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A47 Southern Bypass Junctions

Capacity Assessment Report

November 2008

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A	November 2008	G Smith/S Weston	C N Jolley	E T Tyrer	First Issue
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Summary

Mott MacDonald as Norfolk County Council Strategic Partner has been requested to carry out an initial capacity assessment of three of the A47 Norwich southern bypass junctions. This assessment includes a summary of the modelled Joint Core Strategy (JCS) (Option D – similar to Option 1) impacts on the junctions, identification of potential mitigation measures and high level cost estimates.

The three junctions included in this study are:

- Junction 1 - A47/B1108 (Watton Road) roundabouts
- Junction 2 - A47/A11 (Thickthorn) roundabout
- Junction 3 - A47/A140 (Harford) roundabout

The assessment was based on the traffic data extracted from the existing NATS SATURN model tests for the Northern Distributor Road with JCS development at years 2012 and 2027. The results of this assessment are as follows:

- Although the JCS development would increase the traffic flows at B1108 Watton Road roundabouts, delays are expected to be minimal by 2027 and queue lengths are minimum or no queues for 2027. Therefore, no mitigation measures are currently deemed necessary;
- A11 Thickthorn roundabout would have significant delays and queues due to the JCS development. A low cost option is shown on drawing number 233902BF/002 and a major realignment option is shown on drawing number 233902BF/003. The capital cost for these options, including optimism bias, is estimated as £150 000 to £40.6 million; and
- A140 Harford roundabout would also be significantly affected by the JCS development traffic. Drawing number 233902BF/013 shows a proposed layout for partial signalisation option and drawing number 233902BF/012 shows a proposed layout of roundabout alterations. The capital cost of these options, including optimism bias, is estimated as £180 000 to £1.2 million. Other options have more significant growth on the A140 corridor south of Norwich. In this instance the junction improvement requited are potentially up to £40.6 million, as a solution as radical as proposed at A11 Thickthorn roundabout may be required.
- The overall capital cost including optimism bias, with exclusions as set out in the report, is estimated as £330 000 to £81 million.

If Norfolk County Council wish to consider the impact of the JCS development on the A47 junctions further then surveys and modelling are required.

1 Introduction

Due to the significant scale of growth anticipated to happen in the South East region, Broadland, Norwich City and South Norfolk Councils are working together to produce a Joint Core Strategy for their areas. The JCS can be interpreted as the overarching strategy for the Local Development Frameworks (LDFs).

The primary aim of the JCS is to focus on delivering the significant quantities of growth anticipated, and the JCS would also include identification and high level assessments of any infrastructure improvements that would be required as the results of the growth scenarios.

Consequently, Norfolk County Council has requested its Strategic Partner Mott MacDonald to carry out an initial capacity assessment of the A47 southern bypass junctions.

1.1 Objectives

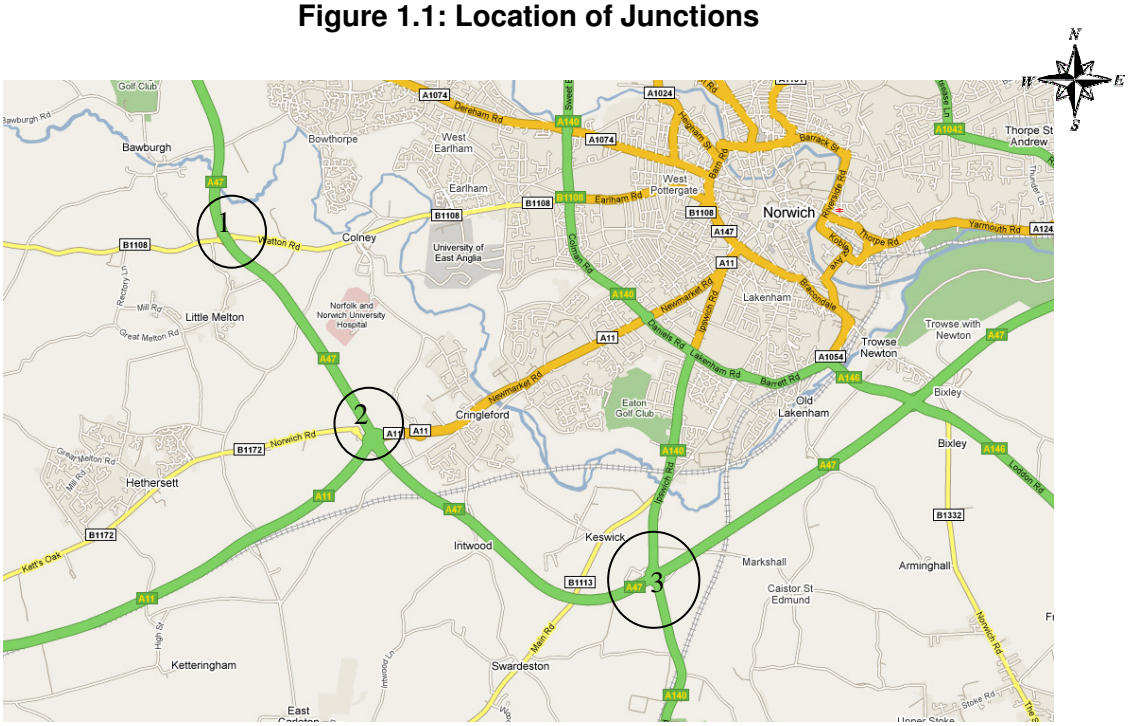
The purpose of the study is to assess the capacity of the A47 southern bypass junctions for the future scenario of Joint Core Strategy (JCS) developments plus Northern Distributor Road (NDR). The assessment considers practicable improvements, such as: free flow slip roads and extra grade separation.

The three junctions assessed are:

- Junction 1 - A47/B1108 (Watton Road)
- Junction 2 - A47/A11 (Thickthorn)
- Junction 3 - A47/A140 (Harford)

The locations of these three junctions are illustrated in Figure 1.1 below.

Figure 1.1: Location of Junctions



Scale: NTS

During the inception meeting with officers from Norfolk County Council, it was agreed that the assessments are not to consider any sustainable transport measures that are emerging, eg possible Bus Rapid Transit (BRT) schemes, which could lead to junction modifications to mitigate delays to buses. Junction modifications to improve cycle and pedestrian movements are not considered either.

1.2 Study Methodology

The methodology adopted in this study as follows:

- Obtain traffic data by extracting existing data from the NATS SATURN model tests for the NDR with JCS (Option D – similar to Option 1) at years 2012 and 2027;
- Summarise traffic growth from base (2006) in terms of percentage impact for each link, eg off slip from A47 northbound in Excel spreadsheets;
- Summarise delays for base and future years for each link 'Direct Output' from SATURN model tests;
- Summarise turning movements for base and future years for each link 'Direct Output' from SATURN model tests;
- Obtain current layouts for existing junctions; (Note: 'as built' drawings not available; layouts produced from a combination of OS data and 'Google maps' data obtained through the licensed TRICS database.)
- Review any previous recent proposals for junction modifications; (Note: discussions with the Highways Agency suggested none available.)

- Undertake a workshop with Norfolk County Council and Mott MacDonald staff to identify high level mitigation measures for all three junctions;
- Prepare sketch drawings for mitigation options agreed as viable at the workshop;
- Provide high level estimate of costs for construction of each mitigation option. This is for the capital cost only, excluding land costs, statutory undertaker works, design development, surveys and accommodation works; and
- Prepare and issue draft report to Norfolk County Council.

It has been agreed with Norfolk County Council that the following elements would not be included, namely:

- New inputs into SATURN model;
- New traffic surveys; and
- Junction modelling

1.3 Assumptions in JCS Option D

Scenario D is 5 sites including some housing outside the NDR, as follows:

- 3 000 in Broadland and South Norfolk fringes to 2016
- 5 000 in Norwich between 2016 and 2026 @500/year
- 5 000 in northeast sector inside NDR between 2016 and 2026 @500/year
- 2 000 in northeast sector outside NDR between 2016 and 2026 @200/year
- 5 000 in southwest sector between 2016 and 2026 @500/year
- 3 000 in Wymondham between 2016 and 2026 @300/year

1.4 Report Structure

Chapter 2 describes existing conditions and future problems.

Chapter 3 discusses proposed solutions.

Chapter 4 summarises capital cost estimates

Chapter 5 provides conclusions and recommendations for future works on the study.

2 Existing Conditions and Future Traffic

2.1 B1108 Watton Road Roundabouts

The B1108 Watton Road roundabout is a grade-separated double roundabout. The two roundabouts: Watton Road roundabout (West) and Watton Road roundabout (East), are asymmetric and are separated by a short section of the B1108 Watton Road for approximately 107 metres, of which over half of this is on a 60 metre bridge span over the A47.

The junction connects the A47 and B1108 Watton Road. The A47 is a dual carriageway, which runs in north to south direction underneath the B1108 Watton Road flyover.

The B1108 Watton Road is a single carriageway. From the roundabout, the road continues south westerly towards Kimberly and easterly towards Norwich.

Watton Road Roundabout (West)

The Watton Road roundabout (West) is a normal 4-arm roundabout with the inscribed circle diameter (ICD) of 40 metres. The roundabout is located on the west side of the A47 dual carriageway road.

From East in clockwise direction, the roundabout approach roads are:

- The B1108 Watton Road (bridge) approach road is a one-lane single carriageway. The road widens to two lanes shortly before the give way line;
- The A47 (South) off slip road is located to the south east of the roundabout. The slip road only has one lane, but it widens to the two lanes approximately 40 metres prior to the give way line;
- The B1108 Watton Road (West) is located to the west of the roundabout. It is also a one-lane single carriageway, which then widens to two lanes approximately 10 metres prior to the give way line.
- The A47 (North) on slip road is located to the north of the roundabout and is restricted for exit only

Watton Road Roundabout (East)

The Watton Road roundabout (East) is a 6-arm roundabout, with an ICD of 43 metres. The roundabout is located on the east side of the A47 road.

From East in clockwise direction, the roundabout approaches are:

- B1108 Watton Road (East) approach is a one-lane single carriageway, located to the east of the roundabout. The approach road widens to two lanes approximately 15 metres from the roundabout;
- The A47 (South) on slip road is located to the south of the roundabout and is restricted for exit only;

- The B1108 Watton Road (bridge) is located to the west of the roundabout. The road is a one-lane single carriageway and it widens to two lanes around 10 metres prior to the roundabout;
- The A47 (North) off slip road is located to the northwest of the roundabout. Although the approach road is wide enough for two lanes, there is no lane markings provided.
- Access Road. This unnamed access road is located to the north of the roundabout. The road is restricted for exit only from the roundabout to a field and 'The Bungalow'.
- Colney Wood Burial Park access road is also located to the north of the roundabout, almost immediately next to the aforementioned access road. Traffic is only allowed to exit on to the roundabout from this access road, the entrance to it is on the B1108.

The existing road markings at this roundabout are shown in drawing number 233902BF/021.

2.1.1 Surrounding Areas

The northeast quadrant is a mix of a field, a radio mast, 'The Bungalow' and Colney Wood Burial Park. The southeast quadrant is a mix of a field and Rybeck plantation and the southwest quadrant is used for a nursery. The northwest quadrant is primarily agricultural land, although an electricity sub-station is also identified.

2.1.2 Traffic Flows

Base traffic flows in year 2006 and forecast traffic flows, delays, and queue lengths in years 2012 and 2027 have been derived from NATS SATURN model tests as shown in the Appendix A.

Watton Road Roundabout (West)

The SATURN model data predict that during the morning peak period the JCS would increase traffic from 2006 to 2012 by a maximum of 32%, which is on the A47 (S) off slip road, primarily an increase of traffic from the A47 (S) off slip road to Watton Road (W). During the evening peak period, the model data predicts that Watton Road (E) traffic would be increased by 20%, with the main movement to the A47 (N) on slip road.

Between 2012 and 2027, the JCS would increase traffic by a maximum of 35% on Watton Road (W), with the main movement between Watton Road (W) and A47 (N) on slip road during the morning peak period. During the evening peak period, the SATURN model forecasts an increase of 20% on Watton Road (W) approach road which predominantly would go to Watton Road (E).

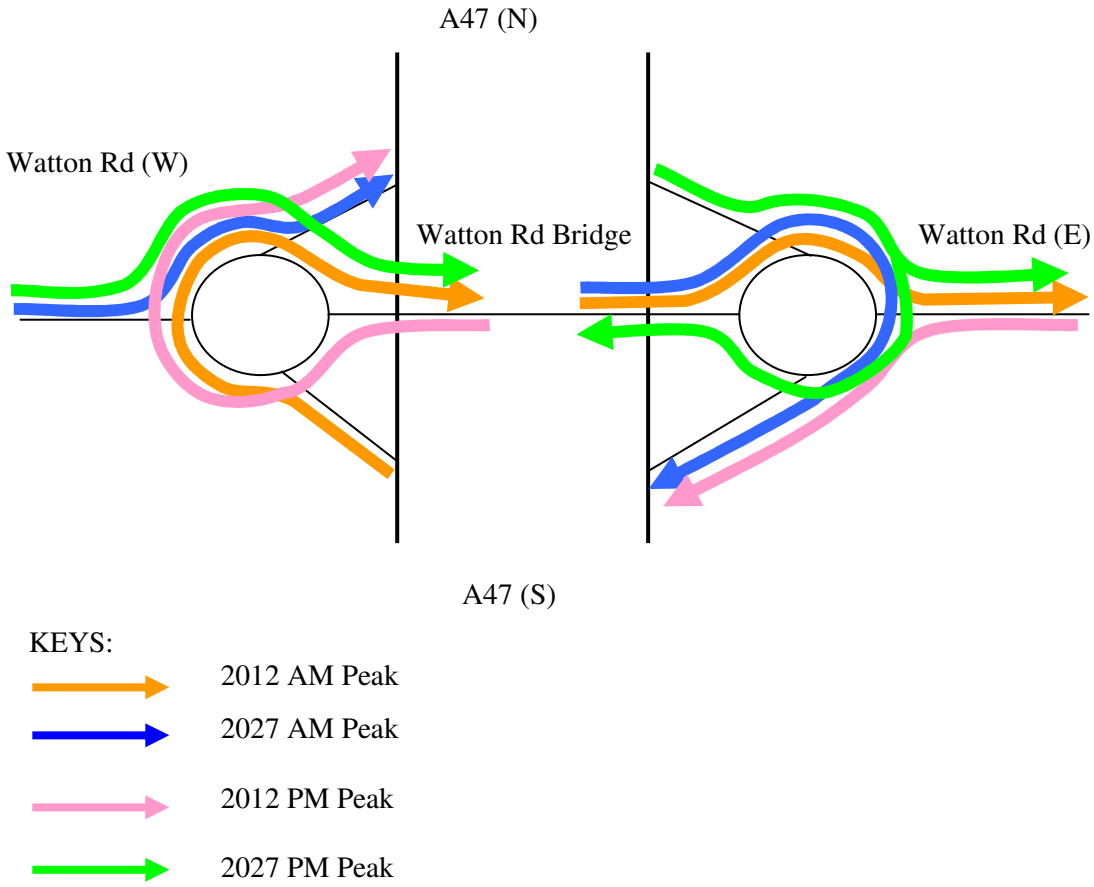
The main movements that are predicted to be most affected by the JCS are shown in figure 2.1, below.

Watton Road Roundabout (East)

The SATURN model data predict that between 2006 and 2012 the biggest impact of the JCS would be on the Watton Road bridge with 18%, with the main movement from Watton Road bridge to Watton Road (E) during the morning peak period. During the evening peak period, traffic on Watton Road bridge is predicted to increase by 23%, with a predominant movement between Watton Road bridge and the A47 (S) on slip road.

Between 2012 and 2027, it is predicted that traffic from Watton Road (W) to A47 (S) on slip road would be increased by a maximum of 23%, which is the highest increase during the morning peak period. During the evening peak period, traffic on the A47 (N) off slip road is predicted to increase by 39% which would go in equal portions (50:50) to Watton Road (E) and to Watton Road bridge

Figure 2.1: Watton Road: Most Affected Movements



2.1.3 Delays and Queue Lengths

Delays on both Watton Road roundabouts are expected to remain minimal even by 2027, and minimal queues or no queues are also predicted for 2027.

2.2 A11 Thickthorn Roundabout

The A11 Thickthorn roundabout is a 6-arm signalised roundabout, which connects the A11 and the A47. The A47 is a dual carriageway, which runs north-south, at this location. The A47 is grade separated from the roundabout by a flyover. To the north, the A47 provides a link to Swaffham and to Great Yarmouth to the southeast. The A11 is also a dual carriageway, which runs east-southwest. From the roundabout the A11 continues northeasterly towards Norwich and southwesterly towards Thetford and Attleborough.

From East in clockwise direction, the roundabout approach roads are:

- The A11 Newmarket Road (East) approach is located to the east of the roundabout. The approach road is flared to three lane approximately 70 metres prior to the stop line, and there are four lanes at the stop line.
- The A47 (South) off slip road joins the roundabout from the southeasterly direction. The slip road gradually flares to provide three lanes at the stop line. The nearside lane is marked with a left arrow, the middle lane with left and straight ahead arrows, whilst the outside lane is marked with a straight ahead arrow.
- The A11 (Southwest) approach is located to the southwest of the roundabout. The approach road widens from two lanes to four lanes approximately 130 metres from the stop line.
- The B1172 approach road is located to the northwest of the roundabout and is not signalised. The road connects the roundabout to the B1172 Norwich Road. Most of the length of the nearside lane is marked as bus lane. The bus lane stops approximately 27 metres prior to the roundabout.
- The A47 (North) off slip road is located to the northwest of the roundabout. The slip road widens to three lanes approximately 40 metres from the roundabout.
- Newmarket Road is a track that runs parallel with the A11 Newmarket Road. The road serves as a private access to agricultural land and private properties along its north side. The approach road is not included in the existing traffic signal arrangement.

2.2.1 Circulatory Carriageway

The north-half of the circulatory carriageway, ie between the A11 (West) approach and Newmarket Road approach, are wider than the one at the south-half; the north part of the roundabout has four lanes, whilst there are only three lanes provided on the south part.

The existing road markings at this roundabout are shown in drawing number 233902BF/001.

2.2.2 Surrounding Areas

The land in the northeast and southeast quadrants is predominantly agricultural land, and the land in the southwest quadrant is mainly fields. The land in the northwest quadrant accommodates Thickthorn Park and Ride (P&R), Thickthorn Services; a motel, an electricity sub station and a petrol filling station.

2.2.3 Traffic Flows

During the morning peak period the NATS model data indicate that apart from the B1172 Norwich Road approach, the JCS would increase the traffic on the remaining of the roundabout approaches. The biggest increase is predicted on the A47 (S) off slip with 60% during 2006 and 2012, followed by the A11 (E) approach with an increase of 31%. The corresponding numbers for 2012 and 2027 are 51% increase on the A11 (W) approach and 26% increase on the A47 (S) off slip road.

During the evening peak period the JCS is expected to increase the traffic flows on all of the roundabout approaches. The biggest increase during 2006 and 2012 is identified on the A47 (S) off slip road with 35%, followed by 33% on the A47 (N) off slip road. During 2012 and 2027, the corresponding numbers are 56% on the A47(S) off slip road and 37% of the A11 (W) approach road.

