A1(M) Origin Destination Survey – data analysis report *draft4*

Prepared for Skyhigh Traffic Data Australia Pty Ltd
UK2

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A1(M) OD Survey DRAFT

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1.0 Introduction

In May 2012 Skyhigh Traffic Data conducted an origin-destination survey of selected traffic movements along the A1(M), from the general vicinity of Welwyn Garden City in the south to Ashbrook in the north. This report describes the processing and matching analysis undertaken for morning and afternoon peak period data.

The field method involved the recording of vehicles and their registration plates using automatic number plate recognition video techniques. This was undertaken at 5 stations, three of which were two-way and two were one-way, yielding 8 observed carriageways.

Vehicle classifications were:

- cars,
- LGV,
- HGV, and
- PSV.

This report describes the approach used in the processing and matching analysis of the data, conducted in July 2012, with the inclusion of supplementary analysis for traffic movement between Zones 2 and 3. It also includes analysis undertaken in August 2012 which extracted travel time information for routes along zones 1>2>3>4 and zones 1>2>3>5. The analysis provides matrices of observed movements within the study area between the stations.

This report provides:

- an outline of data collection in Chapter 2.
- a description of how the data was processed to produce clean records in Chapter 3, along with the expansion process applied to the data.
- Chapter4 describes supplementary analysis undertaken to investigate traffic movements between Zone 2 and Zone 3.
- Chapter 5 describes supplementary analysis that investigated travel time along zones 1>2>3>4 and zones 1>2>3>5.
- Chapter 6 provides a description of the reporting outputs from the analysis.

2.0 Data Collection

2.1 Site Location

There were 8 individual carriageways observed within the study area, and these were processed by lane, yielding 18 individual traffic streams. The station numbers, road locations and station indices are tabulated below.

Table 2-1: Observation station locations and indices

Zone	Lane No	Lane Name	Camera	Road	Description	Direction	HRA index	Lane Name	Stat Name
1	1	nearside	1	A1(M)	north of Ayot Green	NB	1	1NB	1NB
1	2	middle	2	A1(M)	north of Ayot Green	NB	2	2NB	1NB
1	3	offside	3	A1(M)	north of Ayot Green	NB	3	3NB	1NB
1	3	offside	4	A1(M)	north of Ayot Green	SB	4	4SB	1SB
1	2	middle	5	A1(M)	north of Ayot Green	SB	5	5SB	1SB
1	1	nearside	6	A1(M)	north of Ayot Green	SB	6	6SB	1SB
2	1	nearside	1	A1 NB Off Slip	Junction 6	NB	7	7NB	2NB
2	2	offside	2	A1 NB Off Slip	Junction 6	NB	8	8NB	2NB
3	1	nearside	1	A1 NB On Slip	B656 Link Road/A1000/B197	NB	9	9NB	3NB
3	2	offside	2	A1 NB On Slip	B656 Link Road/A1000/B197	NB	10	10NB	3NB
4	1	nearside	1	A1(M)	Fishers Green	NB	11	11NB	4NB
4	2	offside	2	A1(M)	Fishers Green	NB	12	12NB	4NB
4	1	offside	4	A1(M)	Fishers Green	SB	13	13SB	4SB
4	2	nearside	3	A1(M)	Fishers Green	SB	14	14SB	4SB
5	1	nearside	1	Broadhall Way	east of A1(M)	EB	15	15EB	5EB
5	2	offside	2	Broadhall Way	east of A1(M)	EB	16	16EB	5EB
5	1	nearside	3	Broadhall Way	east of A1(M)	WB	17	17WB	5WB
5	2	offside	4	Broadhall Way	east of A1(M)	WB	18	18WB	5EB

The following figure shows the layout of the observation system.

