

Road Network Performance & Research Team

RNPR Traffic Note 7 May 2008

Weather conditions and the levels of cycling on the Transport for London Road Network (TLRN)



Précis:

This report explores the impact of weather conditions, i.e. rainfall and temperature, on the levels of cycling experienced in London. Correlation between the variables is tested on a London-wide and site specific basis for three years: 2004, 2005 and 2006.

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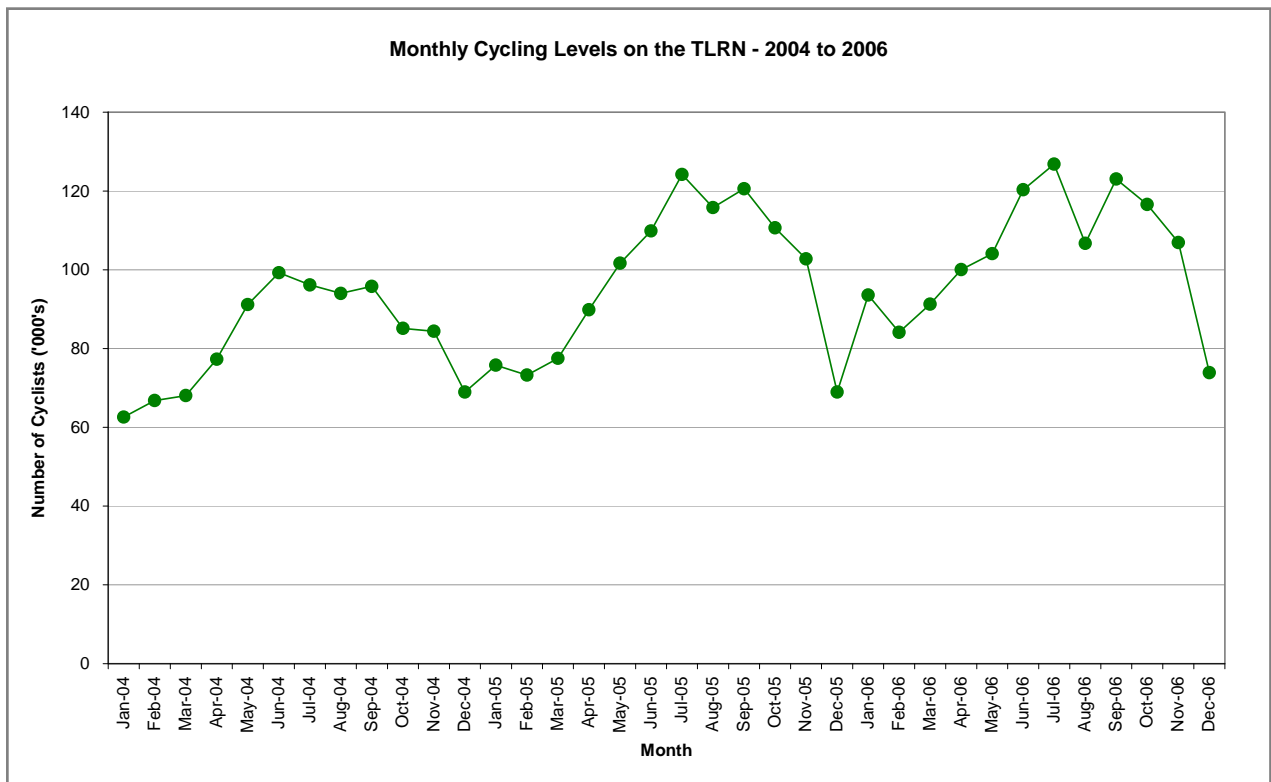
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1 Introduction

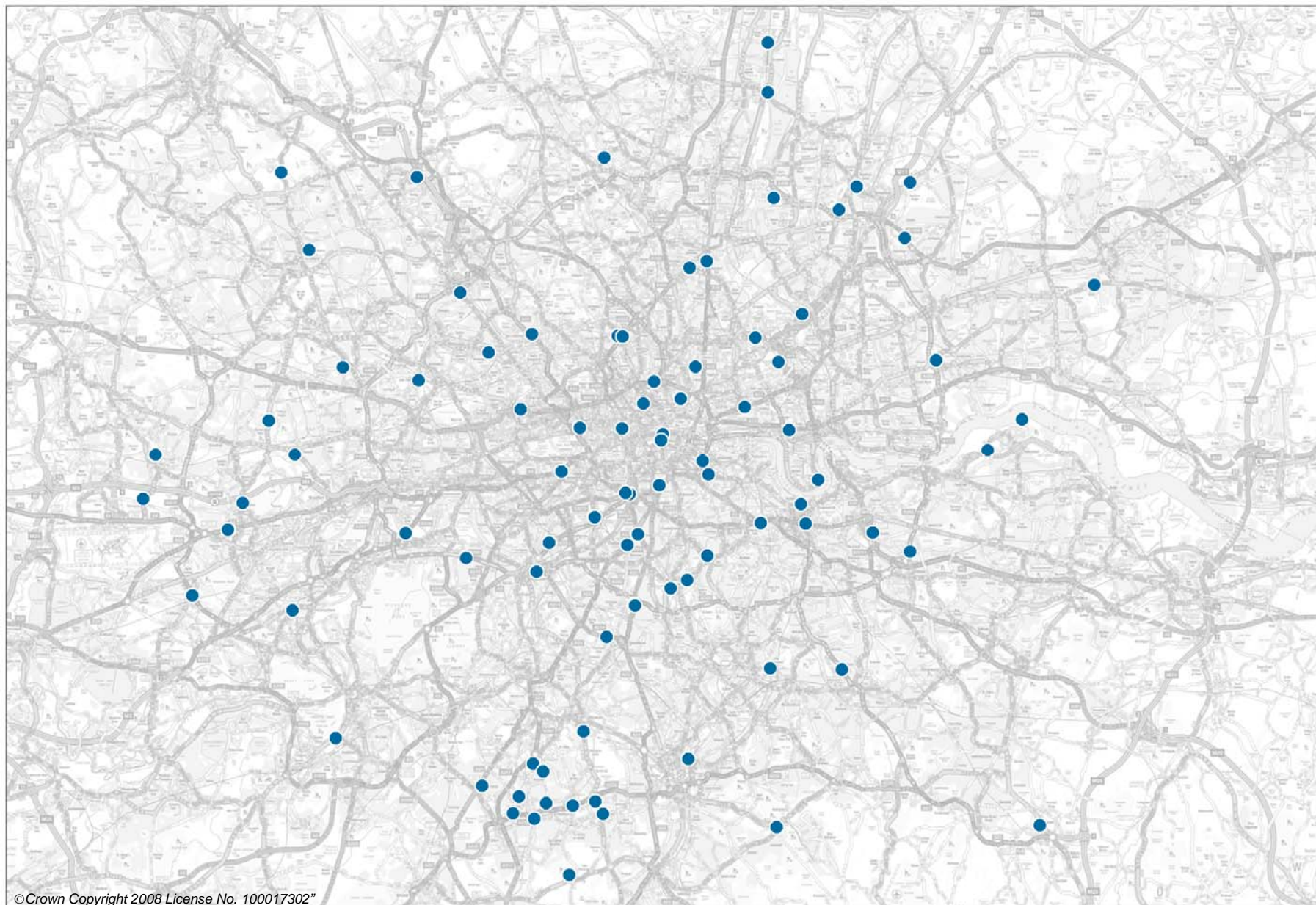
- 1.1 This traffic note, produced by Road Network Performance and Research (RNPR) within TfL, investigates the effect of weather conditions on the level of cycling across London. Various factors impact the levels of cycling month by month and day by day. One factor is the weather.
- 1.2 There is a general perception that pronounced lows and highs in cycling flows are the result of weather influences, it being generally expected that levels of cycling fall with an increase in rainfall and increase with a rise in temperature, although there may be a temperature threshold above which cycling levels begin to fall. This report sets out to test such hypotheses by comparing cycle flow trends against temperature and rainfall conditions.
- 1.3 Road Network Performance and Research currently has 92 Automatic Cycle Counters (ACCs). These are situated both on the Transport for London Road Network (TLRN) and the Borough Principal Road Network (BPRN) and continuously collect cycle count data. A map showing ACC site locations is shown in Figure 2 on Page 4.
- 1.4 Figure 1 below shows the long term trend in cycle flows on the TLRN. The graph shows cycle levels to have increased year on year between 2004 and 2006, as well as the seasonal variation over each year.

Figure 1 – Long term trend in cycle flows on the TLRN, 2004 – 2006.



- 1.5 This report will focus on a study period of three years – 2004, 2005 and 2006, looking into weather conditions and cycling levels experienced over time.
- 1.6 Figure 1 shows July 2006 to have experienced the highest levels of cycling since January 2004. This report sets out to investigate whether the high levels of cycling seen in July 2006 and the comparatively low levels recorded in August can be attributed at all to temperature and rainfall conditions. Detailed analysis of five individual ACC sites will investigate any correlation.
- 1.7 Weather data used within this report is provided to TfL by The Meteorological Office on a monthly basis. Data is extracted from the London Weather Centre monitoring site at Holborn in central London.
- 1.8 This report looks at 12-hour data (7am – 7pm).

