MOTT MACDONALD

Gatwick Airport Station Upgrade - Outline Business Case

Economic Case - Appendices

August 2018

MOTT MACDONALD

Technical Note

Project:	Gatwick Airport Station Outline Business Case		
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Approved by:	Chris Judge	**Checked by:**	Chris Judge
Subject:	Gatwick Airport Station Demand Forecasts v2b (Draft)		

1 Introduction

In preparation for an Outline Business Case for the upgrade of Gatwick Airport station, this note sets out a passenger rail demand forecast for the period from 2016/17 to 2036/37 and 2046/47

The forecast is based on PDFH guidance, consistent with WebTAG.

The forecast pivots from annual 2016/17 base year station usage, and considers the following four markets:

- Air Passengers
- Airport workers
- Non-airport users (commuters, or business /leisure travel)
- Other (escort /meet and greet trips associated with the Airport)

Passengers interchanging at the station (i.e. not passing through the gateline) are not directly considered in this demand forecast.

The base year data and forecast have been derived using a variety of sources including MOIRA, published station usage data, exogenous growth variables from the DfT DDG dataset, and estimates of current rail mode share.

The purpose of this demand forecast is two-fold:

- To directly inform the revenue impacts and economic benefits to be used within the Outline Business Case for the station upgrade, most notably the economic case.
- To verify the suitability of inputs and outputs from the LEGION model scenarios that will provide assessment of the benefits associated with reduced station congestion and shorter journey times to access the rail platforms.

The forecast is developed using annual data, therefore the associated growth rate implicitly represents a weighted average of peak /off peak periods, weekdays /weekends, and ‘busy’ /non-busy days.

In addition to setting out the forecast of annual station demand undertaken by Mott MacDonald (section 2-4 below) this note provides a review and comparison of the 2036 'busy day' forecast as utilised within recent pedestrian (LEGION) modelling of station layout options.

2 Demand forecast

The central growth forecast, and three sensitivity tests are reported below in figure 1 and table 1.

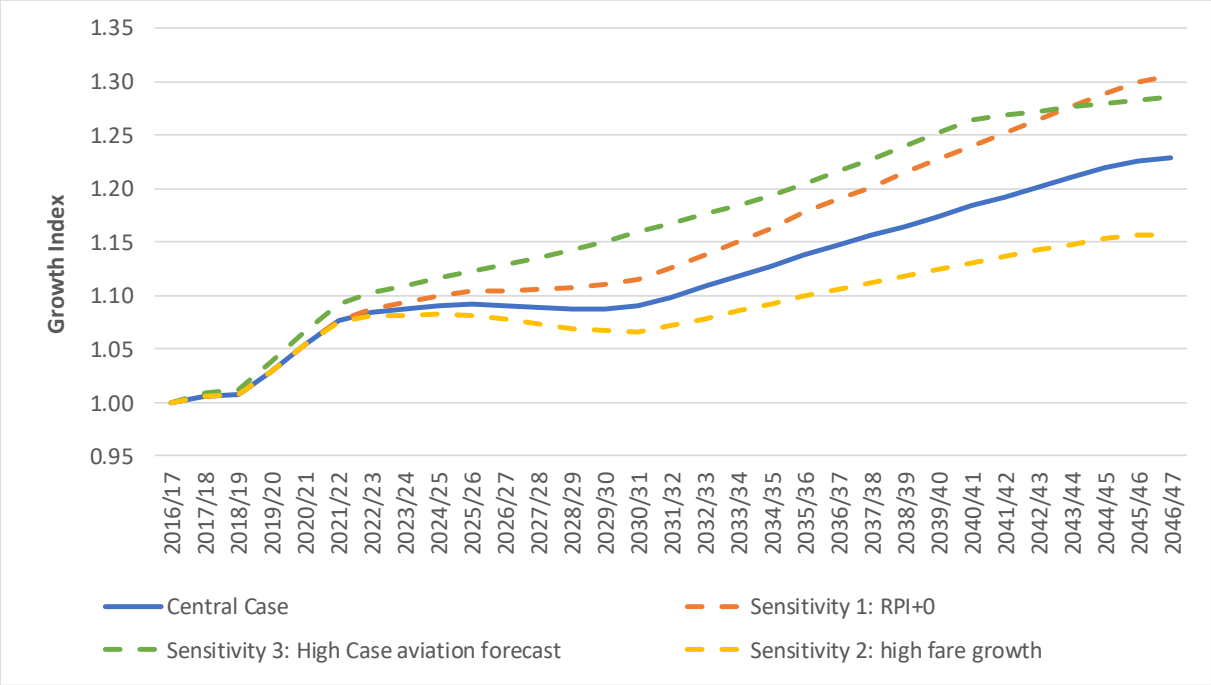


Figure 1: Gatwick Airport rail station forecast demand growth

	Annual passenger demand (millions)				Growth on 2016/17	
	2016/17	2036/37	2046/47		2036/37	2046/47
2016/17 base	**19.4**					
Central Case		**22.2**	**23.9**		**15%**	**23%**
Sensitivity 1: RPI+0		*23.0*	*25.5*		*19%*	*32%*
Sensitivity 2: high fare growth		*21.4*	*22.4*		*11%*	*16%*
Sensitivity 3: high Case aviation forecast		*23.5*	*25.0*		*22%*	*29%*

Table 1: Gatwick Airport Rail station forecast demand growth

These central case forecasts are underpinned by the following assumptions and inputs (further details provided below in section 4):

- Air passenger growth forecasts; published by DfT in July 2017, as incorporated into the December 2017 vintage DfT DDG data (growth of 11% and 19% to 2036/37 and 2046/47 respectively).
- Population, employment and GDP per capita growth; driving growth in non-Airport related passenger demand (source: DDG data).
- Fuel cost and car journey time (assumptions again taken from DfT DDG data).
- Fares increases, assuming current Government policy of RPI+1% maximum permitted annual increase in regulated fares beyond 2020 (dampened by an expectation that fares to/from Gatwick will increase at roughly half of this prevailing rate).
- Demand growth representing improved rail journey opportunities, journey times and capacity increase associated with completion of the Thameslink Programme (full MOIRA and capacity modelling has not been undertaken, but a high-level indicative /interim assumption is made – see section below).
- Growth in Airport workers.

The central case growth forecast implies an increase in rail mode share from 38% (2016/17) to 39% over the forecast period.

Figure 2 below segments the central case growth forecast to 2046/47, based on the high-level growth drivers described above.

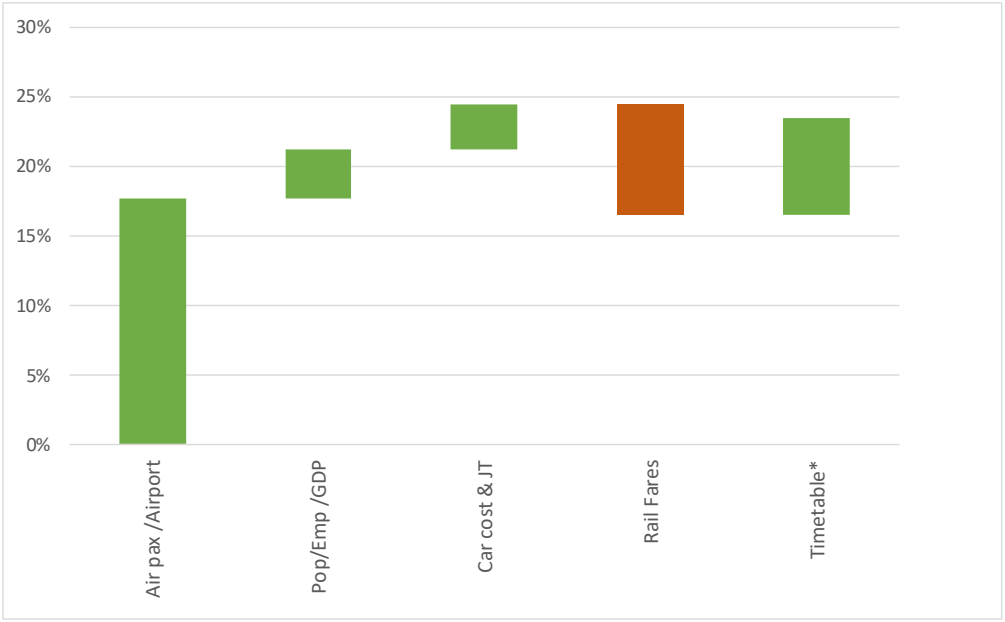


Figure 2: Composition of central case growth (2016/17 to 2046/47)

The three sensitivities reported above in Figure1 and Table1 represent:

- Sensitivity 1: Zero real terms increase in rail fares, representing an alternative to current Government Policy.

- Sensitivity 2: An assumption that fares to & from Gatwick increase at the full prevailing rate of the maximum regulated increase (RPI+1 post 2020).
- Sensitivity 3: Use of DfT high case aviation forecasts.

Each sensitivity test is independent of each other.

3 Base demand and station usage

Base year (2016/17) annual station usage is assumed to be 19.4m journeys. This total is derived from MOIRA and LENNON ticket sales data, but controlled to the station entries and exists figure published in the ORR annual station usage dataset[1].

Segmentation of this base demand is presented in Figure 3.

