A66 Northern Trans-Pennine Project
TR010062

3.8 Combined Modelling and Appraisal Report
Appendix C – Transport Model Package

APFP Regulations 5(2)(q)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Volume 3

June 2022

Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

A66 Northern Trans-Pennine Project Development Consent Order 202x

3.8 COMBINED MODELLING AND APPRAISAL REPORT APPENDIX C – TRANSPORT MODEL PACKAGE

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GLOSSARY

Acronym	Definition	Acronym	Definition
AADT	Average Annual Daily Traffic	NO2	Nitrogen Dioxide
AMCB	Analysis of Monetised Costs and Benefits	NOx	Nitrogen Oxide
AONB	Area of Outstanding Natural Beauty	NSIP	Nationally Significant Infrastructure Project
AST	Appraisal Summary Table	OBC	Outline Business Case
BCR	Benefit-Cost Ratio	OGV	Other Goods Vehicle
C&P	Commercial and Procurement	PCF	Project Control Framework
COBALT	Cost and Benefit to Accidents – Light Touch	PM10	Particulate Matter 10 micrometres or less in diameter
D&B	Design and Build	PRA	Preferred Route Announcement
DCO	Development Consent Order	PVB	Present Value of Benefits
DfT	Department for Transport	PVC	Present Value of Costs
DI	Distributional Impacts	QUADRO	Queues and Delays at Roadworks
DTDV	Day to Day Variability	RIS	Roads Investment Strategy
EU	European Union	SAC	Special Area of Conservation
GDP	Gross Domestic Product	SEP	Strategic Economic Plan
GMPP	Governments Major Projects Portfolio	SPA	Special Protection Area
GVA	Gross Value Added	SRN	Strategic Road Network
HGV	Heavy Goods Vehicle	SRO	Senior Responsible Owner
IPA	Infrastructure Projects Authority	SSSI	Site of Special Scientific Interest
IPDC	Investment Portfolio Delivery Committee	TAG	Transport Appraisal Guidance
JTR	Journey Time Reliability	TfN	Transport for the North
LEP	Local Enterprise Partnership	TUBA	Transport User Benefit Appraisal
LGV	Light Goods Vehicle	VAT	Value Added Tax
LSOA	Lower Super Output Area	VOC	Vehicle Operating Costs
MyRIAD	Motorway Reliability Incidents and Delays	WCH	Walkers, Cyclists and Horse-riders

1 Introduction

1.1 Project Overview

1.1.1 National Highways are currently undertaking the A66 Northern Trans-Pennine Route study. The study is looking at options to upgrade the A66 corridor between the M6 at Penrith and the A1(M) at Scotch Corner. The study is at National Highways Project Control Framework (PCF) Stage 3 – Preliminary Design within the 'Development Phase'. The scope of the project is to dual the six sections of single carriageways along the A66 including improvements to the M6 J40 and A1(M) Scotch Corner junctions at each end of the route.

1.1.2 The Transport Model Package contains the analytic material created during the production of the base year transport model which will be used to underpin the scheme's business case, design and operational and environmental assessments.

1.1.3 The A66 transport model (A66TM) was developed based on the North Regional Transport Model (NRTM) in PCF Stage 1, and further refined in PCF Stage 2. At PCF Stage 3, the opportunity will be taken to update the base year model from 2015 to 2019 with traffic counts collected from various sources and update the forecasts considering the most up to date available information.

1.2 Purpose of the report

1.2.1 The purpose of this Transport Model Package is to:

- Document the development of the A66TM for PCF Stage 3; and
- Summarise the data collected to support the model development.

1.3 Report Layout

1.3.1 The report is laid out as follows:

- Chapter 2 provides a summary of the scheme;
- Chapter 3 contains a description of the model;
- Chapter 4 details the standards the model is required to achieve;
- Chapter 5 details the matrix development;
- Chapter 6 describes the network development;
- Chapter 7 describes the assignment process;
- Chapter 8 details the model calibration;
- Chapter 9 details the model validation; and
- Chapter 10 provides a description of the demand model.

2 Scheme Background

2.1 Introduction

2.1.1 The A66 Northern Trans-Pennine Project was one of six strategic studies announced as part of the Department for Transport's (DfT's) Road Investment Strategy: Investment Plan, December 2014.

2.1.2 The A66 is a key national and regional strategic route, linking the east and west of northern England across the Pennines, and is the best available option for traffic travelling between the south east of England and the west of Scotland. However, there is no complete dual carriageway along the A66 between the M6 junction 40 at Penrith and the A1(M) at Scotch Corner. The only existing east-west road of dual carriageway or motorway standard north of the M62 is the M8 in Scotland. This is a significant barrier to the movement of freight and the utilisation of the A66 route, which represents a major constraint to economic growth in the north of England.

2.1.3 Along the 50 mile stretch between the M6 at Penrith and the A1(M) at Scotch Corner, the A66 has been upgraded from single carriageway to dual carriageway in a number of stages since the 1970s. The most recent section to be dualled was the Temple Sowerby Bypass which opened to traffic in 2007. However, there are six remaining single carriageway sections, and an at-grade junction (Figure 2-1) making the route slow, accident-prone and unreliable.

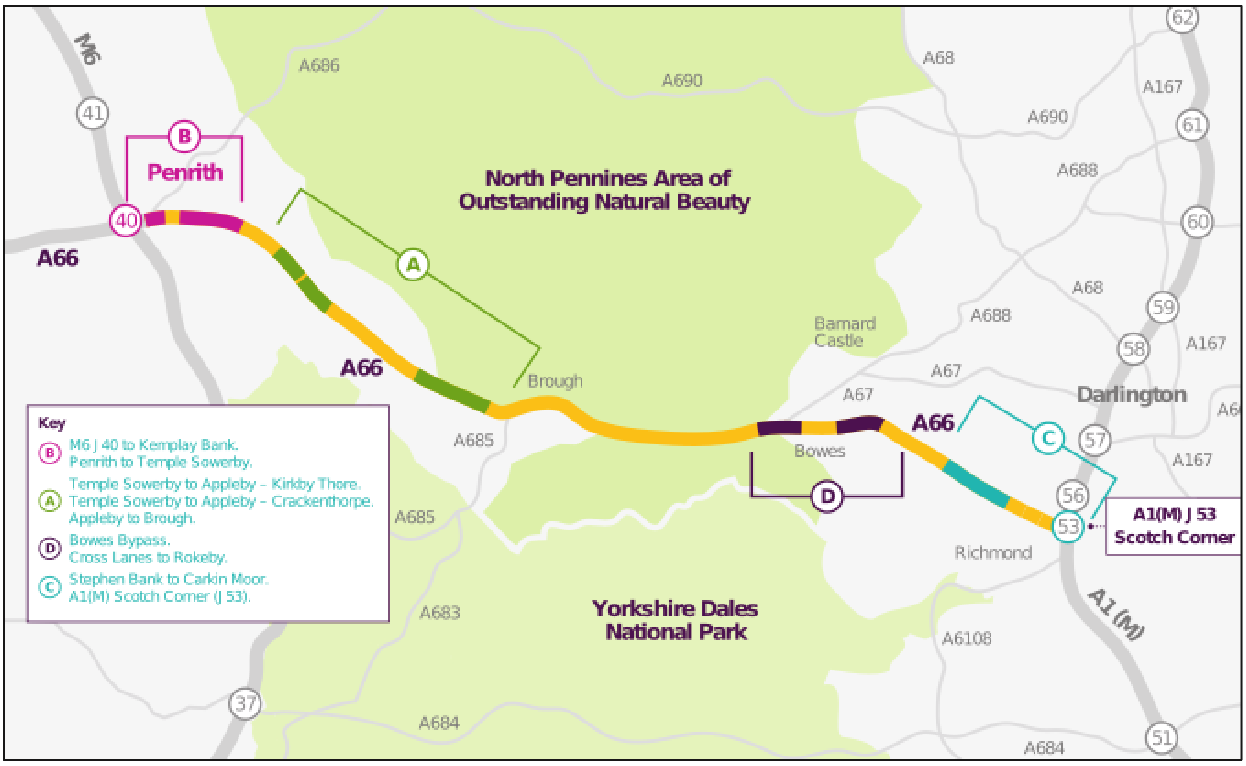


Figure 2-1: A66 Northern Trans-Pennine Project Route Sections

2.1.4 The Northern Powerhouse Independent Economic Review [1] identified the critical importance of improving connectivity across the North and the Northern Trans-Pennine Routes Study identified the A66 as the priority for investment. Upgrading the route is a UK National priority which forms a key part of the 'levelling-up' and Northern Powerhouse agendas, enabling better connectivity between North and South and increasing economic performance in the North.

2.2 Objectives of Proposed Project

2.2.1 The strategic objective of the project is to investigate the potential to create a new improved strategic corridor linking the A1(M) with the M6 by upgrading the A66 corridor and making other improvements along its length. Further aims and objectives are to improve strategic, regional and national connectivity, particularly for HGVs, considering a more attractive alternative route to the M62 for some east-west crossing movements, improving journey time reliability on the A66 and promoting economic growth.

2.2.2 The objectives of the A66 Northern Trans-Pennine project are found in Table 2-1.

Table 2-1: Project Objectives

Option	Description
Economic Growth	Support the economic growth objectives of the Northern Powerhouse agenda
	Improve national connectivity including freight
	Improve access for tourism
	Improve access for local services and jobs
Transport	Improve road safety
	Improve journey time reliability for road users
	Improve and promote the A66 as a strategic connection for all traffic
	Improve the resilience of the route to the impact of events such as incidents, roadworks and severe weather events
	Seek to improve NMU provision along the route
Community	Reduce the impact of the route on severance for local communities
Environment	Minimise adverse impacts on the environment and where possible optimise environmental improvement opportunities

2.3 Previous Analysis

2.3.1 During PCF Stages 1 and 2, using an enhanced version of the North Regional Transport Model (NRTM), traffic forecasting and economic appraisal was undertaken to determine the preferred route.

[1] TfN - Northern Powerhouse Independent Economic Review, Final Executive Summary Report, June 2016

2.3.2 The PCF Stage 1 A66 Transport Model (A66TM) was developed to assess options along the A66 corridor and to inform the option identification process. The NRTM was used as a starting point, with key elements of the model structure retained and the networks, representation of demand, and validation all refined in the area of interest. At PCF Stage 2, the A66TM was further refined to improve assessment of the scheme.

2.3.3 Scheme-specific data was collected to enhance the model, including a traffic survey programme along the A6 corridor between Penrith and A1(M) Scotch Corner during November and early December 2017, as well as additional traffic counts from Cumbria County Council.

2.4 Transport Model and Data Requirements

2.4.1 From a traffic modelling perspective, the principal requirement for the A66 Northern Trans-Pennine Route Study is to have a robust traffic model that can be used to appraise the project. In addition, the model specification, underlying data and performance need to withstand scrutiny.

2.4.2 The A66 is used by a mixture of both strategic and local traffic, therefore the transport model needs to cover a sufficiently wide geographical area to reflect strategic traffic movements on the A66 corridor and competing Trans-Pennine routes, and local movements along the corridor. The model must be capable of reflecting the impacts of increased congestion on the route, and competing routes, including the operation of key junctions and the responses to upgrading the route. Given the strategic nature of some of the traffic using the route, the model must be capable of reflecting not only reassignment, but other demand responses including trip generation, redistribution and modal choice.

2.4.3 The model must be capable of providing traffic forecasts to support the economic and environmental appraisals and operational design, specifically:

- Economic assessment – the assessment of transport economic efficiency benefits; reliability benefits; accidents benefits (as part of Social Impacts); Distributional Impacts and wider economic impacts.
- Environmental impacts – those topics that require traffic data i.e., air quality, noise and vibration, people and communities and climate.
- Operational Assessments – including main carriageway and junction operation.

3 Model Description / Specification

3.1 Overview

3.1.1 The A66TM was developed during PCF Stage 1 and Stage 2 from the Northern Regional Model (NRTM), which was developed in 2015. At PCF Stage 3, the opportunity has been taken to update the base year model from 2015 to 2019 with data and traffic counts collected from various sources.

3.2 Model Software

3.2.1 Model composition and software is based on the NRTM and keeps the same structure of a highway SATURN supply model and a variable demand model system which uses a combination of the Departments for Transport's (DfT) Dynamic Integrated Assignment and DEmand Modelling (DIADEM) Variable Demand Modelling software and a bespoke graphical user interface (GUI) known as the Highways England Integrated Demand Interface (HEIDI).

3.2.2 SATURN operates as a static equilibrium highway assignment model which incorporates both simulation and assignment loops. The highway assignment model uses SATURN software version 11.4.07H.

3.2.3 DIADEM software is designed to enable practitioners to easily set up variable demand models. DIADEM provides a user-friendly method for setting up a multi-stage transport demand model and finding equilibrium between demand and supply, using the SATURN package as the supply model. The variable demand model uses the bespoke version of the software version developed specifically for National Highways.

3.2.4 HEIDI is a bespoke programme developed to assemble trip end data and to organise and implement forecast model runs. HEIDI invokes a DIADEM run which in turn invokes SATURN. HEIDI version 6.2h will be used for the A66 forecast model runs.

3.3 Study Area

3.3.1 The study area and the model's geographical extent will include the same area as the PCF Stage 1 and 2 A66TM model, however, the Transport Reliability Area (TRA) has been extended further north and south at either end of the A66 along the M6 and A1(M). This has been revised considering impacts from the scheme identified within PCF Stage 2 forecasting. The TRA is shown in Figure 3-1.

3.4 Modelled Base Year

3.4.1 The PCF Stage 1 and 2 model has been updated to March 2019. An average weekday (Monday to Friday) is used in line with the NRTM.

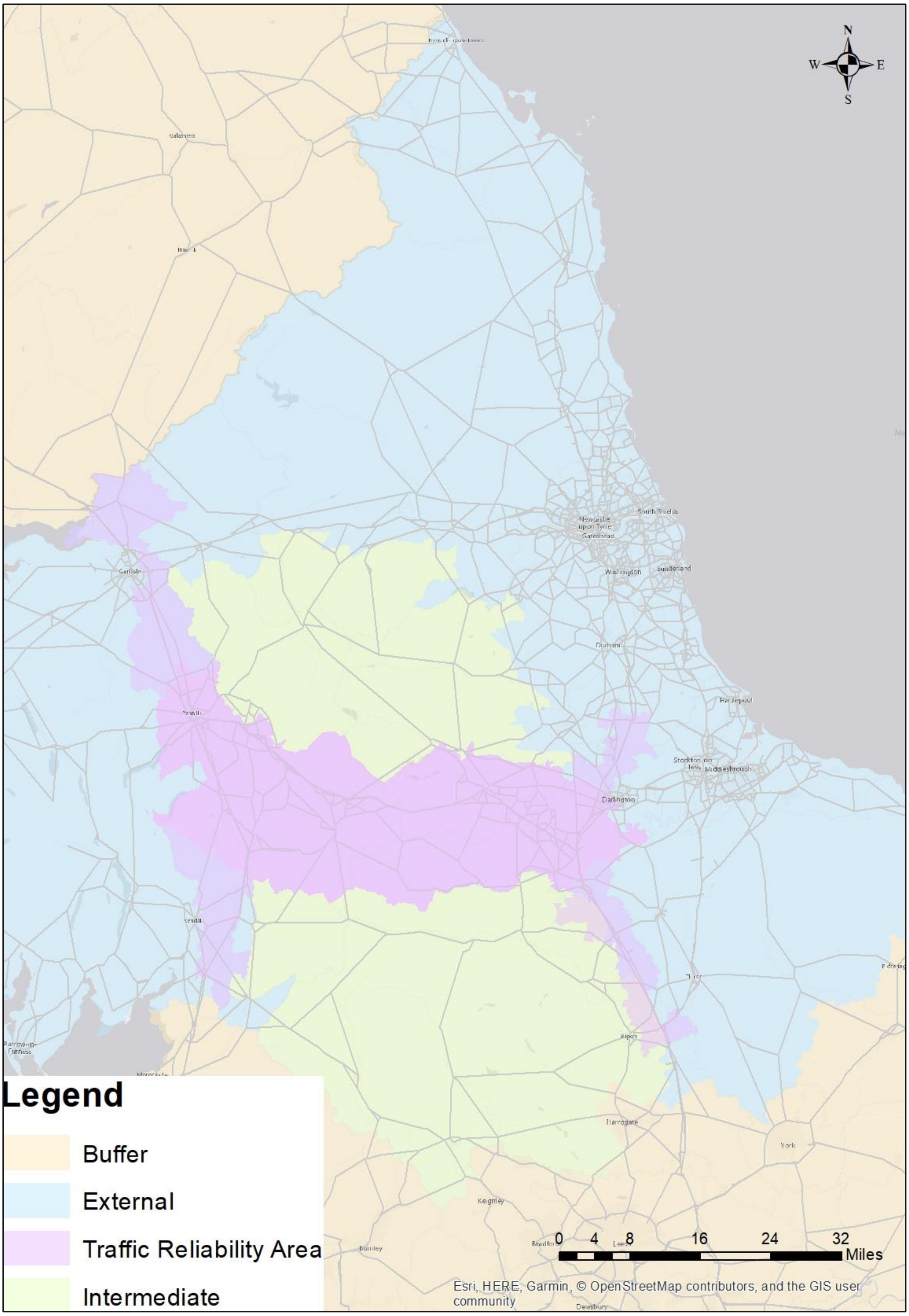


Figure 3-1: Stage 3 A66TM Modelled Area

3.5 Model Months and Seasonality

3.5.1 There is evidence that the A66 is affected by seasonality with high flows during August and lower flows during the winter months. In PCF Stage 1 the impact of the high flows during August was considered through investigation into the development of a seasonal model. Monthly flow profiles of weekday traffic in 2019 have been plotted at 3 WebTRIS locations along the A66 route as follows:

- between Kemplay Bank and M6 J40 at the western end of the A66 (Figure 3-2 and Figure 3-3);
- near Appleby towards the central section of the A66 (Figure 3-4 and Figure 3-5); and,
- east of Bowes at the eastern end of the A66 (Figure 3-6 and Figure 3-7).

3.5.2 While the flow on the route during August is generally higher than during the rest of the year, particularly at Appleby and Bowes the evidence indicates that it is proportionate to address seasonality impacts through the application of annualisation factors rather than the development of a bespoke summer model. This is because operational experience on the route suggests that the capacity issues on the route are local capacity issues around Penrith when leisure traffic mixes with commuting traffic during the late afternoon/early evening peak period. The flows in this location are consistently high at all times of the year during this time period (Figure 3-2 and Figure 3-3). This congestion issue is being addressed by the coverage of the PM peak hour model, which is discussed in section 3.6 below. Therefore, considering the relative lack of congestion on the full route, as indicated by the flat journey time to flow relationship on the A66 (see Figure 3-8).

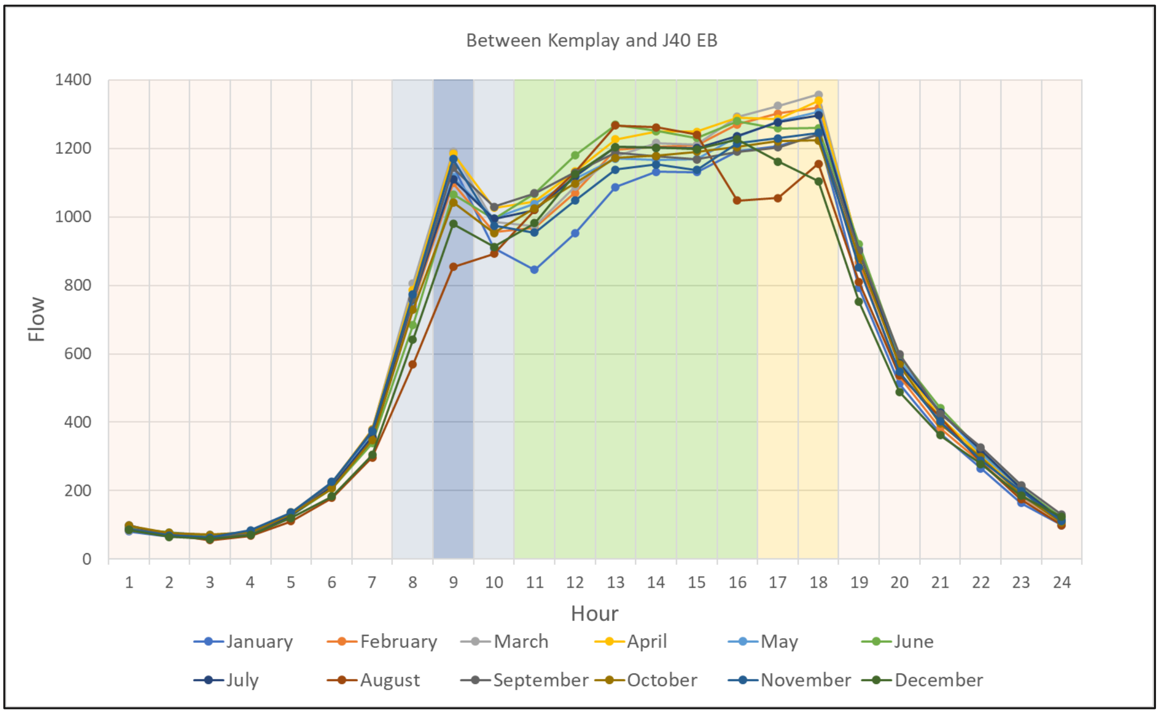


Figure 3-2: 2019 A66 Weekday Flow by Month between Kemplay Bank and M6 J40 (EB)

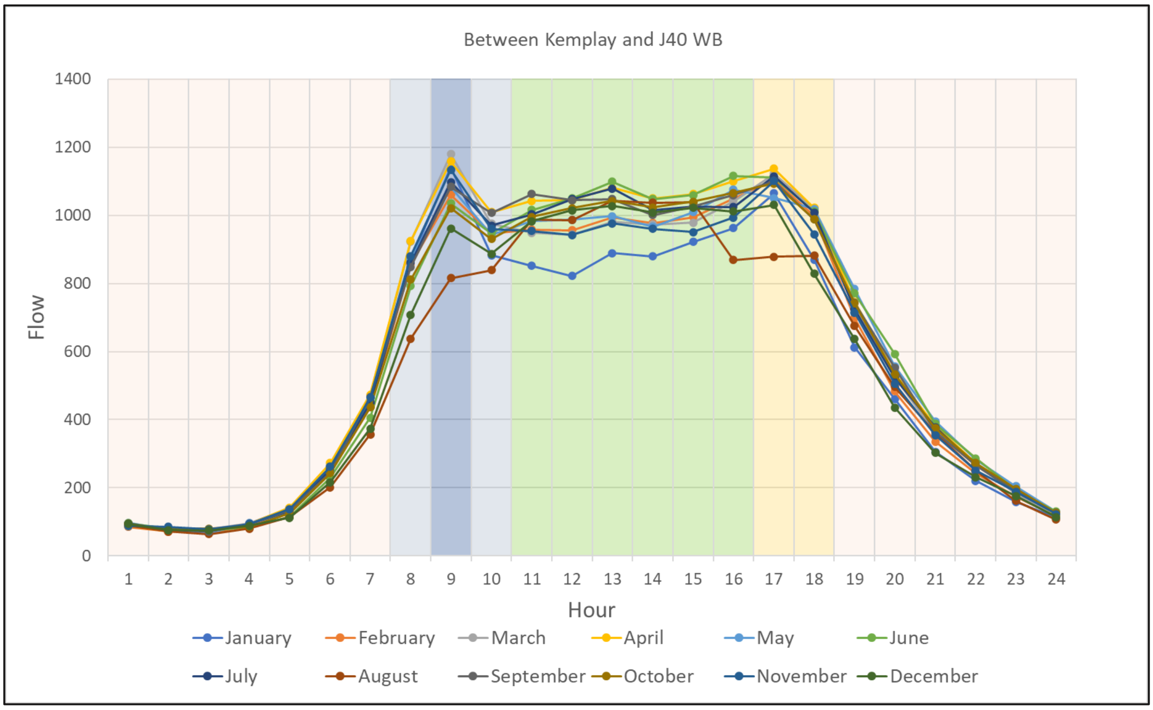


Figure 3-3: 2019 A66 Weekday Flow by Month between Kemplay Bank and M6 J40 (WB)

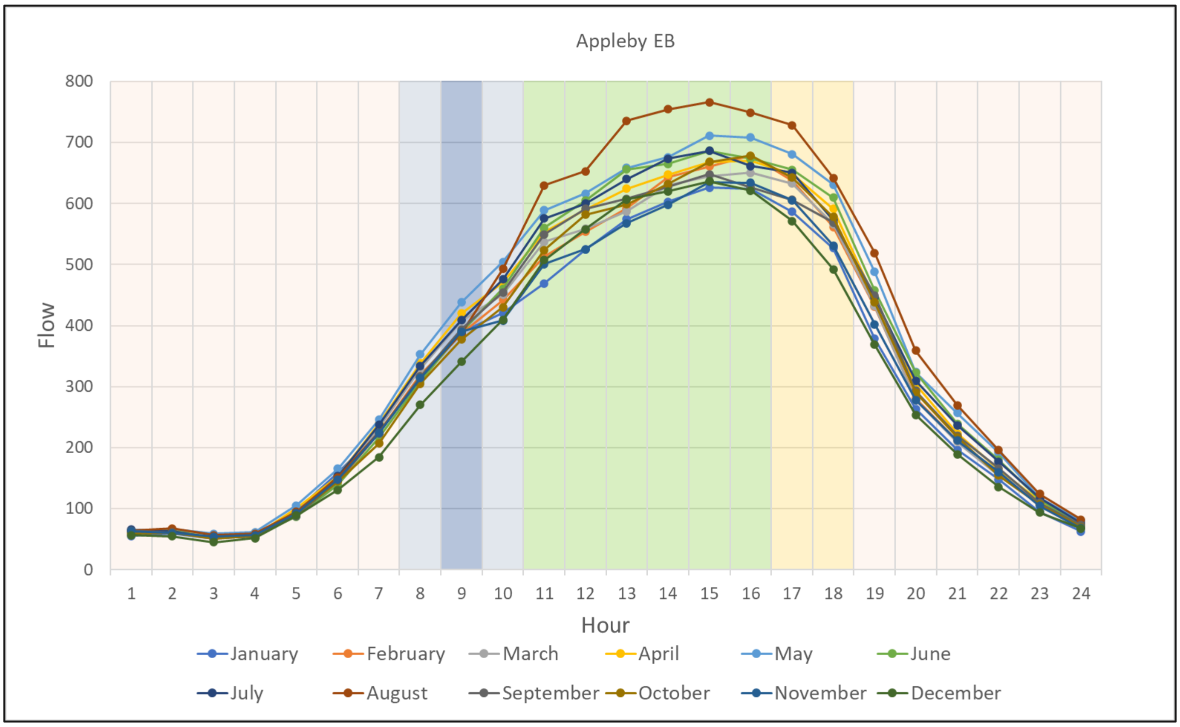


Figure 3-4: 2019 A66 Weekday Flow by Month at Appleby (EB)

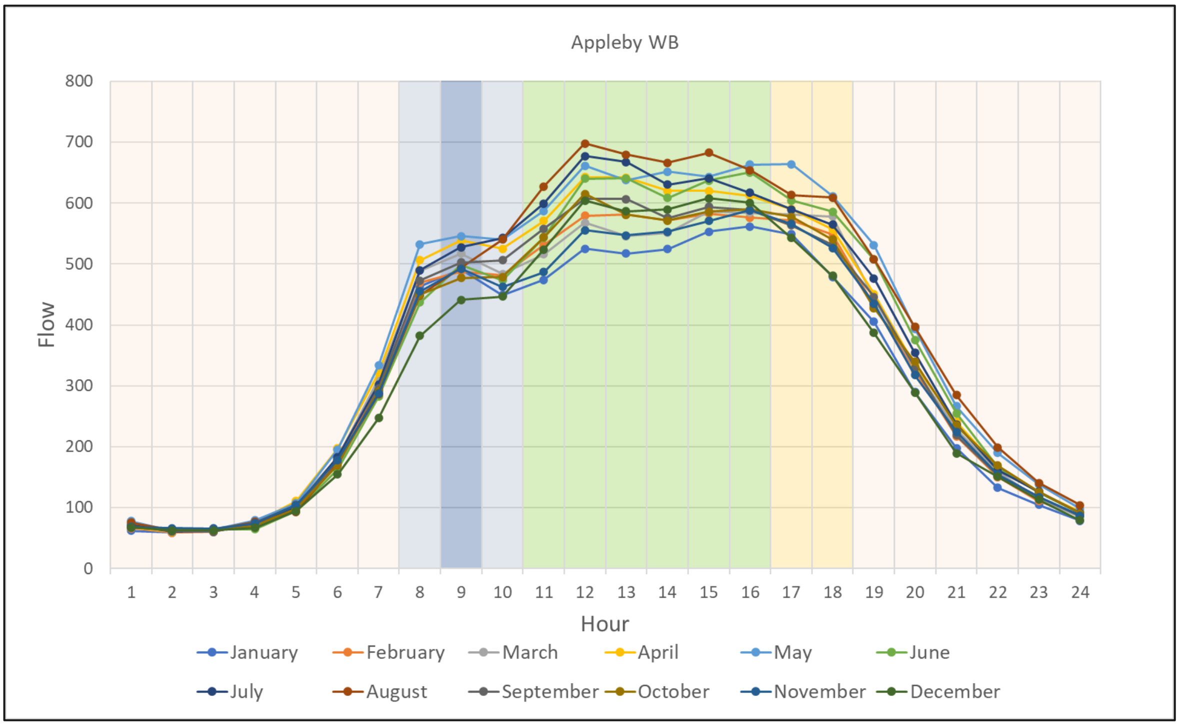


Figure 3-5: 2019 A66 Weekday Flow by Month at Appleby (WB)

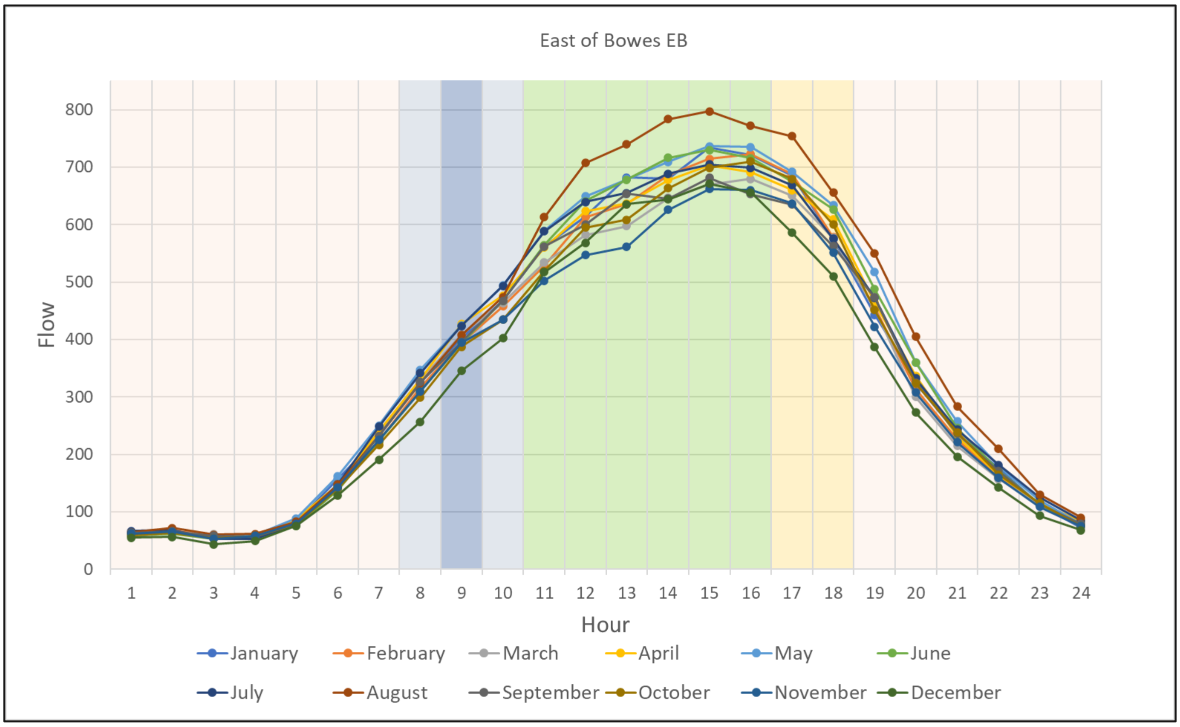


Figure 3-6: 2019 A66 Weekday Flow by Month East of Bowes (EB)

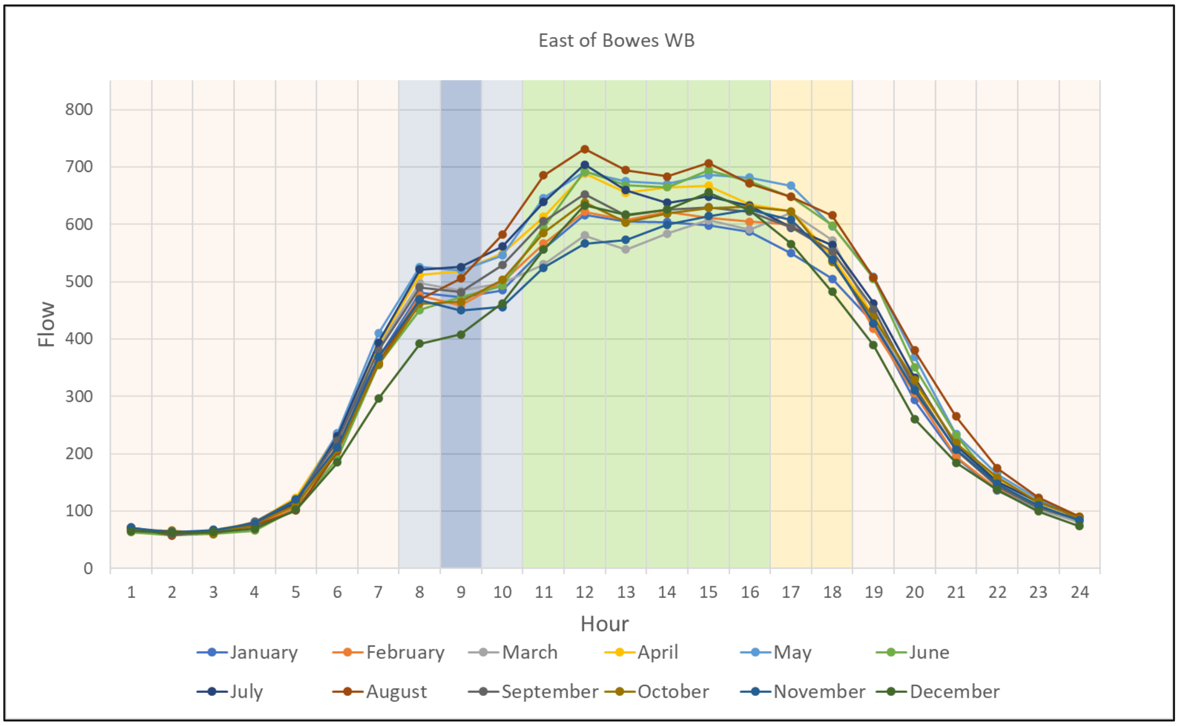


Figure 3-7: 2019 A66 Weekday Flow by Month East of Bowes (WB)

3.6 Modelled Time Periods

3.6.1 The NRTM is based on 2 three-hour periods covering the AM and PM peaks together with a 6-hour interpeak. Alternative model time periods were investigated at the start of PCF Stage 3. To do this, the journey time taken to complete the whole route from Penrith to Scotch Corner throughout the day was plotted against average temporal flow distributions for the WebTRIS data discussed in section 3.5 above.

3.6.2 The relatively flat journey time profiles during the day indicate that using average period flows would appropriate for the majority of the A66 mainline. These flat profiles are shown in Figure 3-8.

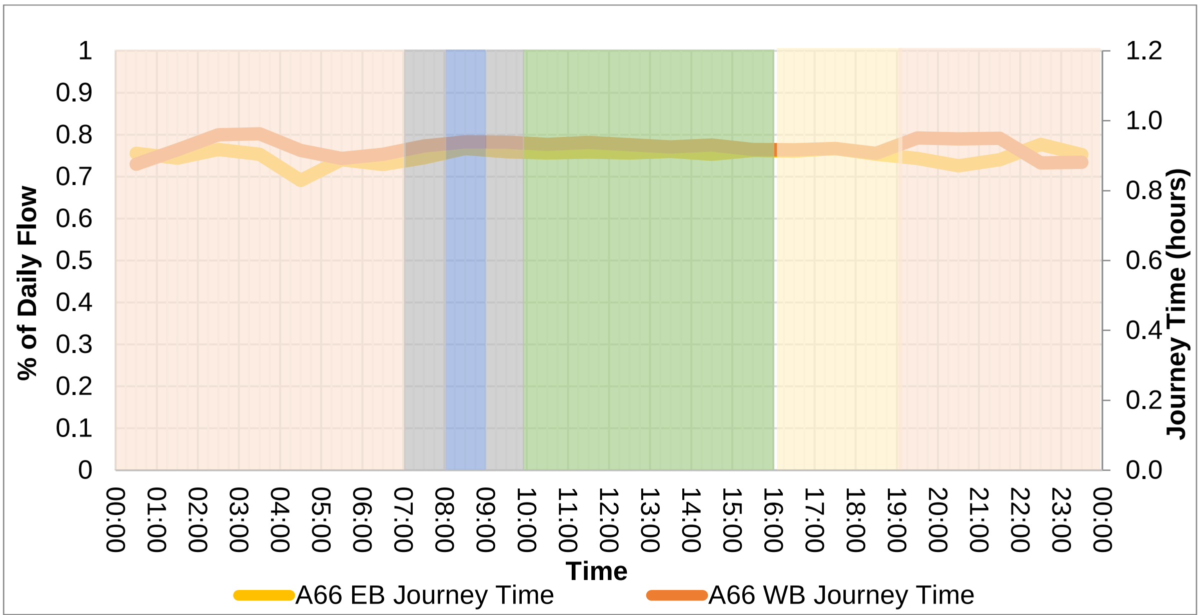


Figure 3-8: 2019 A66 Mainline Flow and Journey Time Plot

3.6.3 There is, however, evidence that at the terminal junctions it may be more appropriate to isolate the true AM and PM peak hours / periods, such that the traffic flow levels align with those within the operational models for the junctions, particularly at the M6 Junction 40. The peak hour performance of the road network at the M6 junction 40 and more broadly around Penrith has been identified as one of the key areas that could potentially be affected by the scheme. This is because the proposed grade separation of the A66 at the A6/A66 Kemplay Bank roundabout is likely to impact on the route choice into and out of Penrith during peak hours. More traffic may find it quicker to use the A6 (at Kemplay Bank) as opposed to the A592 (at M6 Junction 40). To understand the length of the peak traffic conditions at these locations, flow and journey time profiles for the M6 junction 40 have been combined and are shown in Figure 3-9.

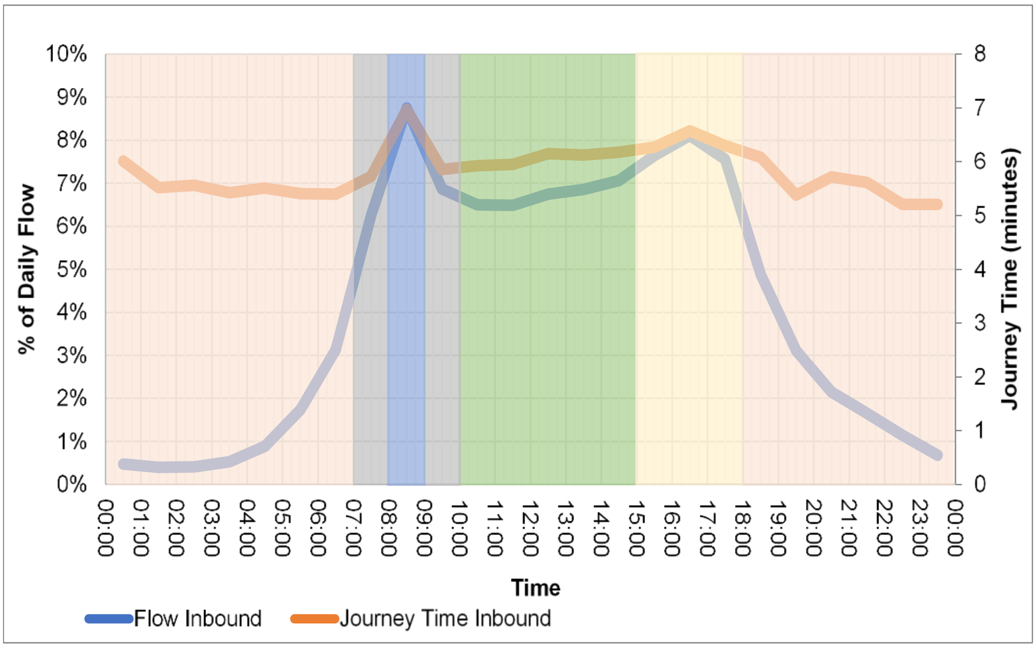


Figure 3-9: M6 Junction 40 Flow and Journey Time Plot

3.6.4 Considering the flow and journey time profile the following is concluded:

- The AM peak lasts for only 1 hour, peaking sharply between 08:00-09:00. The flow during this hour is 20% higher at this location than the average flow contained in the NRTM peak period between 07:00 and 10:00; and
- The NRTM PM peak period covers 16:00 to 19:00. The data presented above suggests a more appropriate PM period would cover 16:00-18:00. The average flow during this two-hour period is 14% greater than in the 3-hour period used within NRTM.

3.6.5 This leaves two unmodelled hours within the AM period, i.e., 07:00-08:00 and 09:00-10:00, and a single hour in the PM period (i.e., 18:00-19:00). For TUBA purposes, and to maintain the correct journey purpose proportions, it is suggested that uncalibrated shoulder peaks are developed i.e. using the correct proportion of the AM/PM matrices for the particular hour be used, together with the skims from these models. These shoulder peaks can also be used within the demand model.

3.6.6 In summary, the modelled time periods are:

- AM Peak Hour (08:00-09:00)
- Inter-Peak Period (10:00-16:00)
- PM Peak Average Hour (16:00-18:00)
- Off-Peak Period (19:00-07:00).

3.7 Model Zoning

3.7.1 The model zoning will largely be retained from the PCF Stage 2 A66TM which incorporated changes to the NRTM zone system to include more zone detail in the traffic reliability area together with less zone detail away from the A66 corridor in the rest of the modelled area. Additional zones have been added during PCF Stage 3 with some zone disaggregation in Penrith. This is discussed in Section 0.

3.8 Demand and Segmentation

3.8.1 The base year model represents an average March weekday in 2019. Vehicle class definitions are from the COBA manual, with OGV1 (Other Goods Vehicles 1) and OGV2 (Other goods Vehicles 2) combined together and referred to as HGVs, and the car user class split into Car Commute, Car Employers Business and Car Other trips to allow for variations in the perceived costs of travel between different journey purposes. LGVs have all been assumed to be employer's business trips, and other goods vehicles (OGV1 and OGV2) along with Passenger Service Vehicles (PSV) have been combined with HGVs. As the number of PSVs picked up in the manual counts were so low it was assumed they would have a negligible effect combined with the HGV movements.

3.8.2 The highway assignment model user classes are as follows:

- User class 1 – Car, Employers Business
- User class 2 – Car, Commute
- User class 3 – Car, Other
- User class 4 – Light Goods Vehicles
- User class 5 – Heavy Goods Vehicles

3.8.3 The demand model also includes the following rail purposes:

- Rail – Commuting
- Rail – Other
- Rail – Employers Business

3.8.4 Goods vehicles are excluded from the demand model.

3.9 Variable Demand Modelling

3.9.1 TAG Unit M2-1 provides guidance on the need for variable demand modelling. The modelled approach was undertaken according to this guidance. However, given the scale of the Recommended Preferred Route scheme, the estimated cost of options and evidence from PCF Stage 0 that variable demand modelling had an impact on benefits, there is a need to include the impacts of variable demand.

3.9.2 The variable demand modelling system developed for the A66TM is largely unchanged from that developed for the NRTM. Changes are limited to updating it and recalibrating it to reflect the enhanced A66TM networks and zonings systems and recalibrated demand. The reasoning behind the specification of the structure of the VDM are contained in the NRTM model development report and remain valid for the A66TM.

3.9.3 The key characteristics of the VDM are as follows:

- Incremental pivot point approach
- Pivot point between base and test
- Home Based Production / Attraction
- Non-Home-Based Origin / Destination

- Goods Fixed
- Special Generators Fixed

3.9.4 The VDM model applies to the entire modelled area (simulation and buffer area) and predicts the key traveller responses of:

- Mode Choice (between Car Available Car Users and Rail);
- Destination Choice (a change of origin and\or destination); and
- Macro Time of Day Choice (MTOD) (a change of time period in which travel is made).

3.9.5 Public Transport supply and demand are represented as inter-urban rail travel only. It is considered the main competitor to the car when the RTMs were developed. This assumption and its representation in the model have been retained for the A66TM. Further details are provided in chapter 10.

3.9.6 A land use transport interaction model has not been used after considering the scheme's location, surrounding development, current network conditions, and the likely impacts with the scheme in place.

4 Model Standards

4.1 Overview

4.1.1 Model development has followed TAG guidance. In particular, model acceptability has been judged against the model calibration and validation criteria included in TAG unit M3-1, and model convergence has been assessed against the guidelines also included in TAG unit M3-1.

4.1.2 TAG unit M3-1 notes that the validation of a highway assignment model should include comparisons of the following:

- assigned flows and counts totalled for each screenline or cordon, as a check on the quality of the trip matrices;
- assigned flows and counts on individual links and turning movements at junctions as a check on the quality of the assignment; and
- modelled and observed journey times along routes, as a check on the quality of the network and the assignment.

4.1.3 In addition to this the matrices have been updated from the original NRTM model based on the principles discussed in TAG unit M2-2.

4.2 Trip Matrix and Link Flow Validation Criteria

4.2.1 According to the guidelines, the model validation is measured by assessing the goodness of fit between the assigned hourly flows and journey times and the corresponding independent observed data.

4.2.2 For trip matrix validation, the measure which should be used is the percentage differences between modelled flows and counts. Comparisons at screenline level provide information on the quality of the trip matrices.

4.2.3 For link flow validation, two criteria are presented:

- the absolute and percentage differences between modelled flows and counts; and
- the GEH statistic.

4.2.4 The GEH formula is as follows:

$$GEH = \sqrt{\frac{(M-O)^2}{(M+O)/2}}$$

where:
M = modelled flow (vehicles per hour)
O=observed flow (vehicles per hour)

4.2.5 The validation criterion and acceptability guideline for screenline flows and link flows are presented in Table 4-1.

Table 4-1: Link Flow Validation and Acceptability Guidelines

Criteria	Description	Acceptability Guidelines
Screenline flow validation criterion and acceptability guidelines		
Difference between modelled flows and counts should be less than 5% of the counts		All or nearly all screenlines
Link flow and turning movements validation criterion and acceptability guidelines		
1	Individual flows within 100 vph for flows <700 vph	>85% of cases
	Individual flows within 15% for flows 700-2,700 vph	
	Individual flows within 400vph for flows >2,700 vph	
2	GEH <5 for individual flows	>85% of cases

Source: TAG – Unit M3-1

4.2.6 These criteria have been used for testing the model against data used in model building, as part of the calibration process, as well as testing the model against independent data as part of the validation process.

4.3 Journey Time Validation

4.3.1 In addition to the validation of link flows the model has also been validated against observed journey times.

4.3.2 For journey time validation, the measure which should be used is the percentage difference between modelled and observed journey times, subject to an absolute maximum difference. The validation criterion and acceptability guideline for journey times are defined in Table 4-2.

Table 4-2: Journey Time Validation and Acceptability Guidelines

Criteria	Acceptability Guidelines
Modelled times along routes should be within 15% of surveyed times (or 1 minute, if higher than 15%)	>85% of cases

Source: TAG – Unit M3-1

4.4 Assignment Convergence Criteria

4.4.1 Before the results of any traffic assignment are used to influence decisions, the stability (degree of convergence) of an assignment must be confirmed. For the A66TM the criteria set out in TAG Unit M3-1 were used to assess the assignment convergence of the SATURN models for the AM, inter-peak and PM average time period hours (Table 4-3).

Table 4-3: Assignment Convergence Acceptability Guidelines

Criteria	Acceptability Guidelines
Delta and %GAP	Less than 0.1% or at least stable with convergence fully documented and all other criteria met
Percentage of links with flow change (P) <1%	Four consecutive iterations greater than 98%
Percentage of links with cost change (P2) <1%	Four consecutive iterations greater than 98%

Source: TAG – Unit M3-1

4.5 Changes due to matrix estimation

4.5.1 TAG Unit M3-1 also sets out measures for testing the significance of changes brought about through matrix calibration (estimation), shown in Table 4-4. These include the correlation of changes in cell values, trips, scale of sector-to-sector changes and changes in the mean and standard deviation of trip lengths. Table 4-4 sets out the measures and criteria used to assess matrix estimation changes in TAG Unit M3-1 which are used as the basis for reviewing the impact of matrix estimation on the model.

Table 4-4: Significance of matrix estimation changes

Measure	Significance Criteria
Matrix zonal cell values	Slope within 0.98 and 1.02 Intercept near zero R^2 in excess of 0.95
Matrix zonal trip ends	Slope within 0.99 and 1.01 Intercept near zero R^2 in excess of 0.98
Trip length distributions	Means within 5% Standard deviations within 5%
Sector-to-sector level matrices	Differences within 5%

5 Matrix Development

5.1 Car Matrix Development

Introduction

5.1.1 The process to develop the matrices for the A66TM is summarised in Figure 5-1 below. Further details of the process are contained within this chapter.

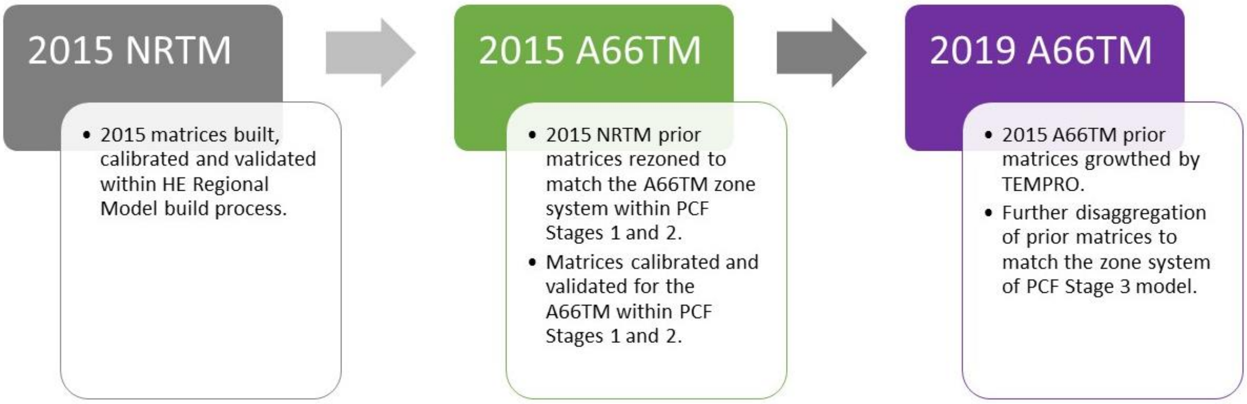


Figure 5-1: Matrix Development Process

2015 NRTM Matrices

5.1.2 The development of the NRTM car matrices was based primarily on mobile phone data supplied through Highway England's Traffic Information System (TIS). This data was subject to further adjustments and the robustness of data confirmed through a set of verification tests. Synthetic matrices were also produced for the NRTM to infill short distance trips, and therefore improve the NRTM prior matrix quality. These processes are described in detail in the NRTM Model Validation Report.[2]

5.1.3 The matrices were originally developed using Mobile Phone Origin Destination (MPOD) data in the form of person trip matrices, as the primary data source. However, due to limited confidence in certain aspects of the data, and in particular short distance trips, a set of synthetic matrices were developed to replace the short distance MPOD trips.

5.1.4 The synthetic matrices used census data to generate trip ends plus generalised costs and observed trip distributions for the gravity model development. Further data sets were also required to develop LGV, HGV, rail and air travel profiles, in addition to independent data sources for the verification checks.

5.1.5 A summary of the sources used in matrix development is shown in Table 5-1 below.

[2] Highways England 'Northern Regional Transport Model – Model Development Report – March 2017

Table 5-1: NRTM matrix development data sources

Data Set	Source	Year(s)	Usage in NRTM
MOIRA	ATOC	2015	Rail fares, generalised costs and base year rail demand
MPOD Provisional Dataset	Telefónica	2015	Car origin-destination trip matrices
NAPALM	DfT	2015	Modelled air travel passenger demand for forecasting
TEMPRO	DfT	2015	Trip ends for Scotland
TrafficMaster	DfT	2015	LGV origin-destination trip movements
TAG	DfT	2014, 2015	VOC, VOT and occupancy values
Civil Aviation Authority Passenger Surveys	DfT	2014	Overlay airport demand distributions onto MPOD data
Business Register Employment Survey	ONS	2011 – 2014	Generate factors for census employment data to base year
Households and Families Survey	ONS	2011 – 2014	Generate factors for census household data to base year
Mid-Year Population Estimates	ONS	2011 – 2014	Generate factors for census population data to base year
UK Census Data	NOMIS	2011	Planning data inputs for CTripEnd
Media Use and Attitudes Report 2015	OFCOM	2009 – 2014	Mobile phone ownership by age and socio-economic group
National Travel Survey (NTS)	DfT via UK Data Service	2009 – 2014	Observed trip length distributions, trip rates and trip purpose splits by various variables
National Rail Transport Survey	DfT	2007	Derive zone-to-zone movements from data extracted from MOIRA
Continuing Survey of Road Goods Transport	DfT	2006 – 2014	Generate factors for BFYM values to base year
Base Year Freight Matrix (BYFM)	DfT	2006	HGV origin-destination trip movements

2015 A66TM for PCF1 and PCF2

5.1.6 To inform PCF Stages 1 and 2 of the A66 project, the NRTM matrices were refined for use within the A66TM. To do this, the prior 2015 NRTM matrices were rezoned to match the A66TM such that detail was added to the model in the fully modelled area adjacent to the A66, while some zonal detail was removed in the more remote urban areas away from the scheme.

5.1.7 The rezoning of the NRTM demand matrices was undertaken using the 2011 Census residential and workplace data. The demand in urban areas, such as Newcastle, Middlesbrough, and Carlisle, was merged, while the demand in the detailed modelled area was split, all in accordance with the new zone system.

5.1.8 To accurately split the demand, the NRTM prior matrices were separated out into journey purpose, then Home Based (HB) and Non-Home Based (NHB) car trips, and finally outbound and return direction. The resulting matrices were then in a format where the 2011 Census data could be applied to split the demand.

5.1.9 The NRTM HB proportions were used to factor the car matrices. To calculate outbound and return direction trips, MPOD data factors were used to split the journeys. This was done at sector level, so the same outbound factor applied to all the trips originating in the sector – the NRTM zone to 13 sectors correspondence was used.

5.1.10 In and around the simulation fully modelled area, Census output area resident population and economic activity data were used as a basis to split NRTM model demand data to fit the more detailed A66TM zones, as follows:

- Resident population – used to split the home end of HB trips;
- Workplace population – used to split the non-home end of HB Commute and HB Employers Business trips and both ends of NHBEB, LGV and HGV trips; and
- Resident + Workplace population – used to split the non-home end of HB Other and both ends of NHBO trips.

5.1.11 In the urban areas remote from the A66 fully modelled area, the demand was merged in accordance with the new model zones. Further detail is contained within the Stage 2 Transport Model Package[3].

PCF Stage 3 A66TM Matrix Updates

5.1.12 During PCF Stage 3, the matrices have been updated from a base year of 2015 to a base year of 2019. The two key activities have been:

- updating the matrices from 2015 to 2019,
- further refinement of the matrices to reflect further zone disaggregation.

5.1.13 The Transport Data Package[4] describes the process followed to update the matrices using 2019 MPOD data. It concluded that the traffic distribution patterns from the 2015 data provide the best starting point for the Stage 3 modelling work and that the most appropriate way to update them will be to apply growth from 2015 to 2019 from the NTM taken from TEMPRO.

5.1.14 TEMPRO trip end data by area, and journey type were downloaded for 2015 and 2019. Data for the A66TM simulation area (i.e., the Fully Modelled Area and Intermediate areas) was downloaded at detailed sub

[3] Highways England - A66 Northern Trans-Pennine Project, Transport Model Package, Stage 2 - May 2019

[4] Highways England - A66 Northern Trans-Pennine Project, Transport Data Package, Stage 3 - May 2021

local authority district level to allow trip end growth factors to be applied. Within the buffer area growth was applied using county factors. The matrices were then growthed using these factors and balanced using a Furness procedure. The resultant matrix total growth is shown by model segment in Table 5-2. Growth has been applied to the PA and OD matrix segments in line with the disaggregation between home based and non-home based information within TEMPRO.

Table 5-2: Car Matrix resultant matrix growth

			2015 Stage 2 Model	2019 Stage 3 Model	Resultant Matrix Growth	NTM TEMPRO Growth (GB)	A66 Corridor Growth
PA	24 Hour	Business	1,993,192	2,076,976	4.20%	4.08%	N/A
		Commute	12,858,781	13,112,844	1.98%	1.80%	
		Other	14,196,856	14,706,085	3.59%	3.68%	
OD	AM	Business	188,496	193,324	2.56%	2.85%	9.8%
		Other	332,637	342,895	3.08%	3.10%	
	IP	Business	209,685	215,061	2.56%	2.62%	9.5%
		Other	589,889	608,825	3.21%	3.22%	
	PM	Business	204,906	210,422	2.69%	2.64%	3.8%
		Other	469,386	484,586	3.24%	3.26%	
	OP	Business	60,102	61,642	2.56%	2.68%	4.7%
		Other	169,064	174,862	3.43%	3.48%	

5.1.15 The resultant matrix growth is closely equivalent to that observed at GB level within Tempro. Overall growth within Tempro is lower than that observed on the A66, particularly during the AM and Inter peak. This difference will be accounted for within the remainder of the model revalidation.

5.1.16 Further matrix manipulation was undertaken to split the matrices to account for Zone disaggregation within Penrith using the methodology outlined in 5.1.10. The matrices were then subjected to factoring at a sector level to balance flows across screenlines prior to matrix estimation. This is discussed further in section 8.2 of this report.

5.2 LGV Matrix Development

5.2.1 The collation of 2019 Teletrac Navman data is discussed within the Transport Data Package. The main strengths of the Teletrac Navman dataset is that it provides LGV trip data at OD level, at a detailed spatial and temporal resolution. This allows the day-to-day variation in trip patterns to be observed. The data represents around 2% of national fleet but is expected to contain biases in that the units are more likely to be installed in fleet LGVs undertaking business trips and trips made by higher income travellers.

5.2.2 Similar data (TrafficMaster data) was used as the primary data source within the development of the Regional Traffic Models in 2015.

5.2.3 The following steps were applied to the original TeletracNavman source data:

- Rezone Lower Super Output Area (LSOA) zone data to A66 zoning system. This was achieved by creating a cross-reference between LSOA and A66 zone geometry in GIS and calculating overlap percentages between LSOA zones and A66 zones.
- There was an issue as some zones did not match LSOA zones – the codes for these had the pattern of Scottish zoning systems. Therefore, Scottish zones' data types had to be established – these were found to be an old (2001) version of the Scottish Data Zone format
- Use the overlap percentages to map TeletracNavman trips from LSOA/Data Zone to A66 zones, splitting trips between A66 zones according to overlap areas. This applies to both origin and destination zones. For example, if a trip's origin and destination LSOA zones each overlapped 50/50 with two A66 zones, 0.25 trips would be assigned to each of the four pairings of the two A66 origin zones and the two A66 destination zones.
- Apply filtering and factors to convert input data from all time periods into average-hour AM, IP, and PM peak data.
- Derive scaling factors which can be applied to scale up the input data to the level of the 2015 matrices. This was undertaken as the 2015 matrices are the best current reference of aggregate level LGV trip making across the network.

5.2.4 When the resultant matrices were compared at 12-hour level, it was found that internal Scotland trips had decreased markedly. These missing trips can be attributed to the fact that TeletracNavman have not been commissioned to maintain data within this area. As these trips do not affect our study area this was considered not to be critical to this study.

5.2.5 During RTM1 a process was followed to address the trip length bias by controlling the raw data to fit observed trip-length distributions from the National Travel Survey. Therefore, a similar process was followed, as the new data was found to have significantly different trip length distributions to those found in the 2015 matrices. As a result, the following steps were added to the process in order to improve the trip length distribution. This process is used in substitution of the scaling-up factors described in the above:

- define distance bands (0-10km, 10-20km, 20-30km, 30-40km, 40-50km, 50-75km, 75-100km, 100-150km, >150km);
- for each peak, calculate the number of trips within each of these distance bands in the prior matrices;
- for each peak, calculate the number of trips within each of these distance bands in the new (Teletrac) trip data; and

- scale up the trips in each distance band to equal the total number of trips in the corresponding distance band in the prior matrices.

5.2.6 This improved the relative fit of the 2015 and 2019 matrices in terms of the numbers of trips between the study area and the external areas.

5.2.7 Reference to RTF 2018[5] shows that LGV growth between 2015 and 2020 is 10.1% for England and Wales. RTF 2018 also shows LGV usage to have increased within the North East by 10.0% and 9.5% in the North West.

5.2.8 The 2019 prior matrix contained above was factored at a screenline level during calibration and validation, prior to matrix estimation. This further scaling was necessary to account for growth in LGV traffic between 2015 and 2019, and for the changes in the modelled periods between the PCF2 and PCF3 matrices. The factors were developed through comparison of assigned flows to traffic counts on the model screenlines.

5.2.9 The final prior matrices are shown in Table 5-3. Within the AM peak period only relatively small factors were found to be necessary, whilst in the interpeak and PM peak periods, larger factors were found to be necessary as the assigned flows across the majority of screenlines were considerably lower than observed. Applying larger factors to all trips was however preferable to allowing matrix estimation to make large adjustments to the matrices as this would lead to the possibility of uncontrolled matrix distortion.

Table 5-3: Final Prior Matrices by Period

AM Peak				
From / To	Internal	External England	Scotland	**Total**
Internal	61,353	1,424	452	63,230
External England	1,520	660,427	55	662,003
Scotland	450	63	24,217	24,730
Total	63,323	661,915	24,724	749,962
Inter Peak				
From / To	Internal	External England	Scotland	**Total**
Internal	61,829	1,343	345	63,516
External England	1,173	479,411	42	480,626
Scotland	373	67	17,307	17,747
Total	63,375	480,820	17,694	561,889
PM Peak				
From / To	Internal	External England	Scotland	**Total**
Internal	53,867	1,246	393	55,507
External England	1,099	469,364	34	470,497
Scotland	351	62	19,784	20,197
Total	55,317	470,673	20,211	546,201

[5] https://www.gov.uk/government/publications/road-traffic-forecasts-2018

Off Peak				
From / To	Internal	External England	Scotland	**Total**
Internal	10,397	280	58	10,735
External England	230	126,941	15	127,186
Scotland	66	13	18,010	18,089
Total	10,693	127,235	18,083	156,010

5.2.10 Figure 5-2 shows the areas considered above in Table 5-3.

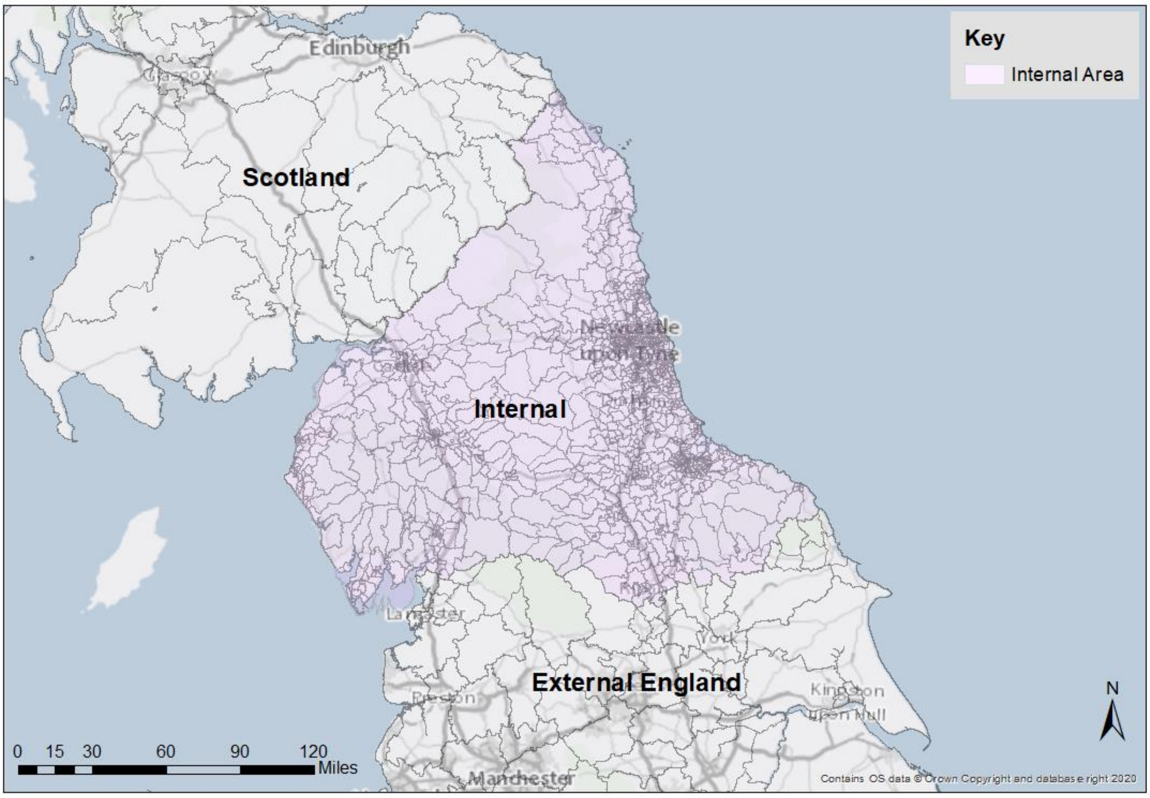


Figure 5-2: Internal/External Areas

5.3 Freight Matrix Development

5.3.1 The original NRTM freight matrices were based on the DfT's Base Year Freight Matrices (BYFM), which provide road freight vehicle movements for a base year of 2006. Therefore, a more up to date source of data was considered to be desirable. 2018 prior freight matrices were provided by TfN based on data supplied by MDS Transmodal, provided in the A66TM zone system. The matrices matched the A66TM model time periods, and as they had been developed for a pan northern highway assignment model, little further processing was required.

5.3.2 The process undertaken by TfN to disaggregate GBFM total HGV PCUs output to time period matrices by vehicle type followed two main steps as follows.

- Converting from Annual HGV PCUs to Annual Rigids/Artics.
- Converting Annual Rigids/Artics to time period PCUs.

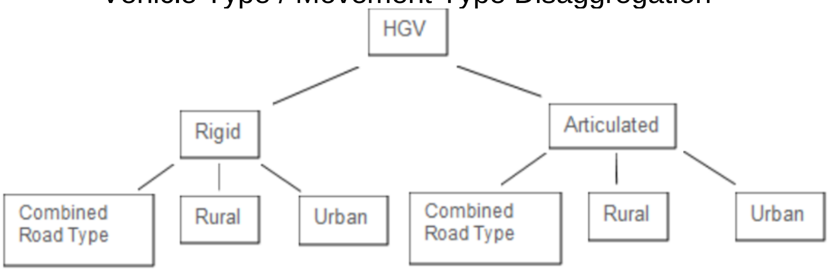
5.3.3 The split of annual HGV PCUs to Annual Rigids/Artics is informed by proportions found in DfT regional level data.

5.3.4 Apportioning the data to time periods then follows a process using functionality based on a methodology developed by Ian Williams[6]. The methodology uses aggregate WebTRIS analysis to produce a variety of time profiles that distinguish between different types of HGVs, LGVs and different road types, namely:

- Motorways
- Urban A-road
- Rural A-road.

5.3.5 Movements are classified into each of these categories and processed together to create traffic volume index tables by hour and weekday. This allows a temporal distribution to be applied to each movement / vehicle type. Some indicative illustrations of this process are shown in Figure 5-3.

Vehicle Type / Movement Type Disaggregation



Example Traffic Volume Index

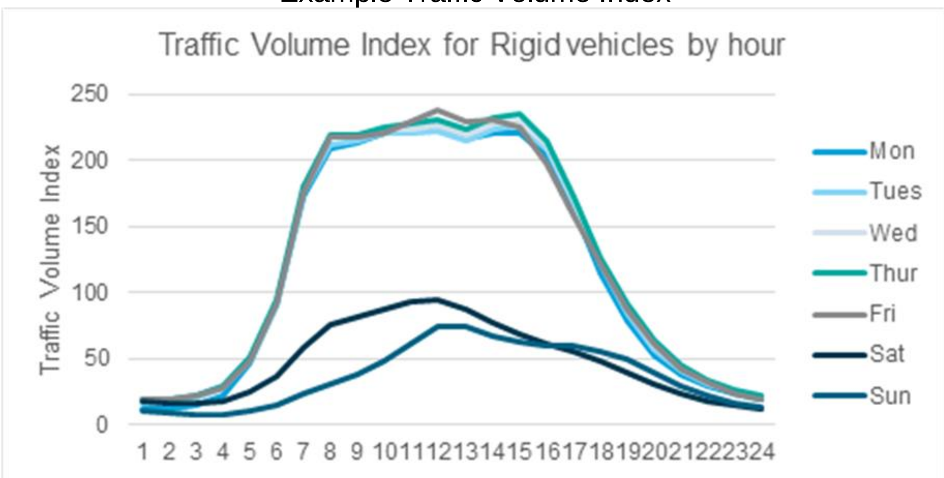


Figure 5-3: Principles within TfN Methodology to split 24 Hour PCUs to Vehicle Types and Time Period

5.3.6 Matrix estimation, i.e. adjusting the prior matrices to improve their match to individual link counts or screenlines has not been undertaken by either MDS Transmodal, nor TfN. Upon receipt of these matrices within the A66 project they were checked to ensure:

- they were symmetrical at a 24-hour level;

[6] Ian Williams is a freight modelling specialist who has been providing advice to National Highways on the development of the freight matrices within the RTM2 commission

- the average trip length was compared against the DfT domestic and inter-nation road freight statistics; and
- that the largest freight generators within the matrices were allocated to appropriate industrial zones.

5.3.7 Upon completion of these checks, it was found that these matrices needed to be factored at screenline level to provide a better fit to the observed flow data at an aggregate level, before matrix estimation could be applied.

6 Network Development

6.1 Network Development in PCF1 and PCF2

6.1.1 The model network is based on the NRTM network. The NRTM network includes an area of simulation network, where junction modelling is included, and buffer network, where the network representation is link based.

6.1.2 In the NRTM, a tiered approach to network coding was used. In the core modelled area, detailed simulation coding was generally reserved for the Strategic Road Network (SRN), roads connected to the SRN and running parallel. In the rural and urban areas away from the SRN relatively simplistic 'template' simulation coding was adopted. Outside of the core modelled area the NRTM covers the remainder in less detail in the form of a buffer network with fixed speed links and no junction coding.

6.1.3 The approach to network coding in the NRTM, particularly along the A66 corridor was not appropriate for A66 scheme assessment and was therefore enhanced at PCF Stage 1. At PCF Stage 2 only minor changes were made to further refine network representation.

6.1.4 For the A66TM, the geographical extent of the network is based on the NRTM. The modelling undertaken during Stage 0 provided a good understanding of the potential demand and reassignment impacts of an improved A66. Initial modelling of the full A66 dualling option provided an indication of the extent of reassignment and hence a basis for determining the extent of the network.

6.1.5 The extent of both the simulation area and buffer area have been retained from NRTM; however, the simulation area has been further subdivided to include fully modelled, intermediate and external areas containing different levels of simulation coding. This reflects the need to enhance the network detail included in the NRTM, particularly along the A66 corridor and competing corridors.

6.1.6 The extent of the network, together with the boundaries of the simulation and buffer areas was shown in Figure 3-1.

6.2 Network Coverage and Approach to Network Representation

6.2.1 At PCF Stage 1 the NRTM network was reviewed, and a revised hierarchy was developed for the A66TM model. The model area was sub-divided, and in each area a different level of network and zone system detail implemented based on the level of impact the potential schemes are expected to have. The areas are as follows, and were shown in Figure 3-1

- Simulation Fully Modelled Area: Core scheme area, centred on A66 between A1 (M) and M6;
- Simulation Intermediate Area: bounded by the A1, A69, M6 and A65/A59, provides an area of transition between the fully modelled area and the remainder of the simulation area;

- Simulation External Area: Covers the remainder of the NRTM simulation area; and
- Buffer Area: This covers the rest of England, Scotland and Wales.

6.2.2 The level of network coverage and level of detail included in the network is presented in Table 6-1, together with the reasoning for the approach adopted and any changes compared to the donor NRTM model.

Table 6-1: Approach to Network Coding

Area	Importance to the Scheme	Level of Network Detail and Coding	Changes from NRTM	Comments
Simulation fully modelled area	This is the area over which significant impacts of interventions are expected.	Network Density: • Motorways • A and B roads • 'C' or ungraded roads that play an important role in allowing development traffic to access the rest of the network Coding Standard: • All junctions are fully represented in detailed simulation coding based on on-site observations and aerial photography. • Speed flow curves included on all links	NRTM Simulation coding reviewed, and additional junction detail added. Additional network included to represent local road feeding into the A66 Disaggregation of zones to allows better loading onto the network.	The level of detailed contained in NRTM was not considered sufficient to fully capture network performance.
Simulation intermediate area	this is the area over which the impacts of interventions are considered to be quite likely but relatively weak in magnitude.	Network Density: • Motorways • A and B roads • 'C' or ungraded roads that play an important role in allowing development traffic to access the rest of the network Coding Standard: • Junctions not represented • Fixed link speeds	No additional network added No change to NRTM coding methodology minor modifications in terms of link definition and speed flow curves; NRTM network checked for completeness and coding checked.	The current level of detail in NRTM was considered to be sufficient to provide an area of transition
Simulation external area	Covering the remainder of the NRTM simulation area. In this area impacts of interventions are expected to be small and the level of network and zoning detail is considered to be excessive for testing A66 schemes, particularly in the Tyne and Wear urban area	Network Density: • Motorways • A and B roads • 'C' or ungraded roads that play an important role in allowing development traffic to access the rest of the network Coding Standard: • Junctions not represented • Fixed link speeds	Tyne and Wear, Teesside – a simplification of network detail and zoning with an aggregation of zones, and the associated rationalisation of network coverage In other areas of the simulation external area no changes to the zoning or simulation coding.	Zoning and network coding were simplified in Tyne and Wear and Teesside urban area to reduce model noise.

6.3 Simulation Network Link Coding

6.3.1 For each link in the simulation area the following information is required:

- Link length;
- Speed flow curve index; and
- Link length for each link was obtained from the OS ITN layer.

6.3.2 Speed flow curves were allocated based on the characteristics of each link. This includes:

- The speed limits;
- The number of lanes;
- The road standard;
- Road quality; and
- Location of road (urban/suburban/rural).

6.3.3 The speed flow curves adopted have been inherited from the NRTM which were based on the Regional Traffic Models network coding manual. The characteristics of the links which determine the speed flow curves have been reviewed and if necessary, the speed flow curves allocated to links amended.

6.3.4 At PCF Stage 1, the speed limits were reviewed in the simulation fully modelled and the simulation intermediate area. Within the simulation fully modelled area the network was modelled in further detail with regards to junctions and changes in carriageway type, particularly along the A66. Link speeds were adjusted where appropriate, particularly along the A66.

6.3.5 Information on speed limits for the modelled road network (fully modelled, intermediate and external areas) was collected and applied to the model links, using Google Maps street view and supplemented by site visits. Where deemed appropriate, link speed adjustments were made.

6.3.6 Link capacities are based on the Regional Traffic Models Network Coding Manual. These were checked for each link in the simulation fully modelled area and adjusted where appropriate.

6.3.7 Details of all the speed flow curves used are presented in **Appendix A**.

6.4 Buffer Area Link Coding

6.4.1 The buffer area network links are “fixed speed”, comprising link length and link observed speed by modelled time period. Link length originates from the OS ITN layer mapped to model links using a correspondence table. Observed speeds by time period are based on Teletrac data. The RTM Data Consistency Group provided an agreed method of processing the speed data from Teletrac and allocating it to the network[7].

6.4.2 The buffer area link coding was inherited from the NRTM.

[7] Mouchel: TN26 - TrafficMaster JT Data Process, November 2015

6.5 Height and Weight Restrictions

6.5.1 Given the nature of the road network within the vicinity of the A66 corridor, several routes are unsuitable for large vehicles due to environmentally sensitive areas, or weight and height restrictions. At PCF Stage 1, Google Maps and on-site observations were used to identify links with weight and height restrictions, which were included as HGV restrictions in the model network.

6.5.2 HGV restrictions are illustrated in Figure 6-1 (A66 West), Figure 6-2 (A66 Central) and Figure 6-3 (East)

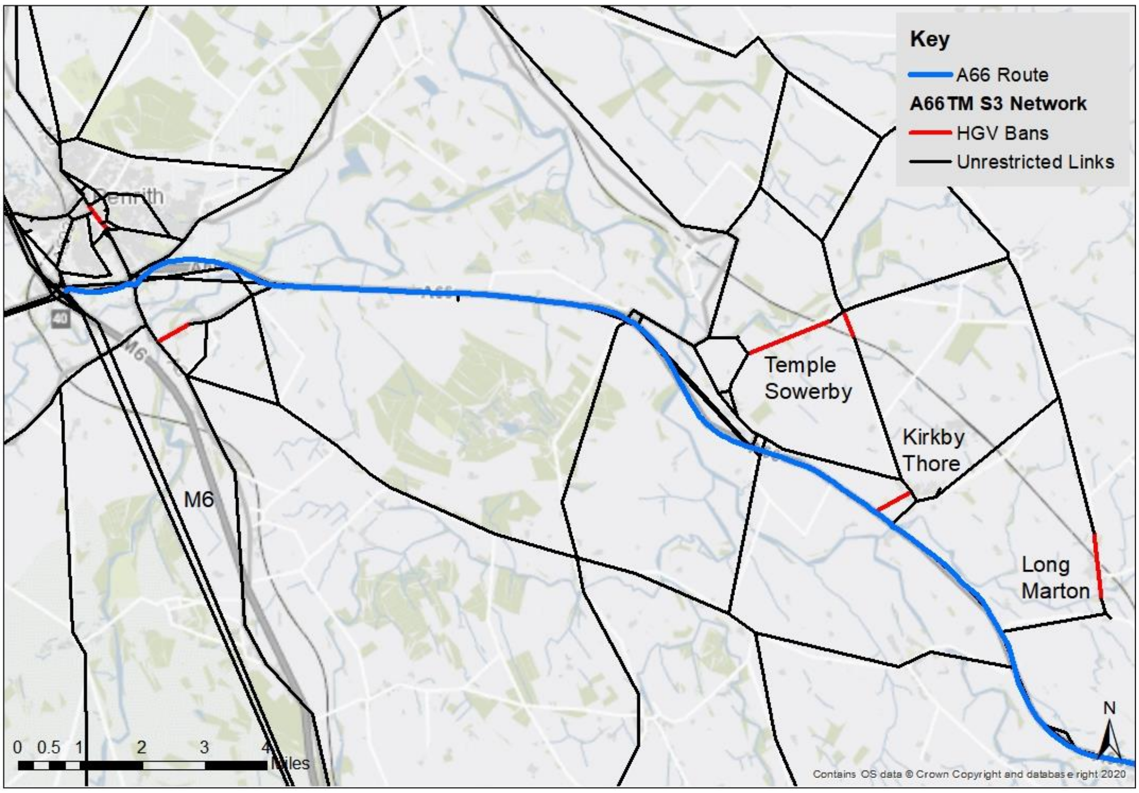


Figure 6-1: Links with HGV restrictions close to the A66 (West)

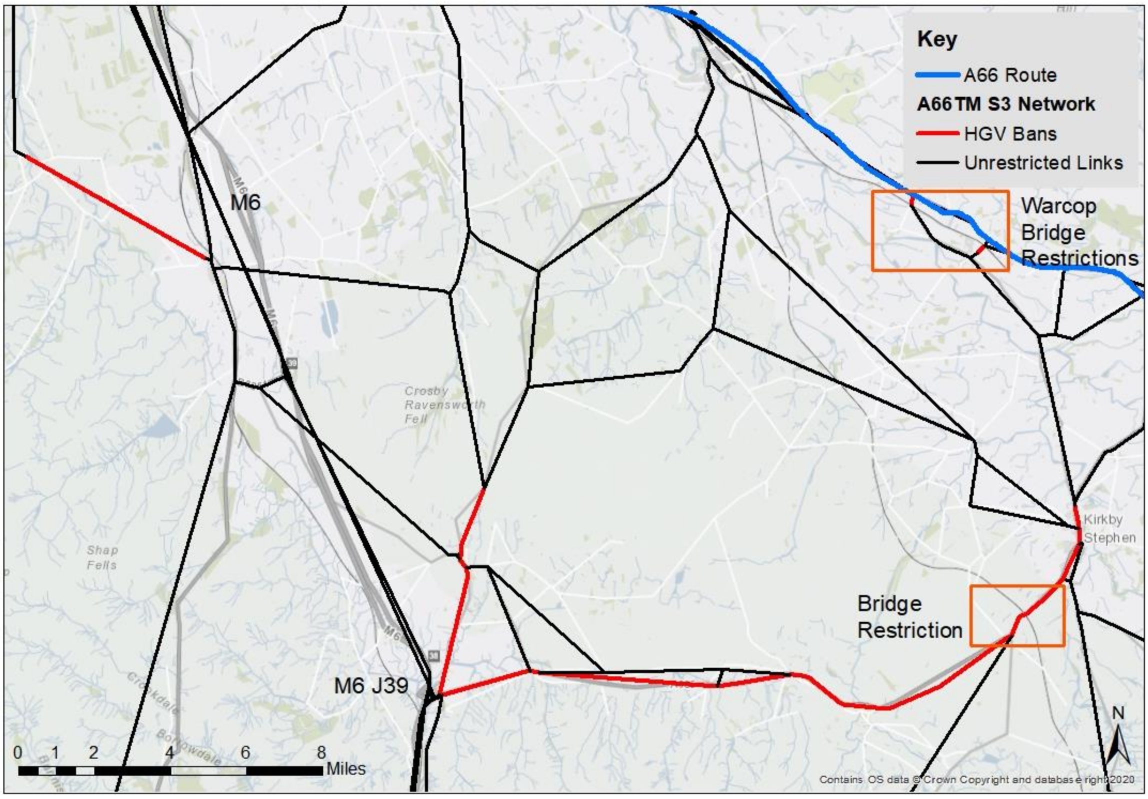


Figure 6-2: Links with HGV restrictions close to the A66 (Central)

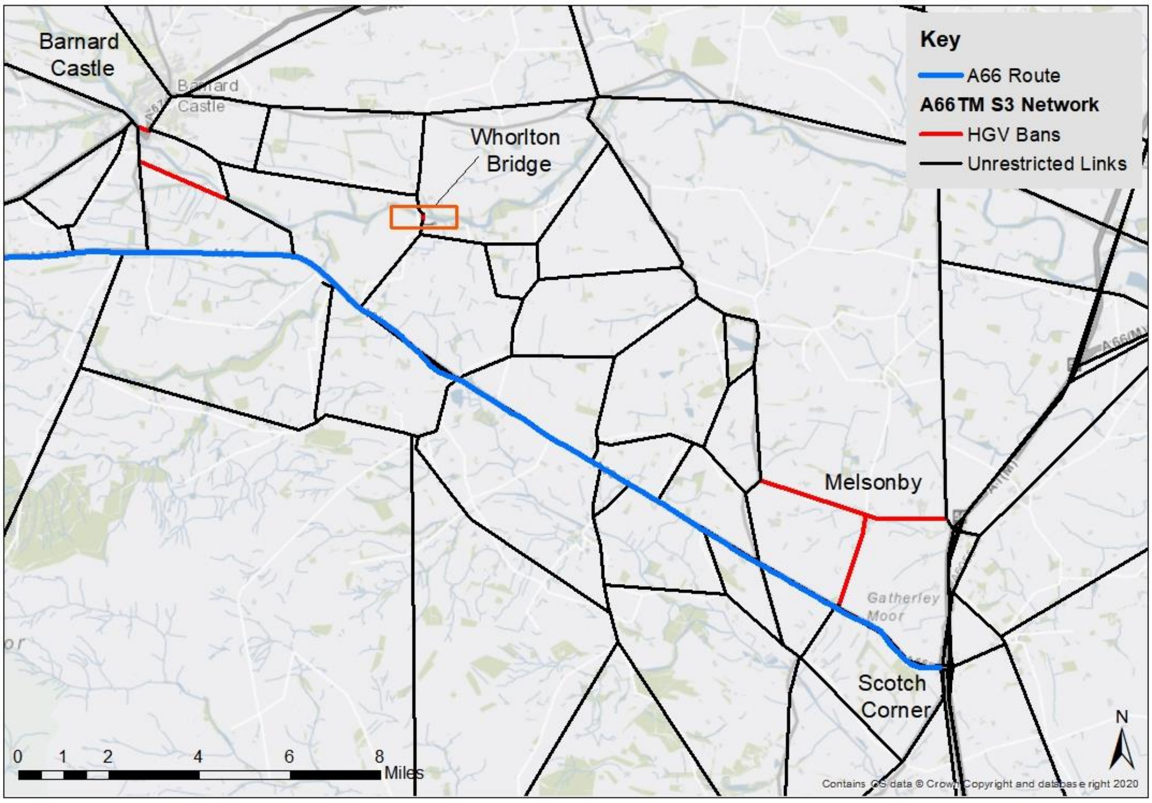


Figure 6-3: Links with HGV restrictions close to the A66 (East)

6.6 PCF Stage 3 Network Coding

6.6.1 The majority of the A66 model network remains unchanged from Stage 2, however, several updates were required to develop the Stage 3 model. These include:

- additional scheme coding to include RIS1 National Highways and local highway schemes built since 2015;
- additional scheme coding in Penrith to better reflect route choice and improve the accuracy of traffic flows;
- additional scheme coding north of Kirkby Thore;
- additional scheme coding east of Scotch Corner between Middleton Tyas, Scorton and Croft-on-Tees to capture local traffic which could route via the Scotch Corner junction; and
- additional scheme coding and updated zone loadings to improve convergence in Durham, Middlesbrough and Carnforth.

