SEStran, TACTRAN, Fife Council, Dundee City Council and Transport Scotland

South Tay Park-and-Ride Project

Technical Report

Scott Wilson Ltd

May 2010

SEStran, TACTRAN, Fife Council, Dundee City Council and Transport Scotland

South Tay Park-and-Ride (P&R) Project

Technical Report

Revision Schedule

South Tay Park-and-Ride Project
Technical Report
May 2010
S106888

Rev	Date	Details	Prepared by	Reviewed by	Approved by
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1.0 INTRODUCTION

1.1 Background

1.1.1 SEStran (South East Scotland Transport Partnership), TACTRAN (Tayside and Central Scotland Transport Partnership), Fife Council, Dundee City Council and Transport Scotland appointed Scott Wilson to provide technical support for the South Tay Park-and-Ride (P&R) Project.

1.2 Outline Optioneering Appraisal

1.2.1 The first part of the study involved identifying outline layout options for the P&R site and providing outline engineering analysis on these layouts. Part of the study was also to give consideration to environmental issues. To achieve this, Scott Wilson collated topographical data for the site as well as historic site investigation data and existing drainage plans.

1.2.2 The options were presented to the client working group in December 2009 (see meeting notes in Appendix A) which allowed the emerging arrangements to be reduced to a single preferred option for further development. The options presented are detailed in the Outline Optioneering Technical Note (included in Appendix B) but in summary comprised:

- Option 1 – taking access via a new roundabout on the B946 junction with the A92 Link Road. This maximised the length of the access road and minimised major earthworks within the main part of the site - therefore maximising the area available for parking;
- Option 2 – comprised formation of a signalised junction (or roundabout) directly opposite the existing access to the Tay Road Bridge Joint Board (TRBJB) car park off the B946 Link Road;
- Option 3 – had access taken from between the A92 roundabout and the TRBJB car park access; and
- Option 4 – took access either directly from the A92 Roundabout or southbound A92 with an egress in the positions defined in Option 2 or 3 above.

1.2.3 Option 1 was discarded on the grounds of both expense in forming the access road, and that the layout was considered unlikely to attract bus operators due to the distance of travel from the A92 to access the car park.

1.2.4 Option 4 was discounted on the ground that it was confirmed as contrary to Transport Scotland policy which presumes against development access directly from the Trunk Road.

1.2.5 Option 3 was considered the preferred option, noting that on development of the design and the traffic assessment studies, the access may require to move eastward towards the access to the existing TRBJB car park and therefore potentially merging this arrangement with Option 2.

1.2.6 Environmental consideration was not part of the reason for rejecting/accepting any of the relevant options as the site layouts were similar in each option from a potential landscaping point of view. However, the development of environmental mitigation measures was considered as part of the brief for design of the preferred solution.

1.2.7 As a result, the preferred solution was taken forward to more detailed development, including detailed design, landscaping and cost estimate. This Technical Note presents the findings of this analysis.

1.3 Structure of this Report

1.3.1 The overall structure of this report is as follows:

Chapter 2 – presents the preferred engineering design for the scheme and the overall project costs;

Chapter 3 – provides an assessment of the impact of the scheme on landscape and proposed mitigation;

Chapter 4 – summarises the impact of the Park-and-Ride scheme on traffic conditions in the vicinity; and

Chapter 5 – outlines the results from the ground condition investigations.

1.3.2 Various appendices also contain supporting documents such as CAD drawings, ground investigation survey findings and other information.

2.0 ENGINEERING DESIGN AND INFRASTRUCTURE

2.1 Park-and-Ride Access and Junction Arrangement

2.1.1 During the development of options, junction access and road geometry were considered to ensure viability, but were not developed in detail until the preferred option was selected by the client group.

2.1.2 On agreement of Option 3 as the preferred option (See Appendix A for copies of meeting notes), a layout for the junction was developed in detail comprising a ghost island type arrangement formed by creating two exit lanes from the A92 roundabout onto the Link Road, with the right hand lane dedicated for park-and-ride (P&R) traffic.

2.1.3 The distance from the roundabout to the centre line of the new access is approximately 65 metres. At design development stage this was considered to be an optimum balance of safety / ease of driving and maximising queue length whilst creating an access in as westerly position as possible where the change in level between the existing road level and P&R site are minimised.

2.1.4 To form the ghost island / dedicated right turn arrangement, widening of the existing carriageway is required. As shown in Appendix C (drawing S106888/SK/012 revision A), this comprises approximately 1 metre of widening on both sides of the road which it is considered can be achieved within the road boundary.

2.1.5 The junction has been designed with a radius of 10.5 m which is consistent with Fife Council Development Guidelines. In addition, bus movements have been tracked entering and exiting the junctions from all directions which has defined the ultimate form of the junction which is shown to include widening specifically to accommodate westbound movements.

2.1.6 Further works in the area of the Link Road and junction are proposed to comprise:

- removal of the existing westbound bus layby on the Link Road immediately adjacent to the proposed access. If necessary, this could be replaced with a simple on street stop opposite the existing eastbound bus stop east of the TRBJB car park access; and
- a new footway would be constructed between the TRBJB car park access and the junction (extending into the car park) to link the proposed P&R to bus stops on the Link Road, the existing car park and the existing footpath network around the B946.

2.1.7 From the junction on the Link Road, the proposed access takes the form of a 7.3 m wide single carriageway with a footway on the east side.

2.1.8 Whilst Fife Council were consulted on the use of Housing Road standards for the access which would permit a width of 6.0 m (for a bus route)[1], a greater width was adopted due to the curve widening that would otherwise have been required on the two bends on the route which would have resulted in a constantly varying road width.

2.1.9 In all other respect the standards for Housing Roads were adopted with a maximum gradient for the car park access road of 6.7% and a minimum vertical curve k value of 6.5.

[1] Fife Council Development Guidelines, Table 5.8.

2.1.10 A long section of the proposed access road is shown in Appendix C (drawing S106888/SK/006).

2.2 Bus Terminus, Turning and Layover

2.2.1 Whilst the original layout for the bus terminus comprised a turning roundel, the design has been amended to its current form to create a circulatory system around a terminal building. This arrangement provides two benefits:

- the arrangement proposed in minimises walking distances to the bus stances within the car park; and
- it maximises the efficiency of the developed area by positioning the building within what would otherwise be a vacant area created for vehicle turning.

2.2.2 The terminus floor area is modelled on Ingliston Park-and-Ride facilities as a benchmark allowing for waiting, ticket booths and a kiosk if appropriate. Cycle racks and other facilities can be provided within the area designated for the building.

2.2.3 It was considered important by stakeholders that provision be made for bus layover. Such provision has been accommodated along the eastern boundary of the developed area. This is considered as being appropriate as it is both remote from other parking (and therefore not attracting misuse) and on the bus circulatory system for ease of access.

2.3 Car Park Layout

2.3.1 The layout of the access road and location of the bus terminus were a function of the vertical difference in height between the Link Road and the car park site which offered little flexibility in terms of land use for the north and eastern areas of the site.

2.3.2 Having located these key elements, the remaining area was considered generally available for car parking, taking into account:

- existing topography and the need to minimise visual impact of the car park on what is an exposed site due to its elevation;
- screen landscaping;
- drainage requirements; and
- layout and gradient to accommodate a safe and usable facility.

2.3.3 The layout of the car park was developed to maximise the number of spaces by achieving a high ratio of spaces to surfaced area. This is achieved by maximising aisle length and adopting logical search path, appropriate for what will be considered a relatively long stay facility.

2.3.4 The layout proposed is shown in Appendix C (drawing S106888/SK/012).

2.3.5 At present the layout is shown comprising standard 5 m x 2.5 m parking bays, of which 458 can be accommodated within the site.

2.3.6 In order to meet recommendations in the Park Mark standard, facilities will be required for disabled bays which will comprise a bay width of up to 3.6 m per space. This will result in a reduction of approximately 3 spaces for every 7 disabled spaces provided.

2.3.7 An allowance for 22 disabled spaces (4% + 4) may be considered reasonable allowance at this stage subject to consultation. This would reduce the total number of spaces by approximately 10 to 448 spaces in total.

2.4 Car Park Drainage

2.4.1 An indicative scheme for draining the car park has been developed incorporating the principles of Sustainable Drainage (SUDs). To develop this arrangement Scott Wilson has been in liaison with SEPA, Fife Council and Scottish Water to establish requirements and the presence of local infrastructure.

2.4.2 It will be necessary for the facility to deliver a minimum of two levels of SUDs treatment in accordance with the Controlled Activities Regulations General Binding Rules. However as the car park accommodates less than 1,000 spaces it does not require to be licensed.

2.4.3 Current proposals are developed on the assumption that the car park drainage could connect to existing infrastructure within the Link Road which outfalls to the River Tay.

2.4.4 The capacity of the existing drainage would require to be validated. However, the proposal assumes that attenuation will be required as a minimum to greenfield run-off levels (which are likely to be accommodated in the existing drainage at present due to the topography of the area).

2.4.5 Based on the foregoing, the proposed drainage system comprises:

- asphalt surfaced running areas for aisles and bus routes;
- permeable block paved parking bays;
- permeable sub-base with subsurface filter drains;
- attenuation tanks located below parking bays; and
- filter drains adjacent to the access road outfalling to the existing drainage network.

2.4.6 The proposed layout for the drainage is shown in Appendix C (drawing S106888/SK011) appended with this note.

2.5 Ground Conditions

2.5.1 Due to the topography of the site, and the exposed geology in the cuttings of the A92 in the area of the roundabout, and on the B946 Link Road, it was considered vital in considering any arrangement for the proposed car park to develop an understanding of ground conditions.

2.5.2 To achieve this, historic borehole logs were acquired for the local area. In general these date to prior to the construction of the current A92, roundabout and land B946 Link Road.

2.5.3 There a 5 boreholes in the area of the site as follows:

- Borehole Ref 1A – B946 Link Road south of TRBJB car park access (immediately north of the site);
- Borehole Ref 1B – A92 roundabout (immediately north west of the site);
- Boreholes 1 and 2 – at intersection of A92 and dismantled rail line (immediately south west of the site); and
- Borehole Ref 2A – North of dismantled rail line (north of the site).

2.5.4 In general the boreholes demonstrate between:

- 0.23 and 0.4 m thickness of topsoil; over
- fine sand thickness between 0.6 – 1.0 m; over
- firm sandy clay between 0.6 (BH Ref 1B) and 4 m (BH Ref 1 and 1A); over
- broken rock at a depth of between 4.9 m (BH Ref 1B) and 6 m.

2.5.5 Based on the foregoing, and for the purposes of cost estimation, the following conditions have been assumed:

- 0.35 m thick topsoil;
- 2.90 m thick sandy gravel;
- weather rock 2.0 m thick; and
- solid rock from 5.25 m below ground level.

2.6 Construction Cost Estimate

2.6.1 Construction costs have been developed for the works based on cost plans for similar schemes compiled in late 2009. We have used rates from a recent actual tender for a Park-and-Ride site in West Central Scotland. This tender was not the lowest price but rather in the middle of the range of tenders received, since it allows for an average of the current market conditions.

2.6.2 Cost estimates are based on a number of assumptions regarding ground conditions, which have been validated by preliminary site investigation works, as detailed in Chapter 5.

2.6.3 Appendix C contains a more detailed breakdown of the cost estimates, and a summary is shown in Table 2.1.

Table 2.1 – South Tay Park and Ride Construction Cost

Item	Measure	Cost Estimates
Access Road		
Earthworks (Removal)	13,551 m^3	£348,938
Roadworks (including drainage and lighting)	1,586 m^2	£132,474
Car Park		
Earthworks (Topsoil)	4,704 m^3	£5,174
Earthworks (Non rock including offsite disposal)	15,477 m^3	£270,847
Surplus Materials off site	13,442 m^3	£105,385
Roadworks (including drainage and lighting)	12,467 m^2	£902,306
Terminal Building		
Provision of terminal building	sum	£75,000
Total Infrastructure Cost		**£1,840,125**
Contractors Preliminaries	20%	£368,025
Land Purchase		£30,988
Landscaping		£51,266*
Contingency	15%	£343,561
Total Budget Cost		**£2,633,966**

*See Section 3 later in this Technical Note for details

2.6.4 Detailed consultations with public utility companies were not part of the engineering works in this study, however a public utilities search was carried out as part of the ground investigations surveys (which are discussed later in Chapter 5) which showed there was a minor element of utilities at the south west corner of the site. Therefore we have applied a standard allowance of £10,000 to account for the potential cost implications of working with utility companies during the course of the construction works. This default allowance has been applied to both the main car park and access road elements of the project.

2.6.5 The passenger terminal building does not include for staff facilities. It is assumed the provision of a brick-clad steel framed structure with profiled metal roof is sufficient.

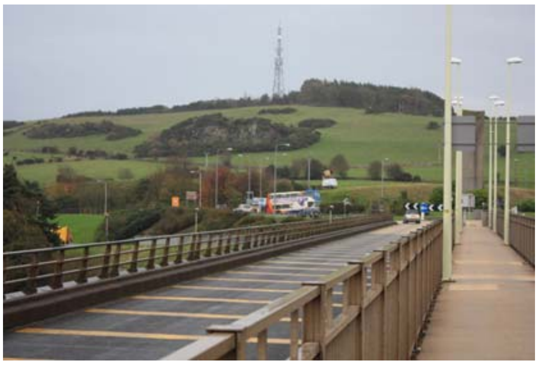
2.6.6 No allowance has been made in this estimation for Optimism Bias or other costs (e.g. planning, design etc). The Upper Boundary for Optimism Bias for this type of project is 44%, but this can be reduced as the project progresses through the development process.

2.6.7 Allowance has not been made for the provision of utility supplies to the terminal building at this time as this will be subject to detailed assessment by third parties. Costs however assume all surplus materials are removed to a licensed facility and therefore incur some tax. All assumptions require to be validated by specific site investigation.

2.6.8 In addition to the above cost estimate, at the request of SEStran, we have also estimated the costs for constructing a car park with a reduced number of parking spaces (350 spaces in total). This would equate to a total capital cost of circa £2,244,024 including landscaping and contingency at 15%. In both scenarios, the majority of the cost estimate is due to the roadworks.

3.0 LANDSCAPING

3.1 Site Overview



3.1.1 The proposed location of the car park and associated bus terminus is within an area of rolling green fields close to the working farm at Northfield. The site is bordered to the west by the A92 local trunk road which connects Dundee to Glenrothes. To the northwest of the site, the A92 passes onto the Tay Road Bridge, and users of the bridge travelling southbound across the river currently have clear views across the roundabout into the proposed site. Immediately north of the site runs the B946, a local road connecting the A92 with the Tay riverside and Newport-on-Tay, and providing access to the Tay Bridge Picnic area and kiosk opposite the proposed site entrance.

3.1.2 Both the A92 and B946 are within cuttings approximately 9m below the level of the proposed car park. The banks of the cuttings are populated with a mixture of trees and shrubs and in some areas open grassy banks.

3.1.3 East of the site lies a farm within green fields. South of the proposed site the ground rises significantly and the land use is largely open green fields with rocky outcrops, patches of shrubby growth and small areas of woodland. On the horizon there is a large mast.

3.1.4 There appears to be no specific landscape or conservation designations which impact upon the site. The 'Fife Local Landscape Designation Review' document prepared for Fife Council by Land Use Consultants in November 2008 identified the area as character area CH63, part of the coastal hills and described it by saying 'These open sloping fields have strong association with the Tay, however they are not highly distinctive in character and are partially fragmented by land use. This landscape is visually detached from the hills to the south…'. Overall the Report described this coastal strip as '… important in providing setting for settlement and is important in relation to other landscape units.' In the Landscape Enhancement Study for Newport and Wormit in 2004, the area around the bridge head identifies key opportunities for landscape enhancement, through the management of grassland and scrub as habitat for wildlife, and work to field boundaries through planting of trees and hedges to re-establish the rural character of the landscape.

3.2 Impact of the Park-and-Ride Proposals

Ecological Impact

3.2.1 The nature of the site as open grassed fields has only minimal landscape value in terms of ecology. The tree belt alongside the B946 on the bank of the cutting is populated by a mix of tree and shrub species which act as a screen to the nearby farm, help to stabilise the bank and provide colour and interest to passing motorists.

3.2.2 Construction of the access road will impact upon this established tree belt and will result in the loss of an area of at least 40m x 12m. In terms of vegetation this loss can be mitigated by the establishment of new belt planting around the development. However, the tree belt may be home to nesting birds and we would therefore recommend a full ecological survey be undertaken prior to commencement of any works, and that any tree clearance works be undertaken outside the bird nesting season.

3.2.3 Peripheral areas of the site may also be developed as valuable habitat for native plants and wildlife, and increase the number of species found on the site.

Landscape Impact

3.2.4 The impact of the development on the character of the local area would be relatively small with appropriate mitigation works. The footprint of the development falls within the area of one field and therefore would cause only a minor impact on the pattern of field boundaries. Screen planting could easily be accommodated around the site to reflect the existing corridor planting alongside the A92 and B946, and small clusters of woodland and shrub growth further up the hill. Creation of the access road is expected to involve exposure of the bed rock, which will appear stark at first but once colonised by grasses and wildflowers will reflect the exposed rock slopes on the hillside above the site.

3.2.5 It is worth noting that the rock cutting created by the road access will be hidden in view from the Tay Road Bridge and the Wormit residential area west of the A92.

Visual Impact

3.2.6 The landscape impact of the development is largely visual. Key viewpoints into the site will be from:

- Tay Road Bridge;
- Tay Road Bridge Picnic Area and Car Park;
- houses in Newport on Tay (Spearshill Road, Elizabeth Crescent and Northfield Road);
- A92 northbound approaching the roundabout; and
- B946 in both directions for views of access road.

3.2.7 Most significantly affected will be passing road users, particularly those using the Tay Road Bridge, some picnic site users and the residents of Spearshill Road, Elizabeth Crescent and Northfield Road in Newport on Tay. More distant views from the River and Dundee on the north shore may also discern the glistening of vehicle roofs on a sunny day. Screen planting could diminish the effects of the development on all of these low level views.

3.2.8 The development will be clearly visible from the hillside above the site, however there are no marked footpaths or tracks from where the site will be visible. The only receptors above the site will be those people operating and servicing the mast at the crest of the hill.

3.3 Mitigation of Impact

3.3.1 The visual effects of the new P&R facility can be relatively easily mitigated through landscape enhancement of the site. A considered area of tree and shrub planting within and around the car park will screen the P&R facility from passing motorists and local residents, and replace the trees lost through creation of the new access road. Green areas around the site can be designed to increase biodiversity and create habitat for local species of plants and wildlife, for example wildflower planting, or installation of bird and bat boxes.

3.3.2 It is proposed to use a mix of native tree and shrub species from a local source to create a strong screening belt around the car park. This mix will reflect the species already found in and around the site and will help to settle the development within the existing landscape. Planting will be used to reinforce the existing tree belt along the northern face of the site, and infill the gaps at the northwest corner near the roundabout and along the western face, which is currently maintained as part of the highway verge. Some evergreen species will be incorporated for a denser screen during the winter months, and mature specimens will be planted in key locations to provide an instant impact while the main planting groups become established.

3.3.3 Prior to commencement of any works, it may be possible to undertake some of the mitigation planting to the northwest corner of the site. This would enable the tree belt to become established and begin to form a useful screen, in advance of any works. Early establishment of the screen would also reduce the impact of the development during construction.

3.4 Details of the Proposals

Landscape Planting and Screening

3.4.1 The proposed tree and shrub species for screening are developed from the National Vegetation Classification for Woodlands which identifies this area as type W8 – Lowland mixed broadleaved woodland with dog's mercury.

Table 3.1 – Proposed Landscape Screening

	Latin Name	Common Name	Percentage Mix
Major Species	Crataegus monogyna	Hawthorn	10%
	Corylus avellana	Hazel	10%
	Fraxinus excelsior	Ash	15%
	Quercus robur	Oak	20%
Minor Species	Betula pendula	Silver Birch	10%
	Betula pubescens	Downy Birch	5%
	Ilex aquifolium	Holly	5%
	Malus sylvestris	Crab Apple	5%
	Prunus spinosa	Blackthorn	5%
	Salix caprea	Goat Willow	5%
	Sambucus nigra	Elder	5%
	Viburnum opulus	Guelder Rose	5%

3.4.2 A mix of tree and shrub sizes should be incorporated into the screening belt and should include some more mature specimens for instant impact. Standard trees (Field Maple, Willow and Oak) should be located along the northern and western boundaries and staked during the first 3 years to provide support in this exposed location.

Ornamental Car Park Planting

3.4.3 Within the car park incidental areas will be planted with a groundcover carpet of three different ivy species interspersed with feature trees. The following species of Sorbus and field maple have been chosen for their compact lollipop shape.

Table 3.2 – Proposed Ornamental Planting

	Latin Name	Common Name	Percentage Mix
Feature Trees	Acer campestre 'Streetwise'	Field Maple	50%
	Sorbus thuringiaca 'Fastigiata'	Hybrid Service Tree	50%
Groundcover Planting	Hedera helix	Ivy	40%
	Hedera helix 'Little Diamond'	Ivy	30%
	Hedera helix 'Jester's Gold	Ivy	30%

Grassland

3.4.4 Two different grass seed mixes should be used for the area surrounding the car park. We propose a traditional grass mix for the edge of the car park to be regularly mown allowing car park users easy access for loading. The majority of the grassland areas should be seeded with a wildflower mix incorporating a variety of grasses and wild flowers, to provide a potential habitat for wildlife.

3.5 Future Development of the Landscaping Plan

3.5.1 The proposed landscape layout for the site, incorporating screening and opportunities for ecological development as described above, can be found in Appendix D.

3.5.2 In addition to the proposed landscape works we recommend the following surveys be undertaken prior to a final contractors design being prepared:

- under policy E25 of the new St Andrew's and East Fife local plan the developer would be required to undertake a full tree survey.
- ecological survey of the tree belt to establish the presence of any nesting birds and/or the tree clearance works should be undertaken outside the bird nesting season.

3.5.3 From the above, the proposed landscaping might require some amendments in light of any significant issues identified.

Cost Estimates

3.5.4 The total cost for the landscaping plan was estimated at £51,266 (including contingencies). Further details are shown in Appendix D.

3.5.5 The above cost has been included within the total project costs set out in Chapter 2.

4.0 TRAFFIC APPRAISAL

4.1 Introduction

4.1.1 An initial traffic analysis was undertaken for the outline options identified during the first phase of this study, to estimate the impact of the Park-and-Ride (P&R) site on traffic conditions at the A92 / B946 Link Road roundabout.

4.1.2 Following the identification of the preferred design as detailed in Chapter 2, a more detailed traffic appraisal was undertaken for both the A92 / B946 Link Road roundabout, and the proposed entrance to the site. This Chapter presents the methodology used and the results of this appraisal.

4.2 Methodology

4.2.1 The appraisal was carried out using the ARCADY 6 and PICADY 4.1 computer packages, respectively for roundabout and priority junction analysis. Printouts from these programs are included in Appendix E.

Traffic Surveys

4.2.2 Traffic data was obtained from a number of Manual Classified Counts (MCC) carried out by Count On Us on Monday 30th of November 2009. This programme of surveys was originally planned to be carried out during a midweek day, when traffic is generally higher, but this was prevented by repeated adverse weather. As a result, uplift factors were applied to the Monday traffic data to convert it to Thursday flows. These MCCs were carried out at the following junctions:

- A92 / B946 Link Road (3-arm roundabout);
- B946 Link Road / TRBJB Car Park Access (priority T-junction); and
- B946 / B946 Link Road (priority T-junction).

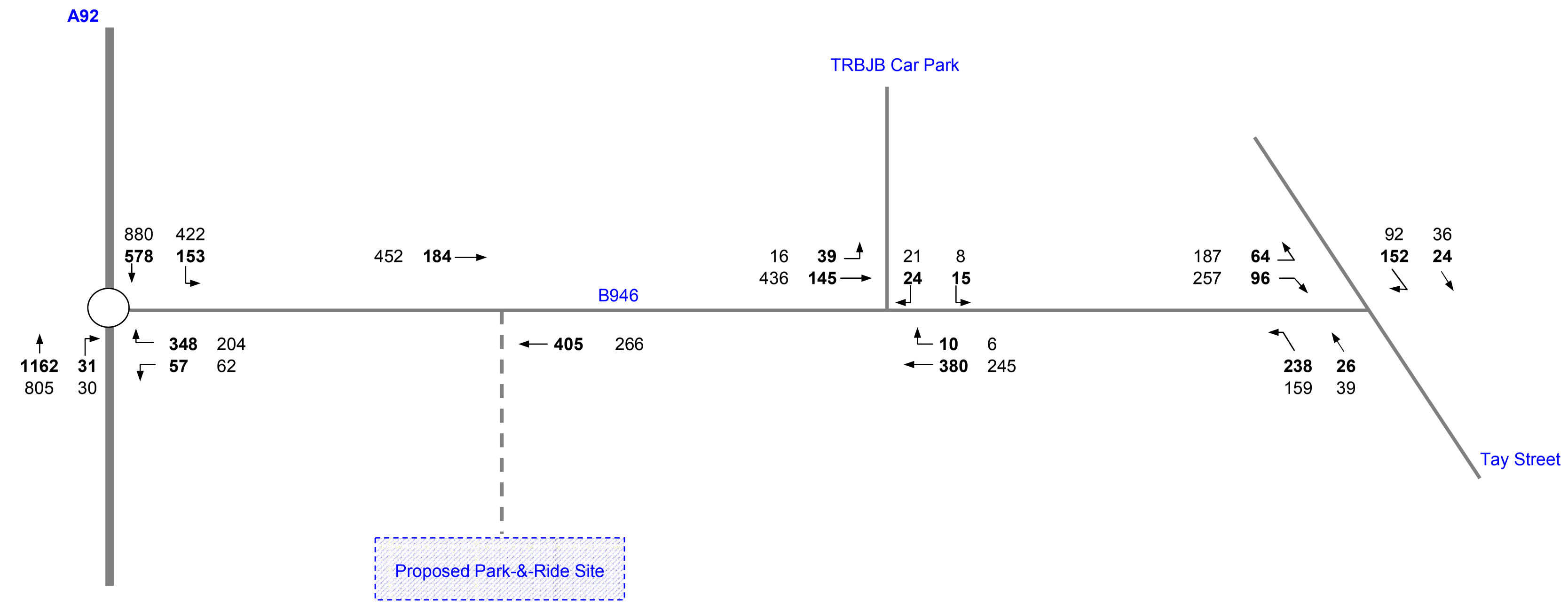
4.2.3 Traffic data was collected during the AM Peak period (0700 to 1000hrs) and PM Peak period (1600 to 1900hrs). Vehicles were classified using the standard vehicle classification, which includes the following types:

- Cars;
- Light Goods Vehicles (LGV);
- Other Goods Vehicles 1 (OGV1);
- Other Goods Vehicles 2 (OGV2); and
- Buses and Coaches (PSV).

4.2.4 The resulting 2009 traffic flows are illustrated in Figure 4.1 overleaf.

4.2.5 Additional traffic data was obtained from a number of permanent Automatic Traffic Counters (ATC) in the vicinity of the site.

4.2.6 From the MCC data, it was estimated that the AM Peak hour occurs between 0700 and 0800hrs, and the PM Peak hour between 1600 and 1700hrs and traffic flows from these periods were therefore used to obtain a worst-case scenario.



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AM Peak (0700 to 0800)
PM Peak (1600 to 1700)

South Tay Park-and-Ride Project

Observed Manual Classified Counts
30 November 2009 - AM & PM Peak

Figure 4.1

Traffic Growth

4.2.7 From the detailed engineering design in Chapter 2, we would suggest there are no adverse engineering or technical issues which would prevent the potential P&R options being constructed and opened by 2015. Therefore we have assumed an opening year of 2015 and appraised the traffic impacts of the scheme at this year. Consequently, the 2009 flows were growthed to a '2015 Do Nothing' scenario using observed growth rates from the ATC data.

4.2.8 The resulting 2015 values of traffic are illustrated in Figure 4.2.

Park-and-Ride Traffic

4.2.9 To account for the opening of the P&R scheme, a 2015 'Do Something' scenario was tested, which included traffic generated by the proposed site.

4.2.10 As shown in the engineering design in Chapter 2, the proposed design for the P&R site will provide a capacity of circa 458 spaces. We have assumed the full number of spaces would be used to indicate the total number of cars attracted to the study area in a worst case scenario.

4.2.11 In addition, a significant proportion of the potential users of the P&R site are likely to be currently travelling along the A92 between Dundee and the South, and vice versa. Hence, all traffic generated by the scheme is considered to be abstracted from existing traffic movements in the area. Consequently, we have assumed there is no induced additional traffic generated by the new P&R site. This assumption might require further analysis should the project progress forward.

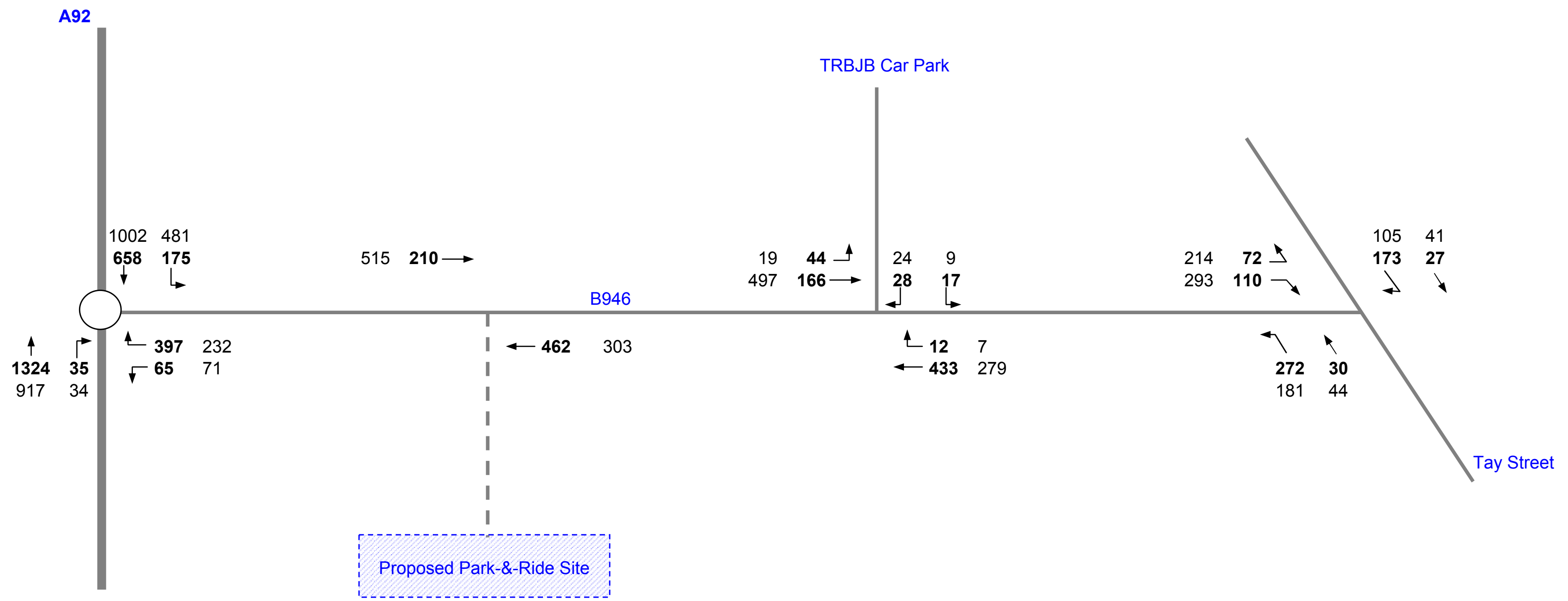
4.2.12 Analysis of the ATC data showed that of the vehicles entering/leaving Dundee through the Tay Bridge during the 3-hour peak periods (0700 to 1000hrs and 1600 to 1900hrs), up to 45% were travelling during the peak hour. It was estimated that the traffic profile on the A92 was a reasonable proxy for the utilisation of the Park-and-Ride and a value of 45% of Park-and-Ride users accessing/egressing the site during the peak hour was therefore used.

4.2.13 The distribution of P&R traffic at the A92 roundabout and the new P&R site access was sourced from the previous STAG study[2] which suggested a split of one third of traffic from/to the east of the site and two thirds from/to the south along the A92. These trips were then reassigned from the relevant junction turning movements from the 2015 Do Nothing background traffic to give the total P&R flows for the 2015 Do Something scenario. These are shown in Figure 4.3.

4.2.14 The impact of the proposed scheme at the TRBJB car park entrance and at the B946 Link road T-junction was not analysed, as traffic flows at these junctions are the same as in the Do Nothing scenario and hence there would be no increase in congestion expected with the introduction of the P&R scheme.

4.2.15 In order to take into account movements of buses using the P&R site, it was estimated that 4 buses per hour (bph) currently travelling on the A92 in both directions would service the site (Service 99 – the St Andrew's express). Additionally, the services currently passing on the B946 in front of the site would also detour into the P&R (8 bph in each direction). The turning movements at both analysed junctions were therefore adjusted accordingly.