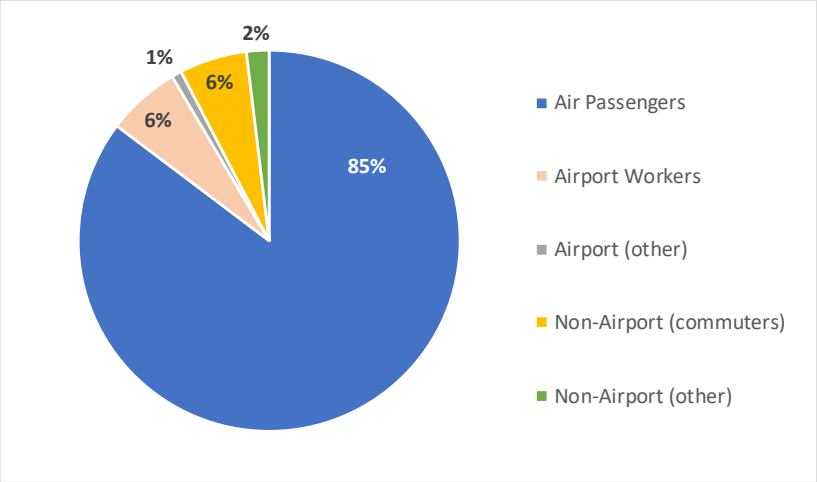


Figure 3: Base year Gatwick Airport rail station passenger journeys

The following assumptions have been made in deriving this base dataset:

- 2016/17 rail mode share = 38% (source: GAL publication)
- 2016/17 total air passengers = 43.9m (source: CAA data)
- Airport workers in 2016/17 = 24,000 (source: GAL publication)
- Airport worker rail mode share = 11% (source: GAL publication)
- % Airport visitor not an air passenger (i.e. meet and greet) = 1%
- % non-airport rail passengers who are commuting = 75% (inferred /judgment from MOIRA ticket type split)

[1] http://orr.gov.uk/statistics/published-stats/station-usage-estimates

4 Forecast methodology and assumptions

Air Passenger Growth

Derived from DfT Dec17 vintage DDG forecasts, consistent with July 2017 DfT Aviation Forecasts[2].

Central case forecast assumes data directly from DDG projection (DfT Central Case aviation forecast), whereas High case growth sensitivity is inferred and interpolated from July 2017 DfT Aviation forecasts.

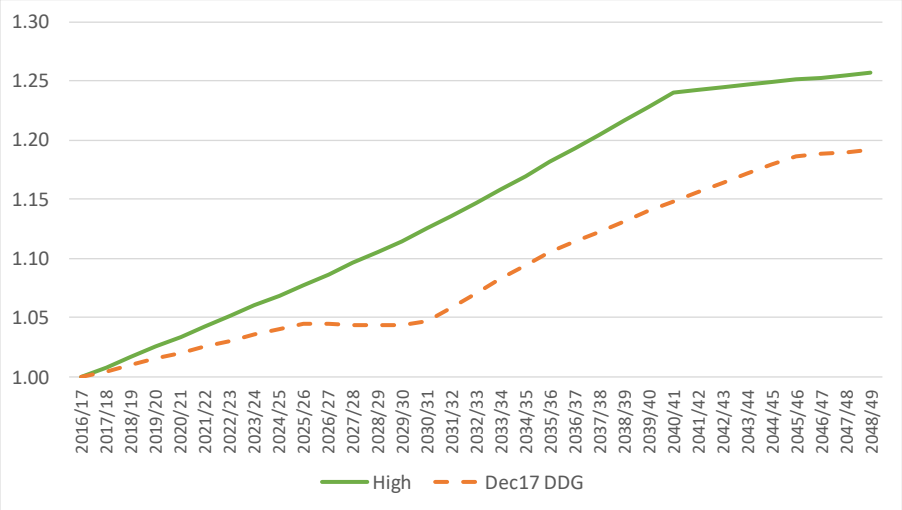


Figure 4: Gatwick Airport air passenger growth forecasts

Central case air passenger growth from 2016/17 to 2036/17 and 2046/47 is 11% and 19% respectively (this scenario assumes no increase in Gatwick Airport Terminal Capacity to 2040 and no additional runway).

Consistent with PDFH 5.1, a rail demand elasticity of 1 to air passenger growth is assumed.

Population, Employment and GDP per Capita

A PDFH v5.1 methodology is used to forecast growth in the segment of Gatwick rail station demand that does not use the Airport. Population, employment and GDP per capita forecasts are derived from the DfT Dec DDG dataset.

Population

Commuters are driven by the relative population growth of the catchment surrounding the station (assumed to be the local authority areas of Mid-Sussex, Mole Valley, Reigate and Crawley) compared with the London

[2] https://www.gov.uk/government/publications/uk-aviation-forecasts-2017

and South East (LSE) average, while non-commuters are driven by a suitable weighted average of this local catchment and the wider LSE area.

Between 2016/17 and 2036/37 relative population growth remains flat, whilst the catchment for trips to/from the stations grows at 16%.

Employment

Central London Employment growth of 10% between 2016/17 and 2036/37 (Source: DDG) is assumed to drive commuter trips (a weighted average elasticity of 1.2 is assumed).

GDP per capita

Business and leisure trips are driven by SE / London GDP per capita growth of 33% over the period between 2016/17 and 2036/37 (a weighted average elasticity of 1.2 is assumed).

Fuel Cost and Car Journey Time

This growth variables are again taken from the DfT's DDG (Dec17) dataset. PDFH elasticities fall within the range of 0.2-0.3 for both variables, and given only modest 4% increase in car journey time over the core 20 year forecast, this is offset by a commensurate decrease in expected car fuel cost (itself driven primarily by an assumed increase in vehicle efficiency).

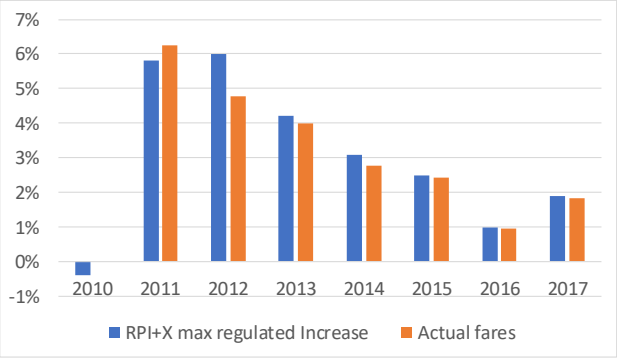
Over the longer forecast period to 2046/47, some of the assumed fuel cost decrease is reversed leading to net demand growth.

Fares Increases

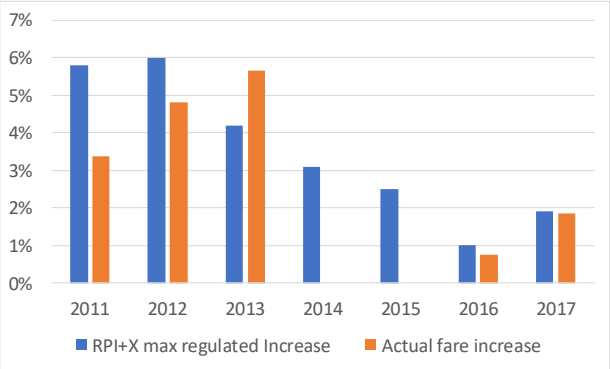
The central case forecast scenario assumes that the maximum permitted increase in regulated rail fares increases at RPI+1% per annum from 2021 onwards.

However, not all fares to/from Gatwick are regulated, and competition on the route is high given multiple operators. Gatwick Express and other operator-only fares are essentially unregulated [*check required*], but might to an extent be expected to increase in line with prevailing fares increases on the route.

Analysis has been undertaken to review historic fares increases, to determine the relationship between the prevailing regulated increase (RPI+X) and actual increase. As per the figure and table below, this shows a softened relationship between increase in fares to/from Gatwick at overall regulated increases.



Gatwick to London – season ticket fares: high correlation, but low market share



Gatwick to London – off-peak return fares: moderate correlation, significant market share

Additionally, over a 4-year period to 2017 Gatwick Express fares (30% of rail revenue to from Gatwick Airport) have increased at 1.7% compared to a maximum permitted increase of 9% for regulated fares.

On the basis of this review and a judgement regarding the nature of fares competition on the route, fares to/from Gatwick are assumed to increase on average at 50% of the regulated increase.

A PDFH v4 fares elasticity of -0.5 is assumed.

NB: draft guidance in PDFH v6, expected to be adopted but currently under review, is for a to/from Airport fares elasticity of -1.

Timetable and Capacity

Completion of the Thameslink Programme is due to deliver the following benefits to Gatwick Airport:

- New direct journey opportunities to Cambridge, Peterborough and intermediate destinations north of London.
- Additional train capacity from longer, new, 12-car formation rolling stock.
- Improved connectivity and marginal journey time savings to/from Central London, given greater frequency of services to Thameslink stations.

- Increased frequency of early morning (pre 6am) trains [specification of this service remains to be verified, and may be independent of the Thameslink Programme]

In the absence of a future timetable available in MOIRA, no detailed modelling of the demand benefits of these changes has been undertaken.

However, based on indicative MOIRA runs undertaken with a much-simplified version of the assumed timetable benefits (the additional direct services and marginal journey time improvement) a combined demand uplift of **6%** has been assumed, phased over 4 years from 2019.

Additional detail regarding expected journey time, timetable and capacity improvements would allow for a more comprehensive assessment, quite possibly leading to ability to evidence greater growth potential.

5 Review of 'busy day' demand growth

Sections 2-4 above identify an annual total and forecast of passengers using of Gatwick Airport rail station. However, assessment of station layout options and pedestrian modelling (using LEGION) requires single day or peak period demand to be considered.

An important distinction is drawn between 'busy day' demand (reflecting a particular day of week and seasonal trends) most appropriate as a 'worst case' position for station sizing, and average or typical day demand that might be more representative of the year as a whole.

LEGION modelling undertaken by Costain & Kerbian on behalf of NR, has utilised forecasts made available from GAL that represent a forecast of 'busy day' demand in 2036. These forecasts include breakdown by time of day (by 15-minute segment) and so allow identification of peak periods.

The remainder of this section reviews this 2036 demand forecast and makes comparison to the base position and growth rate established by the Mott MacDonald forecast for DfT.

Review of GAL's 2036 'busy day' demand forecasts

Understanding of this forecast is based on review of the spreadsheet[3], clarifications from GAL, and the 'Dynamic Modelling - Inputs and Assumptions' note produced alongside the Legion modelling.

The 2036 'busy day' forecast captures the following inputs and assumptions:

- Profiles of air passenger rail usage for 2026, derived from a run of the 'CAST' model.
- An uplift for growth from 2026 to 2036 based on 5% air passenger volume growth and an increase in rail mode share from 38 to 46%
- Two post-model adjustments; reducing demand to account for landside transfers and other reprofiling.
- Addition of demand for airport workers and non-airport users (commuters)

[3] GAL 2036 Rail station modelling data - Jan17 update – FINAL.xls

It has not been possible to identify equivalent directly observed, actual or base year 'busy day' demand.