Existing and future turning movements showed at all arms that the left-turn movement was less than 50%, so filter lanes are not appropriate. 'Select Link Analysis' data shows that the dominant movements on the A11 are straight ahead in both AM and PM peaks with the right turn from the A11 (West) to A47 (South) also being significant, particularly in the AM peak. From the B1172, the dominant movements are right turns to the A47 (South).

2.2.4 Delays and Queue Lengths

(i) Delays

During the morning peak period, the B1172 Norwich Road approach road is predicted to have the highest delays of 137 seconds, or 2.28 minutes per vehicle. This is likely due to the significant increase of traffic flows on the rest of the roundabout approaches and on the circulatory carriageway between the A11 (W) and the B1172 Norwich Road. Long delays are also identified on the A47 (N) off slip road with 136 seconds and on the circulatory carriageway between the A11 (W) off slip road and B1172 Norwich Road approach.

During the evening peak period, long delays are predicted on the A47 (North) off slip with delays of 89 seconds. Delays are also expected on the A47 (S) off slip, and on the circulatory carriageway between the A11 (W) and the B1172 Norwich Road.

(ii) Queue Lengths

During the morning peak period, long queues of 44 vehicles (in total) are expected on the circulatory carriageway between the A11 (W) and the B1172 Norwich Road. Assuming that one pcu is approximately 6 metres and the queue lengths are divided equally with the number of lanes, the queue lengths equate to 66 metres per lane, which would block the B1172 Norwich Road exit and the A11 (W) approach. Total queues of 16 vehicles, or 24 metres per lane, are also expected on the circulatory carriageway between the A47 (N) on slip road and the B1172 Norwich Road, and queue lengths of 6 vehicles per lane, or 36 metres per lane, are expected on the A47 (N) off slip approach.

During the evening peak period, queues are identified on the A47 (S) and the A47 (N) off slip roads, on the circulatory carriageway between the A11 (W) and the B1172 and on the circulatory carriageway between the A11 (E) and the A47 (S) on slip road. However, these queues are expected no to block the successive exits or approach roads.

A copy of data extracted from NATS SATURN model data is included in Appendix A.

2.3 A140 Harford Roundabout

The A140 Harford roundabout is a 6-arm grade separated roundabout. The roundabout is 'stretched' northwards and southwards. Hence, the longest kerb to kerb distance north to south is measured as 120 metres, whilst the corresponding number for east to west is 80 metres.

The roundabout primarily connects the A47 and the A140. The A47 runs in east-west direction along the flyover over the roundabout. The road provides a link to Great Yarmouth in an easterly direction and to Swaffham and Thetford in a westerly direction.

The A140 joins the roundabout in north south direction. To the north, the road runs towards Norwich and to the south towards Long Stratton.

From East in clockwise direction, the roundabout approaches are:

- The A47 (East) off-slip road runs approximately for a distance of 410 metres from the A140 roundabout. This approach road widens to two lanes approximately 60 metres from the give way line. There are footpaths running in north-south direction across the verge on the north and south sides of the slip road. These footpaths are 'connected' with 'Stud' road markings less than 10 metres away from the give way line.

- Markshall Farm Road is a one-lane single carriageway road. It runs parallel to the A47 for approximately 500 metres then it runs in southeasterly direction towards Caistor St Edmund for the remainder of its length. There is only one lane at the give way line.

- The A140 (South) Ipswich Road approach is also a one-lane single carriageway. The approach road widens to two lanes approximately 40 metres from the roundabout, and then widens to three lanes approximately 15 metres prior to the give way line.

- The A47 (West) off slip road runs for a distance of 340 metres approximately measured from the roundabout. The slip road widens to two lanes approximately 60 metres from the roundabout. There are also footpaths across the verge area on the south side

- Harford Park and Ride access road is a one-lane single carriageway road, primarily just to serve the park and ride site. There are two lanes at the roundabout approach approximately 15 metres from the give way line; and

- The A140 (North) Ipswich Road is a one-lane single carriageway. The road widens to two lanes approximately 60 metres from the roundabout, and then to three lanes approximately 20 metres prior to the give way line.

The existing road markings at this roundabout are shown in drawing number 233902BF/011.

2.3.1 Circulatory Carriageway

The circulatory carriageway has been marked with spiral marking system, which directs drivers to use the appropriate lane for their intended exits. With the exceptions of the two circulatory carriageway opposite the A47 (East) and the A47 (West), which have three lanes to provide an extra lane for drivers exiting to Markshall Farm Road and to Harford Park and Ride site, the remainder of the circulatory carriageway has two lanes and any unused areas are hatched.

2.3.2 Surrounding Areas

Apart from the northwest quadrant, which is used as Harford Park and Ride site, the roundabout is surrounded by agricultural land.

2.3.3 Traffic Flows

The NATS model data predict that the biggest increase in traffic flows during the morning period between 2006 and 2012 would be on Markshall Farm Road with an increase of 98%. The extracted data also show that traffic flows on the A47 (E) off slip road would be increased by over 50%. During the evening peak period, the data indicates a significant increase of traffic to the Park and Ride site and nearly 42% increase of traffic flows on Markshall Farm Road approach.

Between 2012 and 2027, the model data show over 50% increase of traffic on Markshall Farm Road during the morning period. This is followed by 28% increase of traffic of the A140 (S) approach road. During the evening peak period, the model data illustrate that the traffic into the Park and Ride would continue to increase by a significant amount, and there is a nearly 38% of increase of traffic on the A47 (W) off slip road.

2.3.4 Delays and Queues

(i) Delays

The NATS model data identify during the morning peak period longest delays of 265 seconds, or nearly 4.5 minutes per vehicle, on the A140 (S) approach road. This is followed by: 122 seconds, or 2 minutes per vehicle, on Markshall Farm Road; 1.6 minutes per vehicle delay on the circulatory carriageway between the A47 (W) off slip road and Harford Park and Ride access road.

During the evening peak period, the longest delay of 1.5 minutes per vehicle is identified on the A47 (W) off slip road. The remaining roundabout arms have delays of less than one minute per vehicle.

(ii) Queue Lengths

During the morning period, the A140 (S) approach road has the longest queue length of approximately 90 vehicles over the three lanes, or approximately 240 metres per lane. Markshall Farm Road approach has a maximum queue length of 18 vehicles, or 108 metres, and the A47 (W) off slip road has a maximum queue length of 35 vehicles over the two lanes, which equates to 105 metres.

A copy of data extracted from NATS model data is included in Appendix A.

3 Proposed Solutions

3.1 B1108 Watton Road Roundabout

As the NATS model data predict that there would be no significant delays or queues by 2027, it was agreed during the workshop that no improvements to the junction appear to be necessary.

3.2 A11 Thickthorn Roundabout

3.2.1 Option 1: Low Cost Measures

During the workshop, the following were identified as low cost measures that could relieve some of the congestion on the junction due to JCS:

- Left-in to the Park and Ride from the A11 (West) , but left-out was not proposed due to its proximity to the roundabout;
- Closure of 'old' Newmarket Road arm, with possible re-provision off A11 (East);
- Closure of access to depot on A47 South off-slip.

The proposed measures are shown on drawing number 233902BF/002.

3.2.2 Option 2: Major Realignment

The following more radical options were also considered:

- Closing B1172 Park and Ride arm and re-providing access to the west of the Park and Ride site by a new junction with the A11 (West);
- Providing a grade separated right turn movements from the two arms of the A11 with new bridges. It was noted that the land-take for these could be large with a requirement for the horizontal alignment to suit a 120 kph design speed and at the same time to merge back into the A47 before the rail underbridge;
- Providing a grade separation for the A11 straight-ahead movement.

But during the workshop the radical solution that was preferred for further development is a significantly increased diameter roundabout relocated to the south of the existing using the existing southern underbridge and a new overbridge, with the B1172/P&R access effectively separated. It was noted that earthworks to achieve a suitable vertical alignment could be a significant element of this option therefore a scheme design in MX has been produced. Drawing number 233902BF/003 shows the proposed solution, and drawing number 233902BF/004 shows the locations of proposed road markings.

Buildability

The level of the roundabout would be constrained by the existing level of the A47 flyover. There is no data of the level on the A47 bridge deck, so the level was assumed by adding 5 metres for headroom allowance. It would be difficult to re-grade the A47 downhill slope, as it is constrained by the footbridge located to the south of Cantley Lane. Although there are two options whether to construct the south part of the improved roundabout above or below the A47 (S) downhill slope. It was agreed during the workshop that the option to build above the current A47 (S) would be the one included in the cost.

The north part of the improved roundabout would be constructed at current level of the existing roundabout, and therefore the A47 (N) on slip road does not need to be re-graded. This however would mean that the new link road between the new roundabouts at Thickthorn Park and Ride and at Newmarket Road would need to be built in a cutting to provide the minimum headroom required between the new link road and the A47 (N) on slip road.

3.3 A140 Harford Roundabout

3.3.1 Option 1: Partial Signalisation

It was agreed during the workshop that mitigation measures are required at this junction. The initial proposal was a partial signalisation of the A140 (South) and the A47 (West) off slip, but not Markshall Farm Road. Markshall Farm Road is not to be signalised because the short chord length between this road and the A140 (South) that could lead to problems with green times/stacking. In addition, Markshall Farm Road is currently used as a 'rat run' so poorer access onto the junction from this road was considered to be acceptable.

Drawing number 233902BF/013 shows the layout of the proposed solution.

3.3.2 Option 2: Proposed Alterations

It should also be noted that if other options are considered for JCS, with more housing growth allocated at Long Stratton this could lead to considerably more traffic at this junction. However, in the timescale available for the current study, it was recognised that it is not possible to run the NATS models for different JCS options, hence a more radical solution for junction improvement at this location was proposed, based on the assumption that the preferred option for the JCS could lead to more traffic.

As there are no land use constraints to the south of the junction, it was agreed with the Council officers that the ICD of the roundabout should be increased by stretching the roundabout to the south, and this solution has been designed and costed.

The layout of the proposed alterations is shown in drawing number 233902BF/012.

It is conceivable that if there is significant more housing growth on the A140 corridor as identified in option 3 then a solution as radical as proposed at A11 Thickthorn roundabout may be required.

4 High Level Cost Estimates

The estimated cost for construction of the proposed solutions at Harford roundabout and Thickthorn roundabout are given in Table 4.1 below.

Table 4.1: Cost Estimates

Junction	Option	Cost Reference	Cost	Optimism Bias	Total
A11 Thickthorn Roundabout	Option 1: Low Cost Measures	Thickthorn Minor	£105 000	£45 000	£150 000
A11 Thickthorn Roundabout	Option 2: Major Realignment	Thickthorn Major	£24 620 000	£16 000 000	£40 620 000
A140 Harford Roundabout	Option 1: Partial Signalisation	Harford Minor	£125 000	£55 000	£180 000
A140 Harford Roundabout	Option 2: Proposed Alterations	Harford Major	£820 000	£370 000	£1 190 000

The table above is for estimated capital works only, at first Quarter 2008, and does not take into account VAT, land costs, statutory undertaker works, design development, surveys and accommodation works. Breakdowns of the costs for each link are included in the Appendix B. In accordance with Mott MacDonald's interpretation of DfT guidance, Optimism Bias of 45% for costs less than £5 million and 65% for costs over £5 million have been included in the estimates.

Utility diversions costs are excluded from these estimates so there is a risk of diversion costs which could significantly increase the costs of Thickthorn Option 1 and Harford Option 2. This risk would be reduced at the next stage of work by locating services by a combination of service searches, topographical survey and / or trial trenching and dialogue with the utilities.

It is conceivable that if there is significant more housing growth on the A140 corridor then a solution as radical as proposed at A11 Thickthorn roundabout may be required at A140 Harford potentially costing up to £40.6m.

Further cost certainty could be achieved by topographical surveys which would allow junction modifications to be designed with correct levels.

5 Conclusions and Recommendations

This high level study concludes that the impacts of the JCS (Option D – Option 1) traffic on the following junctions with the A47 would be as follows:

- B1108 Watton Road Roundabouts - there are no modifications required;
- A11 Thickthorn roundabout would require improvements, with a capital cost (including optimism bias) of £150 000 to £40.6 million;
- A140 Harford roundabout would require improvements, with a capital cost (including optimism bias) of £180 000 to £1.2 million but potentially up to £40.6 million, as at A11 Thickthorn roundabout ; and
- Overall cost (with exclusions as previously discussed but with optimism bias) in the order of £330 000 to £81 million.

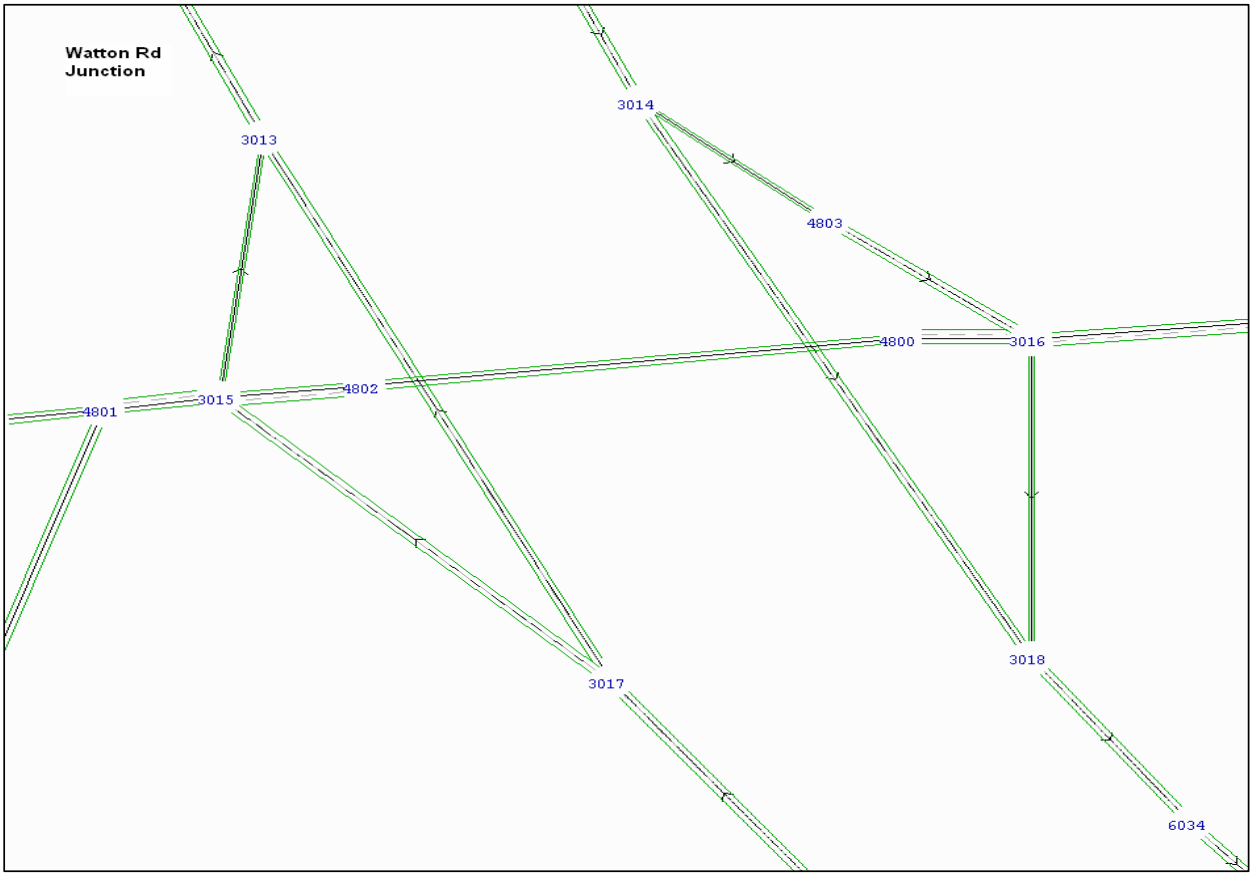
When a preferred option is determined for the JCS, if Norfolk County Council wish to consider the impact of the JCS development on the A47 junctions further, then the following actions are required:

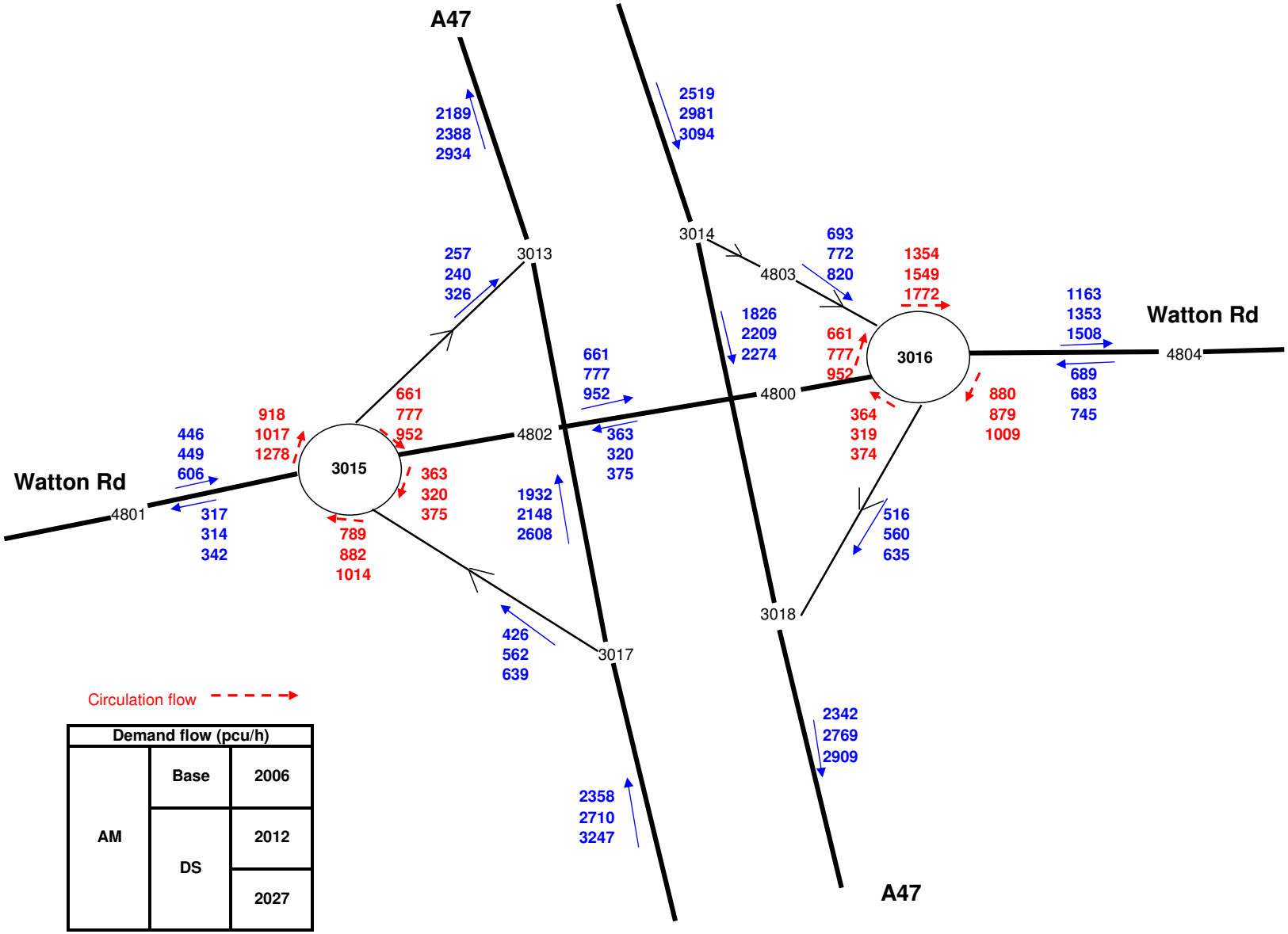
- Service searches.
- Topographical surveys are required to allow junction modifications to be designed with correct levels.
- TRANSYT model of Harford roundabout modifications.
- VISSIM model of Thickthorn roundabout because these signals are MOVA controlled based.
- Consideration of junction modifications to accommodate the sustainable transport measures that are emerging, eg possible Bus Rapid Transit (BRT) schemes, and junction modifications to improve cycle and pedestrian movements.
- Dialogue with the Highways Agency.