Figure 1 – Observation system
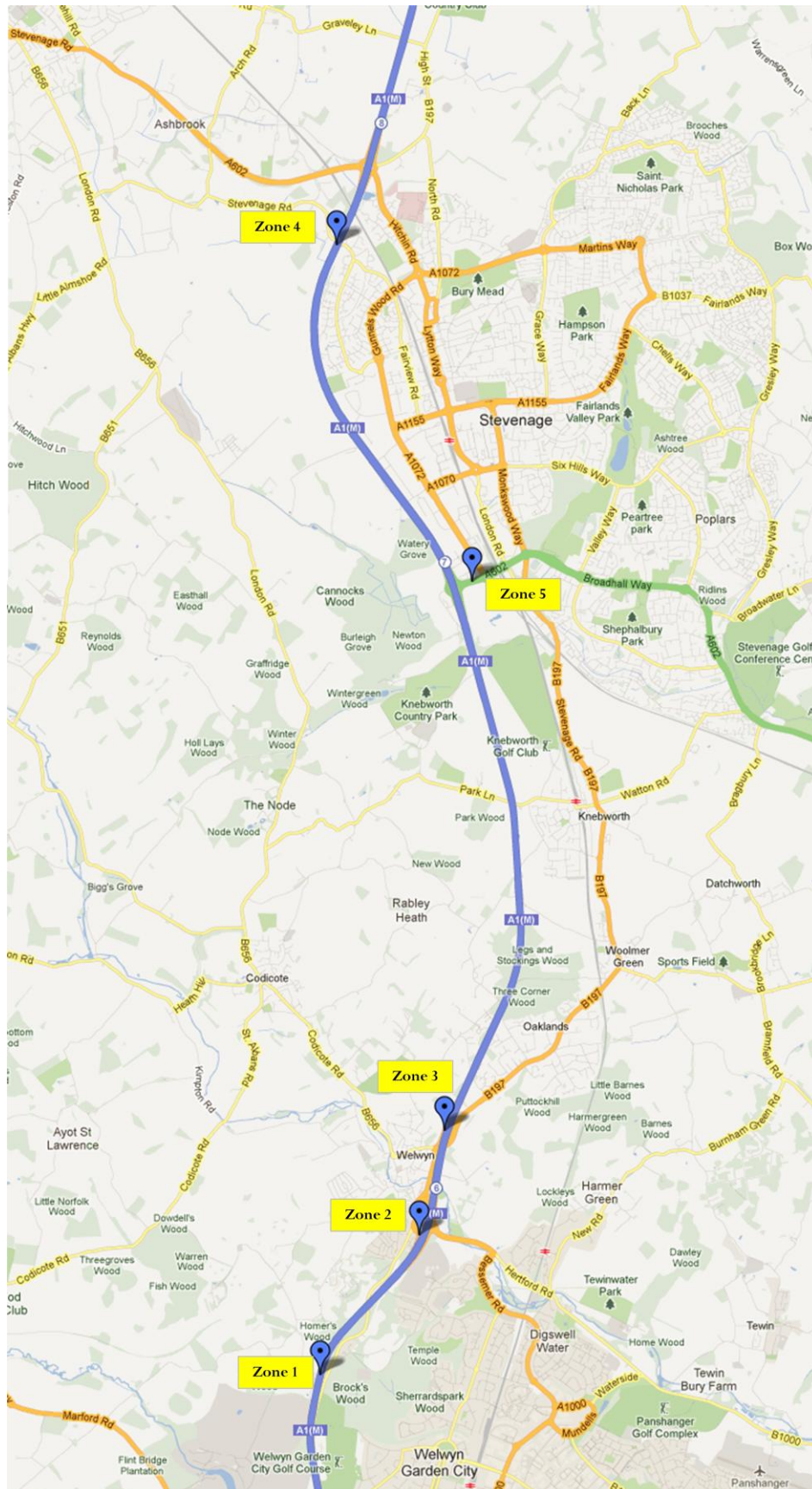
2.2 Observations

Registration plates were recorded at each station, with all character positions recorded by autoroute video and software, along with the time in HHMMSS format. Post-processing identified the vehicle class (1=light vehicles, and 2= all heavy vehicles). Where any plate character position was not entirely clear, then its number plate had a '-' recorded in that position(s) (i.e., an incomplete plate). Any registration plate with less than seven characters recorded was treated as incomplete.