Figure 2 – Locations of automatic cycle counters monitored by TfL London Streets



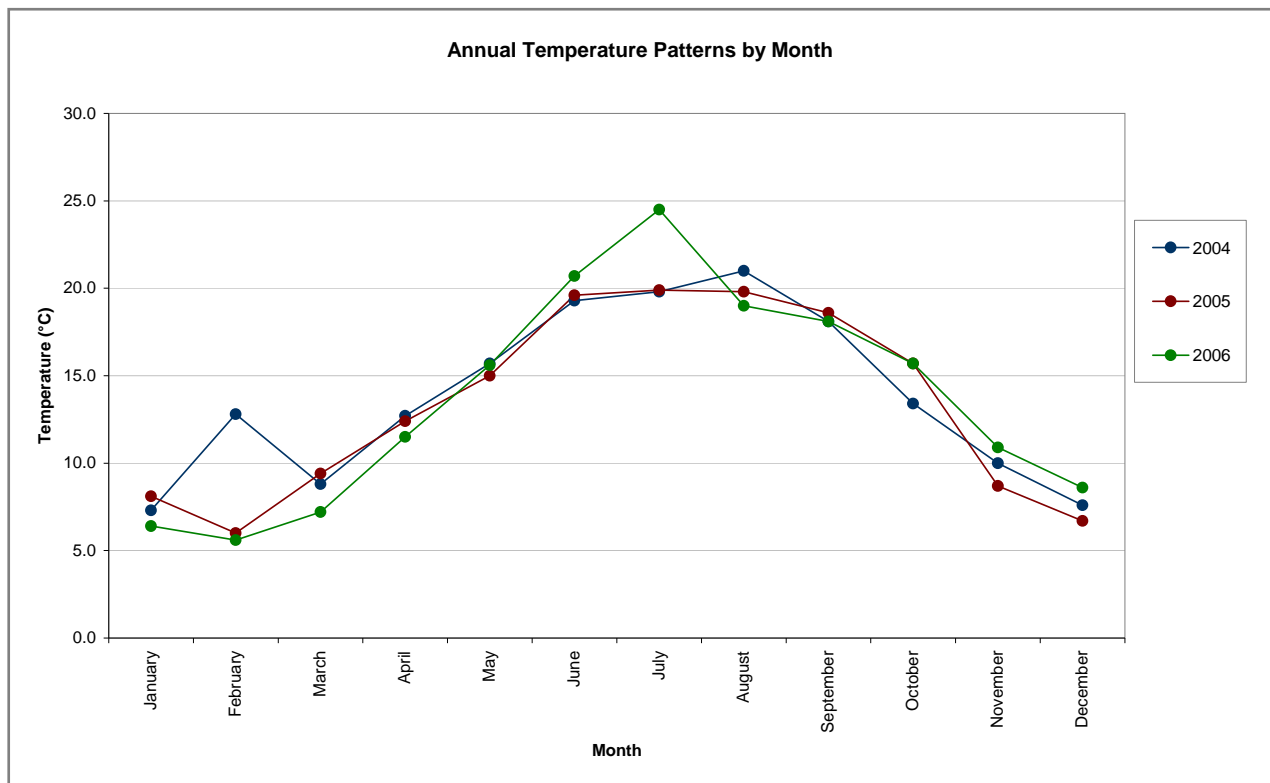
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2 Weather

2.1 This section provides an insight into weather conditions and patterns experienced in London for the years 2004, 2005 and 2006.

2.2 Figure 3 below shows month by month 12-hour average temperature variation for the three years.

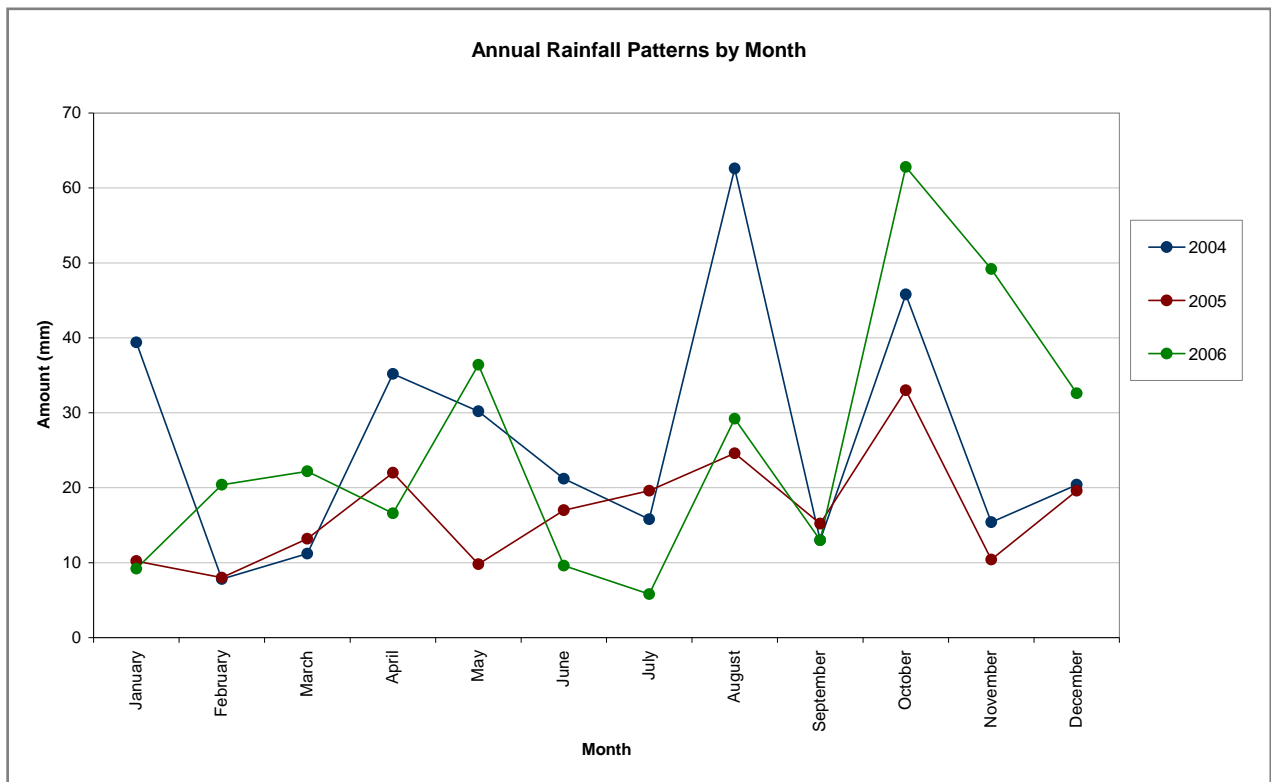
Figure 3 – Annual 12-hour average temperature patterns for London, by year and month.



2.3 Figure 3 shows average monthly temperatures to differ year on year. It dramatically highlights the higher than usual 12-hour average of 25°C seen in July 2006, when the average temperature increased to much higher levels than those recorded in July 2004 and 2005. In terms of daytime highs, temperatures of 30°C were sustained daily throughout July 2006. 2004 saw a seasonal high in February, along with the highest average temperature for the year recorded in August. However in 2005 the highest average temperature was recorded in July. 2006 experienced the highest average temperatures for November and December.

2.4 Figure 4 overleaf shows rainfall variation by month for the years 2004, 2005 and 2006.

Figure 4 – Annual 12-hour total rainfall for London, by year and month.



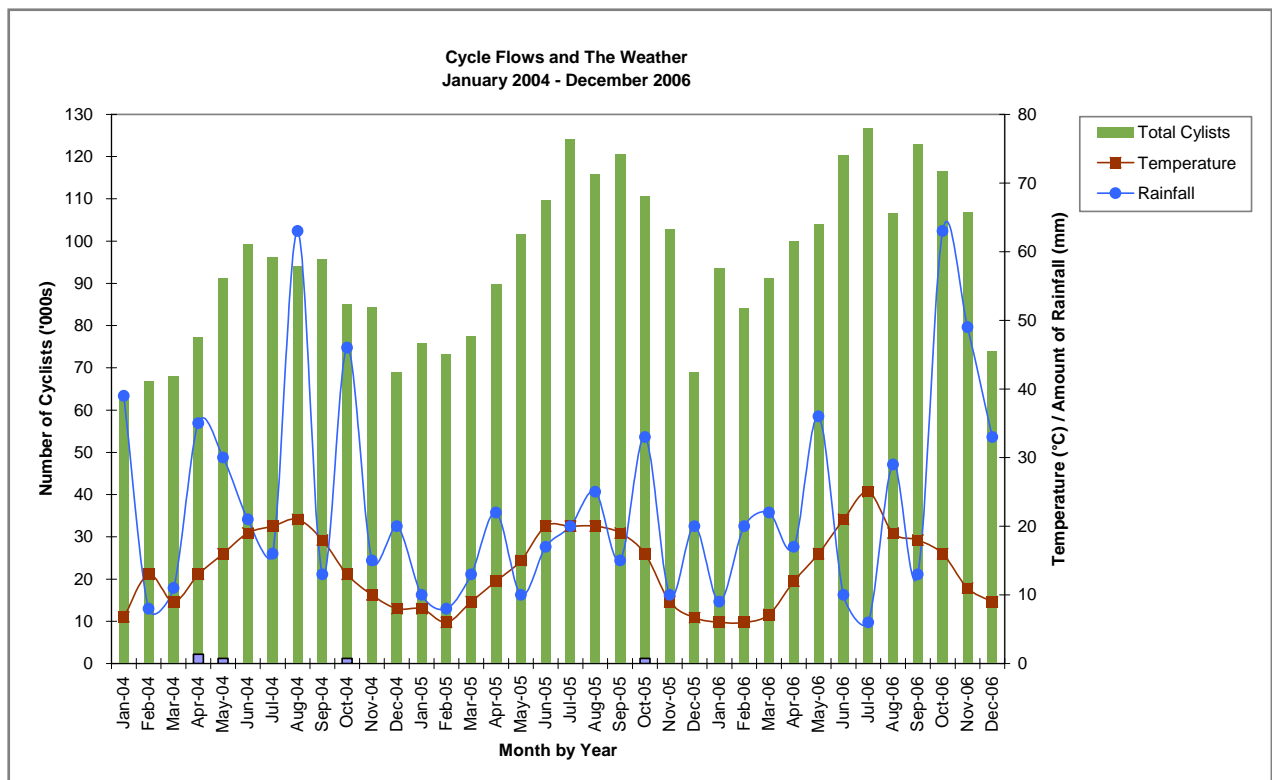
2.5 Figure 4 shows the amount of rainfall to differ widely for each month year on year. One exception is September, when, for all three years, total rainfall ranged between 13 and 15mm. Both August 2004 and October 2006 experienced the greatest amount of rainfall in a month with 63mm of rain recorded. The least amount of rainfall for the three years occurred in July 2006, when 6mm fell. 2004 was the wettest year overall.

