2038
London Resort	50%	63%	44%
Dartford & Gravesham	12%	9%	14%
One hour of resort (non-London)	13%	10%	16%
London	25%	18%	27%

3.6 The overnight stay preferences are applied to the number of bednight stays calculated in the previous section to get the expected demand for hotel rooms in each broad area. The demand is calculated for each of the three assessment years, for 'peak day', 'design day' and 'average day'.

3.7 The 2016 accommodation stock audits[3] from Visit Britain and occupancy levels[4] are used to determine the available stock of hotel (and similar accommodation) rooms in each area. The available stock in Dartford and Gravesham was found to be insufficient to fulfill the expected demand. We present two scenarios to deal with this:

- Scenario one: the supply of hotel rooms in Dartford and Gravesham increase to fill the additional demand. All demand in the local area is assumed to be met; and
- Scenario two: Dartford and Gravesham hotel supply is constrained and the excess demand is reallocated to the one hour and London catchment areas using the respective overnight stay preferences.

3.8 This analysis conservatively does not account for other forms of accommodation such as Airbnb. Incorporating this would increase the available accommodation stock and enable Dartford and Gravesham to meet more of the shortfall.

Table 8: Hotel room distribution by broad area (Scenario one, 2038)

Broad area	Peak Day	Design Day	Average Day
London Resort	4,000	3,890	3,340
Dartford & Gravesham	3,440	2,785	965
1-hour (non-London)	3,085	2,480	855
London	7,040	5,665	1,945
Total	**17,565**	**14,820**	**7,105**

Table 9: Hotel room distribution by broad area (Scenario two, 2038)

Broad area	Peak Day	Design Day	Average Day
London Resort	4,000	3,890	3,340
Dartford & Gravesham	195	200	365
1-hour (non-London)	4,290	3,445	1,075
London	9,080	7,290	2,325
Total	**17,565**	**14,820**	**7,105**

3.9 Tables 8 and 9 show the hotel room distribution by broad area for each scenario in 2038. The overall demand is the same under each scenario, but the distribution is different. The key difference is for Dartford and Gravesham because scenario 1 allows for the demand to fill the additional demand. Where demand is fixed (scenario 2), excess demand is relocated to outside Dartford and Gravesham.

[3] https://www.visitbritain.org/accommodation-stock
[4] https://www.visitbritain.org/accommodation-occupancy-latest-results

4 Hotel Distribution by District

Key inputs:

- Hotel distribution by broad area (previous section output)
- Driving time to each district (Google maps)
- Number of hotel rooms in each district (Visit Britain)

Key assumptions:

- Number of trips made decays exponentially with distance. As distance from London Resort increases, the number of trips made gets increasingly smaller. This exact decay formula is based on empirical findings from trips made to central London.
- The attractiveness of a location for staying overnight is proxied by the number of hotel rooms at that location.
- Decisions of where to stay are driven 50% by distance and 50% by attractiveness.

Method

4.1 The specific districts in which off-site visitors choose to stay is assumed to be driven by two key decisions: the attractiveness of the location, and the distance from the theme park. The number of hotels in the district is chosen as a proxy for the attractiveness of the location. The number of people wanting to stay in a district is assumed to decay exponentially with the driving distance from the destination. In other words, the demand for staying in a place falls at an increasing rate the further away it is from the theme park.

4.2 The outputs from the 'hotel distribution by broad area' exercise split the distribution between Dartford and Gravesham, 1 hour (non-London) drive time, and London. Within these areas, hotel stays are disaggregated into individual districts:

- For hotel stays within Dartford and Gravesham, disaggregation between Dartford and Gravesham is based entirely on the relative attractiveness of each district (the number of hotel rooms);
- For hotel stays within 1 hour (non-London), 50% of hotel stay weightings are based on the relative attractiveness of the constituent districts, with the other 50% based on the distance from the theme park; and
- For hotel stays within London, a 50% weighting is applied to both the attractiveness and the distance measures (same as 1 hour).

4.3 As was the case with the 'hotel distribution by broad area', two scenarios are produced. Scenario one is the distribution of hotels based on Dartford and Gravesham hotel supply expanding to fill the projected demand. Scenario two assumes that Dartford and Gravesham hotel supply is static and redistributes excess demand to the remaining districts based on the method described.

4.4 The disaggregated hotel distributions are presented in the appendices.

5 Scenario Testing

Additional scenarios

5.1 The core scenario tested two options – one where supply in Dartford and Gravesham hotels grew to meet demand, and one where it was constrained to the existing level of capacity.

5.2 Two further options are explored which are aimed at attributing more hotel demand toward Thurrock. It is proposed that there will be car parking provided for visitors to London Resort in Tilbury, Thurrock, and that around 25% of visitors will arrive via Tilbury.

5.3 When distributing trips between the local authorities, the trips from the wider area are distributed partly based on drivetime. This is explained in the previous section. In the first additional scenario tested, the drivetime from Thurrock from the current 32 minute drivetime to 11 minutes as it is assumed it will be comparable in time to trips from Dartford and Gravesham. This doubles the number of trips to Thurrock, but still makes up only around 1% of total hotel demand. Appendix 3 and 4 shows the distributions based on this additional scenario.

5.4 A second additional scenario is that Thurrock forms a part of the *local area* on the basis that with the reduced travel time to London Resort via shuttle, the local authority becomes similar in characteristics to that of Dartford and Gravesham. In the core scenario it is assumed that those people wishing to stay locally to the site are distributed solely between Dartford and Gravesham. Adding the additional capacity of Thurrock to that local area definition allows more guests to be allocated locally rather than spilling over into surrounding areas in the constrained capacity scenario (core scenario two).

Reduced travel time to Thurrock

5.5 In this scenario only the distribution of trips within a one-hour radius of London Resort is changed. The distribution of trips to Thurrock changes from 40 to 72 on Design Day (2038) in core scenario one, and from 54 to 96 on Design Day (2038) in core scenario two.

Thurrock in local area definition

5.6 In this scenario, the local trips that were previously distributed between the spare hotel capacity in Dartford and Gravesham are extended to include Thurrock. This has the effect of reducing the demand allocated to Dartford and Gravesham while also increasing the available local capacity, preventing some spillover of excess capacity into the wider one-hour catchments.

5.7 Volterra recommend using this scenario (Appendix 6) as the core scenario. This scenario assumes that hotel demand is constrained by the available rooms in the district. Demand that exceeds the available supply of hotel rooms is reallocated to hotels in the wider areas. This also assumes that Thurrock is equally as attractive to staying in Dartford and Gravesham and so the local demand is shared with the hotel stock in Thurrock. This is due to the proposed parking and ferry service at Tilbury.

5.8 **This is a conservative scenario from a transport point of view as its crowds stays out of Dartford & Gravesham into London. It also is considered a more realistic assessment of the likely effect on Thurrock given the uplift in accessibility to Tilbury.**

Summary

5.9 The full breakdown of hotel room allocations by local authority district for each scenario is set out in the appendices.

6 APPENDIX 1 Hotel distribution by local authority district (Core Scenario One)

Average Day Hotel rooms

District	2024	2029	2038
Dartford	126	227	608
Gravesham	74	134	359
Brentwood	4	7	20
Basildon	4	8	22
Tandridge	4	7	19
Thurrock (U)	4	7	19
Castle Point	3	5	14
Reigate & Banstead	5	9	26
Chelmsford	3	6	16
Epping Forest	3	6	16
Harlow	3	5	14
Rochford	2	4	11
Crawley	9	17	47
Broxbourne	3	5	13
Epsom and Ewell	2	4	11
Mid Sussex	4	7	19
Runnymede	5	8	24
Maldon	3	5	14
Mole Valley	3	6	17
Elmbridge	4	7	19
Guildford	5	10	27
Horsham	5	8	23
Southend on Sea (U)	2	4	12
St Albans	2	4	11
Welwyn Hatfield	2	4	12
Hertsmere	3	5	15
Woking	2	4	11
Wealden	5	8	23
Colchester	3	6	16
Spelthorne	3	5	14
Uttlesford	3	6	17
Medway (U)	6	11	30
Maidstone	7	13	35
Tonbridge and Malling	6	10	28
Sevenoaks	6	10	28
Swale	6	11	30
Tunbridge Wells	5	9	25
Ashford	5	10	27
Canterbury	10	18	50
Shepway	6	11	30
Thanet	5	9	26
Dover	4	8	22
Bexley	18	31	84
Greenwich	17	29	79
Bromley	13	22	58
Barking & Dagenham	12	20	53