The survey period covered:

- Morning peak period of 4 hours from 6:00am to 10:00am
- Evening peak period of 4 hours from 4:00pm to 8:00pm.

3.0 Data Processing and Expansion

3.1 Data processing

Raw data was processed by:

- Examining records for invalid characters and duplicates.
- Checking travel time cut offs between stations.
- Extracting feasible matches.

Invalid characters were translated to valid characters where possible – this translation almost entirely consisted of changing lower case letters to upper case, and where a non-alpha and non-numeric character was recorded, converting this to '-'. The most common edit was to change a plate of all '-' (but less than seven dashes) to all seven positions with dashes.

Further processing removed duplicate records except where records had plates of all dashes'-'. Duplicate records have identical information in them (i.e., same station, plate, time[1], class). There were 137 duplicate records in the morning period and 93 in the evening peak period.

Feasible routes through the observation system were identified – these are:

Table 3-3: Feasible routes through the observation system

From	to
1NB	2NB
1NB	4NB
1NB	5EB
3NB	4NB
3NB	5EB
4SB	1SB
4SB	5EB
5WB	1SB
5WB	4NB

Travel time distributions were explored to identify appropriate minimum and maximum travel times between stations (aggregating individual lanes at each station). The following two tables (the first for the morning peak period and the second for the evening peak period) show the travel time distributions and the travel time cut-offs extracted from them – the accepted travel time range for a trip is coloured yellow.

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[1] If identical information was contained in consecutive records at the same station, even though the time stamp had advanced, then the second record was treated as a duplicate of the first one.

Table 3-2: Inter-station travel time frequency distribution (with replacement and relaxed travel time cut-offs), morning peak period

O_D	min	max	Travel time in minutes																			
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1NB_2NB	1	2	582	37								1										
1NB_4NB	6	14						124	912	734	387	84	7	3	3	1			1		1	1
1NB_5EB	4	10					2	77	700	556	91		1	1	1			1				
3NB_4NB	5	9						63	395	197	49	2						1				
3NB_5EB	4	9					77	302	84	2		1										
4SB_1SB	6	19						5	407	396	281	203	435	300	197	145	216	329	223	132	31	
4SB_5EB	2	11		6	115	92	104	62	36	89	50	35	12	1	1					1	1	
5WB_1SB	4	10				2	126	298	604	880	265	9	4	1	1	2	1	1	1	1	2	
5WB_4NB	2	6		35	664	337	14	2			1		2			1	1					2

Table 3-3: Inter-station travel time frequency distribution (with replacement and relaxed travel time cut-offs), evening peak period

O_D	min	max	Travel time in minutes																			
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1NB_2NB	0	4	2	1041	383	81	22		1							2						
1NB_4NB	5	19					1	3	246	619	405	340	367	383	338	323	344	290	161	79	12	8
1NB_5EB	4	17	1				4	106	306	195	141	164	195	147	142	122	91	45	2	3	1	
3NB_4NB	5	12			1			62	166	264	484	247	31	1	1		2	2	2	1	1	
3NB_5EB	4	9					46	146	187	234	46	3										
4SB_1SB	5	13			1			3	234	1690	682	368	73	3	2	2		1	2	2		1
4SB_5EB	1	5		2	192	830	154		1			1				1	3	1	2		1	
5WB_1SB	4	10					18	864	904	132	4	3	1		1	1	1	2		1		1
5WB_4NB	1	9			1	30	861	812	38	2			9	4		2			1	1	1	

3.2 Expansion

Reporting of matrices includes matches (unexpanded) and expanded. Expansion has been implemented to account for incomplete registration plates and to apply weights to reflect known or implied cell volumes.

Where a character position or positions were not clear to the data recorder, then a dash ('-') was inserted in the recorded registration plate. If at least one dash was in the recorded plate, then it was precluded from further matching analysis. In order to account for this in the results, a process of expansion was applied.

Expansion factors for each station were calculated using the following approach:

Expansion factor = total plates (including those with a '-')/good plates   **[1]**

This was undertaken by class and by 15-minute period.