[2] Cross Tay Sustainable Transportation Study, JMP, April 2009



Annual Growth: 2.2%

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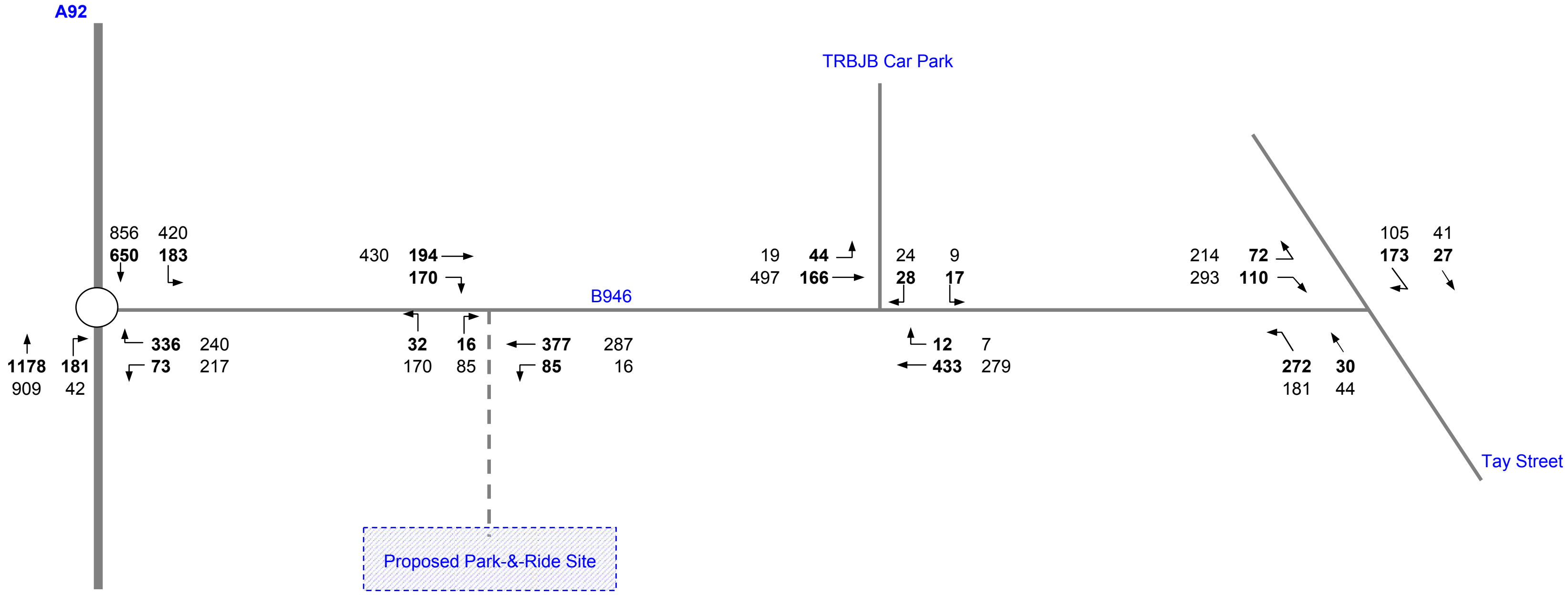
AM Peak (0700 to 0800)
PM Peak (1600 to 1700)

South Tay Park-and-Ride Project

Figure 4.2

2015 Do Nothing - AM & PM Peak



Number of Spaces 460

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AM Peak (0700 to 0800)
PM Peak (1600 to 1700)

South Tay Park-and-Ride Project

Figure 4.3

2015 with Park-and-Ride - AM & PM Peak

Junction Layouts

4.2.16 Geometry layout data of the A92 / B946 Link Road roundabout was measured from OS maps and entered into the ARCADY model. Geometry data for the site entrance was based on the proposed engineering design (See Appendix C).

4.3 Junction Modelling Results

Traffic Impact on the A92 / B946 Roundabout

4.3.1 The impact of the proposed Park-and-Ride site on the A92 / B946 Link Road Roundabout was assessed, for both AM and PM Peak Hours. For each time period, maximum Ratios of Flow-to-Capacity (RFC) and queue lengths were calculated. RFCs are a measure of the capacity utilisation of a junction and values above 85% are considered to be when the junction has reached practical operating capacity.

4.3.2 The analysis was first carried out with 2009 base flows, to assess current traffic conditions at the junction. The results are shown in the Table 4.1.

Table 4.1 – A92 / B946 Link Road Roundabout (2009)

		2009	
		Max RFC	Max Queue (veh)
AM	A92 North	38.5%	0.6
	B946	31.0%	0.4
	A92 South	69.4%	2.2
PM	A92 North	63.3%	1.7
	B946	22.8%	0.3
	A92 South	46.7%	0.9

4.3.3 The ARCADY analysis suggests the A92/B946 roundabout is currently operating below practical capacity, with all RFCs being lower than 85% and some maximum queue lengths being negligible.

4.3.4 The RFCs and maximum queue lengths in 2015, for both 'Do Nothing' and 'Do Something' scenarios are shown in Table 4.2.

Table 4.2 – A92 / B946 Link Road Roundabout (2015)

		2015 Do Nothing		2015 Do Something	
		RFC	Max Queue (veh)	RFC	Max Queue (veh)
AM	A92 North	44.0%	0.8	45.6%	0.8
	B946	36.6%	0.6	32.2%	0.5
	A92 South	80.3%	4	78.3%	3.5
PM	A92 North	72.2%	2.5	62.3%	1.6
	B946	27.4%	0.4	38.2%	0.6
	A92 South	53.7%	1.1	53.8%	1.2

4.3.5 The 2015 Results show that despite the general growth in traffic, no significant congestion occurs in the 'Do Nothing' scenario.

4.3.6 The introduction of the proposed P&R leads to a slight decrease in both RFCs and queue lengths for most movements, with only a few movements experiencing a minor increase, with no noticeable impact on congestion.

4.3.7 In terms of queuing stacking capacity on the B946, the available length of road between the new junction access and the A92 roundabout is approximately 60m. As queuing levels are significantly lower than this length, the queuing stacking capacity is considered acceptable.

Traffic Impact on the Park-and-Ride Entrance

4.3.8 Traffic conditions at the entrance to the proposed site were also analysed, for the 2015 'Do Something' scenario AM and PM peak hours. For each time period, maximum Ratios of Flow-to-Capacity (RFC) and queue lengths were calculated. Results are illustrated in Table 4.3 below.

Table 4.3 – Park-and-Ride Entrance (2015 Do Something)

		Do Something	
		RFC	Max Queue (veh)
AM	P&R to A92	5.5%	0.1
	P&R to B946	5.0%	0.1
	A92 to P&R	33.2%	0.5
PM	P&R to A92	30.0%	0.4
	P&R to B946	24.3%	0.3
	A92 to P&R	5.8%	0.1

4.3.9 The resulting RFCs show that no congestion is expected at the entrance to the site, with queuing being negligible.

Sensitivity Test

4.3.10 A sensitivity test with 100% of the P&R users accessing/egressing the site during peak hours was carried out, in order to ensure the proposed junction arrangement still operates acceptably in a worst case scenario.

4.3.11 The resulting maximum RFCs and queue lengths are illustrated in Tables 4.4 and 4.5, respectively for the A92 roundabout and the site entrance priority junction.

Table 4.4 – A92 / B946 Link Road Roundabout (2015 Sensitivity Test)

		Sensitivity Test (100% of Traffic during Peak Hour)	
		RFC	Max Queue (veh)
AM	A92 North	48.2%	0.9
	B946	25.6%	0.3
	A92 South	76.2%	3.2
PM	A92 North	49.9%	1.0
	B946	48.7%	0.9
	A92 South	53.8%	1.2

Table 4.5 – Park-and-Ride Entrance (2015 Sensitivity Test)

		Sensitivity Test (100% of Traffic during Peak Hour)	
		RFC	**Max Queue (veh)**
AM	**P&R to A92**	5.4%	0.1
	P&R to B946	5.6%	0.1
	A92 to P&R	66.3%	1.9
PM	**P&R to A92**	73.2%	2.6
	P&R to B946	59.4%	1.4
	A92 to P&R	5.8%	0.1

4.3.12 The 2015 sensitivity test results show that even with 100% of P&R users accessing and leaving the site during the peak hours, both junctions operate satisfactorily.

5.0 GROUND CONDITION INVESTIGATIONS

5.1 Introduction

5.1.1 This section presents the analysis of ground investigation surveys carried out at the Landfall site. The site is green field land, generally sloping from south to north towards the River Tay. The site has been previously utilised for agriculture and there is an existing farm to the east of the site boundary.

5.1.2 There is a bund of over 3m in height that extends from east to west across the northern section of the site. This bund is adjacent to, and runs almost parallel to, the tree line boundary of the existing road to the north. There are visible rock outcrops outwith the site boundary to the south of the site.

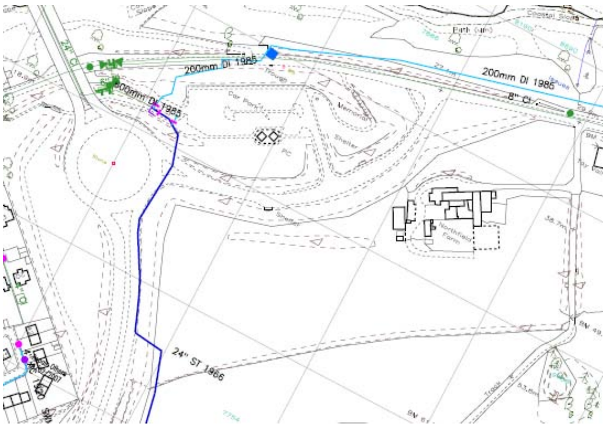
5.1.3 The proposed works shown in the engineering design indicate cuts of up to 8m in the north section with side slopes of approx 1 in 2. Cut depths across the car park site are in the range of 1.4m approx, and sparse fill areas in the southeast and western corners reach a maximum of 1.3m.

5.2 Public Utilities Search

5.2.1 A search of published data on existing public utilities at the site was carried out, including sourcing information from utility companies. From the feedback, it was found that both an overhead power cable and a 24-inch water main from Scottish Water cross the southwest corner of the site.

5.2.2 Figure 5.1 and 5.2 below respectively show the location of the water main and a photo of the overhead cable.

Figure 5.1 – Water Mains Pipe Route



Source: Scottish Water

Figure 5.2 – Power Overhead Cable

5.3 Site Investigation

5.3.1 Raeburn Drilling Geotechnical Ltd carried out the trial pitting and laboratory investigation at the site on 31 March 2010 under the supervision of geotechnical staff from Scott Wilson Ltd. The site investigation included a limited number of machine-excavated trial pits and geotechnical laboratory testing.

5.3.2 A copy of the Raeburn laboratory analysis report is included in Appendix F of this report.

5.3.3 The laboratory testing carried out on soil and rock samples were:

- 7 No. Moisture Content tests
- 2 No. Liquid Limit (LL), Plastic Limit (PL), Plasticity Index tests
- 4 No. Particle Size Distribution tests
- 2 No. Soluble Sulphate (2:1 ratio) tests
- 2 No. pH tests
- 2 No. Dry Density /Moisture Content Relationship tests (using 2.5kg rammer)
- 1 No. CBR test
- 3 No. Natural Water Content tests on rock samples
- 1 No. Los Angeles Coefficient test on rock sample

5.3.4 No contamination testing was carried out.

5.4 Ground Conditions Summary

Topsoil

5.4.1 Topsoil covered by grass ranged from 0.15m to 0.45m in depth across the site. The topsoil is described as mostly sandy gravel.

Made Ground

5.4.2 The made ground deposits are the most predominant upper strata sequence in the north-central and western sections of the site. They constitute the bund and areas immediately south and southwest of the bund. These strata have been observed at ranges from ground level to 4m below ground level (bgl) across the site. They comprise silts, sands and gravels with occasional cobbles and rootlets. The made ground materials appear to be reworked natural soils.

5.4.3 At one trial pit site, a LL test was recorded as 27% and the PL was non-plastic. Moisture content results in these deposits range from 12 – 16%. An average CBR of 0.35% was recorded at 0.5m bgl at the same site. Sulphate content tests gave 0.02 g/l and 0.01 g/l while pH tests recorded values of 7.9 and 5.8 results over two trial pit sites. Dry density/moisture content relationship tests gave optimum moisture contents of 8.4 - 8.8% in the gravel/silt made ground deposits.

5.4.4 The local farmer informed the Scott Wilson Site Engineer that the bund spanning east to west of the northern section of the site was formed by deposition of materials excavated during construction of the Tay Bridge.

Silt and Clay/Silt

5.4.5 This strata sequence is recorded at three trial pit sites. It is predominantly a very sandy gravely silt. The deposits range between 0.3m bgl to over 4.25m bgl. They have been described as made ground deposits by the Raeburn laboratory analysis, and were found in the central, northwest and southwest areas of the site. The Scott Wilson Engineer on site considered the silt deposits in the west and south central sections to be natural.

5.4.6 Moisture content results range from 12 – 15%.

Sand and Gravels

5.4.7 These deposits generally underlie the topsoil and/or made ground deposits. They were recorded between 0.3m and 4m bgl. The strata are described as silty to very silty clayey sands and gravels.

5.4.8 Moisture content ranges from 12 – 13%. LL of 26% and PL of 17% were recorded.

Rock

5.4.9 Bedrock was encountered in four trial pit locations. It is described as grey vesicular Basalt and was recorded at depths ranging from 0.2m to 3.8m bgl.

5.4.10 A Los Angeles Coefficient of 23 was recorded in a rock sample from TP1. Natural water content ranges are from 2 – 8.2% (from shallow rock in the east end of the site).

Groundwater

5.4.11 Groundwater was encountered at varying depths ranging from 1m to 4m bgl.

Stability of Pits

5.4.12 All trial pit walls were recorded as stable during the site investigation.

Rock excavation

5.4.13 The deep excavation at the proposed access road in the northern and north eastern sections of the site, reaching depths of 8m bgl, is likely to encounter bedrock from approximately 2 - 4m below existing ground level. The rock depth reduces as the access road proceeds due east. Excavation for the foundation for the southeast building/bus stand will be likely to encounter rockhead at approx 0.15m to 0.5m bgl.

5.4.14 Any further excavations elsewhere on site within 1.5m depth of the existing ground level are unlikely to encounter bedrock. The bedrock was difficult to dig with a machine excavator in the trial pits.

Material Reusability

5.4.15 Reuse of excavated materials has been assessed based on SHW 600 series Tables 6/1 and 6/2 and the limited tests available.

<u>Made Ground</u>

5.4.16 At the deep cut through the bund area north of the site, the upper 2m – 3m approx is likely to be made ground. Also, the upper material excavated in the car park area to 1.5m below existing ground level will likely be made ground. This very silty sand and gravel is variable but a large proportion should be suitable for reuse, dependant on further testing.

Silt and Clay/Silt

5.4.17 As the project progresses to detailed design, further tests should be carried out to refine assumptions for detailed cost estimates.

Sands and Gravels

5.4.18 Sand and gravel material excavated for the access road north of the bund to depths of 2m approx (at the north end of the site) may be reusable as Selected Granular Fill (Class 6F1).

Rock

5.4.19 Excavated rock may be suitable as Selected Granular Fill (Class 6F1 or Class 6N).

5.4.20 An estimate of about 75% of excavated material from cuts, including rock cuttings, may be suitable for reuse. However, further tests are necessary to confirm the reusability of materials.

Slope Stability (at Proposed Access Road)

5.4.21 The existing grassed over bund has a slope of approximately 1v:2h and appears stable. Therefore, cuttings in this area should be suitable with 1 in 2 slopes for the superficial soils, subject to additional ground investigation and slope stability assessment.

5.4.22 Rock excavation of 4m and greater is estimated. The stability of the rock cuts at 1 in 2 slopes or steeper will need to be assessed based on rock joint orientation.

CBR

5.4.23 A very low CBR value of 0.3% was recorded in a made ground sample, carried out in silty gravely sands at shallow depths. The low value was likely due to the high moisture content in the sample. The design CBR value in silts is normally 1 – 2%. Higher CBR values are more likely to be recorded in the western section of the site in less silty materials.

5.4.24 As the project progresses to detailed design, we would recommend further CBR tests be undertaken across the proposed car park area.

Groundwater

5.4.25 Measures to prevent standing water or channel water egress from superficial or rock faces may be necessary during construction.

Additional GI Surveys

5.4.26 Supplementary GI surveys are recommended to acquire both contaminated soil and detailed geotechnical design information across the site. The risk of contaminants within the soil and groundwater is considered to be low.

5.5 Effects on the Scheme Cost

5.5.1 Following completion of the preliminary site investigation works, Scott Wilson have reviewed the cost plan and design taking into account the interpreted geotechnical information. With respect to the main car park area, the assumptions were made previously regarding the requirement to fully excavate unsuitable materials for formation of the car park foundation and running surface. Through confirmation that prevailing conditions within the site are predominantly silty gravels within the zone of construction, the previous assumptions have been proven correct. Therefore the cost plan continues to reflect removal of materials up to 1 metre below ground level in some areas.

5.5.2 The site investigation information does however provide some confidence on the nature of surplus materials that will arise within the site, and specifically that they will be inert and likely to be free from contamination. This has allowed a review of the rate for material removal from site to be undertaken, taking into account the probability that it could be re-used for beneficial purposes elsewhere within a reasonable distance.

5.5.3 Within the access road, where depths of excavation are significant between existing road level and car park level, the investigation works suggest rock is at a greater depth than previously assumed based on historic data.

5.5.4 As a result, the volume of material excavation that attracts a higher rate for rock is reduced (balanced by an increase in volume of non rock materials). It could be assumed that any rock excavated can be used productively on site as general fill or to infill any soft spots in the mass earthworks area to manage risk and cost to the contractor.

5.5.5 The refined cost estimates were set out earlier in Table 2.1 in Chapter 2 of this report.

Appendix A

Minutes of Meeting

Meeting Notes

*Job Title / Ref.:	SEStran and TACTRAN South Tay Park and Ride	**Job No.**	**S 106888** Project No.
Subject of Meeting	Inception Meeting	Meeting No.: 1	Date & Time: 12-Nov-09 14:00
Attendees:	Alex Macaulay AM SEStran Trond Haugen TH SEStran Jane Findlay JF Fife Council Andrew Davidson AD Transport Scotland Ewan Gourlay EG Dundee City Council Niall Gardener NG TACTRAN Marwan AL-Azzawi MA Scott Wilson Simon Shillington SS Scott Wilson	Venue: SEStran offices Distribution: Attendees plus Project Team	Notes By: Marwan AL-Azzawi

Item No.	NOTES	ACTION
1	**<u>Introductions and Background</u>** TH welcomed everyone to the meeting and introductions were made. The purpose of this Inception Meeting was to kick-off the South Tay Park and Ride project for which a meeting agenda was tabled by MA and was followed as the basis for discussions. There was also a presentation by Scott Wilson which outlined the initial results of their optioneering work to develop options to take forward into the rest of the study. These minutes reflect the items raised in the agenda and the presentation.	
2	**<u>Review of the Proposed Study Approach</u>** The proposed study methodology was discussed and agreed.	
3	**<u>Review of Scott Wilson Data Needs from Client Group</u>** To enable the study to progress, SW requested the following information. <u>Turning Count Information</u> • traffic count information on routes in the area (B946, Tay Street) to be supplied to SW for 2007, 2008 and 2009 traffic flows by Fife Council and Dundee City Council; • SW to organise new junction turning counts for A92 roundabout; and • Dundee City Council to look at Hyder report published in 2004 and send to SW. <u>Land Ownership</u> • SS mentioned one of the topographic survey boundaries conflicted with the plan issued in the brief. SW would like a title plan if possible. NG to contact TRBJB to confirm boundaries.	JF/EG SW EG NG

Meeting Notes

Item No.	NOTES	ACTION
4	**<u>Presentation on Outline Optioneering</u>** <u>Options</u> SS gave a presentation on his site visit and engineering analysis. This identified a number of issues and opportunities which were discussed. After review of the engineering analysis, there are four options to be considered in the study: • Option 1 : on–street lay-bys for bus facilities with access to a new car park at the top of the plateau; • Option 2 : junction access for bus/cars from B946 replacing the existing junction at the entrance to the TRBJB car park, with bus facilities integrated within the new car park; • Option 3 : as option 2 but a new junction from the B946 for bus/cars, closer to the A92. This could be a staggered signalised junction with the existing car park access; and • Option 4 : trunk-road access off the A92 roundabout. MA emphasised the agreed study approach only allowed for 3 options to be considered, based on a high level analysis, with an engineering-based sifting to identify one preferred solution to take forward to detailed drawings and cost estimates. After discussion it was agreed AD would discuss within Transport Scotland of the potential support for Option 4 (A92 roundabout access) and if it was found to be unacceptable then it would not be pursued. MA agreed to forward the presentation with the sketch plans for the options to the client group to consider. {Post Meeting Note: MA has issued the presentation with sketch plans} Any comments to be sent back to SW within 2 weeks.	AD
5	**<u>Stakeholders to Consult</u>** There are various stakeholders who will need to be consulted as part of the project. This will include: • contacts in relevant local authorities (JF to supply planning/environment and roads contacts) • Transport Scotland (AD to provide contact details) • Bus Operators (TH to supply)	JF AD TH
6	**<u>Study Management</u>** The client staff liaison will be carried out between TH and MA as the principal points of contact. With regards to consultation protocols / requirements SW can be flexible and do not need to involve the client group in all discussions.	
7	**<u>Any Other Business</u>** AM asked when the objections period to the Local Plan is due to close. JF advised the closing date for representations is 24 December 2009. TH confirmed SW might need to report to the client group by a period of time before the closing date in order for the group to prepare and submit a suitable response.	

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Meeting Notes

*Job Title / Ref.:	SEStran and TACTRAN South Tay Park and Ride	**Job No.** S 106888 Project No.	
Subject of Meeting	Progress Meeting	Meeting No.: 2	Date & Time: 16-Dec-09 13:00
Attendees:	Alex Macaulay AM SEStran Trond Haugen TH SEStran Jane Findlay JF Fife Council Andrew Davidson AD Transport Scotland Ewan Gourlay EG Dundee City Council Niall Gardener NG TACTRAN Marwan AL-Azzawi MA Scott Wilson Simon Shillington SS Scott Wilson	Venue: SEStran offices Distribution: Attendees plus Project Team	Notes By: Marwan AL-Azzawi

Item No.	NOTES	ACTION
1	**Introductions and Background** TH welcomed everyone to the meeting and introductions were made. The purpose of this Progress Meeting was to discuss and agree the preferred option to take forward into more detailed design for the South Tay Park and Ride project. Prior to the meeting, Scott Wilson had prepared and issued an Outline Optioneering Technical Note and had received comments from key stakeholders. This meeting was called to discuss any amendments to the emerging preferred solution and reach agreement	
2	**Engineering** SS reported Scott Wilson had taken option 3 and the comments received from Outline Optioneering Technical Note and amended the design accordingly. They then looked at 3 variations of option 3, one with a bus turning area outside the car park and another 2 variants with the bus going into the car park although these latter variants have fewer spaces. Various drawings were presented and discussed TH said there is a need to be mindful of maximum walking distances. SS said the longest walking length is circa 150m. MA said this length is within the suggested guidance of 400m TH asked about spaces for further expansion. MA said the south-east corner of the site has been left out due to uncertainty of the farmers land boundary but can be used for future expansion. NG confirmed he has not received feedback on the farmer's land boundary There was discussion on existing bus stops on B746. AM questioned whether it would be necessary to keep the existing bus stops on B746. NG said we might need to keep them due to no P&R bus services on a Sunday. MA said you would have to move one of them as it is next to the proposed junction access, presumably relocated on the road at a suitable location opposite the other stop NG asked whether the existing footpath on B746 would be extended. JF thought there should be a footpath on the new access road in to car park. After discussion it was agreed the new access road should have a footpath on one side There was also discussion on the need to provide spaces for buses to lay-over. TH is to speak to bus operators on whether they want spaces and revert back to us. In the meantime, the design process is to assume there is space to be provided to accommodate one bus	TH

Item No.	NOTES	ACTION
	AM asked about comparative costs of the 3 variants. SS said the car park surface areas are a proxy for the potential costs SS asked about widening of existing road width at the new junction access. It was agreed widening on the north side is acceptable	
3	**Junction Analysis** MA set out the results of junction analysis. The conclusion was the proposed junction arrangements in the drawings presented do not seriously impact on existing A92 roundabout. However, MA said there are constraints on the number of spaces since too many spaces could lead to increased impacts on the road network There was discussion on the traffic demand estimates. NG said the previous study estimated circa 215 trips in AM peak and 300 trips all day. MA said the analysis had used the maximum number of spaces of each option variant (i.e. from circa 440 trips to circa 540 trips) to provide a more robust analysis MA said the junction analysis has only focused on testing the impacts at an assumed opening year of 2015 MA said the analysis has used the trip distribution patterns from the previous study but the new traffic surveys on the existing TRBJB car park access shows a different pattern which intuitively seems more accurate. After discussion it was agreed we should use the observed distribution from the new surveys	`
4	**Landscaping** MA reported the following: • new landscaping on the west and south sides of site was proposed as shielding; • there is also the potential to provide pockets of planting and landscaping in the car park site to break up the visual impact of the large provision of spaces. This would reduce the number of spaces and increase costs; and • there has also talk about tilting the site to hide it more, which would significantly increase costs. After discussion, the client group confirmed this should not be pursued SS asked about the provision of lighting. After discussion it was agreed this would be low level lighting not high masts and CCTV could be wanted on the bus terminus building if there was sufficient views	
5	**Option to Develop** After discussion it was agreed a hybrid of option 3 and option 3A would be the preferred solution. This would have a terminus building on the south-east area of the site with buses turning into the car park. There would be a footpath on the access road (one side) up to the service building. There would also be an assumed one space for a bus lay-over	

Meeting Notes

Item No.	NOTES	ACTION
6	**<u>Local Plan Submission</u>** After discussion, SW were asked to prepare a plan showing the proposed layout with indicative landscaping arrangement and send to the client group by early next week	SW
7	**<u>Any Other Business</u>** AD asked about Optimism Bias (OB) in the cost estimates. MA explained SW's proposal for estimating cost only include contingency using standard percentages	

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Appendix B

Outline Engineering Technical Note

SEStran, TACTRAN, Fife Council, Dundee City Council and Transport Scotland

South Tay Park-and-Ride Project

Outline Optioneering Technical Note

Scott Wilson Ltd

December 2009




Revision Schedule

South Tay Park-and-Ride Project
Outline Optioneering Technical Note
December 2009
S106888

Rev	Date	Details	Prepared by	Reviewed by	Approved by
1	9 December 2009	Technical Note	**Geoffrey Cornelis** Transport Planner **Simon Shillington** Associate **Tomos Ap Tomos** Senior Engineer	**Dr Marwan AL-Azzawi** Associate	**Dr Marwan AL-Azzawi** Associate

Contents

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1.0 INTRODUCTION

1.1 Background

1.1.1 SEStran (South East Scotland Transport Partnership), TACTRAN (Tayside and Central Scotland Transport Partnership), Fife Council, Dundee City Council and Transport Scotland appointed Scott Wilson to provide technical support for the South Tay Park-and-Ride (P&R) Project.

1.1.2 The study involves identifying outline layout options for the P&R site and providing outline engineering analysis on these initial options, and then developing a more detailed design and cost estimate for a single option identified as being the preferred potential solution.

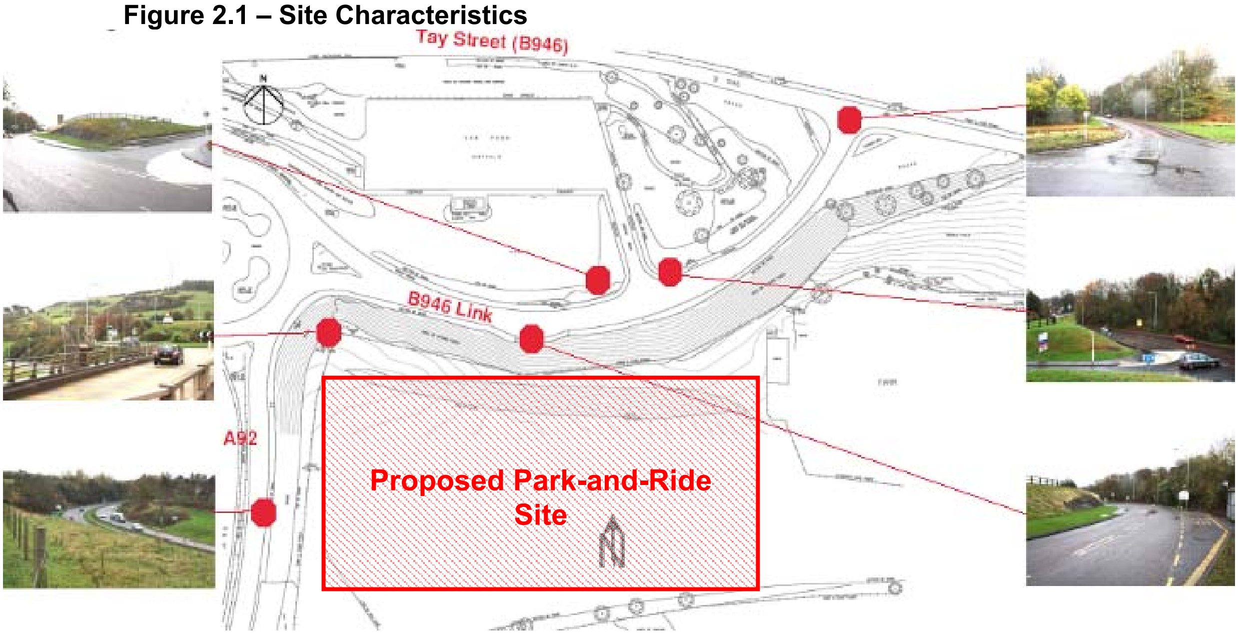
1.1.3 This Technical Note presents the findings of the first part of the study, mainly the high-level engineering appraisal of options. The intention is these be considered by the client group and a preferred solution is identified to take forward to more detailed development.

2.0 OUTLINE OPTIONEERING

2.1 Site Visit

2.1.1 Scott Wilson visited the proposed site to scope out the area and identify potential outline options. This examination considered visual boundaries and access levels.

Figure 2.1 – Site Characteristics

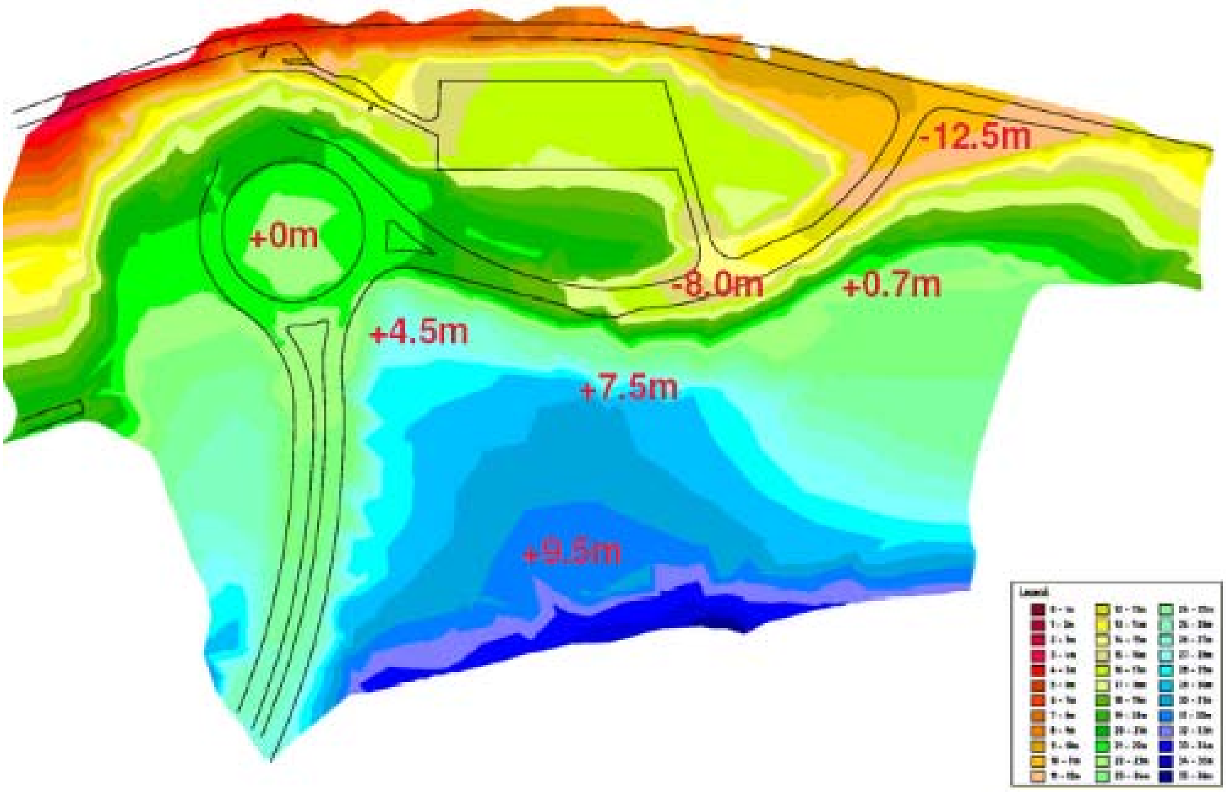


2.1.2 The proposed site is located next to the roundabout intersecting the A92 Trunk Road with the B946 Link Road, which links the A92 to Tay Street. There is an existing small car park opposite the proposed new site, with access off the B946 Link Road. This car park is owned by the Tay Road Bridge Joint Board (TRBJB). To the east of the site is land owned by Tayfield Estates which has not been included in this study.

2.2 Topography Appraisal

2.2.1 A desk study investigation was carried out to establish ground conditions. This looked at the varying levels of the area using topography surveys from previous studies.

Figure 2.2 – Site Topography



2.2.2 The existing topography of the Landfall site represents a significant challenge to the delivery of a suitable Park-and-Ride arrangement.

2.2.3 The B946 Link Road between the A92 Roundabout and its junction with Tay Street (B946) falls approximately 11.5m from a survey level 21.5m OD at the A92 roundabout exit to a level of 10m OD at the junction with the main B946 (levels based on G.L. Surveys drawing dated August 1998). This is the main access route bounding the Landfall site.

2.2.4 The usable Northern frontage of the Landfall site varies between 7-12m above the B946 Link Road. The Landfall site itself varies 8m in level across its area approximately between 23m OD and 31m OD, the majority of the site only varies by 3-4m with existing falls within the parameters of accepted car park design.

2.3 Presentation and Options Discussion

2.3.1 Using the findings from the topography appraisal and the site visit, we identified some initial options for discussion with the client group.

2.3.2 A presentation on engineering aspects was given by Scott Wilson, which was attended by representatives from the following stakeholders:

- SEStran;
- TACTRAN;
- Fife Council;
- Dundee City Council; and
- Transport Scotland.

