

Redditch Borough
Council

**Residential
Development,
Webheath**

Transport Assessment

FINAL

Redditch Borough Council
Residential Development, Webheath
Transport Assessment

July 2002

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1. INTRODUCTION

As part of the Local Plan Review process, Ove Arup & Partners was commissioned by Redditch Borough Council (RBC) and Worcestershire County Council (WCC) to undertake a Transport Assessment in respect of the potential residential development at Webheath, Redditch as part of the Local Plan No 3.

This report considers the viability and associated transportation issues of residential development on land in Webheath and is divided into the following Chapters:

- Chapter 2 of this report considers the site location and existing road network;
- Chapter 3 of this report considers the existing conditions;
- Chapter 4 of this report considers the proposed development and access options;
- Chapter 5 of this report considers the base traffic data;
- Chapter 6 of this report considers trip generation, traffic growth and assessment years;
- Chapter 7 of this report considers trip distribution and assignment;
- Chapter 8 of this report considers the highway impact;
- Chapter 9 of this report considers the access strategy and associated improvements;
- Chapter 10 of this report considers sustainable transport.

A separate Technical Appendix contains all of the junction capacity assessments.

2. SITE LOCATION & EXISTING ROAD NETWORK

The site is located to the south west of Redditch Town Centre. The site is bounded to the north by Pumphouse Lane and to the east by Church Road. Beyond Church Road there is significant established residential development, two schools and a series of local community shops and amenities including a post office and a dentist. The main strategic route into the area is the A448 Bromsgrove Highway with access to the site via Birchfield Road, Middle Piece Drive, Heathfield Road, Foxlydiate Lane and Church Road.

Figure 1 shows site location and the strategic and local highway network and the existing amenities.

3. EXISTING CONDITIONS

Vehicles accessing the vicinity of the site have two options for leaving the A448 Bromsgrove Highway. Vehicles can leave at the junction of the A448 Bromsgrove Highway / B4504 Windmill Drive and then travel along Middle Piece Drive and either Blackstitch Lane or Heathfield Road to Church Road. The second option is for vehicles to leave the A448 Bromsgrove Highway at the junction of A448 Bromsgrove Highway / B4096 Birchfield Road and then travel along Foxlydiat Lane to Church Road. Both routes into the area are shown on Figure 2. It should be noted that there are a number of other routes into and out of the Webheath area which will carry a small proportion of generated traffic. By focussing on the two main routes into the site and excluding others a worst case scenario will be assessed.

On-site observations suggest that whilst there are no major traffic related problems in the area there are a number of potential localised problems on Heathfield Road and at the Windmill Drive / Middle Piece Drive roundabout junction.

Heathfield Road is a narrow two-way local distributor road with residential frontage on both sides. The residential frontage on one side of the road has off-street parking whilst on the other side of the road the properties are largely terraced with no off-street parking. As a result, residents are required to park on-street. The problems are further exacerbated by a local community shop / post office part way along Heathfield Road. On street parking in the area restricts traffic to one-way working at any time causing disruption to the flow of traffic on Heathfield Road.

Traffic survey data indicates that the two-way flow in Heathfield Road is in the order of 359 and 233 vehicles during the morning and evening peak periods respectively.

Also from these site visits it was observed that there are some capacity related problems at the Middle Piece Drive / Windmill Drive roundabout junction. In particular, queuing is observed on Windmill Drive North during the evening peak hour.

For analysis purposes, the following key junctions along the two routes into the site have been identified:

- Birchfield Road / Foxlydiat Lane priority junction;
- Foxlydiat Lane / Church Road roundabout junction;
- Windmill Drive / Middle Piece Drive roundabout junction;
- Middle Piece Drive / Heathfield Road priority junction; and
- Heathfield Road / Church Road roundabout junction.

3.1 ACCIDENT SUMMARY

Worcestershire County Council provided Arup with records of personal injury accidents which occurred in the Webheath area of Redditch during the period January 1997 to December 2001 inclusive. Summaries of these accidents can be seen below in table 3.1 and 3.2.

Table 3.1: Summary of Accident Type

Accident Involving:	Slight	Serious	Fatal	Total
Vehicle	25	1		26
Cyclist/Motorcyclist	1	1		2
Pedestrian	2			2
Total	28	2		30

Table 3.2: Summary of Casualties

Casualties:	Slight	Serious	Fatal	Total
Vehicle Driver	23	2		25
Passenger	4			4
Motorcyclist		1		1
Cyclist	1			1
Pedestrian	2			2
Total	30	3		33

From the accident summaries provided accidents clusters at the following locations have been investigated:

- Birchfield Rd / A448 Bromsgrove Highway
- Heathfield Rd and Blackstitch Lane
- Middle Piece Drive / Windmill Drive
- Windmill Drive / A448 Bromsgrove Highway

3.1.1 Birchfield Rd / A448 Bromsgrove Highway

At this junction 8 accidents were identified. 2 (25%) of these accidents were serious casualties, 1 involving a motorcyclist. The remaining 6 (75%) accidents were slight casualties.

The causation of these accidents were as follows:

- 3 (38%) of the accidents involved the driver losing control of the vehicle.
- 2 (25%) of the accidents were unpredictable incidents.
- 1 (12%) was a shunt accident.
- 2 of the accidents had changing lanes as a contributing factor.

The 38% of accidents where the driver lost control may have been due to weather conditions, which were recorded as wet/damp and in one incident frost/ice.

3.1.2 Heathfield Rd and Blackstitch Lane

On Heathfield Rd and Blackstitch Lane there have been 10 accidents recorded in the 5 year period. All of these accidents were slight casualties, 1 involved a pedestrian and 1 involved a cyclist.

The causation of these accidents were as follows:

- 5 (50%) of the accidents involved right turners out from Middle Piece Drive onto Heathfield Road.
- 1 (10%) of the accidents was driver error.
- 1 (10%) of the accidents involved a pedestrian running out from between parked cars.
- 1 (10%) of the accidents involved a cyclist running into a parked vehicle.
- 1 (10%) of the accidents was due to driver illness.
- 1 (10%) of the accidents was a junction accident.

The most common factor identified with these accidents was those involving right-turners. This may be due to visibility problems or driver error. There was no identifiable weather or special conditions linking these accidents. Traffic calming measures and other such safety measures may need to be considered for this section of road.

3.1.3 Middle Piece Drive / Windmill Drive

There have been 8 accidents recorded at this junction. All of these accidents involved slight casualties with 1 involving a pedestrian.

The causation of these accidents are as follows:

- 5 (63%) of the accidents were shunt accidents.
- 1 (12%) of the accidents involved a vehicle reversing into a pedestrian.
- 1 (12%) of the accidents involved a vehicle losing control.
- 1 (12%) of the accidents was attributed to driver error.

The most common factor identified for accidents at this junction was those involving shunts. Only one of these accidents occurred during wet conditions. These shunts may be due to driving inattentively and speeding.

3.1.4 Windmill Drive / A448 Bromsgrove Highway

4 accidents were recorded at the Windmill Drive / A448 Bromsgrove Highway junction. All 4 accidents involved slight casualties.

The causation for these accidents were as follows:

- 2 (50%) of the accidents involved loss of control by the driver.
- 1 (25%) of the accidents was a shunt accident.
- 1 (25%) of the accidents was a drunk driving accident.

One of the accidents was due to wet weather conditions and another was caused by oil spillage on the road surface.

4. PROPOSED DEVELOPMENT & ACCESS OPTIONS

The proposed residential development site at Webheath can accommodate a maximum of 600 new dwellings, subject to adequate capacity on the highway network. For analysis purposes therefore, a maximum of 600 new residential dwellings will be considered.

Access to the site is constrained by existing development frontage and the topography of the local area. The following accesses have been identified for further consideration:

- Access 1 – via a revised layout of the existing Church Road / Heathfield Road / Blackstitch Lane / Green Lane roundabout junction;
- Access 2 - off Church Road;
- Access 3 - from the housing estate on Great Hocklings Lane.

The location of these accesses is shown on Figure 2.

4.1.1 Access 1 via a New Arm to Church Road / Heathfield Road Roundabout

At present Church Road / Heathfield Road is a four-arm roundabout. The junction could be modified to accommodate an access into the proposed development site. This could be achieved by realigning the Green Lane arm and creating a new priority junction between the site access and Green Lane. Green Lane is a minor road as indicated by the observed two-way flows of 160 and 72 vehicles during the morning and evening peak periods respectively.

Figure 3 shows the proposed access arrangements.

4.1.2 Access 2 off Church Road

Access to the site could be provided at the low point on Church Road (opposite Church Road no. 40-46). The two-way flows on Church Road are generally light (70 and 117 vehicles during the morning and evening peak periods respectively). Church Road in this location is 6.0m wide on average and visibility at this point is considered to be generally good.

Figure 4 shows the proposed access arrangements.

4.1.3 Access 3 off Great Hocklings Lane

Access to the site could be provided off Great Hocklings Lane. Great Hocklings Lane is a cul-de-sac of approximately 300 metres in length serving some 127 residential properties. The typical width of Great Hocklings Lane is 5.5m and the opportunity exists to extend Great Hocklings Lane across Pumphouse Lane to provide access into the site.

Figure 5 shows the proposed access arrangements.

4.2 WCC Access Design Criteria

The 'Highway Criteria Policy and Layout' document published by WCC, which is currently under review, sets out the highway requirements for new developments and details the highway hierarchy as:

- Strategic Road;
- Main Distributors;
- Local Distributors; and
- Access Roads

The document sets out the requirements for distributor road access for developments of more than 300 dwellings as a 6.7m wide carriageway, 30mph traffic speed and no frontage access.

The detailed design layout for new development defines the criteria that determines the type of access road that can be used. The type of access road that can be provided will determine the number of dwellings permitted according to the "Highway Criteria Policy and Layouts". The different options of roads are as follows:

- Distributor Roads
- Major Access Roads
- Minor Access Roads

4.2.1 Distributor Roads

Distributor roads serving more than 300 houses should be designed for a traffic speed of 30mph and be constructed with a standard road width of 6.7m and no frontage access.

4.2.2 Major Access Roads

These are roads serving between 100 and 300 dwellings and will not normally be a cul-de-sac. Where they are a cul-de-sac then the development should be restricted to a maximum of 200 dwellings and be provided with an emergency access.

The standard carriageway width should be 5.5m with a minimum footway width of 1.8m along each side of the carriageway. The layout should be designed to maintain speeds less than 30mph. This is to be achieved by limiting lengths of straight, junction radii, carriageway width and horizontal alignment.

The alignment of major access ways should limit straight lengths to not more than 80m otherwise traffic calming measures will be required. A centre line radius of 40m is required to effectively reduce speed and this will require a forward visibility of 60m along the centre line of the inner traffic lane.

4.2.3 Minor Access Roads

These are roads to serve up to 100 dwellings. The standard carriageway width should be 5.5m with a minimum footway width of 1.8m on each side where dwellings have direct access. The carriageway width may be reduced to 4.8m where less than 50 houses are served. The design and layout of these roads should ensure traffic speeds of 20mph.

4.3 Access Strategy

It is proposed that all three accesses discussed previously be developed as accesses to the proposed development site. According to WCC criteria each of these accesses can serve up to 300 dwelling when not a cul-de-sac.

The proposed major accesses at Church Road and Church Road/Heathfield Road would accommodate approximately 425 dwellings. These accesses would connect together forming a loop.

It is proposed that Great Hocklings Road caters for the approximately 125 existing dwellings and 175 new dwellings. This access road would connect onto the proposed road between Church Road and the Church Road/Heathfield Loop Road Junction.

4.4 Local Authority Highway Scheme Improvements

WCC has confirmed in discussions that there are no major highway / traffic improvement schemes planned for the area in the near future. In addition, there are no major development proposals in the area that need to be included in any assessment.

5. BASE TRAFFIC DATA

In the absence of any existing traffic data traffic surveys were undertaken between 07:30 - 09:30 hours and 16:30 -18:30 hours on Wednesday 6th February 2002 at the following locations:

- 1 - Foxlydiat Lane / Church Road Roundabout;
- 2 - Foxlydiat Lane / Birchfield Road Priority Junction;
- 3 - Heathfield Road/Birchfield Road Priority Junction;
- 4 - Middle Piece Drive / Heathfield Road Priority Junction;
- 5 - Heathfield Road / Church Road/ Blackstitch Lane/Green Lane Roundabout; and
- 6 - Windmill Drive / Middle Piece Drive Roundabout.

The survey locations are illustrated on Figure 6.

The base traffic data shows that the peak hours for trips on the local highway network are:

- Morning peak hour: 0800 hours to 0900 hours; and
- Evening peak hour: 1700 hours to 1800 hours.

Figure 7 & 8 show the morning and evening peak hour flows respectively on the highway network from the surveys undertaken.

Analysis of the surveyed junctions has been undertaken using ARCADY (for roundabouts) and PICADY (for priority junctions). The analysis is detailed in Appendix A of the Technical Appendices and is summarised below.