The 2036 'busy day' forecast is shown in the table and figure below.

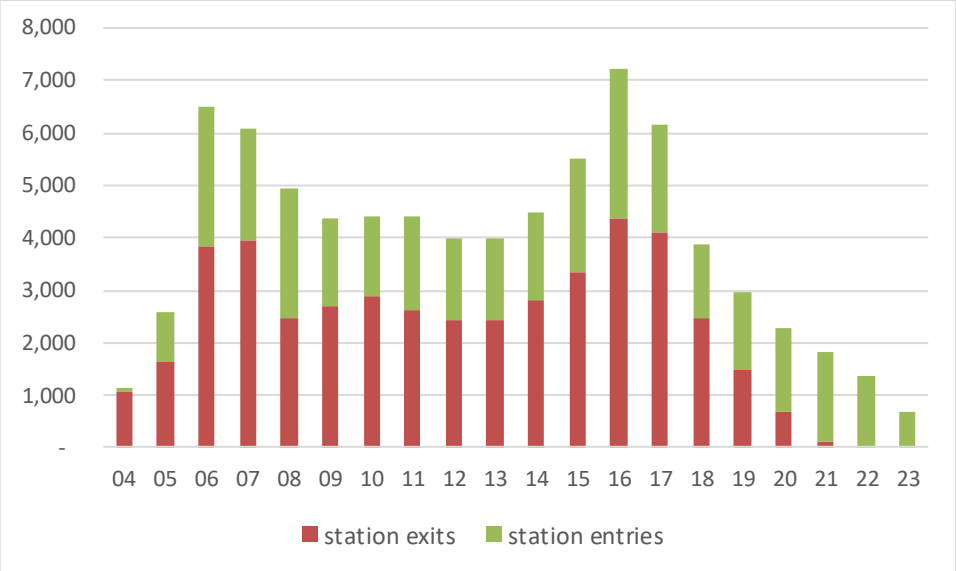


Figure 5: Forecast of 2036 Gatwick Airport station entries and exits (source: GAL forecasts)

	station entries	34,228
	station exits	46,815
	entries & exits (2036 forecast)	**81,043**
(a)	2026 'Cast' model output	64,103
(b)	growth to 2036	17,729
(c)	adjustment for landside transfers	-1,859
(d)	profile adjustments (arrivals only)	-10,475
(e)	staff travel	5,909
(f)	commuters (non airport users)	5,636
	entries & exits (2036 forecast)	**81,043**

Table 2: Forecast of 2036 Gatwick Airport station entries and exits (source: GAL forecasts)

Comparison to alternative (DfT) growth forecasts

Comparison between the 2036 'busy day' forecast and annual forecast is not straightforward for two reasons:

- No equivalent base year 'busy day' position is known, so the comparison cannot be made by considering % growth. This would have been the preferred approach, given that relative growth should be broadly applicable to both a busy day and average day position (if anything a busy day would be expected to grow more slowly given airline schedules and Airport capacity constraint).

- Assumptions to convert between annual total passenger usage and ‘busy day’ are not readily available (particularly given an Airport station will not follow a standard annualization /seasonality profile).

Two methods are considered below to verify the total ‘busy day’ station usage forecast for 2036, the 81,000 daily rail station entries and exits in the GAL output that forms the basis for the LEGION modelling.

Method 1:

A typical annualization factor to convert from annual to typical (Autumn) weekday rail demand is 290-300. This factor accounts for lower demand at weekends and during holiday periods, and the average characteristics of a London and South-East station with significant commuter use.

In the absence of data to determine an annualisaton factor specifically for Gatwick Airport (data has been requested), it is reasonable to assume that the annualization factor is likely to be higher but not lower than that for a more typical station. This is because whilst flight schedules and air passenger demand differs by season and day of week, airport use has less variation between weekday and weekend compared with commuters.

On this basis, the forecast of 2036 ‘busy day’ demand is reviewed below using two different annualization factors.

GAL ‘busy day’ forecast	DfT / MM Forecast			Difference
	Annual station usage	annualisation factor	typical day	
81,000	22,200,000	300	74,000	-9%
		325	68,308	-16%

Table 3: Forecasts of Gatwick station rail demand in 2036

The conclusion reached is that GAL’s 2036 ‘busy day’ forecast is broadly 10-15% higher than inferred by the alternative DfT forecast.

Method 2:

Data is available from a pedestrian survey at Gatwick Airport station in 2014. This data identifies 12,600 passengers passing through the gateline during the 3-hour evening peak period (1600 – 1900).

As shown in the table below, this station usage can be compared with the equivalent period of the GAL ‘busy day’ forecast for 2036. The implied growth is then compared with the growth assumed by the DfT forecast (noting an additional 10%[4] growth above the 15% of the central forecast to account for the period between 2014 and 2016).

[4] Derived from ORR station usage data, growth of 10% between 2014/15 and 2016/17 at Gatwick Airport station

	2014	2036	growth
GAL forecast	12,603	17,270	37%
DfT / MM forecast		15,798	25%
Difference		**-9%**	

Table 4: Forecasts of Gatwick station rail demand in 2036 (entries & exits in the PM peak period: 1600-1900)

This method suggests the GAL forecast for 2036 'busy day' demand is 9% higher than that of the DfT forecast.

Summary and Conclusions (draft – for discussion)

- Review of the data and information sources available suggests the GAL forecast of 2036 'busy day' demand is 10-15% higher than that implied by the central case forecast undertaken by Mott MacDonald for DfT.
- Comparison between the two forecasts, and hence the interim conclusion above, could be improved by better data to identify base year or observed station demand and/or the pattern of demand for different days throughout the year.
- The primary comparison considered in this note, between the GAL and DfT demand forecast, is overall total growth in 'busy day' station demand. Beyond this, consideration is required with respect to the profile of demand within the day and treatment of growth within the 3-hour peaks.
    - It should be expected that given the Airport capacity constraint, peak period and busy days will grow more slowly than the annual average.
- The GAL forecasts are based on a number of assumptions, and include output from a run of the 'CAST' model using 2026 airline schedules. Assumed growth between 2026 and 2036 appears very high (driven by an unrealistic increase in rail mode share over the period[5]), however this is moderated by other assumptions including zero growth for the non-airport passenger segment and a post model 'profile adjustment'.
- Several other features of the GAL forecasts used within the LEGION modelling would benefit further investigation or discussion:
    - The 2036 'busy day' station entries & exists forecasts appear unbalanced, with 37% more station exits than entries.
    - The profile of demand within the day would benefit from comparison to baseline survey or revealed preference data.

[5] This conclusion is attached to the assumed increase in rail mode share from 38 to 46% specifically applied to growth between 2026 and 2036. If instead this growth is a proxy for rail mode share increase from 2014 (the possible basis for the CAST model input assumption?) then the assumption is much ore reasonable.

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Technical Note

Project:	Gatwick Airport Station Outline Business Case		
Prepared by:	Tom Poole / David Alexander	**Date:**	07-03-2018
Approved by:	David Alexander	**Checked by:**	David Alexander
Subject:	Gatwick Airport Station Demand Forecasts – new 2020, 2028 and 2036 forecasts		

1 Introduction and overview

As part of work undertaken to inform the Outline Business Case for the upgrade of Gatwick Airport station, forecasts have been developed to provide updated demand inputs to the LEGION pedestrian model.

'Busy day' rail passenger forecasts have been produced for 2020, 2028 and 2036. These capture station entries and exits, and provide both daily total and output by 15-minute time segment or peak period.

The assumptions underlying the aggregate annual forecast of Gatwick rail demand growth is as per previous work documented separately (see TN1 dated 07/02/2018[1]). This note however sets out the following:

a) A comparison of the new 2020, 2028 and 2036 forecasts with the previous 2036 output (supplied by GAL) used to inform the existing LEGION model runs, and explanation of reasons for key differences.

b) Consideration of the current annual profile of demand at Gatwick station, and therefore the definition and suitability of a 'busy day' for station capacity assessment purposes.

c) Review of the day profile of demand, and verification of the best available observed or derived baseline (2017) data.

d) Consideration of potential changes to the day and annual profile in the future.

e) Other assumptions required to develop the new forecasts, and the process used to provide additional disaggregate station demand flows required by the LEGION model.

Elements (b) and (c) above make use of data made available since the first Technical Note (TN1). This includes train loading data from GTR, the 2014 station survey, ticket gate counts and a review of flight schedules.

This note refers to station demand forecasts circulated by Gatwick Airport Limited (GAL). This output is underpinned by data from GAL's 'CAST' model, but also includes other adjustments and assumptions. For convenience this is referred to as the "GAL" forecast, and it is the forecast currently adopted within the LEGION modelling.

[1] See Gatwick Airport Rail Demand Forecast TN1 v3.doc. This version captures a small update from the document circulated previously in draft; the forecast increases due to better justification of an uplift associated with enhancements to the Thameslink timetable.

2 Summary output - forecast station demand

The table below summarises the new forecasts of rail passenger entries /exits at Gatwick station for a consistently defined 'busy day'.

	Existing 'GAL' forecast			New forecast (Mott MacDonald / DfT)		
	2017	2036		2020	2028	2036
Total	**60,818**	**81,043**		**65,193**	**68,113**	**71,799**
% growth from 2017		33.3%		7.2%	12.0%	18.1%
PM peak 3-hours	**14,367**	**19,302**		**15,464**	**16,156**	**17,031**
% growth from 2017		34.3%		7.6%	12.5%	18.5%
AM peak 3-hours	**12,795**	**17,665**		**13,963**	**14,588**	**15,378**
% growth from 2017		38.1%		9.1%	14.0%	20.2%

Table 1: Gatwick station 'busy day' demand forecasts (station entries and exists)

As reported further in the sections below, the 2017 baseline represented by the GAL forecast methodology is found to reconcile well with available survey data (both the day total and profile have been reviewed). It is therefore used as the baseline upon which the new (Mott MacDonald / DfT) forecast is applied.

Across the day, the new 2036 forecast is 11% lower than currently modelled in LEGION from the GAL forecast. This represents a growth rate roughly half the rate (54%) adopted previously.