2.3.3 This presentation identified a number of issues and opportunities which were discussed. After review of the engineering appraisal, there were four options identified by the attendees which were considered:

- Option 1 – this would provide a new car park at the proposed site, with access only for cars. P&R facilities would be provided at existing bus stops on the B946 via on-street bus lay-bys. In this option, passengers would have to walk down from the car park to the on-street bus lay-bys via new stairs and DDA[1]-compliant ramps;
- Option 2 – this would provide a new car park at the proposed site, with access from the B946 for both cars and buses. This would replace the existing junction at the entrance to the existing small TRBJB car park. A new bus terminus and associated P&R facilities would be integrated within the new car park design allowing level interchange;
- Option 3 – this would be similar to Option 2, but will provide a new junction access from the B946 for cars and buses, west of the existing TRBJB car park access. The advantage of this option is that it allows access/egress to be closer to the A92 roundabout, where differences in ground level are not as severe. As with Option 2, a new bus terminus and associated P&R facilities would be integrated within the new car park design allowing level interchange; and
- Option 4 – this would provide a slip lane access off the A92 roundabout, to a new car park at the proposed site. The slip lane would allow cars and buses to enter the new car park and a separate egress would be provided onto the B946. As with Options 2 and 3, a new bus terminus and associated P&R facilities would be integrated within the new car park design allowing level interchange.

2.3.4 The study approach allowed for 3 options to be considered based on a high-level engineering-based appraisal. The intention is to identify one preferred solution to take forward to detailed drawings and cost estimates. At the presentation it was agreed that Transport Scotland would consider the potential level of support for Option 4 (access off the A92 roundabout) and whether it would be acceptable. Until then, Scott Wilson would progress the high-level engineering appraisal of Options 1 to 3. The client group will then need to decide which option to take forward into more detailed engineering and cost analysis. The results of this appraisal of the first three options are set out in the rest of this Technical Note.

[1] Disability Discrimination Act

3.0 OUTLINE ENGINEERING APPRAISAL

3.1 Introduction

3.1.1 This section identifies the high-level engineering aspects of the first three options as set out in section 2 with regard to implementing a Park-and-Ride (P&R) facility at this location. Option 1 only allows car access to the site and as a result has a lesser horizontal geometric standard, whereas Options 2 and 3 allow for both car and bus access into the new car park.

3.1.2 Fife Council Development Guidelines have been used as the basis for the preliminary horizontal and vertical design standard for the P&R access road. As there is no direct guidance on P&R access roads, the horizontal and vertical geometry chosen are based on a hybrid of the industrial access road standard for horizontal geometry with the vertical geometry broadly based on the standard for a residential core road.

3.1.3 The residential core standard allows a maximum gradient of 8% although this is limited to 6.7% on a bus route. These parameters were used to establish the maximum gradient suitable for accessing the P&R facility via bus.

3.2 Option 1 (New Car Park with On-Street Bus Lay-Bys)

3.2.1 Option 1 proposes a new roundabout at the junction between the B946 Link Road and Tay Street (B946). A new car park would be constructed at the top of the existing plateau of the proposed site. A fourth arm would be added to the roundabout to access the new car park. Due to geometric constraints of this route, it would only be intended for passenger car use with buses using the additional roundabout as a turning facility and maintaining their drop-off and collection at the existing on-street bus stops. Appendix A includes a schematic layout figure of Option 1.

3.2.2 The route is 6m wide with 0.5m verges and would pass to the north of the existing farmhouse requiring retention of approximately 7m on the south side and some 2-3m on the north side. The route is predominately beyond the reasonably developable parking area of the upper site which allows the maximum extent of the site to be utilised. Whilst a degree of earthworks excavation is required to facilitate the access roads, minimal excavation is required to achieve the significant area of car park proposed.

3.2.3 We would estimate that with the inclusion of retention to car park area, the maximum number of parking spaces that can be accommodated could be in the region of 738. It should be noted that significant engineering works would be required to provide a pedestrian access to the existing on-street bus stops.

3.3 Option 2 (New Car Park with Combined Car and Bus Access)

3.3.1 Option 2 is intended to provide a direct access to the upper Landfall site with a junction opposite the existing access to the TRBJB small car park. The geometry of the access would allow buses into the site with a turning facility at the upper end suitable for accommodating up to two buses at a time. Appendix A includes a schematic layout figure of Option 2.

3.3.2 The position of the access and the requirement to minimise encroachment on the adjacent land result in a significantly reduced parking area, with the estimated number of parking spaces only reaching 488. This could be marginally increased with the introduction of retention on the southern boundary of the site. To accommodate buses, the access road width has been increased to 7.3m with 0.5m verges.

3.3.3 Due to the short length of access road and the vertical geometric constraints outlined in Section 2.2, the end of the access road is approximately 6m lower than existing ground at this point. This results in a car park which requires a significant volume of excavation to achieve the proposed levels. Given the compact nature of the site, this excavated material would require removal from site.

3.3.4 This layout also affords an area of approximately 450sqm to be utilised between the proposed car park and the bus turning facility to accommodate a shelter or terminus facility.

3.4 Option 3 (as Option 2 but Access Closer to the A92 Roundabout)

3.4.1 Option 3 also provides direct access into a proposed new car park facility. However to endeavour to overcome the weaknesses of Option 2 the access has been moved westwards, closer to the existing roundabout with the A92. The junction is located approximately 60m east of the exit from the A92 roundabout. Appendix A includes a schematic layout figure of Option 3.

3.4.2 The access is again 7.3m wide allowing buses into the site with a turning facility at the upper end suitable for accommodating up to two buses at a time. However, the westward shift allows the access road length to be doubled. This, in conjunction with starting from a higher level on the B946 Link Road, results in the access road reaching existing ground level at the bus turning area.

3.4.3 Achieving existing ground levels at the end of the access road allows the car park level to be significantly raised above Option 2, resulting in significantly less earthworks, which would reduce overall costs. As with Option 1 the main access route is contained outwith the principal developable area of the site. This results in approximately 540 car park spaces being achieved with the inclusion of retention to the car park in the vicinity of the access road.

3.4.4 As with Option 2 this layout also affords an area of approximately 450sqm to be utilised between the proposed car park and the bus turning facility to accommodate a shelter or terminus facility.

3.5 Estimated Infrastructure Volumes and Costs

3.5.1 Table 3.1 identifies the approximate volumes and areas required to construct each option based on the preliminary design carried out to date.

3.5.2 As can be seen from Table 3.1 there is a significant variation in earthworks volumes between the various options and this is likely to be the decisive factor in determining the preferred option, in terms of engineering and construction costs.

3.5.3 Option 1 requires substantial earthworks and a significant amount of retention to allow the access road to be constructed. This is offset by the least earthworks excavation for the parking area and the provision of the greatest number of parking spaces. Additional offsite works in the construction of a new roundabout are also required.

3.5.4 Option 2 requires the greatest volume of earthworks to be excavated for both the car park and the access road, whilst providing the least amount of parking spaces of any of the options. Retention to adjacent land is also required to achieve the level proposed by this option.

3.5.5 Option 3 requires the least amount of earthworks for the access road, which will significantly reduce construction costs. In addition, the car park excavation, although over 2.5 times greater than that required for Option 1, is still significantly less than the requirements for Option 2. The retention wall proposed is optional and could be removed by reducing the number of parking spaces, although this would provide a less efficient car park shape.

Table 3.1 – Infrastructure Requirements

	Number of Parking Spaces	No of Spaces Lost without Retention	Access Road Length (m)	Access Road Earthworks Volumes (m^3)	Car Park Surface Area (m^2)	Car Park Earthworks Volumes (m^3)	Wall Area of Required Retention (m^2)
Option 1	738	67	259	18,230	16,030	44,320	1,000
Option 2	488	0	109	20,570	10,640	52,100	200
Option 3	540	39	203	13,281	11,450	12,100	350

Note: this is provisional information based on the manual conversion of a 2D survey into 3D. Further accuracy would require the original 3D surveys to be used.

3.5.6 When considering potential construction costs, Table 3.2 estimates a cost per parking space for each of the options. As can be seen, the earthworks required for Option 2 results in a significant uplift per parking space over the other two options. It should also be noted that whilst Option 1 produces a similar cost range to Option 3 this is as a result of the number of spaces achieved. Reducing the number of spaces to the level of Option 3 would result in the cost per space increasing towards the level of Option 2.

Table 3.2 – Infrastructure Projected Costs per Space

Car Park	Parking Spaces	Cost Range Per Space
Option 1	738	£7,000 - £8,000
Option 2	488	£11,000 - £12,000
Option 3	540	£6,500 - £7,500

Note: these costs exclude any buildings or terminus facilities.

3.6 Traffic Appraisal

Methodology

3.6.1 An initial traffic analysis was undertaken to estimate the impact of the proposed Park-and-Ride site on traffic conditions at the A92 / B946 Link Road roundabout. This was to evaluate whether this junction has sufficient capacity to cope with the additional traffic, and specifically that no significant queuing occurs on the B946 Link Road which could back up to the proposed site entrance or the TRBJB car park.

3.6.2 The appraisal was carried out using the ARCADY computer package, used for single roundabout junction analysis.

3.6.3 Traffic data was obtained from a number of Manual Classified Counts (MCC) carried out by Count On Us on Monday 30th of November 2009. This programme of surveys was originally planned to be carried out during a midweek day, when traffic is generally higher, but this was prevented by repeated adverse weather. As a result, uplift factors were applied to the Monday traffic data to convert it to Thursday flows. These MCCs were carried out at the following junctions:

- A92 / B946 Link Road (3-arm roundabout);
- B946 Link Road / TRBJB Car Park Access (priority T-junction); and
- B946 / B946 Link Road (priority T-junction).

3.6.4 Traffic data was collected during the AM Peak period (0700 to 1000hrs) and PM Peak period (1600 to 1900hrs). Vehicles were classified using the standard vehicle classification, which includes the following types:

- Cars;
- Light Goods Vehicles (LGV);
- Other Goods Vehicles 1 (OGV1);
- Other Goods Vehicles 2 (OGV2); and
- Buses and Coaches (PSV).

3.6.5 Additional traffic data was obtained from a number of permanent Automatic Traffic Counters (ATC) in the vicinity of the site. These covered the years from 2007 to 2009 (inclusive) and were as follows:

- Tay Bridge – Exit from Bridge to East and Entry from West to Fife;
- Tay Bridge – Exit Slip from East to Fife;
- Tay Bridge – Exit Slip from Fife WB;
- A92 Tay Bridge Southern Approach; and
- B946 Tay Bridge Link Road.

3.6.6 These ATC data was processed to analyse the weekly profile of traffic flows and estimate annual growth rates in the area.

3.6.7 Geometry layout data of the junctions was measured from OS maps and entered into the ARCADY model.

Traffic Impact on the A92 / B946 Roundabout

3.6.8 The impact of the proposed Park-and-Ride site on the A92 / B946 Link Road Roundabout was assessed, for both AM and PM Peak Hours. For each time period, maximum Ratios of Flow-to-Capacity (RFC) and queue lengths were calculated. RFCs are a measure of the capacity utilisation of a junction and values above 100% are considered to be when the junction is fully congested.

3.6.9 The analysis was first carried out with 2009 base flows, to assess current traffic conditions at the junction. The results are shown in the Table 3.3.

Table 3.3 – A92 / B946 Link Road Roundabout (2009 Traffic Levels)

		2009	
		Max RFC	**Max Queue (veh)**
AM	**A92 North**	61.5%	1.6
	B946	47.2%	0.9
	A92 South	45.1%	0.8
PM	**A92 North**	63.6%	1.7
	B946	23.6%	0.3
	A92 South	53.7%	1.1

3.6.10 The ARCADY analysis suggests the A92/B946 roundabout is currently operating below capacity, with all RFCs being lower than 100% and maximum queue lengths being negligible.

3.6.11 From our experience, we would suggest there are no adverse engineering or technical issues which would prevent the potential Park-and-Ride options being constructed and opened by 2015. Therefore we have assumed an opening year of 2015 and appraised the traffic impacts of the options at this year. Consequently, the 2009 flows were growthed to a '2015 Do Nothing' scenario using observed growth rates from the ATC data.

3.6.12 The findings from Table 3.1 suggest Option 1 can provide circa 740 spaces, Option 2 can provide circa 490 spaces and Option 3 can provide circa 540 spaces. The additional traffic impacts as a result of introducing these options on the A92/B946 roundabout was also tested using ARCADY. For each option, we have assumed the full number of spaces would be used to indicate the total number of cars attracted to the study area. Assuming the car park would be full is also the worst case scenario, in terms of the potential congestion implications on the A92/B946 roundabout. Furthermore, it was assumed that all vehicles would access the Park-and-Ride site during the AM Peak hour and leave during the PM Peak hour.

3.6.13 Regarding the trip distribution of the new traffic, it was assumed that all trips would access the B946 Link Road from the A92 in order to obtain a robust analysis. Distribution at the roundabout was sourced from the previous STAG study[2] which suggested a split of one third of traffic from/to the north and two thirds from/to the south. These trips were then superimposed on top of the 2015 Do Nothing background traffic to give the total design flows for each option.

3.6.14 The resulting RFCs and maximum queue lengths from ARCADY are shown in Table 3.4.

[2] Cross Tay Sustainable Transportation Study, JMP, April 2009

Table 3.4 – A92 / B946 Link Road Roundabout (2015)

		Do Nothing		Option 1		Option 2		Option 3	
		RFC	Max Queue (veh)	RFC	Max Queue (veh)	RFC	Max Queue (veh)	RFC	Max Queue (veh)
AM	A92 North	74.4%	2.8	88.3%	6.7	83.0%	4.6	83.8%	4.9
	B946	63.7%	1.7	58.2%	1.7	59.0%	1.4	58.7%	1.4
	A92 South	56.7%	1.3	89.1%	7	77.9%	3.4	80.3%	3.9
PM	A92 North	77.5%	3.4	76.1%	3.1	75.6%	3.1	75.7%	3.1
	B946	30.9%	0.4	104.3%	24.1	77.3%	3.2	82.5%	4.3
	A92 South	66.0%	1.9	73.2%	2.6	70.5%	2.3	71.2%	2.4

3.6.15 The 2015 Results show that despite the general growth in traffic, no significant congestion occurs in the 'Do Nothing' scenario.

3.6.16 The addition of the Park-and-Ride traffic leads to a noticeable increase in both RFCs and queue lengths, but only Options 2 and 3 stay within reasonable limits. Option 1 results in unacceptable traffic impacts.

3.6.17 In terms of queuing stacking capacity, Option 3 has the shortest available length of road with a new junction access provided approximately 60m along the B946 from the A92 roundabout. However, the maximum queue length at the roundabout entry on the B946 is 4.3 vehicles in the 2015 PM Peak hour scenario. Assuming an average vehicle requires a length of 5m for queuing, then the total length of road required for stacking would be less than 22m. Since this is less than the 60m provided this is considered acceptable.

4.0 SUMMARY

4.1.1 Below is a summary of the findings from the previous sections:

Option 1

- Bus Park-and-Ride facilities are accommodated on the existing B946 Link Road;
- Provides the greatest car park surface area and maximises the spaces available;
- In comparison to the other options, limited earthworks are required to achieve the car parking area;
- However, this comes at the expense of significant engineering requirements to achieve the access road; and
- In addition, the traffic impacts on the A92/B946 Roundabout would reach unacceptable levels.

Option 2

- Provides the shortest direct access for buses from the B946 Link Road with space for a bus terminus building within the new car park area;
- However, the shortest route comes at the expense of increased earthworks with the greatest volume required to be removed from site;
- The significant volume of earthworks required results in the highest cost per space of all the options; and

- There are no significant traffic impacts on the A92/B946 roundabout.

Option 3

- Requires the lowest volume of earthworks for the access road;
- Provides all the facilities of Option 2 at the lowest cost per space;
- Route into the Park-and-Ride site is twice as long as Option 2; and
- There are no significant traffic impacts on the A92/B946 roundabout.

4.1.2 Comparing the findings noted above, Option 3 provides a Park-and-Ride facility significantly greater than the minimum 400 spaces required and results in the least capital cost outlay per space of all the three options. It also has no significant traffic impact on the A92/B946 roundabout.

4.1.3 It should be noted that earthworks is a significant element in the cost of all the options. Currently there is insufficient ground investigation information available to accurately determine the type of material that will be encountered. The lack of this information makes it particularly difficult to accurately estimate the cost of the project at this time. This will need to be considered during the detailed design in the following stages of the study.

4.1.4 Regarding the fourth option (access directly from the A92 roundabout) discussed at the presentation to the client group, at the time of writing this note no feedback from Transport Scotland has been received on whether this potential option would be acceptable.

Appendix A – Outline Sketch Plans of the Options

Revision Details	By / Check	Date	Suffix

Drawing Status
INFORMATION

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Job Title
SOUTH TAY PARK AND RIDE

Drawing Title
CAR PARK LAYOUT AND ACCESS ROAD OPTION 1

Scale at A1 1:500		
Drawn IMACP	Checked TAT	Approved SGJS
Date 23/11/09	Date 23/11/09	Date 30/11/09

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Rev -

Plot Date :
AutoCAD File Name :
DB1H

Revision Details	By / Check	Date	Suffix

Drawing Status: INFORMATION

Job Title: SOUTH TAY PARK AND RIDE

Drawing Title: CAR PARK LAYOUT AND ACCESS ROAD OPTION 2

Scale at A1		
1:500		
Drawn	Checked	Approved
IMACP	TAT	SGJS
Date	Date	Date
23/11/09	23/11/09	30/11/09

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AutoCAD File Name :
DB1H

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Job Title: SOUTH TAY PARK AND RIDE

Drawing Title: CAR PARK LAYOUT AND ACCESS ROAD OPTION 3

Scale at A1		
1:500		
Drawn	Checked	Approved
IMACP	TAT	SGJS
Date	Date	Date
23/11/09	23/11/09	30/11/09

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Drawing Number: S106888/SK/003 Rev: -

Plot Date :
AutoCAD File Name :
DB1H

Appendix C

Engineering Layout

Notes:

Car Park Surface area = 11678.4m^2

No. of spaces = 458

Area per space = 25.5m^2

1. Street lighting design to achieve nominal lighting levels using reduced height poles to minimise visual impact

Revision Details	By / Check	Date	Suffix
Bus turning area revised	MACP / SJGS	11.02.10	A

Drawing Status: INFORMATION

Job Title: SOUTH TAY PARK AND RIDE

Drawing Title: OPTION 3C CAR PARK LAYOUT

Scale at A1		
1:500		
Drawn: IMACP	Checked: TAT	Approved: SJGS
Date: 15/01/10	Date: 15/01/10	Date: 15/01/10

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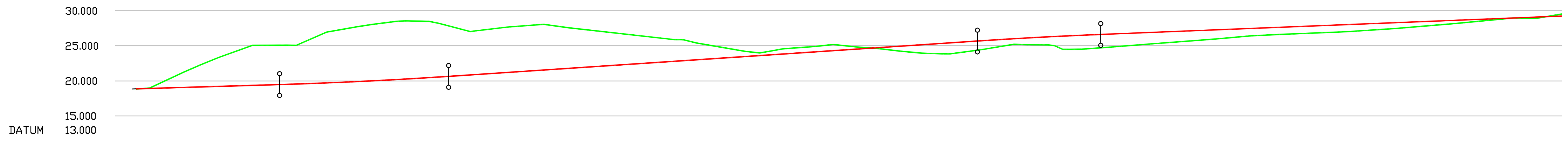
Drawing Number: S106888/SK/012 Rev: A

Plot Date :
AutoCAD File Name :

DB1H

Notes:
1. For section locations refer to Drawing No. S106888-SK-007.



CHAINAGE	EXISTING GROUND LEVEL	ALIGNMENT LEVEL
0.000	18.844	18.875
1.758		
10.000	22.671	19.175
20.000	25.102	19.475
20.399		19.487
25.000		19.642
30.000	27.504	19.846
31.226		
33.311		
35.000		20.089
40.000	28.572	20.371
44.449		20.654
50.000	27.375	21.026
57.534		
60.000	27.800	21.696
70.000	26.635	22.366
80.000	25.370	23.036
90.000	24.215	23.706
90.535		
100.000	25.095	24.376
110.000	24.117	25.046
119.706		25.696
120.000	24.422	25.716
125.000		26.029
130.000	25.115	26.304
135.000		26.541
137.256		26.635
138.938		
140.000	24.934	26.745
150.000	25.710	27.145
151.934		
160.000	26.498	27.545
162.914		
170.000	26.935	27.945
180.000	27.542	28.345
190.000	28.410	28.745
200.000	29.055	29.145
202.866	29.553	29.259

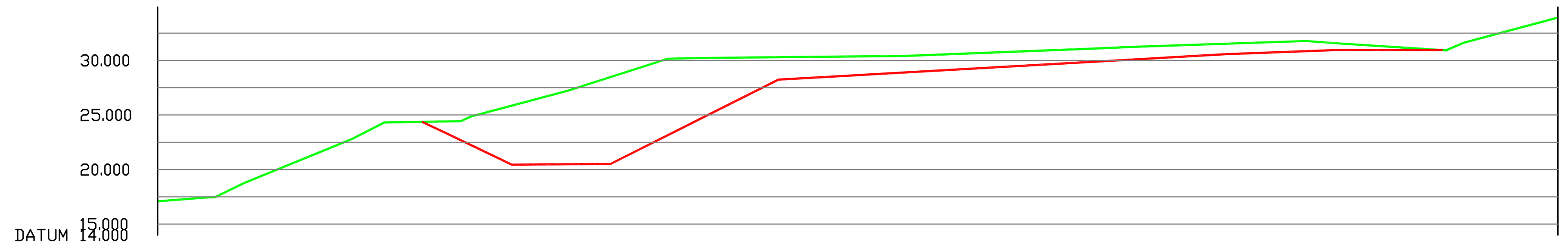
VERTICAL ALIGNMENT: G= 3.000% 1: 33.3 | KF= 6.50 L= 24.050 | G= 6.700% 1: 14.9 | L= 17.550 KF= -6.50 | G= 4.000% 1: 25.0

HORIZONTAL ALIGNMENT: R= 30.000 | R= 30.000 | R= 45.000 | R= 30.000

SECTION A-A

CHAINAGE	EXISTING LEVEL	PROPOSED LEVEL
0.000	23.703	
10.000	23.597	
20.000	26.599	
30.000	27.811	
33.129		28.295
40.000	28.762	29.429
50.000	29.420	29.415
60.000	29.977	29.402
70.000	30.434	29.389
80.000	30.690	29.376
90.000	30.823	29.279
100.000	30.880	29.419
110.000	30.925	29.701
120.000	30.814	29.522
130.000	30.597	29.290
140.000	30.371	29.061
150.000	30.121	28.832
160.000	29.863	28.604
170.000	29.452	28.416
180.000	29.026	28.230
190.000	28.496	28.044
196.952		28.139
200.000	28.052	
210.000	27.782	
213.407		27.698
220.000	27.484	28.479
230.000	27.156	28.319
233.944		27.071
240.000	27.004	
241.827	26.983	

SECTION B-B



CHAINAGE	EXISTING LEVEL	PROPOSED LEVEL
0.000	17.088	
10.000	19.604	
20.000	23.905	
24.249		24.371
30.000	25.191	21.645
40.000	27.977	20.500
40.2[illegible]		
50.000	30.216	24.752
60.000	30.328	28.410
61.120		
70.000	30.465	28.978
80.000	30.855	29.546
90.000	31.258	30.115
100.000	31.597	30.643
110.000	31.448	30.950
117.794		30.947
120.000	31.664	
128.463	33.876	

SECTION C-C

Revision Details	By / Check	Date	Suffix
Long Section A-A revised	RM / TAT	21/12/09	B
Long Section A-A revised, note updated & retention removed from Section C-C.	IMACP / TAT	15.12.09	A

Drawing Status: INFORMATION

Job Title: SOUTH TAY PARK AND RIDE

Drawing Title: CAR PARK LAYOUT AND ACCESS ROAD OPTION 3 LONG SECTION AND CROSS SECTIONS

Scale at A1		
1:500		
Drawn: IMACP	Checked: TAT	Approved: SGJS
Date: 08/12/09	Date: 08/12/09	Date: 08/12/09

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Plot Date :
AutoCAD File Name :

Revision Details	By / Check	Date	Suffix

Drawing Status
INFORMATION

Job Title
SOUTH TAY PARK AND RIDE

Drawing Title
OPTION 3C CAR PARK LAYOUT DRAINAGE STRATEGY

Scale at A1		
1:500		
Drawn: IMACP/AF	Checked: TAT	Approved
Date: 05/01/10	Date: 05/01/10	Date

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Drawing Number: S106888/SK/011
Rev: -

DB1H

South Tay Park-and-Ride Project Detailed Cost Table

Item	Measure	Unit	Unit Rate	Cost Estimate
ACCESS ROAD				
Site Clearance		Allow	Sum	£3,500.00
Earthworks (rock)	4,065	m³	£45.00	£182,938.50
Earthworks (non rock including offsite disposal)	9,486	m³	£17.50	£165,999.75
Capping	1,110	m²	£7.84	£8,702.40
Sub-base	1,586	m²	£3.10	£4,916.60
Base course	1,586	m²	£10.12	£16,050.32
Binder course	1,586	m²	£8.49	£13,465.14
Surface course	1,586	m²	£9.33	£14,797.38
Friction Surfacing	500	m²	£5.00	£2,500.00
Kerbing & Traffic islands		Allow	Sum	£5,000.00
Road marking & signage		Allow	Sum	£10,000.00
Drainage	1,586	m²	£7.47	£11,847.42
Footways	384.4	m²	£21.50	£8,264.60
Fencing and street furniture		Allow	Sum	£5,000.00
Street lighting	1,586	m²	£5.00	£7,930.00
Utilities diversions/protection		Allow	Sum	£10,000.00
Reinstatement		Allow	Sum	£1,500.00
Traffic Management		Allow	Sum	£9,000.00
ACCESS ROAD SUB TOTAL				**£481,412.11**
CAR PARK				
Site clearance		Allow	Sum	£5,000.00
Earthworks (Topsoil)	4,704	m³	£1.10	£5,174.40
Earthworks (non rock including offsite disposal)	15,477	m³	£17.50	£270,847.50
Capping (Internal roads)	13,442	m²	£7.84	£105,385.28
Sub-base (Internal roads)	6,137	m²	£3.10	£19,024.70
Base course (Internal roads)	6,137	m²	£10.12	£62,106.44
Binder course (Internal roads)	6,137	m²	£8.49	£52,103.13
Surface course (Internal roads)	6,137	m²	£9.33	£57,258.21
Impermeable Membrane (Permeable paving)	7,304	m²	£3.53	£25,783.12
Crushed Rock (Permeable paving)	7,304	m²	£7.34	£53,611.36
Non-woven Textile (Permeable paving)	7,304	m²	£1.31	£9,568.24
Laying course & paving (Permeable paving)	7,304	m²	£20.49	£149,658.96
Topsoiling		Allow	Sum	£3,500.00
Kerbing & Traffic islands		Allow	Sum	£30,000.00
Drainage (Pipes and Chambers)	12,467	m²	£7.47	£93,128.49
Drainage (Attenuation Works)	12,467	m²	£7.03	£87,643.01
Drainage (Ditches and surface features)	12,467	m²	£0.32	£3,989.44
Footways	573.41	m²	£21.50	£12,328.32
Fencing	600	m	£87.48	£52,488.00
Road marking & signage		Allow	Sum	£10,000.00
Street lighting	11,023	m²	£5.00	£55,115.00
Existing Utilities protection		Allow	Sum	£10,000.00
Utilities ducting		Allow	Sum	£35,000.00
CCTV Ducting & ancillary works		Allow	Sum	£75,000.00
CAR PARK SUB TOTAL				**£1,283,713.60**
TERMINAL BUILDING				
Budget Cost				£75,000.00
Infrastructure Costs Subtotal				**£1,840,125.71**
OTHER COSTS				
Land Purchase				£30,988.00
Landscaping				£51,266.00
Allow Contractors Prelims	20%			£368,025.14
Contingency	15%			£343,561
TOTAL BASE COST + CONTINGENCY				**£2,633,965.57**

Appendix D

Landscaping Layout Plan and Cost Estimates

Landscape Note

South Tay Park and Ride Scheme, Newport-on-Tay, Fife

1. Introduction

Scott Wilson landscape architects have been commissioned to prepare a landscape scheme to surround the new car park and help to reduce its impact on the local area, most significantly the visual impact.

The landscape assessment and proposals are based on the engineer's layout drawing number S106888/SK/010 option 3C.

2. Site Description

The proposed location of the car park and associated bus terminus is within an area of rolling green fields close to the working farm at Northfield. The site is bordered to the west by the A92 local trunk road which connects Dundee to Glenrothes, and beyond that homes within Newport-on-Tay. North west of the site the A92 passes onto the Tay Road Bridge, and users of the bridge travelling southbound across the river currently have clear views across the roundabout into the proposed site. Immediately north of the site runs the B946, a local road connecting the A92 with the Tay riverside and Newport-on-Tay and provides access to the Tay Bridge Picnic area and kiosk opposite the proposed site entrance.

Both the A92 and B946 are within cuttings approximately 9m below the level of the proposed car park. The banks of the cuttings are populated with a mix of trees and shrubs and in some areas open grassy banks.

East of the site lies the farm within green fields. South of the proposed site the ground rises significantly, the land use is largely open green fields with rocky outcrops, patches of shrubby growth and small areas of woodland, on the horizon there is a large mast.

There appear to be no specific landscape or conservation designations which impact upon the site. The 'Fife Local Landscape Designation Review' document prepared for Fife Council by Land Use Consultants in November 2008 identified the area as character area CH63 part of the coastal hills and described it by saying *'These open sloping fields have strong association with the Tay, however they are not highly distinctive in character and are partially fragmented by land use. This landscape is visually detached from the hills to the south…'.* Overall the Report described this coastal strip as '… important in providing setting for settlement and is important in relation to other landscape units.' In the Landscape Enhancement Study for Newport and Wormit in 2004, the area around the bridge head identifies key opportunities for landscape enhancement, through the management of grassland and scrub as habitat for wildlife, and work to field boundaries through planting of trees and hedges to re-establish the rural character of the landscape.

3. Impact of the development

Ecological Impact
The nature of the site as open grassed fields has only minimal landscape value in terms of ecology. The tree belt alongside the B946 on the bank of the cutting is populated by a mix of tree and shrub species which act as a screen to the nearby farm, help to stabilise the bank and provide colour and interest to passing motorists.

Construction of the access road will impact upon this established tree belt and will result in the loss of an area of at least 40m x 12m. In terms of vegetation this loss can easily be mitigated by establishment of new belt planting around the development. However, the tree belt may be home to nesting birds, therefore we would recommend a full ecological survey be undertaken prior to commencement of any works, and that any tree clearance works be undertaken outside the bird nesting season.

Peripheral areas of the site may also be developed as valuable habitat for native plants and wildlife, and increase the number of species found on the site.

Landscape Impact
The impact of the development on the character of the local area would be relatively small with appropriate mitigation works. The footprint of the development falls within the area of one field and therefore would cause only a minor impact on the pattern of field boundaries. Screen planting could easily be accommodated around the site to reflect the existing corridor planting alongside the A92 and B946, and small clusters of woodland and shrub growth further up the hill. Creation of the access road is expected to involve exposure of the bed rock this will appear stark at first but once colonised by grasses and wildflowers it will reflect the exposed rock slopes on the hillside above the site.

Visual Impact
The landscape impact of the development is largely visual. Key viewpoints into the site will be from:

- Tay Road Bridge
- Tay Road Bridge Picnic Area and Car Park
- Houses in Newport on Tay (Spearshill Road, Elizabeth Crescent and Northfield Road)
- A92 northbound approaching the roundabout
- B946 in both directions for views of access road

Most significantly affected will be passing road users, particularly those using the Tay Road Bridge, some picnic site users and the residents of Spearshill Road, Elizabeth Crescent and Northfield Road in Newport on Tay. More distant views from the River and Dundee on the north shore may also discern the glistening of vehicle roofs on a sunny day. Screen planting could diminish the effects of the development on all of these low level views.

The development will be clearly visible from the hillside above the site, however there are no marked footpaths or tracks from where the site will be visible. The only receptors above the site will be those people operating and servicing the mast at the crest of the hill.

4. Mitigation of Impact

The visual effects of the new park and ride facility can be easily mitigated through landscape enhancement of the site. A considered area of tree and shrub planting within and around the car park will screen the park and ride facility from passing motorists and local residents, and replace the trees lost through creation of the new access road. Green areas around the site can be designed to increase biodiversity and create habitat for local species of plants and wildlife, for example wildflower planting, or installation of bird and bat boxes.

It is proposed to use a mix of native tree and shrub species from a local source to create a strong screening belt around the car park. This mix will reflect the species already found in and around the site and will help to settle the development within the existing landscape. Planting will be used to reinforce the existing tree belt along the northern face of the site and infill the gaps at the north west corner near the roundabout and along the western face which is currently maintained as part of the highway verge. Some mature specimens will be planted in key locations to provide an instant impact while the main planting groups become established.

Prior to commencement of any works, it may be possible to undertake some of the mitigation planting to the north west corner of the site. This would enable the tree belt to become established and begin to form a useful screen, in advance of any works. Early establishment of the screen would also reduce the impact of the development during construction.

5. Proposals

Landscape Planting and Screening
The proposed tree and shrub species for screening are developed from the National Vegetation Classification for Woodlands which identifies this area as type W8 – Lowland mixed broadleaved woodland with dog's mercury.

	Latin Name	Common Name	Percentage Mix
Major Species	Crataegus monogyna	Hawthorn	10%
	Corylus avellana	Hazel	10%
	Fraxinus excelsior	Ash	15%
	Quercus robur	Oak	20%
Minor Species	Betula pendula	Silver Birch	10%
	Betula pubescens	Downy Birch	5%
	Ilex aquifolium	Holly	5%
	Malus sylvestris	Crab Apple	5%
	Prunus spinosa	Blackthorn	5%
	Salix caprea	Goat Willow	5%
	Sambucus nigra	Elder	5%
	Viburnum opulus	Guelder Rose	5%

A mix of tree and shrub sizes should be incorporated into the screening belt and should include some more mature specimens for instant impact. Standard trees (Field Maple, Willow and Oak) should be located along the northern and western boundaries and staked during the first 3 years to provide support in this exposed location.

Ornamental Car Park Planting
Within the car park incidental areas will be planted with a groundcover carpet of three different ivy species interspersed with feature trees. The following species of Sorbus and field maple have been chosen for their compact lollipop shape.

