

Oxford Phase 2 report

Version 1.0

Capacity Analysis – System Operator

07/01/2020

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Overview

What we did?

The aim of this project was to see whether it is possible to produce a compliant Concept Train Plan (CTP) incorporating up to four East-West Rail (EWR) trains per hour into the December 2019 timetable at Oxford station, plus extra freight services. The timetabling period was weekdays only, from 6am to 10am and the analysis was split into three parts.

The first used current (Phase 1) infrastructure, Parts 2 and 3 used Phase 2 infrastructure.

What we found?

Part 1 – two EWR trains per hour was possible, but four was not. The maximum number of freight services that could also be incorporated was three over the four-hour period.

Part 2 – including both two and four EWR trains per hour into the timetable was possible, and there were also paths for four extra freight services over the four-hour period.

It was not possible to produce a more regular timetable by extending EWR and/or Chiltern services to Cowley and/or Didcot.


Part 3 – extending EWR trains to Didcot Parkway is not possible due to a lack of available paths for stopping services returning to Oxford. There is, however, scope to timetable another five new Down freight services through Oxford (two via the DCL to Banbury and three via EWR). It is also possible to add an hourly service in each direction between Oxford and Birmingham Moor Street services into the timetable, but one would need to take the path of a Didcot-Banbury freight train created in Part 2 of this study.

What were the assumptions?

- Geographic scope: Didcot to Banbury and Bicester Gavray Junction. East West Rail services were validated as far as Oxford Parkway only.
- Timetable Planning Rules used: Wales & Western, December 2019 (Part 1) and December 2020 (Parts 2 and 3)
- Rolling stock: Class 185, two-engine timing loads (EWR); 75/C/66/1400 (freight); Class 170 (based on Class 168 timings) (Birmingham Moor Street services)
- Source timetable: December 2019 (extracted on 27 August 2019)

What are the risks?

- This study uses a weekday-only 6am to 10am timetabling period, so does not take into account off-pattern services outside these hours
- Infrastructure assumptions that are not delivered will change the outputs of this analysis
- Robustness assessments can only give a high-level insight into the expected reliability of the CTP and should not be viewed as performance modelling
Some analysis relies on IRTs rather than industry-approved SRTs

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Abbreviations	
Acronym	Meaning
CS	Configuration State
CTP	Concept Train Plan
DB	Down Bletchley
DCL	Didcot-Chester Line
DO	Down Oxford
DOR	Down Oxford Relief
ECS	Empty Coaching Stock
EWR	East-West Rail
IRT	Indicative Running Time
SRT	Sectional Running Time
TPR	Timetable Planning Rules
TPS	Timetable Planning System
TRT	Technical Running Time
UB	Up Bletchley
UO	Up Oxford
UOR	Up Oxford Relief

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Part A: Executive Summary

The aim of this project was to see whether it is possible to produce a compliant concept train plan (CTP) incorporating up to four East-West Rail (EWR) trains per hour into the December 2019 timetable at Oxford station, as well as additional freight services.

The timetabling period was weekdays only, from 6am to 10am, with the study broken down into three parts and then subdivided into different sections.

The below tables show the aim of each section, whether the goal was achieved and any relevant timetabling notes or changes which needed to take place:

Part 1 – this used current (Phase 1) infrastructure at Oxford:

	Aim	Y/N	Notes
1.1	Add two EWR services per hour to the December 2019 timetable	Yes	Used XX:27 / XX:57 departure and XX:17 / XX:47 arrival pattern at Oxford from previous EWR studies. This was possible by flexing the times of 29 services (seven passenger, fourteen freight and eight ECS).
1.2	Two EWR services per hour plus four additional freight services (timing loads 75/C/66/1400) per hour – one in each direction via the Didcot-Chester Line (to Banbury) and one via EWR	No	It was only possible to add three extra freight services over the whole four-hour period: two Down (from Oxford) trains via the DCL and EWR and an Up service via EWR. No services needed to be flexed to do this.
1.3	Four EWR services per hour plus additional freight	No	This was done by utilising all available capacity and flexing one freight service. While it was possible to timetable four EWR departures into all but one hourly period (8am to 9am), it was only possible to timetable four arrivals per hour into one period (7am to 8am). That meant a CTP was not possible. When these extra EWR services were added, only two additional freight trains (Down via EWR and the DCL) over the four-hour period were feasible.

Part 2 – Phase 2 infrastructure at Oxford:

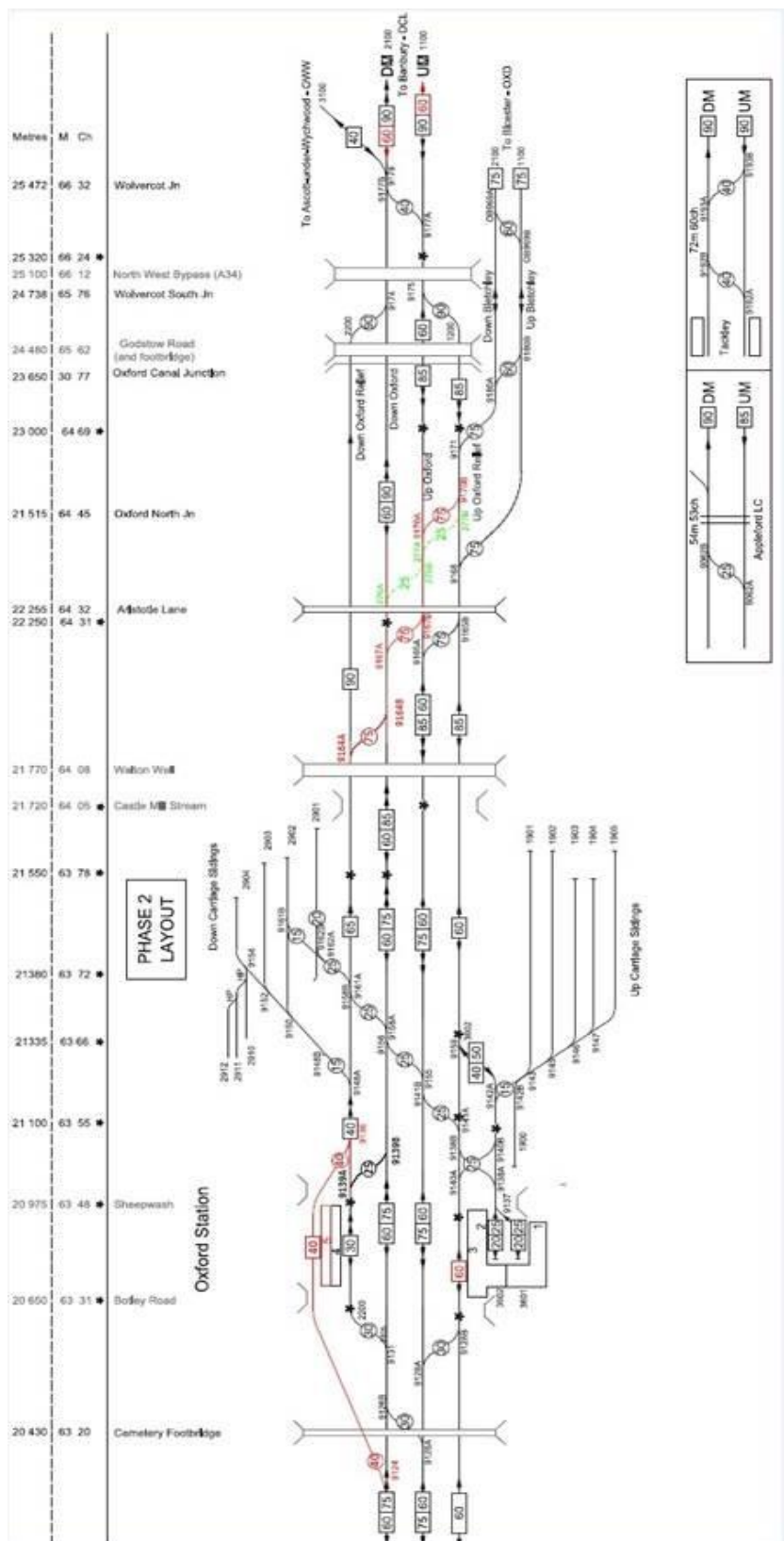


Figure 1: Phase 2 infrastructure at Oxford, including Platform 5 and 75mph crossovers at Oxford North Junction

Phase 2 infrastructure provides additional capacity, enabling additional paths to be accommodated with less flex required to other services. For example, only 21 services needed to be flexed to accommodate two EWR trains per hour, against 29 services needing to be flexed to do the same thing on Phase 1 infrastructure.

	Aim	Y/N	Notes
2.1	Add two EWR services per hour to the December 2019 timetable	Yes	This was possible by flexing the times of 21 services (three passenger, ten freight and eight ECS).
2.2	Two EWR services per hour plus four additional freight services (timing loads 75/C/66/1400) – one in each direction via the Didcot-Chester Line (to Banbury) and one via EWR	Yes	It was possible to add four extra freight services over the four-hour period. This was by being able to depart through and starting Up (to Didcot) passenger trains from Platform 4 and move through and terminating Down services to Platform 5, the 75mp crossovers at Oxford North and flexing two freight trains.
2.3	Four EWR services per hour plus the additional four freight trains	Yes	Although it was possible to include the extra services, a regular pattern could not be achieved. The variance in the EWR service pattern is seven minutes later for an arrival and eight minutes earlier for a departure. Seven trains (two existing EWR, three other passenger, one freight and one ECS) had their times flexed.
2.4	Look at extending EWR services to Cowley to provide connectional benefits and a more regular timetable of departures at Oxford	No	Neither of these proved possible. While it was feasible to extend both EWR and Chiltern services to Cowley due to the re-platforming done in <i>Part 2.2</i> , the return journeys were not possible. This was due to a lack of paths at Kennington Junction and again crossing back over the Up Main Line at Hinksey North Junction to get back into Platform 3, or capacity at Platform 4 not matching up with available paths.
2.5	Look at extending Chiltern (London Marylebone) services to Cowley to provide connectional benefits and reduced dwell times at Oxford		

Part 3 – Phase 2 infrastructure at Oxford:

	Aim	Y/N	Notes
3.1	Look at extending EWR services to Didcot to provide connectional benefits and a more regular timetable of departures at Oxford. These would be in place of the existing stopping services from Oxford to Didcot Parkway which were removed from the timetable for the purposes of this study.	No	A regular timetable is not possible as the only paths available for stopping services are those already taken by Oxford to Didcot Parkway shuttles and these do not always marry up with EWR timings. As there is only a single track in each direction between Didcot North and Kennington Junction, any stopping services which look viable departing Oxford or Didcot Parkway lose headway compliancy with following through services at some point between the two junctions.
3.2	Can additional freight services be fitted into spare capacity?	Yes	Five new Down freight services can be timetabled through Oxford (two via the DCL to Banbury and three via EWR) but no extra Up freight trains. No flexing of other trains was necessary.
3.3	Add an hourly Birmingham Moor Street to Oxford service into the timetable. These will be pathed immediately behind the existing CrossCountry services to and from Newcastle via Birmingham New Street	Yes	One Oxford to Birmingham Moor Street service takes the path of a freight train created in <i>Part 2.2</i> . Seven passenger, ten freight and one empty coaching stock (ECS) needed to be flexed to accommodate these trains.

Part B: Introduction

B.01 Background

The Oxford Corridor Phase 2 – Capacity Improvements scheme aims to improve capacity and capability on the Didcot North Junction to Aynho Junction route (known as the “Oxford Corridor”) to meet the Network Rail’s Strategic Business Plan objectives for capacity enhancement and journey time improvements.

This scheme forms part of a package of rail enhancement proposals that will deliver significant economic and strategic benefits to the wider Oxford area and the country. The enhanced infrastructure in the Oxford area is required to deliver the service specification of East West Rail (EWR) Phase 2 and add further robustness to the Intercity Express Programme and the Strategic Freight Network.

The Oxford area is part of the strategic rail freight corridor for traffic from Southampton to the Midlands and the North. The scheme will increase route capacity through the provision of additional passenger and freight train paths in each direction.

The works are currently planned in four elements, with delivery planned in Control Period 6 (2019 to 2024):

Phase 2, Part A: Level crossings: level crossing mitigations between Wolvercote Junction and Heyford are required to improve safety and create extra capacity by unlocking headway improvements. Bi-directional signalling will also be commissioned through this area.

Phase 2, Part B: Track works – high-speed crossovers: the project shall develop 75mph high speed crossovers at Oxford North Junction to support improved EWR service provision to the East-West route towards Bicester

Phase 2, Part C: Botley Road Bridge: develop a new span to accommodate an additional west side island platform.

Phase 2, Part D: Oxford station works – western entrance and track works: provide a new down-side twin-face platform to support additional train services.

B.02 Aims and objectives

The strategic aims of the project are to:

- Increase capacity and capability on the Oxford Corridor
- Meet further increased demand for platform capacity arising from either East-West Rail Phase 2 or other additional future additional planned through services
- Meet forecast increased demand for pedestrian flow capacity at Oxford station
- Improve passenger experience at Oxford station
- Reduce level crossing risk between Wolvercote and Heyford, associated with headway improvements
- Take account of future Masterplan redevelopment options for the Oxford station area

The overall objective of the Capacity Analysis work is to support an update to the business case by providing a better understanding of the capacity of the proposed infrastructure to support future planned services.

B.03 Geographic scope

Analysis was carried out on services stopping or terminating at, starting from and passing through Oxford station.

The scope of the analysis was between Didcot and Banbury on the Didcot and Chester Line (GW200, then MD401) and Bicester Gavray Junction on the East-West Rail (EWR) line (GW277). EWR services using this line were validated only as far as Oxford Parkway.

The project does not include a study of services to and from West Coast Main Line.

Part C: Findings

C.01 Part 1.1

C.01.01 Aim

To accommodate two East-West Rail (EWR) departures and arrivals into Oxford per hour in the December 2019 timetable using Phase 1 infrastructure. This is for a weekday-only period between 6am and 10am.

C.01.02 Findings

Previous studies show that it is possible to create a concept train plan (CTP) including two EWR services per hour into the May 2019 timetable at Oxford using Phase 1 infrastructure (see *East-West Rail Oxford – Milton Keynes 2tph Optimisation Report*, 27/09/19)

Using the times of these services as a base (XX:27 / XX:57 departure and XX:17 / XX:47 arrival pattern), it is also possible to incorporate two EWR services per hour into the December 2019 timetable.