Appendix A Results from NATS SATURN Model Tests

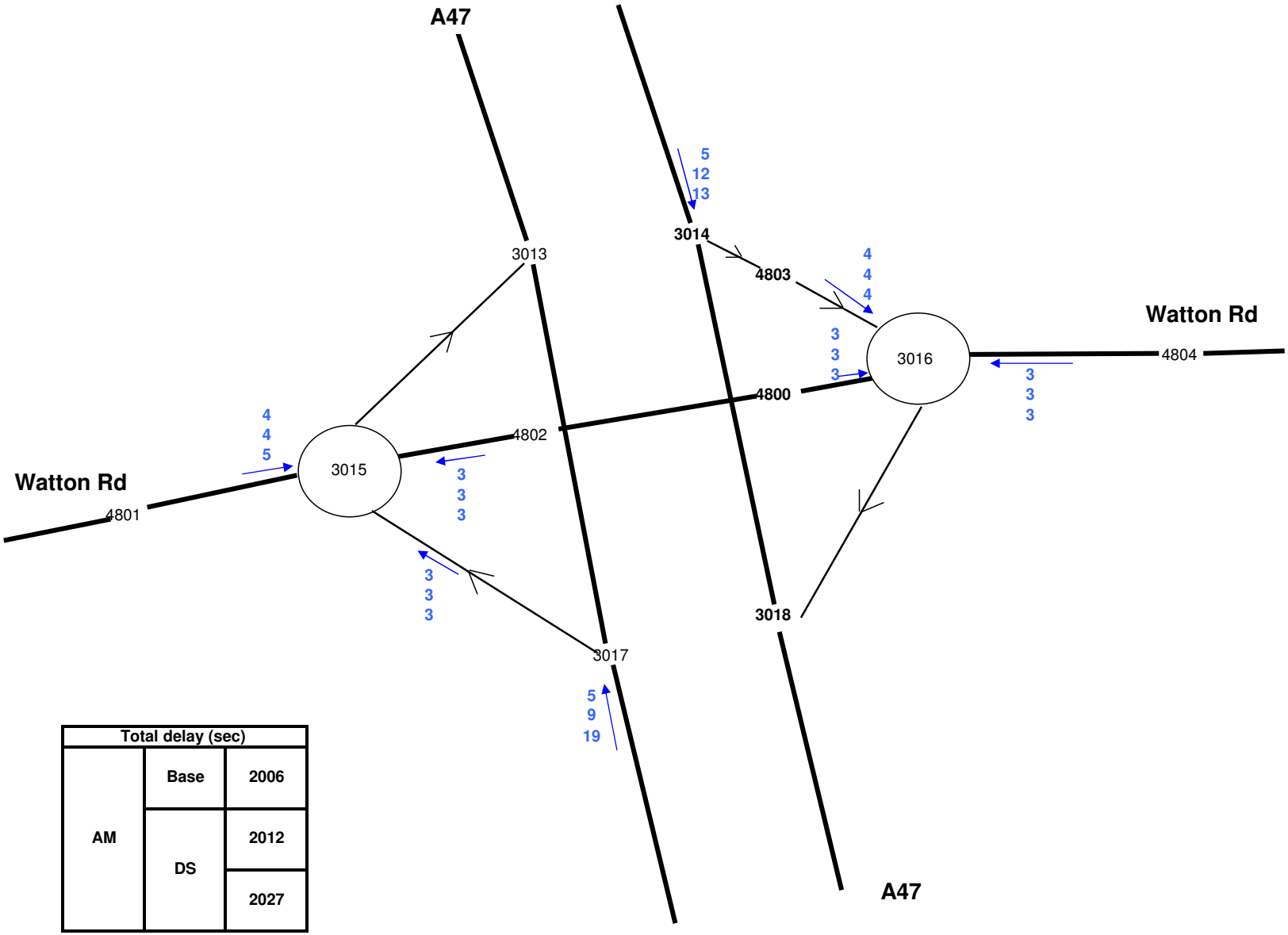
1. B1108 Watton Road Roundabouts (7 pages A4)
2. A11 Thickthorn Roundabout (8 pages A4)
3. A140 Harford Roundabout (8 pages A4)

Node	Turning movements		Watton Rd Junction					
			AM			PM		
	From	To	2006	2012	2027	2006	2012	2027
3017	6035	3013	1932	2148	2608	1930	2117	2400
		3015	426	562	639	373	462	518
3015	4801	3013	28	28	59	44	40	44
		4802	418	421	547	380	385	468
	4802	3013	229	212	267	446	637	671
		4801	134	108	108	215	221	298
	3017	4801	183	206	234	175	201	254
		4802	243	356	405	198	261	264
		3013	0	0	0	0	0	0
3014	7017	3018	1826	2209	2274	1341	1572	1904
		4803	693	772	820	261	231	320
3016	4800	3018	164	172	242	242	277	344
		4804	497	605	711	337	368	388
	4804	3018	352	388	393	282	467	555
		4800	337	295	352	642	837	929
	4803	3018	0	0	0	0	0	0
		4800	26	25	23	19	21	41
		4804	666	748	797	242	210	279

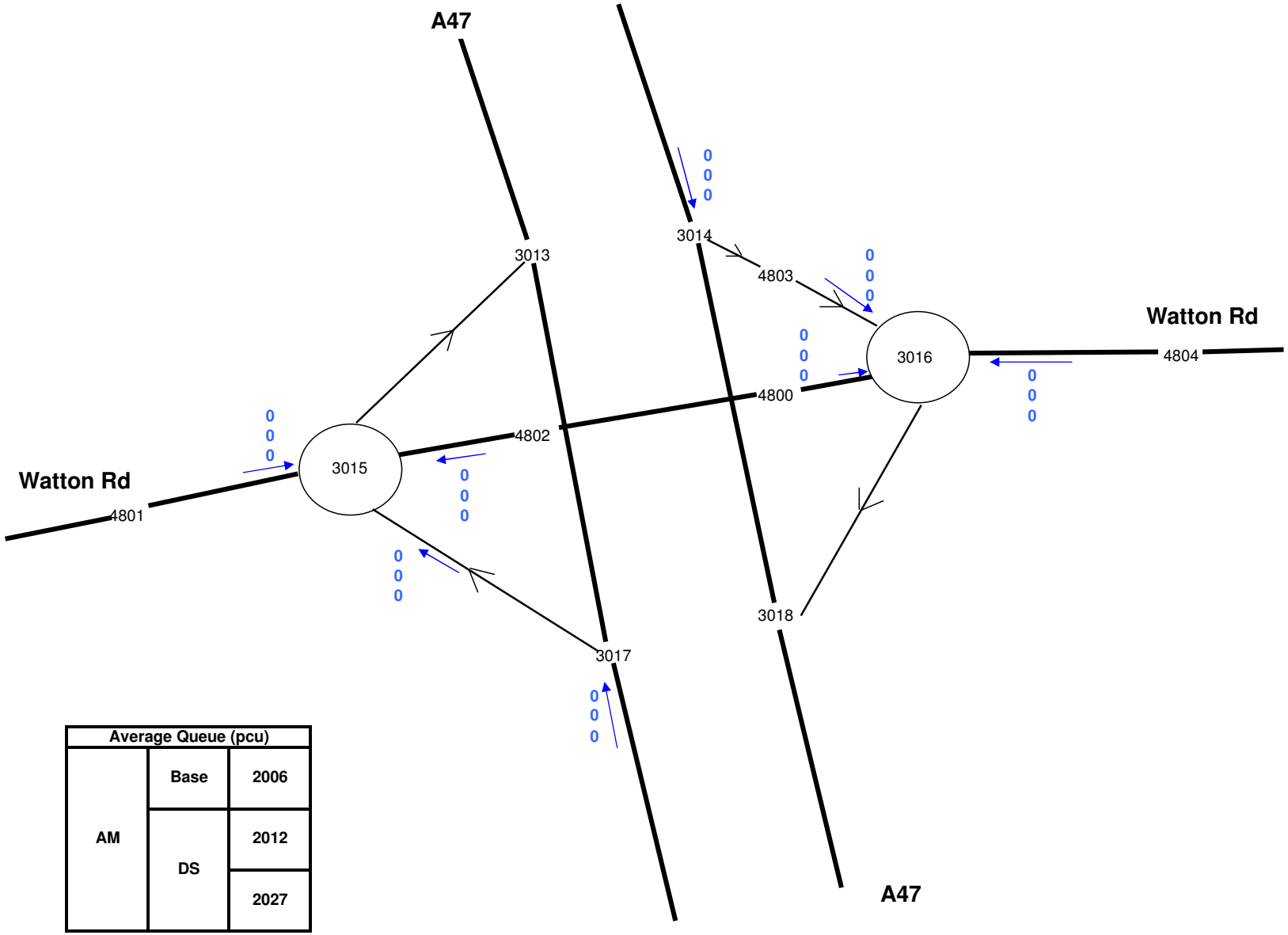




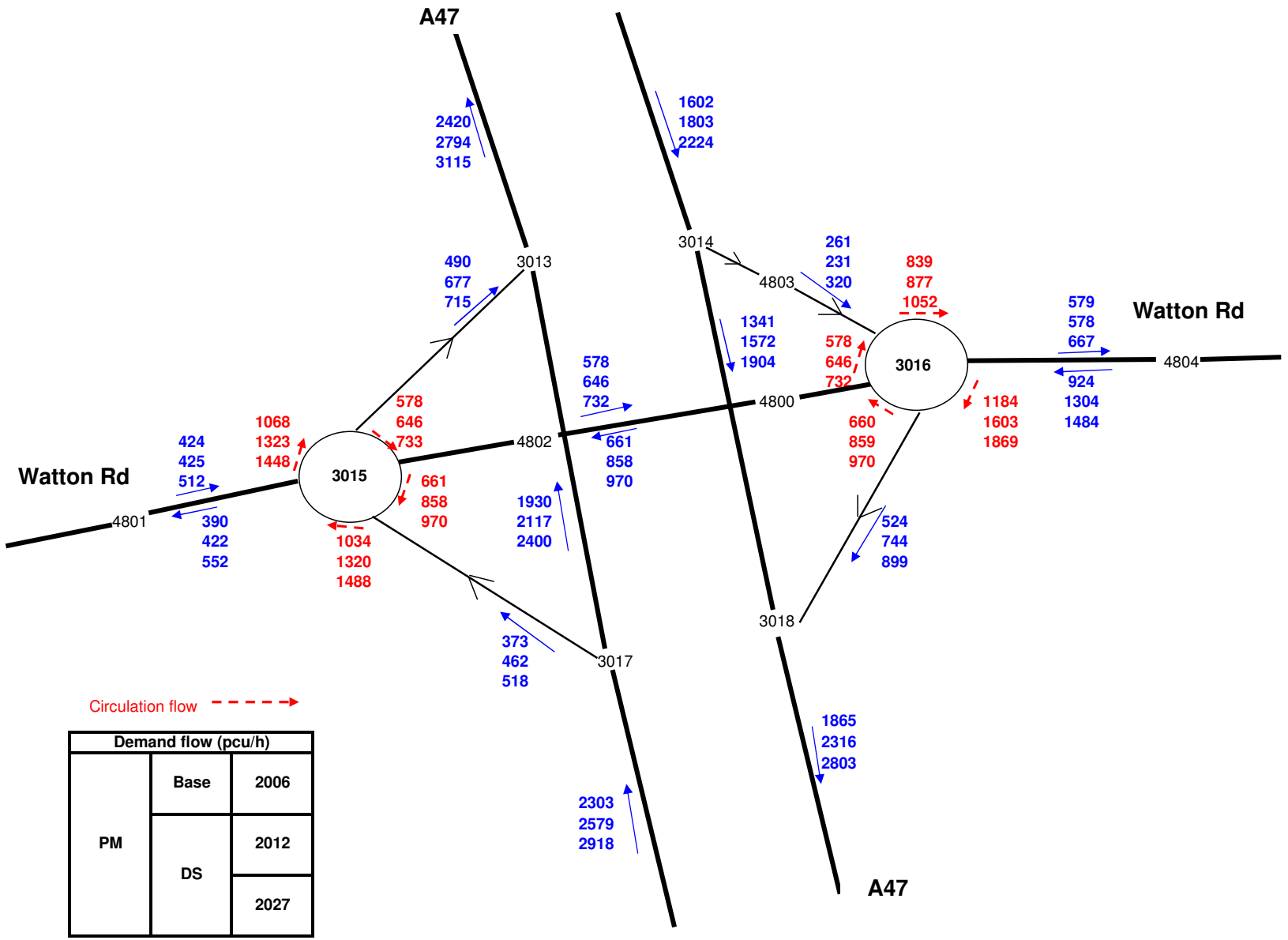
Demand flow (pcu/h)		
AM	Base	2006
	DS	2012
		2027



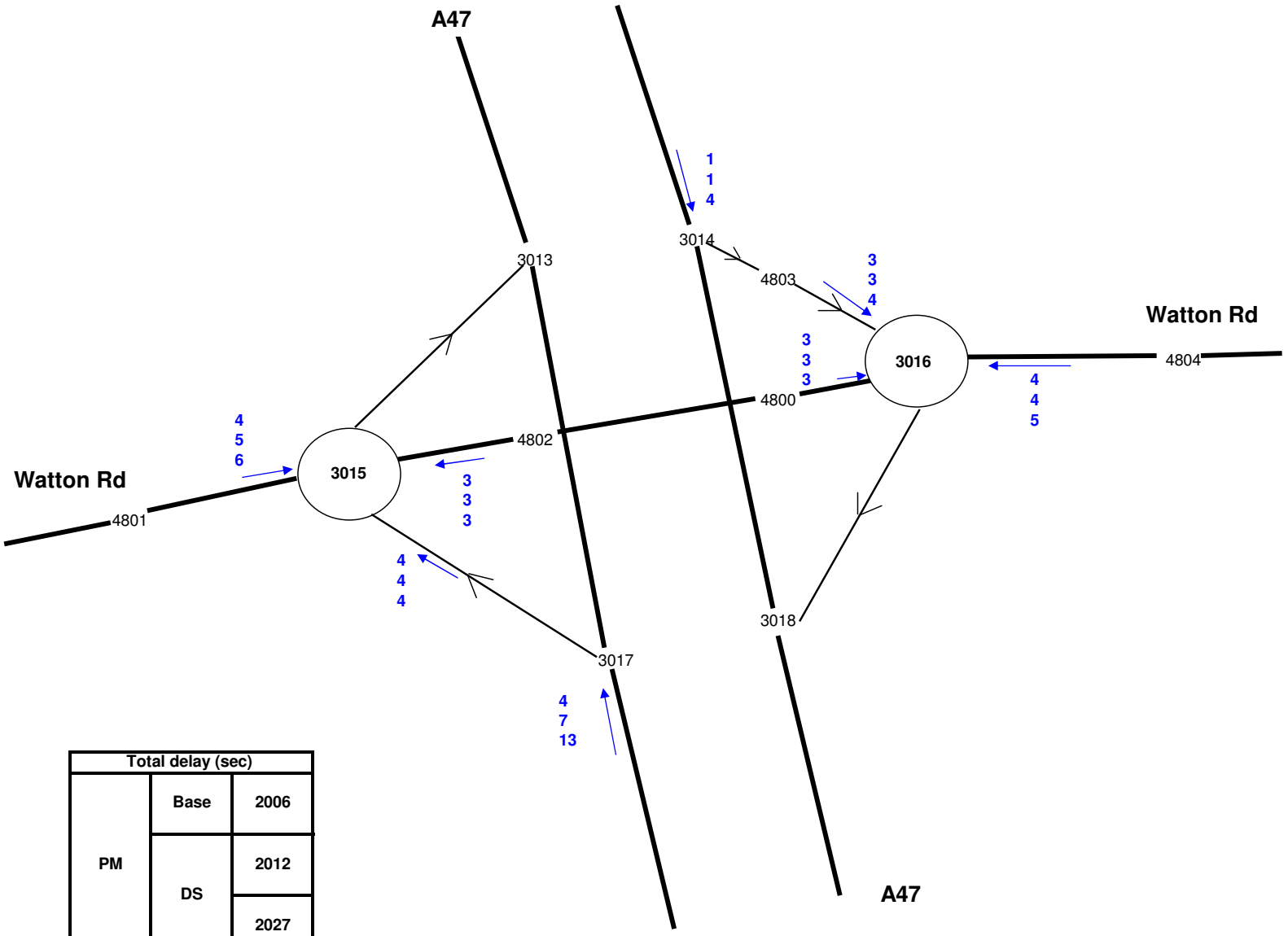
Total delay (sec)		
AM	Base	2006
	DS	2012
		2027



