APPENDIX 3

Technical Note

Project:	Slough A4 Bus Lane Monitoring		
Subject:	Slough A4 Bus Journey Times		
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Date:	25/08/2021	Project No.:	5198014
Atkins No.:	5198014	Icepac No.:	
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Document history

Revision	Purpose description	Origin-ated	Checked	Reviewed	Author-ised	Date
Rev 1.0	Technical Note	AR	LB	MG	MG	23/07/21
Rev 1.1	SBC comments	MG				25/08/21
Rev 1.2	Final Version	MG				23/09/21

Client signoff

Client	Slough Borough Council
Project	Slough A4 Bus Lane Monitoring
Project No.	5198014
Client signature / date	

1. Introduction

During August 2020, experimental bus lanes were introduced on the A4 in Slough, both eastbound and westbound between the 'Sainsburys' (A412) junction to the east and the 'Huntercombe' (M4 spur junction) to the west. The western extent of the bus lane provision was subsequently cut back to the 'Cippenham Lane' junction. The chronology is:

- Introduction in stages during August 2020, coinciding with extensive works at the Wexham Road junction in the autumn of 2020;
- Operation cut back to the AM and PM peaks only from December 2020; and at the same time
- Additional classes of vehicles allowed from December 2020 including taxis, private hire vehicles, zero-emission vehicles, motorcycles, pedal cycles and e-scooters. The traffic orders permitting these classes are in operation until February 2022.

The purpose of this note is to assess the effect of these bus lanes on journey times for buses; hence comparing before and after the introduction of the bus lanes.

Journey times for general traffic have also been reviewed for the same sections and time periods, to provide a means of comparison on these routes, and showing the relative fluctuation across the year.

It is also necessary to consider the results within the context of the effects of the COVID pandemic and its associated restrictions throughout 2020.

This technical note summarises the process undertaken to derive the relevant journey times for comparison along the A4 corridor in Slough: this includes bus journey times and general traffic journey times as a means of comparison.

2. General Traffic Journey Times

In order to assess the performance of the buses using the bus lane relative to general traffic, journey time data was also collected for general traffic. These journey times have been derived from the Slough 'Drakewell' real-time database for Bluetooth journey time and ATC data in Slough.

This provides general traffic journey time data along key corridors in Slough and is available for various time periods and years and can provide monthly summaries (averages) or specific daily outputs.

In this context, journey times have been derived for the A4 corridor, both eastbound and westbound, for the same segments as the bus journey times[1], namely:

- Dover Road to Heart of Slough (library); and
- Dover Road to the Sainsbury's roundabout (Uxbridge Road).

These sections have been provided both eastbound (towards Heathrow) and westbound (towards Maidenhead).

The data has been derived for weekdays only, for the peak hours (being AM Peak: 08:00-09:00 and PM Peak: 17:00-18:00) in order to be consistent with the bus journey time data analysis (section 3). This has been summarised as an average per month from February 2020 to December 2020. The average times between the AM and PM Peak Hours have subsequently been derived.

The results are included in Figure 4-1 and Figure 4-2 below, alongside the bus journey times.

[1] Segment is Dover to Tuns junction EB, Tuns junction to HoS EB, HoS to Sainsburys Rdbt EB. Source: COVID-19 A4 Traffic Volumes 2021 wk14 +cycles.xlsx

3. Bus Journey Times for First Route 4

3.1. Overview

Throughout much of 2020 Atkins received a data feed of First Berkshire Bus Service 4 from JMW. Service 4 runs between Heathrow and Maidenhead via Slough (see map below), and an analysis exercise of the JMW data was undertaken in order to monitor the performance of bus priority measures along the A4 through Slough Town Centre. The aim of this study is to determine changes in journey time and variability for the following bus route segments, which include both eastbound and westbound directions:

- Dover Road to Heart of Slough (Library stop);
- Dover Road to Uxbridge Road Sainsbury's;
- Heart of Slough (Library stop) to Dover Road; and
- Uxbridge Road Sainsbury's to Dover Road.