Ten of the 16 services timetabled to arrive and depart during the four-hour period remain the same. Three Down (from Oxford) EWR services and three Up EWR services (to Oxford) have had to be re-timed to resolve conflicts and headway issues, as *Table 1* shows:

Down trains			
Service	Original departure time	Amended departure	Difference (minutes)
2D01JB	5:57:00	5:55:00	-2
2D07JB*	8:57:00	8:58:00	+1
2D09JB*	9:57:00	9:58:00	+1
Up trains			
Service	Original arrival time	Amended arrival	Difference (minutes)
2U05JB	8:46:00	8:52:00	+6
2U06JB**	9:19:00	9:20:00	+1
2U07JB	9:46:00	9:53:00	+7

*Brought back onto timetabled pattern by departure from Oxford Parkway

**On timetabled pattern until departure from Oxford Parkway

Table 1: EWR services created from analysis using the May 2019 timetable which would need to be retimed to fit into the December 2019 timetable on Phase 1 infrastructure

Note: The headcodes have been included to better identify the different services created for this study

It has also been necessary to move one EWR service to the Up Carriage Sidings (UCS) on arrival to Oxford, with the 8:14:00 arrival into Oxford (2U04JB) shunting there from Platform 1 and then departing Oxford (8:29:00) from Platform 2 – assuming this move is feasible within a 15-minute turnaround time. There are no rules in the Timetable Planning Rules about this, but its feasibility is assumed on a five-minute turnaround on arrival in Oxford, two minutes to move in each direction to and from the UCS and then three minutes each in the UCS and on the train's return to Oxford.

As well as amending the timings of certain EWR trains, some minor flexing of other services is needed to accommodate five of the nine Down EWR trains and five of the seven Up (to Oxford) services.

Amendments have been made to the timings of seven passenger services, 14 freight trains and eight empty coaching stock (ECS), as *Table 2* shows:

Train operating companies (TOCs)	Down Oxford EWR services	Up Oxford EWR services
Great Western Trains	1	
Cross Country	1	2
Chiltern	1	2
Freight operating companies (FOCs)	Down Oxford EWR services	Up Oxford EWR services
Freightliner	4	7
DB Schenker		2
GB Railfreight		1
ECS	Down Oxford EWR services	Up Oxford EWR services
ECS	6	2
Total amendments	13	16

Table 2: The number of services needing to be flexed in order to accommodate two EWR trains per hour into the December 2019 timetable at Oxford on Phase 1 infrastructure, and the various train operating companies (TOCs) and freight operating companies (FOCs) affected

C.02 Part 1.2

C.02.01 Aim

To add four additional freight services (timing loads 75/C/66/1400) per hour passing through Oxford between 6am and 10am.

These will be in addition to the two East-West Rail (EWR) services per hour at Oxford incorporated into the December 2019 timetable on Phase 1 infrastructure.

One freight service in each direction on the Didcot-Chester Line (GW200, then MD401) and one in each direction on the EWR line (GW277), validated as far as Didcot, Banbury and Oxford Parkway.

C.02.02 Findings

No times were specified for the new freight services, so the study therefore started by identifying any spare slots during the time period.

Freight services incur greater headway margins and increased junction margins due to slower crossing speeds, as these tables show:

Line	Stretch	Normal headway	If following freight
DCL	Didcot to Wolvercote Junction	3 minutes	4 minutes
EWR	Oxford North Junction to Bicester Gavray Junction	4 minutes	5 minutes

Table 3: Increased headway values incurred if following a freight service compared to standard timings

STANDARD VALUES - MINIMUM														
First Train	Transit speed													
Length	5	10	15	20	25	30	40	60	70	75	90	100	110	125
Single Loco	4	3½	3	3	2½	2½	2½	2½	2½	2½				
2 Car	4½	3½	3	3	3	2½	2½	2½	2½	2½	2½			
3 Car	4½	3½	3	3	3	2½	2½	2½	2½	2½	2½			
4 Car	5	3½	3	3	3	2½	2½	2½	2½	2½	2½	2½	2½	2½
5/6 Car (Castle)	5	3½	3½	3	3	3	2½	2½	2½	2½	2½	2½	2½	2½
8/9 Car / D245	5½	4	3½	3	3	3	2½	2½	2½	2½	2½	2½	2½	2½
10 Car, / HST8	5½	4	3½	3	3	3	2½	2½	2½	2½	2½	2½	2½	2½
Freights														
Up to 40 SLUs	6	4½	3½	3½	3	3	3	2½	2½	2½	2½			
Up to 50 SLUs	6½	4½	4	3½	3	3	3	2½	2½	2½	2½			
Up to 60 SLUs	7	5	4	3½	3½	3	3	2½	2½	2½	2½			
Up to 80 SLUs	8½	5½	4½	4	3½	3½	3	3	3	2½	2½			
Up to 103 SLUs	9½	6	4½	4	4	3½	3	3	3	3	2½			
Times shown are for the second movement														

Table 3.1: Great Western junction margins showing slower crossing speeds for freight

Trying to fit them into the timetable was also impacted by heavy occupancy on the Up Oxford Main Line and Up Oxford Relief Line into Oxford and a significant number of movements at Oxford North restricting the ability to path extra services through there – especially with the additional allowances which need to be accommodated for freight services crossing the junction.

That meant it was only possible to fit two Down (from Oxford) and One Up (to Oxford) services into the whole of the four-hour period:

	SRT			Line	Allowances		SRT			Line	Allowances
Didcot North Junction		Arrive		DML		Didcot North Junction		Arrive		DML	
		Depart	06:00:00		{½}			Depart	07:42:30		{½}
Kennington Junction	00:09:30	Arrive		DML		Kennington Junction	00:09:30	Arrive		DML	
		Depart	06:10:00					Depart	07:52:30		
Oxford	00:02:00	Arrive		DML		Hinksey	00:04:00	Arrive	07:56:30	DKGL	
		Depart	06:12:00					Depart	08:11:00		
Wolvercote Junction	00:03:00	Arrive		DML		Oxford	00:04:00	Arrive		DML	
		Depart	06:15:00					Depart	08:15:00		
Heyford	00:09:00	Arrive		DCV		Oxford North Junction	00:02:00	Arrive		UO to UOR	{1½}
		Depart	06:24:00					Depart	08:18:30		
Aynho Junction	00:06:00	Arrive		DCV		Woodstock Road Junction	00:01:30	Arrive		DB	{½}
		Depart	06:30:00					Depart	08:20:30		
Banbury Depot Junction	00:04:30	Arrive		DCV		Oxford Parkway	00:01:30	Arrive		DB	
		Depart	06:34:30					Depart	08:22:00		
Banbury	00:00:30	Arrive		2 Dn							
		Depart	06:35:00								
				Line	Allowances					Line	Allowances
Banbury		Arrive	Not possible			Oxford Parkway		Arrive		UB	
		Depart						Depart	06:52:00		
Aynho Junction	00:04:30	Arrive				Woodstock Road Junction	00:01:30	Arrive		DB to UML	
		Depart						Depart	06:53:30		
Heyford	00:05:30	Arrive				Oxford North Junction	00:01:30	Arrive		UML	{½}
		Depart						Depart	06:55:30		
Wolvercote Junction	00:08:00	Arrive				Oxford	00:02:30	Arrive		3 up	{1}
		Depart						Depart	06:59:00		
Oxford North Junction	00:02:00	Arrive				Kennington Junction	00:02:00	Arrive		UML	
		Depart						Depart	07:01:00		
Oxford	00:02:30	Arrive				Didcot North Junction	00:07:00	Arrive		Avoiding line	
		Depart						Depart	07:09:00		[1]
Kennington Junction	00:02:00	Arrive									
		Depart									
Didcot North Junction	00:07:00	Arrive									
		Depart									

Table 4: Timings of possible additional freight services passing through Oxford between 6am and 10am which can be accommodated into the December 2019 timetable on Phase 1 infrastructure

The problems of timetabling additional freight can be shown by the fact that while it appears there is an obvious window at Oxford at 7:25:00 in which to path an extra freight service to Didcot, that is not possible as the 7:21:00 departure from Platform 3 (2L15DB) is a stopping service. It means that high-speed service 1P02DA, while departing Oxford 11 minutes after the stopper, has made up five of those by Didcot North. With a minimum headway of four minutes following a stopper, it is impossible to schedule another service between these two.

While there is plenty of capacity on Platform 4 before the morning peak, as well as gaps between 7am and 8am, any available paths from Banbury and crossing Oxford North Junction from the Up Oxford Main Line to the Down Oxford Main Line do not match up with spare platforming opportunities.

It is important to note that the additional freight services have only been validated as far as the geographical boundaries of this study (Didcot Parkway, Banbury and Oxford Parkway), with no analysis or timetabling work carried out beyond these points.

C.03 Part 1.3

C.03.01 Aim

To incorporate four East-West Rail (EWR) services per hour at Oxford into the December 2019 timetable on Phase 1 infrastructure, plus four additional freight services per hour (timing loads 75/C/66/1400) passing through Oxford between 6am and 10am.

One freight service in each direction on the Didcot-Chester Line (GW200, then MD401) and one in each direction on the EWR line (GW277), validated as far as Didcot, Banbury and Oxford Parkway.

C.03.02 Findings

Having introduced two EWR services into the December 2019 timetable following the XX:27 / XX:57 departure pattern and XX:17 / XX:47 arrival pattern at Oxford, the ideal scenario would have been to timetable services at regular intervals between these times.

A regular departure pattern may be more feasible after the morning peak, when the Chiltern departures to London Marylebone from Oxford follow a fixed half-hourly pattern (XX:11 / XX:41, plus or minus a couple of minutes).

However, from 6am to 9am, Chiltern trains depart at: 6:00:00; 6:25:00; 6:43:00; 7:12:00; 7:43:00; 8:02:00; 8:22:00; 8:40:00 (then 9:10:00 and 9:38:00).

A number of these services have long turnaround times at Oxford, the longest being the 8:02:00 service which is at Platform 1 for 34 minutes following the arrival of the service which forms it at 7:28:00.

Chiltern and EWR services are primarily timetabled to arrive and depart Oxford on the Up Relief Line into Platforms 1 and 2. These bay platforms are designed as six-car length with permissive signalling (allowing two trains to use them at the same time). However, as many Chiltern services are diagrammed as four, five or six cars, if one train is in the platform, even if it only has three carriages, then it is considered fully occupied. This is in line with previous EWR timetabling studies.

Empty coaching stock (ECS) using the Up Relief increase the capacity on this line, and the scope for pathing additional EWR services is further impacted by a number of factors highlighted in *Figure 1.1*:

- ECS moving from the Down Carriage Sidings to Platform 3 (*red line*)
- Freight services coming from Oxford Parkway. These either use the Up Bletchley and Up Oxford Relief line (*green line*) or the Down Bletchley and new 75mph crossover to move onto the Up Oxford Main Line at Oxford North Junction (*orange line*). There are a total of three freight movements over the four-hour period via EWR
- Freight services using the Up Oxford Relief to move back onto the Up Oxford if they have been routed away from the Main Line and looped at Oxford North (*purple line*).

They could also cross back onto the Up Oxford Main Line via the previous (*orange*) crossover, removing the conflict with the Up Bletchley Line. This move is not shown on the graph, but would create a larger conflict with the (*blue*) Down Oxford Main Line moves

- Services departing or passing through Oxford on the Down Oxford Main Line having to cross the Up Oxford and Up Relief Line to depart Oxford North on the Down Bletchley Line – especially as the current crossover speeds are only 25mph (*blue line*). This increases the junction margin between services plus the journey times of services departing Platform 4 towards Oxford Parkway
- Empty paths on the Up Oxford and Up Oxford Relief Line not matching up with spare capacity on Platforms 1 and 2

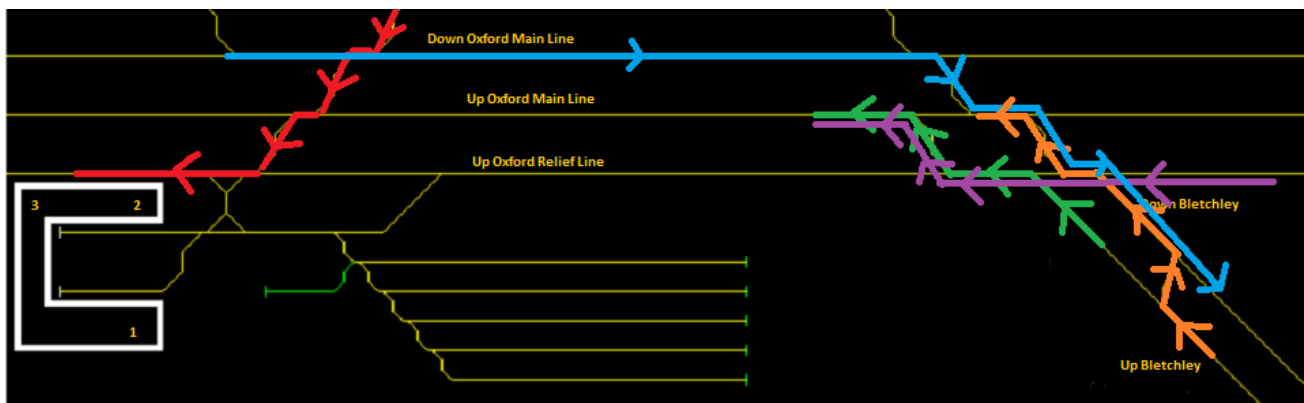


Figure 1.1: Different movements at Oxford North Junction

These occupancy graphs, by way of example, show occupancy on the Up Oxford Main Line at Oxford North between 7am and 9am.