5.1 Foxlydiat Lane / Church Road Roundabout

Foxlydiat Lane / Church Road roundabout is a four-arm roundabout junction which provides access to a residential development off Great Hocklings Lane. The ARCADY analysis below shows that the junction operates well within capacity under existing conditions with little or no queuing delay during the morning and evening peak periods:

Table 5.1: Foxlydiat Lane / Church Road Roundabout 2002 Existing Flows

Arm	AM Pk (08:00-09:00 Hrs)		PM Pk (17:00-18:00 Hrs)	
	Max RFC	Max Queue	Max RFC	Max Queue
A – Cur Lane	0.037	0	0.039	0
B – Foxlydiat Lane	0.043	0	0.149	0
C – Church Road	0.094	0	0.090	0
D – Great Hocklings Lane	0.082	0	0.023	0

5.2 Foxlydiat Lane / Birchfield Road Priority Junction

Foxlydiat Lane / Birchfield Road is a three-arm priority junction. The PICADY analysis below shows that the junction operates well within capacity under existing conditions with little or no queuing delay during the morning and evening peak periods:

Table 5.2: Foxlydiat Lane / Birchfield Road Priority Junction 2002 Existing Flows

Arm	AM Pk (08:00-09:00 Hrs)		PM Pk (17:00-18:00 Hrs)	
	Max RFC	Max Queue	Max RFC	Max Queue
A – Birchfield Road East				
B – Foxlydiat Lane				
Left Turn	0.232	0	0.069	0
Right Turn	0.136	0	0.049	0
C – Birchfield Road West				
Right Turn	0.044	0	0.250	0

5.3 Heathfield Road/Birchfield Road Priority Junction

Heathfield Road/Birchfield Road is a three-arm priority junction. The PICADY analysis below shows that the junction operates well within capacity under existing conditions with little or no queuing delay during the morning and evening peak periods:

Table 5.3: Heathfield Road/Birchfield Road Priority Junction 2002 Existing Flows

Arm	AM Pk (08:00-09:00 Hrs)		PM Pk (17:00-18:00 Hrs)	
	Max RFC	Max Queue	Max RFC	Max Queue
A – Birchfield Road East				
B – Heathfield Road				
Left & Right Turn	0.299	0	0.178	0
C – Birchfield Road West				
Right Turn	0.150	0	0.219	0

5.4 Middle Piece Drive / Heathfield Road Priority Junction

Middle Piece Drive / Heathfield Road is a three-arm priority junction. The PICADY analysis below shows that the junction operates well within capacity under existing conditions with only minor queues and delay during the morning and evening peak periods:

Table 5.4: Middle Piece Drive / Heathfield Road Priority Junction 2002 Existing Flows

Arm	AM Pk (08:00-09:00 Hrs)		PM Pk (17:00-18:00 Hrs)	
	Max RFC	Max Queue	Max RFC	Max Queue
A – Heathfield Road (N)				
B – Middle Piece Drive				
Left & Right Turn	0.345	1	0.376	1
C – Heathfield Road (S)				
Right Turn	0.369	1	0.136	0

5.5 Heathfield Road / Church Road / Blackstitch Lane/ Green Lane Roundabout

Heathfield Road / Church Road/ Blackstitch Lane/ Green Lane roundabout is a four-arm roundabout junction. The ARCADY analysis below shows that the junction operates well within capacity under existing conditions with little or no queuing delay during the morning and evening peak periods:

Table 5.5: Heathfield Road / Church Road Roundabout 2002 Existing Flows

Arm	AM Pk (08:00-09:00 Hrs)		PM Pk (17:00-18:00 Hrs)	
	Max RFC	Max Queue	Max RFC	Max Queue
A – Heathfield Road	0.093	0	0.180	0
B – Blackstitch Lane	0.141	0	0.198	0
C – Green Lane	0.273	0	0.128	0
D – Church Road	0.252	0	0.170	0

5.6 Windmill Drive / Middle Piece Drive Roundabout

Windmill Drive / Middle Piece Drive roundabout is a four-arm roundabout junction which provides access to the Webheath residential area.

The ARCADY analysis of the Windmill Drive / Middle Piece Drive roundabout junction shows that the junction is approaching capacity during the morning peak hour with queues beginning to form on the Middle Piece Drive west approach to the junction. The junction exceeds capacity during the evening peak hour with significant queues forming on Windmill Drive north approach.

Table 5.6: Windmill Drive / Middle Piece Drive Roundabout 2002 Existing Flows

Arm	AM Pk (08:00-09:00 Hrs)		PM Pk (17:00-18:00 Hrs)	
	Max RFC	Max Queue	Max RFC	Max Queue
A – Windmill Drive (N)	0.374	1	0.934	11
B – Middle Piece Drive (E)	0.337	1	0.429	1
C – Windmill Drive (S)	0.771	3	0.390	1
D – Middle Piece Drive (W)	0.813	4	0.338	1

5.7 Summary of Year 2002 Existing Conditions Analyses

The analyses shows that at present all junctions operate within capacity at both peak hours with the exception of the Windmill Drive / Middle Piece Drive roundabout junction which is approaching capacity during the morning peak period and at capacity during the evening peak period.

6. TRIP GENERATION, ASSESSMENT YEARS & TRAFFIC GROWTH

6.1 Trip Generation

The proposed residential development will inevitably generate some additional trips in the area. It is generally difficult to quantify the level of trip generation associated with any new development as local characteristics, transportation provision and demographics from area to area will influence travel habits.

However, the existing residential area of Webheath to the north of the development site provides an ideal opportunity to collect data on local trip generation. Surveys were undertaken on 8th March 2002 to count the number of vehicles arriving and leaving the area. Figure 9 shows an area of housing which can only be accessed, from Tynsall Avenue and Springdale Avenue.

The survey area contains 469 residential properties and has an affordable housing ratio of about 11%.

The table below shows the morning and evening peak hour arrivals and departures for the 469 houses and the equivalent trip rate per household for the area.

Table 6.1: Trips and Trip Rates for the Existing Webheath Residential Area

No. of Houses	Morning Peak Hour		Evening Peak Hour	
	Arrivals	Departures	Arrivals	Departures
469 Houses	96	241	243	118
1 House	0.205	0.514	0.518	0.251
600 Houses	123	308	311	151

It is worth noting the mix of housing in the existing residential areas of Webheath and that for new residential developments in the Borough. The area surveyed contains a mix of private and affordable housing. The existing mix in the area is approximately 89% private housing and 11% affordable housing. The target for affordable housing on new residential developments is in the region of 32%. As a result, the trip rates from the survey are likely to provide a robust analysis as a higher proportion of affordable housing would typically result in lower car ownership and trip generation at peak times.

6.2 Assessment Years & Traffic Growth

For analysis purposes, the assessment years are 2002 and 2012.

Traffic growth in the area from 2002 to 2012 is expected to growth in line with NRTF (1997) and TEMPRO medium growth. The table below shows the growth factors between 2002 and 2012 based on NRTF (1997) and TEMPRO.

Table 6.2: Growth Rates

	LOW	MEDIUM	HIGH
TEMPRO3.1	1.130	1.167	1.203
NRTF (1997)	1.132	1.169	1.206

The table shows that NRTF (1997) and TEMPRO forecast similar growth rates between 2002 and 2012 with background traffic projected to grow by 16.9% on NRTF (1997) medium growth. This factor has therefore been used to establish base traffic for 2012.

Figure 10 & 11 show the 2012 morning and evening peak hour base flows (i.e. excluding development) respectively on the highway network from the surveys undertaken.

7. TRIP DISTRIBUTION AND ASSIGNMENT

Access from the strategic highway network is via two junctions on the A448 Bromsgrove Highway. Trip distribution into the development site is proposed based on existing patterns of trips into the area. For example, vehicles arriving from the northwest will use the A448 Bromsgrove Highway, exit at the junction with the B4096, along Birchfield Road and Foxlydiate Lane. It is unlikely vehicles would continue along the A448 Bromsgrove Highway and exit at the junction with Windmill Drive.

Figures 12 and 13 shows the proposed trip distribution and assignment for the morning and evening peak hours respectively whilst Figures 14 and 15 show the development trips distributed over the network for the morning and evening peak hours respectively. Two points of note are:

- The trips shown are based on an assumed 600 properties and therefore represent the worst case. Highway impact analysis may show inadequate capacity in critical areas and thus limit the size of development possible; and
- With the exception of movements at the site accesses, the overall pattern of generated trips is unchanged.

8. HIGHWAY IMPACT ANALYSIS

Figure 16 & 17 show the morning and evening peak hour base plus development flows respectively on the highway network based on the assumed 600 house residential development for the year 2002. Figure 18 & 19 show the morning and evening peak hour base plus development flows respectively on the highway network based on the assumed 600 house residential development for the year 2012.

8.1 Changes in Traffic Flows on the Highway Network

The main key links and the increase in vehicles along these routes have been identified and are summarised in the table below:

Table 8.1: Changes in Traffic Flows on the Highway Network for 2002 AM Peak

Link	Base Flows (Vehicles/hour)	Base Flows & Generated Flows (Vehicles/Hour)	Increase in Flow in Vehicles per minute
Foxlydiate Rd - Northbound	121	260	2
Foxlydiate Rd - Southbound	50	127	1
Great Hocklings Rd Northbound	79	168	1
Great Hocklings Rd Southbound	14	53	1
Church Road - Westbound	70	81	1
Church Road - Eastbound	125	167	1
Heathfield Rd - Northbound	117	189	1
Heathfield Rd - Southbound	151	181	1
Blackstitch Rd - Northbound	159	256	2
Blackstitch Rd - Southbound	84	100	0
Middle Piece Drive- Eastbound	617	786	3
Middle Piece Drive- Westbound	396	442	1
Windmill Drive North - Northbound	1202	1371	3
Windmill Drive North - Southbound	392	438	1

Table 8.2: Changes in Traffic Flows on the Highway Network for 2002 PM Peak

Link	Base Flows (Vehicles/hour)	Base Flows & Generated Flows (Vehicles/hour)	Increase in Flow in Vehicle per minute
Foxlydiate Rd - Northbound	67	147	1
Foxlydiate Rd - Southbound	192	372	3
Great Hocklings Rd Northbound	22	66	1
Great Hocklings Rd Southbound	60	150	2
Church Road - Westbound	117	149	1
Church Road - Eastbound	111	201	2
Heathfield Rd - Northbound	48	80	1
Heathfield Rd - Southbound	171	225	1
Blackstitch Rd - Northbound	76	115	1
Blackstitch Rd - Southbound	110	187	1
Middle Piece Drive- Eastbound	374	445	1
Middle Piece Drive- Westbound	567	698	2
Windmill Drive North - Northbound	467	538	1
Windmill Drive North - Southbound	1002	1133	2

Table 8.3: Changes in Traffic Flows on the Highway Network for 2012 Am Peak

Link	Base Flows (Vehicles/hour)	Base Flows & Generated Flows (Vehicles/hour)	Increase in Flow in Vehicle per minute
Foxlydiate Rd - Northbound	141	280	2
Foxlydiate Rd - Southbound	58	135	1
Great Hocklings Rd Northbound	92	181	1
Great Hocklings Rd Southbound	16	52	0
Church Road - Westbound	81	92	0
Church Road - Eastbound	72	113	1
Heathfield Rd - Northbound	136	208	1
Heathfield Rd - Southbound	176	206	1
Blackstitch Rd - Northbound	185	282	2
Blackstitch Rd - Southbound	97	113	0
Middle Piece Drive- Eastbound	720	889	3
Middle Piece Drive- Westbound	461	507	1
Windmill Drive North - Northbound	1402	1571	3
Windmill Drive North - Southbound	457	503	1

Table 8.4: Changes in Traffic Flows on the Highway Network for 2012 PM Peak

Link	Base Flows (Vehicles/hour)	Base Flows & Generated Flows (Vehicles/hour)	Increase in Flow in Vehicles per minute
Foxlydiate Rd - Northbound	77	157	1
Foxlydiate Rd - Southbound	224	404	3
Great Hocklings Rd Northbound	25	69	2
Great Hocklings Rd Southbound	70	160	2
Church Road - Westbound	136	168	1
Church Road - Eastbound	129	219	2
Heathfield Rd - Northbound	66	98	1
Heathfield Rd - Southbound	199	253	1
Blackstitch Rd - Northbound	88	127	1
Blackstitch Rd - Southbound	128	205	1
Middle Piece Drive- Eastbound	436	507	1
Middle Piece Drive- Westbound	661	792	2
Windmill Drive North - Northbound	545	616	1
Windmill Drive North - Southbound	1168	1299	2

As can be seen from the above results in both 2002 and 2012 AM Peaks the maximum increase is on Middle Piece Drive Eastbound and Windmill Drive Northbound where there is an increase of 3 vehicles per minute. Foxlydiate Road Southbound and Church Road East experiences an increase of 2 vehicles per minute. This is not a significant increase on the network and both junctions at these locations operate well within capacity for even the 2012 Base + Generated scenario.

In the PM Peak for both the 2002 and 2012 years the links that experiences the largest increases are as follows:

- Great Hocklings Road Southbound – 3 vehicles per minute
- Great Hocklings Road Northbound – 2 vehicles per minute
- Foxlydiate Road Southbound – 2 vehicles per minute
- Church Road Eastbound – 2 vehicles per minute
- Middle Piece Drive Westbound – 2 vehicles per minute
- Windmill Drive Southbound – 2 vehicles per minute

8.2 Junction Analysis 2002 Base & Generated

2002 Base & Generated junction analysis has been undertaken using ARCADY (for roundabouts) and PICADY (for priority junctions). The analysis is detailed in Appendix B of the Technical Appendices is summarised below.

8.2.1 Foxlydiate Lane / Church Road Roundabout

The ARCADY analysis below shows that the junction operates well within capacity under proposed development conditions with little or no queuing delay during the morning and evening peak periods:

Table 8.5: Foxlydiate Lane / Church Road Roundabout 2002 Base & Generated Flows

Arm	AM Pk (08:00-09:00 Hrs)		PM Pk (17:00-18:00 Hrs)	
	Max RFC	Max Queue	Max RFC	Max Queue
A – Cur Lane	0.041	0	0.041	0
B – Foxlydiate Lane	0.131	0	0.354	1
C – Church Road	0.153	0	0.139	0
D – Great Hocklings Lane	0.179	0	0.069	0

8.2.2 Foxlydiate Lane / Birchfield Road Priority Junction

Foxlydiate Lane / Birchfield Lane is a three-arm priority junction. The PICADY analysis below shows that the junction operates well within capacity under proposed development conditions with little or no queuing delay during the morning and evening peak periods:

Table 8.6: Foxlydiate Lane / Birchfield Road Priority Junction 2002 Base & Generated Flows

Arm	AM Pk (08:00-09:00 Hrs)		PM Pk (17:00-18:00 Hrs)	
	Max RFC	Max Queue	Max RFC	Max Queue
A – Birchfield Road East				
B – Foxlydiate Lane				
Left Turn	0.498	1	0.212	0
Right Turn	0.168	0	0.063	0
C – Birchfield Road West				
Right Turn	0.186	0	0.573	1

8.2.3 Heathfield Road/Birchfield Road Priority Junction

Heathfield Road/Birchfield Road is a three-arm priority junction. The PICADY analysis below shows that the junction operates well within capacity under proposed development conditions with little or no queuing delay during the morning and evening peak periods:

Table 8.7: Lower Common / Heathfield Road/Birchfield Road Priority Junction 2002 Base & Generated Flows

Arm	AM Pk (08:00-09:00 Hrs)		PM Pk (17:00-18:00 Hrs)	
	Max RFC	Max Queue	Max RFC	Max Queue
A – Birchfield Road East				
B – Heathfield Road Left & Right Turn	0.299	0	0.178	0
C – Birchfield Road West Right Turn	0.150	0	0.219	0

8.2.4 Middle Piece Drive / Heathfield Road Priority Junction

Middle Piece Drive / Heathfield Road is a three-arm priority junction. The PICADY analysis below shows that the junction operates well within capacity under proposed development conditions with only minor queues and delay during the morning and evening peak periods:

Table 8.8: Middle Piece Drive / Heathfield Road Priority Junction 2002 Base & Generated Flows

Arm	AM Pk (08:00-09:00 Hrs)		PM Pk (17:00-18:00 Hrs)	
	Max RFC	Max Queue	Max RFC	Max Queue
A – Heathfield Road (N)				
B – Middle Piece Drive Left & Right Turn	0.406	1	0.478	1
C – Heathfield Road (S) Right Turn	0.498	1	0.194	0

8.2.5 Heathfield Road / Church Road/Blackstitch Lane/Access Road Roundabout

Heathfield Road / Church Road roundabout is a four-arm roundabout junction. The ARCADY analysis below shows that the junction operates well within capacity under proposed development conditions with little or no queuing delay during the morning and evening peak periods:

Table 8.9: Heathfield Road / Church Road Roundabout 2002 Base & Generated Flows

Arm	AM Pk (08:00-09:00 Hrs)		PM Pk (17:00-18:00 Hrs)	
	Max RFC	Max Queue	Max RFC	Max Queue
A – Heathfield Road	0.159	0	0.278	0
B – Blackstitch Lane	0.172	0	0.355	1
C – Green Lane	0.495	1	0.229	0
D – Church Road	0.389	1	0.214	0

8.2.6 Windmill Drive / Middle Piece Drive Roundabout

Windmill Drive / Middle Piece Drive roundabout is a four-arm roundabout junction, which provides access to the Webheath residential area.