Additional Scheme Coding

6.6.2 As the base year will be updated to 2019, schemes that have been implemented since 2015 within the fully modelled area have been included. Table 6-2 provides a summary of RIS1 National Highways schemes and local highway schemes which have been added to the Stage 3 model.

Table 6-2: Additional Scheme Coding

Scheme name	Description	Opening year
	RIS1 National Highways Schemes	
Leeming Bar Bypass	Bedale, Aiskew and Leeming Bar bypass. 4.8km single carriageway bypass linking the A684 north of Bedale and the A684 east of Leeming Bar crossing the A1(M) via an interchange at J51.	2016
A1(M) Leeming to Barton	Replacing existing dual carriageway with a new 3-lane motorway along the 12 mile stretch of the A1 between Leeming and Barton. Also includes signal improvements/extra capacity at Scotch Corner.	2018
A1(M) Coal House to Metro Centre	A1 corridor modifications including junction rearrangements and widening.	2016
	Local Highway Schemes	
A66 Ravensworth Speed Reduction Scheme	Speed reduction on two-mile stretch which includes junctions serving West Layton, Ravensworth and Mainsgill Farm Shop.	2018
Ulverston Signals	Three signal improvements on A590. Includes signalisation of existing layout plus pedestrian facilities; right turn ban out of Swan Street. New south arm and signalisation of resulting 4-way junction on 2-lane dual carriageway section of A590.	2017
M6 Heysham Link	Link from M6 J34 to Heysham.	2016
Billy Mill Junction	A1058, Gosforth – Replacing the roundabout with a signalised junction & providing two lanes eastbound along Beach Road.	2017
Four Lane Ends Pinch Point	A188 Benton Lane corridor modifications with junction realignments and widening.	2016

Scheme name	Description	Opening year
High Flatworth	A193 – Approach widening with junction reallocations	2017
Norham	A1058 – Widening the bridge to four lanes & signalising the slip road junctions	2019
West Park	A192 Earsdon Road Lane corridor modifications with junction realignments and widening	2017
West Shiremoor	Dualling of Holystone Way with associated junction modifications and new A191 signalised junction	2017
Lindisfarne	A19/A194 – Corridor modifications with junction realignments, widening and signalisation	2017

Penrith

6.6.3 As part of the PCF Stage 3 modelling work for the A66, a review of the existing Stage 2 base model network has been undertaken. Following a review of the impacts of the scheme within Stage 1 and 2, it was decided that refinements should be made to better reflect traffic distribution through Penrith to allow effects on M6 Junction 40 and Kemplay Bank to be represented more accurately. This section describes the network changes made and the basis for making these updates. Additional network has been coded based on the Regional Traffic Models Network Coding Manual version 09.

6.6.4 Network links have been added to connect the A592 (Ullswater Road) and the A6 (Bridge Lane) along Wetheriggs Lane and Clifford Road. The additional links serve a large area of residential development on the south side of Penrith in addition to a supermarket, leisure centre and primary school. The improvements allow the model to better reflect the distribution of traffic between Ullswater Road and Bridge Lane as well as turning movements on their approaches and exits to Junction 40 and Kemplay Bank.

6.6.5 The signalised junction at Roper Street/Victoria Road/Kilgour Street is fully represented in the Stage 3 model. This allows the model to better reflect congestion at the junction which can sometimes occur during the day, particularly on Victoria Road.

6.6.6 Additional network links have also been added on the east side of Penrith along Carleton Road, Oak Road, Drovers Lane and Friargate. The Stage 2 network in this area of the model is simplified which makes it difficult to represent route choice through the centre of Penrith, particularly since some sections of the road network in the centre are one-way only. This includes Middlegate and Castlegate which are restricted to clockwise traffic only.

6.6.7 Figure 6-4 shows the Stage 2 model network in Penrith and the new network links that have been added as part of the Stage 3 model development work. Section 0 provides further information regarding updates that were made to the zone system within Penrith.

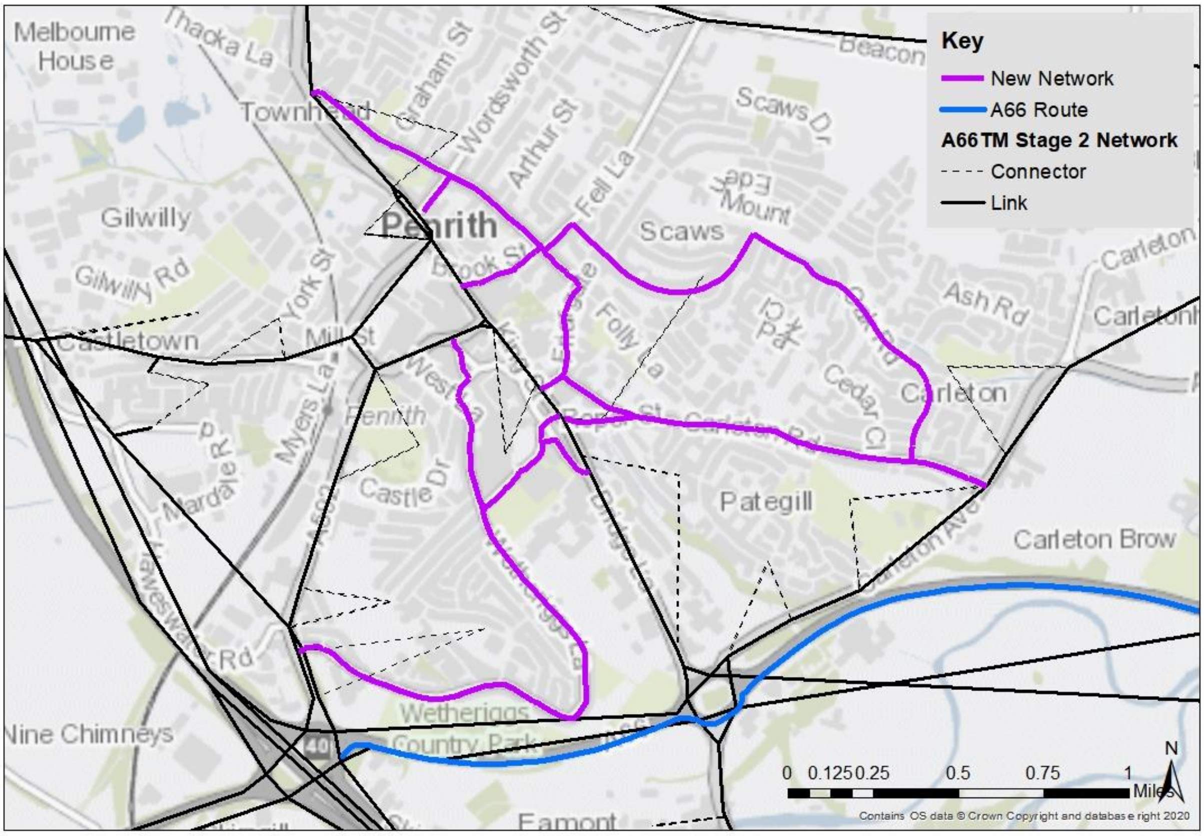


Figure 6-4: Penrith Stage 3 Network Improvements

6.6.8 In addition to the changes north of the A66, signal timings were adjusted on the A6 bridge which crosses the River Eamont and is restricted to one-way only traffic. Whilst Skirsgill Lane is not represented in the model network, the signal timings have been updated to include an extended inter-green time which would otherwise serve traffic using Skirsgill Lane. The resulting green time on the A6 is considered more realistic and has helped to improve validation performance on the A6 south arm of Kemplay Bank including turning counts to and from this arm.

6.6.9 Figure 6-5 shows the updated network and zone layout in SATURN which includes the zone updates detailed in Section 0. Centroid connectors have also been relocated where appropriate.

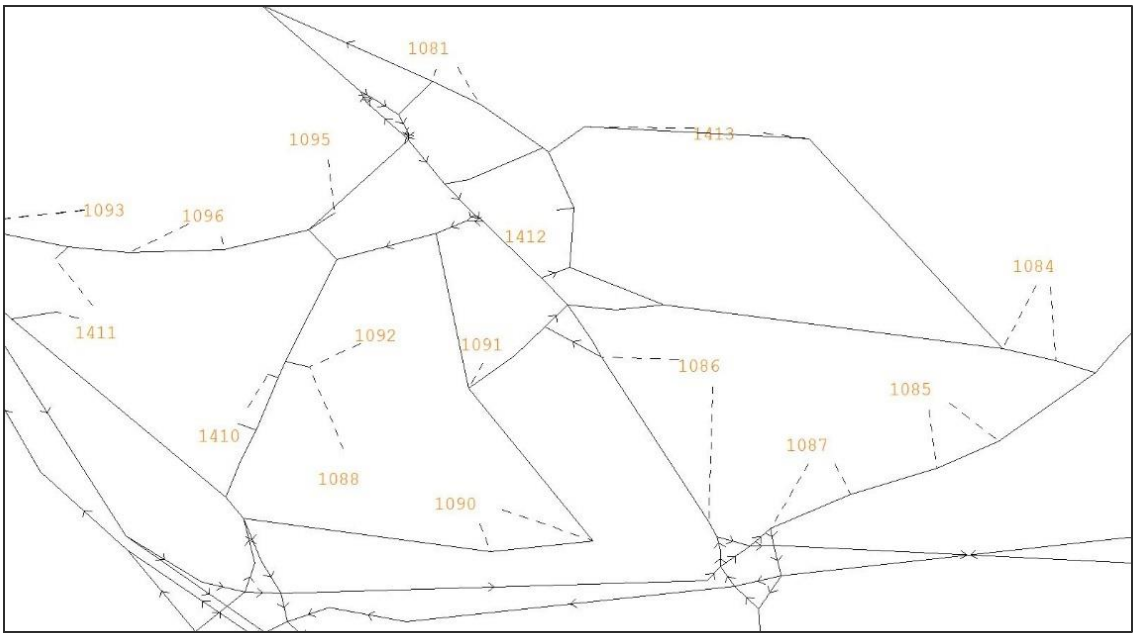


Figure 6-5: A66TM Stage 3 Penrith zone loadings in SATURN

Kirkby Thore

6.6.10 Following a review of the Stage 2 model network along the A66, an additional link was added in Kirkby Thore. Whilst traffic demand is likely to be low in rural areas, it is important to ensure the road network is appropriately represented, particularly at junctions along the A66. Figure 6-6 shows where a network has been added north of Kirkby Thore.

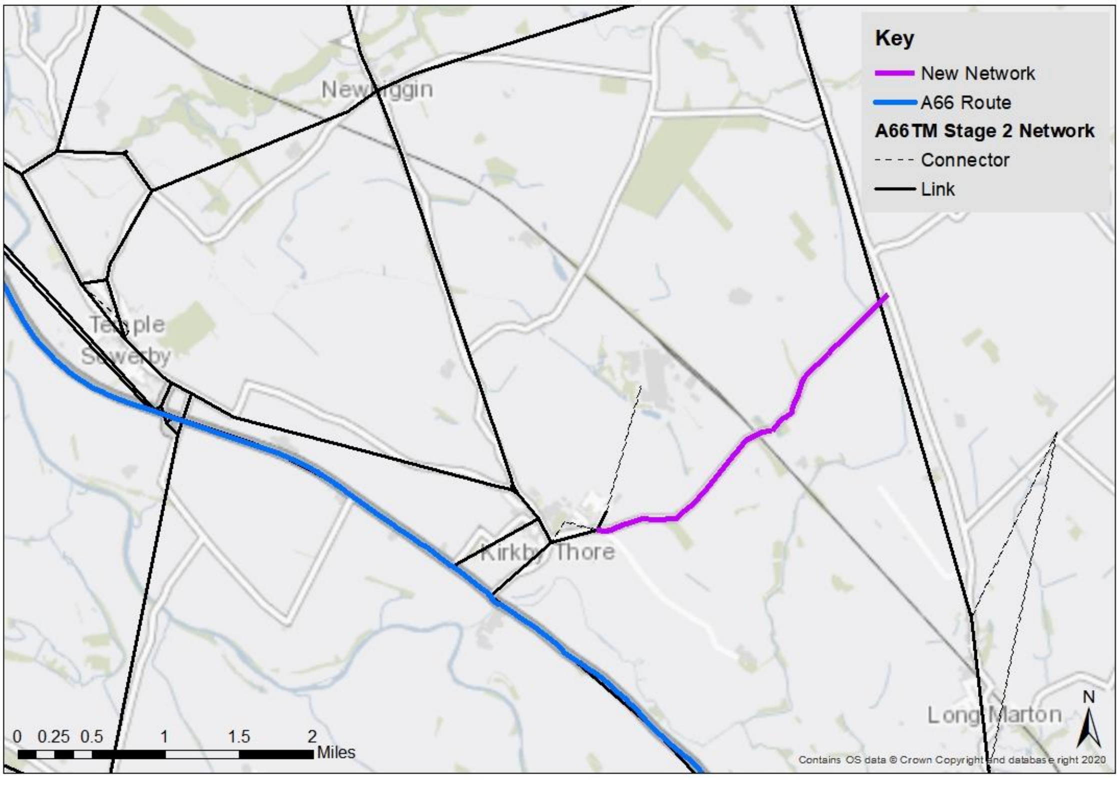


Figure 6-6: Kirkby Thore Stage 3 Network Updates

Scotch Corner

6.6.11 Additional network links have been added east of Scotch Corner. This includes the north-south link between Scorton and Middleton Tyas and Richmond Road which provides an east-west link between Middleton Tyas and Croft-on-Tees. Whilst traffic flows on these rural roads are minimal, they could impact the turn flows at Scotch Corner, particularly on Middleton Tyas Lane. Signal timings and junction coding has also been updated from the 2015 Base model at Scotch Corner.

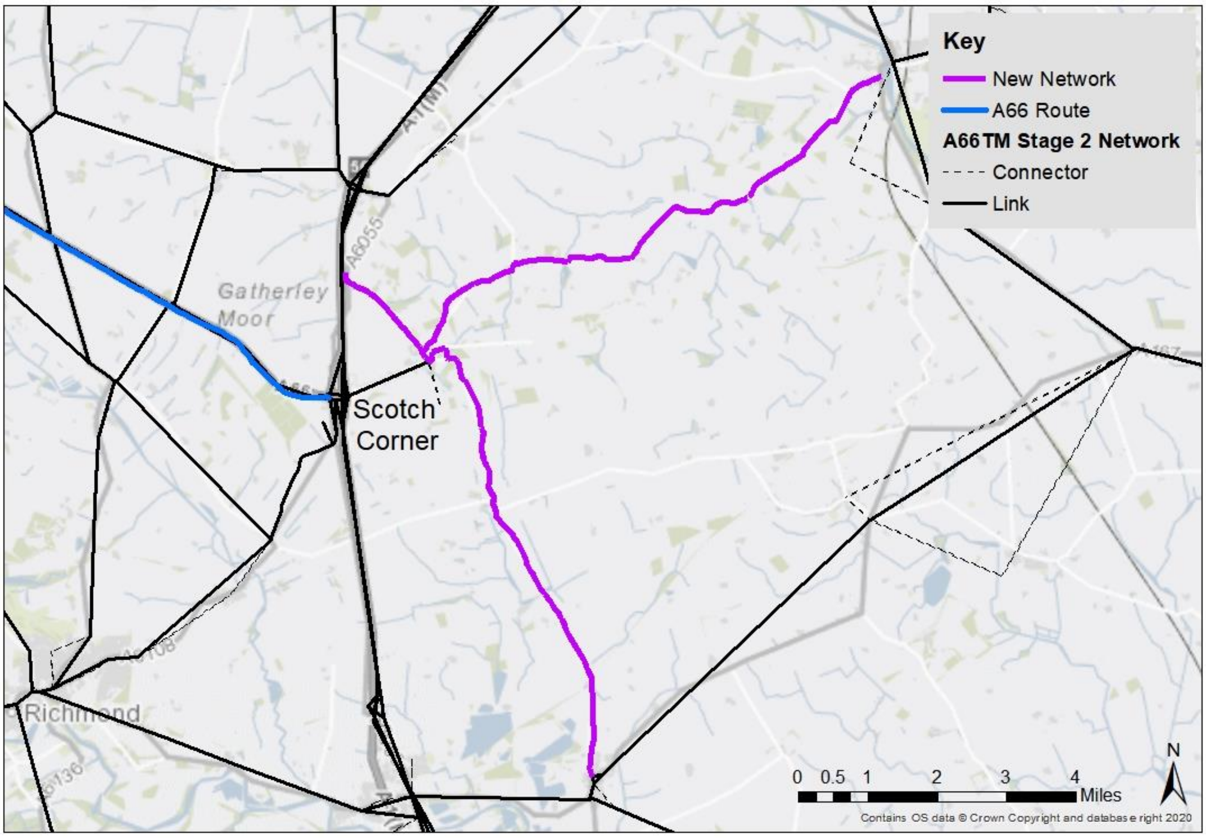


Figure 6-7: Stage 3 Network Updates east of Scotch Corner

6.7 Zone System

6.7.1 The model zone system is based on the NRTM zoning system, with some adjustments made to reflect the scheme.

6.7.2 The NRTM zone system uses LSOA as a basis, aggregating up to larger zones at Middle Super Output Area (MSOA) level where appropriate. In the external area, zones are based on MSOAs aggregated to county levels.

6.7.3 At Stage 1, the NRTM model zones were adjusted in accordance with the A66TM defined model areas as follows:

- Simulation Fully Modelled Area: Zones were disaggregated (split) to fit with the more detailed network in and around the A66. All disaggregated zones adhere to the Census boundaries.

- Simulation Intermediate Area: NRTM zones were largely retained, but with some disaggregation close to the simulation fully modelled area.
- Simulation External Area: Zone aggregation in the urban areas, most notably the North East area to simplify the model and to fit with a less detailed model network in these areas.
- Buffer Area: NRTM zone system retained.

6.7.4 Table 6-3 and Table 6-4 show the number of NRTM zones and number of A66TM model zones, categorised by the type of zone change applied (split or merged) and model area (simulation or external area).

Table 6-3: A66TM Zone Numbers

Zone change	NRTM – Number of zones	A66TM Stage 2 – Number of zones	A66TM Stage 3 – Number of zones
Split Zones	65	181	185
Merged Zones	403	143	143
No Change – Zones Retained	1,082	1,082	1,082
Total	1,550	1,406	1,410

6.7.5 The difference in the total number of zones between the A66TM Stage 2 and Stage 3 model is due to:

- Zone disaggregation in Penrith; and
- Two new zones representing future developments in Cumbria (Eden 41 Business Park) and in North Yorkshire (Scotch Corner Designer Village).

Table 6-4: A66TM Zone Detail

Model Area	NRTM – Number of zones	A66TM Stage 2 – Number of zones	A66TM Stage 2 – Number of zones
Simulation	1,431	1,287	1,291
External	119	119	119
Total	1,550	1,406	1,410

6.7.6 The A66TM model zone system is shown in Figure 6-8, Figure 6-9 and Figure 6-10.

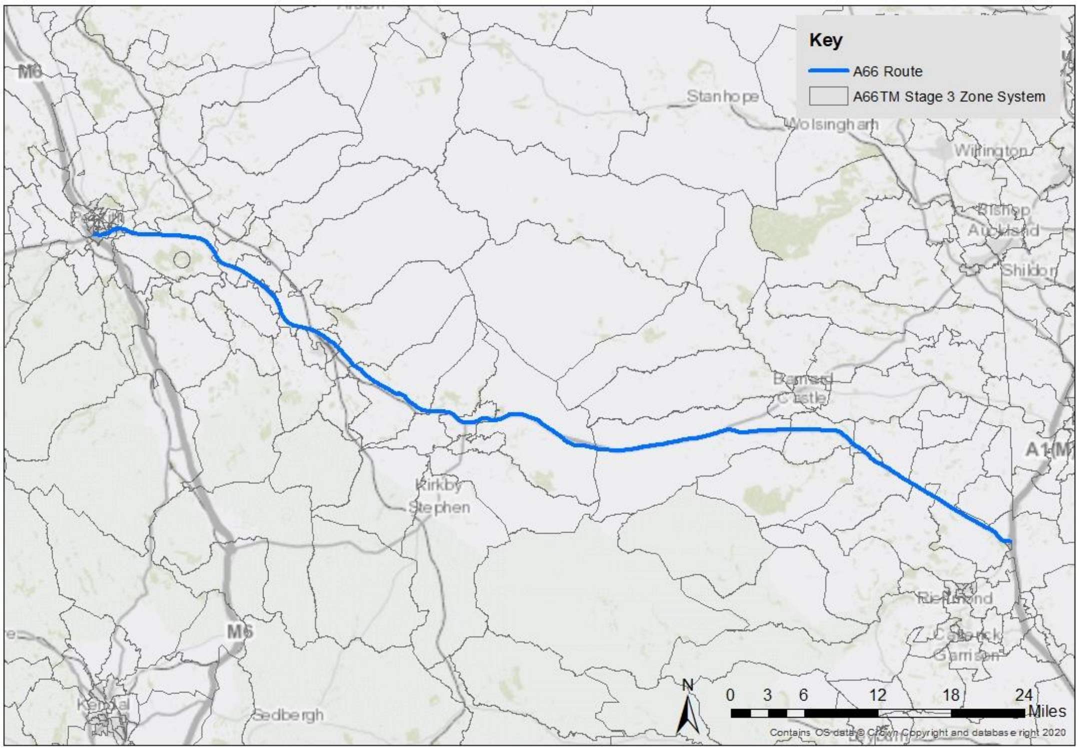


Figure 6-8: Zones around the A66

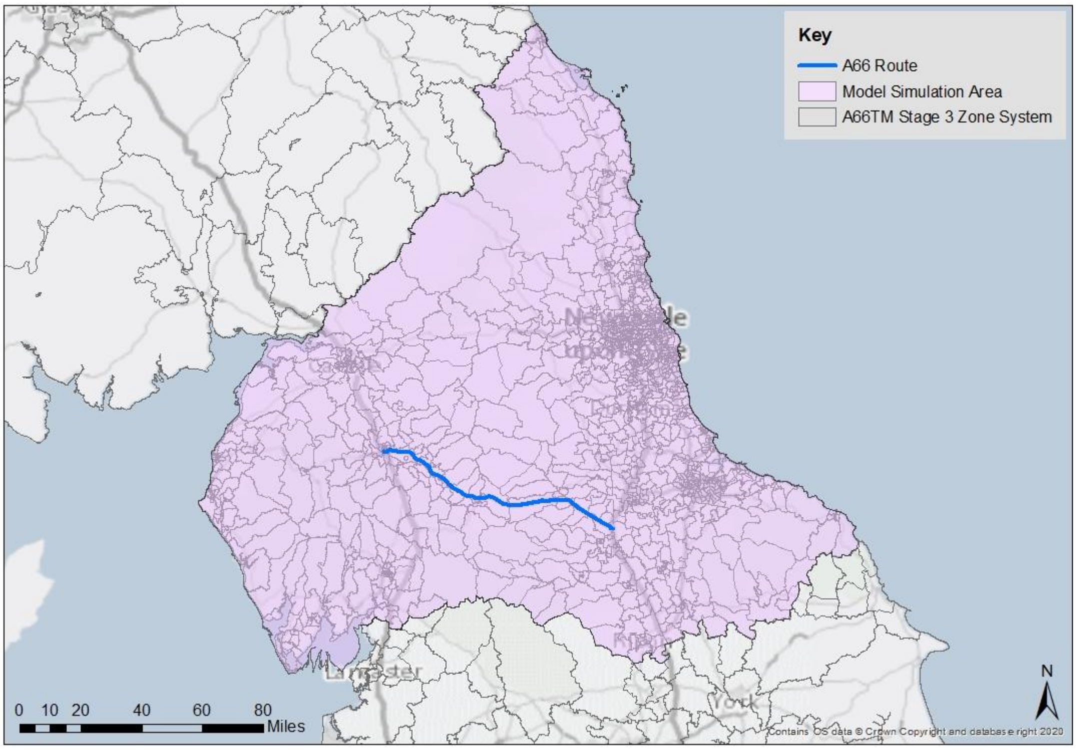


Figure 6-9: Zone system within Model Simulation Area

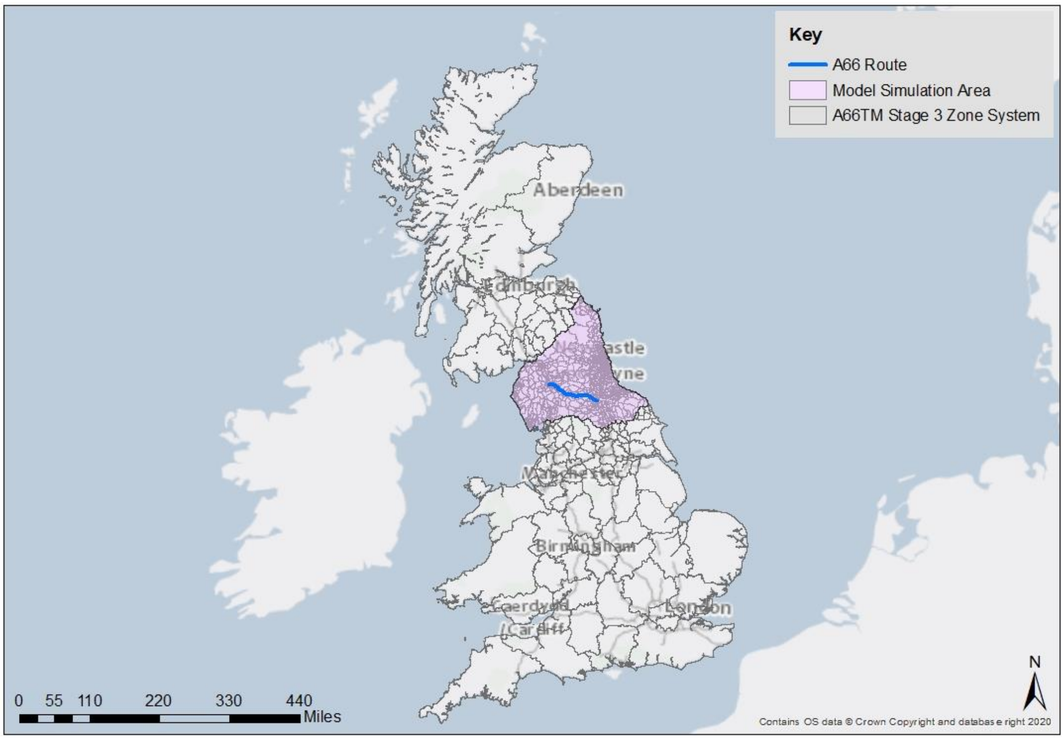


Figure 6-10: National Zone System

Penrith Zone Updates

6.7.7 The zone system in Penrith has been updated as part of the Stage 3 network improvements. This included splitting two zones and rearranging centroid connectors to improve model behaviour and better represent the land uses within them. Zones which have been split include:

- Zone 1094 towards the south west of Penrith disaggregated to form zones 1410 and 1411. This was split along the West Coast Main Line (WCML) to form a zone to the west (1411) largely consisting of residential development and HGV distribution depots and a zone east (1410) of the WCML which represents retail areas along the A592; and
- Zone 1083 on the eastern side of Penrith disaggregated to form zones 1412 and 1413. This zone was split along Folly Lane to create zone 1413 to the north, which contains mostly suburban residential development and zone 1412 which includes a mix of residential and retail units in the town centre.

6.7.8 Figure 6-11 shows the zone system in Penrith and the zone changes which were undertaken for the Stage 3 model.

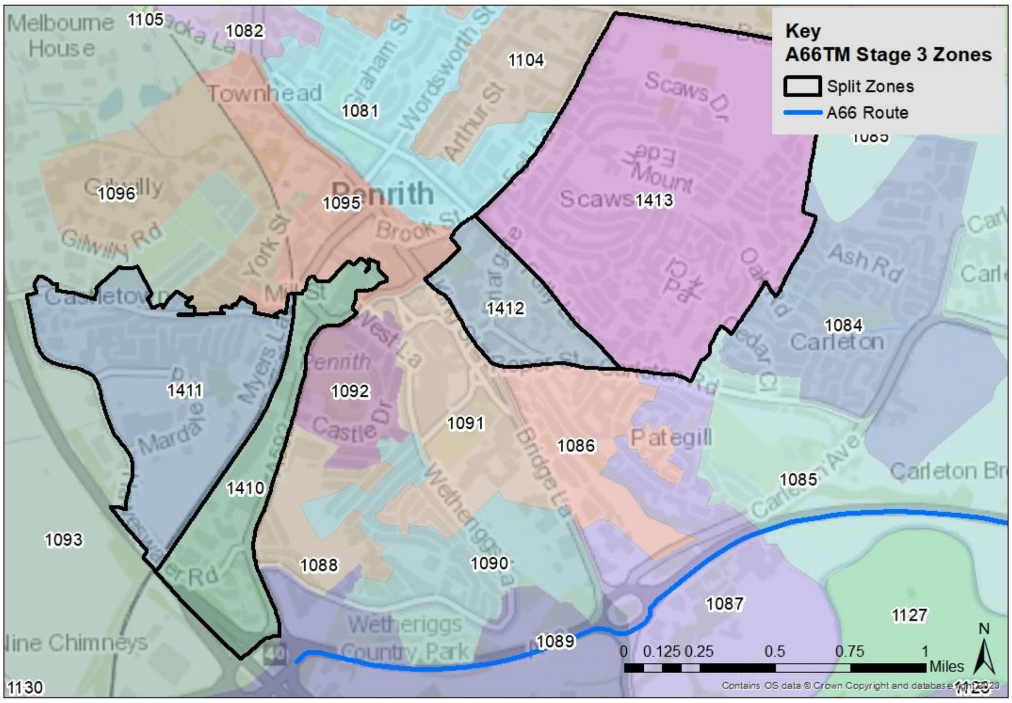


Figure 6-11: Zone disaggregation in Penrith

Convergence Improvements

6.7.9 Initial assignments using the updated 2019 matrices revealed several network issues which were resulting in poor model convergence. Some network zone loadings within Middlesbrough were found to be problematic from the zones identified in Figure 6-12. This was generally caused by large volumes of traffic, particularly HGV traffic loading directly onto the network, particularly smaller junctions. Within this updated model, the freight demand has been substantially rebuilt using 2018 data; therefore, additional attention was paid to ensuring there was sufficient capacity to allow the demand to enter the highway network. This is important as in some cases some centroid connectors can often represent access at more than one junction. It should be noted that the demand from these zones was excluded from factoring increases as part of the HGV sector to sector adjustments in the prior matrices, particularly due to capacity restrictions at smaller junctions.

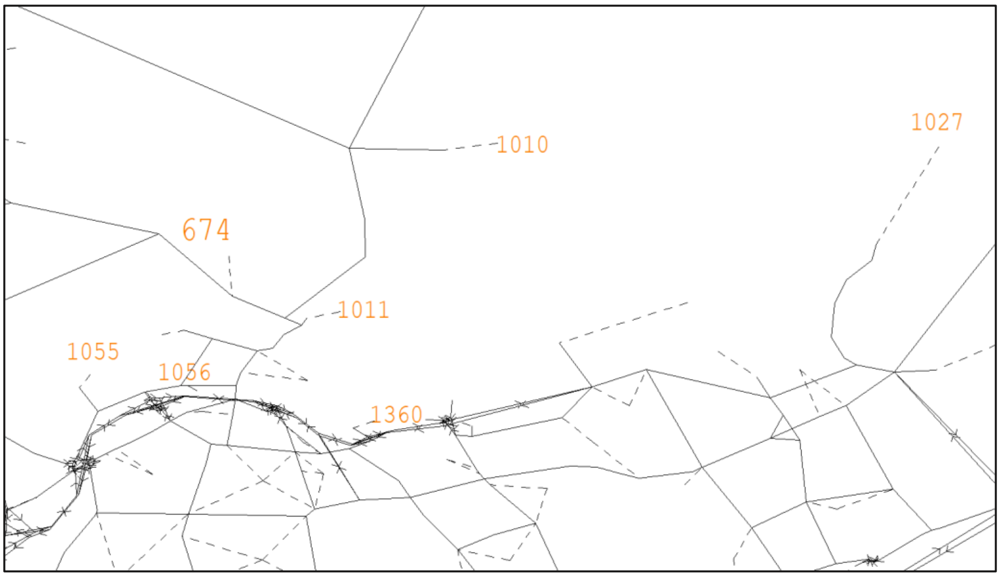


Figure 6-12: Zones in Middlesbrough with high HGV demand

6.7.10 Initial assignments were also improved by modifying some centroid connectors which loaded directly onto junctions. This caused particularly bad convergence in this location and only occurred in a few isolated locations within the simulation area. Figure 6-13 shows an example of a change which was made to a zone loading that covered a large area across Carnforth, Warton and Silverdale. By adding North Road in the centre of Carnforth and using a spanning connector for zone 201, convergence in this location improved significantly.

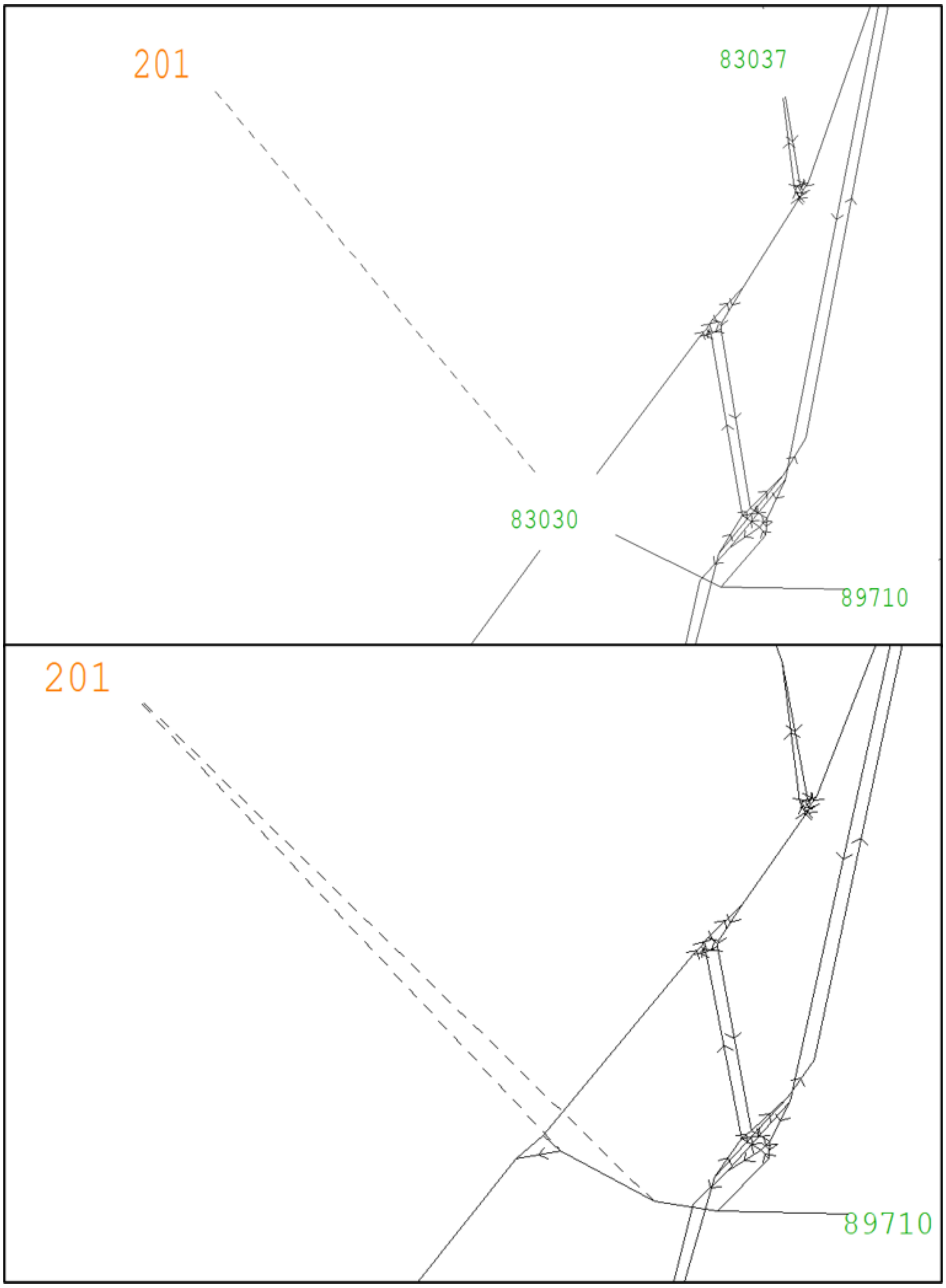


Figure 6-13: Carnforth revised network and zone loading original (above) and updated (below)

7 Assignment Process

7.1 Assignment Procedures

7.1.1 The assignment procedure adopted for the highway model is based on an equilibrium assignment with multiple demand segments for an average hour in AM peak, interpeak and PM peak time periods.

7.1.2 The assignment technique uses Wardrop equilibrium assignment, achieved using Franke-Wolfe user equilibrium algorithm in SATURN.

7.1.3 The assignment methodology includes the following:

- Path-based algorithm;
- Blocking back; and
- Each time period is modelled as a standalone model, no interaction with the previous time period (i.e., no PASSQ from the previous time period).

7.2 Assignment Units

7.2.1 The assignment works across the multiple user classes with traffic flow measured in passenger car units (PCU) as defined below:

- Car and LGV = 1 PCU/vehicle; and
- HGV = 2.5 PCU/vehicle

7.2.2 This is consistent with the NRTM.

7.3 Generalised Costs

7.3.1 The generalised costs within the assignment model are essential as they affect traffic routing on the road network. They are applied in the following form:

*Generalised Cost = Time + PPK/PPM*Distance + Toll*

Where PPM is Pence per Minute, and PPK is Pence per Kilometer.

7.3.2 The user class HGV in the model is a mix of:

- Other Goods Vehicles 1 (OGV1), including goods vehicles over 3.5 tonnes with two or three axles, and
- Other Goods Vehicles 2 (OGV2), including all rigid vehicles with four or more axles and all articulated vehicles.

7.3.3 Consistent with the NRTM model a split of 40:60 (OGV1:OGV2) was assumed for the calculation of generalised costs.

7.3.4 An Excel workbook was provided by National Highways with source data which reflects the May 2021 v1.15 release of the TAG Databook.

7.3.5 Table 7-1 and Table 7-2 show the PPM and PPK generalised cost parameters used, which are all in 2010 prices. The value of time given in TAG Unit A1.3 for HGVs relates to the driver's time and does not take account of the influence of owners on the routeing of these vehicles. On these grounds, TAG recommends that it may be more appropriate to use a value of time around twice the TAG Unit A1.3 values which were applied.

Table 7-1: Value of Time Costs Parameters – PPM

Element	User Class	AM Peak	Inter Peak	PM Peak
Car	Employers Business	30.92	31.68	31.36
	Commute	20.73	21.07	20.81
	Other	14.31	15.24	14.98
LGV		22.41	22.41	22.41
HGV		44.63	44.63	44.63

Table 7-2: Vehicle Operating Cost Parameters – PPK

Element	User Class	AM Peak	Inter Peak	PM Peak
Car	Employers Business	12.55	12.55	12.55
	Commute	6.14	6.14	6.14
	Other	6.14	6.14	6.14
LGV		13.75	13.75	13.75
HGV		42.15	42.15	42.15

7.3.6 Tolls have been coded for the Tyne Tunnel along the A19, East of Newcastle. These are summarised in Table 7-3.

Table 7-3: Tyne Tunnel Tolls

Car - Business	Car – Commute	Car – Other	LGV	HGV
£1.22	£1.45	£1.45	£1.25	£2.44

7.3.7 These values are based on a 2019 toll price for cars and LGV's of £1.70 per vehicle and for HGV's £3.40, which were then converted into 2010 prices using the GDP deflator provided in the latest TAG Databook.

7.3.8 The costs used for the assignment are based on 2010 perceived prices (i.e., without taxation) and therefore, the toll charge for User Class 1 (employers' business) is lower than the cost for both commuting or other user class categories (UC2 and UC3). Additionally, toll charges for LGVs have been calculated using a weighted average of personal and freight trips based on Table A1.3.4 in the latest TAG Databook, giving a default proportional split of 12% for LGV personal and 88% for LGV freight.

7.3.9 It is noted that in 2019, all users of the Tyne Tunnel had the option to pre-pay toll fees at a discount of 10% to the advertised cash price. This has not been assessed in detail for the purpose of calculating assignment toll charges and is considered to have negligible impact on the assessment of the A66 scheme.

7.4 Assignment Parameters

7.4.1 The assignment parameters used for the NRTM were applied. Table 7-4 below summarises the key values.

Table 7-4: Assignment Parameters

Parameter	Value	Description
ISTOP	99	% of links that are within PCNEAR % convergence
KONSTP	5	Assignment stopping criteria method
MASL	100	Maximum number of assignment/ simulation loops
NISTOP	4	Number of successive loops which must satisfy ISTOP criteria
NITA	30	Maximum number of assignment iterations in SATASS
NITA_S	512	Number of assignment iterations for the final SAVEIT
NITS	50	Maximum number of simulation iterations in SATSIM
PCNEAR	1	Percentage change for ISTOP
STPGAP	0.05	Gap value (%) used to terminate assignment-simulation loops when KONSTP = 1 or 5

8 Model Calibration

8.1 Summary of Data Collection

8.1.1 The data used to support the development of the Stage 3 model includes the following A66 specific counts:

- A66 Stage 1 data;
- A66 Stage 2 data; and
- Cumbria data

8.1.2 Previously, 2015 RTM 1 count data was used to inform the development of the Stage 1 and Stage 2 A66TM. The Stage 3 model has been updated to include 2019 RTM2 count data which contains the following:

- RTM2 surveys;
- WebTRIS data;
- Local Authority data;
- DfT data; and
- Teletrac data.

Stage 1 and Stage 2 Count Data Collection

8.1.3 Traffic count surveys were undertaken during November and early December 2017 along the A66 corridor as part of the Stage 1 A66 study. November is classed as a neutral month in TAG Unit M1.2 – Data Sources and Surveys.

8.1.4 The types of survey undertaken were:

- Automatic Traffic Counts (ATC) – 2 weeks duration, 24-hour coverage;
- Manual Classified Link Counts (MCC) – 7 days duration, 24-hour coverage; and
- Manual Classified Turning Counts (MCTC) – 12 hours duration.

8.1.5 Each of the surveys undertaken provided data across the model time periods. Since no new data could be collected due to the Covid-19 pandemic and given the age of the data and proximity to the scheme, this data forms part of the Stage 3 model dataset.

8.1.6 Several additional traffic counts were available from Cumbria County Council due to data collections for the update to the Penrith traffic model, covering roads in and around Penrith in June 2018.

8.1.7 Mott MacDonald commissioned additional traffic surveys in March/April 2019 as follows:

- Manual Classified Turning Counts (MCTC) and ANPR survey at Scotch Corner (12 hours duration); and
- Manual Classified Link and Turning Counts at junctions along the A66 from M6 J40 at Penrith to the A1(M) at Scotch Corner.

8.1.8 A summary of the Stage 1 and Stage 2 count data which has been used in the Stage 3 model is shown in Figure 8-1. All data obtained outside of March 2019 has been rebased to provide a consistent dataset. The process required adjusting data for observed annual traffic growth and monthly variability in traffic flows to derive a dataset representative of a common month and year. The methodology for rebasing and factoring to a common year/month has been applied in line with the RTM2 data collection set out in the PCF3 Transport Data Collection Package[8].

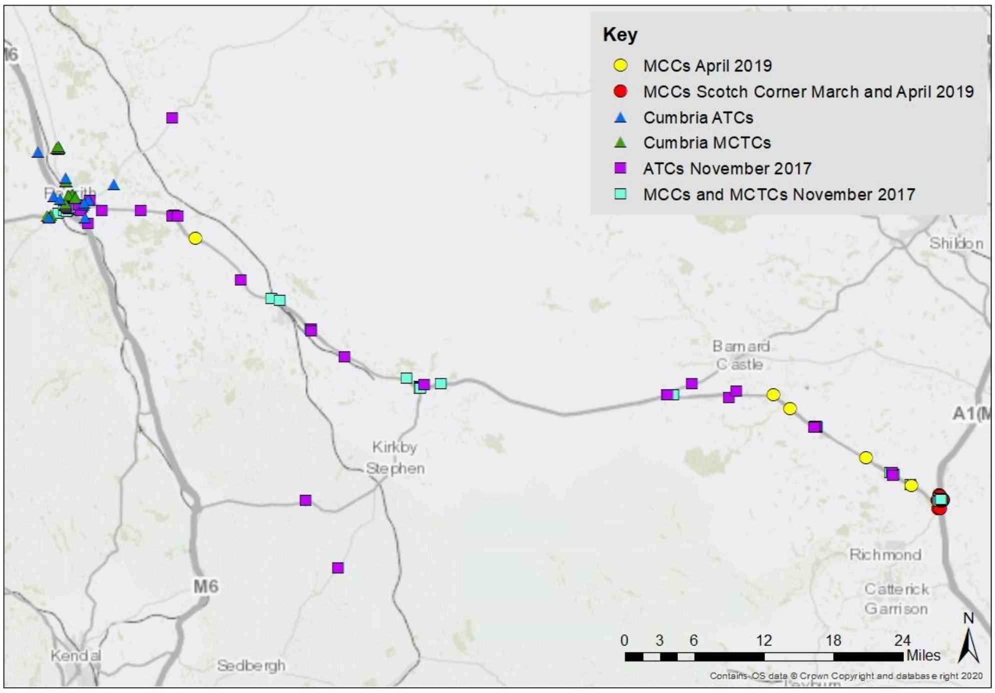


Figure 8-1: Stage 1 and Stage 2 count data

Stage 3 Count Data Collection

8.1.9 The impact of Covid-19 has resulted in an inability to collect new primary data to a quality that is more typically used in the development of traffic models, and that meets the recommendations in TAG Unit M1.2. To enable the progression of RTM2, alternative approaches and data sources were explored to infill missing data.

8.1.10 The review of the data sources, both observed volumetric data (i.e., March 2020 surveys, Local Authority data, WebTRIS etc.) and the interim data sources (i.e., DfT MCC, expanded Teletrac data, RTM1 data), has identified relative strengths and weaknesses of these data sets. As a result, there is a recommended approach for using data for the RTM2 count locations.

8.1.11 For the SRN, WebTRIS data has been used where possible. Nevertheless, the outstanding issues identified in terms of its processing have been considered, including:

- cross checking WebTRIS link counts against count sites on the same links, and counts on adjacent links, to determine sites with material issues; and

[8] A66 Northern Trans-Pennine Transport Data Package. Document Ref: HE565627-AMY-GEN-S00-RP-TR-000006

- following the removal of erroneous sites, calculation of average demands using all available and viable link counts, to maximise the reliability of the data being generated.

8.1.12 Additional count data was required beyond that identified as available from Local Authorities.

8.1.13 For non-SRN roads, where viable datasets are available, an assumed hierarchy of counts to be used based on the relative strengths of each data set has been followed, whereby the counts higher up the hierarchy are used as a priority over counts further down:

- DfT ATC data;
- Local Authority data, HS2 data, or other volumetric data derived from other sources (e.g., ATR database) that pass the statistical reliability tests;
- March 2020 surveys that pass the statistical reliability tests;
- Local Authority data, HS2 data, or other volumetric data derived from other sources (e.g., ATR database) that fail the statistical reliability tests, but a ‘deeper dive’ indicates there is data that can be used (albeit of a lower quality);
- March 2020 surveys that fail the statistical reliability tests, but a ‘deeper dive’ indicates there is data that can be used (albeit of a lower quality);
- DfT MCC data;
- Teletrac data; and finally
- RTM1 count data

8.1.14 Figure 8-2 shows the collated count dataset from the Stage 3 data collection.

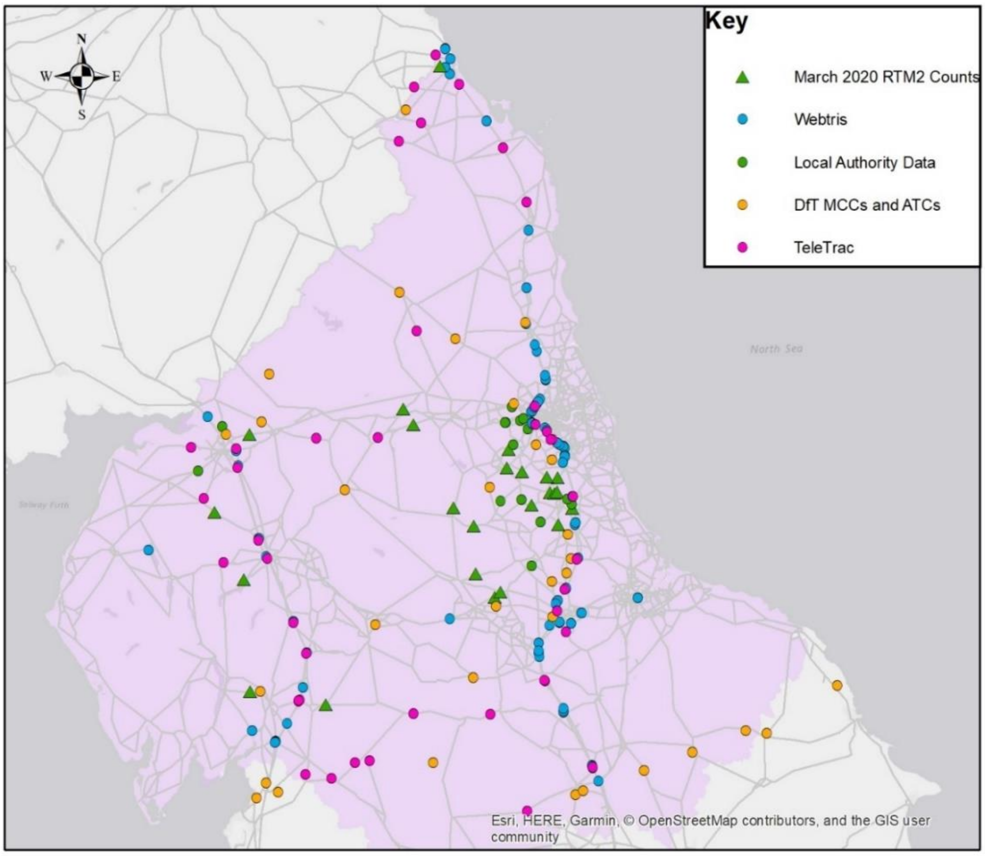


Figure 8-2: Stage 3 2019 A66TM RTM Count Locations

Final Count Dataset

8.1.15 The traffic data used in Stage 3, including screenlines for calibration and validation are shown in Figure 8-3 below. Ad hoc counts have been retained where data has been updated since the work undertaken at Stage 2. Screenlines have been retained as far as possible from the Stage 2 model subject to availability of counts and count locations.

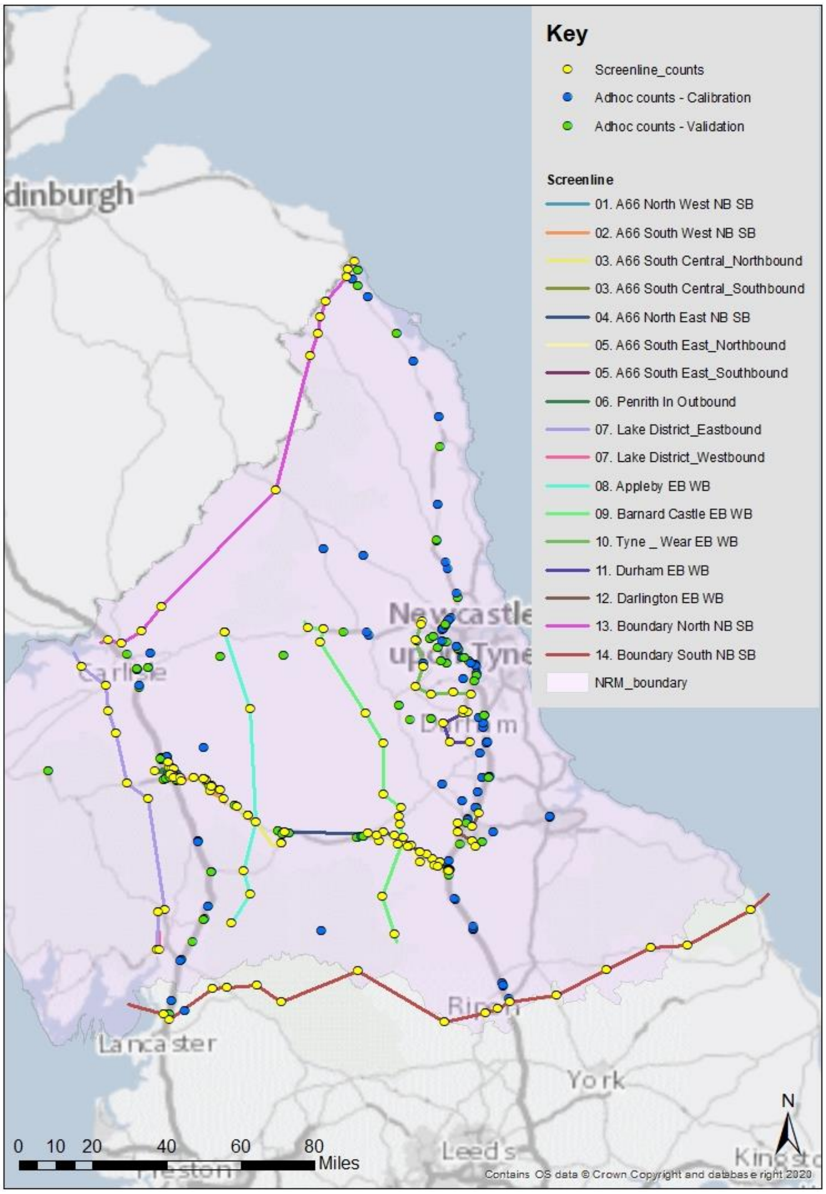


Figure 8-3: Screenlines and Adhoc Count Locations used for Calibration and Validation

8.1.16 Detailed information for each of the screenlines shown in Figure 8-3 is provided in Table 8-1 below.

Table 8-1: Stage 3 Final Screenlines for Calibration and Validation

Screenline	Direction	Type	Number of Sites
01. Penrith	Inbound	Calibration	6
01. Penrith	Outbound	Calibration	6
02. Lake District	Eastbound	Calibration	9
02. Lake District	Westbound	Calibration	9
03. Appleby	Eastbound	Validation	6
03. Appleby	Westbound	Validation	6
04. Barnard Castle	Eastbound	Calibration	11
04. Barnard Castle	Westbound	Calibration	11
05. Tyne & Wear	Eastbound	Calibration	9
05. Tyne & Wear	Westbound	Calibration	9
06. Durham	Eastbound	Calibration	6
06. Durham	Westbound	Calibration	6
07. Darlington	Eastbound	Calibration	5
07. Darlington	Westbound	Calibration	5
08. Boundary North	Northbound	Calibration	12
08. Boundary North	Southbound	Calibration	12
09. Boundary South	Northbound	Calibration	17
09. Boundary South	Southbound	Calibration	17

8.1.17 Further information regarding the data collection and processing used for the Stage 3 model is provided within the Transport Data Package[9].

Journey Time Data

8.1.18 Journey time data has been obtained from the Department for Transport's (DfT's) Teletrac Navman GPS dataset for the North. The data contains average journey times for each link in the ITN network in 15-minute intervals and has been provided for North England March, June and October 2019, representing three neutral months. A list and map of journey time routes used to assess the Stage 3 model are shown in Section 9, Table 9-9 and Figure 9-1.

Mapping Data

8.1.19 Network data has been provided in the form of digitised road network, taken from Ordnance Survey's Highways Network. This corresponds to the Teletrac journey data provided by the DfT.

8.2 Checks of Network Characteristics

8.2.1 Network checks have been undertaken for the base year network. These are not intended to guarantee an 'error free' network but offered a

[9] A66 Northern Trans-Pennine Transport Data Package. Document Ref: HE565627-AMY-GEN-S00-RP-TR-000006

systematic approach to testing the standard of the network to help improve the quality.

SATURN Compilation check

8.2.2 This is to prove that the network, including the buffer network, may be compiled in SATURN with the option “Set WRIGHT = TRUE” without raising unacceptable errors. The option increases the seriousness of certain errors considered important by the software developers. The calibrated network does not contain fatal or semi-fatal errors.

8.2.3 ‘Serious warnings’ are sometimes unavoidable function of the network building process. Where they have been identified they were closely monitored throughout the calibration / validation phase.

Inspection of Key Junctions

8.2.4 This task includes checking key junctions and intersections, that have the greatest influence in the model calibration and validation, are coded appropriately. These include:

- M6 J40 (M6/A66)
- Kemplay Bank roundabout (A66/A6)
- Scotch Corner (A1M/A66)
- Bowes grade-separated junction (A66 / A67)

8.2.5 The representation of these junctions, and indeed all junctions along the A66, was found to be accurate.

Inspection of Link Lengths

8.2.6 The accurate coding of link lengths is crucial to enable an accurate appraisal to be undertaken. As part of the journey time data compilation, model link lengths on journey time routes were checked against the lengths within the Teletrac Navman data network.

8.2.7 A check to ensure that link speeds were not excessive was undertaken on all links within the journey time routes, with a view to removing any link with a speed of greater than 120kph.

8.2.8 Given the development of the network within the NRTM project and from previous stages of this study, all adjustments were found to be minimal. The total modelled link length was checked against the Teletrac Navman network in both eastbound and westbound directions.

8.2.9 Table 8-2 shows a comparison of eastbound and westbound route lengths along the full length of the A66 between M6 Junction 40 and Scotch Corner.

Table 8-2: A66 route length check and comparison of observed and modelled data

Direction	Teletrac (from observed link length data)	SATURN modelled link length	Manual measured route length check
A66 Eastbound between Junction 40 and Scotch Corner	79,824m	79,816m	79,845m
A66 Westbound between Scotch Corner and Junction 40	79,837m	79,834m	79,839m

Network Link Consistency

8.2.10 The following link consistency checks have been undertaken.

- Check network link types and distances are consistent along a road in both directions – this included checking the modelled link lengths against Teletrac link length data and undertaking manual checks along the A66 route length.
- Confirm capacities are appropriately coded – as per RTM or Stage 1/2 improvement.
- Check speed flow curves – whether it is consistent for both directions on two-way links.
- A full review of the junction coding on the A66 was undertaken, to ensure consistency and accuracy in terms of; junction type, lane numbers and allocations, saturation flows, and (where relevant) signal data.
- Signal data was kept mostly the same as in the Stage 2 model. Where known junction improvements had taken place between 2015 and 2019, signals were updated accordingly. This was undertaken at Scotch Corner.

8.2.11 These tests confirm that the network structure has been constructed in accordance with the coding manual.

8.3 Prior Matrix Adjustments

8.3.1 The purpose of the matrix building process for the NRTM was to generate a strategic prior matrix whereby all or nearly all the long screenlines were within 10% of the observed counts. Adjusting the prior matrix before matrix estimation is undertaken to limit the distortion that matrix estimation can cause. A target of 10% was chosen as this allowed us to measure model performance against the original NRTM and Stage 2 A66TM. Adjustments have been made to the car matrix, and new LGV and HGV matrices as part of the matrix calibration process following the principles outlined in TAG Unit 2-2.

8.3.2 Figure 8-3 shows the location of the counts and screenlines used for calibration and validation of the model.

8.3.3 These adjustments have attempted to improve the performance of modelled flows across screenlines within the model. A staged approach was adopted whereby adjustments have been made to improve the fit against long screenlines on the model boundary and overall flow levels across all screenlines by vehicle class by time period. Once this had been broadly achieved further adjustments were made at sector level to improve the flow calibration across the shorter internal screenlines. The sector system used to do this is shown in Figure 8-4.

8.3.4 Section 4.2 sets out the criteria which have been used to test the validation of the prior matrices against observed data.

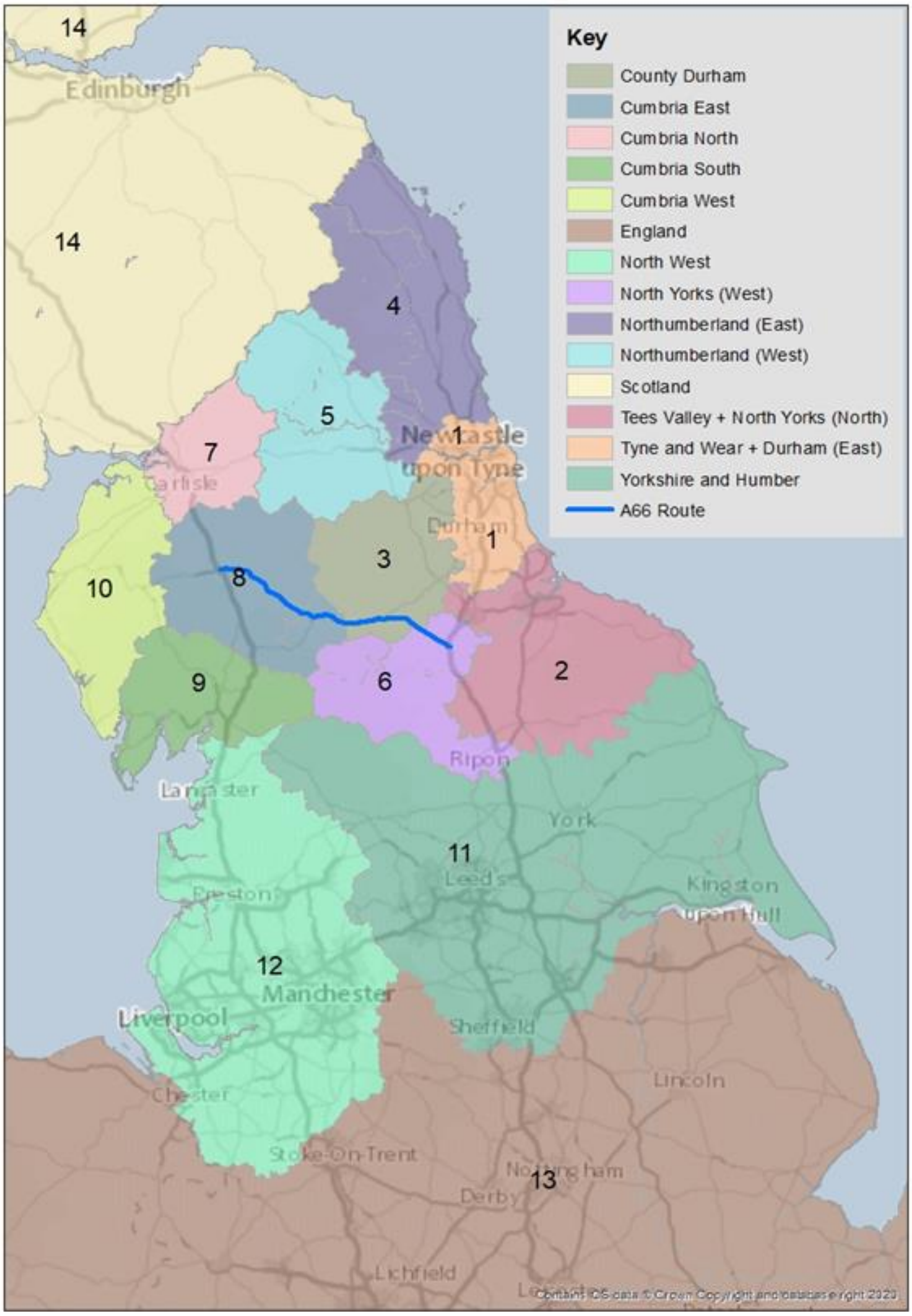


Figure 8-4: Matrix Adjustment Sectors

8.3.5 The prior matrix validation on calibration and validation links; and screenlines; is presented in Table 8-3 below. These show an approximate level of validation on screenlines and in all time periods, with around 80% of screenlines within 10% of the observed flows across all time periods. Link validation is better with 60%-71% of all links meeting the validation criteria as shown in Table 8-4. The performance of SRN links is broadly superior to that of non-SRN links within the prior assignments.

8.3.6 The performance of the prior matrix is broadly similar to that achieved within the NRTM and Stage 2 A66TM at screenline level for the interpeak, while for the AM and PM peaks the performance is less good. Within NRTM and Stage 2 A66TM 15 or 16 of the modelled screenlines were within 10% of observed flows for all periods. At link level the performance is similar to that achieved within the NRTM and Stage 2 A66TM. This slight deterioration in performance is not unexpected given the additional work required during Stage 3 to develop a consistent set of data.

Table 8-3. Prior Matrix Validation (All Vehicles)

Performance Measure	AM Peak		Inter-Peak		PM Peak	
	No.	%	No.	%	No.	%
All screenlines or cordons within 5% of observed flows	5	28%	11	61%	7	39%
All screenlines or cordons within 10% of observed flows	11	61%	16	89%	13	72%
All screenlines or cordons within GEH <4	6	33%	14	78%	10	56%
All screenlines and cordons with GEH <7.5	15	83%	18	100%	15	83%

Table 8-4. Link Flow Validation Summary – Prior Matrices (All Vehicles)

Performance Measure	AM Peak	Inter-Peak	PM Peak
All Links (494)			
- within GEH of 5.0	56%	71%	66%
- within GEH of 7.5	79%	88%	85%
- pass cal/val guidance link criterion	85%	85%	85%
By Calibration/Validation			
Calibration Counts (341)			
- within GEH of 5.0	57%	72%	66%
- within GEH of 7.5	79%	90%	86%
- pass cal/val guidance link criterion	85%	85%	85%
Validation Counts (153)			
- within GEH of 5.0	55%	72%	69%
- within GEH of 7.5	79%	90%	88%
- pass cal/val guidance link criterion	85%	85%	85%
By Road Type			
SRN link Counts (230)			

Performance Measure	AM Peak	Inter-Peak	PM Peak
- within GEH of 5.0	56%	75%	69%
- within GEH of 7.5	77%	90%	85%
- pass cal/val guidance link criterion	85%	85%	85%
Non-SRN link Counts (264)			
- within GEH of 5.0	57%	68%	64%
- within GEH of 7.5	81%	88%	86%
- pass cal/val guidance link criterion	85%	85%	85%

8.4 Matrix Estimation

8.4.1 As shown above, the model performance falls short of the criteria set out in Section 4.2. As such, matrix estimation was used to further refine the trip matrices, following network checks and validation to attain a more reasonable performance.

8.4.2 Section 4.5 provides a set of four measures against which the changes brought about by matrix estimation should be monitored to ensure that the prior matrix distribution is not distorted by the estimation.

8.4.3 Matrix estimation was undertaken for cars, LGVs and HGVs separately, by constraining them to observed count data. Cars were not subcategorised, as it is not possible to distinguish between the trip purposes from the count data. All calibration screenline counts have been used in this process, with additional ad-hoc calibration counts.

8.4.4 XAMAX defines the maximum balancing factor used to limit excessive changes to the prior matrix. A value of two was used for the car matrices, and five for the LGV and HGV estimation. This reflects the relative confidence in the data used to develop the demand for each of these vehicle classes. A convergence criterion of 0.01 was also used in relation to the matrix adjustment process.

8.4.5 A total of 6 loops of matrix estimation were undertaken to generate the final calibrated trip matrix by time period.

Table 8-5: Matrix Estimation Parameters

Parameter	Description	Value
XAMAX	The maximum balancing factor to be applied to avoid large changes to the prior matrix.	Max value: Car: 2 LGV/HGV: 5
EPSLIN	The convergence criteria for the difference between individual observed counts and their respective model flow	0.01
ITERMX	The maximum number of iterations that will be run to achieve convergence	99

8.5 Blending

8.5.1 Matrix estimation was undertaken as two separate runs in line with the NRTM and subsequent A66TM work. This included a blend consisting of a fully unconstrained and a constrained matrix estimation run as follows:

- Fully unconstrained matrix estimation for all OD pairs across all vehicle types; and
- Constrained matrix estimation for cars with OD pairs frozen for skim distances greater than 20km. LGVs and HGVs remain unconstrained.

8.5.2 A blend of 30:70 was used to create the final assignment matrices (30% unconstrained, 70% constrained) from the matrix estimation runs, which is consistent with both the NRTM and Stage 2 A66TM. By using a blend of both matrix estimation runs, it ensured that changes due to matrix estimation were limited for long distance car trips. In addition, it was undesirable for the estimation process to distort longer distance movements which were considered to be more robust in prior matrices. This approach also improved compliance with TAG guidelines for cars.

8.5.3 The impacts of matrix estimation are provided in Table 8-6 which considers the following sections of the matrix across each vehicle type:

- Full data set – full matrix;
- Both trip ends – trips which start and end in the model simulation area; and
- One trip end – trips which start or end in the model simulation area.

Table 8-6: Impacts of Matrix Estimation

Measure	TAG Significance Criteria	Data set	Car	LGV	HGV
Matrix zonal cell values	Slope within 0.98 and 1.02; Intercept near zero; R2 > 0.95	Full	Pass	Pass	Pass
		Both trip ends	Pass	Pass	Outside criteria
		One trip end	Slope 0.85 – 0.99 R2 0.90–0.99	Outside criteria	Outside criteria
Matrix trip ends	Slope within 0.99 and 1.01; Intercept near zero; R2 > 0.98	Full	Pass	Pass	Pass
		Both trip ends	PM Pass, AM and IP Slope between 0.97 and 1.03	Just outside criteria Slope 0.98-1.02 R2 0.97- 0.99	Outside criteria Slope 0.95-1.01 R2 0.95-0.96
Trip length distributions	Means within 5%; Standard Deviations within 5%	Full	Pass	Pass	Pass
		Both trip ends	Pass	Pass	Outside Criteria 7% - 13%
		One trip end	Pass	IP & PM Pass AM -6%	AM Pass IP & PM 6%
Sector to sector matrices	Differences within 5%	Full	Considered GEH due to very low flows in several cells.		

Measure	TAG Significance Criteria	Data set	Car	LGV	HGV
			% GEH <5 achieved within range of 99-100% for cars across all time periods. % GEH <5 achieved within range of 96-97% for LGVs across all time periods. % GEH <5 achieved within range of 83-91% for HGVs across all time periods.		

8.5.4 The results in Table 8-6 show the following:

- Matrix zonal cell values, matrix trip ends, and trip length distributions pass the TAG criteria for all vehicle types when considering the full matrix data set;
- Trip length distributions pass when considering both trip ends (except for HGVs) and one trip end for cars only;
- The changes in sector-to-sector movements do not meet TAG criteria based on percentage differences. This is largely due to absolute totals for sector-to-sector movements being low, therefore it is considered more appropriate to use GEH to assess the changes due to matrix estimation. This indicates that the changes due to matrix estimation are not significant, particularly for cars.

8.5.5 The impacts due to matrix estimation are more significant for LGVs and HGVs, which is largely due to the higher balancing factor (XAMAX) which is 5 for both LGVs and HGVs but only 2 for cars.

8.5.6 **Appendix B** provides a detailed summary of impacts due to matrix estimation for the AM, inter-peak and PM peak models. This includes a comparison of trip length distributions for each model time period and purpose against those within the original NRTM. These are shown to not differ significantly.

8.5.7 Prior and post matrix totals by user class are provided in Table 8-7 for the AM peak, Table 8-8 for the inter-peak and Table 8-9 for the PM peak.

Table 8-7: Prior and Post Matrix totals by User Class – Full Matrix AM

Element	User Class	Prior Matrix Total	Post Matrix Total	Difference	% Change
Car	Employers Business	578,753	579,017	264	0.05%
	Commute	3,299,145	3,302,015	2,870	0.09%
	Other	1,644,998	1,646,480	1,482	0.09%
LGV		749,962	751,106	1,144	0.15%
HGV		283,748	284,137	390	0.14%

Table 8-8: Prior and Post Matrix totals by User Class – Full Matrix IP

Element	User Class	Prior Matrix Total	Post Matrix Total	Difference	% Change

Car	Employers Business	508,529	508,365	-165	-0.03%
	Commute	1,302,014	1,300,580	-1,434	-0.11%
	Other	2,920,393	2,918,620	-1,773	-0.06%
LGV		561,889	561,879	-10	0.00%
HGV		267,385	267,153	-232	-0.09%

Table 8-9: Prior and Post Matrix totals by User Class – Full Matrix PM

Element	User Class	Prior Matrix Total	Post Matrix Total	Difference	% Change
Car	Employers Business	605,822	605,847	25	0.00%
	Commute	2,715,789	2,716,122	333	0.01%
	Other	3,225,761	3,225,904	144	0.00%
LGV		546,201	546,359	159	0.03%
HGV		199,756	199,293	-463	-0.23%

Network routing

8.5.8 To ensure the model reasonably reflects route choices within the region, routing checks were undertaken on trips within the network. **Appendix C** includes a series of route choice plots through the model between the following key locations within the model which were used to accomplish routing checks:

- Carlisle
- Carnforth
- Durham
- Middlesbrough
- Newcastle-upon-Tyne
- Penrith
- Thirsk

8.5.9 In each case, the plot shows the minimum cost route within the final converged assignment. It should be noted that the assignment algorithm would allow other minimum cost routes to be chosen in earlier assignment iterations. Examination of these plots confirms that all chosen routes are representative of routes typically chosen within route finding applications.

9 Model Validation

9.1 Overview

9.1.1 The validation of the highway network is divided into two main elements:

- Validation of demand matrices – based on comparison of observed and modelled traffic flow across screenlines and cordons; and
- Assignment validation – based on a comparison of observed and modelled traffic flows at individual sites and observed and modelled journey times along defined routes.

9.1.2 Acceptability guidelines on both demand and assignment validation are included in TAG unit M3-1 and reproduced in Chapter 3.

9.1.3 This chapter describes the Stage 3 highway model validation.

9.2 Assignment Model Convergence

9.2.1 Before the results of any traffic assignment are used to influence decisions, the stability (degree of convergence) of an assignment must be confirmed. The criteria set out in TAG Unit M3.1 were used to assess the assignment convergence of the SATURN models for the AM, inter-peak and PM average time period hours. The convergence measures and base model acceptable values were set out in Section 3.4.

9.2.2 A summary of the SATURN convergence for the AM, interpeak and PM average time period hours is shown in Table 9-1 where:

- %Flows – Link flows differing by <1% between assignment-simulation loops
- %GAP – Wardrop equilibrium gap function post simulation

Table 9-1: Calibrated Assignment Statistics

AM Peak			Inter Peak			PM Peak		
Loop	% Flow	% GAP	Loop	% Flow	% GAP	Loop	% Flow	% GAP
22	98.7	0.0006	14	98.6	0.0011	20	98.6	0.0013
23	98.6	0.0004	15	99.0	0.0008	21	98.6	0.0019
24	98.7	0.0004	16	98.7	0.0011	22	98.9	0.0013
25	98.8	0.0004	17	98.9	0.0005	23	98.8	0.0017

9.2.3 Among these statistics, of particular importance is the % GAP parameter, which TAG recommends is less than 0.1%. As the tables show this is achieved in all three models indicating that they have converged to satisfactory levels.

9.2.4 Full assignment statistics for each time period are presented in **Appendix D**.

9.3 Trip Matrix Validation

9.3.1 TAG Unit M3.1 provides acceptability guidelines for matrix validation and recommends that differences between modelled flows and counts should be less than 5% of counts for screenlines and cordons. As the total observed traffic flows on a number of the screenlines adjacent to the A66 are very low, the GEH statistic has also been used to assess performance.

9.3.2 A summary of the screenline performance for total vehicles after matrix calibration is shown in Table 9-2. A detailed breakdown of performance by vehicle class can be found in Appendix F – *Screenline Performance*.

Table 9-2: Matrix Validation – All Vehicles

Performance Measure	AM Peak		Inter-Peak		PM Peak	
	No.	%	No.	%	No.	%
All screenlines or cordons within 5% of observed flows	17	94%	17	94%	18	100%
All screenlines or cordons within 10% of observed flows	18	94%	18	100%	18	100%
All screenlines or cordons within GEH <4	18	94%	18	100%	18	100%
All screenlines and cordons with GEH <7.5	18	100%	18	100%	18	100%

9.3.3 The matrix screenline validation performance results are very similar to those reported at Stage 2, apart from the percentage of screenlines or cordons within 5% of observed flows, which has improved slightly to 94%/94%/100% from 83%/89%/83%. This is partly due to factoring of prior matrices and the changes made at Penrith to improve network coverage and zoning.

9.3.4 A detailed breakdown of validation by individual screenline is shown in Table 9-3 to Table 9-5. The analysis indicates that the majority of screenlines meet the TAG validation criteria. Further details including breakdown by vehicle type is available in the Calibration and Validation Dashboard.

Table 9-3: Screenline Performance AM Peak

Screen-line	Direction	Count Sites	Total Vehicles				Cars			
			Obs	Mod	% Diff	GEH	Obs	Mod	% Diff	GEH
Penrith	Inbound	6	2,586	2,495	-3.5%	1.8	2,226	2,141	-3.9%	1.8
	Outbound	6	1,698	1,707	0.6%	0.2	1,372	1,404	2.3%	0.9
Lake District	Eastbound	9	3,753	3,716	-1.0%	0.6	2,937	2,891	-1.6%	0.8
	Westbound	9	4,101	4,028	-1.8%	1.1	2,974	2,874	-3.4%	1.9
Barnard Castle	Eastbound	11	1,844	1,875	1.7%	0.7	1,467	1,499	2.2%	0.8
	Westbound	11	1,857	1,893	1.9%	0.8	1,465	1,503	2.6%	1.0
Tyne & Wear	Eastbound	9	5,161	5,014	-2.8%	2.1	4,299	4,160	-3.2%	2.1
	Westbound	9	4,838	4,867	0.6%	0.4	3,762	3,811	1.3%	0.8
Durham	Eastbound	6	4,671	4,628	-0.9%	0.6	3,737	3,727	-0.3%	0.2
	Westbound	6	2,897	2,893	-0.1%	0.1	2,318	2,305	-0.6%	0.3
Darlington	Eastbound	5	2,674	2,643	-1.1%	0.6	2,190	2,157	-1.5%	0.7
	Westbound	5	2,470	2,482	0.5%	0.3	2,052	2,048	-0.2%	0.1
Boundary North	Northbound	12	2,637	2,598	-1.5%	0.8	1,774	1,769	-0.3%	0.1
	Southbound	12	3,058	3,002	-1.8%	1.0	2,137	2,102	-1.6%	0.8
Boundary South	Northbound	17	8,586	8,656	0.8%	0.8	6,253	6,238	-0.2%	0.2
	Southbound	17	8,131	8,331	2.5%	2.2	5,656	5,892	4.2%	3.1
Appleby	Eastbound	6	1,226	1,370	11.8%	4.0	873	942	7.9%	2.3
	Westbound	6	1,473	1,483	0.7%	0.3	1,100	1,048	-4.7%	1.6

Table 9-4: Screenline performance Inter Peak

Screenline	Direction	Count Sites	Total Vehicles				Cars			
			Obs	Mod	% Diff	GEH	Obs	Mod	% Diff	GEH
Penrith	Inbound	6	1,684	1,768	5.0%	2.0	1,412	1,500	6.3%	2.3
	Outbound	6	1,706	1,742	2.1%	0.9	1,449	1,499	3.4%	1.3
Lake District	Eastbound	9	3,485	3,410	-2.1%	1.3	2,680	2,598	-3.0%	1.6
	Westbound	9	3,205	3,226	0.7%	0.4	2,514	2,529	0.6%	0.3
Barnard Castle	Eastbound	11	1,674	1,654	-1.2%	0.5	1,326	1,306	-1.5%	0.5
	Westbound	11	1,639	1,588	-3.1%	1.3	1,314	1,269	-3.4%	1.3
Tyne & Wear	Eastbound	9	3,886	3,795	-2.3%	1.5	3,149	3,071	-2.5%	1.4
	Westbound	9	3,950	3,874	-1.9%	1.2	3,162	3,099	-2.0%	1.1
Durham	Eastbound	6	2,781	2,776	-0.2%	0.1	2,209	2,209	0.0%	0.0
	Westbound	6	2,847	2,841	-0.2%	0.1	2,262	2,260	-0.1%	0.0
Darlington	Eastbound	5	1,812	1,841	1.6%	0.7	1,422	1,443	1.5%	0.5
	Westbound	5	1,783	1,831	2.7%	1.1	1,409	1,453	3.2%	1.2
Boundary North	Northbound	12	2,962	2,861	-3.4%	1.9	2,153	2,091	-2.9%	1.3
	Southbound	12	3,226	3,077	-4.6%	2.7	2,338	2,234	-4.4%	2.2
Boundary South	Northbound	17	8,233	8,207	-0.3%	0.3	6,220	6,054	-2.7%	2.1
	Southbound	17	8,323	8,197	-1.5%	1.4	5,579	5,565	-0.3%	0.2
Appleby	Eastbound	6	1,399	1,396	-0.2%	0.1	999	977	-2.2%	0.7
	Westbound	6	1,325	1,315	-0.8%	0.3	992	929	-6.4%	2.0

Table 9-5: Screenline performance PM Peak

Screenline	Direction	Count Sites	Total Vehicles				Cars			
			Obs	Mod	% Diff	GEH	Obs	Mod	% Diff	GEH
Penrith	Inbound	6	1,896	1,948	2.8%	1.2	1,602	1,666	4.0%	1.6
	Outbound	6	2,328	2,352	1.0%	0.5	2,083	2,120	1.8%	0.8
Lake District	Eastbound	9	4,159	4,007	-3.7%	2.4	3,395	3,239	-4.6%	2.7
	Westbound	9	3,912	4,000	2.2%	1.4	3,290	3,368	2.4%	1.4
Barnard Castle	Eastbound	11	1,868	1,922	2.9%	1.2	1,586	1,641	3.4%	1.4
	Westbound	11	1,897	1,910	0.7%	0.3	1,631	1,647	0.9%	0.4
Tyne & Wear	Eastbound	9	4,848	4,750	-2.0%	1.4	4,224	4,138	-2.0%	1.3
	Westbound	9	5,226	5,178	-0.9%	0.7	4,581	4,545	-0.8%	0.5
Durham	Eastbound	6	3,184	3,209	0.8%	0.4	2,744	2,773	1.0%	0.5
	Westbound	6	4,628	4,570	-1.3%	0.9	4,000	3,955	-1.1%	0.7
Darlington	Eastbound	5	2,560	2,631	2.8%	1.4	2,214	2,277	2.8%	1.3
	Westbound	5	2,513	2,575	2.5%	1.2	2,163	2,227	2.9%	1.3
Boundary North	Northbound	12	3,310	3,236	-2.3%	1.3	2,571	2,522	-1.9%	1.0
	Southbound	12	3,147	3,125	-0.7%	0.4	2,422	2,447	1.0%	0.5
Boundary South	Northbound	17	9,285	9,316	0.3%	0.3	7,632	7,598	-0.4%	0.4
	Southbound	17	9,255	9,171	-0.9%	0.9	6,701	6,846	2.2%	1.8
Appleby	Eastbound	6	1,558	1,608	3.2%	1.3	1,195	1,183	-1.0%	0.3
	Westbound	6	1,449	1,460	0.7%	0.3	1,158	1,111	-4.1%	1.4

9.4 Assignment Validation

9.4.1 The acceptability criteria set out in Section 4.2 for model calibration also apply to the model validation. The traffic flow data that has not been used for calibration provided a set of independent data that has been used for validation instead.