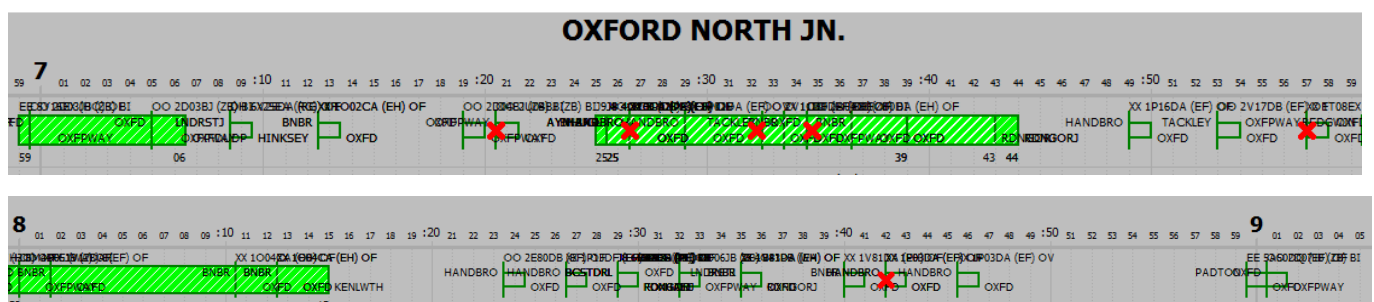


Figure 2: Occupancy on the Up Oxford Main Line at Oxford North Junction between 7am and 9am when two East-West Rail services have been added to the December 2019 timetable. The red crosses indicate services not formally offered in the December 2019 timetable (eg EWR trains) and the ones with green hatching are freight trains with a built-in dwell at the junction

Therefore, the approach was to try and fit additional EWR services into any available capacity. However, when factoring in platform re-occupancy rules (three-minute gap between services), there is only a six-minute window available on Platform 1 in the whole 8am to 9am hourly period and just 12 minutes on Platform 2:

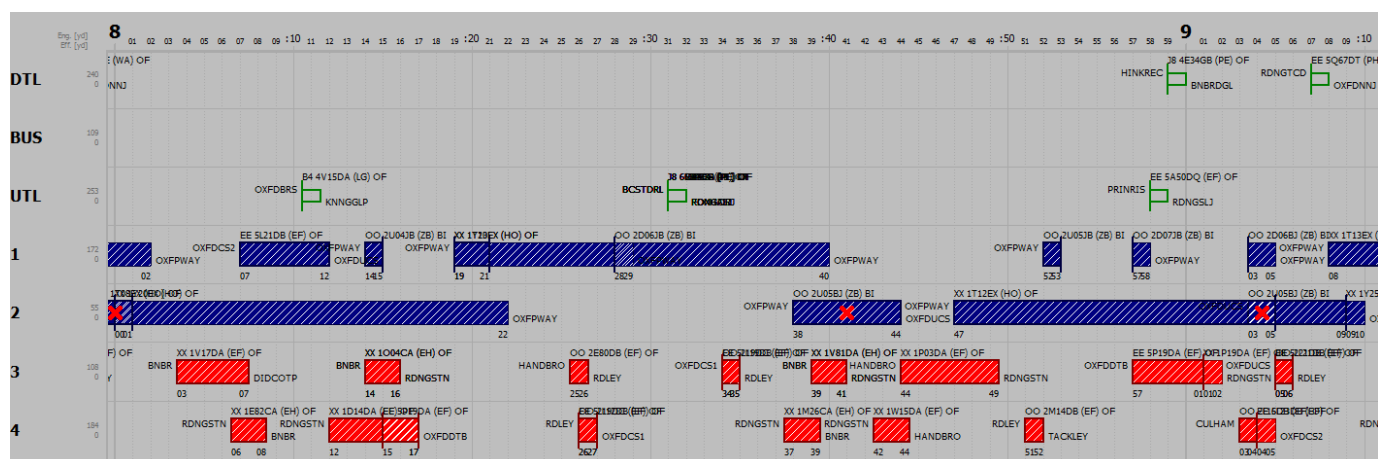


Figure 3: TPS extract showing platform occupancy at Oxford between 8am and 9am when two East-West Rail services have been added to the December 2019 timetable, plus services using through lines (freight and ECS). DTL = Down Through Line; UTL = Up Through Line; Bus = bus services

Table 5 shows the maximum number of EWR services which can be added to the December 2019 timetable at Oxford on Phase 1 infrastructure. They include the need for several ECS moves to either the Up Carriage Sidings across the mouth of Platforms 1 and 2 – or in one instance at Hinksey and then departing an EWR service from Platform 4. This move is usually just done by eight or nine-car Chiltern services in the peak which have to turn around there due to their length:

Departures from Oxford:

5am-6am				5:55:00	Chiltern
6am-7am	6:10:00	6:29:00	6:48:00	6:57:00	6:00:00 6:25:00 6:43:00
7am-8am	7:02:00	7:15:00	7:30:00	7:57:00	7:12:00 7:43:00
8am-9am		8:29:00		8:58:00	8:02:00 8:22:00 8:40:00
9am-10am	9:05:00	9:27:00	9:47:00	9:58:00	9:10:00 9:38:00

Arrivals into Oxford:

6am-7am		6:21:00	6:47:00	6:56:00	Chiltern
7am-8am	7:05:00	7:17:00	7:23:00	7:52:00	7:28:00

8am-9am		8:14:00	8:38:00	8:52:00	<i>8:00:00 8:19:00 8:47:00</i>
9am-10am		9:20:00	9:24:00	9:53:00	<i>9:10:00 9:45:00</i>

Table 5: Timings of EWR trains which can be added to the December 2019 timetable at Oxford on Phase 1 infrastructure between 5.55am and 10am

Notes: - Times in bold are new EWR services added to the two EWR trains created in Part 1.1
 - Greyed-out cells indicates no additional services possible in this time period
 - Chiltern arrivals and departures from London Marylebone have been added in italics in the final column

The two paths previously identified on East-West Rail are through to Milton Keynes and known as Configuration State 1 (CS1). The additional services are new paths known as Configuration State 2 (CS2). These are trains that will ultimately end up in Cambridge.

Table 1 splits up the services according to the two different Configuration States:

Departures from Oxford:

	CS1		CS2	
5am-6am		5:55:00		
6am-7am	6:29:00	6:57:00	6:10:00	6:48:00
7am-8am	7:30:00	7:57:00	7:02:00	7:15:00
8am-9am	8:29:00	8:58:00	Not possible	Not possible
9am-10am	9:27:00	9:58:00	9:05:00	9:47:00

Arrivals into Oxford:

	CS1		CS2	
6am-7am	6:21:00	6:47:00	Not possible	6:56:00
7am-8am	7:17:00	7:23:00	7:05:00	7:52:00
8am-9am	8:14:00	8:38:00	Not possible	8:52:00
9am-10am	9:20:00	9:24:00	Not possible	9:53:00

Table 1: Timings of EWR trains which can be added to the December 2019 timetable at Oxford on Phase 1 infrastructure between 5.55am and 10am split up into Configuration States 1 and 2

Note: Times in bold are new EWR services added to the two EWR trains already included in the December 2019 timetable during Part 1.1

As can be seen, even when it is possible to fit four services into a one-hour period, the gaps between trains do not neatly follow a 15-minute pattern, as *Table 2* shows:

Departures from Oxford:

5am-6am					N/A
6am-7am	15:00	19:00	19:00		09:00
7am-8am	05:00	13:00	15:00		27:00
8am-9am		32:00			29:00
9am-10am	07:00	22:00	20:00		11:00

Arrivals into Oxford:

6am-7am		N/A	26:00	09:00
7am-8am	09:00	12:00	06:00	29:00
8am-9am		22:00	24:00	14:00
9am-10am		28:00	04:00	29:00

Table 2: Gaps between one EWR service and the next in minutes which can be added to the December 2019 timetable at Oxford on Phase 1 infrastructure between 5.55am and 10am

Note: Times in bold are new EWR services added to the two EWR trains already included in the December 2019 timetable during Part 1.1

After timetabling these services, it was still possible to fit in two Down (from Oxford) freight trains over the whole of the four-hour period:

- Via the Didcot-Chester Line (to Banbury), departing Oxford at 6:12:00
- Via EWR (to Oxford Parkway), departing Oxford at 8:15:00

However, the previously identified path for the one possible Up (to Oxford) freight service (departing Oxford to Didcot at 6:59:00) was no longer feasible as it was instead taken up by an EWR service.

C.04 Part 2.1

C.04.01 Aim

To accommodate two East-West Rail (EWR) departures and arrivals into Oxford per hour in the December 2019 timetable between 6am and 10am using Phase 2 infrastructure.

C.04.02 Findings

As with Part 1 (Phase 1 infrastructure), it was possible to create a concept train plan (CTP) including two EWR services per hour at Oxford using Phase 2 infrastructure.

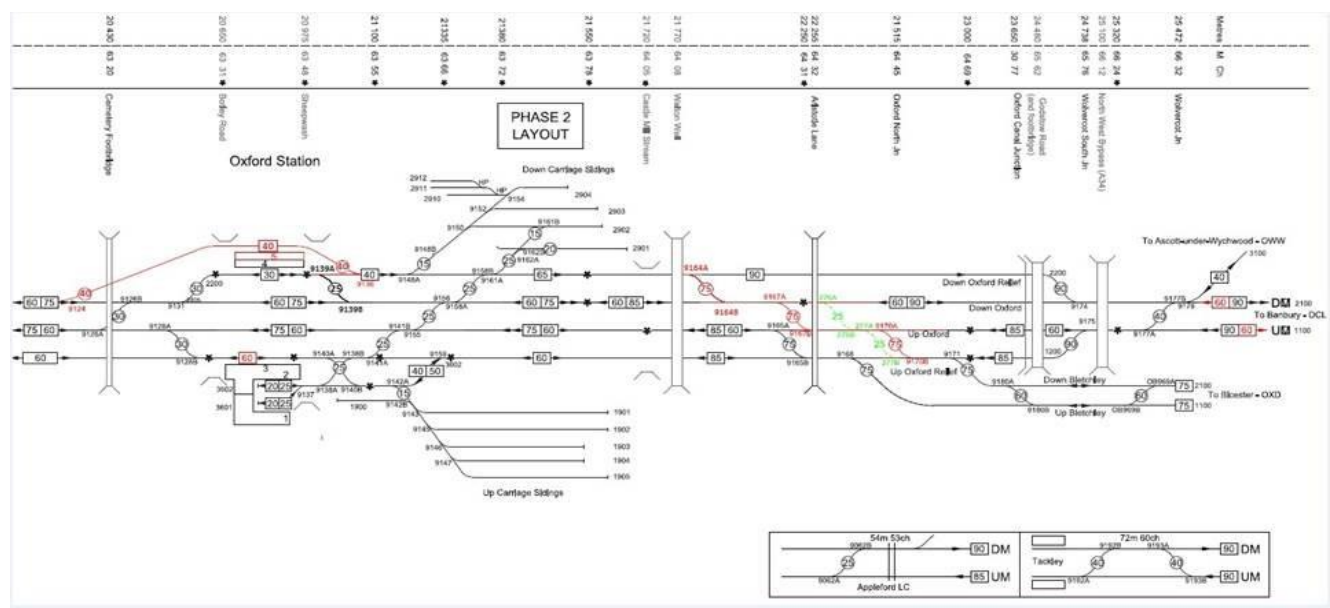


Figure 4: Phase 2 infrastructure at Oxford, including Platform 5 and 75mph crossovers at Oxford North (for larger version, see page 9)

The addition of Platform 5, as well as using Platform 4 by trains departing towards the South as well as North and East (eliminating ladder moves across all lines from the Down Carriage Sidings to Platform 3), meant that only four EWR services needed to be re-timed. That is against six base times needing to be amended during *Part 1.1*.

One Down (from Oxford) EWR service and three Up (to Oxford) EWR services had to be amended to resolve conflicts and headway issues, as *Table 3* shows:

Down trains			
Service	Original departure time	Amended departure	Difference (minutes)
2D01JB	5:57:00	5:55:00	-2

Up trains			
Service	Original arrival time	Amended arrival	Difference (minutes)
2U05JB	8:46:00	8:52:00	+6
2U06JB**	9:19:00	9:18:00	-1
2U07JB	9:46:00	9:52:00	+6

**30 seconds earlier than timetabled pattern arriving into Oxford Parkway

Table 3: EWR services created from analysis using the May 2019 timetable which would need to be retimed to fit into the December 2019 timetable on Phase 2 infrastructure

Two changes are the same as Part 1 (2D01JB and 2U05JB), while Phase 2 infrastructure means that 2U06JB can arrive into Oxford a minute earlier than its base time, rather than a minute later (on Phase 1 infrastructure). That is the same for 2U07JB, which only needs to have six minutes of pathing included into its journey time rather than seven, meaning the service that it forms (2D09JB) can still leave on its timetabled pattern.

As with Part 1, it was also necessary to move one EWR service to the Up Carriage Sidings, with 2U04JB (8:14:00 arrival into Oxford) shunting there from Platform 1 and then departing Oxford (8:29:00) from Platform 2.

Some minor flexing and re-platforming of other services is needed to accommodate five of the nine Down (from Oxford) EWR trains and also five of the seven Up (to Oxford) services, as *Table 4* shows:

Train operating companies	Down Oxford EWR services	Up Oxford EWR services
Chiltern	1	2
Freight operating companies	Down Oxford EWR services	Up Oxford EWR services
Freightliner	3	7
ECS	Down Oxford EWR services	Up Oxford EWR services
ECS	6	2
Total amendments	10	11

Table 4: The number of services needing to be flexed in order to accommodate two EWR trains per hour into the December 2019 timetable at Oxford on Phase 2 infrastructure, and the various train operating companies (TOCs) and freight operating companies (FOCs) affected

C.05 Part 2.2

C.05.01 Aim

This part initially looked at timetabling four additional freight services (timing loads 75/C/66/1400) passing through Oxford between 6am and 10am.

These were in addition to the two East-West Rail (EWR) services per hour already incorporated into the December 2019 timetable on Phase 2 infrastructure.

One freight service in each direction on the Didcot-Chester Line (GW200, then MD401) and one in each direction on the EWR line (GW277), validated as far as Didcot, Banbury and Oxford Parkway.

C.05.02 Findings

This analysis looked to accommodate:

- 1) Up (to Didcot) via EWR
- 2) Down (to Oxford Parkway) via EWR
- 3) Up (to Didcot) via DCL
- 4) Down (to Banbury) via DCL

Before doing so, though, efforts were made to use Phase 2 infrastructure to increase the number of available paths during the time period. This included:

- Eliminating ladder moves across all lines from the Down Carriage Sidings to Platform 3 by instead starting Up passenger services from Platform 4. This means any empty coaching stock (ECS) are purely up the Down Oxford Relief Line
- Re-platforming some other stopping up services from Platform 3 to Platform 4. This opens up additional capacity on the heavily used Up Oxford Main Line
- Re-routing Down ECS from Kennington Junction to the Down Carriage Sidings via Platform 4, opening up additional paths on the Down Oxford Main Line
- Re-platforming terminating and stopping Down services from Platform 4 to Platform 5 to open up this additional capacity. All eight terminating services over the four-hour period then go through to the Down Carriage Sidings

Of these eight terminating services moved to Platform 5 for the purposes of this study, three could feasibly turn around in Platform 4, were they to terminate there, before returning to Didcot. This would eliminate ECS to the Down Carriage Sidings and extra unit diagrams.

However, the other five remain in Oxford for a significant amount of time (the longest is 1h13mins) before forming an Up service, so need to move to the Down Carriage Sidings to avoid blocking a platform.

To create additional freight paths, 34 passenger services and ECS were re-platformed while two freight services (6X25EA and 6V25DA) had their times flexed slightly by adding dwell time at Oxford North Junction before moving to Hinksey Sidings.