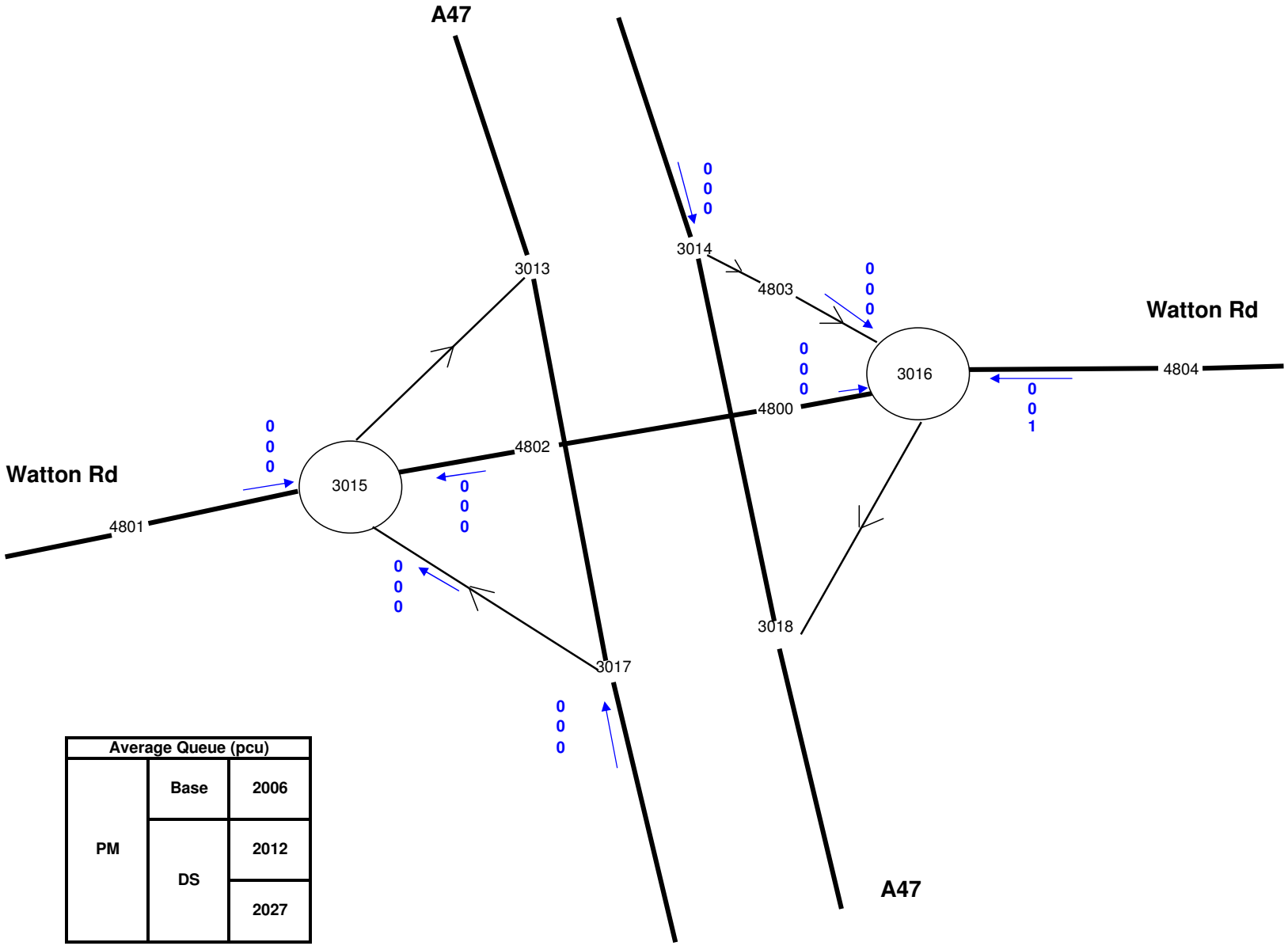
Average Queue (pcu)		
AM	Base	2006
	DS	2012
		2027



Demand flow (pcu/h)		
PM	Base	2006
	DS	2012
		2027

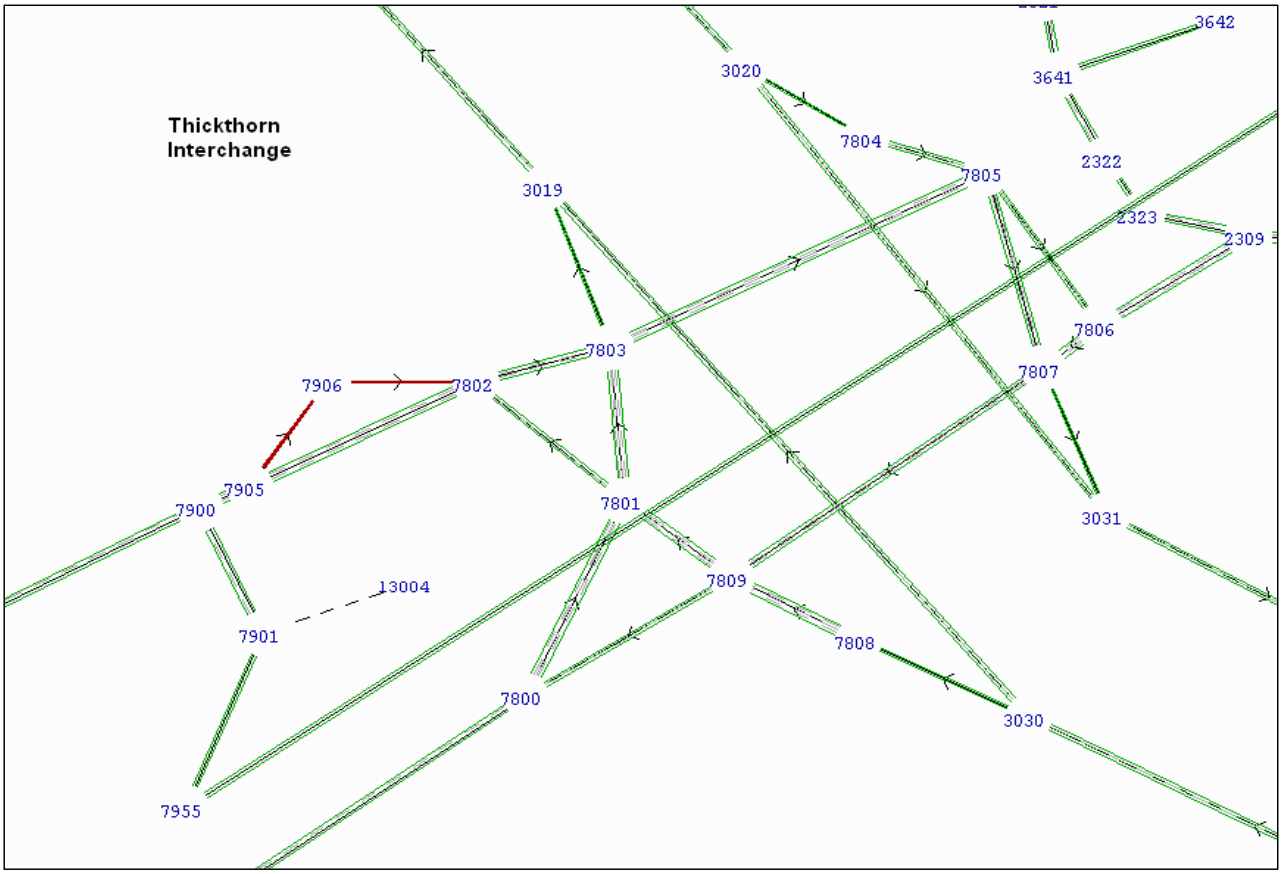


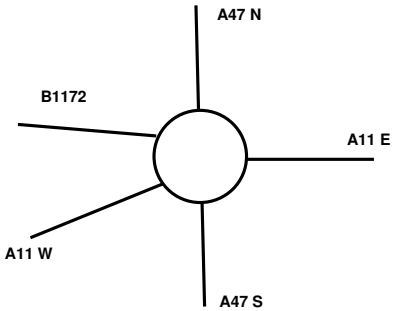
Total delay (sec)		
PM	Base	2006
	DS	2012
		2027



Average Queue (pcu)		
PM	Base	2006
	DS	2012
		2027

Node	Turning movements		Thickthorn Junction					
			AM			PM		
	From	To	2006	2012	2027	2006	2012	2027
3020	6034	7804	476	528	568	319	425	457
		3031	1866	2242	2340	1546	1891	2346
7806	7805	2309	1822	1616	1953	1178	1353	1607
	2309	7807	1360	1783	2100	1653	1913	2299
7807	7805	3031	759	882	1190	538	719	938
		7809	220	286	332	204	259	402
	7806	3031	242	318	396	441	528	557
		7809	1118	1466	1704	1212	1384	1742
3030	6037	3019	1903	2152	2642	1707	1903	2176
		7808	746	1195	1501	790	1065	1660
7800	7809	2094	1073	1513	2071	1384	1758	2919
	2094	7801	1604	1797	2719	1248	1502	2062
7802	7905	7803	668	615	443	529	594	740
	7801	7905	502	1031	1117	402	463	454
3031	7807	6036	1001	1199	1586	979	1248	1496
	3020	6036	1866	2242	2340	1546	1891	2346
3019	7803	6035	455	558	604	597	676	742
	3030	6035	1903	2152	2642	1707	1903	2176
7805	7803	7806	1551	1372	1716	969	1085	1342
		7807	774	884	1190	632	820	1148





Thickthorn O-D Matrix data AM							
	A47 N	A11 E	A47 S	A11 W	B1172	Total out	year
A47 N	0	266	1632	185	4	2087	2006
	0	243	2231	262	21	2757	2012
	0	236	2336	322	11	2905	2027
A11 E	275	0	245	664	152	1336	2006
	385	0	322	843	229	1779	2012
	412	0	396	1114	175	2097	2027
A47 S	1802	382	0	160	162	2506	2006
	2157	415	0	385	394	3351	2012
	2653	462	0	606	416	4137	2027
A11 W	113	844	471	0	171	1599	2006
	105	719	578	0	392	1794	2012
	208	1077	919	0	507	2711	2027
B1172	67	297	301	11	0	676	2006
	73	238	301	3	0	615	2012
	1	161	283	0	0	445	2027
Total in	2257	1789	2649	1020	489		2006
	2720	1615	3432	1493	1036		2012
	3274	1936	3934	2042	1109		2027

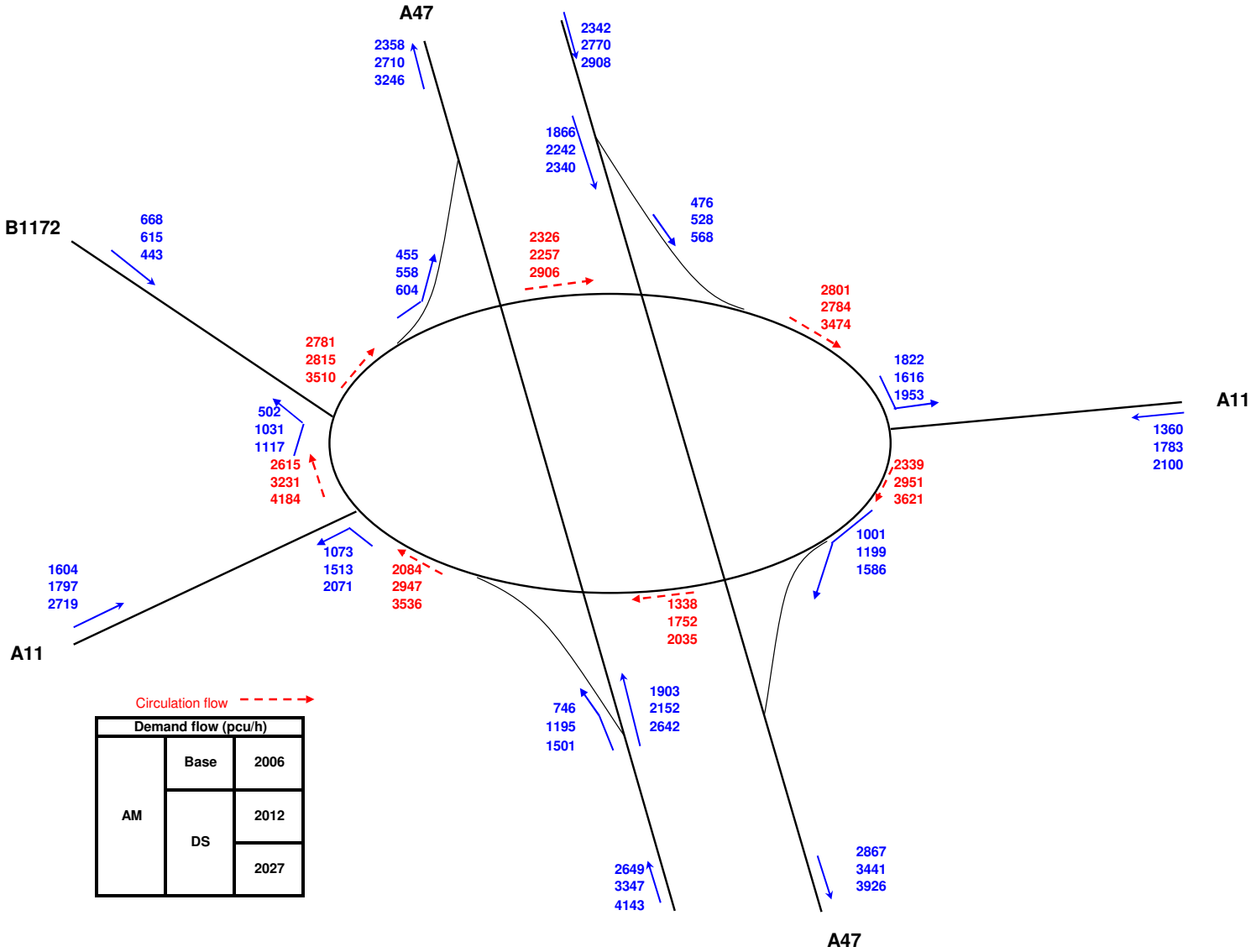
Thickthorn O-D Matrix data PM							
	A47 N	A11 E	A47 S	A11 W	B1172	Total out	year
A47 N	0	234	1454	85	14	1787	2006
	0	267	1883	120	35	2305	2012
	0	264	2331	188	3	2786	2027
A11 E	269	0	426	811	182	1688	2006
	303	0	525	921	146	1895	2012
	290	0	550	1347	94	2281	2027
A47 S	1518	167	0	376	213	2274	2006
	1886	217	0	604	247	2954	2012
	2127	237	0	1148	316	3828	2027
A11 W	261	647	333	0	11	1252	2006
	275	702	479	0	36	1492	2012
	410	915	675	0	55	2055	2027
B1172	71	175	194	98	0	538	2006
	84	166	241	102	0	593	2012
	74	170	289	216	0	749	2027
Total in	2119	1223	2407	1370	420		2006
	2548	1352	3128	1747	464		2012
	2901	1586	3845	2899	468		2027

	Total out AM		
	Link flow	SLA	Dif
A47 N	2342	2087	-10.89%
	2770	2757	-0.47%
	2908	2905	-0.10%
A11 E	1360	1336	-1.76%
	1783	1779	-0.22%
	2100	2097	-0.14%
A47 S	2649	2506	-5.40%
	3347	3351	0.12%
	4143	4137	-0.14%
A11 W	1604	1599	-0.31%
	1797	1794	-0.17%
	2719	2711	-0.29%
B1172	668	676	1.20%
	615	615	0.00%
	443	445	0.45%
	Average		-1.21%

	Total out PM		
	Link flow	SLA	Dif
	1865	1787	-4.18%
	2316	2305	-0.47%
	2803	2786	-0.61%
	1653	1688	2.12%
	1913	1895	-0.94%
	2299	2281	-0.78%
	2649	2274	-14.16%
	3347	2954	-11.74%
	4143	3828	-7.60%
	1248	1252	0.32%
	1502	1492	-0.67%
	2062	2055	-0.34%
	529	538	1.70%
	594	593	-0.17%
	740	749	1.22%
	Average		-2.42%

	Total in AM		
	Link flow	SLA	Dif
	2358	2257	-4.28%
	2710	2720	0.37%
	3246	3274	0.86%
	1822	1789	-1.81%
	1616	1615	-0.06%
	1933	1936	0.16%
	2867	2649	-7.60%
	3441	3432	-0.26%
	3926	3934	0.20%
	1073	1020	-4.94%
	1513	1493	-1.32%
	2071	2042	-1.40%
	502	489	-2.59%
	1031	1036	0.48%
	1117	1109	-0.72%
	Average		-1.53%