District	2024	2029	2038
Havering	12	20	54
Lewisham	11	19	51
Newham	16	27	72
Hackney	10	18	47
Southwark	14	24	66
Tower Hamlets	20	34	90
Waltham Forest	9	15	40
Redbridge	9	16	44
Islington	12	21	57
Croydon	9	16	42
Westminster	54	93	249
Lambeth	15	26	68
City of London	12	20	54
Sutton	6	10	28
Haringey	6	10	27
Barnet	7	12	31
Enfield	5	9	23
Kensington & Chelsea	34	59	159
Wandsworth	6	10	27
Camden	34	59	157
Kingston upon Thames	6	10	26
Merton	5	8	21
Brent	7	13	34
Ealing	5	8	21
Hammersmith & Fulham	10	16	44
Harrow	4	6	17
Hillingdon	13	23	61
Hounslow	7	12	33
Richmond upon Thames	7	12	31
Total	**792**	**1,393**	**3,766**

Design Day Hotel rooms

District	2024	2029	2038
Dartford	379	875	1,752
Gravesham	223	516	1,033
Brentwood	12	29	60
Basildon	13	30	63
Tandridge	11	26	54
Thurrock (U)	11	26	54
Castle Point	8	20	41
Reigate & Banstead	16	37	77
Chelmsford	10	23	47
Epping Forest	10	23	48
Harlow	8	20	41
Rochford	7	16	33
Crawley	27	65	135
Broxbourne	8	18	38
Epsom and Ewell	6	15	31
Mid Sussex	11	26	55
Runnymede	14	33	69

District	2024	2029	2038
Maldon	8	19	40
Mole Valley	10	24	49
Elmbridge	11	27	55
Guildford	16	38	80
Horsham	13	32	66
Southend on Sea (U)	7	16	34
St Albans	7	16	33
Welwyn Hatfield	7	17	35
Hertsmere	9	21	43
Woking	7	16	33
Wealden	13	32	66
Colchester	9	22	45
Spelthorne	8	19	39
Uttlesford	10	24	51
Medway (U)	17	41	86
Maidstone	21	49	103
Tonbridge and Malling	17	39	82
Sevenoaks	17	39	82
Swale	18	42	87
Tunbridge Wells	15	35	72
Ashford	16	38	79
Canterbury	29	70	146
Shepway	18	42	88
Thanet	15	37	76
Dover	13	31	64
Bexley	54	122	244
Greenwich	51	115	230
Bromley	37	85	170
Barking & Dagenham	34	78	155
Havering	34	78	156
Lewisham	33	74	149
Newham	46	104	208
Hackney	30	69	138
Southwark	42	96	191
Tower Hamlets	58	132	263
Waltham Forest	25	58	115
Redbridge	28	64	127
Islington	36	82	165
Croydon	27	61	121
Westminster	160	364	726
Lambeth	44	100	199
City of London	35	79	157
Sutton	18	40	81
Haringey	17	40	79
Barnet	20	45	90
Enfield	15	34	67
Kensington & Chelsea	102	232	462
Wandsworth	17	40	79
Camden	100	229	457
Kingston upon Thames	17	38	75
Merton	14	31	61
Brent	21	49	98
Ealing	13	31	61
Hammersmith & Fulham	28	64	128
Harrow	11	25	50
Hillingdon	39	89	177
Hounslow	21	48	96
Richmond upon Thames	20	46	91
Total	**2,350**	**5,421**	**10,931**

7 APPENDIX 2 Hotel distribution by local authority district (Core Scenario Two)

Average Day Hotel Rooms

District	2024	2029	2038
Dartford	126	227	231
Gravesham	74	134	136
Brentwood	4	7	26
Basildon	4	8	27
Tandridge	4	7	24
Thurrock (U)	4	7	23
Castle Point	3	5	18
Reigate & Banstead	5	9	33
Chelmsford	3	6	20
Epping Forest	3	6	21
Harlow	3	5	18
Rochford	2	4	14
Crawley	9	17	59
Broxbourne	3	5	17
Epsom and Ewell	2	4	13
Mid Sussex	4	7	24
Runnymede	5	8	30
Maldon	3	5	17
Mole Valley	3	6	21
Elmbridge	4	7	24
Guildford	5	10	34
Horsham	5	8	28
Southend on Sea (U)	2	4	15
St Albans	2	4	14
Welwyn Hatfield	2	4	15
Hertsmere	3	5	19
Woking	2	4	14
Wealden	5	8	29
Colchester	3	6	20
Spelthorne	3	5	17
Uttlesford	3	6	22
Medway (U)	6	11	37
Maidstone	7	13	45
Tonbridge and Malling	6	10	35
Sevenoaks	6	10	35
Swale	6	11	38
Tunbridge Wells	5	9	31
Ashford	5	10	34
Canterbury	10	18	63
Shepway	6	11	38
Thanet	5	9	33
Dover	4	8	28
Bexley	18	31	100
Greenwich	17	29	94
Bromley	13	22	70
Barking & Dagenham	12	20	64
Havering	12	20	64
Lewisham	11	19	61
Newham	16	27	85
Hackney	10	18	56
Southwark	14	24	78
Tower Hamlets	20	34	108
Waltham Forest	9	15	47

District	2024	2029	2038
Redbridge	9	16	52
Islington	12	21	67
Croydon	9	16	50
Westminster	54	93	298
Lambeth	15	26	82
City of London	12	20	64
Sutton	6	10	33
Haringey	6	10	32
Barnet	7	12	37
Enfield	5	9	28
Kensington & Chelsea	34	59	190
Wandsworth	6	10	33
Camden	34	59	187
Kingston upon Thames	6	10	31
Merton	5	8	25
Brent	7	13	40
Ealing	5	8	25
Hammersmith & Fulham	10	16	53
Harrow	4	6	20
Hillingdon	13	23	73
Hounslow	7	12	39
Richmond upon Thames	7	12	37
Total	**792**	**1,393**	**3,766**

Design Day Hotel rooms

District	2024	2029	2038
Dartford	126	126	126
Gravesham	74	74	74
Brentwood	15	39	83
Basildon	16	41	88
Tandridge	14	36	76
Thurrock (U)	14	35	75
Castle Point	11	27	57
Reigate & Banstead	20	50	107
Chelmsford	12	31	66
Epping Forest	12	31	66
Harlow	11	27	57
Rochford	9	22	46
Crawley	35	88	188
Broxbourne	10	25	53
Epsom and Ewell	8	20	43
Mid Sussex	14	36	76
Runnymede	18	45	96
Maldon	10	26	55
Mole Valley	13	32	68
Elmbridge	14	36	77
Guildford	21	52	110
Horsham	17	43	91
Southend on Sea (U)	9	22	47
St Albans	9	22	46
Welwyn Hatfield	9	23	49
Hertsmere	11	28	60
Woking	9	22	46
Wealden	17	43	92
Colchester	12	30	63
Spelthorne	10	26	55

District	2024	2029	2038
Uttlesford	13	33	70
Medway (U)	22	56	119
Maidstone	27	67	143
Tonbridge and Malling	21	53	113
Sevenoaks	21	53	113
Swale	23	57	121
Tunbridge Wells	19	47	100
Ashford	20	51	109
Canterbury	38	95	202
Shepway	23	58	122
Thanet	20	50	106
Dover	17	42	88
Bexley	65	155	314
Greenwich	61	146	296
Bromley	45	108	219
Barking & Dagenham	41	98	199
Havering	41	99	201
Lewisham	39	94	191
Newham	55	132	268
Hackney	37	87	177
Southwark	51	121	246
Tower Hamlets	70	167	338
Waltham Forest	31	73	148
Redbridge	34	81	164
Islington	44	105	212
Croydon	32	77	156
Westminster	193	461	934
Lambeth	53	126	256
City of London	42	100	202
Sutton	21	51	104
Haringey	21	50	101
Barnet	24	57	116
Enfield	18	43	86
Kensington & Chelsea	123	294	595
Wandsworth	21	50	102
Camden	121	290	588
Kingston upon Thames	20	48	97
Merton	16	39	79
Brent	26	62	126
Ealing	16	39	79
Hammersmith & Fulham	34	81	165
Harrow	13	32	64
Hillingdon	47	112	228
Hounslow	25	61	123
Richmond upon Thames	24	58	117
Total	**2,350**	**5,421**	**10,931**