The ARCADY analysis of the Windmill Drive / Middle Piece Drive roundabout junction shows that the junction exceeds capacity during the morning peak hour with queues on the Middle Piece Drive West approach to the junction. The junction exceeds capacity during the evening peak hour with significant queues forming on Windmill Drive North. This result is not entirely unexpected as the Windmill Drive / Middle Piece Drive roundabout junction

forms one of the main access and egress points from the existing and proposed Webheath residential areas.

Table 8.10: Windmill Drive / Middle Piece Drive Roundabout 2012 Base & Generated Flows

Arm	AM Pk (08:00-09:00 Hrs)		PM Pk (17:00-18:00 Hrs)	
	Max RFC	Max Queue	Max RFC	Max Queue
A – Windmill Drive (N)	0.416	1	1.057	47
B – Middle Piece Drive (E)	0.345	1	0.462	1
C – Windmill Drive (S)	0.791	4	0.415	1
D – Middle Piece Drive (W)	1.035	29	0.402	1

8.3 Junction Analysis 2012 Base & Generated

2012 Base & Generated analysis has been undertaken using ARCADY (for roundabouts) and PICADY (for priority junctions). The analysis is provided in Appendix C of the Technical Appendices and is summarised below.

8.3.1 Foxlydiat Lane / Church Road Roundabout

The ARCADY analysis below shows that the junction continues to operate within capacity at 2012 with generated trips included with little or no queuing delay during the morning and evening peak periods:

Table 8.11: Foxlydiat Lane / Church Road Roundabout 2012 Base & Generated Flows

Arm	AM Pk (08:00-09:00 Hrs)		PM Pk (17:00-18:00 Hrs)	
	Max RFC	Max Queue	Max RFC	Max Queue
A – Cur Lane	0.047	0	0.047	0
B – Foxlydiat Lane	0.139	0	0.380	1
C – Church Road	0.169	0	0.156	0
D – Great Hocklings Lane	0.194	0	0.073	0

8.3.2 Foxlydiat Lane / Birchfield Road Priority Junction

The PICADY analysis below shows that the junction continues to operate within capacity at 2012 with generated trips included with minor queues and delays during the morning and evening peak periods:

Table 8.12: Foxlydiat Lane / Birchfield Road Priority Junction 2012 Base & Generated Flows

Arm	AM Pk (08:00-09:00 Hrs)		PM Pk (17:00-18:00 Hrs)	
	Max RFC	Max Queue	Max RFC	Max Queue
A – Birchfield Road East				
B – Foxlydiat Lane				
Left Turn	0.552	1	0.226	0
Right Turn	0.211	0	0.080	0
C – Birchfield Road West				
Right Turn	0.196	0	0.621	2

8.3.3 Heathfield Road / Birchfield Road Priority Junction

The PICADY analysis below shows that the junction continues to operate within capacity at 2012 with generated trips included with minor queues and delays during the morning and evening peak periods:

Table 8.13: Heathfield Road / Birchfield Road Priority Junction 2012 Base & Generated Flows

Arm	AM Pk (08:00-09:00 Hrs)		PM Pk (17:00-18:00 Hrs)	
	Max RFC	Max Queue	Max RFC	Max Queue
A – Birchfield Road East				
B – Heathfield Road Left & Right Turn	0.360	1	0.217	0
C – Birchfield Road West Right Turn	0.179	0	0.262	0

8.3.4 Middle Piece Drive / Heathfield Road Priority Junction

The PICADY analysis below shows that the junction continues to operate within capacity at 2012 with generated trips included with minor queues and delays during the morning and evening peak periods:

Table 8.14: Middle Piece Drive / Heathfield Road Priority Junction 2012 Base & Generated Flows

Arm	AM Pk (08:00-09:00 Hrs)		PM Pk (17:00-18:00 Hrs)	
	Max RFC	Max Queue	Max RFC	Max Queue
A – Heathfield Road (N)				
B – Middle Piece Drive Left & Right Turn	0.472	1	0.547	1
C – Heathfield Road (S) Right Turn	0.564	1	0.219	0

8.3.5 Heathfield Road / Church Road / Blackstitch Lane / Access Road Roundabout

The ARCADY analysis below shows that the junction continues to operate within capacity at 2012 with generated trips included with minor queues and delays during the morning and evening peak periods:

Table 8.15: Heathfield Road / Church Road Roundabout 2012 Base & Generated Flows

Arm	AM Pk (08:00-09:00 Hrs)		PM Pk (17:00-18:00 Hrs)	
	Max RFC	Max Queue	Max RFC	Max Queue
A – Heathfield Road	0.210	0	0.355	1
B – Blackstitch Lane	0.178	0	0.377	1
C – Green Lane	0.532	1	0.250	0
D – Church Road	0.445	1	0.245	0

8.3.6 Windmill Drive / Middle Piece Drive Roundabout

The ARCADY analysis of the Windmill Drive / Middle Piece Drive roundabout junction shows that the junction exceeds capacity during the morning peak and evening peak hours

with significant queues forming on the Windmill Drive south and Middle Piece Drive West approaching in the AM Peak and on Windmill Drive north in the PM peak.

Table 8.16: Windmill Drive / Middle Piece Drive Roundabout 2012 Base & Generated Flows

Arm	AM Pk (08:00-09:00 Hrs)		PM Pk (17:00-18:00 Hrs)	
	Max RFC	Max Queue	Max RFC	Max Queue
A – Windmill Drive (N)	0.475	1	1.247	156
B – Middle Piece Drive (E)	0.409	1	0.542	1
C – Windmill Drive (S)	0.960	15	0.491	1
D – Middle Piece Drive (W)	1.341	129	0.476	1

8.4 Summary of Year 2002 & 2012 Base & Generated

The analyses shows that with the exception of the Windmill Drive / Middle Piece Drive roundabout, all of the junctions can accommodate the forecast traffic from a 600 unit residential development.

The Windmill Drive / Middle Piece Drive roundabout already operates at capacity and any development is likely to require improvements to the junction to offset the potential impact. Alternatively, an access strategy could be implemented so that the impact on this junction is minimised. It should also be noted that there are other routes that may be taken in and out of the area which would reduce the traffic flows at this junction. The foregoing analysis is a worst case scenario.

These options are discussed in the next Chapter.

9. ACCESS STRATEGY & ASSOCIATED IMPROVEMENTS

9.1 Windmill Drive / Middle Piece Drive

The site survey and analysis show that Windmill Drive/Middle Piece Drive suffers from capacity problems. There is scope for improvements on the Windmill Drive north approach and Middle Piece Drive west. Widening of these lanes will increase the capacity on these arms. See Figure 20.

The improved geometry of Windmill Drive / Middle Piece Drive has been analysed using ARCADY. The tables below summarise the results of the analysis for both 2002 and 2012.

The modifications show that the operation of the roundabout in capacity terms will be better for 2002 Base and Generated than for 2002 Base Flows.

The roundabout will be operating at capacity in 2012 with the generated traffic.

Table 9.1: Windmill Drive/Middle Piece Drive Modified Junction 2002 Base & Generated Flows

Arm	AM Pk (08:00-09:00 Hrs)		PM Pk (17:00-18:00 Hrs)	
	Max RFC	Max Queue	Max RFC	Max Queue
A – Windmill Drive (N)	0.334	0	0.845	5
B – Middle Piece Drive (E)	0.346	1	486	1
C – Windmill Drive (S)	0.791	4	421	1
D – Middle Piece Drive (W)	0.793	4	324	1

Table 9.2: Windmill Drive / Middle Piece Drive Modified Junction 2012 Base & Generated Flows

Arm	AM Pk (08:00-09:00 Hrs)		PM Pk (17:00-18:00 Hrs)	
	Max RFC	Max Queue	Max RFC	Max Queue
A – Windmill Drive (N)	0.393	1	0.994	24
B – Middle Piece Drive (E)	0.421	1	0.657	2
C – Windmill Drive (S)	0.960	15	0.517	1
D – Middle Piece Drive (W)	1.003	21	0.382	1

It is considered that the operation of the junction will be satisfactory in 2012 provided modification to the layout are carried out. It should be noted that the following conservative assumptions have been made:

- The distribution of generated traffic has utilised only 2 routes whereas in reality it is likely at a proportion of the generated traffic will make use of other routes;
- The development of the generated trips was based on a residential area with a lower proportion of affordable housing than is expected to be the case for the proposed development; and
- Existing flows have been factored up by medium growth rather than the more commonly used low growth forecasts.

It should be noted that the existing roundabout does not meet current design standards. These issues will have to be addressed in the design process.

9.2 Great Hocklings Road Access

It is recommended that the extension of Gt Hocklings Road into the new development will be made by giving this road priority at its intersection with Pumphouse Lane.

Pumphouse Lane is a narrow country lane, visibility issues can more easily be resolved by giving Gt Hocklings Road priority.

The turning head on Gt Hocklings Road can be removed as part of the access provision.

See details in Figure 5.

9.3 Church Road Access

The Church Road access is to be designed in accordance with the HWCC highway design manual for new developments.

Visibility requirements can be achieved at this location. See details in Figure 4.

The PICADY analysis for this junction is detailed in Table 9.3 below. Full results are shown in Appendix D.

Table 9.3: Church Road / Site Access 2012 Base & Generated Flows

Arm	AM Pk (08:00-09:00 Hrs)		PM Pk (17:00-18:00 Hrs)	
	Max RFC	Max Queue	Max RFC	Max Queue
Site Access				
Left Turn	0.086	0	0.063	0
Right Turn	0.080	0	0.038	0
Church Road	0.080	0	0.192	0

9.4 Heathfield Road Access

The Heathfield Road / Church Road / Blackstitch Lane roundabout access has already been assessed and shown to operate satisfactorily following modification, see Figure 3.

In order to achieve the access to the development from this roundabout it will be necessary to realign Green Lane as shown in Figure 3.

The operation of the Green Lane / Site Access priority junction has been assessed using PICARDY and is set out in the table below. Full results are shown in Appendix D.

Table 9.4: Green Lane / Site Access Junction 2012 Base & Generation Flow

Arm	AM Pk (08:00-09:00 Hrs)		PM Pk (17:00-18:00 Hrs)	
	Max RFC	Max Queue	Max RFC	Max Queue
Green Lane				
Right & Left Turn	0.477	1	0.221	0
Site Access	0.000	0	0.000	0

10. SUSTAINABLE TRANSPORT

10.1 Buses

At present the area is served by a limited number of buses. Figure 21 shows bus routes in the area of the development. The table below summarises the bus times and frequencies.

Table 10.1: Summary of Bus Services

Service No.	Route	Monday - Friday		Saturday		Sunday
		Day	Evening	Day	Evening	
68	Town Centre – Webheath via Downsell Road	Every 30 mins	Replaced by 343	Every 30 mins	Replaced by 343	Replaced by 343
68A	Town Centre - Webheath via Springvale Rd	Every 30 mins	–	Every 30 mins	–	–
74	Town Centre - Hilltop	3 Journeys	–	3 Journeys	–	–
143	Birmingham-Bromsgrove – Redditch via Catshill	Every 30 mins	–	Every 30 mins	–	–
343	Catshill - Bromsgrove - Redditch	–	Hourly	–	Hourly	Hourly

It is recommended that the proposed development of the site for 600 houses be accompanied by a strengthening of bus services to serve both the proposed development and the existing residential area of Webheath. Whilst there are a number of ways to achieve this the most obvious option would be the strengthening of the Route 74 service and its diversion into the new development. Access into the development could be via Great Hocklings Lane or the new access off Church Road. The service could exit the development via the Church Road/Heathfield Road roundabout and resume its existing route. The layout for the new development shall be carried out in accordance with the HWCC document 'Highway Criteria Policy and Layouts for New Developments'. This requires that bus stops are provided within 400m of all houses. The traffic calming aspects of the highway layout will have to take into consideration the routing of buses.

It is recommended that any service development that requires subsidy should be supported for a period of 3-5 years to enable patronage to develop.

10.2 Walking

The existing residential area of Webheath has associated with it a number of walkways providing connections between cul-de-sacs. Whilst these are valuable in providing permeability of the area they have not been designed to provide access to the existing schools.

As part of the proposed development it is recommended that excellent pedestrian access be provided from the development to the existing schools in Webheath. The provision should be made in line with Safer Routes to Schools best practise and should include the following:

- Route to Mount Carmel RC School from the proposed access at Church Road (option 2). The route is to be as direct as possible and should provide for children and parents to continue on to Webheath First School;
- Pedestrian access within the development must link to this route; and
- Pedestrian provision to be in accordance with 'Highway Criteria Policy and Layouts'.