The basis for choice of 'busy day' is also reviewed below, with the conclusion that for 2017 it is a good representation of daily demand at the 95th percentile of all days over the year. A more extreme (absolute worst-case) busiest day would however appear to be 10-15% higher, and if chosen would negate the lower growth forecast from the DfT / Mott MacDonald assumptions above.

Consideration is also given to the change in day and annual demand profile over time. The view held is that (over the long-term) peak period and 'busy day' demand would only grow more slowly, not faster, than the annual total or average. This is due to airport capacity that is increasingly reaching saturation point. Evidence to quantify this impact is however difficult to conclude and no alteration to the profile has been directly applied.

3 Review of GAL forecasts

As part of reviewing the basis for the new forecasts, and to validate the day profile and 2017 baseline, the existing GAL 2036 forecasts have been further reviewed.

The chart and table below shows a breakdown of the constituent elements of this forecast.

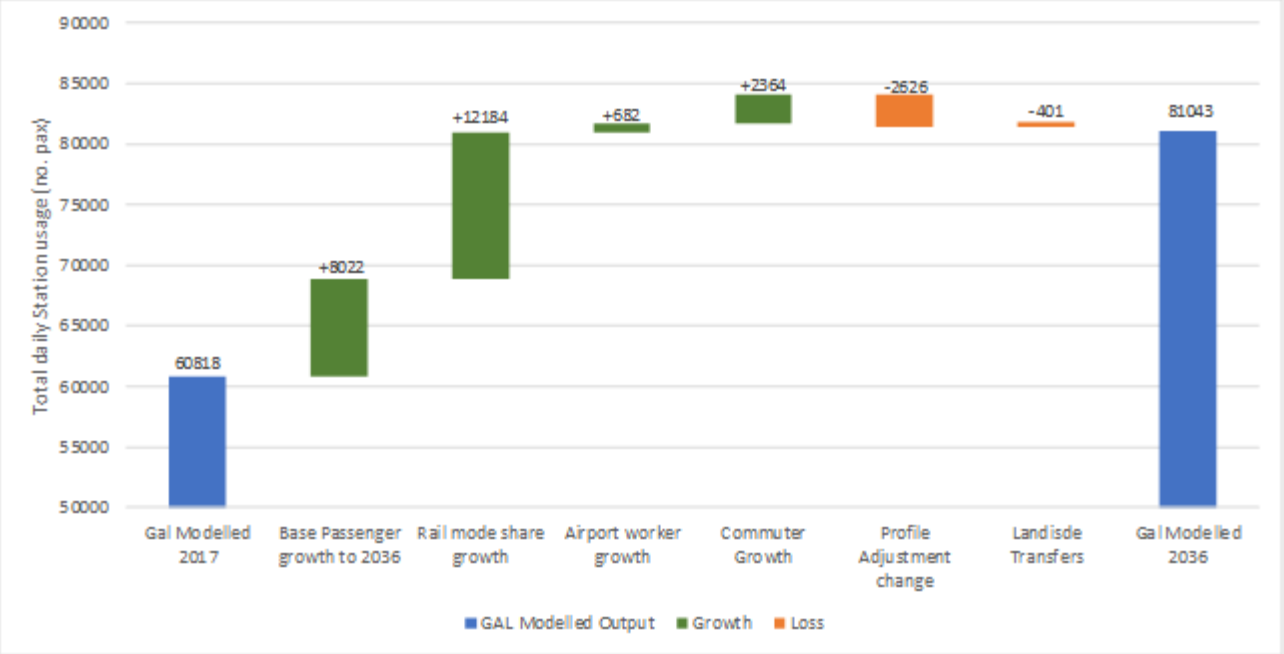


Figure 1: GAL 2036 'busy day' Gatwick station demand forecast (2017 to 2036)

	2017	2036	2017 - 2036 Difference	2017 - 2036 Difference
Air Pax (rail mode share at 2014 level)	59,286	67,308	8,022	33%*
Rail mode share	2,340	14,524	12,184	
Airport workers	5,227	5,909	682	13%
Commuters	3,273	5,636	2,364	72%
Profile Adjustment	-7,850	-10,475	-2,626	33%
Landside transfers	-1,458	-1,859	-401	28%
Total	**60,818**	**81,043**	**20,225**	**33%**

Table 2: GAL 2036 'busy day' Gatwick station demand forecast (2017 to 2036). [*represents combined growth from increase in air passengers and rail model share]

The forecast above represents 33% growth between 2017 and 2036. It is understood to be based on output from the 'CAST' model, forecasting air passenger growth based on a flight schedule assumed for 2026, but then supplemented by other assumptions and adjustments.

The following comments are made in relation to the forecasts:

- Assumed growth in air passengers between 2017 and 2036 is consistent with the DfT aviation growth forecast (see figure 2 below); albeit the profile and position in 2028 is materially different.
- The rail mode share included in the 2017 baseline is consistent with the surveyed / reported level (at 38%), however significant – and mostly unsubstantiated – station demand growth from an increase in rail model share to 46% is also included.

- Growth in ‘commuters’ (in this context representing all rail passengers not using the Airport) appears high, possibly a provision for under-reporting in the baseline.
- The two final adjustments applied (profile adjustment and landside transfers[2]) are not fully understood and appear counter-intuitive with respect to the increment between 2017 and 2036.

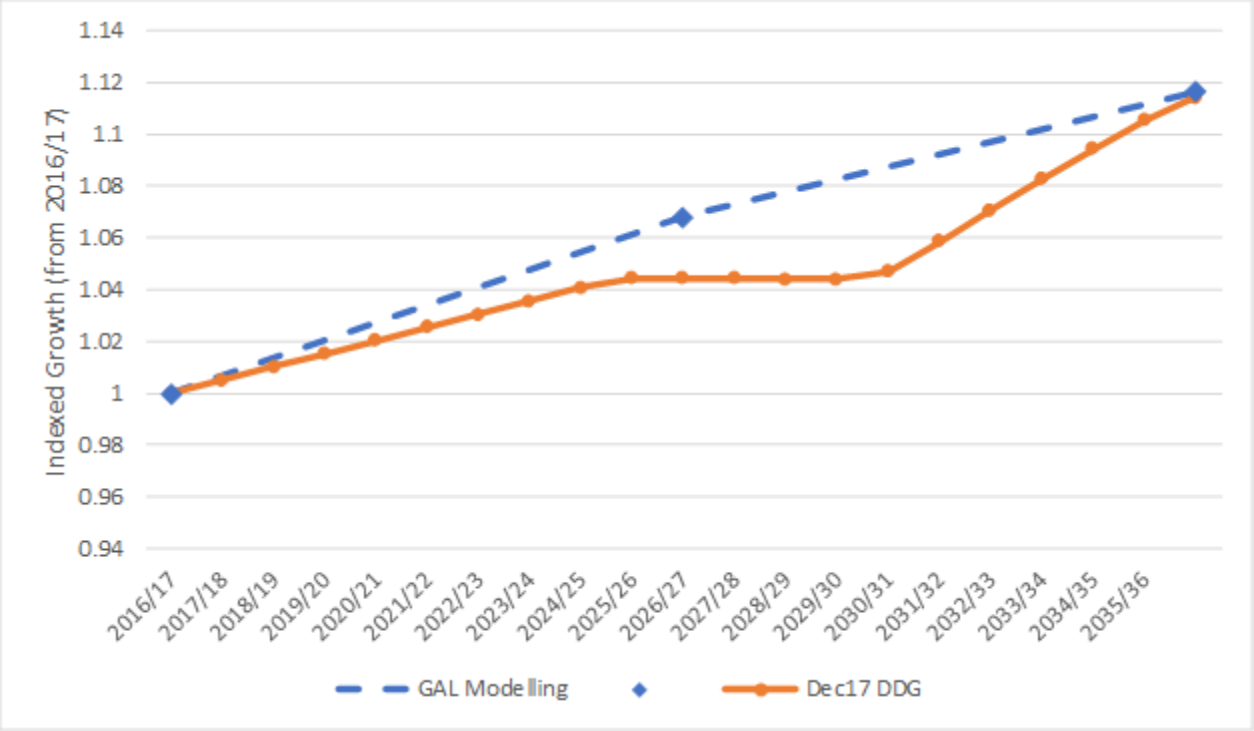


Figure 2: Comparison of GAL and DfT (DDG) air passenger forecasts

4 2017 baseline demand

A key requirement for the updated demand forecasts is a robust understanding of current or base year demand, both in terms of relationship between a ‘busy day’ and annual total, and profile of demand over different times of day.

This section considers three elements of evidence that support the suitability of the 2017 demand baseline implicit within the GAL forecast.

[2] As reported previously in TN1, reducing station demand due to landside transfers appears illogical given that it is applied to a total that already captures rail trips only.

(i) Review of 2014 Survey

The only available, complete and directly observed data reporting demand at the station is from a survey undertaken in May 2014, covering the hours 1600 – 2000.

This data is used to benchmark or validate the 'busy day' output from the 2017 baseline from the GAL forecast.

An uplift of 15% has been calculated to adjust the 2014 survey output to represent three years of growth to 2017, and derivation and breakdown of this assumption is shown below in table 3.

	14/15	15/16	16/17	17/18
Gatwick station usage (ORR data)	17,494,324	18,028,846	19,361,658	
		3.1%	7.4%	
	2014	2015	2016	2017
Gatwick air passengers (CAA data)	38,103,667	40,269,087	43,119,628	45,556,899
		5.7%	7.1%	5.7%
Composite growth		3.1%	7.4%	5.7%
Annual to 'busy day' factor*		0.88	0.88	0.88
Busy day growth		3%	7%	5%
		1.03	1.09	1.15
			15%	

Table 3: Basis for 15% adjustment to uplift 2014 survey data to 2017 [* factor calibrated based on the difference between total annual growth, and growth over the May – August period when airport use is closer to saturation point]

A comparison between the GAL 2017 'busy day' baseline and uplifted 2014 data is shown below, and identifies a strong fit between the two datasets over what is (by most measures) the busiest three-hour time period at the station.