8 APPENDIX 3 Scenario testing – Reduced Journey time to Thurrock (with core scenario one)

Average Day Hotel Rooms

District	2024	2029	2038
Dartford	126	227	608
Gravesham	74	134	359
Brentwood	4	7	20
Basildon	4	8	21
Tandridge	4	6	18
Thurrock (U)	7	12	33
Castle Point	3	5	14
Reigate & Banstead	5	9	26
Chelmsford	3	6	16
Epping Forest	3	6	16
Harlow	3	5	14
Rochford	2	4	11
Crawley	9	16	46
Broxbourne	3	5	13
Epsom and Ewell	2	4	10
Mid Sussex	4	7	19
Runnymede	5	8	23
Maldon	3	5	13
Mole Valley	3	6	17
Elmbridge	4	7	19
Guildford	5	10	27
Horsham	4	8	22
Southend on Sea (U)	2	4	11
St Albans	2	4	11
Welwyn Hatfield	2	4	12
Hertsmere	3	5	15
Woking	2	4	11
Wealden	5	8	23
Colchester	3	5	15
Spelthorne	3	5	13
Uttlesford	3	6	17
Medway (U)	6	10	29
Maidstone	7	12	35
Tonbridge and Malling	5	10	27
Sevenoaks	5	10	27
Swale	6	11	30
Tunbridge Wells	5	9	24
Ashford	5	10	27
Canterbury	10	18	50
Shepway	6	11	30
Thanet	5	9	26
Dover	4	8	22
Bexley	18	31	84
Greenwich	17	29	79
Bromley	13	22	58
Barking & Dagenham	12	20	53
Havering	12	20	54
Lewisham	11	19	51
Newham	16	27	72
Hackney	10	18	47
Southwark	14	24	66
Tower Hamlets	20	34	90
Waltham Forest	9	15	40

District	2024	2029	2038
Redbridge	9	16	44
Islington	12	21	57
Croydon	9	16	42
Westminster	54	93	249
Lambeth	15	26	68
City of London	12	20	54
Sutton	6	10	28
Haringey	6	10	27
Barnet	7	12	31
Enfield	5	9	23
Kensington & Chelsea	34	59	159
Wandsworth	6	10	27
Camden	34	59	157
Kingston upon Thames	6	10	26
Merton	5	8	21
Brent	7	13	34
Ealing	5	8	21
Hammersmith & Fulham	10	16	44
Harrow	4	6	17
Hillingdon	13	23	61
Hounslow	7	12	33
Richmond upon Thames	7	12	31
Total	**792**	**1,393**	**3,766**

Design Day Hotel rooms

District	2024	2029	2038
Dartford	379	875	1,752
Gravesham	223	516	1,033
Brentwood	12	28	58
Basildon	12	29	61
Tandridge	11	25	53
Thurrock (U)	20	46	97
Castle Point	8	19	39
Reigate & Banstead	15	36	76
Chelmsford	9	22	46
Epping Forest	9	22	46
Harlow	8	19	40
Rochford	7	16	32
Crawley	27	64	134
Broxbourne	8	18	37
Epsom and Ewell	6	14	30
Mid Sussex	11	26	54
Runnymede	14	33	68
Maldon	8	19	39
Mole Valley	10	23	48
Elmbridge	11	26	55
Guildford	16	38	79
Horsham	13	31	65
Southend on Sea (U)	7	16	33
St Albans	7	16	33
Welwyn Hatfield	7	17	35
Hertsmere	9	21	43
Woking	7	16	32
Wealden	13	31	66
Colchester	9	21	45
Spelthorne	8	19	39

District	2024	2029	2038
Uttlesford	10	24	50
Medway (U)	17	40	84
Maidstone	20	48	101
Tonbridge and Malling	16	38	79
Sevenoaks	16	38	80
Swale	17	41	86
Tunbridge Wells	14	34	71
Ashford	16	37	77
Canterbury	29	69	144
Shepway	18	42	87
Thanet	15	36	75
Dover	13	30	63
Bexley	54	122	244
Greenwich	51	115	230
Bromley	37	85	170
Barking & Dagenham	34	78	155
Havering	34	78	156
Lewisham	33	74	149
Newham	46	104	208
Hackney	30	69	138
Southwark	42	96	191
Tower Hamlets	58	132	263
Waltham Forest	25	58	115
Redbridge	28	64	127
Islington	36	82	165
Croydon	27	61	121
Westminster	160	364	726
Lambeth	44	100	199
City of London	35	79	157
Sutton	18	40	81
Haringey	17	40	79
Barnet	20	45	90
Enfield	15	34	67
Kensington & Chelsea	102	232	462
Wandsworth	17	40	79
Camden	100	229	457
Kingston upon Thames	17	38	75
Merton	14	31	61
Brent	21	49	98
Ealing	13	31	61
Hammersmith & Fulham	28	64	128
Harrow	11	25	50
Hillingdon	39	89	177
Hounslow	21	48	96
Richmond upon Thames	20	46	91
Total	**2,350**	**5,421**	**10,931**

9 APPENDIX 4 Scenario testing – Reduced Journey time to Thurrock (with core scenario two)

Average Day Hotel Rooms

District	2024	2029	2038
Dartford	126	227	231
Gravesham	74	134	136
Brentwood	4	7	25
Basildon	4	8	27
Tandridge	4	6	23
Thurrock (U)	7	12	42
Castle Point	3	5	17
Reigate & Banstead	5	9	33
Chelmsford	3	6	20
Epping Forest	3	6	20
Harlow	3	5	17
Rochford	2	4	14
Crawley	9	16	58
Broxbourne	3	5	16
Epsom and Ewell	2	4	13
Mid Sussex	4	7	23
Runnymede	5	8	30
Maldon	3	5	17
Mole Valley	3	6	21
Elmbridge	4	7	24
Guildford	5	10	34
Horsham	4	8	28
Southend on Sea (U)	2	4	14
St Albans	2	4	14
Welwyn Hatfield	2	4	15
Hertsmere	3	5	19
Woking	2	4	14
Wealden	5	8	28
Colchester	3	5	19
Spelthorne	3	5	17
Uttlesford	3	6	22
Medway (U)	6	10	36
Maidstone	7	12	44
Tonbridge and Malling	5	10	34
Sevenoaks	5	10	35
Swale	6	11	37
Tunbridge Wells	5	9	31
Ashford	5	10	34
Canterbury	10	18	63
Shepway	6	11	38
Thanet	5	9	33
Dover	4	8	27
Bexley	18	31	100
Greenwich	17	29	94
Bromley	13	22	70
Barking & Dagenham	12	20	64
Havering	12	20	64
Lewisham	11	19	61
Newham	16	27	85
Hackney	10	18	56
Southwark	14	24	78
Tower Hamlets	20	34	108
Waltham Forest	9	15	47

District	2024	2029	2038
Redbridge	9	16	52
Islington	12	21	67
Croydon	9	16	50
Westminster	54	93	298
Lambeth	15	26	82
City of London	12	20	64
Sutton	6	10	33
Haringey	6	10	32
Barnet	7	12	37
Enfield	5	9	28
Kensington & Chelsea	34	59	190
Wandsworth	6	10	33
Camden	34	59	187
Kingston upon Thames	6	10	31
Merton	5	8	25
Brent	7	13	40
Ealing	5	8	25
Hammersmith & Fulham	10	16	53
Harrow	4	6	20
Hillingdon	13	23	73
Hounslow	7	12	39
Richmond upon Thames	7	12	37
Total	**792**	**1,393**	**3,766**

Design Day Hotel rooms

District	2024	2029	2038
Dartford	126	126	126
Gravesham	74	74	74
Brentwood	15	38	80
Basildon	16	40	85
Tandridge	14	35	73
Thurrock (U)	25	63	134
Castle Point	10	26	55
Reigate & Banstead	20	49	105
Chelmsford	12	30	64
Epping Forest	12	30	64
Harlow	10	26	55
Rochford	8	21	45
Crawley	35	88	186
Broxbourne	10	24	52
Epsom and Ewell	8	20	41
Mid Sussex	14	35	75
Runnymede	18	45	95
Maldon	10	26	54
Mole Valley	13	32	67
Elmbridge	14	36	76
Guildford	20	51	109
Horsham	17	42	90
Southend on Sea (U)	9	22	46
St Albans	8	21	45
Welwyn Hatfield	9	23	48
Hertsmere	11	28	59
Woking	8	21	45
Wealden	17	43	91
Colchester	12	29	62
Spelthorne	10	25	54