9.4.2 Table 9-6 and Table 9-7 shows the summary of the link flow validation in each of the three peak time periods, detailing the proportion of cases that pass the criteria. In accordance with TAG the validation is presented for cars and all vehicles together.

Table 9-6: Link Flow Validation Summary – Calibrated Matrices (All Vehicles)

Performance Measure	AM Peak	Inter-Peak	PM Peak
All Links (494)			
- within GEH of 5.0	84%	89%	87%
- within GEH of 7.5	95%	97%	95%
- pass cal/val guidance link criterion	85%	85%	85%
By Calibration/Validation			
Calibration Counts (341)			
- within GEH of 5.0	89%	93%	91%
- within GEH of 7.5	96%	98%	96%
- pass cal/val guidance link criterion	85%	85%	85%
Validation Counts (153)			
- within GEH of 5.0	71%	81%	78%
- within GEH of 7.5	91%	93%	91%
- pass cal/val guidance link criterion	85%	85%	85%
By Road Type			
SRN link Counts (230)			
- within GEH of 5.0	84%	92%	88%
- within GEH of 7.5	96%	96%	95%
- pass cal/val guidance link criterion	85%	85%	85%
Non-SRN link Counts (264)			
- within GEH of 5.0	83%	87%	86%
- within GEH of 7.5	94%	97%	94%
- pass cal/val guidance link criterion	85%	85%	85%

Table 9-7: Link Flow Validation Summary – Calibrated Matrices (Cars)

Performance Measure	AM Peak	Inter-Peak	PM Peak
All Links (449)			
- within GEH of 5.0	84%	89%	87%
- within GEH of 7.5	95%	97%	95%
- pass cal/val guidance link criterion	85%	85%	85%
By Calibration/Validation			
Calibration Counts (324)			
- within GEH of 5.0	89%	93%	91%
- within GEH of 7.5	96%	98%	96%
- pass cal/val guidance link criterion	85%	85%	85%
Validation Counts (125)			
- within GEH of 5.0	71%	81%	78%
- within GEH of 7.5	91%	93%	91%
- pass cal/val guidance link criterion	85%	85%	85%

9.4.3 The results indicated that for all vehicles, when considering both calibration and validation counts, the validation exceeds the TAG criteria in all time periods. When considering the independent validation counts the model is just short of TAG criteria. This outcome is the same when considering cars only.

9.5 Journey Time Validation

9.5.1 In addition to the validation of link flows, the model has been also validated against observed journey times by direction along a series of fourteen routes. The routes used are shown graphically in Figure 9-1.

9.5.2 A summary of the number and proportion of journey time routes passing the journey time validation criteria and acceptability guideline for each time period is shown in Table 9-8.

Table 9-8: Journey Time Validation Summary

Route Class	No. of Routes	AM Peak		Inter Peak		PM Peak	
		No.	%	No.	%	No.	%
SRN	14	14	100%	14	100%	14	100%
Non-SRN	20	20	100%	20	100%	20	100%
Total	34	34	100%	34	100%	34	100%

9.5.3 TAG acceptance criteria states that greater than 85% of routes should meet the individual route acceptance criteria. The overall percentage of routes meeting the TAG criteria exceeds 85% in all time periods. All routes achieve TAG criteria in all modelled time periods. This reveals a slight improvement compared with the Stage 2 model where 96% of the 28 journey time routes validated in the IP and PM peaks.

9.5.4 Detailed plots of each of the journey routes for each of the time periods are presented in the calibration/validation dashboards. A summary of the journey time routes is shown below in Table 9-9.

Table 9-9: Journey Time Validation route descriptions

Route	Dir	Description	SRN / Other
A1 Northern	NB	From junction with A689 to junction with A697	SRN
	SB	From junction with A697 to junction with A689	SRN
A1 Southern	NB	A1(M)/A59 to junction with A689	SRN
	SB	From junction with A689 to A1(M)/A59	SRN
A6 Northern	NB	Penrith to M6 Junction 44	Other
	SB	M6 Junction 44 to Penrith	Other
A6 Southern	NB	Carnforth to Penrith	Other
	SB	Penrith to Carnforth	Other
A65	EB	M6/A65 Junction to A1(M)/A59 Junction	Other
	WB	A1(M)/A59 Junction to M6/A65 Junction	Other
A66	EB	From junction with M6 to junction with A1	SRN
	WB	From junction with A1 to junction with M6	SRN
A67	EB	Barnard Castle to Darlington	Other
	WB	Darlington to Barnard Castle	Other
A68	NB	A68/A1(M) to junction with A69	Other
	SB	From junction with A69 to A68/A1(M)	Other
A685	EB	M6 Junction 38 to A66	Other
	WB	A66 to M6 Junction 38	Other
A686	EB	Penrith to A69/A686 Junction	Other
	WB	A69/A686 Junction to Penrith	Other
A688	EB	A66 to A1(M) Junction 61	Other
	WB	A1(M) Junction 61 to A66	Other
A69	EB	A1/A69 to M6 J43	SRN
	WB	M6 J43 to A1/A69	SRN
M6 Northern	NB	From junction with A66 to A74(M) off-slip	SRN
	SB	A74(M) to junction with A66	SRN
M6 Southern	NB	From junction with A683 to junction with A66	SRN
	SB	From junction with A66 to junction with A683	SRN
A66W	EB	M6 J40 to Workington	SRN
	WB	Workington to M6 J40	SRN
B6277	SB	A69 Brampton to Barnard Castle via Mickleton	Other
	NB	Barnard Castle to A69 Brampton via Mickleton	Other
A684	EB	M6 J37 to A1(M) J51	Other
	WB	A1(M) J51 to A1(M) J37	Other

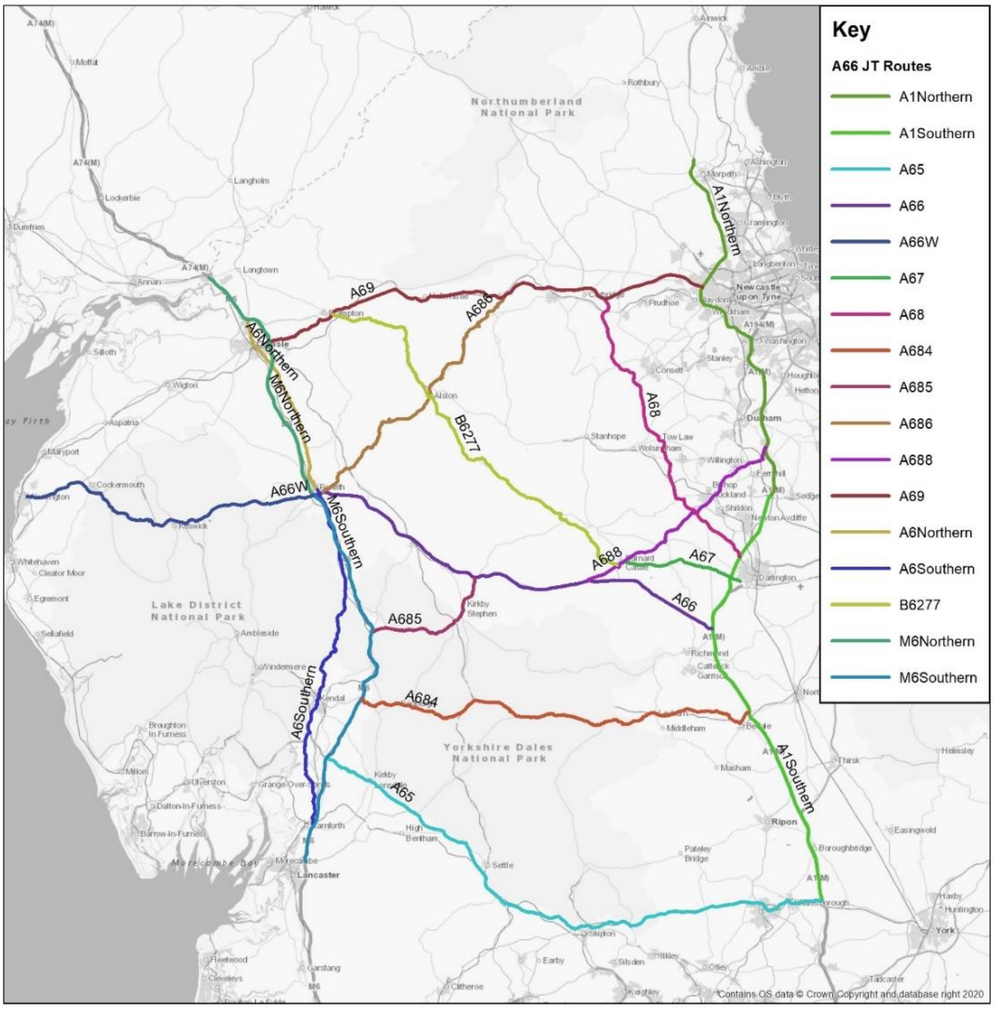


Figure 9-1: Journey Time Routes

9.5.5 Table 9-10, Table 9-11 and Table 9-12 summarise the results of the journey time validation for individual routes for the AM, inter-peak and PM periods respectively. The summary tables above show a good match between the observations (taken from Teletrac) and the SATURN modelled journey times on all routes in all time periods, while Figure 9-1 shows the location of each journey time route.

Table 9-10: Journey Time Validation AM Peak

	Direction	Distance (km)	Observed JT (mins)	Modelled JT (mins)	JT Diff (mins)	% Diff
A1 Northern	NB	71	53.7	51.4	-2.3	-4.3%
	SB	71	48.9	46.8	-2.1	-4.2%
A1 Southern	NB	79	45.8	45.2	-0.6	-1.3%
	SB	79	46.2	45.5	-0.7	-1.4%
A6 Northern	NB	35	40.0	40.0	-0.1	-0.2%
	SB	34	38.1	38.3	0.2	0.5%
A6 Southern	NB	67	64.4	64.4	-0.1	-0.1%
	SB	66	59.9	58.3	-1.6	-2.7%
A65	EB	105	105.4	97.7	-7.7	-7.3%
	WB	106	107.4	98.0	-9.4	-8.7%
A66	EB	80	52.9	53.6	0.7	1.4%
	WB	80	54.0	54.0	0.1	0.1%
A67	EB	22	18.5	17.7	-0.8	-4.5%
	WB	22	19.5	17.7	-1.9	-9.6%
A68	NB	59	51.0	48.6	-2.3	-4.6%
	SB	59	50.9	48.9	-1.9	-3.7%
A685	EB	25	20.3	21.1	0.8	4.0%
	WB	25	20.5	21.2	0.7	3.4%
A686	EB	58	57.2	55.2	-2.0	-3.5%
	WB	58	56.1	56.5	0.4	0.7%
A688	EB	44	43.7	43.3	-0.4	-0.9%
	WB	44	44.0	44.1	0.1	0.3%
A69	EB	84	62.9	61.7	-1.3	-2.0%
	WB	84	59.5	59.5	0.0	-0.1%
M6 Northern	NB	46	25.9	24.9	-1.0	-3.9%
	SB	46	25.6	25.0	-0.7	-2.6%
M6 Southern	NB	71	39.2	39.0	-0.3	-0.7%
	SB	71	39.7	39.2	-0.5	-1.3%
A66W	EB	58	42.9	43.7	0.8	1.8%
	WB	58	45.7	43.8	-1.9	-4.1%
B6277	NB	79	77.8	70.9	-6.8	-8.8%
	SB	79	81.0	70.9	-10.1	-12.5%
A684	EB	78	81.2	77.0	-4.3	-5.3%
	WB	78	82.1	77.0	-5.1	-6.2%

Table 9-11: Journey Time Validation Inter-peak

	Direction	Distance (km)	Observed JT (mins)	Modelled JT (mins)	JT Diff (mins)	% Diff
A1 Northern	NB	71	44.3	47.6	3.3	7.5%
	SB	71	44.7	43.0	-1.8	-4.0%
A1 Southern	NB	79	45.8	44.7	-1.2	-2.5%
	SB	79	46.5	44.6	-2.0	-4.2%
A6 Northern	NB	35	39.3	39.8	0.4	1.1%
	SB	34	38.1	37.6	-0.5	-1.3%
A6 Southern	NB	67	63.9	61.3	-2.5	-4.0%
	SB	66	61.8	58.1	-3.7	-6.0%
A65	EB	105	102.3	99.9	-2.4	-2.3%
	WB	106	103.7	100.7	-3.1	-3.0%
A66	EB	80	52.8	54.4	1.6	2.9%
	WB	80	53.9	54.1	0.2	0.4%
A67	EB	22	19.0	17.3	-1.6	-8.7%
	WB	22	19.2	17.5	-1.8	-9.2%
A68	NB	59	50.4	48.0	-2.4	-4.8%
	SB	59	50.1	47.6	-2.5	-5.0%
A685	EB	25	20.7	21.2	0.5	2.6%
	WB	25	21.0	21.1	0.1	0.3%
A686	EB	58	55.8	55.2	-0.6	-1.1%
	WB	58	56.8	55.7	-1.1	-1.9%
A688	EB	44	43.1	41.4	-1.8	-4.1%
	WB	44	43.0	42.0	-1.0	-2.2%
A69	EB	84	60.4	59.1	-1.3	-2.1%
	WB	84	59.8	57.8	-1.9	-3.2%
M6 Northern	NB	46	25.6	24.9	-0.7	-2.8%
	SB	46	25.8	24.9	-0.8	-3.2%
M6 Southern	NB	71	39.3	39.0	-0.3	-0.7%
	SB	71	40.0	39.3	-0.7	-1.8%
A66W	EB	58	43.2	43.5	0.3	0.6%
	WB	58	45.1	43.4	-1.6	-3.6%
B6277	NB	79	75.8	70.9	-5.0	-6.6%
	SB	79	79.4	70.8	-8.6	-10.8%
A684	EB	78	84.3	77.1	-7.2	-8.5%
	WB	78	86.3	77.0	-9.4	-10.9%

Table 9-12: Journey Time Validation PM Peak

	Direction	Distance (km)	Observed JT (mins)	Modelled JT (mins)	JT Diff (mins)	% Diff
A1 Northern	NB	71	48.3	53.8	5.6	11.5%
	SB	71	52.0	46.1	-5.9	-11.3%
A1 Southern	NB	79	45.3	45.7	0.4	0.9%
	SB	79	45.2	45.1	-0.2	-0.4%
A6 Northern	NB	35	39.7	40.1	0.4	1.0%
	SB	34	39.5	38.1	-1.4	-3.4%
A6 Southern	NB	67	61.8	62.4	0.6	0.9%
	SB	66	61.0	59.6	-1.4	-2.3%
A65	EB	105	102.1	98.3	-3.8	-3.8%
	WB	106	105.4	100.0	-5.4	-5.2%
A66	EB	80	52.7	55.1	2.3	4.4%
	WB	80	53.6	54.5	0.9	1.6%
A67	EB	22	18.3	17.5	-0.8	-4.3%
	WB	22	18.8	17.7	-1.2	-6.1%
A68	NB	59	48.9	49.2	0.3	0.6%
	SB	59	49.1	48.1	-0.9	-1.9%
A685	EB	25	20.3	21.4	1.1	5.3%
	WB	25	20.4	21.2	0.8	4.0%
A686	EB	58	54.3	55.6	1.2	2.2%
	WB	58	56.3	56.1	-0.3	-0.4%
A688	EB	44	43.0	42.7	-0.3	-0.8%
	WB	44	43.9	46.4	2.6	5.9%
A69	EB	84	59.1	60.3	1.2	2.1%
	WB	84	58.9	59.0	0.2	0.3%
M6 Northern	NB	46	24.9	25.0	0.1	0.5%
	SB	46	25.4	25.0	-0.4	-1.7%
M6 Southern	NB	71	38.2	39.1	1.0	2.5%
	SB	71	39.1	39.4	0.3	0.7%
A66W	EB	58	42.0	44.0	2.0	4.8%
	WB	58	43.7	44.8	1.1	2.4%
B6277	NB	79	76.4	70.9	-5.5	-7.2%
	SB	79	73.5	70.9	-2.6	-3.6%
A684	EB	78	79.9	77.3	-2.6	-3.2%
	WB	78	81.1	77.0	-4.1	-5.1%

9.6 Assignment Validation on Key Junctions and Links

9.6.1 An assessment of key junctions and links on the A66 has been undertaken to ensure good validation performance along the route between M6 Junction 40 and Scotch Corner. Table 9-13 shows the TAG validation criteria for link flows and turning movements. A colour coding system in line with Table 9-14 has been used to highlight where flows pass of fail TAG criteria.

Table 9-13: Link Flow and Turning Movement Validation Criteria and Guidance

Link flow and turning movement validation criteria and guidance		
Criteria	Description of Criteria	Guideline
1	Individual flows within 100 veh/h of counts for flows less than 700 veh/h	>85% of cases
	Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	
	Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	
2	GEH < 5 for individual flows	>85% of cases

Table 9-14: Criteria Key

	Pass	Fail
TAG criteria	PASS	FAIL

9.6.2 A detailed summary of turning movement validation is provided in **Appendix E**.

M6 Junction 40

9.6.3 Table 9-15, Table 9-16 and Table 9-17 show total vehicle turn flows and validation performance at M6 Junction 40. The majority of turn flows pass TAG criteria with the exception of a select few movements which include:

- AM: A592 to A66 East (-103 vehicles, GEH 6.7)
- AM: M6 South to A66 West (-119 vehicles, GEH 9.5)
- AM: M6 North to A66 East (+135 vehicles, GEH 5.6)
- IP: A592 to A66 East (-131 vehicles, GEH 8.0)
- IP: A66 West to M6 South (-112 vehicles, GEH 10.7)
- PM: A592 to A66 East (-130 vehicles, GEH 7.0)
- PM: A66 East to A66 West (+103 vehicles, GEH 6.7)
- PM: A66 West to M6 South (-105 vehicles, GEH 10.4)

9.6.4 In instances where turning movements do not pass TAG criteria, there are often other nearby ATC link calibration counts which influence model flows. Achieving a consistent count dataset at a turn level for this comparison proved to be challenging. Indeed, TAG Unit M3.1 recognises that achieving turn flow validation across all movements can be difficult and interpretations should have a wider context and consider whether the model is suitable for its intended purpose. The work undertaken to achieve the turning validation shown was undertaken as part of the need to improve model performance on the screenline around Penrith.

Table 9-15: M6 Junction 40 Model Flows (vehicles) - AM

AM	A592	A66 East	M6 South	A66 West	M6 North	Total
A592	-	180 *(-103)*	180	240	136	736
A66 East	194	-	101	303	496	1094
M6 South	209	135	-	98 *(-119)*	-	441
A66 West	246	281	50	-	135	712
M6 North	277	651 *(+135)*	-	158	-	1086
Total	926	1247	330	799	767	4069

Table 9-16: M6 Junction 40 Model Flows (vehicles) - IP

IP	A592	A66 East	M6 South	A66 West	M6 North	Total
A592	-	201 *(-131)*	169	233	147	750
A66 East	140	-	91	250	463	944
M6 South	154	127	-	60	-	340
A66 West	208	308	55 *(-112)*	-	124	694
M6 North	167	529	-	114	-	810
Total	669	1164	314	657	735	3539

Table 9-17: M6 Junction 40 Model Flows (vehicles) - PM

PM	A592	A66 East	M6 South	A66 West	M6 North	Total
A592	-	279 *(-130)*	213	296	211	998
A66 East	140	-	102	286 *(+103)*	528	1056
M6 South	187	127	-	63	-	377
A66 West	225	348	49 *(-105)*	-	157	779

M6 North	182	562	-	131	-	875
Total	733	1317	363	775	896	4085

Kemplay Bank

9.6.5 Table 9-18, Table 9-19 and Table 9-20 show total vehicle turn flows and validation performance at Kemplay Bank. All turn flows pass TAG criteria except for the following two movements during the PM peak:

- PM: A6 Bridge Lane to A66 West (-117 vehicles, GEH 11.1)
- PM: A6 South to A66 West (+107 vehicles, GEH 7.6)

Table 9-18: Kemplay Bank Model Flows (vehicles) - AM

AM	A6 Bridge Lane	A686 Carleton Ave	A66 East	A6 South	A66 West	Total
A6 Bridge Lane	-	34	98	171	40	343
A686 Carleton Ave	13	-	52	45	210	319
A66 East	188	41	-	7	580	816
A6 South	290	50	-	-	264	604
A66 West	244	200	549	253	-	1246
Total	735	325	699	476	1094	3328

Table 9-19: Kemplay Bank Model Flows (vehicles) - IP

IP	A6 Bridge Lane	A686 Carleton Ave	A66 East	A6 South	A66 West	Total
A6 Bridge Lane	-	37	125	195	41	399
A686 Carleton Ave	22	-	45	29	148	244
A66 East	147	33	-	6	538	724
A6 South	160	39	1	-	218	418
A66 West	189	179	590	207	-	1164
Total	518	289	761	438	944	2950

Table 9-20: Kemplay Bank Model Flows (vehicles) - PM

PM	A6 Bridge Lane	A686 Carleton Ave	A66 East	A6 South	A66 West	Total
A6 Bridge Lane	-	55	165	272	53 *(-117)*	544
A686 Carleton Ave	26	-	43	30	183	281
A66 East	154	41	-	7	567	770
A6 South	176	66	-	-	254 *(+107)*	495
A66 West	202	231	647	237	-	1317
Total	558	392	854	547	1056	3407

Scotch Corner

9.6.6 Table 9-21, Table 9-22 and Table 9-23 show total vehicle turn flows and validation performance at Scotch Corner. All turn flows pass TAG criteria except for two movements during the AM peak which include:

- AM: A1(M) South to A66 (+140 vehicles, GEH 8.1)
- AM: A66 to A1(M) South (+120 vehicles, GEH 6.6)

Table 9-21: Scotch Corner Model Flows (vehicles) - AM

AM	A6055	A1(M) North	Middleton Tyas Ln	A1(M) South	A6108	A66	Total
A6055	-	-	-	-	-	-	-
A1(M) North	-	-	-	-	276	193	469
Middleton Tyas Ln	-	-	-	95	44	62	202
A1(M) South	-	-	65	-	10	373 *(+140)*	448
A6108	280	-	72	8	-	21	381
A66	194	-	54	391*(+120)*	6	-	645
Total	474	-	191	493	336	650	2145

Table 9-22: Scotch Corner Model Flows (vehicles) - IP

IP	A6055	A1(M) North	Middleton Tyas Ln	A1(M) South	A6108	A66	Total
A6055	-	-	-	-	-	-	-
A1(M) North	-	-	-	-	198	163	362
Middleton Tyas Ln	-	-	-	87	45	43	174
A1(M) South	-	-	58	-	10	431	499
A6108	215	-	52	8	-	23	298
A66	188	-	46	426	6	-	667
Total	403	-	156	520	259	660	1999

Table 9-23: Scotch Corner Model Flows (vehicles) - PM

PM	A6055	A1(M) North	Middleton Tyas Ln	A1(M) South	A6108	A66	Total
A6055	-	-	-	-	-	-	-
A1(M) North	-	-	-	-	249	209	458
Middleton Tyas Ln	-	-	-	108	59	46	212
A1(M) South	-	-	72	-	11	478	560
A6108	310	-	69	11	-	31	421
A66	208	-	55	451	7	-	721
Total	518	-	197	569	325	764	2372

Inspection of A66 Mainline Flows for Total Vehicles and Cars

9.6.7 Table 9-24, Table 9-25 and Table 9-26 show flows for total vehicles and cars along the A66 during the AM, IP and PM. All modelled link flows are within a GEH of 5 and therefore pass TAG criteria. It should be noted that around half of these sites are used within calibration. Originally all of the counts on the A66 had been held back for validation, however decisions were taken to include certain counts in calibration to ensure the model represented the changing flow characteristics of the full length of the A66.

9.6.8 Figure 9-2 shows the count locations used to assess A66 mainline flow validation.

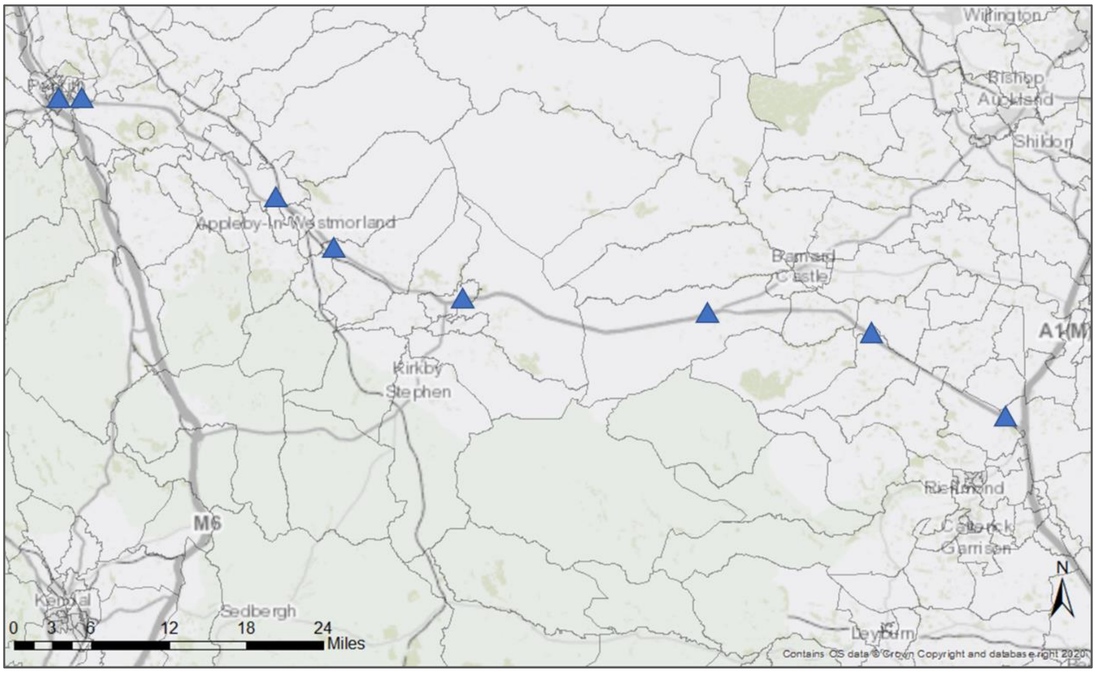


Figure 9-2: Count locations for inspection of A66 mainline flows

Table 9-24: A66 Flows for Total Vehicles and Cars - AM

	Total Vehicles				Cars			
	Obs	Mod	% Diff	GEH	Obs	Mod	% Diff	GEH
West of Kemplay EB*	1213	1246	3%	0.95	888	923	4%	1.16
West of Kemplay WB*	1198	1094	-9%	3.08	898	819	-9%	2.69
East of Kemplay EB*	584	699	20%	4.51	351	470	34%	5.90
East of Kemplay WB*	791	816	3%	0.89	526	556	6%	1.29
North of Appleby EB	485	614	27%	5.52	283	401	42%	6.38
North of Appleby WB	449	511	14%	2.84	233	327	41%	5.65
Appleby EB	416	522	25%	4.89	241	319	32%	4.66
Appleby WB	531	583	10%	2.20	324	384	19%	3.20
Brough EB	451	559	24%	4.82	261	364	39%	5.81
Brough WB	559	638	14%	3.20	303	437	44%	6.97
Bowes EB	507	562	11%	2.39	296	365	23%	3.78
Bowes WB	573	641	12%	2.78	368	439	19%	3.54
Smallways EB*	562	631	12%	2.83	350	423	21%	3.69
Smallways WB*	574	644	12%	2.85	356	441	24%	4.29
West of Scotch Corner EB*	581	644	11%	2.58	365	435	19%	3.51
West of Scotch Corner WB*	518	650	26%	5.50	312	449	44%	6.99

** Calibration count*

Table 9-25: A66 Flows for Total Vehicles and Cars - IP

	Total Vehicles				Cars			
	Obs	Mod	% Diff	GEH	Obs	Mod	% Diff	GEH
West of Kemplay EB*	1138	1164	2%	0.78	821	853	4%	1.11
West of Kemplay WB*	965	944	-2%	0.67	709	695	-2%	0.53
East of Kemplay EB*	726	761	5%	1.30	479	519	8%	1.79
East of Kemplay WB*	682	724	6%	1.58	461	509	10%	2.16
North of Appleby EB	621	662	7%	1.62	390	434	11%	2.20
North of Appleby WB	478	526	10%	2.18	293	343	17%	2.77
Appleby EB	574	589	3%	0.61	371	369	-1%	0.11
Appleby WB	539	584	8%	1.90	359	382	7%	1.24
Brough EB	627	653	4%	1.03	396	432	9%	1.76
Brough WB	594	641	8%	1.86	386	435	13%	2.42
Bowes EB	662	656	-1%	0.24	440	433	-2%	0.35
Bowes WB	649	644	-1%	0.18	460	436	-5%	1.13
Smallways EB*	640	652	2%	0.47	401	418	4%	0.83
Smallways WB*	626	644	3%	0.73	403	426	6%	1.10
West of Scotch Corner EB*	637	667	5%	1.17	375	409	9%	1.72
West of Scotch Corner WB*	612	660	8%	1.90	380	432	14%	2.58

** Calibration count*

Table 9-26: A66 Flows for Total Vehicles and Cars - PM

	Total Vehicles				Cars			
	Obs	Mod	% Diff	GEH	Obs	Mod	% Diff	GEH
West of Kemplay EB*	1336	1317	-1%	0.52	1046	1046	0%	0.02
West of Kemplay WB*	1068	1056	-1%	0.37	824	812	-1%	0.39
East of Kemplay EB*	860	854	-1%	0.21	623	621	0%	0.08
East of Kemplay WB*	682	769	13%	3.25	454	560	23%	4.70
North of Appleby EB	695	783	13%	3.25	502	556	11%	2.34
North of Appleby WB	470	529	13%	2.64	300	358	19%	3.16
Appleby EB	598	638	7%	1.61	404	431	7%	1.32
Appleby WB	573	598	4%	1.03	401	410	2%	0.44
Brough EB	653	710	9%	2.19	449	497	11%	2.23
Brough WB	607	633	4%	1.02	422	445	5%	1.10
Bowes EB	708	713	1%	0.21	497	499	0%	0.06
Bowes WB	688	636	-8%	2.04	510	447	-12%	2.89
Smallways EB*	702	708	1%	0.21	476	485	2%	0.42
Smallways WB*	636	698	10%	2.40	443	504	14%	2.82
West of Scotch Corner EB*	719	721	0%	0.06	492	496	1%	0.18
West of Scotch Corner WB*	720	764	6%	1.63	482	538	12%	2.49

** Calibration count*

9.6.9 Both modelled and observed Stage 3 A66 traffic flows have been compared with Stage 2 to better understand validation along on the A66. Table 9-28 shows the average traffic flows from the following locations on the A66 (these locations are consistent with Figure 9-2):

- West of Kemplay Bank
- East of Kemplay Bank
- North of Appleby
- Appleby
- Brough
- Bowes
- Smallways

Table 9-27: Stage 2 and Stage 3 average A66 traffic flow in Stage 2 and Stage 3 (all vehicles)

	AM			IP			PM		
	Obs	Mod	% Diff	Obs	Mod	% Diff	Obs	Mod	% Diff
Stage 2 2015									
Eastbound	507	547	8%	680	701	3%	672	687	2%
Westbound	577	655	13%	614	643	5%	570	621	9%
Total two-way	**1084**	**1201**	**11%**	**1294**	**1343**	**4%**	**1242**	**1307**	**5%**
Stage 3 2019									
Eastbound	602	690	15%	713	734	3%	793	818	3%
Westbound	668	704	5%	648	673	4%	675	703	4%
Total two-way	**1270**	**1394**	**10%**	**1360**	**1407**	**3%**	**1468**	**1520**	**4%**

Inspection of A66 Mainline Flows for LGVs and HGVs

9.6.10 Given the importance of freight benefits to the scheme appraisal significant effort was made to replicate LGV and HGV movements along the route. Table 9-28, Table 9-29 and Table 9-30 show flows for LGVs and HGVs along the A66 during the AM, interpeak and PM. All modelled link flows are within a GEH of 5 and therefore pass TAG criteria. Some LGV link flows show a high percentage difference between Appleby and Bowes although several of these locations have an observed flow of below 50 LGVs.

Table 9-28: A66 Flows for LGVs and HGVs - AM

AM	LGVs				HGVs			
	Obs	Mod	% Diff	GEH	Obs	Mod	% Diff	GEH
West of Kemplay EB*	102	102	-1%	0.05	222	221	0%	0.06
West of Kemplay WB*	79	82	3%	0.30	221	193	-13%	1.94
East of Kemplay EB*	88	87	-1%	0.11	143	142	-1%	0.16
East of Kemplay WB*	105	103	-1%	0.12	157	156	-1%	0.07
North of Appleby EB	65	73	13%	1.03	131	140	7%	0.77
North of Appleby WB	74	55	-25%	2.34	141	129	-8%	1.02
Appleby EB	30	49	66%	3.09	145	154	6%	0.70
Appleby WB	46	64	40%	2.46	161	135	-16%	2.17
Brough EB	59	58	-2%	0.14	129	137	7%	0.74
Brough WB	105	77	-27%	2.98	149	124	-17%	2.16
Bowes EB	82	58	-29%	2.83	128	139	8%	0.88
Bowes WB	55	77	42%	2.79	150	125	-17%	2.15
Smallways EB*	66	65	-1%	0.09	143	143	0%	0.05
Smallways WB*	79	77	-2%	0.21	137	126	-8%	0.91
West of Scotch Corner EB*	65	64	-1%	0.09	146	145	0%	0.06
West of Scotch Corner WB*	80	78	-2%	0.20	122	123	1%	0.10

** Calibration count*

Table 9-29: A66 Flows for LGVs and HGVs – Inter-peak

IP	LGVs				HGVs			
	Obs	Mod	% Diff	GEH	Obs	Mod	% Diff	GEH
West of Kemplay EB*	93	92	-1%	0.08	224	219	-2%	0.34
West of Kemplay WB*	62	62	-1%	0.08	194	188	-3%	0.44
East of Kemplay EB*	91	91	0%	0.03	151	151	0%	0.04
East of Kemplay WB*	77	77	0%	0.02	139	138	0%	0.06
North of Appleby EB	84	79	-5%	0.49	145	149	3%	0.34
North of Appleby WB	53	40	-25%	1.91	129	144	11%	1.27
Appleby EB	41	60	46%	2.66	162	160	-1%	0.17
Appleby WB	33	51	52%	2.70	147	151	3%	0.31
Brough EB	85	81	-4%	0.40	144	140	-3%	0.31
Brough WB	68	68	1%	0.09	138	137	0%	0.05
Bowes EB	108	82	-25%	2.73	113	141	25%	2.46
Bowes WB	38	69	82%	4.24	151	140	-8%	0.96
Smallways EB*	89	87	-2%	0.15	148	147	0%	0.03
Smallways WB*	75	75	-1%	0.05	144	143	0%	0.05
West of Scotch Corner EB*	95	93	-2%	0.16	165	164	0%	0.04
West of Scotch Corner WB*	74	74	0%	0.04	155	155	0%	0.06

** Calibration count*

Table 9-30: A66 Flows for LGVs and HGVs - PM

PM	LGVs				HGVs			
	Obs	Mod	% Diff	GEH	Obs	Mod	% Diff	GEH
West of Kemplay EB*	91	90	-1%	0.06	199	181	-9%	1.31
West of Kemplay WB*	60	61	2%	0.13	184	182	-1%	0.15
East of Kemplay EB*	91	90	-1%	0.09	144	144	0%	0.02
East of Kemplay WB*	84	83	-2%	0.15	139	127	-9%	1.12
North of Appleby EB	53	85	61%	3.90	139	143	3%	0.31
North of Appleby WB	38	32	-16%	1.04	131	140	7%	0.79
Appleby EB	40	68	72%	3.86	154	139	-10%	1.25
Appleby WB	30	42	38%	1.93	142	146	3%	0.37
Brough EB	67	80	20%	1.55	135	133	-2%	0.21
Brough WB	45	47	4%	0.25	138	141	2%	0.21
Bowes EB	109	81	-26%	2.88	102	134	32%	2.97
Bowes WB	30	47	56%	2.70	148	143	-4%	0.48
Smallways EB*	83	82	-1%	0.07	141	141	0%	0.03
Smallways WB*	42	49	16%	1.01	148	145	-2%	0.30
West of Scotch Corner EB*	81	81	0%	0.03	144	144	0%	0.03
West of Scotch Corner WB*	69	65	-6%	0.47	165	161	-2%	0.29

** Calibration count*

9.6.11 A detailed summary of A66 mainline flow validation is provided in **Appendix F**.

10 Demand Model Development

10.1 The Need for Variable Demand

10.1.1 TAG Unit M2-1 provides guidance on the need for variable demand modelling. Given the scale of options being considered, the estimated cost of options and evidence from Stage 0 that variable demand modelling had an impact on benefits, there is a need to include the impacts of variable demand.

10.2 Description

10.2.1 The variable demand modelling system developed for the A66TM is unchanged from that developed for the NRTM, except for the Step Length parameter which was set to 0.8. Changes are limited to updating it and recalibrating it to reflect the enhanced A66TM networks and zoning systems and recalibrated demand.

10.2.2 The variable demand model specification is shown in Table 10-1 to Table 10-6, this remains unchanged from the NRTM with the exception of the Modelled Time Slices and the Step Length parameter.

10.2.3 Within the NRTM the model the time slices were based on average hour models across each time period, namely:

- AM Average Hour representing the AM period of 07:00-10:00
- Inter-Peak Average Hour representing the IP 10:00-16:00
- PM Average Hour representing the PM period of 16:00-19:00

10.2.4 As discussed in section 3.6 the A66TM was adapted to model the congestion effects during the morning and evening peak hours. As such the AM and PM periods have each been split into two time slices comprising:

- the calibrated and validated peak hour(s)
- uncalibrated shoulder hour(s)

10.2.5 The uncalibrated shoulder period is derived by applying a simple factor to the calibrated peak hour matrix to reduce the quantum of demand assigned during the peak shoulder hours. The skim time for each i-j movement within the demand model within either the AM or PM period would therefore be derived from a demand weighted average of the skim time generated from assignments of the peak and shoulder matrices.

Table 10-1 Demand Model Segmentation

Parameter/ Setting	Data Source		Notes
Modelled time slices	AM Peak 08:00-09:00 AM Shoulder 07:00-08:00 and 09:00-10:00 IP 10:00-16:00 PM Peak 16:00-18:00 PM Shoulder 18:00-19:00 OP 19:00-07:00		AM Peak, IP, PM Peak travel costs derived from calibrated assignments. AM and PM shoulder travel costs derived from an uncalibrated assignment of a portion of the AM and PM matrix assigned to the AM and PM peak networks OP travel costs derived from uncalibrated assignment of MPD derived OP matrix to IP network to represent free flow conditions.
Time period factors	AM Peak=1, AM Shoulder =2, IP=6, PM Peak=2, PM Shoulder =1, OP=12		Simple calculation consistent across all movements and purposes as average peak hours
Assigned User classes	Car Employers Business Car Commute Car Other Light Good Vehicles Heavy Good Vehicles		
VDM Segments	Segment	ID	Fixed elements relate to 'special zones' which include unique travel patterns that are not subject to VDM response. This may be a port or airport where 'Other' (passengers), and Employers Business are not subject to VDM responses.
	Home Based Employers Business	1	
	Home Based Commute	2	
	Home Based Other	3	
	Non-Home-Based Employers Business	4	
	Non- Home Based Other	5	
	Fixed – Employers Business	6	
	Fixed – Commute	7	
	Fixed - Other	8	
	Light Good Vehicles	9	
	Heavy Good Vehicles	10	
Sectors	13 sectors defined: 9 Internal 4 External		

Table 10-2: Demand Model Parameters

Parameter/ Setting	Data Source	Matrix	Notes
Model type	Home Based	Incremental PA	
	Non-Home Based	Incremental OD	
	Goods	Fixed	
	Special Generators	Fixed	
Model responses and hierarchy	(Macro) Time of Day Choice Mode Choice Distribution		Distribution is singly constrained for Employers Business and Other, doubly constrained for Commute.
Logit parameters: lambda, theta	Median TAG		
Distribution Intra-zonal cost calculation	DIADEM Default values (ρ=0.5, minimum cost=5)		
Cost co-efficient (VOTs etc)	TAG with distance based VOT		
Cost damping parameters and specification	Damped utility by function of cost		
Occupancy factors	TAG		

Table 10-3: Demand Matrices

Parameter/ Setting	Data Source
Home-based (24hr PA)	Calibrated assignment matrices split using MPOD data and transposed then aggregated to 24-hour using PA Outbound and Return proportions (see below)
Non-home-based (hourly OD)	Calibrated assignment matrices split using MPOD data
Goods (hourly OD)	Calibrated assignment matrices
Special Generators	Calibrated assignment matrices with extraction of demand for specific zones and demand segments
Combination of Moira and NRTS assigned to demand segments (see following section)	

Table 10-4: Cost Matrices

Parameter/ Setting	Data Source		Notes
Reference SATURN UFS files			Extracted from SATURN road assignment
Rail costs skims for reference and forecast	Base	VISUM Time Skims	Extracted from National Rail network and then compressed to North Model zone system.
	Forecast		
Rail fare skims for reference and forecast	Base	VISUM In Vehicle Time Skim applied to distance-based fare function	

Table 10-5 Production Attraction Data

Parameter/ Setting	Data Source
Outbound proportions Return proportions (by time period for each demand segment, sector movement, and mode)	DIADEM Manual (from NTS) Proportions applied for Employers Business for all sectors. MPOD derived proportions used for Work and Other for 13 sectors based on origin trip ends. Proportions adjusted to reflect assignment matrix proportions with outbound/return split based on initial values for each time period.
Tour proportions	Default values provided in DIADEM from NTS data, which are then furnessed within DIADEM application to match defined Outbound and Return proportions (see above).

Table 10-6: DIADEM Parameters

Parameter/ Setting	Data Source
Algorithm	Fixed Step Length (changed from 0.5 to 0.8 for the A66 TM model calibration).
Convergence	Target GAP of 0.1% for entire model and 0.2% for simulation area.

10.3 Public Transport Representation

10.3.1 Public Transport supply and demand is represented as inter-urban rail travel only, it being considered the main competitor to car when the RTMs were developed. This assumption and its representation in the model have been retained for the A66TM given the sparsity of bus services within the study area. The demand is primarily based on MOIRA2 weekday station-to-station matrices, and the supply based on timetable and network data obtained from the Traveline National Dataset.

10.3.2 Rail fare representation is also unchanged from the NRTM, which is primarily based on a derived MOIRA-distance based relationship.

10.4 Model Calibration

Model Structure

10.4.1 The approach taken in defining the demand model structure and coefficients follows TAG unit M2 variable demand modelling. As reported in the NRTM model validation report, the main consideration for RTM models and their derivative is extrapolation of these assumptions in order to represent a high proportion of long-distance trips in such a geographical extensive model network.

Model Parameters and Convergence

10.4.2 All calibration in terms of choice of model parameters, cost damping mechanisms and description of model convergence is described in the NRTM model validation report. The same set up has been retained for the A66TM, and therefore this same description and justification of model calibration also applies to the A66TM.

10.4.3 The focus and associate strength of the RTMs is the representation of highway demand across long distance inter-urban movements along the SRN. The A66TM has been developed in order to assess improving a long section of the A66 (between A1(M) Scotch corner and M6 J40 Penrith), affecting a relatively large proportion of strategic traffic, which based on the strengths of the NRTM should therefore be well represented within the model and demand response.

10.4.4 The A66TM is more detailed closer to the scheme areas, allowing better definition of demand trip ends and routing along the network. The same responses inherited from the NRTM are obviously being to these shorter distance trips.

Cost Damping

10.4.5 TAG provides guidance on the variation in values of time over distance. For the NRTM development, the approach to interpret these values of time was applied in a way consistent with national evidence. The mechanism used considers the following:

- Considers options for a distance cut-off to define d_c
- Estimates a value for d_0 using distance elasticities defined in TAG in order to reproduce the average distance weighted values set out in the TAG Databook.

$$VOT_d = VOT.\left(\frac{\max(d, d_c)}{d_0}\right)^{n_c}$$

where:

- d is the trip length
- d_0 is the distance underpinning the national average values of time
- d_c is a calibrated parameter value designed to prevent short distance trips becoming unduly sensitive.
- VOT is the average value of time
- n_c is the distance elasticity.

10.4.6 Further details of the cost damping mechanism are provided in the NRTM model validation report.

10.5 Realism Tests

10.5.1 As described in TAG unit M2-1, it is essential to ensure that a variable demand model behaves realistically once it has been constructed, by changing various components of the travel costs and time and checking that the overall demand response accords with general experience. The acceptability of the model response is determined by its demand elasticities, calculated by amending a cost or time component by a small global proportionate amount and calculating the proportionate change in travel made.

10.5.2 The elasticity recommended and used for the realism tests is:

$$e = \frac{\log(T^1) - \log(T^0)}{\log(C^1) - \log(C^0)}$$

where:

- T^1 and T^0 indicate values of demand in the test and base runs
- C^1 and C^0 indicate levels of cost in the test and base runs.

10.5.3 Two tests are required to ensure that elasticities lie with specific bounds:

- Car fuel costs (should lie with the range -0.25 to -0.35); and
- Public Transport fares (should lie with the range -0.2 to 0.9).

10.5.4 For car fuel costs, both matrix and network-based elasticities should be calculated. For public transport fares, only matrix-based calculations are needed. The calculations follow the same approach undertaken for the RTM realism tests.

10.5.5 As this is a highway assignment model with public transport fixed costs, it is reasonable that the focus has been placed on the car fuel costs elasticities, with less of an emphasis on the public transport fare response.

10.6 Car Fuel Cost Elasticities

10.6.1 Model runs were undertaken with the fuel costs adjusted by +10%. The results in terms of matrix skim and link-based assignment statistics were then extracted and used to show the response at both the matrix and network level. Adjustments were made to the median illustrative destination choice parameters within the model in order to match the outturn elasticity expected within TAG. The values adopted were:

- Home-based work: 0.113
- Home-based employers' business: 0.038
- Home-based other: 0.125
- Non-home-based employers' business: 0.069
- Non-home-based other: 0.091

10.6.2 All values are within the illustrative range suggested by TAG Unit M2-1. Matrix-based, and network-based elasticity have been calculated in accordance with the change in car vehicle kilometres. The results are shown in Table 10-7 and Table 10-8 respectively.

Table 10-7: Car Cost Fuel Elasticities – Matrix Calculation (Any trip with an Internal Origin)

Elasticity	Business	Work (Commute)	Other	Total
AM Shoulder	-0.13	-0.29	-0.38	-0.25
AM Peak	-0.13	-0.27	-0.37	-0.25
Inter Peak	-0.15	-0.28	-0.41	-0.30
PM Peak	-0.12	-0.27	-0.39	-0.28
PM Shoulder	-0.12	-0.28	-0.39	-0.28
Off Peak	-0.16	-0.29	-0.41	-0.31
24 Hour	-0.14	-0.28	-0.40	-0.29

Table 10-8 Car Fuel Cost Elasticities – Network Calculation (Simulation Area only)

Elasticity	Car Business	Work (Commute)	Car Other	Car Total
AM Shoulder	-0.13	-0.26	-0.34	-0.24
AM Peak	-0.11	-0.27	-0.35	-0.18
Inter Peak	-0.15	-0.26	-0.36	-0.28
PM Peak	-0.08	-0.26	-0.36	-0.20
PM Shoulder	-0.13	-0.25	-0.35	-0.25
Off Peak	-0.17	-0.27	-0.38	-0.29
24 Hour	-0.09	-0.26	-0.37	-0.25

10.6.3 The following is noted:

- Similar range of values across both sets of elasticity calculations. The matrix-based calculations show slightly more elastic results than the network-based calculations. This is to be expected as TAG Unit M2.1 notes; *the network calculation is likely to underestimate the fuel cost elasticity if the change in car-kms includes fixed elements, such as external to external.*
- The overall fuel cost elasticity is -0.29 (matrix based) which is within the range of -0.25 to -0.35 specified by TAG Unit M2.1.
- The pattern of average elasticities shows values for employers' business trips as -0.14, for other trips -0.4, and for commuting as -0.28, which broadly aligns with the expectations of TAG.
- The pattern of all-purpose elasticities shows peak period elasticities which are lower than interpeak elasticities which are lower than off-peak elasticities.

10.7 Public Transport Fare Elasticities

10.7.1 Public Transport fare elasticities were tested through a +10% fare adjustment. Demand based results were then extracted to calculate the response at matrix level. The elasticity results are shown in Table 10-9. The median illustrative destination choice parameters from TAG have been adopted.

Table 10-9: Public Transport Fare Elasticities

Elasticity	Business	Commute	Other	Overall
AM Peak	-0.28	-0.30	-1.10	-0.40
Inter Peak	-0.30	-0.29	-1.10	-0.72
PM Peak	-0.33	-0.29	-1.09	-0.49
Off Peak	-0.29	-0.29	-1.08	-0.49
24 Hour	-0.29	-0.29	-1.09	-0.47

10.7.2 The overall elasticity is -0.47 which is within the range of -0.2 to -0.9 specified within TAG. The pattern of average public transport fare elasticities shows values for non-discretionary purposes which are lower than those for discretionary trips. The pattern of all-purpose public transport fare elasticities shows peak period elasticities which are lower than inter-peak elasticities.

10.7.3 The off-peak elasticity is lower than that for the inter peak period which is unexpected, however, given the overall daily elasticity value, and the low number of trips within the off peak it is considered unlikely to impact upon the appraisal.

11 Model Limitations

11.1.1 The models, VDM, and forecasting processes have all been developed in line with TAG. As with any model there are limitations and uncertainties. These should be taken into consideration when interpreting the model forecasts presented in this report, or when planning the use of the model for scheme appraisal.

11.1.2 An overall assessment of the model has been made regarding the ability of the base year transport model and its ability to provide forecasts to underpin the scheme's business case, design and operational and environmental assessments.

Model Data

11.1.3 Covid has had an impact upon the ability to collect traffic data with which to update the 2015 model to something more contemporary, such that it is suitable to inform the DCO application. Initially it was planned to update the traffic model to a 2020 base year. However, due to the onset of Covid, a decision was taken to generate a 2019 'pre Covid' base year model to make best use of the most up to date, representative data available. This is detailed below.

11.1.4 In terms of volumetric traffic count data, a number of ATC surveys were undertaken in March 2020, although the programme was curtailed due to the onset of lockdown. This data has been supplemented by 2019 data from Highways England / DfT permanent traffic counters, recent Local Authority data (less than 5 years old), and data collected historically as part of the A66 study.

11.1.5 Nevertheless, a small number of data gaps remain, which have been filled by using a method of generating synthesised counts making use of the DfT Teletrac dataset. Teletrac provide processed anonymised GPS data for the fleet of vehicles it operates - approximately 0.5% of all vehicles on the roads. By developing a relationship between Teletrac data and known count locations, this relationship can be used to calculate traffic flows at location where the flow is not known. Out of 475 count locations across the network, around 60 sites have been synthesised in this manner. This method was developed for Highways England's national programme of Regional Transport Models and will be applied as a data infill method for the RTMs as they are updated this year.

11.1.6 A review of the 2019 dataset against the 2015 dataset showed a consistent view of traffic volumes on the road network. While there had been growth from 2015 to 2019 there was a good level of agreement between the two datasets.

11.1.7 In terms of origin destination data, it has been concluded that the traffic distribution patterns from the 2015 Mobile Network Data (MND) provide the best starting point for the Stage 3 modelling work and that the most appropriate way to update them will be to apply growth from 2015 to

2019 from the NTM taken from TEMPRO. Applying changes from observed data has not been possible within the project timescales as:

- the Covid-19 pandemic has rendered any data collection exercise (post March 2020) both impractical and meaningless (as traffic movements are untypical), and
- while significant effort has been made to infer any changes in trip patterns from the available data (i.e. by comparing available 2019 MND with 2015 MND), it is concluded that it is impossible to separate the effects of changes in trip making and the change in the way that the data has been captured or processed. It should be noted that para 4.4.4 of TAG Unit M2.2 states that former guidance relating to the '5 year rule' should no longer be used, and that older data may be acceptable.
- following the NMD data analysis above, there is no evidence to show a reduction in the strategic trip making, such as between Scotland and areas to the south such as Yorkshire, the midlands, or the south of England. Given that there have been no significant developments within the area since 2015 that would significantly affect the patterns of movement on the A66 it is considered that continuing with the 2015 data is the most pragmatic approach to undertaking a representative appraisal of the Project within the required timescales.

11.1.8 The base year HGV matrices have been updated using observed 2018 freight movements based on available data supplied by Transport for the North and MDS Transmodal. MDS Transmodal is a firm of transport economists which specialises particularly in freight modes of transport. Due to the timeframes required to acquire and process the data, 2018 data was the most up to date data available for use. It is not anticipated that that the patterns of freight movement across the region will have changed significantly between 2018 and 2019.

11.1.9 The inclusion of the 2018 MDS Transmodal data in place of the previous data (from 2006) used in earlier versions of the A66TM represents a significant improvement within the model.

Model Convergence

11.1.10 TAG Unit M3-1 recommends that before the results of any traffic assignment are used to influence decisions, the stability (or degree of convergence) of the assignment must be confirmed at the appropriate level. The importance of achieving convergence, at an appropriate level, is related to the need to provide stable, consistent and robust model results.

11.1.11 Table 9-1 demonstrates that the base model converges well and is stable. It achieves the TAG convergence criteria in a reasonable number of loops (a maximum of 24 loops within the AM peak). The small number of loops illustrates that convergence is achieved easily and is not forced. There are some limited convergence issues within the most congested parts of the model, most notably around the A19 within the east of Tyneside. It is recommended that this is monitored during model forecasting, and any significant Transport Economic Efficiency benefits calculated for trips wholly within this area should be treated cautiously.

Model Assignment

11.1.12 The performance of the model in terms of flows meeting the link and screenline flow validation criteria approaches the guidelines recommended within Tag Unit 3-1. Similarly, in terms of journey time validation and routing checks the model has been demonstrated to perform in a satisfactory manner.

11.1.13 In terms of the model's ability to forecast the impacts of the proposed project on the local road network within the vicinity of the A66 there are two known issues.

11.1.14 While the model achieves a reasonable turn validation at the major interchanges, i.e. M6 Junction 40, Kemplay Bank and the A1(M) junction 40 any detailed capacity assessment of these junctions should be undertaken in the appropriate operation model informed by the forecast traffic increases from the A66TM. This methodology has been followed within the assessment of junction capacity with the **3.7 Transport Assessment.**

Demand Model Development

11.1.15 It is recognised that the employers' business response is stronger than the -0.1 suggested in TAG Unit M2.1 but results by purpose largely align with expectations, given recent experience from other models, and the significant changes to the TAG values of time (with the EB value reducing significantly) that have been made since the target fuel cost elasticities were originally derived.

11.1.16 The commute fuel cost elasticity is weaker than the 0.3 suggested by TAG, but this has also been affected by the change in values of time (albeit in the opposite direction to EB). Experience also shows that when the commute purpose is doubly-constrained for distribution then it tends to be less elastic than TAG suggests.

11.1.17 Overall the A66TM is considered to meet expectations for its intended use, namely providing traffic forecasts to be used in the traffic and economic appraisal of the A66 northern Trans Pennine Scheme.

A Appendix A

A.1 Speed Flow Curves

Index	Description	Free flow speed (kph)	Capacity Speed (kph)	Link Capacity (pcu/hr)	Power (N)
Rural					
1	Rural Motorway D5	113	81	11650	2.80
2	Rural Motorway D4	113	81	9320	2.80
3	Rural Motorway D3	113	81	6990	2.80
4	Rural Motorway D3 + Dynamic Hard Shoulder 60mph	100	75	9320	4.7
5	Rural Motorway D2	113	74	4659	2.80
6	Rural All-Purpose D4 (60mph)	98	76	8397	2.75
7	Rural All-Purpose D4 50mph	80	62	8397	2.20
8	Rural All-Purpose D3 (70mph)	112	80	6298	2.75
9	Rural All-Purpose D3 60mph	98	76	6298	2.75
10	Rural All-Purpose D3 50mph	80	62	6298	2.20
11	Rural All-Purpose D2 (70 mph)	112	73	4199	2.75
12	Rural All-Purpose D2 50mph	80	62	4199	2.20
13	Rural All-Purpose D2 40mph	64	35	4199	1.60
14	Rural WS2 10.0m A Road	93	55	1686	2.15
15	Rural S2 7.3m A Road (TD9/81)	87	58	1328	1.99
16	Rural S2 7.3m A Road (Older)	82	53	1328	2.04
17	Rural S2 A Road 40mph	64	35	1328	2.39
18	Rural S2 6.5m Poor	67	45	1010	1.79
19	Rural S2 Other Road (slow)	54	35	1328	1.53
20	Rural S2 Other Road (narrow carriageway)	82	53	950	2.11
21	Rural S2 Other Road (slow, narrow carriageway)	54	35	950	1.53
44	Rural Motorway D3 + Roadworks	80	64	5580	2.6
45	Rural All-Purpose D5 (70mph)	112	80	10,497	2.75
46	Rural All-Purpose D5 (60mph)	98	76	10,497	2.75
47	Rural All-Purpose D4 (70 mph)	112	80	8,397	2.75
48	Rural Motorway D6	113	81	13,980	2.8
Suburban					
22	Suburban D4	71	35	7080	1.42
23	Suburban D3	71	35	5310	1.42
24	Suburban D2 (slight development)	75	35	3540	2.56
25	Suburban D2 (typical development)	71	35	3540	1.42
26	Suburban D2 (heavy development)	58	35	3540	0.93
27	Suburban D2 (30mph)	48	30	3540	1.28
28	Suburban S4 (slight development)	54	25	3400	2.00
29	Suburban S4 (typical development)	54	25	2500	2.00
30	Suburban S2 (50mph)	71	35	1680	1.52
31	Suburban S2 (light development)	65	25	1680	2.63
32	Suburban S2 (typical development)	61	25	1680	1.58
33	Suburban S2 (heavy development)	58	25	1680	1.03
34	Suburban S2 (30mph)	48	25	1680	1.28

Urban					
35	Urban Non-central 50% development	48	30	896	2.22
36	Urban Non-central 80% development	48	25	896	1.49
37	Urban Non central 90% development	46	25	896	1.25
38	Urban Central INT = 2	37	15	944	1.51
39	Urban Central INT = 4.5	33	15	944	1.19
40	Urban Central INT = 9	28	15	896	0.72
Small town					
41	Small Town 35% development	63	32	1344	2.91
42	Small Town 60% development	56	30	1344	2.37
43	Small Town 90% development	46	30	1344	1.27

B Appendix B

B.1 Matrix Estimation Impacts – AM

Changes in Trip Ends and Cell Values

Full Data

	Origin Trip Ends			Destination Trip Ends			Cell Values		
	Slope	Intercept	R2	Slope	Intercept	R2	Slope	Intercept	R2
Car - Commute	1.00	0.21	1.00	1.00	0.28	1.00	1.00	0.00	1.00
Car - Business	1.00	2.10	1.00	1.00	2.09	1.00	1.00	0.00	1.00
Car - Other	1.00	1.09	1.00	1.00	1.08	1.00	1.00	0.00	1.00
LGV	1.00	0.90	1.00	1.00	0.85	1.00	1.00	0.01	1.00
OGV	1.00	0.18	1.00	1.00	0.47	1.00	1.00	0.00	1.00

Both Trip Ends in the Main Modelled Area

	Origin Trip Ends			Destination Trip Ends			Cell Values		
	Slope	Intercept	R2	Slope	Intercept	R2	Slope	Intercept	R2
Car - Commute	1.01	0.20	0.99	1.03	-0.09	0.99	1.01	0.00	0.99
Car - Business	1.00	1.74	0.99	1.02	-0.05	0.99	1.01	0.00	0.98
Car - Other	1.00	0.98	0.99	1.02	0.04	0.99	1.01	0.00	0.98
LGV	1.02	0.75	0.98	1.01	0.99	0.97	1.00	0.01	0.96
OGV	1.01	0.32	0.96	0.99	0.94	0.96	0.93	0.00	0.92

One Trip End in the Main Modelled Area

	Origin Trip Ends			Destination Trip Ends			Cell Values		
	Slope	Intercept	R2	Slope	Intercept	R2	Slope	Intercept	R2
Car - Commute							0.99	0.00	0.98
Car - Business							0.95	0.00	0.92
Car - Other							0.96	0.00	0.90
LGV							0.83	0.01	0.68
OGV							0.80	0.00	0.58

Matrix Totals

	Prior	Post	Diff	% Diff
Car - Commute	578,753	579,017	264	0.0%
Car - Business	3,299,145	3,302,015	2,870	0.1%
Car - Other	1,644,998	1,646,480	1,482	0.1%
LGV	749,962	751,106	1,144	0.2%
OGV	283,748	284,137	390	0.1%
Total	6,556,605	6,562,755	6,150	0.1%

Sectors

Differences

	Within 5%	Percentage
Car - Commute	110	56%
Car - Business	114	58%
Car - Other	110	56%
LGV	39	20%
OGV	21	11%
Total	64	33%

	Within 15%	Percentage
Car - Commute	190	97%
Car - Business	190	97%
Car - Other	185	94%
LGV	69	35%
OGV	45	23%
Total	122	62%

Distribution

	Within 0.1%	Percentage
Car - Commute	196	100%
Car - Business	196	100%
Car - Other	196	100%
LGV	195	99%
OGV	194	99%
Total	196	100%

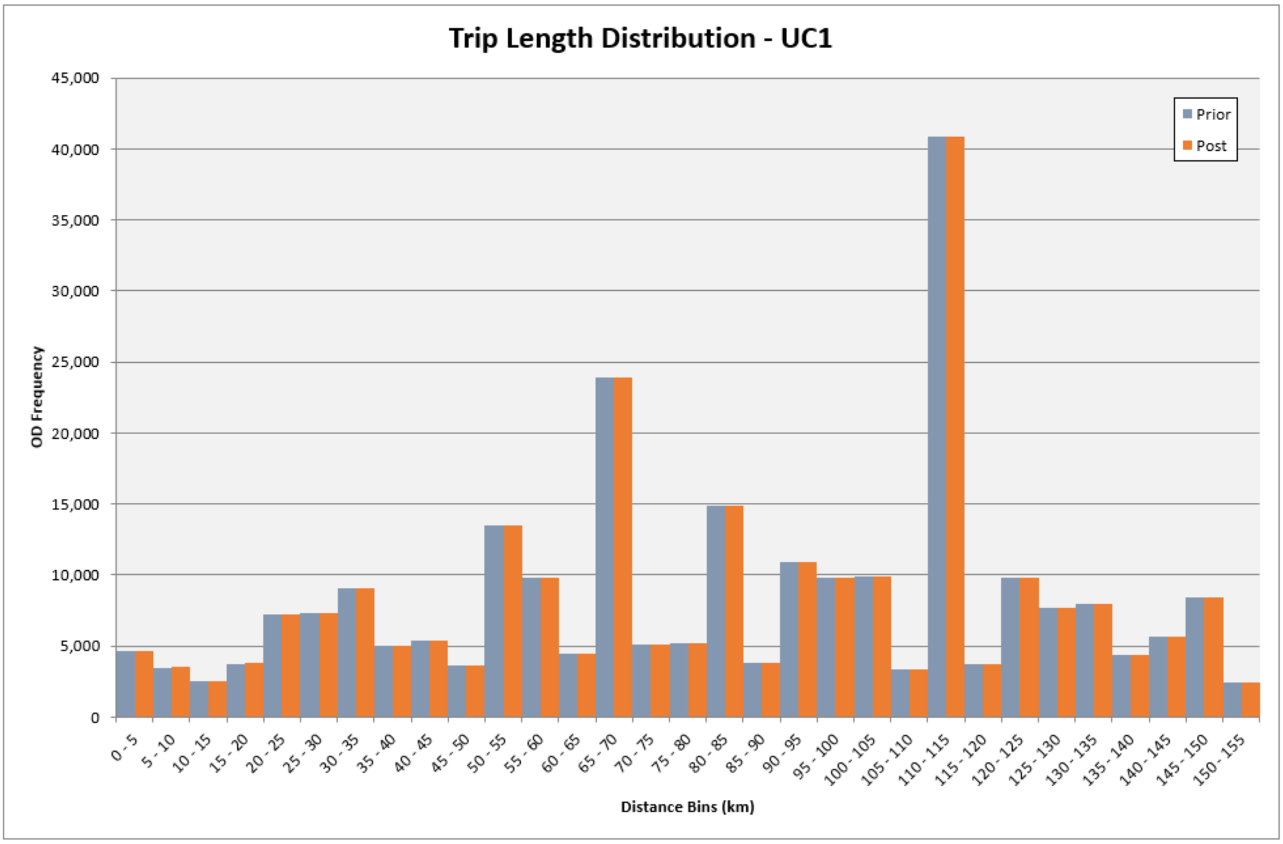
	Within 1%	Percentage
Car - Commute	196	100%
Car - Business	196	100%
Car - Other	196	100%
LGV	196	100%
OGV	196	100%
Total	196	100%

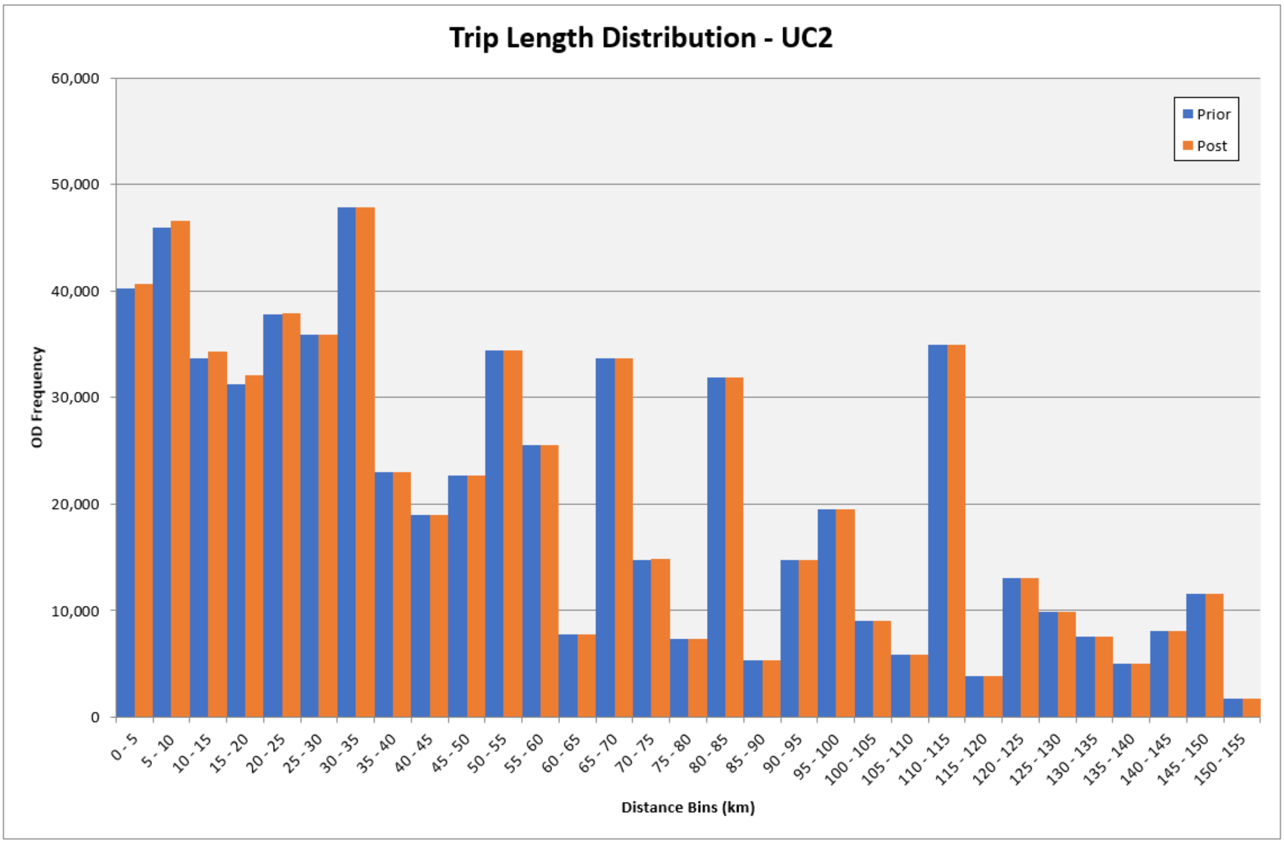
GEH

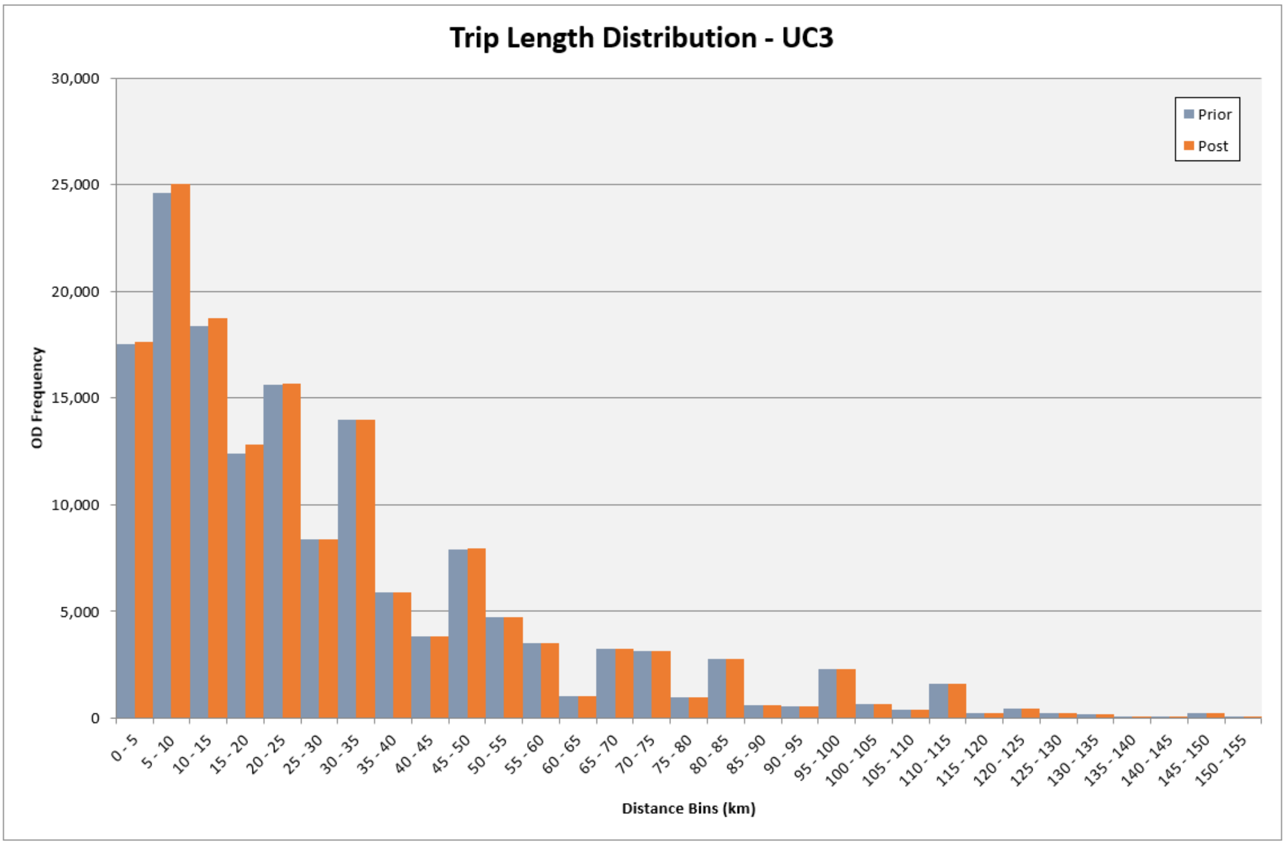
	GEH < 5	Percentage
Car - Commute	196	100%
Car - Business	194	99%
Car - Other	195	99%
LGV	189	96%
OGV	163	83%
Total	183	93%

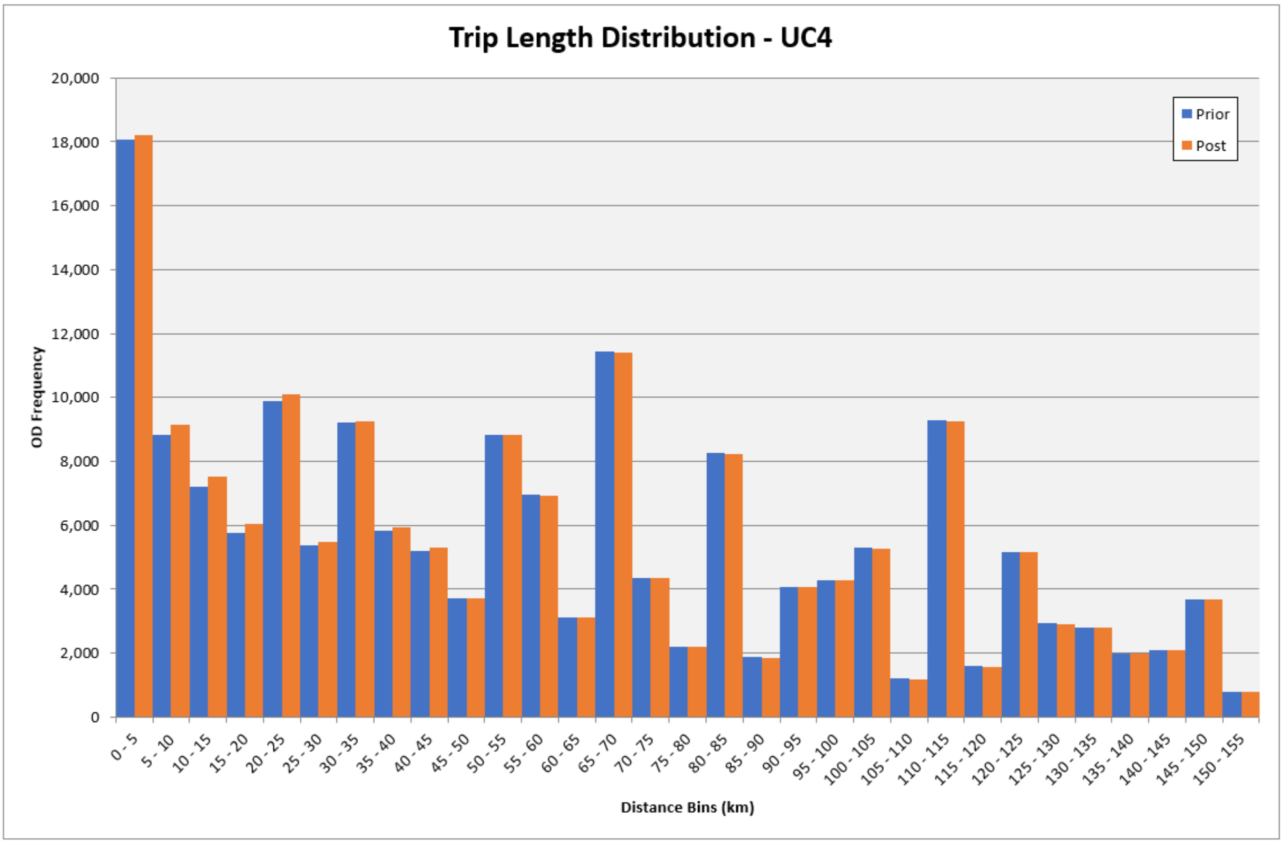
	GEH < 10	Percentage
Car - Commute	196	100%
Car - Business	195	99%
Car - Other	196	100%
LGV	196	100%
OGV	194	99%
Total	195	99%

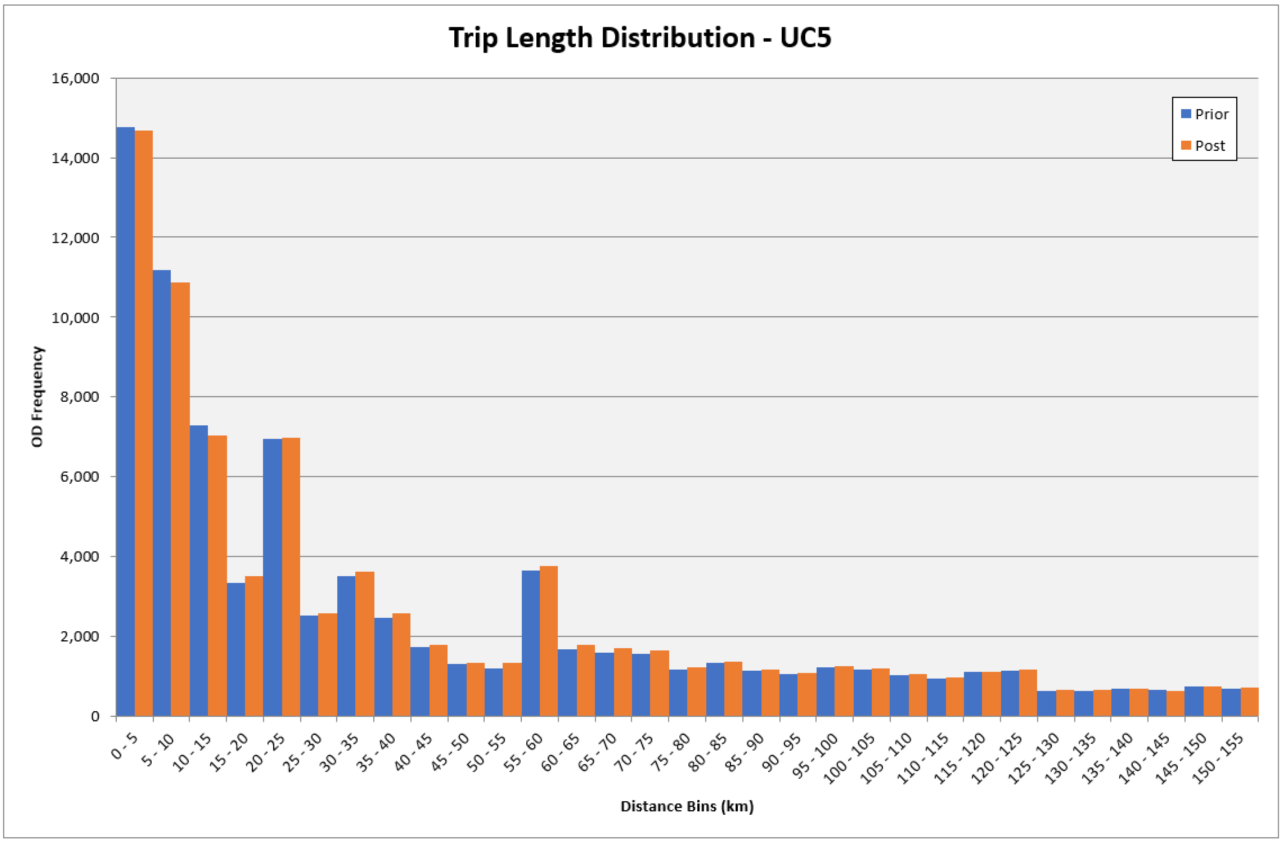
Trip Length Distributions – AM Peak






Trip Length Distribution - UC3
OD Frequency
Distance Bins (km)
Prior
Post
30,000
25,000
20,000
15,000
10,000
5,000
0
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
90 - 95
95 - 100
100 - 105
105 - 110
110 - 115
115 - 120
120 - 125
125 - 130
130 - 135
135 - 140
140 - 145
145 - 150
150 - 155


Trip Length Distribution - UC4
OD Frequency
Distance Bins (km)
Prior
Post
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
90 - 95
95 - 100
100 - 105
105 - 110
110 - 115
115 - 120
120 - 125
125 - 130
130 - 135
135 - 140
140 - 145
145 - 150
150 - 155



Trip Length Distribution - UC5
Prior
Post
OD Frequency
Distance Bins (km)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
90 - 95
95 - 100
100 - 105
105 - 110
110 - 115
115 - 120
120 - 125
125 - 130
130 - 135
135 - 140
140 - 145
145 - 150
150 - 155

B.2 Matrix Estimation Impacts - IP

Changes in Trip Ends and Cell Values

Full Data									
	Origin Trip Ends			Destination Trip Ends			Cell Values		
	Slope	Intercept	R2	Slope	Intercept	R2	Slope	Intercept	R2
Car - Commute	1.00	-0.10	1.00	1.00	-0.13	1.00	1.00	0.00	1.00
Car - Business	1.00	-1.04	1.00	1.00	-1.04	1.00	1.00	0.00	1.00
Car - Other	1.00	-1.28	1.00	1.00	-1.29	1.00	1.00	0.00	1.00
LGV	1.00	0.03	1.00	1.00	-0.01	1.00	1.00	0.00	1.00
OGV	1.00	-0.37	1.00	1.00	-0.42	1.00	1.00	0.00	1.00