2.6 Table 1 and Figure 5 overleaf show the number of cyclists for each study year by month, against temperature and rainfall conditions. They show the greatest volume of cycling to occur between June and September. August 2004 can be seen to have experienced both the hottest average monthly temperature and the greatest amount of rainfall for that year. However, the decrease in cyclists seen in this month compared to July that year is mirrored in both 2005 and 2006. Despite this, some figures, such as those for July and August 2006, suggest a correlation between weather conditions and the number of cyclists may exist.

Table 1 – Monthly weather conditions and cycling prevalence on the TLRN.

Month	Thousands of cyclists								
	2004			2005			2006		
	Number of Cyclists	Temp (°C)	Rainfall (mm)	Number of Cyclists	Temp (°C)	Rainfall (mm)	Number of Cyclists	Temp (°C)	Rainfall (mm)
January	63	7	39	76	8	10	94	6	9
February	67	13	8	73	6	8	84	6	20
March	68	9	11	77	9	13	91	7	22
April	77	13	35	90	12	22	100	12	17
May	91	16	30	102	15	10	104	16	36
June	99	19	21	110	20	17	120	21	10
July	96	20	16	124	20	20	127	25	6
August	94	21	63	116	20	25	107	19	29
September	96	18	13	121	19	15	123	18	13
October	85	13	46	111	16	33	117	16	63
November	84	10	15	103	9	10	107	11	49
December	69	8	20	69	7	20	74	9	33

Figure 5 – January 2004 – December 2006 TLRN cycling levels.



2.7 Figure 6 and Figure 7 overleaf show the correlation between the number of cyclists and temperature and the number of cyclists and amount of rainfall during 2006, respectively. Possible correlations range between -1 and +1. A result of -1 relates to a perfect negative correlation, +1 relates to a perfect positive correlation, and 0 relates to no correlation at all.

2.8 Figure 6 shows an apparent correlation between temperature and the number of cyclists, with a correlation coefficient of +0.86. Figure 7 suggests no correlation in existence at all between amount or rainfall and the number of cyclists in 2006, with a correlation coefficient of -0.08.

Figure 6 – Correlation chart showing number of cyclists against average temperature.

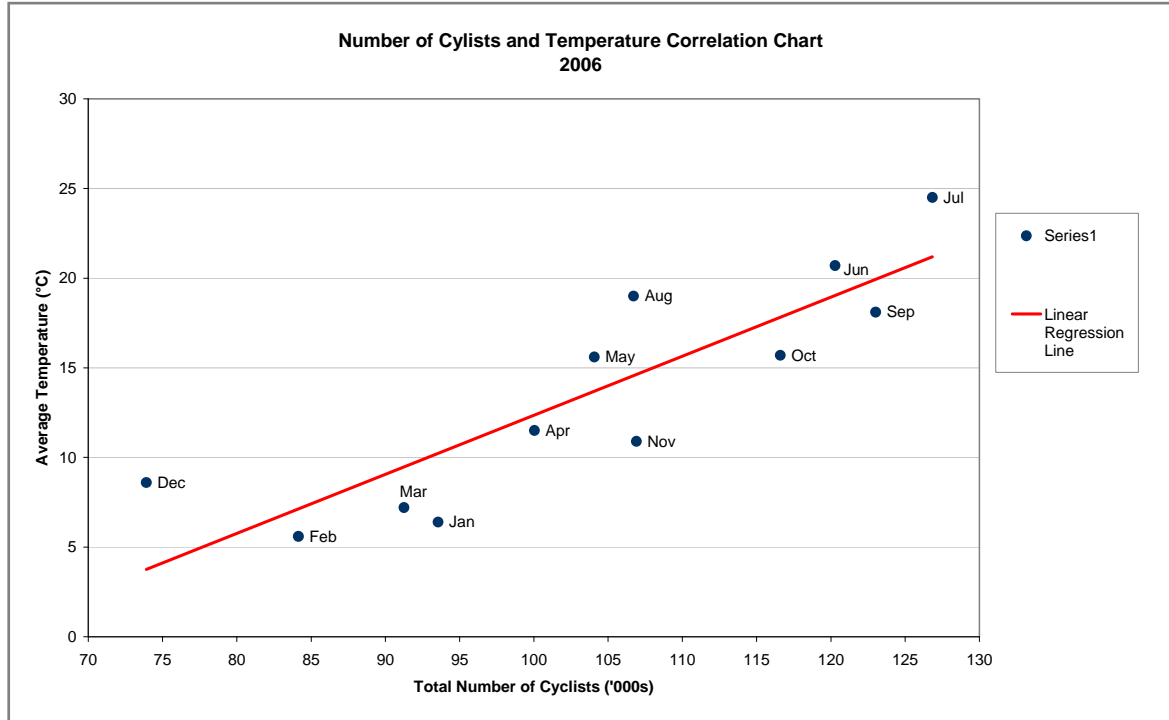
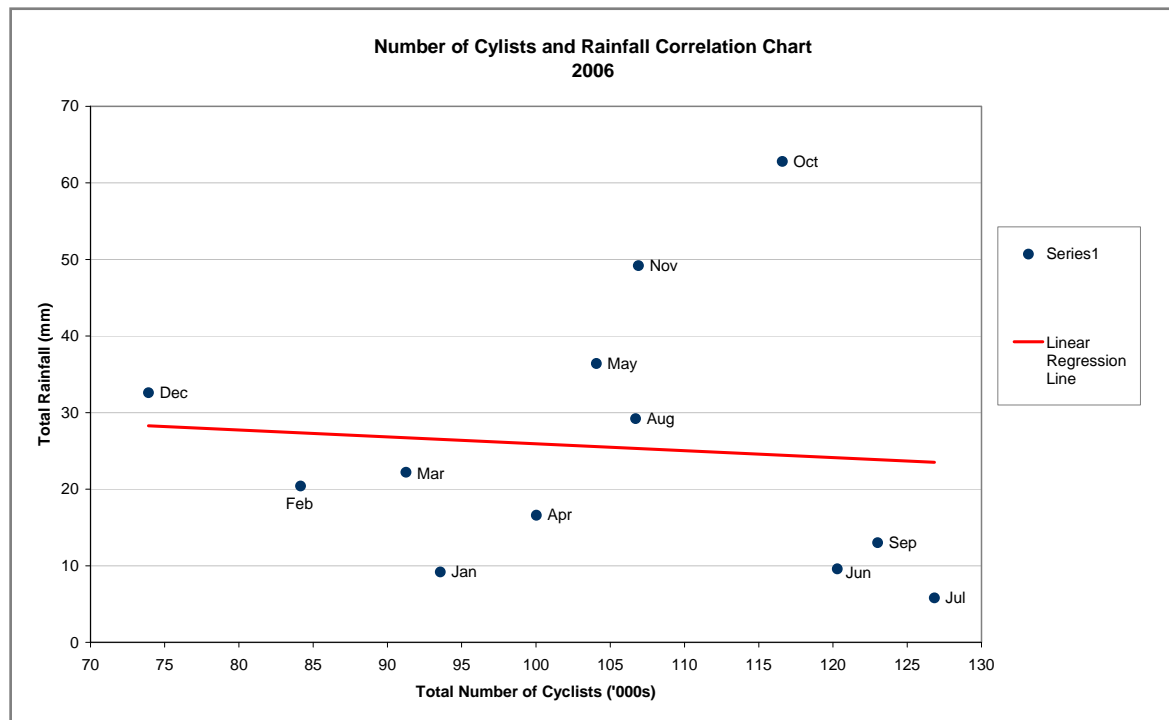


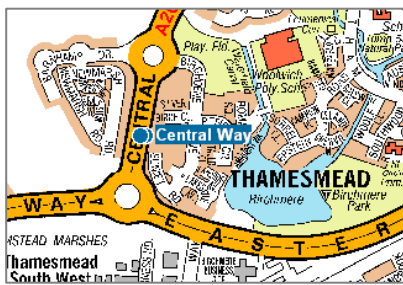
Figure 7 – Correlation chart showing number of cyclists against total rainfall.



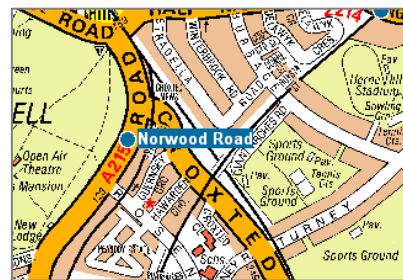
3 Detailed Site Analysis

- 3.1 As already commented, temperature and rainfall patterns over the summer months of 2006, featured acute weather conditions compared to previous years. Correlation graphs and coefficients confirm that a correlation exists between the number of cyclists and temperature.
- 3.2 This section sets out to investigate any proposed correlations further. By looking at a selection of TLRN ACC sites on a site by site basis, it is hoped that further insight into hypothesis claims and suggested correlations between variables may be attained.
- 3.3 Five sites on the TLRN were selected for more detailed analysis. These were selected on a random basis, although selection was screened to ensure a geographical spread of sites was present. The locations of these are shown below.