Unlike *Part 1.2*, where it was only possible to plan three freight services into the timetable, the additional infrastructure options offered by Phase 2 meant it is possible to plan four freight trains into the timetable:

	SRT		4D01JB	Line	Allowances			SRT		4D02JB	Line	Allowances
Didcot North Junction		Arrive		DO			Didcot North Junction		Arrive		DO	
		Depart	08:05:00						Depart	05:58:00		
Kennington Junction	00:09:30	Arrive		DO			Kennington Junction	00:09:30	Arrive		DO	
		Depart	08:15:00		{½}				Depart	06:08:00		{½}
Oxford	00:02:00	Arrive		DO			Oxford	00:02:00	Arrive		DO	
		Depart	08:17:00						Depart	06:10:00		
Wolvercote Junction	00:03:00	Arrive		DO			Oxford North Junction	00:02:00	Arrive		UO to UOR	
		Depart	08:20:00						Depart	06:14:00		(2)
Heyford	00:09:00	Arrive		DCV			Woodstock Road Junction	00:01:30	Arrive		DB	
		Depart	08:29:00						Depart	06:15:30		
Aynho Junction	00:06:00	Arrive		DCV			Oxford Parkway	00:01:30	Arrive		DB	
		Depart	08:35:00						Depart	06:17:00		
Banbury Depot Junction	00:04:30	Arrive		DCV								
		Depart	08:39:30									
Banbury	00:00:30	Arrive		2 Dn								
		Depart	08:40:00									
			4U01JB	Line	Allowances					4U02JB	Line	Allowances
Banbury		Arrive		UCV			Oxford Parkway		Arrive		UB	
		Depart	08:43:00						Depart	07:04:00		
Aynho Junction	00:04:30	Arrive		UCV			Woodstock Road Junction	00:01:30	Arrive		Up main	
		Depart	08:47:30						Depart	07:05:30		
Heyford	00:05:30	Arrive		UCV			Oxford North Junction	00:01:30	Arrive		UOR	{½}
		Depart	08:53:00						Depart	07:07:30		
Wolvercote Junction	00:08:00	Arrive		UO			Oxford	00:02:30	Arrive		3 up	{1}
		Depart	09:01:00						Depart	07:11:00		
Oxford North Junction	00:02:00	Arrive		UO			Kennington Junction	00:02:00	Arrive		Up main	
		Depart	09:03:00						Depart	07:13:00		
Oxford	00:02:30	Arrive		UO			Didcot North Junction	00:07:00	Arrive		Avoiding line	
		Depart	09:05:30						Depart	07:21:00		[1]
Kennington Junction	00:02:00	Arrive		UO								
		Depart	09:07:30									
Didcot North Junction	00:07:00	Arrive		UO	[1]							
		Depart	09:15:30									

Table 5: Additional freight services timed through Oxford between 6am and 10am which can be included in the December 2019 timetable at Oxford on Phase 2 infrastructure

The re-platforming of passenger services and the options opened up by Phase 2 meant there were additional Down freight paths which could also have been chosen.

C.06 Part 2.3

C.06.01 Aim

To create a concept train plan (CTP) fitting four East-West Rail (EWR) services per hour plus the four additional freight services (two via DCL, two via EWR) into the December 2019 timetable at Oxford between 6am and 10am using Phase 2 infrastructure.

C.06.02 Findings

Building on the work done in *Part 2.2* to increase the number of available paths on the crowded Up Oxford and Up Oxford Relief Lines, some further re-platforming and re-routing of other services and ECS as well as five services / ECS needing to be re-timed marginally.

Where possible, additional EWR services have been routed in and out of Oxford via the Up Oxford Relief Line to Platforms 1 and 2.

However, two arrive and depart from Platform 3, which was now possible thanks to other Up services heading towards Didcot being re-platformed to Platform 4.

Figure 5 and *Figure 6* show platform occupancy at Oxford between 7am and 9am with the additional EWR services added. By making more use of Platforms 4 and 5, there is still capacity on Platform 3:

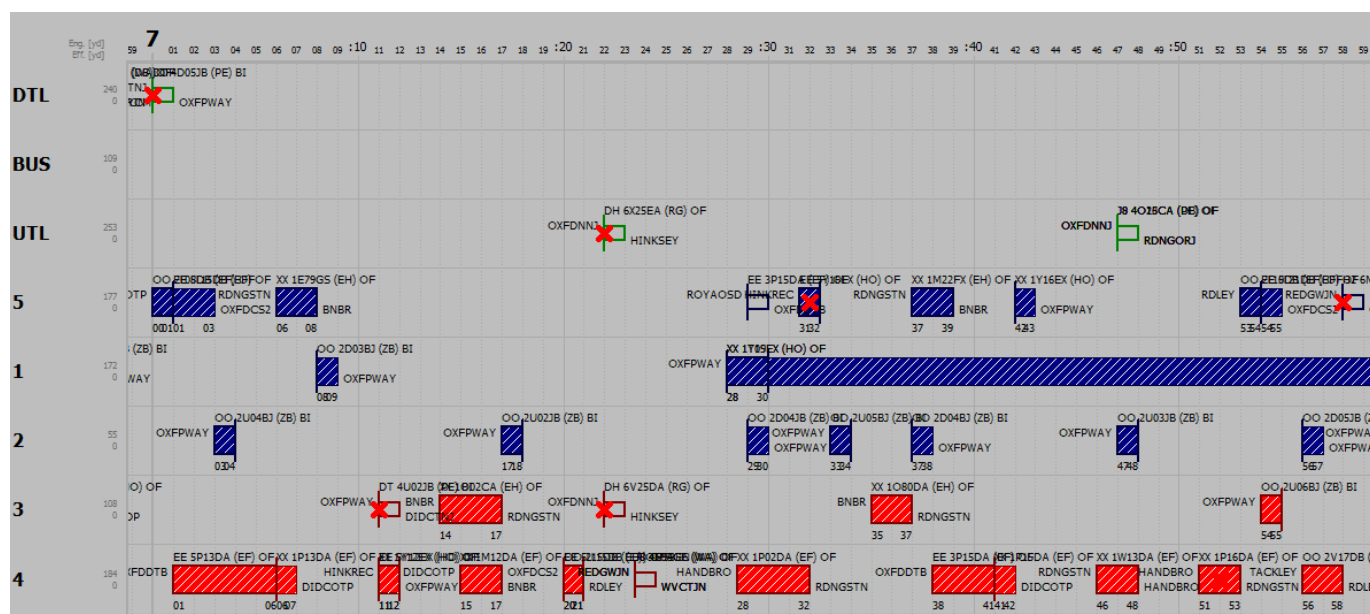


Figure 5: TPS extract showing platform occupancy at Oxford between 7am and 8am when two EWR trains per hour plus additional freight has been added to the December 2019 timetable using Phase 2 infrastructure. DTL = Down Through Line; UTL = Up Through Line; Bus = bus services

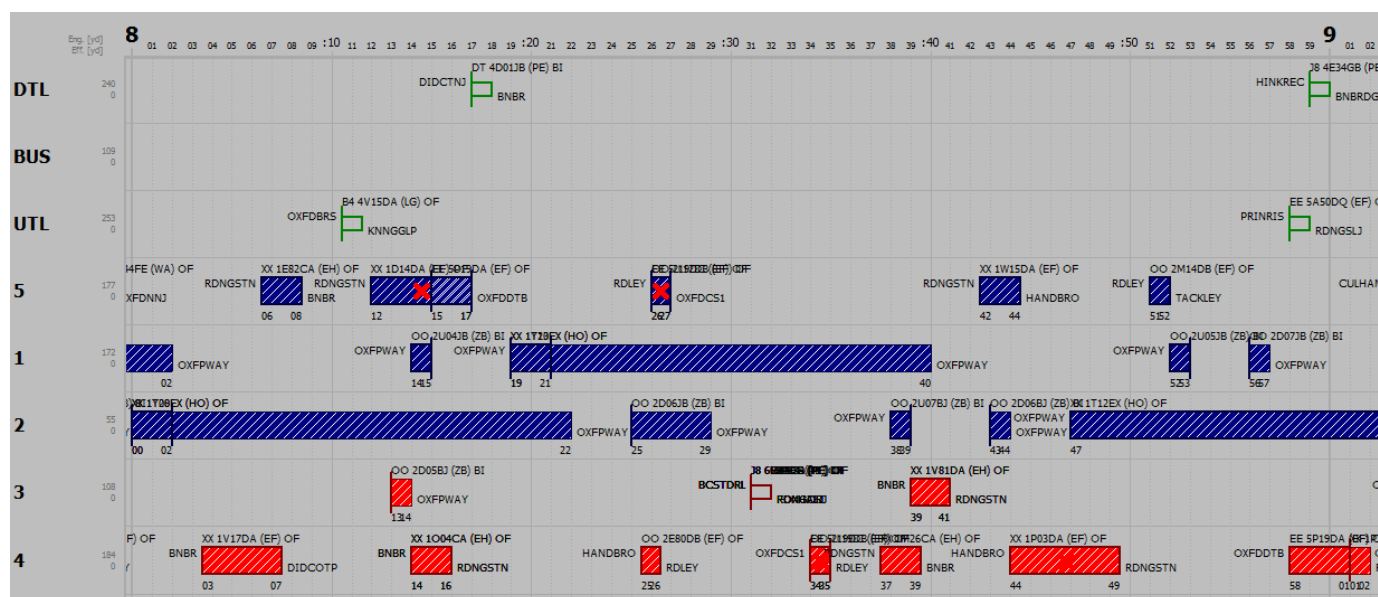


Figure 6: TPS extract showing platform occupancy at Oxford between 8am and 9am when two EWR trains per hour plus additional freight has been added to the December 2019 timetable using Phase 2 infrastructure. DTL = Down Through Line; UTL = Up Through Line; Bus = bus services

Using all available capacity while ensuring that services comply to all Timetable Planning Rules (TPRs) *Table 6* shows that the following EWR trains are possible:

Departures from Oxford:

5am-6am				5:55:00	Chiltern
6am-7am	6:16:00	6:29:00	6:48:00	6:57:00	6:00:00 6:25:00 6:43:00
7am-8am	7:09:00	7:30:00	7:38:00	7:57:00	7:12:00 7:43:00
8am-9am	8:14:00	8:29:00	8:44:00	8:57:00	8:02:00 8:22:00 8:40:00
9am-10am	9:13:00	9:27:00	9:41:00	9:57:00	9:10:00 9:38:00

Arrivals into Oxford:

6am-7am	6:08:00	6:24:00	6:37:00	6:47:00	Chiltern
7am-8am	7:03:00	7:17:00	7:33:00	7:47:00	7:28:00
8am-9am	7:54:00	8:14:00	8:38:00	8:52:00	8:00:00 8:19:00 8:47:00
9am-10am	9:05:00	9:18:00	9:35:00	9:52:00	9:10:00 9:45:00

Table 6: Timings of four EWR trains added to the December 2019 timetable at Oxford on Phase 2 infrastructure between 6am and 10am

Note: Times in bold are additional services added to the two EWR trains already created in Part 2.1

The two paths previously identified on East-West Rail are through to Milton Keynes and known as Configuration State 1. The additional services are new paths known as Configuration State 2. These are trains that will ultimately end up in Cambridge. *Table 11* shows the pattern of these trains:

Departures from Oxford:

	CS1		CS2	
5am-6am		5:55:00		
6am-7am	6:29:00	6:57:00	6:16:00	6:48:00
7am-8am	7:30:00	7:57:00	7:09:00	7:38:00
8am-9am	8:29:00	8:57:00	8:14:00	8:44:00
9am-10am	9:27:00	9:57:00	9:13:00	9:41:00

Arrivals into Oxford:

	CS1		CS2	
6am-7am	6:24:00	6:47:00	6:08:00	6:37:00
7am-8am	7:17:00	7:47:00	7:03:00	7:33:00
8am-9am	8:14:00	8:52:00	7:54:00	8:38:00
9am-10am	9:18:00	9:52:00	9:05:00	9:35:00

Table 7: Timings of four EWR trains added to the December 2019 timetable at Oxford on Phase 2 infrastructure between 6am and 10am split into Configuration State 1 (Milton Keynes) and Configuration State 2 (Cambridge)

Note: Times in bold are additional services added to the two EWR trains already created in Part 2.1

Working on a XX:12 / XX:27 / XX:42 / XX:57 departure and XX:02 / XX:17 / XX:32 / XX:47 arrival pattern, the most an EWR service is off pattern is by seven minutes later for an arrival and eight minutes earlier for a departure:

Departures from Oxford:

5am-6am				-2
6am-7am	+4	+2	+6	0
7am-8am	+7	+3	-4	0
8am-9am	+2	+2	+2	0
9am-10am	+1	0	-1	0

Arrivals into Oxford:

6am-7am	+6	+7	+5	0
7am-8am	+1	0	+1	0
8am-9am	-8	-3	+6	+5
9am-10am	+3	+1	+3	+5

Table 8: Gaps between one service and the next in minutes when adding four EWR trains per hour to the December 2019 timetable at Oxford on Phase 2 infrastructure between 5.55am and 10am

To accommodate the additional services, two timetabled EWR trains need to be re-routed to either depart or arrive into Oxford on the Up Oxford Main Line, while one (2D07JB) has to be re-timed to depart 30 seconds earlier (8:59:30 instead of 9:00:00).

A total of 15 other services need to be re-routed, re-platformed or re-timed to accommodate the additional EWR trains. Only five of these need to be flexed (times altered), shown below in *Table 9*:

Train operating companies	Down Oxford EWR services	Up Oxford EWR services
Chiltern	1	2
Freight operating companies	Down Oxford EWR services	Up Oxford EWR services
GB Railfreight		1
Empty coaching stock	Down Oxford EWR services	Up Oxford EWR services
	1	

Total amendments	2	3
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Table 9: The number of services needing to be flexed in order to accommodate four EWR trains per hour into the December 2019 timetable at Oxford on Phase 2 infrastructure, and the various train operating companies (TOCs) and freight operating companies (FOCs) affected

Of the services which need re-routing, one is the Up freight train created via EWR which needs to pass through Oxford via the Up Oxford Relief Line and Platform 3 rather than moving to the Up Oxford at Oxford North. This adds a minute to its journey time, as services can run faster on the Main Lines than platform lines.

Across *Parts 2.1-2.3*, as well as having to re-route and re-platform 64 passenger and freight trains and ECS, a total of 26 services needed to be flexed to fit in the four EWR services per hour and additional freight trains, as *Table 10* shows:

Train operating companies	Down Oxford EWR services	Up Oxford EWR services
Chiltern	2	4
Freight operating companies	Down Oxford EWR services	Up Oxford EWR services
Freightliner	3	7
GB Railfreight		1
Empty coaching stock	Down Oxford EWR services	Up Oxford EWR services
	7	2
Total amendments	12	14

Table 10: The total number of services needing to be flexed in order to accommodate four EWR trains per hour plus four additional freight services between 6am and 10am into the December 2019 timetable at Oxford on Phase 2 infrastructure, and the various train operating companies (TOCs) and freight operating companies (FOCs) affected

Although it is possible to accommodate the 33 EWR services into the December 2019 timetable, almost three-quarters of them (25) have at least one minimum margin with another service. This could be platform re-occupancy, headway or a junction margin.

Having to timetable some EWR services onto the Main Lines, rather than keeping them purely on the Up Oxford Relief Line in and out of Oxford also increases the risk of spreading delay to other trains in the event of any late running.

So, while the CTP is compliant, there is performance risk. *Part D:* and *Part F.01* expand on the implications of timetabling trains with minimum margins.

C.07 Part 2.4

C.07.01 Aim

Having accommodated four East-West Rail (EWR) services per hour into the December 2019 timetable at Oxford on Phase 2 infrastructure, look at the connectional opportunities offered by these to Cowley (two per hour).

C.07.02 Background

This was a very high-level study, as no station currently exists at Cowley, with the line (GW260) used purely by freight trains to and from the Morris Cowley plant.

It is a single track from close to Kennington Junction, with trains to Cowley joining the Up Kennington Goods Line at Hinksey South, and Down trains either returning to Oxford Down the Up Oxford Main Line before moving onto the Up Oxford Relief Line towards Platform 3 at Hinksey North, or having to cross the Up Oxford Main Line to reach the Down Oxford Main Line.