	Latin Name	Common Name	Percentage Mix
Feature Trees	Acer campestre 'Streetwise'	Field Maple	50%
	Sorbus thuringiaca 'Fastigiata'	Hybrid Service Tree	50%
Groundcover Planting	Hedera helix	Ivy	40%
	Hedera helix 'Little Diamond'	Ivy	30%
	Hedera helix 'Jester's Gold	Ivy	30%

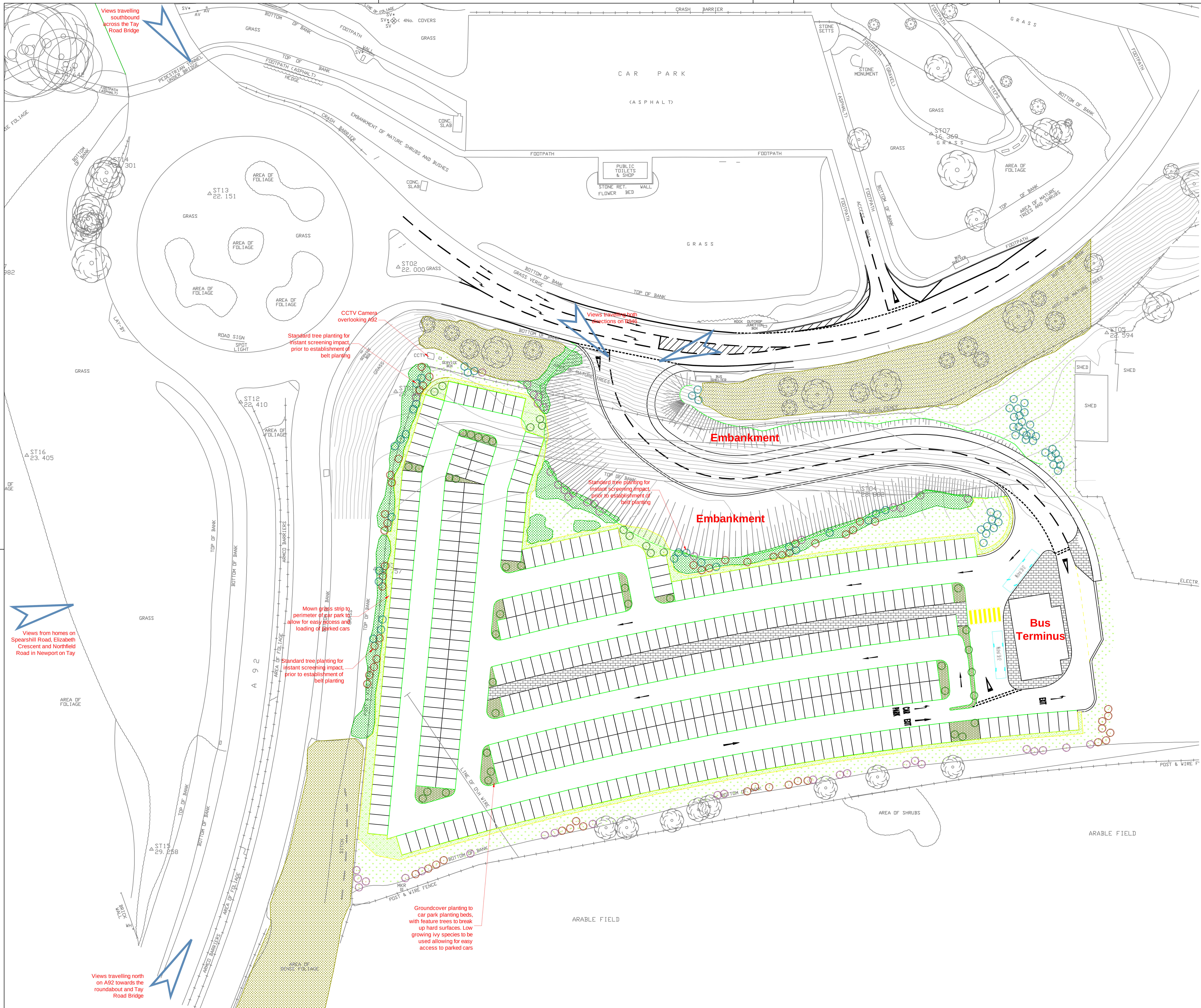
Grassland
Two different grass seed mixes will be used for the area surrounding the car park. We propose a traditional grass mix for the edge of the car park to be regularly mown allowing car park users easy access for loading. The majority of the grassland areas should be seeded with a wildflower mix incorporating a variety of grasses and wild flowers, to provide a potential habitat for wildlife.

6. Recommendations

The proposed landscape layout for the site incorporating screening and opportunities for ecological development as described above, can be found at the end of this note.
Please note that landscape treatment of the access road embankment should be considered following further site investigation and detailed design of the slope.

In addition to the proposed landscape works we recommend the following surveys be undertaken prior to a final design being prepared:

- Tree Survey – under policy E25 of the new St Andrew's and East Fife local plan the developer would be required to undertake a full tree survey.
- Ecological survey of the tree belt to establish the presence of any nesting birds and/or that tree clearance works should be undertaken outside the bird nesting season.



KEY

Existing Tree Belt
Existing dense tree belt to road embankments with varied species mix including, birch and oak.

Proposed Screen Planting
New tree and shrub planting to site perimeter to screen views and gap up existing perimeter planting, species mix to include, birch, oak, hawthorn and holly.

Standard Tree Planting
Standard tree planting to north west corner to provide some instant screening during establishment of the shelter belt.

Acer campestre

Betula pendula

Quercus ilex

Groundcover Planting with Feature Trees
Ivy carpet groundcover planting with feature trees Acer campestre 'Streetwise' and Sorbus thuringiaca 'Fastigiata'.

Grassland/Wildflower Areas
New grassland habitat to be managed for wildlife habitat. Grass mix to be chosen from local source, and to include local wildflower and grass species.

Mown Grass Edge Strip
1m strip to edge of car park to be close mown for easy access to parked cars. Mix to be chosen from local source, with low rye grass content.

Key Viewpoints
Location of key views into the site which require mitigation to reduce the impact.

Embankment
Landscape treatment to be determined following detailed investigation and design of landform.

PLANTING NOTES

Site Clearance - Landscape areas to be cleared of all rubbish and debris. All weeds to be sprayed 3 weeks prior to planting works and cleared from the site. Hand digging only within 2m of existing trees and shrubs to be retained. All green material removed from site to be shredded and composted at a local facility.

Cultivation - All shrub areas shall be hand dug or rotavated to 200mm minimum depth, graded to even falls and all stones in excess of 50mm diameter removed to tip. Hand digging only within 2m of existing trees and shrubs. Ornamental shrub beds to have well composted Forest Bark or similar approved incorporated at time of rotovation at a rate of 1 No 80L bag per 2m².

Excavation of Planting Pits - Planting pits for standard trees - (1000 x 1000 x 750mm) and backfill with topsoil and a well composted Forest Bark or similar approved in a 3:1 volume mix, topsoil to bark. The Contractor is solely responsible for the location of all services and drains within the working areas. The Contractor shall comply with any special requirements of utility companies and the local authority to protect services and drains. Planting pits for whips and transplants to be 300 x 300 x 300mm) and backfilled with topsoil and a well composted Forest Bark or similar approved material in a 3:1 ratio.

Plant Stock - All plants shall be supplied as indicated on the schedule attached. They shall be free from pests and diseases, hardy, good evenly branched specimens with healthy, extensive fibrous root systems. Plants shall be delivered to site in numbers that ensure all can be planted within a working day. All plants shall be watered before and immediately after planting. All plants stored on site shall have root protection and prevented from drying out. Backfill shall consist of a 3:1 volume mixture of topsoil to well composted forest bark, and shall be gently firmed around the roots. On planting the stock shall receive the following volumes of water, standard trees: 27litres (6 gallon), whips and transplants 4.5 litres (1 gallon).

Standard trees to be container grown, 10-12cm girth with 1.8m clear stem. Each tree shall, according to species, have a well defined, straight, central leader and well balanced branching crown with branches growing out from the stem in reasonable symmetry.

Whips and transplants to be supplied bare root, with good fibrous roots and thriving well-balanced shoots.

Ivy plants to be container grown with good fibrous roots and thriving well-balanced shoots. Canes to be removed.

Stakes and Ties - Standard trees should be double staked and tied. Trees should be placed centrally in the pit with stakes placed either side (stake size minimum 1800mm 75mm diameter). Stakes should be sawn off to approx third of the length of clear stem height of the tree. 2 No reinforced tree ties 50mm width should be used to secure the tree 50mm below the tops of the stakes.

Mulch - All ornamental shrub planting areas and tree pits (to 500mm dia) to be spread with well composted medium grade Forest bark or similar approved. Mulch depth to be 50mm after settlement.

Ground Preparation - Grassed areas shall be cultivated, and the surface lightly and uniformly firmed and reduced to a fine tilth up to 25mm in depth. During cultivation works, all stones exceeding 20mm in diameter, roots and other extraneous matter shall be collected and removed from site to tip. All weeds shall be removed by hand.

Grass Seeding
Supply and sow grass seed mixtures including for broadcasting of seed by hand, raking into surface and lightly rolling. Overseeding to be undertaken 2-3 months following the initial seeding to fill any gaps and bare patches.
Seed mixes:
Mown Grass Edges - A18 for Motorway and Road Verges as supplied by British Seed Houses (or similar approved) at 20gm/m²
Grassland/Wildflower Areas - RE9 Farmland Mixture as supplied by British Seed Houses (or similar approved) at 5gm/m².

Watering - On completion of the seeding, the Contractor shall lightly water the area at a rate of 5 litres per square metre with fine sprinklers or sprays so as to avoid washing the soil or seed away.

Maintenance - Duration 3 years after Practical Completion. Allow for monthly visits during each growing season to include the following:

- Hand weed shrub areas
- Collect litter and other debris during course of weeding and remove to tip.
- Attend to stakes and ties and refirm plants as necessary.
- Prune plant material as necessary to encourage healthy plant growth and good shape.
- Water all stock on 5 no occasions during the first growing season. Contractor to use discretion as to watering requirement depending on rainfall. Apply water at a rate of 54 litres per standard tree and 4.5 litres for all shrubs.
- Check all plant material for signs of damage by pests and disease and take appropriate action when required.
- Cut all grassed edge areas as necessary to maintain a grass sward of 25mm in height
- At end of growing season replace failed stock and top up mulch where necessary.
- Remove tree stakes from screen belt following the second year.
- Remove tree stakes from ornamental planting at end of maintenance period.

PROPOSED PLANTING MIX

	Latin Name	Common Name	Percentage Mix	Specification	Notes
Screen Planting Belt					
Major Species	Crataegus monogyna	Hawthorn	10%	1+1, 40-60	Small feathers and whips to be planted in grid pattern 3 no per m².
	Corylus avellana	Hazel	10%	1+1, 40-60	
	Fraxinus excelsior	Ash	15%	1+1, 60-100	
	Quercus robur	Oak	20%	1+1, 60-100	
Minor Species	Betula pendula	Silver Birch	10%	1+1, 40-60	
	Betula pubescens	Downy Birch	5%	1+1, 40-60	
	Ilex aquifolium	Holly	5%	2 ltr pot, CG 40-60	
	Malus sylvestris	Crab Apple	5%	1+1, 40-60	
	Prunus spinosa	Blackthorn	5%	1+1, 40-60	
	Salix caprea	Goat Willow	5%	0+1, 60-100	
	Sambucus nigra	Elder	5%	1+1, 40-60	
	Viburnum opulus	Guelder Rose	5%	1+1, 40-60	
Standard Tree Planting					
Standard Trees	Acer campestre	Field Maple		10-12cm, RB	Standard trees to be planted as shown and staked
	Betula pendula	Willow		10-12cm, RB	
	Quercus ilex	Oak		10-12cm, RB	
Groundcover Planting with Feature Trees					
Feature Trees	Acer campestre 'Streetwise'	Field Maple	50%	14-16cm, RB	Standard trees to be planted as shown and staked
	Sorbus thuringiaca 'Fastigiata'	Hybrid Service Tree	50%	14-16cm, RB	
Groundcover Planting	Hedera helix	Ivy	40%	2 ltr pot, CG, 40-60	Ivy plants to be planted 5 per m² in groups of 3-9 to form a groundcover carpet
	Hedera helix 'Little Diamond'	Ivy	30%	2 ltr pot, CG, 40-60	
	Hedera helix 'Jester's Gold	Ivy	30%	2 ltr pot, CG, 40-60	

Revision Details | By / Check | Date | Suffix

Drawing Status: INFORMATION

Job Title: SOUTH TAY PARK AND RIDE

Drawing Title: OPTION 3C CAR PARK LAYOUT PROPOSED LANDSCAPE LAYOUT

Scale at A1: 1:500
Drawn: SLW | Checked | Approved
Date: 21/12/09 | Date | Date

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Scott Wilson Ltd
www.scottwilson.com

Drawing Number: S106888/SK/601 | Rev: -

Plot Date :
AutoCAD File Name :
DB1H

Cost Estimate Landscape Works

No	Description	Quantity	Unit	Rate	Total
	Site Preparation				
	PRIOR TO COMMENCEMENT OF WORKS - Erect protective fencing to surround existing planting areas to extent of root protection area	152	lin m	10	£1,520.00
	Remove all litter and debris, and stones in excess of 50mm diameter and remove to approved tip.	4600	m2	0.15	£690.00
	Cultivate and grade all landscape areas to tie in to surrounding kerb heights and existing planting areas.	4600	m2	3.50	£16,100.00
	Setting out of planting scheme	1	sum	200.00	£200.00
	Weedkill tree and shrub planting stations as per manufacturers instructions and at least three weeks prior to commencement of planting works.	2409	no	0.20	£481.80
	Standard Trees				
	Excavate tree pit 1000 x 1000 x 800mm including for storage of topsoil, supply select standard rootballed trees as specified, plant tree and backfill with 3:1 mixture topsoil to well rotted bark including Enmag fertiliser in accordance with the manufacturer's recommendations, grade surface to even falls including removal of debris in excess of 50mm, and stake with 2 no 1200mm posts and two no black rubber tree ties.				
	Acer campestre (10-12)	44	no	60.00	£2,640.00
	Acer campestre 'Streetwise' (14-16)	12	no	85.00	£1,020.00
	Betula pendula (10-12)	65	no	60.00	£3,900.00
	Quercus ilex (10-12)	54	no	60.00	£3,240.00
	Sorbus thuringiaca 'Fastigiata' (14-16)	22	no	85.00	£1,870.00
	Screen Belt Planting Mix				
	Excavate planting pit 300 x 300 x 300mm including for storage of topsoil, supply bare root plants as specified, plant shrub and backfill with 3:1 mixture topsoil to well rotted bark including Enmag fertiliser in accordance with the manufacturer's recommendations, grade surface to even falls including removal of debris in excess of 50mm				
	Major Species				
	Crataegus monogyna (1+1, 40-60)	225	no	1.60	£360.00
	Corylus avellana (1+1, 40-60)	225	no	1.80	£405.00
	Fraxinus excelsior (1+1, 60-100)	337	no	1.60	£539.20
	Quercus robur (1+1, 60-100)	450	no	1.60	£720.00
	To summary				£33,686.00

Cost Estimate Landscape Works

No	Description	Quantity	Unit	Rate	Total
	Screen Belt Planting Mix (Cont.)				
	Minor Species				
	Betula pendula (1+1, 40-60)	225	no	1.60	£360.00
	Betula pubescens (1+1, 40-60)	112	no	1.60	£179.20
	Ilex aquifolium (2 ltr pot, CG 40-60)	112	no	1.60	£179.20
	Malus sylvestris (1+1, 40-60)	112	no	1.80	£201.60
	Prunus spinosa (1+1, 40-60)	112	no	1.50	£168.00
	Salix caprea (0+1, 60-100)	112	no	2.00	£224.00
	Sambucus nigra (1+1, 40-60)	112	no	1.80	£201.60
	Viburnum opulus (1+1, 40-60)	112	no	1.60	£179.20
	Groundcover Planting Mix				
	Excavate planting pit 300 x 300 x 300mm including for storage of topsoil, supply plants as specified, plant shrub and backfill with 3:1 mixture topsoil to well rotted bark including Enmag fertiliser in accordance with the manufacturer's recommendations, grade surface to even falls including removal of debris in excess of 50mm				
	Hedera helix (2 ltr pot, CG, 40-60)	580	no	2.00	£1,160.00
	Hedera helix ‘Little Diamond’ (2 ltr pot, CG, 40-60)	435	no	2.00	£870.00
	Hedera helix ‘Jester’s Gold (2 ltr pot, CG, 40-60)	435	no	2.00	£870.00
	Grass Seeding				
	Grass seeding to cultivated areas by hand including pre-seeding fertiliser, and hand rake into the surface. To include a second visit for overseeding patchy areas to obtain dense coverage.				
	Mix 1 - Natural grassland areas	2170	m2	0.40	£868.00
	Mix 2 - Low maintenance mown edges	680	m2	0.40	£272.00
	Mulch				
	Supply and spread well compacted forest bark to tree planting stations to a depth of 50mm on settlement	24	m3	25.00	£600.00
	Supply and spread well compacted forest bark to ornamental shrub beds to a depth of 50mm on settlement	14	m3	25.00	£350.00
	To summary				£6,682.80

Cost Estimate Landscape Works

No	Description	Quantity	Unit	Rate	Total
	Maintenance				
	Undertake landscape maintenance of the site for 3 years following practical completion. Tasks to include the following: · Weeding of whip areas at least once per month. · Collect litter and other debris during course of weeding and remove to tip. · Check stakes and tree ties and refirm plants as necessary. · Prune plant material as necessary to encourage healthy plant growth and good shape. · Water all stock on 5 No. occasions during the first growing season during periods of low rainfall. · At end of the first growing season replace failed stock and reapply Enmag fertilizer. · Check all plant material for signs of damage by pests and disease and take appropriate action when required. · Cut grass areas when necessary to maintain a grass sward of between 25-75mm in height.				£2,000.00
	To summary				£2,000.00

Cost Estimate Landscape Works

No	Description	Quantity	Unit	Rate	Total
	Summary				
	Total from Page 1				£33,686.00
	Total from Page 2				£6,682.80
	Total from Page 3				£2,000.00
	Sub total				£42,368.80
	Preliminaries @ 10%				£4,236.88
	Sub total				£46,605.68
	Contingencies @ 10%				£4,660.57
	Grand total				£51,266.25

Appendix E

Junction Traffic Analysis Computer Printouts

A R C A D Y 6

ASSESSMENT OF ROUNDABOUT CAPACITY AND DELAY

Analysis Program: Release 5.0 (JANUARY 2009)

For sales and distribution information,
program advice and maintenance, contact:

TRL Limited Tel: +44 (0) 1344 770758
Crowthorne House Fax: +44 (0) 1344 770356
Nine Mile Ride Email: software@trl.co.uk
Wokingham, Berks. Web: www.trlsoftware.co.uk
RG40 3GA,UK

Run with file:-
"t:\MOU10 RJB\TrP\000 - Projects\SEStran Framework Agreement\South Tayside P&R\Modelling\Arcady\
South Tay Bridge Rdb ATC AM 2009.vai"
(drive-on-the-left) at 11:06:28 on Tuesday, 15 December 2009

.FILE PROPERTIES

RUN TITLE: South Tay Bridge Roundabout
LOCATION:
DATE: 25/11/09
CLIENT:
ENUMERATOR: gcornelis [UK1004173D]
JOB NUMBER:
STATUS:
DESCRIPTION:

.INPUT DATA

ARM A - North
ARM B - East
ARM C - South

.GEOMETRIC DATA

T5

ARM	V (M)	E (M)	L (M)	R (M)	D (M)	PHI (DEG)	SLOPE	INTERCEPT (PCU/MIN)
ARM A	7.20	7.20	0.00	40.00	75.60	15.0	0.599	39.142
ARM B	3.20	6.70	30.00	40.00	75.60	15.0	0.528	31.251
ARM C	6.80	6.80	0.00	60.00	75.60	15.0	0.584	37.247

V = approach half-width L = effective flare length D = inscribed circle diameter
E = entry width R = entry radius PHI = entry angle

.TRAFFIC DEMAND DATA

Only sets included in the current run are shown

.SCALING FACTORS

T13

ARM	FLOW SCALE(%)
A	100
B	100
C	100

TIME PERIOD BEGINS(06.45)AND ENDS(08.15)
.LENGTH OF TIME PERIOD -(90) MINUTES
.LENGTH OF TIME SEGMENT - (15) MINUTES

.DEMAND FLOW PROFILES ARE SYNTHESISED FROM THE TURNING COUNT DATA

.DEMAND SET TITLE: South Tay Bridge Roundabout (AM)

T15

ARM	NUMBER OF MINUTES FROM START WHEN FLOW STARTS TO RISE	TOP OF PEAK IS REACHED	FLOW STOPS FALLING	RATE OF FLOW (VEH/MIN) BEFORE PEAK	AT TOP OF PEAK	AFTER PEAK
ARM A	15.00	45.00	75.00	9.14	13.71	9.14
ARM B	15.00	45.00	75.00	5.06	7.59	5.06
ARM C	15.00	45.00	75.00	14.91	22.37	14.91

DEMAND SET TITLE: South Tay Bridge Roundabout (AM)

T33

TIME	FROM/TO	ARM A	ARM B	ARM C
		TURNING PROPORTIONS / TURNING COUNTS / (PERCENTAGE OF H.V.S)		
06.45 - 08.15				
	ARM A	0.000	0.209	0.791
		0.0	153.0	578.0
		(11.4)	(11.4)	(11.4)
	ARM B	0.859	0.000	0.141
		348.0	0.0	57.0
		(4.2)	(4.2)	(4.2)
	ARM C	0.974	0.026	0.000
		1162.0	31.0	0.0
		(5.7)	(5.7)	(5.7)

QUEUE AND DELAY INFORMATION FOR EACH 15 MIN TIME SEGMENT

T70

TIME	DEMAND	CAPACITY	DEMAND/	PEDESTRIAN	START	END	DELAY	GEOMETRIC DELAY	AVERAGE DELAY

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
06.45-07.00									
ARM A	9.17	34.92	0.263	- - -	0.0	0.4	5.2	-	0.039
ARM B	5.08	25.91	0.196	- - -	0.0	0.2	3.6	-	0.048
ARM C	14.97	32.73	0.457	- - -	0.0	0.8	12.2	-	0.056

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
07.00-07.15									
ARM A	10.95	34.87	0.314	- - -	0.4	0.5	6.8	-	0.042
ARM B	6.07	25.10	0.242	- - -	0.2	0.3	4.7	-	0.053
ARM C	17.87	32.24	0.554	- - -	0.8	1.2	18.0	-	0.069

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
07.15-07.30									
ARM A	13.41	34.81	0.385	- - -	0.5	0.6	9.2	-	0.047
ARM B	7.43	24.01	0.310	- - -	0.3	0.4	6.6	-	0.060
ARM C	21.89	31.56	0.694	- - -	1.2	2.2	31.7	-	0.102

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
07.30-07.45									
ARM A	13.41	34.81	0.385	- - -	0.6	0.6	9.4	-	0.047
ARM B	7.43	24.00	0.310	- - -	0.4	0.4	6.7	-	0.060
ARM C	21.89	31.56	0.694	- - -	2.2	2.2	33.4	-	0.103

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
07.45-08.00									
ARM A	10.95	34.87	0.314	- - -	0.6	0.5	7.0	-	0.042
ARM B	6.07	25.10	0.242	- - -	0.4	0.3	4.9	-	0.053
ARM C	17.87	32.23	0.555	- - -	2.2	1.3	19.5	-	0.070

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
08.00-08.15									
ARM A	9.17	34.91	0.263	- - -	0.5	0.4	5.4	-	0.039
ARM B	5.08	25.89	0.196	- - -	0.3	0.2	3.7	-	0.048
ARM C	14.97	32.72	0.457	- - -	1.3	0.8	13.0	-	0.056

.QUEUE AT ARM A

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE	
07.00	0.4	
07.15	0.5	
07.30	0.6	*
07.45	0.6	*
08.00	0.5	
08.15	0.4	

.QUEUE AT ARM B

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE
07.00	0.2
07.15	0.3
07.30	0.4
07.45	0.4
08.00	0.3
08.15	0.2

.QUEUE AT ARM C

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE	
07.00	0.8	*
07.15	1.2	*
07.30	2.2	**
07.45	2.2	**
08.00	1.3	*
08.15	0.8	*

.QUEUEING DELAY INFORMATION OVER WHOLE PERIOD

T75

ARM	TOTAL DEMAND (VEH)	TOTAL DEMAND (VEH/H)	* QUEUEING * * DELAY * (MIN)	* QUEUEING * * DELAY * (MIN/VEH)	* INCLUSIVE QUEUEING * * DELAY * (MIN)	* INCLUSIVE QUEUEING * * DELAY * (MIN/VEH)
A	1006.2	670.8	43.0	0.04	43.0	0.04
B	557.5	371.6	30.2	0.05	30.2	0.05
C	1642.1	1094.7	127.8	0.08	127.9	0.08
ALL	3205.7	2137.1	201.0	0.06	201.0	0.06

* DELAY IS THAT OCCURRING ONLY WITHIN THE TIME PERIOD.
* INCLUSIVE DELAY INCLUDES DELAY SUFFERED BY VEHICLES WHICH ARE STILL QUEUEING AFTER THE END OF THE TIME PERIOD.
* THESE WILL ONLY BE SIGNIFICANTLY DIFFERENT IF THERE IS A LARGE QUEUE REMAINING AT THE END OF THE TIME PERIOD.

END OF JOB

A R C A D Y 6

ASSESSMENT OF ROUNDABOUT CAPACITY AND DELAY

Analysis Program: Release 5.0 (JANUARY 2009)

For sales and distribution information,
program advice and maintenance, contact:

TRL Limited   Tel: +44 (0) 1344 770758
Crowthorne House   Fax: +44 (0) 1344 770356
Nine Mile Ride   Email: software@trl.co.uk
Wokingham, Berks.   Web: www.trlsoftware.co.uk
RG40 3GA,UK

Run with file:-
"t:\MOU10 RJB\TrP\000 - Projects\SEStran Framework Agreement\South Tayside P&R\Modelling\Arcady\
South Tay Bridge Rdb ATC PM 2009.vai"
(drive-on-the-left) at 11:07:11 on Tuesday, 15 December 2009

.FILE PROPERTIES
****

RUN TITLE: South Tay Bridge Roundabout
LOCATION:
DATE: 25/11/09
CLIENT:
ENUMERATOR: gcornelis [UK1004173D]
JOB NUMBER:
STATUS:
DESCRIPTION:

.INPUT DATA
****
ARM A - North
ARM B - East
ARM C - South

.GEOMETRIC DATA

T5

ARM	V (M)	E (M)	L (M)	R (M)	D (M)	PHI (DEG)	SLOPE	INTERCEPT (PCU/MIN)
ARM A	7.20	7.20	0.00	40.00	75.60	15.0	0.599	39.142
ARM B	3.20	6.70	30.00	40.00	75.60	15.0	0.528	31.251
ARM C	6.80	6.80	0.00	60.00	75.60	15.0	0.584	37.247

V = approach half-width   L = effective flare length   D = inscribed circle diameter
E = entry width   R = entry radius   PHI = entry angle

.TRAFFIC DEMAND DATA

Only sets included in the current run are shown

.SCALING FACTORS

T13

ARM	FLOW SCALE(%)
A	100
B	100
C	100

TIME PERIOD BEGINS(15.45)AND ENDS(17.15)
.LENGTH OF TIME PERIOD -(90) MINUTES
.LENGTH OF TIME SEGMENT - (15) MINUTES

.DEMAND FLOW PROFILES ARE SYNTHESISED FROM THE TURNING COUNT DATA

.DEMAND SET TITLE: South Tay Bridge Roundabout (PM)

T15

ARM	NUMBER OF MINUTES FROM START WHEN FLOW STARTS TO RISE	TOP OF PEAK IS REACHED	FLOW STOPS FALLING	RATE OF FLOW (VEH/MIN) BEFORE PEAK	AT TOP OF PEAK	AFTER PEAK
ARM A	15.00	45.00	75.00	16.27	24.41	16.27
ARM B	15.00	45.00	75.00	3.33	4.99	3.33
ARM C	15.00	45.00	75.00	10.44	15.66	10.44

DEMAND SET TITLE: South Tay Bridge Roundabout (PM)

T33

TIME	FROM/TO	ARM A	ARM B	ARM C
		TURNING PROPORTIONS TURNING COUNTS (PERCENTAGE OF H.V.S)		
15.45 - 17.15				
	ARM A	0.000	0.324	0.676
		0.0	422.0	880.0
		(2.8)	(2.8)	(2.8)
	ARM B	0.767	0.000	0.233
		204.0	0.0	62.0
		(5.0)	(5.0)	(5.0)
	ARM C	0.964	0.036	0.000
		805.0	30.0	0.0
		(6.6)	(6.6)	(6.6)

. QUEUE AND DELAY INFORMATION FOR EACH 15 MIN TIME SEGMENT

T70

TIME	DEMAND	CAPACITY	DEMAND/	PEDESTRIAN	START	END	DELAY	GEOMETRIC DELAY	AVERAGE DELAY

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
15.45-16.00									
ARM A	16.34	37.84	0.432	- - -	0.0	0.8	11.1	-	0.046
ARM B	3.34	24.07	0.139	- - -	0.0	0.2	2.4	-	0.048
ARM C	10.48	33.47	0.313	- - -	0.0	0.5	6.7	-	0.043
16.00-16.15									
ARM A	19.51	37.80	0.516	- - -	0.8	1.1	15.6	-	0.055
ARM B	3.99	22.95	0.174	- - -	0.2	0.2	3.1	-	0.053
ARM C	12.51	33.18	0.377	- - -	0.5	0.6	8.9	-	0.048
16.15-16.30									
ARM A	23.89	37.73	0.633	- - -	1.1	1.7	24.7	-	0.072
ARM B	4.88	21.43	0.228	- - -	0.2	0.3	4.3	-	0.060
ARM C	15.32	32.79	0.467	- - -	0.6	0.9	12.8	-	0.057
16.30-16.45									
ARM A	23.89	37.73	0.633	- - -	1.7	1.7	25.7	-	0.072
ARM B	4.88	21.41	0.228	- - -	0.3	0.3	4.4	-	0.061
ARM C	15.32	32.79	0.467	- - -	0.9	0.9	13.1	-	0.057
16.45-17.00									
ARM A	19.51	37.80	0.516	- - -	1.7	1.1	16.5	-	0.055
ARM B	3.99	22.93	0.174	- - -	0.3	0.2	3.2	-	0.053
ARM C	12.51	33.18	0.377	- - -	0.9	0.6	9.3	-	0.048
17.00-17.15									
ARM A	16.34	37.84	0.432	- - -	1.1	0.8	11.7	-	0.047
ARM B	3.34	24.05	0.139	- - -	0.2	0.2	2.5	-	0.048
ARM C	10.48	33.47	0.313	- - -	0.6	0.5	7.0	-	0.044

.QUEUE AT ARM A

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE	
16.00	0.8	*
16.15	1.1	*
16.30	1.7	**
16.45	1.7	**
17.00	1.1	*
17.15	0.8	*

.QUEUE AT ARM B

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE
16.00	0.2
16.15	0.2
16.30	0.3
16.45	0.3
17.00	0.2
17.15	0.2

.QUEUE AT ARM C

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE	
16.00	0.5	
16.15	0.6	*
16.30	0.9	*
16.45	0.9	*
17.00	0.6	*
17.15	0.5	

.QUEUEING DELAY INFORMATION OVER WHOLE PERIOD

T75

ARM	TOTAL DEMAND (VEH)	TOTAL DEMAND (VEH/H)	* QUEUEING * * DELAY * (MIN)	* QUEUEING * * DELAY * (MIN/VEH)	* INCLUSIVE QUEUEING * * DELAY * (MIN)	* INCLUSIVE QUEUEING * * DELAY * (MIN/VEH)
A	1792.1	1194.7	105.2	0.06	105.2	0.06
B	366.1	244.1	19.9	0.05	19.9	0.05
C	1149.3	766.2	57.7	0.05	57.7	0.05
ALL	3307.6	2205.0	182.8	0.06	182.9	0.06

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* THESE WILL ONLY BE SIGNIFICANTLY DIFFERENT IF THERE IS A LARGE QUEUE REMAINING AT THE END OF THE TIME PERIOD.