Site 1: Central Way



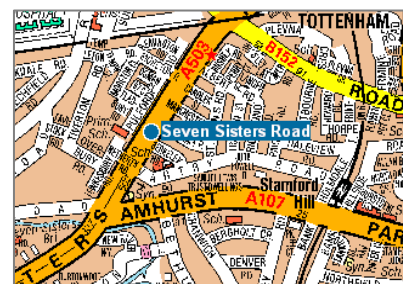
Site 2: Norwood Road



Site 3: Harlington Road East



Site 4: Seven Sisters Road



Site 5: High Road Tottenham



Site 1: Central Way

3.4 Table 2 shows the number of cyclists by direction, year and month on Central Way. Corresponding temperature and rainfall patterns are also shown.

Table 2 – Total number of cyclists at Central Way against temperature and rainfall by year, month and direction.

Year	Month	Northbound Cyclists	Southbound Cyclists	Total Cyclists	Temperature (°C)	Rainfall (mm)
2004	June	341	367	708	19	21
	July	230	341	571	20	16
	August	169	305	474	21	63
	September	222	316	538	18	13
2005	June	223	328	551	20	17
	July	216	290	506	20	20
	August	209	318	527	20	25
	September	186	258	444	19	15
2006	June	309	428	737	21	10
	July	270	385	655	25	6
	August	216	277	493	19	29
	September	277	275	552	18	13

3.5 Table 2 shows the overall total number of cyclists to range between 400 and 700, indicating relatively small daily flows at this site. The table shows September 2005 to have experienced the lowest flows and June 2006 the greatest out of the three study years. Low levels were also experienced in August 2004 and August 2006. Both 2004 and 2006 figures show August to have the lowest recorded cycle flows for the four study months in each of these years. 2005 is the exception, with its highest flows recorded in August. July 2006 can be seen to have been the hottest month for all study years. However, cycling levels for this month were lower than June 2006. Despite this, cycling levels were higher in July 2006 than in July 2004 and 2005.

3.6 To establish whether there is a correlation between the number of cyclists and the weather at this site, Figure 8 and Figure 9 overleaf show daily cyclist totals against average daily temperature and rainfall conditions for July and August 2006, respectively.

3.7 Figure 8 and Figure 9 show weekdays to be the most popular days for cycling at this site. Figure 8 shows Wednesday 19th and Wednesday 26th to be the hottest days for July, with average 12-hour temperatures of 30°C. Recorded flows for July were at their highest on the second hottest day, 26th July, suggesting temperature may affect flows at this site. The lowest temperature was recorded on Friday 14th July, a date seen to have the lowest Friday flow for July. Figure 9 shows the highest quantity of rain to have fallen on Sunday 13th August. Recorded flows suggest rain may have affected flow, with the lowest August Sunday flow seen on this date.

Figure 8 – Central Way, July cycling levels.

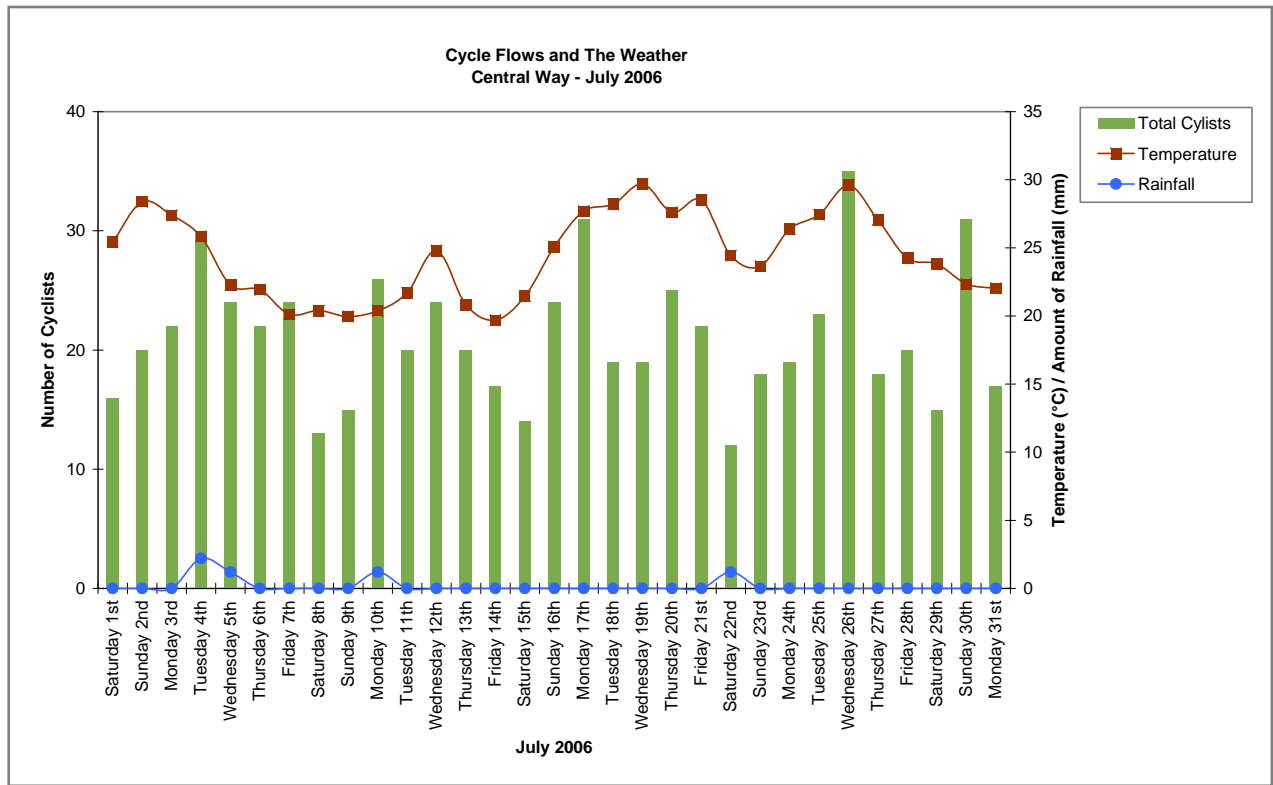
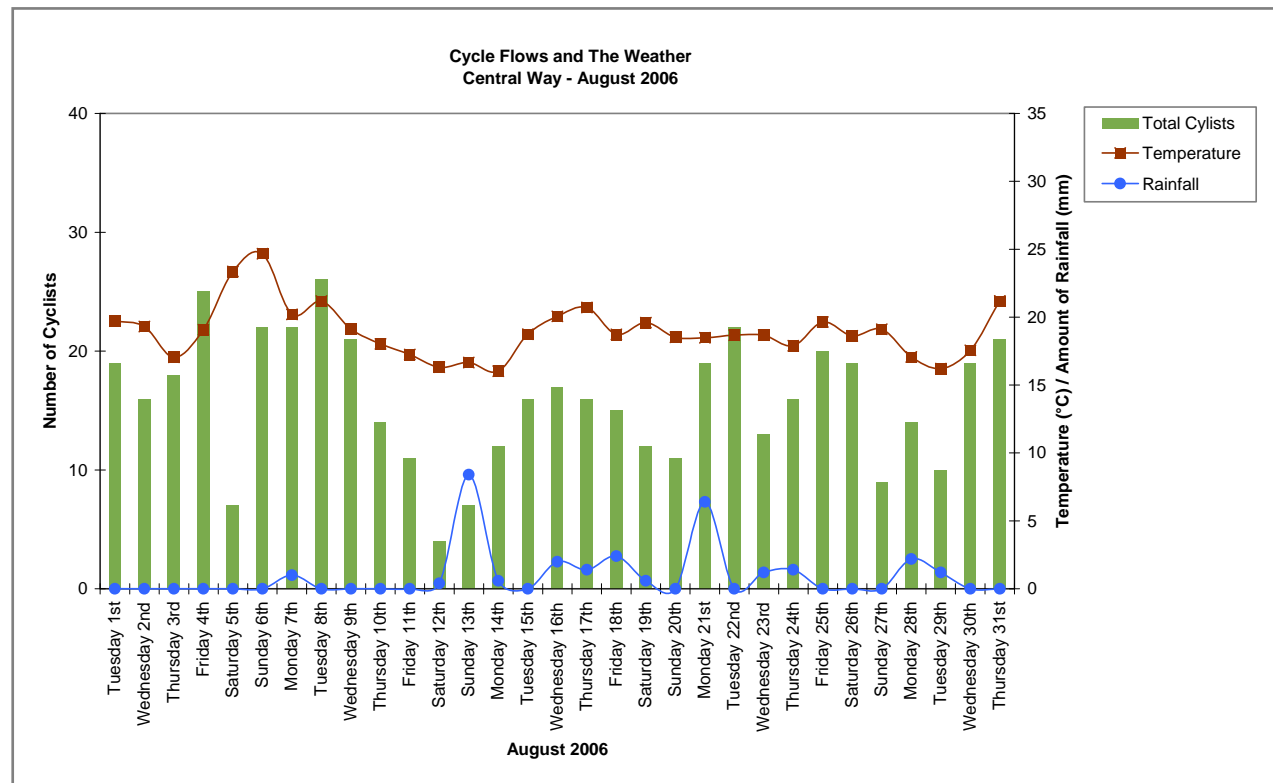


Figure 9 – Central Way, August cycling levels.



Site 2: Norwood Road

3.8 Table 3 shows the number of cyclists by direction, year and month on Norwood Road. Corresponding temperature and rainfall patterns are shown for each month.

Table 3 – Total number of cyclists at Norwood Road against temperature and rainfall by year, month and direction.