	Total in PM		
	Link flow	SLA	Dif
	2304	2119	-8.03%
	2579	2548	-1.20%
	2918	2901	-0.58%
	1178	1223	3.82%
	1353	1352	-0.07%
	1607	1586	-1.31%
	2525	2407	-4.67%
	3139	3128	-0.35%
	3842	3845	0.08%
	1384	1370	-1.01%
	1758	1747	-0.63%
	2919	2899	-0.69%
	402	420	4.48%
	463	464	0.22%
	454	468	3.08%
	Average		-0.46%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2908
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2242
2340
476
528
568
B1172
668
615
443
455
558
604
2326
2257
2906
2801
2784
3474
2781
2815
3510
1822
1616
1953
A11
1360
1783
2100
502
1031
1117
2615
3231
4184
2339
2951
3621
1001
1199
1586
1073
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2035
A11
1903
2152
2642
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1195
1501
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3347
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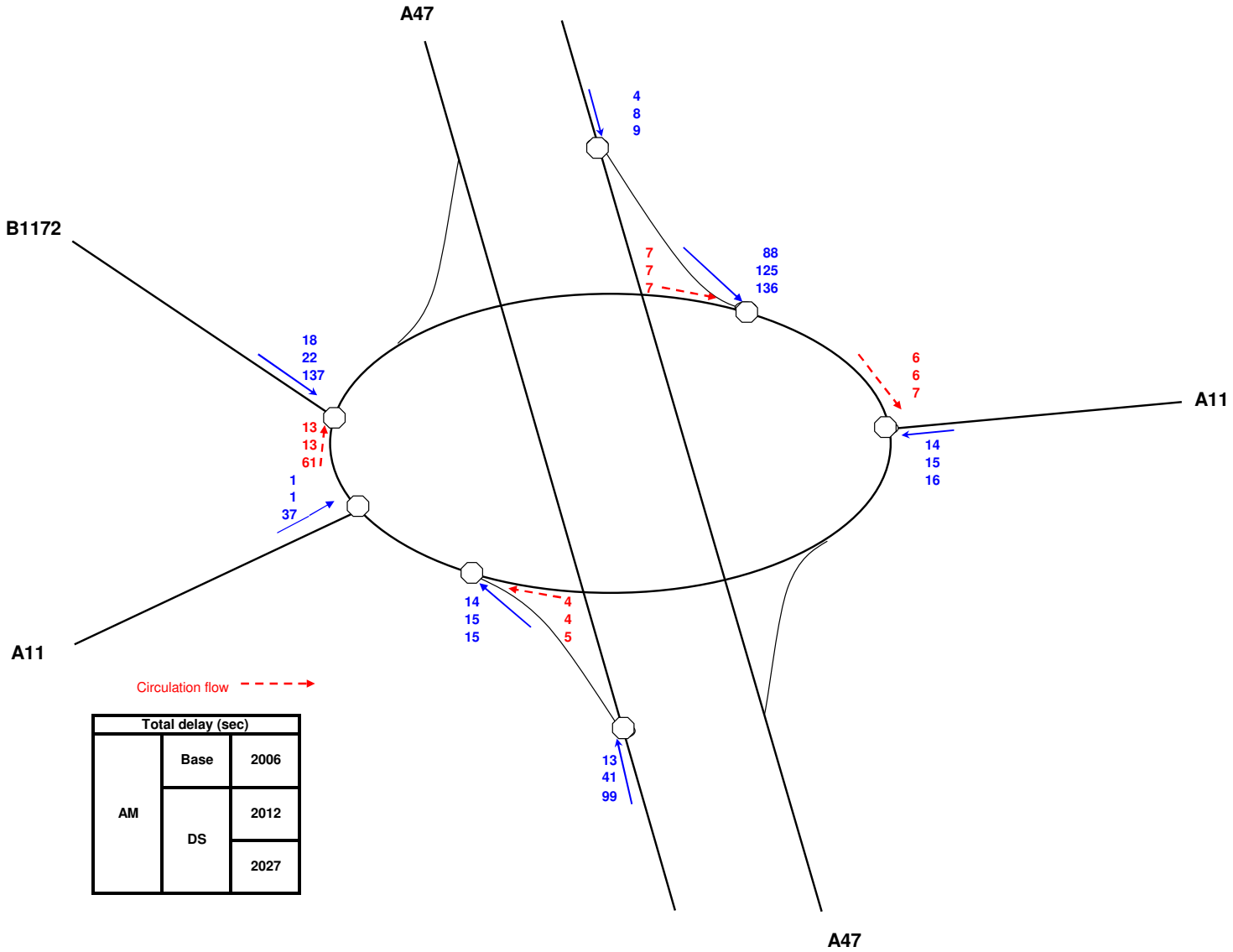
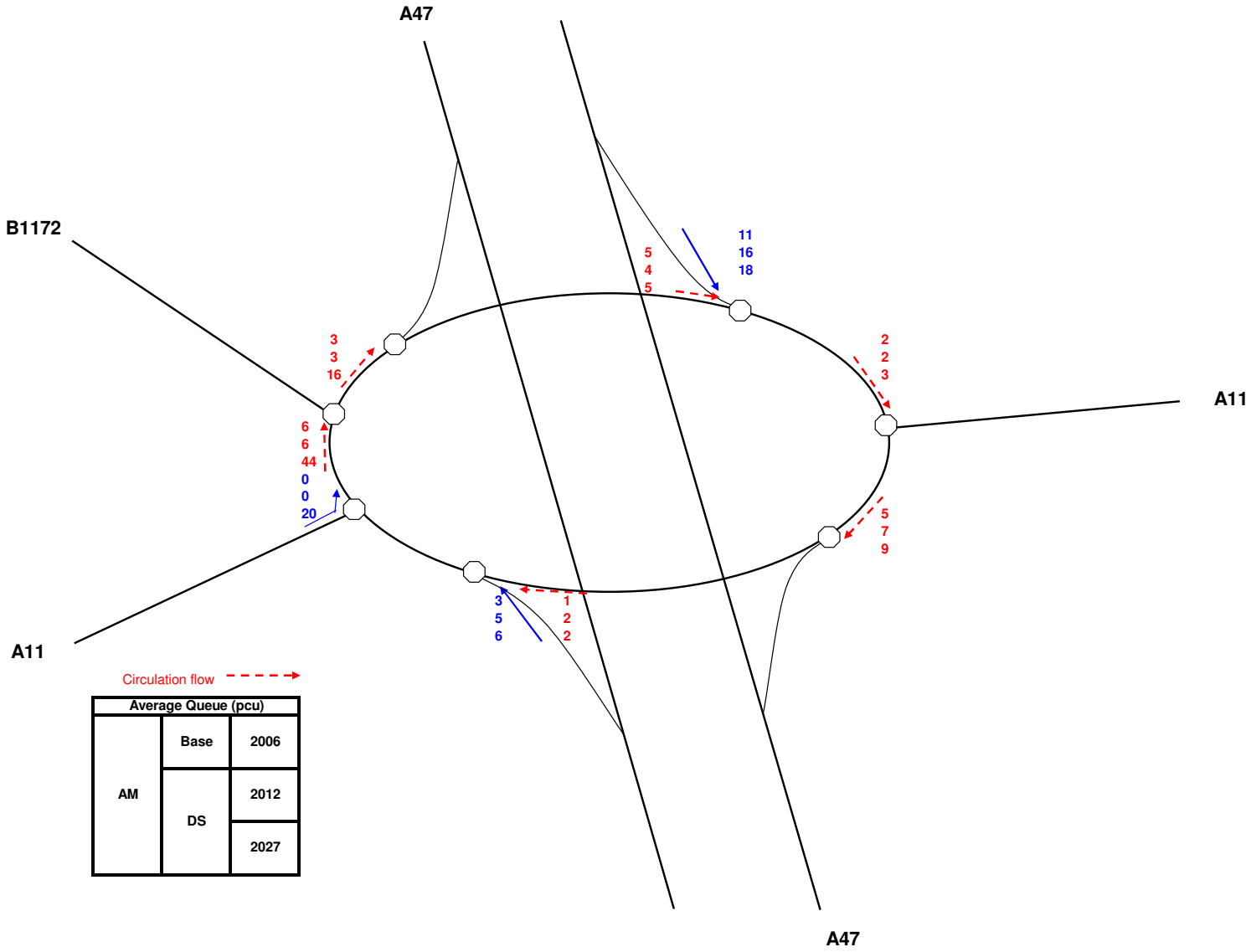
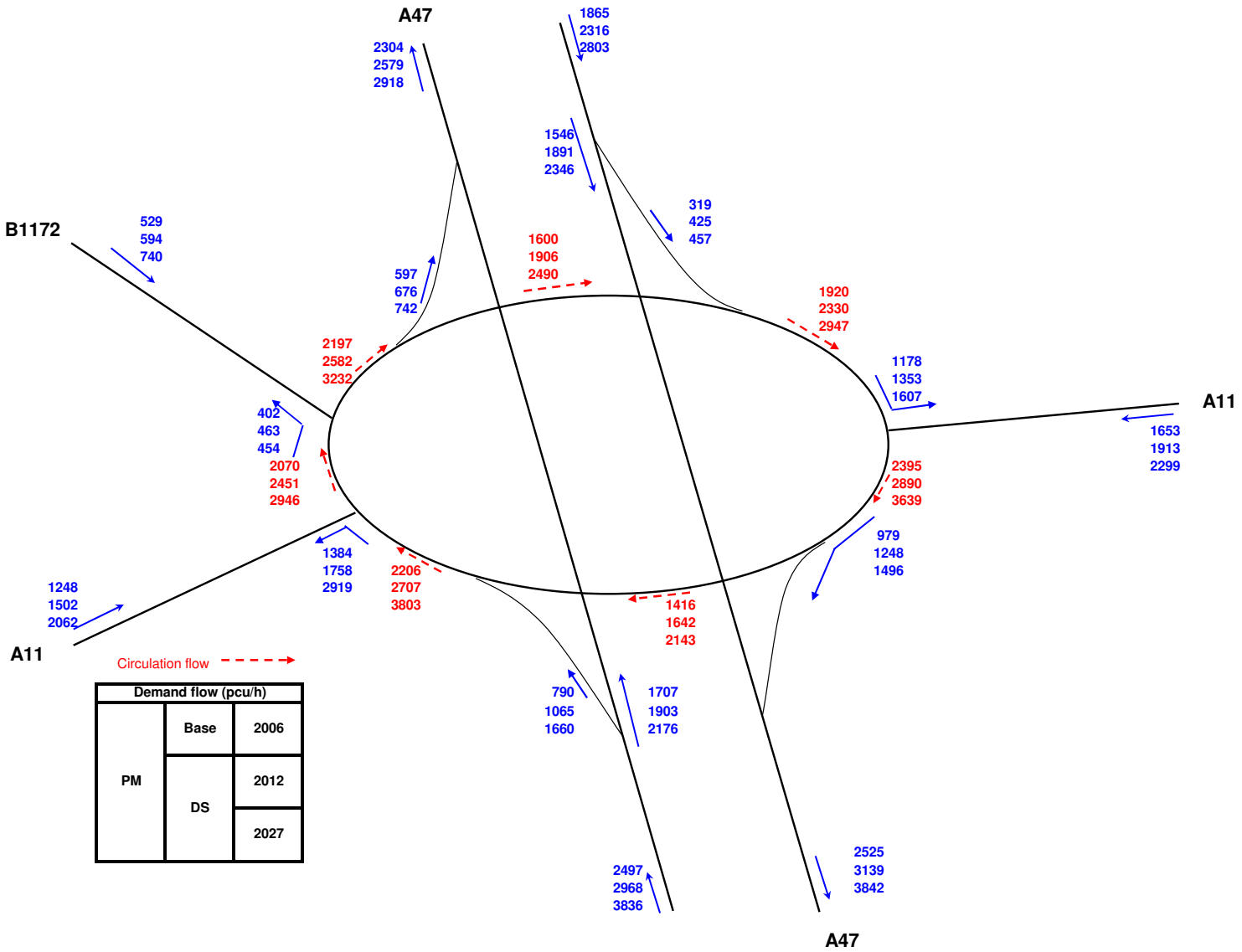
2867
3441
3926
A47
Circulation flow
Demand flow (pcu/h)
AM
Base
2006
DS
2012
2027



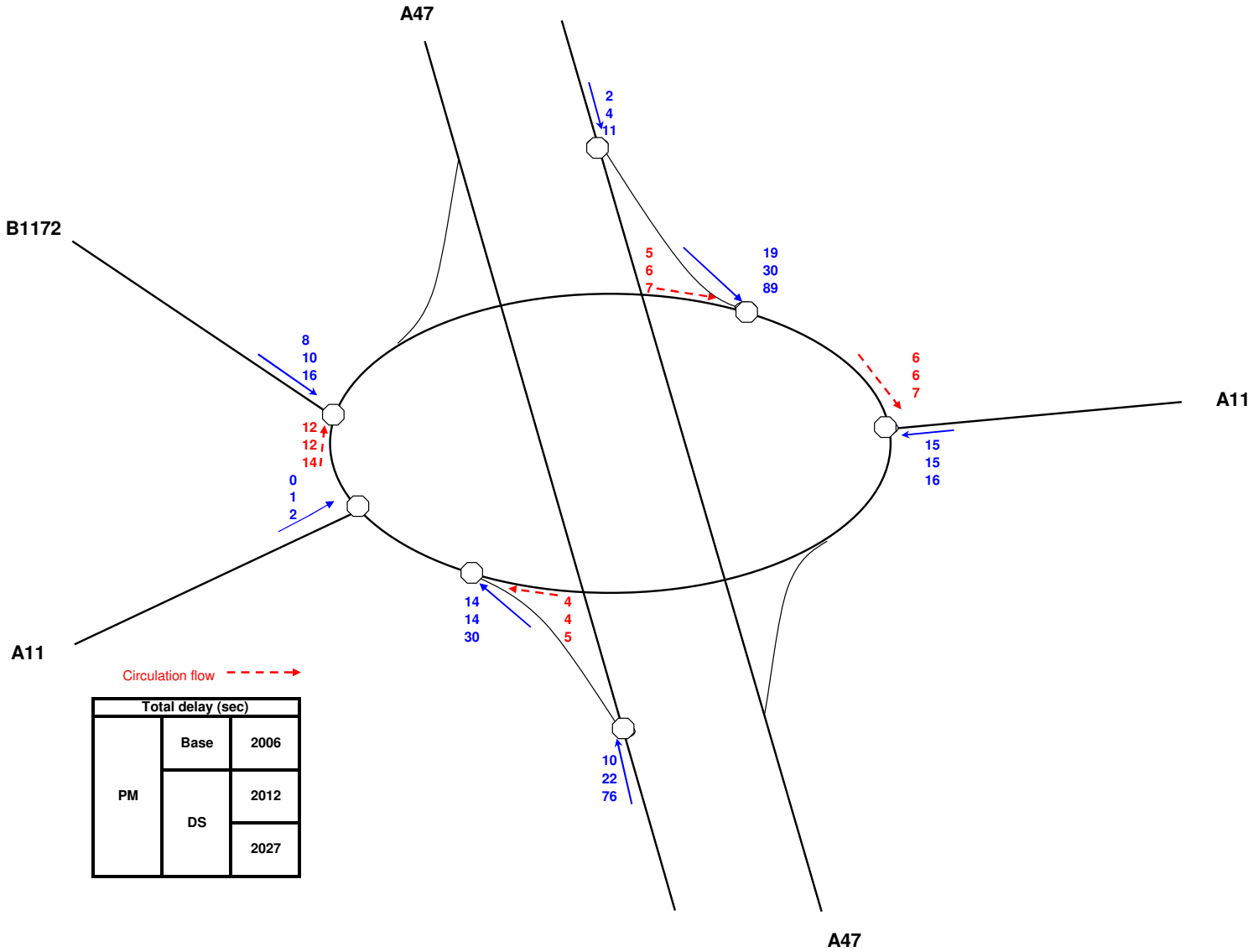
Total delay (sec)		
AM	Base	2006
	DS	2012
		2027



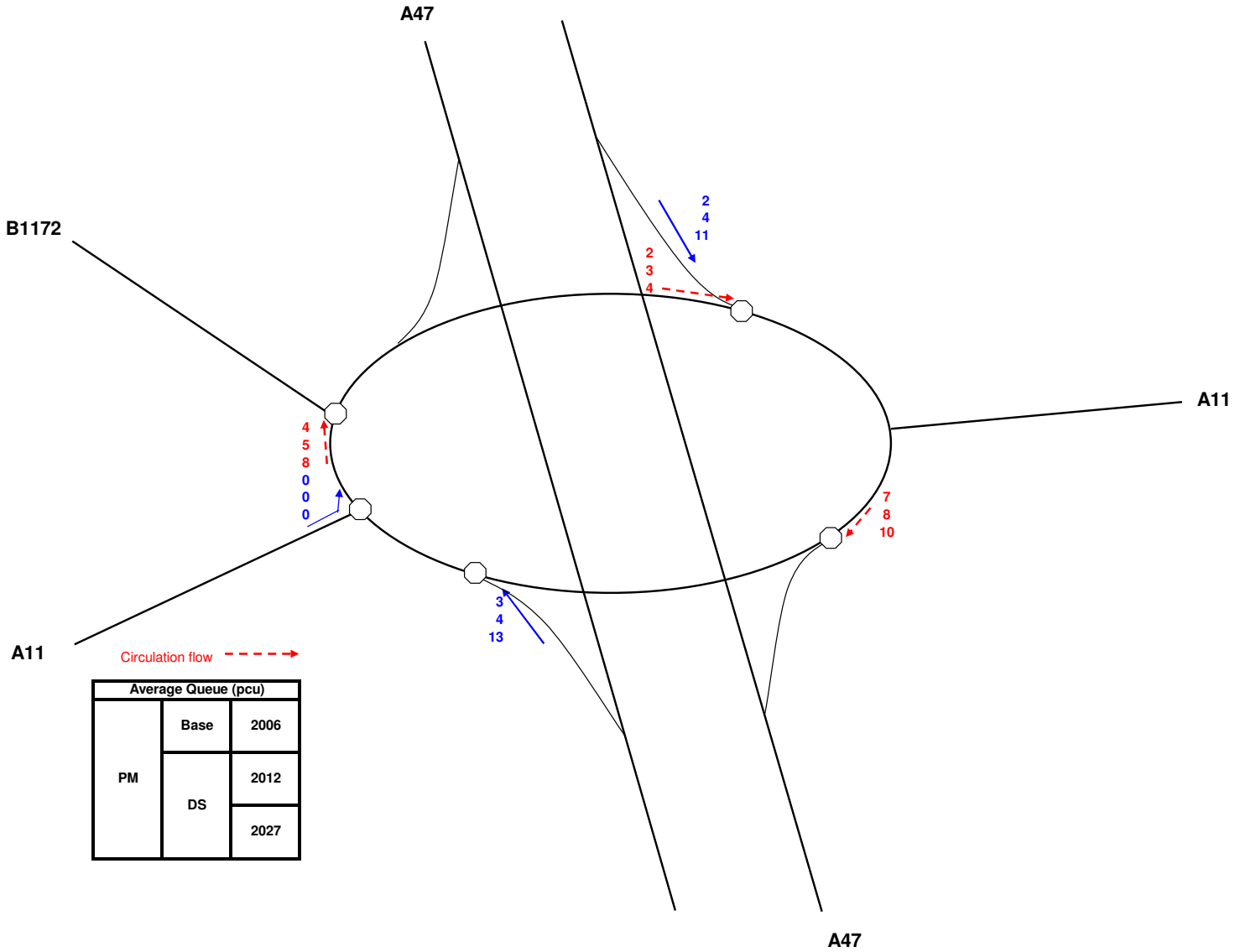
Average Queue (pcu)		
AM	Base	2006
	DS	2012
		2027



Demand flow (pcu/h)		
PM	Base	2006
	DS	2012
		2027

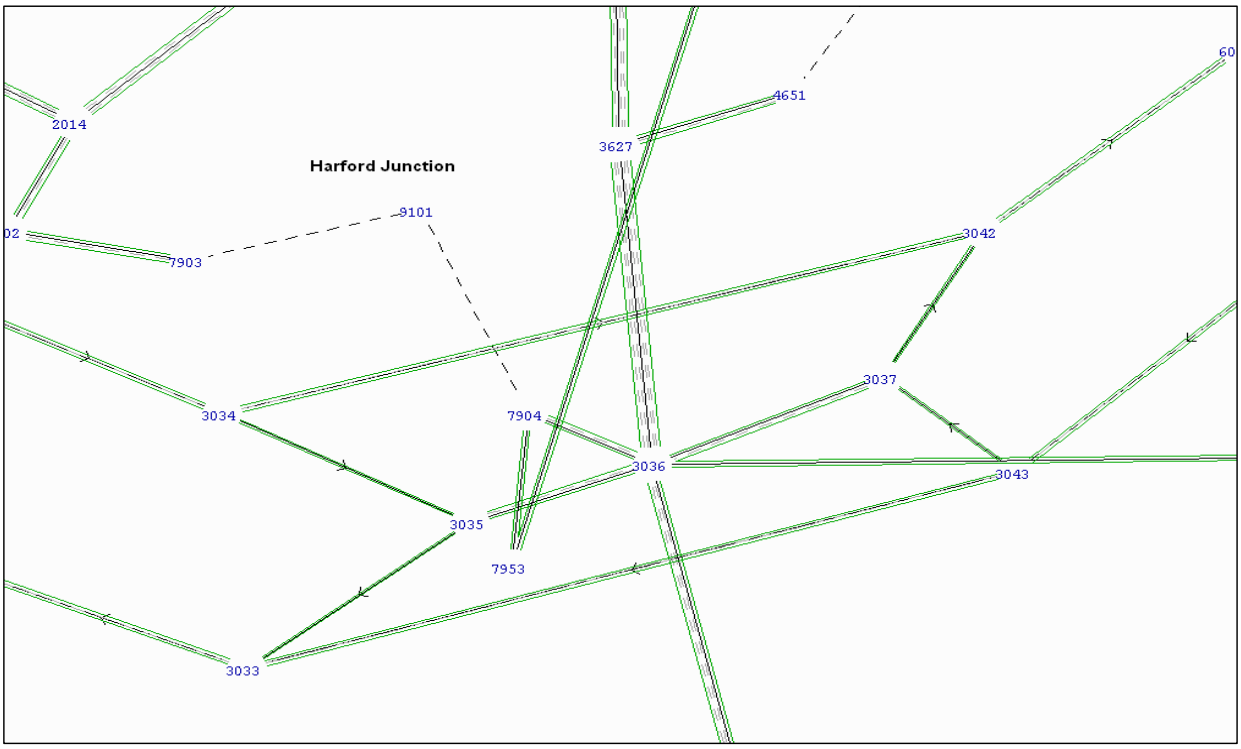


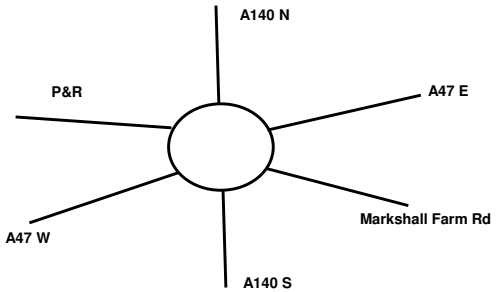
Total delay (sec)		
PM	Base	2006
	DS	2012
		2027