Both Trip Ends in the Main Modelled Area									
	Origin Trip Ends			Destination Trip Ends			Cell Values		
	Slope	Intercept	R2	Slope	Intercept	R2	Slope	Intercept	R2
Car - Commute	0.97	0.15	1.00	0.99	0.02	1.00	1.00	0.00	0.99
Car - Business	0.98	0.37	1.00	0.98	0.40	1.00	0.99	0.00	0.99
Car - Other	0.98	0.92	1.00	0.98	0.31	1.00	1.00	0.00	0.99
LGV	0.99	0.39	0.99	0.98	0.87	0.99	0.99	0.00	0.98
OGV	0.96	0.63	0.95	0.95	0.97	0.95	0.90	0.00	0.91

One Trip End in the Main Modelled Area									
	Origin Trip Ends			Destination Trip Ends			Cell Values		
	Slope	Intercept	R2	Slope	Intercept	R2	Slope	Intercept	R2
Car - Commute							0.98	0.00	0.99
Car - Business							0.98	0.00	0.90
Car - Other							0.87	0.00	0.93
LGV							0.93	0.00	0.65
OGV							0.85	0.00	0.54

Matrix Totals

	Prior	Post	Diff	% Diff
Car - Commute	508,529	508,365	-165	0.0%
Car - Business	1,302,014	1,300,580	-1,434	-0.1%
Car - Other	2,920,393	2,918,620	-1,773	-0.1%
LGV	561,889	561,879	-10	0.0%
OGV	267,385	267,153	-232	-0.1%
Total	5,560,210	5,556,596	-3,614	-0.1%

Sectors

Differences

	Within 5%	Percentage
Car - Commute	141	72%
Car - Business	134	68%
Car - Other	126	64%
LGV	40	20%
OGV	23	12%
Total	68	35%

	Within 15%	Percentage
Car - Commute	194	99%
Car - Business	190	97%
Car - Other	187	95%
LGV	72	37%
OGV	54	28%
Total	133	68%

Distribution

	Within 0.1%	Percentage
Car - Commute	196	100%
Car - Business	196	100%
Car - Other	196	100%
LGV	196	100%
OGV	194	99%
Total	196	100%

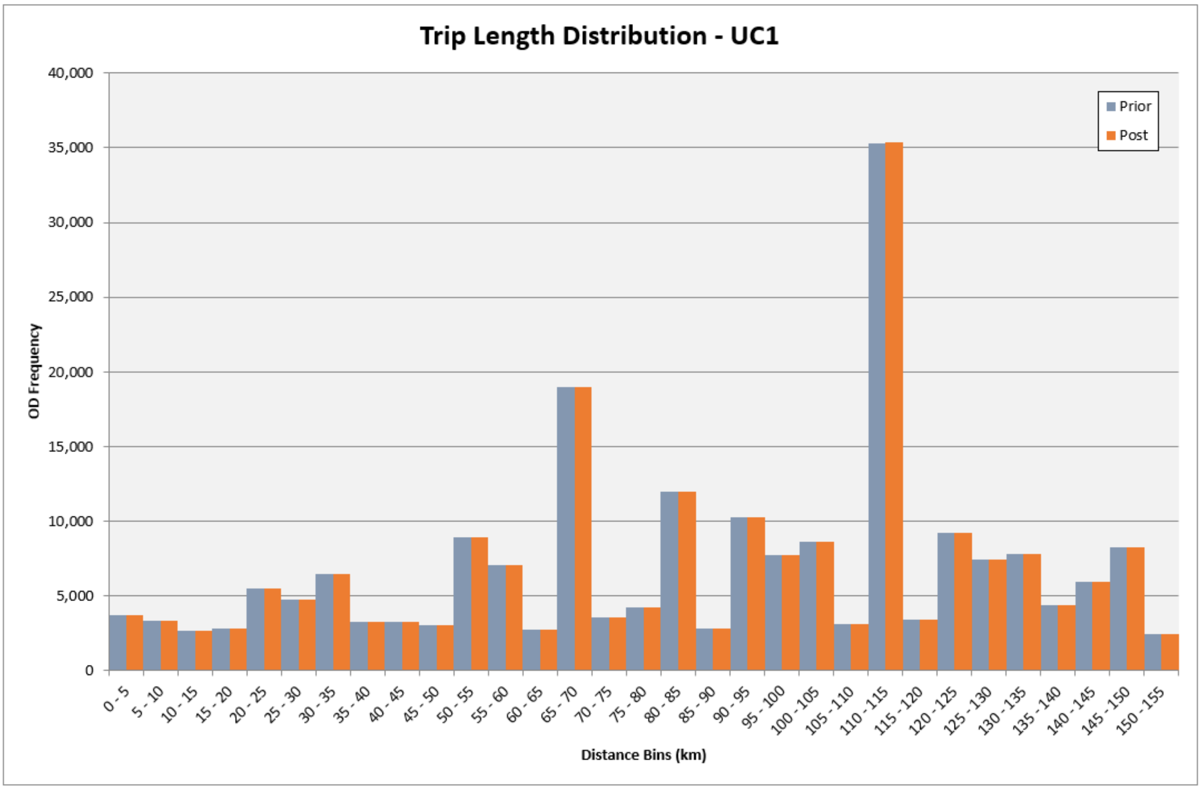
	Within 1%	Percentage
Car - Commute	196	100%
Car - Business	196	100%
Car - Other	196	100%
LGV	196	100%
OGV	196	100%
Total	196	100%

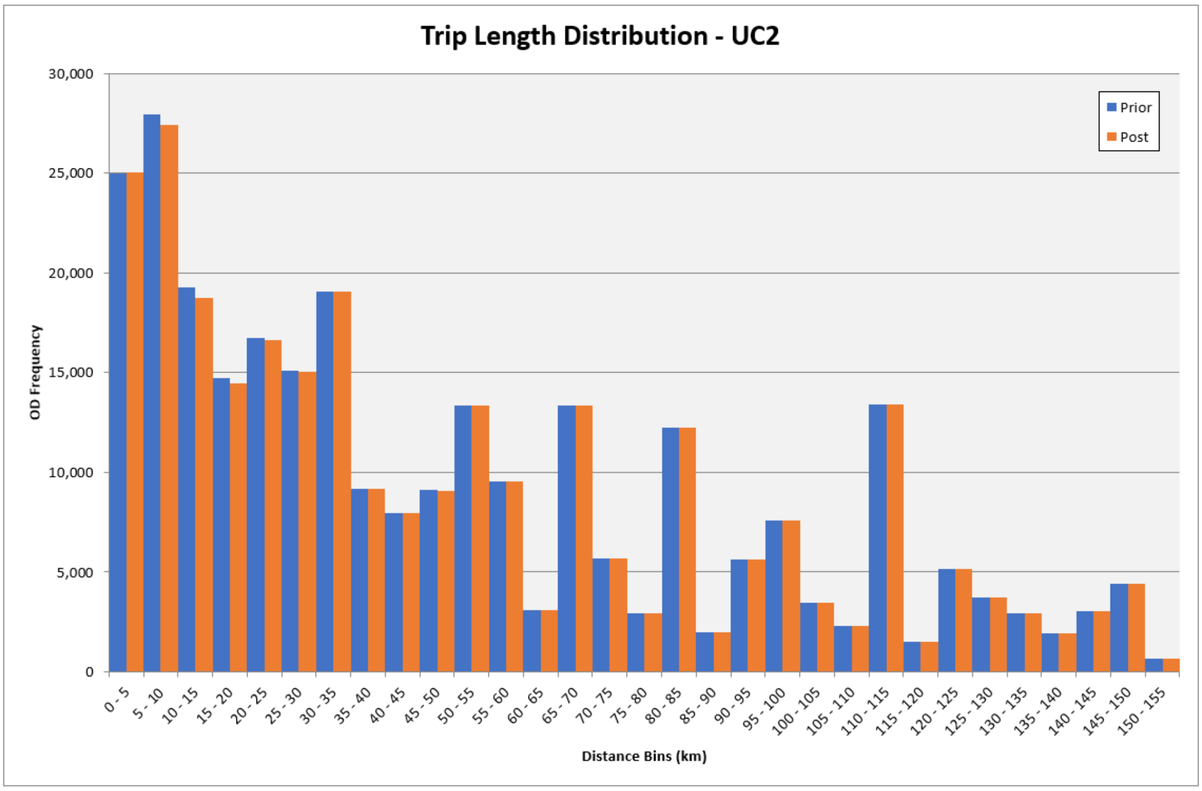
GEH

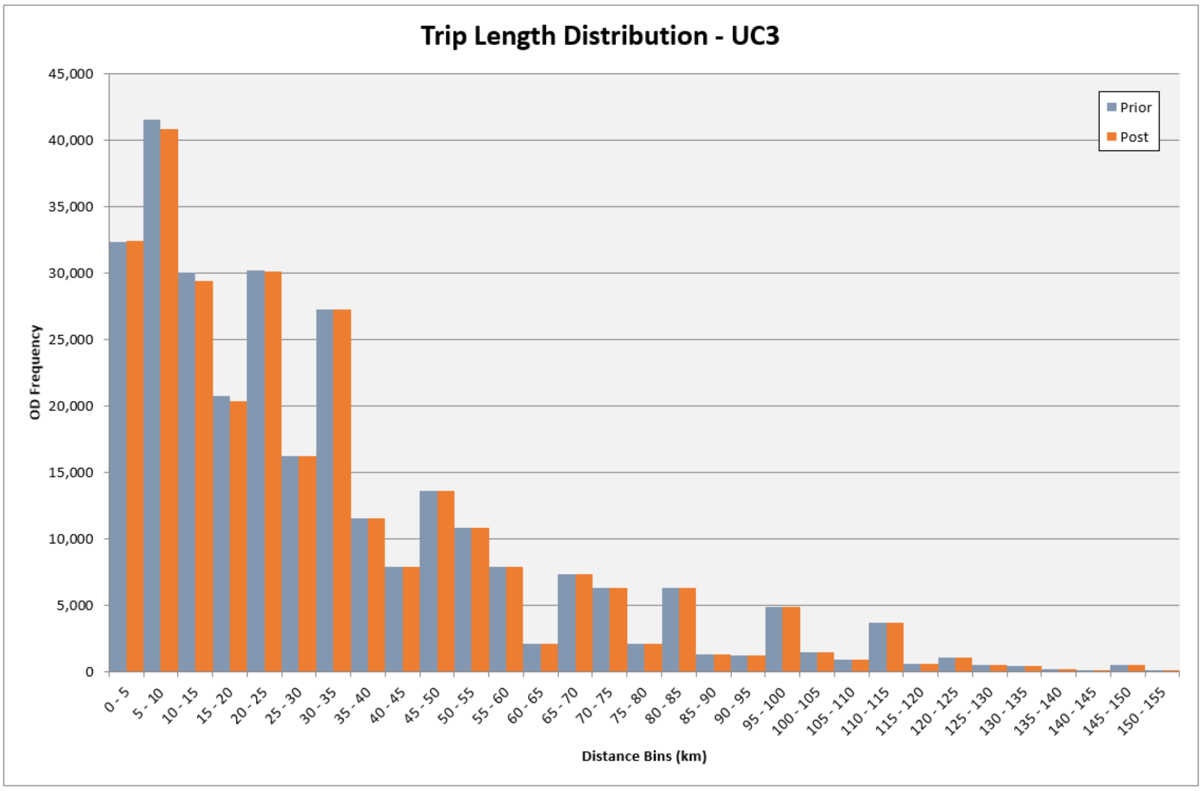
	GEH < 5	Percentage
Car - Commute	196	100%
Car - Business	196	100%
Car - Other	195	99%
LGV	190	97%
OGV	168	86%
Total	190	97%

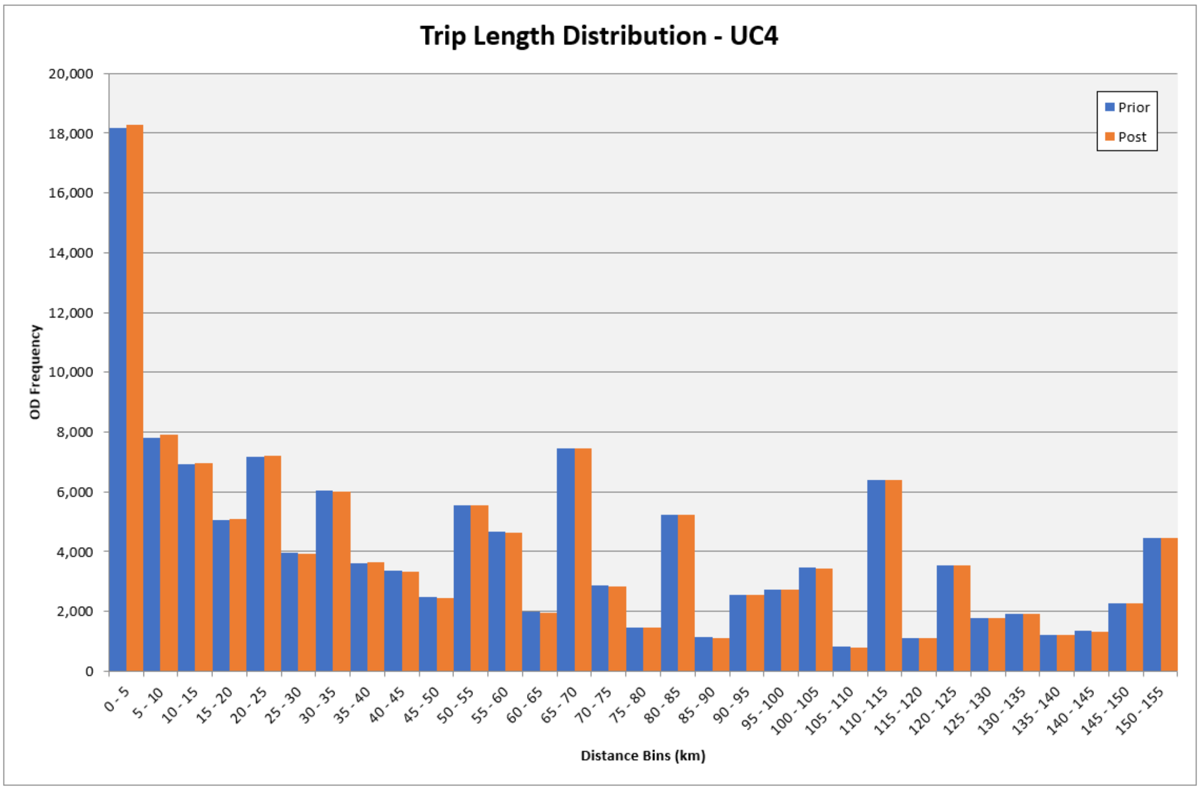
	GEH < 10	Percentage
Car - Commute	196	100%
Car - Business	196	100%
Car - Other	196	100%
LGV	196	100%
OGV	195	99%
Total	196	100%

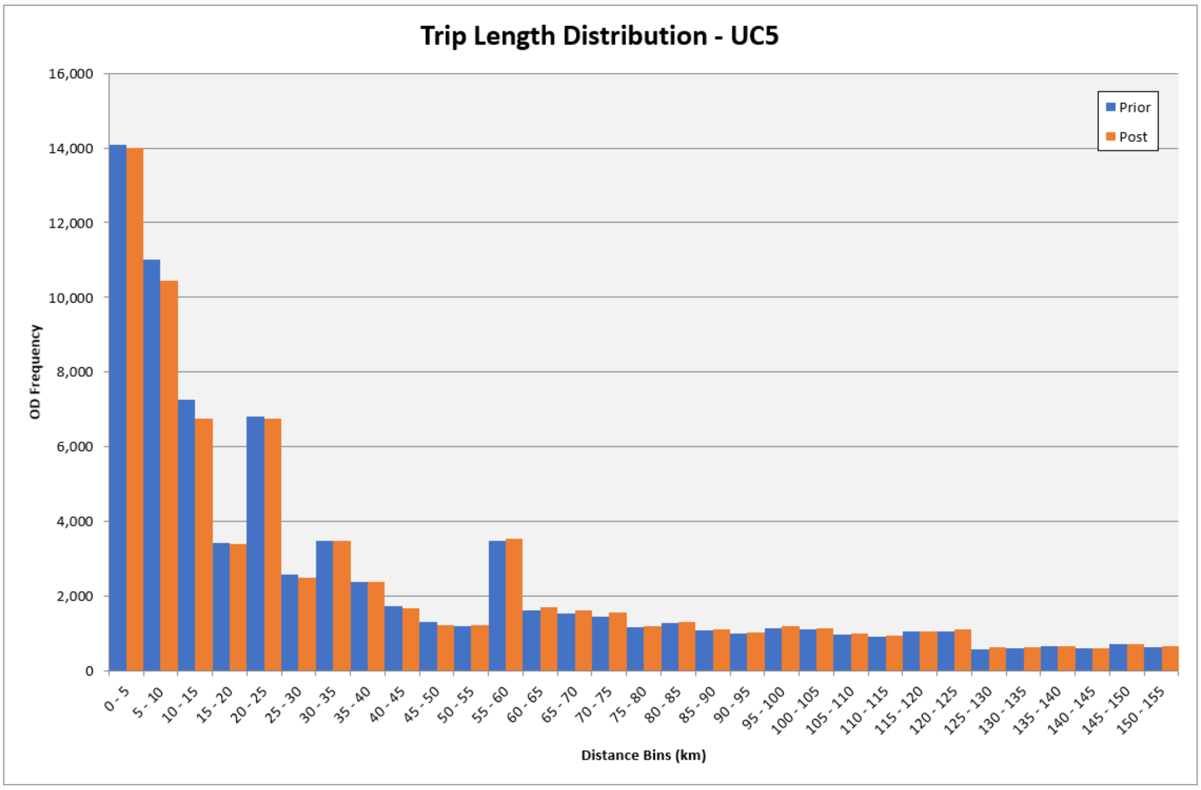
Trip Length Distributions – IP Peak






Trip Length Distribution - UC3
Prior
Post
OD Frequency
Distance Bins (km)
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
90 - 95
95 - 100
100 - 105
105 - 110
110 - 115
115 - 120
120 - 125
125 - 130
130 - 135
135 - 140
140 - 145
145 - 150
150 - 155


Trip Length Distribution - UC4
Prior
Post
OD Frequency
Distance Bins (km)
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
90 - 95
95 - 100
100 - 105
105 - 110
110 - 115
115 - 120
120 - 125
125 - 130
130 - 135
135 - 140
140 - 145
145 - 150
150 - 155



Trip Length Distribution - UC5
OD Frequency
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Prior
Post
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
90 - 95
95 - 100
100 - 105
105 - 110
110 - 115
115 - 120
120 - 125
125 - 130
130 - 135
135 - 140
140 - 145
145 - 150
150 - 155
Distance Bins (km)

B.3 Matrix Estimation Impacts – PM

Changes in Trip Ends and Cell Values

Full Data									
	Origin Trip Ends			Destination Trip Ends			Cell Values		
	Slope	Intercept	R2	Slope	Intercept	R2	Slope	Intercept	R2
Car - Commute	1.00	0.08	1.00	1.00	0.03	1.00	1.00	0.00	1.00
Car - Business	1.00	0.25	1.00	1.00	0.25	1.00	1.00	0.00	1.00
Car - Other	1.00	0.12	1.00	1.00	0.11	1.00	1.00	0.00	1.00
LGV	1.00	0.15	1.00	1.00	0.09	1.00	1.00	0.00	1.00
OGV	1.00	-0.38	1.00	1.00	-0.34	1.00	1.00	0.00	1.00

Both Trip Ends in the Main Modelled Area									
	Origin Trip Ends			Destination Trip Ends			Cell Values		
	Slope	Intercept	R2	Slope	Intercept	R2	Slope	Intercept	R2
Car - Commute	1.01	-0.02	1.00	1.00	0.11	1.00	1.01	0.00	0.99
Car - Business	1.00	0.04	0.99	0.99	1.08	0.99	1.00	0.00	0.99
Car - Other	1.00	0.32	1.00	0.99	1.12	0.99	1.00	0.00	0.99
LGV	1.00	0.17	0.98	0.99	0.63	0.98	0.99	0.01	0.96
OGV	0.99	0.25	0.95	0.96	0.76	0.96	0.91	0.00	0.91

One Trip End in the Main Modelled Area									
	Origin Trip Ends			Destination Trip Ends			Cell Values		
	Slope	Intercept	R2	Slope	Intercept	R2	Slope	Intercept	R2
Car - Commute							0.97	0.00	0.99
Car - Business							0.94	0.00	0.94
Car - Other							0.85	0.00	0.94
LGV							0.93	0.01	0.53
OGV							0.80	0.00	0.52

Matrix Totals

	Prior	Post	Diff	% Diff
Car - Commute	605,822	605,847	25	0.0%
Car - Business	2,715,789	2,716,122	333	0.0%
Car - Other	3,225,761	3,225,904	144	0.0%
LGV	546,201	546,359	159	0.0%
OGV	199,756	199,293	-463	-0.2%
Total	7,293,329	7,293,526	197	0.0%

Sectors

Differences

	Within 5%	Percentage		Within 15%	Percentage
Car - Commute	135	69%	Car - Commute	190	97%
Car - Business	124	63%	Car - Business	190	97%
Car - Other	127	65%	Car - Other	190	97%
LGV	37	19%	LGV	62	32%
OGV	21	11%	OGV	46	23%
Total	76	39%	Total	140	71%

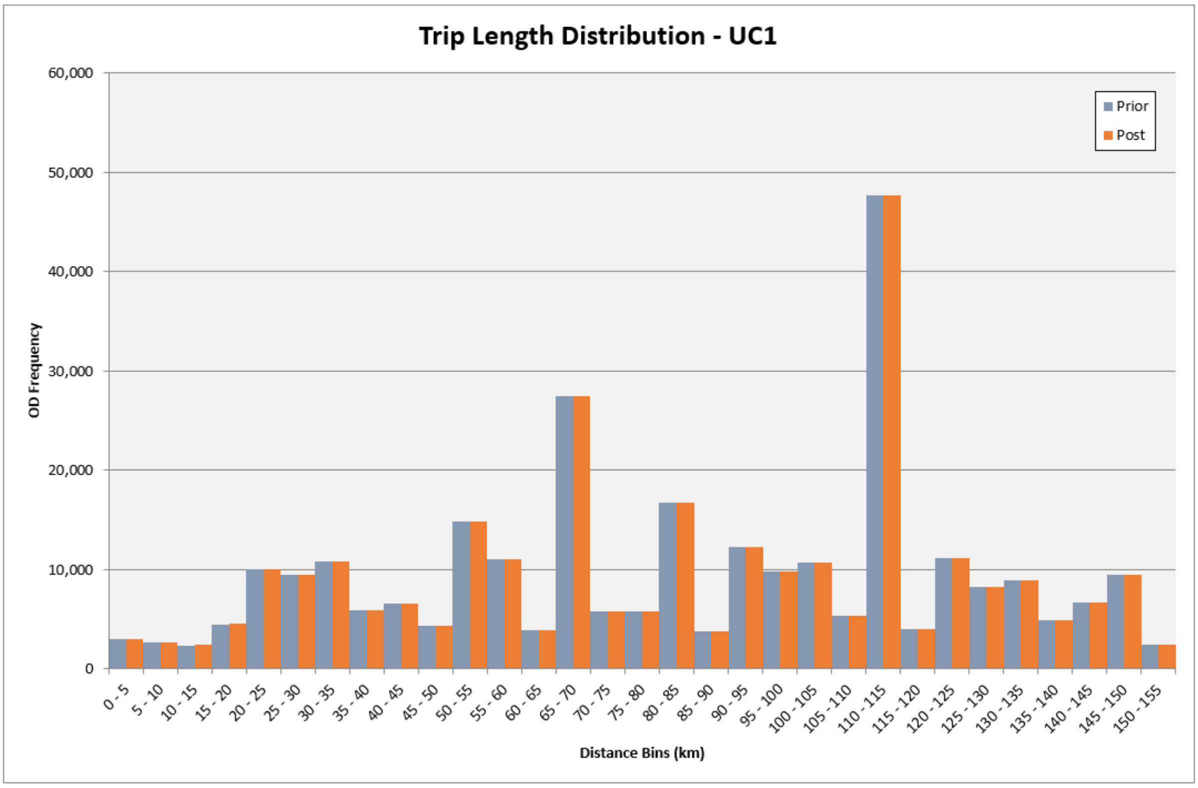
Distribution

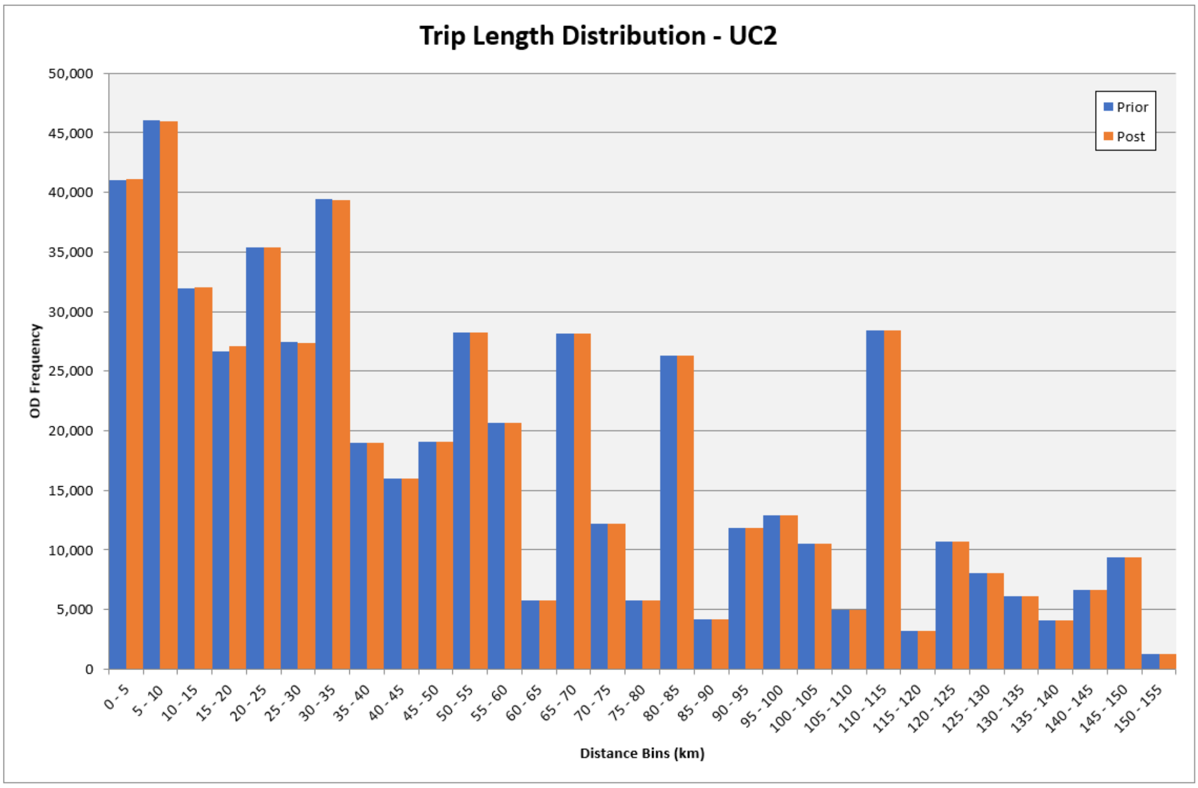
	Within 0.1%	Percentage		Within 1%	Percentage
Car - Commute	196	100%	Car - Commute	196	100%
Car - Business	196	100%	Car - Business	196	100%
Car - Other	196	100%	Car - Other	196	100%
LGV	196	100%	LGV	196	100%
OGV	194	99%	OGV	196	100%
Total	196	100%	Total	196	100%

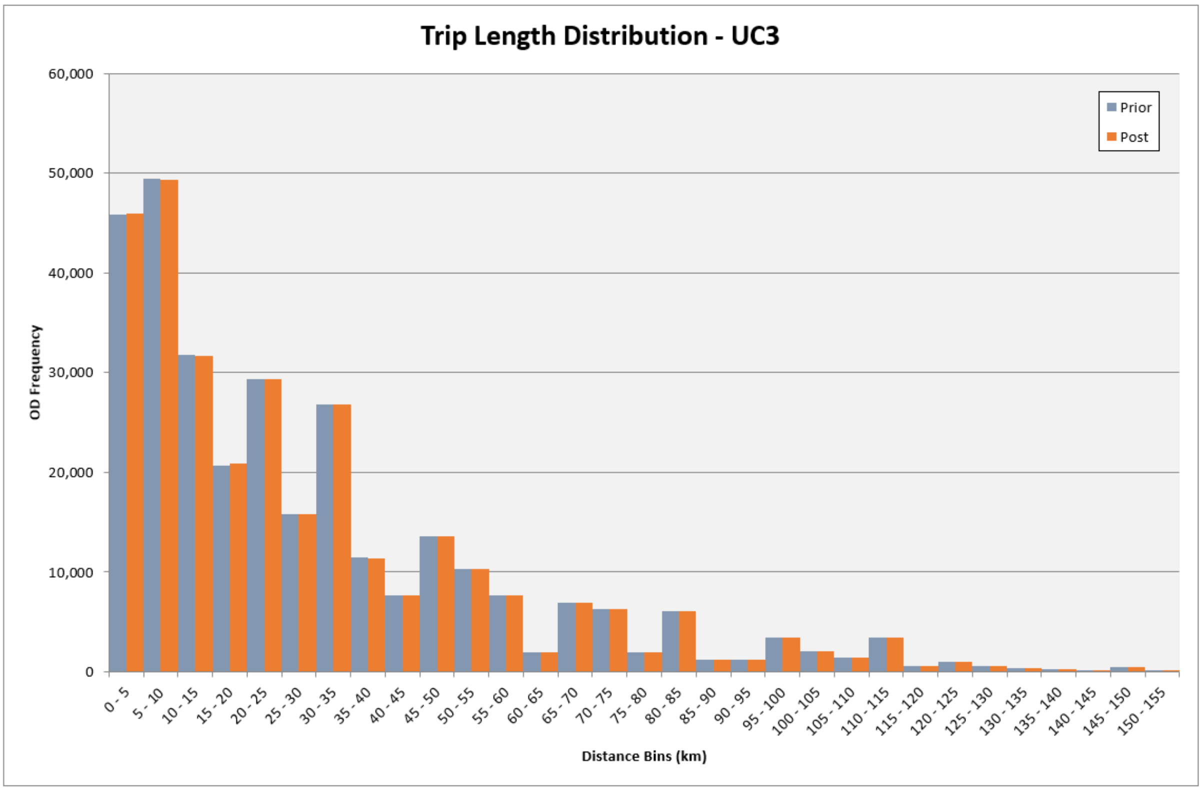
GEH

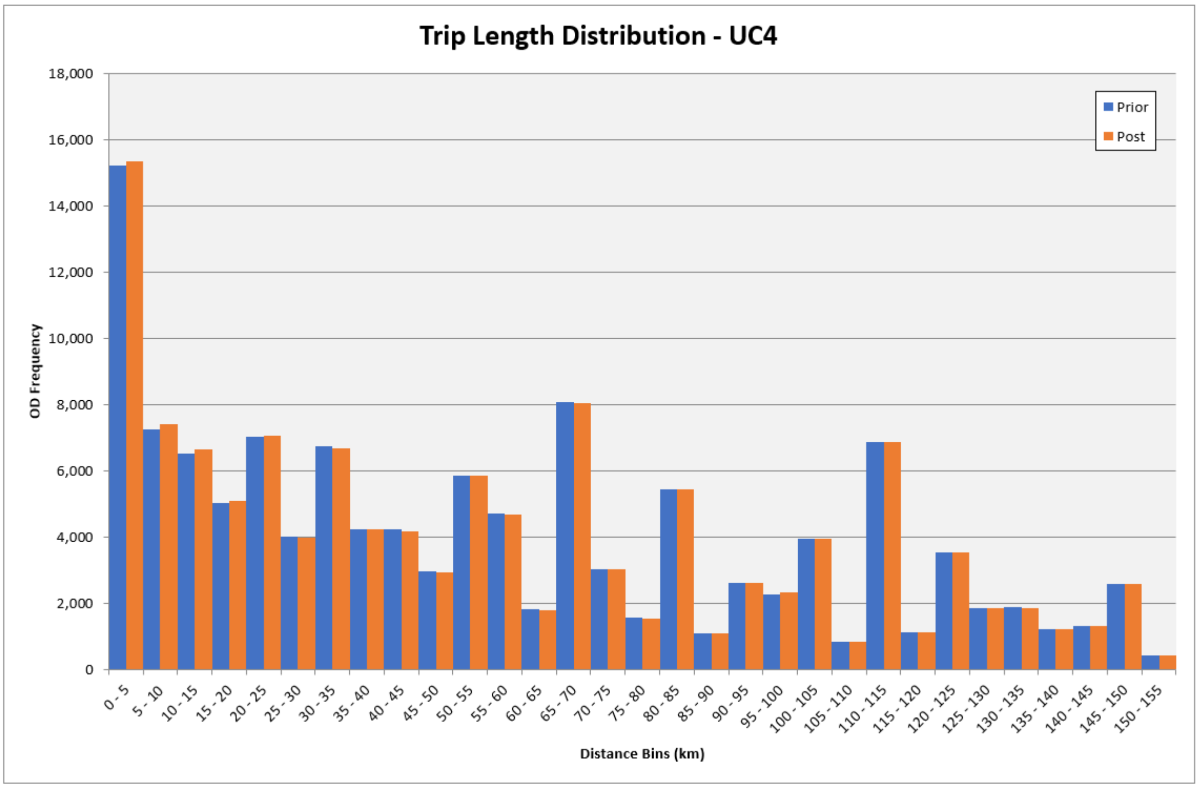
	GEH < 5	Percentage		GEH < 10	Percentage
Car - Commute	196	100%	Car - Commute	196	100%
Car - Business	195	99%	Car - Business	196	100%
Car - Other	196	100%	Car - Other	196	100%
LGV	190	97%	LGV	195	99%
OGV	178	91%	OGV	195	99%
Total	190	97%	Total	196	100%

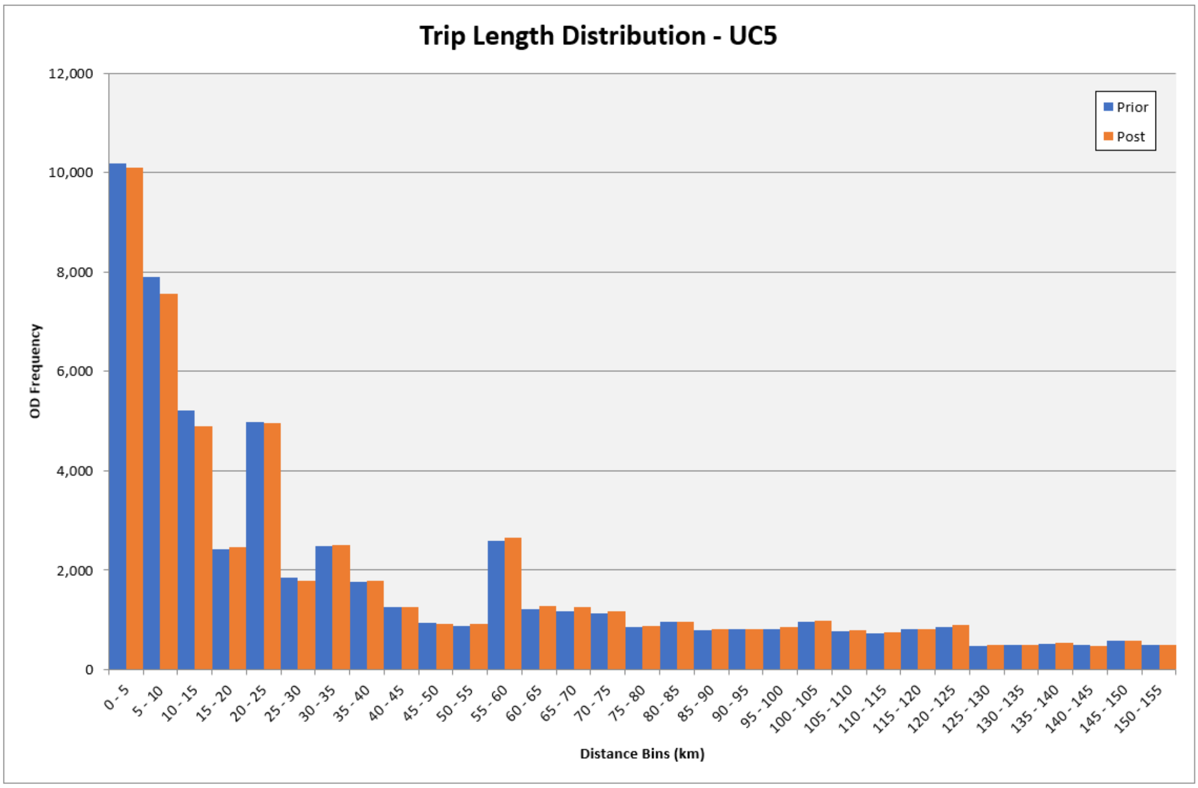
Trip Length Distributions – PM Peak





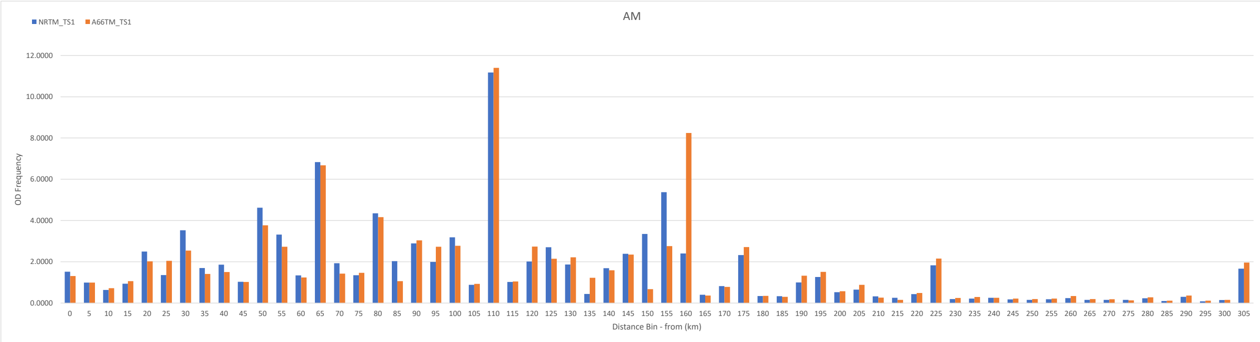

Trip Length Distribution - UC3
Prior
Post
OD Frequency
Distance Bins (km)
60,000
50,000
40,000
30,000
20,000
10,000
0
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
90 - 95
95 - 100
100 - 105
105 - 110
110 - 115
115 - 120
120 - 125
125 - 130
130 - 135
135 - 140
140 - 145
145 - 150
150 - 155

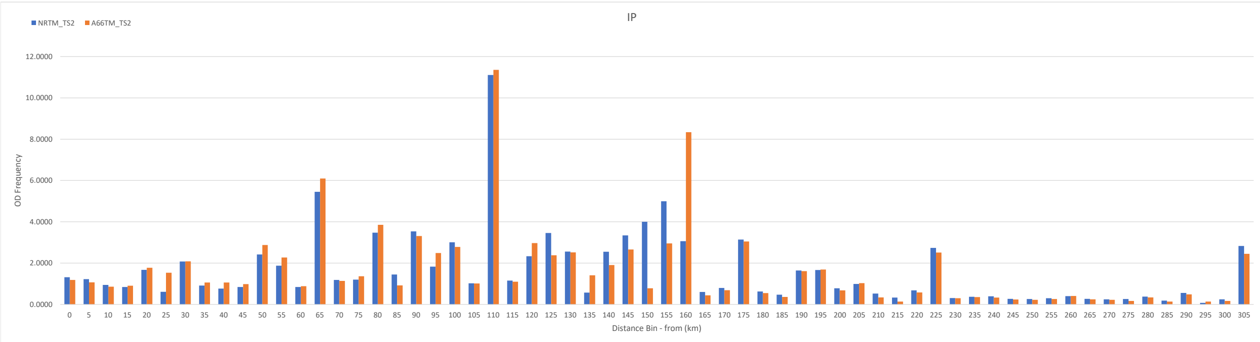

Trip Length Distribution - UC4
Prior
Post
OD Frequency
Distance Bins (km)
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
90 - 95
95 - 100
100 - 105
105 - 110
110 - 115
115 - 120
120 - 125
125 - 130
130 - 135
135 - 140
140 - 145
145 - 150
150 - 155

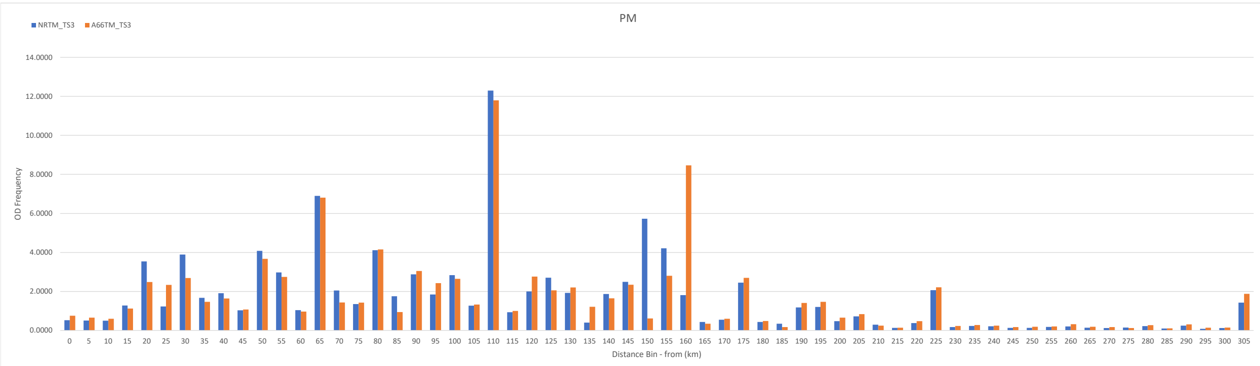


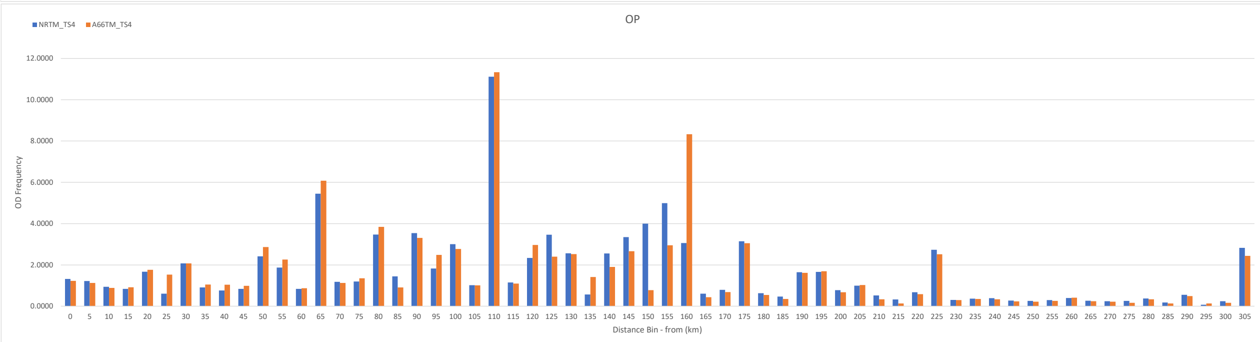
Trip Length Distribution - UC5
OD Frequency
Distance Bins (km)
Prior
Post
0
2,000
4,000
6,000
8,000
10,000
12,000
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
90 - 95
95 - 100
100 - 105
105 - 110
110 - 115
115 - 120
120 - 125
125 - 130
130 - 135
135 - 140
140 - 145
145 - 150
150 - 155

B.4 Trip Length Distribution Comparison NRTM vs A66TM

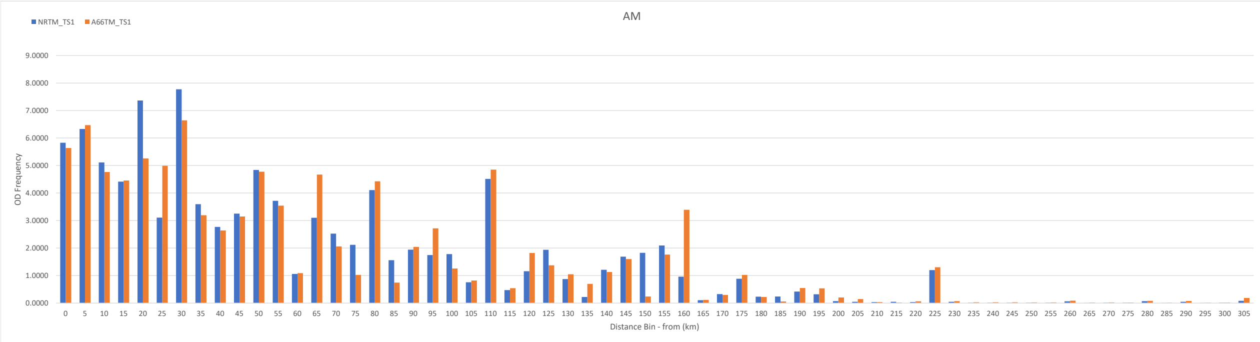

AM
NRTM_TS1
A66TM_TS1
OD Frequency
Distance Bin - from (km)

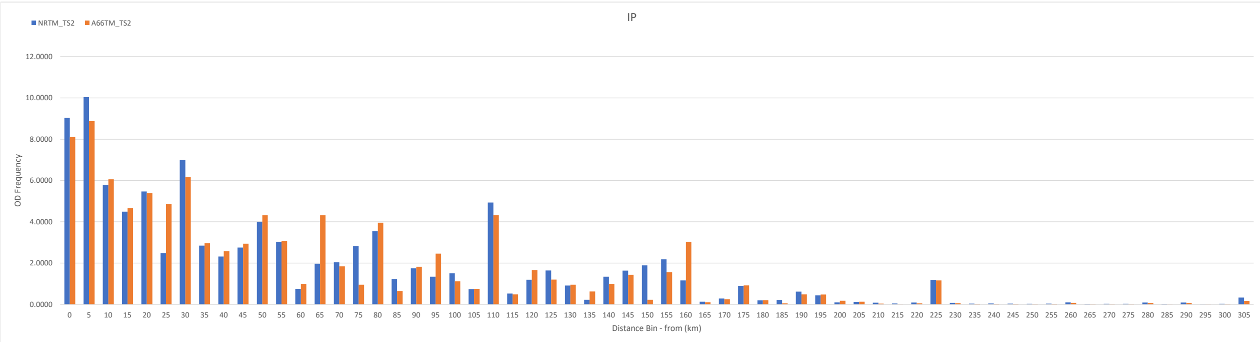

IP
NRTM_TS2
A66TM_TS2
OD Frequency
Distance Bin - from (km)

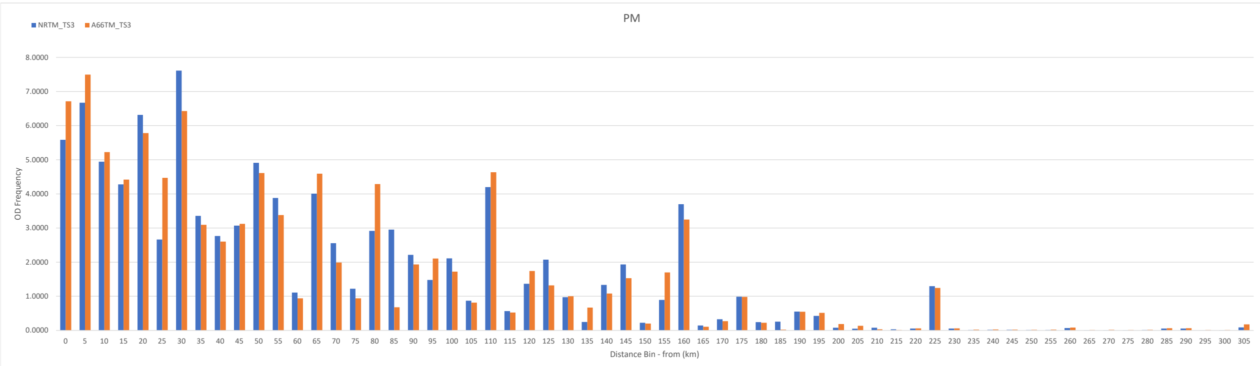

PM
NRTM_TS3
A66TM_TS3
OD Frequency
Distance Bin - from (km)

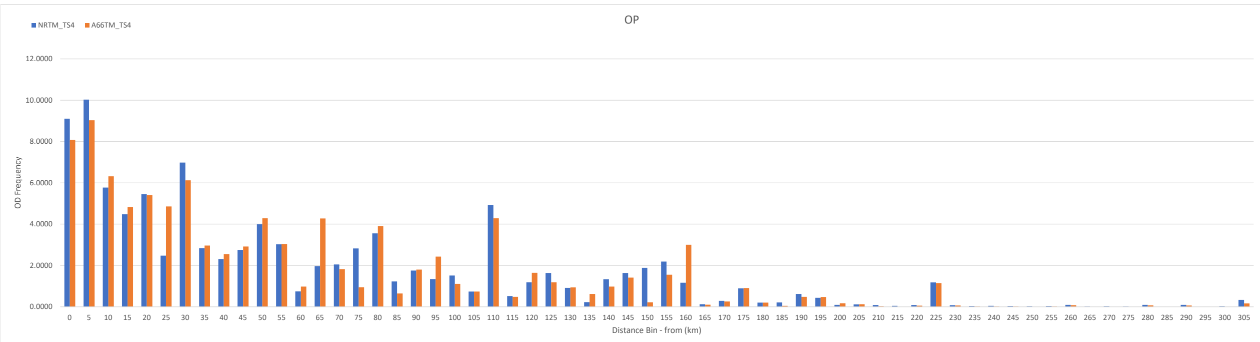

OP
NRTM_TS4
A66TM_TS4
OD Frequency
Distance Bin - from (km)

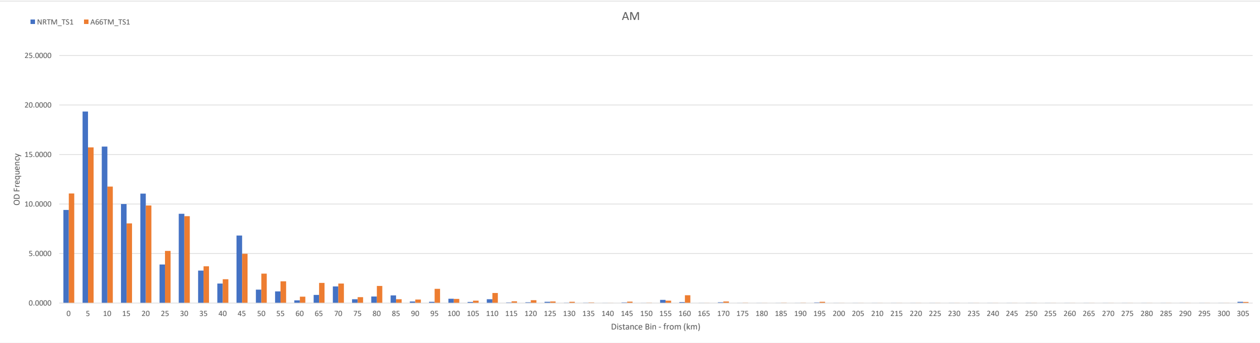
UC2

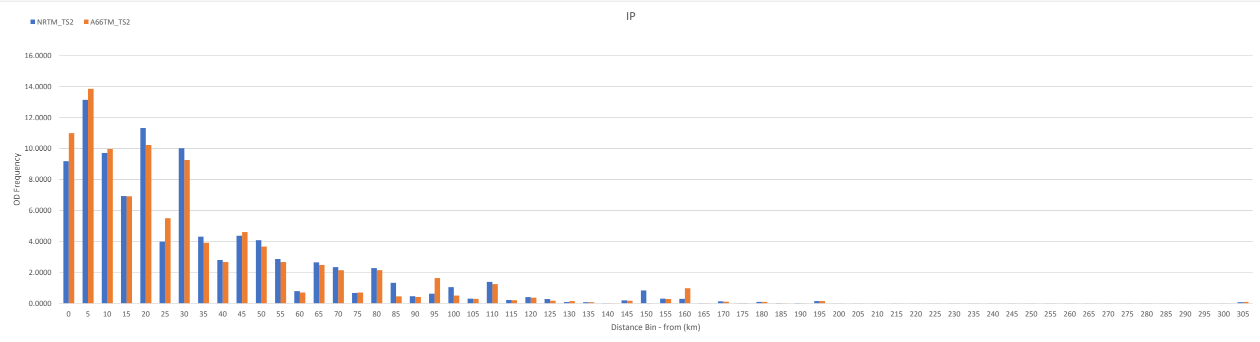

AM
NRTM_TS1
A66TM_TS1
OD Frequency
Distance Bin - from (km)

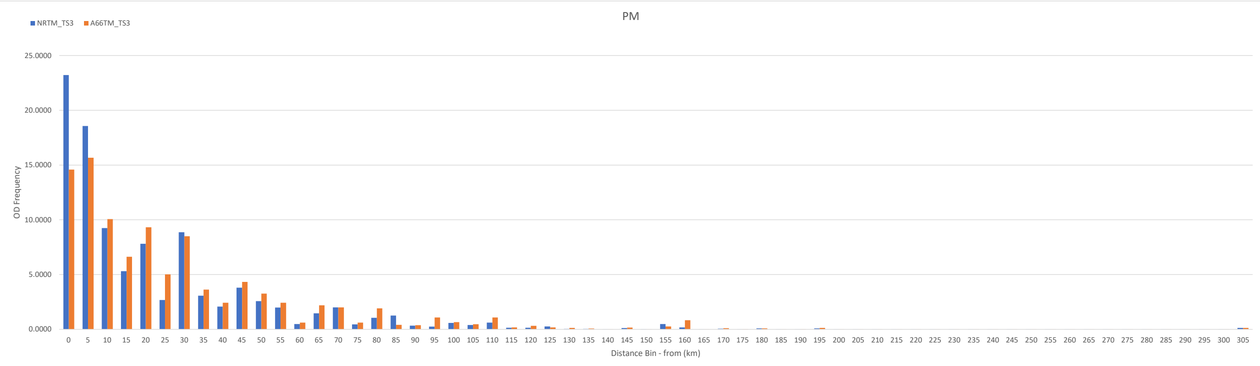

IP
NRTM_TS2
A66TM_TS2
OD Frequency
Distance Bin - from (km)

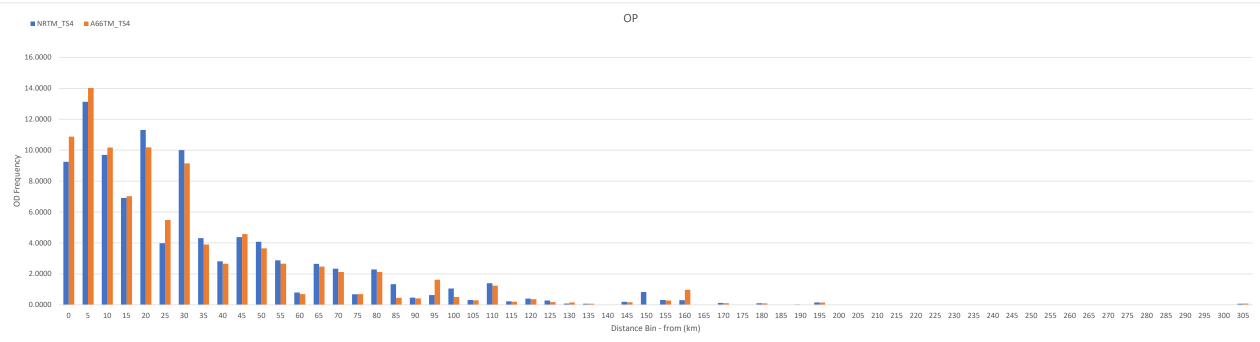

PM
NRTM_TS3
A66TM_TS3
OD Frequency
Distance Bin - from (km)


OP
NRTM_TS4
A66TM_TS4
OD Frequency
Distance Bin - from (km)

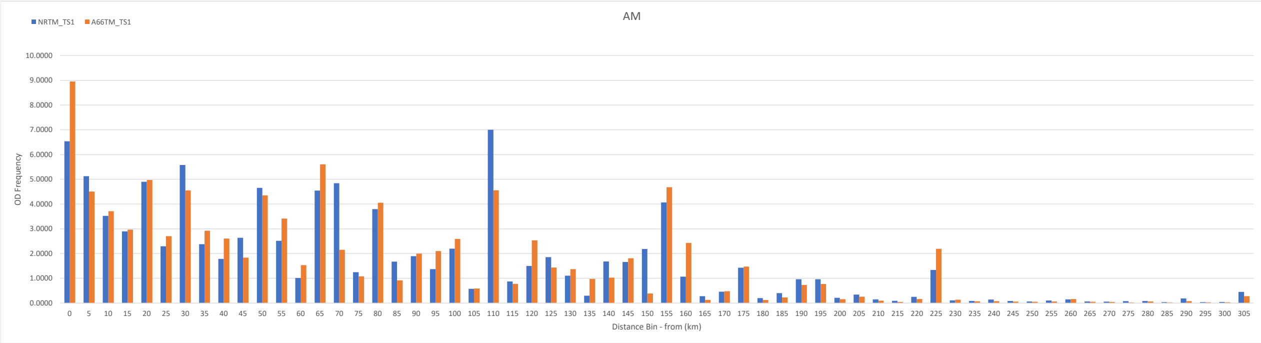

NRTM_TS1
A66TM_TS1
AM
OD Frequency
Distance Bin - from (km)

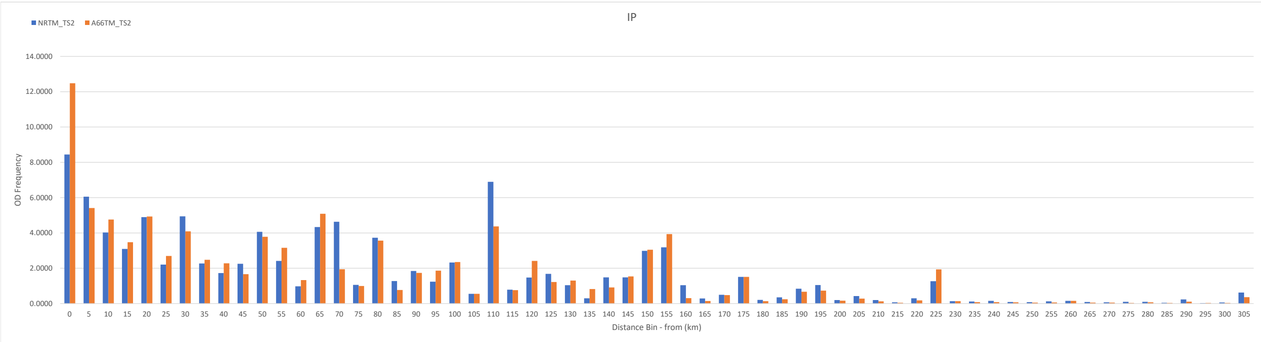

NRTM_TS2
A66TM_TS2
IP
OD Frequency
Distance Bin - from (km)

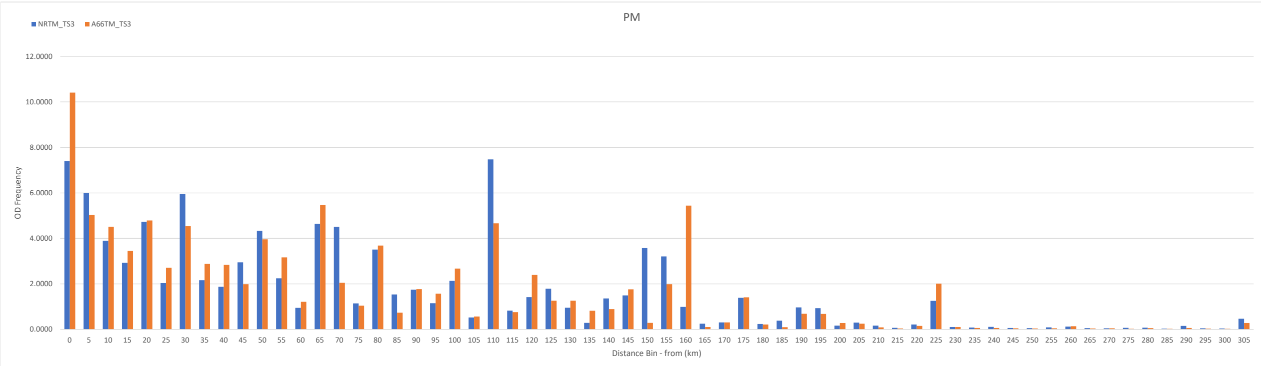

NRTM_TS3
A66TM_TS3
PM
OD Frequency
Distance Bin - from (km)

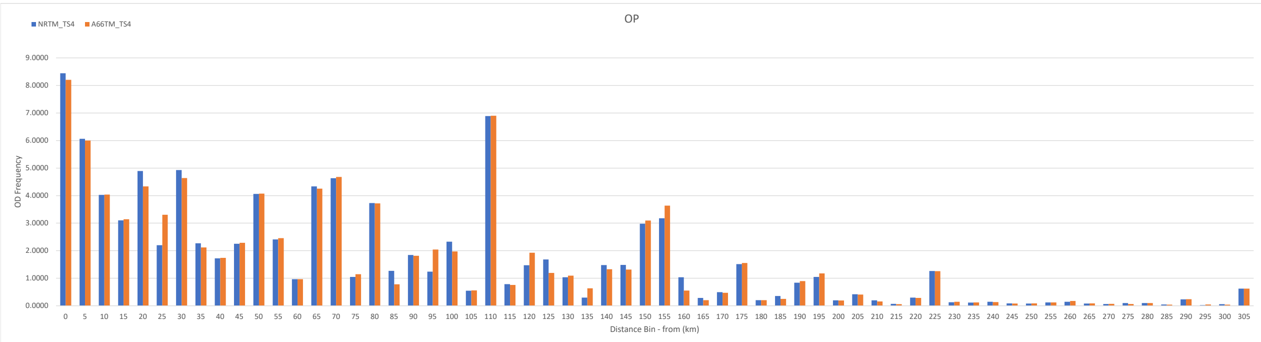

NRTM_TS4
A66TM_TS4
OP
OD Frequency
Distance Bin - from (km)

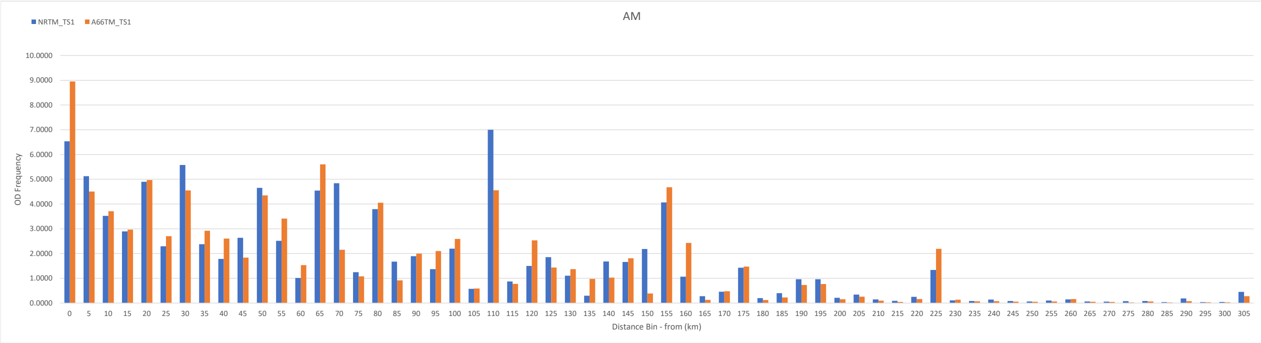
UC4

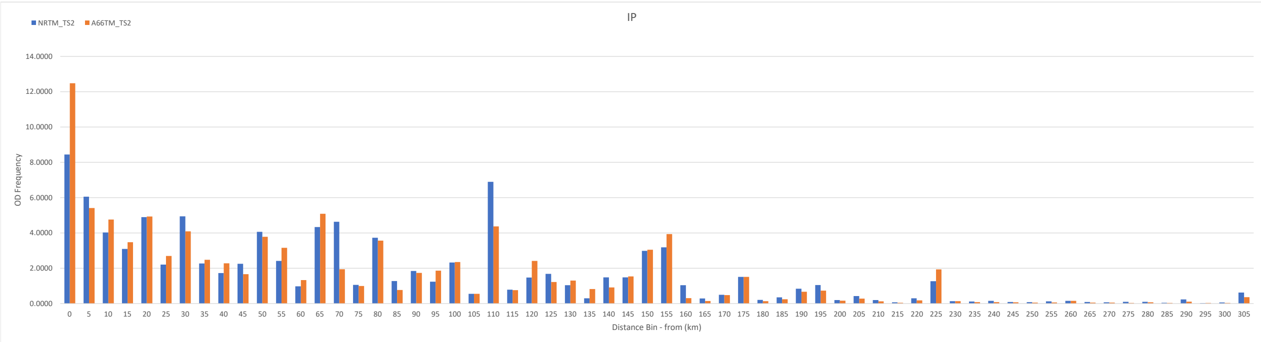

AM
NRTM_TS1
A66TM_TS1
OD Frequency
Distance Bin - from (km)

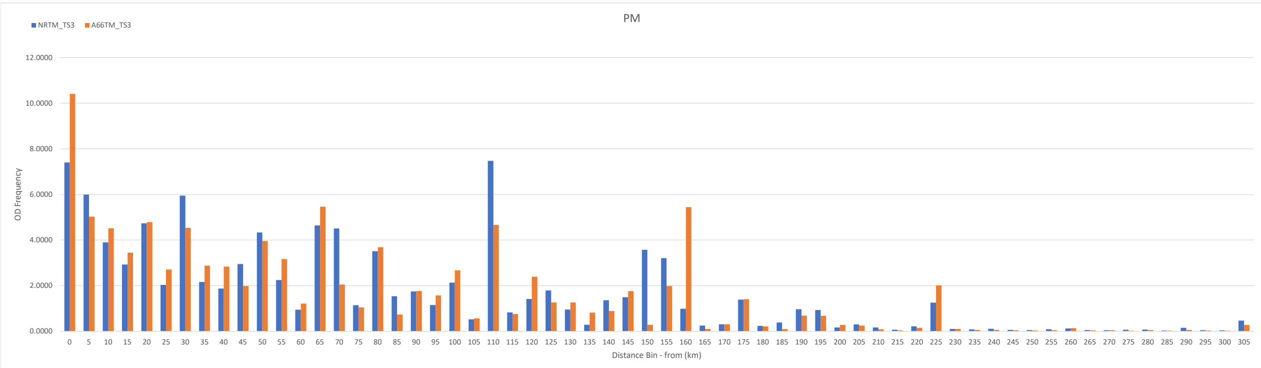

IP
NRTM_TS2
A66TM_TS2
OD Frequency
Distance Bin - from (km)

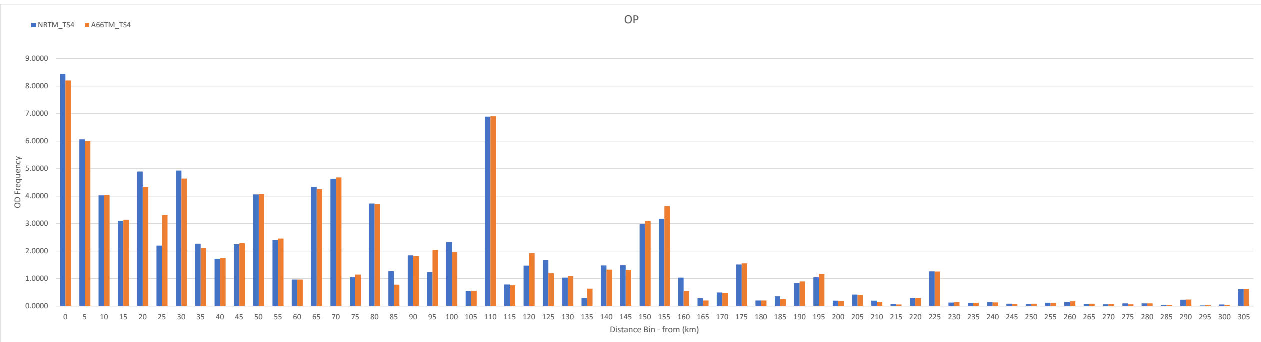

PM
NRTM_TS3
A66TM_TS3
OD Frequency
Distance Bin - from (km)


OP
NRTM_TS4
A66TM_TS4
OD Frequency
Distance Bin - from (km)


AM
NRTM_TS1
A66TM_TS1
OD Frequency
Distance Bin - from (km)


IP
NRTM_TS2
A66TM_TS2
OD Frequency
Distance Bin - from (km)


PM
NRTM_TS3
A66TM_TS3
OD Frequency
Distance Bin - from (km)


OP
NRTM_TS4
A66TM_TS4
OD Frequency
Distance Bin - from (km)

C Appendix C

C.1 Route Choice Plots

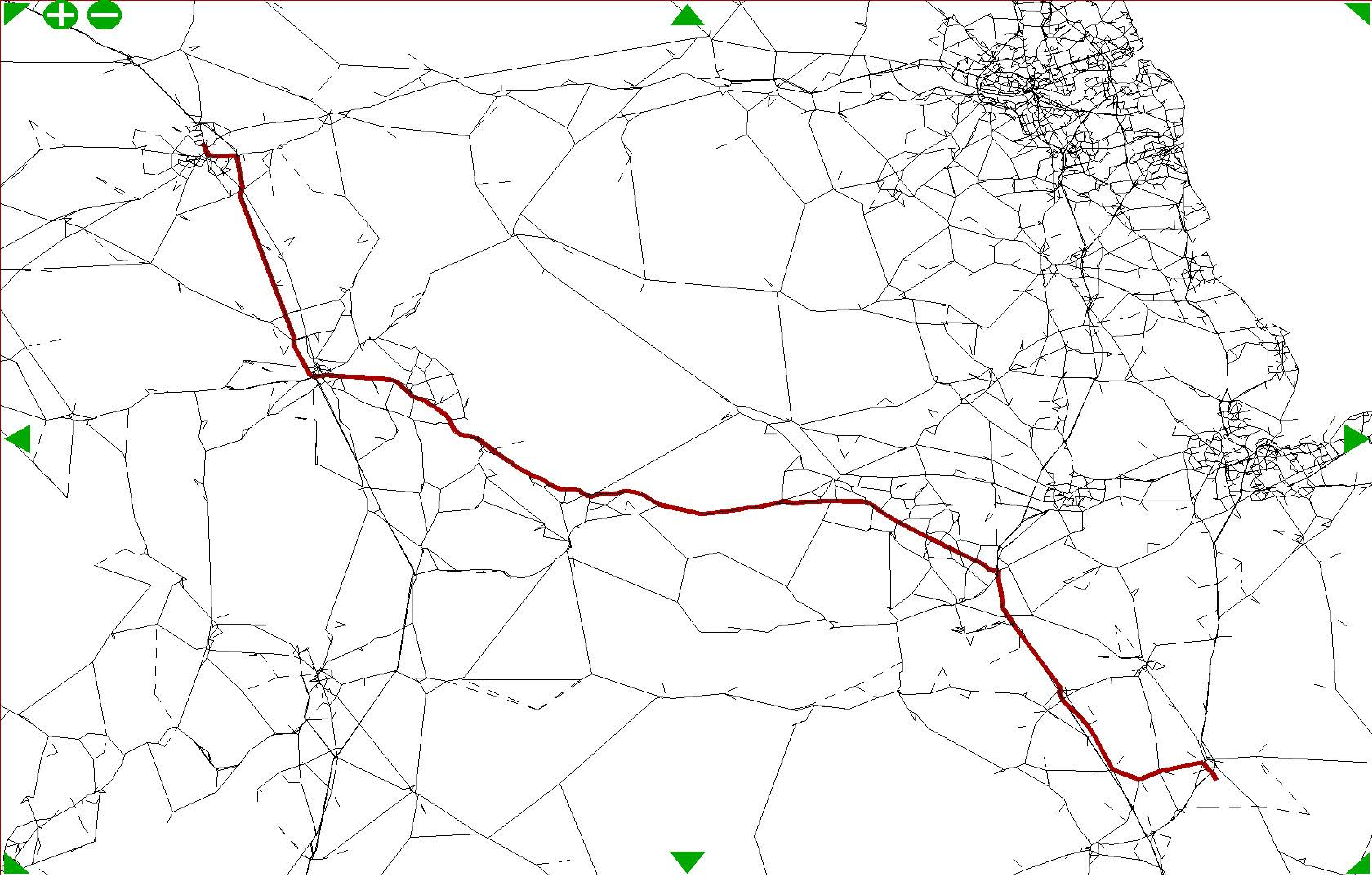
ARUP

Subject AM Route Choice Outputs

Date 04 March 2022 **Job No/Ref** 276821

1. Carlisle to Carnforth
2. Carlisle to Thirsk
3. Carlisle to Middlesbrough
4. Carlisle to Penrith
5. Carlisle to Newcastle upon Tyne
6. Carlisle to Durham


Tree for:
Origin 184
Dest. 201
User Cl. 1
Minimum
COST = 6163
Skimmed
Time = 3722
Delay= 195
Dist =100241
Speed= 96.95
FCost= 6163
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22



Tree for:

Origin 184
Dest. 305

User Cl. 1

Minimum
COST = 10530

Skimmed

Time = 6733
Delay= 485
Dist =155906
Speed= 83.36
FCost= 10530

Definitions:
See 11.8.2.1

T vrs D plot

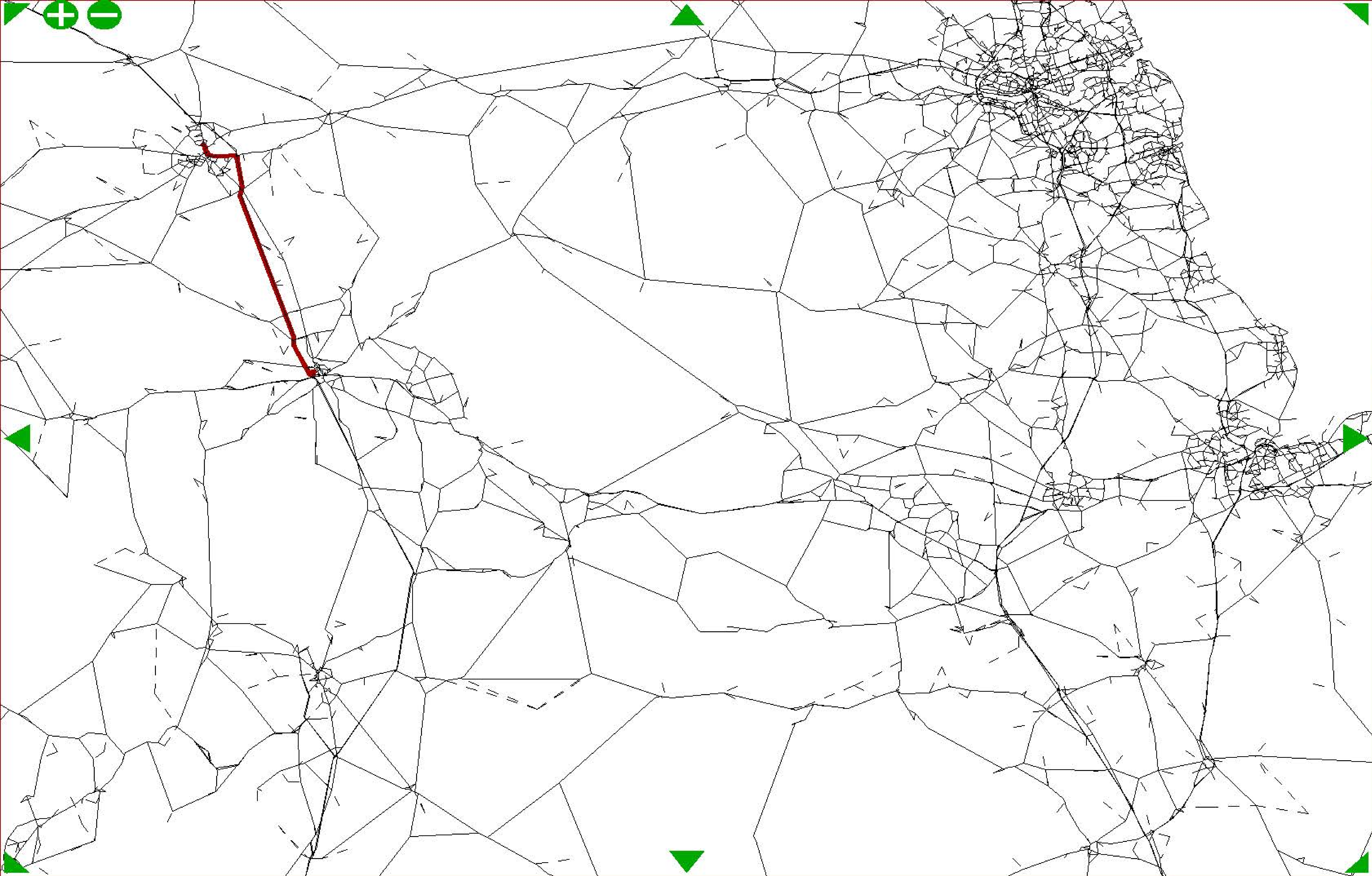
Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22


Tree for:
Origin 184
Dest. 1023
User Cl. 1
Minimum
COST = 10307
Skimmed
Time = 6581
Delay= 649
Dist =153003
Speed= 83.70
FCost= 10307
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22



Tree for:

Origin 184
Dest. 1088

User Cl. 1

Minimum
COST = 2471

Skimmed

Time = 1633
Delay= 173
Dist. = 34407
Speed= 75.86
FCost= 2471

Definitions:
See 11.8.2.1

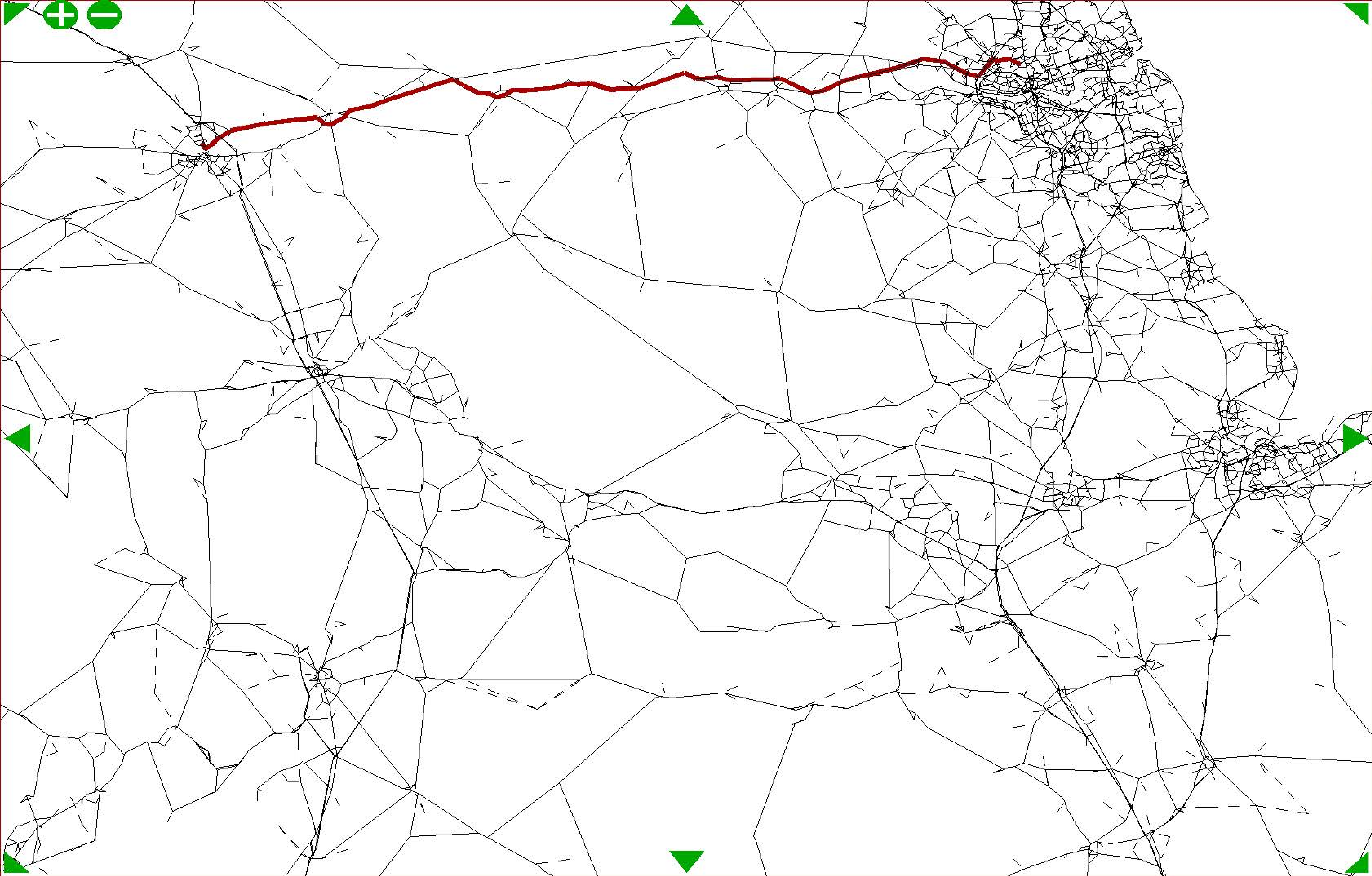
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22



Tree for:

Origin 184
Dest. 1274

User Cl. 1

Minimum
COST = 6800

Skimmed

Time = 4494
Delay= 453
Dist. = 94662
Speed= 75.83
FCost= 6800

Definitions:
See 11.8.2.1

T vrs D plot

Q - Return

+ Menu bar!