10.3 Cycling

All pedestrian links within the development are to be designed to accommodate cyclists. In particular the route linking the development to the Mount Carmel RC School and Downsell Road shall have adequate width to accommodate both pedestrians and cyclists at school leaving time. Cycle linkage from the development to the centre of Redditch is to be considered as part of the development proposals.

The provision for cyclists shall follow the guidelines set out in 'Highway Criteria Policy and Layouts'.

10.4 Green Travel Plan

The proposed development will require a Green Travel Plan which will identify ways in which the impact of traffic generation will be mitigated.

11. CONCLUSION

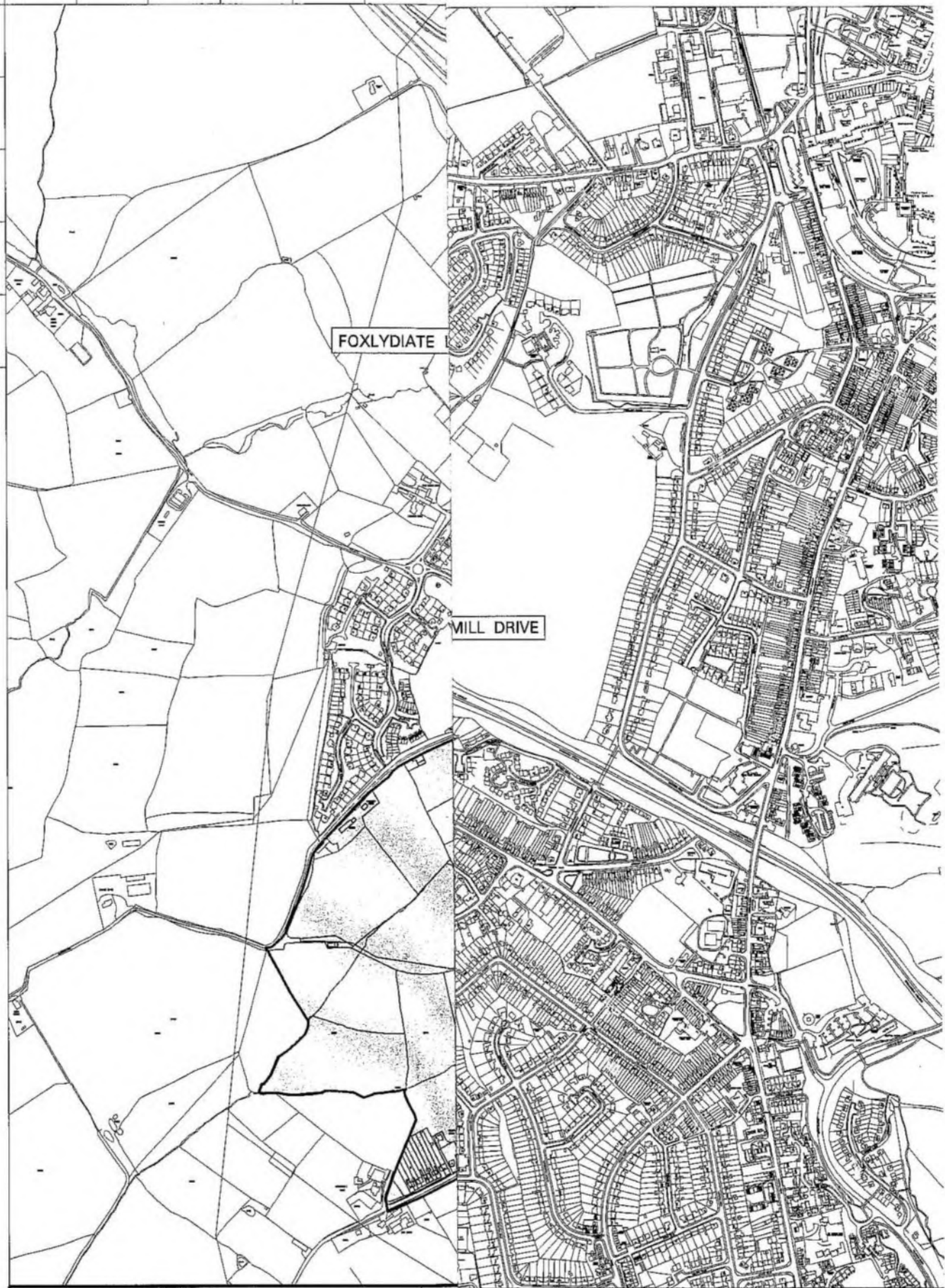
The development at Webheath of 600 houses can be accommodated in traffic terms with the following provisions:

- Access via Great Hocklings Road linking into an internal site loop road.
- Access via Church Road
- Access via a modified roundabout junction at Heathfield Road/Church Road/Blackstitch Lane together with a realignment of Green Lane.
- Modifications to the Windmill Drive/Middle Piece Drive roundabout.
- Provision of bus services into the new development.
- Provision of pedestrian and cycle links within the development and from the Church Road access to Mount Carmel RC School.
- Consideration to be given to traffic calming measures on Heathfield Road and Blackstitch Lane given the accidents identified on the roads and the increased flows.
- Highway infrastructure to be developed in accordance with the HWCC Highway Criteria Policy and Layouts for New Developments.

FIGURES

5cm

5cm



FOXLYDIATE

MILL DRIVE

Date	Scale
30/1/2001	1:10000
Drawn	Drawing No.
NAS	FIGURE 1

R
W



SITE

5cm SCALE WITH CAUTION AS DISTORTION CAN OCCUR

5cm



Date	30/11/2001	Scale	1:10000
Drawn	NAS	Drawing No.	FIGURE 1

RESIDENTIAL DEVELOPMENT
WEBHEATH REDDITCH

AREA IN VICINITY OF SITE



5cm SCALE WITH CAUTION AS DISTORTION CAN OCCUR

5cm



Date 09/07/02	Scale 1:10000	RESIDENTIAL DEVELOPMENT WEBHEATH REDDITCH	PROPOSED ACCESS OPTIONS	KEY ■■■■ ROUTES INTO THE AREA
Drawn CAB	Drawing No. FIGURE 2			

5cm SCALE WITH CAUTION AS DISTORTION CAN OCCUR

HILL

Upper Norgrove House

Shelter

160

HEATHFIELD ROAD

185
185

PROPOSED MINI ROUNDABOUT

BLACKSTITCH LANE

ACCESS TO RESIDENTIAL DEVELOPMENT

5.5m

R=6m

R=6m

R=40m

5.5m

R=40m

19

24

GREEN LANE

20

NOTE:
60m VISIBILITY SPLAY WILL BE
REQUIRED AT THE JUNCTION OF
CRUMPFIELDS LANE /GREEN LANE

Date	Scale
09/07/02	1:500
Drawn	Drawing No.
CAB	FIGURE 3

RESIDENTIAL DEVELOPMENT
WEBHEATH
REDDITCH

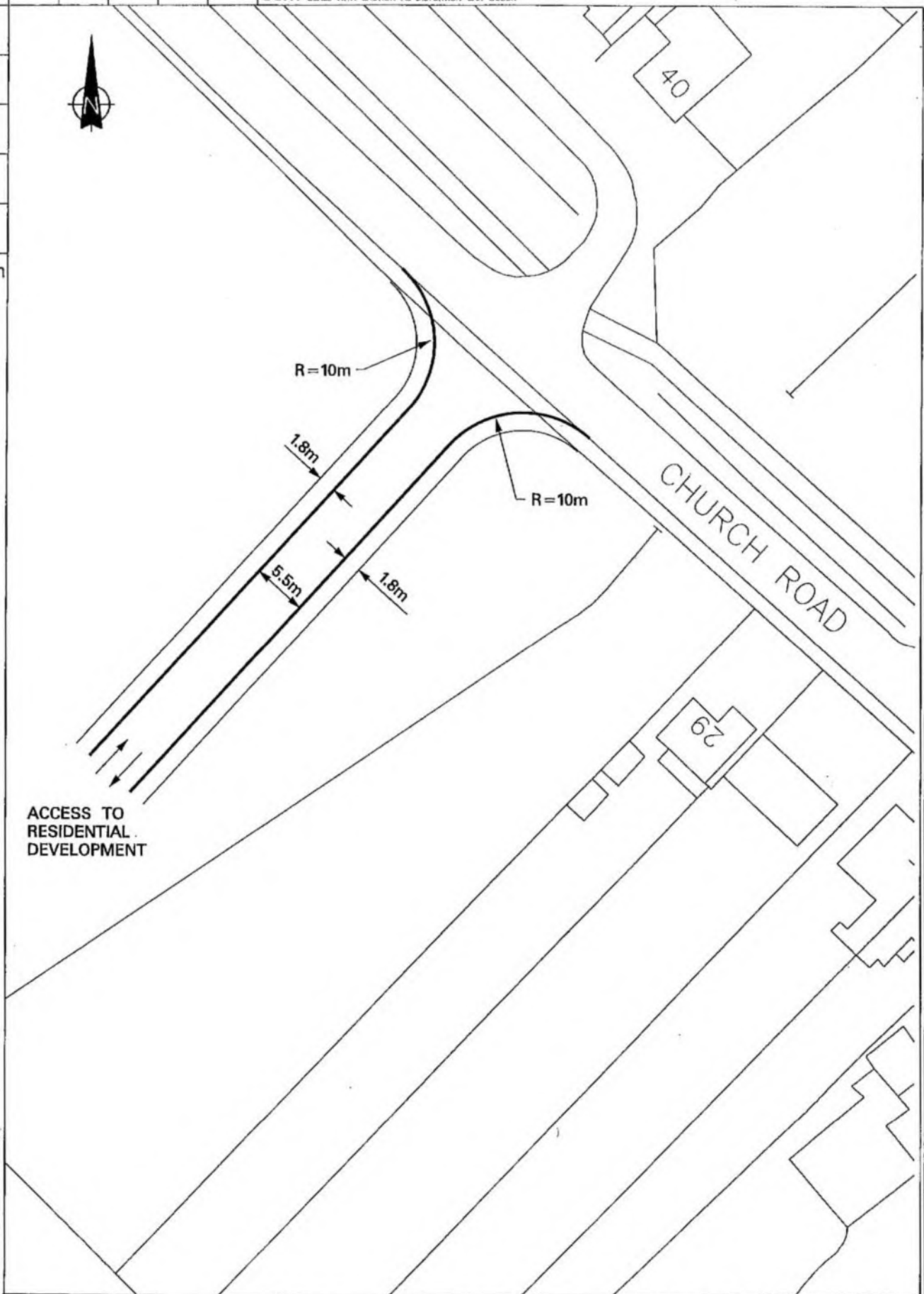
PROPOSED ACCESS AT THE JUCTION
OF HEATHFIELD ROAD /BLACKSTITCH
LANE /CHURCH LANE

5cm

5cm SCALE WITH CAUTION AS DISTORTION CAN OCCUR



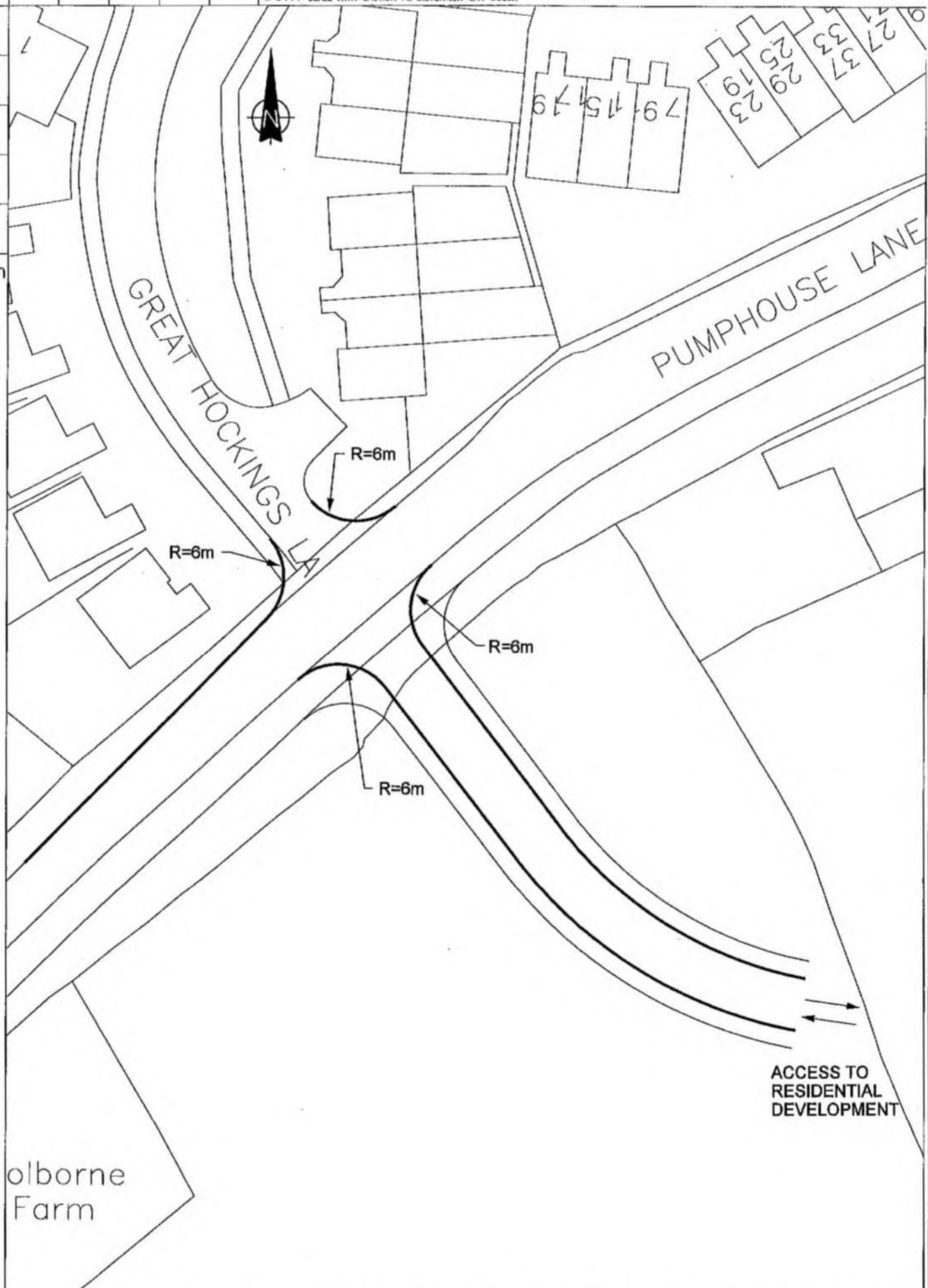
5cm



Date 09/07/02	Scale 1:500	RESIDENTIAL DEVELOPMENT WEBHEATH REDDITCH	PROPOSED ACCESS OFF CHURCH ROAD
Drawn CAB	Drawing No. FIGURE 4		