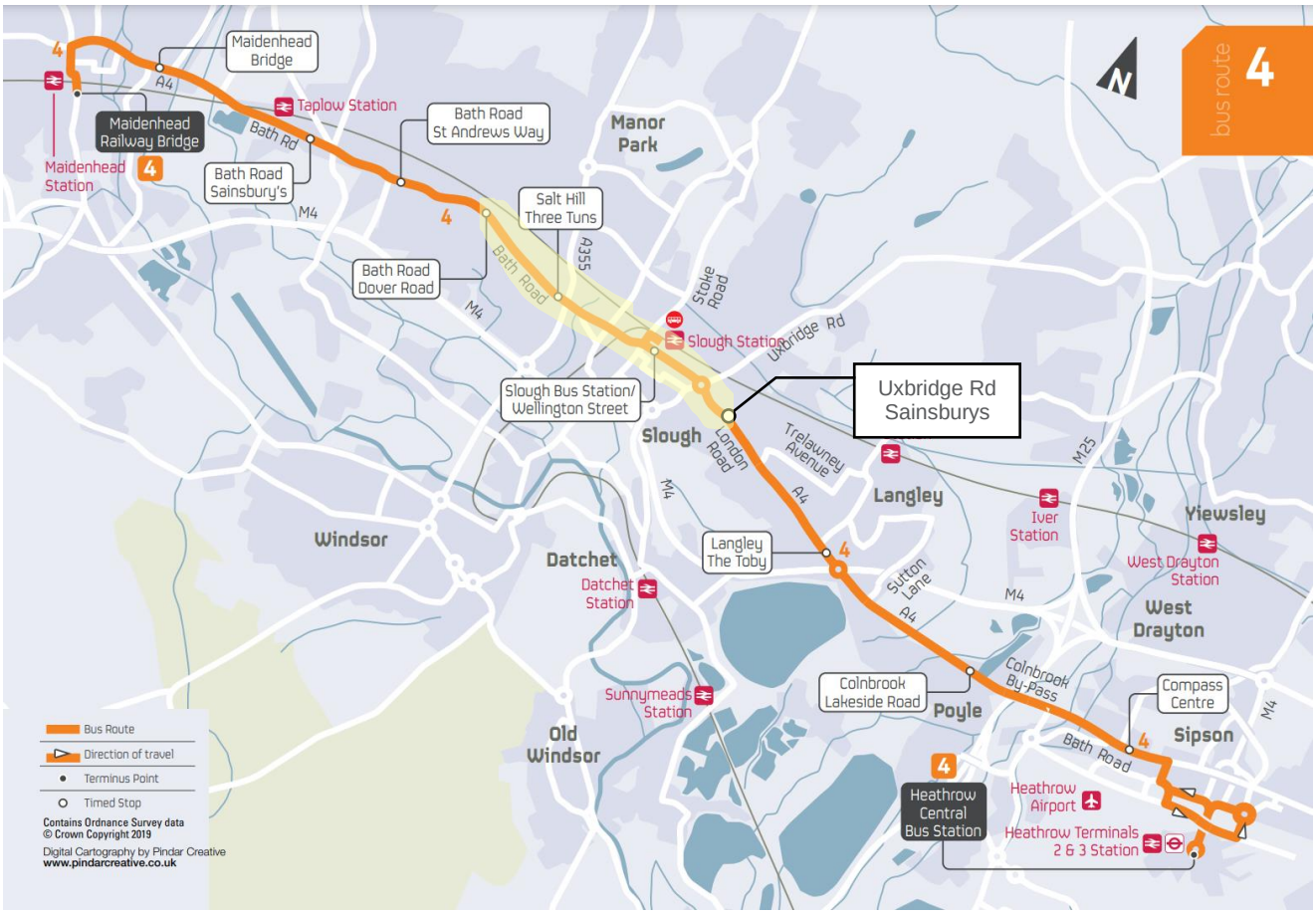

Figure 3-1 - Route Map for Service 4[2], with study area highlighted in yellow.

3.1.1. Parameters

For the purposes of this study, the following parameters were used:

The data analysed includes weekdays only for both morning and evening peaks unless otherwise stated. AM and PM Peaks represent data between 08:00 and 09:00 and 17:00 and 18:00 respectively, except for the months of April and May where a reduced service due to COVID-19 lockdown measures required the inclusion

[2] Source: https://www.firstbus.co.uk/uploads/maps/Route_4_web.pdf

of services starting at 07:30 and 16:30 for a more complete dataset. Journey times do not include dwell time, and are derived directly from the calculated 'Runtime' column of the JMW data:

- Bus arrival is registered at a stop as the bus being within 30 metres of the stop;
- Departures are registered as the bus pulls away more than 30 metres from the stop; and
- Real Time Data is communicated every 30 seconds from the bus. This may not occur due to mobile coverage issues or anomalies with the SIRI feed.

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3.2. Heathrow Direction (Eastbound)

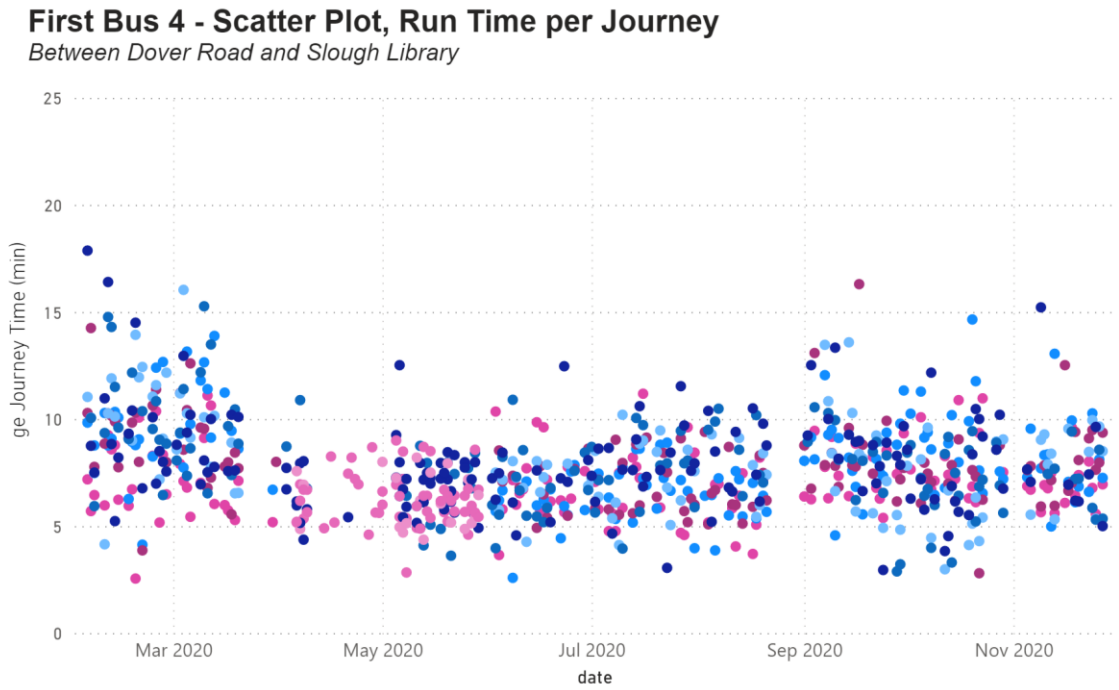

Figure 3-2 – Journey Time Scatter Plot - Dover Road to Library. Individual AM Peak (pink) and PM Peak (blue) journeys only.

The figure above shows the individual runtimes of all Service 4 journeys from February to November 2020, showing the 'spread' of the data for both AM (pink points) and PM journeys (blue points). A wide 'spread' of journey times indicates a high levels of journey variability, which is likely to result in poor reliability of the bus service at each stop of the study area and beyond.

Due to Covid-19 lockdown restrictions, there was a reduction in the number of journeys from mid-March until early June. However, the data shows there was little variability in journey time for the remaining services when in the context of low traffic congestion due to the lockdown travel restrictions, and it can be inferred that congestion has a significant impact on Service 4. Post-lockdown, the spread of the data continues to be relatively low into November when compared to February/March, despite general traffic increasing to pre-lockdown levels, which could therefore be due to the introduction of the bus lanes. Evening peak[3] journeys are more variable than morning peak[4] journey times in February and March 2020, but data spread is reduced in September-November, when bus priority measures were implemented.