District	2024	2029	2038
Uttlesford	13	33	69
Medway (U)	22	55	116
Maidstone	26	66	140
Tonbridge and Malling	21	52	110
Sevenoaks	21	52	111
Swale	22	56	119
Tunbridge Wells	18	46	99
Ashford	20	51	107
Canterbury	37	94	200
Shepway	23	57	121
Thanet	20	49	105
Dover	16	41	88
Bexley	65	155	314
Greenwich	61	146	296
Bromley	45	108	219
Barking & Dagenham	41	98	199
Havering	41	99	201
Lewisham	39	94	191
Newham	55	132	268
Hackney	37	87	177
Southwark	51	121	246
Tower Hamlets	70	167	338
Waltham Forest	31	73	148
Redbridge	34	81	164
Islington	44	105	212
Croydon	32	77	156
Westminster	193	461	934
Lambeth	53	126	256
City of London	42	100	202
Sutton	21	51	104
Haringey	21	50	101
Barnet	24	57	116
Enfield	18	43	86
Kensington & Chelsea	123	294	595
Wandsworth	21	50	102
Camden	121	290	588
Kingston upon Thames	20	48	97
Merton	16	39	79
Brent	26	62	126
Ealing	16	39	79
Hammersmith & Fulham	34	81	165
Harrow	13	32	64
Hillingdon	47	112	228
Hounslow	25	61	123
Richmond upon Thames	24	58	117
Total	**2,350**	**5,421**	**10,931**

10 APPENDIX 5 Scenario testing – Thurrock part of local area definition (with core scenario one)

Average Day Hotel Rooms

District	2024	2029	2038
Dartford	90	162	434
Gravesham	53	96	256
Thurrock (U)	57	103	277
Brentwood	4	8	21
Basildon	4	8	22
Tandridge	4	7	19
Castle Point	3	5	15
Reigate & Banstead	5	10	27
Chelmsford	3	6	17
Epping Forest	3	6	17
Harlow	3	5	15
Rochford	2	4	12
Crawley	9	17	47
Broxbourne	3	5	13
Epsom and Ewell	2	4	11
Mid Sussex	4	7	19
Runnymede	5	9	24
Maldon	3	5	14
Mole Valley	3	6	17
Elmbridge	4	7	19
Guildford	6	10	28
Horsham	5	8	23
Southend on Sea (U)	2	4	12
St Albans	2	4	12
Welwyn Hatfield	2	4	12
Hertsmere	3	5	15
Woking	2	4	12
Wealden	5	8	23
Colchester	3	6	16
Spelthorne	3	5	14
Uttlesford	4	6	18
Medway (U)	6	11	30
Maidstone	7	13	36
Tonbridge and Malling	6	10	29
Sevenoaks	6	10	29
Swale	6	11	31
Tunbridge Wells	5	9	25
Ashford	6	10	28
Canterbury	10	18	51
Shepway	6	11	31
Thanet	5	10	27
Dover	4	8	22
Bexley	18	31	84
Greenwich	17	29	79
Bromley	13	22	58
Barking & Dagenham	12	20	53
Havering	12	20	54
Lewisham	11	19	51
Newham	16	27	72
Hackney	10	18	47
Southwark	14	24	66
Tower Hamlets	20	34	90
Waltham Forest	9	15	40

District	2024	2029	2038
Redbridge	9	16	44
Islington	12	21	57
Croydon	9	16	42
Westminster	54	93	249
Lambeth	15	26	68
City of London	12	20	54
Sutton	6	10	28
Haringey	6	10	27
Barnet	7	12	31
Enfield	5	9	23
Kensington & Chelsea	34	59	159
Wandsworth	6	10	27
Camden	34	59	157
Kingston upon Thames	6	10	26
Merton	5	8	21
Brent	7	13	34
Ealing	5	8	21
Hammersmith & Fulham	10	16	44
Harrow	4	6	17
Hillingdon	13	23	61
Hounslow	7	12	33
Richmond upon Thames	7	12	31
Total	**792**	**1,393**	**3,766**

Design Day Hotel rooms

District	2024	2029	2038
Dartford	270	625	1,250
Gravesham	159	368	737
Thurrock (U)	172	398	797
Brentwood	12	30	62
Basildon	13	31	65
Tandridge	11	27	56
Castle Point	9	20	42
Reigate & Banstead	16	38	78
Chelmsford	10	23	49
Epping Forest	10	24	49
Harlow	9	20	42
Rochford	7	17	35
Crawley	28	66	137
Broxbourne	8	19	39
Epsom and Ewell	6	15	32
Mid Sussex	11	27	56
Runnymede	14	34	70
Maldon	8	20	41
Mole Valley	10	24	50
Elmbridge	11	27	56
Guildford	16	39	81
Horsham	14	32	67
Southend on Sea (U)	7	17	35
St Albans	7	16	34
Welwyn Hatfield	7	17	36
Hertsmere	9	21	44
Woking	7	16	34
Wealden	14	32	67
Colchester	9	22	46
Spelthorne	8	19	40
Uttlesford	10	25	52

District	2024	2029	2038
Medway (U)	18	42	88
Maidstone	21	51	106
Tonbridge and Malling	17	40	84
Sevenoaks	17	40	84
Swale	18	43	89
Tunbridge Wells	15	36	74
Ashford	16	38	80
Canterbury	30	71	148
Shepway	18	43	89
Thanet	16	37	77
Dover	13	31	65
Bexley	54	122	244
Greenwich	51	115	230
Bromley	37	85	170
Barking & Dagenham	34	78	155
Havering	34	78	156
Lewisham	33	74	149
Newham	46	104	208
Hackney	30	69	138
Southwark	42	96	191
Tower Hamlets	58	132	263
Waltham Forest	25	58	115
Redbridge	28	64	127
Islington	36	82	165
Croydon	27	61	121
Westminster	160	364	726
Lambeth	44	100	199
City of London	35	79	157
Sutton	18	40	81
Haringey	17	40	79
Barnet	20	45	90
Enfield	15	34	67
Kensington & Chelsea	102	232	462
Wandsworth	17	40	79
Camden	100	229	457
Kingston upon Thames	17	38	75
Merton	14	31	61
Brent	21	49	98
Ealing	13	31	61
Hammersmith & Fulham	28	64	128
Harrow	11	25	50
Hillingdon	39	89	177
Hounslow	21	48	96
Richmond upon Thames	20	46	91
Total	**2,350**	**5,421**	**10,931**

11 APPENDIX 6 Scenario testing – Thurrock part of local area definition (with core scenario two) - RECOMMENDED

Average Day Hotel Rooms

District	2024	2029	2038
Dartford	90	162	231
Gravesham	53	96	136
Thurrock (U)	57	103	147
Brentwood	4	8	25
Basildon	4	8	27
Tandridge	4	7	23
Castle Point	3	5	17
Reigate & Banstead	5	10	32
Chelmsford	3	6	20
Epping Forest	3	6	20
Harlow	3	5	17
Rochford	2	4	14
Crawley	9	17	56
Broxbourne	3	5	16
Epsom and Ewell	2	4	13
Mid Sussex	4	7	23
Runnymede	5	9	29
Maldon	3	5	17
Mole Valley	3	6	21
Elmbridge	4	7	23
Guildford	6	10	33
Horsham	5	8	28
Southend on Sea (U)	2	4	14
St Albans	2	4	14
Welwyn Hatfield	2	4	15
Hertsmere	3	5	18
Woking	2	4	14
Wealden	5	8	28
Colchester	3	6	19
Spelthorne	3	5	17
Uttlesford	4	6	21
Medway (U)	6	11	36
Maidstone	7	13	43
Tonbridge and Malling	6	10	35
Sevenoaks	6	10	35
Swale	6	11	37
Tunbridge Wells	5	9	30
Ashford	6	10	33
Canterbury	10	18	61
Shepway	6	11	37
Thanet	5	10	32
Dover	4	8	27
Bexley	18	31	96
Greenwich	17	29	90
Bromley	13	22	67
Barking & Dagenham	12	20	61
Havering	12	20	61
Lewisham	11	19	59
Newham	16	27	82
Hackney	10	18	54
Southwark	14	24	75
Tower Hamlets	20	34	104
Waltham Forest	9	15	45