END OF JOB

Run with file:-
"t:\MOU10 RJB\TrP\000 - Projects\SEStran Framework Agreement\South Tayside P&R\Modelling\Arcady\
South Tay Bridge Rdb ATC AM 2015DN.vai"
(drive-on-the-left) at 11:13:41 on Tuesday, 15 December 2009

.FILE PROPERTIES
****

RUN TITLE: South Tay Bridge Roundabout - 2015 Do Nothing AM
LOCATION:
DATE: 25/11/09
CLIENT:
ENUMERATOR: gcornelis [UK1004173D]
JOB NUMBER:
STATUS:
DESCRIPTION:

.INPUT DATA
****
ARM A - North
ARM B - East
ARM C - South

.GEOMETRIC DATA

T5

ARM	V (M)	E (M)	L (M)	R (M)	D (M)	PHI (DEG)	SLOPE	INTERCEPT (PCU/MIN)
ARM A	7.20	7.20	0.00	40.00	75.60	15.0	0.599	39.142
ARM B	3.20	6.70	30.00	40.00	75.60	15.0	0.528	31.251
ARM C	6.80	6.80	0.00	60.00	75.60	15.0	0.584	37.247

V = approach half-width L = effective flare length D = inscribed circle diameter
E = entry width R = entry radius PHI = entry angle

.TRAFFIC DEMAND DATA

Only sets included in the current run are shown

.SCALING FACTORS

T13

ARM	FLOW SCALE(%)
A	100
B	100
C	100

TIME PERIOD BEGINS(06.45)AND ENDS(08.15)
.LENGTH OF TIME PERIOD -(90) MINUTES
.LENGTH OF TIME SEGMENT - (15) MINUTES

.DEMAND FLOW PROFILES ARE SYNTHESISED FROM THE TURNING COUNT DATA

.DEMAND SET TITLE: South Tay Bridge Roundabout (AM)

T15

ARM	NUMBER OF MINUTES FROM START WHEN FLOW STARTS TO RISE	TOP OF PEAK IS REACHED	FLOW STOPS FALLING	RATE OF FLOW (VEH/MIN) BEFORE PEAK	AT TOP OF PEAK	AFTER PEAK
ARM A	15.00	45.00	75.00	10.41	15.62	10.41
ARM B	15.00	45.00	75.00	5.78	8.66	5.78
ARM C	15.00	45.00	75.00	16.99	25.48	16.99

DEMAND SET TITLE: South Tay Bridge Roundabout (AM)

T33

TURNING PROPORTIONS / TURNING COUNTS / (PERCENTAGE OF H.V.S)

TIME	FROM/TO	ARM A	ARM B	ARM C
06.45 - 08.15				
	ARM A	0.000	0.210	0.790
		0.0	175.0	658.0
		(11.4)	(11.4)	(11.4)
	ARM B	0.859	0.000	0.141
		397.0	0.0	65.0
		(4.2)	(4.2)	(4.2)
	ARM C	0.974	0.026	0.000
		1324.0	35.0	0.0
		(5.7)	(5.7)	(5.7)

. QUEUE AND DELAY INFORMATION FOR EACH 15 MIN TIME SEGMENT

T70

TIME	DEMAND	CAPACITY	DEMAND/	PEDESTRIAN	START	END	DELAY	GEOMETRIC DELAY	AVERAGE DELAY

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
06.45-07.00									
ARM A	10.45	34.89	0.300	- - -	0.0	0.4	6.3	-	0.041
ARM B	5.80	25.34	0.229	- - -	0.0	0.3	4.3	-	0.051
ARM C	17.05	32.38	0.527	- - -	0.0	1.1	16.0	-	0.065

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
07.00-07.15									
ARM A	12.48	34.84	0.358	- - -	0.4	0.6	8.2	-	0.045
ARM B	6.92	24.43	0.283	- - -	0.3	0.4	5.8	-	0.057
ARM C	20.36	31.82	0.640	- - -	1.1	1.8	25.3	-	0.087

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
07.15-07.30									
ARM A	15.29	34.77	0.440	- - -	0.6	0.8	11.5	-	0.051
ARM B	8.48	23.18	0.366	- - -	0.4	0.6	8.4	-	0.068
ARM C	24.94	31.05	0.803	- - -	1.8	3.9	53.4	-	0.156

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
07.30-07.45									
ARM A	15.29	34.77	0.440	- - -	0.8	0.8	11.7	-	0.051
ARM B	8.48	23.17	0.366	- - -	0.6	0.6	8.6	-	0.068
ARM C	24.94	31.04	0.803	- - -	3.9	4.0	59.1	-	0.163

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
07.45-08.00									
ARM A	12.48	34.84	0.358	- - -	0.8	0.6	8.5	-	0.045
ARM B	6.92	24.42	0.283	- - -	0.6	0.4	6.1	-	0.057
ARM C	20.36	31.81	0.640	- - -	4.0	1.8	28.5	-	0.090

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
08.00-08.15									
ARM A	10.45	34.89	0.300	- - -	0.6	0.4	6.5	-	0.041
ARM B	5.80	25.33	0.229	- - -	0.4	0.3	4.5	-	0.051
ARM C	17.05	32.37	0.527	- - -	1.8	1.1	17.3	-	0.066

.QUEUE AT ARM A

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE	
07.00	0.4	
07.15	0.6	*
07.30	0.8	*
07.45	0.8	*
08.00	0.6	*
08.15	0.4	

.QUEUE AT ARM B

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE	
07.00	0.3	
07.15	0.4	
07.30	0.6	*
07.45	0.6	*
08.00	0.4	
08.15	0.3	

.QUEUE AT ARM C

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE	
07.00	1.1	*
07.15	1.8	**
07.30	3.9	****
07.45	4.0	****
08.00	1.8	**
08.15	1.1	*

.QUEUEING DELAY INFORMATION OVER WHOLE PERIOD

T75

ARM	TOTAL DEMAND (VEH)	TOTAL DEMAND (VEH/H)	* QUEUEING * * DELAY * (MIN)	* QUEUEING * * DELAY * (MIN/VEH)	* INCLUSIVE QUEUEING * * DELAY * (MIN)	* INCLUSIVE QUEUEING * * DELAY * (MIN/VEH)
A	1146.6	764.4	52.8	0.05	52.8	0.05
B	635.9	423.9	37.8	0.06	37.8	0.06
C	1870.6	1247.0	199.6	0.11	199.6	0.11
ALL	3653.0	2435.4	290.2	0.08	290.2	0.08

* DELAY IS THAT OCCURRING ONLY WITHIN THE TIME PERIOD.
* INCLUSIVE DELAY INCLUDES DELAY SUFFERED BY VEHICLES WHICH ARE STILL QUEUEING AFTER THE END OF THE TIME PERIOD.
* THESE WILL ONLY BE SIGNIFICANTLY DIFFERENT IF THERE IS A LARGE QUEUE REMAINING AT THE END OF THE TIME PERIOD.

END OF JOB

Run with file:-
"t:\MOU10 RJB\TrP\000 - Projects\SEStran Framework Agreement\South Tayside P&R\Modelling\Arcady\
South Tay Bridge Rdb ATC PM 2015DN.vai"
(drive-on-the-left) at 11:22:47 on Tuesday, 15 December 2009

.FILE PROPERTIES
****

RUN TITLE: South Tay Bridge Roundabout - 2015 Do Nothing PM
LOCATION:
DATE: 25/11/09
CLIENT:
ENUMERATOR: gcornelis [UK1004173D]
JOB NUMBER:
STATUS:
DESCRIPTION:

.INPUT DATA
****
ARM A - North
ARM B - East
ARM C - South

.GEOMETRIC DATA

T5

ARM	V (M)	E (M)	L (M)	R (M)	D (M)	PHI (DEG)	SLOPE	INTERCEPT (PCU/MIN)
ARM A	7.20	7.20	0.00	40.00	75.60	15.0	0.599	39.142
ARM B	3.20	6.70	30.00	40.00	75.60	15.0	0.528	31.251
ARM C	6.80	6.80	0.00	60.00	75.60	15.0	0.584	37.247

V = approach half-width L = effective flare length D = inscribed circle diameter
E = entry width R = entry radius PHI = entry angle

.TRAFFIC DEMAND DATA

Only sets included in the current run are shown

.SCALING FACTORS

T13

ARM	FLOW SCALE(%)
A	100
B	100
C	100

TIME PERIOD BEGINS(15.45)AND ENDS(17.15)
.LENGTH OF TIME PERIOD -(90) MINUTES
.LENGTH OF TIME SEGMENT - (15) MINUTES

.DEMAND FLOW PROFILES ARE SYNTHESISED FROM THE TURNING COUNT DATA

.DEMAND SET TITLE: South Tay Bridge Roundabout (PM)

T15

ARM	NUMBER OF MINUTES FROM START WHEN: FLOW STARTS TO RISE	TOP OF PEAK IS REACHED	FLOW STOPS FALLING	RATE OF FLOW (VEH/MIN): BEFORE PEAK	AT TOP OF PEAK	AFTER PEAK
ARM A	15.00	45.00	75.00	18.54	27.81	18.54
ARM B	15.00	45.00	75.00	3.79	5.68	3.79
ARM C	15.00	45.00	75.00	11.89	17.83	11.89

DEMAND SET TITLE: South Tay Bridge Roundabout (PM)

T33

TURNING PROPORTIONS / TURNING COUNTS / (PERCENTAGE OF H.V.S)

TIME	FROM/TO	ARM A	ARM B	ARM C
15.45 - 17.15				
	ARM A	0.000	0.324	0.676
		0.0	481.0	1002.0
		(2.8)	(2.8)	(2.8)
	ARM B	0.766	0.000	0.234
		232.0	0.0	71.0
		(5.0)	(5.0)	(5.0)
	ARM C	0.964	0.036	0.000
		917.0	34.0	0.0
		(6.6)	(6.6)	(6.6)

. QUEUE AND DELAY INFORMATION FOR EACH 15 MIN TIME SEGMENT

T70

I TIME DEMAND CAPACITY DEMAND/ PEDESTRIAN START END DELAY GEOMETRIC DELAY AVERAGE DELAY I

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
15.45-16.00									
ARM A	18.61	37.81	0.492	- - -	0.0	1.0	14.1	-	0.052
ARM B	3.80	23.28	0.163	- - -	0.0	0.2	2.9	-	0.051
ARM C	11.93	33.27	0.359	- - -	0.0	0.6	8.2	-	0.047

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
16.00-16.15									
ARM A	22.22	37.76	0.588	- - -	1.0	1.4	20.7	-	0.064
ARM B	4.54	22.01	0.206	- - -	0.2	0.3	3.8	-	0.057
ARM C	14.25	32.94	0.433	- - -	0.6	0.8	11.2	-	0.053

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
16.15-16.30									
ARM A	27.21	37.69	0.722	- - -	1.4	2.5	36.3	-	0.094
ARM B	5.56	20.28	0.274	- - -	0.3	0.4	5.5	-	0.068
ARM C	17.45	32.49	0.537	- - -	0.8	1.1	16.8	-	0.066

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
16.30-16.45									
ARM A	27.21	37.69	0.722	- - -	2.5	2.6	38.4	-	0.095
ARM B	5.56	20.26	0.275	- - -	0.4	0.4	5.6	-	0.068
ARM C	17.45	32.49	0.537	- - -	1.1	1.2	17.3	-	0.066

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
16.45-17.00									
ARM A	22.22	37.76	0.588	- - -	2.6	1.4	22.4	-	0.065
ARM B	4.54	21.97	0.207	- - -	0.4	0.3	4.0	-	0.057
ARM C	14.25	32.94	0.433	- - -	1.2	0.8	11.8	-	0.054

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
17.00-17.15									
ARM A	18.61	37.81	0.492	- - -	1.4	1.0	15.0	-	0.052
ARM B	3.80	23.25	0.164	- - -	0.3	0.2	3.0	-	0.051
ARM C	11.93	33.26	0.359	- - -	0.8	0.6	8.6	-	0.047

.QUEUE AT ARM A

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE	
16.00	1.0	*
16.15	1.4	*
16.30	2.5	***
16.45	2.6	***
17.00	1.4	*
17.15	1.0	*

.QUEUE AT ARM B

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE
16.00	0.2
16.15	0.3
16.30	0.4
16.45	0.4
17.00	0.3
17.15	0.2

.QUEUE AT ARM C

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE	
16.00	0.6	*
16.15	0.8	*
16.30	1.1	*
16.45	1.2	*
17.00	0.8	*
17.15	0.6	*

.QUEUEING DELAY INFORMATION OVER WHOLE PERIOD

T75

ARM	TOTAL DEMAND (VEH)	TOTAL DEMAND (VEH/H)	* QUEUEING * * DELAY * (MIN)	* QUEUEING * * DELAY * (MIN/VEH)	* INCLUSIVE QUEUEING * * DELAY * (MIN)	* INCLUSIVE QUEUEING * * DELAY * (MIN/VEH)
A	2041.2	1360.8	146.8	0.07	146.8	0.07
B	417.1	278.0	24.8	0.06	24.8	0.06
C	1309.0	872.7	73.8	0.06	73.8	0.06
ALL	3767.3	2511.5	245.4	0.07	245.4	0.07

* DELAY IS THAT OCCURRING ONLY WITHIN THE TIME PERIOD.
* INCLUSIVE DELAY INCLUDES DELAY SUFFERED BY VEHICLES WHICH ARE STILL QUEUEING AFTER THE END OF THE TIME PERIOD.
* THESE WILL ONLY BE SIGNIFICANTLY DIFFERENT IF THERE IS A LARGE QUEUE REMAINING AT THE END OF THE TIME PERIOD.

END OF JOB

A R C A D Y 6

ASSESSMENT OF ROUNDABOUT CAPACITY AND DELAY

Analysis Program: Release 5.0 (JANUARY 2009)

For sales and distribution information,
program advice and maintenance, contact:

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Nine Mile Ride Email: software@trl.co.uk
Wokingham, Berks. Web: www.trlsoftware.co.uk
RG40 3GA,UK

Run with file:-
"t:\MOU10 RJB\TrP\000 - Projects\SEStran Framework Agreement\South Tayside P&R\Modelling\Arcady\Final\
South Tay Bridge Rdb ATC AM 2015-460sp.vai"
(drive-on-the-left) at 14:15:24 on Wednesday, 27 January 2010

.FILE PROPERTIES

RUN TITLE: South Tay Bridge Roundabout - 2015 P&R460 AM
LOCATION:
DATE: 25/11/09
CLIENT:
ENUMERATOR: gcornelis [UK1004173D]
JOB NUMBER:
STATUS:
DESCRIPTION:

.INPUT DATA

ARM A - North
ARM B - East
ARM C - South

.GEOMETRIC DATA

T5

ARM	V (M)	E (M)	L (M)	R (M)	D (M)	PHI (DEG)	SLOPE	INTERCEPT (PCU/MIN)
ARM A	7.20	7.20	0.00	40.00	75.60	15.0	0.599	39.142
ARM B	3.20	6.70	30.00	40.00	75.60	15.0	0.528	31.251
ARM C	6.80	6.80	0.00	60.00	75.60	15.0	0.584	37.247

V = approach half-width L = effective flare length D = inscribed circle diameter
E = entry width R = entry radius PHI = entry angle

.TRAFFIC DEMAND DATA

Only sets included in the current run are shown

.SCALING FACTORS

T13

ARM	FLOW SCALE(%)
A	100
B	100
C	100

TIME PERIOD BEGINS(06.45)AND ENDS(08.15)
.LENGTH OF TIME PERIOD -(90) MINUTES
.LENGTH OF TIME SEGMENT - (15) MINUTES

.DEMAND FLOW PROFILES ARE SYNTHESISED FROM THE TURNING COUNT DATA

.DEMAND SET TITLE: South Tay Bridge Roundabout (AM)

T15

ARM	NUMBER OF MINUTES FROM START WHEN FLOW STARTS TO RISE	TOP OF PEAK IS REACHED	FLOW STOPS FALLING	RATE OF FLOW (VEH/MIN) BEFORE PEAK	AT TOP OF PEAK	AFTER PEAK
ARM A	15.00	45.00	75.00	10.41	15.62	10.41
ARM B	15.00	75.00	75.00	5.11	7.67	5.11
ARM C	15.00	45.00	75.00	16.99	25.48	16.99

DEMAND SET TITLE: South Tay Bridge Roundabout (AM)

T33

TURNING PROPORTIONS / TURNING COUNTS / (PERCENTAGE OF H.V.S)

TIME	FROM/TO	ARM A	ARM B	ARM C
06.45 - 08.15				
	ARM A	0.000	0.220	0.780
		0.0	183.0	650.0
		(10.6)	(10.6)	(10.6)
	ARM B	0.822	0.000	0.178
		336.0	0.0	73.0
		(4.2)	(4.2)	(4.2)
	ARM C	0.867	0.133	0.000
		1178.0	181.0	0.0
		(5.2)	(5.2)	(5.2)

. QUEUE AND DELAY INFORMATION FOR EACH 15 MIN TIME SEGMENT

T70

TIME	DEMAND	CAPACITY	DEMAND/	PEDESTRIAN	START	END	DELAY	GEOMETRIC DELAY	AVERAGE DELAY

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
06.45-07.00									
ARM A	10.45	34.10	0.307	- - -	0.0	0.4	6.5	-	0.042
ARM B	5.13	25.43	0.202	- - -	0.0	0.3	3.7	-	0.049
ARM C	17.05	32.97	0.517	- - -	0.0	1.1	15.4	-	0.062

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
07.00-07.15									
ARM A	12.48	33.85	0.369	- - -	0.4	0.6	8.6	-	0.047
ARM B	6.13	24.54	0.250	- - -	0.3	0.3	4.9	-	0.054
ARM C	20.36	32.50	0.627	- - -	1.1	1.7	24.0	-	0.082

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
07.15-07.30									
ARM A	15.29	33.51	0.456	- - -	0.6	0.8	12.3	-	0.055
ARM B	7.51	23.31	0.322	- - -	0.3	0.5	6.9	-	0.063
ARM C	24.94	31.84	0.783	- - -	1.7	3.5	48.2	-	0.140

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
07.30-07.45									
ARM A	15.29	33.50	0.456	- - -	0.8	0.8	12.5	-	0.055
ARM B	7.51	23.30	0.322	- - -	0.5	0.5	7.1	-	0.063
ARM C	24.94	31.84	0.783	- - -	3.5	3.5	52.6	-	0.144

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
07.45-08.00									
ARM A	12.48	33.83	0.369	- - -	0.8	0.6	9.0	-	0.047
ARM B	6.13	24.52	0.250	- - -	0.5	0.3	5.1	-	0.054
ARM C	20.36	32.49	0.627	- - -	3.5	1.7	26.7	-	0.084

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
08.00-08.15									
ARM A	10.45	34.09	0.307	- - -	0.6	0.4	6.8	-	0.042
ARM B	5.13	25.41	0.202	- - -	0.3	0.3	3.9	-	0.049
ARM C	17.05	32.96	0.517	- - -	1.7	1.1	16.7	-	0.063

.QUEUE AT ARM A

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE	
07.00	0.4	
07.15	0.6	*
07.30	0.8	*
07.45	0.8	*
08.00	0.6	*
08.15	0.4	

.QUEUE AT ARM B

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE
07.00	0.3
07.15	0.3
07.30	0.5
07.45	0.5
08.00	0.3
08.15	0.3

.QUEUE AT ARM C

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE	
07.00	1.1	*
07.15	1.7	**
07.30	3.5	***
07.45	3.5	****
08.00	1.7	**
08.15	1.1	*

.QUEUEING DELAY INFORMATION OVER WHOLE PERIOD

T75

ARM	TOTAL DEMAND (VEH)	TOTAL DEMAND (VEH/H)	* QUEUEING * DELAY * (MIN)	* QUEUEING * DELAY * (MIN/VEH)	* INCLUSIVE QUEUEING * DELAY * (MIN)	* INCLUSIVE QUEUEING * DELAY * (MIN/VEH)
A	1146.6	764.4	55.6	0.05	55.6	0.05
B	563.0	375.3	31.6	0.06	31.6	0.06
C	1870.6	1247.0	183.6	0.10	183.6	0.10
ALL	3580.1	2386.7	270.8	0.08	270.8	0.08

* DELAY IS THAT OCCURRING ONLY WITHIN THE TIME PERIOD.
* INCLUSIVE DELAY INCLUDES DELAY SUFFERED BY VEHICLES WHICH ARE STILL QUEUEING AFTER THE END OF THE TIME PERIOD.
* THESE WILL ONLY BE SIGNIFICANTLY DIFFERENT IF THERE IS A LARGE QUEUE REMAINING AT THE END OF THE TIME PERIOD.

END OF JOB

A R C A D Y 6

ASSESSMENT OF ROUNDABOUT CAPACITY AND DELAY

Analysis Program: Release 5.0 (JANUARY 2009)

For sales and distribution information,
program advice and maintenance, contact:

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Run with file:-
"t:\MOU10 RJB\TrP\000 - Projects\SEStran Framework Agreement\South Tayside P&R\Modelling\Arcady\Final\
South Tay Bridge Rdb ATC PM 2015-460 sp.vai"
(drive-on-the-left) at 14:15:37 on Wednesday, 27 January 2010

.FILE PROPERTIES

RUN TITLE: South Tay Bridge Roundabout - 2015 P&R460 PM
LOCATION:
DATE: 25/11/09
CLIENT:
ENUMERATOR: gcornelis [UK1004173D]
JOB NUMBER:
STATUS:
DESCRIPTION:

.INPUT DATA

ARM A - North
ARM B - East
ARM C - South

.GEOMETRIC DATA

T5

ARM	V (M)	E (M)	L (M)	R (M)	D (M)	PHI (DEG)	SLOPE	INTERCEPT (PCU/MIN)
ARM A	7.20	7.20	0.00	40.00	75.60	15.0	0.599	39.142
ARM B	3.20	6.70	30.00	40.00	75.60	15.0	0.528	31.251
ARM C	6.80	6.80	0.00	60.00	75.60	15.0	0.584	37.247

V = approach half-width L = effective flare length D = inscribed circle diameter
E = entry width R = entry radius PHI = entry angle

.TRAFFIC DEMAND DATA

Only sets included in the current run are shown

.SCALING FACTORS

T13

ARM	FLOW SCALE(%)
A	100
B	100
C	100

TIME PERIOD BEGINS(15.45)AND ENDS(17.15)
.LENGTH OF TIME PERIOD -(90) MINUTES
.LENGTH OF TIME SEGMENT - (15) MINUTES

.DEMAND FLOW PROFILES ARE SYNTHESISED FROM THE TURNING COUNT DATA

.DEMAND SET TITLE: South Tay Bridge Roundabout (PM)

T15

ARM	NUMBER OF MINUTES FROM START WHEN FLOW STARTS TO RISE	TOP OF PEAK IS REACHED	FLOW STOPS FALLING	RATE OF FLOW (VEH/MIN) BEFORE PEAK	AT TOP OF PEAK	AFTER PEAK
ARM A	15.00	45.00	75.00	15.95	23.92	15.95
ARM B	15.00	45.00	75.00	5.71	8.57	5.71
ARM C	15.00	45.00	75.00	11.89	17.83	11.89

DEMAND SET TITLE: South Tay Bridge Roundabout (PM)

T33

TURNING PROPORTIONS / TURNING COUNTS / (PERCENTAGE OF H.V.S)

TIME	FROM/TO	ARM A	ARM B	ARM C
15.45 - 17.15				
	ARM A	0.000	0.329	0.671
		0.0	420.0	856.0
		(2.8)	(2.8)	(2.8)
	ARM B	0.525	0.000	0.475
		240.0	0.0	217.0
		(3.4)	(3.4)	(3.4)
	ARM C	0.956	0.044	0.000
		909.0	42.0	0.0
		(6.6)	(6.6)	(6.6)

. QUEUE AND DELAY INFORMATION FOR EACH 15 MIN TIME SEGMENT

T70

TIME	DEMAND	CAPACITY	DEMAND/	PEDESTRIAN	START	END	DELAY	GEOMETRIC DELAY	AVERAGE DELAY

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
15.45-16.00									
ARM A	16.01	37.75	0.424	- - -	0.0	0.7	10.8	-	0.046
ARM B	5.73	24.60	0.233	- - -	0.0	0.3	4.4	-	0.053
ARM C	11.93	33.24	0.359	- - -	0.0	0.6	8.2	-	0.047

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
16.00-16.15									
ARM A	19.12	37.68	0.507	- - -	0.7	1.0	15.0	-	0.054
ARM B	6.85	23.50	0.291	- - -	0.3	0.4	6.0	-	0.060
ARM C	14.25	32.91	0.433	- - -	0.6	0.8	11.2	-	0.054

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
16.15-16.30									
ARM A	23.42	37.60	0.623	- - -	1.0	1.6	23.7	-	0.070
ARM B	8.39	21.99	0.381	- - -	0.4	0.6	9.0	-	0.073
ARM C	17.45	32.45	0.538	- - -	0.8	1.2	16.9	-	0.066

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
16.30-16.45									
ARM A	23.42	37.60	0.623	- - -	1.6	1.6	24.6	-	0.071
ARM B	8.39	21.98	0.382	- - -	0.6	0.6	9.2	-	0.074
ARM C	17.45	32.45	0.538	- - -	1.2	1.2	17.3	-	0.067

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
16.45-17.00									
ARM A	19.12	37.68	0.507	- - -	1.6	1.0	15.9	-	0.054
ARM B	6.85	23.47	0.292	- - -	0.6	0.4	6.3	-	0.060
ARM C	14.25	32.90	0.433	- - -	1.2	0.8	11.8	-	0.054

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
17.00-17.15									
ARM A	16.01	37.75	0.424	- - -	1.0	0.7	11.3	-	0.046
ARM B	5.73	24.58	0.233	- - -	0.4	0.3	4.7	-	0.053
ARM C	11.93	33.23	0.359	- - -	0.8	0.6	8.6	-	0.047

.QUEUE AT ARM A

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE	
16.00	0.7	*
16.15	1.0	*
16.30	1.6	**
16.45	1.6	**
17.00	1.0	*
17.15	0.7	*

.QUEUE AT ARM B

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE	
16.00	0.3	
16.15	0.4	
16.30	0.6	*
16.45	0.6	*
17.00	0.4	
17.15	0.3	

.QUEUE AT ARM C

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE	
16.00	0.6	*
16.15	0.8	*
16.30	1.2	*
16.45	1.2	*
17.00	0.8	*
17.15	0.6	*

.QUEUEING DELAY INFORMATION OVER WHOLE PERIOD

T75

ARM	TOTAL DEMAND		* QUEUEING * DELAY *		* INCLUSIVE QUEUEING * DELAY *	
	(VEH)	(VEH/H)	(MIN)	(MIN/VEH)	(MIN)	(MIN/VEH)
A	1756.3	1170.9	101.3	0.06	101.3	0.06
B	629.0	419.4	39.6	0.06	39.6	0.06
C	1309.0	872.7	73.9	0.06	73.9	0.06
ALL	3694.3	2462.9	214.9	0.06	214.9	0.06

* DELAY IS THAT OCCURRING ONLY WITHIN THE TIME PERIOD.
* INCLUSIVE DELAY INCLUDES DELAY SUFFERED BY VEHICLES WHICH ARE STILL QUEUEING AFTER THE END OF THE TIME PERIOD.
* THESE WILL ONLY BE SIGNIFICANTLY DIFFERENT IF THERE IS A LARGE QUEUE REMAINING AT THE END OF THE TIME PERIOD.

END OF JOB

___________________ A R C A D Y 6 ___________________

ASSESSMENT OF ROUNDABOUT CAPACITY AND DELAY

Analysis Program: Release 5.0 (JANUARY 2009)

For sales and distribution information,
program advice and maintenance, contact:

TRL Limited   Tel: +44 (0) 1344 770758
Crowthorne House   Fax: +44 (0) 1344 770356
Nine Mile Ride   Email: software@trl.co.uk
Wokingham, Berks.   Web: www.trlsoftware.co.uk
RG40 3GA,UK

Run with file:-
"t:\MOU10 RJB\TrP\000 - Projects\SEStran Framework Agreement\South Tayside P&R\Modelling\Arcady\Final\
South Tay Bridge Rdb ATC AM 2015-460sp (test 100%).vai"
(drive-on-the-left) at 10:13:22 on Tuesday, 16 February 2010

.FILE PROPERTIES

RUN TITLE: South Tay Bridge Roundabout - 2015 P&R460 AM
LOCATION:
DATE: 25/11/09
CLIENT:
ENUMERATOR: gcornelis [UK1004173D]
JOB NUMBER:
STATUS:
DESCRIPTION:

.INPUT DATA

ARM A - North
ARM B - East
ARM C - South

.GEOMETRIC DATA

T5

ARM	V (M)	E (M)	L (M)	R (M)	D (M)	PHI (DEG)	SLOPE	INTERCEPT (PCU/MIN)
ARM A	7.20	7.20	0.00	40.00	75.60	15.0	0.599	39.142
ARM B	3.20	6.70	30.00	40.00	75.60	15.0	0.528	31.251
ARM C	6.80	6.80	0.00	60.00	75.60	15.0	0.584	37.247

V = approach half-width   L = effective flare length   D = inscribed circle diameter
E = entry width   R = entry radius   PHI = entry angle

.TRAFFIC DEMAND DATA

Only sets included in the current run are shown

.SCALING FACTORS

T13

ARM	FLOW SCALE(%)
A	100
B	100
C	100

TIME PERIOD BEGINS(06.45)AND ENDS(08.15)
.LENGTH OF TIME PERIOD -(90) MINUTES
.LENGTH OF TIME SEGMENT - (15) MINUTES

.DEMAND FLOW PROFILES ARE SYNTHESISED FROM THE TURNING COUNT DATA

.DEMAND SET TITLE: South Tay Bridge Roundabout (AM)

T15

ARM	NUMBER OF MINUTES FROM START WHEN FLOW STARTS TO RISE	TOP OF PEAK IS REACHED	FLOW STOPS FALLING	RATE OF FLOW (VEH/MIN) BEFORE PEAK	AT TOP OF PEAK	AFTER PEAK
ARM A	15.00	45.00	75.00	10.41	15.62	10.41
ARM B	15.00	45.00	75.00	4.06	6.09	4.06
ARM C	15.00	45.00	75.00	17.00	25.50	17.00

DEMAND SET TITLE: South Tay Bridge Roundabout (AM)

T33

TIME	FROM/TO	TURNING PROPORTIONS / TURNING COUNTS / (PERCENTAGE OF H.V.S) ARM A	ARM B	ARM C
06.45 - 08.15				
	ARM A	0.000	0.220	0.780
		0.0	183.0	650.0
		(10.6)	(10.6)	(10.6)
	ARM B	0.775	0.000	0.225
		252.0	0.0	73.0
		(4.2)	(4.2)	(4.2)
	ARM C	0.743	0.257	0.000
		1010.0	350.0	0.0
		(5.2)	(5.2)	(5.2)

. QUEUE AND DELAY INFORMATION FOR EACH 15 MIN TIME SEGMENT

T70

TIME	DEMAND	CAPACITY	DEMAND/	PEDESTRIAN	START	END	DELAY	GEOMETRIC DELAY	AVERAGE DELAY

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
06.45-07.00									
ARM A	10.45	32.90	0.318	- - -	0.0	0.5	6.8	-	0.044
ARM B	4.08	25.43	0.160	- - -	0.0	0.2	2.8	-	0.047
ARM C	17.06	33.58	0.508	- - -	0.0	1.0	14.9	-	0.060

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
07.00-07.15									
ARM A	12.48	32.41	0.385	- - -	0.5	0.6	9.2	-	0.050
ARM B	4.87	24.54	0.198	- - -	0.2	0.2	3.7	-	0.051
ARM C	20.38	33.22	0.613	- - -	1.0	1.6	22.7	-	0.077

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
07.15-07.30									
ARM A	15.29	31.74	0.482	- - -	0.6	0.9	13.5	-	0.061
ARM B	5.96	23.31	0.256	- - -	0.2	0.3	5.0	-	0.058
ARM C	24.96	32.73	0.762	- - -	1.6	3.1	43.6	-	0.125

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
07.30-07.45									
ARM A	15.29	31.73	0.482	- - -	0.9	0.9	13.9	-	0.061
ARM B	5.96	23.30	0.256	- - -	0.3	0.3	5.1	-	0.058
ARM C	24.96	32.73	0.762	- - -	3.1	3.2	47.0	-	0.128

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
07.45-08.00									
ARM A	12.48	32.38	0.385	- - -	0.9	0.6	9.6	-	0.050
ARM B	4.87	24.52	0.199	- - -	0.3	0.2	3.8	-	0.051
ARM C	20.38	33.22	0.613	- - -	3.2	1.6	25.1	-	0.079

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
08.00-08.15									
ARM A	10.45	32.88	0.318	- - -	0.6	0.5	7.1	-	0.045
ARM B	4.08	25.41	0.160	- - -	0.2	0.2	2.9	-	0.047
ARM C	17.06	33.57	0.508	- - -	1.6	1.0	16.0	-	0.061

.QUEUE AT ARM A

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE	
07.00	0.5	
07.15	0.6	*
07.30	0.9	*
07.45	0.9	*
08.00	0.6	*
08.15	0.5	

.QUEUE AT ARM B

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE
07.00	0.2
07.15	0.2
07.30	0.3
07.45	0.3
08.00	0.2
08.15	0.2

.QUEUE AT ARM C

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE	
07.00	1.0	*
07.15	1.6	**
07.30	3.1	***
07.45	3.2	***
08.00	1.6	**
08.15	1.0	*

.QUEUEING DELAY INFORMATION OVER WHOLE PERIOD

T75

ARM	TOTAL DEMAND (VEH)	TOTAL DEMAND (VEH/H)	* QUEUEING * * DELAY * (MIN)	* QUEUEING * * DELAY * (MIN/VEH)	* INCLUSIVE QUEUEING * * DELAY * (MIN)	* INCLUSIVE QUEUEING * * DELAY * (MIN/VEH)
A	1146.6	764.4	60.2	0.05	60.2	0.05
B	447.3	298.2	23.3	0.05	23.3	0.05
C	1871.9	1248.0	169.4	0.09	169.4	0.09
ALL	3465.8	2310.6	252.9	0.07	252.9	0.07

* DELAY IS THAT OCCURRING ONLY WITHIN THE TIME PERIOD.
* INCLUSIVE DELAY INCLUDES DELAY SUFFERED BY VEHICLES WHICH ARE STILL QUEUEING AFTER THE END OF THE TIME PERIOD.
* THESE WILL ONLY BE SIGNIFICANTLY DIFFERENT IF THERE IS A LARGE QUEUE REMAINING AT THE END OF THE TIME PERIOD.