[3] PM Peak in this study runs from 17:00-18:00 typically, or 16:30-18:00 during the March lockdown period
[4] AM Peak runs from 8:00-9:00 typically, or 7:30-9:00 during the March lockdown period

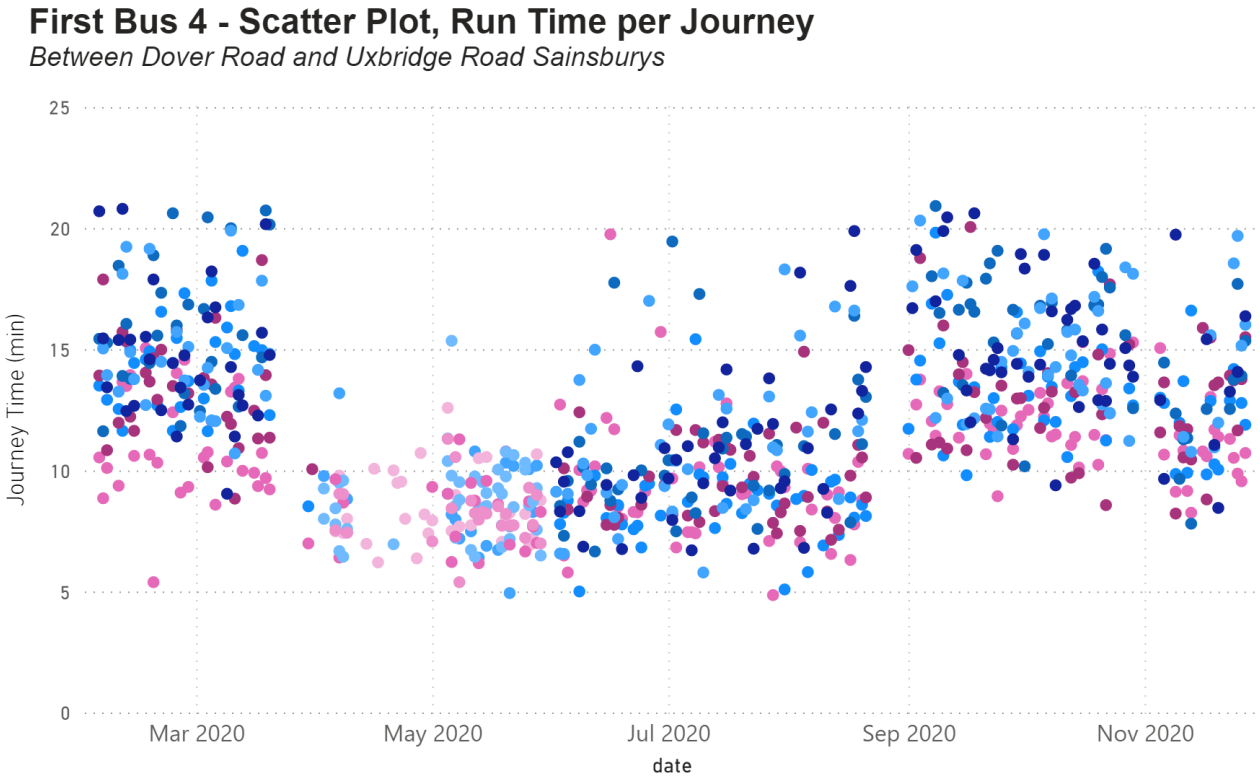

Figure 3-3 - Scatter Plot - Dover Road to Uxbridge Road Sainsbury's Journey Times. Individual AM Peak (pinks) and PM Peak (blues) journeys only.

When analysing the extended journey to Uxbridge Road in Figure 3-3, high levels of journey time variability can be observed throughout the year. Due to Covid-19 lockdown restrictions, there was a reduction in the number of bus and general traffic journeys from mid-March until early June, which resulted in significant reductions in journey times for First Bus 4. Journeys became 5-10 minutes shorter in many instances, showing the severe impact general traffic flows have on the bus service.

In the morning peak, journey times (in pink) are shorter and far less variable than PM journey times, similar to the segment from Dover Road – Library shown in Figure 3-2. Evening peak journey times (in blue) are variable throughout 2020, but reductions in both time and variability can be observed during the March lockdown period. Traffic congestion appears to have a significant impact on journey times along the Library to Uxbridge Road segment. Variability across the year suggests that the implementation of a bus lane did not improve journey time reliability for the evening services on this section.