These expansion factors were applied multiplicatively for the first and last station observed. That is, for an observation I, passing from Station O to Station D, the expansion factor is computed using the following:

$$\text{ExpFactorObservation I} = \text{Expansion Factor Station O} * \text{Expansion Factor Station D} \qquad [2]$$

Where:

- *Expansion Factor Station O is the expansion factor calculated for origin station using [1] above*
- *Expansion Factor Station D is the expansion factor calculated for destination station using [1] above*

The survey design meant that several of the origin station to destination station matrices' cell values could be implied from the counts. This permitted the estimated frequency of matched records expanded for incomplete registration to be further weighted so that the total cell values were similar to the implied volume from the counts. It should be noted that the volumes used were, available, based on counts by class, rather than numbers of registration plates.

Some cells for which direct volumes were not available, could be deduced from knowledge about other cells' values.

There were two other cells (southbound from Station 4 to Station 1 and from Station 5 to Station 1) where if was not possible to imply or deduce volumes, unless information about traffic volumes using the southbound slip roads on and off at Hertford Road becomes available. In this case adjustment factors for similar types of cells were applied.

The following table identifies the treatment of the different cells in the matrix.

Table 3-4: Categorising volumetric adjustments

Site	Lane	HRA Ind	Site Lane *HRA Ind*	1SB near *6*	1SB mid *5*	1SB off *4*	2NB near *7*	2NB off *8*	4NB near *11*	4NB off *12*	5EB near *15*	5EB off *16*
1NB	near	1					A		D		B1	
1NB	mid	2					A		D		B1	
1NB	off	3					A		D		B1	
3NB	near	9							E		B2	
3NB	off	10							E		B2	
4SB	near	14		G:D's weights							F	
4SB	off	13		G:D's weights							F	
5WB	near	17		H:C's weights					C			
5WB	off	18		H:C's weights					C			

note:
- implied volumes
- deduced volumes
- application of other cell's weights
- infeasible

The approach used for each cell is outlined in the following table.

Table 3-5: Approach used to derive volumetric estimates for cells

Cell	Movement	Approach
A	1NB to 2NB	Volume is count site 1 approach C
B1 and B2	1NB to 5EB 3NB to 5EB	Combined volume is count site 4 movement from approach C to departure B less half leakage to Whittle Way This combined volume is then split between the two cells pro rata to the frequency of the incomplete plate expanded frequencies
C	5WB to 4NB	Count site 4 movement from approach B to departure A
D	1NB to 4NB	Volume at 1NB less estimate of 1NB to 2NB [cell A] and less estimate of 1NB to 5EB [cell B1]
E	3NB to 4NB	Volume at count site 3 departure A less estimate of 3NB to 5EB [cell B2]
F	4SB to 5EB	Volume at count site 4 movement from approach A to departure B less half leakage to Whittle Way
Whittle Way	Leakage EB on Broadhall Way	An estimate of the leakage of this link is derived by comparing count site 4 departure B with count site 5 approach D
G	4SB to 1SB	Apply weights from cell D (1NB to 4NB) which also has mainline observation stations at entry and exit points
H	5WB to 1SB	Apply weights from cell C (5WB to 4NB) which also has a mainline station at one end and ramp station at the other

The above weights were applied by hour and by class for both the quarter hour matrices and the hourly matrices. This retains the matched plate distribution by lane for the various cells when weighted.

Note that unexpanded matrices (*count of matched vehicles*), incomplete plate weighted matrices (*incomplete plate expansion factors)* and volume-weighted matrices are all reported to permit an assessment of the impact of the expansion process by the data analyst.

At site 4, camera 4 did not record data from 9am to 10am. An adjustment has been made to the matrices to account for this by taking the relatively between the two lanes in the hour commencing 8:00am and applying this ratio to the matches recorded by remaining camera at this site (site 4 camera 3) for the other lane. To illustrate:

If camera 4 had 50 matches (or weighted matches) in a cell from 8:00am to 9:00am and camera 3 had 100 matches (or weighted matches) in the corresponding cell, then the relatively for that cell is 0.5. If, between, after 9:00am a cell for camera 3 had a value of 300 recorded, then the estimate for the corresponding cell for camera 4 was 300 * 0.5 = 150. The hourly relativities were applied to hourly and quarter-hourly matrices.