END OF JOB

__________________ A R C A D Y 6 __________________

ASSESSMENT OF ROUNDABOUT CAPACITY AND DELAY

Analysis Program: Release 5.0 (JANUARY 2009)

For sales and distribution information,
program advice and maintenance, contact:

TRL Limited   Tel: +44 (0) 1344 770758
Crowthorne House   Fax: +44 (0) 1344 770356
Nine Mile Ride   Email: software@trl.co.uk
Wokingham, Berks.   Web: www.trlsoftware.co.uk
RG40 3GA,UK

Run with file:-
"t:\MOU10 RJB\TrP\000 - Projects\SEStran Framework Agreement\South Tayside P&R\Modelling\Arcady\Final\
South Tay Bridge Rdb ATC PM 2015-460 sp (test 100%).vai"
(drive-on-the-left) at 10:13:35 on Tuesday, 16 February 2010

.FILE PROPERTIES
****

RUN TITLE: South Tay Bridge Roundabout - 2015 P&R460 PM
LOCATION:
DATE: 25/11/09
CLIENT:
ENUMERATOR: gcornelis [UK1004173D]
JOB NUMBER:
STATUS:
DESCRIPTION:

.INPUT DATA
****

ARM A - North
ARM B - East
ARM C - South

.GEOMETRIC DATA

T5

ARM	V (M)	E (M)	L (M)	R (M)	D (M)	PHI (DEG)	SLOPE	INTERCEPT (PCU/MIN)
ARM A	7.20	7.20	0.00	40.00	75.60	15.0	0.599	39.142
ARM B	3.20	6.70	30.00	40.00	75.60	15.0	0.528	31.251
ARM C	6.80	6.80	0.00	60.00	75.60	15.0	0.584	37.247

V = approach half-width   L = effective flare length   D = inscribed circle diameter
E = entry width   R = entry radius   PHI = entry angle

.TRAFFIC DEMAND DATA

Only sets included in the current run are shown

.SCALING FACTORS

T13

ARM	FLOW SCALE(%)
A	100
B	100
C	100

TIME PERIOD BEGINS(15.45)AND ENDS(17.15)
.LENGTH OF TIME PERIOD -(90) MINUTES
.LENGTH OF TIME SEGMENT - (15) MINUTES

.DEMAND FLOW PROFILES ARE SYNTHESISED FROM THE TURNING COUNT DATA

.DEMAND SET TITLE: South Tay Bridge Roundabout (PM)

T15

ARM	NUMBER OF MINUTES FROM START WHEN FLOW STARTS TO RISE	TOP OF PEAK IS REACHED	FLOW STOPS FALLING	RATE OF FLOW (VEH/MIN) BEFORE PEAK	AT TOP OF PEAK	AFTER PEAK
ARM A	15.00	45.00	75.00	12.79	19.18	12.79
ARM B	15.00	45.00	75.00	7.82	11.74	7.82
ARM C	15.00	45.00	75.00	11.89	17.83	11.89

DEMAND SET TITLE: South Tay Bridge Roundabout (PM)

T33

TURNING PROPORTIONS / TURNING COUNTS / (PERCENTAGE OF H.V.S)

TIME	FROM/TO	ARM A	ARM B	ARM C
15.45 - 17.15				
	ARM A	0.000	0.327	0.673
		0.0	335.0	688.0
		(2.8)	(2.8)	(2.8)
	ARM B	0.383	0.000	0.617
		240.0	0.0	386.0
		(3.4)	(3.4)	(3.4)
	ARM C	0.956	0.044	0.000
		909.0	42.0	0.0
		(6.6)	(6.6)	(6.6)

. QUEUE AND DELAY INFORMATION FOR EACH 15 MIN TIME SEGMENT

T70

I TIME DEMAND CAPACITY DEMAND/ PEDESTRIAN START END DELAY GEOMETRIC DELAY AVERAGE DELAY I

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
15.45-16.00									
ARM A	12.84	37.75	0.340	- - -	0.0	0.5	7.6	-	0.040
ARM B	7.85	25.70	0.306	- - -	0.0	0.4	6.4	-	0.056
ARM C	11.93	33.24	0.359	- - -	0.0	0.6	8.2	-	0.047

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
16.00-16.15									
ARM A	15.33	37.68	0.407	- - -	0.5	0.7	10.1	-	0.045
ARM B	9.38	24.81	0.378	- - -	0.4	0.6	8.9	-	0.065
ARM C	14.25	32.91	0.433	- - -	0.6	0.8	11.2	-	0.054

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
16.15-16.30									
ARM A	18.77	37.60	0.499	- - -	0.7	1.0	14.6	-	0.053
ARM B	11.49	23.60	0.487	- - -	0.6	0.9	13.7	-	0.082
ARM C	17.45	32.45	0.538	- - -	0.8	1.2	16.9	-	0.066

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
16.30-16.45									
ARM A	18.77	37.60	0.499	- - -	1.0	1.0	14.9	-	0.053
ARM B	11.49	23.59	0.487	- - -	0.9	0.9	14.1	-	0.083
ARM C	17.45	32.45	0.538	- - -	1.2	1.2	17.3	-	0.067

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
16.45-17.00									
ARM A	15.33	37.68	0.407	- - -	1.0	0.7	10.5	-	0.045
ARM B	9.38	24.80	0.378	- - -	0.9	0.6	9.4	-	0.065
ARM C	14.25	32.90	0.433	- - -	1.2	0.8	11.8	-	0.054

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)	AVERAGE DELAY PER ARRIVING VEHICLE (MIN)
17.00-17.15									
ARM A	12.84	37.75	0.340	- - -	0.7	0.5	7.9	-	0.040
ARM B	7.85	25.69	0.306	- - -	0.6	0.4	6.8	-	0.056
ARM C	11.93	33.23	0.359	- - -	0.8	0.6	8.6	-	0.047

.QUEUE AT ARM A

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE	
16.00	0.5	*
16.15	0.7	*
16.30	1.0	*
16.45	1.0	*
17.00	0.7	*
17.15	0.5	*

.QUEUE AT ARM B

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE	
16.00	0.4	
16.15	0.6	*
16.30	0.9	*
16.45	0.9	*
17.00	0.6	*
17.15	0.4	

.QUEUE AT ARM C

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE	
16.00	0.6	*
16.15	0.8	*
16.30	1.2	*
16.45	1.2	*
17.00	0.8	*
17.15	0.6	*

.QUEUEING DELAY INFORMATION OVER WHOLE PERIOD

T75

ARM	TOTAL DEMAND		* QUEUEING * * DELAY *		* INCLUSIVE QUEUEING * * DELAY *	
	(VEH)	(VEH/H)	(MIN)	(MIN/VEH)	(MIN)	(MIN/VEH)
A	1408.1	938.7	65.5	0.05	65.5	0.05
B	861.6	574.4	59.3	0.07	59.3	0.07
C	1309.0	872.7	73.9	0.06	73.9	0.06
ALL	3578.7	2385.8	198.7	0.06	198.7	0.06

* DELAY IS THAT OCCURRING ONLY WITHIN THE TIME PERIOD.
* INCLUSIVE DELAY INCLUDES DELAY SUFFERED BY VEHICLES WHICH ARE STILL QUEUEING AFTER THE END OF THE TIME PERIOD.
* THESE WILL ONLY BE SIGNIFICANTLY DIFFERENT IF THERE IS A LARGE QUEUE REMAINING AT THE END OF THE TIME PERIOD.

END OF JOB

CAPACITIES, QUEUES, AND DELAYS AT 3 OR 4-ARM MAJOR/MINOR PRIORITY JUNCTIONS

PICADY 4.1 ANALYSIS PROGRAM
RELEASE 4.0 (NOV 2003)

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TEL: CROWTHORNE (01344) 770758, FAX: 770864
EMAIL: SoftwareBureau@trl.co.uk

Run with file:-
"t:\MOU10 RJB\TrP\000 - Projects\SEStran Framework Agreement\South Tayside P&R\Modelling\Picady\Site Entrance\
Final\Site Entrance 2015 AM - 460 Spaces.vpi"
(drive-on-the-left) at 14:16:02 on Wednesday, 27 January 2010

RUN TITLE
****
Site Entrance - 2015 AM - 460 spaces

.MAJOR/MINOR JUNCTION CAPACITY AND DELAY
****

INPUT DATA

```
MAJOR ROAD (ARM C) --------------------- MAJOR ROAD (ARM A)
                          I
                          I
                          I
                          I
                          I
                          I
                   MINOR ROAD (ARM B)
```

ARM A IS East
ARM B IS Site
ARM C IS West

STREAM LABELLING CONVENTION

STREAM A-B CONTAINS TRAFFIC GOING FROM ARM A TO ARM B

STREAM B-AC CONTAINS TRAFFIC GOING FROM ARM B TO ARM A AND TO ARM C

ETC.

.GEOMETRIC DATA

DATA ITEM	MINOR ROAD B
TOTAL MAJOR ROAD CARRIAGEWAY WIDTH	(W) 11.50 M.
CENTRAL RESERVE WIDTH	(WCR) 0.00 M.
MAJOR ROAD RIGHT TURN - WIDTH	(WC-B) 3.50 M.
- VISIBILITY	(VC-B) 70.0 M.
- BLOCKS TRAFFIC	NO
MINOR ROAD - VISIBILITY TO LEFT	(VB-C) 100.0 M.
- VISIBILITY TO RIGHT	(VB-A) 90.0 M.
- LANE 1 WIDTH	(WB-C) -
- LANE 2 WIDTH	(WB-A) -
- WIDTH AT 0 M FROM JUNC.	8.00 M.
- WIDTH AT 5 M FROM JUNC.	4.50 M.
- WIDTH AT 10 M FROM JUNC.	3.50 M.
- WIDTH AT 15 M FROM JUNC.	3.50 M.
- WIDTH AT 20 M FROM JUNC.	3.50 M.
- LENGTH OF FLARED SECTION	1 VEHS

.

.TRAFFIC DEMAND DATA

TIME PERIOD BEGINS 06.45 AND ENDS 08.15

LENGTH OF TIME PERIOD - 90 MINUTES.
LENGTH OF TIME SEGMENT - 15 MINUTES.

DEMAND FLOW PROFILES ARE SYNTHESISED FROM TURNING COUNT DATA

ARM	NUMBER OF MINUTES FROM START WHEN: FLOW STARTS TO RISE	TOP OF PEAK IS REACHED	FLOW STOPS FALLING	RATE OF FLOW (VEH/MIN): BEFORE PEAK	AT TOP OF PEAK	AFTER PEAK
ARM A	15.00	45.00	75.00	5.78	8.66	5.78
ARM B	15.00	45.00	75.00	0.60	0.90	0.60
ARM C	15.00	45.00	75.00	4.55	6.83	4.55

.

TIME	FROM/TO	TURNING PROPORTIONS / TURNING COUNTS (VEH/HR) / (PERCENTAGE OF H.V.S): ARM A	ARM B	ARM C
06.45 - 08.15				
	ARM A	0.000	0.184	0.816
		0.0	85.0	377.0
		(0.0)	(5.7)	(5.7)
	ARM B	0.333	0.000	0.667
		16.0	0.0	32.0

	(0.0)	(0.0)	(0.0)
ARM C	0.533	0.467	0.000
	194.0	170.0	0.0
	(5.3)	(5.3)	(0.0)

TURNING PROPORTIONS ARE CALCULATED FROM TURNING COUNT DATA

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
06.45-07.00								
B-C	0.40	11.20	0.036		0.0	0.0	0.5	
B-A	0.20	6.72	0.030		0.0	0.0	0.4	
C-A	2.42							
C-B	2.13	9.90	0.215		0.0	0.3	3.9	
A-B	1.06							
A-C	4.71							

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
07.00-07.15								
B-C	0.48	10.94	0.044		0.0	0.0	0.7	
B-A	0.24	6.36	0.038		0.0	0.0	0.6	
C-A	2.90							
C-B	2.54	9.67	0.262		0.3	0.4	5.1	
A-B	1.27							
A-C	5.63							

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
07.15-07.30								
B-C	0.58	10.59	0.055		0.0	0.1	0.9	
B-A	0.29	5.87	0.050		0.0	0.1	0.8	
C-A	3.55							
C-B	3.11	9.35	0.332		0.4	0.5	7.1	
A-B	1.55							
A-C	6.89							

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
07.30-07.45								
B-C	0.58	10.59	0.055		0.1	0.1	0.9	
B-A	0.29	5.86	0.050		0.1	0.1	0.8	
C-A	3.55							
C-B	3.11	9.35	0.332		0.5	0.5	7.4	
A-B	1.55							
A-C	6.89							

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
07.45-08.00								
B-C	0.48	10.94	0.044		0.1	0.0	0.7	
B-A	0.24	6.36	0.038		0.1	0.0	0.6	
C-A	2.90							
C-B	2.54	9.67	0.262		0.5	0.4	5.6	
A-B	1.27							
A-C	5.63							

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
08.00-08.15								
B-C	0.40	11.20	0.036		0.0	0.0	0.6	
B-A	0.20	6.72	0.030		0.0	0.0	0.5	
C-A	2.42							
C-B	2.13	9.90	0.215		0.4	0.3	4.2	
A-B	1.06							
A-C	4.71							

QUEUE FOR STREAM B-C

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE
07.00	0.0
07.15	0.0
07.30	0.1
07.45	0.1
08.00	0.0
08.15	0.0

QUEUE FOR STREAM B-A

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE
07.00	0.0
07.15	0.0
07.30	0.1
07.45	0.1
08.00	0.0
08.15	0.0

QUEUE FOR STREAM C-B

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE
07.00	0.3
07.15	0.4
07.30	0.5
07.45	0.5
08.00	0.4
08.15	0.3

QUEUEING DELAY INFORMATION OVER WHOLE PERIOD

STREAM	TOTAL DEMAND (VEH)	TOTAL DEMAND (VEH/H)	* QUEUEING * * DELAY * (MIN)	* QUEUEING * * DELAY * (MIN/VEH)	* INCLUSIVE QUEUEING * * DELAY * (MIN)	* INCLUSIVE QUEUEING * * DELAY * (MIN/VEH)
B-C	43.9	29.3	4.2	0.10	4.2	0.10
B-A	21.9	14.6	3.6	0.17	3.6	0.17
C-A	266.0	177.3				
C-B	233.1	155.4	33.4	0.14	33.4	0.14
A-B	116.6	77.7				
A-C	516.9	344.6				
ALL	1198.4	799.0	41.2	0.03	41.2	0.03

* DELAY IS THAT OCCURRING ONLY WITHIN THE TIME PERIOD .
* INCLUSIVE DELAY INCLUDES DELAY SUFFERED BY VEHICLES WHICH ARE STILL QUEUEING AFTER THE END OF THE TIME PERIOD.
* THESE WILL ONLY BE SIGNIFICANTLY DIFFERENT IF THERE IS A LARGE QUEUE REMAINING AT THE END OF THE TIME PERIOD.

END OF JOB

****** PICADY 4 run completed.

TRL LIMITED

CAPACITIES, QUEUES, AND DELAYS AT 3 OR 4-ARM MAJOR/MINOR PRIORITY JUNCTIONS

PICADY 4.1 ANALYSIS PROGRAM
RELEASE 4.0 (NOV 2003)

FOR SALES AND DISTRIBUTION INFORMATION,
PROGRAM ADVICE AND MAINTENANCE CONTACT:
TRL SOFTWARE BUREAU
TEL: CROWTHORNE (01344) 770758, FAX: 770864
EMAIL: SoftwareBureau@trl.co.uk

THE USER OF THIS COMPUTER PROGRAM FOR THE SOLUTION OF AN ENGINEERING PROBLEM IS IN NO WAY RELIEVED OF HIS RESPONSIBILITY FOR THE CORRECTNESS OF THE SOLUTION

Run with file:-
"t:\MOU10 RJB\TrP\000 - Projects\SEStran Framework Agreement\South Tayside P&R\Modelling\Picady\Site Entrance\
Final\Site Entrance 2015 PM - 460 Spaces.vpi"
(drive-on-the-left) at 14:16:06 on Wednesday, 27 January 2010

RUN TITLE
****
Site Entrance - 2015 PM - 460 spaces

.MAJOR/MINOR JUNCTION CAPACITY AND DELAY
****

INPUT DATA

```
MAJOR ROAD (ARM C) --------------------- MAJOR ROAD (ARM A)
                             I
                             I
                             I
                             I
                             I
                             I
                      MINOR ROAD (ARM B)
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ARM A IS East
ARM B IS Site
ARM C IS West

STREAM LABELLING CONVENTION

STREAM A-B CONTAINS TRAFFIC GOING FROM ARM A TO ARM B

STREAM B-AC CONTAINS TRAFFIC GOING FROM ARM B TO ARM A AND TO ARM C

ETC.

.GEOMETRIC DATA

DATA ITEM	MINOR ROAD B
TOTAL MAJOR ROAD CARRIAGEWAY WIDTH	(W) 11.50 M.
CENTRAL RESERVE WIDTH	(WCR) 0.00 M.
MAJOR ROAD RIGHT TURN - WIDTH	(WC-B) 3.50 M.
- VISIBILITY	(VC-B) 60.0 M.
- BLOCKS TRAFFIC	NO
MINOR ROAD - VISIBILITY TO LEFT	(VB-C) 100.0 M.
- VISIBILITY TO RIGHT	(VB-A) 90.0 M.
- LANE 1 WIDTH	(WB-C) -
- LANE 2 WIDTH	(WB-A) -
- WIDTH AT 0 M FROM JUNC.	8.00 M.
- WIDTH AT 5 M FROM JUNC.	4.50 M.
- WIDTH AT 10 M FROM JUNC.	3.50 M.
- WIDTH AT 15 M FROM JUNC.	3.50 M.
- WIDTH AT 20 M FROM JUNC.	3.50 M.
- LENGTH OF FLARED SECTION	1 VEHS

.

.TRAFFIC DEMAND DATA

TIME PERIOD BEGINS 15.45 AND ENDS 17.15

LENGTH OF TIME PERIOD - 90 MINUTES.
LENGTH OF TIME SEGMENT - 15 MINUTES.

DEMAND FLOW PROFILES ARE SYNTHESISED FROM TURNING COUNT DATA

ARM	NUMBER OF MINUTES FROM START WHEN FLOW STARTS TO RISE	TOP OF PEAK IS REACHED	FLOW STOPS FALLING	RATE OF FLOW (VEH/MIN) BEFORE PEAK	AT TOP OF PEAK	AFTER PEAK
ARM A	15.00	45.00	75.00	3.79	5.68	3.79
ARM B	15.00	45.00	75.00	3.19	4.78	3.19
ARM C	15.00	45.00	75.00	5.78	8.66	5.78

.

TIME	FROM/TO	TURNING PROPORTIONS TURNING COUNTS (VEH/HR) (PERCENTAGE OF H.V.S) ARM A	ARM B	ARM C
15.45 - 17.15				
	ARM A	0.000	0.053	0.947
		0.0	16.0	287.0
		(0.0)	(4.4)	(4.4)
	ARM B	0.333	0.000	0.667
		85.0	0.0	170.0

```
I                  I         I (  0.0)I (  0.0)I (  0.0)I
I                  I         I        I        I        I
I                  I   ARM C I  0.931 I  0.069 I  0.000 I
I                  I         I  430.0 I   32.0 I    0.0 I
I                  I         I (  2.6)I (  2.6)I (  0.0)I
I                  I         I        I        I        I
```

TURNING PROPORTIONS ARE CALCULATED FROM TURNING COUNT DATA

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
15.45-16.00								
B-C	2.13	11.15	0.191		0.0	0.2	3.4	
B-A	1.06	7.12	0.149		0.0	0.2	2.5	
C-A	5.38							
C-B	0.40	10.50	0.038		0.0	0.0	0.6	
A-B	0.20							
A-C	3.59							

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
16.00-16.15								
B-C	2.54	10.85	0.234		0.2	0.3	4.4	
B-A	1.27	6.82	0.186		0.2	0.2	3.3	
C-A	6.42							
C-B	0.48	10.34	0.046		0.0	0.0	0.7	
A-B	0.24							
A-C	4.28							

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
16.15-16.30								
B-C	3.11	10.38	0.300		0.3	0.4	6.2	
B-A	1.55	6.40	0.243		0.2	0.3	4.6	
C-A	7.86							
C-B	0.58	10.13	0.058		0.0	0.1	0.9	
A-B	0.29							
A-C	5.25							

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
16.30-16.45								
B-C	3.11	10.37	0.300		0.4	0.4	6.4	
B-A	1.55	6.40	0.243		0.3	0.3	4.7	
C-A	7.86							
C-B	0.58	10.13	0.058		0.1	0.1	0.9	
A-B	0.29							
A-C	5.25							

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
16.45-17.00								
B-C	2.54	10.84	0.234		0.4	0.3	4.8	
B-A	1.27	6.82	0.186		0.3	0.2	3.6	
C-A	6.42							
C-B	0.48	10.34	0.046		0.1	0.0	0.7	
A-B	0.24							
A-C	4.28							

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
17.00-17.15								
B-C	2.13	11.15	0.191		0.3	0.2	3.6	
B-A	1.06	7.12	0.149		0.2	0.2	2.7	
C-A	5.38							
C-B	0.40	10.50	0.038		0.0	0.0	0.6	
A-B	0.20							
A-C	3.59							

QUEUE FOR STREAM B-C

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE
16.00	0.2
16.15	0.3
16.30	0.4
16.45	0.4
17.00	0.3
17.15	0.2

QUEUE FOR STREAM B-A

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE
16.00	0.2
16.15	0.2
16.30	0.3
16.45	0.3
17.00	0.2
17.15	0.2

QUEUE FOR STREAM C-B

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE
16.00	0.0
16.15	0.0
16.30	0.1
16.45	0.1
17.00	0.0
17.15	0.0

QUEUEING DELAY INFORMATION OVER WHOLE PERIOD

STREAM	TOTAL DEMAND (VEH)	TOTAL DEMAND (VEH/H)	* QUEUEING * * DELAY * (MIN)	* QUEUEING * * DELAY * (MIN/VEH)	* INCLUSIVE QUEUEING * * DELAY * (MIN)	* INCLUSIVE QUEUEING * * DELAY * (MIN/VEH)
B-C	233.1	155.4	28.7	0.12	28.7	0.12
B-A	116.6	77.7	21.4	0.18	21.4	0.18
C-A	589.6	393.1				
C-B	43.9	29.3	4.4	0.10	4.4	0.10
A-B	21.9	14.6				
A-C	393.5	262.4				
ALL	1398.6	932.4	54.6	0.04	54.6	0.04

* DELAY IS THAT OCCURRING ONLY WITHIN THE TIME PERIOD .
* INCLUSIVE DELAY INCLUDES DELAY SUFFERED BY VEHICLES WHICH ARE STILL QUEUEING AFTER THE END OF THE TIME PERIOD.
* THESE WILL ONLY BE SIGNIFICANTLY DIFFERENT IF THERE IS A LARGE QUEUE REMAINING AT THE END OF THE TIME PERIOD.

END OF JOB

****** PICADY 4 run completed.

CAPACITIES, QUEUES, AND DELAYS AT 3 OR 4-ARM MAJOR/MINOR PRIORITY JUNCTIONS

PICADY 4.1 ANALYSIS PROGRAM
RELEASE 4.0 (NOV 2003)

FOR SALES AND DISTRIBUTION INFORMATION,
PROGRAM ADVICE AND MAINTENANCE CONTACT:
TRL SOFTWARE BUREAU
TEL: CROWTHORNE (01344) 770758, FAX: 770864
EMAIL: SoftwareBureau@trl.co.uk

Run with file:-
"t:\MOU10 RJB\TrP\000 - Projects\SEStran Framework Agreement\South Tayside P&R\Modelling\Picady\Site Entrance\
Final\Site Entrance 2015 AM - 460 Spaces (test 100%).vpi"
(drive-on-the-left) at 10:18:48 on Tuesday, 16 February 2010

RUN TITLE
****
Site Entrance - 2015 AM - 460 spaces

.MAJOR/MINOR JUNCTION CAPACITY AND DELAY
****

INPUT DATA

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                    MAJOR ROAD (ARM C) --------------------- MAJOR ROAD (ARM A)
                                                I
                                                I
                                                I
                                                I
                                                I
                                                I
                                          MINOR ROAD (ARM B)
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ARM A IS East
ARM B IS Site
ARM C IS West

STREAM LABELLING CONVENTION

STREAM A-B CONTAINS TRAFFIC GOING FROM ARM A TO ARM B

STREAM B-AC CONTAINS TRAFFIC GOING FROM ARM B TO ARM A AND TO ARM C

ETC.

.GEOMETRIC DATA

DATA ITEM	MINOR ROAD B
TOTAL MAJOR ROAD CARRIAGEWAY WIDTH	(W) 11.50 M.
CENTRAL RESERVE WIDTH	(WCR) 0.00 M.
MAJOR ROAD RIGHT TURN - WIDTH	(WC-B) 3.50 M.
- VISIBILITY	(VC-B) 70.0 M.
- BLOCKS TRAFFIC	NO
MINOR ROAD - VISIBILITY TO LEFT	(VB-C) 100.0 M.
- VISIBILITY TO RIGHT	(VB-A) 90.0 M.
- LANE 1 WIDTH	(WB-C) -
- LANE 2 WIDTH	(WB-A) -
- WIDTH AT 0 M FROM JUNC.	8.00 M.
- WIDTH AT 5 M FROM JUNC.	4.50 M.
- WIDTH AT 10 M FROM JUNC.	3.50 M.
- WIDTH AT 15 M FROM JUNC.	3.50 M.
- WIDTH AT 20 M FROM JUNC.	3.50 M.
- LENGTH OF FLARED SECTION	1 VEHS

.

.TRAFFIC DEMAND DATA

TIME PERIOD BEGINS 06.45 AND ENDS 08.15

LENGTH OF TIME PERIOD - 90 MINUTES.
LENGTH OF TIME SEGMENT - 15 MINUTES.

DEMAND FLOW PROFILES ARE SYNTHESISED FROM TURNING COUNT DATA

ARM	NUMBER OF MINUTES FROM START WHEN: FLOW STARTS TO RISE	TOP OF PEAK IS REACHED	FLOW STOPS FALLING	RATE OF FLOW (VEH/MIN): BEFORE PEAK	AT TOP OF PEAK	AFTER PEAK
ARM A	15.00	45.00	75.00	5.76	8.64	5.76
ARM B	15.00	45.00	75.00	0.60	0.90	0.60
ARM C	15.00	45.00	75.00	6.66	9.99	6.66

.

TIME	FROM/TO	ARM A	ARM B	ARM C
		TURNING PROPORTIONS / TURNING COUNTS (VEH/HR) / (PERCENTAGE OF H.V.S)		
06.45 - 08.15				
	ARM A	0.000	0.367	0.633
		0.0	169.0	292.0
		(0.0)	(5.7)	(5.7)
	ARM B	0.333	0.000	0.667
		16.0	0.0	32.0

```
I                  I        I (  0.0)I (  0.0)I (  0.0)I
I                  I        I        I        I        I
I                  I  ARM C I  0.364 I  0.636 I  0.000 I
I                  I        I  194.0 I  339.0 I    0.0 I
I                  I        I (  5.3)I (  5.3)I (  0.0)I
I                  I        I        I        I        I
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TURNING PROPORTIONS ARE CALCULATED FROM TURNING COUNT DATA

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
06.45-07.00								
B-C	0.40	11.34	0.035		0.0	0.0	0.5	
B-A	0.20	6.28	0.032		0.0	0.0	0.5	
C-A	2.42							
C-B	4.24	9.91	0.428		0.0	0.7	10.4	
A-B	2.11							
A-C	3.65							

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
07.00-07.15								
B-C	0.48	11.11	0.043		0.0	0.0	0.7	
B-A	0.24	5.82	0.041		0.0	0.0	0.6	
C-A	2.90							
C-B	5.06	9.67	0.523		0.7	1.1	15.2	
A-B	2.52							
A-C	4.36							

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
07.15-07.30								
B-C	0.58	10.79	0.054		0.0	0.1	0.8	
B-A	0.29	5.20	0.056		0.0	0.1	0.9	
C-A	3.55							
C-B	6.20	9.35	0.663		1.1	1.9	25.7	
A-B	3.09							
A-C	5.34							

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
07.30-07.45								
B-C	0.58	10.79	0.054		0.1	0.1	0.9	
B-A	0.29	5.18	0.056		0.1	0.1	0.9	
C-A	3.55							
C-B	6.20	9.35	0.663		1.9	1.9	28.3	
A-B	3.09							
A-C	5.34							

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
07.45-08.00								
B-C	0.48	11.11	0.043		0.1	0.0	0.7	
B-A	0.24	5.80	0.041		0.1	0.0	0.7	
C-A	2.90							
C-B	5.06	9.67	0.523		1.9	1.1	18.0	
A-B	2.52							
A-C	4.36							

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
08.00-08.15								
B-C	0.40	11.34	0.035		0.0	0.0	0.6	
B-A	0.20	6.25	0.032		0.0	0.0	0.5	
C-A	2.42							
C-B	4.24	9.91	0.428		1.1	0.8	11.9	
A-B	2.11							
A-C	3.65							

QUEUE FOR STREAM B-C

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE
07.00	0.0
07.15	0.0
07.30	0.1
07.45	0.1
08.00	0.0
08.15	0.0

QUEUE FOR STREAM B-A

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE
07.00	0.0
07.15	0.0
07.30	0.1
07.45	0.1
08.00	0.0
08.15	0.0

QUEUE FOR STREAM C-B

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE	
07.00	0.7	*
07.15	1.1	*
07.30	1.9	**
07.45	1.9	**
08.00	1.1	*
08.15	0.8	*

QUEUEING DELAY INFORMATION OVER WHOLE PERIOD

STREAM	TOTAL DEMAND (VEH)	TOTAL DEMAND (VEH/H)	* QUEUEING * * DELAY * (MIN)	* QUEUEING * * DELAY * (MIN/VEH)	* INCLUSIVE QUEUEING * * DELAY * (MIN)	* INCLUSIVE QUEUEING * * DELAY * (MIN/VEH)
B-C	43.9	29.3	4.1	0.09	4.1	0.09
B-A	21.9	14.6	4.0	0.18	4.0	0.18
C-A	266.0	177.3				
C-B	464.8	309.9	109.5	0.24	109.5	0.24
A-B	231.7	154.5				
A-C	400.4	266.9				
ALL	1428.8	952.5	117.6	0.08	117.7	0.08

* DELAY IS THAT OCCURRING ONLY WITHIN THE TIME PERIOD .
* INCLUSIVE DELAY INCLUDES DELAY SUFFERED BY VEHICLES WHICH ARE STILL QUEUEING AFTER THE END OF THE TIME PERIOD.
* THESE WILL ONLY BE SIGNIFICANTLY DIFFERENT IF THERE IS A LARGE QUEUE REMAINING AT THE END OF THE TIME PERIOD.

END OF JOB

****** PICADY 4 run completed.

CAPACITIES, QUEUES, AND DELAYS AT 3 OR 4-ARM MAJOR/MINOR PRIORITY JUNCTIONS

PICADY 4.1 ANALYSIS PROGRAM
RELEASE 4.0 (NOV 2003)

FOR SALES AND DISTRIBUTION INFORMATION,
PROGRAM ADVICE AND MAINTENANCE CONTACT:
TRL SOFTWARE BUREAU
TEL: CROWTHORNE (01344) 770758, FAX: 770864
EMAIL: SoftwareBureau@trl.co.uk

Run with file:-
"t:\MOU10 RJB\TrP\000 - Projects\SEStran Framework Agreement\South Tayside P&R\Modelling\Picady\Site Entrance\
Final\Site Entrance 2015 PM - 460 Spaces (test 100%).vpi"
(drive-on-the-left) at 10:19:57 on Tuesday, 16 February 2010

RUN TITLE

Site Entrance - 2015 PM - 460 spaces

.MAJOR/MINOR JUNCTION CAPACITY AND DELAY

INPUT DATA

```
MAJOR ROAD (ARM C) --------------------- MAJOR ROAD (ARM A)
                              I
                              I
                              I
                              I
                              I
                              I
                       MINOR ROAD (ARM B)
```

ARM A IS East
ARM B IS Site
ARM C IS West

STREAM LABELLING CONVENTION

STREAM A-B CONTAINS TRAFFIC GOING FROM ARM A TO ARM B

STREAM B-AC CONTAINS TRAFFIC GOING FROM ARM B TO ARM A AND TO ARM C

ETC.

Site Entrance 2015 PM - 460 Spaces (test 100%).vpo

.GEOMETRIC DATA

DATA ITEM	MINOR ROAD B
TOTAL MAJOR ROAD CARRIAGEWAY WIDTH	(W) 11.50 M.
CENTRAL RESERVE WIDTH	(WCR) 0.00 M.
MAJOR ROAD RIGHT TURN - WIDTH	(WC-B) 3.50 M.
- VISIBILITY	(VC-B) 60.0 M.
- BLOCKS TRAFFIC	NO
MINOR ROAD - VISIBILITY TO LEFT	(VB-C) 100.0 M.
- VISIBILITY TO RIGHT	(VB-A) 90.0 M.
- LANE 1 WIDTH	(WB-C) -
- LANE 2 WIDTH	(WB-A) -
- WIDTH AT 0 M FROM JUNC.	8.00 M.
- WIDTH AT 5 M FROM JUNC.	4.50 M.
- WIDTH AT 10 M FROM JUNC.	3.50 M.
- WIDTH AT 15 M FROM JUNC.	3.50 M.
- WIDTH AT 20 M FROM JUNC.	3.50 M.
- LENGTH OF FLARED SECTION	1 VEHS

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.TRAFFIC DEMAND DATA

TIME PERIOD BEGINS 15.45 AND ENDS 17.15

LENGTH OF TIME PERIOD - 90 MINUTES.
LENGTH OF TIME SEGMENT - 15 MINUTES.

DEMAND FLOW PROFILES ARE SYNTHESISED FROM TURNING COUNT DATA

ARM	NUMBER OF MINUTES FROM START WHEN: FLOW STARTS TO RISE	TOP OF PEAK IS REACHED	FLOW STOPS FALLING	RATE OF FLOW (VEH/MIN): BEFORE PEAK	AT TOP OF PEAK	AFTER PEAK
ARM A	15.00	45.00	75.00	3.79	5.68	3.79
ARM B	15.00	45.00	75.00	6.35	9.52	6.35
ARM C	15.00	45.00	75.00	4.71	7.07	4.71

.