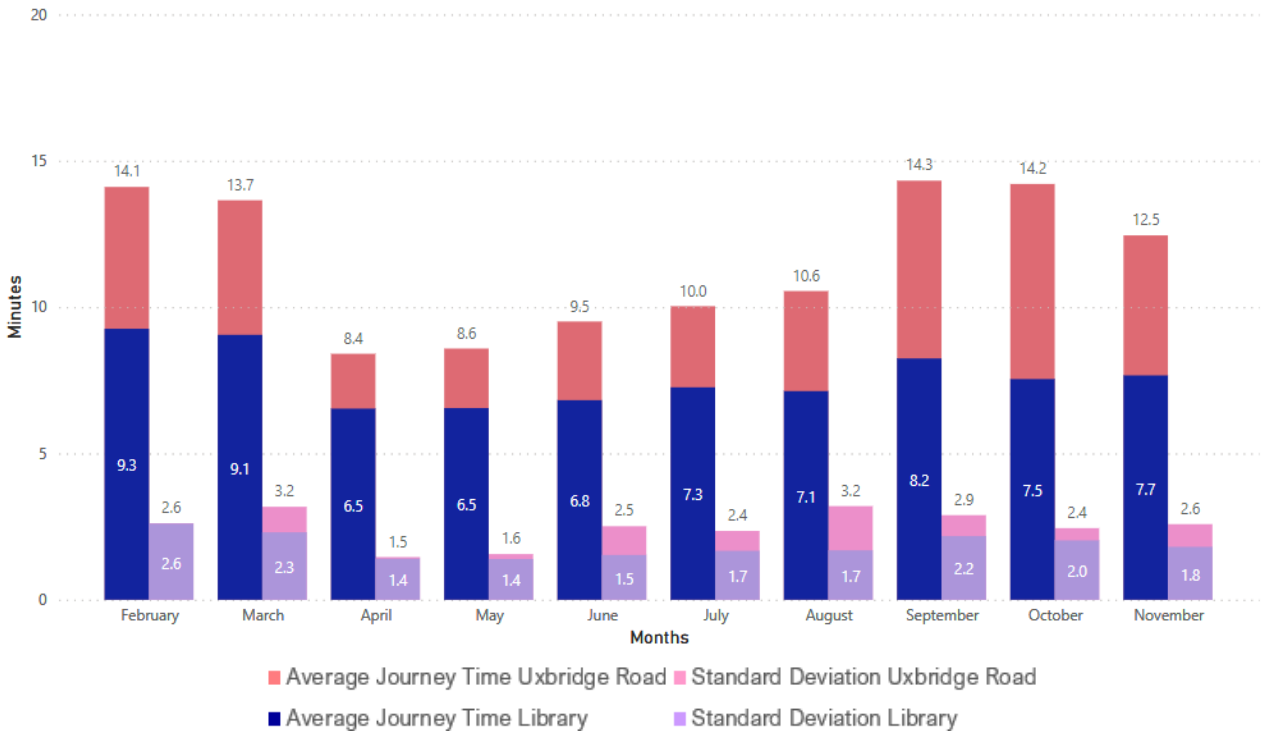

Figure 3-4 - Average journey times and Standard Deviation per month, average of AM and PM peak. Dover Road to Library (blue/purple) and Dover Road to Uxbridge Road Sainsbury's (red/pink)

The late March and April lockdown journey times present a useful 'best case' scenario of low congestion and short journey times for buses. Observed data from April shows the lowest journey times across the 10 months for both the segments, Library (6.5minutes) and Uxbridge Road (8.4 minutes). The highest journey times are in February for the Library segment (9.1 minutes), and in September for the Uxbridge Road segment (14.3 minutes). Post-lockdown and at the start of the school term in September, bus journey times were negatively impacted by reopening on the section between Library and Uxbridge Road. It appears that nearly half of the journey time between Dover Road and Uxbridge Road is made up of congestion-related delays, with a low-to-high journey time gap of 5.9 minutes between April and September. Whilst journey times up to Heart of Slough (Library) remain relatively consistent across the year, the last three stops, between Library and Uxbridge Road, contribute to a significant increase in journey time. However, there is a positive trend beyond September, with journey times decreasing towards the end of 2020.

3.3. Maidenhead Direction (Westbound)

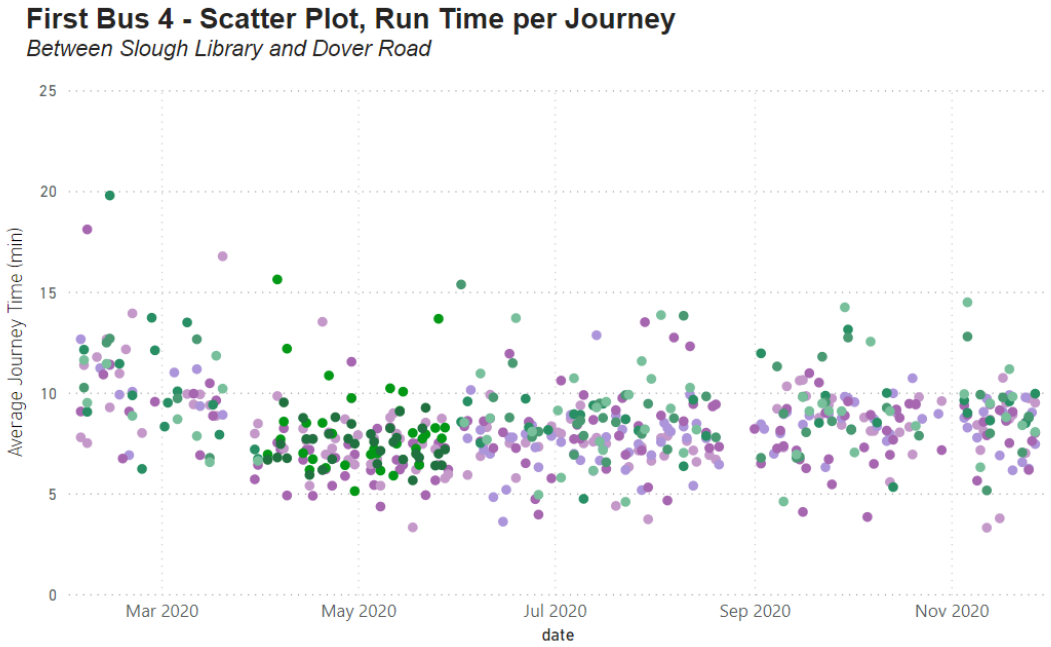

Figure 3-5 - Journey Time Scatter Plot - Library to Dover Road. Individual AM Peak (violets) and PM Peak (greens) journeys only

The figure above shows the individual runtimes of all First Bus 4 journeys from February to November 2020, showing the 'spread' of the data for both AM (violet points) and PM journeys (green points). A wide 'spread' of journey times can indicate high variability, resulting in poor reliability of the bus service at each stop of the study area. Pre-lockdown, there was high variability in the data for both AM and PM peak journeys. No significant patterns can be observed after April which shows typically a 5 minute variability and evening peak journey times are often higher compared to AM journeys, but surprisingly, there was only a low increase in journey time after lockdown reopening and the start of the school term in September.