Average Queue (pcu)		
PM	Base	2006
	DS	2012
		2027

Node	Turning movements		Harford Junction					
			AM			PM		
	From	To	2006	2012	2027	2006	2012	2027
3034	6036	3035	969	1334	1397	775	961	1325
		3042	1898	2107	2529	1750	2178	2516
3036	3627	3037	209	324	458	181	192	213
		2006	11	11	15	33	31	14
		2009	302	296	344	550	547	553
		3035	255	351	484	249	419	603
		7904	107	230	250	0	6	6
	3037	2006	0	0	5	4	3	48
		2009	233	361	472	170	276	268
		3035	0	0	0	0	0	0
		7904	51	189	213	0	5	8
		3627	331	382	382	226	249	355
	2006	2009	3	2	0	18	25	0
		3035	170	314	454	165	252	343
		7904	18	77	99	0	5	8
		3627	20	24	71	30	29	54
		3037	0	0	42	15	12	28
	2009	3035	406	415	426	368	376	441
		7904	125	202	213	1	8	10
		3627	547	469	538	328	272	309
		3037	203	245	353	249	314	429
		2006	0	0	0	0	0	0
	3035	7904	77	410	388	0	11	10
		3627	270	294	202	111	150	218
		3037	0	0	0	0	0	0
		2006	182	183	322	273	355	576
		2009	440	446	486	391	445	521
	7904	3627	0	0	0	50	43	82
		3037	0	0	0	14	15	23
		2006	0	0	0	18	21	21
		2009	0	0	0	119	104	149
		3035	0	0	0	0	1	112
3043	6039	3033	1819	2267	2781	1714	1921	2337
		3037	615	933	1072	399	533	679





Harford O-D Matrix data AM

	A140 N	A47 E	MF Rd	A140 S	A47 W	P&R	Total out	year
A140 N	0	256	17	293	252	101	919	2006
	0	333	12	282	354	232	1213	2012
	0	468	21	336	515	248	1588	2027
A47 E	324	0	0	244	0	48	616	2006
	385	0	1	370	0	188	944	2012
	393	0	5	495	0	216	1109	2027
MF Rd	27	0	0	2	178	20	227	2006
	23	0	0	2	308	80	413	2012
	84	39	0	1	452	91	667	2027
A140 S	571	178	0	0	384	125	1258	2006
	453	247	0	0	420	201	1321	2012
	519	360	0	0	437	208	1524	2027
A47 W	314	0	176	440	0	76	1006	2006
	299	0	183	445	0	409	1336	2012
	214	0	306	480	0	397	1397	2027
P&R	0	0	0	0	0	0	0	2006
	0	0	0	0	0	0	0	2012
	0	0	0	0	0	0	0	2027
Total in	1236	434	193	979	814	370		2006
	1160	580	196	1099	1082	1110		2012
	1210	867	332	1312	1404	1160		2027

Harford O-D Matrix data PM

	A140 N	A47 E	MF Rd	A140 S	A47 W	P&R	Total out	year
A140 N	0	191	32	514	247	23	1007	2006
	0	201	33	526	414	6	1180	2012
	0	233	25	511	603	9	1381	2027
A47 E	230	0	8	217	0	2	457	2006
	253	0	5	291	0	4	553	2012
	356	0	52	289	0	7	704	2027
MF Rd	30	15	0	16	193	0	254	2006
	29	12	0	24	249	0	314	2012
	56	28	0	8	345	7	444	2027
A140 S	338	249	0	0	368	1	956	2006
	267	315	0	0	376	8	966	2012
	302	430	0	0	442	10	1184	2027
A47 W	107	0	269	395	0	0	771	2006
	154	0	355	445	0	11	965	2012
	226	0	574	520	0	12	1332	2027
P&R	59	29	14	119	0	0	221	2006
	44	17	21	105	1	0	188	2012
	77	38	25	148	122	0	410	2027
Total in	764	484	323	1261	808	26		2006
	747	545	414	1391	1040	29		2012
	1017	729	676	1476	1512	45		2027

Total out AM

	Link flow	SLA	Dif
A140 N	884	919	3.96%
	1212	1213	0.08%
	1551	1588	2.39%
A47 E	615	616	0.16%
	933	944	1.18%
	1072	1109	3.45%
MF Rd	211	227	7.58%
	417	413	-0.96%
	666	667	0.15%
A140 S	1281	1258	-1.80%
	1331	1321	-0.75%
	1530	1524	-0.39%
A47 W	969	1006	3.82%
	1334	1336	0.15%
	1397	1397	0.00%
P&R	0	0	0.00%
	0	0	0.00%
	0	0	0.00%
		Average	1.06%

Total out PM

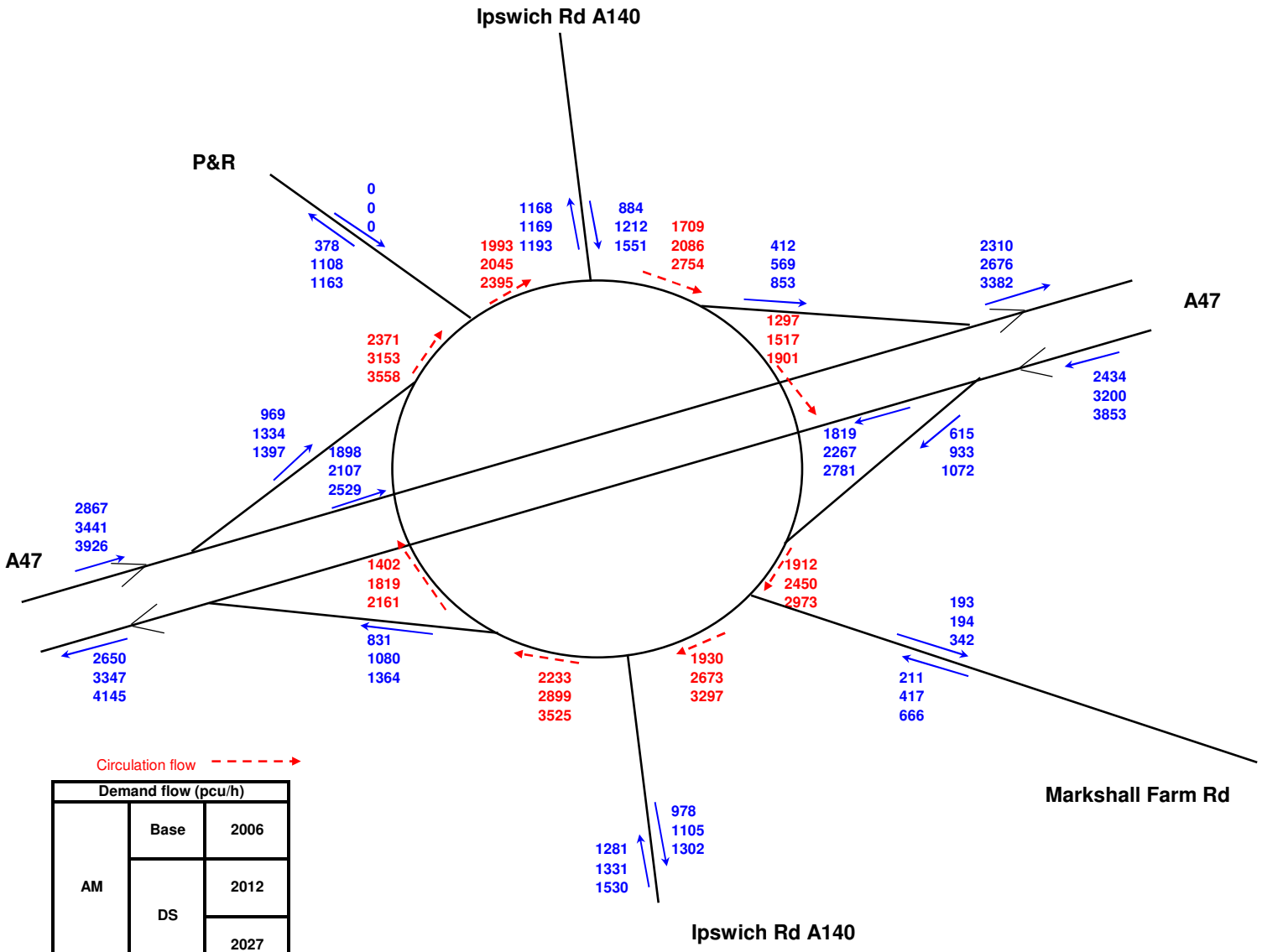
Link flow	SLA	Dif
1013	1007	-0.59%
1195	1180	-1.26%
1389	1381	-0.58%
399	457	14.54%
533	553	3.75%
679	704	3.68%
228	254	11.40%
323	314	-2.79%
433	444	2.54%
946	956	1.06%
970	966	-0.41%
1189	1184	-0.42%
775	771	-0.52%
961	965	0.42%
1325	1332	0.53%
201	221	9.95%
184	188	2.17%
387	410	5.94%
	Average	2.09%

Total in AM

Link flow	SLA	Dif
1168	1236	5.82%
1169	1160	-0.77%
1193	1210	1.42%
412	434	5.34%
569	580	1.93%
853	867	1.64%
193	193	0.00%
194	196	1.03%
342	332	-2.92%
978	979	0.10%
1105	1099	-0.54%
1302	1312	0.77%
831	814	-2.05%
1080	1082	0.19%
1364	1404	2.93%
378	370	-2.12%
1108	1110	0.18%
1163	1160	-0.26%
	Average	0.99%

Total in PM

Link flow	SLA	Dif
745	764	2.55%
743	747	0.54%
1018	1017	-0.10%
459	484	5.45%
533	545	2.25%
693	729	5.19%
328	323	-1.52%
410	414	0.98%
659	676	2.58%
1248	1261	1.04%
1397	1391	-0.43%
1491	1476	-1.01%
782	808	3.32%
1048	1040	-0.76%
1499	1512	0.87%
1	26	2500.00%
35	29	-17.14%
42	45	7.14%
	Average	1.40%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P&R
A47
A47
Markshall Farm Rd
Ipswich Rd A140
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378
1108
1163
1168
1169
1193
1993
2045
2395
884
1212
1551
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2086
2754
412
569
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2107
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1819
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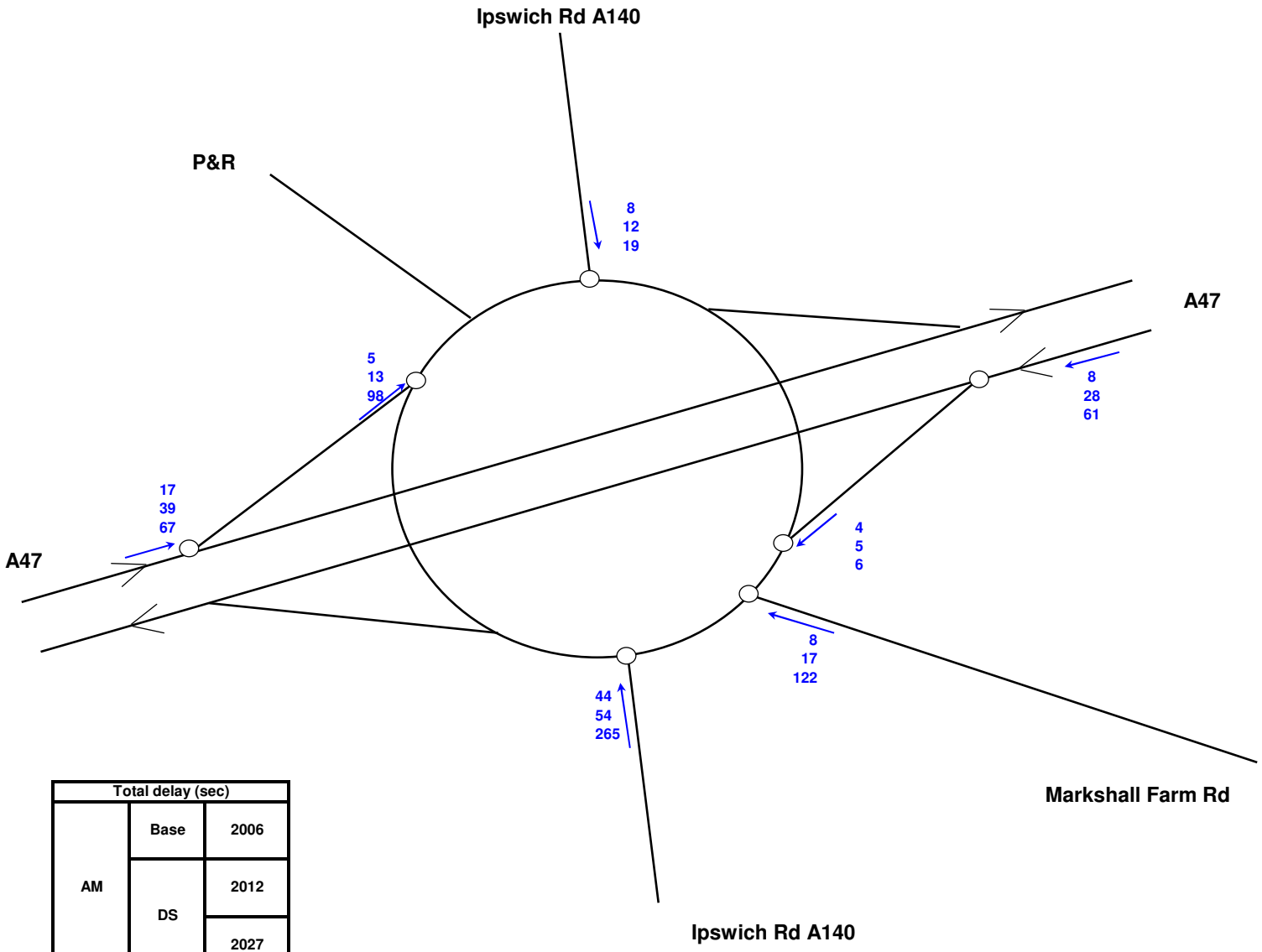
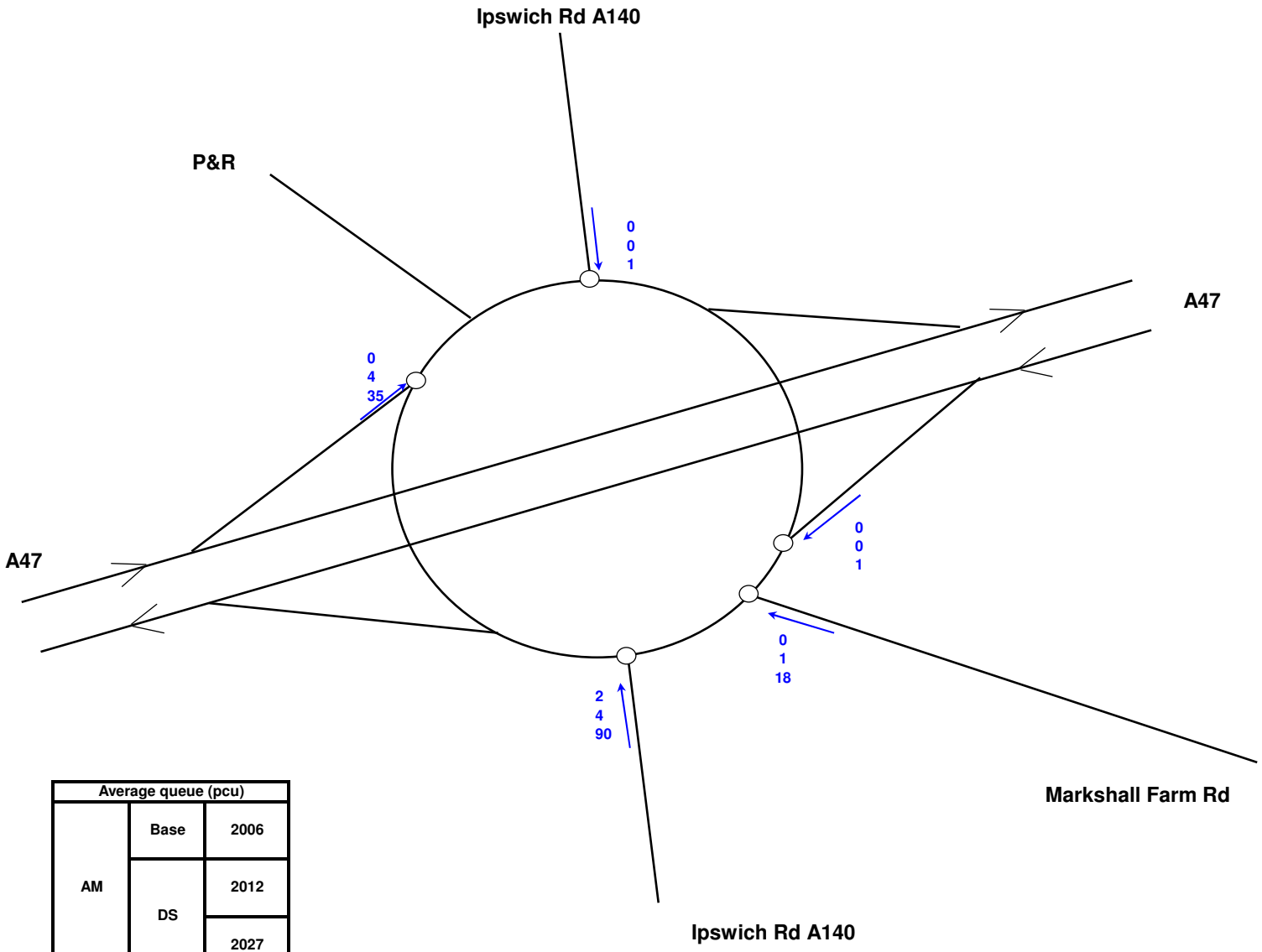
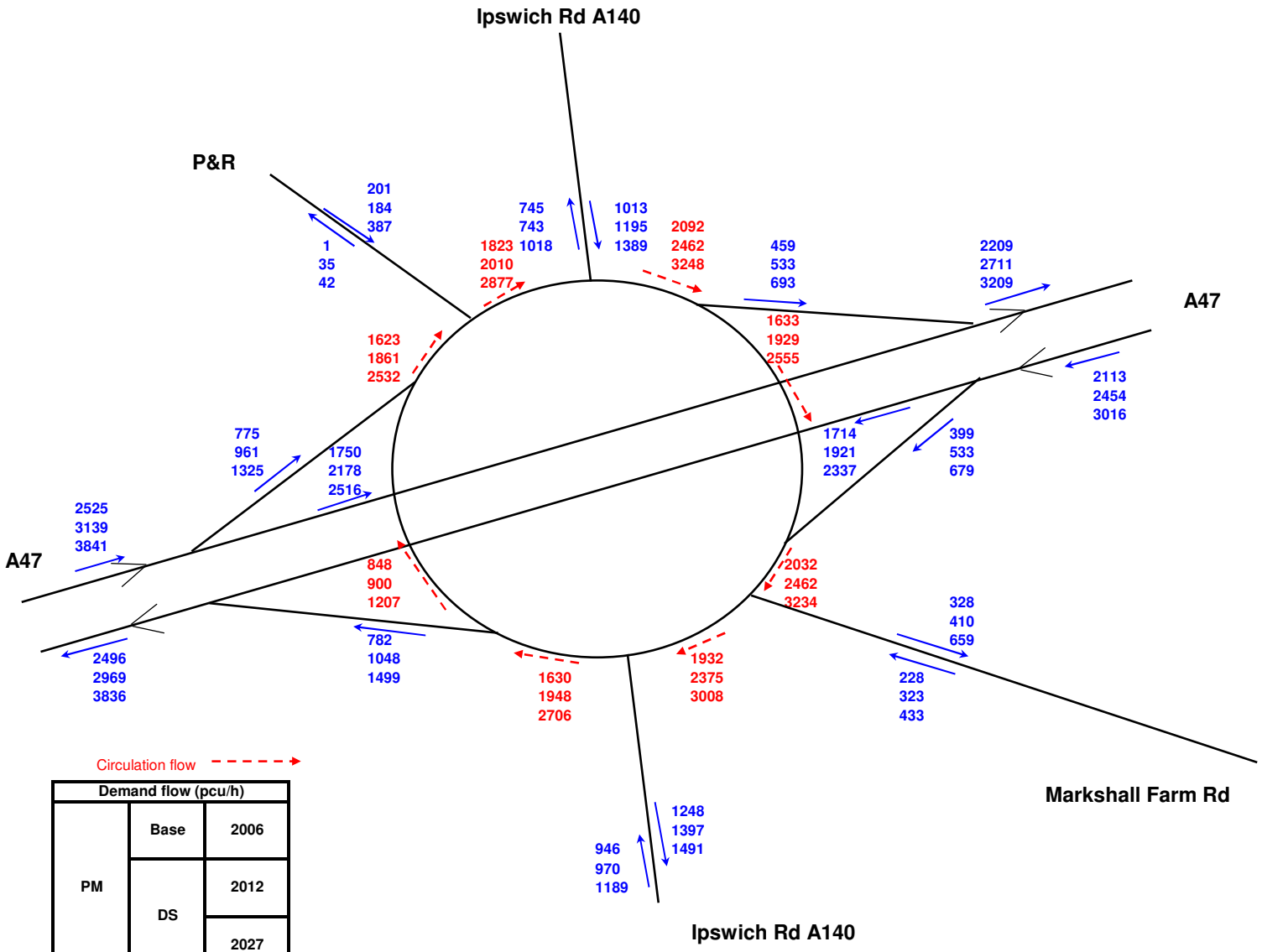
2781
615
933
1072
2867
3441
3926
1402
1819
2161
1912
2450
2973
193
194
342
831
1080
1364
2650
3347
4145
2233
2899
3525
1930
2673
3297
211
417
666
978
1105
1302
1281
1331
1530
Circulation flow
Demand flow (pcu/h)
AM
Base
2006
DS
2012
2027