5cm SCALE WITH CAUTION AS DISTORTION CAN OCCUR

5cm



olborne
Farm

ACCESS TO
RESIDENTIAL
DEVELOPMENT

Date 09/07/02	Scale 1:500	RESIDENTIAL DEVELOPMENT WEBHEATH REDDITCH	PROPOSED ACCESS GREAT HOCKINGS LANE
Drawn CAB	Drawing No. FIGURE 5		

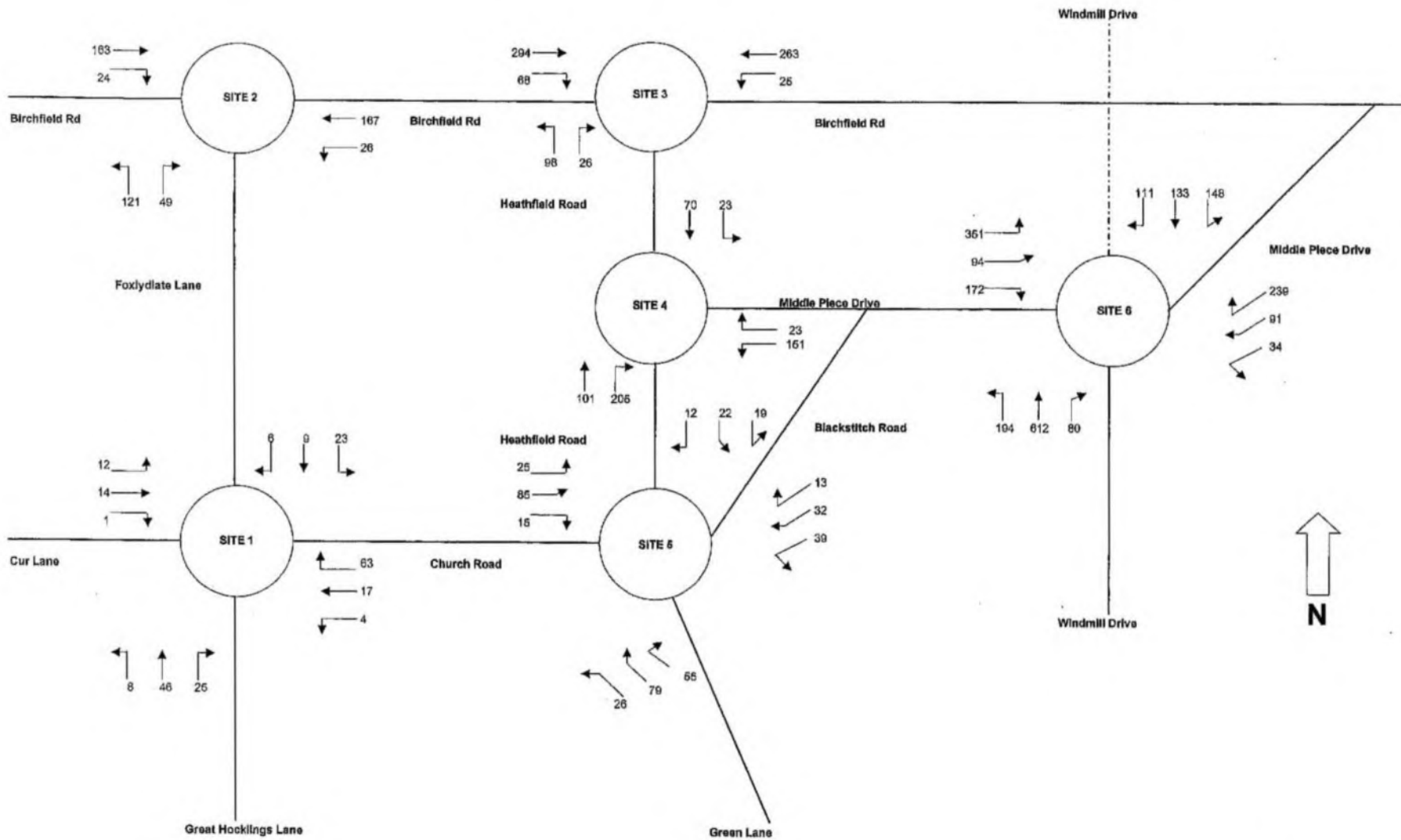
5cm SCALE WITH CAUTION AS DISTORTION CAN OCCUR



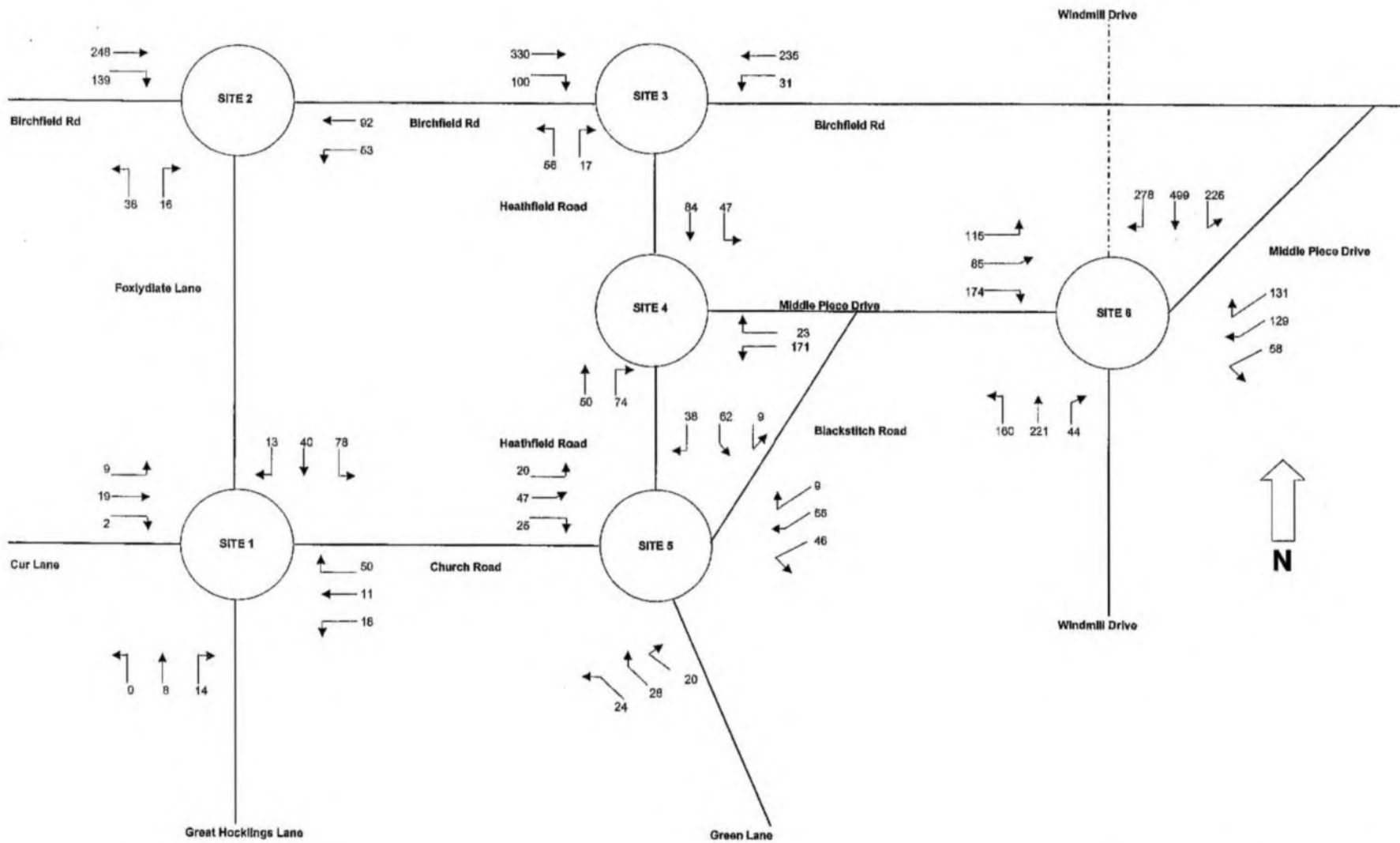
5cm



Date 09/07/02	Scale 1:10000	RESIDENTIAL DEVELOPMENT WEBHEATH REDDITCH	TRAFFIC SURVEY LOCATIONS	① TRAFFIC SURVEY LOCATIONS
Drawn CAB	Drawing No. FIGURE 6			



**FIGURE 7: 2002 BASE FLOWS AM PEAK
(08:00-09:00 HRS)**



**FIGURE 8: 2002 BASE FLOWS PM PEAK
(17:00-18:00 HRS)**

5cm SCALE WITH CAUTION AS DISTORTION CAN OCCUR

5cm



Date 09/07/02	Scale 1:5000	RESIDENTIAL DEVELOPMENT WEBHEATH REDDITCH	TRAFFIC GENERATION SURVEY AREA	KEY: — SURVEY BOUNDARY
Drawn CAB	Drawing No. FIGURE 9			

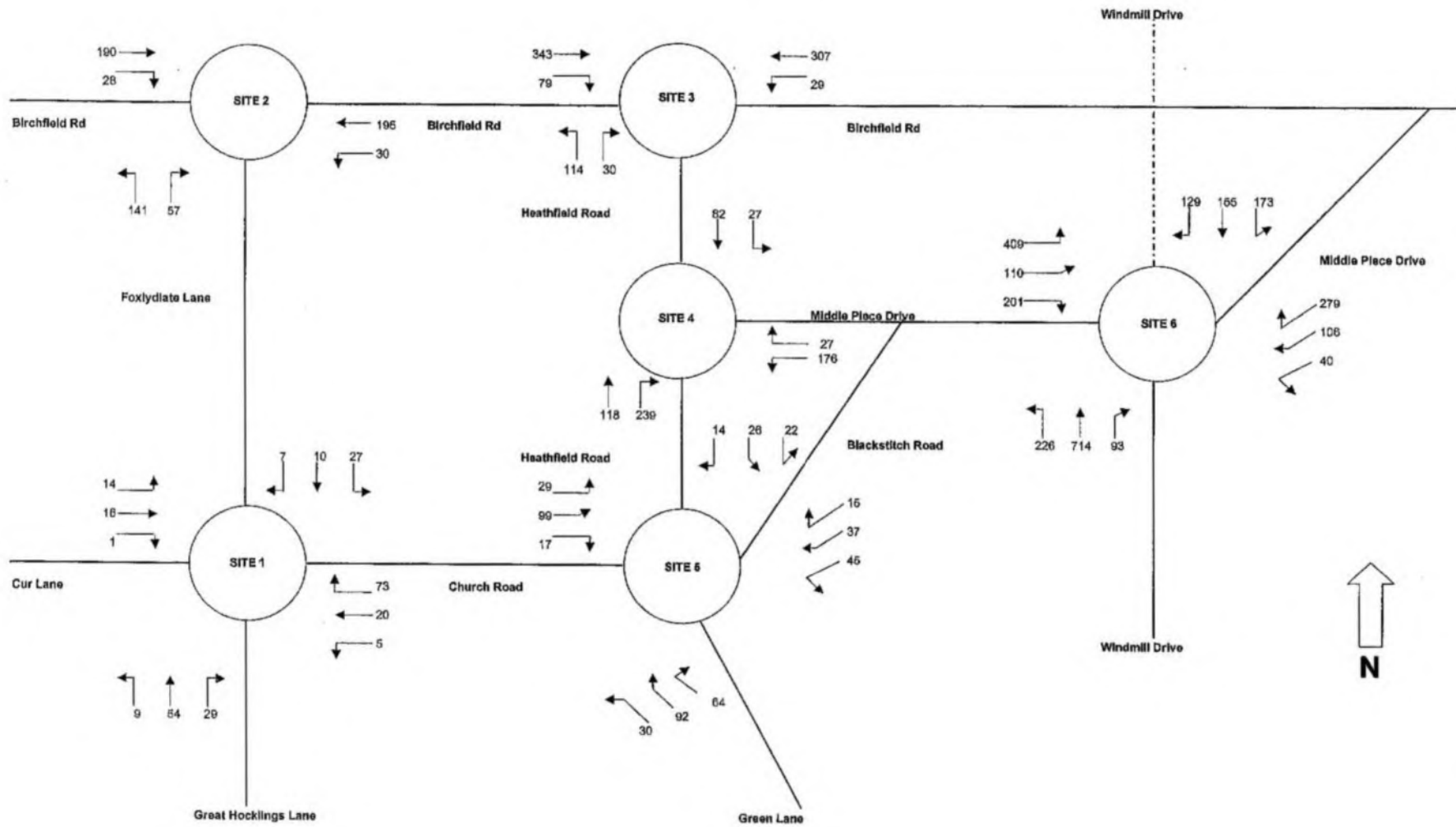


FIGURE 10: 2012 BASE FLOWS AM PEAK
(08:00-09:00 HRS)