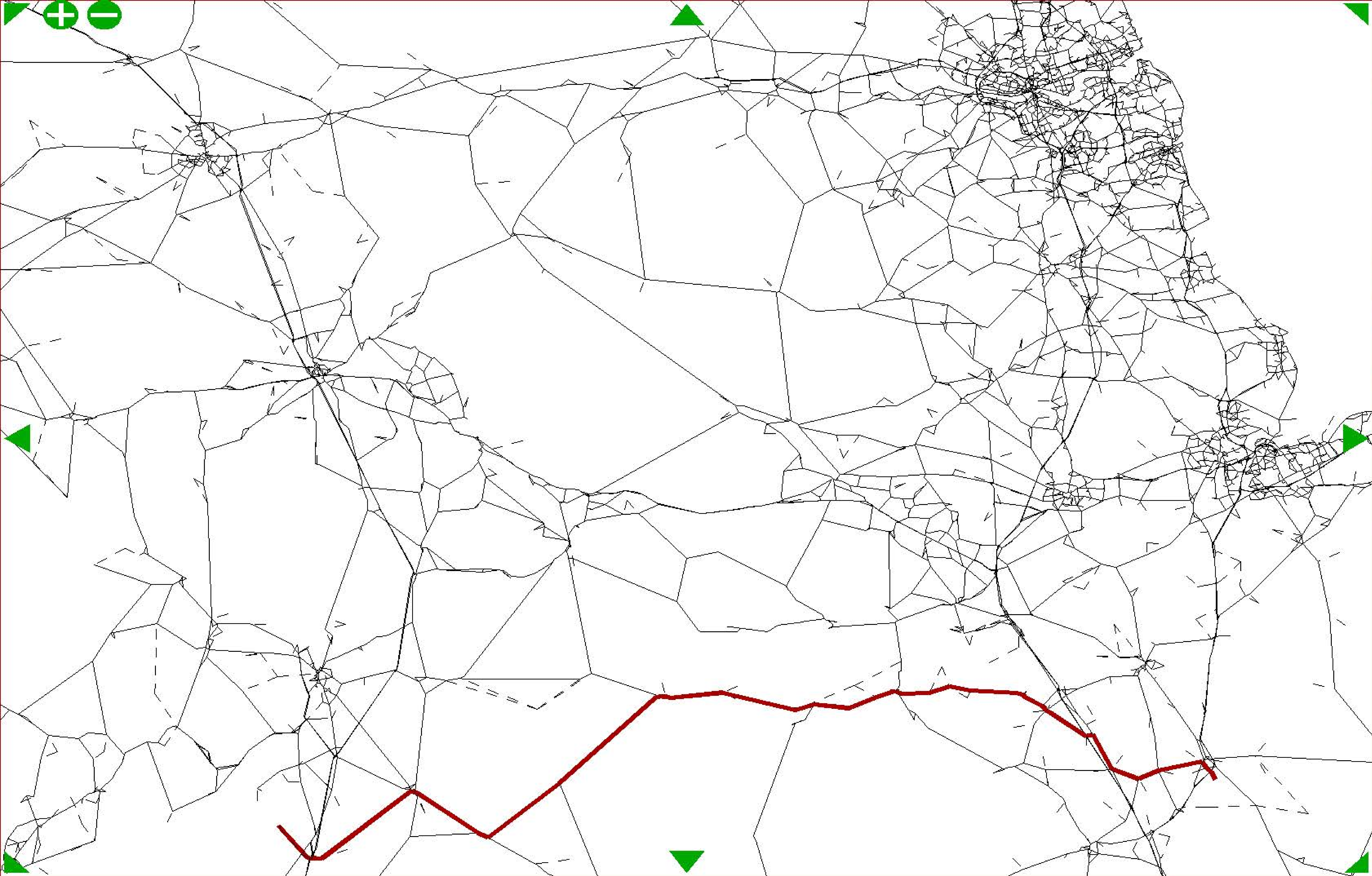
See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22


Tree for:
Origin 184
Dest. 1388
User Cl. 1
Minimum
COST = 8271
Skimmed
Time = 5333
Delay= 616
Dist =120630
Speed= 81.43
FCost= 8271
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22

1. Carnforth to Carlisle
2. Carnforth to Thirsk
3. Carnforth to Middlesbrough
4. Carnforth to Penrith
5. Carnforth to Newcastle upon Tyne
6. Carnforth to Durham

Tree for:
Origin 201
Dest. 184
User Cl. 1
Minimum
COST = 6109
Skimmed
Time = 3573
Delay= 50
Dist =104165
Speed=104.96
FCost= 6109
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22



Tree for:

Origin 201
Dest. 305

User Cl. 1

Minimum
COST = 9819

Skimmed

Time = 6852
Delay= 91
Dist =121828
Speed= 64.01
FCost= 9819

Definitions:
See 11.8.2.1

T vrs D plot

Q - Return

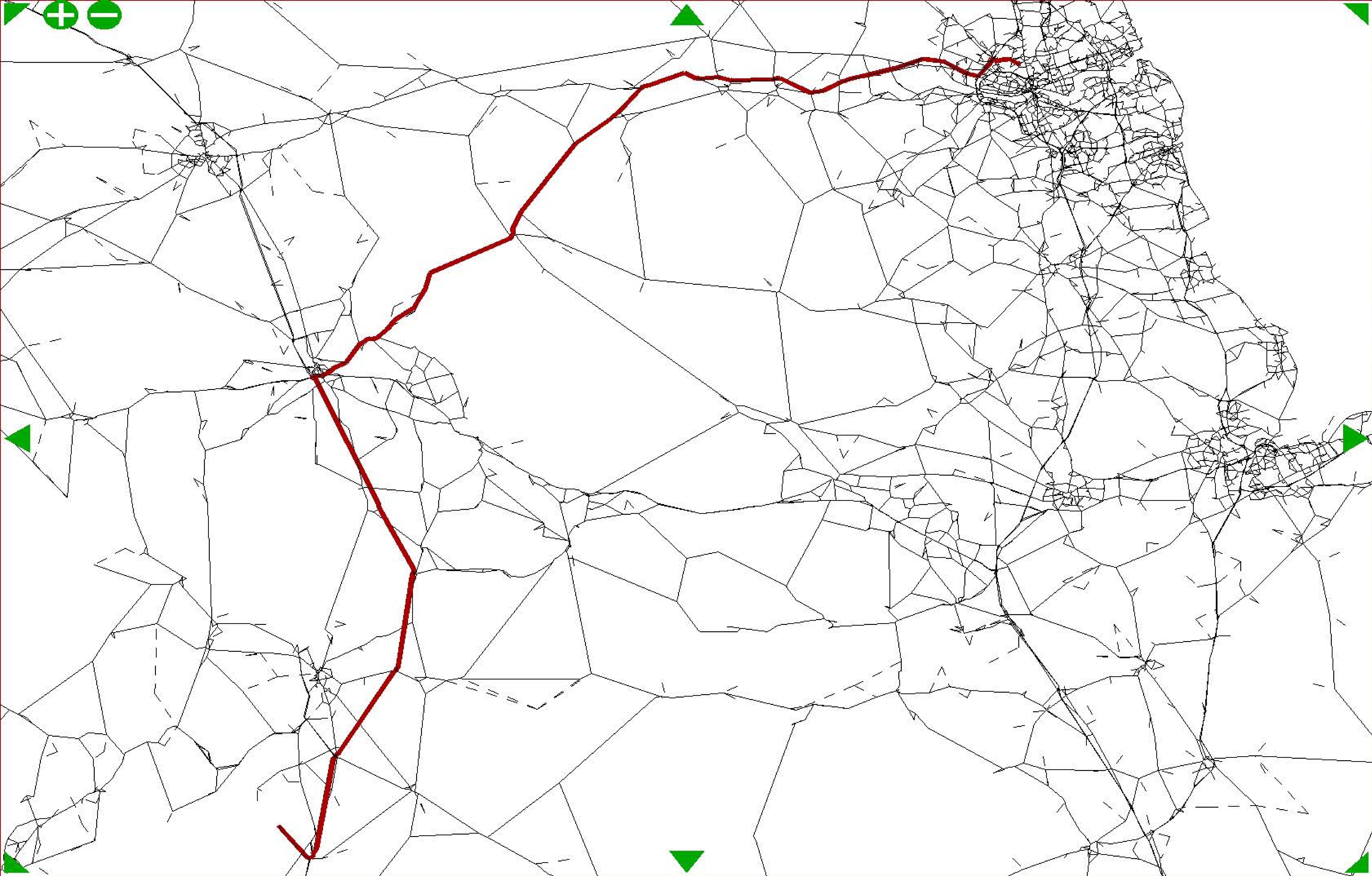
+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22


Tree for:
Origin 201
Dest. 1023
User Cl. 1
Minimum
COST = 9848
Skimmed
Time = 6175
Delay= 368
Dist =150817
Speed= 87.93
FCost= 9848
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22

A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22



Tree for:

Origin 201
Dest. 1274

User Cl. 1

Minimum
COST = 11880

Skimmed

Time = 7710
Delay= 352
Dist =171238
Speed= 79.96
FCost= 11880

Definitions:
See 11.8.2.1

T vrs D plot

Q - Return

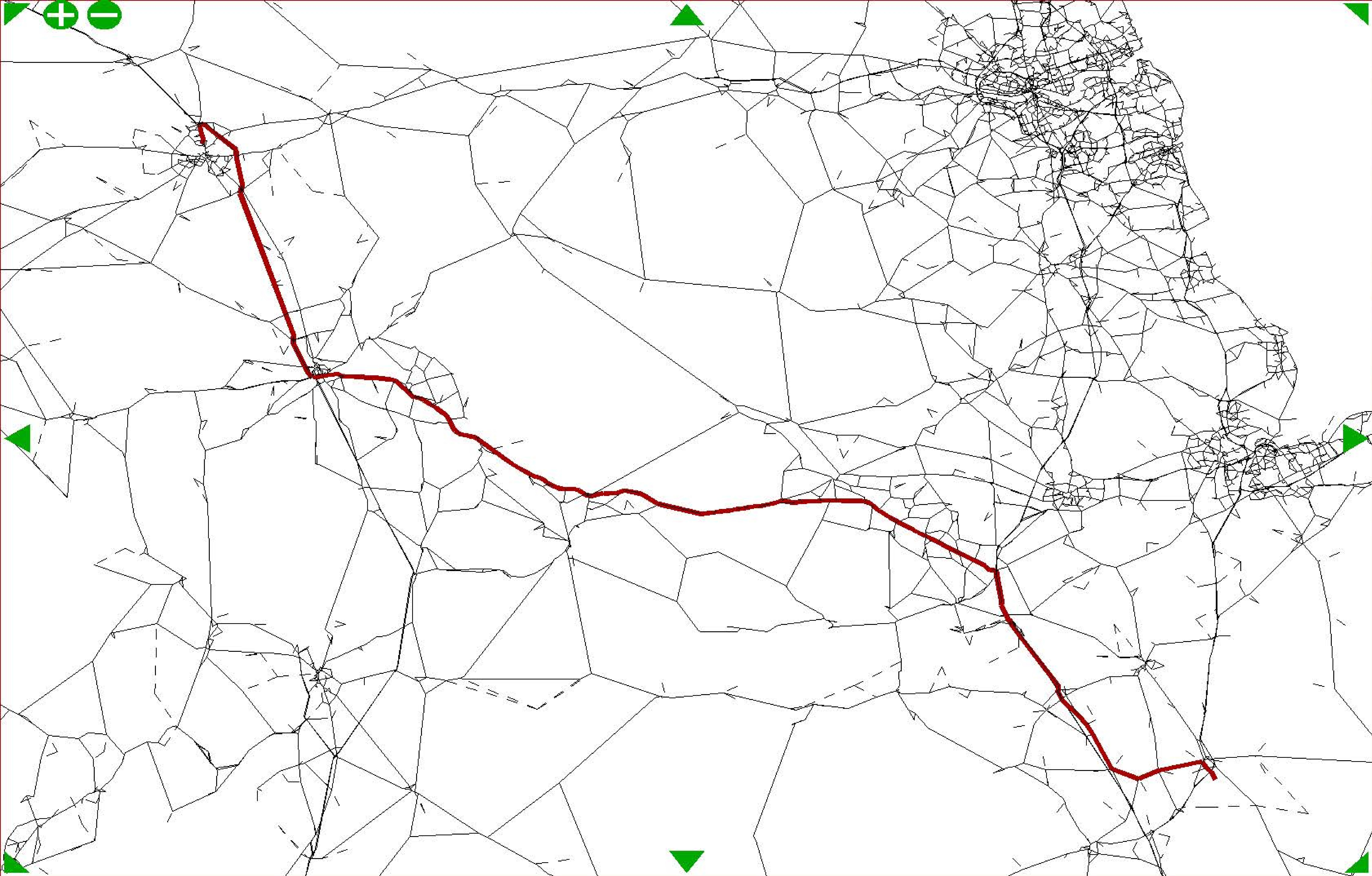
+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22


Tree for:
Origin 201
Dest. 1388
User Cl. 1
Minimum
COST = 9652
Skimmed
Time = 6406
Delay= 443
Dist.=133274
Speed= 74.90
FCost= 9652
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22

1. Thirsk to Carlisle
2. Thirsk to Carnforth
3. Thirsk to Middlesbrough
4. Thirsk to Penrith
5. Thirsk to Newcastle upon Tyne
6. Thirsk to Durham



Tree for:

Origin 305
Dest. 184

User Cl. 1

Minimum
COST = 10518

Skimmed

Time = 6627
Delay= 379
Dist =159796
Speed= 86.81
FCost= 10518

Definitions:
See 11.8.2.1

T vrs D plot

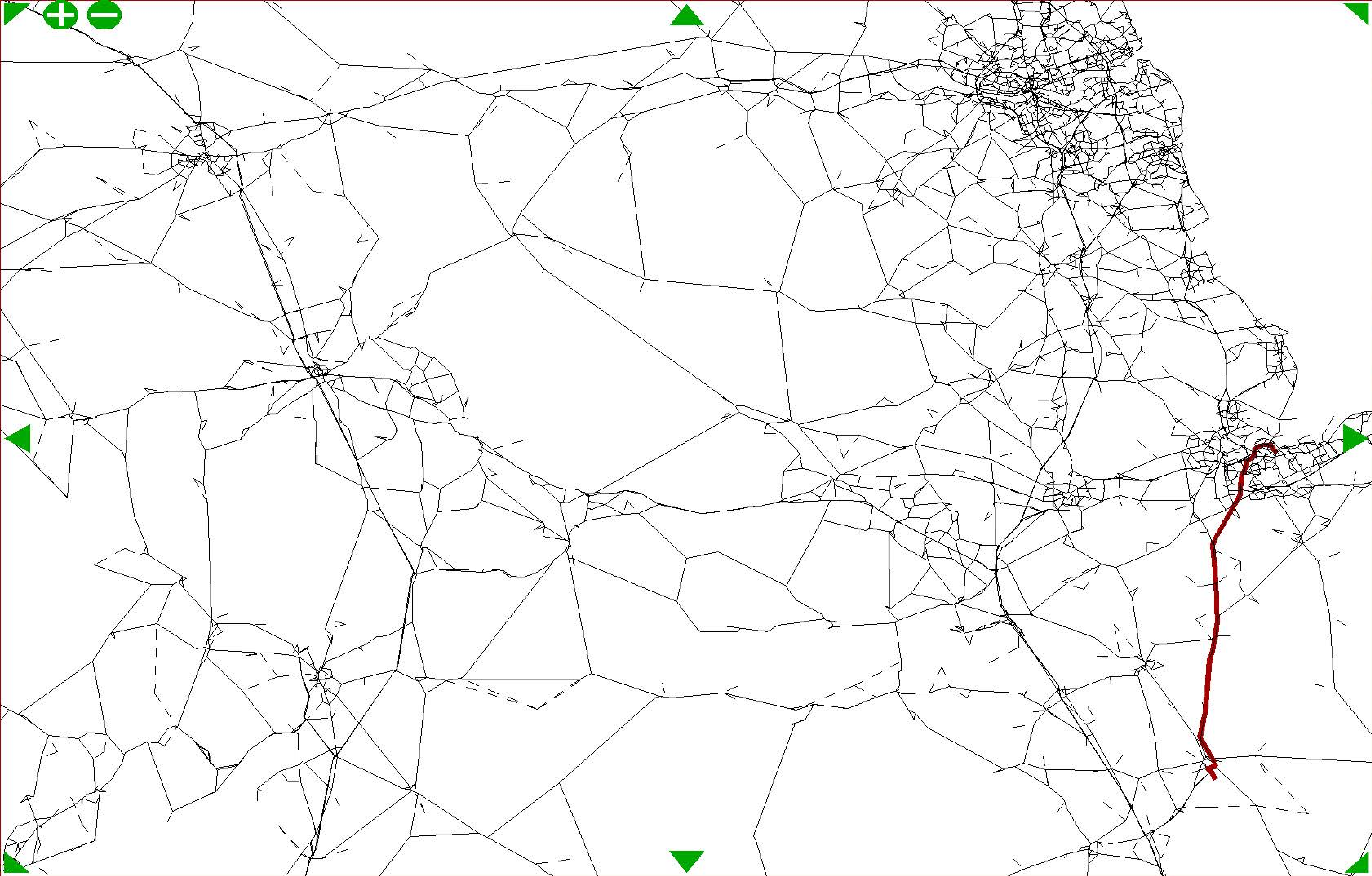
Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22

A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22



Tree for:

Origin 305
Dest. 1023

User Cl. 1

Minimum
COST = 3045

Skimmed

Time = 1914
Delay= 141
Dist = 46401
Speed= 87.25
FCost= 3045

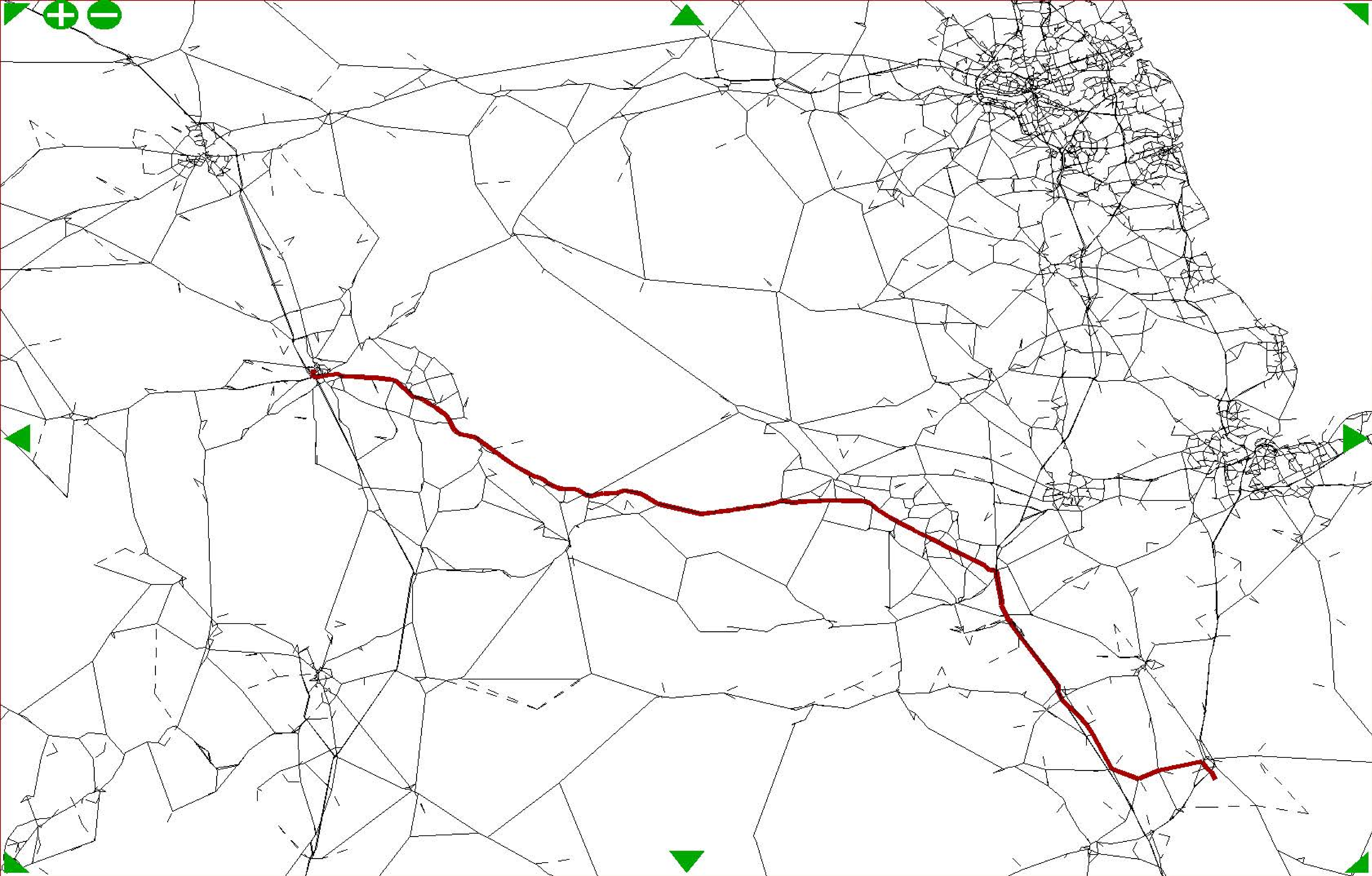
Definitions:
See 11.8.2.1

T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3



Tree for:

Origin 305
Dest. 1088

User Cl. 1

Minimum
COST = 8361

Skimmed

Time = 5357
Delay= 371
Dist =123369
Speed= 82.91
FCost= 8361

Definitions:
See 11.8.2.1

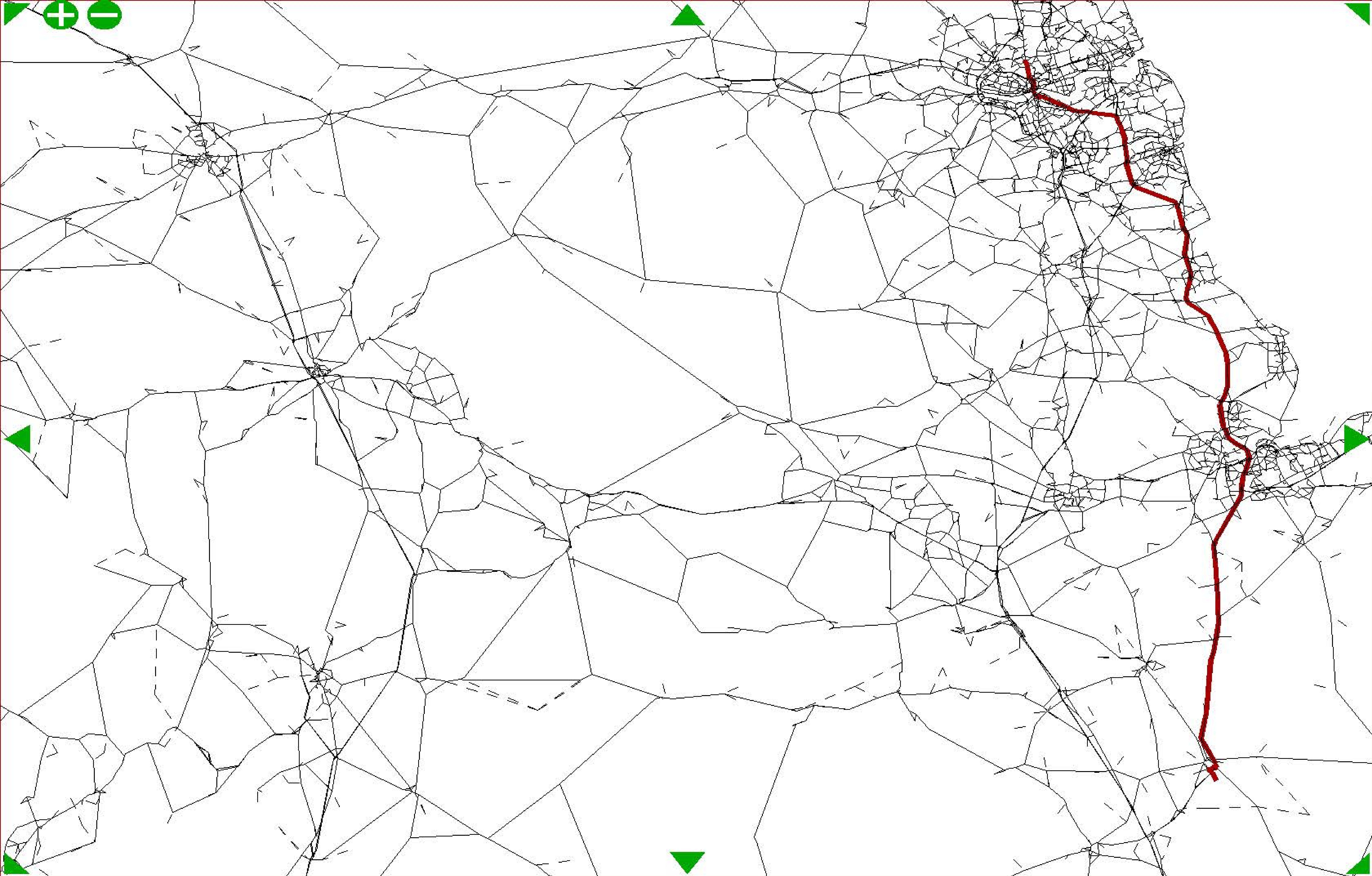
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22



Tree for:

Origin 305
Dest. 1274

User Cl. 1

Minimum
COST = 7234

Skimmed

Time = 4679
Delay= 768
Dist =104902
Speed= 80.71
FCost= 7234

Definitions:
See 11.8.2.1

T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

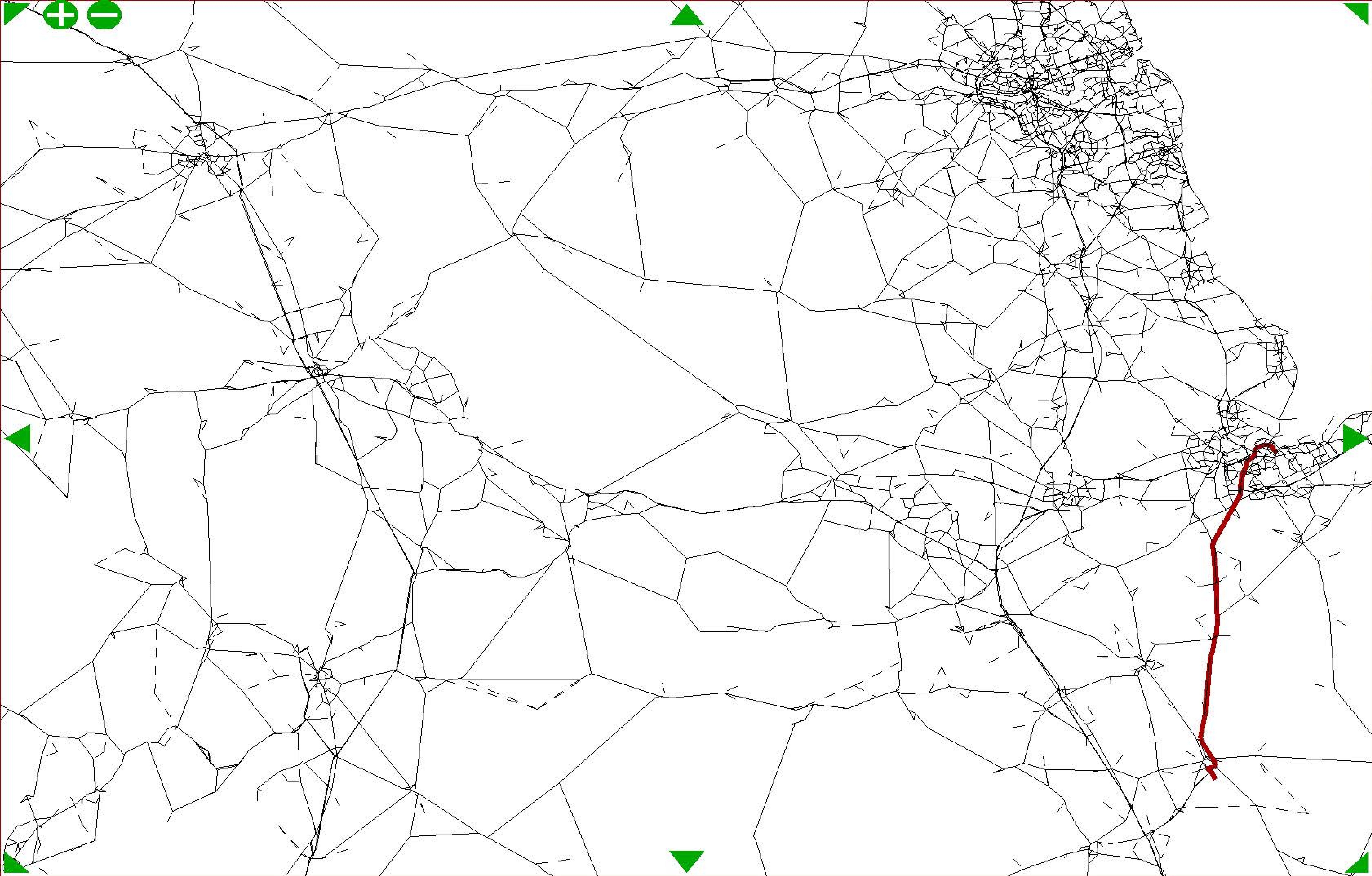
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22


Tree for:
Origin 305
Dest. 1388
User Cl. 1
Minimum
COST = 5456
Skimmed
Time = 3504
Delay= 358
Dist = 80142
Speed= 82.33
FCost= 5456
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22

1. Middlesbrough to Carlisle
2. Middlesbrough to Carnforth
3. Middlesbrough to Thirsk
4. Middlesbrough to Penrith
5. Middlesbrough to Newcastle upon Tyne
6. Middlesbrough to Durham


Tree for:
Origin 1023
Dest. 184
User Cl. 1
Minimum
COST = 10298
Skimmed
Time = 6473
Delay= 574
Dist =157066
Speed= 87.35
FCost= 10298
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22


Tree for:
Origin 1023
Dest. 201
User Cl. 1
Minimum
COST = 9781
Skimmed
Time = 6127
Delay= 413
Dist =150018
Speed= 88.14
FCost= 9781
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22



Tree for:

Origin 1023
Dest. 305

User Cl. 1

Minimum
COST = 2973

Skimmed

Time = 1854
Delay= 138
Dist = 45962
Speed= 89.25
FCost= 2973

Definitions:
See 11.8.2.1

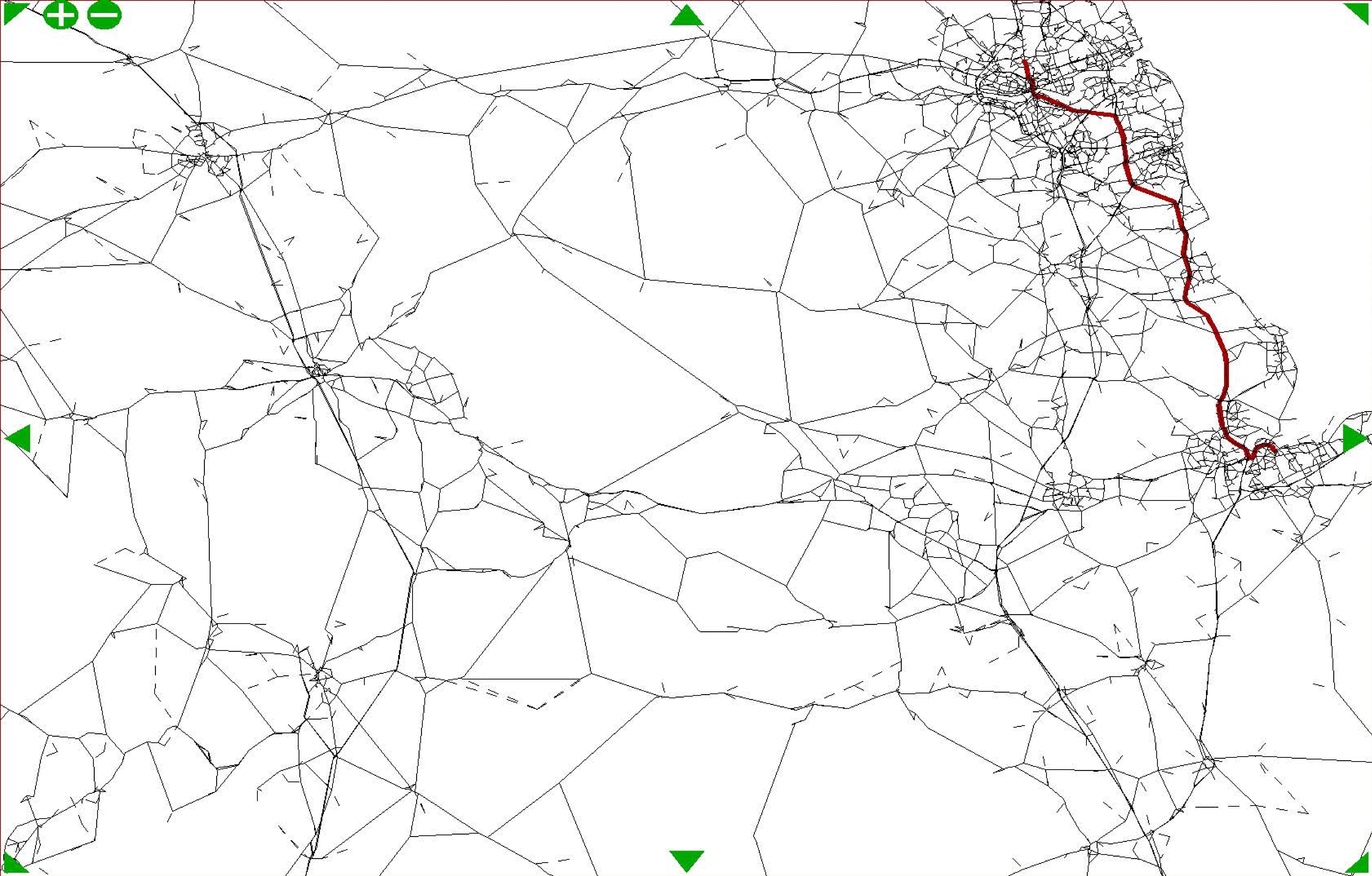
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3


Tree for:
Origin 1023
Dest. 1088
User Cl. 1
Minimum
COST = 8141
Skimmed
Time = 5203
Delay= 566
Dist =120639
Speed= 83.46
FCost= 8141
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22



Tree for:

Origin 1023
Dest. 1274

User Cl. 1

Minimum
COST = 4992

Skimmed

Time = 3357
Delay= 709
Dist = 67163
Speed= 72.03
FCost= 4992

Definitions:
See 11.8.2.1

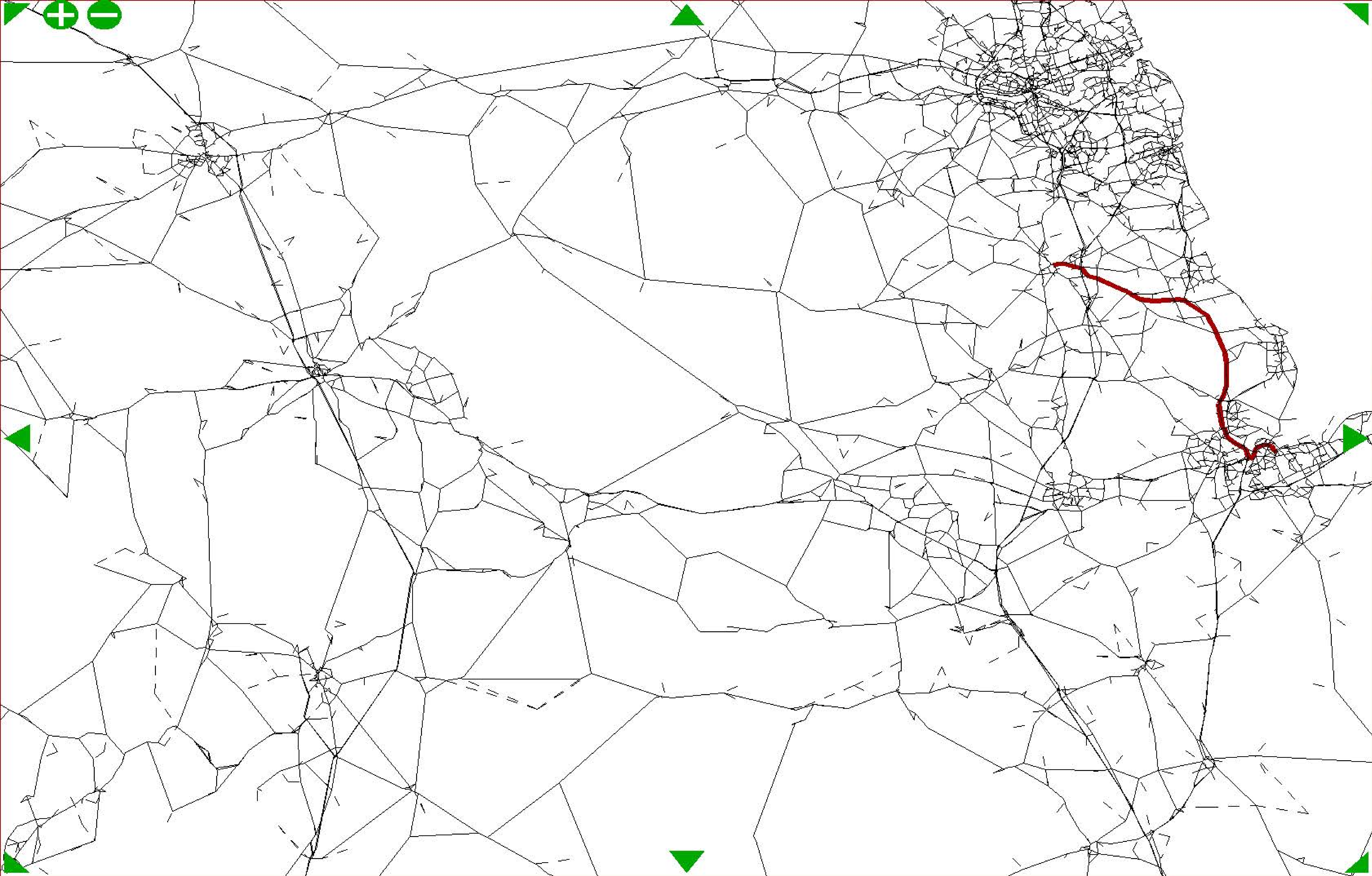
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22



Tree for:

Origin 1023
Dest. 1388

User Cl. 1

Minimum
COST = 3215

Skimmed

Time = 2182
Delay= 298
Dist = 42403
Speed= 69.95
FCost= 3215

Definitions:
See 11.8.2.1

T vrs D plot

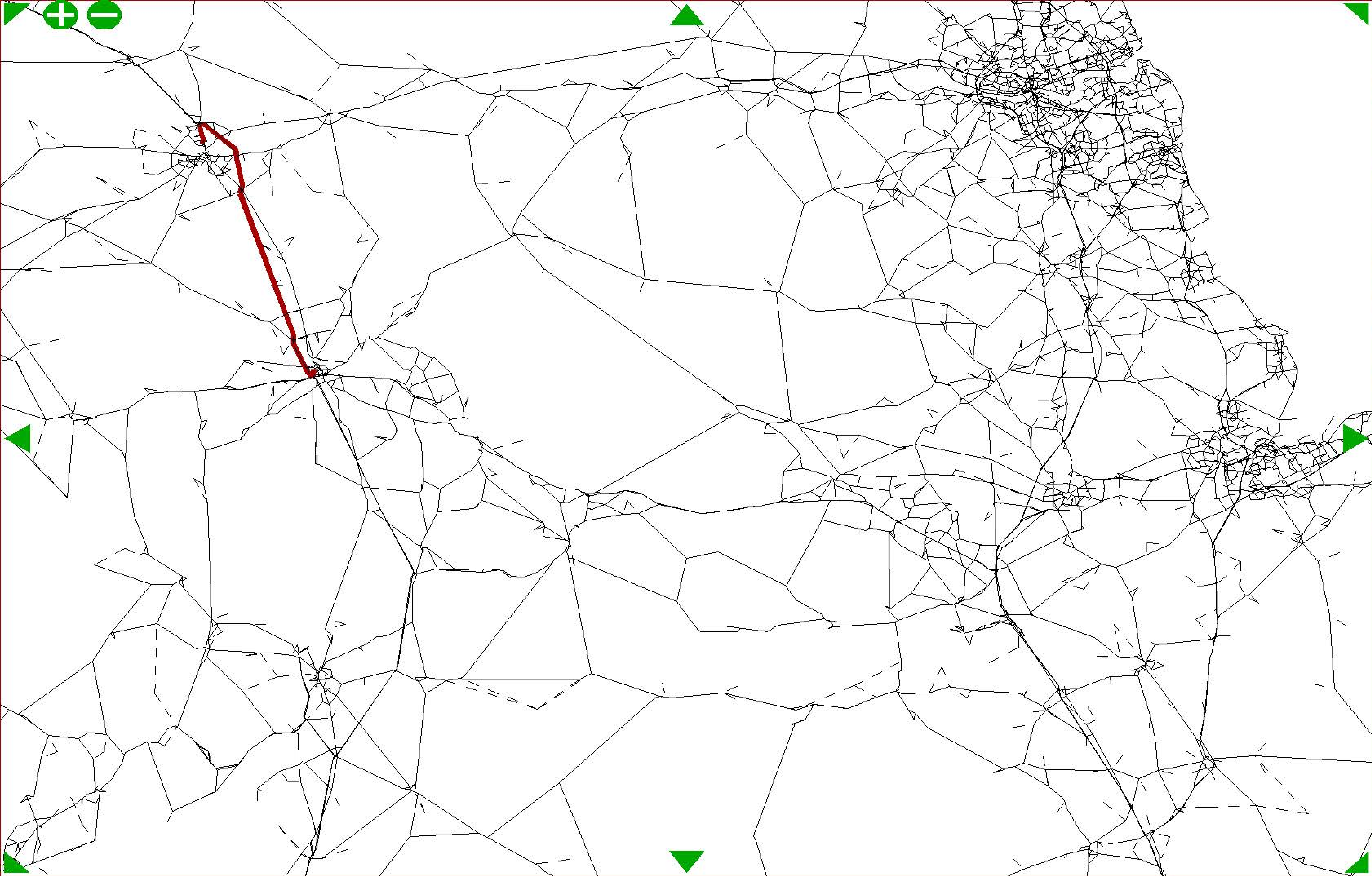
Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22

1. Penrith to Carlisle
2. Penrith to Carnforth
3. Penrith to Thirsk
4. Penrith to Middlesbrough
5. Penrith to Newcastle upon Tyne
6. Penrith to Durham



Tree for:

Origin 1088
Dest. 184

User Cl. 1

Minimum
COST = 2453

Skimmed

Time = 1514
Delay= 33
Dist = 38560
Speed= 91.67
FCost= 2453

Definitions:
See 11.8.2.1

T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22


Tree for:
Origin 1088
Dest. 201
User Cl. 1
Minimum
COST = 3951
Skimmed
Time = 2308
Delay= 44
Dist = 67439
Speed=105.17
FCost= 3951
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22

Tree for:
Origin 1088
Dest. 305
User Cl. 1
Minimum
COST = 8268
Skimmed
Time = 5272
Delay= 319
Dist =123018
Speed= 84.01
FCost= 8268
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22


Tree for:
Origin 1088
Dest. 1023
User Cl. 1
Minimum
COST = 8045
Skimmed
Time = 5120
Delay= 482
Dist =120115
Speed= 84.46
FCost= 8045
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22


Tree for:
Origin 1088
Dest. 1274
User Cl. 1
Minimum
COST = 8076
Skimmed
Time = 5519
Delay= 290
Dist =104981
Speed= 68.48
FCost= 8076
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22


Tree for:
Origin 1088
Dest. 1388
User Cl. 1
Minimum
COST = 7849
Skimmed
Time = 5351
Delay= 557
Dist =102572
Speed= 69.01
FCost= 7849
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22

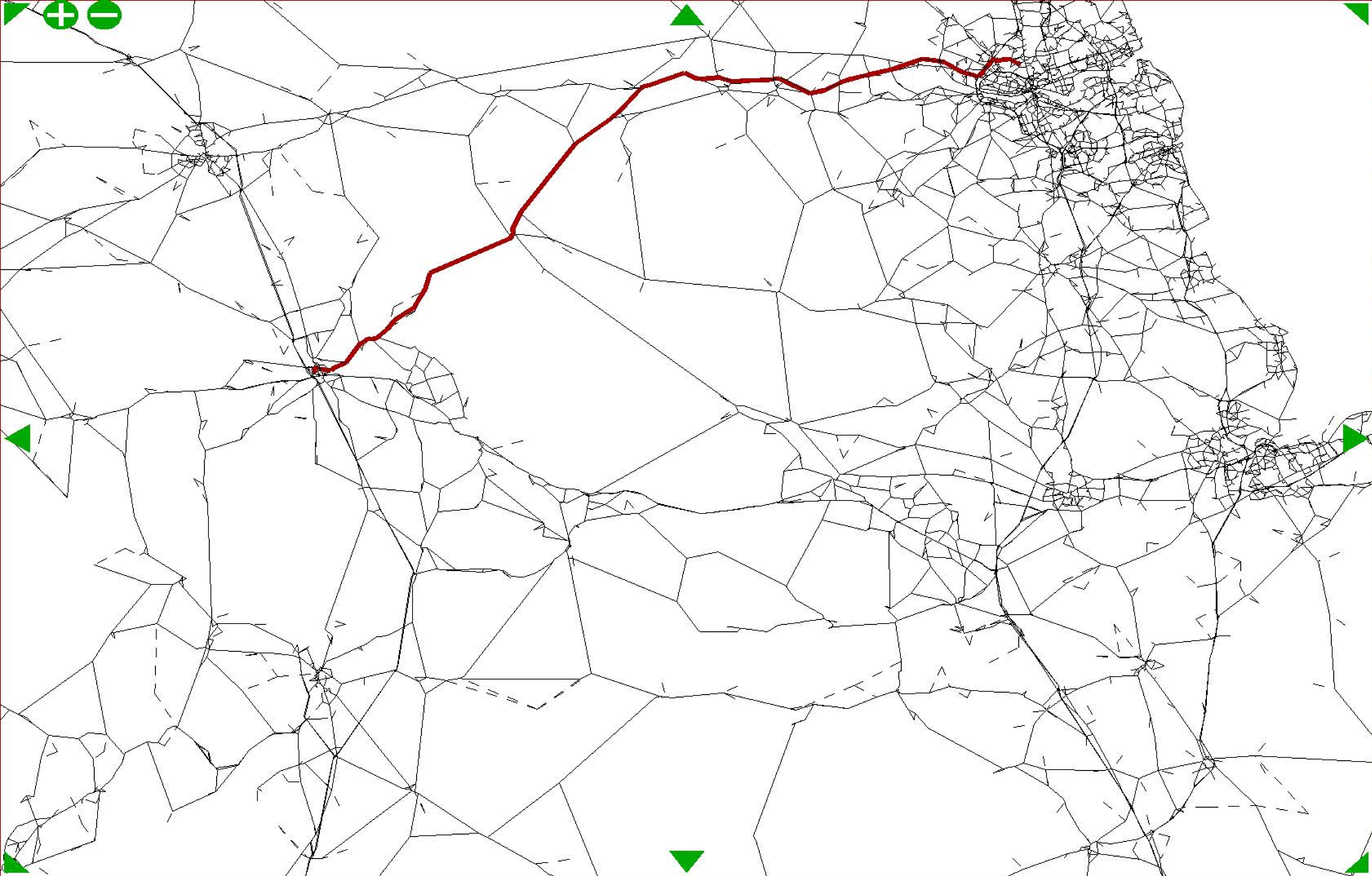
1. Newcastle upon Tyne to Carlisle
2. Newcastle upon Tyne to Carnforth
3. Newcastle upon Tyne to Thirsk
4. Newcastle upon Tyne to Middlesbrough
5. Newcastle upon Tyne to Penrith
6. Newcastle upon Tyne to Durham


Tree for:
Origin 1274
Dest. 184
User Cl. 1
Minimum
COST = 6811
Skimmed
Time = 4482
Delay= 377
Dist = 95623
Speed= 76.80
FCost= 6811
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22


Tree for:
Origin 1274
Dest. 201
User Cl. 1
Minimum
COST = 11727
Skimmed
Time = 7587
Delay= 270
Dist =170029
Speed= 80.68
FCost= 11727
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22


Tree for:
Origin 1274
Dest. 305
User Cl. 1
Minimum
COST = 7227
Skimmed
Time = 4682
Delay= 770
Dist =104483
Speed= 80.33
FCost= 7227
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22


Tree for:
Origin 1274
Dest. 1023
User Cl. 1
Minimum
COST = 4989
Skimmed
Time = 3368
Delay= 687
Dist = 66566
Speed= 71.15
FCost= 4989
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22



Tree for:

Origin 1274
Dest. 1088

User Cl. 1

Minimum
COST = 7972

Skimmed

Time = 5451
Delay= 220
Dist =103544
Speed= 68.39
FCost= 7972

Definitions:
See 11.8.2.1

T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

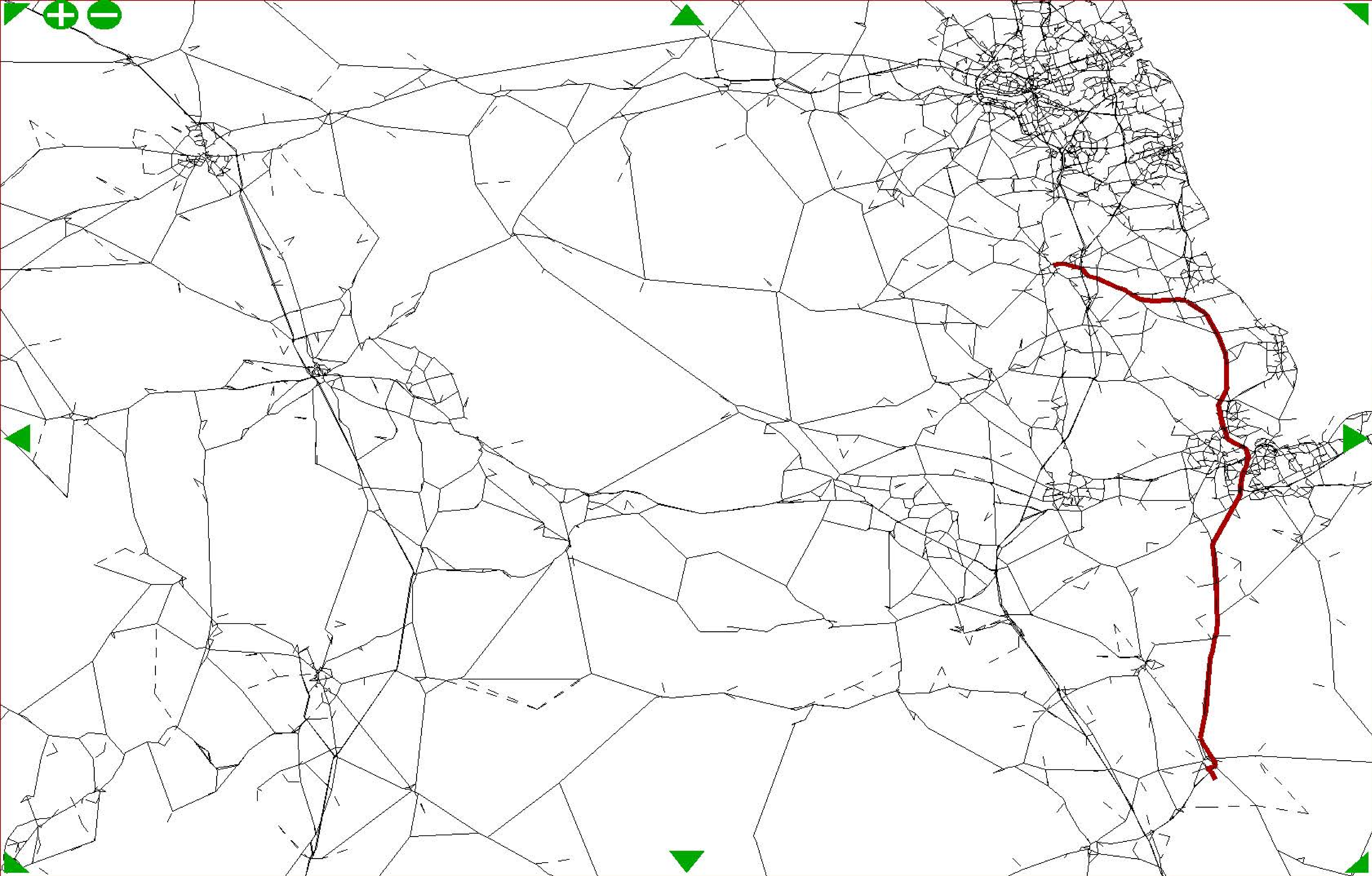
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22


Tree for:
Origin 1274
Dest. 1388
User Cl. 1
Minimum
COST = 2634
Skimmed
Time = 1836
Delay= 348
Dist = 32770
Speed= 64.25
FCost= 2634
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22

1. Durham to Carlisle
2. Durham to Carnforth
3. Durham to Thirsk
4. Durham to Middlesbrough
5. Durham to Penrith
6. Durham to Newcastle upon Tyne


Tree for:
Origin 1388
Dest. 184
User Cl. 1
Minimum
COST = 8307
Skimmed
Time = 5659
Delay= 474
Dist =108729
Speed= 69.17
FCost= 8307
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22


Tree for:
Origin 1388
Dest. 201
User Cl. 1
Minimum
COST = 9593
Skimmed
Time = 6367
Delay= 446
Dist =132466
Speed= 74.90
FCost= 9593
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22



Tree for:

Origin 1388
Dest. 305

User Cl. 1

Minimum
COST = 5445

Skimmed

Time = 3495
Delay= 369
Dist = 80075
Speed= 82.47
FCost= 5445

Definitions:
See 11.8.2.1

T vrs D plot

Q - Return

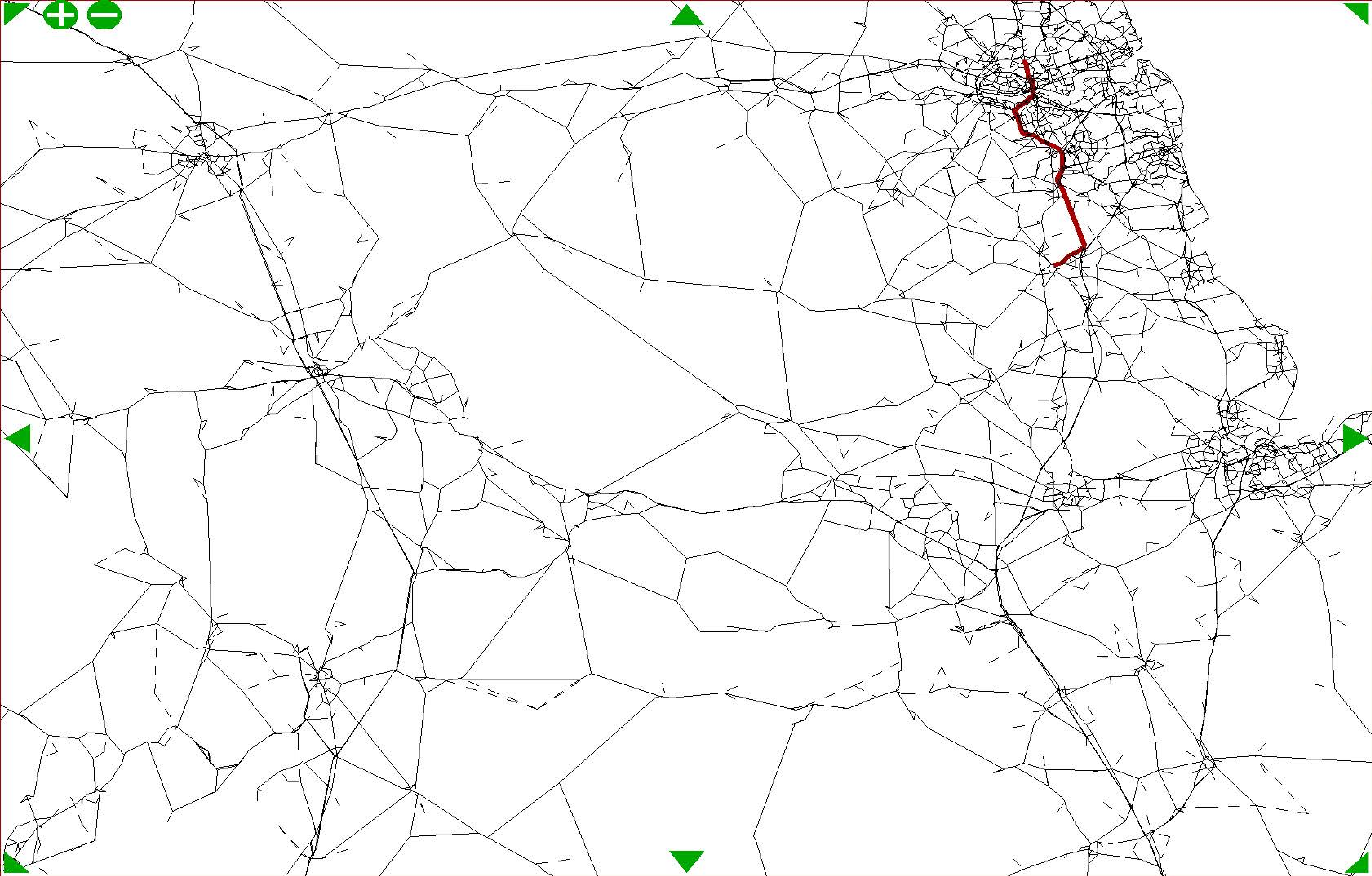
\+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22


Tree for:
Origin 1388
Dest. 1023
User Cl. 1
Minimum
COST = 3208
Skimmed
Time = 2181
Delay= 286
Dist = 42158
Speed= 69.59
FCost= 3208
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22


Tree for:
Origin 1388
Dest. 1088
User Cl. 1
Minimum
COST = 7954
Skimmed
Time = 5443
Delay= 599
Dist =103087
Speed= 68.18
FCost= 7954
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22



Tree for:

Origin 1388
Dest. 1274

User Cl. 1

Minimum
COST = 2678

Skimmed

Time = 1884
Delay= 389
Dist = 32603
Speed= 62.31
FCost= 2678

Definitions:
See 11.8.2.1

T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

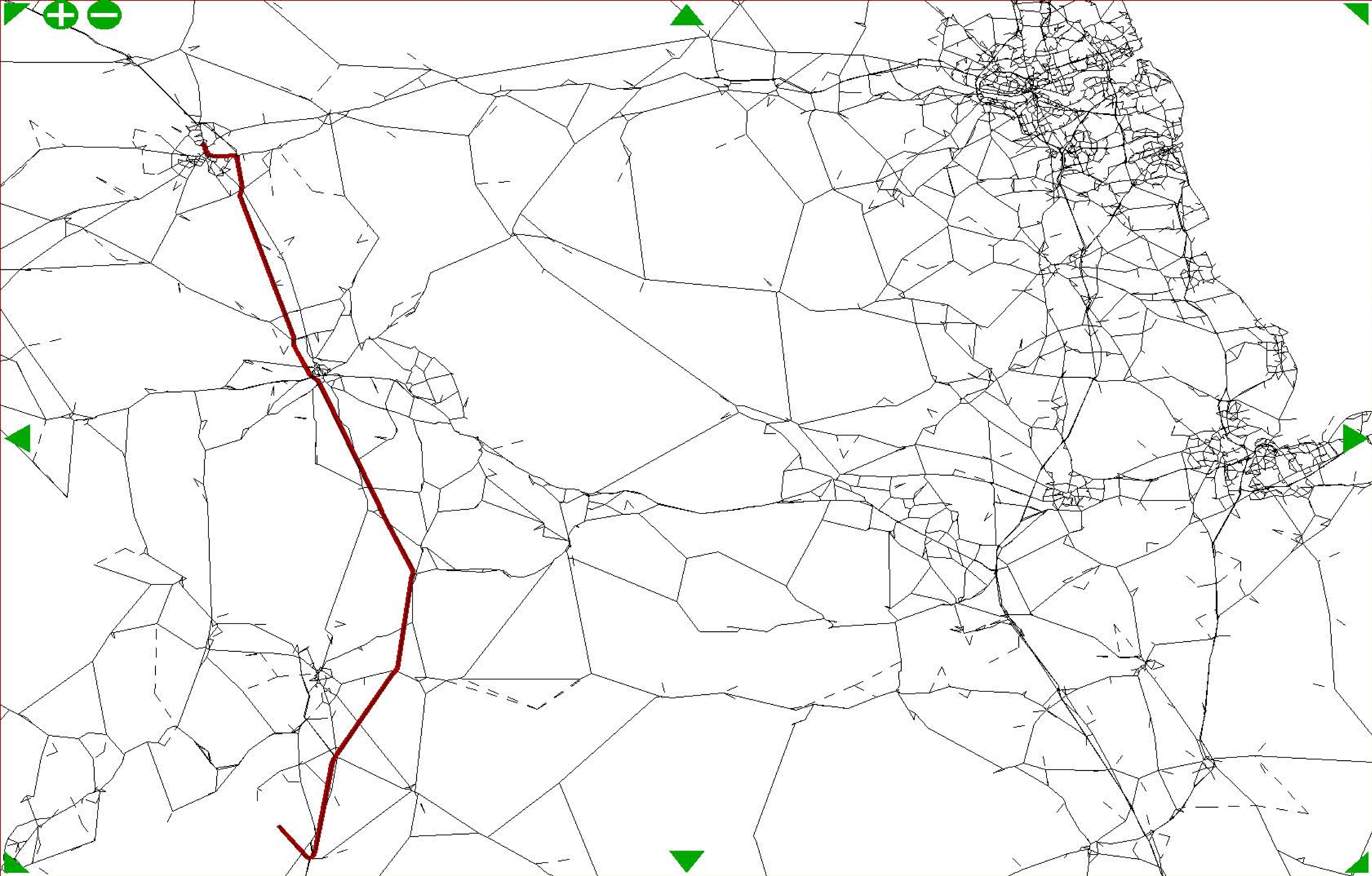
A66 Traffic Model: Stage 3 Base Year 2019 - AM Peak 4- 3-22

ARUP

Subject IP Route Choice Outputs

Date 04 March 2022 **Job No/Ref** 276821

1. Carlisle to Carnforth
2. Carlisle to Thirsk
3. Carlisle to Middlesbrough
4. Carlisle to Penrith
5. Carlisle to Newcastle upon Tyne
6. Carlisle to Durham



Tree for:

Origin 184
Dest. 201

User Cl. 1

Minimum
COST = 6099

Skimmed

Time = 3716
Delay= 187
Dist =100241
Speed= 97.10
FCost= 6099

Definitions:
See 11.8.2.1

T vrs D plot

Q - Return

+ Menu bar!

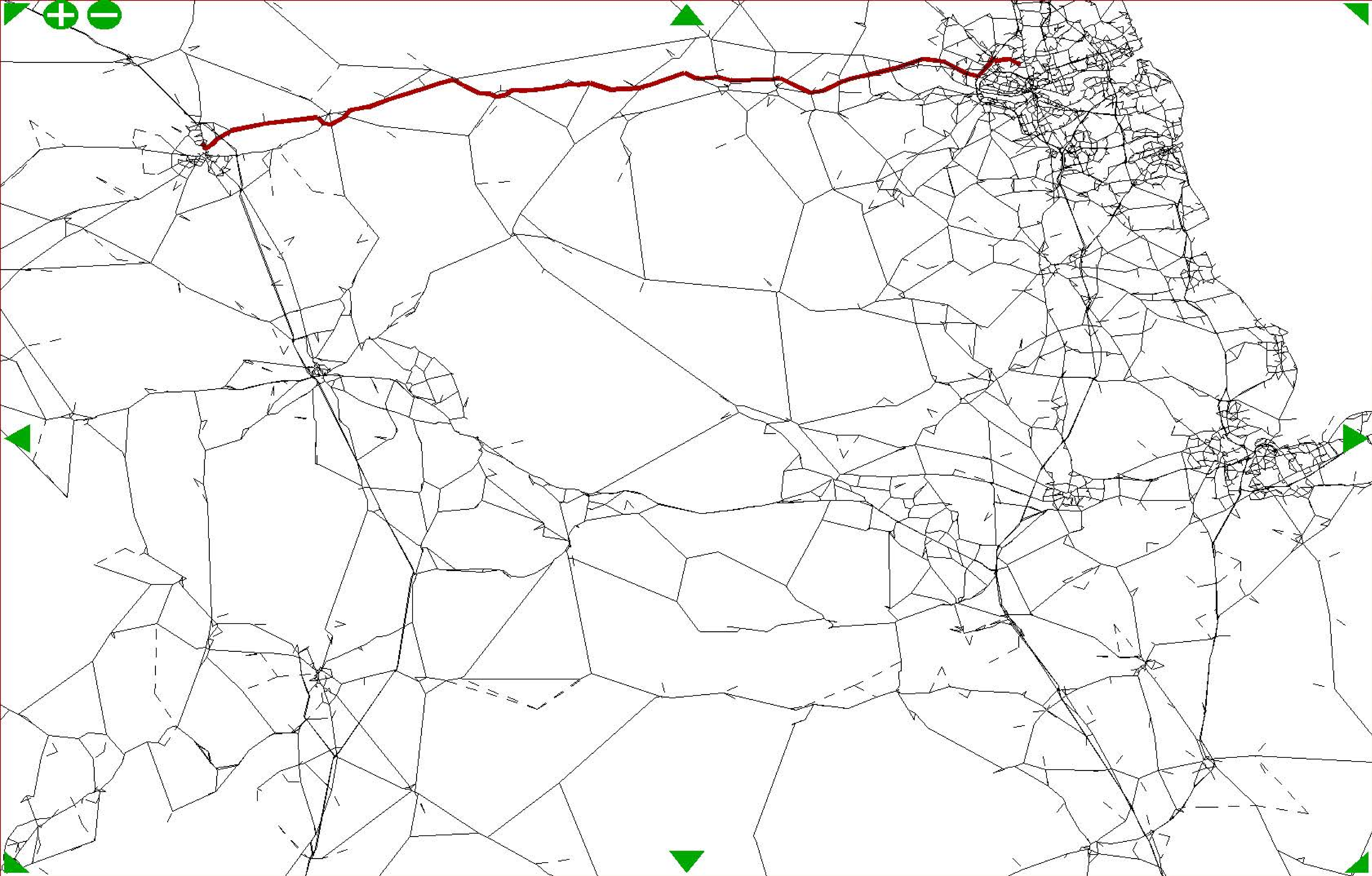
See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22


Tree for:
Origin 184
Dest. 305
User Cl. 1
Minimum
COST = 10464
Skimmed
Time = 6759
Delay= 514
Dist =155906
Speed= 83.04
FCost= 10464
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22

A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22

A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22



Tree for:

Origin 184
Dest. 1274

User Cl. 1

Minimum
COST = 6547

Skimmed

Time = 4297
Delay= 261
Dist = 94662
Speed= 79.31
FCost= 6547

Definitions:
See 11.8.2.1

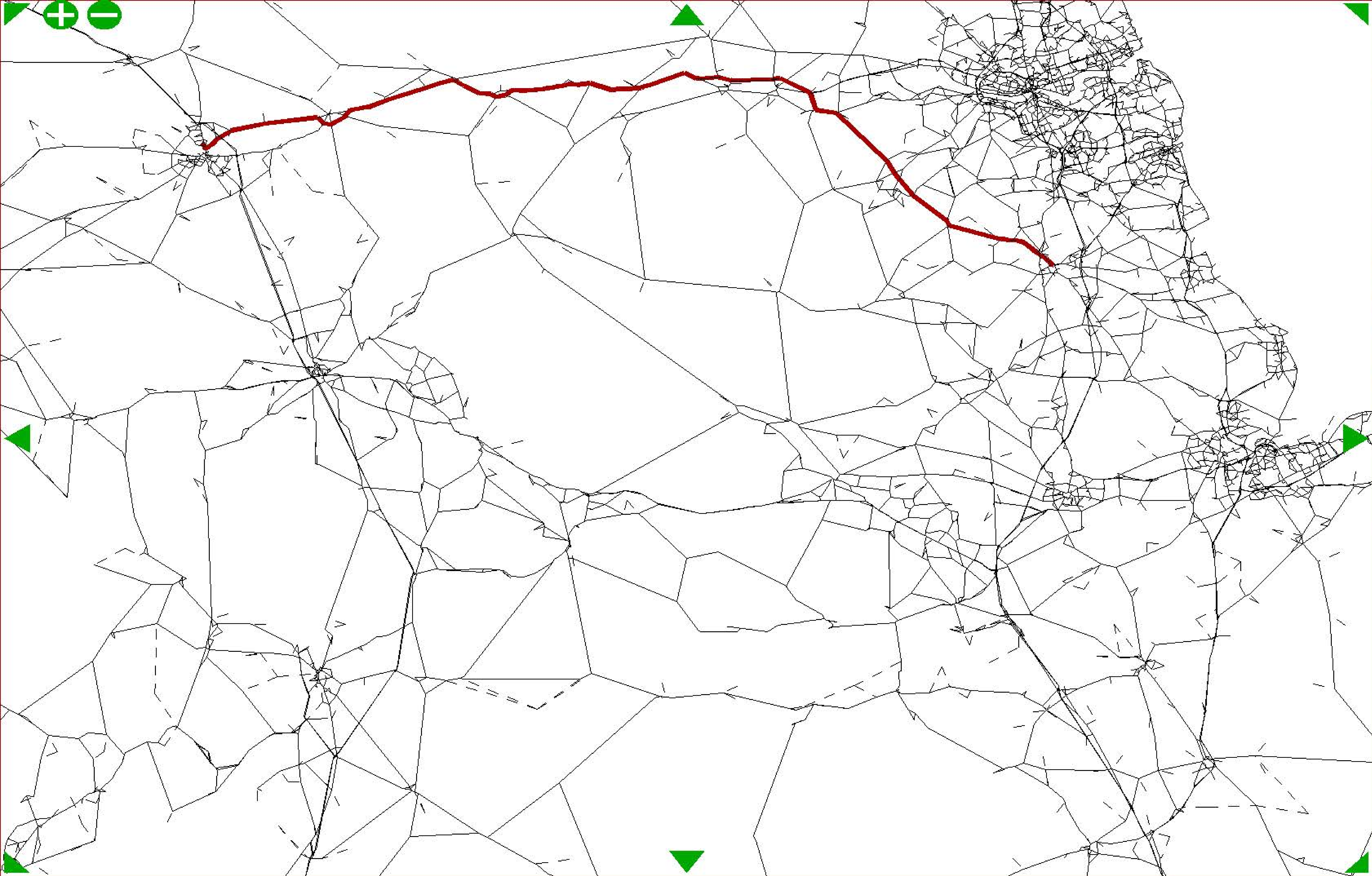
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22



Tree for:

Origin 184
Dest. 1388

User Cl. 1

Minimum
COST = 7916

Skimmed

Time = 5379
Delay= 335
Dist =106748
Speed= 71.45
FCost= 7916

Definitions:
See 11.8.2.1

T vrs D plot

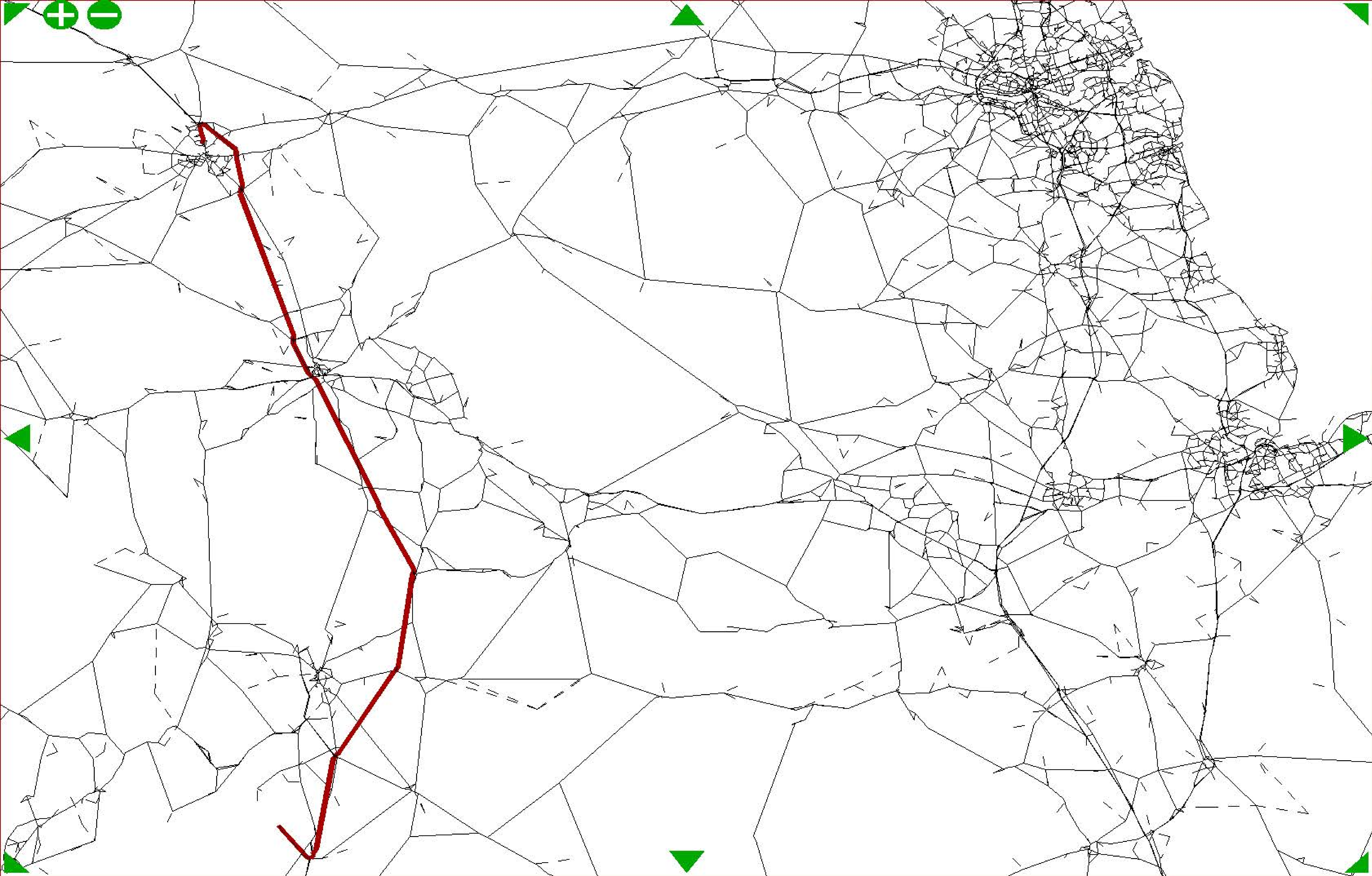
Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22

1. Carnforth to Carlisle
2. Carnforth to Thirsk
3. Carnforth to Middlesbrough
4. Carnforth to Penrith
5. Carnforth to Newcastle upon Tyne
6. Carnforth to Durham



Tree for:

Origin 201
Dest. 184

User Cl. 1

Minimum
COST = 6039

Skimmed

Time = 3563
Delay= 40
Dist =104165
Speed=105.25
FCost= 6039

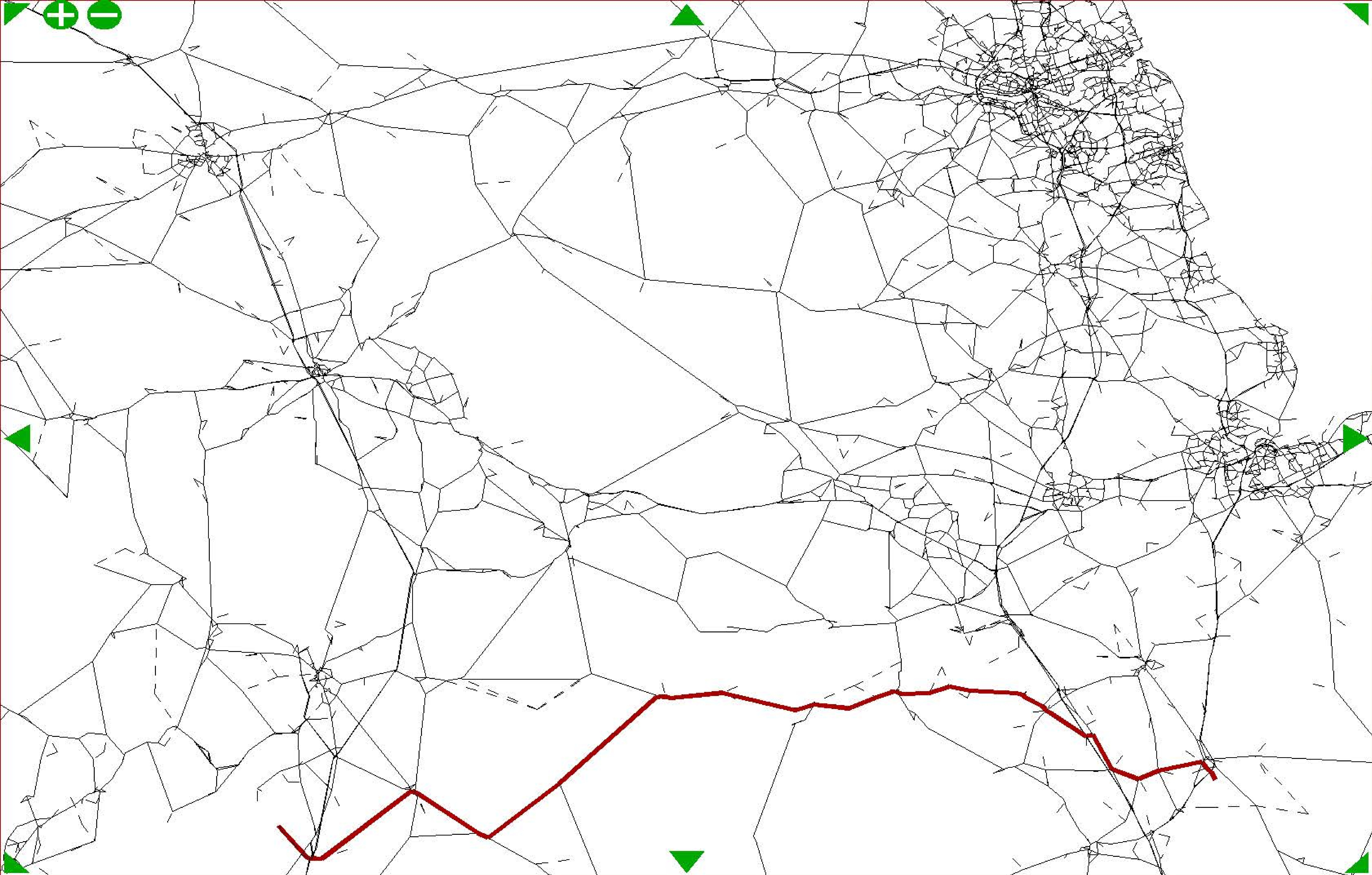
Definitions:
See 11.8.2.1

T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3



Tree for:

Origin 201
Dest. 305

User Cl. 1

Minimum
COST = 9747

Skimmed

Time = 6851
Delay= 90
Dist =121828
Speed= 64.02
FCost= 9747

Definitions:
See 11.8.2.1

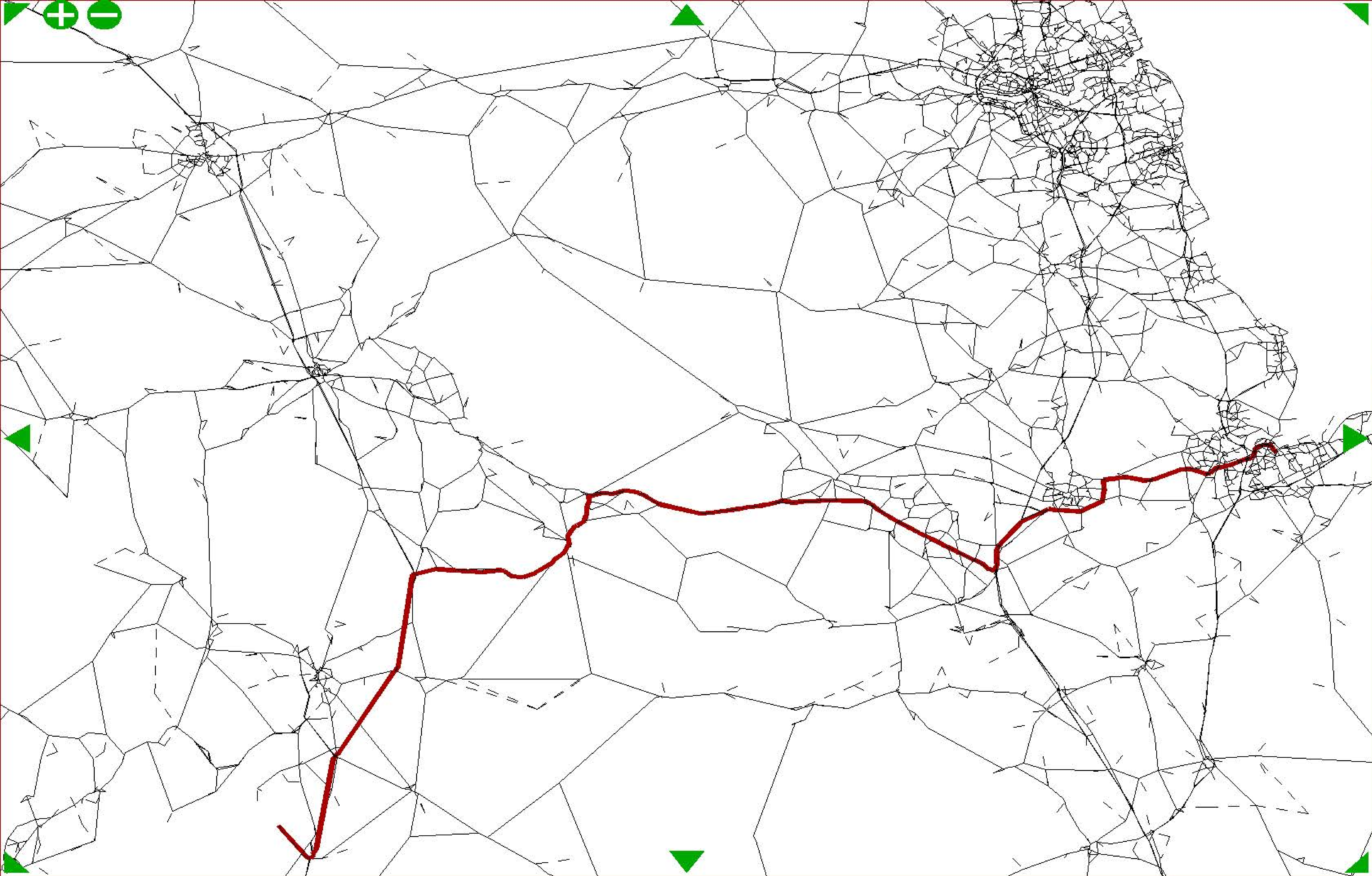
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22



Tree for:

Origin 201
Dest. 1023

User Cl. 1

Minimum
COST = 9702

Skimmed

Time = 6117
Delay= 308
Dist =150817
Speed= 88.76
FCost= 9702

Definitions:
See 11.8.2.1

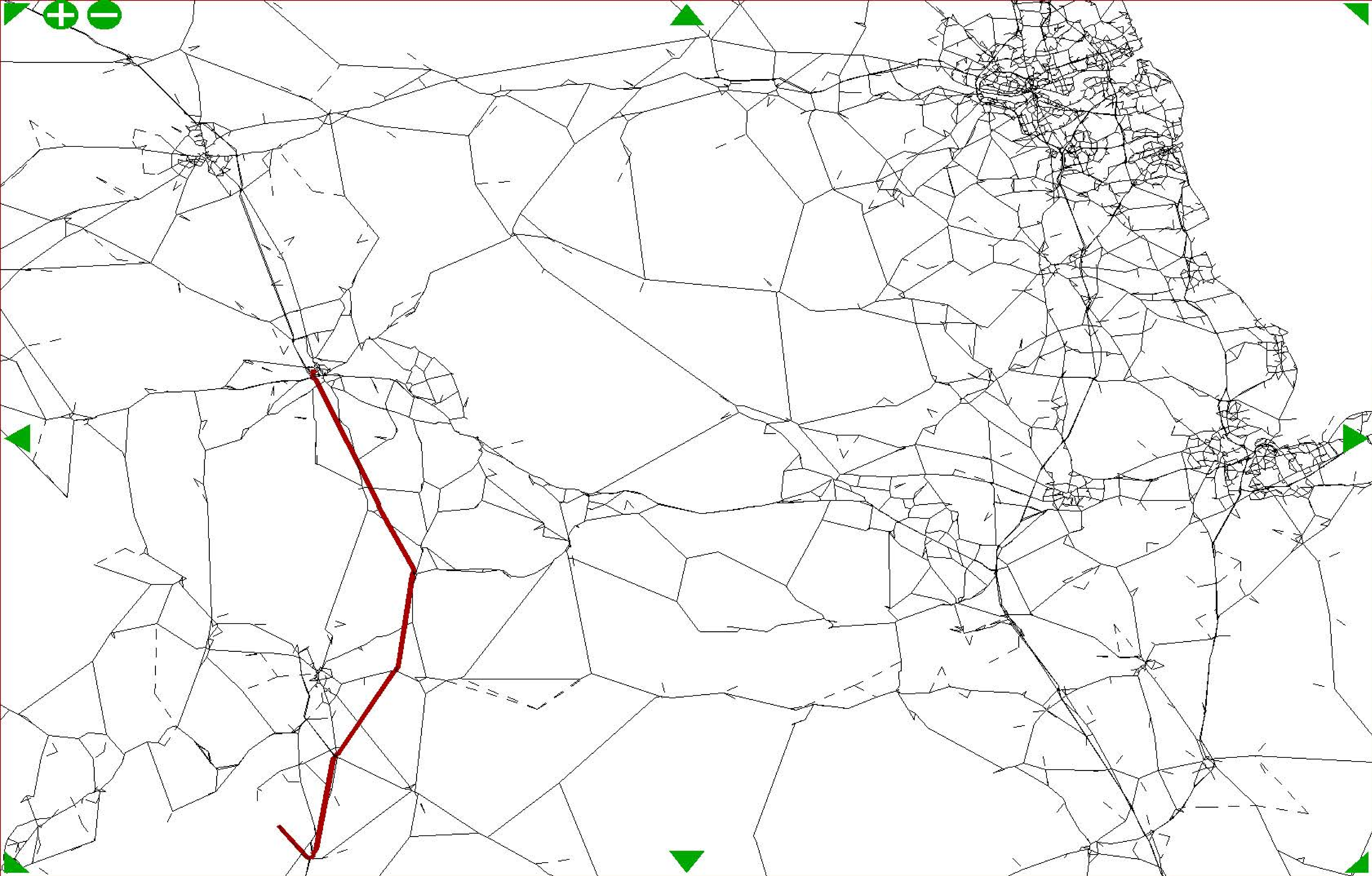
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22



Tree for:

Origin 201
Dest. 1088

User Cl. 1

Minimum
COST = 3969

Skimmed

Time = 2358
Delay= 59
Dist = 67776
Speed=103.47
FCost= 3969

Definitions:
See 11.8.2.1

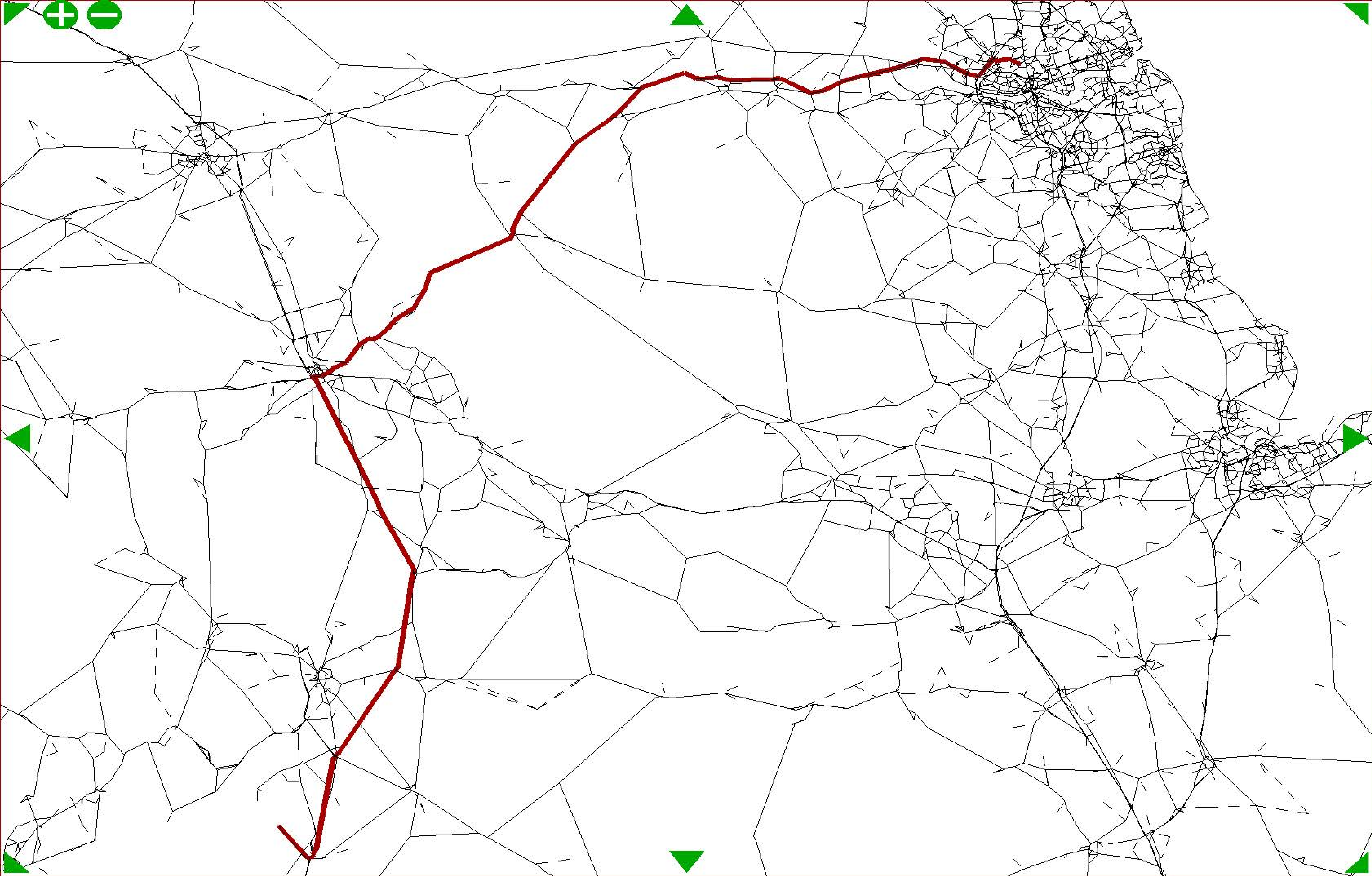
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22



Tree for:

Origin 201
Dest. 1274

User Cl. 1

Minimum
COST = 11635

Skimmed

Time = 7565
Delay= 205
Dist =171238
Speed= 81.49
FCost= 11635

Definitions:
See 11.8.2.1

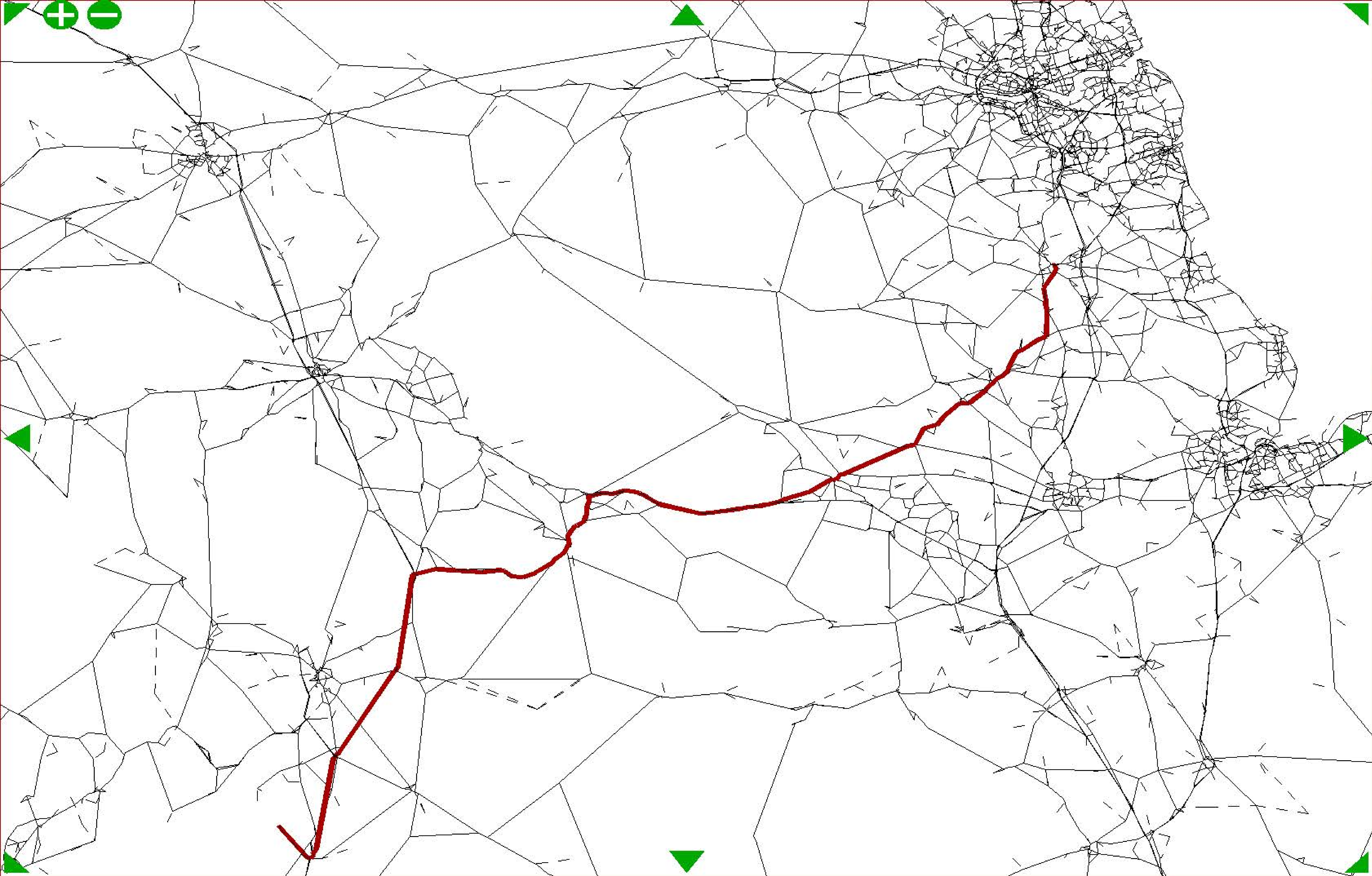
T vrs D plot

Q - Return

+ Menu bar!