District	2024	2029	2038
Redbridge	9	16	50
Islington	12	21	65
Croydon	9	16	48
Westminster	54	93	286
Lambeth	15	26	78
City of London	12	20	62
Sutton	6	10	32
Haringey	6	10	31
Barnet	7	12	35
Enfield	5	9	26
Kensington & Chelsea	34	59	182
Wandsworth	6	10	31
Camden	34	59	180
Kingston upon Thames	6	10	30
Merton	5	8	24
Brent	7	13	38
Ealing	5	8	24
Hammersmith & Fulham	10	16	50
Harrow	4	6	20
Hillingdon	13	23	70
Hounslow	7	12	38
Richmond upon Thames	7	12	36
Total	**792**	**1,393**	**3,766**

Design Day Hotel rooms

District	2024	2029	2038
Dartford	126	126	126
Gravesham	74	74	74
Thurrock (U)	80	80	80
Brentwood	15	40	85
Basildon	16	42	90
Tandridge	14	36	77
Castle Point	11	27	58
Reigate & Banstead	19	50	108
Chelmsford	12	31	67
Epping Forest	12	31	67
Harlow	10	27	58
Rochford	9	22	47
Crawley	34	88	189
Broxbourne	10	25	54
Epsom and Ewell	8	20	44
Mid Sussex	14	36	77
Runnymede	17	45	97
Maldon	10	26	56
Mole Valley	13	32	69
Elmbridge	14	36	78
Guildford	20	52	111
Horsham	17	43	92
Southend on Sea (U)	9	22	48
St Albans	8	22	47
Welwyn Hatfield	9	23	50
Hertsmere	11	28	61
Woking	8	22	47
Wealden	17	43	93
Colchester	11	30	63
Spelthorne	10	26	55

District	2024	2029	2038
Uttlesford	13	33	71
Medway (U)	22	57	121
Maidstone	26	68	145
Tonbridge and Malling	21	54	115
Sevenoaks	21	54	115
Swale	22	57	123
Tunbridge Wells	18	48	102
Ashford	20	51	110
Canterbury	37	95	203
Shepway	22	57	123
Thanet	19	50	107
Dover	16	42	89
Bexley	63	153	312
Greenwich	59	144	294
Bromley	44	107	217
Barking & Dagenham	40	97	198
Havering	40	98	199
Lewisham	38	93	190
Newham	53	130	266
Hackney	35	86	176
Southwark	49	120	244
Tower Hamlets	68	165	336
Waltham Forest	30	72	147
Redbridge	33	80	163
Islington	42	103	210
Croydon	31	76	154
Westminster	186	455	927
Lambeth	51	125	254
City of London	40	98	201
Sutton	21	51	103
Haringey	20	49	101
Barnet	23	56	115
Enfield	17	42	86
Kensington & Chelsea	119	290	591
Wandsworth	20	50	101
Camden	117	286	584
Kingston upon Thames	19	47	96
Merton	16	39	79
Brent	25	61	125
Ealing	16	38	78
Hammersmith & Fulham	33	80	164
Harrow	13	31	64
Hillingdon	45	111	226
Hounslow	25	60	123
Richmond upon Thames	23	57	116
Total	**2,350**	**5,421**	**10,931**

Disclaimer

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London Resort Construction Worker Distribution Note

London Resort Company Holdings

A note by Volterra Partners, December 2020

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1 Introduction

1.1 This note describes the method used to estimate the trip distribution of construction staff employed at the proposed London Resort. The analysis makes use of the journey to work data available by small geographic area (MSOA) from the 2011 Census and commuting data by distance band specific to the construction industry[1]. The analysis also makes use of an "Immediate Impact Area" (IIA) around the site which is defined as the three MSOAs surrounding the London Resort site. This more local area is defined to reflect the local accessibility of the site.

1.2 The construction worker trip data by distance band is distributed between the MSOAs that lie within each distance band. This distribution is adjusted to account for improvements in accessibility from north of the river due to the shuttle service.

1.3 The commute split between car and public transport trips for each origin and destination MSOA is unavailable for specific industries so data is gathered from the census for all industries.

1.4 The following sections describe the approach used to distribute trips made to London Resort by construction workers. This analysis is intended as a starting point of what might be reasonable given existing commuting patterns (including for construction workers) and improvements to accessibility from north of the river. The assumptions will need to be reviewed when the travel options for construction workers are confirmed.

[1] ONS, 2020. CT1109 COVID-19_2011 Census [available at: https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/adhocs/11742ct1109covid192011census]

2 Modelling approach

Distance travelled to work data

2.1 Data is available[2] at a local authority level for the number of commutes made in a variety of distance categories from the local authority for workers in each 2-digit industry. For example, Table 1 shows the number of commutes made to Dartford within each distance category for workers in the construction industry.

Table 1: Commute trips made to Dartford by distance in the construction industry

Distance band	Number of trips	% trips (construction)	% trips (all industry)
Less than 2 km	236	5%	14%
2 km to less than 5 km	471	10%	17%
5 km to less than 10 km	811	17%	26%
10 km to less than 20 km	1,037	21%	21%
20 km to less than 30 km	771	16%	13%
30 km to less than 40 km	360	7%	4%
40 km to less than 60 km	354	7%	3%
60 km and over	844	17%	4%

Source: ONS

2.2 Table 1 shows that construction workers tend to have a longer commute to work than the typical worker: 17% of construction workers commuting to Dartford commute from more than 60km away, compared with 4% for the average worker.

2.3 This trip distribution is used to allocate trips made by construction workers to London Resort directly or via Ebbsfleet train station. For a more detailed distribution, the Middle Layer Super Output Areas[3] (MSOAs) within each distance band are collected, and trips are distributed between these MSOAs based on the number of construction workers residing in each MSOA.[4]

2.4 Figure 1 illustrates the MSOAs within a 5-10km distance band of the site. The number of construction workers residing in the part of each MSOA that lies within the distance band is used to disaggregate trips between MSOAs. The 17% of trips (see Table 2) that lies within the 5km – 10km distance band, for example, are distributed between MSOAs by the proportion of construction workers in the MSOA contained in that band.

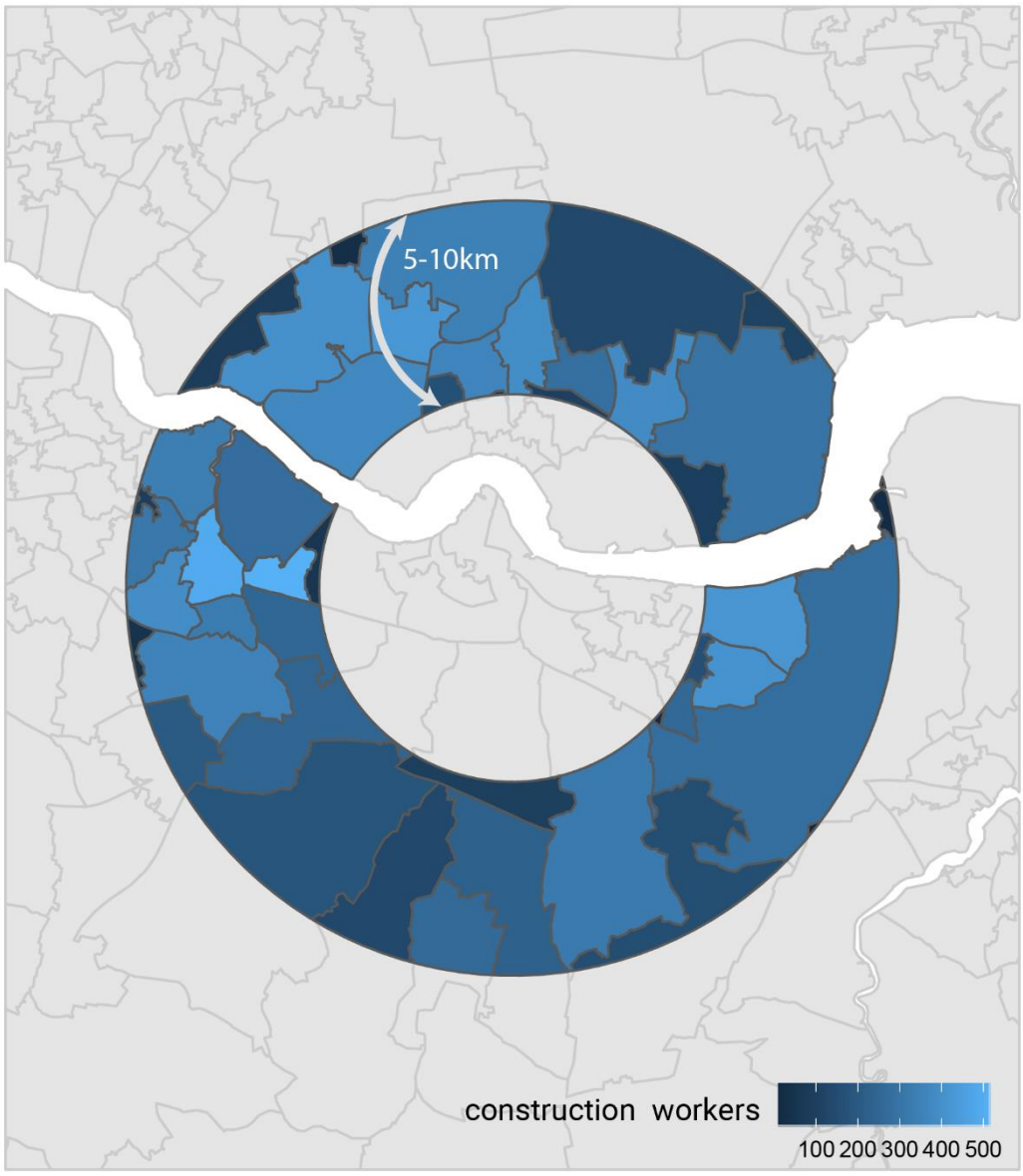
2.5 Since different parts of an MSOA can lie within two different distance bands, the trips are aggregated to give one value for each MSOA.