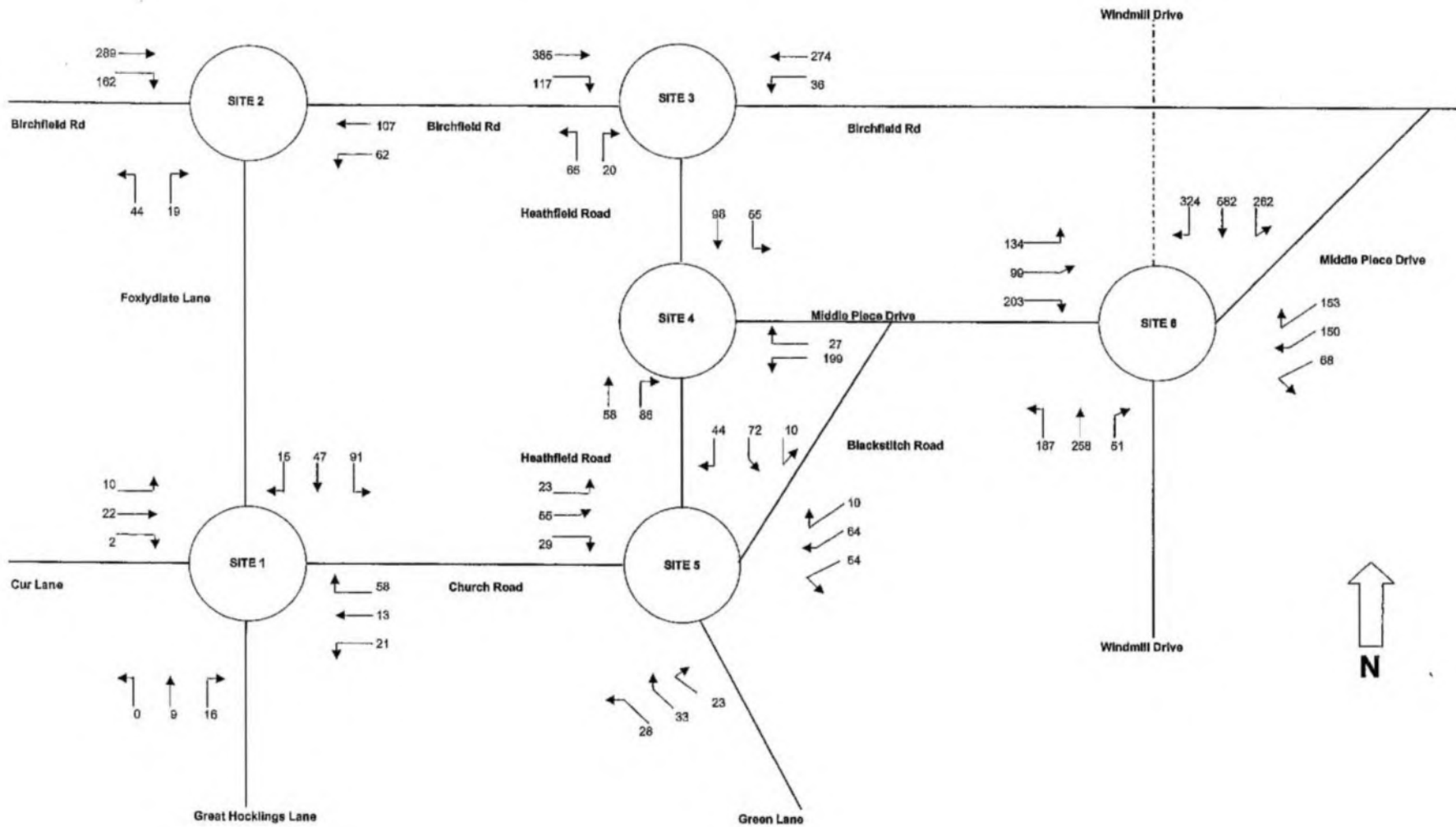


FIGURE 11: 2012 BASE FLOWS PM PEAK
(17:00 -18:00 HRS)

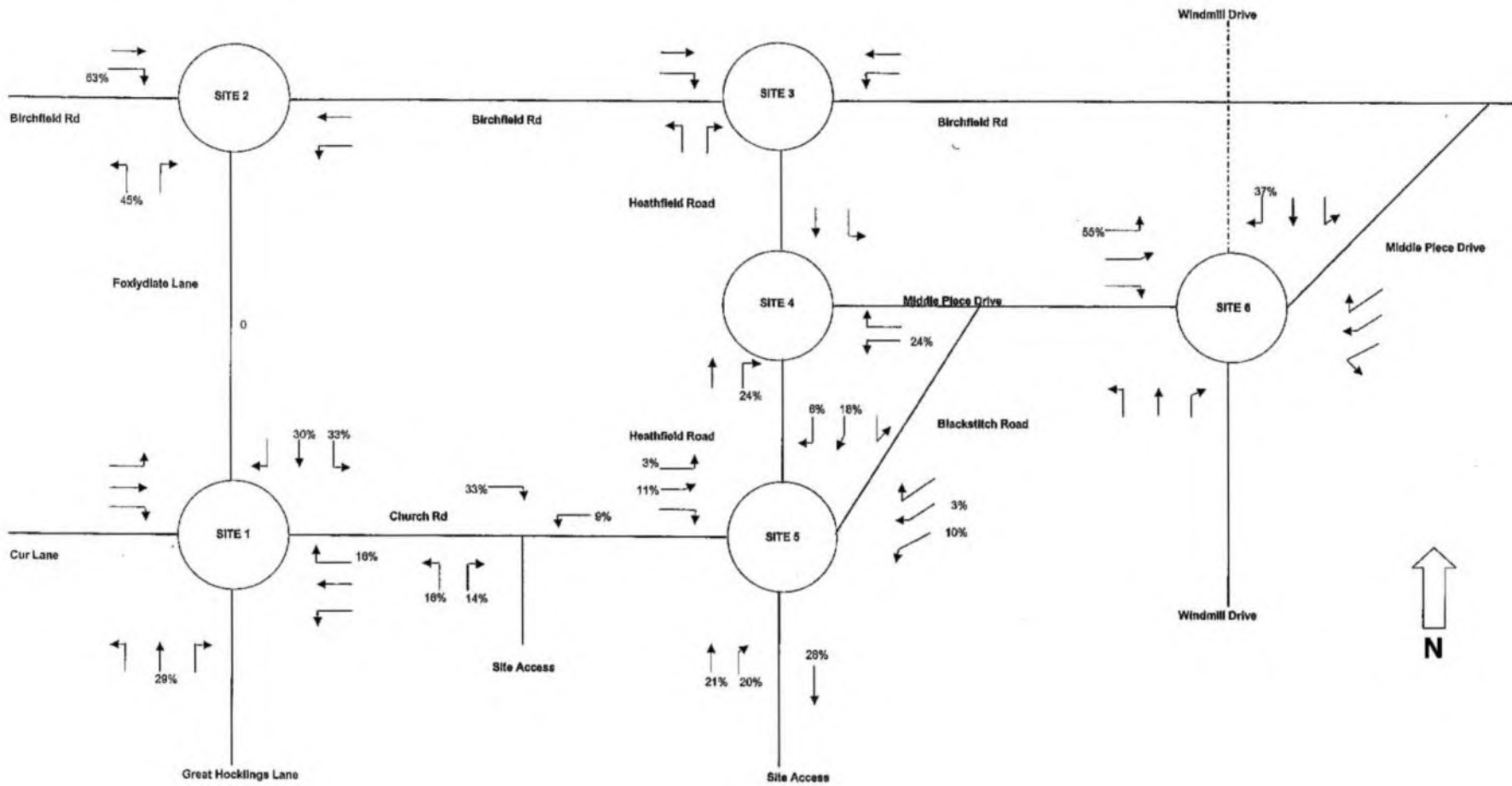


FIGURE 12: PROPOSED TRIP DISTRIBUTION AM PEAK
(08:00-09:00 HRS)

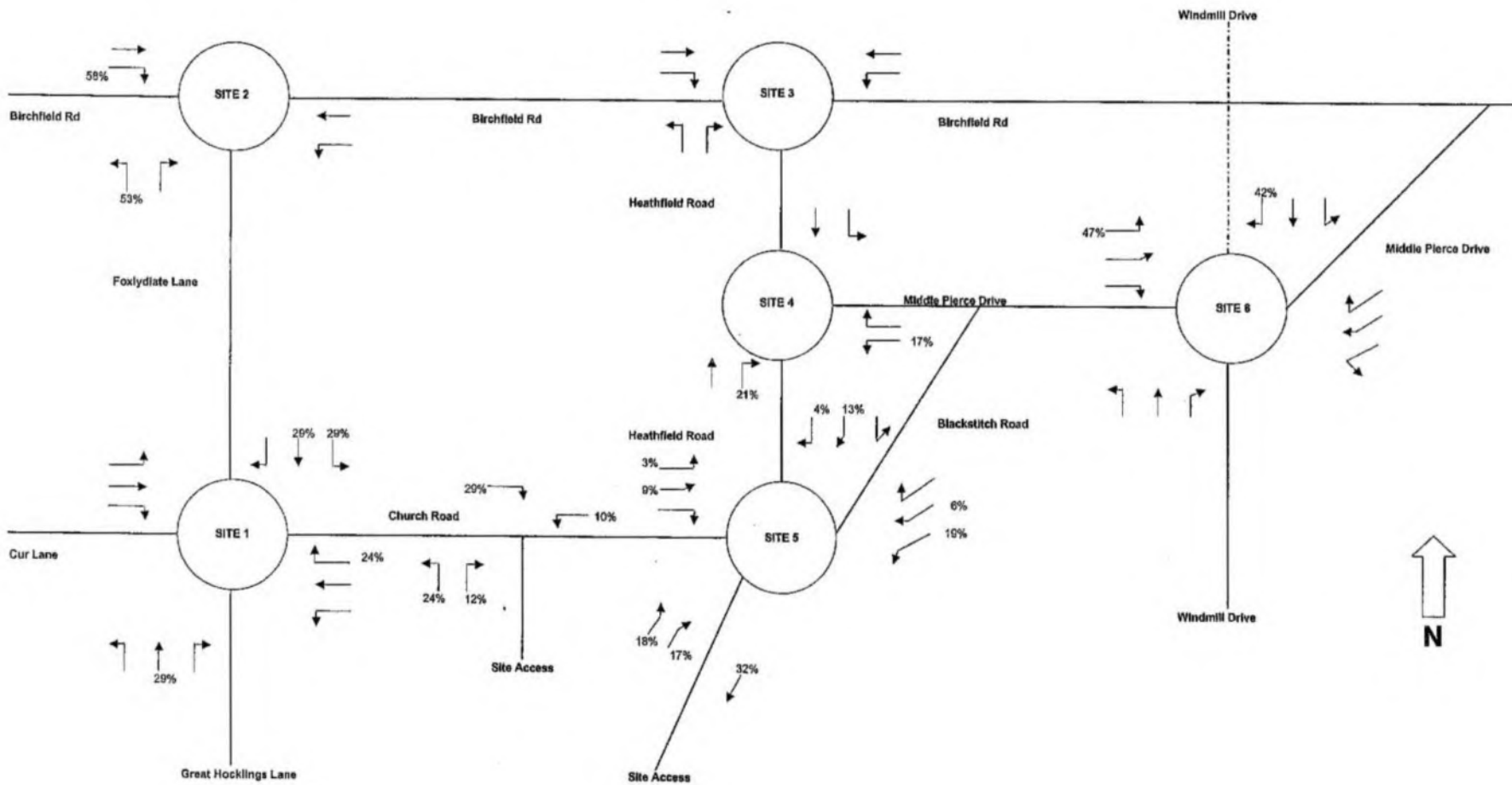
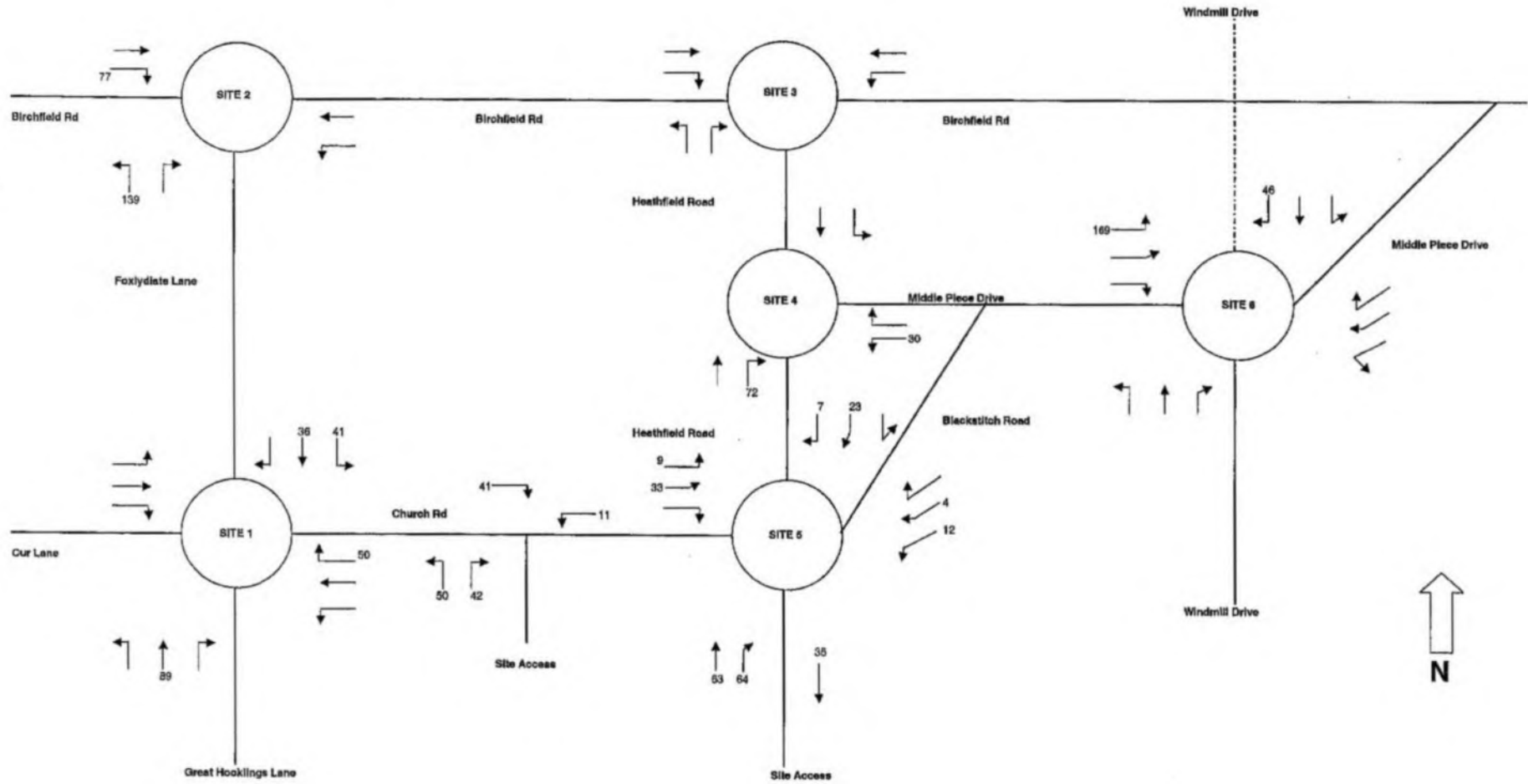