Year	Month	Northbound Cyclists	Southbound Cyclists	Total Cyclists	Temperature (°C)	Rainfall (mm)
2004	June	3,735	3,305	7,040	19	21
	July	3,727	3,335	7,062	20	16
	August	3,428	3,209	6,637	21	63
	September	3,487	3,411	6,898	18	13
2005	June	3,723	3,525	7,248	20	17
	July	4,428	4,071	8,499	20	20
	August	4,345	3,868	8,213	20	25
	September	4,467	4,360	8,827	19	15
2006	June	5,084	4,575	9,659	21	10
	July	5,750	4,818	10,568	25	6
	August	4,990	4,089	9,079	19	29
	September	5,344	4,677	10,021	18	13

- 3.9 Table 3 shows the overall total number of cyclists to range roughly between 7,000 and 11,000; the lowest in August 2004 and greatest in July 2006. Such cycling patterns appear to support the correlation hypothesis. August 2004 can be seen to experience the highest rainfall, coupled with the lowest August flows out of the three study years. Whilst a 2,000 increase on 2005 levels was experienced in July 2006, cycling levels in general appear to have increased year on year at this site.
- 3.10 To establish whether there is a correlation between the number of cyclists and the weather at this site, Figure 10 and Figure 11 overleaf show daily cyclist totals against temperature and rainfall conditions for July and August 2006, respectively.
- 3.11 Figure 10 and Figure 11 show weekdays to be the most popular days for cycling at this site. Figure 10 shows Wednesday 19th and Wednesday 26th to be the hottest days for July, with average 12-hour temperatures of 30°C. Recorded flows were at similar levels compared to preceding Wednesdays. As a result, it is not apparent whether temperature has an impact on flow levels at this site. The lowest temperature was recorded on Friday 14th July, a date seen to have the greatest Friday flow. Figure 11 shows the highest quantity of rain to have fallen on Sunday 13th August. Recorded flows suggest rain may have affected flow, with the lowest August Sunday flow seen on this date.

Figure 10 – Norwood Road, July cycling levels.

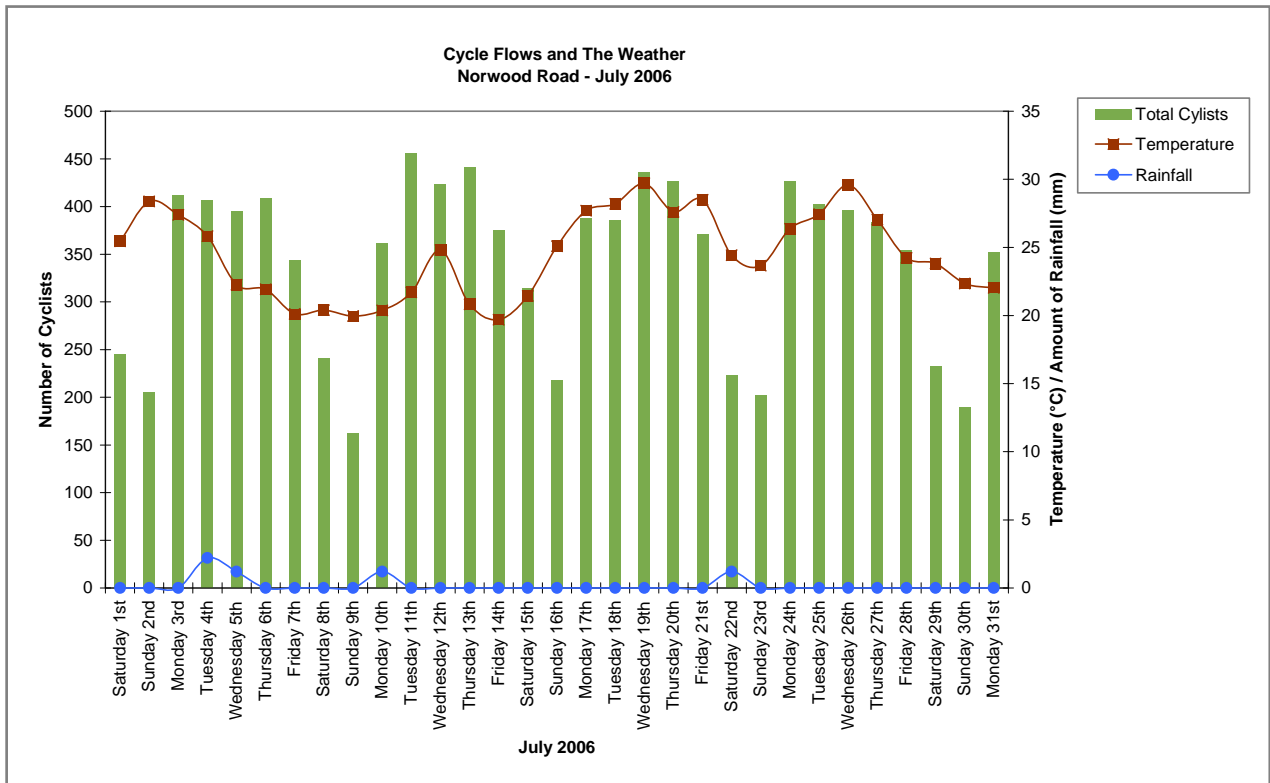
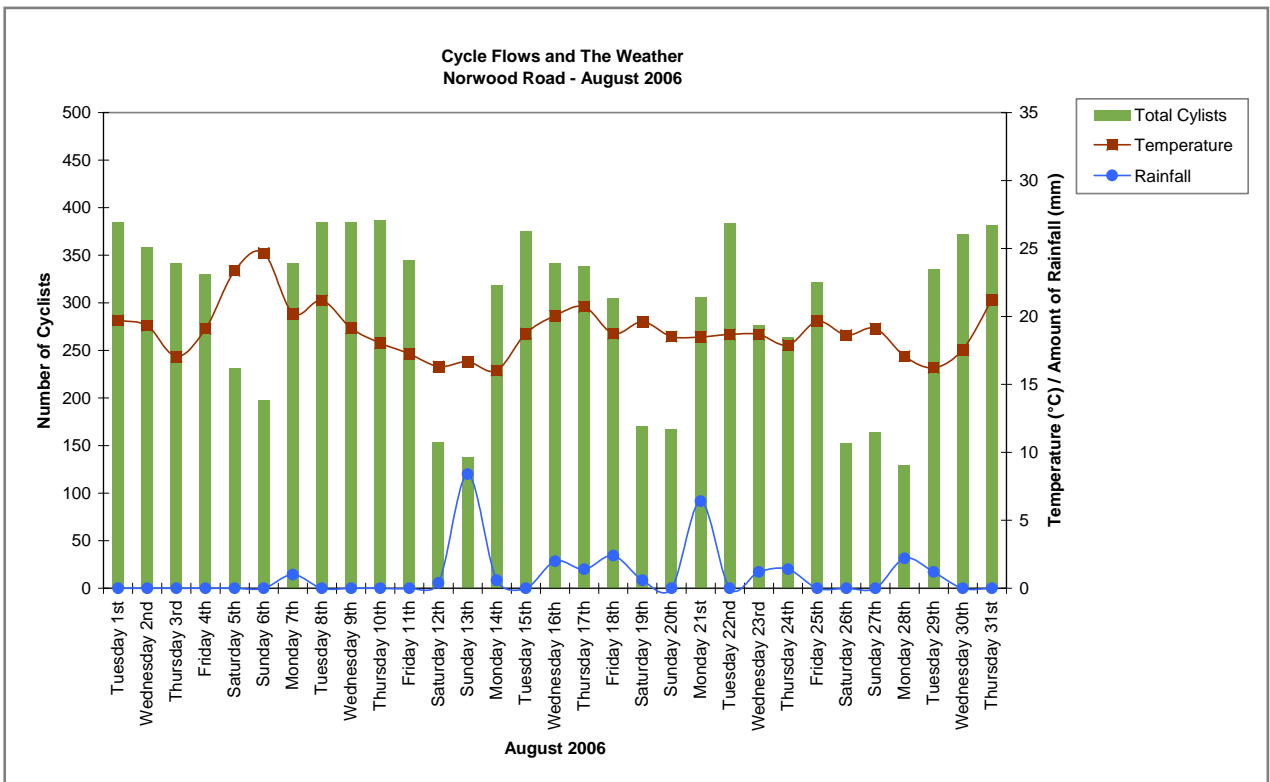


Figure 11 – Norwood Road, August cycling levels.



Site 3: Harlington Road East

3.12 Table 4 shows the number of cyclists by direction, year and month on Harlington Road East. Corresponding temperature and rainfall patterns are shown for each month.

Table 4 – Total number of cyclists at Harlington Road East against temperature and rainfall by year, month and direction.

Year	Month	Northbound Cyclists	Southbound Cyclists	Total Cyclists	Temperature (°C)	Rainfall (mm)
2004	June	735	846	1,581	19	21
	July	816	853	1,669	20	16
	August	720	740	1,460	21	63
	September	687	788	1,475	18	13
2005	June	733	1,071	1,804	20	17
	July	794	1,246	2,040	20	20
	August	742	1,343	2,085	20	25
	September	783	1,280	2,063	19	15
2006	June	1,247	858	2,105	21	10
	July	1,029	874	1,903	25	6
	August	1,116	768	1,884	19	29
	September	857	719	1,576	18	13

- 3.13 Table 4 shows the overall total number of cyclists to range between 1,500 and 2,100; the lowest in August 2004 and greatest in June 2006. August 2004 can be seen to experience the highest rainfall, coupled with the lowest August flows out of the three study years. Whilst July 2006 recorded the highest temperature, the greatest level of cycling was itself experienced in June 2006.
- 3.14 To establish whether there is a correlation between the number of cyclists and the weather at this site, Figure 12 and Figure 13 overleaf show daily cyclist totals against temperature and rainfall conditions for July and August 2006, respectively.
- 3.15 Figure 12 and Figure 13 show Thursday and Friday to be the most popular days for cycling at this site. Figure 12 shows the hottest days for July (Wednesday 19th and Wednesday 26th) to have experienced lower flow levels to those recorded on preceding July 2006 Wednesdays. The lowest temperature was recorded on Friday 14th, however, flows do not appear to have been affected. Figure 13 shows the highest quantity of rain to have fallen on Sunday 13th August. Recorded flows suggest rain is likely to have affected flow, with a considerably low August Sunday flow seen on this date. No identifiable cause is known for the notably high flow seen on 24th August.