[2] ONS, 2020. CT1109 COVID-19_2011 Census [available at: https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/adhocs/11742ct1109covid192011census]

[3] Middle Super Output areas are small areas designed to improve the reporting of small area statistics in England and Wales. They are fixed boundaries drawn such that the minimum population in any MSOA is 5,000 with a mean of 7,200 people.

[4] Estimates of the number of construction workers resident in each MSOA come from the 2011 census.

Figure 1: MSOA distribution within 5-10km of London Resort



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2.6 As Figure 1 illustrates, areas to the north of the river are assumed to be in the same distance band as areas to the south since distance is taken 'as the crow flies'. In reality it is likely that the areas to the north of the would have fewer commute trips given that the journey via the road or rail network is less direct (and would require a longer commute). Adjustments are made to the construction worker distribution to account for this later.

Modal distribution

2.7 The commute split between car and public transport trips for each origin and destination MSOA is unavailable for specific industries. Instead, the modal split of trips

is from the 2011 Census *Location of usual residence and place of work by method of travel to work (MSOA level*) dataset. This gives the number of trips between each origin and destination by the mode of transport used, for workers across all industries - not specific to construction.

2.8 Construction workers tend to be less likely to use public transport than the average worker - 10% of construction workers in Kent commuted using public transport compared with the all-industry average of 24%. It is considered, however, that the location of the site near Ebbsfleet International, and the encouraged use of public transport modes will lead to a higher public transport share. Based on the all industries average, it is estimated that 21% of commute trips to London Resort would be made by public transport.[5] This is expected to be a minimum as the use of public transport will be encouraged for construction workers.

Adjusting for new routes to the site

2.9 At present, access to the London Resort site is limited. No routes exist to easily access from the north of the river. It is planned that there will be a ferry departing from Tilbury to take staff from the north side of the river in the local authority of Thurrock.

2.10 The census commuting data (2011) does not account for the use of these new routes, so adjustments are made to predict how many more trips might be made from areas that would benefit from the ferries.

2.11 The travel time is taken from each MSOA to each destination (London Resort, the ferry at Tilbury, and a potential second ferry at Grays as a proxy for better accessibility from the north of the river). An assumed 10 minute ferry time to London Resort is added to the travel time to each of the ferry terminals. For routes that would become quicker going via the ferry at Tilbury, a predictive model is used to estimate how many trips would be made based on this new travel time.

2.12 As mentioned in 2.6, commute trips are assigned to MSOAs on the basis of 'crow-flies' distance. For those MSOAs north of the river, which face a longer commute than the straight line distance suggests, this means that too many commute trips will have been allocated. The same predictive model is used to adjust down the commutes made from these MSOAs based on the travel time. Examples of how the number of trips has been adjusted are shown in in Figure 6 and 7 in the appendix.

[5] While Kent construction workers have a particularly low public transport mode share, Dartford local authority has the highest public transport mode share in Kent, with 19% of construction workers using public transport compared with 23% across all industries. Based on this, this analysis uses the mode share for all industries, rather than the Kent mode share for construction workers which will understand the likely share of public transport trips.

3 London Resort Staff Distribution

Mode distribution

3.1 The modal distribution of commute trips is car-heavy with 78% of trips estimated to be made by car. Table 2 shows how this translates into the number of staff estimated to travel by car and public transport.

3.2 There is uncertainty about the options for travel to London Resort from the north of the river. Options are currently being considered to offer a ferry from Tilbury ports which may include parking options to allow car and public transport users to arrive at the port.

3.3 Two scenarios are compared here:

- Scenario 1: some transport improvements to trips arriving at Tilbury affecting both car and public transport trips; and
- Scenario 2: improved transport improvements from the north of the river affecting both car and public transport trips. This includes the improvements to Tilbury but also assumes that a service from Grays is included as a proxy for better accessibility from north of the river.

3.4 Under scenario 2, there will be further improvements to trips arriving from the north of the river, on top of the Thurrock ferry. This has been modelled as an additional ferry service from Grays but is a general proxy for larger scale improvements from the north side of the Thames. Under this scenario slightly more trips are made by public transport as accessibility improves further, and more trips are made from the Tilbury area.

3.5 This model is applied to home-based workers – ie workers that will be from within a commutable distance and will not require temporary accommodation. The construction of Gate 1 is expected to support between 3,300 and 5,000 jobs onsite in the peak. Gate 2 is expected to support between 1,100 and 1,700. It is estimated that 50% of the peak workforce (for both gates) will be home-based and commute to the site daily during the peak period. The remaining 50% will be non-home based, travelling from a further distance and require accommodation. This note focuses on the home-based staff who will commute each day and focuses on the peak workforce during Gate 1 which is a worst case assessment of the traffic impact. On that basis, there is estimated to be between 1,650 and 2,500 home based workers who will commute to the site.

Table 2: Staff distribution by mode (both scenarios) – Gate 1 peak on site construction

	Low	Peak
Staff	1,650	2,500
Travel by car	1,300	2,000
Travel by public transport	350	500

Distribution by local authority

3.6 The majority of construction workers commute from Gravesham and Dartford due to the proximity to London Resort. Thurrock also gets a relatively large share of commute trips due to the option of a short 10 minute ferry from Tilbury, and the high level of Thurrock residents working in construction (9,900) compared with Dartford (4,100) and Gravesham (3,300).

3.7 Table 4 shows the distribution of construction worker commutes by local authority. This is also visualised for public transport and car separately in Figure 2 and Figure 3 respectively under scenario 1.