Trains using the Down Oxford can then use Platform 4. If there is no space and they have to depart Platform 3, they will then need to cross the Up Oxford to reach the Up Oxford Relief Line at Hinksey North. There are therefore several potential conflict points with services already timetabled into and out of Oxford.

C.07.03 Platforming

Were EWR services to continue to Cowley, they would ideally need to be able to arrive into Oxford via Platform 3. They would then depart Oxford towards EWR from either Platform 3 or Platform 4.

With only two of the 16 EWR arrivals (7:54:00 and 9:05:00) arriving into Platform 3, with the services they form (8:14:00 and 9:13:00 departures) leaving from the same platform, some re-platforming of services was necessary.

C.07.04 Timings:

Indicative running times (IRTs) for any connections are based on these assumptions:

- The station locations on the Cowley branch are at THA 17m10c for Oxford Science Park (3m54c from Oxford station) and THA 16m30c for Oxford Business Park (4m34c from Oxford)
- No other changes to infrastructure, apart from assuming that trains can run at 50mph from Kennington Junction to Cowley, with 50mph turnout and crossovers
- Timing loads remain the same as previous analysis (rolling stock that performs as well as a three-car Class 185 using two of the three engines)
- Times have been rounded up to the nearest half or full minute

From	To	Timing point location calling pattern (minutes)			
		Pass/Pass	Pass/Stop	Stop/Pass	Stop/Stop
Oxford	Kennington Junction	–	–	3.00	–
Kennington Junction	Oxford Science Park	–	2.00	–	–
Oxford Science Park	Oxford Business Park	–	3.00	–	–
Oxford Business Park	Oxford Science Park	–	3.00	–	–
Oxford Science Park	Kennington Junction	–	–	2.00	–
Kennington Junction	Oxford	–	3.00	–	–

Table 11: Indicative running times (IRTs) for East-West Rail services running between Oxford and proposed stations on the Cowley branch line

C.07.05 Findings

Assuming one-minute dwells at Oxford Science Park, a five-minute turnaround time for services at Oxford Business Park and a three-minute junction margin at Kennington Junction, that means the line between Kennington Junction and Cowley is occupied for a minimum of 20 minutes once a train from Oxford enters that section of track.

Although no timetable planning rules have been created for this stretch, this study assumed that the signalling and other infrastructure were in place allowing a passenger service to follow a freight train terminating at Morris Cowley onto the line, as long as there was a five-minute headway.

There is a freight movement (4V40DB) arriving at the Morris Cowley plant at 6:41:00 (following a 41:30 dwell at Hinksey Reception Lines). Its timings were kept fixed for this study. Even if it were to be flexed and timings amended to reflect the 50mph crossovers and 50mph running speed on the branch line, the difficulty is finding paths across Kennington Junction, as discussed in more detail in *Part F.02*.

Assuming no flexing of the freight service, and the platform occupancy issues at Oxford, the earliest EWR arrival which could feasibly be extended to Cowley was the 7:17:00 (2U04BJ).

Extending this would mean that the service if forms (2D04JB, departing 7:30:00) would have to be formed from empty coaching stock (ECS).

While 2U04BJ could reach Cowley with few issues, the return journey highlighted the difficulties of pathing services back across Kennington Junction towards Oxford; the earliest EWR departure from Oxford it could form was the 7:57:00 – and that was on tight margins. By that time, three other EWR services would have arrived into Oxford – 7:33:00, 7:47:00 and 7:54:00.

There was no advantage trying to send services to Platform 4 rather than Platform 3, as spare capacity there does not match up with available paths. And while there were available paths Down the Up Oxford Main Line, they did not match up with platform vacancies at Oxford.

Accommodating the Cowley services into the timetable would therefore involve extended dwells in Oxford – both for these and other EWR trains.

Conflicts at Kennington Junction and also Hinksey North (if going to Platform 3) mean that any EWR service continuing to Cowley will instead have to form a much later departure (U1-D4, meaning either longer dwells for other EWR services at Oxford or at least one per hour needing to be shunted to the Up Carriage Sidings to avoid occupancy issues in the bay platforms (1 and 2)).

Therefore, while there are some opportunities for EWR trains arriving into Oxford to continue onto Cowley, it is impossible to produce a regular timetable offering EWR connections to Oxford Business Park and Oxford Science Park.

More information about the difficulties of pathing services across Kennington Junction is contained in *Part F.02*.

C.08 Part 2.5

C.08.01 Aim

Extending East-West Rail trains to Cowley to produce a more regular timetable at Oxford was not possible. This study therefore looked at whether it is feasible to extend the journeys of Chiltern services arriving into Oxford from London Marylebone (starting with one per hour) to Cowley. The aim was to reduce platform occupancy at Oxford and to see if regular connections were feasible.

C.08.02 Methodology

Between 6am and 10am, there are ten Chiltern departures to London Marylebone, as well as six arrivals from the capital:

Arrival	Platform	Forms	Departure	Platform	Turnaround (mins)
			6:00:00	1	
			6:25:00	2	
			6:43:00	4	
			7:12:00	4	
7:28:00	1		7:43:00	5	
8:00:00	2		8:02:00	1	34
8:19:00	1		8:22:00	2	22
8:47:00	2		8:40:00	1	21
9:10:00	1		9:08:00	2	21
9:45:00	2		9:38:00	1	28

Table 12: Arrival and departure times for Chiltern services between Oxford and London Marylebone from 6am and 10am. The table shows the departing service that arrivals form as well as the dwell time in Oxford

Extending service to Cowley would cut down on these long dwells – as long as there was scope to re-platform Chiltern trains from the bay platforms (1 and 2) to Platform 3 or 4.

Past analysis has produced the following indicative running times for Chiltern services being extended to Cowley. These are based on Class 168/1 and 172/2 passenger trains and 50mph running on the Cowley branch line:

Oxford	Arrive	XX:00
	Depart	XX:02
Kennington Junction	Depart	XX:05
Oxford Science Park	Arrive	XX:07
	Depart	XX:08
Oxford Business Park	Arrive	XX:11
	Depart	XX:18
Oxford Science Park	Arrive	XX:21
	Depart	XX:22
Kennington Junction	Depart	XX:24
Oxford	Arrive	XX:27
	Depart	XX:29

Table 13: Indicative running times (IRTs) for Chiltern services running between Oxford and proposed stations on the Cowley branch line

The assumptions, geographical locations for the stations and infrastructure were otherwise the same as the EWR study.

Outside the morning peak the average dwell time for a Chiltern service at Oxford is 32 minutes. Therefore, if there is capacity to cross the lines at Kennington Junction or return Down on the Up Oxford Main Line, then any service arriving into Oxford would theoretically have time to make the return trip to Cowley.

However, this would be not be possible during the morning peak due to shorter turnaround times.

C.08.03 Findings

It is possible to re-platform all six Chiltern services arriving into Oxford from London Marylebone between 7am and 10am to Platform 3. Where there is not already spare capacity, this can be done easily by re-platforming EWR services from Platform 3 to the bay platform (1 or 2) into which the Chiltern service was due to terminate.

Analysis of available margins shows the earliest time a Chiltern service extended to Cowley could return to Oxford when compared to the restriction-free IRT of 24 minutes after leaving Oxford. If routed via the Down Oxford, it requires crossing the Up Oxford Main Line; via the Up Oxford is just using the Main Line reversible, as *Table 14* shows:

Oxford arrival	No restrictions (+24 minutes)	Via Down Oxford	Difference (minutes)	Via Up Oxford	Difference (minutes)	Earliest departure
7:28:00	7:52:00	No paths		No paths		
8:00:00	8:24:00	8:25:00	+1	8:24:00	0	8:40:00
8:19:00	8:43:00	8:55:30	+12:30	8:46:00	+3	9:08:00
8:47:00	9:11:00	9:29:00	+18	9:12:00	+1	9:38:00
9:10:00	9:34:00	No paths		No paths		
9:45:00	10:09:00	10:11:00	+2	10:09:00	0	10:41:00

Table 14: This shows the ideal return time for Chiltern services extended from Oxford to Cowley, the first time a service could actually get back to Oxford via the Down Oxford and reversible down the Up Oxford, the difference between the two and the first London Marylebone departure from Oxford that an extended Chiltern service could then form

Highlighting how busy Kennington Junction is during this time, without flexing any services there is only one other spare path across the junction between 7.50am and 10am for any train trying to reach the Down Oxford Main Line from Cowley, and that is at 8:40:30.

Figure 6.1 shows the difficulties of finding paths across Kennington Junction during a one-hour period in the morning peak:

Kennington Junction occupancy, 8am to 9am

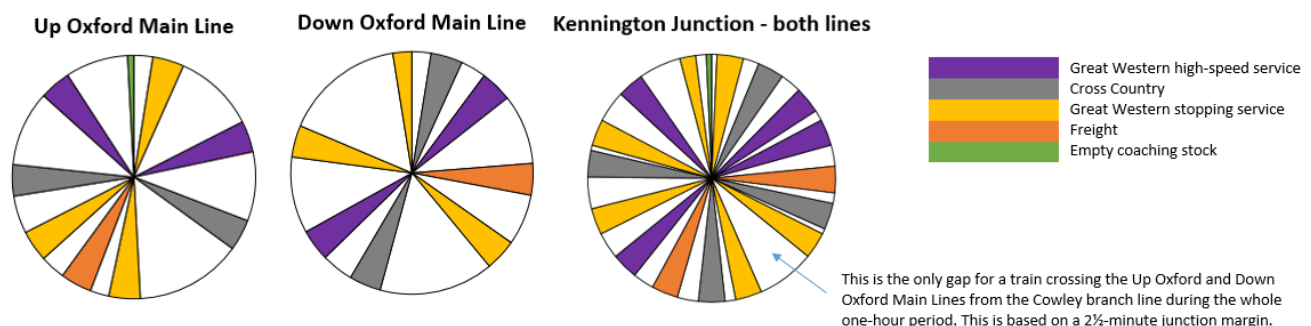


Figure 6.1: Occupancy on the Up and Down Main Lines at Kennington Junction from 8am to 9am

Using the Up Oxford reversible means that any service extended to Cowley can get back to Oxford more easily. However, available paths do not necessarily match up with platform vacancies. Although, for example, the extended 8:00:00 arrival can get back in time to form the 8:40:00 (as opposed to the 8:22:00), there is no way it could remain at a platform for 12-13 minutes to form this departure.

There is scope for services to dwell on the Cowley branch line to reduce waiting times in Oxford – but that is reliant on them then being able to find paths back into Oxford in time to form the relevant connection.

The only window at Platform 3 is 8:34:00 to 8:36:00 (and that does not marry up with paths on the Up Oxford and Up Oxford Relief); Platform 4 is only available from 8:29:00 to 8:30:30 and while Platform 5 is free from 8:30:00 to 8:39:00, there are no paths out of Oxford in that time via the Down Oxford Relief Line.

The results show that any Chiltern train extended to Cowley cannot form the next departure from Oxford – but the one after that at the earliest. And the above timings mean that returning Cowley services would still have long dwells in Oxford. For example, if the extended 8:47:00 could return at 9:15:00 via the Up Oxford then that would still be a 23-minute wait before departing at 9:38:00.

Furthermore, there are three departures (8:02:00, 8:22:00 and 10:10:00) where it would be impossible to send a train to Cowley and then form a departing service at Oxford.

Therefore, extending Chiltern services to Cowley does not appear a viable option.

C.09 Part 3.1

C.09.01 Aim

To look at whether extending East-West Rail (EWR) services to Didcot Parkway will help to improve platform occupancy issues at Oxford, as well as producing a more regular quarter-hourly departure pattern.

C.09.02 Assumptions

No sectional running times (SRTs) exist in BPlan for Class 185 or Class 195 services on this route, therefore indicative running times (IRTs) have been calculated. These are shown below in *Table 15*:

Trains from Oxford:

	Pass/Pass	Pass/Stop	Stop/Pass	Stop/Stop
Oxford				
Kennington Junction	-	-	3.00	-
Radley	-	3.00	-	-
Culham	-	-	-	3.30
Appleford	-	-	-	2.00
Didcot North Junction	-	-	2.00	-
Didcot Parkway	-	2.00	-	-

Trains to Oxford:

	Pass/Pass	Pass/Stop	Stop/Pass	Stop/Stop
Didcot Parkway				
Didcot North Junction	-	-	2.00	-
Appleford	-	1.30	-	-
Culham	-	-	-	2.00
Radley	-	-	-	3.30
Kennington Junction	-	-	3.00	-
Oxford	-	3.00	-	-

Table 15: Indicative running times (IRTs) calculated for EWR services extended from Oxford to Didcot Parkway. These have been rounded to the nearest 30 seconds

These timings are based on the following assumptions:

- Trains will follow the same pattern as current Class 165-1 services, with some/all dwells at Radley, Culham and Appleford or direct from Oxford to Didcot Parkway.
- Extending these EWR trains negates the need for these GWR services in the December 2019 timetable (eg four all-station services to Oxford between 6am and 10am, one through train, one with just a dwell at Culham and one with just a dwell at Radley). These were removed from the timetable for the purposes of his study
- Wales & Western 2020 Timetable Planning Rules apply (minimum turnaround time at Didcot Parkway is five minutes; three-minute headway from Didcot Parkway to Oxford, or four minutes following a stopping service)
- Current infrastructure and speed limits remain south of Oxford

C.09.03 Findings

To continue its journey to Didcot, any EWR train would need to arrive into Platform 3 rather than the bay platforms (1 and 2).

While it was possible to re-platform almost all of the EWR trains into Platform 3 at Oxford, extending their journeys to Didcot Parkway was not always feasible due to the number of other services timetabled to depart Oxford in the same direction.

The first Oxford-Didcot shuttle of the day departs at 6:04:00. There was no way of flexing the first EWR arrival of the day (6:08:00) so that it can take this path. Despite the minimal time difference, that is enough to prevent any onward EWR service from departing Oxford until 6:19:00 at the earliest because of freight (4O20CC) and ECS (5V82DQ) movements.

On the occasions where it was possible to timetable an EWR train through to Didcot, it could not get back to Oxford in time to form a departing service even vaguely close to the one it would have formed.

For example, the 6:37:00 EWR arrival into Oxford could be extended to Didcot Parkway by taking the path of the current 6:37:00 shuttle service. However, the earliest it could depart Didcot Parkway was at 7:33:00, taking the path of the first of the three Down all-stations services (to Oxford) removed from the timetable. As a result, the first Down EWR service it could form would be five departures after the one that it would have formed (7:57:00 rather than 6:48:00).

That return path was also the first one that the extended 6:08:00 service could have taken, with even trying to flex platform usage at Didcot Parkway having no impact.

Not all EWR services could be extended to Didcot as their arrival times into Oxford could not match up with the paths of the shuttle services that had been removed from the timetable.

The main issue for extending services through to Didcot Parkway or trying to find available Northbound paths is due to only having one line in each direction between Kennington Junction and Didcot North Junction.