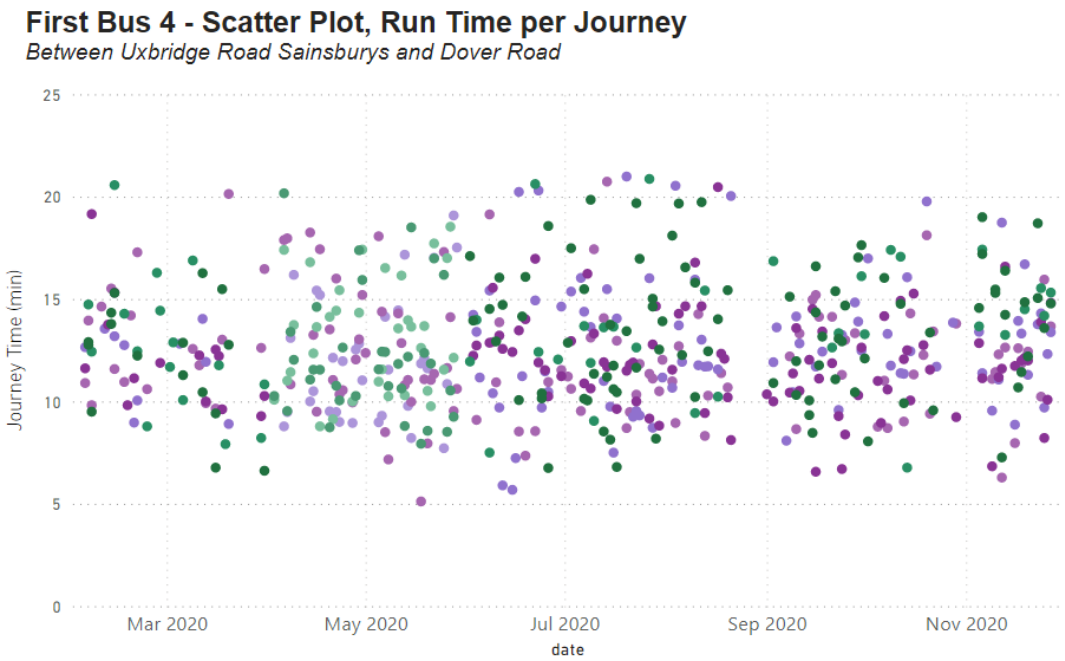

Figure 3-6 - Journey Time Scatter Plot - Uxbridge Road Sainsbury;s to Dover Road. Individual AM Peak (violets) and PM Peak (greens) journeys only

Unlike Figure 3-5, the image above does not show significant patterns across 2020, with a 10-minute spread of the journey time data across the year, and only a slight reduction in journey times after September 2020.

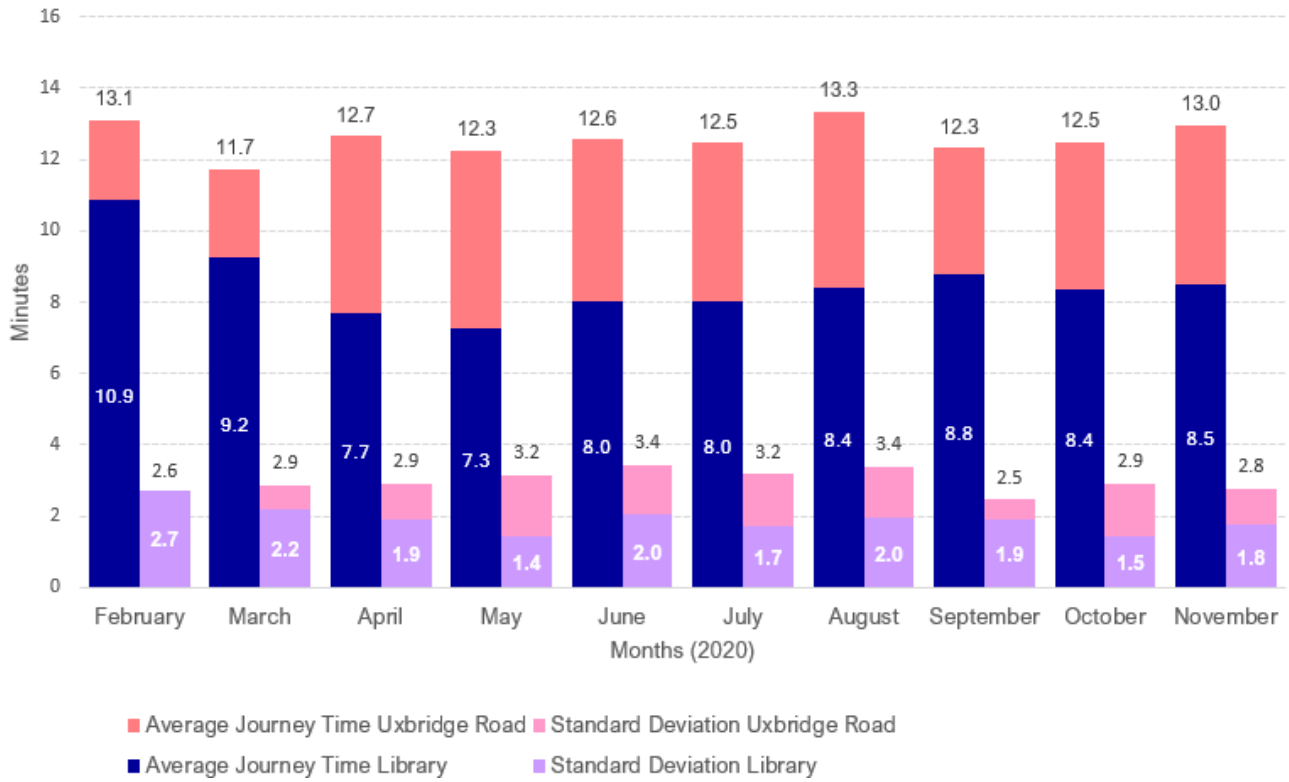

Figure 3-7 - Average journey times and Standard Deviation per month, average of AM and PM peak. Library to Dover Road (blue/purple) and Uxbridge Road Sainsbury's to Dover Road (red/pink).

The image above shows the journey time pattern across 10 months in 2020. It is clear to see the delay experienced by the bus between Slough Library and Uxbridge Road, with a consistently high journey time of

over 3 minutes for three[5] stops. However, by September 2020 journey time reliability improved to levels similar to February 2020 with comparable and slightly lower journey times to pre-lockdown conditions, although having the same levels of reliability.

The section between Dover Road and Slough Library improved in both journey time and reliability after the implementation of bus lanes, saving 2 minutes in journey time, compared to pre-lockdown conditions and becoming significantly more reliable.