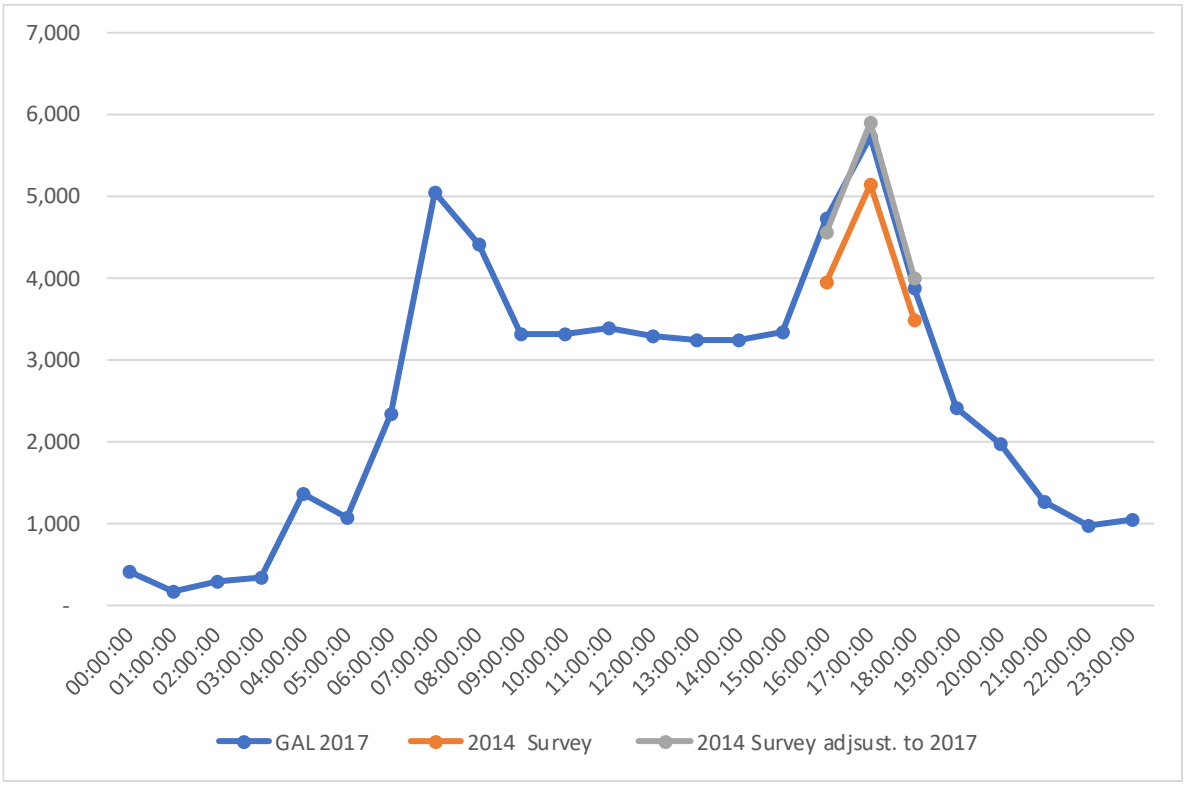


Figure 3: 2017 'busy day' Gatwick station usage (station entries and exits)

(ii) Consideration of 'busy day' versus average day demand

The phrase 'busy day' requires further explanation and definition. The term aims to distinguish rail demand for an average or typical day, versus the characteristics of days when the station is operating closer to worst case conditions in terms of capacity requirement.

The variation between busy days and quieter days will be largely unique to Gatwick station, and is a function of:

- School holiday periods and bank holidays
- Day of week variation – Fridays and Mondays typically being busy for both airport users and commuters
- Weekday vs weekend use (commuter and business travel will typically be lower at the weekend)
- Summer vs winter flight schedules

GAL's 'busy day' is based on the 3rd Friday in August; understood to be based on airport demand and flight schedules.

Analysis of ticket gate data, available consistently over a 12-month period from mid-2014 to mid-2015 has allowed review of demand variation by day of the year. Whilst the annual trends from this data appears robust, it should be recognised that in absolute terms it will be weaker given that (particularly at the ends of the day or during peak periods) ticket gates are sometimes opened for operational reasons or congestion management.

The table below summarises output from the annual ticket gate data.

	Daily passengers	Difference to average
Average day	**41,555**	
Average Monday	45,283	9%
Average Tuesday	40,781	-2%
Average Wednesday	40,881	-2%
Average Thursday	44,730	8%
Average Friday	48,618	17%
Average Saturday	33,121	-20%
Average Sunday	37,467	-10%
Max day (03/07/2015)	57,431	38%
3rd Friday in August	**52,068**	**25%**
3rd Friday in May	51,319	23%
95th percentile	51,719	24%
99th percentile	55,123	33%

Table 4: Analysis of Gatwick station daily ticket gate data (standard 'busy day' highlighted)

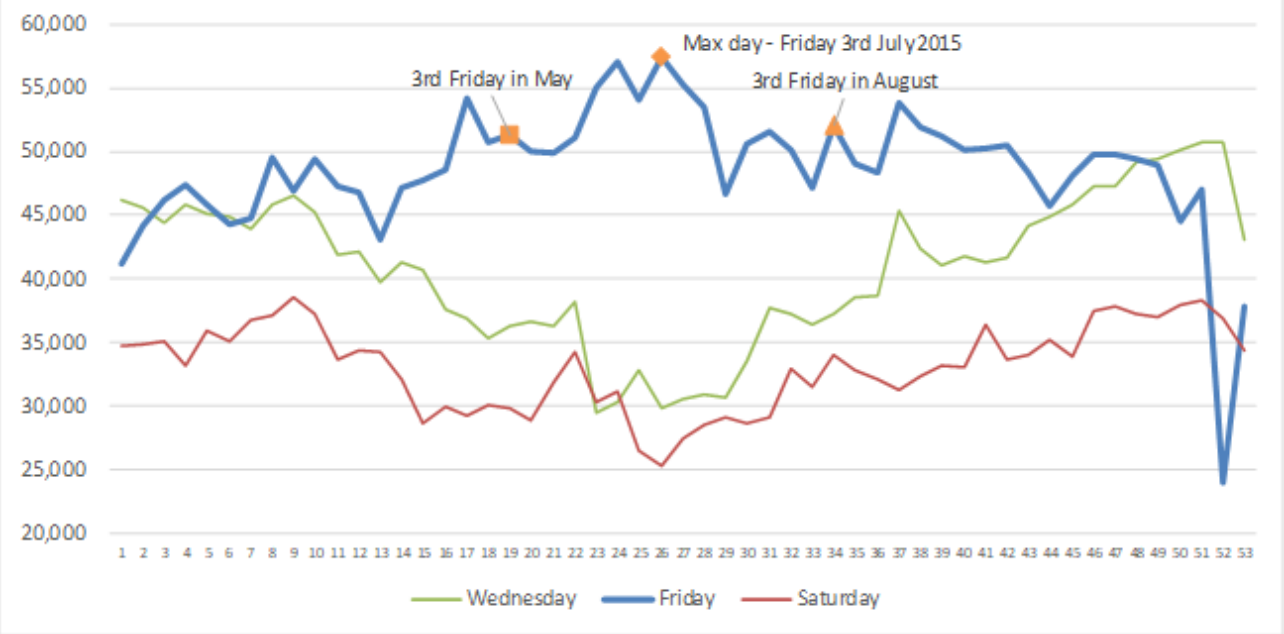


Figure 4: Profile of annual demand (by week) at Gatwick station, measured from 2014-2015 ticket gate data

This analysis identifies the following:

- Fridays (followed by Thursdays and Mondays) are typically the busiest day of the week at the station.
- The busiest period is over the summer months (May to August)
- Weekend days are 10-20% lower than the average day
- The busiest day (from the 12-month period of available data) is a Friday in early July
- The GAL 'busy day' represents a busy Friday in August, at a similar demand level to the busy Friday in May when the 2014 survey was undertaken.
- The busy Fridays in May and August are consistent with the 95th percentile of all days throughout a 12-month period.

The conclusion is that the 2017 baseline as used within the GAL forecast is a good representation of a typical busy day. The very busiest day (from data sampled above from 2014-15) is however circa 12% higher.

It is likely to be undesirable to pivot demand forecasts and station capacity assessment from a single highest busy day over one sample period. Firstly, a single day of data may not be reliable (average are normally considered more robuist), and secondly, it may be accepted that on some exceptional days demand is higher than the level against which the station design has been tested.

The 2020, 2028 and 2036 forecasts developed and summarised by this note therefore adopt a 'busy day' that represents the characteristics equivalent to busy Fridays in May and August, and 25% higher than average day demand.

As a sensitivity test an 'extreme busy day' could be considered as 35-40% higher than an average day.

(iii) Review of time of day profile

To assess the validity of the profile of station usage across the day, Govia Thamselink Railway (GTR) train loading data recorded between February and May 2017 was used to compare relative levels of station flows across each hour of the day.

To ensure a reliable output, only trains terminating or originating at Gatwick Station were included in the analysis, as this allowed for an accurate representation of total train loading on arrival or departure from Gatwick. Gatwick Express services were therefore the focus of this analysis, and make up 31% of total annual station demand giving a reliable sample size.

It is assumed the proportion of Gatwick Express to total station demand remains constant across the day, and services run every 15 minutes which supports this.

Shown below, a comparison between the forecast GAL 2017 baseline and GTR train loading was conducted using the hourly proportion of total day demand. There is a clear similarity in the overall day profile between the two inputs, supporting the validity of the day profile used in GAL 2017 baseline.