TIME	FROM/TO	ARM A	ARM B	ARM C
		TURNING PROPORTIONS / TURNING COUNTS (VEH/HR) / (PERCENTAGE OF H.V.S)		
15.45 - 17.15				
	ARM A	0.000	0.053	0.947
		0.0	16.0	287.0
		(0.0)	(4.4)	(4.4)
	ARM B	0.333	0.000	0.667
		169.0	0.0	339.0

```
I                    I         I (  0.0)I (  0.0)I (  0.0)I
I                    I         I        I        I        I
I                    I  ARM C  I  0.915 I  0.085 I  0.000 I
I                    I         I  345.0 I   32.0 I    0.0 I
I                    I         I (  2.6)I (  2.6)I (  0.0)I
I                    I         I        I        I        I
-----------------------------------------------------------
```

TURNING PROPORTIONS ARE CALCULATED FROM TURNING COUNT DATA

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
15.45-16.00								
B-C	4.24	10.43	0.406		0.0	0.7	9.5	
B-A	2.11	6.98	0.302		0.0	0.4	6.0	
C-A	4.31							
C-B	0.40	10.50	0.038		0.0	0.0	0.6	
A-B	0.20							
A-C	3.59							

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
16.00-16.15								
B-C	5.06	9.76	0.519		0.7	1.0	14.9	
B-A	2.52	6.44	0.391		0.4	0.6	9.0	
C-A	5.15							
C-B	0.48	10.34	0.046		0.0	0.0	0.7	
A-B	0.24							
A-C	4.28							

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
16.15-16.30								
B-C	6.20	8.55	0.725		1.0	2.4	32.1	
B-A	3.09	5.29	0.584		0.6	1.3	17.9	
C-A	6.31							
C-B	0.58	10.13	0.058		0.0	0.1	0.9	
A-B	0.29							
A-C	5.25							

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
16.30-16.45								
B-C	6.20	8.47	0.732		2.4	2.6	37.7	
B-A	3.09	5.20	0.594		1.3	1.4	20.5	
C-A	6.31							
C-B	0.58	10.13	0.058		0.1	0.1	0.9	
A-B	0.29							
A-C	5.25							

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
16.45-17.00								
B-C	5.06	9.68	0.523		2.6	1.1	18.3	
B-A	2.52	6.39	0.395		1.4	0.7	10.8	
C-A	5.15							
C-B	0.48	10.34	0.046		0.1	0.0	0.7	
A-B	0.24							
A-C	4.28							

TIME	DEMAND (VEH/MIN)	CAPACITY (VEH/MIN)	DEMAND/ CAPACITY (RFC)	PEDESTRIAN FLOW (PEDS/MIN)	START QUEUE (VEHS)	END QUEUE (VEHS)	DELAY (VEH.MIN/ TIME SEGMENT)	GEOMETRIC DELAY (VEH.MIN/ TIME SEGMENT)
17.00-17.15								
B-C	4.24	10.39	0.408		1.1	0.7	11.0	
B-A	2.11	6.97	0.303		0.7	0.4	7.0	
C-A	4.31							
C-B	0.40	10.50	0.038		0.0	0.0	0.6	
A-B	0.20							
A-C	3.59							

QUEUE FOR STREAM B-C

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE	
16.00	0.7	*
16.15	1.0	*
16.30	2.4	**
16.45	2.6	***
17.00	1.1	*
17.15	0.7	*

QUEUE FOR STREAM B-A

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE	
16.00	0.4	
16.15	0.6	*
16.30	1.3	*
16.45	1.4	*
17.00	0.7	*
17.15	0.4	

QUEUE FOR STREAM C-B

TIME SEGMENT ENDING	NO. OF VEHICLES IN QUEUE
16.00	0.0
16.15	0.0
16.30	0.1
16.45	0.1
17.00	0.0
17.15	0.0

QUEUEING DELAY INFORMATION OVER WHOLE PERIOD

STREAM	TOTAL DEMAND		* QUEUEING * * DELAY *		* INCLUSIVE QUEUEING * * DELAY *	
	(VEH)	(VEH/H)	(MIN)	(MIN/VEH)	(MIN)	(MIN/VEH)
B-C	464.8	309.9	123.5	0.27	123.5	0.27
B-A	231.7	154.5	71.1	0.31	71.2	0.31
C-A	473.1	315.4				
C-B	43.9	29.3	4.4	0.10	4.4	0.10
A-B	21.9	14.6				
A-C	393.5	262.4				
ALL	1629.0	1086.0	199.1	0.12	199.1	0.12

* DELAY IS THAT OCCURRING ONLY WITHIN THE TIME PERIOD .
* INCLUSIVE DELAY INCLUDES DELAY SUFFERED BY VEHICLES WHICH ARE STILL QUEUEING AFTER THE END OF THE TIME PERIOD.
* THESE WILL ONLY BE SIGNIFICANTLY DIFFERENT IF THERE IS A LARGE QUEUE REMAINING AT THE END OF THE TIME PERIOD.

END OF JOB

****** PICADY 4 run completed.

Appendix F

Ground Investigations Surveys Note

RAEBURN
DRILLING & GEOTECHNICAL LTD

Our Ref: 21707/PC

7 May 2010

Scott Wilson Limited
Citypoint 2
25 Tyndrum Street
Glasgow
G4 0JY

For the attention of Ms Christine Johnson

Dear Madam

SOUTH TAY PARK AND RIDE, DUNDEE
PRELIMINARY GROUND INVESTIGATION

We are pleased to enclose one unbound copy of the above report. We would be pleased to discuss the report with you, or to advise you on any relevant problems which arise during design or construction stages, should you so desire.

We will retain all samples relating to this report for one calendar month. This being the case, all samples will be disposed off on 7 June 2010.

Yours faithfully

P Corr
Project Geologist

S. W. GLASGOW
RECEIVED
10 MAY 2010
JOB No
ACTION
COPY PSD

Encs.

Whistleberry Road, Hamilton, ML3 0HP, Scotland, UK
Tel: +44 (0)1698 711177 Fax: +44 (0)1698 710999
www.raeburndrilling.com

SOIL SAMPLES

U X	General purpose tube sample; X No of blows to drive sampler
UP	Piston sample
	NOTE: Tube samples are 100mm diameter unless otherwise specified in the remarks. Suffix 'a' indicates sample not recovered; suffix 'b' indicates full penetration of sampler not obtained; suffix 'c' indicates full penetration of sampler but limited recovery
D/J/T	Small Disturbed/Jar/Tub sample
B/LB	Bag/Large Bag sample

CORE RECOVERY AND ROCK QUALITY

TCR	Total Core Recovery: The total core recovered expressed as a percentage of the core run length
SCR	Solid Core Recovery: The core recovered as solid cylinders expressed as a percentage of the core run length
RQD	Rock Quality Designation: The core recovered as solid cylinders of length 100mm or more expressed as a percentage of core run length.
RO-S/RO-R	Rotary Open Hole Drilling through Soil / Rotary Open Hole Drilling through Rock
FI	Fracture Index: The number of discontinuities expressed as fractures per metre

Flush: "Depth" indicates depth down to which recorded "Returns" relate

GROUND-WATER

W	Ground-water sample
▼	Ground-water encountered
▼	Depth to which ground-water rose
▽	Ground-water cut off by the casing

IN SITU AND FIELD TESTS

SPT=X a/b (pen) or CPT=X a/b (pen)	Standard penetration test (split barrel sampler(SPT)or cone (CPT)); X is the penetration (N) value; 'a' is blow/75mm for seating drive; 'b' is blows/75mm for test drive; (pen) is test drive penetration if less than 300mm.
CBR	California bearing ratio test
MCV	Moisture condition value test
K	Permeability test
HP	Hand penetrometer test
FV	Field vane test
HV	Hand vane test
ID	Density test

LEGENDS

Material legends are in accordance with BS 5930:1999

before a description indicates that it is based on the Driller's record.

INSTALLATIONS (BACKFILL)

Concrete — Bentonite

Spoil — Bentonite/cement grout

Sand — Solid pipe

Gravel — Slotted pipe

Porous element — Wooden plug

ROTARY DRILLING SIZES

Letter	Nominal Diameter (mm)	
	Borehole	Core
Standard		
N	76	54
H	100	76
P	121	92
S	146	113
Non-standard		
412	108	75

DIMENSIONS

All dimensions in metres unless otherwise stated.

KEY TO BOREHOLE AND TRIAL PIT RECORDS

Boring

The standard method of boring in soil for ground investigation is known as the cable tool method. It uses various tools worked on a wire cable, typically a shell in non-cohesive soils such as sand and gravel, and a clay cutter in cohesive soils such as clay. Very dense soils, boulders or other hard obstructions are disturbed or broken up by chiselling and the fragments removed with the shell. Where the ground conditions require, the borehole is lined with driven steel casings of such sizes that the bottom of the borehole is not less than 125mm diameter.

Where there are constraints upon access, alternative methods of soft ground boring are available. However, each has limitations that need to be taken into account when assessing their suitability and the ground conditions inferred from their results.

Rotary Drilling

Rotary drilling is employed to extend ground investigation beyond the practical limit of cable tool boring in hard formations, commonly rock. Core drilling is used to obtain continuous intact samples of the formation and is generally undertaken with double tube swivel type core barrels fitted with tungsten or diamond bits as appropriate to formation type and hardness. Open-hole rotary drilling using tricone rock roller bits or tungsten insert drag bits, or down-the-hole hammers, is carried out where more limited information is sufficient, strata identification being made from cuttings only. Open-hole rotary drilling methods may also be employed for fast penetration of soils where detailed sampling is not required, prior to coring at depth. Air or water is the flushing medium normally used with rotary drilling methods. Where the ground conditions require, the borehole is lined with inserted or drilled-in casing.

Samples and In-situ Tests

Tube samples of cohesive soils are generally taken with a 100mm internal diameter open drive sampler known as a U100, with an area ratio of 30%. The sampler is driven into the soil at the bottom of the borehole by a sliding hammer. After a sample is taken, the drive head and cutting shoe are unscrewed from the sample tube and any wet or disturbed soil removed from either end. The sample tube is then sealed with wax and fitted with plastic end caps.

A range of more specialised equipment, e.g. piston or foil samplers, may be used to obtain higher quality samples in conditions where conventional open drive sampling is impracticable or unsatisfactory.

Disturbed samples are taken from the boring tools at regular intervals. The samples are sealed in airtight containers. Bulk samples are large disturbed samples from the boring tools, or from trial pits, generally where tube samples are unavailable.

The Standard Penetration Test, SPT, in accordance with BS1377:1990:Part 9:Clause 3.3, determines the resistance of soil to the penetration of a split barrel sampler. A 50mm diameter split barrel sampler is driven 450mm into the soil using a 63.5kg hammer with a 760mm drop, and the penetration resistance, the "N" value, is expressed as the number of blows required to achieve 300mm penetration below an initial penetration of 150mm, the seating drive, through any disturbed soil at the bottom of the borehole.

In coarse soils, the Cone Penetration Test (CPT) is conducted in the same manner as the SPT but using a 50mm diameter 60 degree apex solid cone point to replace the split barrel sampler.

Groundwater

Borehole water levels are recorded, together with the depths at which seepages or inflows of groundwater are detected and the observations noted on the borehole records. These observations may not give an accurate indication of groundwater conditions, for the following reasons:

(a) The borehole is rarely left standing at the relevant depth for sufficient time for the water level to reach equilibrium.
(b) A permeable stratum may have been sealed off by the borehole casing.
(c) It may have been necessary to add water to the borehole to facilitate progress.
(d) There may be seasonal, tidal or other effects at the site.

A more accurate record of groundwater behaviour may be obtained from standpipes or standpipe piezometers.

Gases

Determination and measurement of gases in the ground, commonly in relation to landfills, may be made directly from the ground surface, where a hole is formed by driving a solid and rigid steel spike to depths normally in the range 1.0 to 1.5m. Gas emissions are analysed using an appropriate portable analyser. However, research has shown that the small sample hole size and smearing effects can give a false negative result.

Where more accurate or longer term measurement of emissions is required, gas monitoring standpipes are installed in boreholes.

RAEBURN DRILLING AND GEOTECHNICAL LTD

Site: SOUTH TAY PARK AND RIDE PRELIMINARY GROUND INVESTIGATION, DUNDEE

Client: SESTRAN, TACTRAN and Transport Scotland

Engineer: Scott Wilson Scotland Limited

Contract No: 21707

Trial Pit No: TP01

Trial Pit to 2.40

Location: NO430286 | Dimensions: 1.1 x 2.8 | Equipment: Mechanical Excavator: Caterpillar 314

Progress	Sample Depth	Type	Result		Level (mOD)	Depth	Description of Strata	Legend	Water Depth	Backfill Symbol	Backfill Depth
31/3 2010						0.45	Brown sandy slightly gravelly TOPSOIL				
	0.70	B, T (x2)					Orange brown locally greyish brown very silty very sandy subrounded and subangular fine to coarse GRAVEL with occasional subrounded and subangular cobbles locally passing to very silty fine to coarse sand and subrounded and subangular fine to coarse gravel with occasional subrounded and subangular cobbles and pockets of silt; possible made ground				
	1.70	B, T				2.00			▼		
31/3	2.35	B (x4)				2.40	Dark greenish grey locally vesicular BASALT; recovered as angular fine to coarse gravel and cobbles		2.30		2.40
							END OF TRIAL PIT				

Remarks:

Ground-water was encountered at a depth of 1.90m.
The walls of the pit stood vertical throughout excavation.

Driller	Originator	Ground-water Struck	Rose To	Time(mins)	Cut Off
	PC	1.90			

Chk & App	Status
WTG	**Final**

Fig No: B1

Sheet 1 of 1

Scale 1:50

RAEBURN DRILLING AND GEOTECHNICAL LTD

Site:	SOUTH TAY PARK AND RIDE PRELIMINARY GROUND INVESTIGATION, DUNDEE
Client:	SESTRAN, TACTRAN and Transport Scotland
Engineer:	Scott Wilson Scotland Limited
Contract No:	21707
Trial Pit No:	TP02
Trial Pit to	4.00
Location:	NO430286
Dimensions:	1.1 x 2.9
Equipment:	Mechanical Excavator: Caterpillar 314

Progress	Sample Depth	Type	Result		Level (mOD)	Depth	Description of Strata	Legend	Water Depth	Backfill Symbol	Backfill Depth
31/3 2010						0.30	Brown sandy slightly gravelly TOPSOIL				
	0.90	B, T (x2)				1.40	Orange brown locally greyish brown silty sandy subrounded and subangular fine to coarse GRAVEL with occasional subrounded and subangular cobbles locally passing to very silty fine to coarse sand and subrounded and subangular fine to coarse gravel with occasional subrounded and subangular cobbles and pockets of silt; possible made ground				
	2.00	B, T					Orange brown very silty fine to coarse SAND and subrounded and subangular fine to coarse GRAVEL with occasional subrounded and subangular cobbles and pockets of clay; possible made ground				
	3.50	B, T									
31/3						4.00	.... at 4.00m: OBSTRUCTION END OF TRIAL PIT		▼ 4.00		4.00

Remarks:

Ground-water was encountered at a depth of 4.00m.
The walls of the pit stood vertical throughout excavation.

Driller	Originator	Ground-water Struck	Rose To	Time(mins)	Cut Off
	PC	4.00			

Chk & App	Status
WTG	**Final**

RAEBURN

Fig No: B2

Sheet 1 of 1

Scale 1:50

RAEBURN DRILLING AND GEOTECHNICAL LTD

Site:	SOUTH TAY PARK AND RIDE PRELIMINARY GROUND INVESTIGATION, DUNDEE
Client:	SESTRAN, TACTRAN and Transport Scotland
Engineer:	Scott Wilson Scotland Limited
Contract No:	21707
Trial Pit No:	TP03
Trial Pit to	0.70
Location:	NO430286
Dimensions:	1.1 x 2.7
Equipment:	Mechanical Excavator: Caterpillar 314

Progress	Sample Depth	Type	Result		Level (mOD)	Depth	Description of Strata	Legend	Water Depth	Backfill Symbol	Backfill Depth
31/3 2010						0.15	Brown sandy slightly gravelly TOPSOIL				
	0.30	B	(x3)			0.40	Dark greenish grey locally vesicular BASALT; recovered as angular fine to coarse gravel and cobbles				0.40
							END OF TRIAL PIT				

Remarks:
Ground-water was not encountered.
The walls of the pit stood vertical throughout excavation.

Driller	Originator	Ground-water Struck	Rose To	Time(mins)	Cut Off
	PC				
Chk & App: WTG	Status: **Final**				

Fig No: B3
Sheet 1 of 1
Scale 1:50

RAEBURN DRILLING AND GEOTECHNICAL LTD

Site:	SOUTH TAY PARK AND RIDE PRELIMINARY GROUND INVESTIGATION, DUNDEE
Client:	SESTRAN, TACTRAN and Transport Scotland
Engineer:	Scott Wilson Scotland Limited
Contract No:	21707
Trial Pit No:	TP04
Trial Pit to	3.90
Location:	NO430286
Dimensions:	1.1 x 2.9
Equipment:	Mechanical Excavator: Caterpillar 314

Progress	Sample Depth	Type	Result		Level (mOD)	Depth	Description of Strata	Legend	Water Depth	Backfill Symbol	Backfill Depth
31/3 2010						0.20	MADE GROUND (dark brown sandy gravelly topsoil)				
	0.60	B, T				0.90	PROBABLE MADE GROUND (orange brown silty gravelly fine to coarse sand with occasional subrounded and subangular cobbles locally passing to very clayey fine to coarse sand and subrounded and subangular fine to coarse gravel with occasional subrounded and subangular cobbles)				
	1.40	B, T				2.20	PROBABLE MADE GROUND (orange brown very silty very sandy subrounded and subangular fine to coarse gravel with occasional subrounded and subangular cobbles locally passing to very sandy gravelly silt with occasional subrounded and subangular cobbles)				
	2.40	B, T					PROBABLE MADE GROUND (orange brown locally reddish brown very silty fine to coarse sand and subrounded and subangular fine to coarse gravel with occasional subrounded and subangular cobbles locally passing to very clayey fine to coarse sand and subrounded and subangular fine to coarse gravel with occasional subrounded and subangular cobbles)				
	2.80	B, T									
	3.50	B, T									
31/3						3.90	END OF TRIAL PIT		3.90		3.90

Remarks:

Ground-water seepage was encountered at a depth of 1.25m.
The walls of the pit stood vertical throughout excavation.

Driller	Originator	Ground-water Struck	Rose To	Time(mins)	Cut Off	Fig No:
	PC					B4
Chk & App: WTG	Status: **Final**					Sheet 1 of 1, Scale 1:50

RAEBURN DRILLING AND GEOTECHNICAL LTD

Site: SOUTH TAY PARK AND RIDE
PRELIMINARY GROUND INVESTIGATION, DUNDEE

Client: SESTRAN, TACTRAN and Transport Scotland

Engineer: Scott Wilson Scotland Limited

Contract No: 21707

Trial Pit No: TP05

Trial Pit to 4.25

Location: NO430286 | Dimensions: 1.1 x 2.9 | Equipment: Mechanical Excavator: Caterpillar 314

Progress	Sample Depth	Type	Result	Level (mOD)	Depth	Description of Strata	Legend	Water Depth	Backfill Symbol	Backfill Depth
31/3 2010					0.40	MADE GROUND (dark brown sandy gravelly topsoil)				
	0.60	B, T (x2)			1.50	PROBABLE MADE GROUND (orange brown silty gravelly fine to coarse sand with occasional subrounded and subangular cobbles locally passing to very clayey fine to coarse sand and subrounded and subangular fine to coarse gravel with occasional subrounded and subangular cobbles)		▼		
	1.60	B, T			2.30	PROBABLE MADE GROUND (orange brown very sandy gravelly silt with occasional subrounded and subangular cobbles locally passing to very silty fine to coarse sand and subrounded and subangular fine to coarse gravel with occasional subrounded and subangular cobbles)				
	2.60	B, T			3.20	PROBABLE MADE GROUND (orange brown silty very gravelly fine to coarse sand with occasional subrounded and subangular cobbles locally passing to very clayey fine to coarse sand and subrounded and subangular fine to coarse gravel with occasional subrounded and subangular cobbles)				
31/3	3.60	B, T			4.25	Orange brown very sandy gravelly SILT with occasional subrounded and subangular cobbles locally passing to very silty fine to coarse sand and subrounded and subangular fine to coarse gravel with occasional subrounded and subangular cobbles; possible made ground		DRY		4.25
						END OF TRIAL PIT				

Remarks:
Slight ground-water seepage was encountered at a depth of 1.00m.
The walls of the pit stood vertical throughout excavation.

Driller	Originator	Ground-water Struck	Rose To	Time(mins)	Cut Off
	PC	1.00			

Chk & App	Status
WTG	**Final**

Fig No: B5
Sheet 1 of 1
Scale 1:50

RAEBURN DRILLING AND GEOTECHNICAL LTD

Site:	SOUTH TAY PARK AND RIDE PRELIMINARY GROUND INVESTIGATION, DUNDEE
Client:	SESTRAN, TACTRAN and Transport Scotland
Engineer:	Scott Wilson Scotland Limited
Contract No:	21707
Trial Pit No:	TP06
Trial Pit to	4.00
Location:	NO430286
Dimensions:	1.1 x 3
Equipment:	Mechanical Excavator: Caterpillar 314

Progress	Sample Depth	Type	Result		Level (mOD)	Depth	Description of Strata	Legend	Water Depth	Backfill Symbol	Backfill Depth
31/3 2010						0.35	MADE GROUND (brown sandy gravelly topsoil)				
	0.50	B, T					PROBABLE MADE GROUND (orange brown very silty fine to coarse sand and subrounded and subangular fine to coarse gravel with occasional subrounded and subangular cobbles and pockets of silt)				
	1.50	B, T									
	2.50	B, T					....below 2.50m: occasional boulders				
	3.50	B, T									
31/3						4.00			DRY		4.00
							END OF TRIAL PIT				

Remarks:
Ground-water was not encountered.
The walls of the pit stood vertical throughout excavation.

Driller	Originator	Ground-water Struck	Rose To	Time(mins)	Cut Off	Fig No:
	PC					B6
Chk & App: WTG	Status: **Final**					Sheet 1 of 1, Scale 1:50

RAEBURN DRILLING AND GEOTECHNICAL LTD

Site:	SOUTH TAY PARK AND RIDE PRELIMINARY GROUND INVESTIGATION, DUNDEE
Client:	SESTRAN, TACTRAN and Transport Scotland
Engineer:	Scott Wilson Scotland Limited
Contract No:	21707
Trial Pit No:	TP07
Trial Pit to	4.10
Location:	NO430286
Dimensions:	1.1 x 3
Equipment:	Mechanical Excavator: Caterpillar 314

Progress	Sample Depth	Type	Result		Level (mOD)	Depth	Description of Strata	Legend	Water Depth	Backfill Symbol	Backfill Depth
31/3 2010						0.30	MADE GROUND (dark brown sandy gravelly topsoil)				
						0.80	PROBABLE MADE GROUND (orange brown very sandy gravelly silt with occasional subrounded and subangular cobbles locally passing to very silty fine to coarse sand and subrounded and subangular fine to coarse gravel with occasional subrounded and subangular cobbles)				
						1.20	PROBABLE MADE GROUND (greenish grey sandy slightly gravelly silt with occasional rootlets and subrounded cobbles)				
31/3						4.10	PROBABLE MADE GROUND (orange brown very sandy gravelly silt with occasional subrounded and subangular cobbles locally passing to very silty fine to coarse sand and subrounded and subangular fine to coarse gravel with occasional subrounded and subangular cobbles)		DRY		4.10
							END OF TRIAL PIT				

Remarks:
Ground-water was not encountered.
The walls of the pit stood vertical throughout excavation.

Driller	Originator	Ground-water Struck	Rose To	Time(mins)	Cut Off	Fig No:
	PC					B7
Chk & App	Status					Sheet 1 of 1
WTG	**Final**					Scale 1:50

RAEBURN DRILLING AND GEOTECHNICAL LTD

Site:	SOUTH TAY PARK AND RIDE PRELIMINARY GROUND INVESTIGATION, DUNDEE
Client:	SESTRAN, TACTRAN and Transport Scotland
Engineer:	Scott Wilson Scotland Limited
Contract No:	21707
Trial Pit No:	TP08
Trial Pit to	2.10
Location:	NO430286
Dimensions:	1.1 x 2.9
Equipment:	Mechanical Excavator: Caterpillar 314

Progress	Sample Depth	Samples and Tests Type	Samples and Tests Result		Level (mOD)	Depth	Description of Strata	Legend	Water Depth	Backfill Symbol	Backfill Depth
31/3 2010						0.30	MADE GROUND (brown sandy slightly gravelly topsoil)				
							PROBABLE MADE GROUND (orange brown locally greyish brown silty sandy subrounded and subangular fine to coarse gravel with occasional subrounded and subangular cobbles locally passing to very silty fine to coarse sand and subrounded and subangular fine to coarse gravel with occasional subrounded and subangular cobbles and pockets of silt)				
31/3						2.10	.... at 2.10m: OBSTRUCTION (no progress)		DRY		2.10
							END OF TRIAL PIT				

Remarks:

Ground-water was not encountered.
The walls of the pit stood vertical throughout excavation.

Driller	Originator	Ground-water Struck	Rose To	Time(mins)	Cut Off
	PC				
Chk & App	Status				
WTG	**Final**				

Fig No: B8

Sheet 1 of 1

Scale 1:50

RAEBURN DRILLING AND GEOTECHNICAL LTD

Site:	SOUTH TAY PARK AND RIDE PRELIMINARY GROUND INVESTIGATION, DUNDEE
Client:	SESTRAN, TACTRAN and Transport Scotland
Engineer:	Scott Wilson Scotland Limited
Contract No:	21707
Trial Pit No:	TP09
Trial Pit to	0.50
Location:	NO430286
Dimensions:	1.1 x 2.7
Equipment:	Mechanical Excavator: Caterpillar 314

Progress	Sample Depth	Samples and Tests Type	Result		Level (mOD)	Depth	Description of Strata	Legend	Water Depth	Backfill Symbol	Backfill Depth
31/3 2010						0.20	Brown sandy slightly gravelly TOPSOIL				
31/3	0.40	B	(x2)			0.50	Dark greenish grey locally vesicular BASALT; recovered as angular fine to coarse gravel		DRY		0.50
							END OF TRIAL PIT				

Remarks:
Ground-water was not encountered.
The walls of the pit stood vertical throughout excavation.

Driller	Originator	Ground-water Struck	Rose To	Time(mins)	Cut Off
	PC				
Chk & App: WTG	Status: **Final**				

Fig No: B9
Sheet 1 of 1
Scale 1:50

RAEBURN DRILLING AND GEOTECHNICAL LTD

Site: SOUTH TAY PARK AND RIDE PRELIMINARY GROUND INVESTIGATION, DUNDEE

Client: SESTRAN, TACTRAN and Transport Scotland

Engineer: Scott Wilson Scotland Limited

Contract No: 21707

Trial Pit No: TP10

Trial Pit to 3.80

Location: NO430286 | Dimensions: 1.1 x 3 | Equipment: Mechanical Excavator: Caterpillar 314

Progress	Sample Depth	Type	Result		Level (mOD)	Depth	Description of Strata	Legend	Water Depth	Backfill Symbol	Backfill Depth
31/3 2010						0.30	MADE GROUND (brown sandy slightly gravelly topsoil)				
						3.00	PROBABLE MADE GROUND (orange brown silty gravelly fine to coarse sand with occasional subrounded and subangular cobbles locally passing to very clayey fine to coarse sand and subrounded and subangular fine to coarse gravel with occasional subrounded and subangular cobbles)				
							Orange brown locally reddish brown very silty fine to coarse SAND and subrounded and subangular fine to coarse GRAVEL with occasional subrounded and subangular cobbles; possible made ground				
31/3						3.80	.... at 3.80m: OBSTRUCTION (no progress)		DRY		3.80
							END OF TRIAL PIT				

Remarks:

Ground-water was not encountered.
The walls of the pit stood vertical throughout excavation.

Driller	Originator	Ground-water Struck	Rose To	Time(mins)	Cut Off
	PC				

Chk & App	Status
WTG	**Final**

Fig No: B10

Sheet 1 of 1

Scale 1:50

APPENDIX C
GEOTECHNICAL LABORATORY TESTING

TEST	STANDARD
CLASSIFICATION TESTS	
Determination of moisture content	BS 1377 : 1990 : Part 2 : 3.2
Determination of liquid limit	BS 1377 : 1990 : Part 2 : 4.3 and 4.4
Determination of plastic limit and plasticity index	BS 1377 : 1990 : Part 2 : 5.3 and 5.4
Determination of bulk density	BS 1377 : 1990 : Part 2 : 7.2
Determination of particle density (formerly specific gravity)	BS 1377 : 1990 : Part 2 : 8.2 and 8.3
Sieve analysis by wet or dry sieving	BS 1377 : 1990 : Part 2 : 9.2 and 9.3
Sedimentation by the hydrometer method	BS 1377 : 1990 : Part 2 : 9.5
CHEMICAL TESTS	
Determination of organic matter content	BS 1377 : 1990 : Part 3 : 3.4
Determination of mass loss on ignition	BS 1377 : 1990 : Part 3 : 4.3
Determination of sulphate content of soil and groundwater	BS 1377 : 1990 : Part 3 : 5.2, 5.3 and 5.5
Determination of chloride content	BS 1377 : 1990 : Part 3 : 7.2 and 7.3
Determination of pH value	BS 1377 : 1990 : Part 3 : 9.5
COMPACTION-RELATED TESTS	
Determination of dry density/moisture content relationship	BS 1377 : 1990 : Part 4 : 3.3 to 3.6
Determination of moisture condition value (MCV)	SDD Tech Memo SH7/83; SDD Appls Guide No.1 Rev. 1989
Determination of California Bearing Ratio (CBR)	BS 1377 : 1990 : Part 4 : 7.4
CONSOLIDATION AND STRENGTH TESTS	
Determination of one-dimensional consolidation properties	BS 1377 : 1990 : Part 5 : 3.5
Determination of undrained shear strength in triaxial compression	BS 1377 : 1990 : Part 7 : 8.4 and 9.4
ROCK TESTS	
Determination of point load strength	DIHM based on ISRM Commission on Testing Methods, 1985
Determination of unconfined compressive strength	DIHM based on ASTM D2938-86

NOTES ON LABORATORY PROCEDURES

TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES

Site: **SOUTH TAY PARK AND RIDE PRELIMINARY GROUND INVESTIGATION, DUNDEE**

Client: SESTRAN, TACTRAN & TRANSPORT SCOTLAND

Engineer: Scott Wilson Scotland Limited (Glasgow)

Contract No 21707

~ Indicates test not carried out

Exploratory Hole	Depth m	Sample Ref	Sample Type	Lab Sample ID	Non Engineering Sample Description	Moisture Content %	Atterberg limits: Liquid Limit %	Plastic Limit %	Plasticity Index	Percentage retained 425µm %	Atterberg Classification	Particle Density Mg/m³	Density: Bulk Mg/m³	Dry Mg/m³	Total Stress: Shear Strength kPa	Apparent Cohesion C kPa	Angle of Shearing Resistance Phi	Other Tests
TP01	1.70		B	AS28742	Brown very silty very sandy GRAVEL with occasional cobbles	~	~	~	~	~		~	~	~	~	~	~	SIEVE PIPETTE
TP01	2.35		B	AS28743	Grey silty sandy GRAVEL and COBBLES	8.2	~	~	~	~		~	~	~	~	~	~	LAC
TP02	2.00		T	AS28744	Brown sandy clayey GRAVEL	13	26	17	9	70	CL	~	~	~	~	~	~	~
TP03	0.30		B	AS28745	Brown silty sandy GRAVEL and COBBLES	3.1	~	~	~	~		~	~	~	~	~	~	~
TP04	0.60		B	AS28746	Brown SAND and GRAVEL	~	~	~	~	~		~	~	~	~	~	~	pH VALUE 2:1 EXTRACT
Notes	Opinions and interpretations are outside the scope of UKAS accreditation				UKAS Accredited Test Y/N	Y	Y	Y	Y	Y	-	Y	Y	Y	Y	Y	Y	See individual report sheets

Test details are given on the 'Notes on Laboratory Procedures' sheet

Originator	Checked & Approved
DM	[signature] 07/05/2010

SUMMARY OF GEOTECHNICAL TESTS

Figure C1

Sheet 1 of 3

TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES

Site	**SOUTH TAY PARK AND RIDE PRELIMINARY GROUND INVESTIGATION, DUNDEE**	**Contract No**	**21707**
Client	SESTRAN, TACTRAN & TRANSPORT SCOTLAND		~ Indicates test not carried out
Engineer	Scott Wilson Scotland Limited (Glasgow)		

Sample Identification							Atterberg limits						Density		Total Stress			
Exploratory Hole	Depth m	Sample Ref	Sample Type	Lab Sample ID	Non Engineering Sample Description	Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity Index	Percentage retained 425µm %	Atterberg Classification	Particle Density Mg/m³	Bulk Mg/m³	Dry Mg/m³	Shear Strength kPa	Apparent Cohesion C kPa	Angle of Shearing Resistance Phi	Other Tests
TP04	1.40		B	AS28747	Brown very silty SAND and GRAVEL with cobbles	13	~	~	~	~		~	~	~	~	~	~	SIEVE PIPETTE COMPACTION
TP04	1.40		T	AS28748	Brown very silty SAND and GRAVEL with cobbles	16	27	NP	~	68		~	~	~	~	~	~	~
TP04	2.40		B	AS28749	Brown gravelly sandy CLAY	13	~	~	~	~		~	~	~	~	~	~	COMPACTION
TP04	2.80		B	AS28750	Brown very silty SAND and GRAVEL with occasional cobbles	~	~	~	~	~		~	~	~	~	~	~	SIEVE PIPETTE
TP05	0.60		T	AS28751	Brown silty SAND and GRAVEL	~	~	~	~	~		~	~	~	~	~	~	pH VALUE 2:1 EXTRACT
Notes	Opinions and interpretations are outside the scope of UKAS accreditation				UKAS Accredited Test Y/N	Y	Y	Y	Y	Y	-	Y	Y	Y	Y	Y	Y	See individual report sheets

Test details are given on the 'Notes on Laboratory Procedures' sheet

Originator	Checked & Approved		
DM	07/05/2010	**SUMMARY OF GEOTECHNICAL TESTS**	**Figure C1** Sheet 2 of 3

TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES

Site: **SOUTH TAY PARK AND RIDE PRELIMINARY GROUND INVESTIGATION, DUNDEE**

Client: SESTRAN, TACTRAN & TRANSPORT SCOTLAND

Engineer: Scott Wilson Scotland Limited (Glasgow)

Contract No 21707

~ Indicates test not carried out

Sample Identification				Lab Sample ID	Non Engineering Sample Description	Moisture Content	Atterberg limits					Particle Density	Density		Total Stress			Other Tests
Exploratory Hole	Depth m	Sample Ref	Sample Type			%	Liquid Limit %	Plastic Limit %	Plasticity Index	Percentage retained 425µm %	Atterberg Classification	Mg/m³	Bulk Mg/m³	Dry Mg/m³	Shear Strength kPa	Apparent Cohesion C kPa	Angle of Shearing Resistance Phi	
TP05	1.60		T	AS28752	Brown gravelly sandy CLAY	15	~	~	~	~		~	~	~	~	~	~	~
TP05	3.60		T	AS28753	Brown gravelly sandy CLAY	12	~	~	~	~		~	~	~	~	~	~	~
TP06	0.50		B	AS28754	Brown very silty SAND and GRAVEL with cobbles and pockets of clay	12	~	~	~	~		~	~	~	~	~	~	SIEVE PIPETTE CBR
TP09	0.40		B	AS28755	Brown sandy clayey GRAVEL and COBBLES	2	~	~	~	~		~	~	~	~	~	~	~
Notes: Opinions and interpretations are outside the scope of UKAS accreditation					UKAS Accredited Test Y/N	Y	Y	Y	Y	Y	-	Y	Y	Y	Y	Y	Y	See individual report sheets

Test details are given on the 'Notes on Laboratory Procedures' sheet

Originator	Checked & Approved
DM	[signature] 07/05/2010

SUMMARY OF GEOTECHNICAL TESTS

Figure C1

TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES

Site: **SOUTH TAY PARK AND RIDE, PRELIMINARY GROUND INVESTIGATION, DUNDEE**

Contract No 21707

Client: Sestran Tactran & Transport Scotland

Engineer: Scott Wilson Scotland limited (Glasgow)

Exploratory Hole	Depth m	Sample Ref	Sample Type	Lab Sample ID	Non Engineering Sample Description	Sample Passing 2.0 mm Test Sieve	Organic Matter: Organic Content	Organic Matter: Sulphides or Chlorides Present	Mass Loss on Ignition	Sulphate Content as SO4: Total Acid Soluble Sulphate	Sulphate Content as SO4: Sulphate Content of 2:1 Water:Soil Extract	Sulphate Content as SO4: Sulphate Content of Groundwater	Carbonate Content - CO2	Chloride Content: Water Soluble Chloride Content	Chloride Content: Water : Soil Ratio	Chloride Content: Acid Soluble Chloride Content	pH Value	Total Dissolved Solids
						%	%		%	%	g/l	mg/l	%	%		%	pH Units	mg/L
TP04	0.60		B	AS28746	Brown SAND with some gravel. Gravel is fine to medium.	52	~	~	~	~	0.02	~	~	~	~	~	7.9	~
TP05	0.60		T	AS28751	Brown clayey SAND with some gravel. Gravel is fine to medium.	67	~	~	~	~	0.01	~	~	~	~	~	5.8	~
Notes	Opinions and interpretations are outside the scope of UKAS accreditation				Terra Tek Analysis Method / Accreditation M=Mcerts U=UKAS N=No accreditation		TP041 U		TP042 M	TP029 M	TP043 M	TP065 U	~ N	TP031 N		TP031 N	TP019 M	TP035 N

Originator	Checked & Approved
TH	S. Longreen 30/04/2010

RESULTS OF CHEMICAL AND ELECTRO-CHEMICAL TESTS

Figure C2

Sheet 1 of 1

Revision 1.4 14/05/2009
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TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES

Site	SOUTH TAY PARK AND RIDE PRELIMINARY GROUND INVESTIGATION, DUNDEE	Contract No	21707
Client	SESTRAN, TACTRAN & TRANSPORT SCOTLAND		
Engineer	Scott Wilson Scotland Limited (Glasgow)		

Sample Identification									
Hole ID	Depth m	Sample Ref	Sample Type	Lab Sample ID	10-14mm Size Fraction Passing 11.2mm Sieve %	Particle Density (8-12.5 mm) Mg/m³	Los Angeles Coefficient	Aggregate Impact Value %	Comments
TP01	2.35		B	AS28743	35	~	23	~	Test portion consistes of crushed material graded 10-14mm
					UKAS accredited test		Yes	No	

Notes Opinions and interpretations are outside the scope of UKAS accreditation.