4. Bus Journey and General Traffic Times

In order to determine the impact of the bus priority measures in Slough, an analysis has been undertaken to compare general traffic journey times to the bus journey times.

This analysis has the following parameters:

- Bus data includes weekdays only, the average of AM and PM Peaks;
- Vehicle journey time data is for AM and PM weekday peak periods, Monday to Friday, and was gathered via Bluetooth;
- Heathrow direction is Eastbound; and
- Maidenhead direction is Westbound.

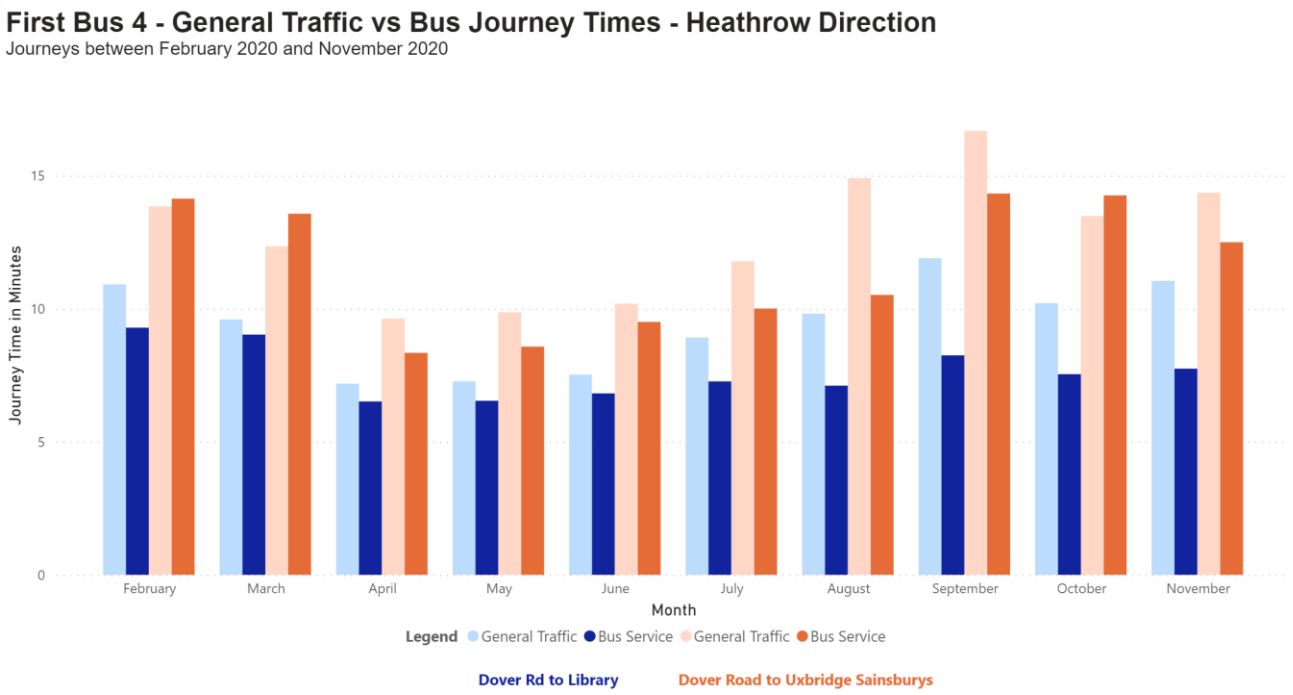

Figure 4-1 – Average Journey Times per month for Service 4 and General Traffic – Eastbound direction. Dover Road to Library (blue) and Dover Road to Uxbridge Road Sainsbury's (orange)

The above graph shows that in most months, through 2020, bus journey times were lower than general traffic journey times, for both journey segments in the eastbound direction, (i.e. between Dover Road and the Library and between Dover Road and Uxbridge Road Sainsbury's), with the exception of February, March and October, when bus journey times were slightly higher on the longer route section only. Furthermore, the

[5] Refers to Uxbridge Road Sainsury's, Sorting Office, and Library. The stop "Slough Town Centre, Slough Bus Station (Bay 4)" has not been included in this study due to data capture issues as the bus navigates through the station. Since the bus is circuiting within 30m of the stop, arrival and departure times are consistently inaccurate.

difference in journey times, between buses and general traffic, were greatest between August and November, likely related to the introduction of the bus lanes reducing bus journey times, as well as to some extent related to the fact that overall traffic flows were likely to be higher due to the easing of lockdown restrictions, related to COVID-19, during these times, pushing up general traffic times. In particular, on the segment between Dover Road and the Library stops, bus journey times remained relatively constant (April to November), whilst the traffic journey times increased from July. They are also notably lower than comparative months of February and March (pre-lockdown), suggesting the bus lanes have some impact here.

Overall, it therefore demonstrates that the bus lanes were providing buses with a comparative advantage over car journeys, particularly as traffic builds up (post-lockdown), with some exceptions on the longer route (to Uxbridge Road Sainsbury's) mainly seen in October.