It meant that even when there appeared to be an available path, this turned out not to be the case as stopping EWR services quickly lost headway compliancy with through trains behind them.

The lack of available Northbound paths was the main reason for not being able to produce a regular and compliant timetable between Didcot Parkway and Oxford.

Aside from the paths offered by removing shuttle services to Oxford (departing Didcot Parkway at 7:34:00, 8:07:00 and 8:34:00), the only other opportunities for EWR services which could be extended to Didcot Parkway were return paths departing at 9:13:00 and 9:46:00.

Coupled with these available paths not always matching up to spare capacity at Oxford, no benefit could be found to extending EWR services to Didcot. Instead, spare capacity could be explored for timetabling additional freight services.

C.10 Part 3.2

C.10.01 Aim

Identify spare capacity in the study period into which additional freight trains could be timetabled.

C.10.02 Methodology

This was a very high-level study to purely identify any opportunities rather than flexing or re-platforming other services.

C.10.03 Findings

There is no spare capacity for extra Up (to Oxford) freight trains via either EWR or the DCL.

When there are available paths through Oxford North Junction and Oxford station, any opportunities are then lost by freight services then coming into conflict with slower stopping services or being caught up and losing headway compliancy with faster through services.

However, there is scope to timetable five extra Down (from Oxford) freight trains without the need to flex any other services. These are shown below in *Table 16*:

	SRT		4D03JB	Line	Allowances	4D04JB	Line	Allowances			SRT		4D05JB	Line	Allowances	4D06JB	Line	Allowances	4D07JB	Line	Allowances
Didcot North Junction		Arrive		DO			DO				Didcot North Junction		Arrive	DO			DO			DO	
		Depart	05:46:00			09:45:00						Depart	06:48:00			08:32:00			09:19:00		
Kennington Junction	00:09:30	Arrive		DO			DO				Kennington Junction	00:09:30	Arrive	DO			DO			DO	
		Depart	05:56:00	{½}		09:55:00	{½}					Depart	06:58:00	{½}		08:43:00	{½}(1)		09:29:00	{½}	
Oxford	00:02:00	Arrive		DO			DO				Oxford	00:02:00	Arrive	DO			DO			DO	
		Depart	05:58:00			09:58:00	(1)					Depart	07:00:00			08:47:00	(2)		09:33:00	(2)	
Wolvercote Junction	00:03:00	Arrive		DO			DO				Oxford North Junction	00:02:00	Arrive	UO to UOR		UO to UOR			UO to UOR		
		Depart	06:02:00			10:02:30	(1½)					Depart	07:05:00	(3)		08:50:00	(1)		09:35:00		
Heyford	00:09:00	Arrive		DCV			DCV				Woodstock Road Juncti	00:01:30	Arrive	DB			DB			DB	
		Depart	06:13:00	(2)		10:13:00	(½)					Depart	07:06:30			08:53:30	(2)		09:36:30		
Aynho Junction	00:06:00	Arrive		DCV			DCV				Oxford Parkway	00:01:30	Arrive	DB			DB			DB	
		Depart	06:19:00			10:18:00						Depart	07:09:00			08:55:00			09:38:00		
Banbury Depot Junctio	00:04:30	Arrive		DCV			DCV														
		Depart	06:26:30	(3)		10:22:30															
Banbury	00:00:30	Arrive		2 Dn			2 Dn														
		Depart	06:27:00			10:23:00															

Table 16: Timings of additional freight services (4D03JB, 4D04JB, 4D05JB, 4D06JB and 4D07JB) which can be added to the December 2019 timetable at Oxford on Phase 2 infrastructure between 6am and 10am. These are in addition to the four EWR trains per hour created in Part 2 of this study

C.11 Part 3.3

C.11.01 Aim

Whether it is possible to plan an hourly Birmingham Moor Street-Oxford service into the December 2019 timetable at Oxford. This would be pathed immediately behind the existing CrossCountry services to and from Newcastle via Birmingham New Street.

C.11.02 Findings

The CrossCountry trains behind which this study was looking to path additional services are the 7:08:00, 8:08:30 and 9:14:30 departures from Oxford and the 7:37:00, 8:41:00 and 9:42:00 arrivals.

It was possible to timetable hourly services to and from Birmingham Moor Street (BMO) behind these, thanks to the reduced four-minute headways (rather than six – as shown by *Figure 6.2*) offered by Phase 2 between Wolvercote Junction and Heyford:

GW200 DIDCOT TO HEYFORD (EXCL.)			
TIMING POINT	DOWN	UP	NOTES
Didcot Parkway to Wolvercote Junction	3 4"	3 4"	" Following stopping passenger A 4-minute minimum headway shall be applied at Didcot North Junction following a Class 4, 6 or 7 service which is running to or from West Curve Junction
Wolvercote Junction to Heyford	6	6	

Figure 6.2: Headways between Wolvercote Junction and Heyford in the 2019 Timetable Planning Rules

Their sectional running times are based on existing Class 168 timings extracted from BPlan on 1 October 2019, as these are the same as the planned Class 170 trains for this route.

Seven passenger, ten freight and one empty coaching stock (ECS) needed to be flexed to accommodate them into the timetable, as *Table 17* shows:

Train operating companies	BMO-OXF services	OXF-BMO services
Chiltern	2	
CrossCountry	1	1
East-West Rail	2	
Great Western		1
Freight operating companies	BMO-OXF services	OXF-BMO services
Freightliner	8	1

STVA		1
Empty coaching stock	BMO-OXF services	OXF-BMO services
ECS		1
Total amendments	13	5

Table 17: The number of services needing to be flexed in order to add one Birmingham Moor Street to Oxford train in each direction between 7am and 10am into the December 2019 timetable at Oxford on Phase 2 infrastructure, and the train operating companies (TOCs) and freight operating companies (FOCs) affected

The timings of the Birmingham Moor Street services are:

Trains from Oxford:

	Oxford		Wolvercote Junction	Heyford	Aynho Junction	Banbury	
SRT			3:30	6:00	4:00	4:00	
Headcode	Arrive	Depart	Depart	Depart	Depart	Arrive	Depart
1D02JB	7:11:00	7:12:00	7:15:30	7:22:00	7:26:00	7:30:00	7:31:00
	Platform 5 DOR			{½}		Platform 2	
1D04JB	8:10:30	8:11:00	8:15:30	8:23:00	8:27:00	8:31:00	8:33:00
	Platform 4 DOR		(1)	(1) {½}		Platform 2	
1D06JB	9:24:00	9:25:00	9:28:30	9:34:00	9:38:00	9:43:00	9:44:00
	Platform 4 DOR					{½}){½} Platform 2	

Trains to Oxford:

	Banbury		Aynho Junction	Heyford	Wolvercote Junction	Oxford North Jn	Oxford	
SRT			4:30	4:00	6:00	1:30	1:30	
Headcode	Arrive	Depart	Depart	Depart	Depart	Depart	Arrive	Depart
1U02JB	7:20:00	7:21:00	7:25:30	7:32:30	7:38:00	7:40:00	7:41:30	7:43:00
				(3)		{½}	Platform 3 UML	
1U04JB	8:21:00	8:23:00	8:27:30	8:32:30	8:38:00	8:39:30	8:42:00	8:44:00
				(1)			{½} (½) UML P3	
1U06JB	9:22:00	9:23:00	9:28:00	9:32:30	9:39:00	9:40:30	9:42:00	9:46:00
			{½}	{½}	{½}		UML Platform 3	

Table 18: Timings of the additional services between Birmingham Moor Street and Oxford added to the December 2019 timetable on Phase 2 infrastructure. The timings have only been validated as far as Banbury and have not explored any connectional opportunities

These additional trains are only possible due to the four-minute headways offered by Phase 2 between Heyford and Wolvercote Junction, rather than the six minutes required between trains on this stretch on Phase 1 infrastructure. The existing 2020 Wales & Western Timetable Planning Rules have otherwise been used to plan these extra services.

In order to accommodate the additional services into the December 2019 timetable, all six have at least one minimum margin with other trains (headways, junction margins, platform re-occupancy) which would create additional performance risk.

The 08:11:00 departure from Oxford (1D04JB) is only possible by taking the path of a freight train created in *Part 2.2* of this study (4D01JB, which departs Oxford at 08:17:00).

All three Down services could both start from Oxford or there is the scope for them being through trains. If they were to start from Oxford then they would have to move to Platform 4 or 5 from Hinksey, as there is not sufficient capacity to move them from the Down Carriage Sidings to these platforms.

Moving from Hinksey would also mean just one driver change of end, rather than three if moving to the Down Carriage Sidings.

Part D: Conclusion

It was not possible to accommodate four East-West Rail (EWR) trains per hour into the December 2019 timetable at Oxford plus additional freight services without Phase 2 infrastructure and the benefits which it offers.

The main benefit is the extra Platform 5, which can be used for through and terminating services. This means Southbound departures which start in Oxford can do so from Platform 4, eliminating ladder moves across all lines from the Down Carriage Sidings to Platform 3, and freeing up capacity there.

The faster crossovers at Oxford North (75mph instead of 25mph) are also a benefit. With the turnout and crossover speeds significantly increased for services having to cross as many as three lines (if going from Platform 4 to EWR, for example) then this reduces junction margins and means that more services can be added to the timetable. These include the hourly Birmingham Moor Street to Oxford connections.

The faster crossovers are particularly significant if more freight services using the EWR route are going to be added to future timetables.

However, there is still the issue of arriving and departing services via EWR coming into conflict on the Up Oxford Relief Line at the junction. A proposed solution to this is in Figure 7, *below*:

While not the easiest option due to a swing bridge and housing in the line of the route, thought should be given to linking the Up Bletchley near Woodstock Road Junction and the spur leading to Platforms 1 and 2 – although this would mean losing some of the Up Carriage Sidings.

This would also require a separate crossover between the Up Bletchley and Down Bletchley closer to Oxford North.

This would then allow parallel moves between arriving and departing services via EWR as arrivals could be routed on the new line and departures via the Up Oxford Relief Line.

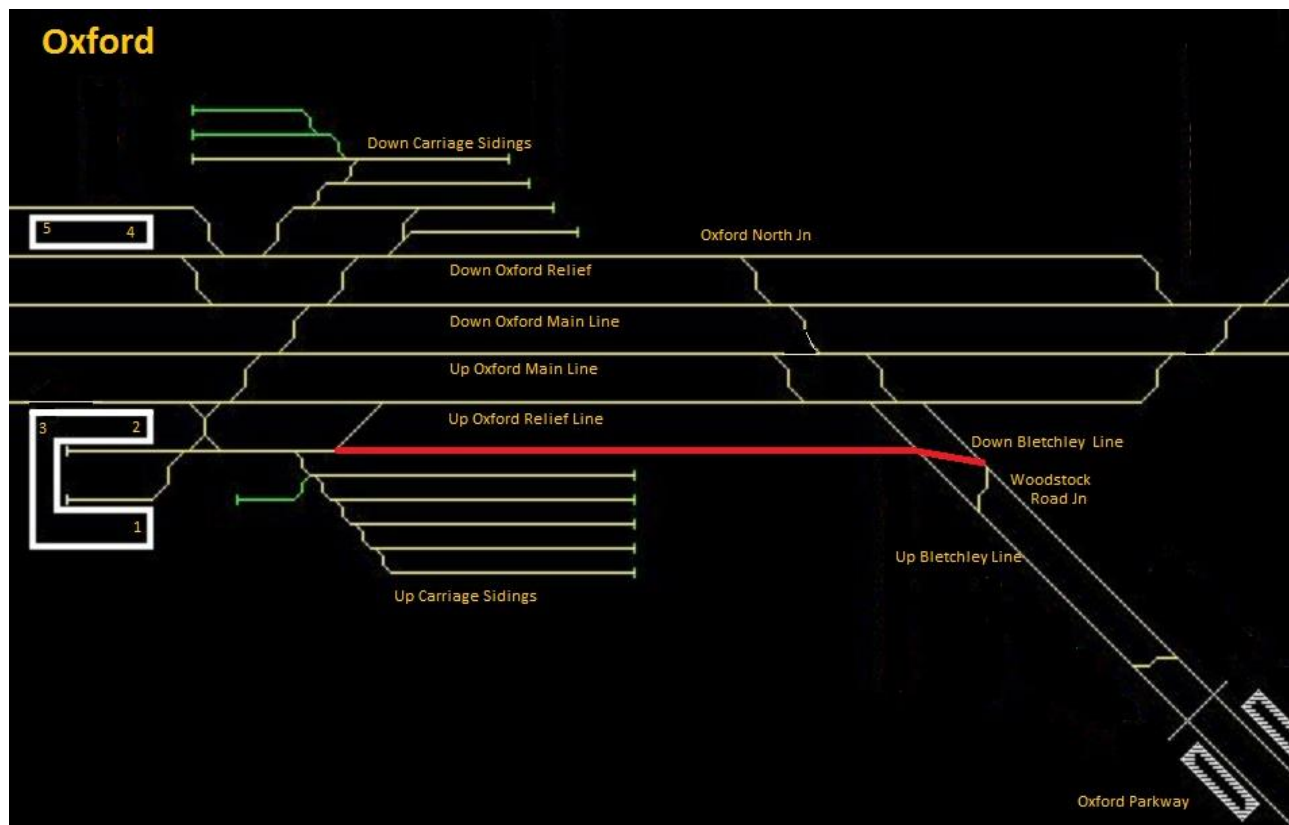


Figure 7: Proposed solution at Oxford North Junction directly linking the Up Bletchley to the bay platforms, with an additional crossover to the Down Bletchley at Oxford Canal Junction

Minimum margins

While it is possible to add four EWR trains per hour to the December 2019 timetable on Phase 2 infrastructure, almost 75 per cent (25 of the 33) of them incur at least one minimum margin with another service – if not more. This could be a junction margin, headway or platform re-occupancy. It means the CTP, while feasible, could create an additional performance risk.

The highest risk is the 7:33:00 arrival into Oxford (2U05BJ), which incurs four minimum margins with other services: two with the Chiltern service (1T05EX) that moves ahead it at Bicester Gavray Junction (arrival time into Oxford Parkway and headway between Oxford Parkway and Oxford North Junction); headway between Oxford North and Oxford (between the EWR train and Cross Country service 1O80DA) and platform re-occupancy at Oxford (it arrives three minutes after the departure of another EWR train, 2D04JB).

Looking at Oxford dwells as an example, four of the 16 EWR services arriving into Oxford between 6am and 10am only spend the minimum five minutes there before turning around and heading back out again:

6am-7am

Arrival	6:08:00	6:24:00	6:37:00	6:47:00
Departure	6:16:00	6:29:00	6:48:00	6:57:00
Dwell (minutes)	8	5	9	10

7am-8am

Arrival	7:03:00	7:17:00	7:33:00	7:47:00
Departure	7:09:00	7:30:00	7:38:00	7:57:00
Dwell (minutes)	6	13	5	10

8am-9am

Arrival	7:54:00	8:14:00	8:38:00	8:52:00
Departure	8:14:00	8:29:00	8:44:00	8:57:00
Dwell (minutes)	20	15	6	5

9am-10am

Arrival	9:05:00	9:18:00	9:35:00	9:52:00
Departure	9:13:00	9:27:00	9:41:00	9:57:00
Dwell (minutes)	8	9	6	5

Table 19: Dwell times at Oxford for the four EWR arrivals per hour there before forming another service and departing

Extending services to Cowley or Didcot

Looking to eliminate these minimum margins and produce a more regular departure pattern from Oxford by extending two EWR services to Cowley per hour does not work either.