Originator	Approved	
SM	07/05/2010	

RESISTANCE TO FRAGMENTATION BY LOS ANGELES AND IMPACT TEST METHODS
BS EN 1097-2 : 1998

TTK **Figure C3**

Sheet 1 of 1

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Lab Project No RT9037 : 07/05/2010 10:39:53

Version 32 - 20/05/2009

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TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES

Site	SOUTH TAY PARK AND RIDE PRELIMINARY GROUND INVESTIGATION, DUNDEE	Contract No **21707**
Client	SESTRAN, TACTRAN & TRANSPORT SCOTLAND	Hole TP01 Sample Ref Depth (m) 1.70
Engineer	Scott Wilson Scotland Limited (Glasgow)	Sample Type B

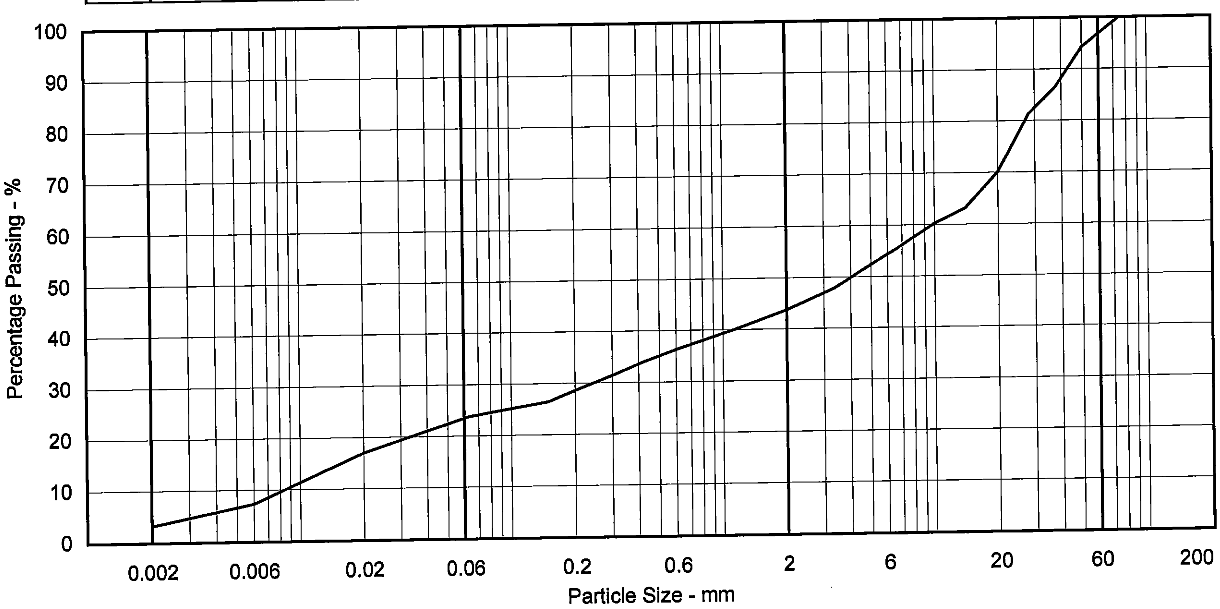
Particle Size	% Passing
125.0 mm	100
90.0 mm	100
75.0 mm	100
50.0 mm	94
37.5 mm	87
28.0 mm	81
20.0 mm	70
14.0 mm	63
10.0 mm	60
6.30 mm	55
5.00 mm	52
3.35 mm	48
2.00 mm	44
1.18 mm	40
600 µm	36
425 µm	34
300 µm	31
212 µm	29
150 µm	26
63 µm	24
20 µm	17
6 µm	7
2 µm	3

Non Engineering Description
Brown very silty very sandy GRAVEL with occasional cobbles

Sample Proportions - %	
Cobbles	3.4
Gravel	52.8
Sand	20.5
Silt	20.1
Clay	3.2

Particle Diameter - mm	
D100	75
D60	9.8
D10	0.0084
Uniformity Coefficient	1166.7

Notes



Originator	Checked & Approved	PARTICLE SIZE DISTRIBUTION	Figure C4
SG	07/05/2010	BS1377:Part 2:1990 Clause 9.2 - Wet Sieving BS1377:Part 2:1990 Clause 9.4 - Sedimentation by Pipette	Sheet 1 of 1

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Lab Project No RT9037 : 07/05/2010 10:41:54

Version 32 - 20/05/2009
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TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES

Site	**SOUTH TAY PARK AND RIDE PRELIMINARY GROUND INVESTIGATION, DUNDEE**	**Contract No**	**21707**
Client	SESTRAN, TACTRAN & TRANSPORT SCOTLAND	Hole	TP04
Engineer	Scott Wilson Scotland Limited (Glasgow)	Sample Ref	
		Depth (m)	1.40
		Sample Type	B

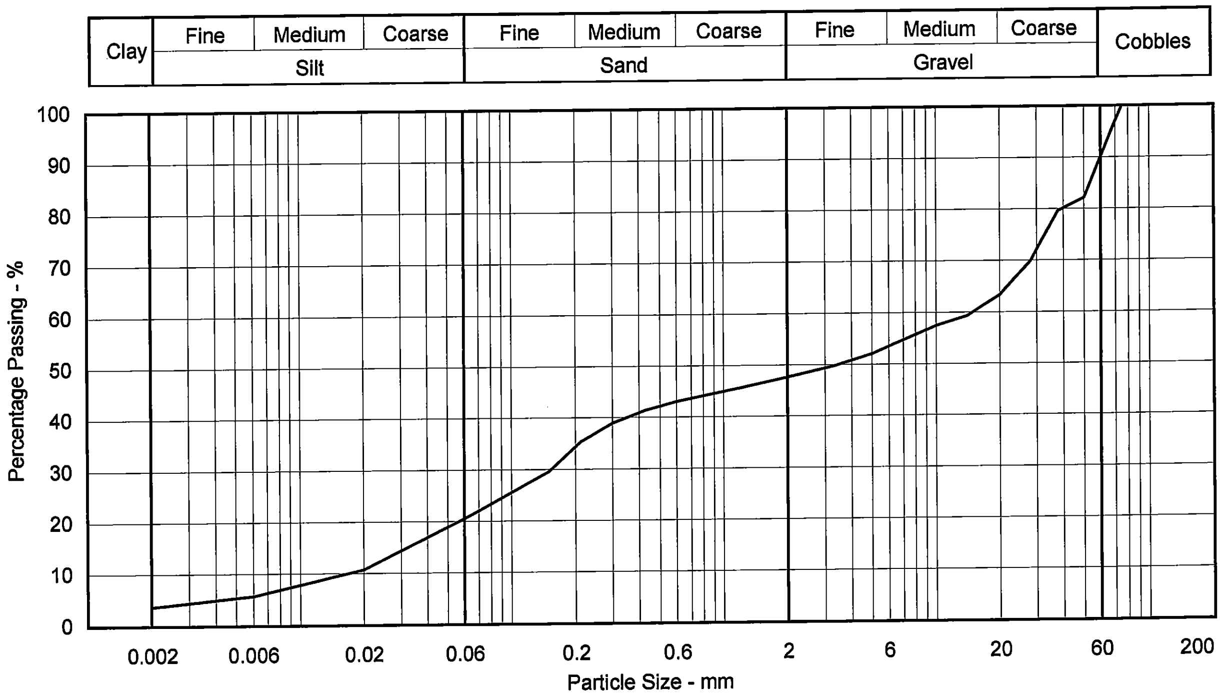
Particle Size	% Passing
125.0 mm	100
90.0 mm	100
75.0 mm	100
50.0 mm	82
37.5 mm	80
28.0 mm	70
20.0 mm	63
14.0 mm	59
10.0 mm	57
6.30 mm	54
5.00 mm	52
3.35 mm	50
2.00 mm	48
1.18 mm	46
600 µm	43
425 µm	41
300 µm	39
212 µm	35
150 µm	30
63 µm	21
20 µm	11
6 µm	6
2 µm	4

Non Engineering Description
Brown very silty SAND and GRAVEL with cobbles

Sample Proportions - %	
Cobbles	10.7
Gravel	41.7
Sand	27.3
Silt	16.7
Clay	3.6

Particle Diameter - mm	
D100	75
D60	15
D10	0.017
Uniformity Coefficient	882.4

Notes



Originator	Checked & Approved	**PARTICLE SIZE DISTRIBUTION**	**Figure C5**
SG	07/05/2010	BS1377:Part 2:1990 Clause 9.2 - Wet Sieving BS1377:Part 2:1990 Clause 9.4 - Sedimentation by Pipette	Sheet 1 of 1

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Lab Project No RT9037 : 07/05/2010 10:41:58

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TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES			
Site	SOUTH TAY PARK AND RIDE PRELIMINARY GROUND INVESTIGATION, DUNDEE	Contract No	21707
Client	SESTRAN, TACTRAN & TRANSPORT SCOTLAND	Hole	TP04
		Sample Ref	
		Depth (m)	2.80
Engineer	Scott Wilson Scotland Limited (Glasgow)	Sample Type	B

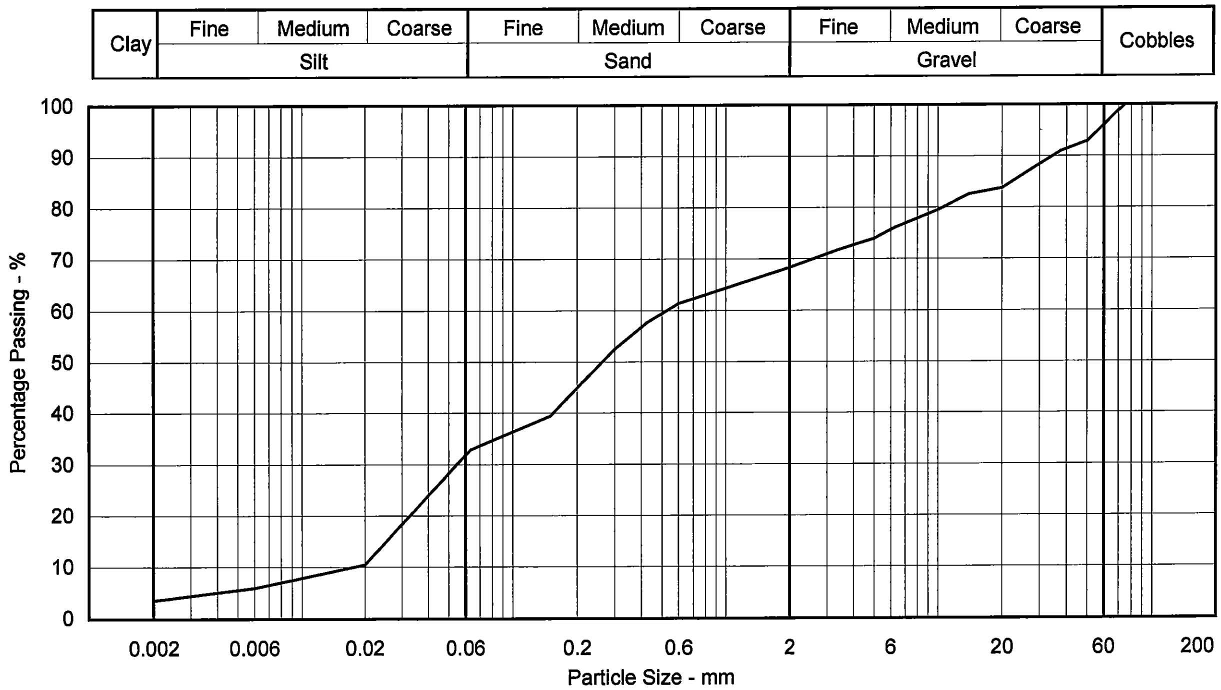
Particle Size	% Passing
125.0 mm	100
90.0 mm	100
75.0 mm	100
50.0 mm	93
37.5 mm	91
28.0 mm	88
20.0 mm	84
14.0 mm	83
10.0 mm	80
6.30 mm	76
5.00 mm	74
3.35 mm	72
2.00 mm	68
1.18 mm	65
600 µm	61
425 µm	58
300 µm	53
212 µm	46
150 µm	39
63 µm	33
20 µm	11
6 µm	6
2 µm	4

Non Engineering Description
Brown very silty SAND and GRAVEL with occasional cobbles

Sample Proportions - %	
Cobbles	4.2
Gravel	27.4
Sand	37.0
Silt	27.9
Clay	3.5

Particle Diameter - mm	
D100	75
D60	0.53
D10	0.017
Uniformity Coefficient	31.2

Notes



Originator	Checked & Approved		
SG	07/05/2010	**PARTICLE SIZE DISTRIBUTION** BS1377:Part 2:1990 Clause 9.2 - Wet Sieving BS1377:Part 2:1990 Clause 9.4 - Sedimentation by Pipette	TTK **Figure C6** Sheet 1 of 1

62 Rochsoloch Road, Airdrie ML6 9BG

Lab Project No RT9037 : 07/05/2010 10:42:03

TERRA TEK
SITE INVESTIGATION AND LABORATORY SERVICES

Site	SOUTH TAY PARK AND RIDE PRELIMINARY GROUND INVESTIGATION, DUNDEE	Contract No	21707
Client	SESTRAN, TACTRAN & TRANSPORT SCOTLAND	Hole	TP06
		Sample Ref	
Engineer	Scott Wilson Scotland Limited (Glasgow)	Depth (m)	0.50
		Sample Type	B

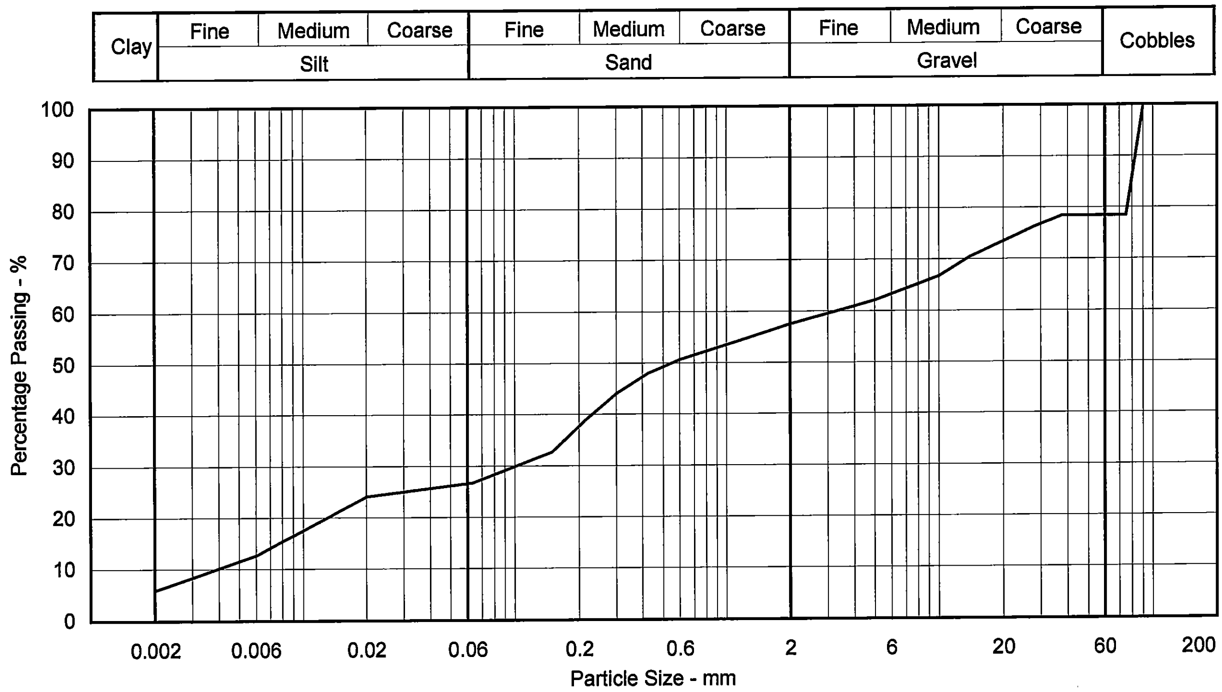
Particle Size	% Passing
125.0 mm	100
90.0 mm	100
75.0 mm	78
50.0 mm	78
37.5 mm	78
28.0 mm	76
20.0 mm	74
14.0 mm	70
10.0 mm	67
6.30 mm	64
5.00 mm	62
3.35 mm	60
2.00 mm	58
1.18 mm	54
600 µm	51
425 µm	48
300 µm	44
212 µm	39
150 µm	33
63 µm	27
20 µm	24
6 µm	13
2 µm	6

Non Engineering Description
Brown very silty SAND and GRAVEL with cobbles and pockets of clay

Sample Proportions - %	
Cobbles	21.6
Gravel	20.9
Sand	31.0
Silt	20.7
Clay	5.9

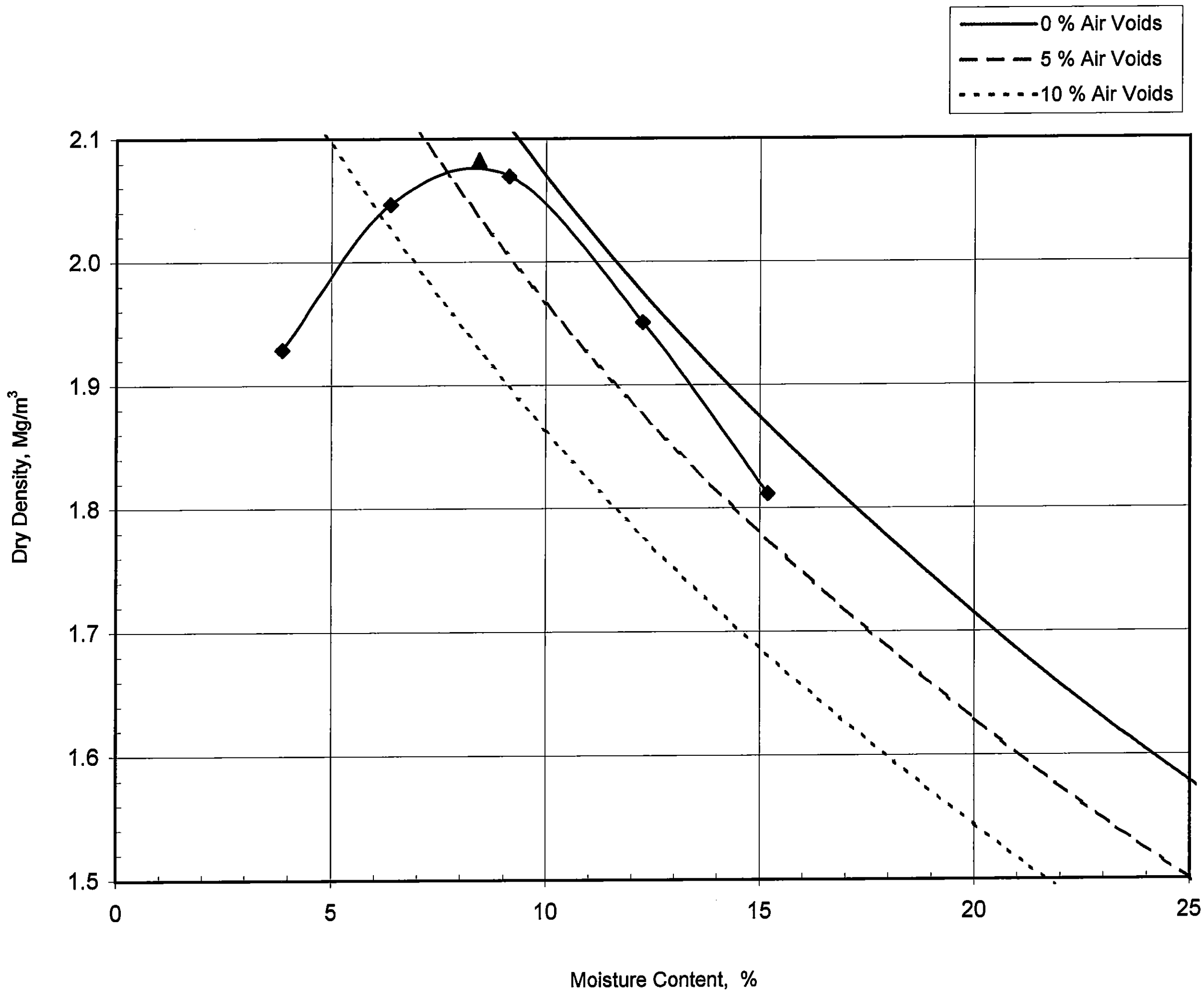
Particle Diameter - mm	
D100	90
D60	3.3
D10	0.0039
Uniformity Coefficient	846.2

Notes



Originator	Checked & Approved		
SG	07/05/2010	**PARTICLE SIZE DISTRIBUTION** BS1377:Part 2:1990 Clause 9.2 - Wet Sieving BS1377:Part 2:1990 Clause 9.4 - Sedimentation by Pipette	**Figure C7** Sheet 1 of 1

TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES	Site	SOUTH TAY PARK AND RIDE PRELIMINARY GROUND INVESTIGATION, DUNDEE	Contract No 21707
	Client	SESTRAN, TACTRAN & TRANSPORT SCOTLAND	Hole TP04 Sample Ref Depth (m) 1.40 Sample Type B
	Engineer	Scott Wilson Scotland Limited (Glasgow)	



Sample Description		Brown very silty SAND and GRAVEL with cobbles
Preparation		Oven dried
Test Method		2.5kg Rammer for soils with some coarse gravel-size particles
Samples Used		Single
Mass Retained on 37.5 mm Sieve	%	8
Mass Retained on 20.0 mm Sieve	%	15
Particle Density - Assumed	Mg/m³	2.61
Natural Moisture Content	%	13
Maximum Dry Density	Mg/m³	2.08
Optimum Moisture Content	%	8.4

Originator	Checked & Approved	Moisture Content / Dry Density Relationship BS1377:Part 4:1990 Clause 3.4	TTK Figure C8
MR	07/05/2010		Sheet 1 of 1

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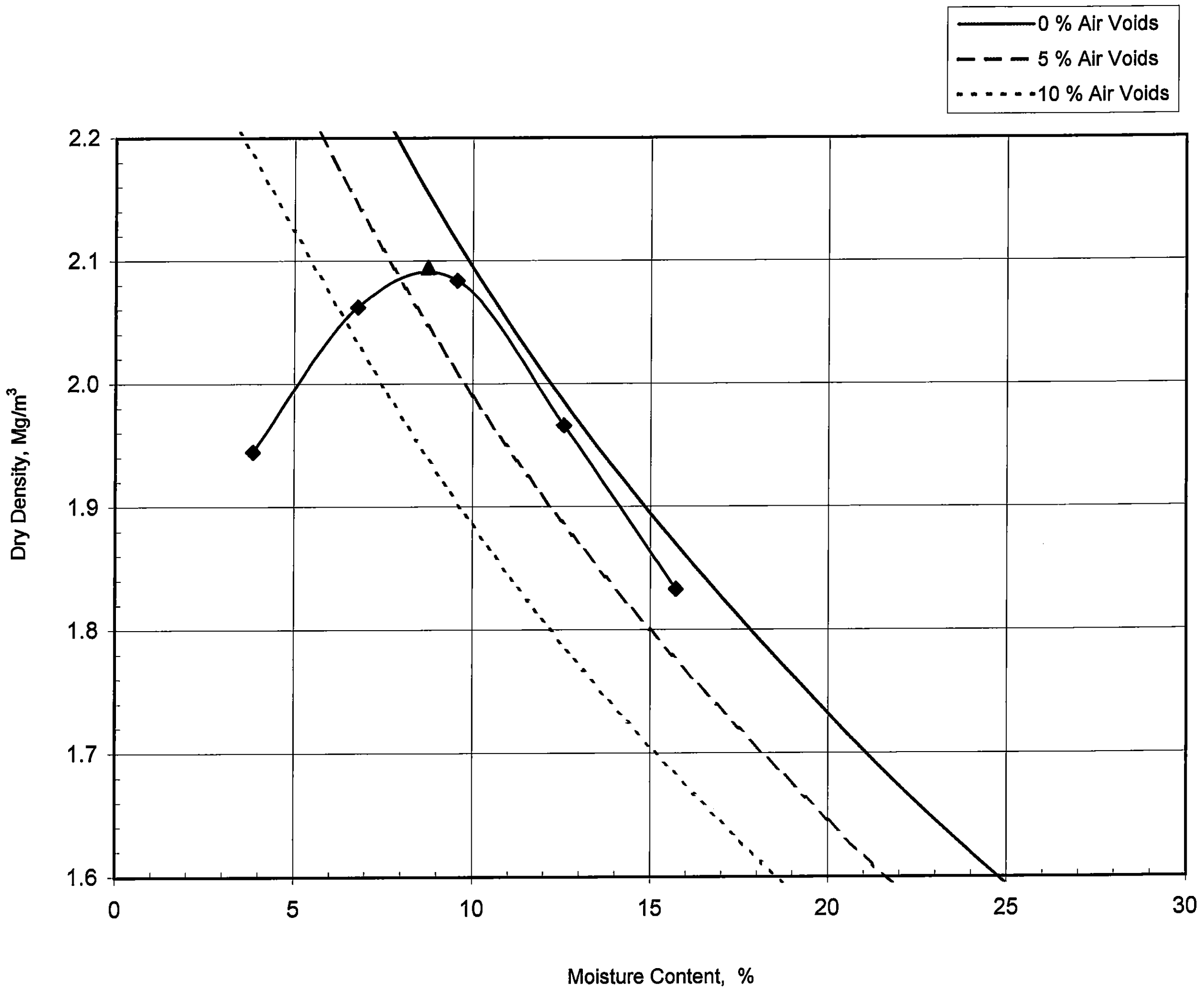
62 Rochsolloch Road, Airdrie ML6 9BG
Lab Project No RT9037 : 07/05/2010 10:42:12

TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES	Site	**SOUTH TAY PARK AND RIDE PRELIMINARY GROUND INVESTIGATION, DUNDEE**	**Contract No** **21707**
	Client	SESTRAN, TACTRAN & TRANSPORT SCOTLAND	Hole TP04 Sample Ref Depth (m) 2.40 Sample Type B
	Engineer	Scott Wilson Scotland Limited (Glasgow)	



Sample Description		Brown gravelly sandy CLAY
Preparation		Oven dried
Test Method		2.5kg Rammer for soils with some coarse gravel-size particles
Samples Used		Single
Mass Retained on 37.5 mm Sieve	%	16
Mass Retained on 20.0 mm Sieve	%	20
Particle Density - Assumed	Mg/m³	2.65
Natural Moisture Content	%	13
Maximum Dry Density	Mg/m³	2.10
Optimum Moisture Content	%	8.8

Originator	Checked & Approved		
MR	07/05/2010	**Moisture Content / Dry Density Relationship** BS1377:Part 4:1990 Clause 3.4	TTK **Figure C9** Sheet 1 of 1

Rev Sept 2005

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Lab Project No RT9037 : 07/05/2010 10:42:16

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TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES	Site	SOUTH TAY PARK AND RIDE PRELIMINARY GROUND INVESTIGATION, DUNDEE	Contract No	21707
			Hole ID	TP06
			Sample No	
	Client	SESTRAN, TACTRAN & TRANSPORT SCOTLAND	Depth (m)	0.50
	Engineer	Scott Wilson Scotland Limited (Glasgow)	Sample Type	B

Description: Brown very silty SAND and GRAVEL with cobbles and pockets of clay

Preparation Details:

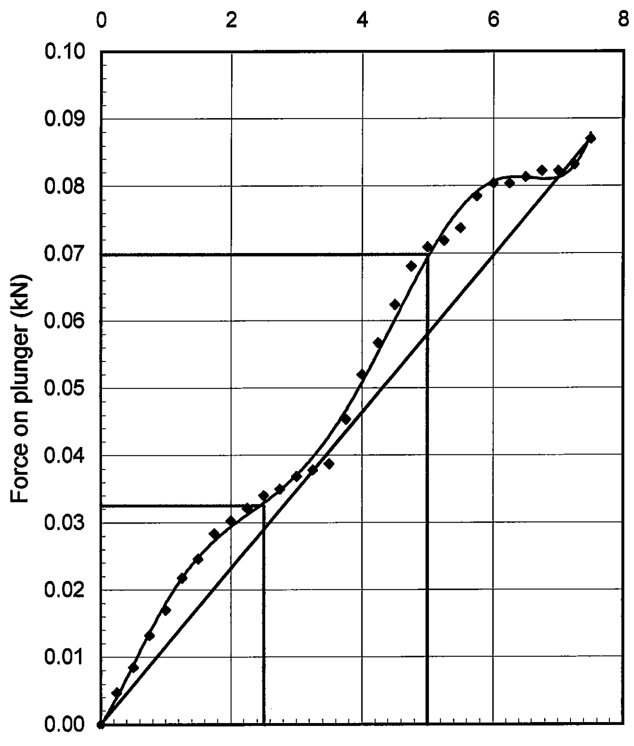
Specimen was prepared at Natural Moisture Content
Compaction using 2.5kg compactive effort

Specimen Bulk Density	2.16	Mg/m³
Specimen Dry Density	1.88	Mg/m³
Mass of sample > 20 mm	11.2	%

Specimen Unsoaked

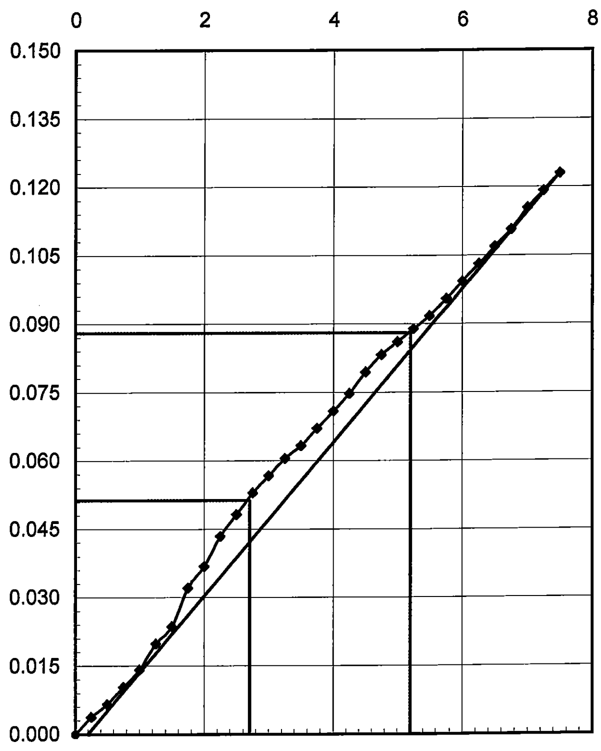
Test Details:	**Top**		**Base**	
Surcharge:	2.0	kg	2.0	kg
Seating Load:	10	N	10	N
Moisture Content:	15	%	14	%
CBR Value:	0.3	%	0.4	%

Top of Specimen
Penetration (mm)



Curve Corrections Applied

Base of Specimen
Penetration (mm)



Curve Corrections Applied

Min divisions not reached due to soft nature of material

Originator	Checked & Approved	**CALIFORNIA BEARING RATIO** BS1377 : Part 4 : Clause 7 : 1990	TTK	**Figure No C10**
CL	[signature] 07/05/2010			Sheet 1 of 1

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