FIGURE 13: PROPOSED TRIP DISTRIBUTION PM PEAK (17:00-18:00 HRS)



**FIGURE 14: DEVELOPMENT TRIP FLOWS AM PEAK
(08:00-09:00 HRS)**

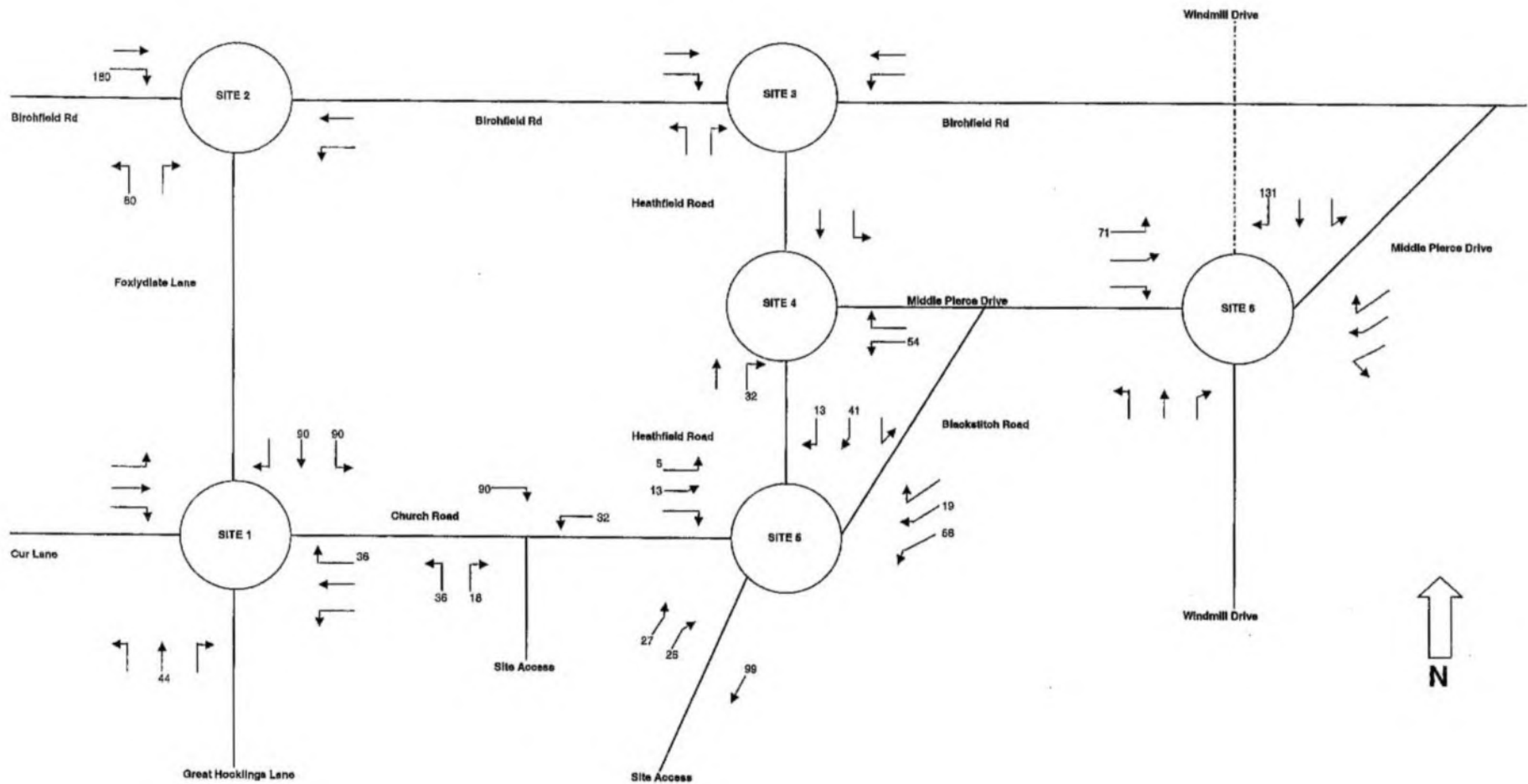


FIGURE 15: DEVELOPMENT TRIP FLOWS PM PEAK
(17:00-18:00 HRS)

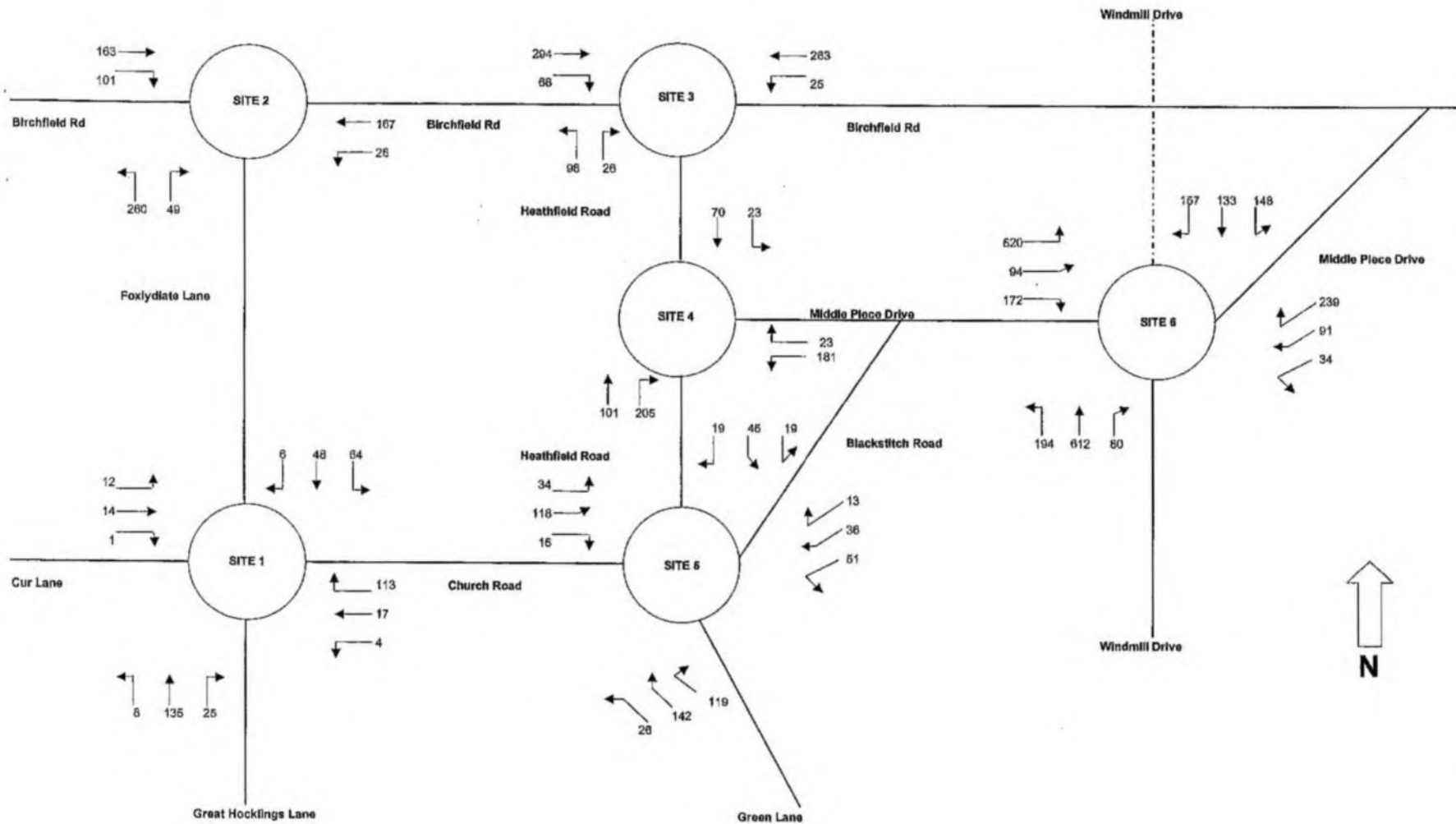
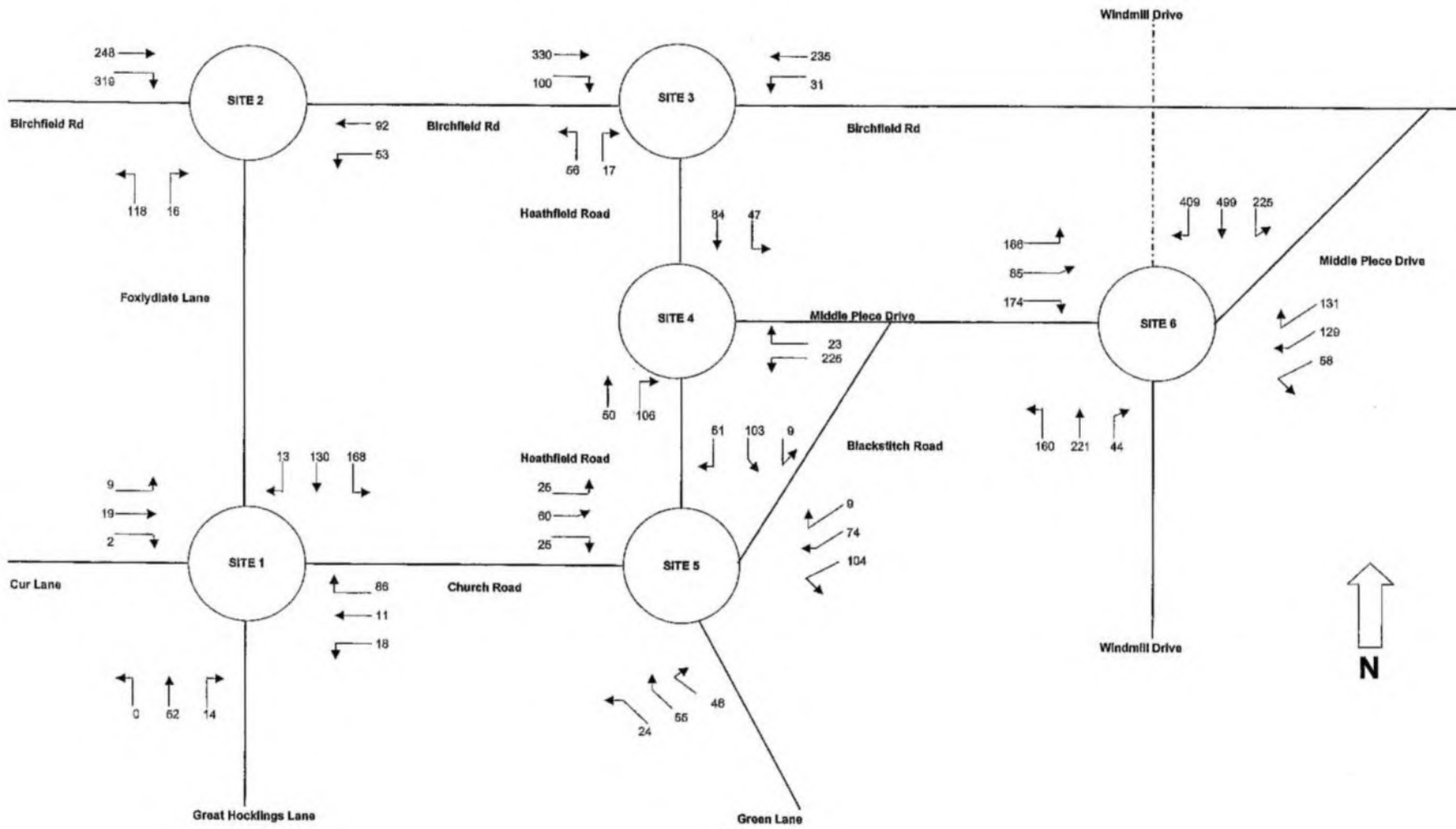


FIGURE 16: 2002 BASE + GENERATED FLOWS AM PEAK
(08:00-09:00 HRS)