Figure 2: Construction worker distribution (public transport) – scenario 1

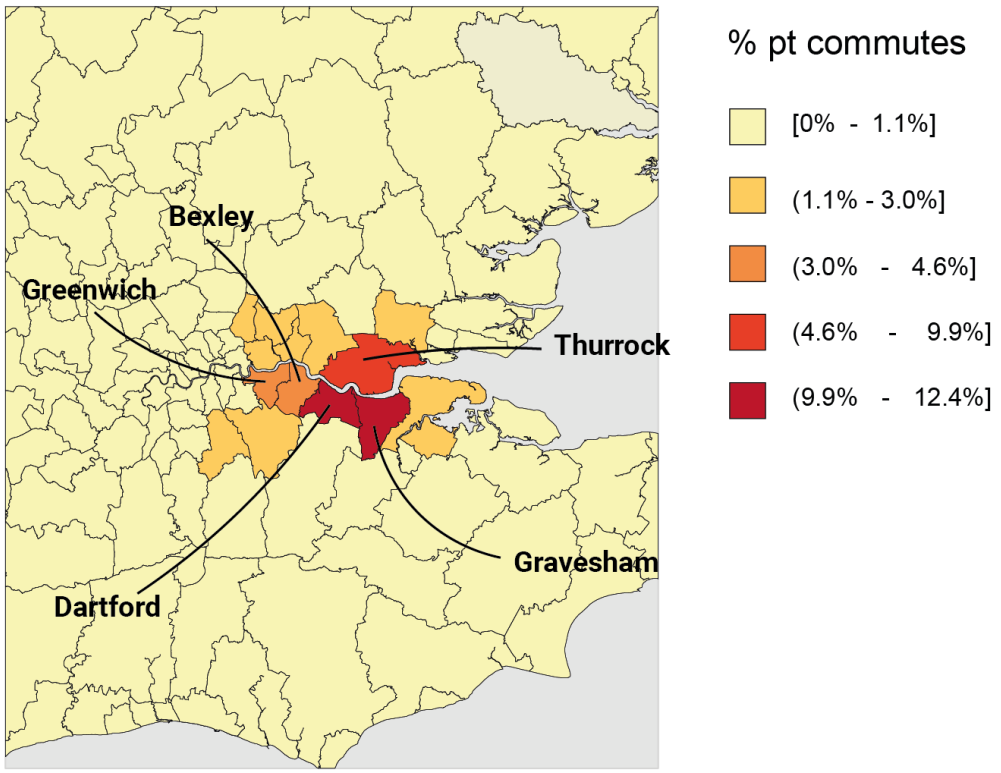

Figure 3: Construction worker distribution (car) – scenario 1

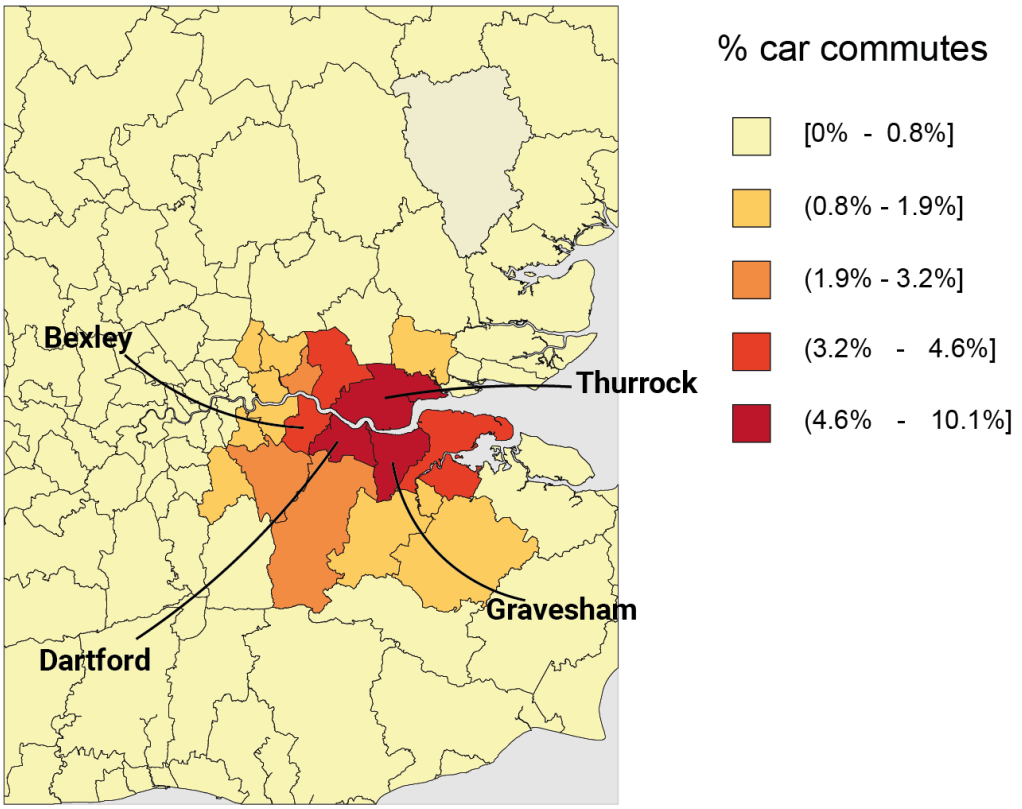

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Table 3: Construction worker trip distribution by local authority

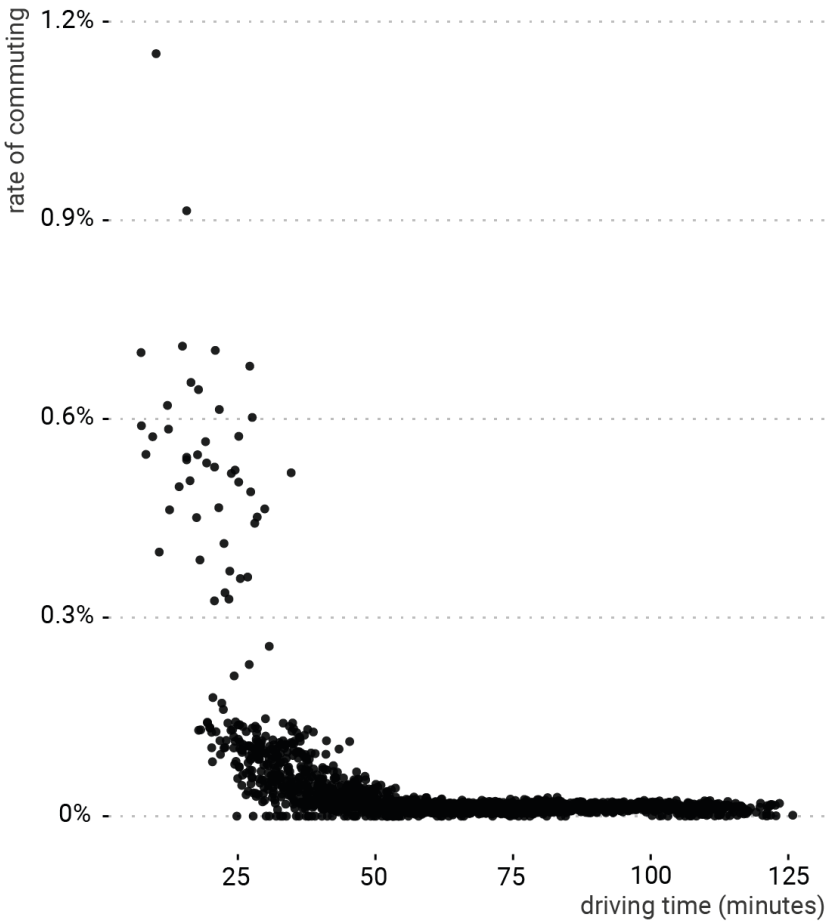
Local authority	Commuting distribution (scenario 1)	Commuting distribution (scenario 2)
Gravesham	11%	10%
Dartford	9%	9%
Thurrock	8%	10%
Bexley	5%	5%
Medway	4%	4%
Havering	4%	4%
Bromley	3%	3%
Sevenoaks	3%	3%
Barking and Dagenham	3%	3%
Greenwich	2%	2%
Newham	2%	2%
Basildon	2%	2%
Redbridge	2%	2%
Waltham Forest	2%	1%
Croydon	1%	1%
Tonbridge and Malling	1%	1%
Lewisham	1%	1%
Maidstone	1%	1%
Southwark	1%	1%
Central Bedfordshire	1%	1%
Epping Forest	1%	1%

Local authority	Commuting distribution (scenario 1)	Commuting distribution (scenario 2)
Enfield	1%	1%
Brentwood	1%	1%
Brent	1%	1%
Barnet	1%	1%
Ealing	1%	1%

5 Appendix: Predicting Trips from North of the Thames

5.1 The trip distribution from MSOAs to London Resort was taken as a starting point. This is the trip distribution from Section 3, adjusted to be in line with comparator site commute patterns. The relationship between this initial trip distribution and travel time (for car trips) is shown in Figure 4.

Figure 4: Travel time vs trips for commutes to the Immediate Area



Source: ONS (2011)

5.2 Based on the relationship between trips and travel time, this analysis aims to predict the impact on the number of trips from Thurrock, and other areas that will benefit from a ferry option at Tilbury. These areas are highlighted in red in Figures 5 and 6. It is hypothesised that these trips are below their 'expected' level of commutes due to poor public transport linkages and the fact car trips must first drive west of London Resort to cross the river.

5.3 Travel times have been calculated from each MSOA to London resort going via Tilbury using the PT/car travel time to Tilbury and adding on a 10 minute penalty for the ferry from Tilbury to Resort. This analysis considers those MSOAs for which it is quicker to go via Tilbury than directly to London Resort and adjusts the journey time on that basis.