Timetabling an EWR train to continue Southbound means reduced dwell time for that service at Oxford as well as freeing up capacity in the bay platforms for other EWR services or Chiltern trains.

However, it also has a knock-on for other EWR services as the pattern of an arrival forming the next departure is completely disrupted.

Due to conflicts at Kennington Junction and Hinksey North, any EWR service continuing to Cowley will instead have to form a much later departure (U1-D4), meaning either longer

dwells for other EWR services at Oxford or at least one per hour needing to be shunted to the Up Carriage Sidings to avoid occupancy issues in the bay platforms (1 and 2).

To accommodate departures to and from Cowley, re-platforming needs to take place to free up space on Platform 3. Where that is not possible, it means delaying the arrivals of EWR trains into Oxford so that they remain compliant with other services.

The same issues mean that extending Chiltern's London Marylebone services to Cowley is also not feasible.

Looking at extending EWR services to Didcot Parkway to try and resolve the same issues does not work either, due to a lack of available Northbound paths. Even with removing the shuttle services from the timetable which operate between Didcot Parkway and Oxford between 6am and 10am, this only opens up five paths over the four-hour period into which you could timetable an extended EWR train. And that is assuming there is a path through to Didcot Parkway in the first place.

The main reason for this is the fact that stopping services lose headway compliance with through services such as freight between Didcot North Junction and Kennington Junction, where there is only one track in each direction and no passing places.

Grade-separating Kennington Junction so that services could move from the Cowley branch line across the Main Lines without impacting on Up and Down services has been evaluated previously and is not feasible. So, a potential solution would be to extend the Up Relief Line from Hinksey North to Hinksey South Junction so that services can run bi-directionally to Platform 3 without impacting Main Line traffic, as shown by the red line in *Figure 8*:

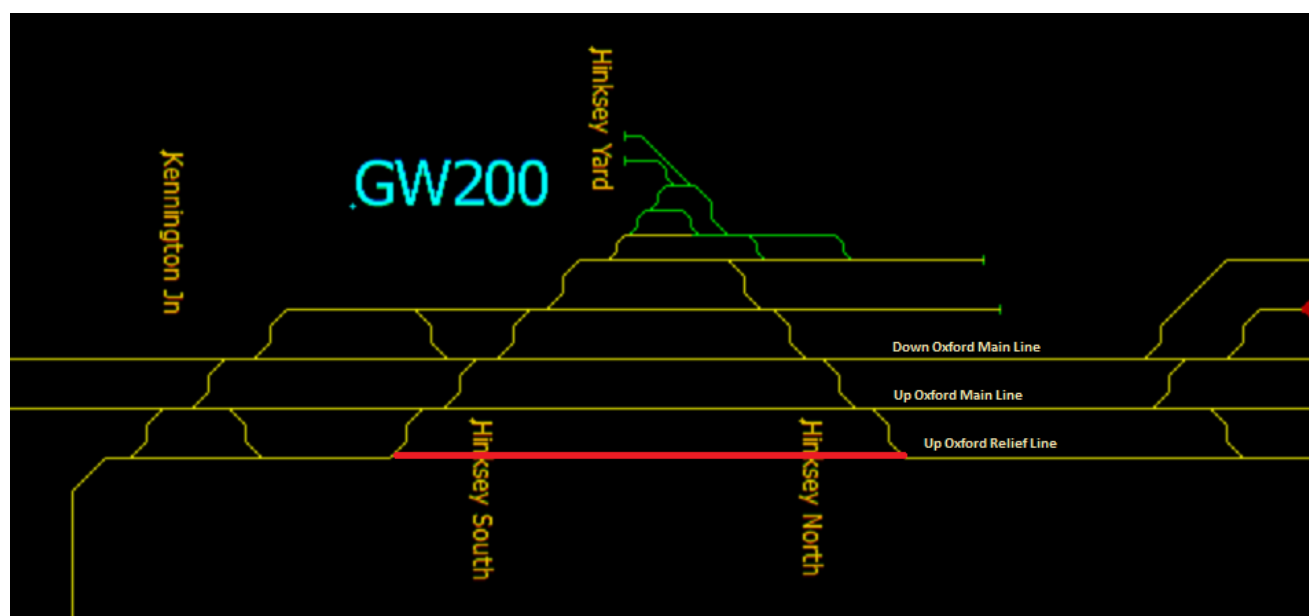


Figure 8: A potential solution to extend EWR or Chiltern services to Cowley is to extend the Up Oxford Relief Line from Hinksey North to Hinksey South

On existing infrastructure South of Oxford, it would appear better to maintain the current stopping services in the timetable between Oxford and Didcot Parkway, rather than extending EWR trains, especially as some of these stoppers either start at Banbury or go through to Reading. It would, however, potentially mean adding more trains to the timetable as these stopping services are not regular during the morning peak.

Otherwise, it would be necessary to either four-track some or all of the stretch between Didcot North Junction and Kennington Junction – where feasible – or create loops where through trains could pass stopping services.

Additional passenger services

The Phase 2 infrastructure makes it possible to plan an hourly Birmingham Moor Street-Oxford service into the December 2019 timetable using Phase 2 infrastructure at Oxford.

With some minor flexing of other services, these can be pathed immediately behind the existing Cross Country services.

Additional freight

While Phase 2 offers scope for more freight paths once additional EWR services and Birmingham Moor Street to Oxford trains have been timetabled, there is not enough spare capacity for regular hourly Up and Down paths via EWR and the DCL.

It may be possible outside of the timetable study period when there are fewer and more regular passenger services and fewer other freight trains. However, here, although a path may be available in one hourly period it is not necessarily free in the next.

The only route where it is possible to path four freight services between 6am and 10am is in the Down direction (from Oxford) via EWR. However, there is no regular pattern, with services departing Oxford at 6:10:00, 7:00:00, 8:47:00 and 9:33:00. Instead, timing additional freight is just a matter of finding spare capacity in the timetable.

It is important to highlight that all validation has only been done using the model boundaries and timescales for this study and using IRTs which may be subject to change.

Part E: Appendix A – Assumptions

E.01 Geographic Scope

Analysis was carried out on services stopping or terminating at, starting from and passing through Oxford station.

The scope of the analysis was between Didcot and Banbury on the Didcot and Chester Line (GW200, then MD401) and Bicester Gavray Junction on the East-West Rail EWR line (GW277). EWR services using this time were validated only as far as Oxford Parkway.

The project does not include a study of services to and from West Coast Main Line.

Identified journey times will remain constant beyond these parameters to services' terminating locations.

E.02 Timetable Scope

The analysis looks at weekday-only services stopping or terminating at, starting from and passing through Oxford station between 6am and 10am.

E.03 Timetable Planning Rules

Wales & Western 2019 (Part 1).

Wales & Western 2020 (Part 2).

E.04 Engineering Access Statement

N/A

E.05 Timing Load Assumptions

December 2019 Enhanced Timetable Sectional Running Times (SRTs) taken from BPlan (values taken on 27 August 2019).

Freight: Indicative running times (IRTs) for freight services between Oxford North and Oxford Parkway have yet to be approved. These are based on Class 66 freight trains (C / 75mph / 1,400 tonnes)

EWR trains: Indicative Running Times (IRTs) from previous studies – calculated for a Class 170 in RailSys; timing load used in TPS for Chiltern is currently 168 although the rolling stock on the network is 168/170. Because existing 168 and 165 SRTs Oxford – Oxford Parkway are the same, new IRTs for the 170 are assumed to be enough for the 168 too.

Journey	Direction	Run		Proposed IRTs for a Chiltern class 168 or 170 (in minutes)				
		From	To	P/P	P/S	S/P	S/S	
Oxford - Marylebone	E-W	Oxford	Oxford North Junction	*+	-	-	02:30	-
		Oxford North Junction	Oxford Parkway	-	03:00	-	-	
	W-E	Oxford Parkway	Oxford North Junction	-	-	03:00	-	
		Oxford North Junction	Oxford	*\$	-	02:30	-	-

* Rounded run times are so tight to the Technical Running Times (TRTs) sum that 30 seconds' extra run time is added on top of the rounded run times; this is incorporated in the IRT value stated.

+ Per TPRs, 30 seconds' extra run time is added on top of the rounded run times for the rolling-brake testing that is required on departure from Oxford; this is incorporated in the IRT value stated.

\$ Driver brake behaviour is judged to be simulated ineffectively by RailSys on the approach to Oxford, and a further 30 seconds' extra run time is added on top of the rounded run times; this is incorporated in the IRT value stated.

EWR services extended to Didcot Parkway will follow the same stopping pattern as current stopping services, with dwells at Radley, Culham and Appleford. No SRTs exist in BPlan for Class 185 or Class 195 services on this route, so IRTs have been calculated and rounded to the nearest 30 seconds.

Birmingham Moor Street services: Class 170 trains, based on existing Class 168 timings extracted from BPlan on 1 October 2019.

E.06 Source Timetable

December 2019 Enhanced Timetable (extracted on 27 August 2019). This was still a work in progress at the time of the analysis so as per the risks, further investigation may be required if there are any changes.

E.07 Infrastructure

Oxford Phase 1 (Part 1) – current infrastructure.

Oxford Phase 2 (Part 2) – includes an additional Platform 5 at Oxford; 75mph crossovers at Oxford North Junction and four-minute headways (rather than six) between Wolvercote Junction and Heyford.

The Cowley connectional study includes two new stations on the branch line – at THA 17m10c for Oxford Science Park (3m54c from Oxford station) and THA 16m30c for Oxford Business Park (4m34c from Oxford). No other changes to infrastructure, apart from assuming that trains can run at 50mph from Kennington Junction to Cowley.

Part F: Appendix A – minimum margins

F.01 Services at minimum margins on Phase 2 infrastructure

Without Phase 2 at Oxford, it is not possible to include four East-West Rail (EWR) services per hour into the December 2019 timetable between 6am and 10am.

While it is possible to produce a compliant concept train plan incorporating these services, as well as extra freight paths, there is still performance risk.

That is because there are minimum margins between services (both EWR and non-EWR).

Platform re-occupancy rules at Oxford require a minimum three minutes between one train departing and the next arriving.

Across the timetable study period there are a total of 21 platform re-occupancy minimum margins.

Table 25 shows their split and the number involving EWR services:

Platform	6am-7am	7am-8am	8am-9am	9am-10am	Total	EWR
1			1		1	1
2		1	1		2	2
3	1				1	0
4	1	5	1	4	11	0
5		3		3	6	0

Table 25: Platform re-occupancy movements at minimum margins at Oxford between 6am and 10am when four EWR services per hour and additional freight are added to the December 2019 timetable using Phase 2 infrastructure

All three minimum re-occupancies on the bay platforms (1 and 2) involve EWR as these trains have had to be fitted in around irregular Chiltern trains during the peak period.

The large number of re-occupancy issues on Platform 4 is mainly due to Up (to Oxford) services being moved there from Platform 3 to open up that platform to EWR arrivals and potentially extending EWR or Chiltern services South of Oxford (to Cowley or Didcot Parkway).

There are 33 EWR services timetabled over the study period – 16 arrivals and 17 departures. The first departure of the day is formed of empty coaching stock (ECS), after that an arriving EWR service turns around to form the next departure.

Of these 16 turnarounds at Oxford, four have minimum five-minute dwells; one in each hour of the study period.

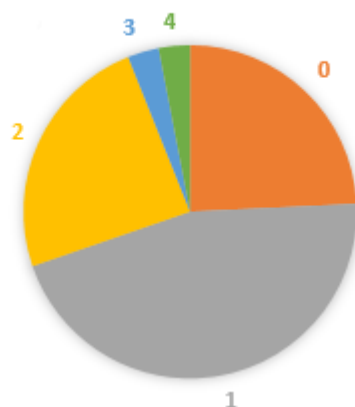
Meanwhile, across the four-hour period, there are 13 minimum junction margins at Oxford North. *Table 206* shows the breakdown and the number involving EWR services:

6am-7am	7am-8am	8am-9am	9am-10am	Total	EWR
3	3	3	4	13	9

Table 206: Service at minimum margins crossing Oxford North Junction between 6am and 10am when four EWR services per hour and additional freight are added to the December 2019 timetable using Phase 2 infrastructure

This shows that while it is feasible to timetable four EWR services per hour at Oxford, a number are only possible by operating on minimum margins. Of the 33 EWR services included in this study, only eight are possible without at least one minimum margin, as *Figure 9* shows:

NUMBER OF MINIMUM MARGINS



Minimum margins	Total
0	8
1	15
2	8
3	1
4	1

Figure 9: The number of minimum margins incurred by individual EWR services included in the December 2019 timetable at Oxford on Phase 2 infrastructure between 6am and 10am

In total, these 25 EWR services incur 38 minimum margins, with the type or location broken down in *Figure 10*:

LOCATION/TYPE OF MINIMUM MARGIN

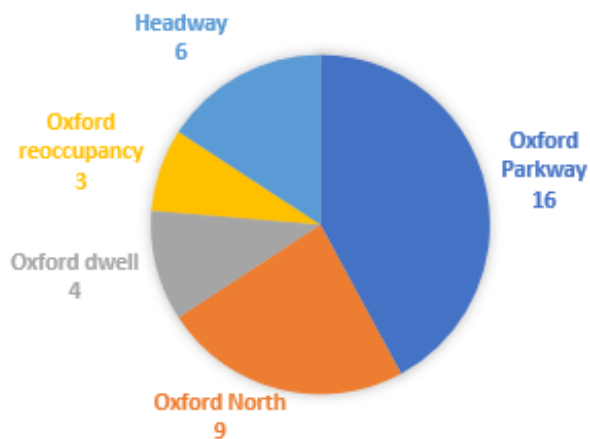


Figure 10: The location or type of minimum margins incurred by individual EWR services included in the December 2019 timetable at Oxford on Phase 2 infrastructure between 6am and 10am

F.02 Kennington Junction occupancy

The report highlights the issue of pathing East-West Rail (EWR) or Chiltern services back to Oxford via the Down Oxford Main Line if they have been extended to Cowley. This is because they have to first cross the Up Oxford Main Line and then rely on a path here matching up with an opportunity on the Down Oxford Main Line. *Figure 21* shows the move:

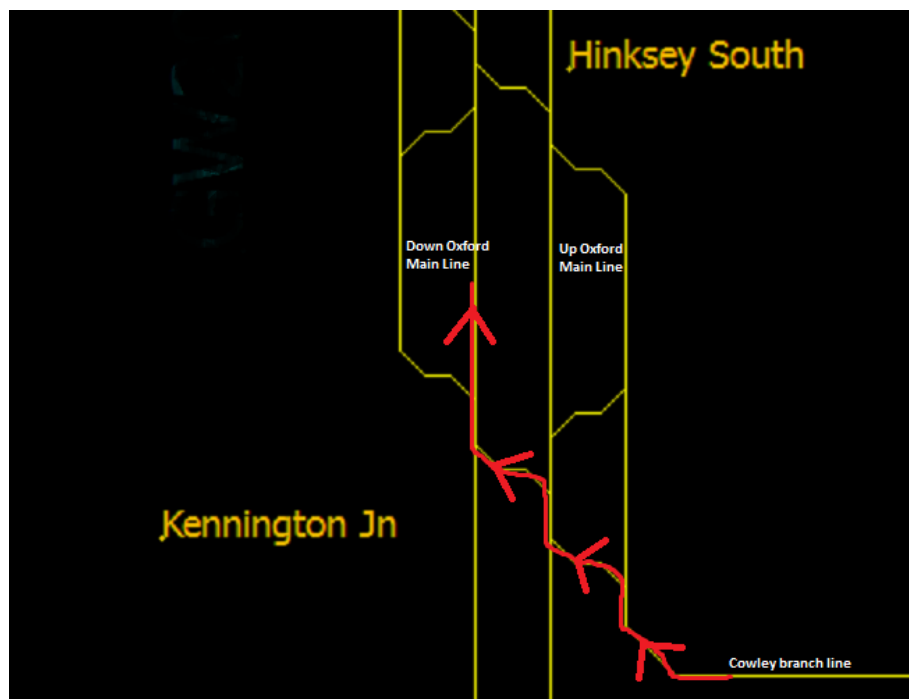


Figure 21: Path taken by services accessing the Down Main Line from the Cowley branch line across Kennington Junction

In total, there are 17 services crossing Kennington Junction on the Main Lines from 8am to 9am – nine using the Up Oxford and eight via the Down Oxford.