Figure 12 – Harlington Road East, July cycling levels.

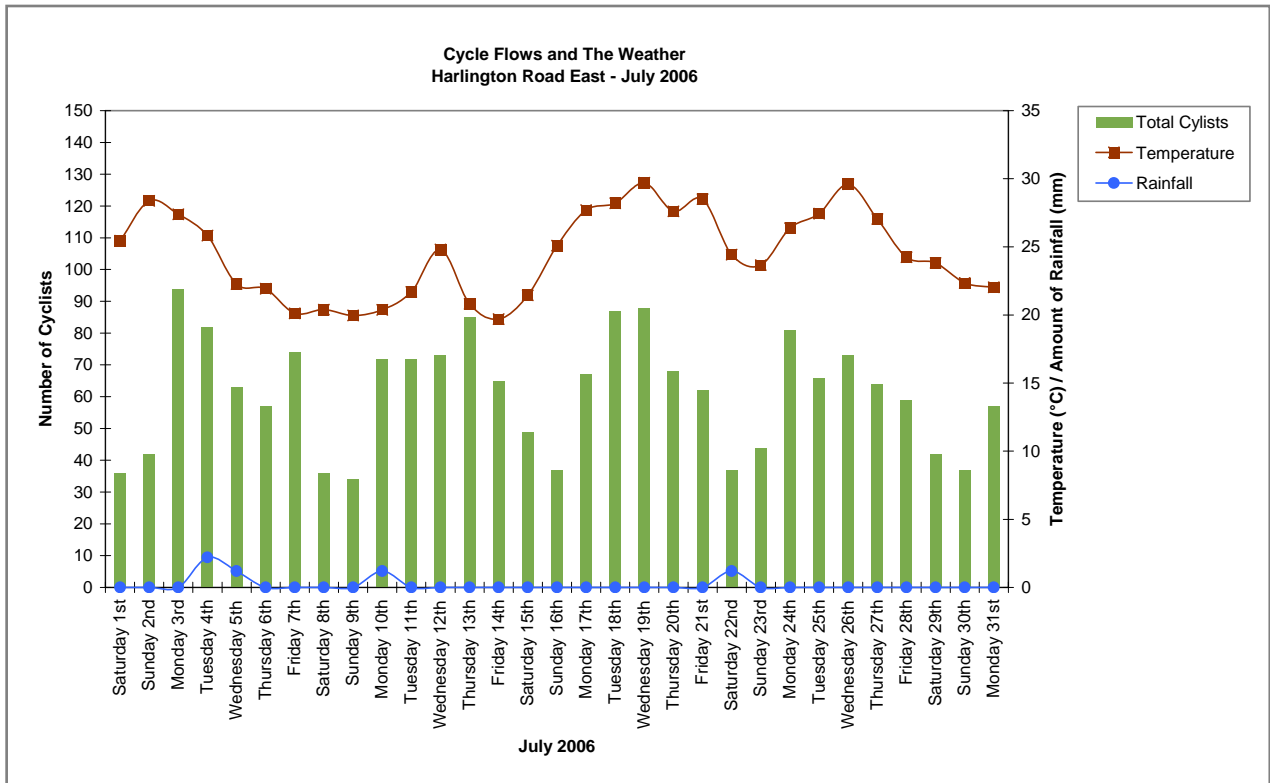
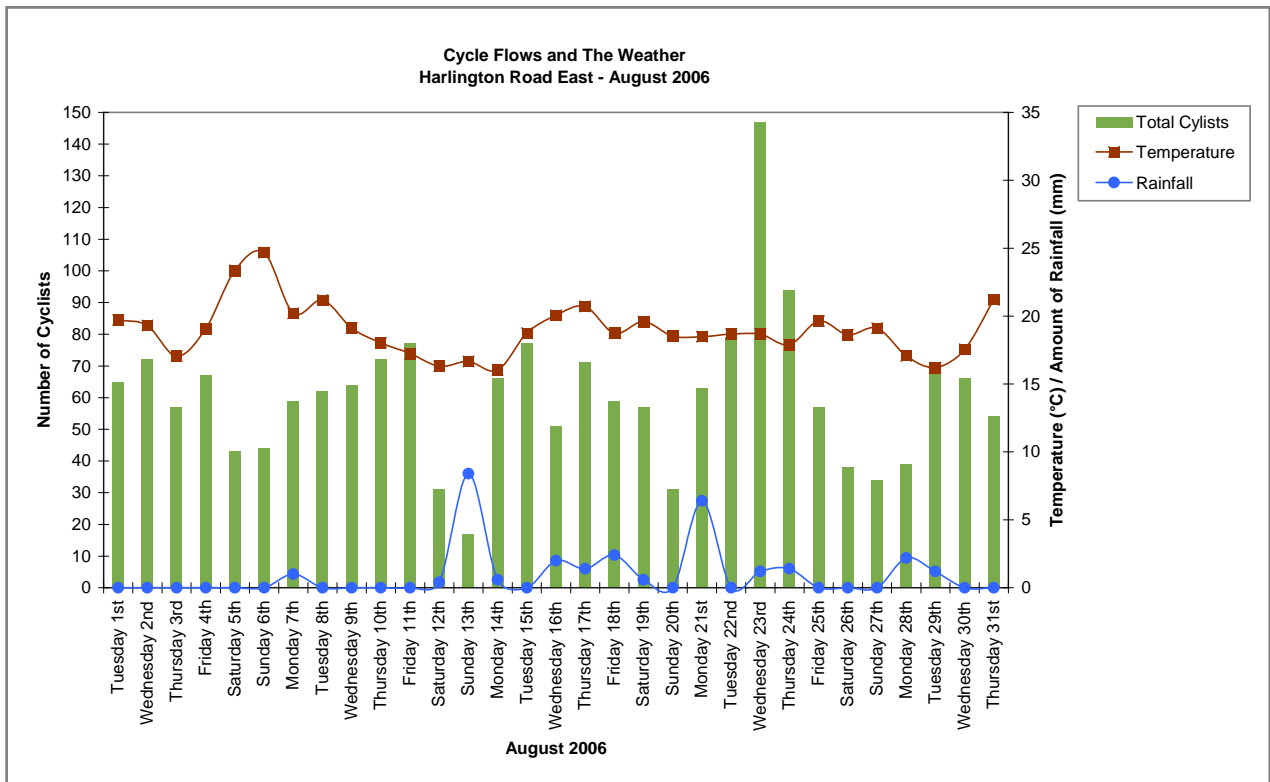


Figure 13 – Harlington Road East, August cycling levels.



Site 4: Seven Sisters Road

- 3.16 Table 5 shows the number of cyclists by direction, year and month on Seven Sisters Road. Corresponding temperature and rainfall patterns are shown for each month.

Table 5 – Total number of cyclists at Seven Sisters Road against temperature and rainfall by year, month and direction.

Year	Month	Northbound Cyclists	Southbound Cyclists	Total Cyclists	Temperature (°C)	Rainfall (mm)
2004	June	2,027	3,192	5,219	19	21
	July	1,839	2,926	4,765	20	16
	August	1,529	2,702	4,231	21	63
	September	1,788	2,452	4,240	18	13
2005	June	2,187	3,362	5,549	20	17
	July	2,684	3,759	6,443	20	20
	August	2,623	3,515	6,138	20	25
	September	2,693	3,809	6,502	19	15
2006	June	3,444	5,178	8,622	21	10
	July	3,746	5,653	9,399	25	6
	August	3,336	4,872	8,208	19	29
	September	3,482	4,972	8,454	18	13

- 3.17 Table 5 shows the total number of cyclists to range between 4,000 and 9,000; the lowest in August 2004 and greatest in July 2006. It is apparent from the figures that cycling flows at this site have risen year on year. Although not proven, weather conditions may be a contributing factor to the significantly higher figure (9,000 cyclists) recorded in July 2006 and the lowest (4,000 cyclists) recorded in August 2004.
- 3.18 To establish whether there is a correlation between the number of cyclists and the weather at this site, Figure 14 and Figure 15 overleaf show daily cyclist totals against temperature and rainfall conditions for July and August 2006, respectively.
- 3.19 Figure 14 and Figure 15 show weekdays to be the most popular days for cycling at this site. Figure 14 shows Wednesday 19th and Wednesday 26th to be the hottest days for July, with average 12-hour temperatures of 30°C. Recorded flows on these dates were similar to previous Wednesdays in this month. The lowest temperature was recorded on Friday 14th, a date seen to have the greatest Friday cycle flow. Figure 15 suggests that high quantities of rain, as seen on Sunday 13th August, have little effect on cycle flows, with similar levels of cycling to those experienced on two out of the three remaining Sundays in August evident.

Figure 14 – Seven Sisters Road, July cycling levels.