Total delay (sec)		
AM	Base	2006
	DS	2012
		2027



Average queue (pcu)		
AM	Base	2006
	DS	2012
		2027



Demand flow (pcu/h)		
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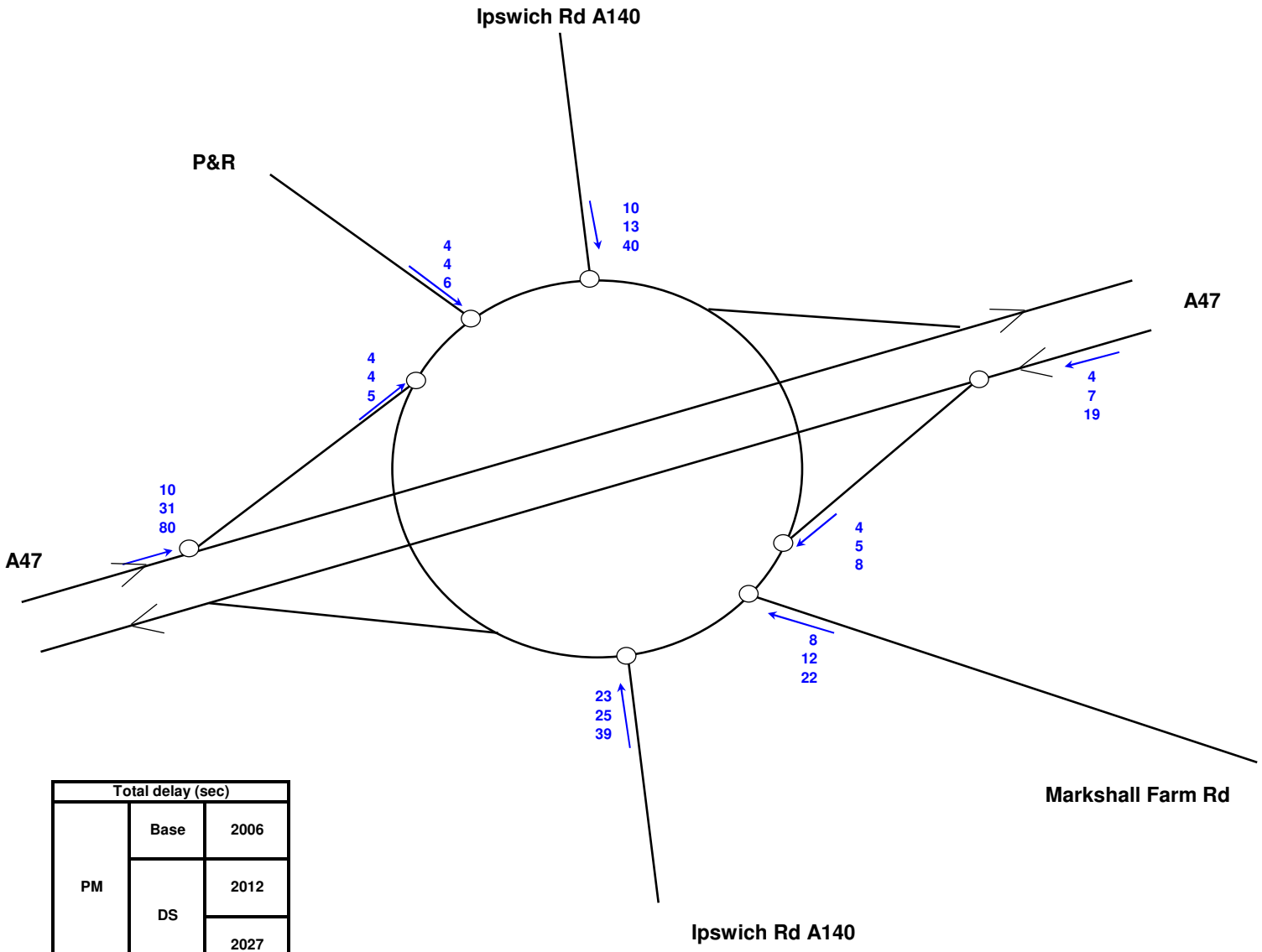
	DS	2012
		2027



Total delay (sec)		
PM	Base	2006
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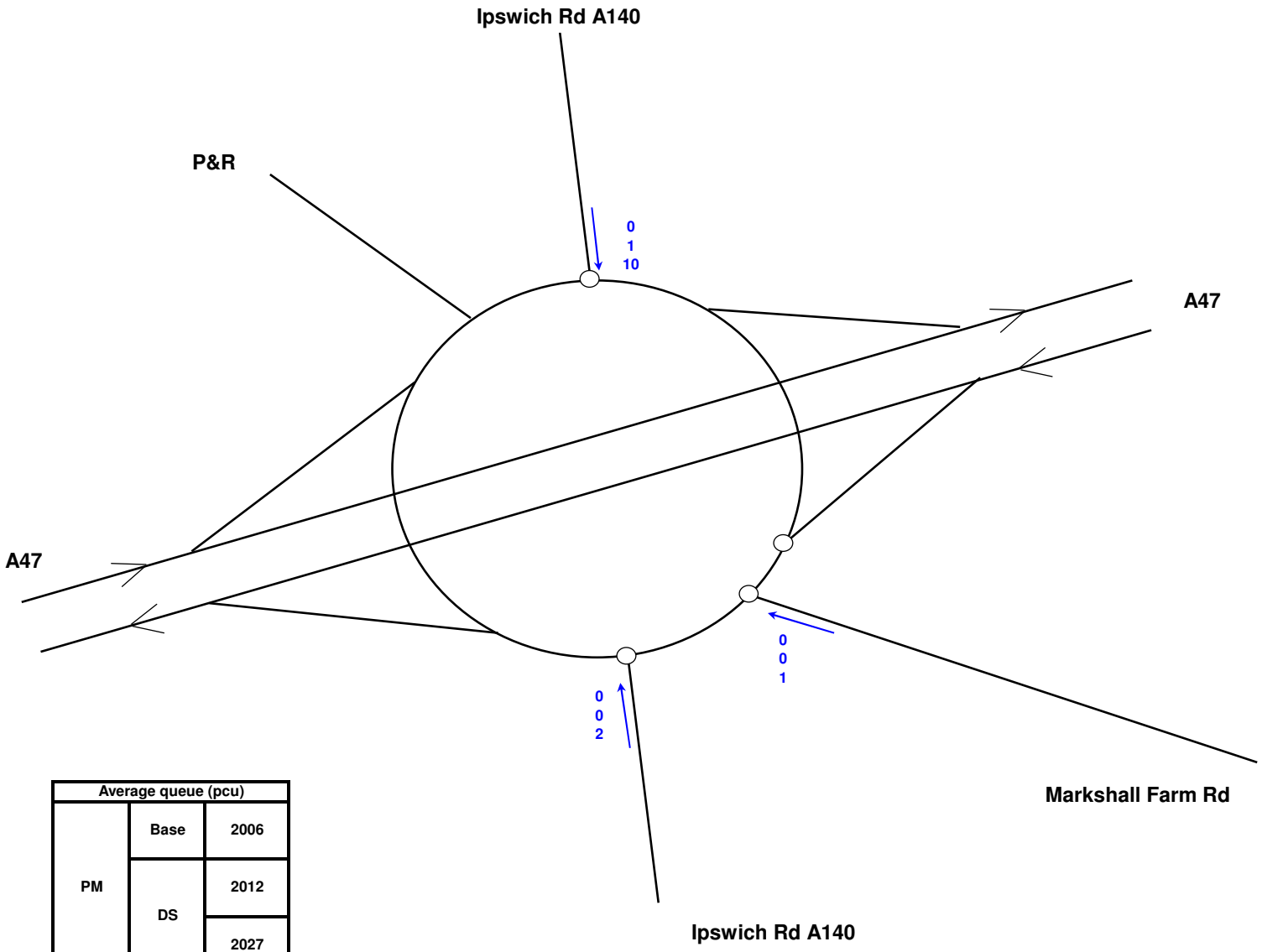
		2027



Average queue (pcu)		
PM	Base	2006
	DS	2012
		2027

Appendix B Breakdown of Cost Estimates

9 pages A4

ESTIMATE SUBMISSION

Job No

233902

Project Title

A47 Southern Bypass Junction Assessment

Client

NORFOLK COUNTY COUNCIL

Prepared By

Christopher Sturgeon

Brief Description of Works

Proposed improvements to carriageways and junctions.

Special Difficulties of Site

Area is heavily trafficked

Basis of Estimate

1Q 2008, Design provided by outline design drawings. Rates from Spons and other projects.

Current Price - including Summary of Sections

Option		Total
Harford Major	£	822,000.00
Harford Minor	£	125,000.00
Thickthorn Major	£	24,620,000.00
Thickthorn Minor	£	104,000.00

Exclusions

V.A.T
Professional Fees
Land and Compensation costs
Accommodation Works
Services
Contingency /Risk/Optimism bias

Brief Details of Previous Estimate

None

Comments re/Endorsements to Present Estimate

Local Traffic management only is assumed. No allowances for an overall TM strategy.

Signed

Date 10/11/2008

A47 Junction Assessment

Cost Options
for Junction Improvements

Norfolk County Council

Franklin + Andrews,
Mott MacDonald House
111 St Mary's Road
Sheffield
Yorkshire
S2 4AP

Phone:44(0) 114 228 3836
Fax: +44 (0) 114 2724699

10-Nov-08

A47 Junction Assessment

Norfolk County Council

Cost options
for Junction Improvements

Issue and Revisions Record

Rev	Date	Orginator	Checked	Approved	Description
4	10/11/2008	CS	IL	PT	Fourth Issue

Franklin + Andrews,
Mott MacDonald House
111 St Mary's Road
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Prepared by: CS

Authorised by: PT

FRANKLIN ANDREWS
CONSTRUCTION ECONOMISTS

A47 Southern Bypass Junction Assessment

Harford Major **Drawing: 012**

Item		Quantity	Unit	Rate	Total
200	Site Clearance				
	General site clearance	3	ha	3500.00	10,500.00
	Remove existing road markings	710	m	1.25	888.00
	Take up and dispose of kerbs	1,250	m	7.00	8,750.00
500	Drainage				
	Resite gullies and pipe connection to existing gullies including chambers	14	nr	1000.00	14,000.00
600	Earthworks				
	Extra over break out hard material	276	m3	50.00	13,800.00
	Dispose unsuitable material off site	276	m3	25.00	6,900.00
	Topsoil to be filled Class 5A	498	m3	20.00	9,960.00
	Structural fill Class 6F	2,290	m3	35.00	80,150.00
	Seeding to topsoil	2,490	m2	1.00	2,490.00
700	Pavement				
	Construct pavement	3,680	m2	60.00	220,800.00
	Interface of new construction with existing	130	m2	30.00	3,900.00
	New Traffic Island	532	m2	50.00	26,600.00
	Perforate carriageway	2,490	m2	10.00	24,900.00
1100	Kerbs Footways & Paved areas				
	Lay new kerbs	1,210	m	20.00	24,200.00
	Bitumen macadam footpath including edgings	1,040	m2	35.00	36,400.00
1200	Traffic Signs & Road Markings				
	Road markings	1,250	m	1.20	1,500.00
	Road markings "Single Headed Arrow"	10	nr	50.00	500.00
	Road markings "Double Headed Arrow"	4	nr	75.00	300.00
	Traffic signal installations	1	nr	60000.00	60,000.00

A47 Southern Bypass Junction Assessment

Harford Major **Drawing: 012**

Item		Quantity	Unit	Rate	Total
1300	Traffic Signs & Road Markings				
	Relocating Street Lighting	12	nr	450.00	5,400.00
	Relocation of signs	10	nr	150.00	1,500.00
	Traffic Management	8	%	553400.00	44,272.00
				Sub Total	597,710.00
				Preliminaries @ 25%	149,427.50
				Sub Total	747,137.50
				Design Development @ 10%	74,713.75
				Grand Total	821,851.25
					822,000.00

A47 Southern Bypass Junction Assessment

Harford Minor **Drawing: 013**

Item		Quantity	Unit	Rate	Total
200	Site Clearance				
	General site clearance	1	ha	1000.00	1,000.00
	Remove existing road markings	500	m	2.50	1,250.00
	Remove existing arrows and letters	13	nr	100.00	1,300.00
1200	Traffic Signs & Road Markings				
	Road markings	310	m	2.50	775.00
	Road markings "Single Headed Arrow"	10	nr	100.00	1,000.00
	Road markings "Double Headed Arrow"	4	nr	125.00	500.00
	Traffic signal installations	1	nr	60000.00	60,000.00
	Traffic Management	1	item	25000.00	25,000.00
				Sub Total	90,825.00
				Preliminaries @ 25%	22,706.25
				Sub Total	113,531.25
				Design Development @ 10%	11,353.13
				Grand Total	124,884.38
					125,000.00

A47 Southern Bypass Junction Assessment

Thickthorn Major **Drawing: 003**

Item		Quantity	Unit	Rate	Total
200	Site Clearance				
	General site clearance	26	ha	1500.00	39,000.00
	Take up and dispose of kerbs	8,900	m	7.00	62,300.00
	A47 road bridge demolition	1	item	900000.00	900,000.00
600	Earthworks				
	Excavate unacceptable material	47,400	m3	5.00	237,000.00
	Deposition of material	47,400	m3	1.00	47,400.00
	Fill to embankments class 6F	45,000	m3	31.00	1,395,000.00
	Extra over break out hard material	27,900	m3	50.00	1,395,000.00
	Dispose unsuitable material off site	27,900	m3	25.00	697,500.00
700	Pavement				
	Construct pavement	56,200	m2	75.00	4,215,000.00
1100	Kerbs Footways & Paved areas				
	Lay new kerbs	10,400	m	20.00	208,000.00
1300	Traffic Signs & Road Markings				
	Lighting Columns	150	nr	2000.00	300,000.00
1600	Piling and embedded retaining walls				
	Retaining wall	140	m2	400.00	56,000.00

A47 Southern Bypass Junction Assessment

Thickthorn Major **Drawing: 003**

Item		Quantity	Unit	Rate	Total
	Bridges				
	New road bridge; on slip	450	m2	2000.00	900,000.00
	New road bridge; off slip	450	m2	2000.00	900,000.00
	New road bridge over A47	740	m2	2000.00	1,480,000.00
	Additional allowance for road bridge interface	50	%	1480000.00	740,000.00
	Replacement road bridge over A47	1,160	m2	2000.00	2,320,000.00
	Additional allowance for road bridge interface	50	%	2320000.00	1,160,000.00
	Traffic Management	5	%	17052200.00	852,610.00
				Sub Total	17,904,810.00
				Preliminaries @ 25%	4,476,202.50
				Sub Total	22,381,012.50
				Design Development @ 10%	2,238,101.25
				Grand Total	24,619,113.75
					24,620,000.00

A47 Southern Bypass Junction Assessment

Thickthorn Minor **Drawing: 002**

Item		Quantity	Unit	Rate	Total
200	Site Clearance				
	General site clearance	1	ha	3500.00	3,500.00
	Take up and dispose of kerbs	131	m	7.00	917.00
700	Pavement				
	New off slip for Park and Ride	350	m2	100.00	35,000.00
	New access to Newmarket Road	160	m2	100.00	16,000.00
	Interface of new construction with existing	60	m2	30.00	1,800.00
1100	Kerbs Footways & Paved areas				
	Lay new kerbs	418	m	30.00	12,540.00
	Traffic Management	8	%	69800.00	5,584.00
				Sub Total	75,341.00
				Preliminaries @ 25%	18,835.25
				Sub Total	94,176.25
				Design Development @ 10%	9,417.63
				Grand Total	103,593.88
					104,000.00