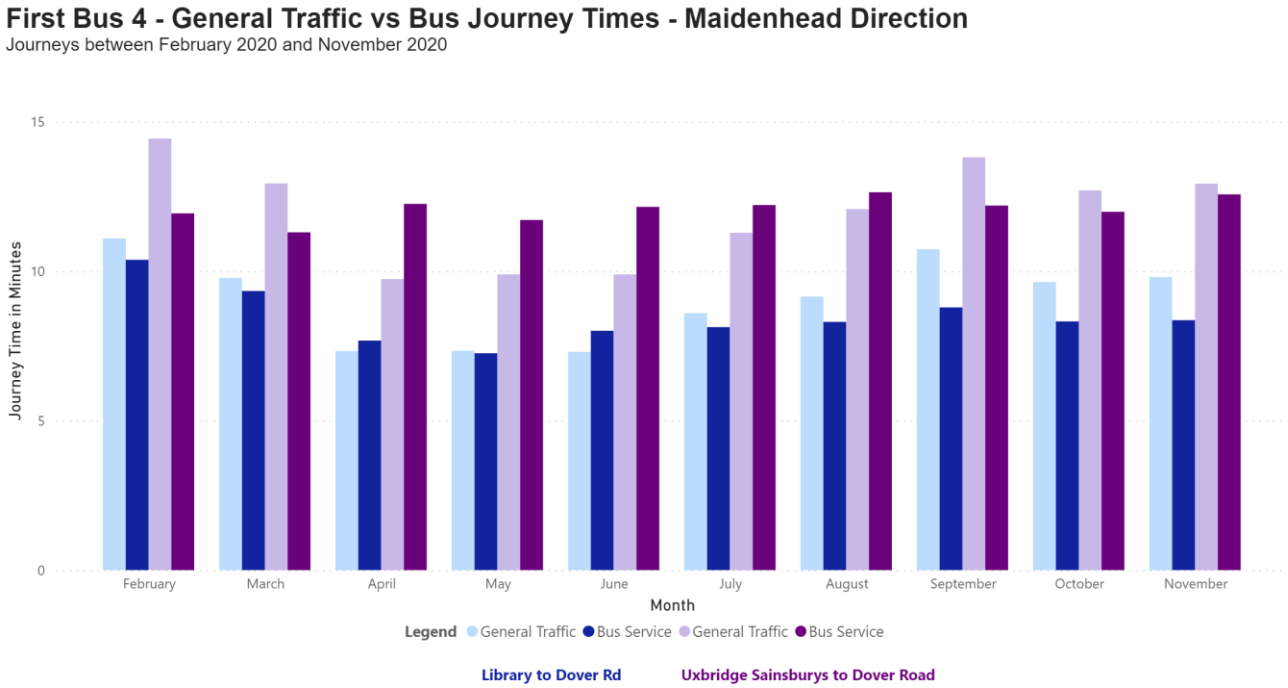

Figure 4-2 – Average Journey Times per month for Service 4 and General Traffic – Westbound direction. Library to Dover Road (blue) and Dover Road to Uxbridge Road Sainsbury's (purple)

The above graph shows the journey times for the westbound direction on the A4 in Slough; again for the shorter section between the Library and Dover Road, as well as the longer section between Uxbridge Road Sainsbury's and Dover Road. This shows less overall variation in journey times across the year, compared to the eastbound direction, except a slight dip between April and June, which could be explained due to the lockdown restrictions resulting in less traffic on the roads. There is also less variation in journey times between buses and general traffic, on both route segments throughout the year. It should also be noted that on the longer route segment, average bus journey times are actually longer than the general traffic journey times between April and August, which could be explained again by the lockdown restrictions resulting in less traffic on the roads and hence relative less congestion for general traffic.

There is some evidence, however, that as journey times increased for general traffic on both the longer and shorter route segments, notably between August and November, bus journey times remained fairly constant (despite overall traffic flow increases), which could be attributed to the introduction of the bus lanes. The bus journey times were comparatively much higher in February and March, on the shorter route segment, before the bus lanes were introduced.

5. Conclusion

This note has reviewed the bus journey times on the A4 in Slough, both eastbound and westbound, on two key route segments (namely between Dover Road and the Heart of Slough (Library stop) and between Dover Road and the Uxbridge Road Sainsbury's) to assess the effect of the introduction of experimental bus lanes on journey times for buses; hence comparing before and after the introduction of the bus lanes.

Journey times for general traffic have also been reviewed for the same sections and time periods, to provide a means of comparison on these routes, and showing the relative fluctuation across the year. It has also been necessary to consider the results within the context of the effects of the COVID-19 pandemic and its associated lockdown restrictions throughout 2020.

Bus journey time data for most of 2020 was derived from JMW for the First Berkshire Bus Service 4, which runs between Heathrow and Maidenhead via Slough.

General traffic journey time data was extracted from the Slough real-time 'Drakewell' database for the same segments and time periods.

Analysis of the resulting journey times was undertaken, for the monthly weekday average peak hour times (AM and PM Peak average), for the purpose of determining changes in journey time and variability and to monitor the performance of bus priority measures along the A4 through Slough Town Centre.

The graphs comparing journey times for buses and general traffic show a clear fluctuation in overall journey times, most clearly in the eastbound direction, towards Heathrow, with these significantly reduced between April and July (as a result of lockdown restrictions, reducing overall traffic volumes). In nearly all months, in the eastbound direction, bus journey times were lower than the corresponding journey times for general traffic. In particular, on the segment between Dover Road and Heart of Slough (Library stop), as journey times for general traffic were increasing post-lockdown (from August to November), the corresponding bus journey times remain at a relatively constant lower level. These improvements were less pronounced (except in August) on the longer route segment. These trends, although seen to some extent also in the westbound direction, were less pronounced than in the eastbound direction.

The results of the analysis presented above show that bus journey times became more reliable after the reallocation of carriageway space to buses. Whilst journey times for general traffic have been steadily increasing throughout the second half of 2020, the bus service journeys generally remain somewhat more consistent, with a slight reduction in variability when compared to February-March 2020.

Appendix A.

A.1. Notes from JMW

We include these notes as a guidance to understanding the stop run time data provided. If the data is being used in a data model or for other audiences, you should take these notes into account when interpreting the data.

The notes below help to give some insight into the data provided.