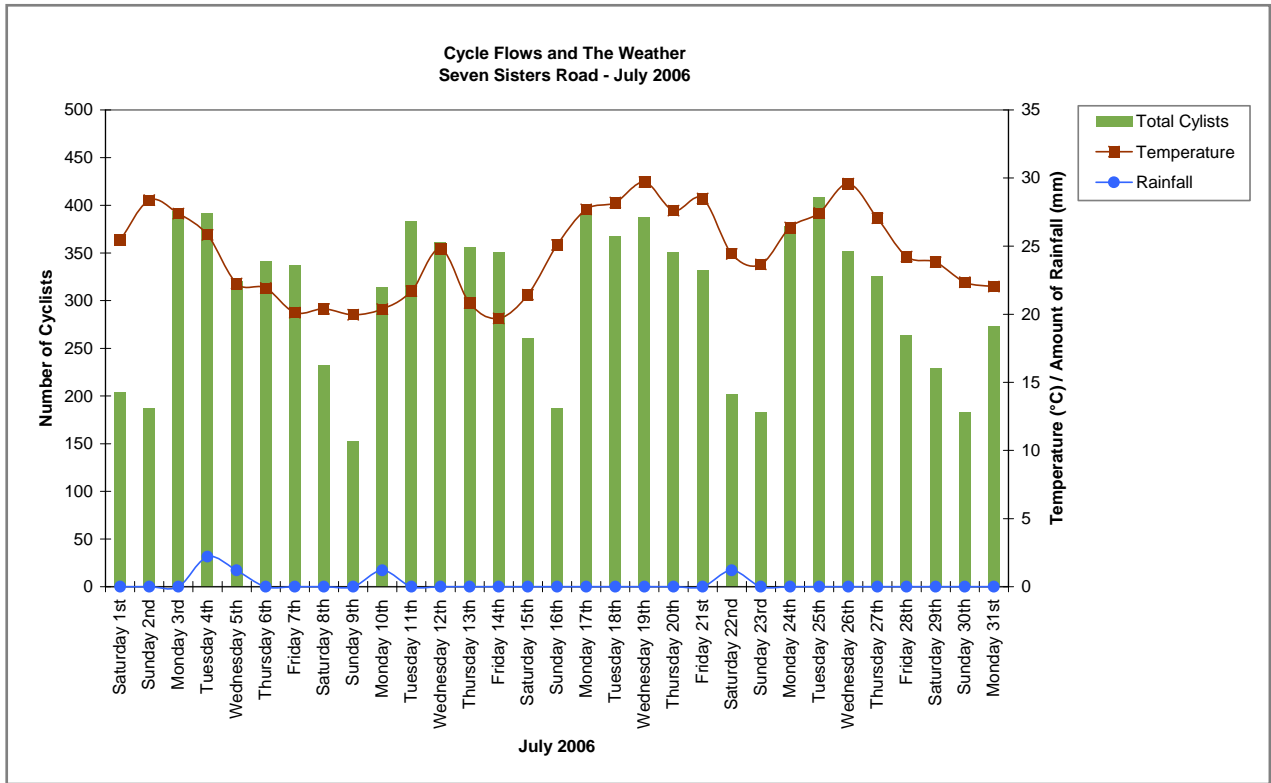
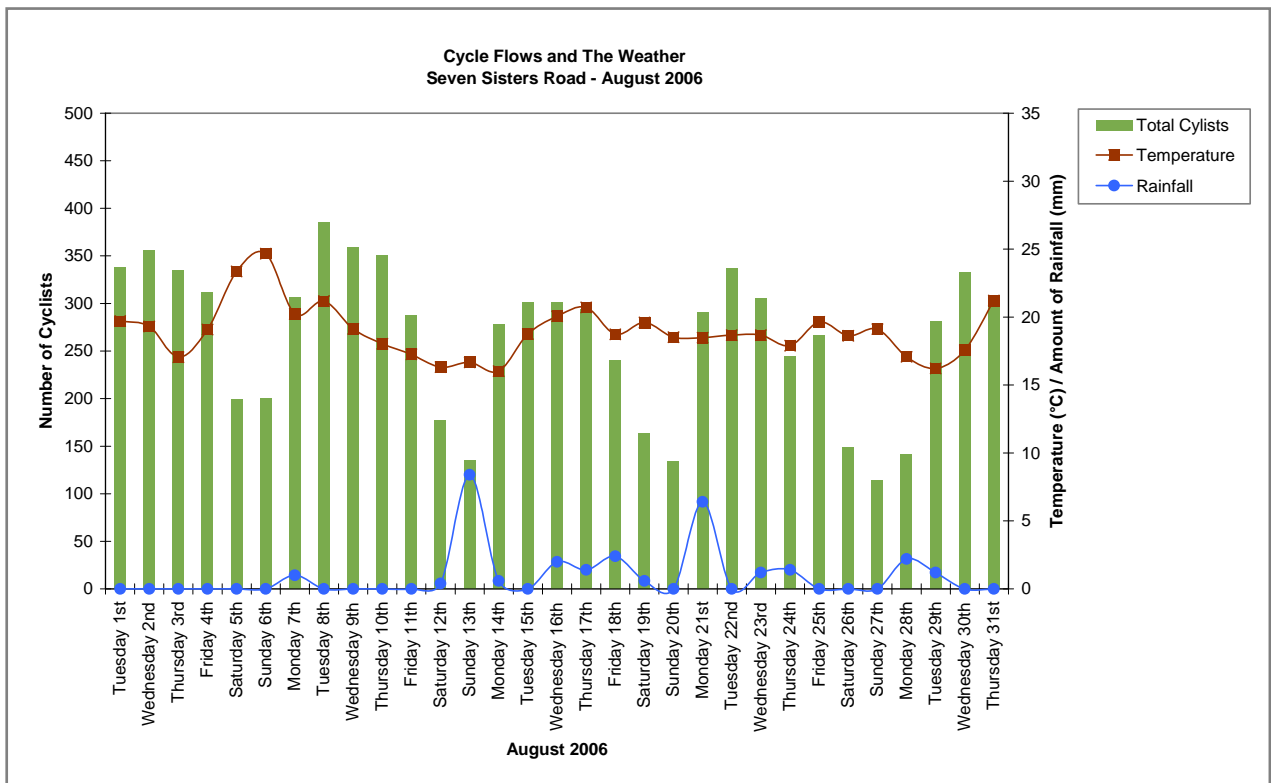


Figure 15 – Seven Sisters Road, August cycling levels.



Site 5: High Road Tottenham

3.20 Table 6 shows the number of cyclists by direction, year and month on High Road Tottenham. Corresponding temperature and rainfall patterns are shown for each month.

Table 6 – Total number of cyclists at High Road Tottenham against temperature and rainfall by year, month and direction.

Year	Month	Northbound Cyclists	Southbound Cyclists	Total Cyclists	Temperature (°C)	Rainfall (mm)
2004	June	2,988	3,648	6,636	19	21
	July	2,919	3,382	6,301	20	16
	August	2,737	3,342	6,079	21	63
	September	3,049	3,661	6,710	18	13
2005	June	3,320	4,025	7,345	20	17
	July	3,809	4,286	8,095	20	20
	August	3,583	4,197	7,780	20	25
	September	3,628	4,486	8,114	19	15
2006	June	5,319	5,647	10,966	21	10
	July	5,822	6,018	11,840	25	6
	August	5,041	5,401	10,442	19	29
	September	5,142	5,155	10,297	18	13

- 3.21 Table 6 shows the total number of cyclists to range roughly between 6,000 and 12,000; the lowest in August 2004 and greatest in July 2006. Although not proven, such cycling patterns appear to support the correlation hypotheses. However, it is worth noting that cycle flows at this site appear to have risen year on year. As a result, the recorded high of approximately 12,000 cyclists in July 2006 may not be solely attributed to the weather.
- 3.22 To establish whether there is a correlation between the number of cyclists and the weather, Figure 16 and Figure 17 overleaf show daily cyclist totals against temperature and rainfall conditions for July and August 2006, respectively.
- 3.23 Figure 16 and Figure 17 show Tuesday and Wednesday to be the most popular days for cycling at this site. Figure 16 shows Wednesday 19th and Wednesday 26th to be the hottest days for July, with average 12-hour temperatures of 30°C. Recorded flows on these dates were similar to preceding Wednesdays. The lowest temperature for July was Friday 14th, a date seen to have the greatest Friday cycle flow. Figure 17 suggests that high quantities of rain, as seen on Sunday 13th August, appear to affect the total number of cyclists, with lower levels, compared to other Sundays in August, experienced.

Figure 16 – High Road Tottenham, July cycling levels.