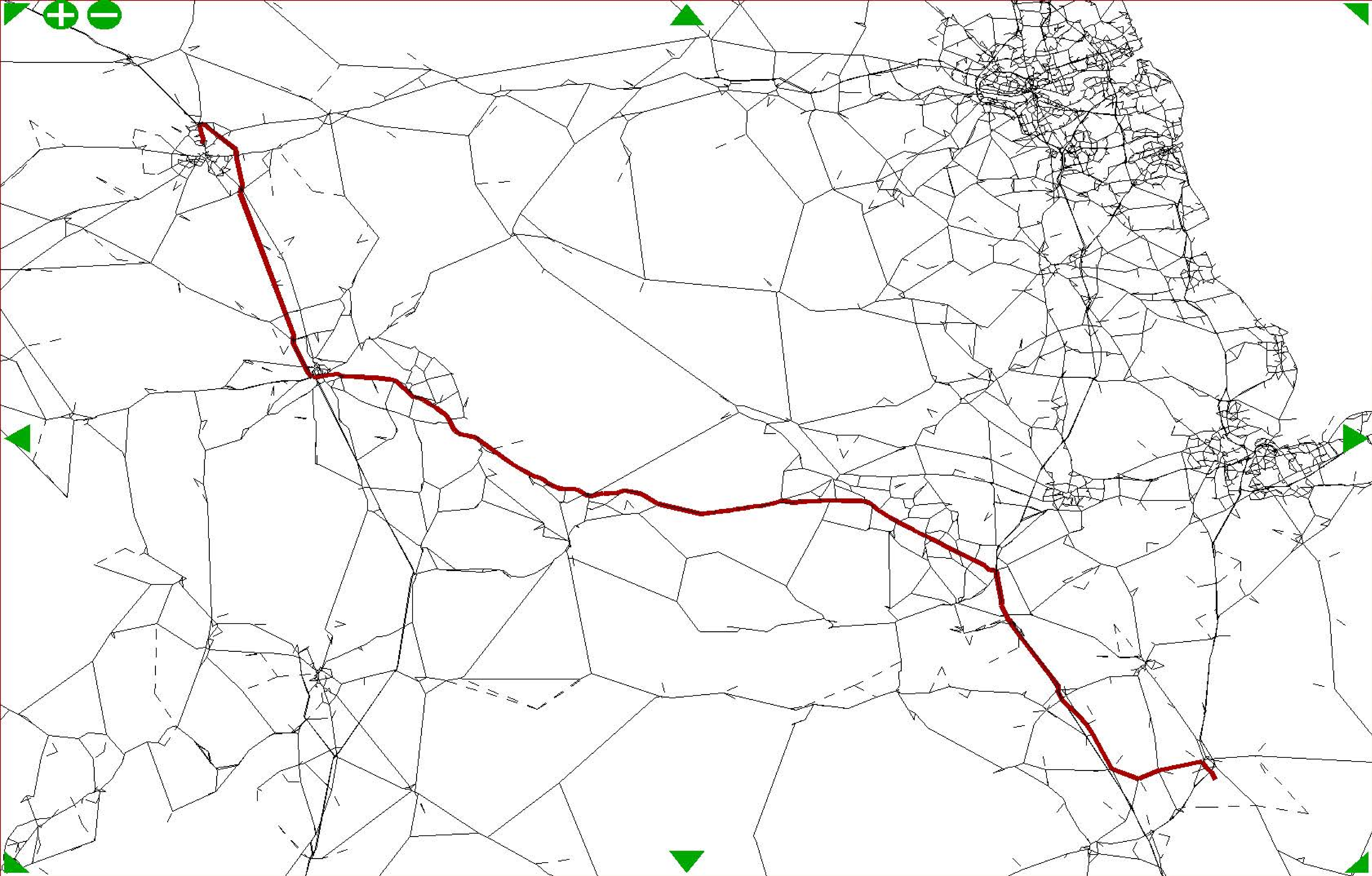
See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22



A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22

1. Thirsk to Carlisle
2. Thirsk to Carnforth
3. Thirsk to Middlesbrough
4. Thirsk to Penrith
5. Thirsk to Newcastle upon Tyne
6. Thirsk to Durham



Tree for:

Origin 305
Dest. 184

User Cl. 1

Minimum
COST = 10410

Skimmed

Time = 6612
Delay= 374
Dist =159796
Speed= 87.01
FCost= 10410

Definitions:
See 11.8.2.1

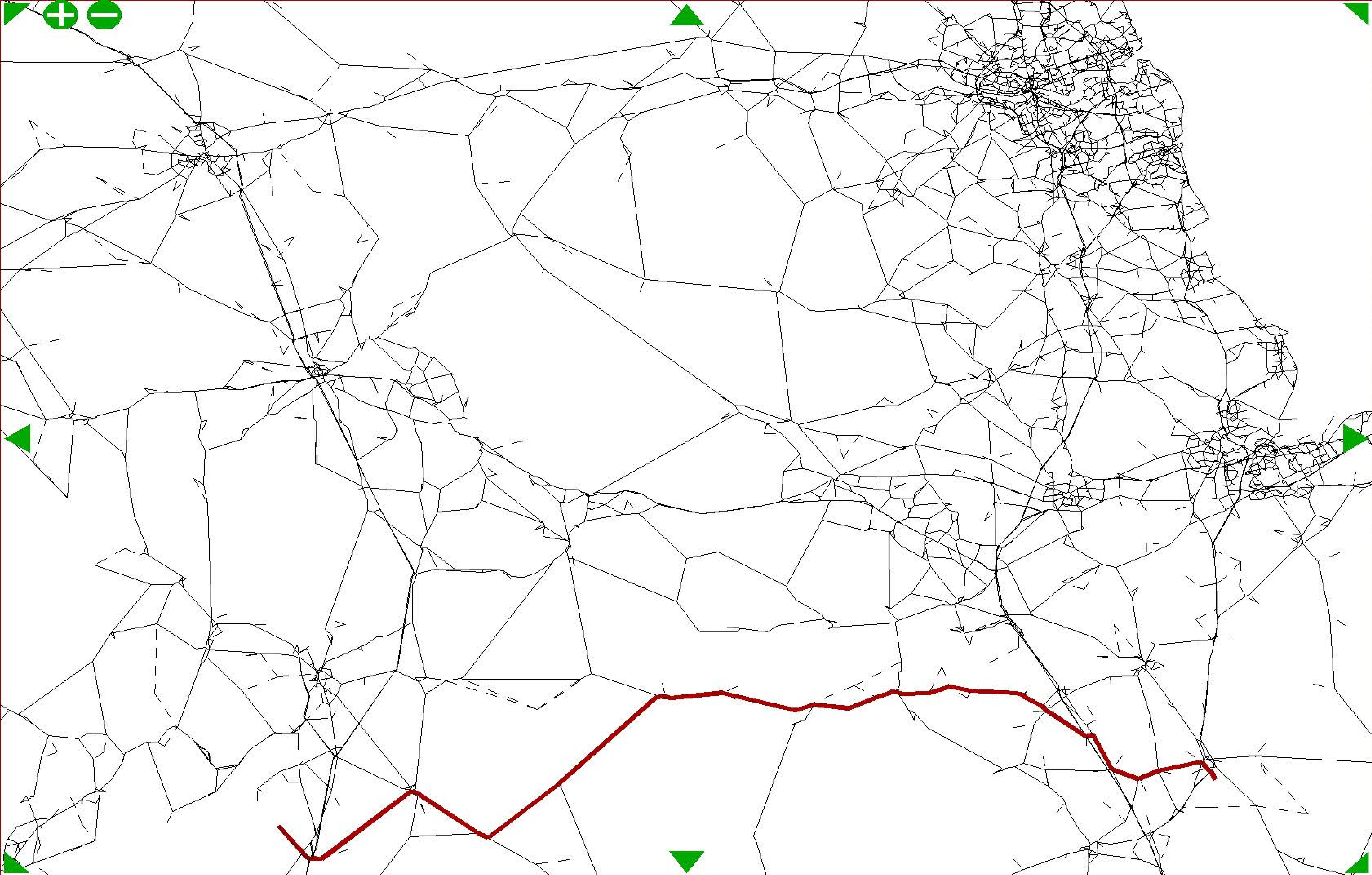
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22



Tree for:

Origin 305
Dest. 201

User Cl. 1

Minimum
COST = 9755

Skimmed

Time = 6861
Delay= 98
Dist =121757
Speed= 63.89
FCost= 9755

Definitions:
See 11.8.2.1

T vrs D plot

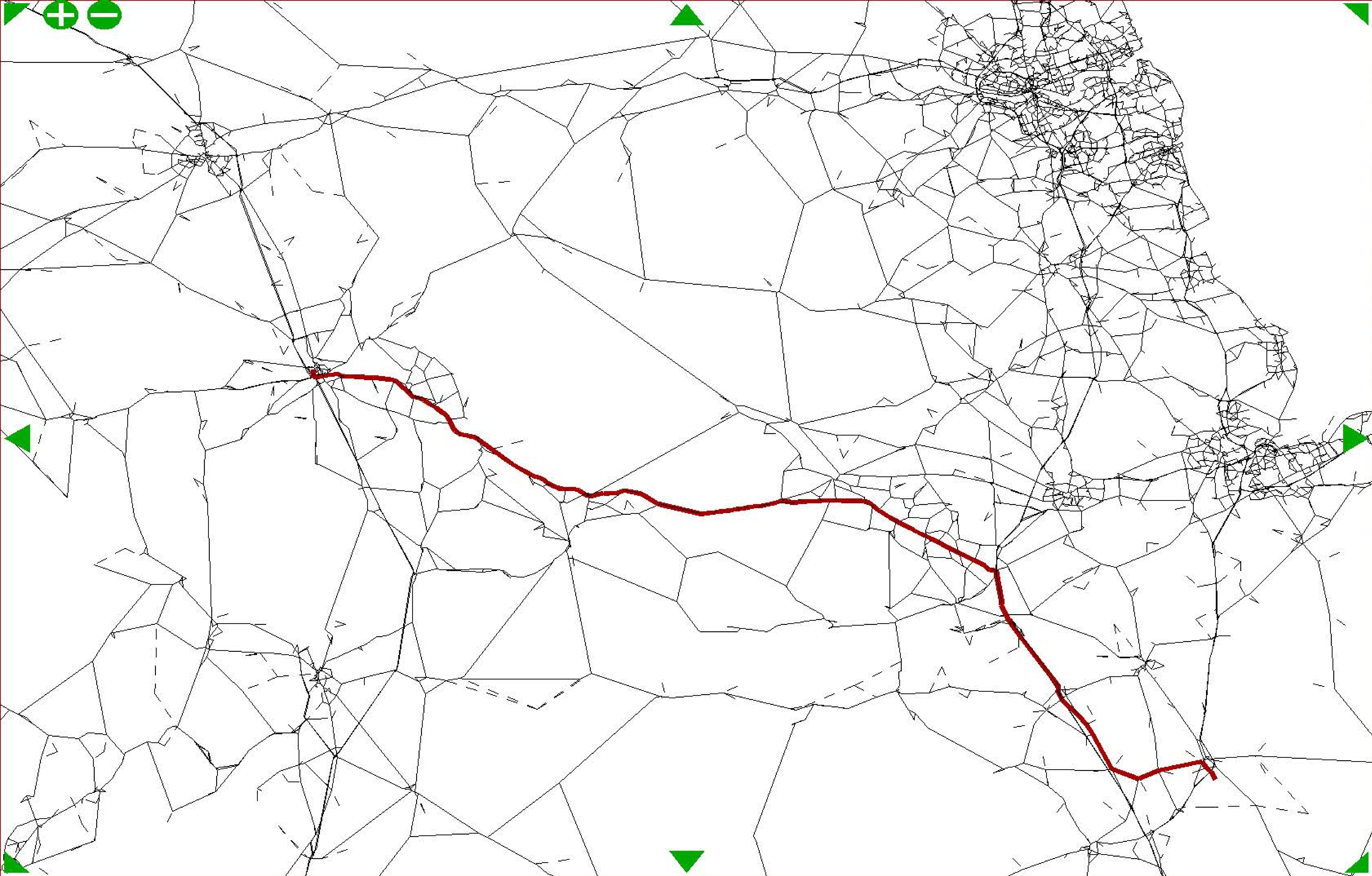
Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22


Tree for:
Origin 305
Dest. 1023
User Cl. 1
Minimum
COST = 2997
Skimmed
Time = 1894
Delay= 120
Dist = 46401
Speed= 88.19
FCost= 2997
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22



Tree for:

Origin 305
Dest. 1088

User Cl. 1

Minimum
COST = 8275

Skimmed

Time = 5343
Delay= 363
Dist =123369
Speed= 83.12
FCost= 8275

Definitions:
See 11.8.2.1

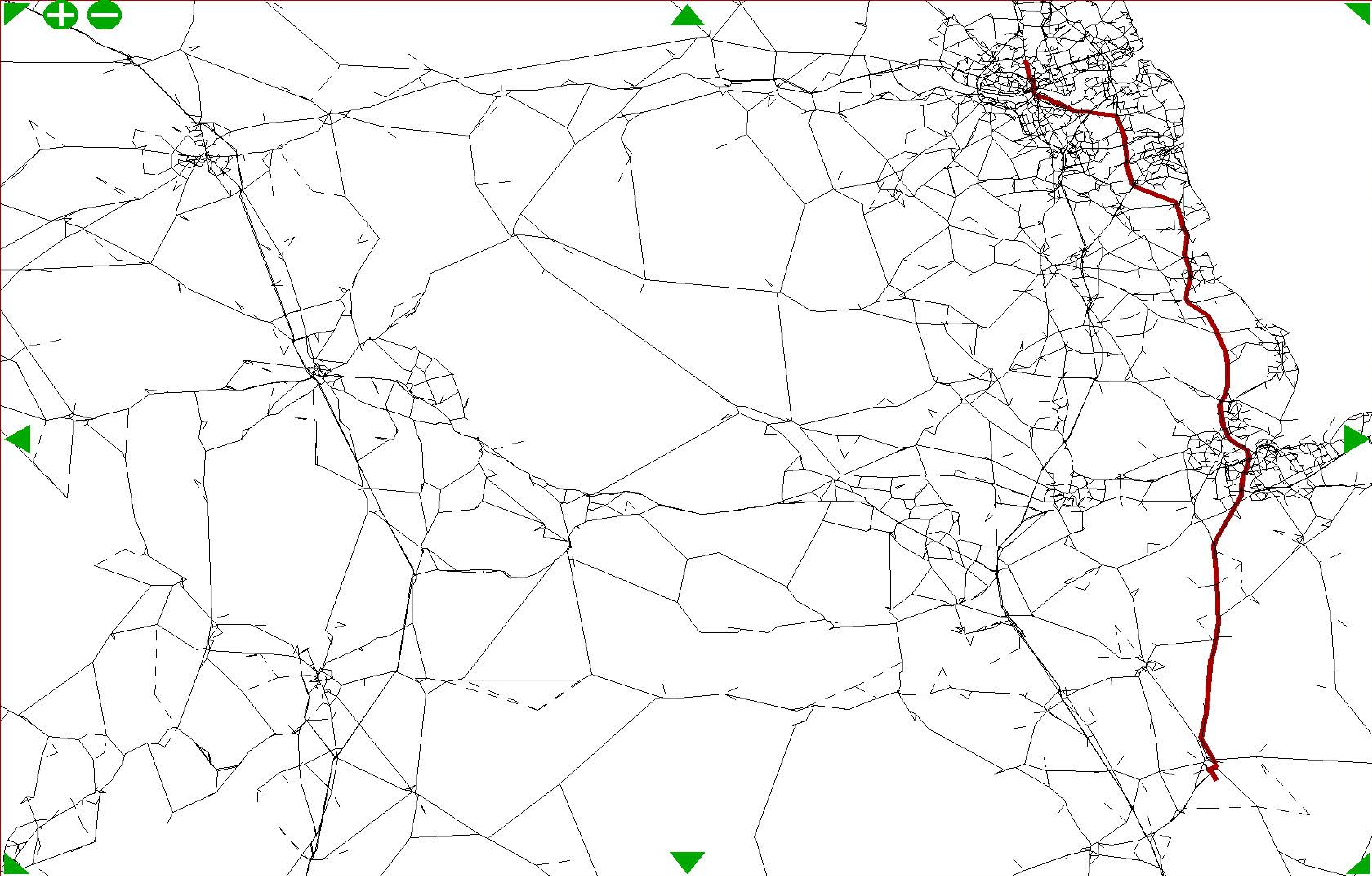
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22



Tree for:

Origin 305
Dest. 1274

User Cl. 1

Minimum
COST = 7091

Skimmed

Time = 4597
Delay= 642
Dist =104902
Speed= 82.15
FCost= 7091

Definitions:
See 11.8.2.1

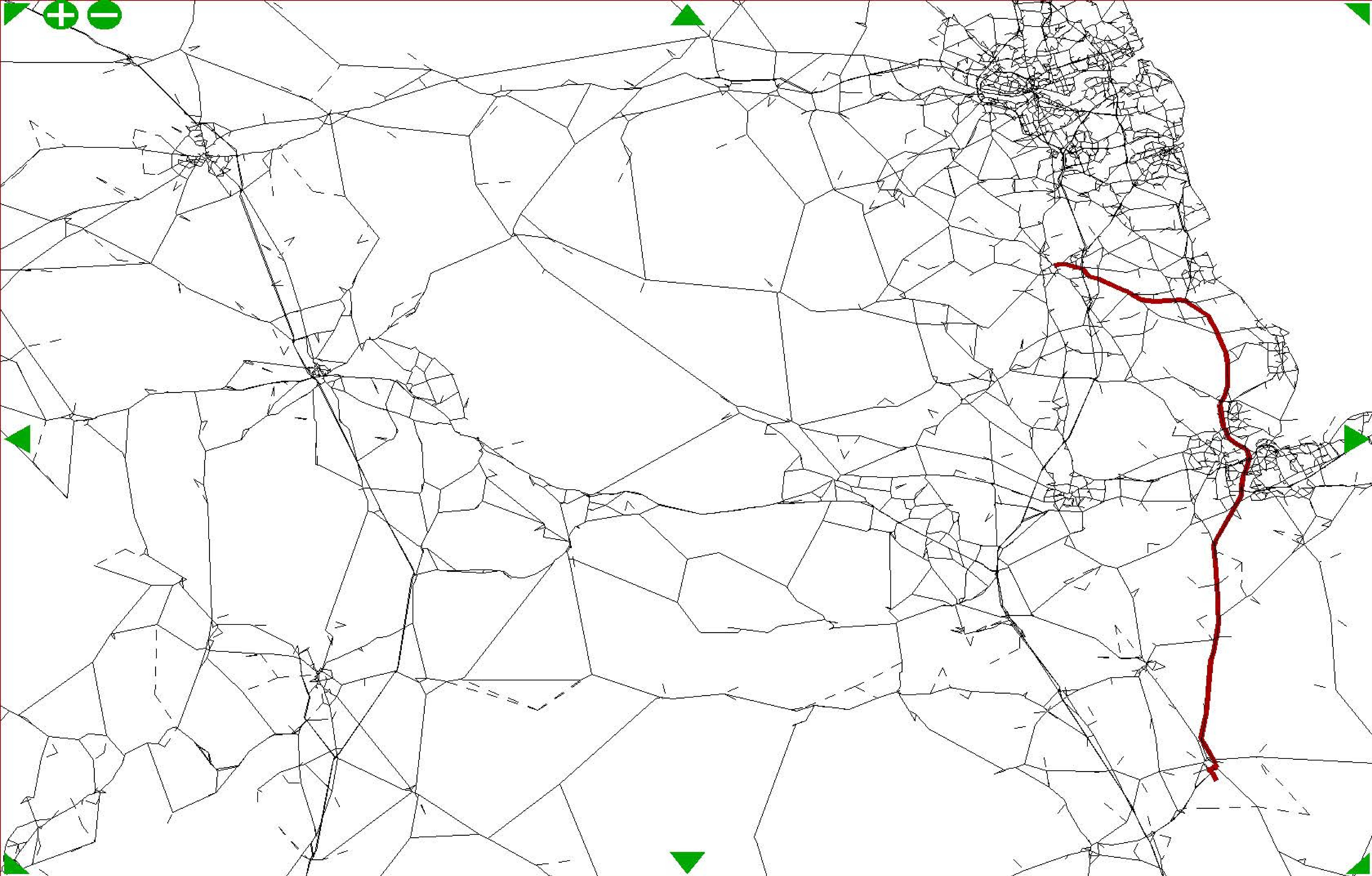
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22



Tree for:

Origin 305
Dest. 1388

User Cl. 1

Minimum
COST = 5334

Skimmed

Time = 3429
Delay= 280
Dist. = 80142
Speed= 84.13
FCost= 5334

Definitions:
See 11.8.2.1

T vrs D plot

Q - Return

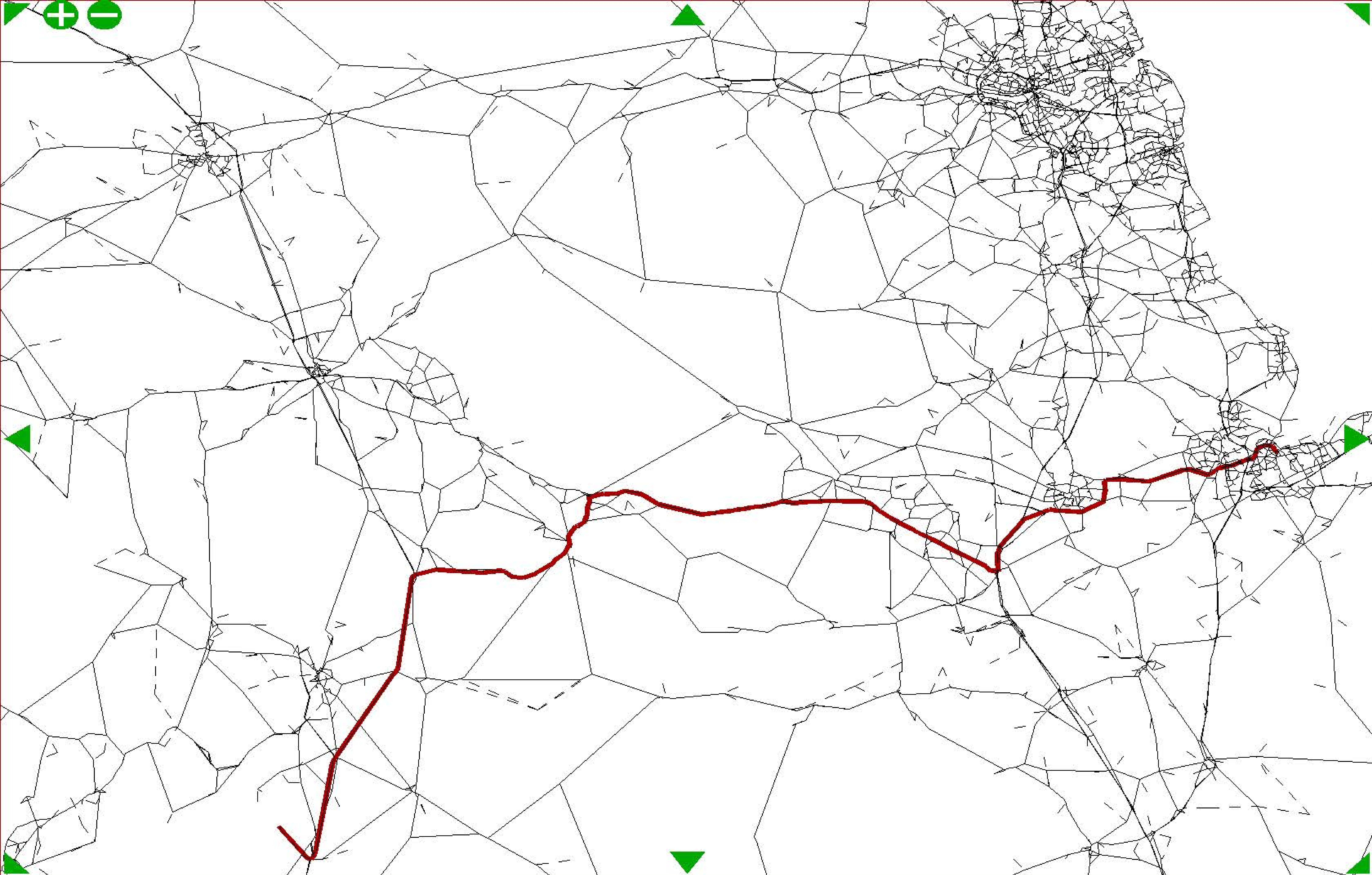
+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22

1. Middlesbrough to Carlisle
2. Middlesbrough to Carnforth
3. Middlesbrough to Thirsk
4. Middlesbrough to Penrith
5. Middlesbrough to Newcastle upon Tyne
6. Middlesbrough to Durham


Tree for:
Origin 1023
Dest. 184
User Cl. 1
Minimum
COST = 10119
Skimmed
Time = 6386
Delay= 478
Dist =157066
Speed= 88.55
FCost= 10119
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22



Tree for:

Origin 1023
Dest. 201

User Cl. 1

Minimum
COST = 9617

Skimmed

Time = 6051
Delay= 324
Dist =150018
Speed= 89.25
FCost= 9617

Definitions:
See 11.8.2.1

T vrs D plot

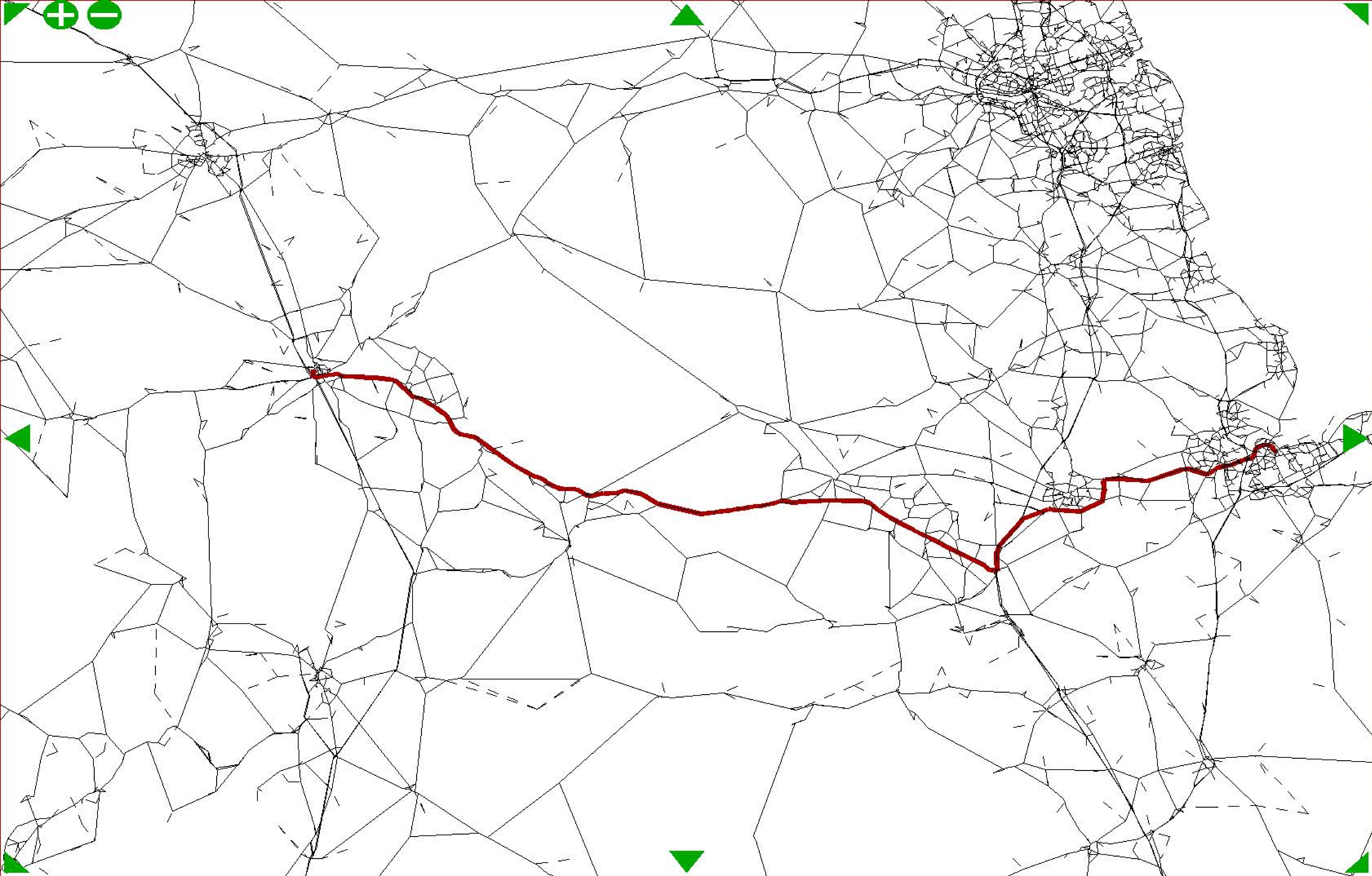
Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22


Tree for:
Origin 1023
Dest. 305
User Cl. 1
Minimum
COST = 2942
Skimmed
Time = 1849
Delay= 134
Dist.= 45963
Speed= 89.47
FCost= 2942
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22



Tree for:

Origin 1023
Dest. 1088

User Cl. 1

Minimum
COST = 7984

Skimmed

Time = 5117
Delay= 467
Dist =120639
Speed= 84.88
FCost= 7984

Definitions:
See 11.8.2.1

T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

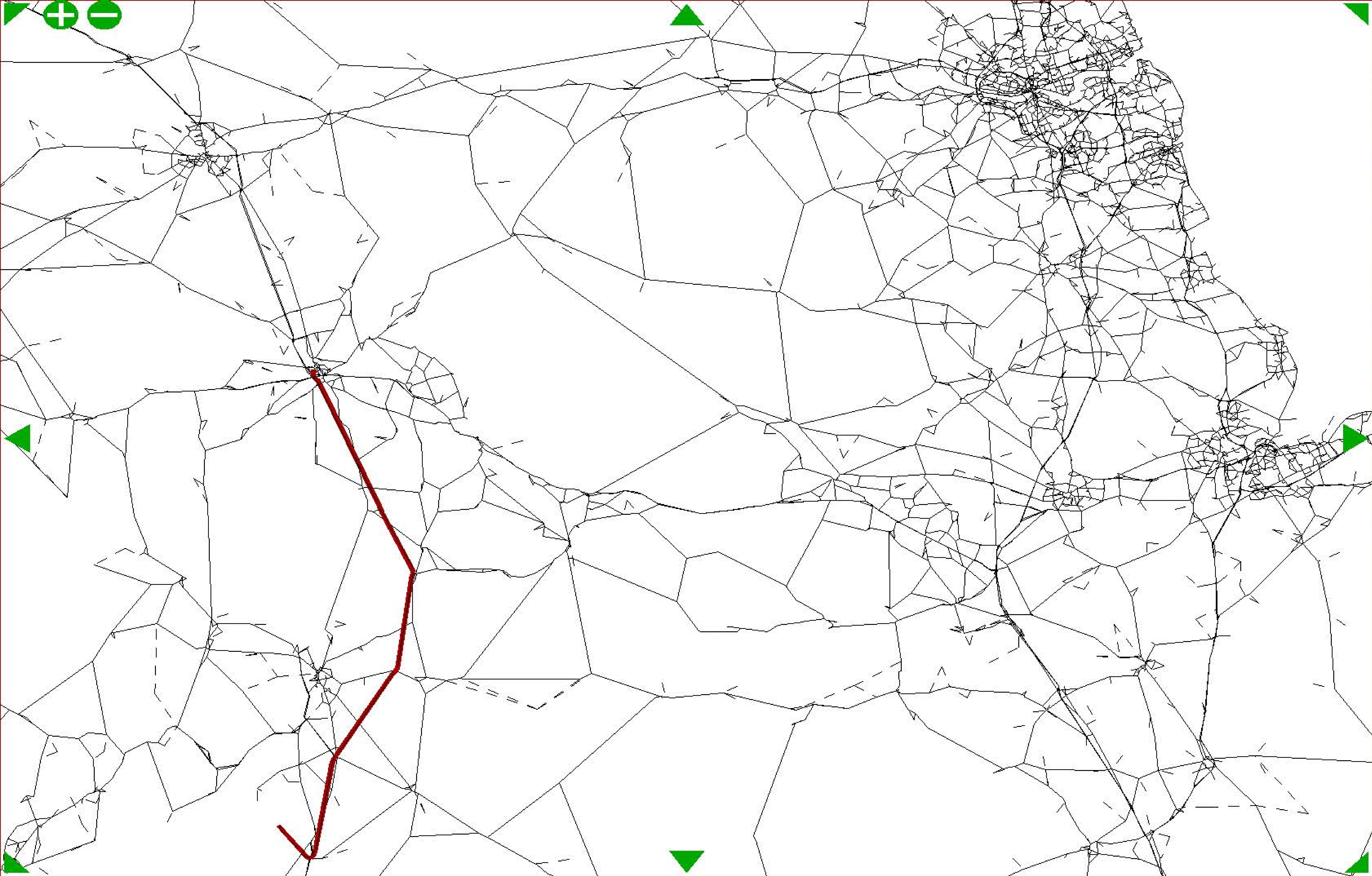
A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22


Tree for:
Origin 1023
Dest. 1274
User Cl. 1
Minimum
COST = 4867
Skimmed
Time = 3271
Delay= 579
Dist = 67163
Speed= 73.92
FCost= 4867
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22


Tree for:
Origin 1023
Dest. 1388
User Cl. 1
Minimum
COST = 3111
Skimmed
Time = 2103
Delay= 217
Dist. = 42403
Speed= 72.59
FCost= 3111
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22

1. Penrith to Carlisle
2. Penrith to Carnforth
3. Penrith to Thirsk
4. Penrith to Middlesbrough
5. Penrith to Newcastle upon Tyne
6. Penrith to Durham


Tree for:
Origin 1088
Dest. 184
User Cl. 1
Minimum
COST = 2425
Skimmed
Time = 1508
Delay= 25
Dist = 38560
Speed= 92.05
FCost= 2425
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3



Tree for:

Origin 1088
Dest. 201

User Cl. 1

Minimum
COST = 3908

Skimmed

Time = 2305
Delay= 40
Dist = 67439
Speed=105.31
FCost= 3908

Definitions:
See 11.8.2.1

T vrs D plot

Q - Return

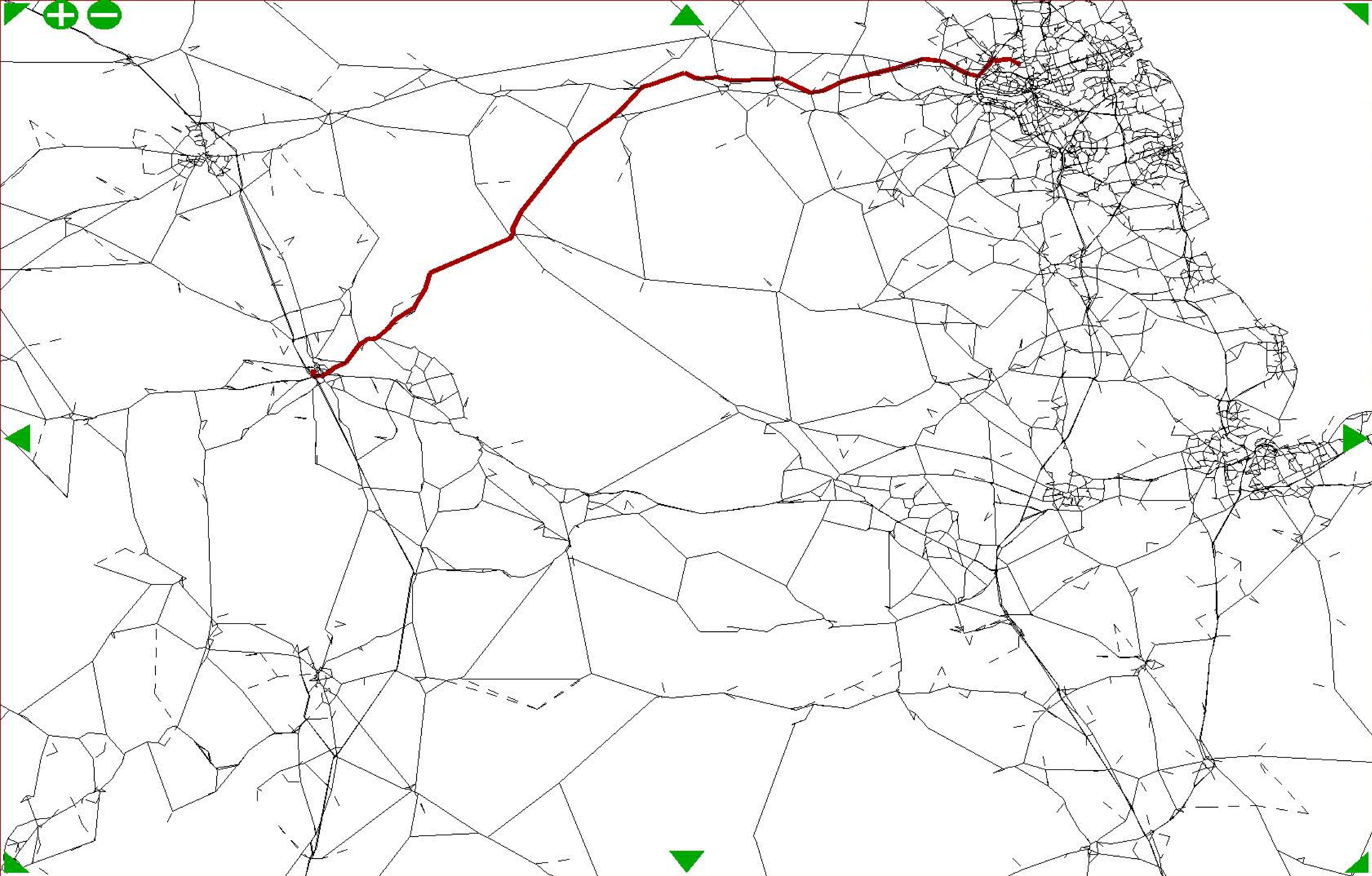
+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22

A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22


Tree for:
Origin 1088
Dest. 1023
User Cl. 1
Minimum
COST = 7953
Skimmed
Time = 5098
Delay= 463
Dist =120115
Speed= 84.82
FCost= 7953
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22



Tree for:

Origin 1088
Dest. 1274

User Cl. 1

Minimum
COST = 7868

Skimmed

Time = 5373
Delay= 154
Dist =104981
Speed= 70.34
FCost= 7868

Definitions:
See 11.8.2.1

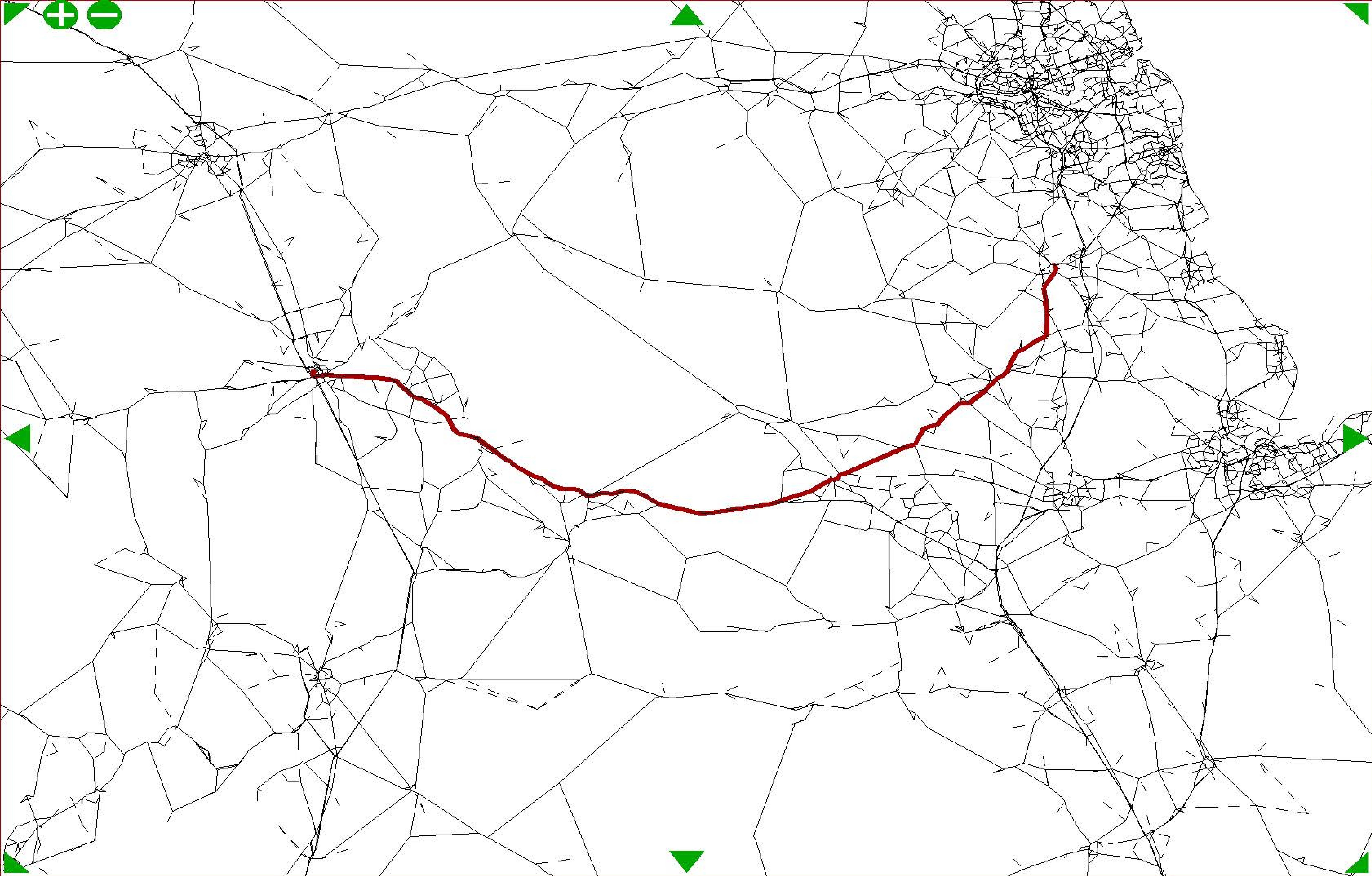
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22



Tree for:

Origin 1088
Dest. 1388

User Cl. 1

Minimum
COST = 7634

Skimmed

Time = 5196
Delav= 403
Dist =102572
Speed= 71.07
FCost= 7634

Definitions:
See 11.8.2.1

T vrs D plot

Q - Return

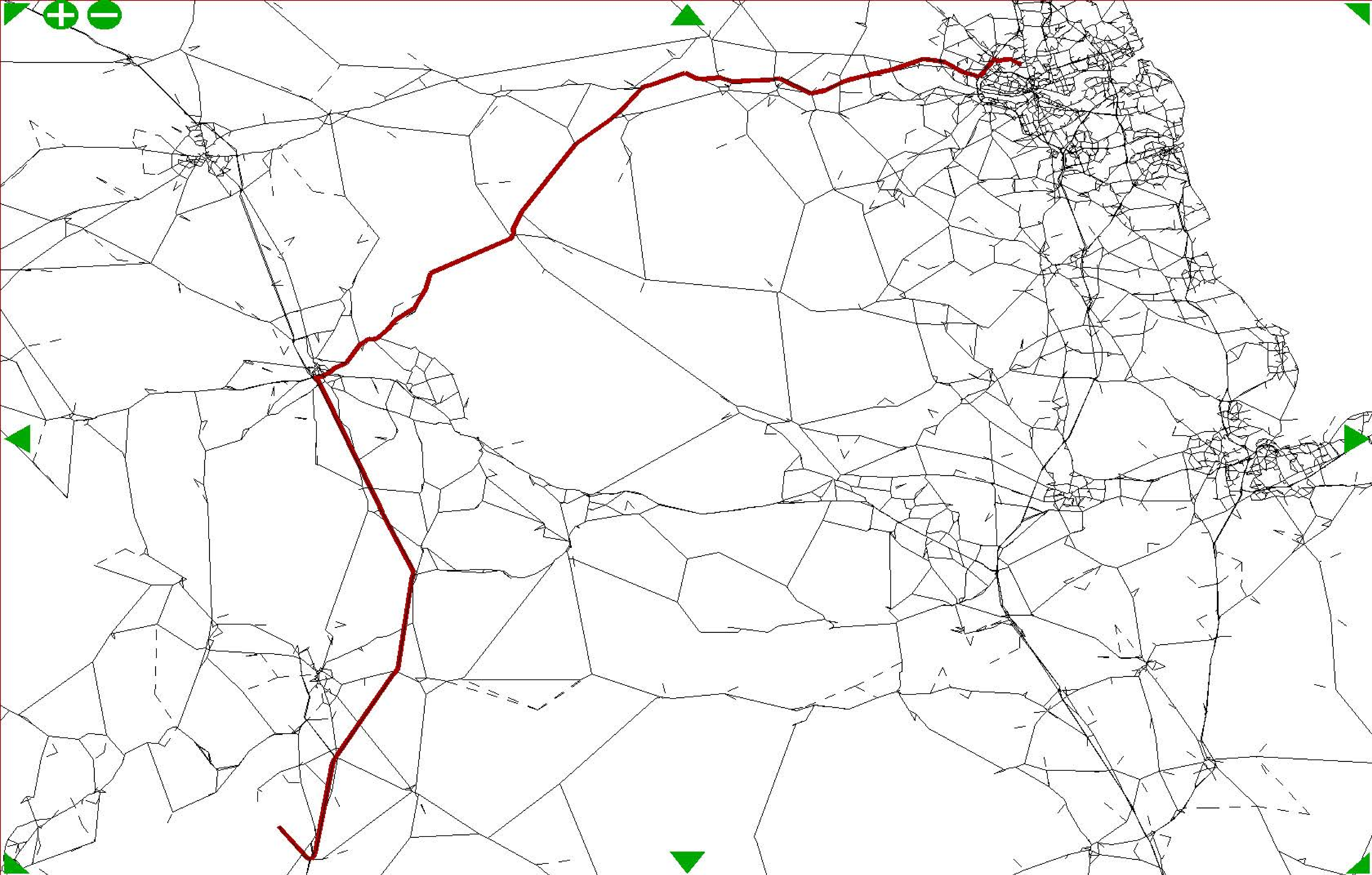
+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22

1. Newcastle upon Tyne to Carlisle
2. Newcastle upon Tyne to Carnforth
3. Newcastle upon Tyne to Thirsk
4. Newcastle upon Tyne to Middlesbrough
5. Newcastle upon Tyne to Penrith
6. Newcastle upon Tyne to Durham


Tree for:
Origin 1274
Dest. 184
User Cl. 1
Minimum
COST = 6615
Skimmed
Time = 4342
Delay= 232
Dist = 95623
Speed= 79.28
FCost= 6615
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22



Tree for:

Origin 1274
Dest. 201

User Cl. 1

Minimum
COST = 11537

Skimmed

Time = 7496
Delay= 180
Dist =170029
Speed= 81.66
FCost= 11537

Definitions:
See 11.8.2.1

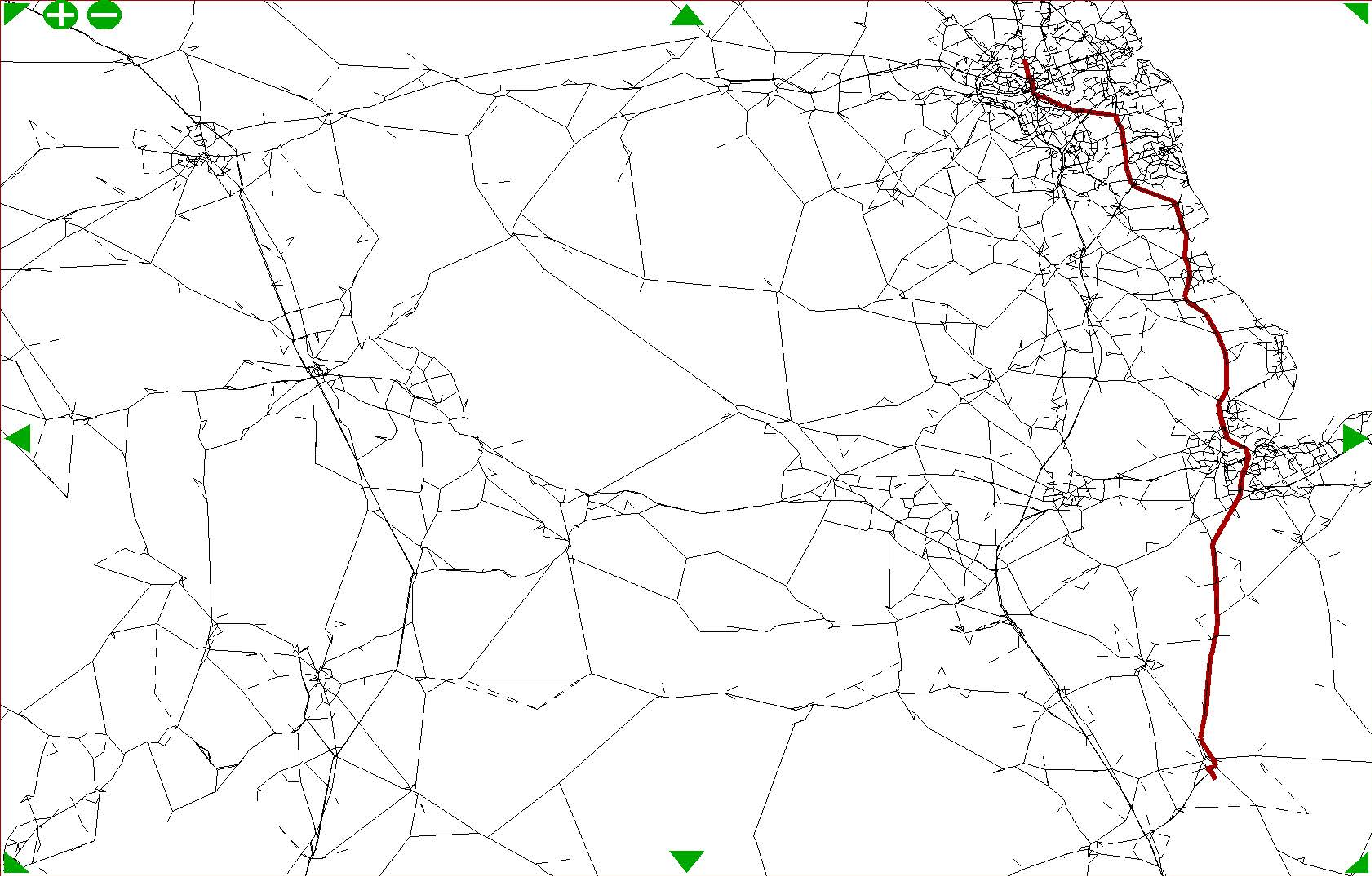
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22



Tree for:

Origin 1274
Dest. 305

User Cl. 1

Minimum
COST = 7032

Skimmed

Time = 4549
Delay= 626
Dist =104483
Speed= 82.69
FCost= 7032

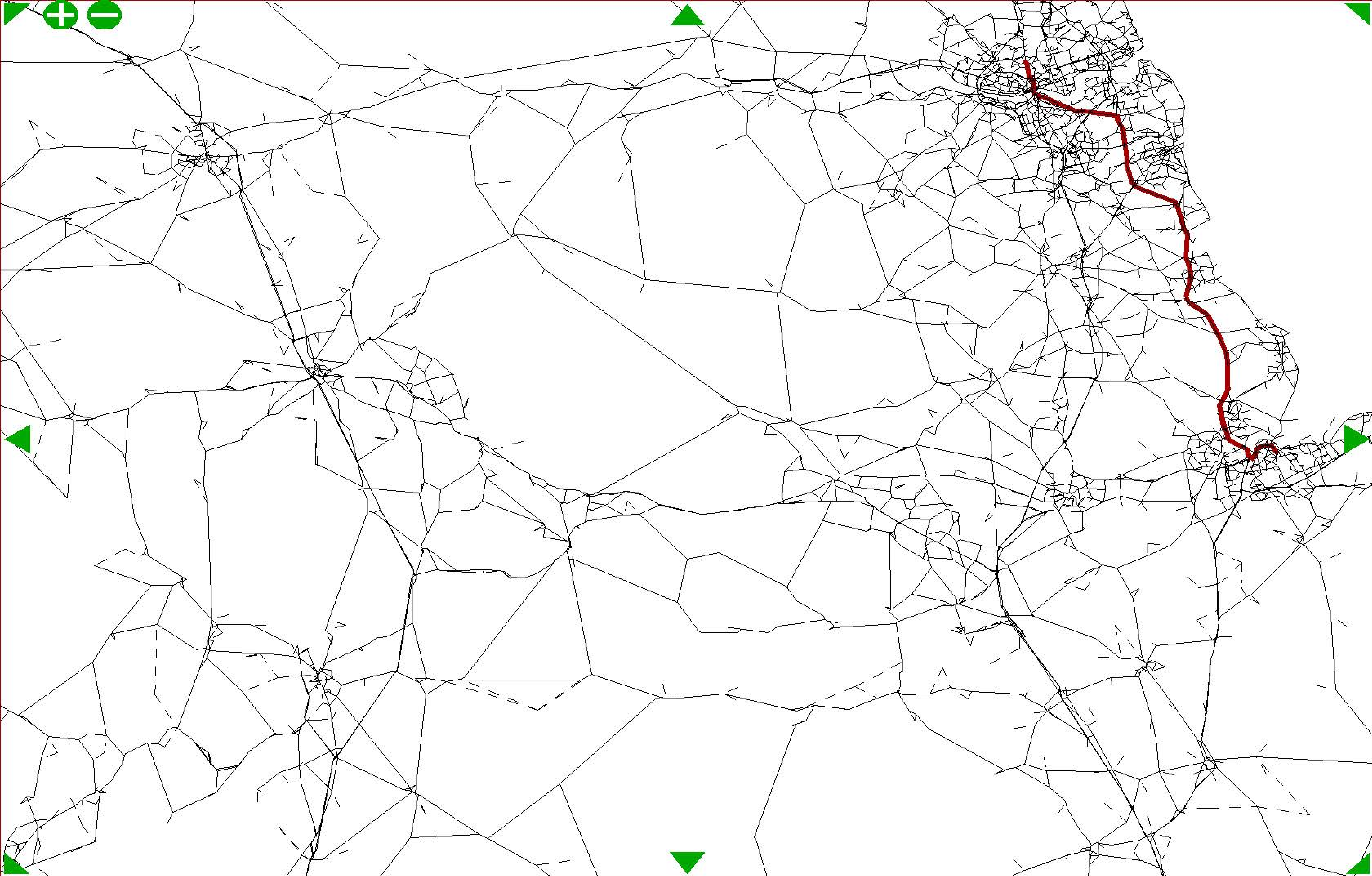
Definitions:
See 11.8.2.1

T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3



Tree for:

Origin 1274
Dest. 1023

User Cl. 1

Minimum
COST = 4814

Skimmed

Time = 3232
Delay= 540
Dist = 66566
Speed= 74.15
FCost= 4814

Definitions:
See 11.8.2.1

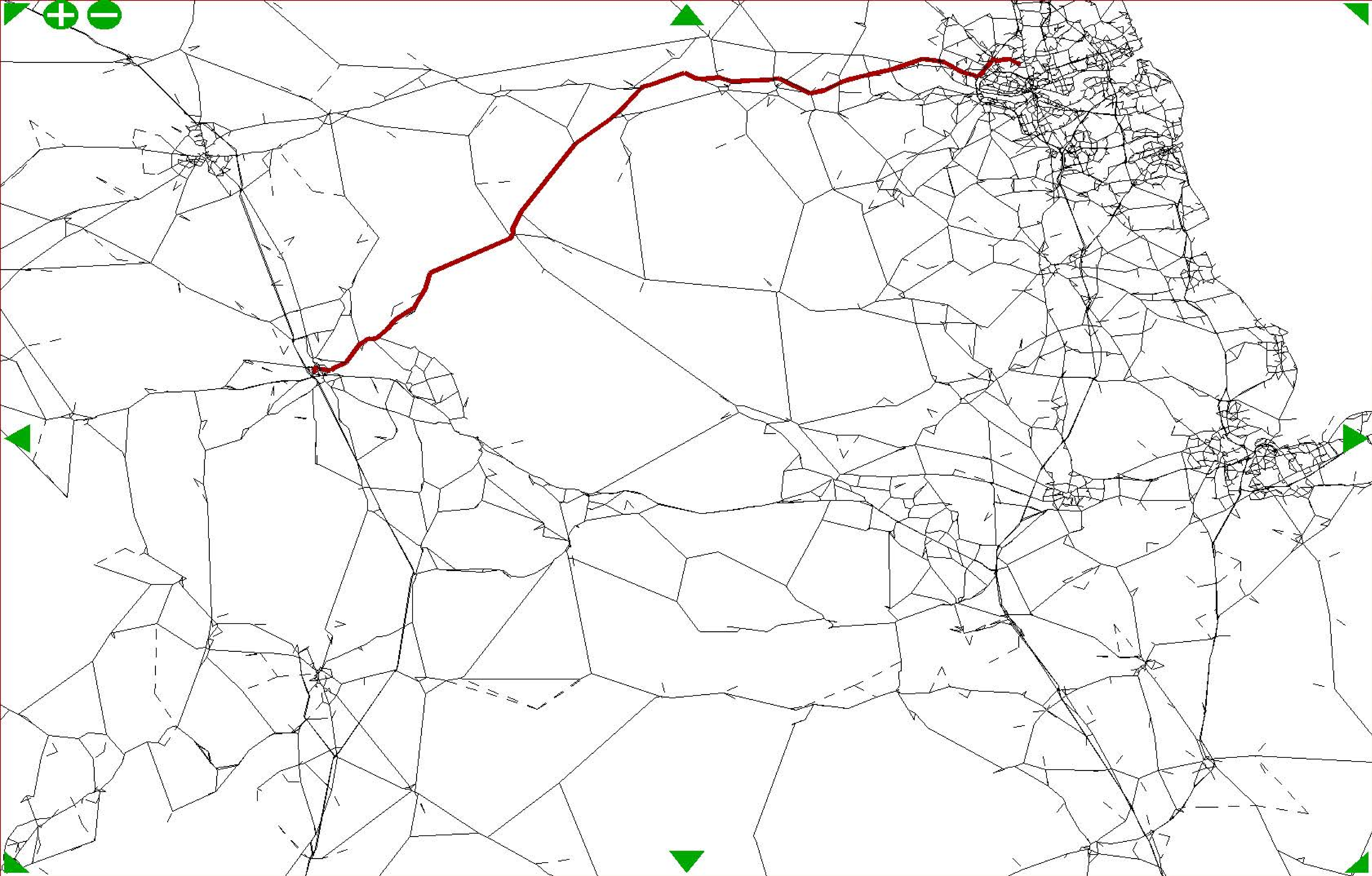
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22



Tree for:

Origin 1274
Dest. 1088

User Cl. 1

Minimum
COST = 7840

Skimmed

Time = 5379
Delay= 146
Dist =103544
Speed= 69.30
FCost= 7840

Definitions:
See 11.8.2.1

T vrs D plot

Q - Return

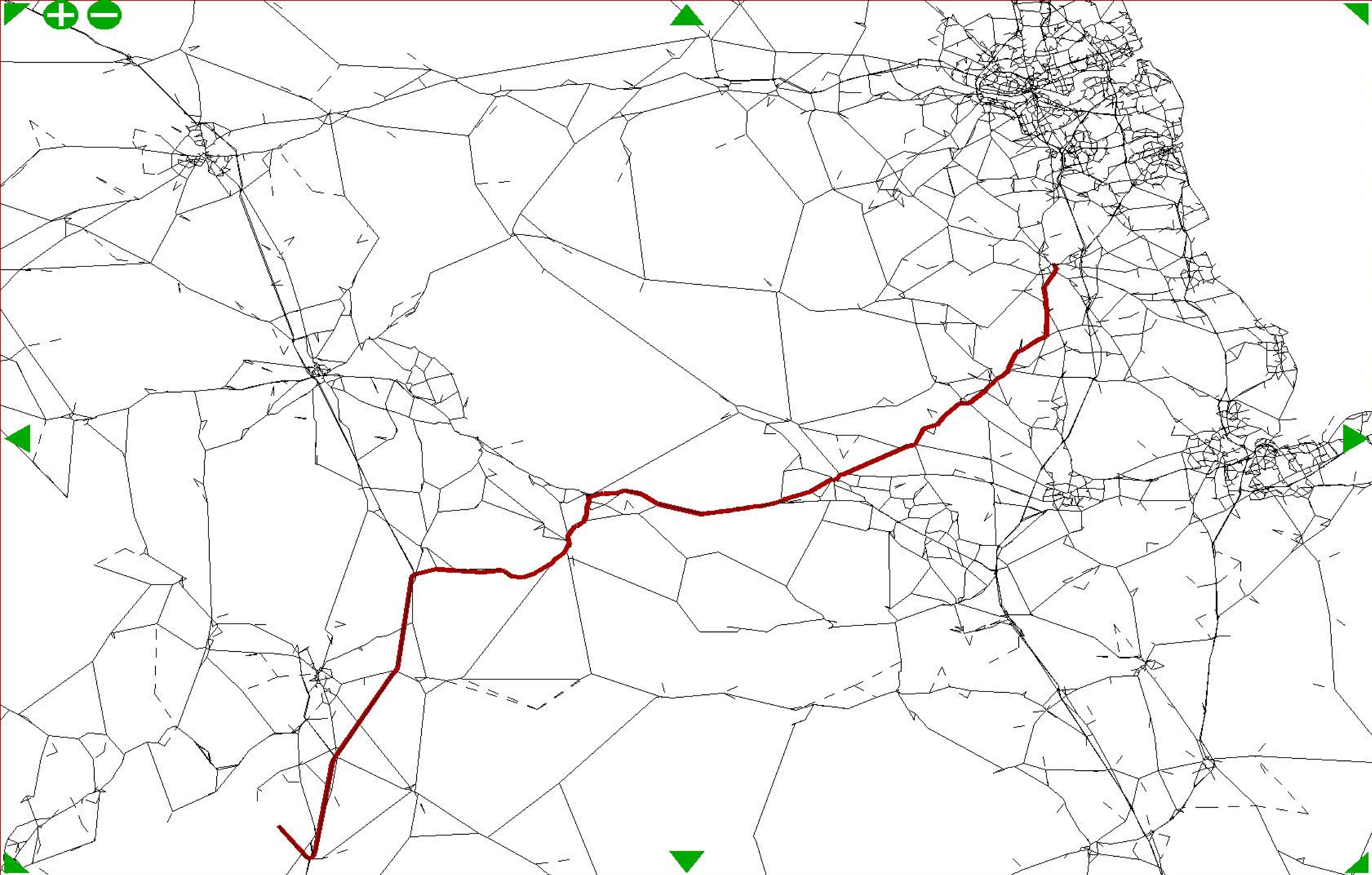
+ Menu bar!