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DRAWING TITLE

A11 (Thickthorn) Roundabout

Existing Road Markings

REV.	DESCRIPTION	CHECKED	DATE
P1	Preliminary Issue		01.10.08

	INIT.	DATE
DESIGNED BY		
DRAWN BY		
CHECKED BY		
APPROVED BY		

DRAWING No. 233902BF/001

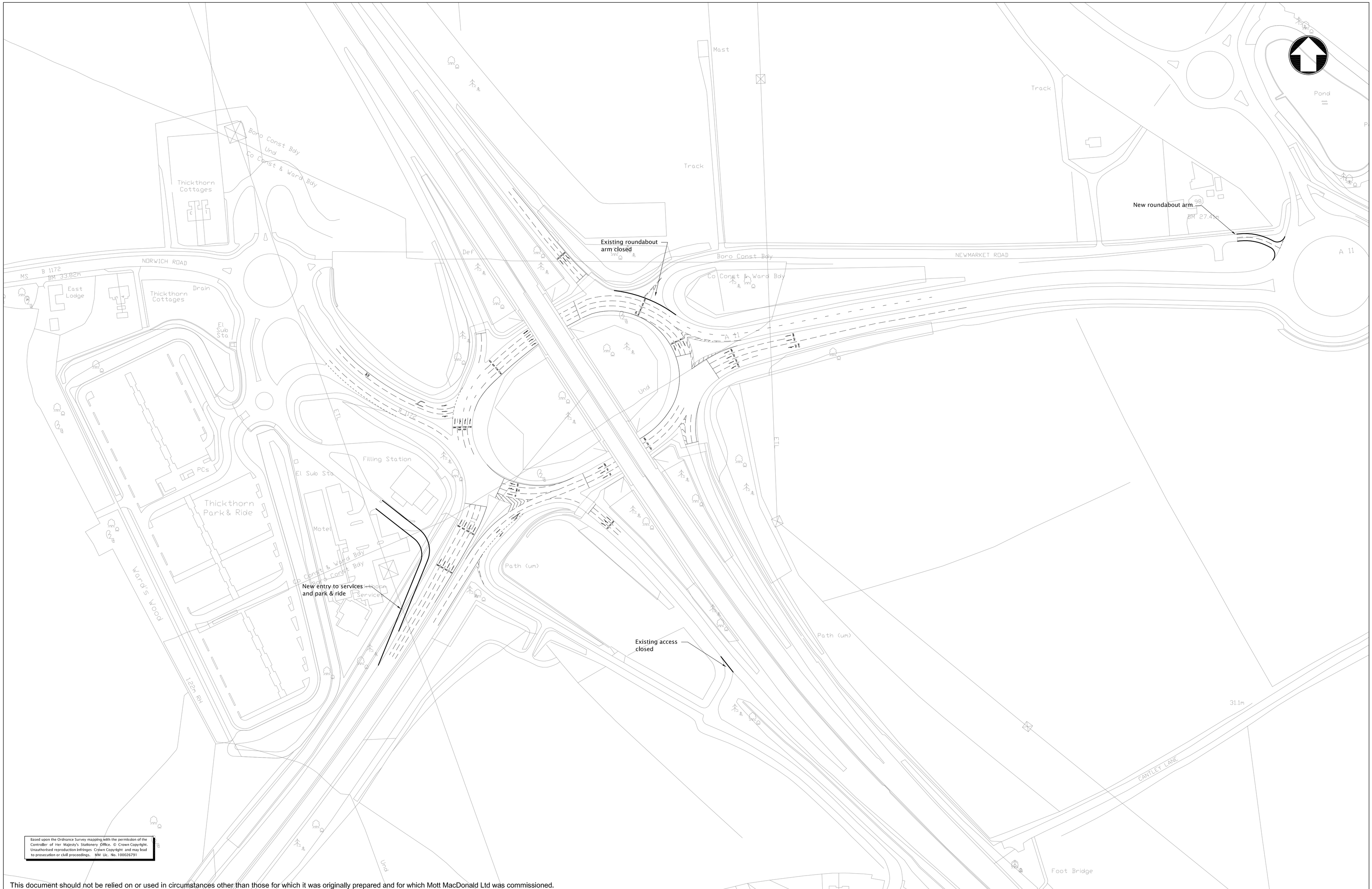
PROJECT TITLE
A47 Junction Assessment

SCALE AT A1 1:1250

FILE No.

ORIGINAL SIZE: A1

26/05/2006



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DRAWING TITLE

A11 (Thickthorn) Roundabout.

Option 1 - Low Cost Measures

REV.	DESCRIPTION	CHECKED	DATE
P1	Preliminary Issue		01.10.08

	INIT.	DATE
DESIGNED BY		
DRAWN BY		
CHECKED BY		
APPROVED BY		

DRAWING No. 233902BF/002

PROJECT TITLE A47 Junction Assessment

SCALE AT A1 1:1250

FILE No.

ORIGINAL SIZE: A1

26/05/2006

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DRAWING TITLE

A11 (Thickthorn) Roundabout

Option 2 - Major Realignment

REV.	DESCRIPTION	CHECKED	DATE
P1	Preliminary Issue		26.10.08

	INIT.	DATE
DESIGNED BY		
DRAWN BY		
CHECKED BY		
APPROVED BY		

DRAWING No. 233902BF/003

PROJECT TITLE A47 Junction Assessment

SCALE AT A1 1:2000

FILE No.

ORIGINAL SIZE: A1

26/05/2006

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DRAWING TITLE

A11 (Thickthorn) Roundabout

Major Realignment Road Markings

REV.	DESCRIPTION	CHECKED	DATE
P1	Preliminary Issue		26.10.08

	INIT.	DATE
DESIGNED BY		
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CHECKED BY		
APPROVED BY		

DRAWING No. 233902BF/004

PROJECT TITLE
A47 Junction Assessment

SCALE AT A1 1:2000

FILE No.

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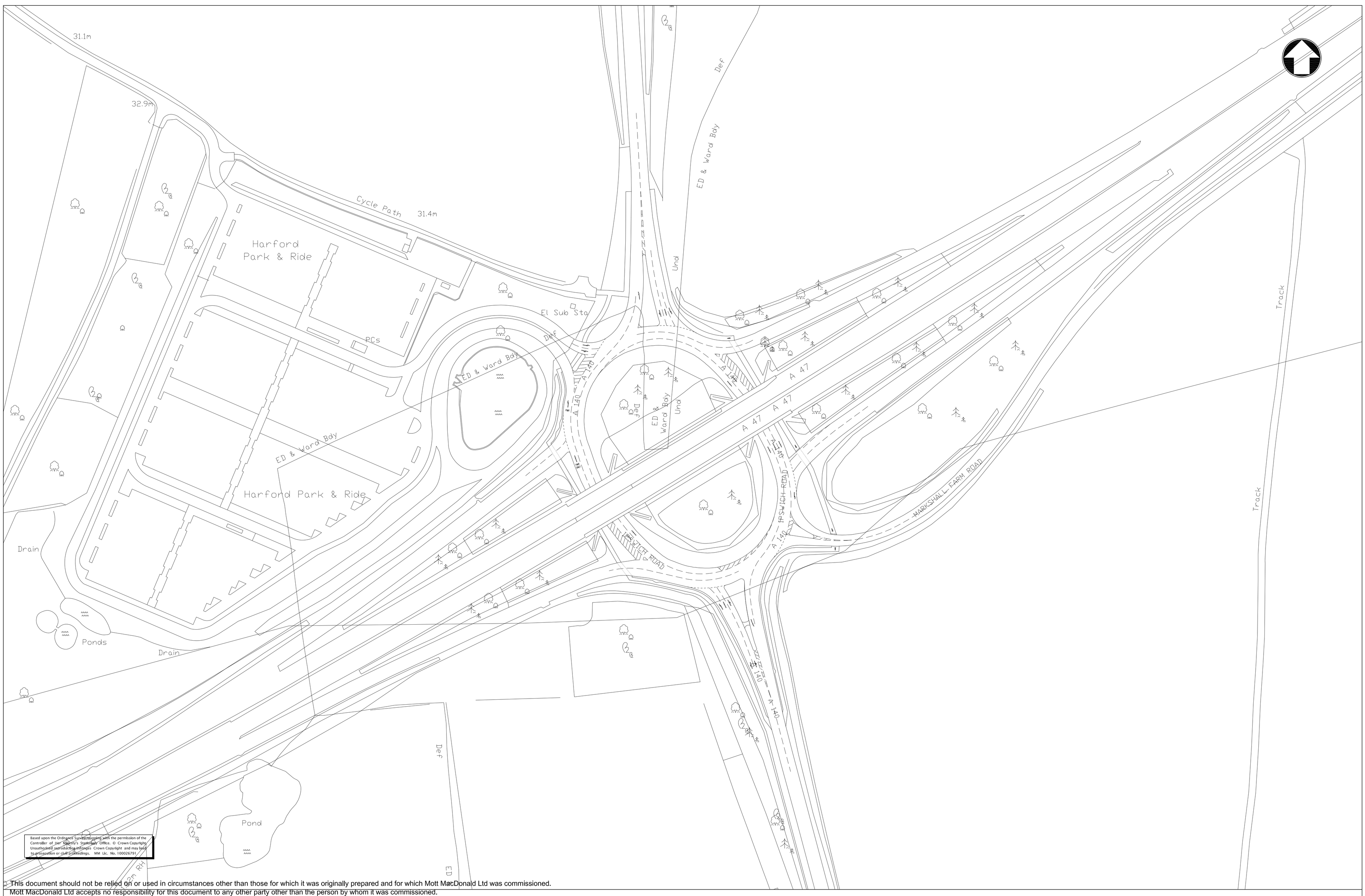
26/05/2006



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DRAWING TITLE

A140 (Harford) Roundabout

Existing Road Markings

REV.	DESCRIPTION	CHECKED	DATE
P1	Preliminary Issue		01.10.08

	INIT.	DATE
DESIGNED BY		
DRAWN BY		
CHECKED BY		
APPROVED BY		

DRAWING No. 233902BF/011

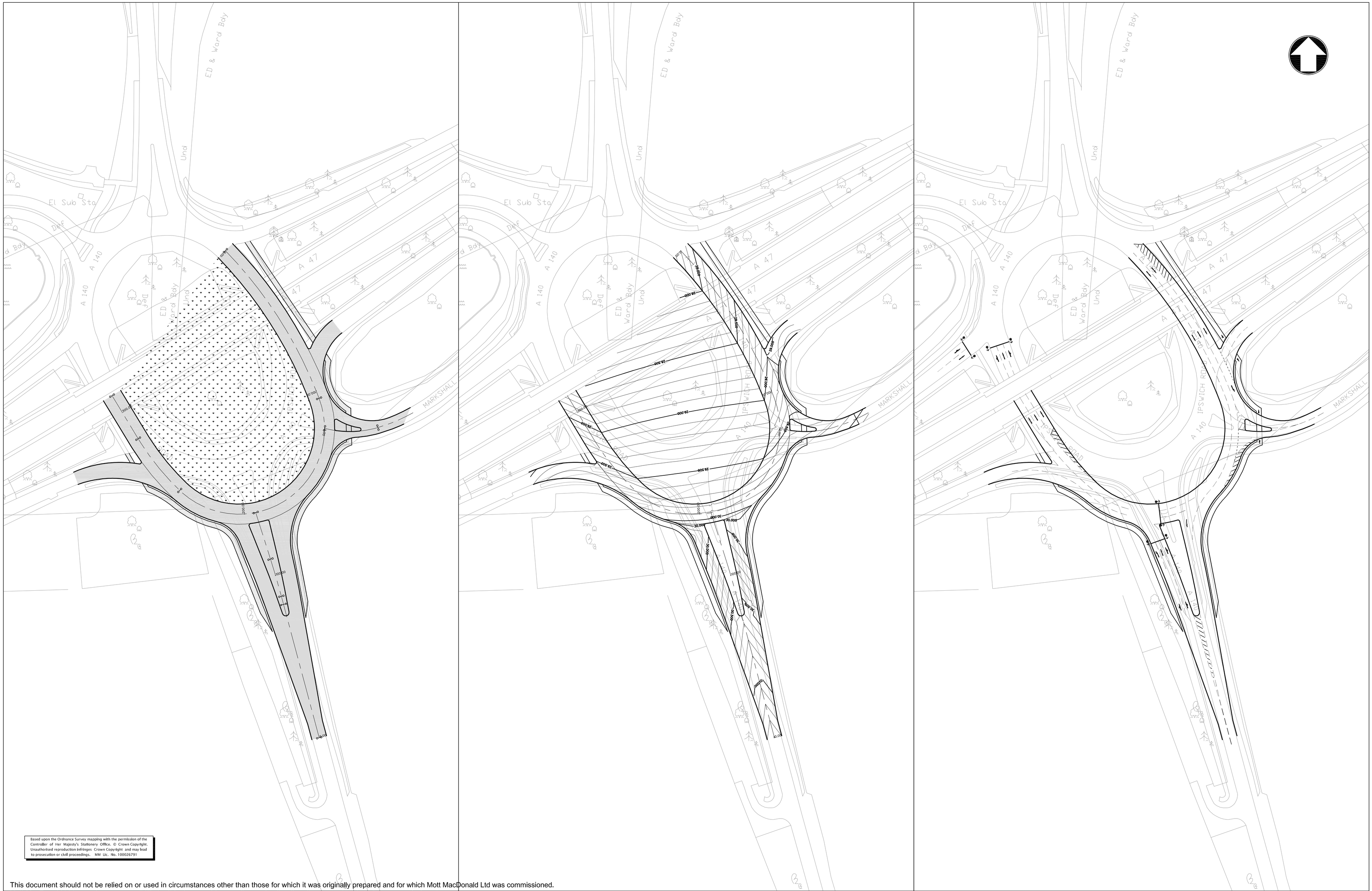
PROJECT TITLE
A47 Junction Assessment

SCALE AT A1 1:1000

FILE No.

ORIGINAL SIZE: A1

26/05/2006



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DRAWING TITLE

A140 (Harford) Roundabout

Option 2 : Proposed Alterations

REV.	DESCRIPTION	CHECKED	DATE
P1	Preliminary Issue		22.10.08

	INIT.	DATE
DESIGNED BY		
DRAWN BY		
CHECKED BY		
APPROVED BY		

DRAWING No. 233902BF/012

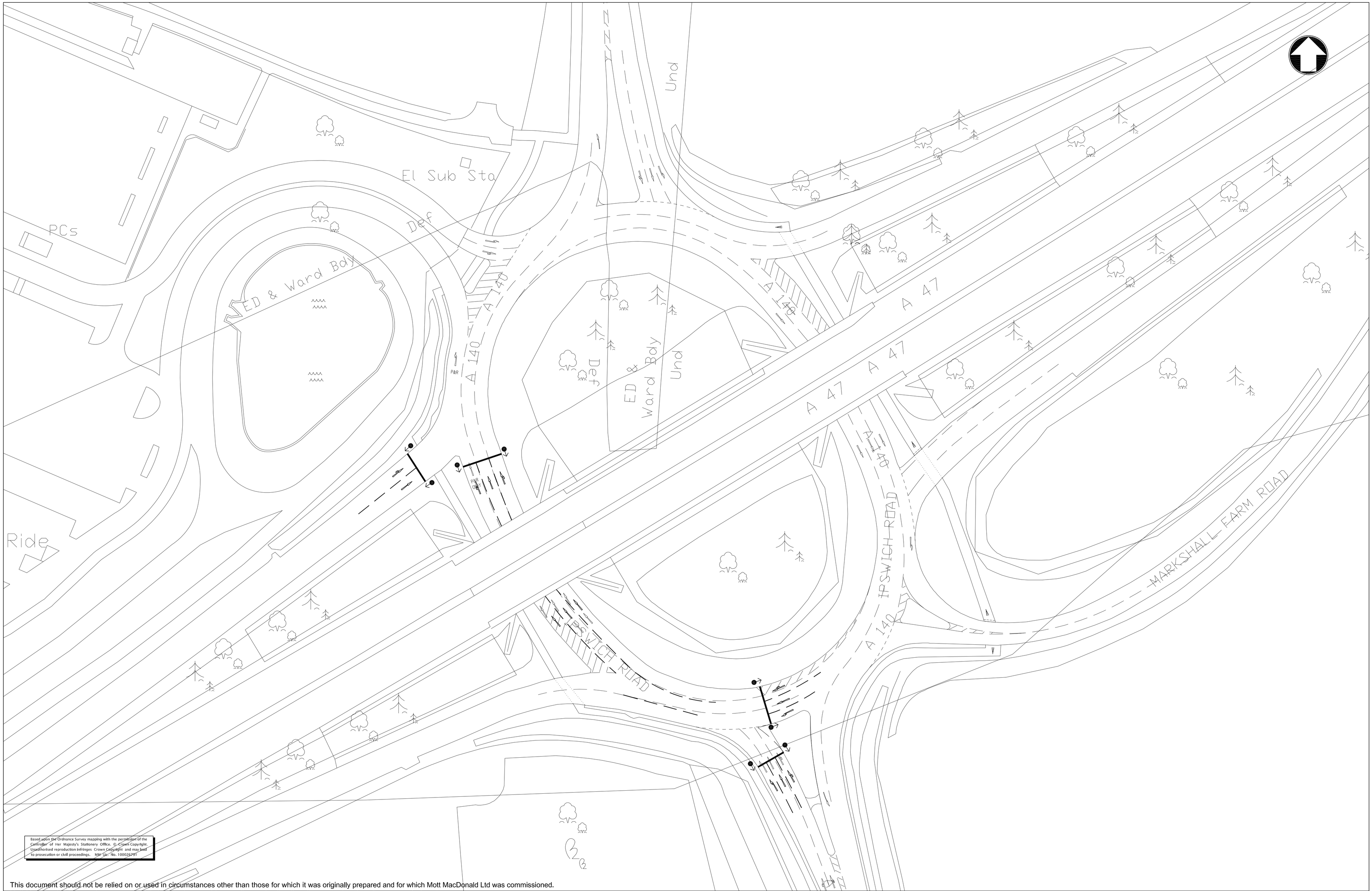
PROJECT TITLE A47 Junction Assessment

SCALE AT A1 1:1000

FILE No.

ORIGINAL SIZE: A1

26/05/2006



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DRAWING TITLE

A140 (Harford) Roundabout. Alteration

Option 1 : Partial Signalisation

REV.	DESCRIPTION	CHECKED	DATE
P1	Preliminary Issue		26.10.08

	INIT.	DATE
DESIGNED BY		
DRAWN BY		
CHECKED BY		
APPROVED BY		

DRAWING No. 233902BF/013

PROJECT TITLE
A47 Junction Assessment

SCALE AT A1 1:500

FILE No.

ORIGINAL SIZE: A1

26/05/2006

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DRAWING TITLE

B1108 (Watton) Roundabouts

Existing Road Markings

REV.	DESCRIPTION	CHECKED	DATE
P1	Preliminary Issue		01.10.08

	INIT.	DATE
DESIGNED BY		
DRAWN BY		
CHECKED BY		
APPROVED BY		

DRAWING No. 233902BF/021

PROJECT TITLE A47 Junction Assessment

SCALE AT A1 1:500

FILE No.

ORIGINAL SIZE: A1

26/05/2006