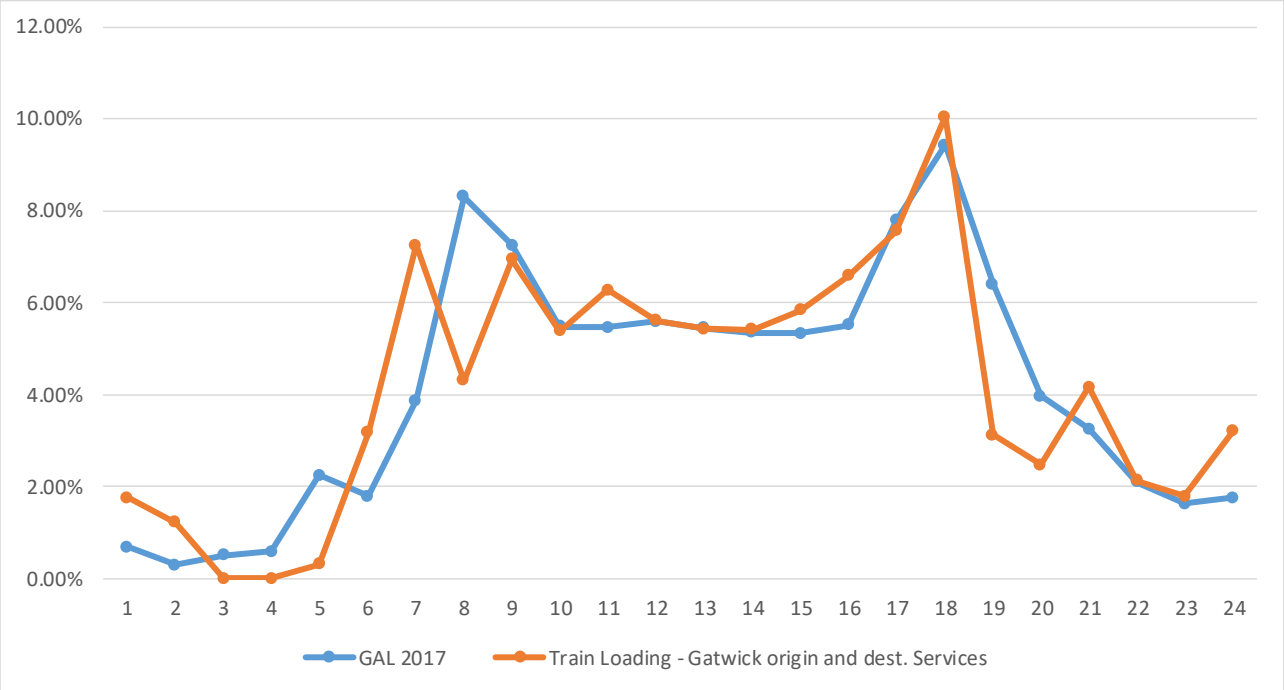


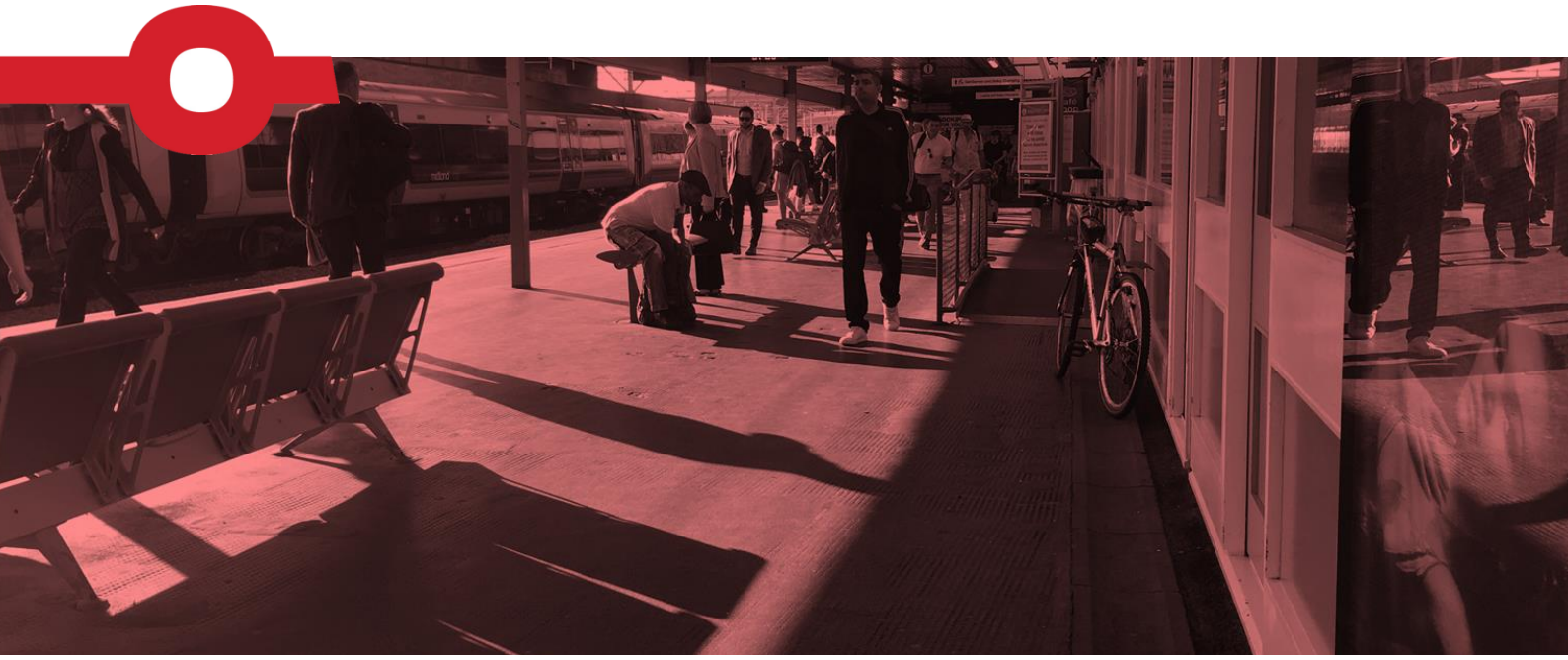
Figure 5: Day profile comparison between GAL 2017 model outputs and recorded GTR train loading data for services terminating or originating from Gatwick Station.

5 Output to Legion Model

A spreadsheet is made available to accompany this note, providing demand output for three scenarios (2020, 2028 and 2036), within the template required for the LEGION model.

This output includes demand by 15-minute segment and for various station pedestrian flows. Overall station usage (entries and exits) is determined from the forecasts summarised in this note, however the proportional splits for different disaggregate flows (e.g. relating to movements to and from particular airport terminals) are retained from the GAL forecasts.

GATWICK AIRPORT STATION MODEL AUDIT



MOTT MACDONALD

SYSTRA

GATWICK AIRPORT STATION BUSINESS CASE

GATWICK AIRPORT STATION MODEL AUDIT

IDENTIFICATION TABLE	
Client/Project owner	Department for Transport
Project	Gatwick Airport Station Business Case
Study	Gatwick Airport Station Model Audit
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APPROVAL

Version	Name		Position	Date	Modifications
1	Author	Nicola Troll		19/06/2018	
	Checked by			DD/MM/YY	
	Approved by			DD/MM/YY	
2	Author	Nicola Troll		12/07/2018	Responding to comments from Motts
	Checked by			DD/MM/YY	
	Approved by			DD/MM/YY	

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1. SUMMARY

1.1.1 We have carried out an audit of the Legion models of Gatwick Station that would be used to calculate the walk time benefits for the proposed scheme. We have looked at the forecast models for 2020, 2028 and 2036 for both do-minimum and do-something scenarios in the morning and evening peak periods.

1.1.2 We have found that the forecast demand is consistent with the Mott MacDonald forecast growths for the station.

1.1.3 We are also satisfied that the issues that we found in our earlier audit has been resolved.

1.1.4 We have also checked that the walk time analysis from the models is the same as that which has been sent to Mott MacDonald from Kerbian.

1.1.5 We were asked to comment on the position of the gatelines in the model. The gatelines in the ticket hall and on the new raft going to the PTI are well placed. The gateline with the most issues are the gatelines for passengers leaving the station via the raft going into the terminal. The ideal solution would be a single gateline in the terminal outside of the raft. We assume, though, that this is not possible as it would be in the terminal building rather on station property. Another potential issue would be whether there would be sufficient room for run-offs on both sides of the gateline.

1.1.6 To continue to have the two sets of gatelines, signage is needed to direct passengers to the gateline furthest from the ticket office which is used less. It would be better to move the gatelines closer to the terminal building to allow for longer queues away from the escalators onto the platforms. Moving them, if possible, may mean that the gates in these locations do not be opened as often.

1.1.7 If the station is not gated consideration needed to be given as to whether passengers will be able to continue to use Oyster Cards and if so some Oyster readers will be necessary. These might be at the entrance and exits to platforms. Whilst they do not create the same barriers as gatelines consideration for their locations is important as it will affect how passengers move through the station.

2. INTRODUCTION AND BACKGROUND

2.1.1 This note follows on from an audit we carried out on a LEGION model of Gatwick Station in August 2017 that was due to form the basis of a business case for improvements to the station. This was reported in an audit report 'Gatwick Airport Station Model Audit' 31/8/2017.

2.1.2 The main conclusions of the report were

- The LEGION model was suitable for assessing options for the station development;
- The LEGION model met Network Rail and IATA design guidance;
- Demand in the model implied high growth rates which were higher than DfT growth assumptions;
- There were some minor issues with the model which were generally immaterial to the performance of the model. For the business case the do-minimum and do-something needed to have a consistent approach to correctly measure journey time benefits;
- There was some uncertainty regarding some of the assumptions used in the model and where the data had come from eg assumptions about the direction in which passengers were travelling.

2.1.3 The models we audited also did not show the final scheme and were for a single year. For the purpose of using the outputs for the business case two years are needed both for do-minimum and do-something scenarios.

2.1.4 Since the this report Mott MacDonald has created growth scenarios that are in line with the DfT expectations of airport growth and people using the Gatwick Airport Station to interchange with local buses through the Public Transport Interchange as well as Gatwick Airport employees. The models we have audited this time contain these demand forecasts.

2.1.5 The original design of the station removed ticket gates at the station as gates often had to be opened to prevent overcrowding at the station. The Department for Transport requested that designs were reconsidered to include gates for revenue protection. The design team were also asked to consider whether there was space for commercial units on the station.

2.1.6 This note is a record of the audit of the final models to be used for the business case to ensure they are suitable for assessment of economic benefits..