4.0 Supplementary Analysis – Zone 2 & 3

In addition to the analysis described in the previous chapter, traffic movements between Zones 2 and 3 were investigated. This movement would entail northbound traffic exiting the A1(M) at Junction 6 (south of Hertford Road, then passing along the A1000 (Welwyn By-Pass Road), through three at-grade roundabout controlled junctions, prior to re-gaining the A1(M), also at Junction 6 (north of Great North Road). Clearly this movement is more circuitous than staying on the A1(M) – however, during periods of congestion, it may offer travel time savings.

The following figure indicates the alternative route with the blue line and the red arrows show the direction of travel (northbound).

Figure 2 – Zone2 to Zone 3 traffic movement
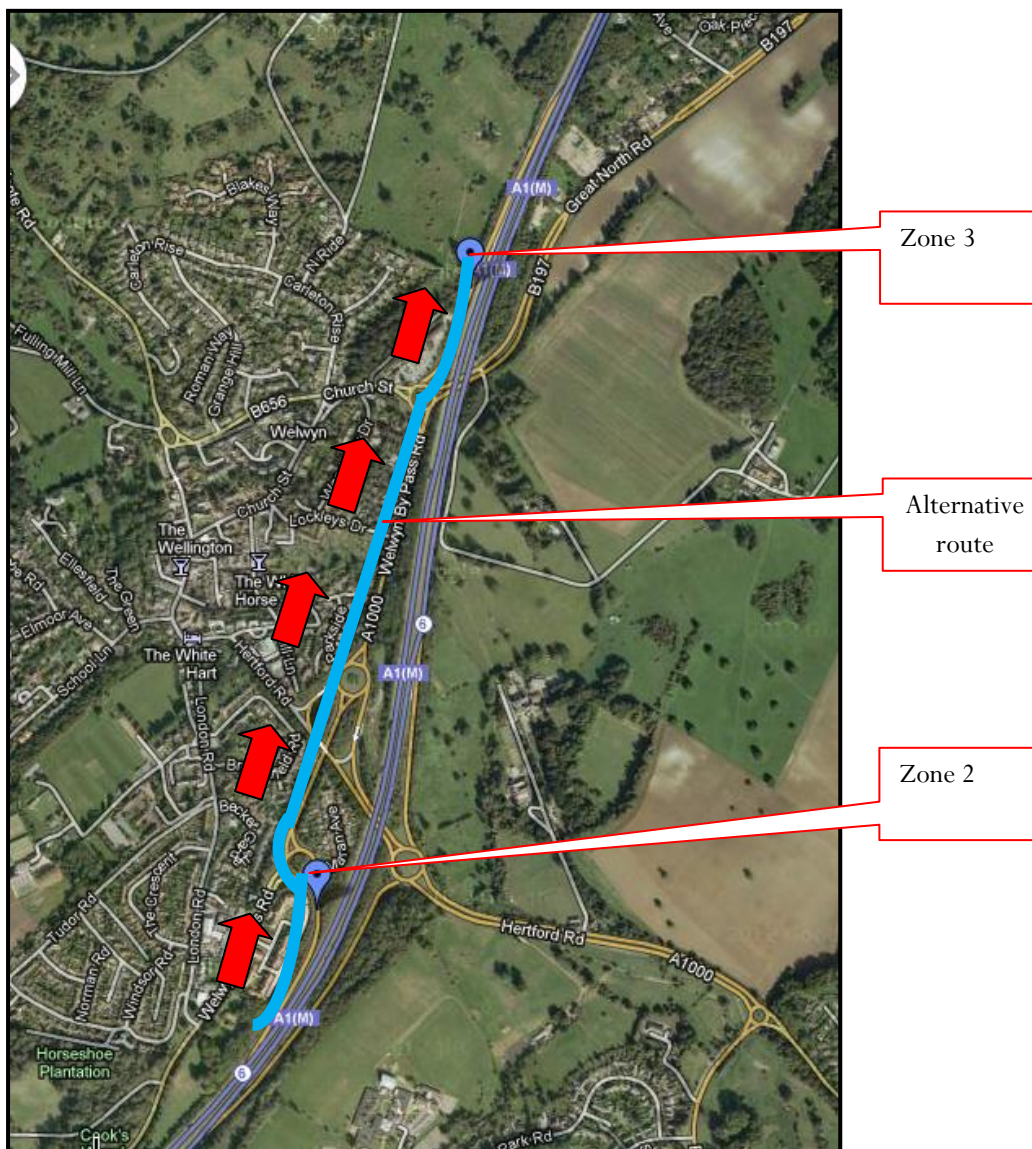
Matches between these two stations were checked to identify travel time distributions in the morning and evening peak periods. These are shown in the two tables below.