Figure 5: Travel time vs trips (Tilbury trips highlighted)

Modelling approach

5.4 From the data it is clear that there is a non-linear relationship between the number of trips and travel time. The approaches considered to model the non-linear relationship were narrowed down to:

- Logistic Regression (logit)
- Multivariate Adaptive Regression Splines (MARS)

5.5 Models such as linear regression with polynomial or log specifications were discounted as poorly fitting.

5.6 It was hypothesised that other factors such as working age population in the origin MSOA would also be a good predictor of the number of trips made to the Immediate Area. It was found that modelling commutes as a proportion of working age residents (the rate of commuting) was more predictive than modelling the absolute number of commute trips.

5.7 To choose between the models, 10-fold cross validation was used to test the model performance on out-of-sample data on 10 different hold-out samples. The performance of each model (R-squared and mean absolute error) are shown in Tables 4 and 5.

5.8 The R-squared is a measure of the proportion of the variance in trips made that can be explained by our model. Mean Absolute Error (MAE) is a measure of the average error – it differs from R-squared by not penalising more heavily those points that are further away from the prediction. R-squared is the more 'meaningful' of the two-evaluation metrics as it is scale-free, whereas MAE can only be judged relative to the other values but is more robust to outliers. Seeing that R-Squared and MAE is highest for the MARS model, MARS is selected for use in prediction.

5.9 The relationship was modelled separately for trips made by PT and by car. In both relationships, the MARS model was chosen as the best performing model.

Table 4: Car model comparisons (cross validated errors)

Model	R-squared	MAE
Logit	0.58	1.8e-04
MARS	0.72	1.3e-04

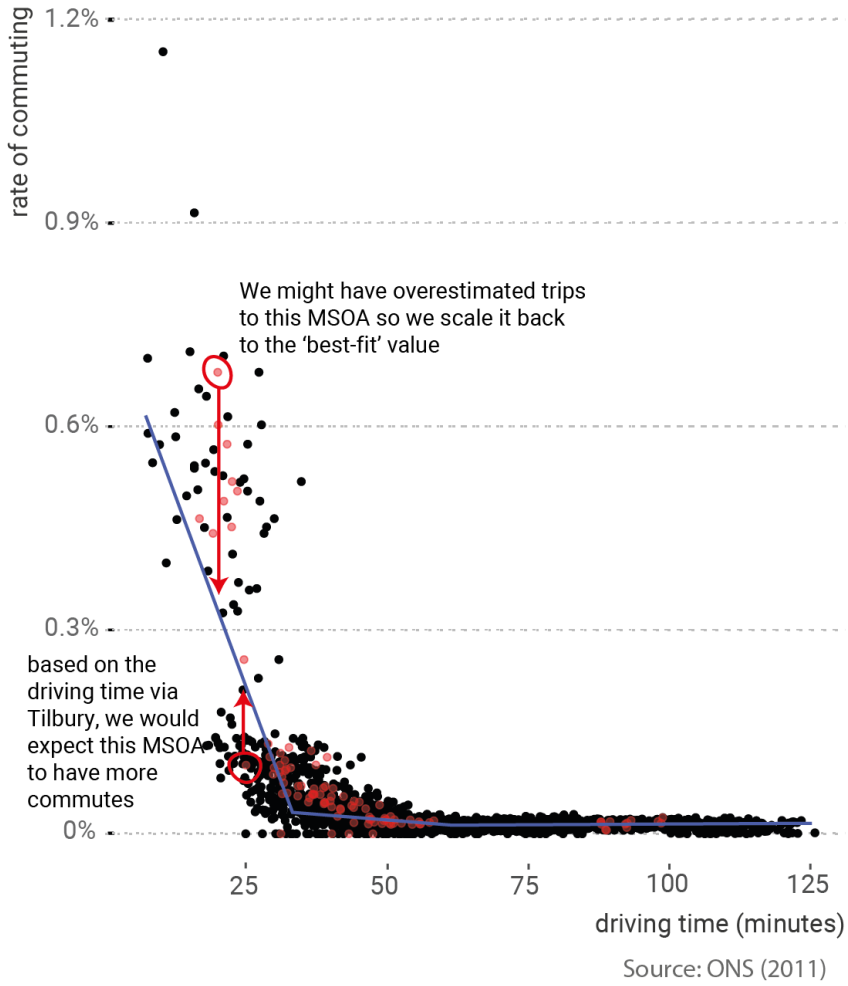
Table 5: PT model comparisons (cross validated errors)

Model	R-squared	MAE
Logit	0.27	6.22e-05
MARS	0.45	6.23e-05

Final model

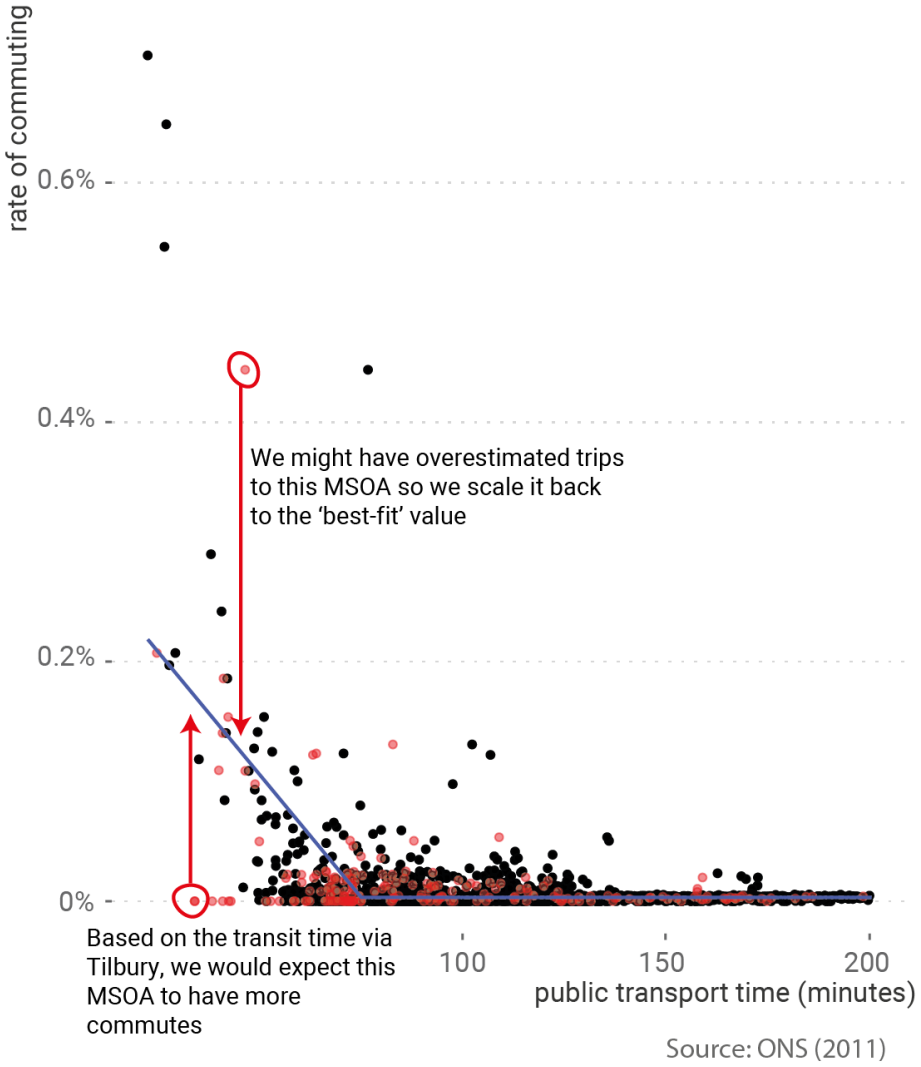
5.10 The final model specification chosen was the MARS model. The model was chosen for its highest cross-validated R-Squared value. This model splits the non-linear dataset into segments where change points are found in the data. Using travel time and working age population as predictors, the model finds two change points, or 'knots' in the relationship. The relationship found between travel time and trips is shown in Figures 7 and 8, with MSOA trips that are quicker via Tilbury highlighted in red.

Figure 6: MARS model fit (car trips)



Source: ONS (2011)

Figure 7: MARS model fit (PT trips)



5.11 The model is used to estimate the number of commuters from Thurrock based on the (adjusted) travel time to the Immediate Area. These predicted commutes are used in preference to the actual observed census data since it is expected that transport constraints on trips from Thurrock will be overcome once London Resort once appropriate interventions are in place. Similarly, it is expected that some of the data derived from the census will over-estimate commute trips as no account was initially made for the higher transport time from MSOAs north of the river.

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