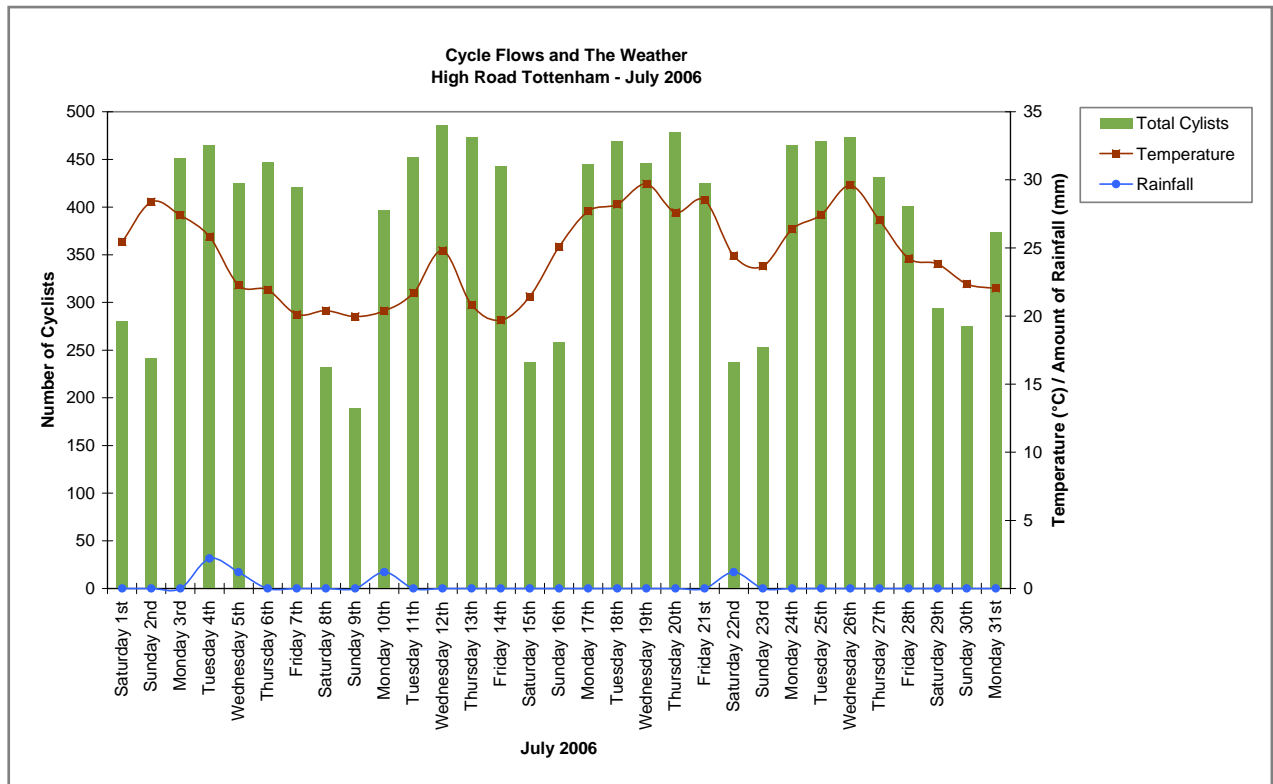
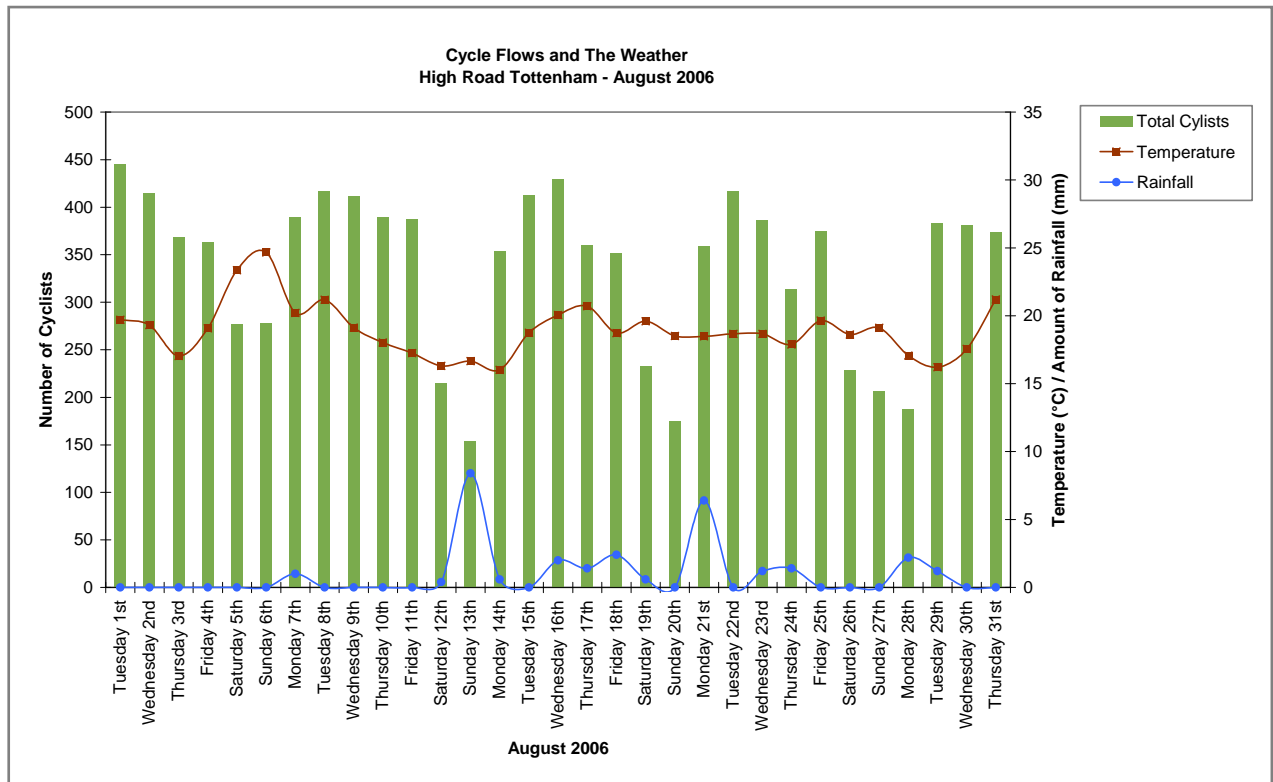


Figure 17 – High Road Tottenham, August cycling levels



4 Summary

- 4.1 The general conclusion is that some correlation is evident between prevailing weather conditions and the number of cyclists on the TLRN network. A strong positive correlation is evident between the number of cyclists and temperature. The correlation coefficient of +0.87 (ideal correlation of +1) shows this to be significant to 5%. However, correlation between the number of cyclists and rainfall is not significant at -0.23 (ideal correlation of -1).
- 4.2 Table 7 below shows correlation calculations between the number of cyclists and the weather on an individual site level. Temperature coefficients show strong positive correlations between temperature and the levels of cycling at each site, with Norwood Road being the strongest. Rainfall coefficients show a slightly different picture with only one, Harlington Road East, showing a strong, statistically significant to 5%, negative correlation between the two variables.

Table 7 – July and August Sunday temperature and rainfall correlation coefficients by site.

ACC Site	Temperature Correlation Coefficient	Rainfall Correlation Coefficient
Central Way	+0.69	-0.50
Norwood Road	+0.91	-0.64
Harlington Road East	+0.66	-0.83
Seven Sisters Road	+0.85	-0.35
High Road Tottenham	+0.80	-0.59

- 4.3 Despite the lack of significant correlation evidence between the number of cyclists and rainfall, there is an indication that rainfall may affect some cyclists' decision to ride. One possible explanation for the low significance may be that experienced rainfall extremes in London are actually themselves not extreme enough to show a correlation. It may be best to investigate this factor after periods of sustained heavy rainfall or flooding, such as that experienced in July 2007.
- 4.4 It is worth noting that cyclists can generally be classified into two types: recreational and commuter. It is likely that weather factors will affect cyclist groups in different ways. It is an appropriate assumption for the majority of cyclists at TLRN sites to be commuting. Although cyclists have not been classified for this study, it is likely that factors such as rainfall are less likely to hinder commuter cycling decisions.
- 4.5 Other factors, particularly in terms of climatic conditions such as strong winds, may also be influential in a cyclist's decision to ride. Future studies will explore the impacts of more extreme weather conditions, such as prolonged sunshine and drought and/or rainfall and flooding, in more detail. The further analyses will involve intensive analysis of day to day data, i.e. focused comparative analyses between cycling levels on days that have experienced high rainfall and those with no rainfall at all, and between days where long daylight hours and high temperatures have been experienced and days where cold conditions prevailed.

5 Library of technical notes

Other technical notes in the RNPR series include:

Technical notes

- ITIS – Validation Paper July 2005
- RNPR Technical Note 1 – ITIS Speed Survey Data
- RNPR Technical Note 2 – Traffic Delays in London on Weekdays, Saturdays and Sundays
- RNPR Technical Note 3 – Total vehicle delay for London
- RNPR Technical Note 4 - Validation of radar traffic monitoring equipment (published as an internal working document)
- RNPR Technical Note 6 - Validation of automatic traffic & cycle counters 2006 (published as an internal working document)

Traffic Notes

DfT NRTCC Counts

- RNPR Traffic Note 1 – Traffic levels on major roads in Greater London 1993-2007 (Published November 2008. Update with 2008 flows due in Autumn 2009)

TfL Automatic Traffic Counts

- RNPR Traffic Note 2 - Expansion factors for road traffic counts in London

TfL Cordon and Screenline Counts

- RNPR Traffic Note 3 – TfL Cordon and Screenlines 1975 to 2007 (2008 update due Spring 2009)
- RNPR Traffic Note 5 - Major and Minor traffic flows measured through TfL Cordon surveys

ITIS and Moving Observer Survey Data

- RNPR Traffic Note 4 – Traffic Speed in London 2003-2007 (Draft in preparation – publication date TBC)
- RNPR Traffic Note 6 – Traffic delays in the London Boroughs 2007 (published on LondonStreetWorks website)

Cycling

- RNPR Traffic Note 7 - Weather conditions and the levels of cycling on the TLRN
- RNPR Traffic Note 8 – Proportion of cyclists violating red lights
- RNPR Traffic Note 9 – Cycling trends in London (due to be published in early 2009)
- RNPR Traffic Note 10 – TfL Pedestrian and Cycle Thames Screenline Surveys 2006-2007 (due to be published in early 2009)
- RNPR Traffic Note 11 – Cycling journey time reliability (due to be published in early 2009)

6 Other useful documents

- London Travel Report 2007 –
<http://www.tfl.gov.uk/assets/downloads/corporate/London-Travel-Report-2007-final.pdf>
- Transport Statistics for Great Britain 2007 -
http://www.dft.gov.uk/162259/162469/221412/217792/2214291/TSGB2007Final_linksV12.pdf

7 Contacts for further information

7.1 If you require further information on this traffic note or have any other related queries please contact:

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8 References

- Cycling data published in this summary note are derived from Transport for London Automatic Cycle Counters.
- Weather data used in the analysis for this summary note is supplied from The Meteorological Office.