3. SCOPE OF THE AUDIT

3.1.1 We received the following LEGION models as part of the final audit:

- Do-Nothing, DfT 2020 forecast am peak - 'GSP OBC DN existing 2020 AM_V11'
- Do-Nothing, Dft 2020 forecast pm peak - 'GSP OBC DN existing 2020 PM_V11'

- Do-Nothing, DfT 2028 forecast am peak - 'GSP OBC DN existing 2028 AM_V11'

- Do-Nothing, DfT 2028 forecast pm peak - 'GSP OBC DN existing 2028 PM_V11'
- Do-Nothing, DfT 2036 forecast am peak - 'GSP OBC DN existing 2036 AM_V11'
- Do-Nothing, DfT 2036 forecast pm peak - 'GSP OBC DN existing 2036 PM_V11'

- Do-Nothing, GAL 2036 forecast am peak - 'GSP OBC DN existing GAL2036 AM_V11'
- Do-Nothing, GAL 2036 forecast pm peak - 'GSP OBC DN existing GAL2036 PM_V11'

- Do-Something, DfT 2020 forecast am peak - 'GSP OBC DS Option 2020 AM_V5'
- Do-Something, Dft 2020 forecast pm peak - 'GSP OBC DS Option 2020 AM_V6'

- Do-Something, DfT 2028 forecast am peak - 'GSP OBC DS Option 2028 AM_V5'
- Do-Something, DfT 2028 forecast pm peak.. - 'GSP OBC DS Option 2028 PM_V6'
-
- Do-Something, DfT 2036 forecast am peak - 'GSP OBC DS Option 2036 AM_V5'
- Do-Something, DfT 2036 forecast pm peak - 'GSP OBC DS Option 2036 PM_V6'

- Do-Something, GAL 2036 forecast am peak - 'GSP OBC DS Option GAL2036 AM_V5'
- Do-Something, GAL 2036 forecast pm peak - 'GSP OBC DS Option GAL2036 AM_V6'

3.1.2 The audit concentrated on the three 'DfT' scenarios which were based on demand growth supplied by Mott MacDonald and aligned to assumptions agreed with DfT. The 'GAL' scenario represents an alternative higher growth forecast developed by Gatwick Airport Ltd for an earlier version of the models.

3.1.3 It is worth noting that the assumptions for the direction of travel used in the model came from a passenger count survey at Gatwick station that used cameras on all of the platforms. Some interesting and potentially counter intuitive information came from the survey

- Passengers are more likely to use trains to access the airport to catch a flight than to leave the airport after catching a flight. This means that passengers are more likely to be met at the station after catching a flight. This accounts for more passengers leaving the station than entering the station in both periods;

- The direction from which people travel by train was determined by the count survey at the station..

3.1.4 As these assumptions come from observed data and as no better alternative evidence is available we have not commented further on these assumptions. As the same assumptions have been used in the do-nothing scenarios and the do-something this is unlikely to have a significant effect on the results.

3.2 Scope of the Review

3.2.1 The scope of this later review was to

- ensure that the issues found in the original models were corrected;
- check the passenger demand in the model met the Mott MacDonald forecasts
- check that the journey time benefits in the model reported by Kerbian were correct

4. AUDIT FINDINGS

4.1.1 A meeting was held with Ian Emslie, the developer of the LEGION models on 11 April 2018. The meeting was held before the final models were built. We discussed what would be needed for the business case in terms of consistencies between the do-minimum and do-something scenarios and where the design was in terms of gating the model.

4.1.2 We ran the models through the LEGION Quality Assurance option. There were no issues for any of the do-nothing scenarios. All of the do-something models had four issues which were PTI focal nodes with nothing linking to them. When we observed the model running passengers were going to and from the PTI using the new links that were part of the scheme. We therefore do not consider these issues to be material to the Business Case journey times.

4.1.3 We extracted the demand from each of the new models to make sure that it was consistent with the Mott MacDonald forecasts. The demand to and from the station ie excluding demand within the airport and from the airport directly to and from the PTIs showed an approximate 4.5% growth between the DfT 2020 and DfT 2028 models (4.7% in the morning peak, 4.4% in the evening peak). The growth between 2028 and 2036 was 5% in the morning peak and 5.5% in the evening peak. This is consistent with the growths proposed by Motts.

4.1.4 We also ran the journey time benefits report for all of the DfT scenarios. For these we got the same overall totals that had been reported by Kerbian and supplied to Mott MacDonald for the project.

4.1.5 The differences in the journey times between the do-nothing and so-something scenarios are not consistent for the different years and this is being investigated by Kerbian. We expected that the congestion impacts might increase the average benefit per person with each scenario, but this has not been the case.

4.1.6 It should be noted that there was some question about the consistency of interchanging passengers as these were showing initially showing a disbenefit with the new design. There are consistent assumptions with them being assumed to not need to look at display boards to get to the correct platform. Interchanging passengers are now showing a small benefit with the new design so this issue has been resolved in the model versions we received.

4.1.7 We therefore consider the model suitable for calculating walk benefits in the business case.

5. GATELINE DESIGN

5.1.1 As stated in the introduction, DfT requested that the design team consider retaining gatelines in the model. The gatelines have been put into the model in reasonable locations, but they may not be in the most ideal location to ensure smooth movements through the station whilst allowing space for passengers to queue as necessary with sufficient run-offs nd we have been asked to comment on their position. Figure 1 shows the scheme design with the gatelines as they have been modelled. It should be noted

that whilst the model runs the gates often need to be opened to prevent long queues building.

5.1.2 There are three locations for the gatelines. The first is the ticket hall which has the most gates. In the do-something scenario the gates are mainly for passengers entering the station, although some gates are outbound because of the location of the lifts. These gates are in the best location, given the limited size of the ticket hall and the need for passengers to buy tickets and wait for trains. Passengers may have to wait some time for their train (their arrival time at the station is determined from flight times) so some space is needed for this activity but it is limited.

5.1.3 There is then a gateline from the new raft to the PTI. This gateline is relatively small, but it is suitable for the number of passengers exiting the station to the PTI. The location for this gateline is OK.

5.1.4 The gatelines that require greatest consideration are those going from the raft to the airport. These gatelines are in the same location as those currently in the station. There are two corridors each containing a gateline. The corridor closest to the tickethall is currently the one that is most widely used. Notices would be required to direct people to the other gateline as a single gateline is not sufficient. The other issue with the gateline is that it is close to the steps and escalators closest to the terminal building. There is room move the gateline closer to the terminal which may prevent the need to open the gateline as often. It would be better though, to have a single gateline off of the concourse. We assume that this is not possible as it would be within the terminal rather than on station property. There would also need to be sufficient room for run-offs between the doors to the raft and the gateline and between the gateline and other objects in the terminal.

Figure 1. Proposed Development Scheme Design for Gatwick Airport Station including Position of Gatelines

5.1.5 If gates are removed from the station there would be a need to install Oyster readers to continue to allow passengers to use Oyster cards. Allowing passengers to use Oyster is very attractive to passengers who have cards. Careful consideration should be given to the Oyster card issue and if readers were installed their location and how this affects movements through the station.

6. CONCLUSIONS AND SUMMARY

6.1.1 For the final audit of the models we have checked that our earlier concerns with some of the model assumptions have been resolved and are pleased to report that they have.

6.1.2 Some of the assumptions about travel direction have come from a count survey that took place on the platforms. As this data has come from observed data and there is no better data we have no further comments to make. It should be noted that more passengers travel by train to access the airport than leave it by train which accounts for a dominant flow leaving the station than entering it in both peak periods.

6.1.3 We have checked the demand growth assumptions in the DfT model versions and are happy that these are consistent to the growth rates proposed by Mott MacDonald.

6.1.4 We have also checked that benefits from the model is the same as those reported by Kerbian.

6.1.5 We were asked to comment on the position of the gatelines in the model. The gatelines in the ticket hall and on the new raft going to the PTI are well placed. The gateline with the most issues are the gatelines for passengers leaving the station via the raft going into the terminal. The ideal solution would be a single gateline in the terminal outside of the raft. We assume, though, that this is not possible as it would be in the terminal building rather on station property. Another potential issue would be whether there would be sufficient room for run-offs on both sides of the gateline.

6.1.6 To continue to have the two sets of gatelines, signage is needed to direct passengers to the gateline furthest from the ticket office which is used less. It would be better to move the gatelines closer to the terminal building to allow for longer queues away from the escalators onto the platforms. Moving them, if possible, may mean that the gates in these locations do not need to be opened as often.

6.1.7 If the station is not gated consideration needs to be given as to whether passengers will be able to continue to use Oyster Cards and if so some Oyster readers will be necessary. These might be at the entrance and exits to platforms. Whilst they do not create the same barriers as gatelines consideration for their locations is important as it will affect how passengers move through the station.

6.1.8 We conclude that the models are suitable for calculating the walk time benefits of the scheme.

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Gatwick Airport Station Business Case

Demand and Revenue Analysis

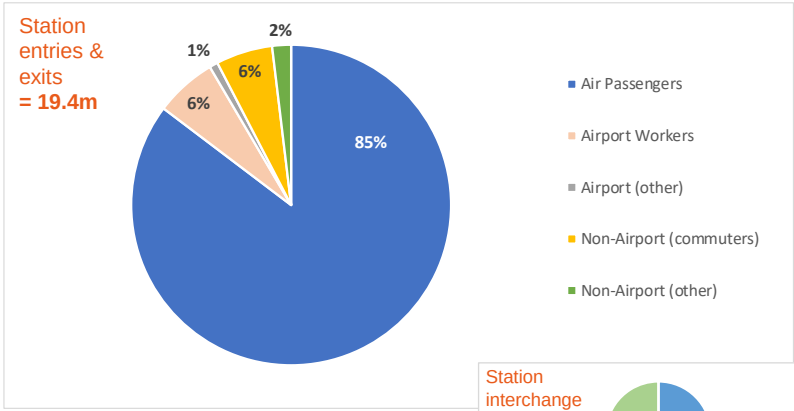
18/12/2017

DRAFT – for discussion

Gatwick Airport station – base year rail demand

- 19.4m annual rail passenger journeys (2016/17)
  - Air passengers represent the largest proportion (>80%), but other segments also require consideration:
    - Airport workers
    - Non-airport trips
- A further 1.2m rail passengers interchange at Gatwick, for onward destinations not associated with the Airport
- Whilst overall rail usage by ticket type is known, segment or journey purpose must be inferred.
  - 38% base year rail mode share, and 24k airport workers assumed
- Total rail revenue from flows to/from Gatwick: £211m (2016/17 prices)