Table 4-1: Morning peak period travel time distribution, matching Zones2 & 3

Matching	Travel time minutes										
Zones	2	3	4	5	6	7	9	10	11	12	15
2_3	5	1	2	2	3	1	1	1	1	1	1

Table 4-2: Evening peak period travel time distribution, matching Zones2 & 3

Matching	Travel time minutes										
Zones	1	2	3	4	7	8	9	10	14	17	20	35
2_3	13	109	89	30	1	1	1	2	1	1	1	1

The above tables indicate few matches in the morning peak period, and a substantial number of matches in the evening peak period. A travel time cut-off of 1 minute to 10 minutes was adopted for the morning and evening peak periods for the trip extraction process. Due to the land use along the A1000, it is possible that some of these vehicles draw off the A1(M) to drop-off or pick-up passengers, rather than just being motivated by saving some travel time.

The matches were expanded by incomplete expansion factors. Due to the openness of the system between Zones 2 and 3, it is not reasonable to expand matches further to cell volumes, as it is not possible to estimate such volumes.

5.0 Travel Time Investigation

Travel time information was extracted along routes:

- 1>2>3>4, and
- 1>2>3>5.

This information was extracted for complete trips along the two routes, providing time of observation at each point. In addition, observation times at stations along partial routes were also extracted. The partial routes for which information was extracted were:

- 1>2>X>4
- X>2>3>4
- X>2>X>4
- 1>2>X>5
- X>2>X>5
- 1>2>3>X
- X>2>3>X
- X>2>3>5.

The purpose of the partial routes is to provide additional observations which may assist to characterise representative travel times through the observation system.

Of note is that the AM period has few matches along these routes.

6.0 Reporting

A set of matrices was produced for feasible matches within the travel cut-offs identified in Chapter 3. All vehicle, car, LGV, HGV and PSV matrices are provided for each hour and each quarter hour of survey.

Hourly matrices are reported in *AONE_Rep2.xlsx*:

- Counts of matches: worksheets H6_ct to H19_ct
- Incomplete plate expansions: worksheets H6_MPExp to H19_MPExp
- Volume weighting: worksheets H6_MPVolExp to H19_MPVolExp

Quarter-hour matrices are reported in *AONE_Rep2_Qrt.xlsx*:

- Counts of matches: worksheets Q600_ct to Q1945_ct
- Incomplete plate expansions: worksheets Q600_MPExp to Q1945_MPExp
- Volume weighting: worksheets Q600_MPVolExp to Q1945_MPVolExp

Supplementary analysis of Zone 2 to 3 matches *AONE_RepSupp.xlsx*:

- Counts of matches: worksheets H6_ct to H19_ct
- Incomplete plate expansions: worksheets H6_MPExp to H19_MPExp

Supplementary analysis of Zone 2 to 3 matches *AONE_RepSupp_Qrt.xlsx*:

- Counts of matches: worksheets H6_ct to H19_ct
- Incomplete plate expansions: worksheets H6_MPExp to H19_MPExp

Travel Times for routes 1>2>3>4 and 1>2>3>5 are reported in:

- *AONE_TTEXTRACT_AM.xlsx*
- *AONE_TTEXTRACT_PM.xlsx*

Each route is reported on a separate worksheet – yellow tabs are for complete routes and grey tabs are for partial routes. A line is left between observations from each hour.