This study has used a margin of 2½ minutes after each Up or Down train crossing the junction, with three minutes needed after EWR and Chiltern services traversing the Main Lines due to the slow line speed (25mph on current infrastructure).

Using those figures – based on Up and Down services making the first move rather than any Cowley connection – it would appear there should be plenty of paths with 37½ minutes free on the Up Main Line and 40 minutes on the Down Main Line.

However, that is not the case due to the flighting of trains and paths on the two Main Lines not matching up.

If the Cowley service makes the first move – even with 50mph turn-on and crossing speeds as opposed to the current 25mph – then the margin increases.

As the pie charts show in *Figure 12*, while in isolation there are plenty of gaps on the two lines, once the two charts are combined then there is only one window to cross the junction across the whole hour:

Kennington Junction occupancy, 8am to 9am

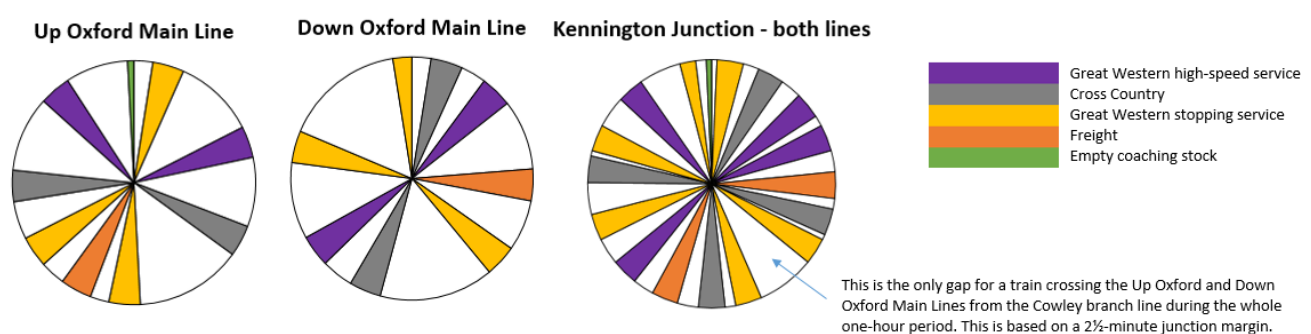


Figure 12: Occupancy on the Up and Down Main Lines at Kennington Junction from 8am to 9am

Although the report discusses other potential options for pathing services back to Oxford – such as Down the Up Main Line – this is designed to show just one of the restrictions when trying to extend any service to Cowley.

Part G: Appendix B – Oxford station

G.01 Usage – Phase 1

Today, Chiltern services to/from London Marylebone generally use the Up Oxford Relief Line bi-directionally from Oxford North Junction to Oxford and terminate in Oxford bay platforms 1 and 2, before returning around 30 minutes later. On occasions where Up (arriving) and Down (departing) trains would come into conflict on the Up Oxford Relief Line, a Down service travelling North from the bays would use the Up Oxford Main Line reversible or occasionally the Down Oxford Main Line.

Passenger trains from the Cotswolds and the North heading to Didcot/Reading/London Paddington generally use Platform 3 in the Up (South) direction. Northbound (Down) trains on the Didcot-Chester Line normally use Platform 4.

Generally, three of these six Down trains per hour currently terminate at Oxford and run empty from Platform 4 to the Down Carriage Sidings, change ends and then await a route where they can carry out a 'ladder movement' across all lines to Platform 3 for a Southbound departure. A late running terminating service into Platform 4 often delays a following passenger train.

Freight uses the Up Oxford and Down Oxford as through lines (at 75mph); however, freight services are quite often looped north of Oxford. In the Down direction they wait on the Down Oxford to be overtaken by a passenger train on the Down Oxford Relief. In the Up direction they generally sit on the Up Oxford Relief Line North of Oxford North Junction to be overtaken. However, when they leave this location, they can clash with Down trains heading towards Oxford Parkway.

Great Western trains generally use the Down Carriage Sidings during the day for turnback moves (as above). However, some will also use the Up Carriage Sidings by day eg for cleaning. Both sets of sidings are heavily used at night.

All lines in the station area are now bi-directional and the majority of moves are made using Automatic Route Setting (ARS). All platforms are passenger permissive, but this facility is not used generally except in perturbation.

G.02 Usage – Phase 2

As Phase 1, except for the following key changes:

Platform 5 added, which has the same functionality as Platform 4. It is intended to be generally used for Down passenger trains. Platforms 4 and 5 will share flashing aspects on approach, allowing fast approach to platforms if clear.

This study has looked at re-platforming some Up passenger services to Platform 4, thereby increasing capacity on the Up Oxford Main Line and at Platform 4 for additional East-West Rail services.

A note is also included in Part 2.2 of how some terminating Great Western services from London Paddington could turn around in Platform 4, without having to go to the Down Carriage Sidings. This would save some train crew and unit diagrams.

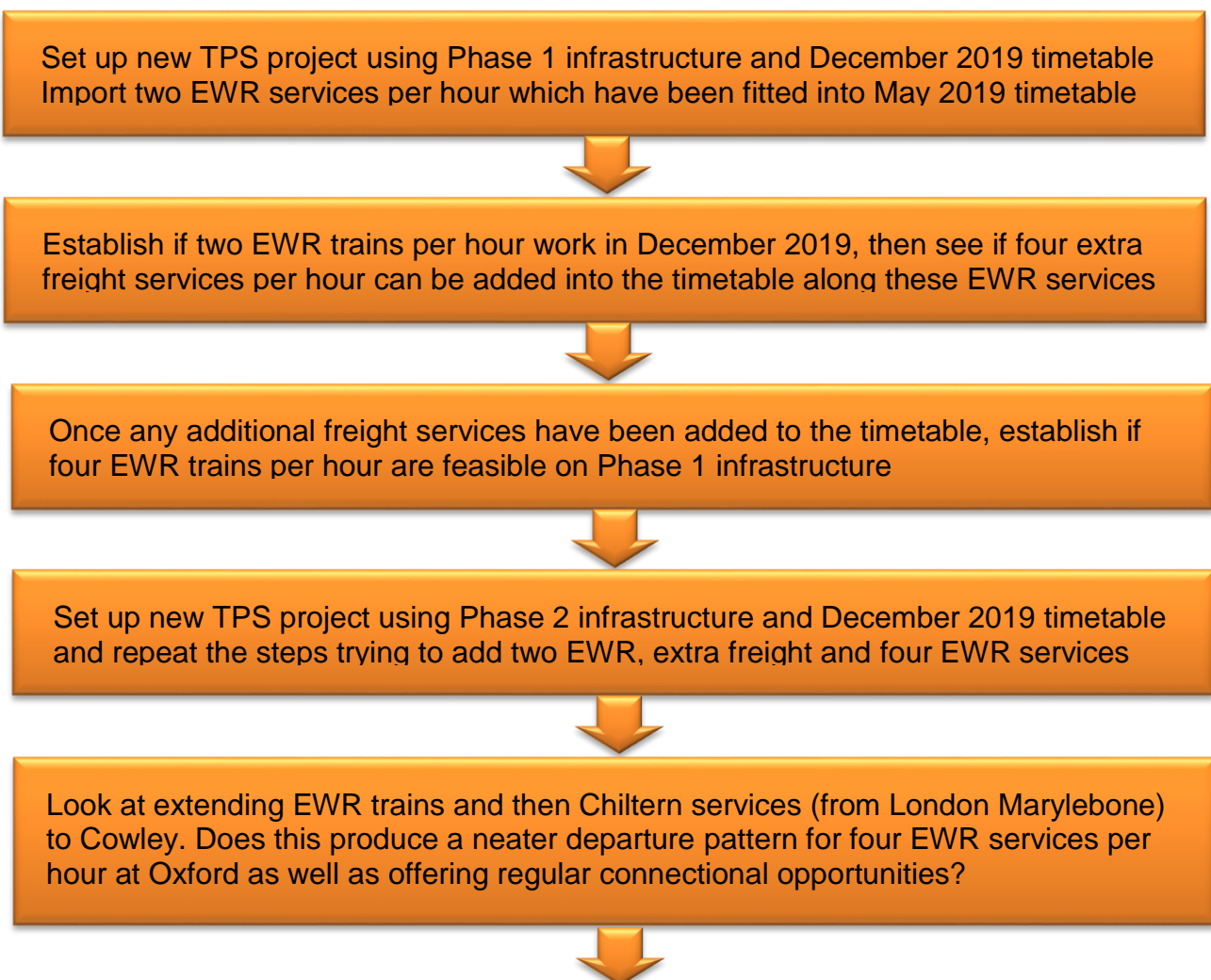
At Oxford North Junction the speed is raised to 75mph throughout, allowing moves from the Down Oxford Relief, Down Oxford Main Line and Up Oxford to Down Bletchley with no approach control on the signalling, saving two minutes. It also allows the same functionality for Up trains heading towards Down Oxford and Down Oxford Relief.

Part H: Appendix C - Methodology

This study builds on previous analysis which established that it was possible to add two EWR services per hour to the May 2019 timetable at Oxford on current (Phase 1) infrastructure.

Taking the times of those EWR services as a base, it looks at extending that work using first Phase 1 and then Phase 2 infrastructure to see if adding up to four EWR trains per hour plus additional freight to the December 2019 timetable are feasible. It also looks at connectional opportunities for services to Cowley and Didcot Parkway. A fuller methodology is contained below in *Figure 9*.

Analysis has only been validated for the study period (6am to 10am) and using the geographical boundaries for the project:



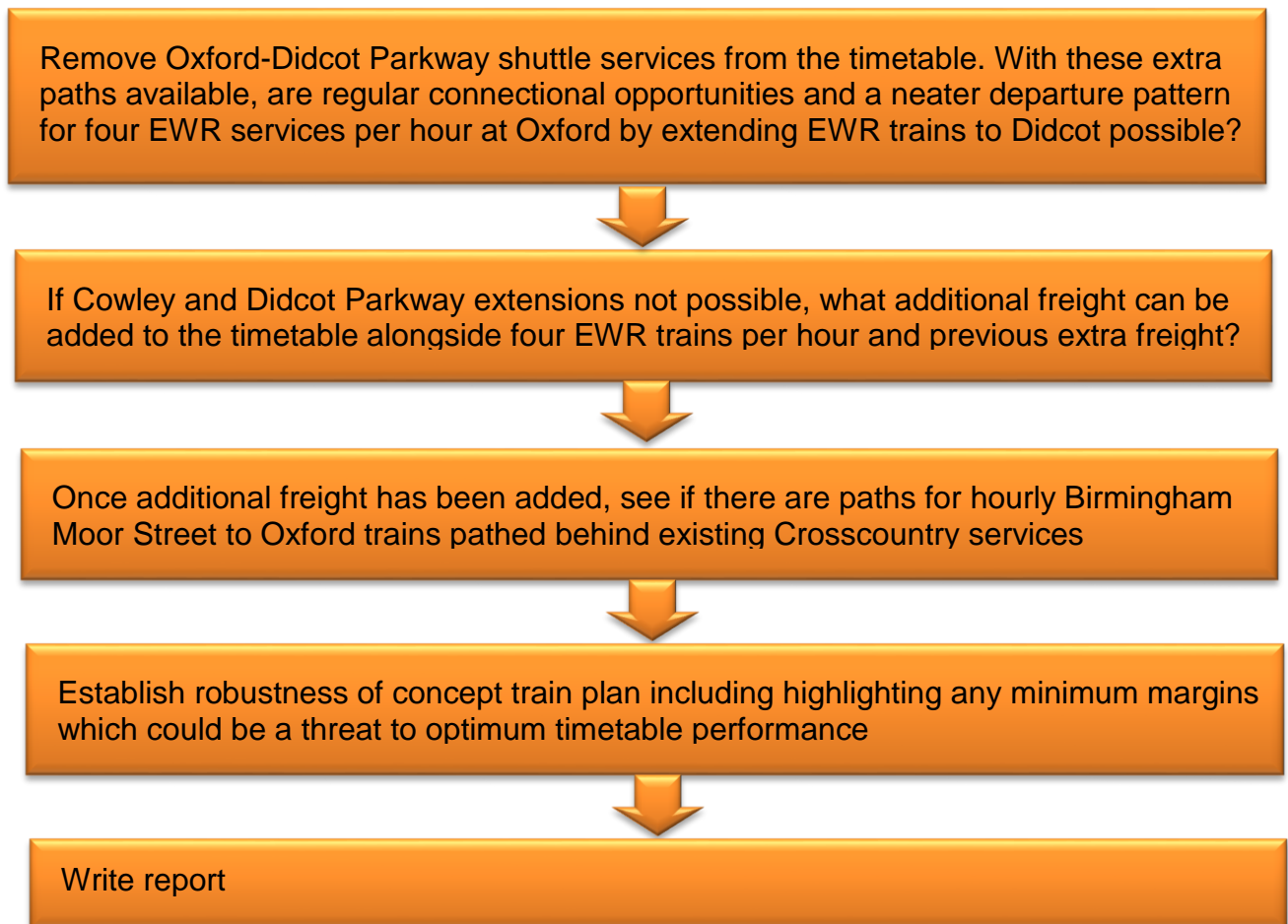


Figure 9: Methodology for study adding additional EWR and freight services to the December 2019 timetable