See 11.8.3


Tree for:
Origin 1274
Dest. 1388
User Cl. 1
Minimum
COST = 2558
Skimmed
Time = 1779
Delay= 299
Dist = 32770
Speed= 66.33
FCost= 2558
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22

1. Durham to Carlisle
2. Durham to Carnforth
3. Durham to Thirsk
4. Durham to Middlesbrough
5. Durham to Penrith
6. Durham to Newcastle upon Tyne


Tree for:
Origin 1388
Dest. 184
User Cl. 1
Minimum
COST = 8085
Skimmed
Time = 5200
Delay= 426
Dist =121372
Speed= 84.03
FCost= 8085
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22



Tree for:

Origin 1388
Dest. 201

User Cl. 1

Minimum
COST = 9398

Skimmed

Time = 6250
Delay= 331
Dist =132466
Speed= 76.30
FCost= 9398

Definitions:
See 11.8.2.1

T vrs D plot

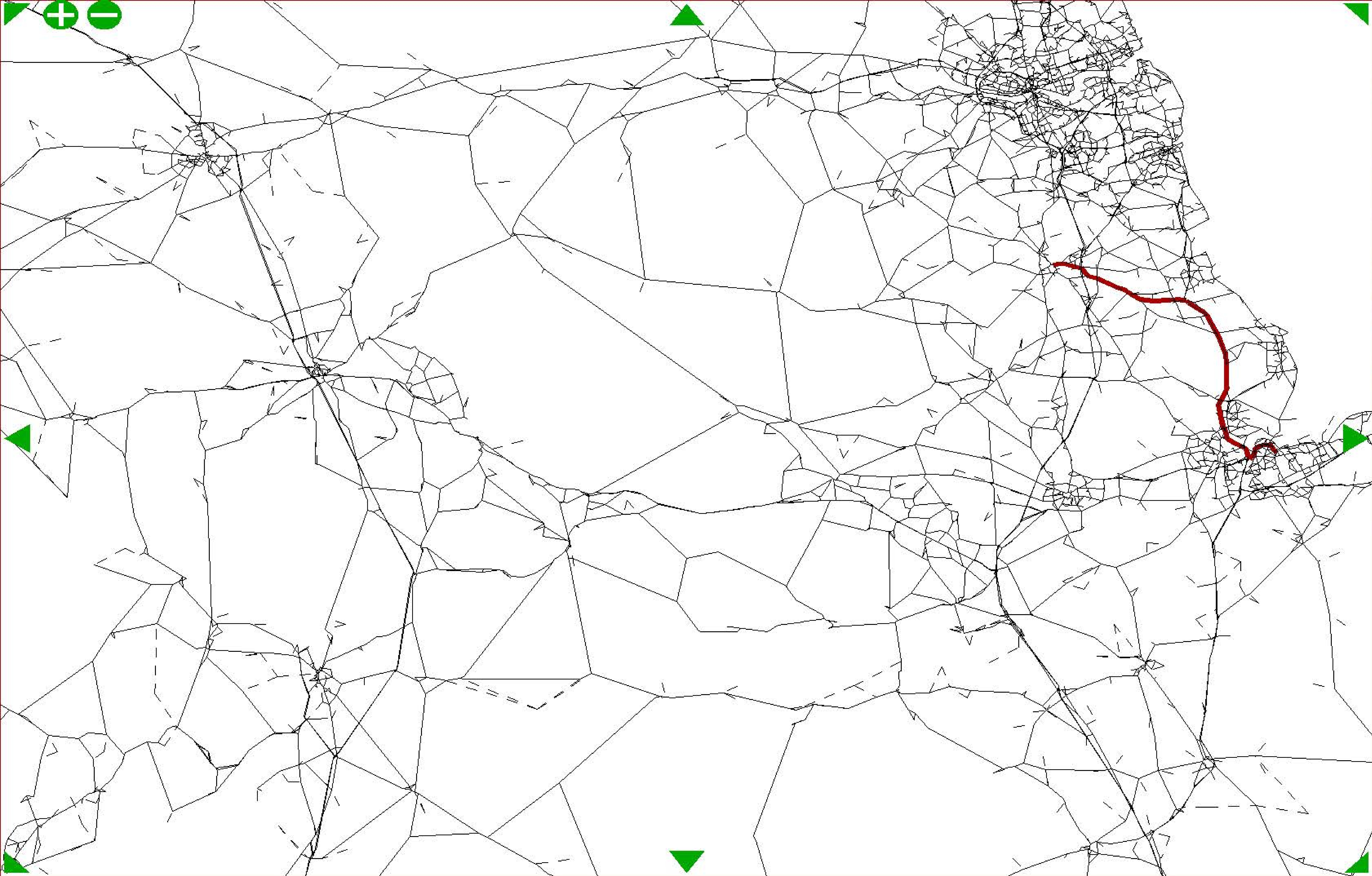
Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22


Tree for:
Origin 1388
Dest. 305
User Cl. 1
Minimum
COST = 5319
Skimmed
Time = 3416
Delay= 288
Dist.= 80075
Speed= 84.39
FCost= 5319
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22



Tree for:

Origin 1388
Dest. 1023

User Cl. 1

Minimum
COST = 3101

Skimmed

Time = 2099
Delay= 202
Dist = 42158
Speed= 72.31
FCost= 3101

Definitions:
See 11.8.2.1

T vrs D plot

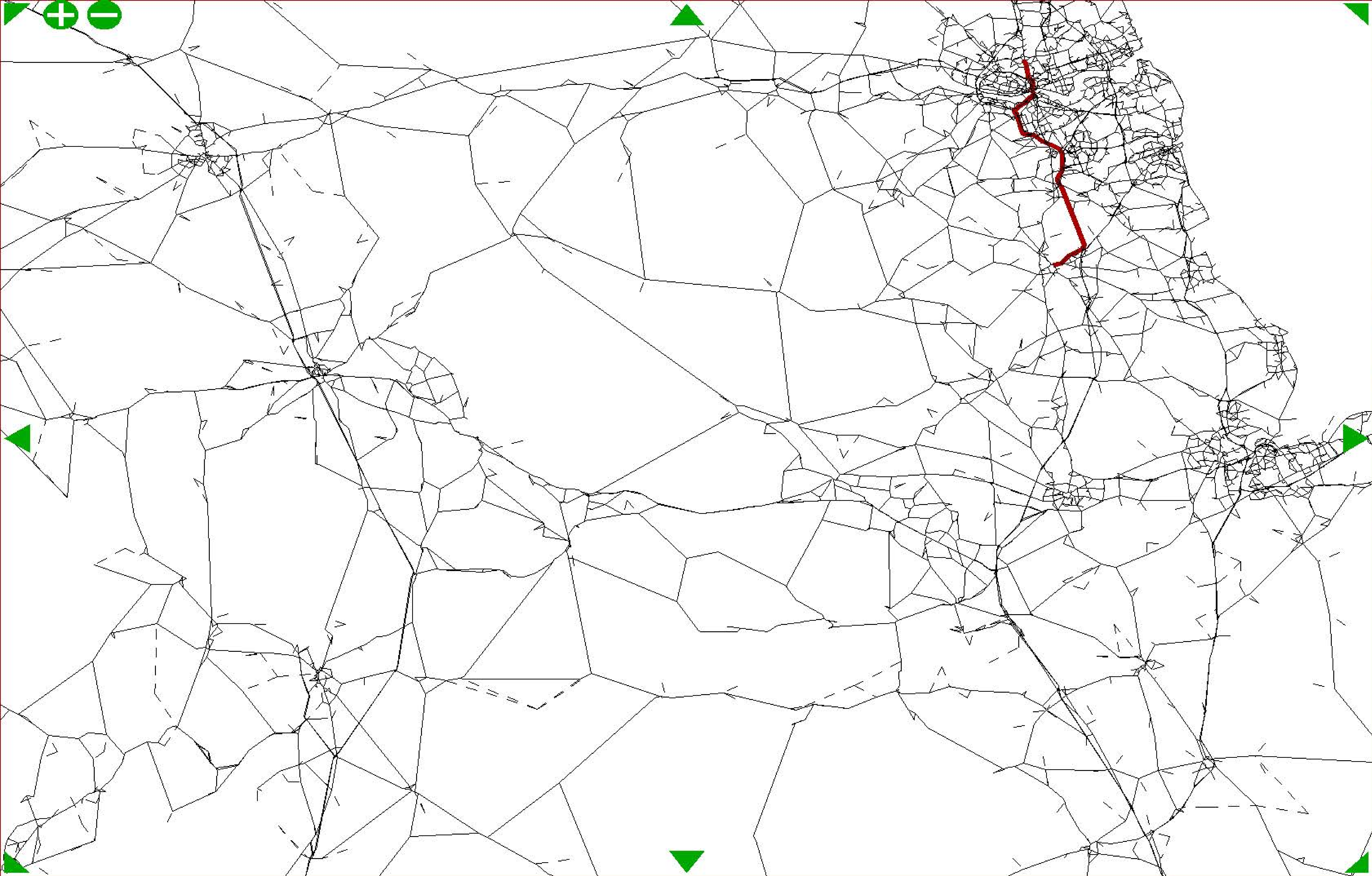
Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22


Tree for:
Origin 1388
Dest. 1088
User Cl. 1
Minimum
COST = 7766
Skimmed
Time = 5316
Delay= 474
Dist =103087
Speed= 69.81
FCost= 7766
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22



Tree for:

Origin 1388
Dest. 1274

User Cl. 1

Minimum
COST = 2597

Skimmed

Time = 1822
Delay= 332
Dist = 32603
Speed= 64.40
FCost= 2597

Definitions:
See 11.8.2.1

T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

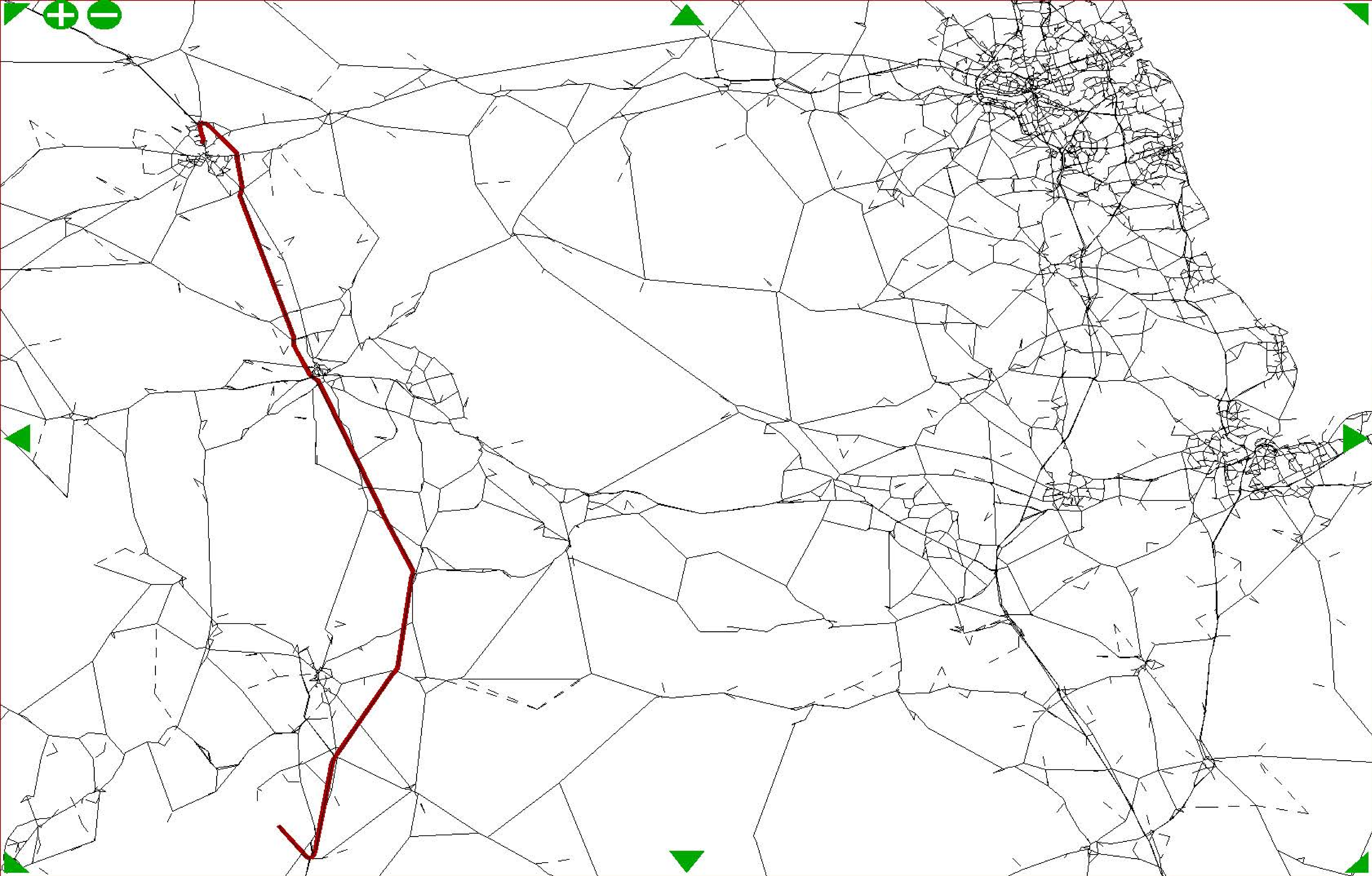
A66 Traffic Model: Stage 3 Base Year 2019 - Inter Peak 4- 3-22

ARUP

Subject PM Route Choice Outputs

Date 04 March 2022 **Job No/Ref** 276821

1. Carlisle to Carnforth
2. Carlisle to Thirsk
3. Carlisle to Middlesbrough
4. Carlisle to Penrith
5. Carlisle to Newcastle upon Tyne
6. Carlisle to Durham



Tree for:

Origin 184
Dest. 201

User Cl. 1

Minimum
COST = 6145

Skimmed

Time = 3640
Delay= 82
Dist =104351
Speed=103.21
FCost= 6145

Definitions:
See 11.8.2.1

T vrs D plot

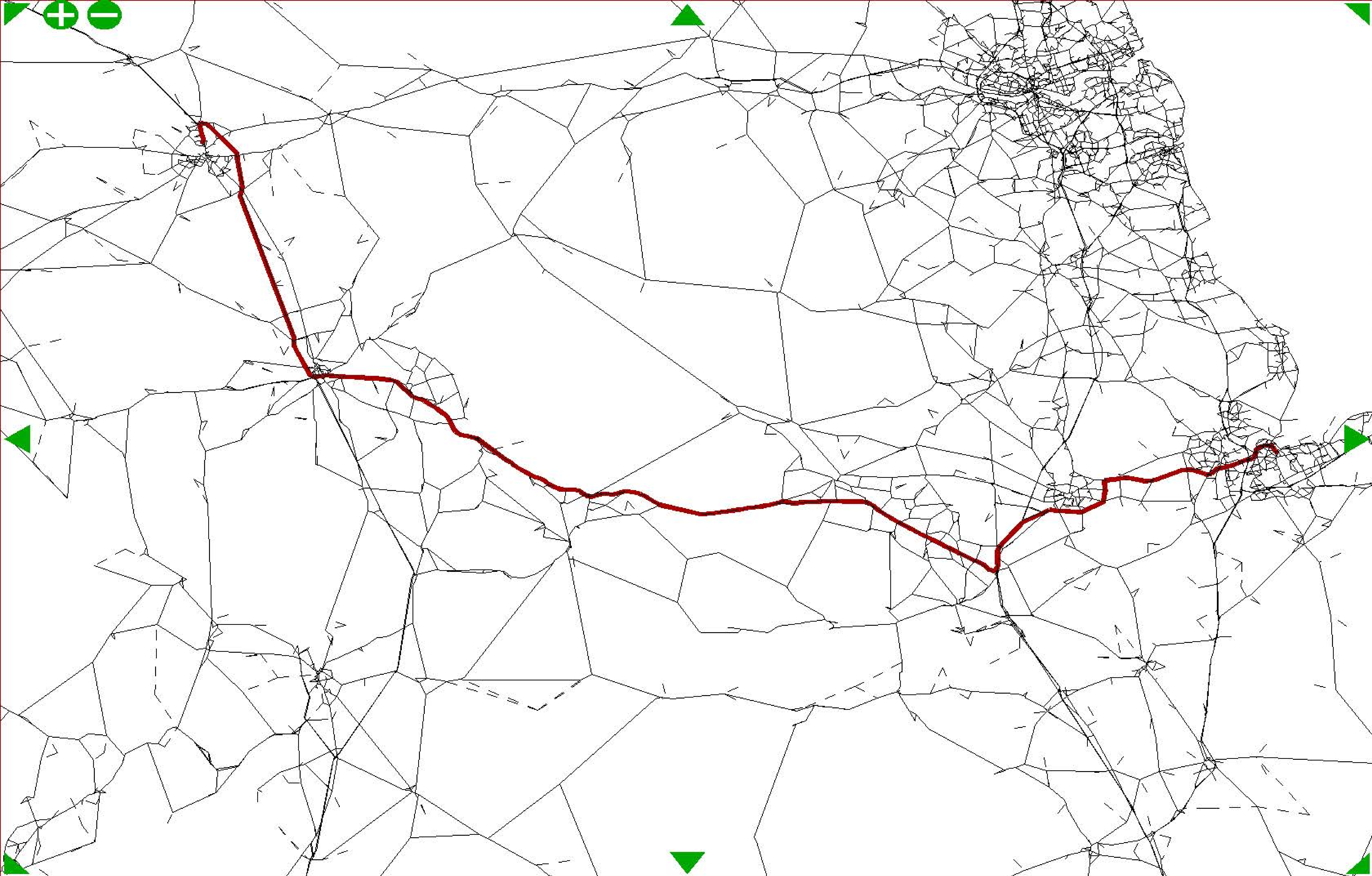
Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22


Tree for:
Origin 184
Dest. 305
User Cl. 1
Minimum
COST = 10555
Skimmed
Time = 6713
Delay= 441
Dist =160016
Speed= 85.81
FCost= 10555
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 184
Dest. 1023

User Cl. 1

Minimum
COST = 10347

Skimmed

Time = 6575
Delay= 615
Dist =157113
Speed= 86.03
FCost= 10347

Definitions:
See 11.8.2.1

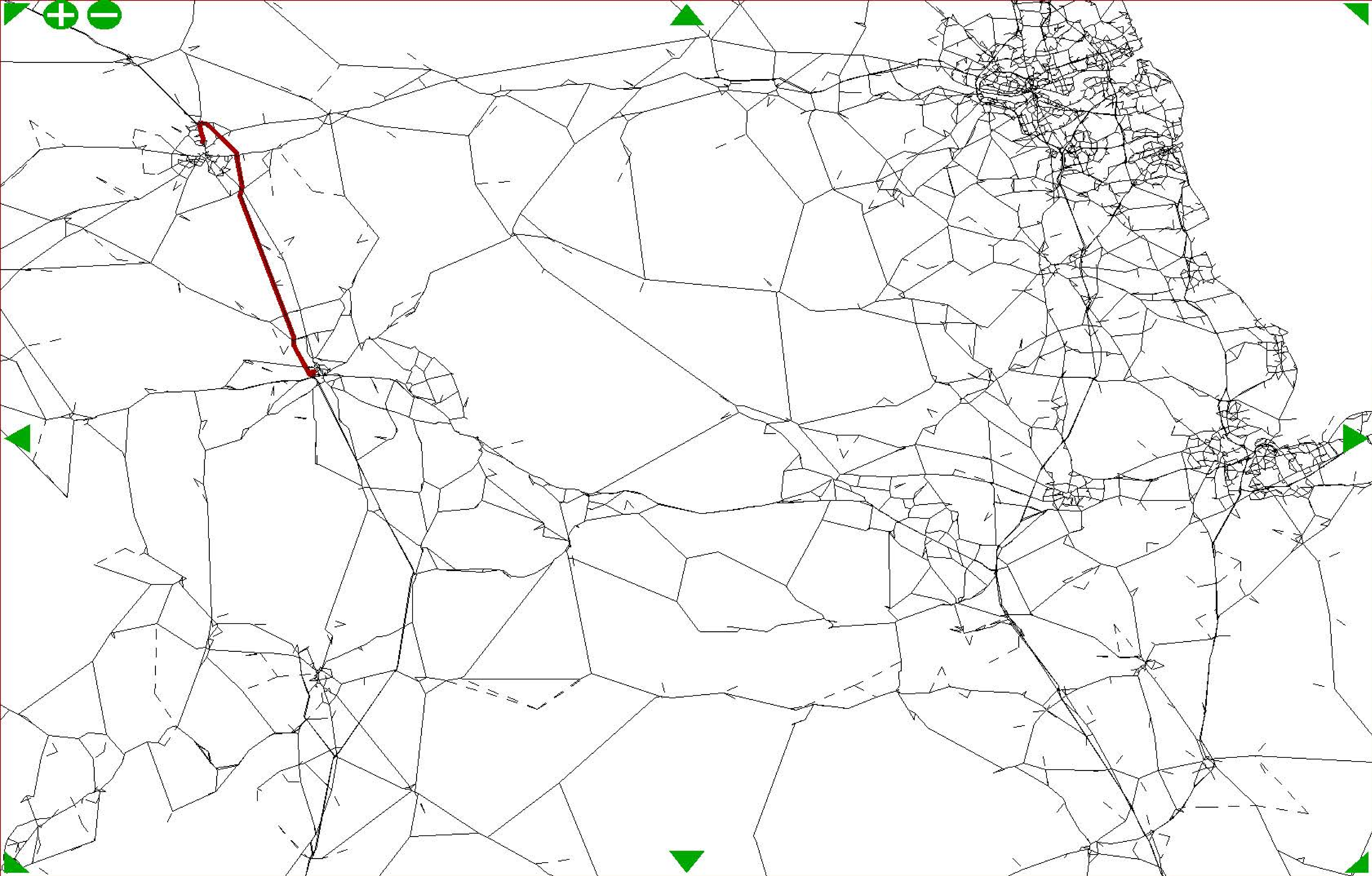
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 184
Dest. 1088

User Cl. 1

Minimum
COST = 2458

Skimmed

Time = 1533
Delay= 42
Dist = 38517
Speed= 90.45
FCost= 2458

Definitions:
See 11.8.2.1

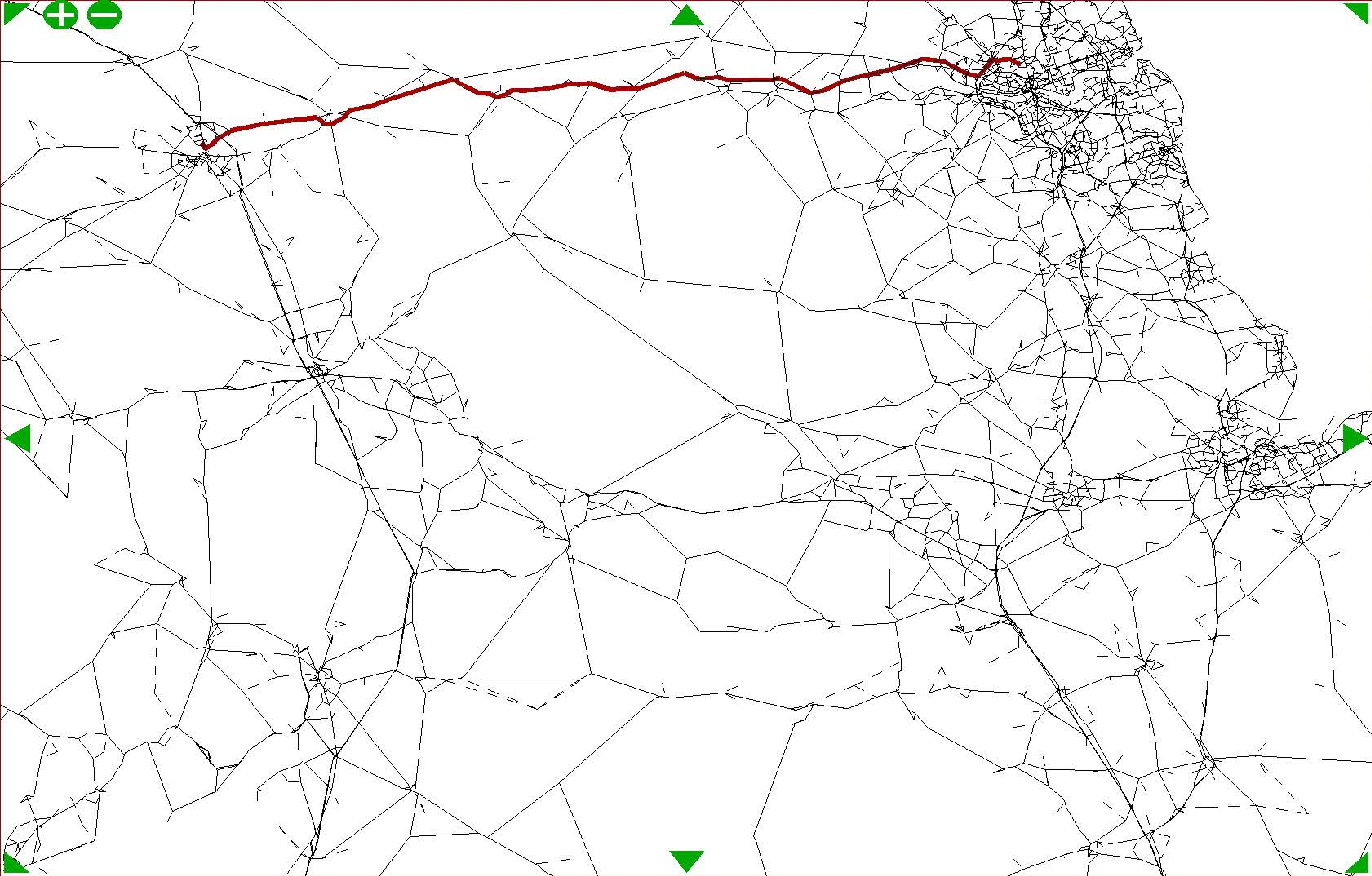
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 184
Dest. 1274

User Cl. 1

Minimum
COST = 6663

Skimmed

Time = 4390
Delay= 356
Dist. = 94662
Speed= 77.62
FCost= 6663

Definitions:
See 11.8.2.1

T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

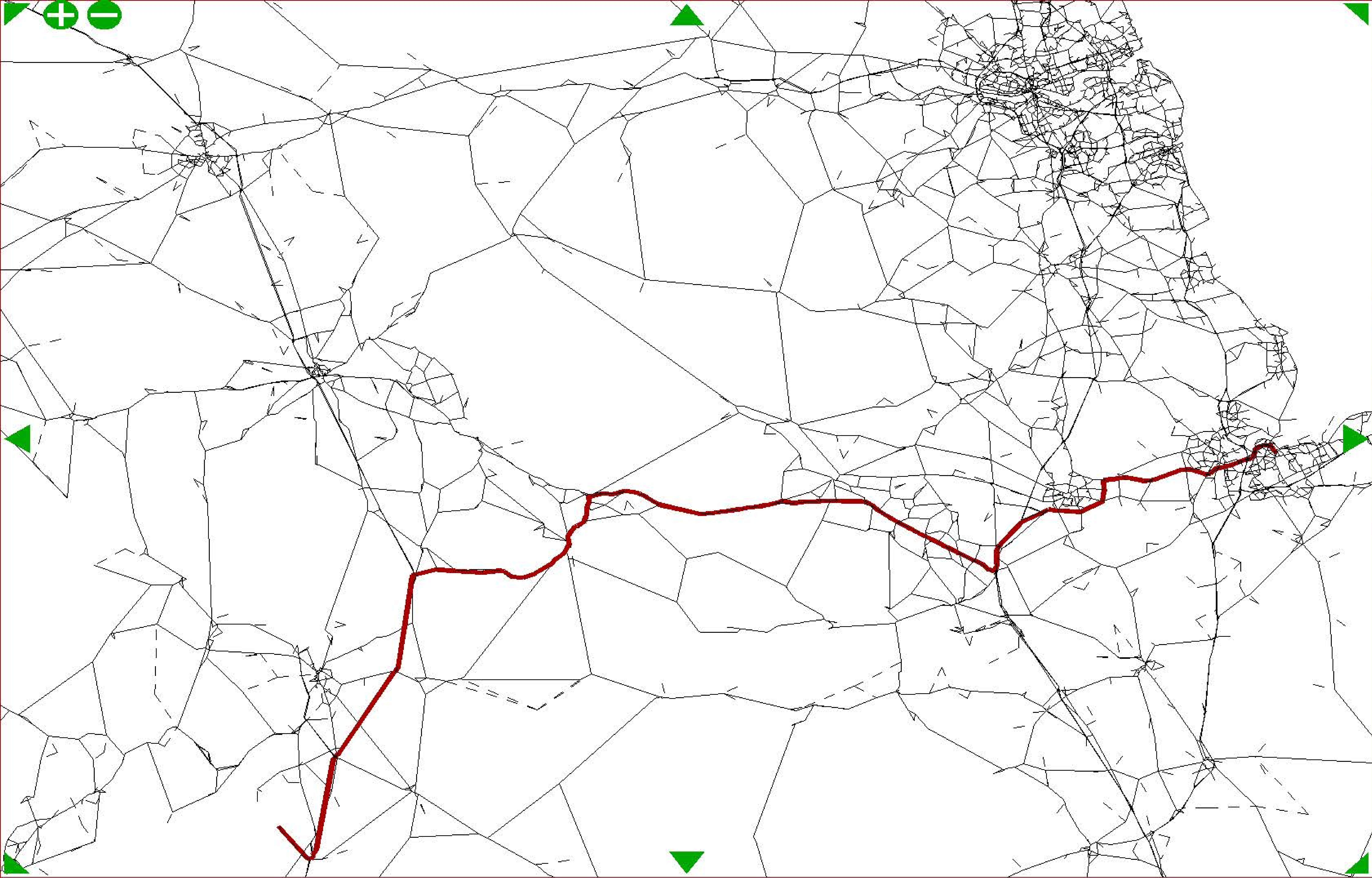
A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22


Tree for:
Origin 184
Dest. 1388
User Cl. 1
Minimum
COST = 8016
Skimmed
Time = 5453
Delay= 410
Dist =106748
Speed= 70.48
FCost= 8016
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22

1. Carnforth to Carlisle
2. Carnforth to Thirsk
3. Carnforth to Middlesbrough
4. Carnforth to Penrith
5. Carnforth to Newcastle upon Tyne
6. Carnforth to Durham


Tree for:
Origin 201
Dest. 184
User Cl. 1
Minimum
COST = 6080
Skimmed
Time = 3579
Delay= 57
Dist =104165
Speed=104.77
FCost= 6080
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22

Tree for:
Origin 201
Dest. 305
User Cl. 1
Minimum
COST = 9800
Skimmed
Time = 6875
Delay= 114
Dist =121828
Speed= 63.80
FCost= 9800
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 201
Dest. 1023

User Cl. 1

Minimum
COST = 9839

Skimmed

Time = 6218
Delay= 414
Dist =150817
Speed= 87.32
FCost= 9839

Definitions:
See 11.8.2.1

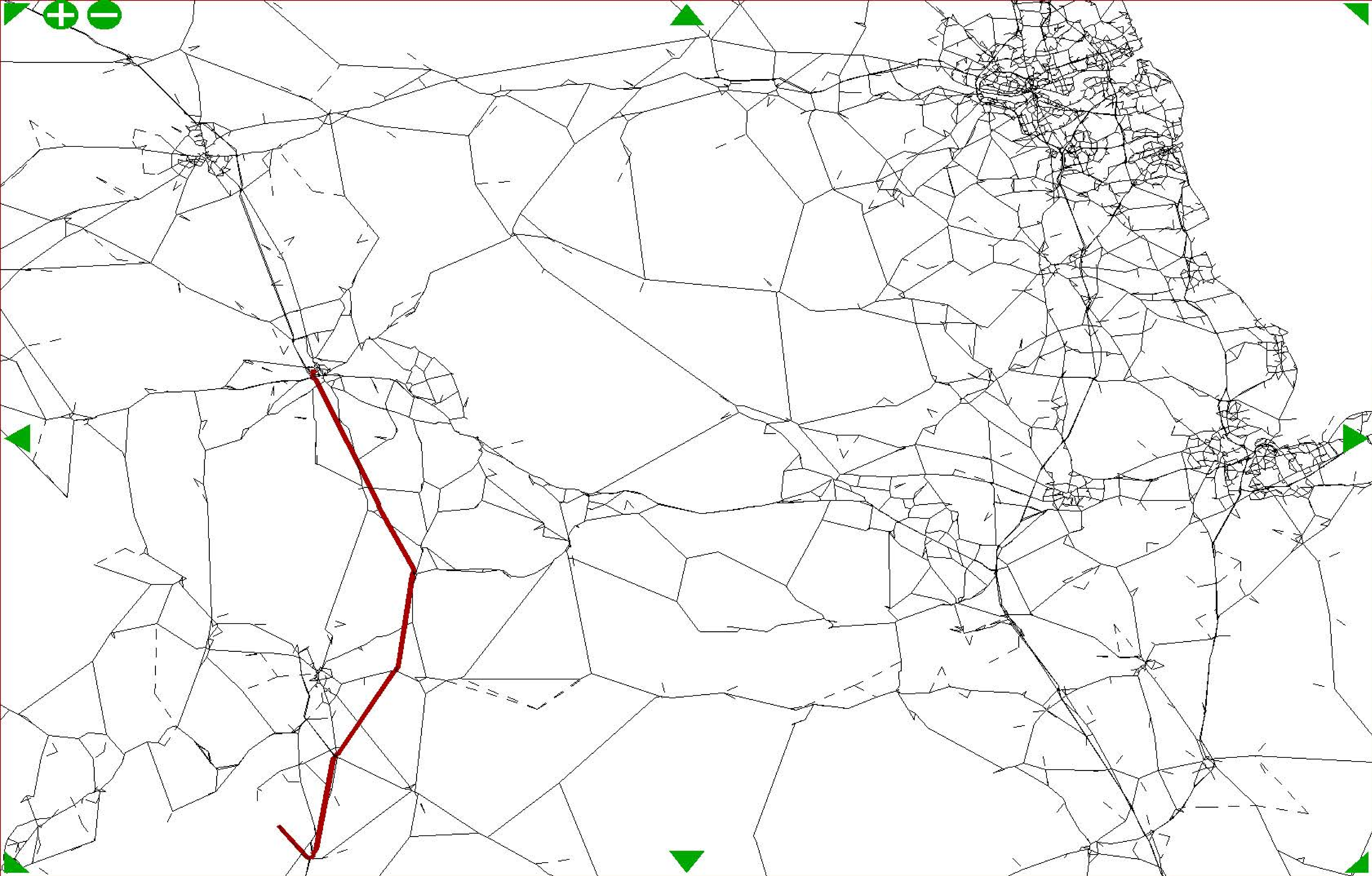
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 201
Dest. 1088

User Cl. 1

Minimum
COST = 4003

Skimmed

Time = 2375
Delay= 76
Dist = 67776
Speed=102.72
FCost= 4003

Definitions:
See 11.8.2.1

T vrs D plot

Q - Return

+ Menu bar!

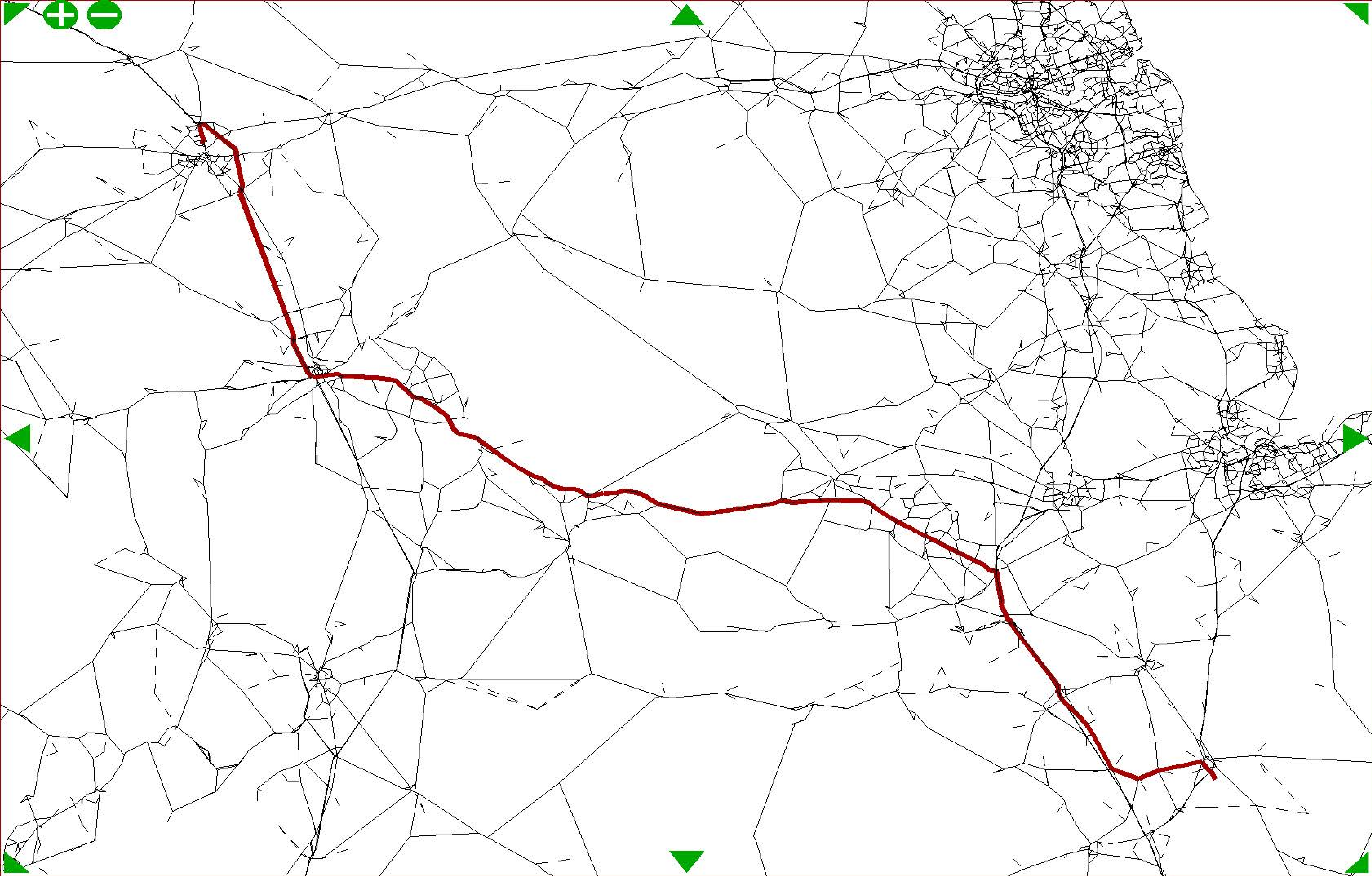
See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22


Tree for:
Origin 201
Dest. 1274
User Cl. 1
Minimum
COST = 11766
Skimmed
Time = 7655
Delay= 296
Dist =171238
Speed= 80.53
FCost= 11766
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22


Tree for:
Origin 201
Dest. 1388
User Cl. 1
Minimum
COST = 9521
Skimmed
Time = 6321
Delay= 355
Dist =133274
Speed= 75.91
FCost= 9521
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22

1. Thirsk to Carlisle
2. Thirsk to Carnforth
3. Thirsk to Middlesbrough
4. Thirsk to Penrith
5. Thirsk to Newcastle upon Tyne
6. Thirsk to Durham



Tree for:

Origin 305
Dest. 184

User Cl. 1

Minimum
COST = 10493

Skimmed

Time = 6656
Delay= 420
Dist =159796
Speed= 86.43
FCost= 10493

Definitions:
See 11.8.2.1

T vrs D plot

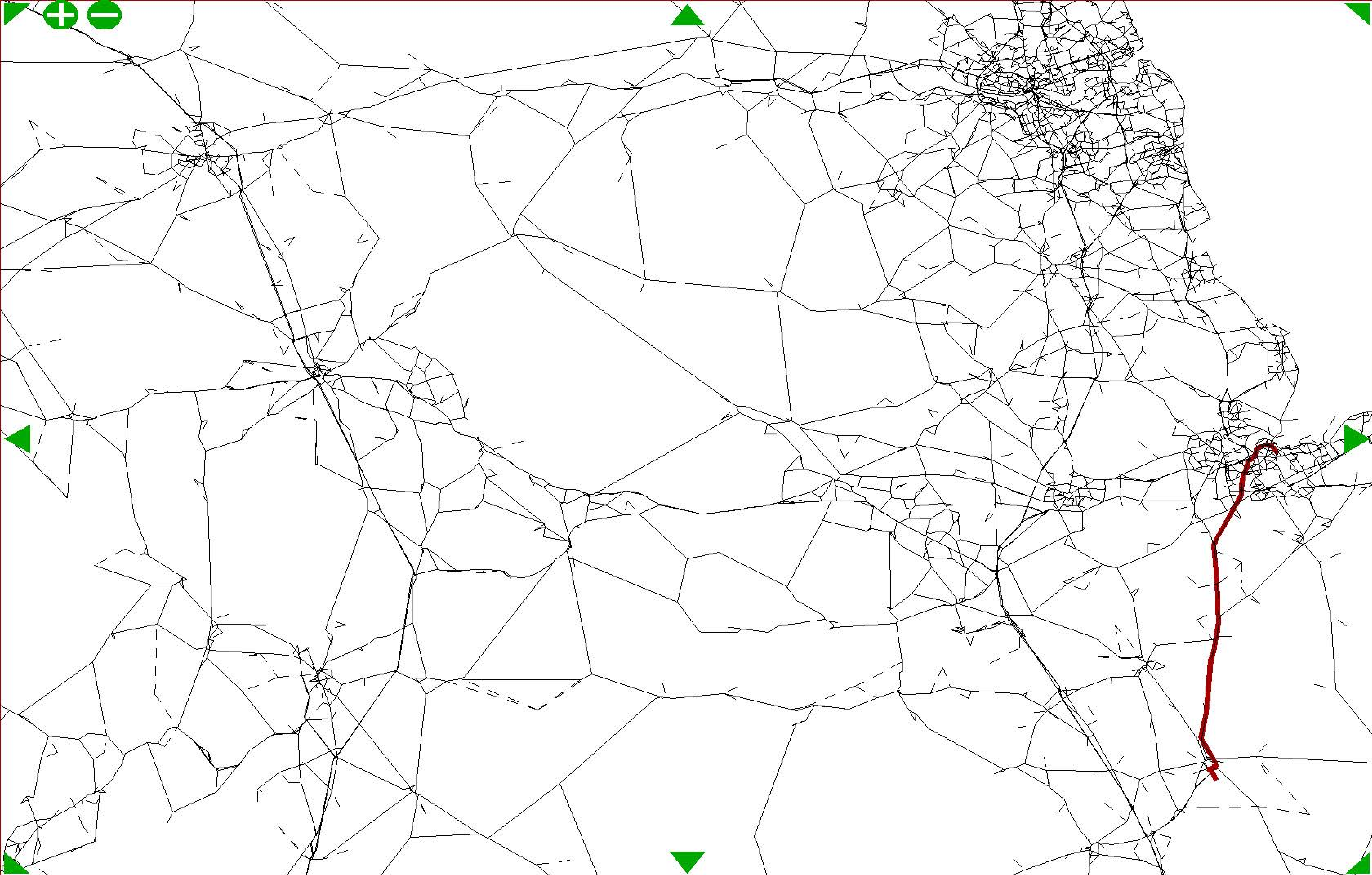
Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22


Tree for:
Origin 305
Dest. 201
User Cl. 1
Minimum
COST = 9803
Skimmed
Time = 6879
Delay= 115
Dist =121757
Speed= 63.72
FCost= 9803
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 305
Dest. 1023

User Cl. 1

Minimum
COST = 3037

Skimmed

Time = 1923
Delay= 150
Dist = 46401
Speed= 86.87
FCost= 3037

Definitions:
See 11.8.2.1

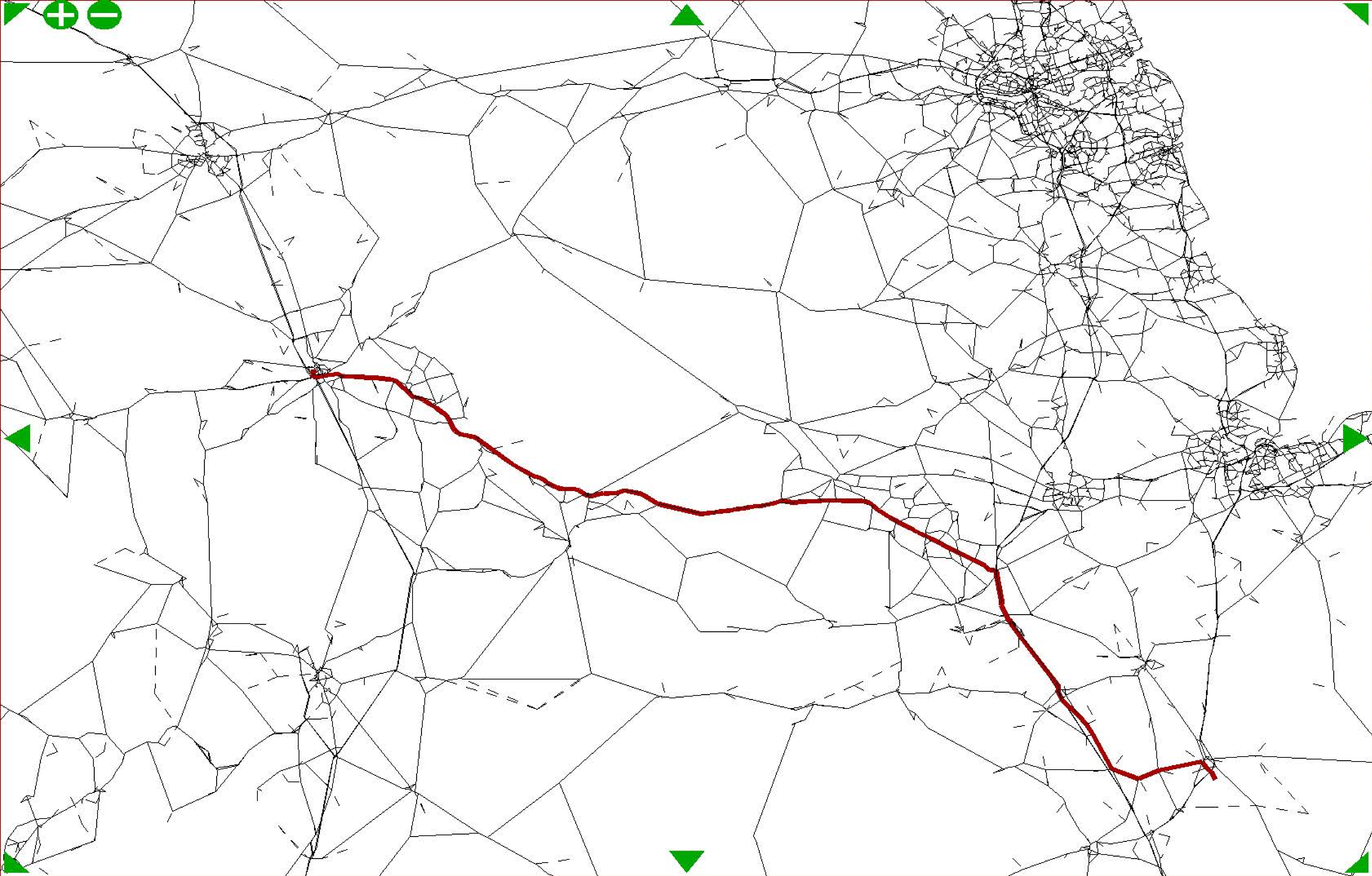
T vrs D plot

Q - Return

\+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 305
Dest. 1088

User Cl. 1

Minimum
COST = 8344

Skimmed

Time = 5382
Delay= 403
Dist =123369
Speed= 82.53
FCost= 8344

Definitions:
See 11.8.2.1

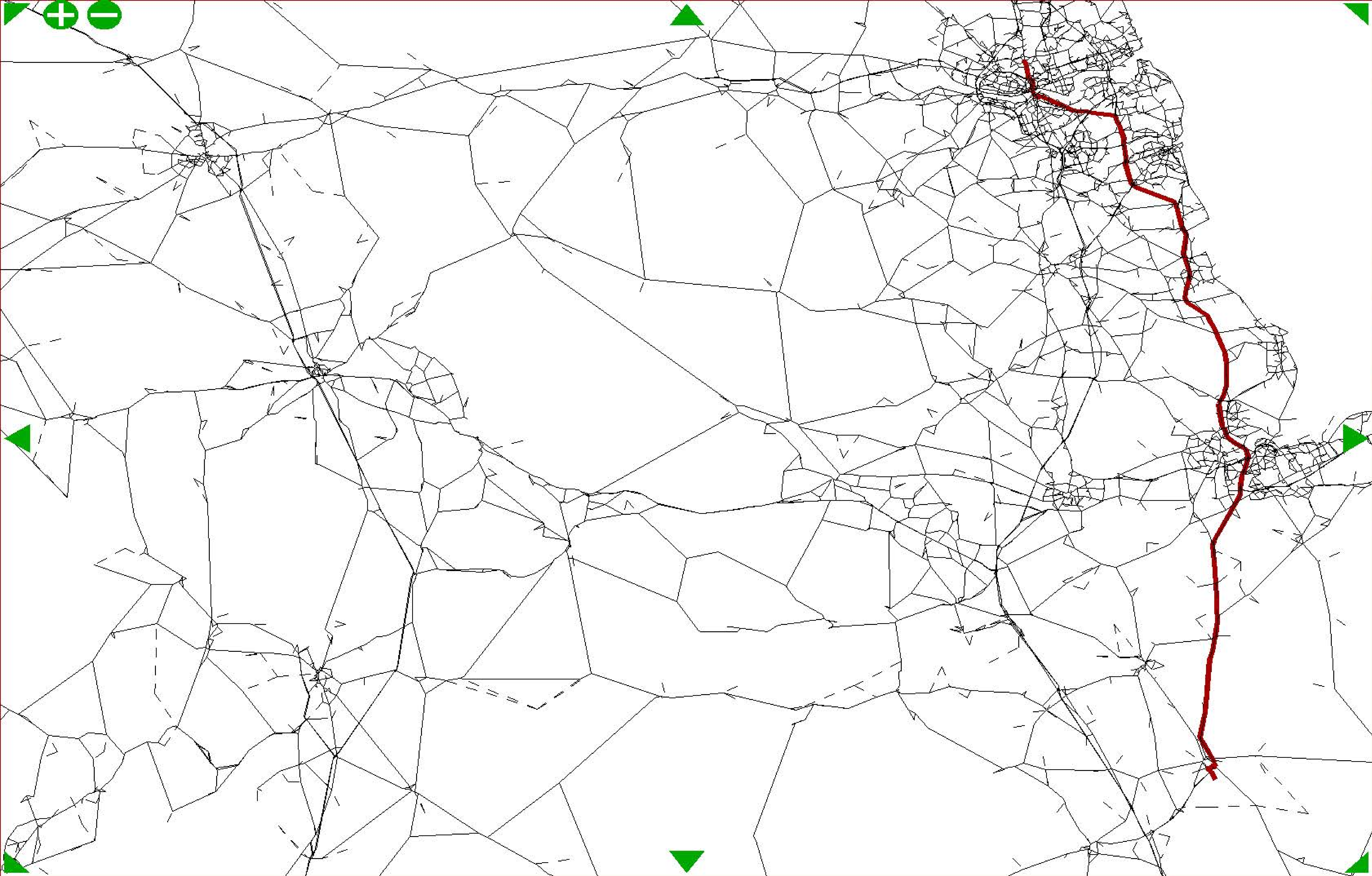
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 305
Dest. 1274

User Cl. 1

Minimum
COST = 7451

Skimmed

Time = 4932
Delay= 988
Dist =104902
Speed= 76.57
FCost= 7451

Definitions:
See 11.8.2.1

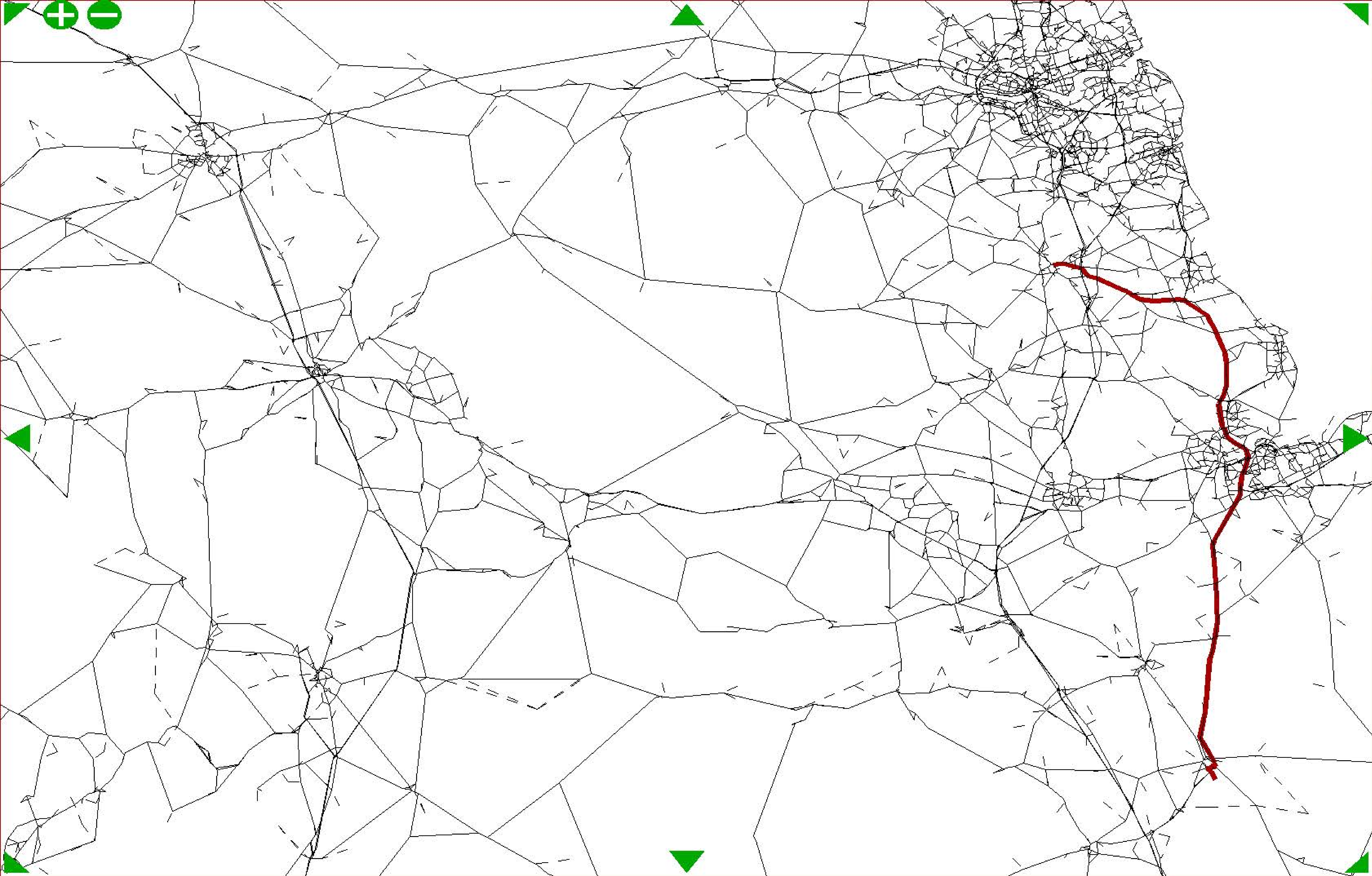
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 305
Dest. 1388

User Cl. 1

Minimum
COST = 5455

Skimmed

Time = 3531
Delay= 383
Dist = 80142
Speed= 81.70
FCost= 5455

Definitions:
See 11.8.2.1

T vrs D plot

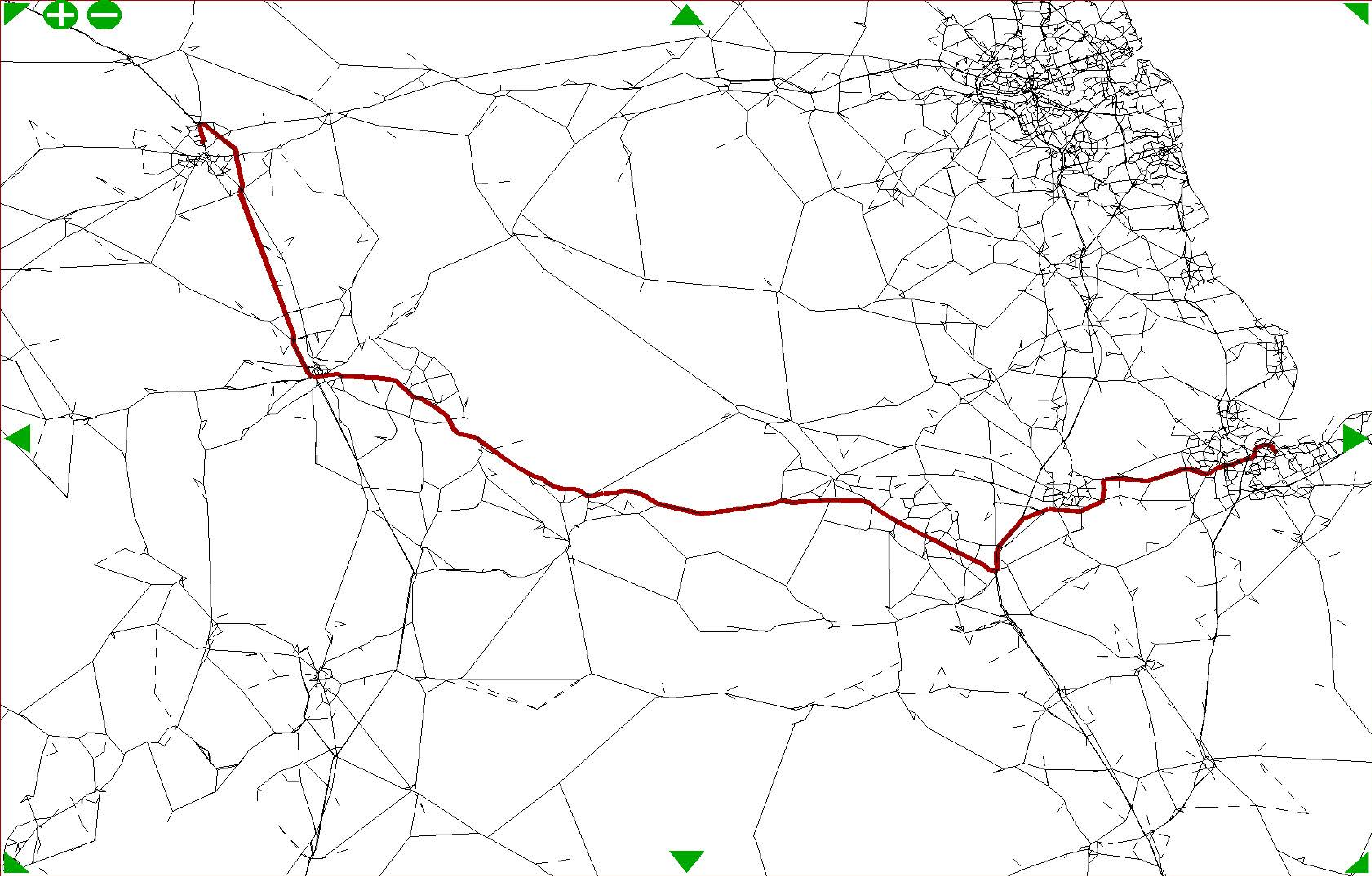
Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22

1. Middlesbrough to Carlisle
2. Middlesbrough to Carnforth
3. Middlesbrough to Thirsk
4. Middlesbrough to Penrith
5. Middlesbrough to Newcastle upon Tyne
6. Middlesbrough to Durham



Tree for:

Origin 1023
Dest. 184

User Cl. 1

Minimum
COST = 10251

Skimmed

Time = 6479
Delay= 578
Dist =157066
Speed= 87.27
FCost= 10251

Definitions:
See 11.8.2.1

T vrs D plot

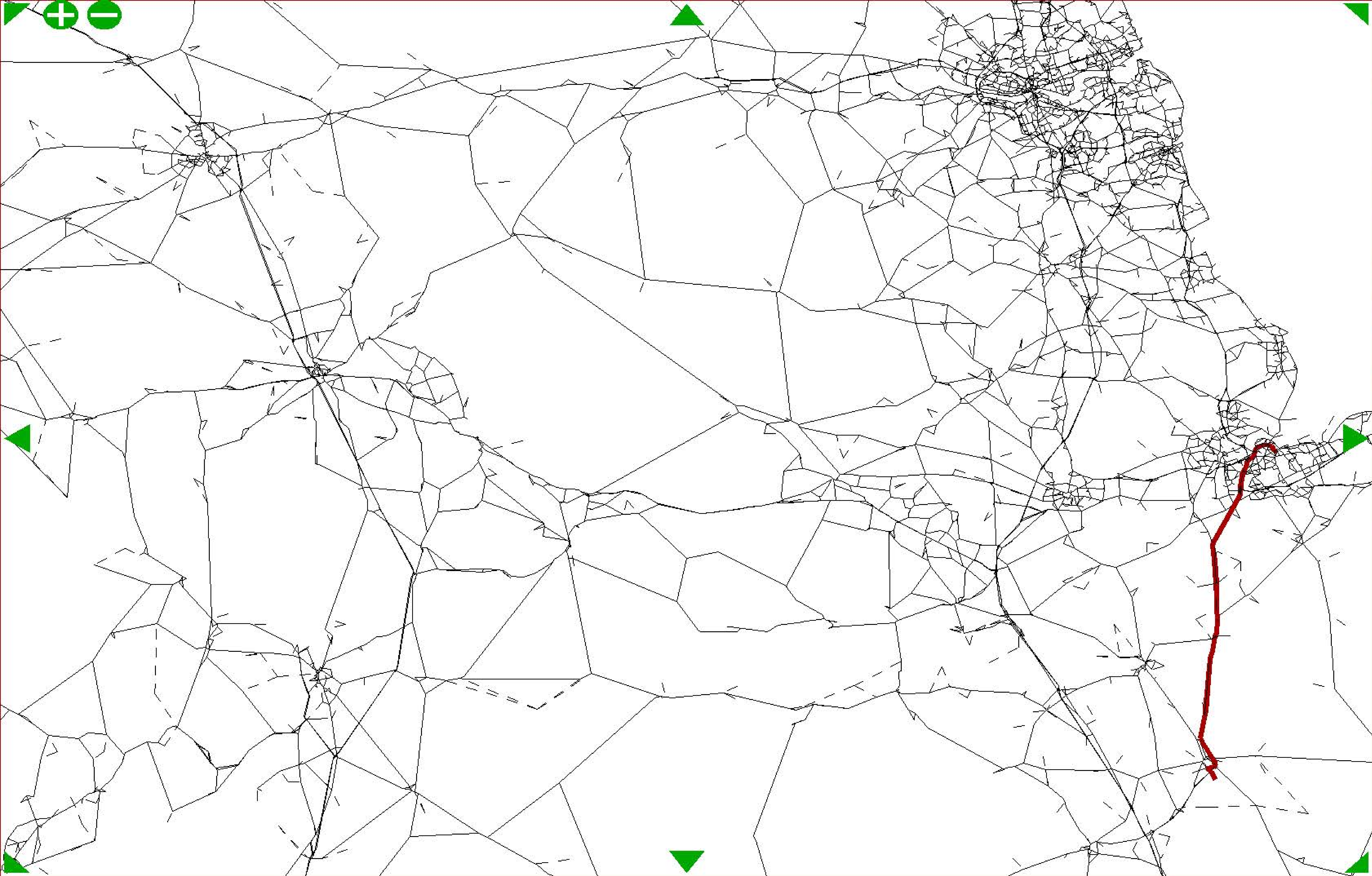
Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22


Tree for:
Origin 1023
Dest. 201
User Cl. 1
Minimum
COST = 9759
Skimmed
Time = 6157
Delay= 436
Dist =150018
Speed= 87.71
FCost= 9759
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 1023
Dest. 305

User Cl. 1

Minimum
COST = 2953

Skimmed

Time = 1849
Delay= 133
Dist = 45962
Speed= 89.47
FCost= 2953

Definitions:
See 11.8.2.1

T vrs D plot

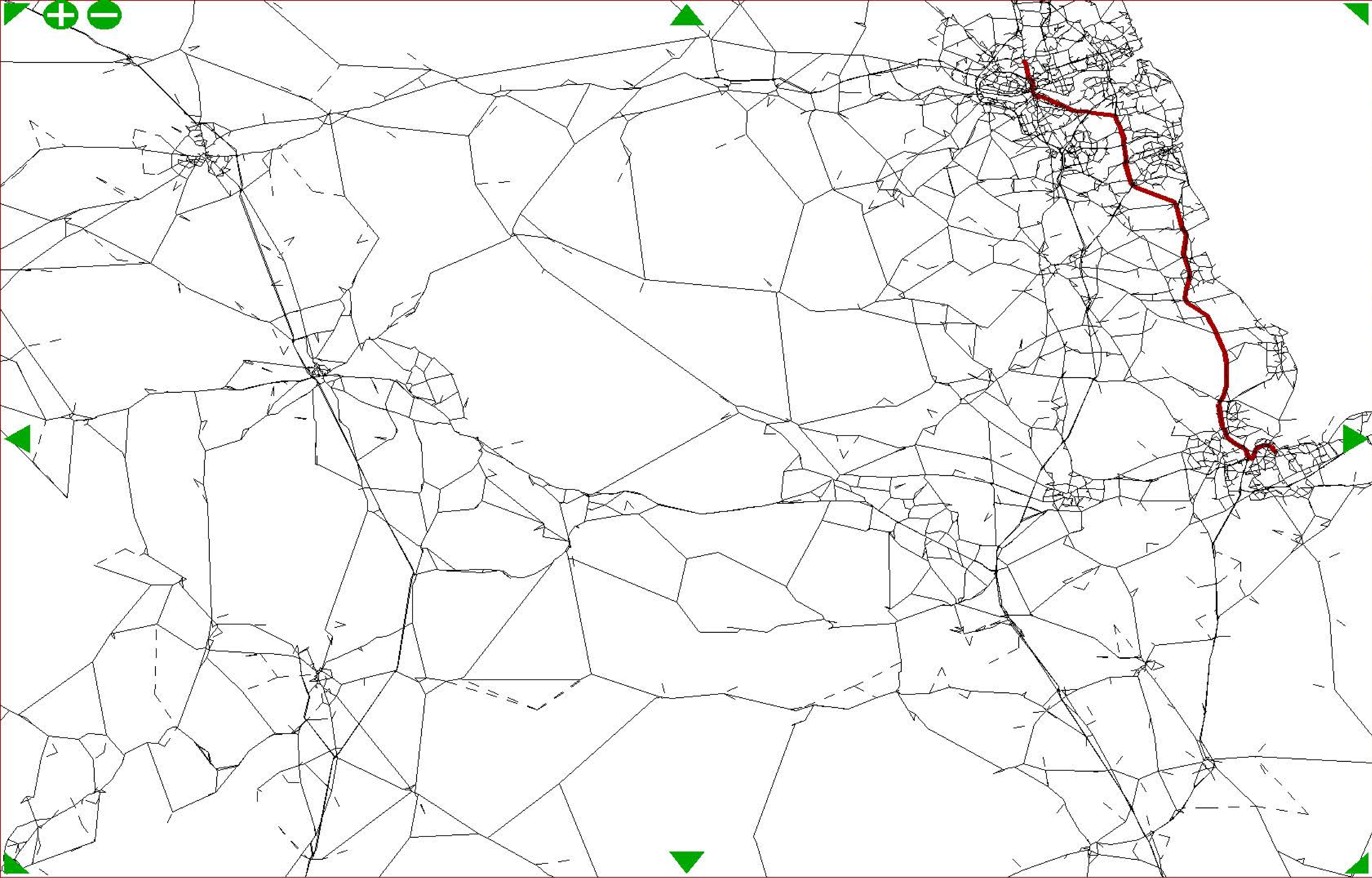
Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22


Tree for:
Origin 1023
Dest. 1088
User Cl. 1
Minimum
COST = 8102
Skimmed
Time = 5205
Delay= 562
Dist =120639
Speed= 83.44
FCost= 8102
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 1023
Dest. 1274

User Cl. 1

Minimum
COST = 5212

Skimmed

Time = 3599
Delay= 918
Dist = 67163
Speed= 67.18
FCost= 5212

Definitions:
See 11.8.2.1

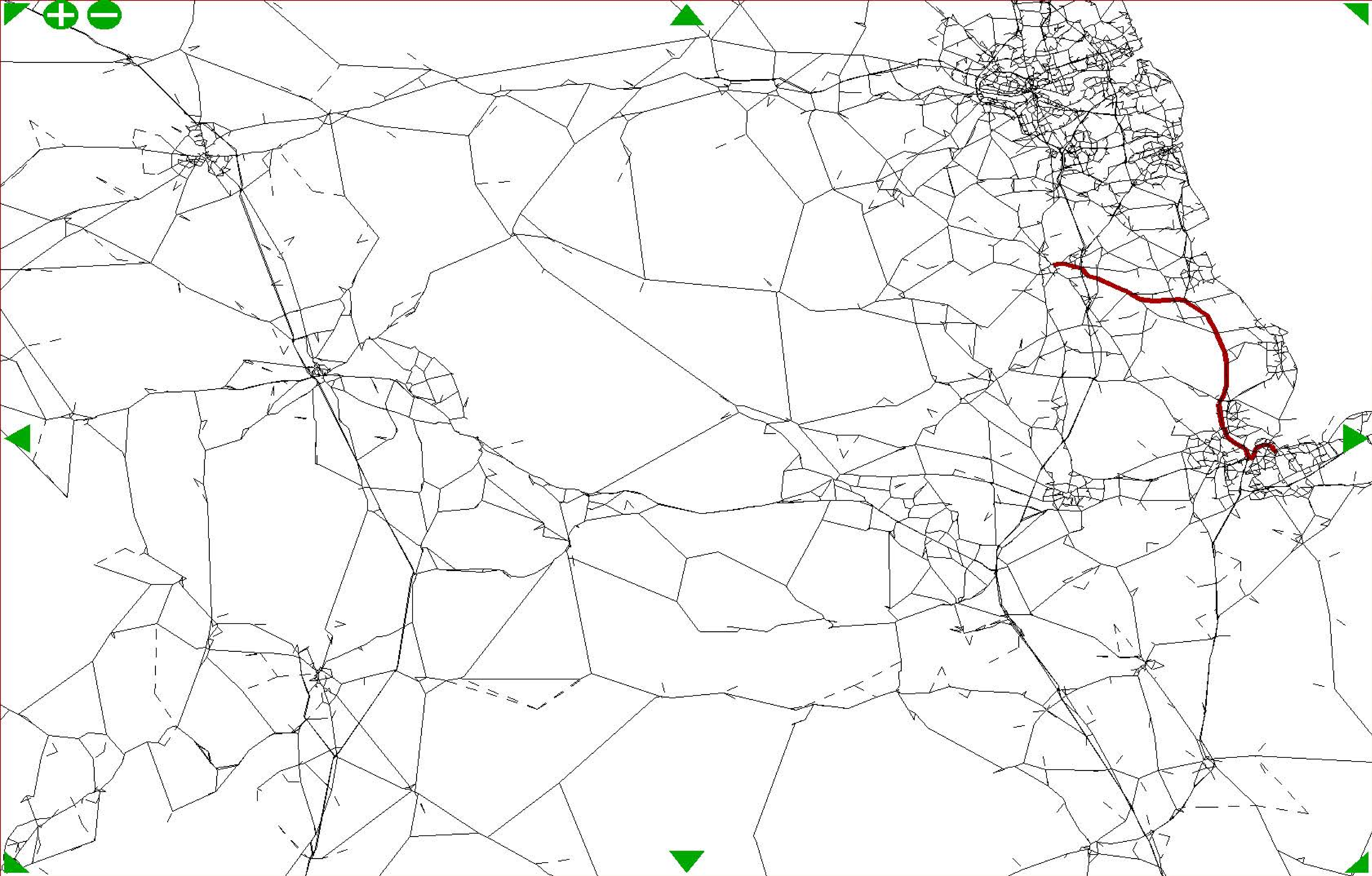
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 1023
Dest. 1388

User Cl. 1

Minimum
COST = 3216

Skimmed

Time = 2198
Delay= 313
Dist = 42403
Speed= 69.44
FCost= 3216

Definitions:
See 11.8.2.1

T vrs D plot

Q - Return

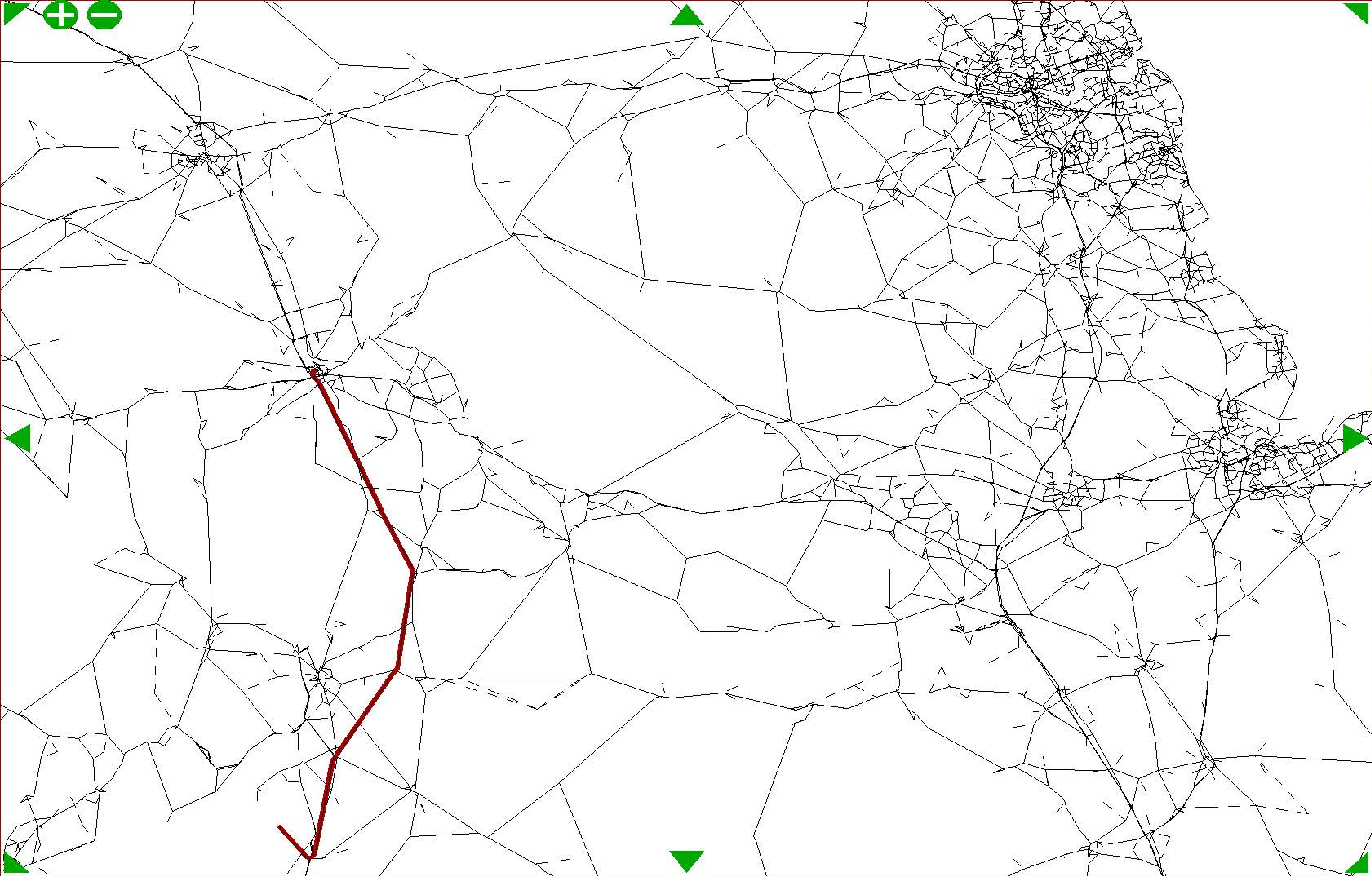
+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22

1. Penrith to Carlisle
2. Penrith to Carnforth
3. Penrith to Thirsk
4. Penrith to Middlesbrough
5. Penrith to Newcastle upon Tyne
6. Penrith to Durham


Tree for:
Origin 1088
Dest. 184
User Cl. 1
Minimum
COST = 2449
Skimmed
Time = 1523
Delay= 40
Dist = 38560
Speed= 91.14
FCost= 2449
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 1088
Dest. 201

User Cl. 1

Minimum
COST = 3946

Skimmed

Time = 2326
Delay= 60
Dist = 67439
Speed=104.37
FCost= 3946

Definitions:
See 11.8.2.1

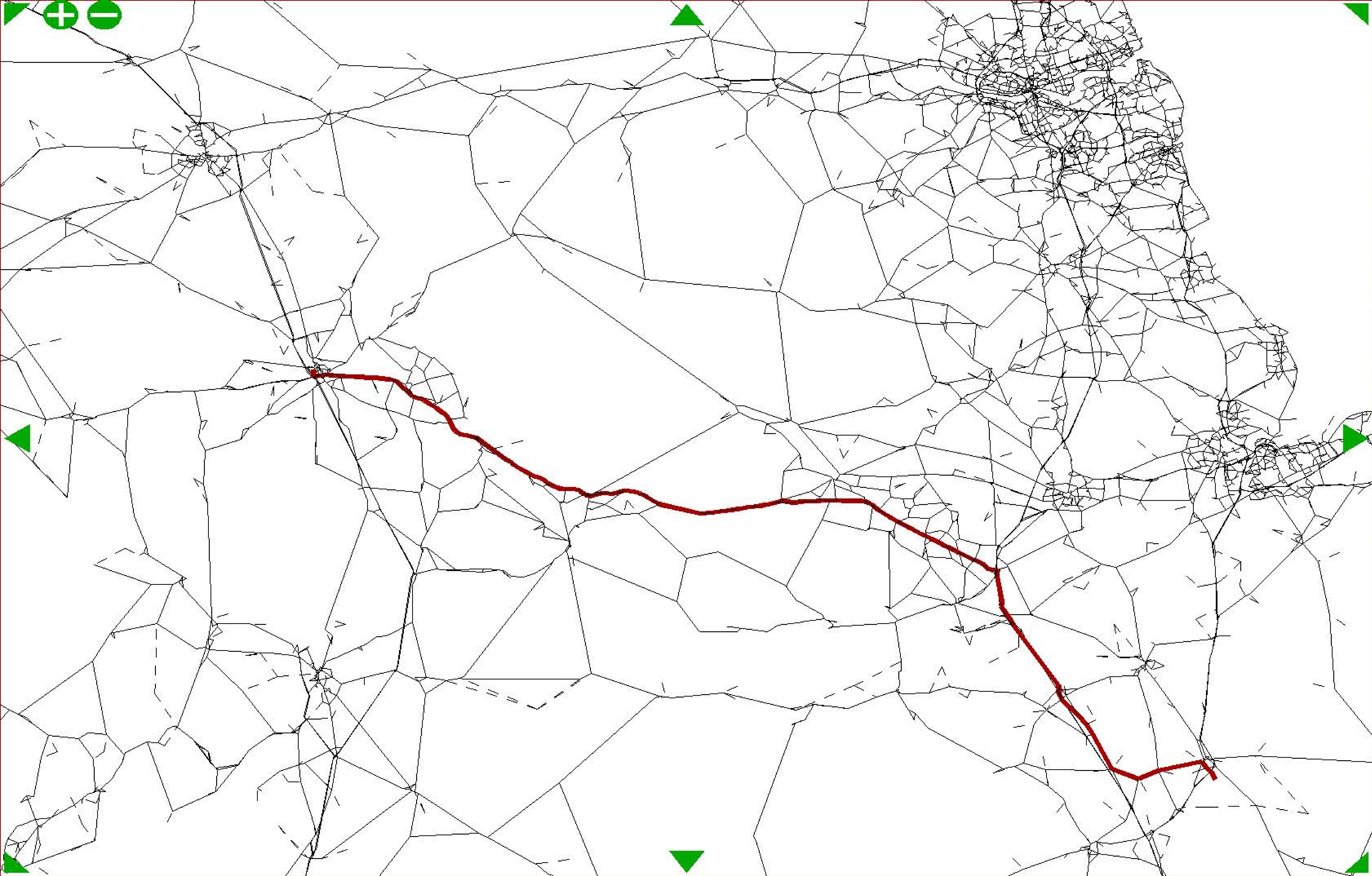
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 1088
Dest. 305

User Cl. 1

Minimum
COST = 8306

Skimmed

Time = 5352
Delay= 412
Dist =123018
Speed= 82.75
FCost= 8306

Definitions:
See 11.8.2.1

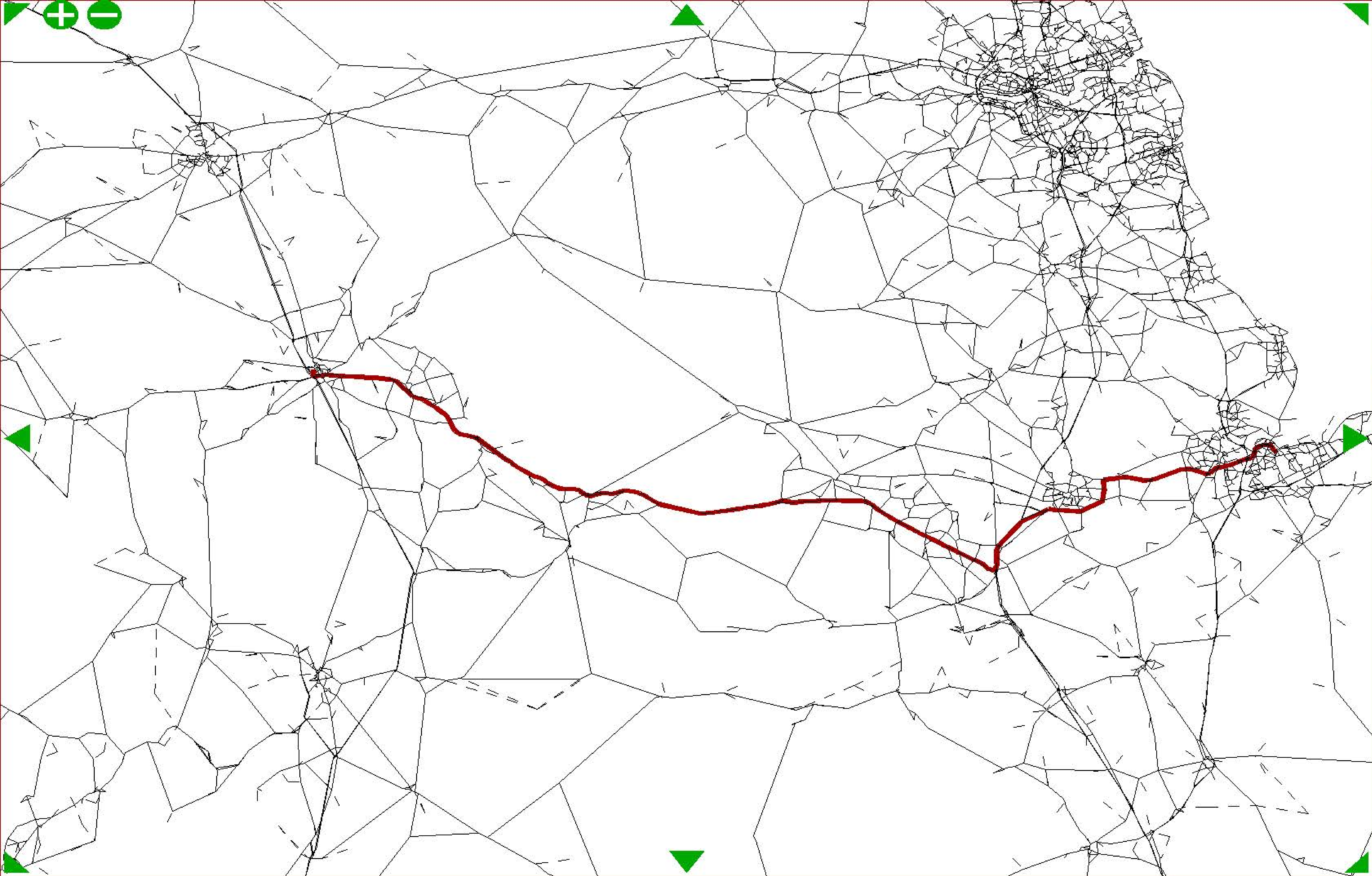
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 1088
Dest. 1023

User Cl. 1

Minimum
COST = 8097

Skimmed

Time = 5213
Delay= 586
Dist =120115
Speed= 82.95
FCost= 8097

Definitions:
See 11.8.2.1

T vrs D plot

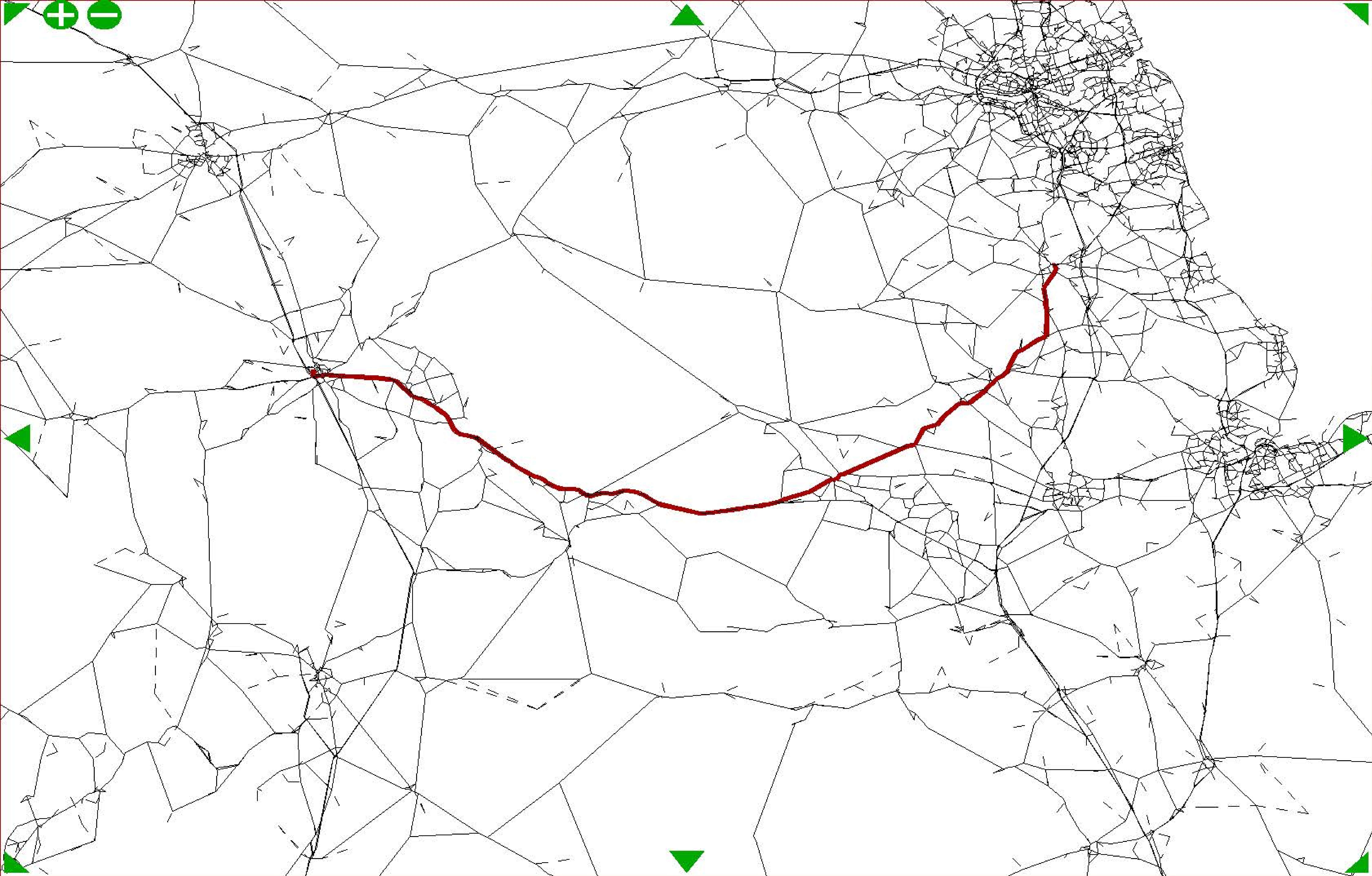
Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22


Tree for:
Origin 1088
Dest. 1274
User Cl. 1
Minimum
COST = 7973
Skimmed
Time = 5452
Delay= 235
Dist =104981
Speed= 69.32
FCost= 7973
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 1088
Dest. 1388

User Cl. 1

Minimum
COST = 7779

Skimmed

Time = 5316
Delay= 527
Dist =102572
Speed= 69.46
FCost= 7779

Definitions:
See 11.8.2.1

T vrs D plot

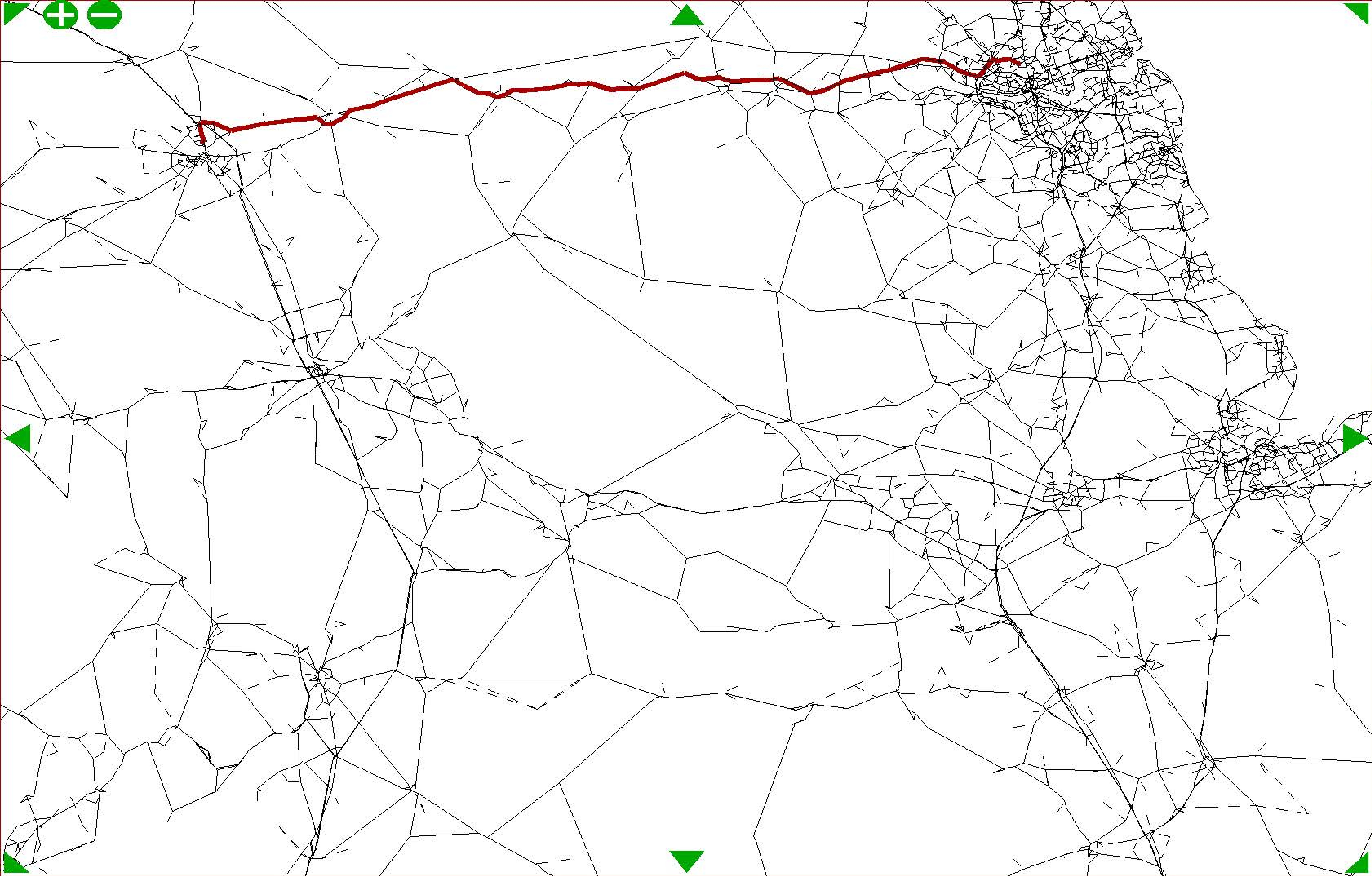
Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22

1. Newcastle upon Tyne to Carlisle
2. Newcastle upon Tyne to Carnforth
3. Newcastle upon Tyne to Thirsk
4. Newcastle upon Tyne to Middlesbrough
5. Newcastle upon Tyne to Penrith
6. Newcastle upon Tyne to Durham



Tree for:

Origin 1274
Dest. 184

User Cl. 1

Minimum
COST = 6719

Skimmed

Time = 4423
Delay= 317
Dist = 95623
Speed= 77.84
FCost= 6719

Definitions:
See 11.8.2.1

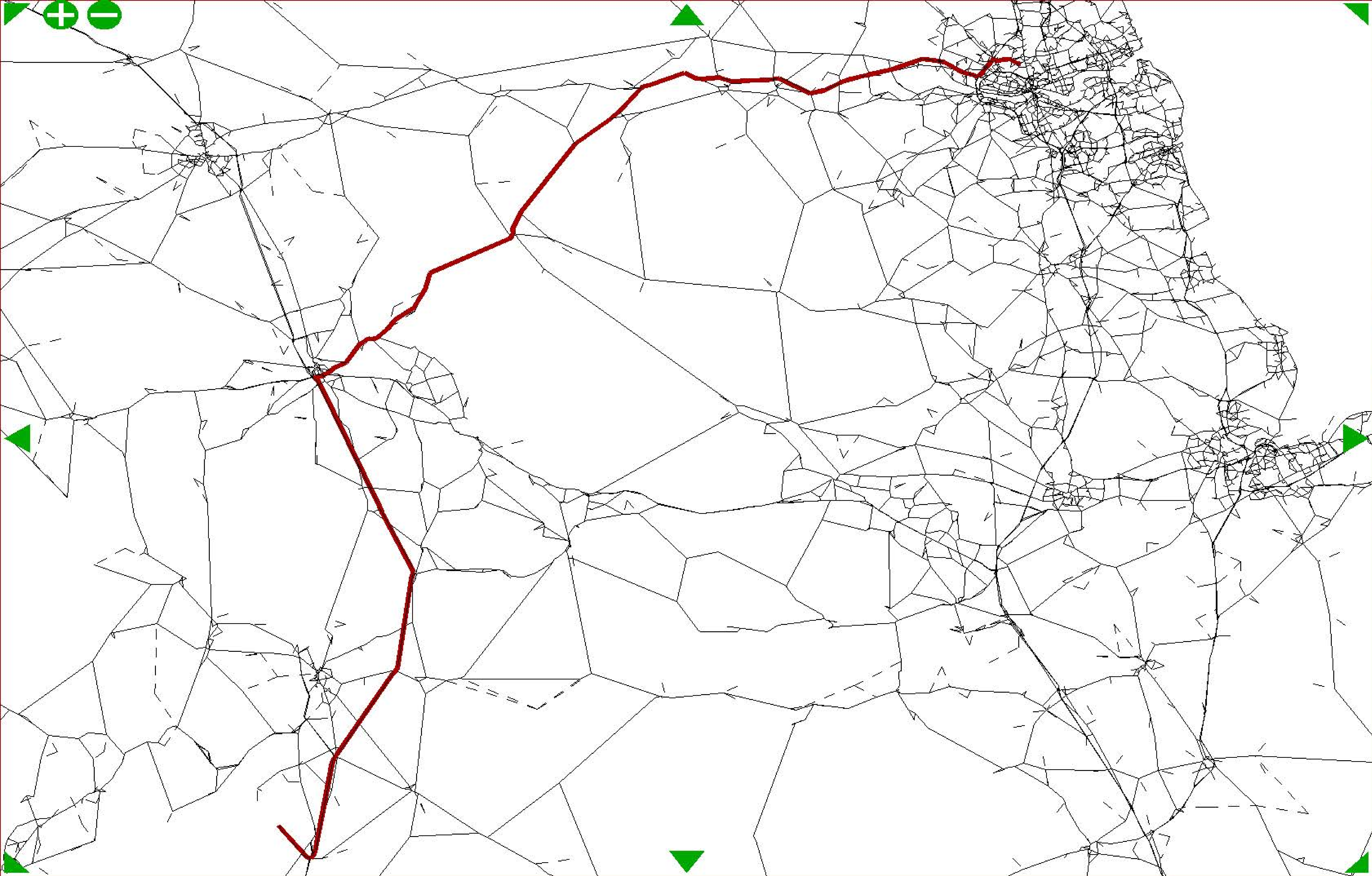
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 1274
Dest. 201

User Cl. 1

Minimum
COST = 11659

Skimmed

Time = 7576
Delay= 266
Dist =170029
Speed= 80.80
FCost= 11659

Definitions:
See 11.8.2.1

T vrs D plot

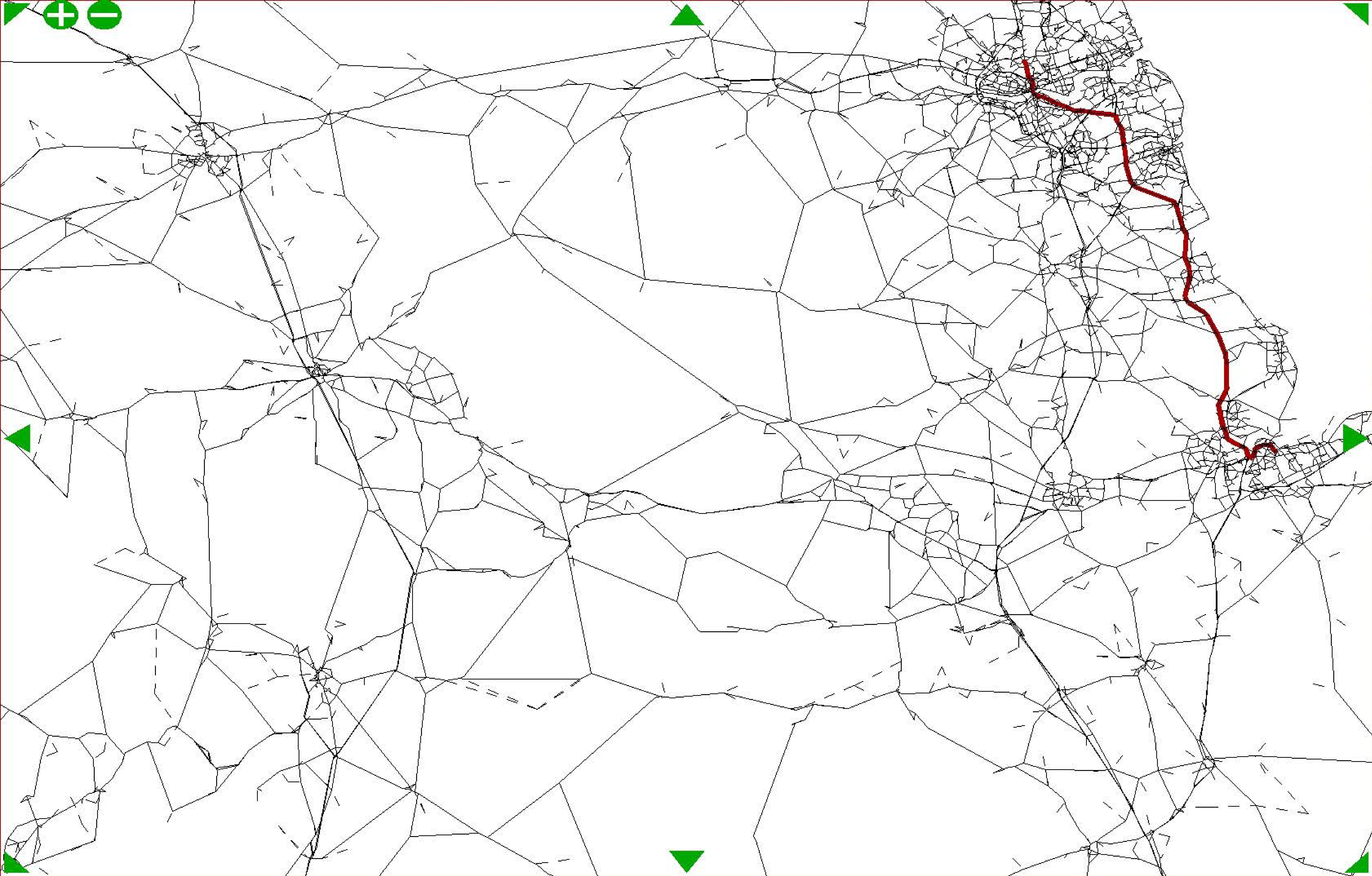
Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22


Tree for:
Origin 1274
Dest. 305
User Cl. 1
Minimum
COST = 7295
Skimmed
Time = 4786
Delay= 862
Dist =104483
Speed= 78.58
FCost= 7295
Definitions:
See 11.8.2.1
T vrs D plot
Q - Return
+ Menu bar!
See 11.8.3
A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 1274
Dest. 1023

User Cl. 1

Minimum
COST = 5083

Skimmed

Time = 3485
Delay= 792
Dist = 66566
Speed= 68.76
FCost= 5083

Definitions:
See 11.8.2.1

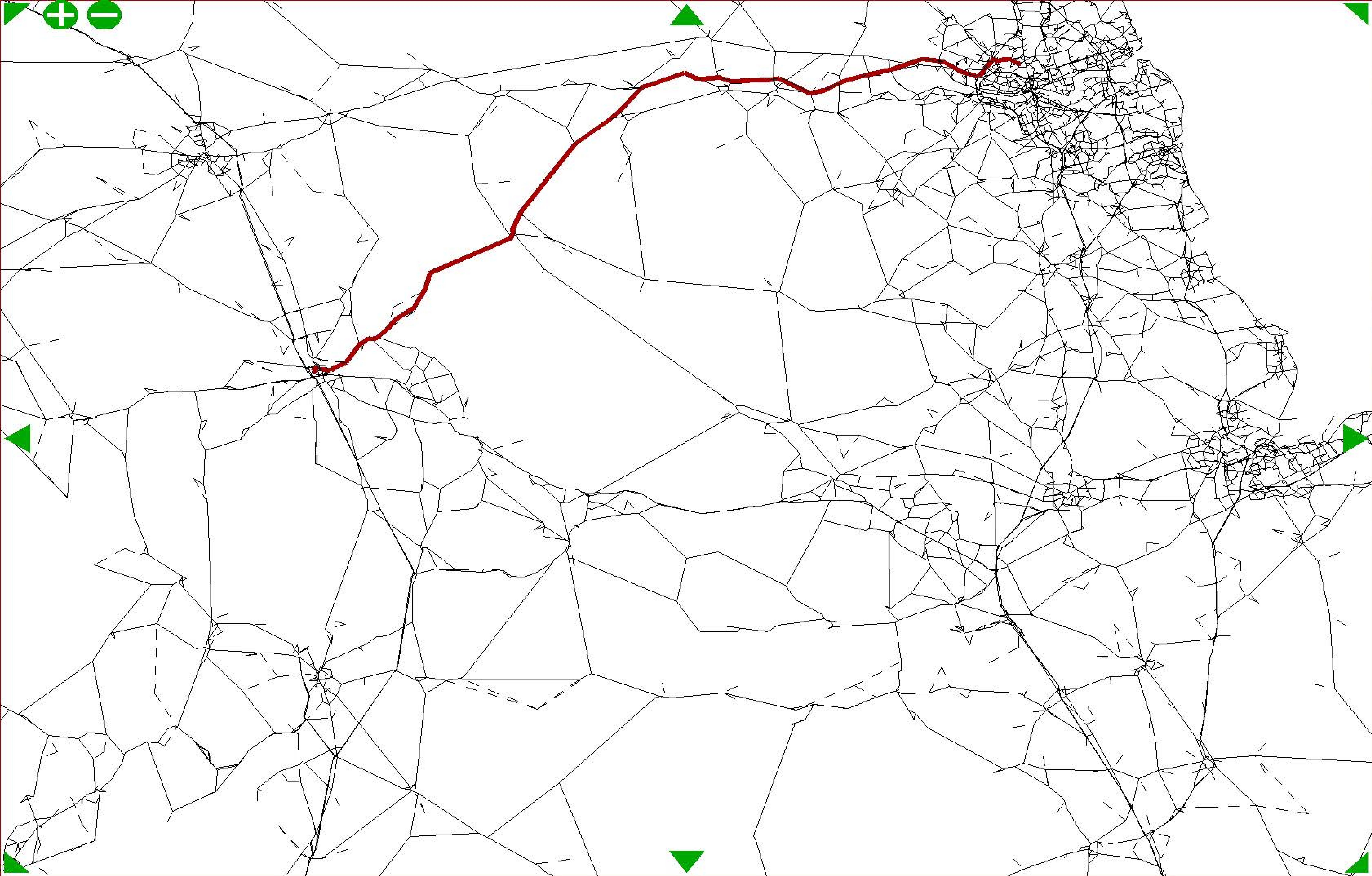
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 1274
Dest. 1088

User Cl. 1

Minimum
COST = 7921

Skimmed

Time = 5435
Delay= 203
Dist =103544
Speed= 68.59
FCost= 7921

Definitions:
See 11.8.2.1

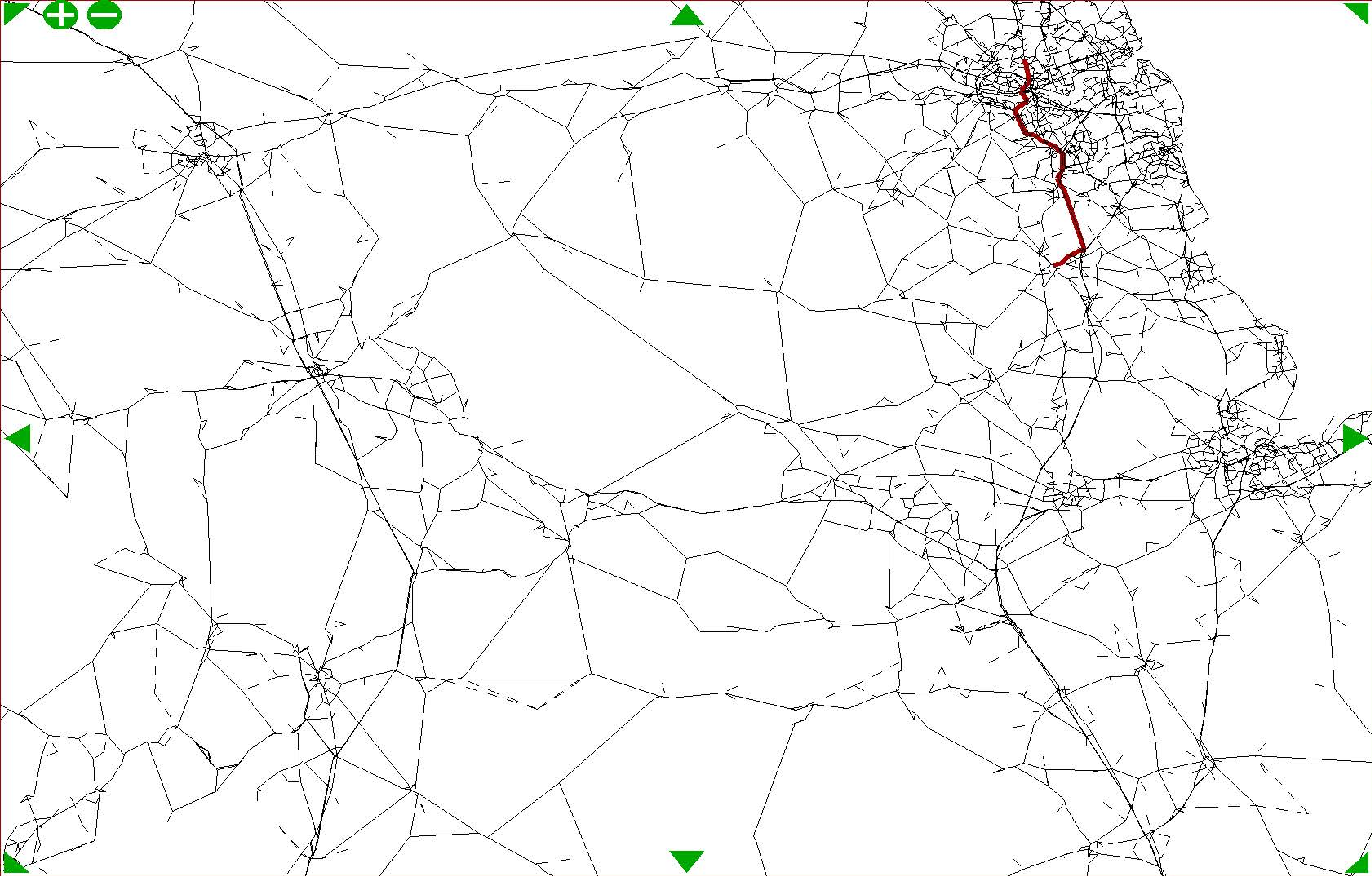
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 1274
Dest. 1388

User Cl. 1

Minimum
COST = 2635

Skimmed

Time = 1860
Delay= 200
Dist = 32284
Speed= 62.50
FCost= 2635

Definitions:
See 11.8.2.1

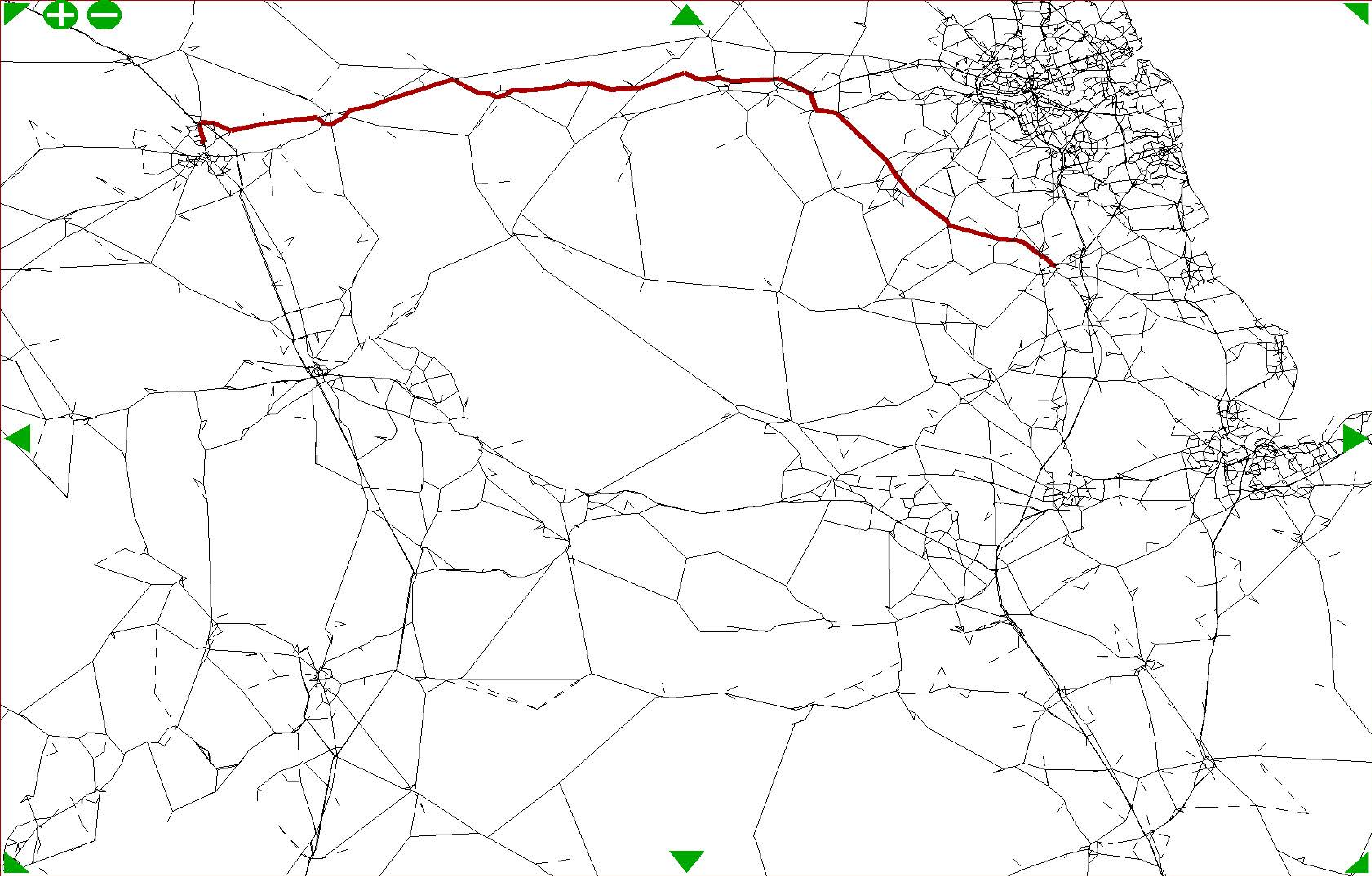
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

1. Durham to Carlisle
2. Durham to Carnforth
3. Durham to Thirsk
4. Durham to Middlesbrough
5. Durham to Penrith
6. Durham to Newcastle upon Tyne



Tree for:

Origin 1388
Dest. 184

User Cl. 1

Minimum
COST = 8355

Skimmed

Time = 5745
Delay= 584
Dist =108729
Speed= 68.14
FCost= 8355

Definitions:
See 11.8.2.1

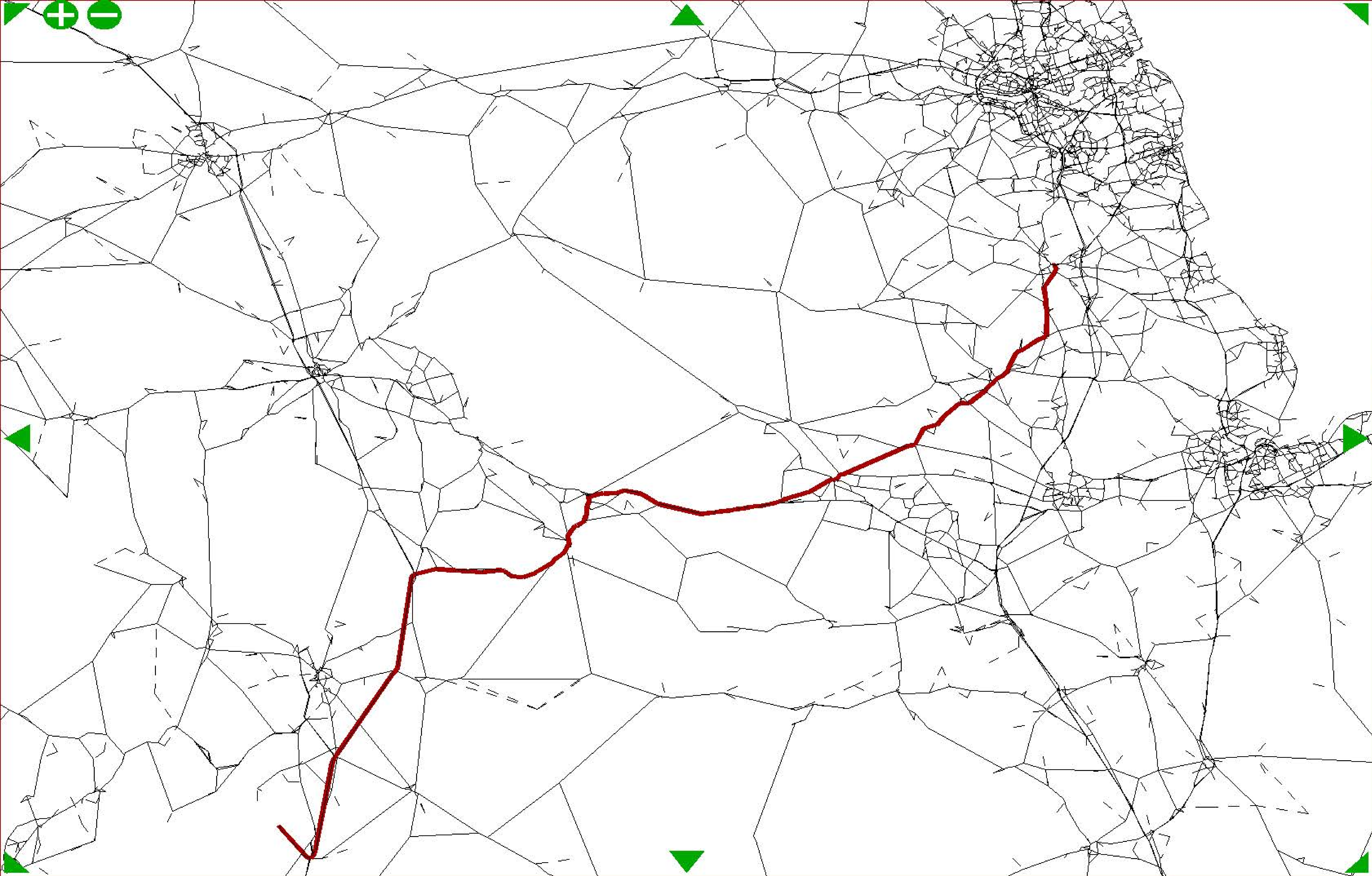
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 1388
Dest. 201

User Cl. 1

Minimum
COST = 9768

Skimmed

Time = 6587
Delay= 667
Dist =132466
Speed= 72.40
FCost= 9768

Definitions:
See 11.8.2.1

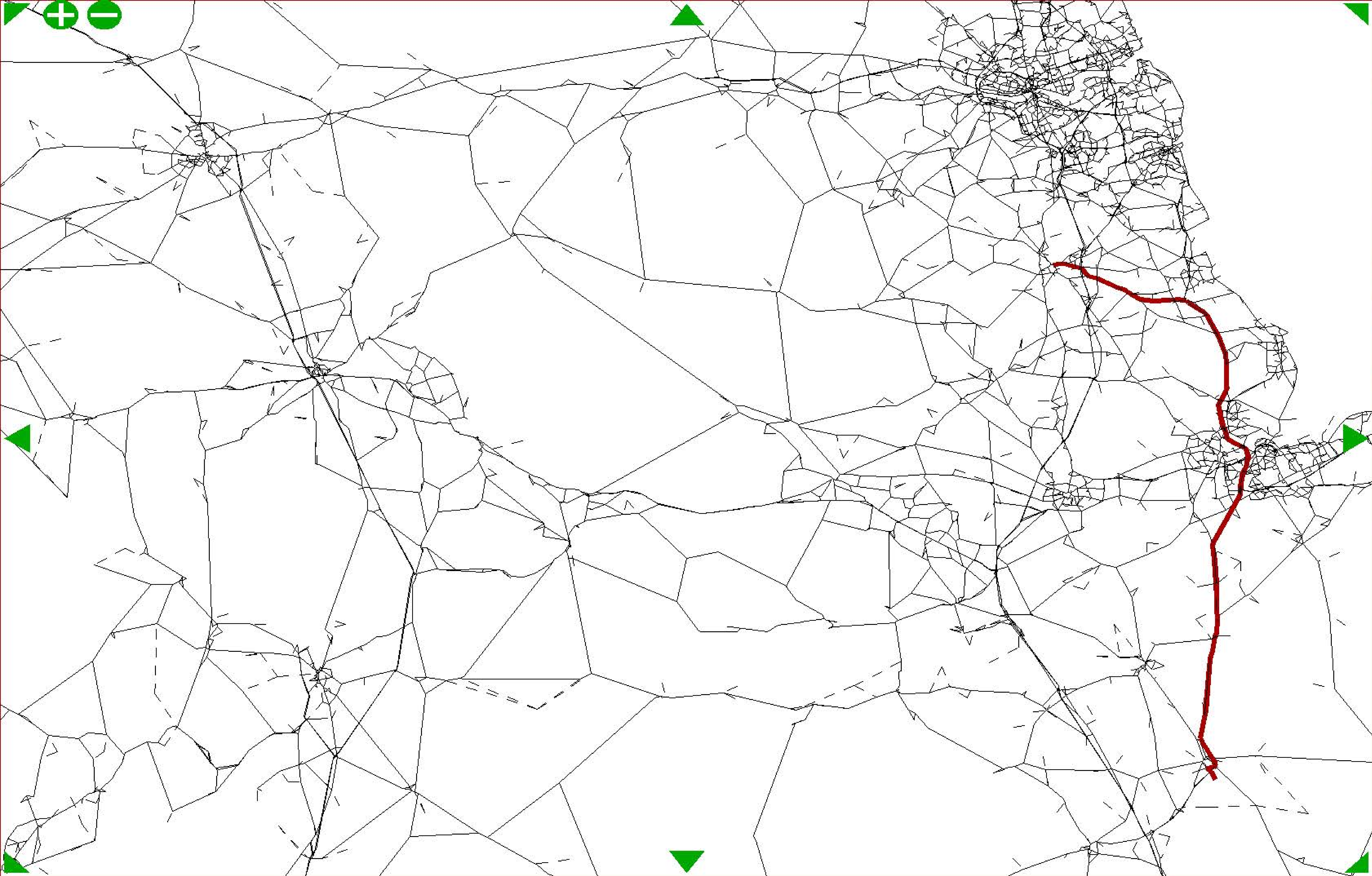
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 1388
Dest. 305

User Cl. 1

Minimum
COST = 5458

Skimmed

Time = 3535
Delay= 411
Dist = 80075
Speed= 81.55
FCost= 5458

Definitions:
See 11.8.2.1

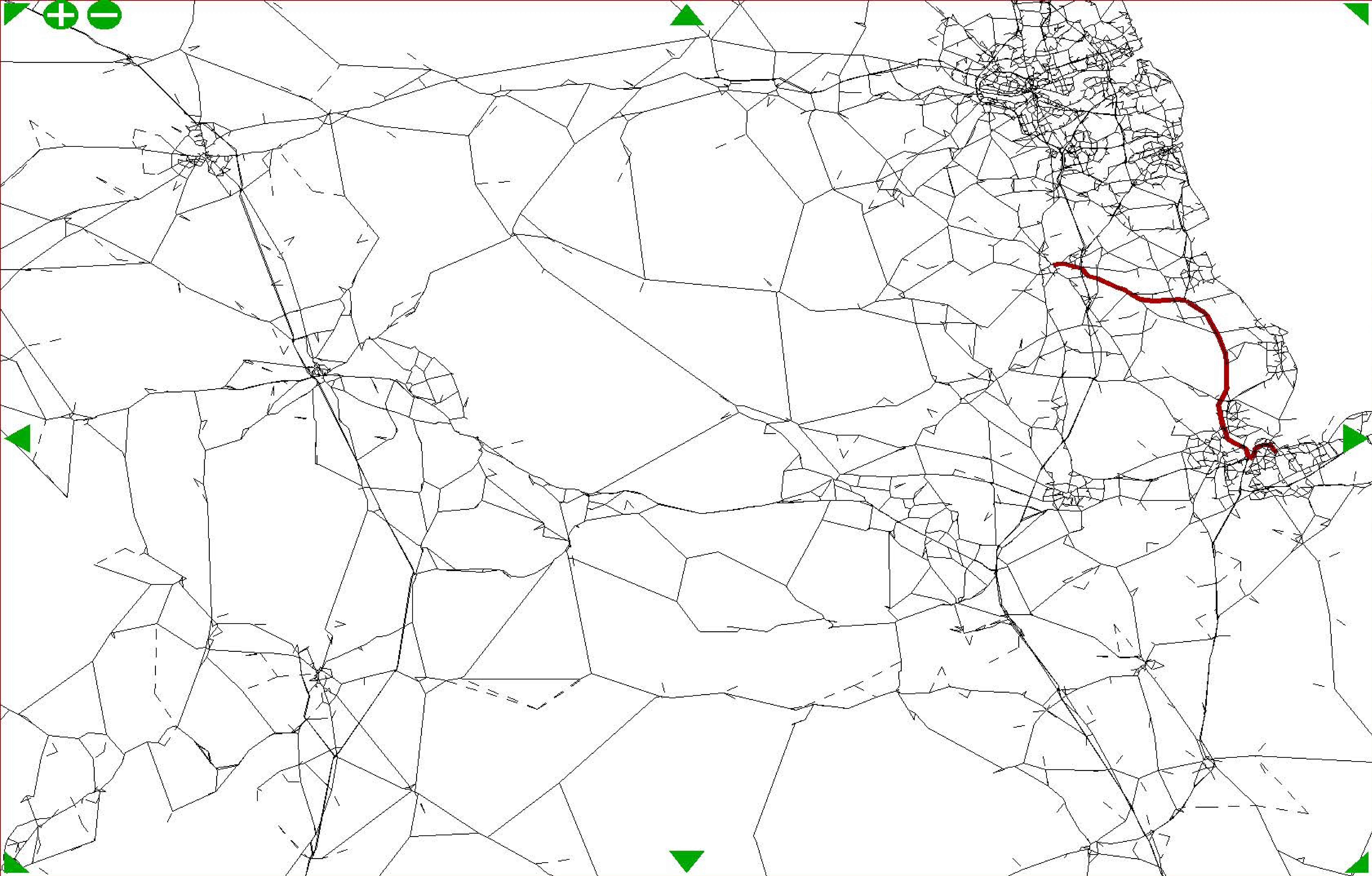
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 1388
Dest. 1023

User Cl. 1

Minimum
COST = 3246

Skimmed

Time = 2234
Delay= 342
Dist = 42158
Speed= 67.95
FCost= 3246

Definitions:
See 11.8.2.1

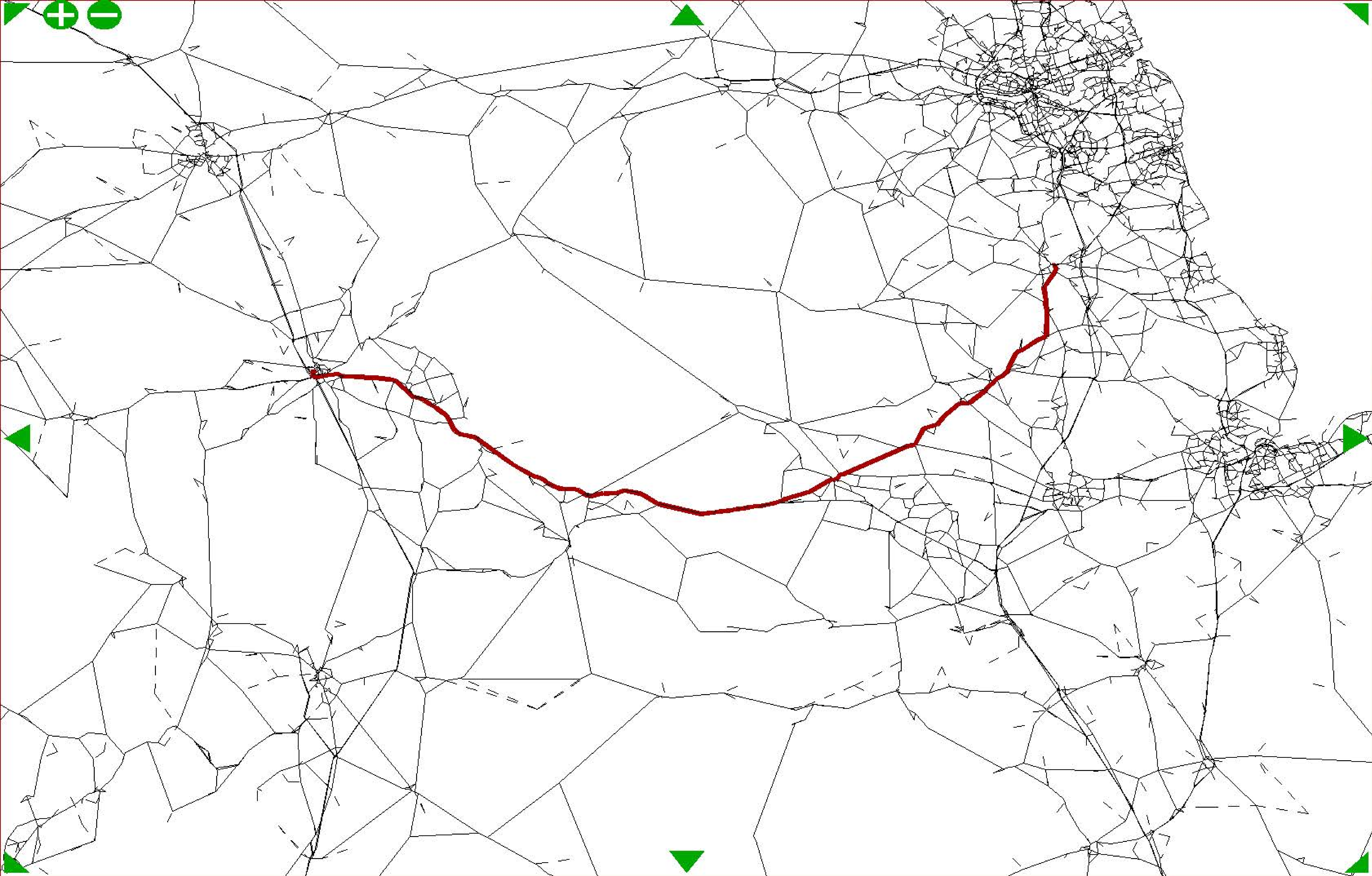
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 1388
Dest. 1088

User Cl. 1

Minimum
COST = 8110

Skimmed

Time = 5635
Delay= 792
Dist =103087
Speed= 65.86
FCost= 8110

Definitions:
See 11.8.2.1

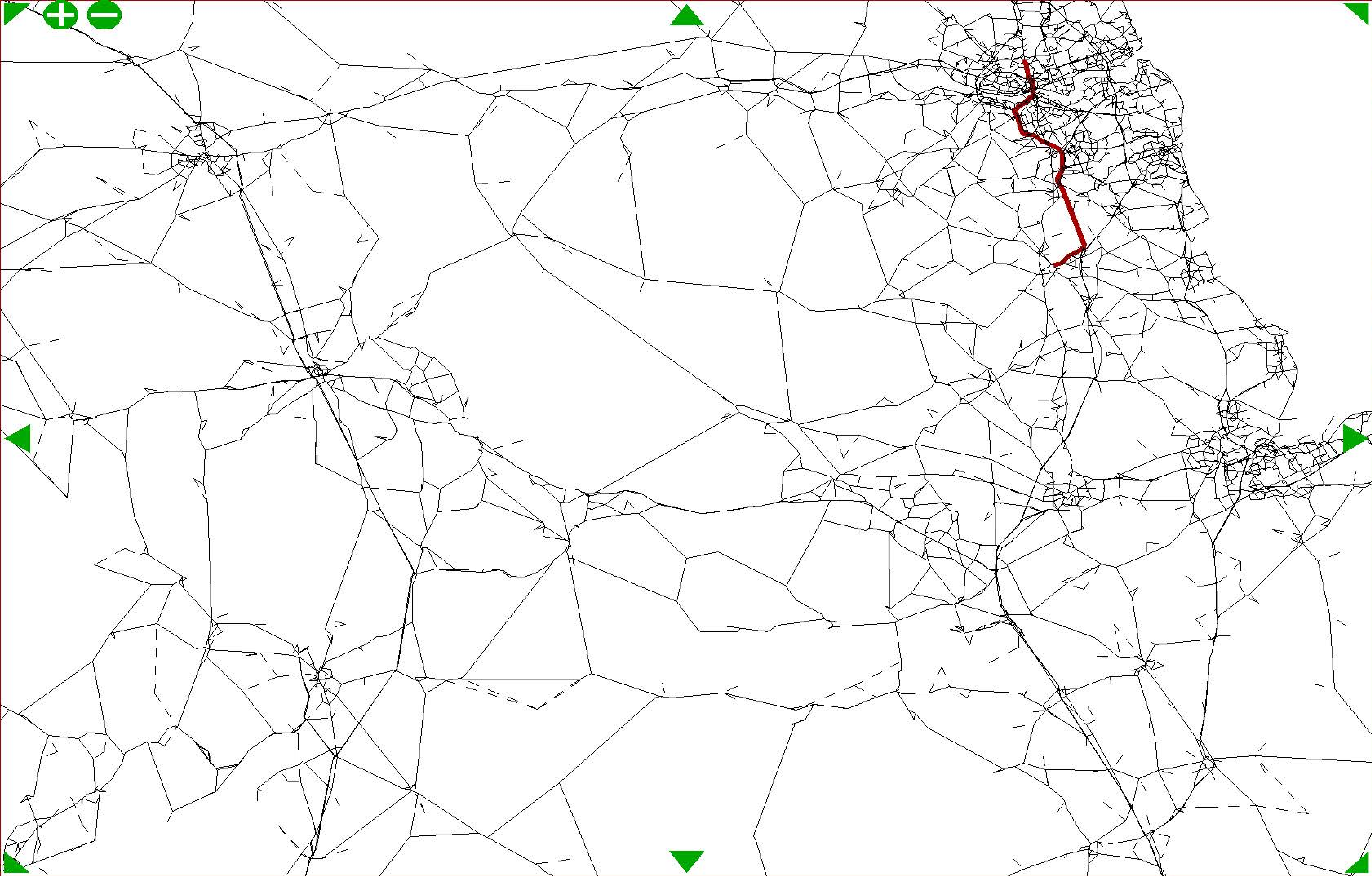
T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22



Tree for:

Origin 1388
Dest. 1274

User Cl. 1

Minimum
COST = 2793

Skimmed

Time = 2010
Delay= 519
Dist = 32603
Speed= 58.38
FCost= 2793

Definitions:
See 11.8.2.1

T vrs D plot

Q - Return

+ Menu bar!

See 11.8.3

A66 Traffic Model: Stage 3 Base Year 2019 - PM Peak 4- 3-22

D Appendix D

D.1 Full Convergence Statistics

Table: Traffic Model Assignment Convergence – AM Peak

LOOP	Ass.	Sim.	A/S Step	%FLOWS	%DELAYS	%V.I.	%GAP
1	0.0305/29	0.113/14	1.000/1		55.8		0.251
2	0.0245/8	0.119/13	1.000/1	46.1	94.8	0.037	0.067
3	0.0224/4	0.111/9	1.000/1	70.9	98.2	0.0028	0.03
4	0.0178/5	0.119/7	1.000/1	78	98.9	0.0031	0.016
5	0.0075/8	0.061/7	1.000/1	80.7	99.1	0.0031	0.011
6	0.0052/8	0.060/7	1.000/1	86.8	99.2	0.0014	0.0074
7	0.0034/9	0.046/7	1.000/1	88.3	99.2	0.00072	0.0059
8	0.0026/8	0.043/7	1.000/1	91.8	99.3	0.00017	0.0035
9	0.0018/11	0.045/7	1.000/1	93.3	99.4	0.00022	0.0029
10	0.0019/10	0.022/4	0.906/2	95.2	99.5	0.00002	0.0025
11	0.0010/11	0.018/3	0.851/3	95.3	99.5	0.00001	0.0024
12	0.0011/7	0.021/3	0.644/3	95.9	99.6	0.00002	0.0017
13	0.0008/11	0.025/7	1.000/1	96.4	99.7	0.00002	0.002
14	0.0007/8	0.018/3	0.592/4	96.7	99.7	0.00004	0.0013
15	0.0006/10	0.023/7	1.000/1	97.5	99.7	0.00002	0.002
16	0.0006/12	0.022/3	0.319/4	96.7	99.7	0.00002	0.00088
17	0.0012/16	0.015/4	0.770/2	97.7	99.7	0.00003	0.00086
18	0.0004/14	0.015/4	0.761/2	97.6	99.7	0.00001	0.00073
19	0.0003/14	0.021/4	0.629/2	97.8	99.7	0.00001	0.00062
20	0.0005/16	0.009/3	0.671/3	98.3	99.8	0	0.00054
21	0.0003/17	0.011/3	0.418/4	98.3	99.8	0	0.00042
22	0.0005/17	0.015/7	1.000/1	98.7	99.7	0	0.00058
23	0.0003/17	0.015/3	0.388/3	98.6	99.8	0.00004	0.00038
24	0.0003/17	0.010/3	0.566/3	98.7	99.8	0	0.0004
25	0.0002/17	0.008/3	0.402/4	98.8	99.8	0.00003	0.00036

Ass. - DELTA FUNCTION (%) / NUMBER OF ITERATIONS

Sim. - FINAL AVER ABS CHANGE IN OUT CFP (PCU/HR) / NUMBER OF ITERATIONS

A/S Step - Step Length used on Ass/Sim Loop / Simulation Iterations

%FLOWS - LINK FLOWS DIFFERING BY < 1% BETWEEN ASS-SIM LOOPS

%DELAYS - TURN DELAYS DIFFERING BY < 1% BETWEEN ASSIGNMENT & SIMULATION

%V.I. - VARIATIONAL INEQUALITY - SHOULD BE > 0

%GAP - WARDROP EQUILIBRIUM GAP FUNCTION POST SIMULATION

Table: Traffic Model Assignment Convergence – Inter Peak

LOOP	Ass.	Sim.	A/S Step	%FLOWS	%DELAYS	%V.I.	%GAP
1	0.0251/22	0.124/13	1.000/1		56.7		0.221
2	0.0247/9	0.163/11	1.000/1	50.8	96.9	0.021	0.038
3	0.0164/5	0.102/7	1.000/1	76.4	99	0.0032	0.019
4	0.0090/8	0.074/7	1.000/1	79	99.3	0.004	0.012
5	0.0056/6	0.061/7	1.000/1	88.8	99.5	0.00084	0.0095
6	0.0043/8	0.053/7	1.000/1	90.4	99.5	0.001	0.0082
7	0.0029/7	0.044/7	1.000/1	93.8	99.7	0.00053	0.0062
8	0.0029/4	0.028/7	1.000/1	97	99.7	0.00013	0.0027
9	0.0017/15	0.024/7	1.000/1	95.1	99.7	0.00065	0.0022
10	0.0013/15	0.027/7	1.000/1	96.5	99.8	0.00019	0.0015
11	0.0017/15	0.026/7	1.000/1	97.3	99.8	0.00017	0.0014
12	0.0012/15	0.023/7	1.000/1	97.8	99.8	0.00009	0.0011
13	0.0005/12	0.020/7	1.000/1	98.1	99.8	0.00004	0.0011
14	0.0005/11	0.019/7	1.000/1	98.6	99.8	0.00003	0.0011
15	0.0006/10	0.017/7	1.000/1	99	99.8	0	0.00081
16	0.0004/14	0.016/7	1.000/1	98.7	99.8	0.00002	0.0011
17	0.0006/15	0.008/3	0.885/3	98.9	99.8	0.00002	0.00048

Ass. - DELTA FUNCTION (%) / NUMBER OF ITERATIONS

Sim. - FINAL AVER ABS CHANGE IN OUT CFP (PCU/HR) / NUMBER OF ITERATIONS

A/S Step - Step Length used on Ass/Sim Loop / Simulation Iterations

%FLOWS - LINK FLOWS DIFFERING BY < 1% BETWEEN ASS-SIM LOOPS

%DELAYS - TURN DELAYS DIFFERING BY < 1% BETWEEN ASSIGNMENT & SIMULATION

%V.I. - VARIATIONAL INEQUALITY - SHOULD BE > 0

%GAP - WARDROP EQUILIBRIUM GAP FUNCTION POST SIMULATION

Table: Traffic Model Assignment Convergence – PM Peak

LOOP	Ass.	Sim.	A/S Step	%FLOWS	%DELAYS	%V.I.	%GAP
1	0.0545/30	0.151/15	1.000/1		55.4		0.427
2	0.0232/12	0.103/13	1.000/1	43.8	93.5	0.051	0.11
3	0.0188/7	0.110/9	1.000/1	66.7	97.5	0.005	0.053
4	0.0236/4	0.113/8	1.000/1	79.3	98.2	0.001	0.039
5	0.0178/4	0.057/3	0.835/3	83.4	98.5	0.00027	0.026
6	0.0158/8	0.061/7	1.000/1	82.2	98.7	0.0016	0.019
7	0.0092/4	0.074/4	0.690/2	89.2	98.8	0.00029	0.011
8	0.0051/11	0.041/7	1.000/1	88	99	0.0018	0.0086
9	0.0040/11	0.037/7	1.000/1	90.9	99.2	0.00062	0.0078
10	0.0037/6	0.035/7	1.000/1	93.7	99.2	0.00002	0.0076
11	0.0037/6	0.030/7	1.000/1	95.6	99.3	0.00018	0.0061
12	0.0028/7	0.025/7	1.000/1	96.2	99.4	0.00011	0.0041
13	0.0019/11	0.032/7	1.000/1	94.4	99.3	0.00018	0.0048
14	0.0033/9	0.046/4	0.724/2	95.5	99.4	0.0001	0.0027
15	0.0030/12	0.024/7	1.000/1	97.3	99.5	0.00015	0.0027
16	0.0026/12	0.024/7	1.000/1	97.2	99.5	0.00007	0.0024
17	0.0012/9	0.022/7	1.000/1	97.8	99.6	0.00001	0.0024
18	0.0011/8	0.018/7	1.000/1	98.4	99.6	0	0.0016
19	0.0011/12	0.017/7	1.000/1	98.2	99.6	0.00005	0.0019
20	0.0009/12	0.017/7	1.000/1	98.6	99.7	0.00003	0.0013
21	0.0008/12	0.017/7	1.000/1	98.6	99.7	0.00003	0.0019
22	0.0007/12	0.017/7	1.000/1	98.9	99.7	0.00001	0.0013
23	0.0006/10	0.015/4	0.914/2	98.8	99.6	0	0.0017

Ass. - DELTA FUNCTION (%) / NUMBER OF ITERATIONS

Sim. - FINAL AVER ABS CHANGE IN OUT CFP (PCU/HR) / NUMBER OF ITERATIONS

A/S Step - Step Length used on Ass/Sim Loop / Simulation Iterations

%FLOWS - LINK FLOWS DIFFERING BY < 1% BETWEEN ASS-SIM LOOPS

%DELAYS - TURN DELAYS DIFFERING BY < 1% BETWEEN ASSIGNMENT & SIMULATION

%V.I. - VARIATIONAL INEQUALITY - SHOULD BE > 0

%GAP - WARDROP EQUILIBRIUM GAP FUNCTION POST SIMULATION

E Appendix E

E.1 Junction Analysis

Turning Movement Validation - J40 - AM Peak

Observed

	A592	A66E	M6S	A66W	M6N	Total
A592	1	283	122	257	155	818
A66E	273	10	79	264	500	1126
M6S	189	99	0	217	2	507
A66W	251	259	136	9	139	794
M6N	313	516	4	146	0	979
Total	1027	1167	341	893	796	4224

Modelled

	A592	A66E	M6S	A66W	M6N	Total
A592	0	180	180	240	136	736
A66E	194	0	101	303	496	1094
M6S	209	135	0	98	0	441
A66W	246	281	50	0	135	712
M6N	277	651	0	158	0	1086
Total	926	1247	330	799	767	4069

Percentage Difference

	A592	A66E	M6S	A66W	M6N	Total
A592	-100%	-36%	48%	-7%	-12%	-10%
A66E	-29%	-	27%	15%	-1%	-3%
M6S	10%	36%	-	-55%	-100%	-13%
A66W	-2%	8%	-63%	-100%	-3%	-10%
M6N	-11%	26%	-100%	8%	-	11%
Total	-10%	7%	-3%	-11%	-4%	-4%

Difference

	A592	A66E	M6S	A66W	M6N	Total
A592	-1	-103	58	-17	-19	-82
A66E	-79	-10	22	39	-4	-32
M6S	20	36	0	-119	-2	-66
A66W	-5	22	-86	-9	-4	-82
M6N	-36	135	-4	12	0	107
Total	-101	80	-11	-94	-29	-155

GEH

	A592	A66E	M6S	A66W	M6N	Total
A592	1.4	6.7	4.7	1.1	1.6	2.9
A66E	5.1	4.5	2.3	2.3	0.2	1.0
M6S	1.4	3.3	-	9.5	2.0	3.0
A66W	0.3	1.3	8.9	4.2	0.3	3.0
M6N	2.1	5.6	2.8	1.0	-	3.3
Total	3.2	2.3	0.6	3.2	1.0	2.4

TAG Criteria Pass / Fail

	A592	A66E	M6S	A66W	M6N	Total
A592	PASS	FAIL	PASS	PASS	PASS	PASS
A66E	PASS	PASS	PASS	PASS	PASS	PASS
M6S	PASS	PASS	PASS	FAIL	PASS	PASS
A66W	PASS	PASS	PASS	PASS	PASS	PASS
M6N	PASS	FAIL	PASS	PASS	PASS	PASS
Total	PASS	PASS	PASS	PASS	PASS	PASS

Turning Movement Validation - J40 - Inter Peak

Observed

	A592	A66E	M6S	A66W	M6N	Total
A592	1	333	104	205	124	766
A66E	160	6	73	189	428	856
M6S	89	54	0	127	2	272
A66W	208	245	167	5	115	741
M6N	158	444	3	88	1	694
Total	616	1082	347	614	669	3327

Modelled

	A592	A66E	M6S	A66W	M6N	Total
A592	0	201	169	233	147	750
A66E	140	0	91	250	463	944
M6S	154	127	0	60	0	340
A66W	208	308	55	0	124	694
M6N	167	529	0	114	0	810
Total	669	1164	314	657	735	3539

Percentage Difference

	A592	A66E	M6S	A66W	M6N	Total
A592	-	-40%	63%	14%	19%	-2%
A66E	-13%	-	24%	32%	8%	10%
M6S	72%	137%	-	-53%	-100%	25%
A66W	0%	25%	-67%	-	8%	-6%
M6N	6%	19%	-100%	29%	-	17%
Total	9%	8%	-9%	7%	10%	6%

Difference

	A592	A66E	M6S	A66W	M6N	Total
A592	-1	-131	65	28	23	-16
A66E	-20	-6	18	61	36	89
M6S	65	73	0	-67	-2	69
A66W	-1	63	-112	-5	9	-47
M6N	9	84	-3	25	-1	116
Total	53	82	-33	43	66	211

GEH

	A592	A66E	M6S	A66W	M6N	Total
A592	1.0	8.0	5.6	1.9	2.0	0.6
A66E	1.6	3.5	2.0	4.1	1.7	3.0
M6S	5.9	7.7	0.8	6.9	1.8	3.9
A66W	0.0	3.8	10.7	3.2	0.8	1.7
M6N	0.7	3.8	2.4	2.5	1.2	4.2
Total	2.1	2.5	1.8	1.7	2.5	3.6

TAG Criteria Pass / Fail

	A592	A66E	M6S	A66W	M6N	Total
A592	PASS	FAIL	PASS	PASS	PASS	PASS
A66E	PASS	PASS	PASS	PASS	PASS	PASS
M6S	PASS	PASS	PASS	PASS	PASS	PASS
A66W	PASS	PASS	FAIL	PASS	PASS	PASS
M6N	PASS	PASS	PASS	PASS	PASS	PASS
Total	PASS	PASS	PASS	PASS	PASS	PASS

Turning Movement Validation - J40 - PM Peak

Observed

	A592	A66E	M6S	A66W	M6N	Total
A592	1	410	154	231	201	996
A66E	178	11	97	184	618	1087
M6S	108	86	1	138	2	333
A66W	242	292	154	10	188	884
M6N	208	503	4	93	2	809
Total	736	1300	409	654	1010	4108

Modelled

	A592	A66E	M6S	A66W	M6N	Total
A592	0	279	213	296	211	998
A66E	140	0	102	286	528	1056
M6S	187	127	0	63	0	377
A66W	225	348	49	0	157	779
M6N	182	562	0	131	0	875
Total	733	1317	363	775	896	4085

Percentage Difference

	A592	A66E	M6S	A66W	M6N	Total
A592	-	-32%	39%	28%	5%	0%
A66E	-21%	-	6%	56%	-15%	-3%
M6S	74%	49%	-	-54%	-100%	13%
A66W	-7%	19%	-68%	-	-16%	-12%
M6N	-12%	12%	-100%	42%	-	8%
Total	0%	1%	-11%	19%	-11%	-1%

Difference

	A592	A66E	M6S	A66W	M6N	Total
A592	-1	-130	59	65	10	2
A66E	-38	-11	6	103	-90	-30
M6S	80	42	-1	-75	-2	44
A66W	-17	57	-105	-10	-30	-105
M6N	-26	59	-4	38	-2	66
Total	-2	17	-45	121	-114	-23

GEH

	A592	A66E	M6S	A66W	M6N	Total
A592	1.4	7.0	4.4	4.0	0.7	0.1
A66E	3.0	4.6	0.6	6.7	3.8	0.9
M6S	6.6	4.0	1.4	7.5	1.7	2.3
A66W	1.1	3.2	10.4	4.4	2.3	3.6
M6N	1.9	2.6	2.8	3.6	1.7	2.3
Total	0.1	0.5	2.3	4.5	3.7	0.4

TAG Criteria Pass / Fail

	A592	A66E	M6S	A66W	M6N	Total
A592	PASS	FAIL	PASS	PASS	PASS	PASS
A66E	PASS	PASS	PASS	FAIL	PASS	PASS
M6S	PASS	PASS	PASS	PASS	PASS	PASS
A66W	PASS	PASS	FAIL	PASS	PASS	PASS
M6N	PASS	PASS	PASS	PASS	PASS	PASS
Total	PASS	PASS	PASS	PASS	PASS	PASS

Turning Movement Validation - Kemplay Bank - AM Peak

Observed

	A6 Bridge Lane	A686 Carleton Ave	A66 East	A6 South	A66 West	Total
A6 Bridge Lane	0	51	90	147	83	371
A686 Carleton Ave	36	3	42	73	210	364
A66 East	214	37	1	23	582	857
A6 South	283	76	12	0	245	616
A66 West	253	246	457	182	19	1157
Total	786	413	602	425	1139	3365

Modelled

	A6 Bridge Lane	A686 Carleton Ave	A66 East	A6 South	A66 West	Total
A6 Bridge Lane	0	34	98	171	40	343
A686 Carleton Ave	13	0	52	45	210	319
A66 East	188	41	0	7	580	816
A6 South	290	50	0	0	264	604
A66 West	244	200	549	253	0	1246
Total	735	325	699	476	1094	3328

Percentage Difference

	A6 Bridge Lane	A686 Carleton Ave	A66 East	A6 South	A66 West	Total
A6 Bridge Lane	-	-34%	9%	16%	-51%	-8%
A686 Carleton Ave	-64%	-	23%	-39%	0%	-12%
A66 East	-12%	12%	-	-69%	0%	-5%
A6 South	2%	-34%	-100%	-	8%	-2%
A66 West	-4%	-19%	20%	39%	-	8%
Total	-7%	-21%	16%	12%	-4%	-1%

Difference

	A6 Bridge Lane	A686 Carleton Ave	A66 East	A6 South	A66 West	Total
A6 Bridge Lane	0	-17	8	24	-43	-28
A686 Carleton Ave	-23	-3	10	-28	0	-45
A66 East	-26	4	-1	-16	-2	-41
A6 South	7	-26	-12	0	19	-12
A66 West	-9	-46	92	71	-19	89
Total	-51	-88	97	51	-45	-37

GEH

	A6 Bridge Lane	A686 Carleton Ave	A66 East	A6 South	A66 West	Total
A6 Bridge Lane	-	2.7	0.8	1.9	5.4	1.5
A686 Carleton Ave	4.6	2.4	1.4	3.7	0.0	2.4
A66 East	1.9	0.7	1.4	4.1	0.1	1.4
A6 South	0.4	3.2	4.9	-	1.2	0.5
A66 West	0.6	3.1	4.1	4.8	6.2	2.6
Total	1.9	4.6	3.8	2.4	1.3	0.6

TAG Criteria Pass / Fail

	A6 Bridge Lane	A686 Carleton Ave	A66 East	A6 South	A66 West	Total
A6 Bridge Lane	PASS	PASS	PASS	PASS	PASS	PASS
A686 Carleton Ave	PASS	PASS	PASS	PASS	PASS	PASS
A66 East	PASS	PASS	PASS	PASS	PASS	PASS
A6 South	PASS	PASS	PASS	PASS	PASS	PASS
A66 West	PASS	PASS	PASS	PASS	PASS	PASS
Total	PASS	PASS	PASS	PASS	PASS	PASS

Turning Movement Validation - Kemplay Bank - Inter Peak

Observed

	A6 Bridge Lane	A686 Carleton Ave	A66 East	A6 South	A66 West	Total
A6 Bridge Lane	1	57	110	152	107	427
A686 Carleton Ave	25	1	26	38	140	230
A66 East	149	17	1	10	460	636
A6 South	182	40	13	0	128	363
A66 West	196	144	581	148	12	1080
Total	552	258	731	348	847	2737

Modelled

	A6 Bridge Lane	A686 Carleton Ave	A66 East	A6 South	A66 West	Total
A6 Bridge Lane	0	37	125	195	41	399
A686 Carleton Ave	22	0	45	29	148	244
A66 East	147	33	0	6	538	724
A6 South	160	39	1	0	218	418
A66 West	189	179	590	207	0	1164
Total	518	289	761	438	944	2950

Percentage Difference

	A6 Bridge Lane	A686 Carleton Ave	A66 East	A6 South	A66 West	Total
A6 Bridge Lane	-	-35%	14%	29%	-62%	-7%
A686 Carleton Ave	-9%	-	70%	-25%	5%	6%
A66 East	-1%	102%	-	-39%	17%	14%
A6 South	-12%	-1%	-90%	-	70%	15%
A66 West	-4%	24%	2%	40%	-	8%
Total	-6%	12%	4%	26%	12%	8%

Difference

	A6 Bridge Lane	A686 Carleton Ave	A66 East	A6 South	A66 West	Total
A6 Bridge Lane	-1	-20	15	44	-67	-29
A686 Carleton Ave	-2	-1	19	-9	8	14
A66 East	-2	17	-1	-4	78	88
A6 South	-22	0	-12	0	90	55
A66 West	-7	35	9	59	-12	85
Total	-34	31	30	89	97	213

GEH

	A6 Bridge Lane	A686 Carleton Ave	A66 East	A6 South	A66 West	Total
A6 Bridge Lane	1.5	2.9	1.4	3.3	7.7	1.4
A686 Carleton Ave	0.4	1.0	3.1	1.6	0.6	0.9
A66 East	0.1	3.4	1.5	1.4	3.5	3.4
A6 South	1.7	0.1	4.4	0.6	6.8	2.8
A66 West	0.5	2.8	0.4	4.4	4.8	2.5
Total	1.5	1.9	1.1	4.5	3.3	4.0

TAG Criteria Pass / Fail

	A6 Bridge Lane	A686 Carleton Ave	A66 East	A6 South	A66 West	Total
A6 Bridge Lane	PASS	PASS	PASS	PASS	PASS	PASS
A686 Carleton Ave	PASS	PASS	PASS	PASS	PASS	PASS
A66 East	PASS	PASS	PASS	PASS	PASS	PASS
A6 South	PASS	PASS	PASS	PASS	PASS	PASS
A66 West	PASS	PASS	PASS	PASS	PASS	PASS
Total	PASS	PASS	PASS	PASS	PASS	PASS

Turning Movement Validation - Kemplay Bank - PM Peak

Observed

	A6 Bridge Lane	A686 Carleton Ave	A66 East	A6 South	A66 West	Total
A6 Bridge Lane	1	60	175	189	170	593
A686 Carleton Ave	24	3	47	66	200	339
A66 East	168	17	3	13	553	753
A6 South	207	59	12	0	147	424
A66 West	188	256	649	212	8	1312
Total	586	394	885	480	1077	3420

Modelled

	A6 Bridge Lane	A686 Carleton Ave	A66 East	A6 South	A66 West	Total
A6 Bridge Lane	0	55	165	272	53	544
A686 Carleton Ave	26	0	43	30	183	281
A66 East	154	41	0	7	567	770
A6 South	176	66	0	0	254	495
A66 West	202	231	647	237	0	1317
Total	558	392	854	547	1056	3407

Percentage Difference

	A6 Bridge Lane	A686 Carleton Ave	A66 East	A6 South	A66 West	Total
A6 Bridge Lane	-	-8%	-6%	44%	-69%	-8%
A686 Carleton Ave	9%	-	-9%	-55%	-8%	-17%
A66 East	-8%	142%	-	-44%	3%	2%
A6 South	-15%	12%	-100%	-	73%	17%
A66 West	8%	-10%	0%	12%	-	0%
Total	-5%	0%	-3%	14%	-2%	0%

Difference

	A6 Bridge Lane	A686 Carleton Ave	A66 East	A6 South	A66 West	Total
A6 Bridge Lane	-1	-5	-10	83	-117	-49
A686 Carleton Ave	2	-3	-4	-36	-17	-58
A66 East	-13	24	-3	-6	14	17
A6 South	-31	7	-11	0	107	72
A66 West	15	-25	-2	25	-8	5
Total	-28	-1	-30	67	-20	-13

GEH

	A6 Bridge Lane	A686 Carleton Ave	A66 East	A6 South	A66 West	Total
A6 Bridge Lane	1.0	0.6	0.8	5.5	11.1	2.0
A686 Carleton Ave	0.4	2.4	0.6	5.2	1.2	3.3
A66 East	1.0	4.5	2.2	1.8	0.6	0.6
A6 South	2.2	0.9	4.8	-	7.6	3.3
A66 West	1.0	1.6	0.1	1.7	4.0	0.1
Total	1.2	0.1	1.0	3.0	0.6	0.2

TAG Criteria Pass / Fail

	A6 Bridge Lane	A686 Carleton Ave	A66 East	A6 South	A66 West	Total
A6 Bridge Lane	PASS	PASS	PASS	PASS	FAIL	PASS
A686 Carleton Ave	PASS	PASS	PASS	PASS	PASS	PASS
A66 East	PASS	PASS	PASS	PASS	PASS	PASS
A6 South	PASS	PASS	PASS	PASS	FAIL	PASS
A66 West	PASS	PASS	PASS	PASS	PASS	PASS
Total	PASS	PASS	PASS	PASS	PASS	PASS

Turning Movement Validation - Scotch Corner - AM Peak

Observed

	A6055	A1(M) North	Middleton Tyas Ln	A1(M) South	A6108	A66	Total
A6055	0	0	1	3	29	3	36
A1(M) North	3	0	69	4	199	167	442
Middleton Tyas Ln	50	0	0	105	39	84	278
A1(M) South	2	0	75	4	64	233	378
A6108	304	0	42	22	18	35	421
A66	233	0	80	271	5	3	592
Total	592	0	267	409	354	525	2147

Modelled

	A6055	A1(M) North	Middleton Tyas Ln	A1(M) South	A6108	A66	Total
A6055	0	0	0	0	0	0	0
A1(M) North	0	0	0	0	276	193	469
Middleton Tyas Ln	0	0	0	95	44	62	202
A1(M) South	0	0	65	0	10	373	448
A6108	280	0	72	8	0	21	381
A66	194	0	54	391	6	0	645
Total	474	0	191	493	336	650	2145

Percentage Difference

	A6055	A1(M) North	Middleton Tyas Ln	A1(M) South	A6108	A66	Total
A6055	-	-	-100%	-100%	-100%	-100%	-100%
A1(M) North	-100%	-	-100%	-100%	38%	16%	6%
Middleton Tyas Ln	-100%	-	-	-10%	14%	-26%	-27%
A1(M) South	-100%	-	-14%	-100%	-85%	60%	18%
A6108	-8%	-	72%	-65%	-100%	-39%	-9%
A66	-17%	-	-33%	44%	28%	-100%	9%
Total	-20%	-	-29%	21%	-5%	24%	0%

Difference

	A6055	A1(M) North	Middleton Tyas Ln	A1(M) South	A6108	A66	Total
A6055	0	0	-1	-3	-29	-3	-36
A1(M) North	-3	0	-69	-4	77	26	27
Middleton Tyas Ln	-50	0	0	-10	5	-22	-76
A1(M) South	-2	0	-10	-4	-54	140	70
A6108	-24	0	30	-14	-18	-14	-40
A66	-39	0	-26	120	1	-3	53
Total	-118	0	-76	84	-18	125	-2

GEH

	A6055	A1(M) North	Middleton Tyas Ln	A1(M) South	A6108	A66	Total
A6055	-	-	1.4	2.4	7.6	2.4	8.5
A1(M) North	2.4	-	11.7	2.8	5.0	1.9	1.2
Middleton Tyas Ln	10.0	-	-	1.0	0.9	2.5	4.9
A1(M) South	2.0	-	1.2	2.8	8.9	8.1	3.4
A6108	1.4	-	4.0	3.7	6.0	2.5	2.0
A66	2.7	-	3.2	6.6	0.6	2.4	2.1
Total	5.1	-	5.0	4.0	1.0	5.2	0.1

TAG Criteria Pass / Fail

	A6055	A1(M) North	Middleton Tyas Ln	A1(M) South	A6108	A66	Total
A6055	PASS	PASS	PASS	PASS	PASS	PASS	PASS
A1(M) North	PASS	PASS	PASS	PASS	PASS	PASS	PASS
Middleton Tyas Ln	PASS	PASS	PASS	PASS	PASS	PASS	PASS
A1(M) South	PASS	PASS	PASS	PASS	PASS	FAIL	PASS
A6108	PASS	PASS	PASS	PASS	PASS	PASS	PASS
A66	PASS	PASS	PASS	FAIL	PASS	PASS	PASS
Total	FAIL	PASS	PASS	PASS	PASS	FAIL	PASS

Turning Movement Validation - Scotch Corner - Inter Peak

Observed

	A6055	A1(M) North	Middleton Tyas Ln	A1(M) South	A6108	A66	Total
A6055	0	0	4	5	23	3	36
A1(M) North	1	0	49	3	131	172	356
Middleton Tyas Ln	52	0	0	99	27	72	250
A1(M) South	6	0	79	5	31	337	457
A6108	234	0	35	20	18	44	350
A66	220	0	80	350	6	1	657
Total	513	0	247	482	234	630	2105

Modelled

	A6055	A1(M) North	Middleton Tyas Ln	A1(M) South	A6108	A66	Total
A6055	0	0	0	0	0	0	0
A1(M) North	0	0	0	0	198	163	362
Middleton Tyas Ln	0	0	0	87	45	43	174
A1(M) South	0	0	58	0	10	431	499
A6108	215	0	52	8	0	23	298
A66	188	0	46	426	6	0	667
Total	403	0	156	520	259	660	1999

Percentage Difference

	A6055	A1(M) North	Middleton Tyas Ln	A1(M) South	A6108	A66	Total
A6055	-	-	-100%	-100%	-100%	-100%	-100%
A1(M) North	-100%	-	-100%	-100%	52%	-5%	2%
Middleton Tyas Ln	-100%	-	-100%	-13%	69%	-40%	-30%
A1(M) South	-100%	-	-26%	-100%	-68%	28%	9%
A6108	-8%	-	50%	-61%	-100%	-47%	-15%
A66	-15%	-	-42%	22%	8%	-100%	1%
Total	-21%	-	-37%	8%	11%	5%	-5%

Difference

	A6055	A1(M) North	Middleton Tyas Ln	A1(M) South	A6108	A66	Total
A6055	0	0	-4	-5	-23	-3	-36
A1(M) North	-1	0	-49	-3	68	-9	6
Middleton Tyas Ln	-52	0	0	-12	18	-29	-76
A1(M) South	-6	0	-21	-5	-21	94	42
A6108	-19	0	17	-12	-18	-21	-52
A66	-32	0	-33	76	0	-1	10
Total	-110	0	-90	38	25	31	-106

GEH

	A6055	A1(M) North	Middleton Tyas Ln	A1(M) South	A6108	A66	Total
A6055	-	-	2.9	3.2	6.8	2.6	8.5
A1(M) North	1.3	-	9.9	2.6	5.3	0.7	0.3
Middleton Tyas Ln	10.2	-	0.6	1.3	3.1	3.8	5.2
A1(M) South	3.3	-	2.5	3.1	4.7	4.8	1.9
A6108	1.3	-	2.6	3.3	5.9	3.6	2.9
A66	2.3	-	4.2	3.9	0.2	1.6	0.4
Total	5.1	-	6.4	1.7	1.6	1.2	2.3

TAG Criteria Pass / Fail

	A6055	A1(M) North	Middleton Tyas Ln	A1(M) South	A6108	A66	Total
A6055	PASS	PASS	PASS	PASS	PASS	PASS	PASS
A1(M) North	PASS	PASS	PASS	PASS	PASS	PASS	PASS
Middleton Tyas Ln	PASS	PASS	PASS	PASS	PASS	PASS	PASS
A1(M) South	PASS	PASS	PASS	PASS	PASS	PASS	PASS
A6108	PASS	PASS	PASS	PASS	PASS	PASS	PASS
A66	PASS	PASS	PASS	PASS	PASS	PASS	PASS
Total	FAIL	PASS	PASS	PASS	PASS	PASS	PASS

Turning Movement Validation - Scotch Corner - PM Peak

Observed

	A6055	A1(M) North	Middleton Tyas Ln	A1(M) South	A6108	A66	Total
A6055	0	0	4	4	26	1	34
A1(M) North	1	0	52	4	199	197	452
Middleton Tyas Ln	58	0	0	83	41	87	269
A1(M) South	2	0	102	3	21	398	525
A6108	306	0	36	19	19	50	429
A66	253	0	96	368	6	1	722
Total	619	0	288	479	312	734	2431

Modelled

	A6055	A1(M) North	Middleton Tyas Ln	A1(M) South	A6108	A66	Total
A6055	0	0	0	0	0	0	0
A1(M) North	0	0	0	0	249	209	458
Middleton Tyas Ln	0	0	0	108	59	46	212
A1(M) South	0	0	72	0	11	478	560
A6108	310	0	69	11	0	31	421
A66	208	0	55	451	7	0	721
Total	518	0	197	569	325	764	2372

Percentage Difference

	A6055	A1(M) North	Middleton Tyas Ln	A1(M) South	A6108	A66	Total
A6055	-	-	-100%	-100%	-100%	-100%	-100%
A1(M) North	-100%	-	-100%	-100%	25%	6%	1%
Middleton Tyas Ln	-100%	-	-	30%	43%	-47%	-21%
A1(M) South	-100%	-	-29%	-100%	-49%	20%	7%
A6108	1%	-	96%	-44%	-100%	-37%	-2%
A66	-18%	-	-42%	23%	27%	-100%	0%
Total	-16%	-	-32%	19%	4%	4%	-2%

Difference

	A6055	A1(M) North	Middleton Tyas Ln	A1(M) South	A6108	A66	Total
A6055	0	0	-4	-4	-26	-1	-34
A1(M) North	-1	0	-52	-4	50	12	6
Middleton Tyas Ln	-58	0	0	25	18	-41	-56
A1(M) South	-2	0	-30	-3	-10	80	35
A6108	4	0	34	-8	-19	-18	-8
A66	-45	0	-40	83	2	-1	-1
Total	-101	0	-91	90	14	31	-58

GEH

	A6055	A1(M) North	Middleton Tyas Ln	A1(M) South	A6108	A66	Total
A6055	-	-	2.6	2.6	7.2	1.4	8.2
A1(M) North	1.0	-	10.2	2.6	3.3	0.9	0.3
Middleton Tyas Ln	10.7	-	-	2.5	2.5	5.0	3.6
A1(M) South	2.0	-	3.2	2.2	2.6	3.8	1.5
A6108	0.2	-	4.7	2.2	6.2	2.9	0.4
A66	2.9	-	4.6	4.1	0.6	1.4	0.0
Total	4.2	-	5.9	3.9	0.8	1.1	1.2

TAG Criteria Pass / Fail

	A6055	A1(M) North	Middleton Tyas Ln	A1(M) South	A6108	A66	Total
A6055	PASS	PASS	PASS	PASS	PASS	PASS	PASS
A1(M) North	PASS	PASS	PASS	PASS	PASS	PASS	PASS
Middleton Tyas Ln	PASS	PASS	PASS	PASS	PASS	PASS	PASS
A1(M) South	PASS	PASS	PASS	PASS	PASS	PASS	PASS
A6108	PASS	PASS	PASS	PASS	PASS	PASS	PASS
A66	PASS	PASS	PASS	PASS	PASS	PASS	PASS
Total	PASS	PASS	PASS	PASS	PASS	PASS	PASS

F Appendix F

F.1 TAG Performance & Model Statistics

Screenline Performance

Performance Measure	Total Vehicles Stage 3 AM Peak		Inter-Peak		PM Peak		Cars Stage 3 AM Peak		Inter-Peak		PM Peak	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
All screenlines or cordons within 5% of observed flows	17	94%	17	94%	18	100%	17	94%	16	89%	18	100%
All screenlines or cordons within 10% of observed flows	17	94%	18	100%	18	100%	18	100%	18	100%	18	100%
All screenlines or cordons within GEH <4	17	94%	18	100%	18	100%	18	100%	18	100%	18	100%
All screenlines and cordons with GEH <7.5	18	100%	18	100%	18	100%	18	100%	18	100%	18	100%

Performance Measure	LGVs Stage 3 AM Peak		Inter-Peak		PM Peak		HGVs Stage 3 AM Peak		Inter-Peak		PM Peak	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
All screenlines or cordons within 5% of observed flows	14	78%	14	78%	15	83%	11	61%	13	72%	9	50%
All screenlines or cordons within 10% of observed flows	15	83%	15	83%	16	89%	16	89%	16	89%	15	83%
All screenlines or cordons within GEH <4	17	94%	16	89%	16	89%	18	100%	17	94%	17	94%
All screenlines and cordons with GEH <7.5	18	100%	18	100%	18	100%	18	100%	18	100%	17	94%

AM Peak

Stage 3

Screenline	Direction	No. of Count	No. of Count	Total Vehicles Obs	Mod	% Diff	GEH	Cars Obs	Mod	% Diff	GEH
Penrith	Inbound	7	6	2,586	2,495	-3.5%	1.8	2,226	2,141	-3.9%	1.8
	Outbound	7	6	1,698	1,707	0.6%	0.2	1,372	1,404	2.3%	0.9
Lake District	Eastbound	10	9	3,753	3,716	-1.0%	0.6	2,937	2,891	-1.6%	0.8
	Westbound	9	9	4,101	4,028	-1.8%	1.1	2,974	2,874	-3.4%	1.9
Barnard Castle	Eastbound	12	11	1,844	1,875	1.7%	0.7	1,467	1,499	2.2%	0.8
	Westbound	12	11	1,857	1,893	1.9%	0.8	1,465	1,503	2.6%	1.0
Tyne & Wear	Eastbound	9	9	5,161	5,014	-2.8%	2.1	4,299	4,160	-3.2%	2.1
	Westbound	9	9	4,838	4,867	0.6%	0.4	3,762	3,811	1.3%	0.8
Durham	Eastbound	6	6	4,671	4,628	-0.9%	0.6	3,737	3,727	-0.3%	0.2
	Westbound	6	6	2,897	2,893	-0.1%	0.1	2,318	2,305	-0.6%	0.3
Darlington	Eastbound	6	5	2,674	2,643	-1.1%	0.6	2,190	2,157	-1.5%	0.7
	Westbound	6	5	2,470	2,482	0.5%	0.3	2,052	2,048	-0.2%	0.1
Boundary North	Northbound	12	12	2,637	2,598	-1.5%	0.8	1,774	1,769	-0.3%	0.1
	Southbound	12	12	3,058	3,002	-1.8%	1.0	2,137	2,102	-1.6%	0.8
Boundary South	Northbound	16	17	8,586	8,656	0.8%	0.8	6,253	6,238	-0.2%	0.2
	Southbound	16	17	8,131	8,331	2.5%	2.2	5,656	5,892	4.2%	3.1
Appleby	Eastbound	9	6	1,226	1,370	11.8%	4.0	873	942	7.9%	2.3
	Westbound	9	6	1,473	1,483	0.7%	0.3	1,100	1,048	-4.7%	1.6
				63,659	63,683	0.0%		48,592	48,510	-0.2%	

IP

Stage 3

Screenline	Direction	No. of Count	No. of Count	Total Vehicles Obs	Mod	% Diff	GEH	Cars Obs	Mod	% Diff	GEH
Penrith	Inbound	7	6	1,684	1,768	5.0%	2.0	1,412	1,500	6.3%	2.3
	Outbound	7	6	1,706	1,742	2.1%	0.9	1,449	1,499	3.4%	1.3
Lake District	Eastbound	10	9	3,485	3,410	-2.1%	1.3	2,680	2,598	-3.0%	1.6
	Westbound	9	9	3,205	3,226	0.7%	0.4	2,514	2,529	0.6%	0.3
Barnard Castle	Eastbound	12	11	1,674	1,654	-1.2%	0.5	1,326	1,306	-1.5%	0.5
	Westbound	12	11	1,639	1,588	-3.1%	1.3	1,314	1,269	-3.4%	1.3
Tyne & Wear	Eastbound	9	9	3,886	3,795	-2.3%	1.5	3,149	3,071	-2.5%	1.4
	Westbound	9	9	3,950	3,874	-1.9%	1.2	3,162	3,099	-2.0%	1.1
Durham	Eastbound	6	6	2,781	2,776	-0.2%	0.1	2,209	2,209	0.0%	0.0
	Westbound	6	6	2,847	2,841	-0.2%	0.1	2,262	2,260	-0.1%	0.0
Darlington	Eastbound	6	5	1,812	1,841	1.6%	0.7	1,422	1,443	1.5%	0.5
	Westbound	6	5	1,783	1,831	2.7%	1.1	1,409	1,453	3.2%	1.2
Boundary North	Northbound	12	12	2,962	2,861	-3.4%	1.9	2,153	2,091	-2.9%	1.3
	Southbound	12	12	3,226	3,077	-4.6%	2.7	2,338	2,234	-4.4%	2.2
Boundary South	Northbound	16	17	8,233	8,207	-0.3%	0.3	6,220	6,054	-2.7%	2.1
	Southbound	16	17	8,323	8,197	-1.5%	1.4	5,579	5,565	-0.3%	0.2
Appleby	Eastbound	9	6	1,399	1,396	-0.2%	0.1	999	977	-2.2%	0.7
	Westbound	9	6	1,325	1,315	-0.8%	0.3	992	929	-6.4%	2.0
				55,919	55,400	-0.9%		42,588	42,087	-1.2%	

PM Peak

Stage 3

Screenline	Direction	No. of Count	No. of Count	Total Vehicles Obs	Mod	% Diff	GEH	Cars Obs	Mod	% Diff	GEH
Penrith	Inbound	7	6	1,896	1,948	2.8%	1.2	1,602	1,666	4.0%	1.6
	Outbound	7	6	2,328	2,352	1.0%	0.5	2,083	2,120	1.8%	0.8
Lake District	Eastbound	10	9	4,159	4,007	-3.7%	2.4	3,395	3,239	-4.6%	2.7
	Westbound	9	9	3,912	4,000	2.2%	1.4	3,290	3,368	2.4%	1.4
Barnard Castle	Eastbound	12	11	1,868	1,922	2.9%	1.2	1,586	1,641	3.4%	1.4
	Westbound	12	11	1,897	1,910	0.7%	0.3	1,631	1,647	0.9%	0.4
Tyne & Wear	Eastbound	9	9	4,848	4,750	-2.0%	1.4	4,224	4,138	-2.0%	1.3
	Westbound	9	9	5,226	5,178	-0.9%	0.7	4,581	4,545	-0.8%	0.5
Durham	Eastbound	6	6	3,184	3,209	0.8%	0.4	2,744	2,773	1.0%	0.5
	Westbound	6	6	4,628	4,570	-1.3%	0.9	4,000	3,955	-1.1%	0.7
Darlington	Eastbound	6	5	2,560	2,631	2.8%	1.4	2,214	2,277	2.8%	1.3
	Westbound	6	5	2,513	2,575	2.5%	1.2	2,163	2,227	2.9%	1.3
Boundary North	Northbound	12	12	3,310	3,236	-2.3%	1.3	2,571	2,522	-1.9%	1.0
	Southbound	12	12	3,147	3,125	-0.7%	0.4	2,422	2,447	1.0%	0.5
Boundary South	Northbound	16	17	9,285	9,316	0.3%	0.3	7,632	7,598	-0.4%	0.4
	Southbound	16	17	9,255	9,171	-0.9%	0.9	6,701	6,846	2.2%	1.8
Appleby	Eastbound	9	6	1,558	1,608	3.2%	1.3	1,195	1,183	-1.0%	0.3
	Westbound	9	6	1,449	1,460	0.7%	0.3	1,158	1,111	-4.1%	1.4
				67,024	66,968	-0.1%		55,191	55,302	0.2%	