1. We register an arrival at a stop as the bus being within 30 metres of the stop.
2. We register a departure as the bus pulling away more than 30 metres from the stop.
3. The system can modify that arrival/departure radius if required but we're not aware of this radius being changed for any stops in Slough.
4. We expect updates every 30 seconds from the bus. This may not occur due to mobile coverage issues or anomalies with the SIRI feed.
5. Due to some anomalies in the SIRI data we may record an arrival time but not be able to determine accurately the departure time if we don't get a good or timely update from the bus. When this occurs the departure time is blank in the data. The cells were left blank as a reflection of the lack of confidence in accurately detecting the departure time. For modelling purposes you can assume the arrival/departure time is the same if the departure time is blank.
6. The following are some notes on the columns:
    a. The arrive/depart columns indicate the arrival and departure time of the bus we detected via the SIRI feed.
    b. The "wait time" column is the actual wait time we calculated for the bus at that stop.
    c. The "run time" column is the time taken to run from the last stop to the current stop.
    d. The "expected wait time" is the wait time from the timetable data.
    e. The "expected run time" is the run time from the timetable data. Note that this includes the wait time from the timetable.
    f. If you're comparing the timetable (expected) run time and the actual run time then you should compare the "run time + wait time" columns with the expected run time-this is due to the expected run time column including the wait time already (see "expected run time" above).
7. During the period of end of March (29th) through April there were several timetable changes that affect the data due to the pandemic. For this data we believe a Sunday service was being operated. During the early stages of the pandemic (first half of April) we have less faith in the data from the ETM/SIRI and observed a lack of data for the service 12 and the X74. This may be caused by the changes to timetables, or indicate buses were not running due to changes by the operator for the pandemic. For data modelling the April data should be used with some caution. We have a high level of confidence in the service 4 data, but less confidence in the X74 and service 12 data.
8. There are some periods where a SIRI feed issue may occur loss of data. This will be seen as a gap in the data. This shouldn't have an effect on analysis of "averages" or summarised data. If further information is required on gaps in data we can look further at individual instances of this occurring.
9. We include "empty" reports if there is no data. This is so you're aware that the data has not been left out and that it doesn't exist or hasn't been recorded. During the pandemic period of April you may see some empty data as indicated in other notes.
10. The following are some general notes on vehicle activity at the end of the service,particularly with relation to the detection at the final stop:
    a. We do not modify the data we receive from the bus ETM. This means that any changes in journey number can affect the data, particularly at the end of the journey. It’s not uncommon for drivers to update the ETM to the next journey on leaving the second last stop and before reaching the final stop. Alternatively they may also update the ETM just prior to the final stop being reached so they're logged on as the next journey. In our data this occurrence may be observed if the final stop on the journey is not shown with an arrival.
    b. It’s also common for some buses to stop and let off passengers for the final stop prior to it reaching the final stop. For example, a driver may not want to immediately pull into the final stop if it will block other buses and may stop some distance short of the final stop before then moving to the final stop (start of next journey) after a short delay just before the next journey starts. This may show as an anomaly on

the final run time to the final stop as the bus won't be seen as arriving at the final stop until it pulls in from where it is waiting even though the journey is actually complete.

11. We measure wait time as a bus that is in close proximity to a stop for two or more updates from the bus. The limitation of this is that the bus may be stopped in traffic but we will still potentially see that stop as the bus waiting if it occurs at the bus stop. The wait times are therefore estimates based on the data we have from the ETM.
12. We're aware that the First timetable data currently on the system has issues with incorrect stops. The issues we're aware of were corrected in July but there is no new data from First. This may affect the wait times for some services. The reason for this is that we measure the wait times we expect the bus to stop at. If the bus stops at a different stop we won't see that "wait" as a wait time as we won't recognise it as being at the stop.
13. Under the new contract we switched from the old software to the new software in February. The transition shouldn't have affected the data we provide but the timetables were refreshed/renewed in February so if there are any data anomalies during February it is likely to be due to the transition.

A.2. Sample Dataset

The following table shows the data structure post-cleaning of the JMW raw data in Python. This cleaning allowed for a simpler analysis process.

DATE	OPERATOR	SERV	JNY	STOP NAME	ARR TIME	DEP TIME	DESTINATION	RUNTIME SEC	DAY OF WEEK
05/02/20	First Berkshire	4	1	Slough Trading Estate, Salt Hill Three Tuns	03:14:36	03:14:36	Heathrow Central	16	Wednesday
05/02/20	First Berkshire	4	1	Slough Town Centre, Library (Stop W)	03:17:54	03:17:54	Heathrow Central	198	Wednesday
05/02/20	First Berkshire	4	1	Slough Town Centre, Wellington Street (Stop B)	03:18:25	03:18:56	Heathrow Central	31	Wednesday
05/02/20	First Berkshire	4	1	Slough Town Centre, Sorting Office (Stop J)	03:19:57	03:20:13	Heathrow Central	61	Wednesday
05/02/20	First Berkshire	4	1	Langley, Uxbridge Road Sainsbury's	03:21:29	03:21:29	Heathrow Central	76	Wednesday
05/02/20	First Berkshire	4	10	Slough Town Centre, Slough Bus Station (Bay 4)	06:28:59	06:31:32	Maidenhead	611	Wednesday
05/02/20	First Berkshire	4	10	Slough Town Centre, Library (Stop E)	06:32:18	06:32:33	Maidenhead	46	Wednesday
05/02/20	First Berkshire	4	10	Elliman, Gala Bingo Hall	06:33:20	06:33:20	Maidenhead	47	Wednesday
05/02/20	First Berkshire	4	10	Chalvey, Salt Hill Park	06:33:50	06:33:50	Maidenhead	30	Wednesday
05/02/20	First Berkshire	4	10	Baylis, Windmill Road	06:35:07	06:35:42	Maidenhead	77	Wednesday
05/02/20	First Berkshire	4	10	Slough Trading Estate, Salt Hill Three Tuns	06:36:24	06:36:24	Maidenhead	42	Wednesday
05/02/20	First Berkshire	4	10	Slough Trading Estate, Twinches Lane North	06:37:11	06:37:27	Maidenhead	47	Wednesday
05/02/20	First Berkshire	4	10	Slough Trading Estate, Leigh Road	06:38:44	06:38:44	Maidenhead	77	Wednesday
05/02/20	First Berkshire	4	10	Slough Trading Estate, Westgate Retail Park	06:40:01	06:40:47	Maidenhead	77	Wednesday
05/02/20	First Berkshire	4	11	Slough Trading Estate, Westgate Retail Park	05:50:20	05:51:06	Heathrow Central	47	Wednesday
05/02/20	First Berkshire	4	11	Slough Trading Estate, Leigh Road	05:51:21	05:51:37	Heathrow Central	15	Wednesday
05/02/20	First Berkshire	4	11	Slough Trading Estate, Twinches Lane North	05:52:07	05:52:38	Heathrow Central	30	Wednesday
05/02/20	First Berkshire	4	11	Slough Trading Estate, Salt Hill Three Tuns	05:53:24	05:53:55	Heathrow Central	46	Wednesday
05/02/20	First Berkshire	4	11	Baylis, Windmill Road	05:55:11	05:55:27	Heathrow Central	76	Wednesday