**FIGURE 17 2002 BASE + GENERATED FLOWS PM PEAK
(17:00-18:00 HRS)**

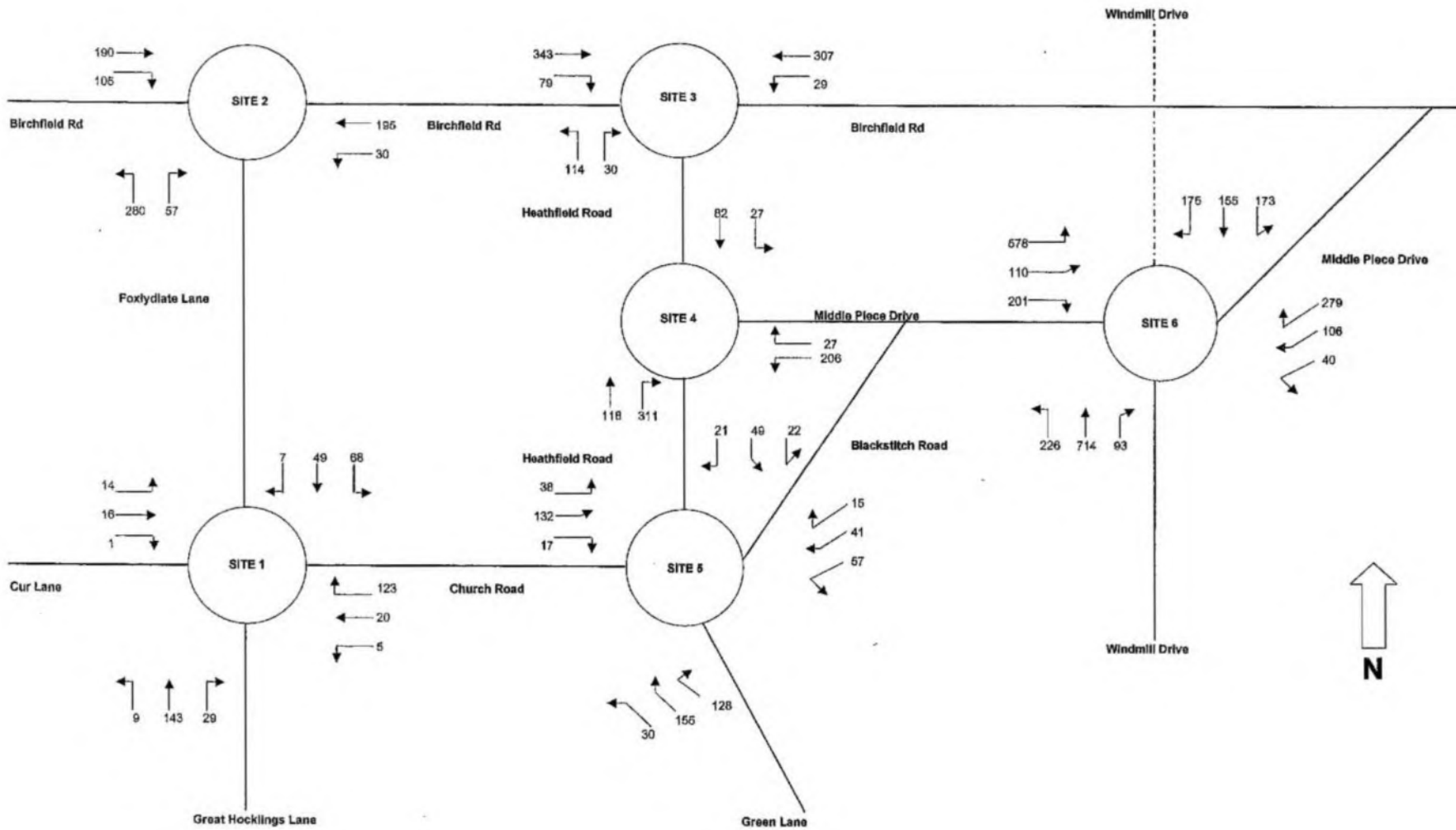
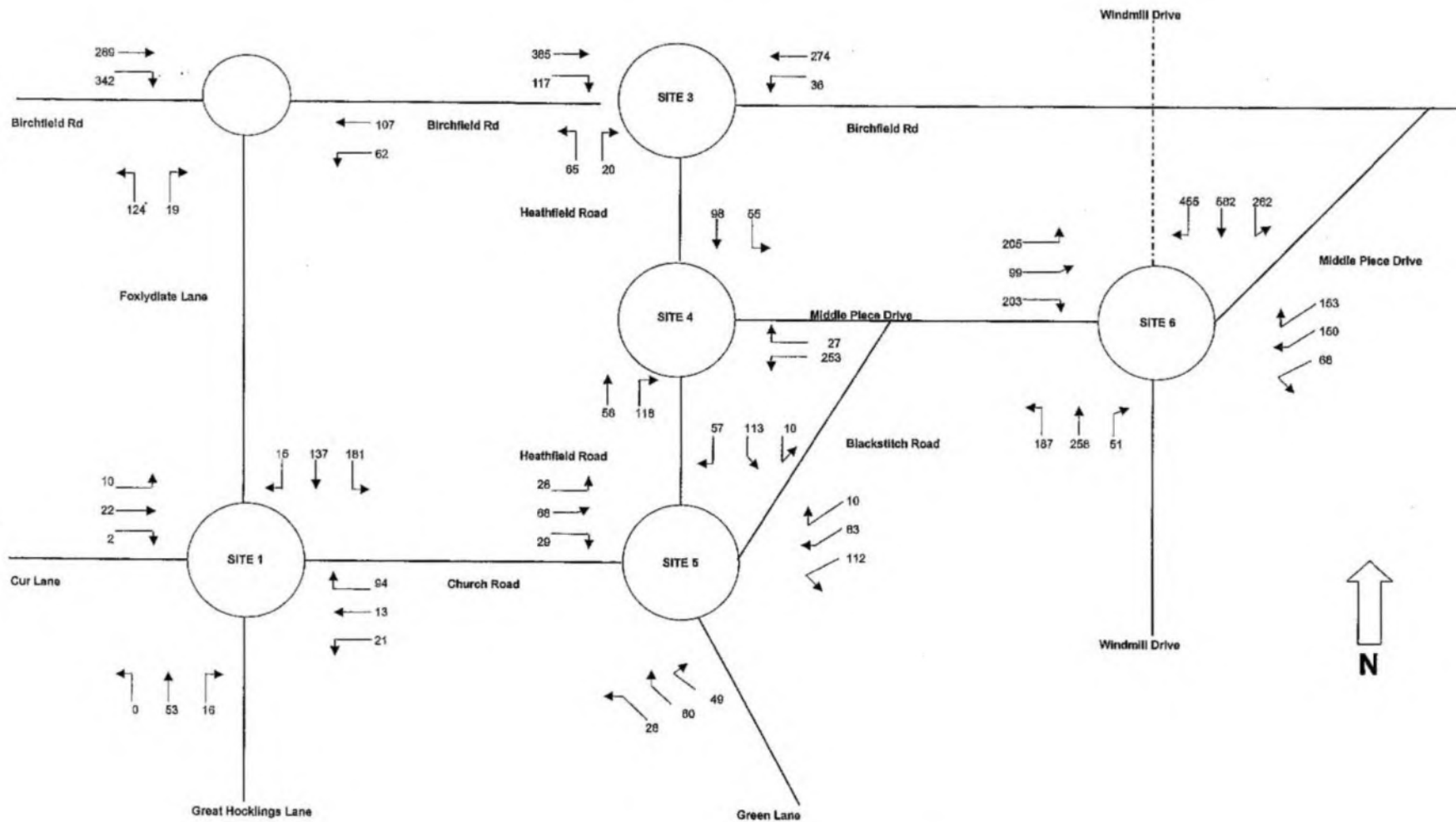


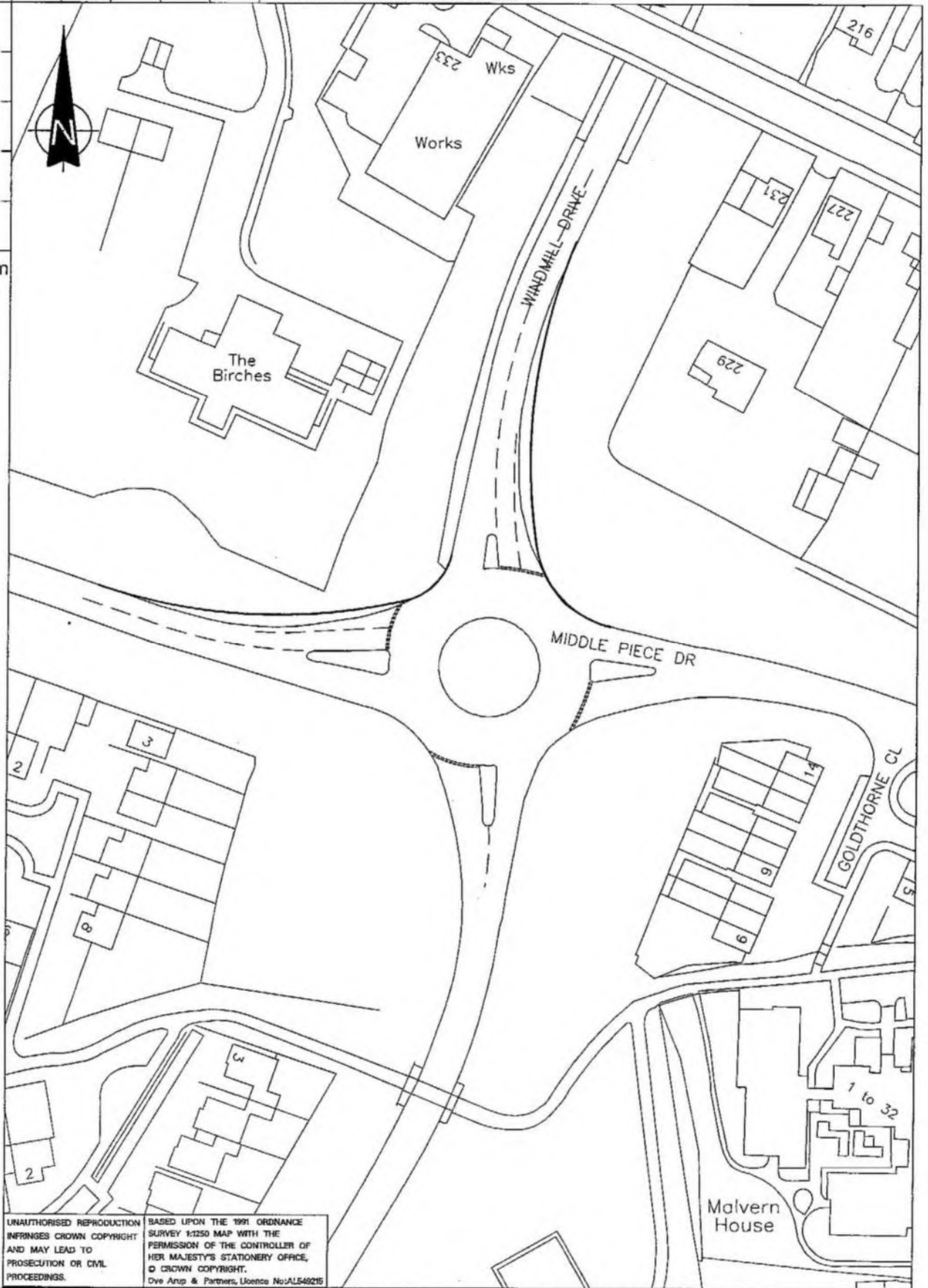
FIGURE 18: 2012 BASE + GENERATED FLOWS AM PEAK (08:00-09:00 HRS)



**FIGURE 19: 2012 BASE + GENERATED FLOWS PM PEAK
(17:00-18:00 HRS)**

5cm SCALE WITH CAUTION AS DISTORTION CAN OCCUR

5cm

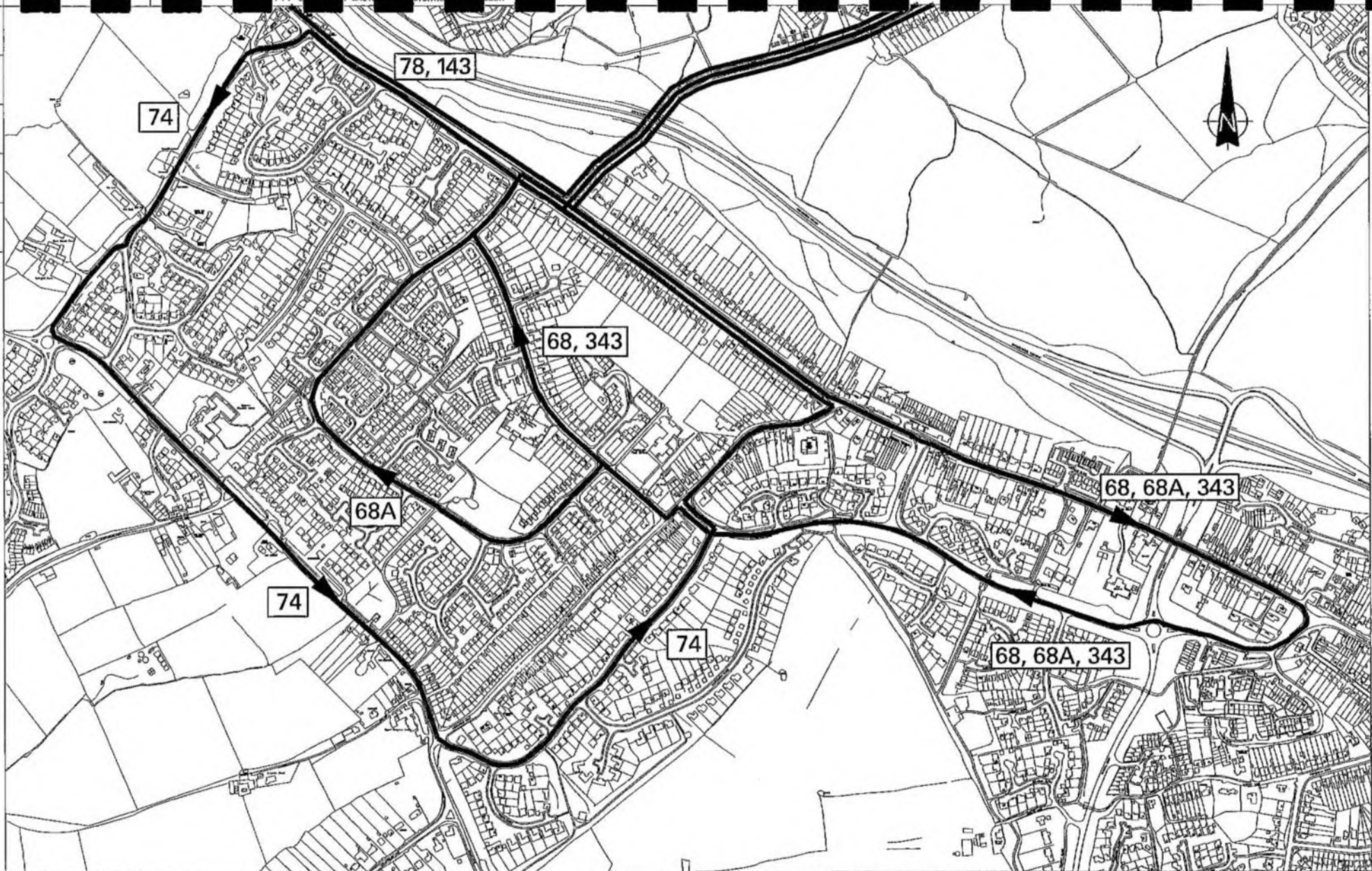





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0307/02	Scale 1:1000	RESIDENTIAL DEVELOPMENT WEBHEATH REDDITCH	WINDMILL DRIVE / MIDDLE PIECE DRIVE JUNCTION IMPROVEMENT
Drawn NAS	Drawing No. FIGURE 20		

15cm SCALE: HIGH CAUTION: NO DISTORTION CAN OCCUR

5cm



Date 12/07/02	Scale N.T.S.	RESIDENTIAL DEVELOPMENT WEBHEATH REDDITCH	BUS ROUTES AND SERVICES	 BUS ROUTES  BUS ROUTES  BUS ROUTES
Drawn TOS	Drawing No. FIGURE 21			