Base Year station usage



Annual (2016/17) journey by segment. source: ORR, CAA, GAL data, Mott Macdonald analysis

Gatwick Airport station – rail demand growth (1 of 3)

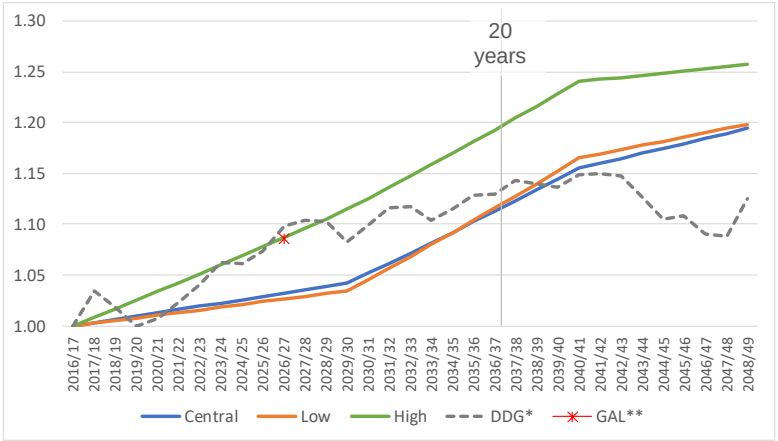
A simple demand forecast has been developed from bottom up principles and DfT exogenous variables…

- Air passenger demand is by far the most significant variable (see right), but other inputs include:
  - Population /Employment /GDP per Capita
  - Car cost and journey time
  - Fares (assuming RPI+1 regime post 2020)
  - Timetable impacts (tbc)

	Air Pax	Population	Employment	GDP per Capita	Car Cost	Car JT	Fares
Air Passengers	x				x	x	x
Airport Workers					x	x	x
Other Airport (meet and greet)	x				x	x	x
Non-Airport (commuters)		x	x		x	x	x
Non-Airport (other)		x		x	x	x	x
Interchanges - commuter		x	x		x	x	x
Interchanges - other		x		x	x	x	x

Consideration of demand forecast variables by segment (Mott MacDonald analysis)

Air Passenger Forecasts…



Forecast air passenger growth:

DfT Aviation forecasts, October 2017 (Central, High and Low)

**DDG: DfT Demand Driver Exogenous Variables (June 2017, update pending))*

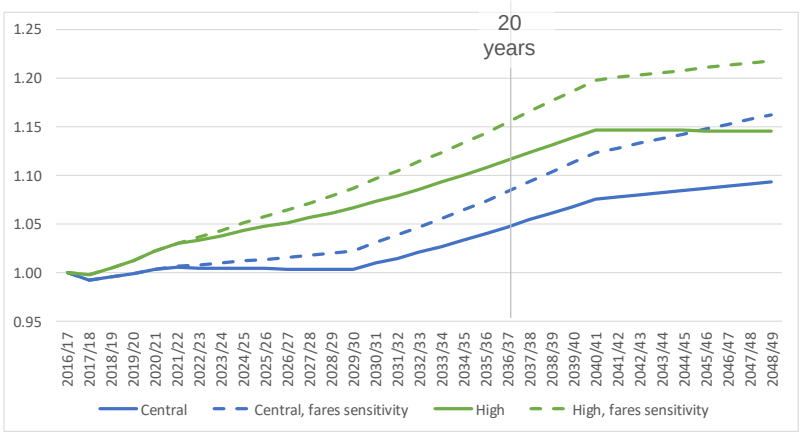
***GAL: derived from expected growth in seats – 2016 to 2026 (busy day)*

Gatwick Airport station – rail demand growth (2 of 3)

Draft (central case) do-minimum rail demand forecast suggests growth of 5-8% over 20 years to 2037…

- Utilisation of 'high' case aviation forecasts increases forecast to **12-16%** over the same time period
- Forecast is draft, subject to review
- Timetable impacts (if any) are not yet captured
- Forecast developed using PDFH v5.1/5.0/4.0 (update to PDFH v6 under consideration)
- Forecast includes an assumed RPI+1% increase in (regulated) fares from 2020:
  - Using a standard strategic assumption leads to a significant demand loss (absorbing two-thirds of growth from air passengers)
  - Further consideration required; a sensitivity test illustrates the impact of assuming the price increase is moderated to 0.5% (reflecting pricing competition /ticket trading)
  - PDFH v6 significantly increases fares elasticity on Airport flows (from -0.5 to -1.0)

Rail Demand Forecast (station entries and exits)



Rail demand growth (Mott MacDonald forecast): Central and High case scenarios use alternative respective DfT aviation forecasts. The 'fares sensitivity' tests the impact of assuming 0.5% rather than 1.0% average fares increase on flows to/from Gatwick (post 2020).

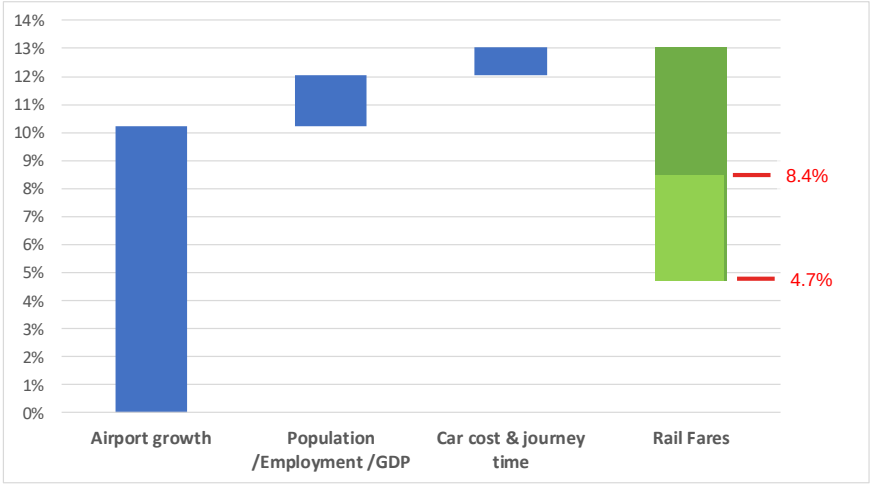
Gatwick Airport station – rail demand growth (3 of 3)

A growth forecast over 20 years (to 2037) will be a key consideration for appraisal purposes…

- Initial view:
  - 5-8% based on DfT central case aviation forecast (see chart right)
  - 12-18% based on DfT high case aviation forecasts

- Further clarification is required to understand the demand growth assumptions included in current LEGION modelling.
  - Existing review suggests peak hour demand growth of circa 50%
  - Basis for this assumption and translation between annual and peak hour growth requires challenge

Rail Demand Growth to 2037 (station entries and exits)



Composition of rail demand growth to 2037 (Mott MacDonald forecast)
Central case aviation forecasts

Gatwick Airport station – Revenue Protection & Ticket Gates (1 of 3)

An assessment is required to estimate passenger revenue loss associated with removal of Gatwick Airport station ticket gates…

- Context:
  - Rail flows to/from Gatwick Airport generate £211m of annual farebox revenue (2016/17 prices)

Gatwick Express	62,145,371	29.4%
Great Western	11,284,690	5.3%
Southern	78,588,887	37.2%
Thameslink	43,115,310	20.4%
Other	16,079,867	7.6%
Total	**211,214,125**	100.0%

  - Ticket gates reduce but do not eliminate fare evasion (*see right*)
  - Given the nature of operation of Gatwick Express (e.g. full on-board ticket checks), current fare evasion is assumed to be negligible ~ subject to verification

- Fare evasion types:

Fare Evasion Category	Benefit from Ticket Gates
No ticket	yes
Out of date ticket	yes
Overriding	(yes)
non-validation of Oyster /contactless	yes
'Dumbbell' ticketing (2 tickets, but not coving full journey)	no
Transferred Use (photo does not match user)	no
Invalid time	no
Child impersonation	no
Invalid class	no
Misuse of railcard	no

- Ticketless travel surveys are undertaken biannually across the GTR franchise; a rich source of data, but we are currently awaiting the disaggregate output…

Gatwick Airport station – Revenue Protection & Ticket Gates (2 of 3)

Assessment of the revenue impact from gating schemes requires a number of assumptions…

- The classic methodology, is to consider the proportion of demand & revenue moving between the following 3 flow categories:
  - gated to gated
  - gated to/from non-gated
  - non-gated to non-gated

- Based on an assessment of the top 500 flows by revenue, Gatwick Airport station flows (today) have the following characteristics:

fully gated	137,150,318	92.0%
part gated	6,854,960	4.6%
unknown	5,063,476	3.4%
total	149,068,754	100.0%

- Removing ticket gates at Gatwick would increase the proportion on non-gated flows, assumed to have a higher prevailing rate of fare evasion

- A model has been developed to calculate revenue loss, but survey data (existing from GTR or DfT) is required to finalise calibration.

- Professional judgement and an understanding of fares evasion at a TOC / route level, has been used to determine the following illustrative position:

Flow Type	Fare evasion level	Typical market composition	Weighted average fare evasion
gated to gated	2.0%	75%	
gated to non-gated	3.5%	20%	
non gated to non-gated	16%	5%	
all		100%	**3%**

- The resulting model output suggests an indicative annual revenue loss of **£2-3m** (1.5-2% of non GatEx revenue)
  - Additional factors require consideration (see next slide)

Gatwick Airport station – Revenue Protection & Ticket Gates (3 of 3)

A number of wider commercial and operational considerations are required…

- Commercial:
  - Compensation – if any – due to Great Western; subject to Franchise Agreement terms (Change Mechanism)
  - Increase in Penalty fare /full fare premium income to offset revenue loss
  - Recalibration of GTR ticketless travel performance regime likely required
  - Cost saving from reduced staff /benefit from staff redeployment

- Operational:
  - Are gates fully staffed & operational today?
  - At what point in the future would the gates become unviable in a do-minimum scenario?
  - Revenue protection activity should be re-organised to minimise revenue loss if ticket gates are withdrawn

- Business Case
  - Construction of do-minimum vs do-something scenario: