SCHEME COSTS TECHNICAL NOTE

Date: 17 September 2020

Confidentiality: Public

Subject: Note on Scheme Costs

Project: Great Yarmouth Third River Crossing

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OVERVIEW

The technical note has been prepared to accompany the DfT Appraisal Cost Pro-Forma sheet. The note sets to outline the steps taken to covert the final outturn costs of the Scheme to the Present Value of Costs used for the Scheme appraisal.

SCHEME COST PROCESSING

Outturn Costs

The final outturn costs are presented in Table 0.1. These are the costs that have been agreed with the contractor.

Table 0.1: Outturn Spending Profile (£000)

Scheme Element	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	Cost
Construction	136	-10	5,916	5,404	37,517	20,927	440	70,330
Utilities	0	0	21	1,130	354	0	0	1,505
Land	39	236	1,004	11,444	3,889	736	-1,095	16,253
Fees	1,714	5,031	2,867	2,754	1,263	1,174	214	15,017
Base Cost	**1,888**	**5,257**	**9,809**	**20,731**	**43,023**	**22,837**	**-441**	**103,105**
QRA	0	0	0	5,733	9,013	2,682	632	18,060
Risk adjusted Base Cost	**1,888**	**5,257**	**9,809**	**26,464**	**52,036**	**25,519**	**191**	**121,164**

Common Price Year Base

The scheme costs are required to be presented in a common price year base, in this case 2020. For the forecast costs this require the removal of inflation. The prices from 2020 have been inflated through the delivery and construction period based on historic trend analysis of the inflationary indices applicable and a nominal allowance for the effects of coronavirus (COVID-19), as set out in Table 0.2.

Table 0.2 Inflation (based on Bank of England CPI Forecasts of General Inflation)

Factors Applied to 2020 Q1 to Give Out-Turn Prices	2020-2021	2021-2022	2022-2023	2023-2024
Stage One (Design) included on 2020 base cost, no further inflation to be applied as Stage One completion before the next annual adjustment of the Prices.	n/a	n/a	n/a	n/a
Stage Two (Fees).	n/a	2.50%	2.50%	2.50%
Stage Two (Construction).	2.50%	3.50%	3.50%	n/a

The final costs are given in Table 0.3.

Table 0.3: Scheme Cost Profile (£000)

Scheme Element	2017-18 Costs (Actual Prices)	2018-19 Costs (Actual Prices)	2019-20 Costs (Actual Prices)	2020-21 Estimated Costs (2020 Q2 Prices)	2021-22 Estimated Costs (2020 Q2 Prices)	2022-23 Estimated Costs (2020 Q2 Prices)	2023-24 Estimated Costs (2020 Q2 Prices)	Cost
Construction	136	-10	5,916	5,360	36,994	20,379	440	69,215
Utilities	0	0	21	1,130	354	0	0	1,505
Land	39	236	1,004	11,444	3,889	736	-1,095	16,253
Fees	1,714	5,031	2,867	2,754	1,242	1,139	209	14,956
Base Cost	1,888	5,257	9,809	20,687	42,480	22,253	-447	101,929
QRA	0	0	0	5,528	8,828	2,557	632	17,545
Risk Adjusted Base Cost	1,888	5,257	9,809	26,215	51,309	24,810	186	119,474

Inflation – Economic Case

The cost of the Scheme should include the effect of forecast construction inflation relative to general inflation as measured by the GDP deflator. Table 0.4 summarises the inflation rates given by TAG data book v1.13 (May 2020) and the Office for National Statistics (ONS) construction output price indices (2020 Q2 release, August 2020). These rates were subsequently used to calculate the inflation factors listed in Table 0.5, to account for the difference between construction inflation and general inflation. The construction inflation rate for April 2019 to March 2020 is applied for all the forecast years. (note construction output price indices for April to June 2020 were excluded from inflation projection due to COVID19 related uncertainty). The factors shown in Table 0.5 have been applied to the construction cost of the Scheme in line with the spend profile.

Table 0.4: General Inflation Rates – Economic Case

Index	2020/21	2021/22	2022/23	2023/24

GDP deflator	1.8%	1.9%	2.0%	2.0%
Construction Inflation Rate	3.0%	3.0%	3.0%	3.0%

Table 0.5: Inflation Factors – Economic Case

Index	2020/21	2021/22	2022/23	2023/24
Construction Inflation Factor	1.012	1.022	1.033	1.044

Inflation has not been applied to the non-construction elements of the Scheme costs. The change per annum in forecast GDP deflator is higher than the Real GDP growth per annum (TAG databook v1.13 (May 2020)). It is therefore assumed that all other costs of the Scheme are not subject to any inflation above the GDP deflator. The inflation factors given **Table 0.5** have been applied to the construction and utilities costs in **Table 0.3** to give cost profile in **Table 0.6**.

Table 0.6: Inflation Adjusted Cost Profile (£000, 2020 Q2 prices from 2020-21)

Scheme Element	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	Cost
Construction	136	-10	5,916	5,422	37,823	21,053	459	70,799
Utilities	0	0	21	1,143	362	0	0	1,526
Land	39	236	1,004	11,444	3,889	736	-1,095	16,253
Fees	1,714	5,031	2,867	2,754	1,242	1,139	209	14,956
Inflation Adjusted Base Cost	**1,888**	**5,257**	**9,809**	**20,762**	**43,317**	**22,927**	**-428**	**103,533**
Risk	0	0	0	5,528	8,828	2,557	632	17,545
Risk Adjusted Base Cost	**1,888**	**5,257**	**9,809**	**26,290**	**52,145**	**25,484**	**205**	**121,079**

Optimism Bias

An Optimism Bias was applied to costs to reflect the uncertainty of the current cost estimates, based on guidance in DfT TAG Unit A1-2, Section 3.5, Table 8 (July 2017). This figure is derived from a weighted average, calculated, based on the proportions of bridge and road costs (66:34) giving an overall optimism bias allowance of **5%** which is applied to the risk-adjusted costs for the forecast years giving a OB adjusted total of **£126.3m.**

Re-basing

The real price in any given year is then the nominal price deflated by the change in the inflation index between that year and the Base year (2010). The GDP price deflator contained in the TAG databook v1.13 (May 2020) has been used to convert prices from the 2020 price year base to 2010 costs (2010 index = 100, 2020 = 119.51). A factor of 0.837 has been applied to the OB adjusted total giving a rebased total of **£105.6m**.

Discounting

The rebased 2010 prices are then discounted to 2010 to account for 'social time preference', that is people's preference to consume goods and services now, rather than in the future. A discount rate of 3.5% per annum is applied. The discounted scheme cost is **£73.3m**.

Market Prices

The final stage in preparing the package cost for appraisal is to convert the cost to the 'market price' using the indirect tax correction factor of 1.19, which reflects the average rate of indirect taxation in the economy. The final scheme cost is **£87.2m**.

OPERATING AND MAINTENANCE

The assessment of traffic related maintenance costs focuses on the plan for non-routine reconstruction and resurfacing of the carriageway. The aim of the process is to calculate the net maintenance and operating cost impact of the Scheme to ensure that this is robustly captured in the present value of costs.

It is assumed that major maintenance would take place every few years for resurfacing of the new built sections of carriageway and for reconstruction works.

Operating costs of the Bridge structure are known, and professional experience of similar infrastructure has informed the costs associated with the operation and maintenance activities. For these reasons an additional 'risk' factor has not been applied to the Operation and Maintenance tasks.

All maintenance and operation costs have been estimated at 2016 Q3 prices for the same reasons as given above.

Inflation over and above GDP deflator has not been applied to maintenance and operation costs due to the uncertainty in forecasting economic conditions far in the future.

Further details are provided in the Economic Appraisal Report (Supporting Document 1).

Table 0.7 Operating and Maintenance Costs

Category	60 year cost (£000s, 2016 prices)	60 year cost (£000s, 2020 prices)	2038 Design Year (£000s, 2020 prices)	60 year cost (£000s, 2010 market prices, discounted to 2010)
Bridge Operation	6,048	6,538	111	1,505
Bridge Maintenance	5,565	6,015	40	1,023
Road Operation and Maintenance	3,934	4,251	72	979
TOTAL	**15,548**	**16,805**	**223**	**4,172**

SUMMARY

This note has outlined the process by which the outturn scheme costs have been processed to present value whole life costs for the Scheme. The outturn cost is **£121.1m**, the present value cost is **£91.4m**.

Table 8: Fuel and Income Adjustment Factors (Source: TAG Table M 4.2.1 May 2019 v1.12)

YEAR	INCOME ADJUSTMENT FACTOR (2016 BASE)	FUEL COST ADJUSTMENT FACTOR (2016 BASE)	COMBINED ADJUSTMENT FACTOR (2016 BASE)

2023	1.010	1.017	1.027
2038	1.048	1.055	1.106

The Fuel and Income Adjusted Reference Case matrix totals for car trips only are summarised in Table 9.

Table 9: Fixed Demand Reference Case Matrix Totals with Fuel & Income adjustments – Car trips

YEAR	PEAK	BASE YEAR DEMAND (2016) – CAR TOTAL	REFERENCE CASE WITH F&I ADJ – CAR TOTAL	% INCREASE (2016 TO REF CASE)
2023	**AM**	144,595	159,047	10%
2023	**IP**	98,287	110,465	12%
2023	**PM**	146,518	161,122	10%
2038	**AM**	144,595	189,631	31%
2038	**IP**	98,287	129,040	31%
2038	**PM**	146,518	192,717	32%

As well as the adjustments to the future year demand, the values of time (VOT) and vehicle operating costs were adjusted in line with the previous modelling, adopting values from DfT TAG Databook November 2018. Table 10 and Table 11 present the ratio of Pence Per Minute (PPM) compared to Pence Per Kilometre (PPK) for each modelled time period and forecast year which have been directly applied within SATURN.

Table 10: 2023 PPM/ PPK Ratios

YEAR	PEAK	PPM/ PPK RATIO AM	PPM/ PPK RATIO IP	PPM/ PPK RATIO PM
2023	**Car Commuting**	0.43:1	0.42:1	0.43:1
2023	**Car Work**	0.37:1	0.35:1	0.36:1
2023	**Car Other**	0.63:1	0.58:1	0.6:1
2023	**LGV**	0.64:1	0.64:1	0.64:1
2023	**HGV**	1.07:1	1.08:1	1.15:1

Table 11: 2038 PPM/ PPK Ratios

YEAR	PEAK	PPM/ PPK RATIO AM	PPM/ PPK RATIO IP	PPM/ PPK RATIO PM
2023	**Car Commuting**	0.31:1	0.31:1	0.31:1
2023	**Car Work**	0.27:1	0.26:1	0.26:1
2023	**Car Other**	0.45:1	0.42:1	0.43:1
2023	**LGV**	0.5:1	0.5:1	0.5:1
2023	**HGV**	0.92:1	0.92:1	0.98:1

OWN COST ELASTICITY METHODOLOGY

TAG M2 states the following on the suitability of utilising fixed demand modelling for the scheme assessment (as opposed to Variable Demand Modelling);

- **2.2.4**: 'In order to establish a case for omitting variable demand in the model, preliminary quantitative estimates of the potential effects of variable demand on both traffic levels and benefits should be made'

- **2.2.6:** 'Where preliminary calculations using an existing variable demand model are carried out, it will be acceptable in general to use a fixed demand assessment where the resulting difference in suppressed/ induced traffic when using the demand model does not change benefits resulting from a scheme by more than 10% in the opening year and 15% in the forecast year (10 to 15 years later) relative to a fixed demand case.'

While TAG stipulates that '*estimates of the potential effects of variable demand on both traffic levels and benefits should be made'*, it only prescribes criteria for acceptable changes to benefits, with no criteria stipulated for demand.

SATURN has a variable demand function where the trips are adjusted to respond to changes in generalised costs – this is an **own-cost** elasticity form model, known in SATURN as elastic assignment. TAG makes allowance for the use such models in the context of the preliminary calculations to understand acceptability of fixed demand methods.

The SATURN 'POWER' parameter is set to ensure the demand responds appropriately to changes in fuel costs. As per TAG M2 paragraphs 6.4.15 and 6.4.17, the following fuel elasticities have been targeted;

- Employers' business trips: -0.1
- Discretionary trips: -0.4
- Commuting and Education: -0.25

The POWER parameter has been calibrated in the 2016 models to ensure that a 10% increase in fuel costs has the desired elastic response in vehicle kilometres travelled for each user class. The 10% increase in fuel costs is represented in the model through revising the fuel component of the PPK (Pence Per Kilometre). The results of this POWER parameter calibration are shown in Table 12, which shows the POWER parameter for each user class has been set to achieve the requisite Fuel Cost Elasticity.

Table 12: Calibration of POWER Parameter

PEAK	CAR TRIP TYPE	FIXED ASSIGNMENT VEH KM'S (T^0)	POWER	ELASTIC ASSIGNMENT VEH KM'S (T^1)	ACHIEVED FUEL COST ELASTICITY
AM	**Discretionary**	1,820,173	-1.235	1,752,068	-0.4001
AM	**Employment**	292,987	-0.63	290,196	-0.1004
AM	**Commuting**	2,047,218	-1.17	1,998,939	-0.2504
IP	**Discretionary**	1,794,998	-1.26	1,728,011	-0.3990
IP	**Employment**	134,444	-0.13	133,166	-0.1002
IP	**Commuting**	397,205	-0.87	387,877	-0.2493
PM	**Discretionary**	2,120,291	-1.51	2,041,076	-0.3995
PM	**Employment**	213,107	-1.895	211,067	-0.1009
PM	**Commuting**	2,214,732	-1.145	2,162,716	-0.2494

The POWER parameters, as derived in Table 12, are used to develop future year forecasts. The elastic response has been calculated separately for the Do Minimum and Do Something scenarios, as such these scenarios are not modelled with identical traffic demand.

Table 13 compares the fixed demand car matrix total without the application of fuel and income adjustments, to the Own-Cost elastic matrices produced in the Do Minimum and Do Something scenarios. The fixed demand car matrix without fuel and income factor adjustments is used as the input reference matrix for the elastic assignments. The changes to future year demand are minor, with a 0 to 0.1% change in the car matrix totals.

Table 13: Own-Cost Elastic Demand Response

YEAR	PEAK	REFERENCE DEMAND – WITHOUT FUEL & INCOME ADJ	OWN COST 'DO MINIMUM'	OWN COST 'DO SOMETHING'
2023	**AM**	154,903	+23 (0%)	-2 (0%)
2023	**IP**	107,587	-25 (0%)	-26 (0%)
2023	**PM**	156,925	-76 (0%)	-91 (-0.1%)
2038	**AM**	171,465	-64 (0%)	-59 (0%)
2038	**IP**	116,678	-18 (0%)	-15 (0%)
2038	**PM**	174,255	-87 (0%)	-103 (-0.1%)

As well as the adjustment to the future year matrices the Values of Time (VoT) and Vehicle Operating Costs (VOC) were adjusted in line with the DfT TAG Databook November 2018, as shown in Table 10 and Table 11.

MODELLED IMPACTS

Difference plots have been generated comparing the delay and actual flow under the fixed and the elasticity assignments, and are provided in Appendix A. These plots show the elastic assignments have a minor overall impact on trips on the network. The changes in demand and delays on the A140 through Long Stratton are generally minor between the fixed and elastic assignments, with a maximum change in demand in Long Stratton of 73 PCU's north of the bypass northbound in 2038 in both AM and IP, see Table 14. This reduction in 73 vehicles is only between 5% and 7% of the total flow north of the bypass northbound. On the bypass itself, the largest reductions in flow are for the 2038 AM assignments, northbound flow reduces by 69 PCUs northbound (8%) and 48 PCUs southbound (6%).

Table 14: Change in Demand on Long Stratton Bypass between Fixed and Elastic Assignments

AREA	2023 AM DM	2023 AM DS	2023 IP DM	2023 IP DS	2023 PM DM	2023 PM DS	2038 AM DM	2038 AM DS	2038 IP DM	2038 IP DS	2038 PM DM	2038 PM DS
North of Bypass NB	-15.1	-13.0	-12.8	-17.0	-16.7	-22.7	-56.9	-72.8	-64.2	-73.0	-56.8	-54.2
North of Bypass SB	-16.1	-20.3	-13.9	-15.3	-6.0	-16.8	-51.2	-77.8	-47.3	-64.0	-18.7	-56.9
South of Bypass NB	-7.9	-8.5	-8.6	-11.7	-15.0	-24.1	-16.8	-63.1	-46.6	-44.0	-74.6	-41.9
South of Bypass SB	-14.7	-15.1	-10.4	-11.4	-2.9	-13.8	-38.6	-61.9	-31.6	-46.2	3.7	-22.8
Bypassed Route NB	-3.5	-2.1	-10.1	-2.0	-14.2	-1.4	-13.9	8.2	-53.9	-1.1	-50.5	-8.8
Bypassed Route SB	-9.7	-1.8	-11.1	-1.7	0.0	-0.2	-22.8	-8.5	-36.7	-7.3	-1.4	-8.0
Bypass NB	0.0	-3.0	0.0	-12.4	0.0	-19.6	0.0	-69.3	0.0	-53.6	0.0	-39.8
Bypass SB	0.0	-12.0	0.0	-11.3	0.0	-13.4	0.0	-47.6	0.0	-46.8	0.0	-22.5

TUBA ANALYSIS

Due to the large extent of the simulation network within the strategic model, there are significant areas of the model which fall outside the expected area of influence for the A140 Long Stratton bypass. This issue means there will be noise and erroneous benefits not associated with the scheme. As such, we have masked benefits for this analysis to only consider trips which would use the bypass or impacted parallel routes such as the A11 corridor.

The economic benefit of the Fixed and Elastic assignments at 2023 and 2038 is presented in Table 15. This table shows that at opening year (2023), the own cost elasticity leads to a 9.5% increase in user benefits, with a -9.8% reduction at 2038, within the 10%/15% TAG criteria.

Table 15: Economic Impact of Elasticity Testing (£)

YEAR	FIXED DEMAND REFERENCE CASE	OWN COST ELASTIC
2023	999,644	1,094,157 (+9.5%)
2038	795,411	717,692 (-9.8%)

Overall this note outlines the methodology and assessment that has been undertaken in line with TAG criteria to determine whether there is a requirement to incorporate Variable Demand Modelling (VDM) as part of the strategic modelling informing the Outline Business Case (OBC) for the A140 Long Stratton Bypass. The analysis undertaken shows that the changes in traffic demand, delay and Tuba outputs do not change significantly between the fixed and elastic assignments. The changes in Tuba outputs for the opening and forecast years vary by less than the thresholds set in the TAG criteria for use of 10% in opening year and 15% 15 years after opening. WSP are therefore of the view that VDM is not required for the assessment of the A140 Long Stratton bypass for the OBC submission.

APPENDIX A – DIFFERENCE PLOTS (OWN COST ELASTICITY)

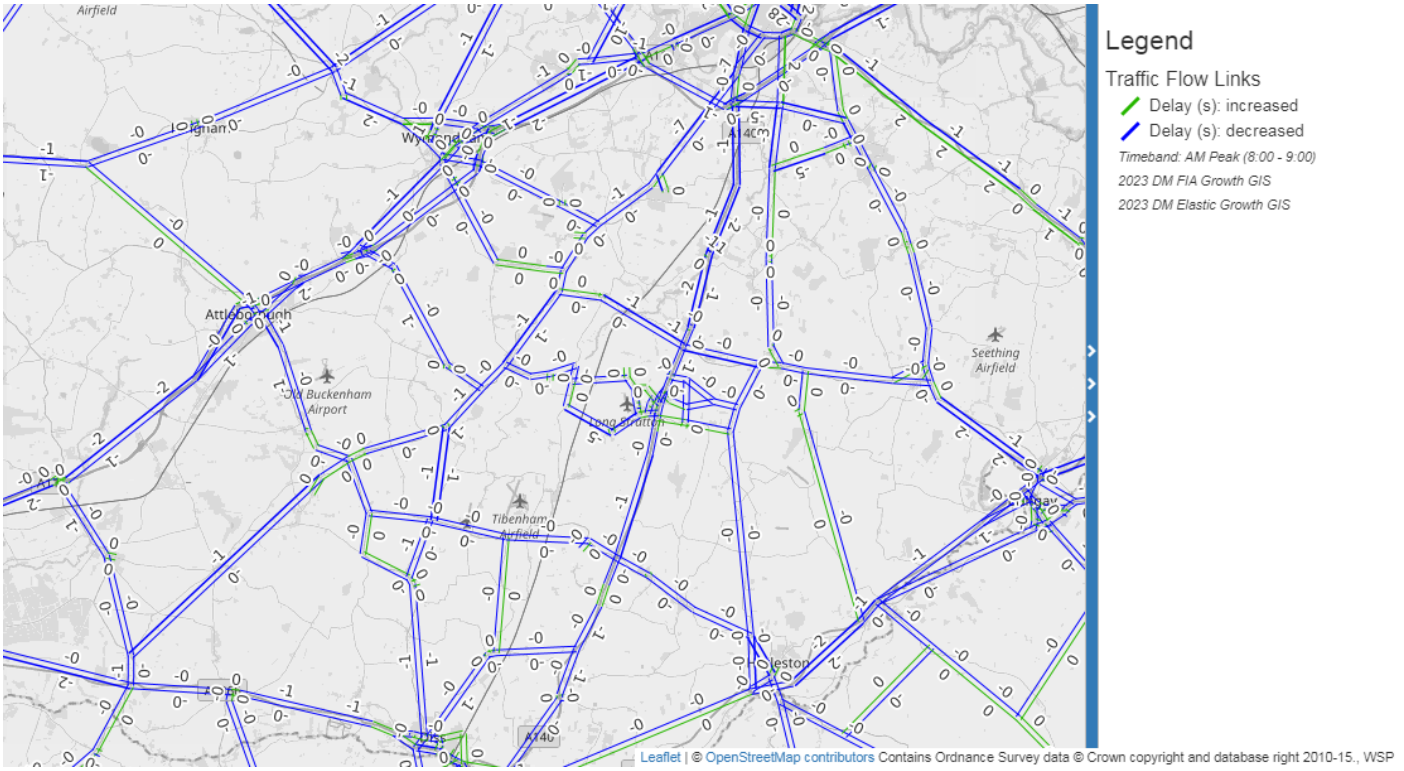

Figure 1: 2023 Do Minimum Elastic – Fixed Demand (incl. Fuel and Income Factors) - AM peak change in delay (seconds)

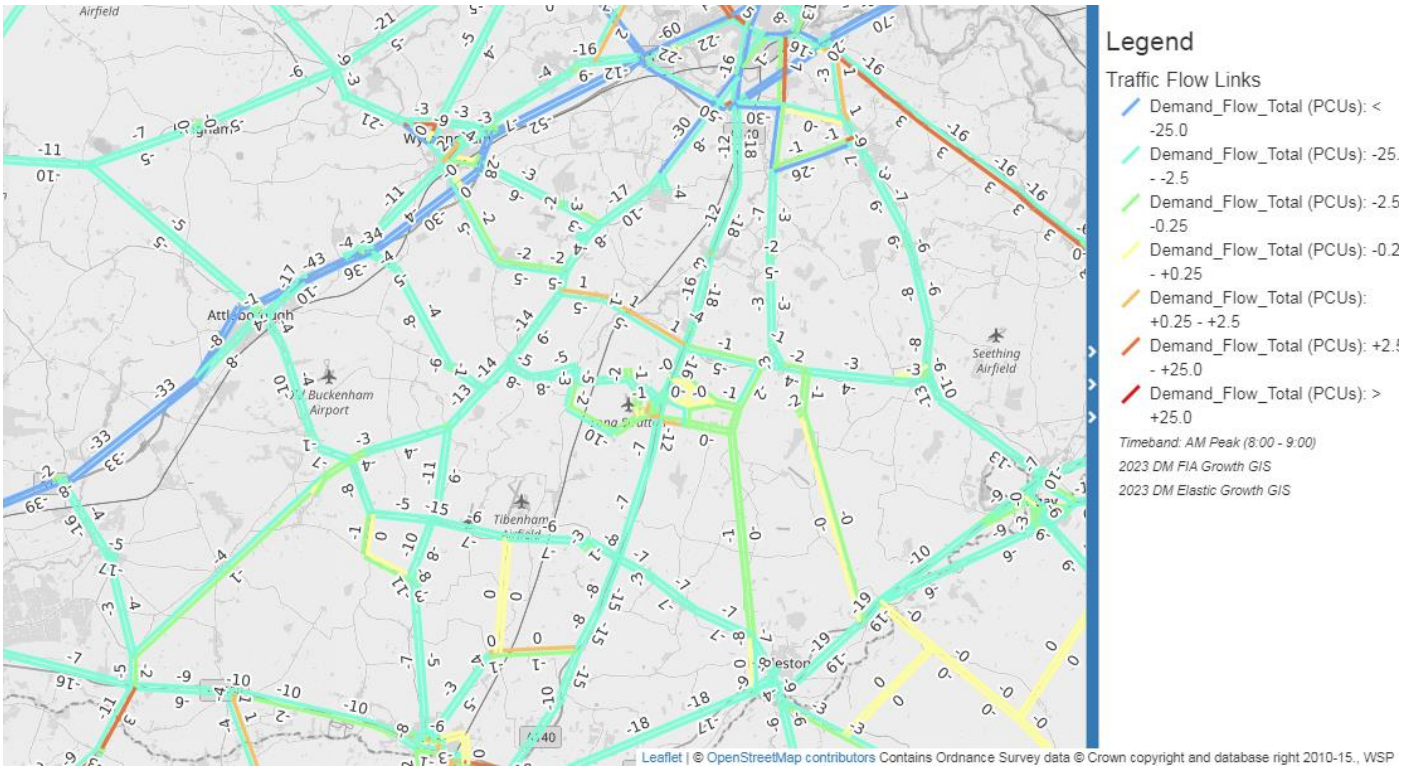

Figure 2: 2023 Do Minimum Elastic – Fixed Demand (incl. Fuel and Income Factors) - AM peak change in demand (PCUs)

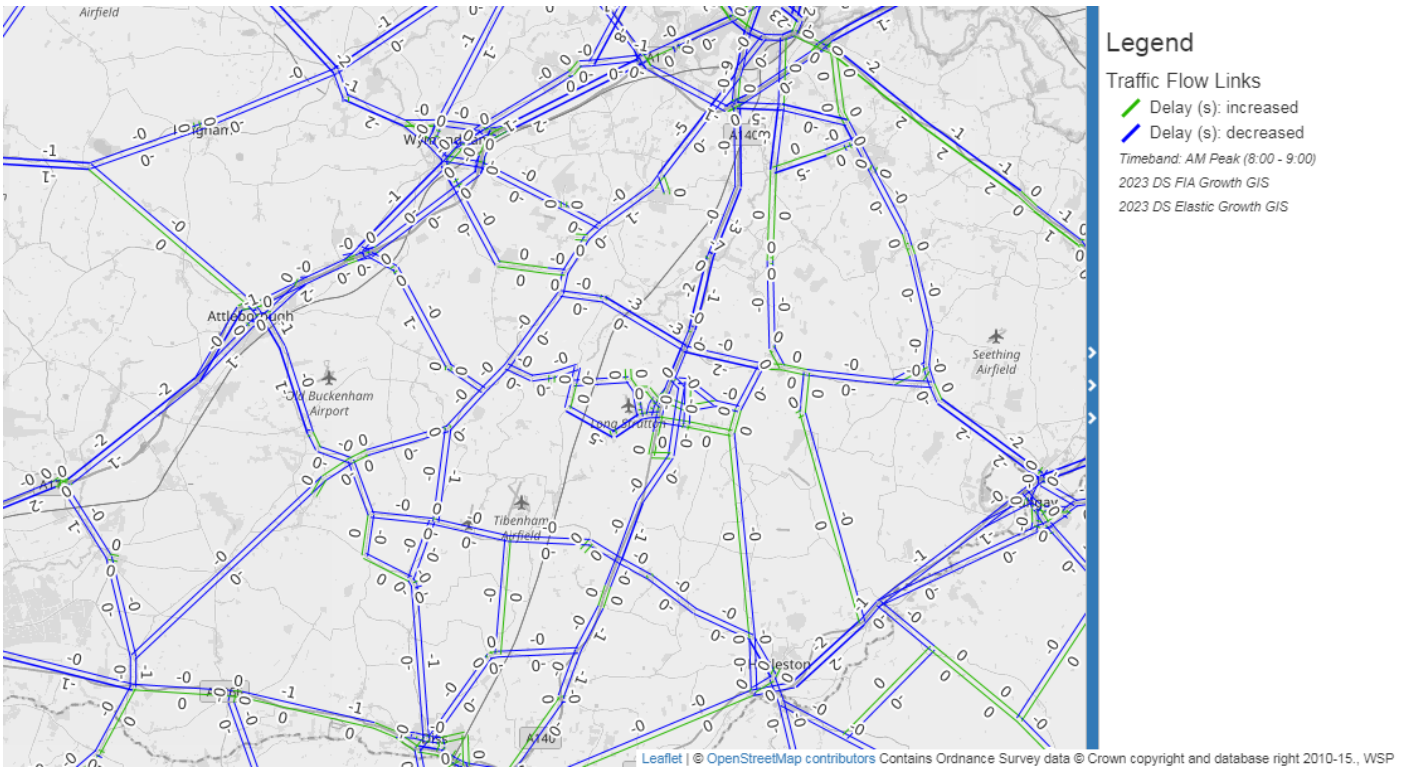

Figure 3: 2023 Do Something Elastic – Fixed Demand (incl. Fuel and Income Factors) - AM peak change in delay (seconds)

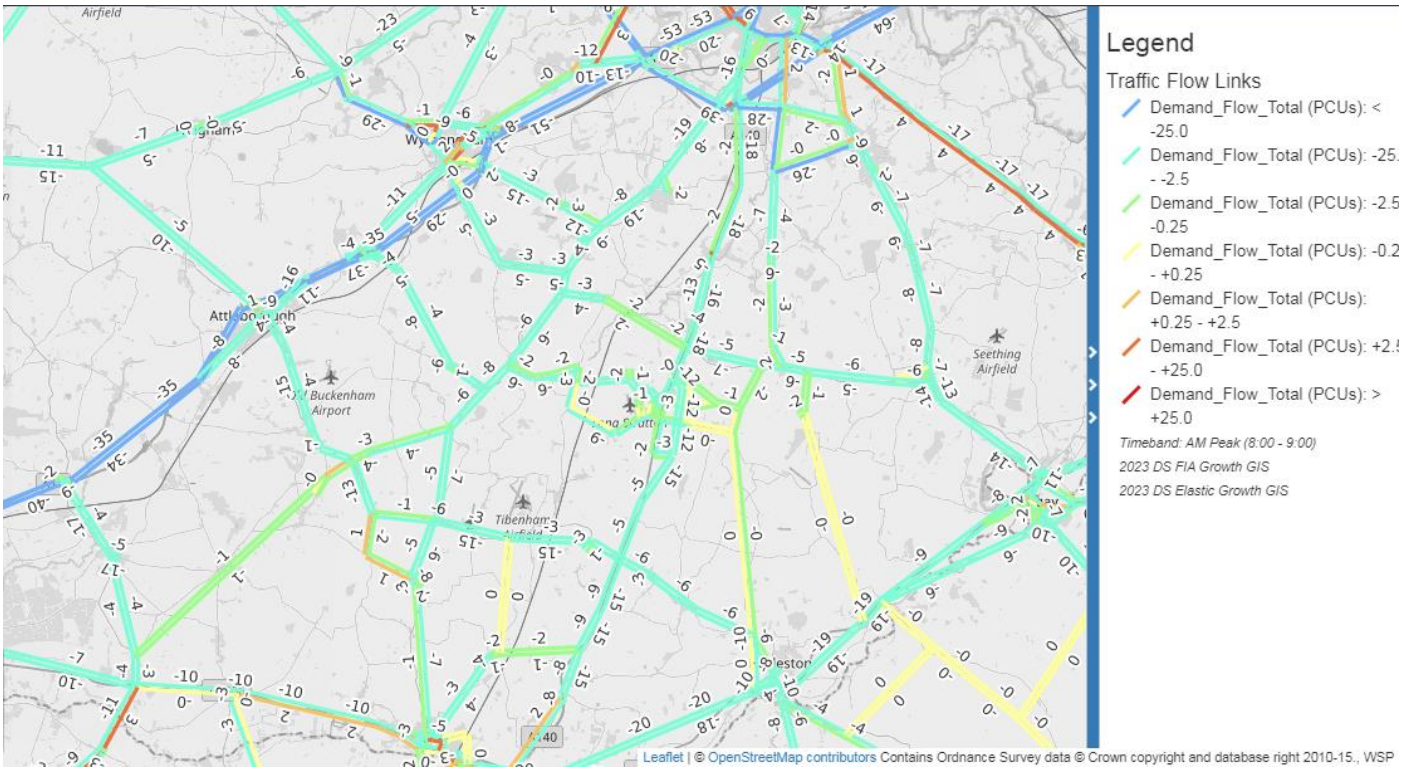

Figure 4: 2023 Do Something Elastic – Fixed Demand (incl. Fuel and Income Factors) - AM peak change in demand (PCUs)

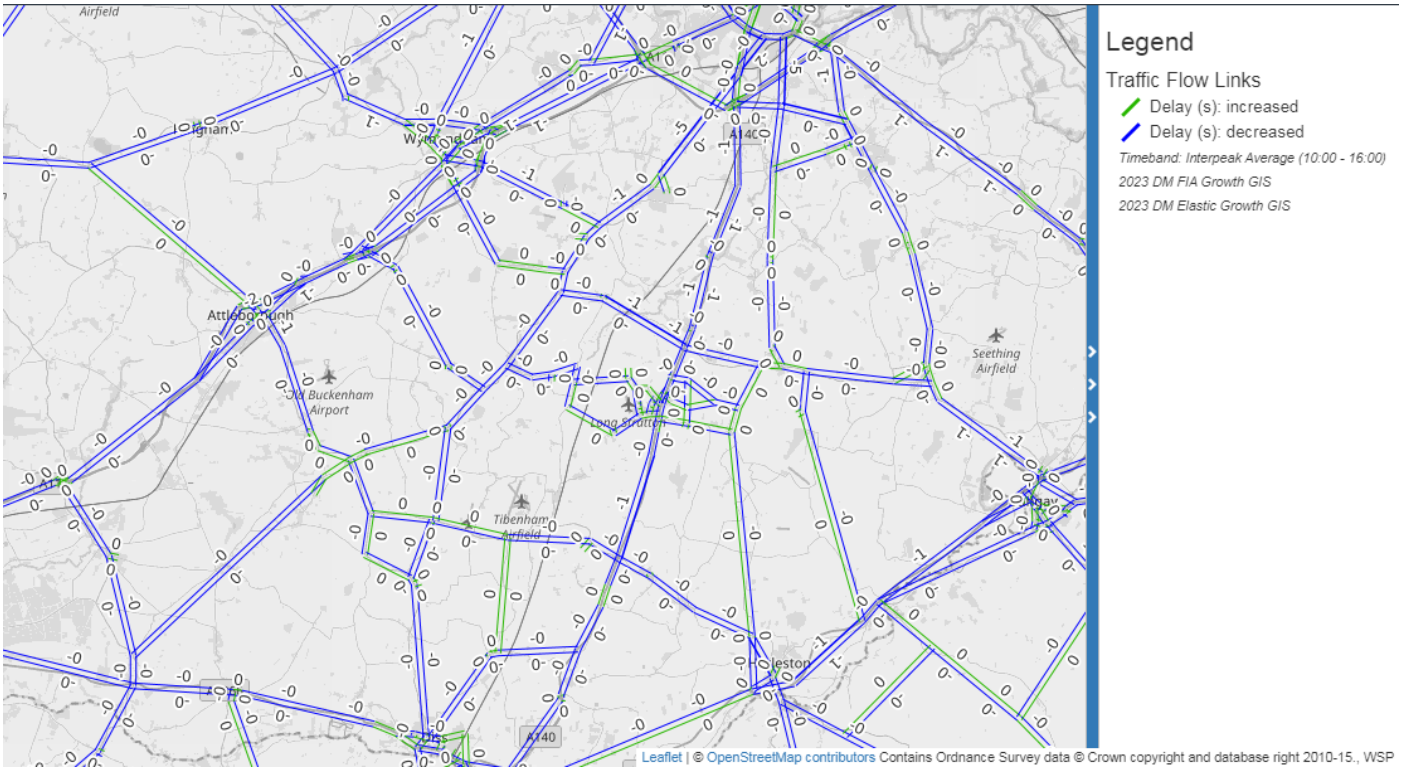

Figure 5: 2023 Do Minimum Elastic – Fixed Demand (incl. Fuel and Income Factors) - IP peak change in delay (seconds)

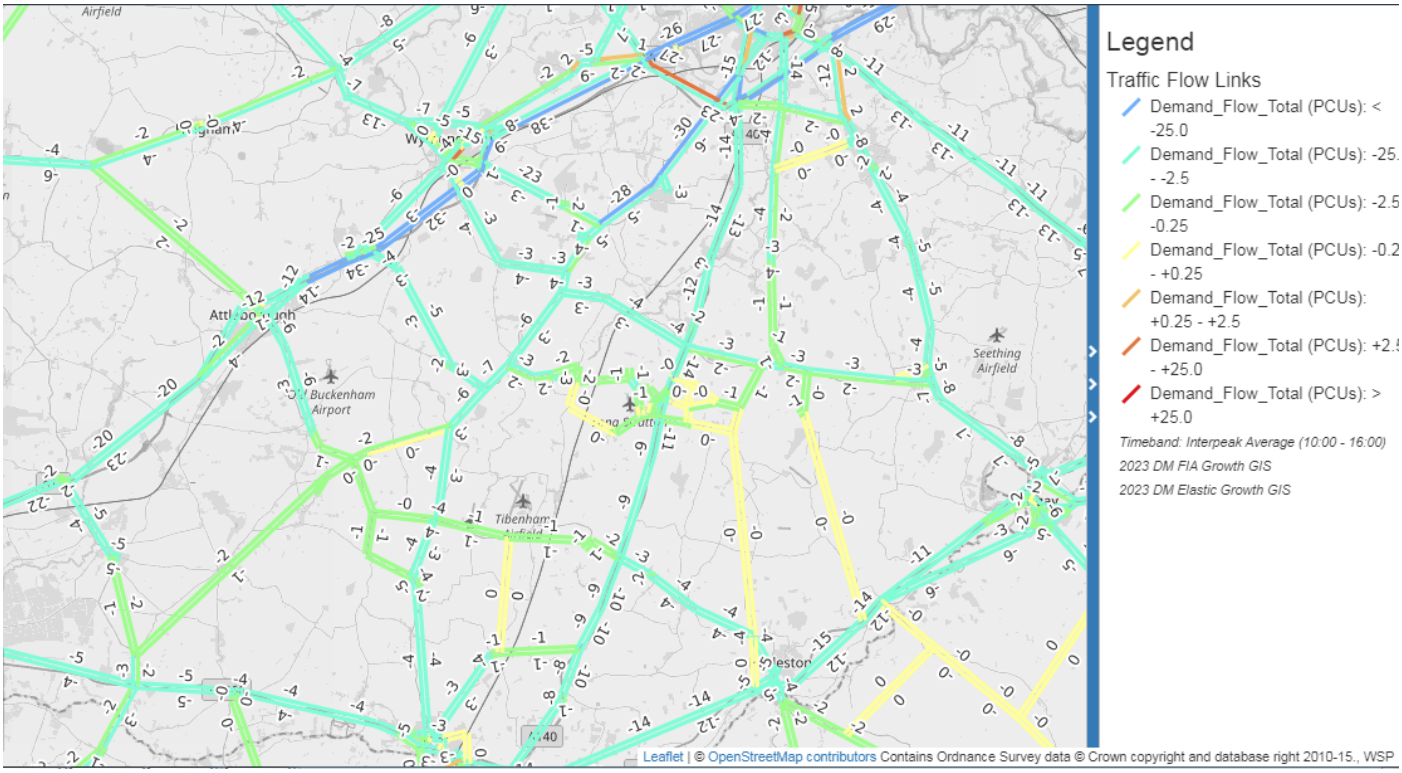

Figure 6: 2023 Do Minimum Elastic – Fixed Demand (incl. Fuel and Income Factors) - IP peak change in demand (PCUs)

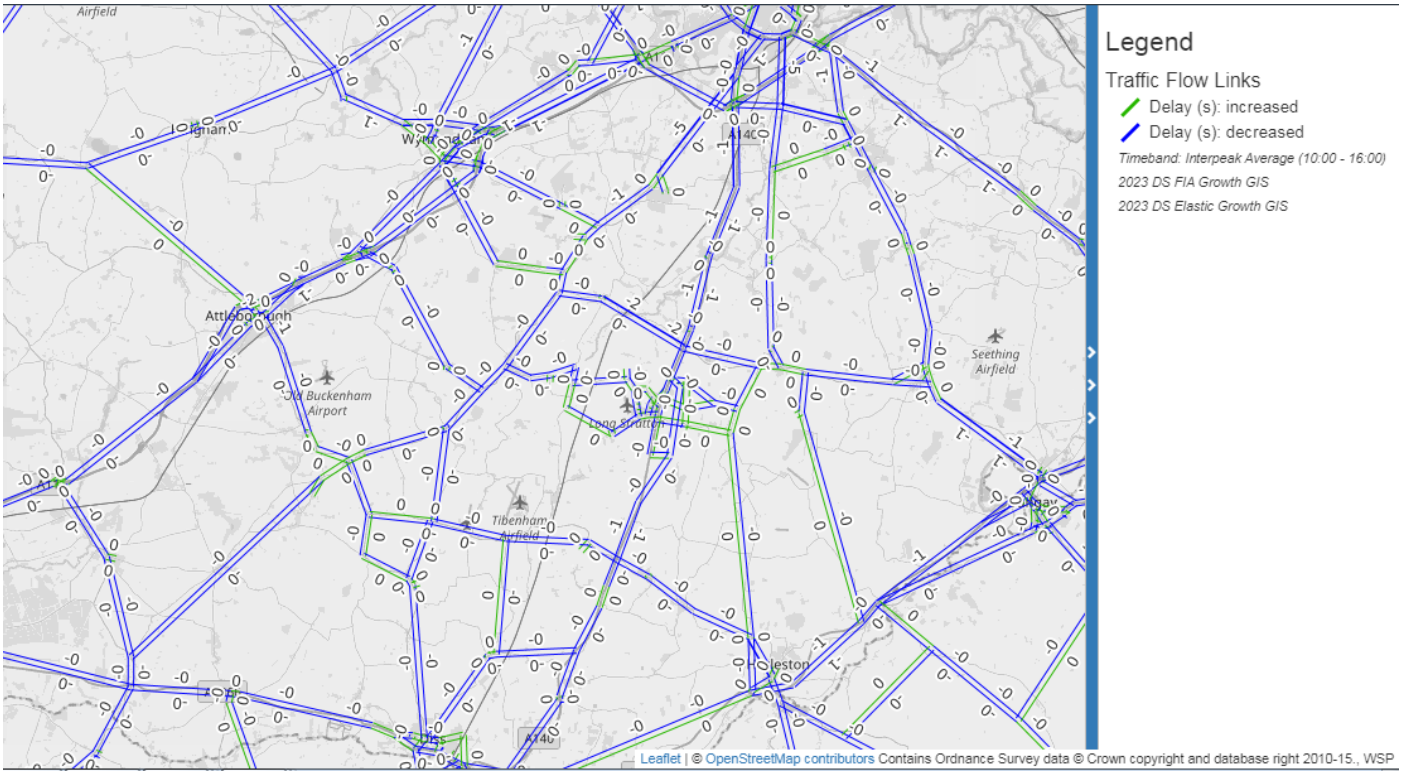

Figure 7: 2023 Do Something Elastic – Fixed Demand (incl. Fuel and Income Factors) - IP peak change in delay (seconds)

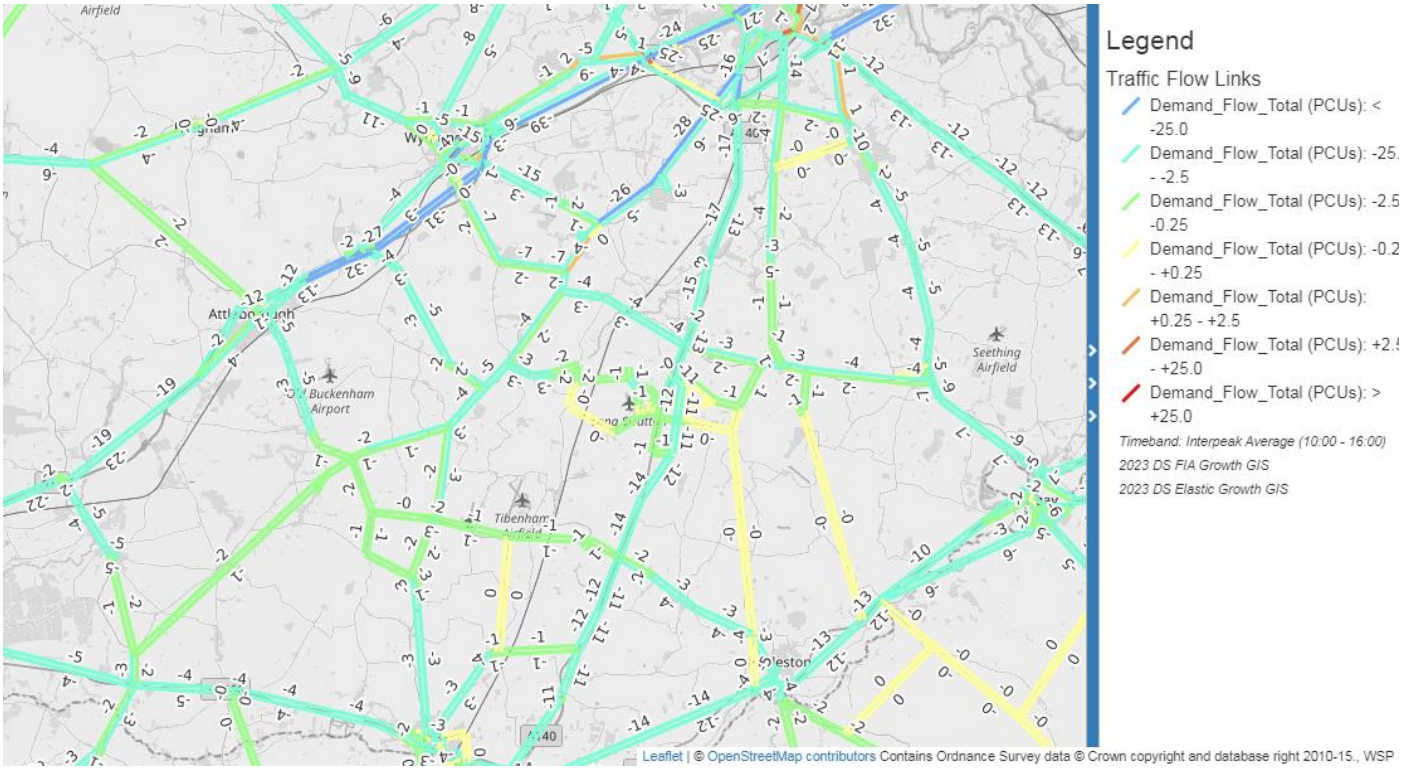

Figure 8: 2023 Do Something Elastic – Fixed Demand (incl. Fuel and Income Factors) - IP peak change in demand (PCUs)

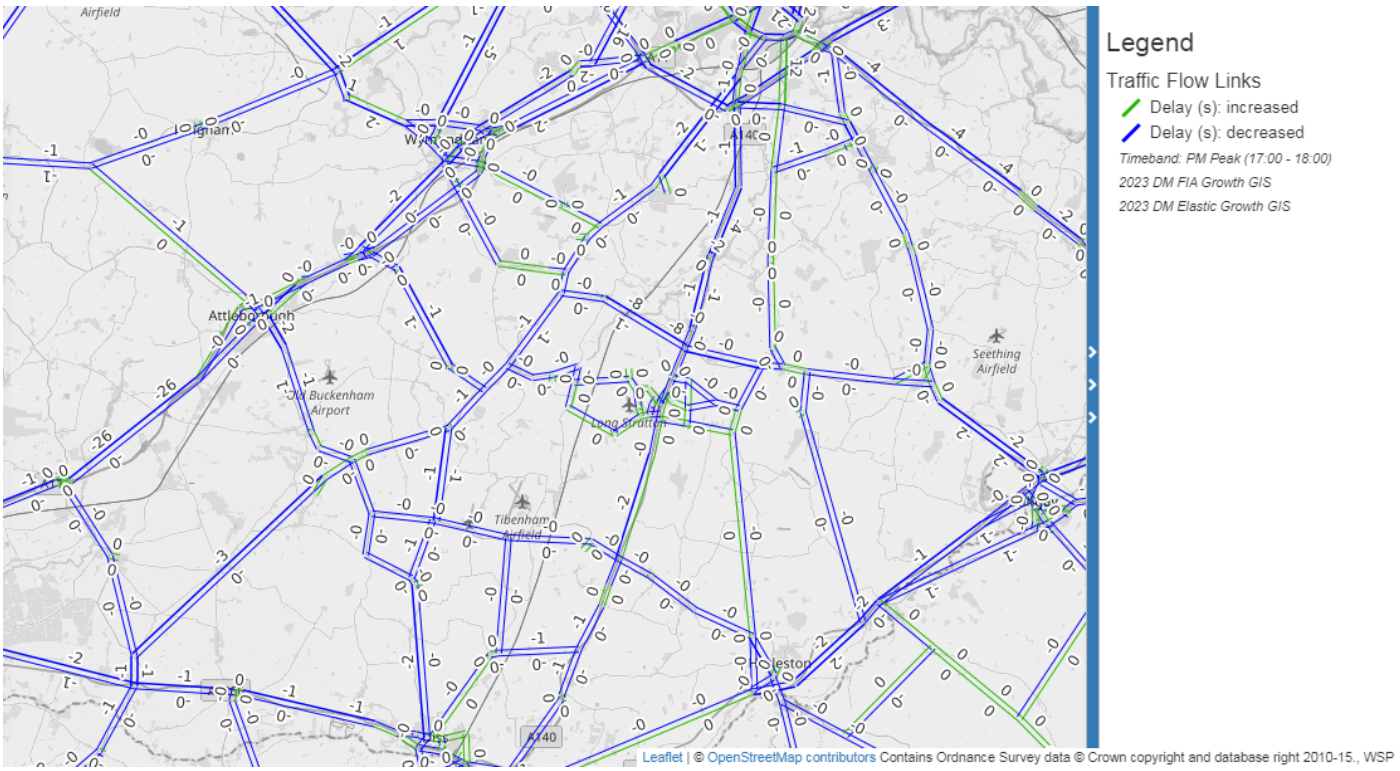

Figure 9: 2023 Do Minimum Elastic – Fixed Demand (incl. Fuel and Income Factors) - PM peak change in delay (seconds)

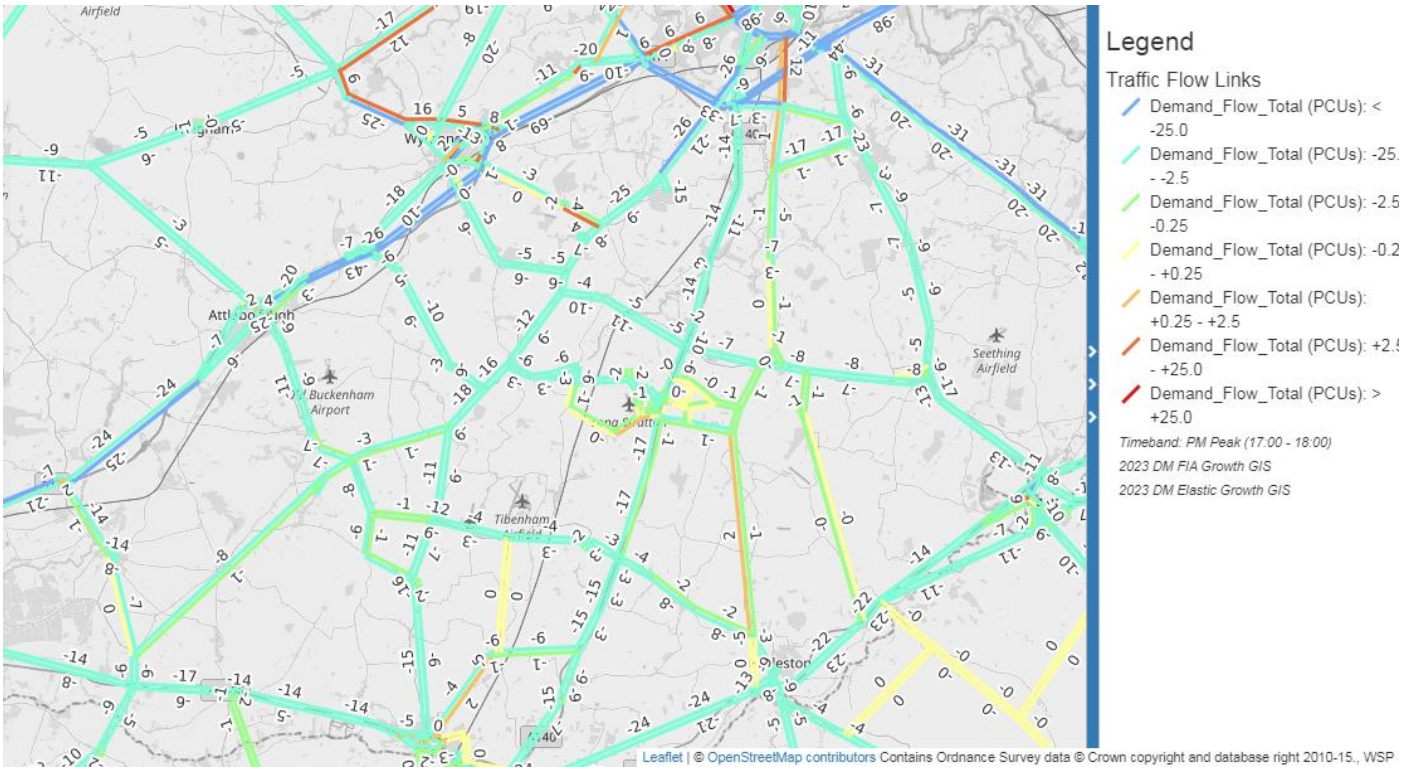

Figure 10: 2023 Do Minimum Elastic – Fixed Demand (incl. Fuel and Income Factors) - PM peak change in demand (PCUs)

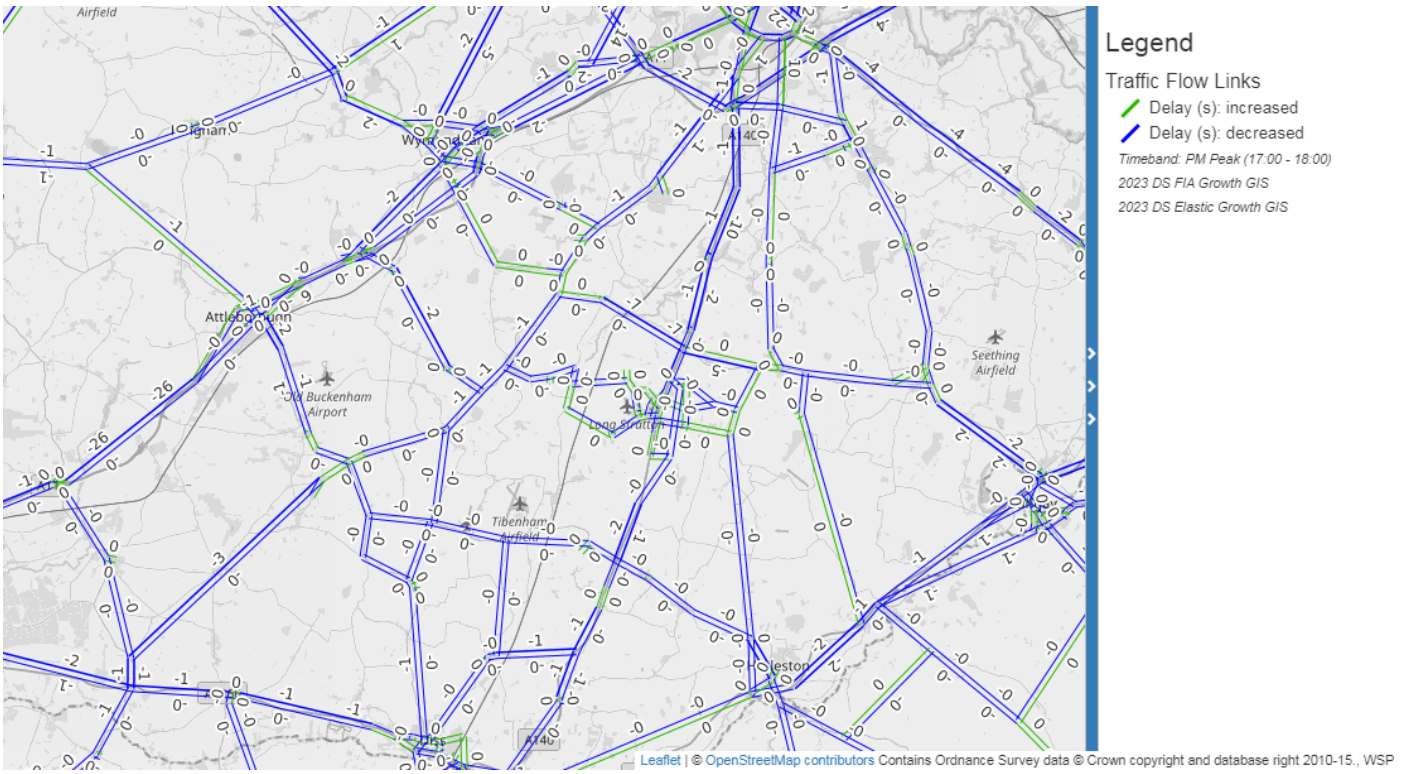

Figure 11: 2023 Do Something Elastic – Fixed Demand (incl. Fuel and Income Factors) - PM peak change in delay (seconds)

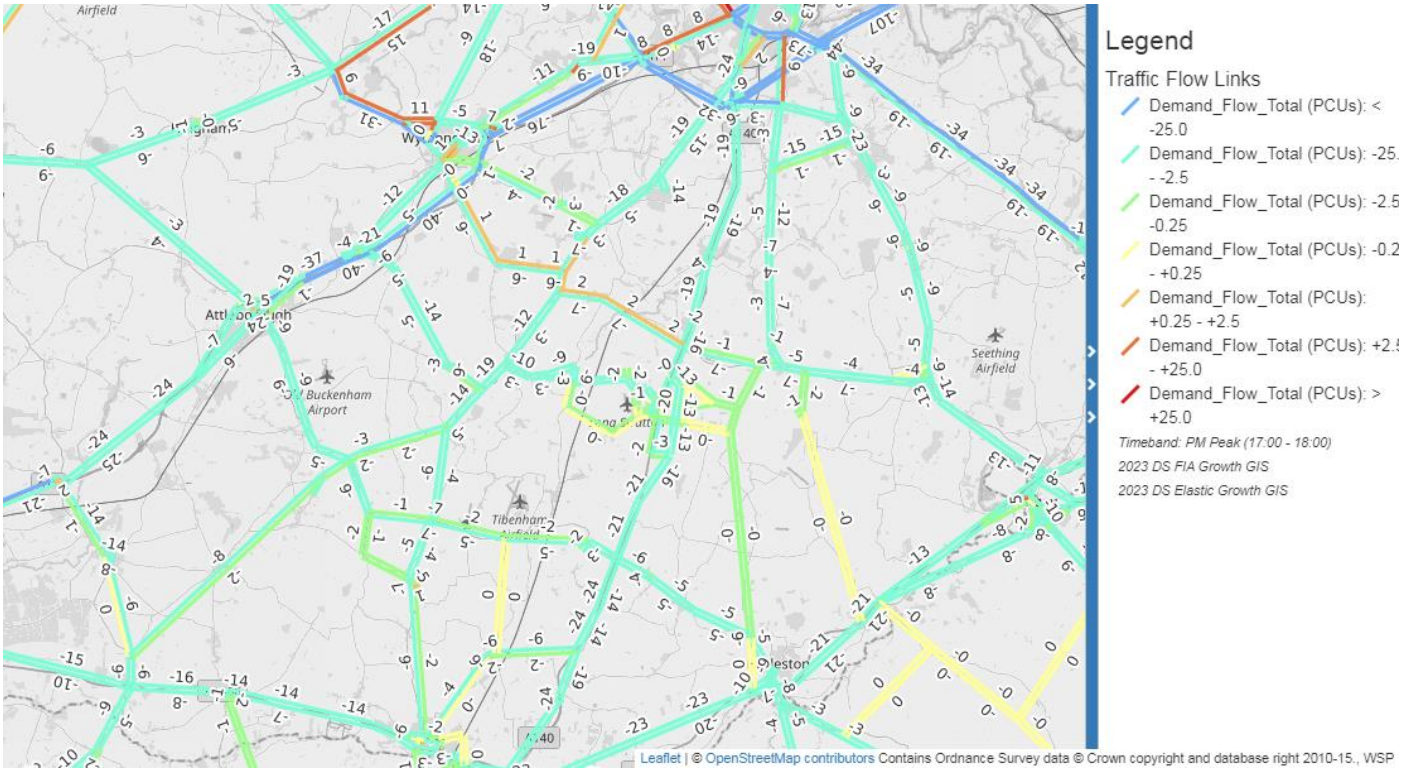

Figure 12: 2023 Do Something Elastic – Fixed Demand (incl. Fuel and Income Factors) - PM peak change in demand (PCUs)

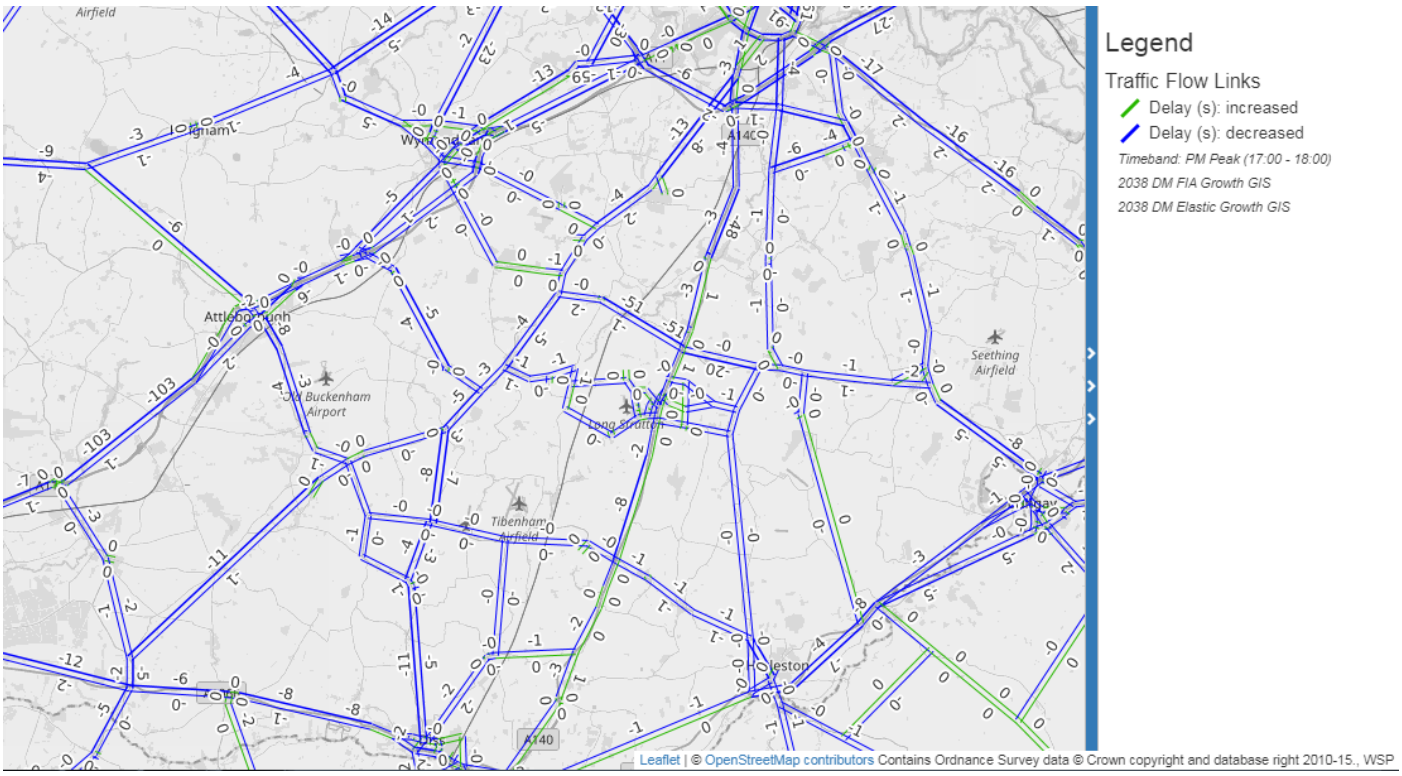

Figure 13: 2038 Do Minimum Elastic – Fixed Demand (incl. Fuel and Income Factors) - AM peak change in delay (seconds)

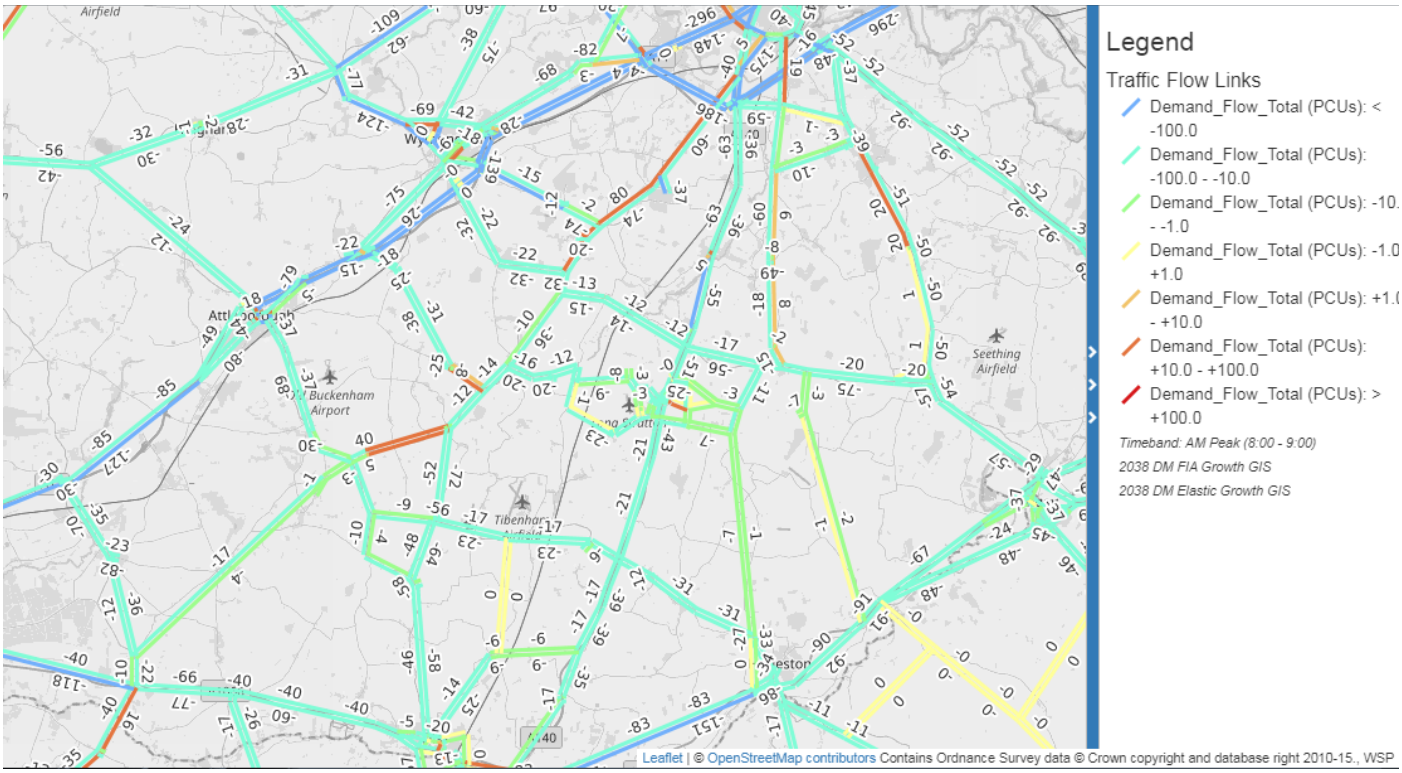

Figure 14: 2038 Do Minimum Elastic – Fixed Demand (incl. Fuel and Income Factors) - AM peak change in demand (PCUs)

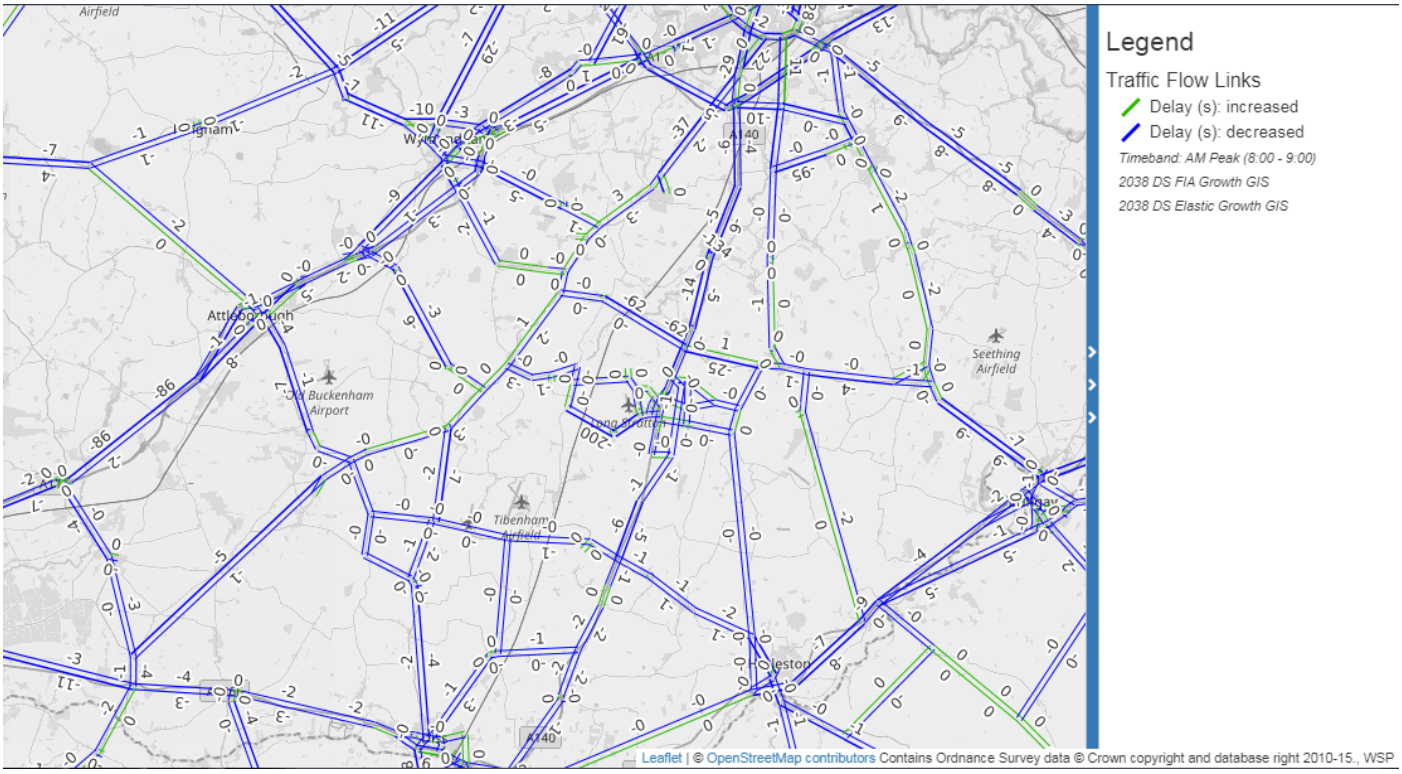

Figure 15: 2038 Do Something Elastic – Fixed Demand (incl. Fuel and Income Factors) - AM peak change in delay (seconds)

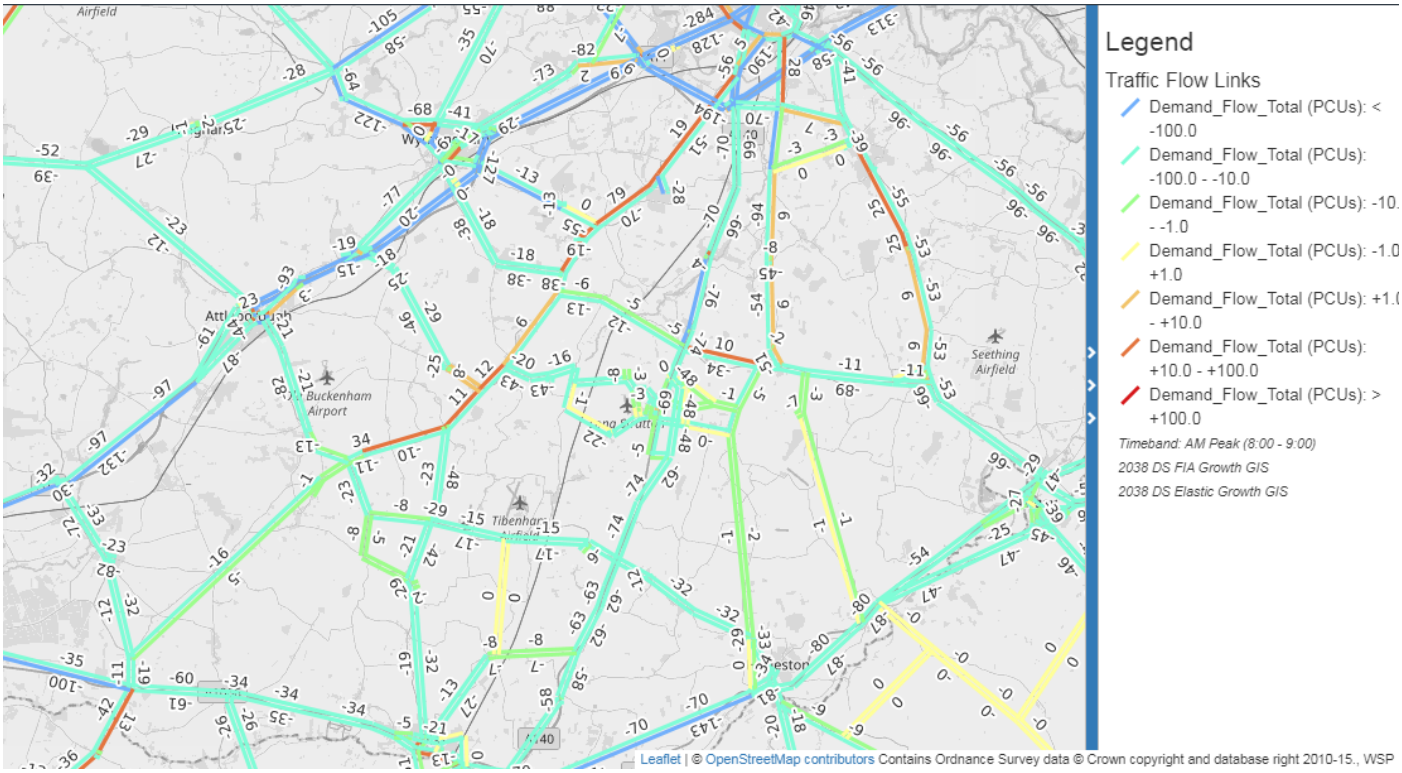

Figure 16: 2038 Do Something Elastic – Fixed Demand (incl. Fuel and Income Factors) - AM peak change in demand (PCUs)

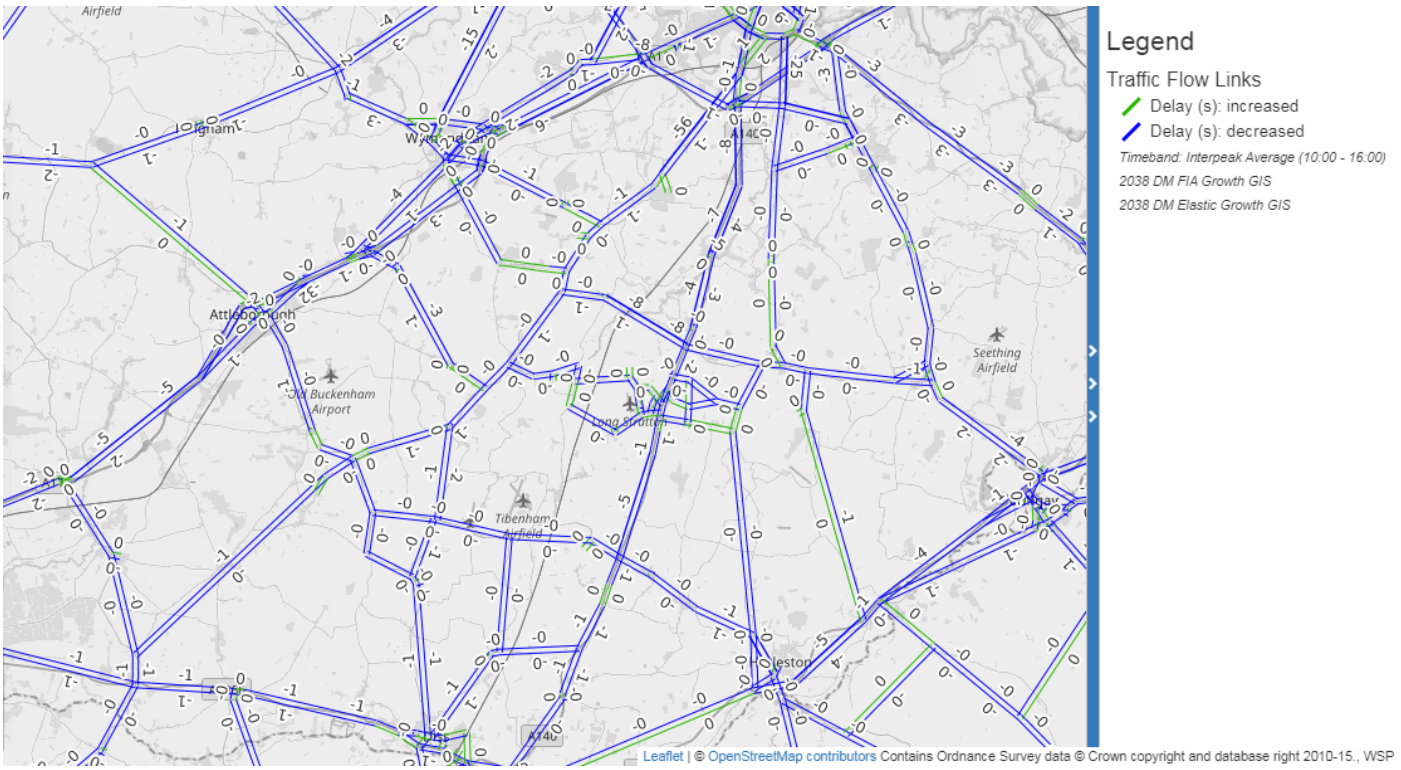

Figure 17: 2038 Do Minimum Elastic – Fixed Demand (incl. Fuel and Income Factors) - IP peak change in delay (seconds)

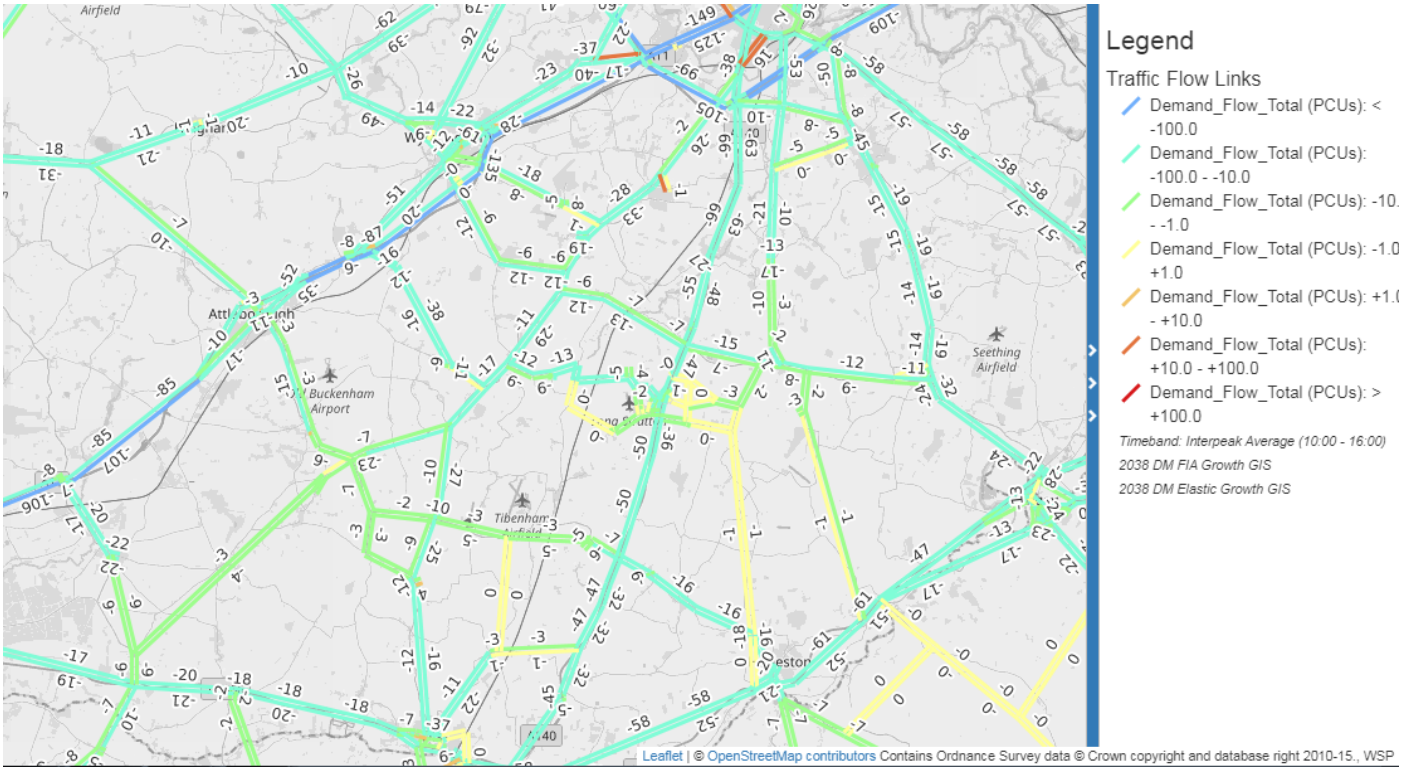

Figure 18: 2038 Do Minimum Elastic – Fixed Demand (incl. Fuel and Income Factors) - IP peak change in demand (PCUs)

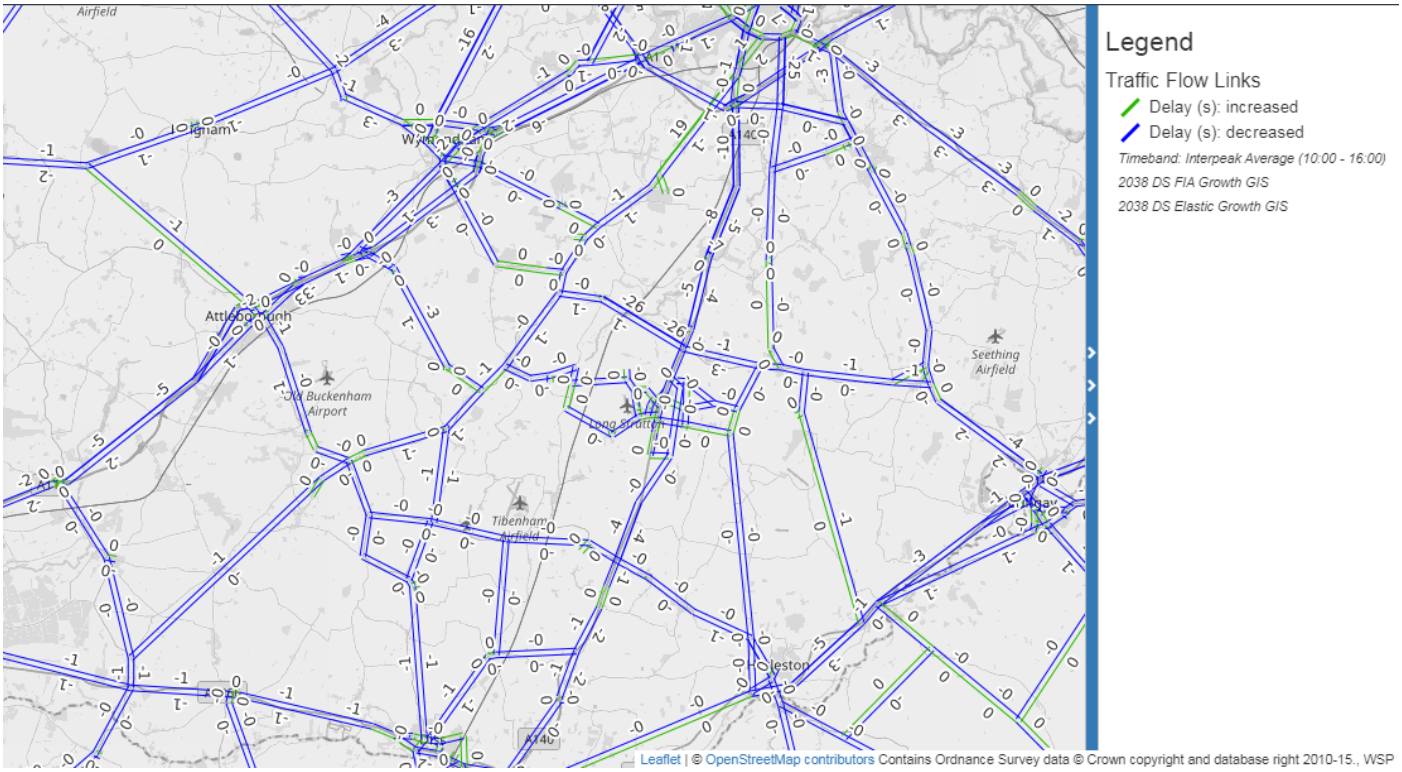

Figure 19: 2038 Do Something Elastic – Fixed Demand (incl. Fuel and Income Factors) - IP peak change in delay (seconds)

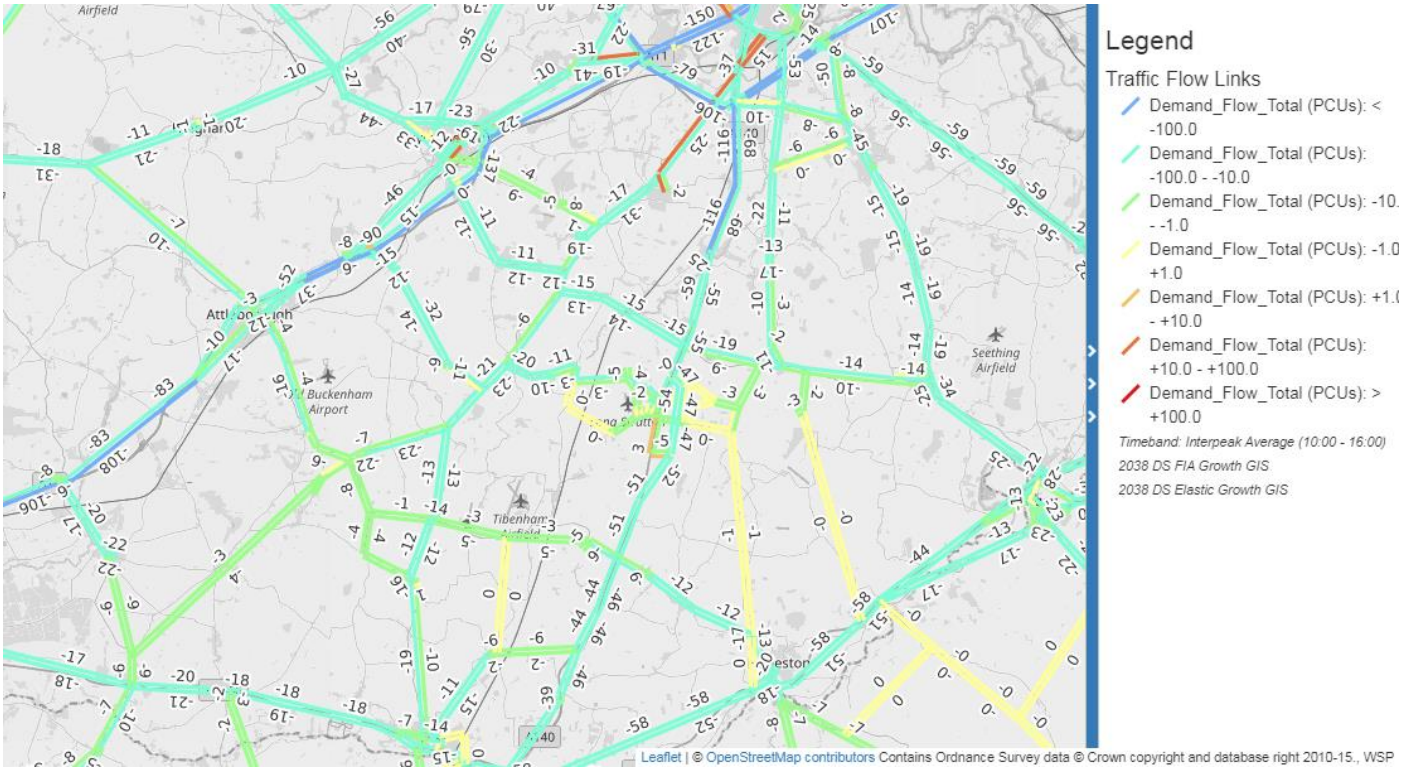

Figure 20: 2038 Do Something Elastic – Fixed Demand (incl. Fuel and Income Factors) - IP peak change in demand (PCUs)

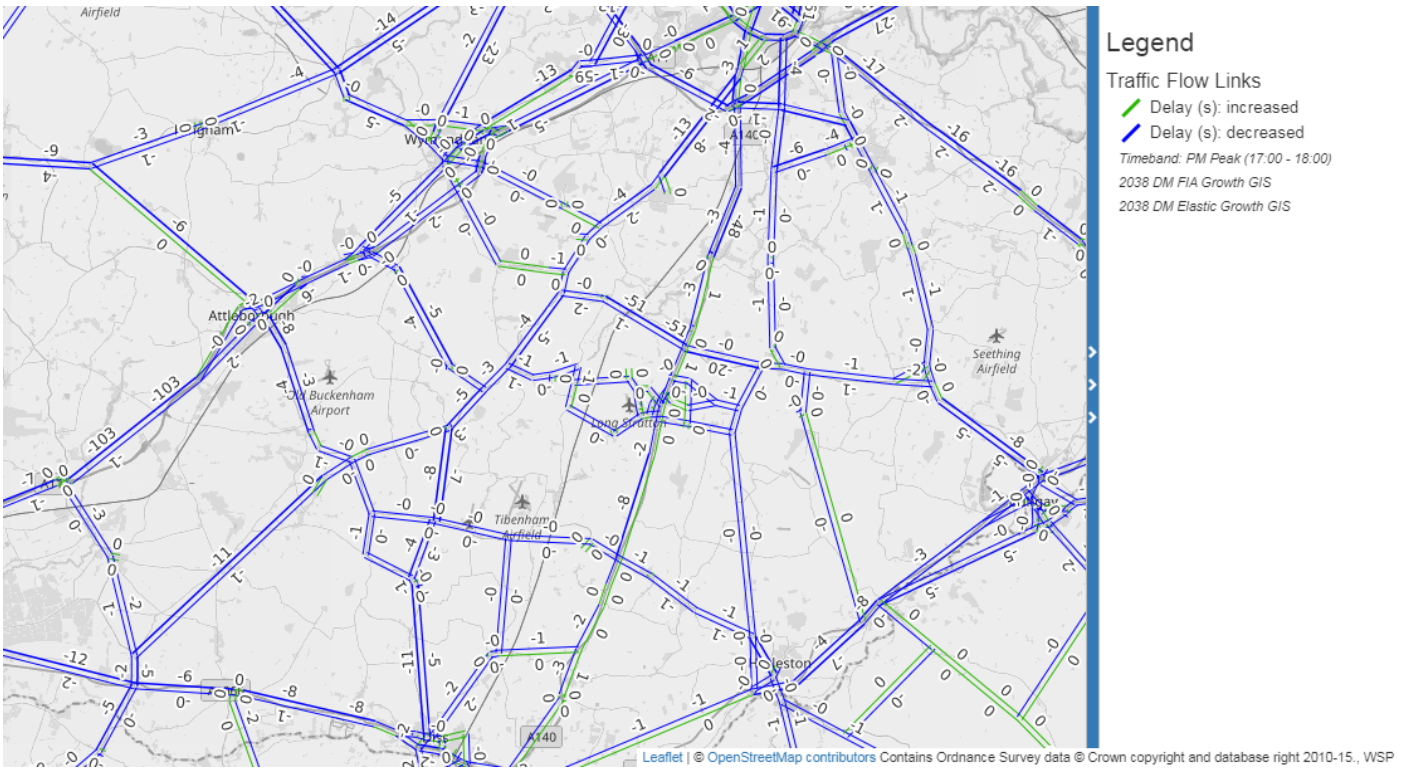

Figure 21: 2038 Do Minimum Elastic – Fixed Demand (incl. Fuel and Income Factors) - PM peak change in delay (seconds)

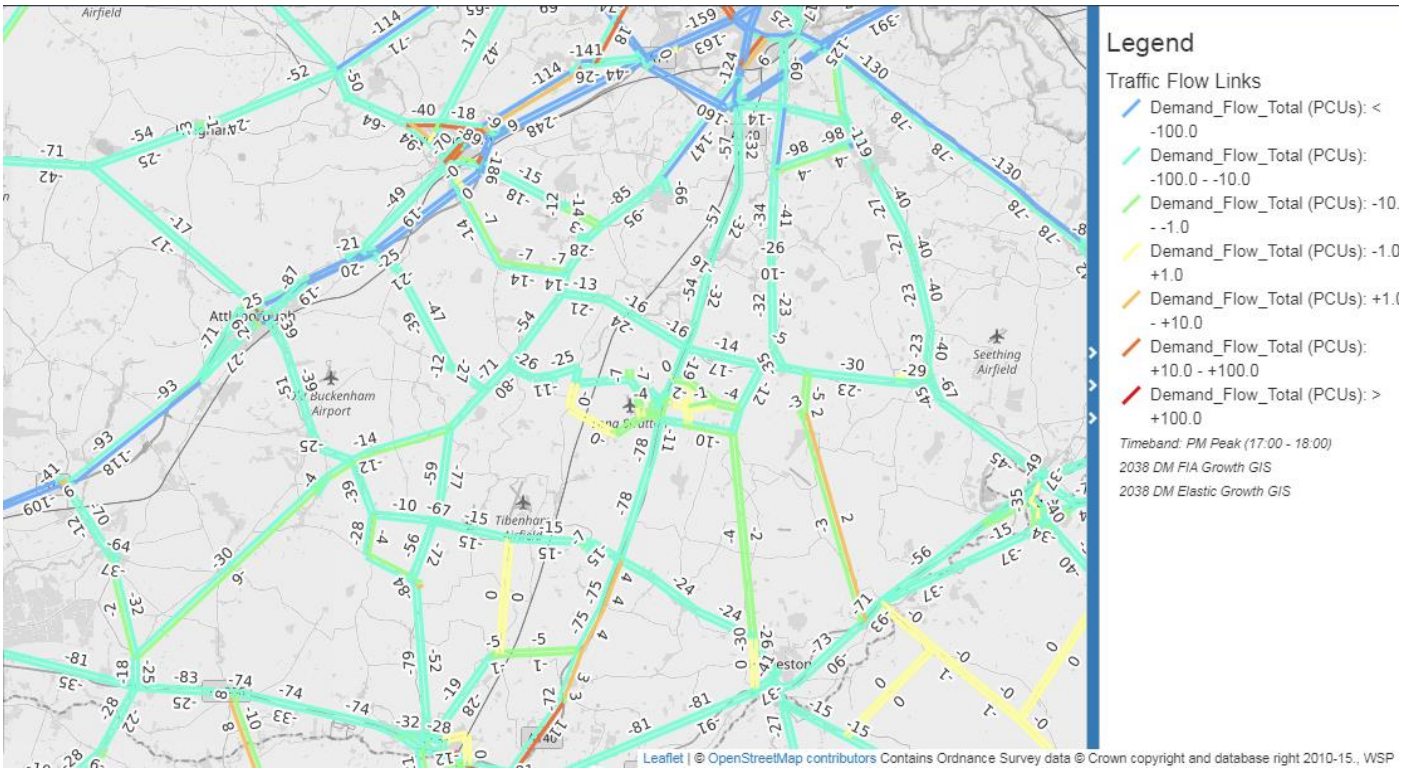

Figure 22: 2038 Do Minimum Elastic – Fixed Demand (incl. Fuel and Income Factors) - PM peak change in demand (PCUs)

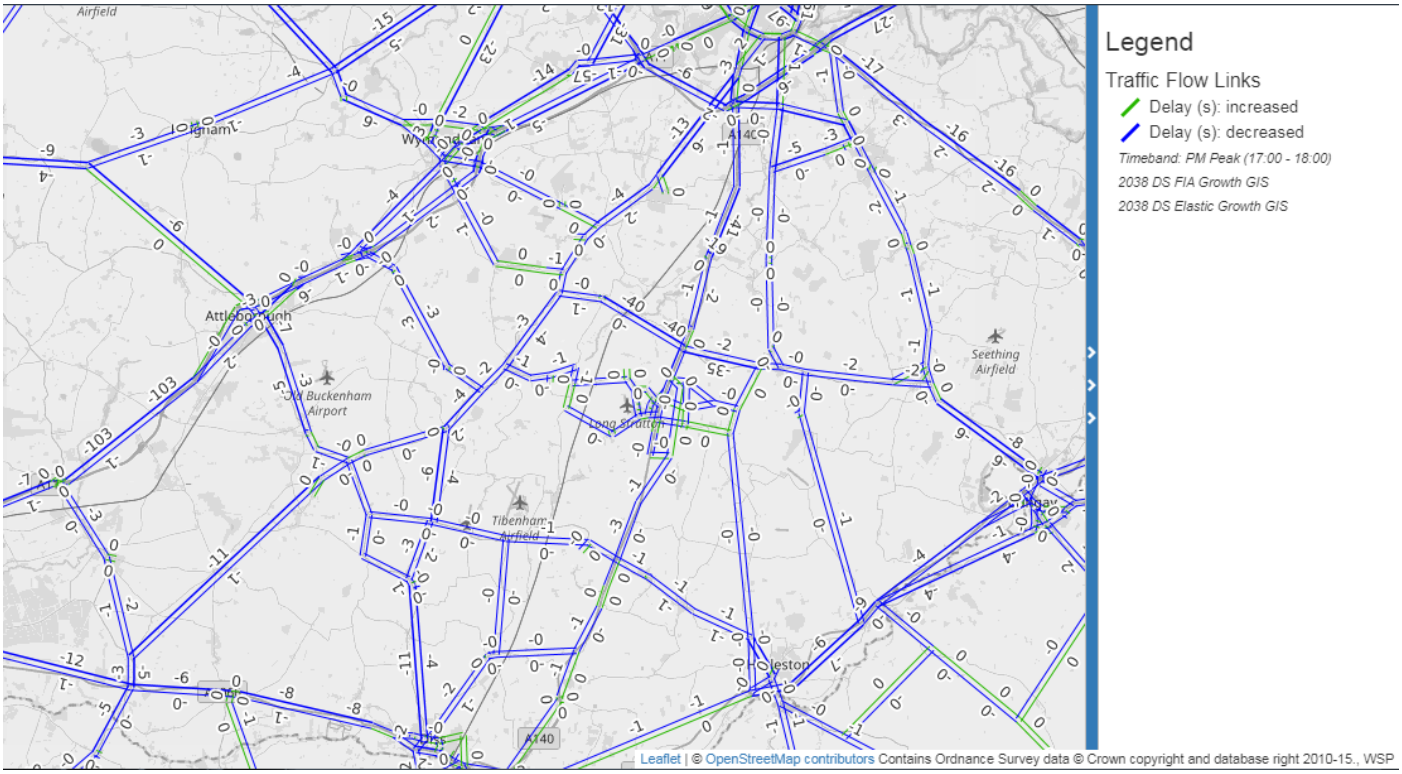

Figure 23: 2038 Do Something Elastic – Fixed Demand (incl. Fuel and Income Factors) - PM peak change in delay (seconds)

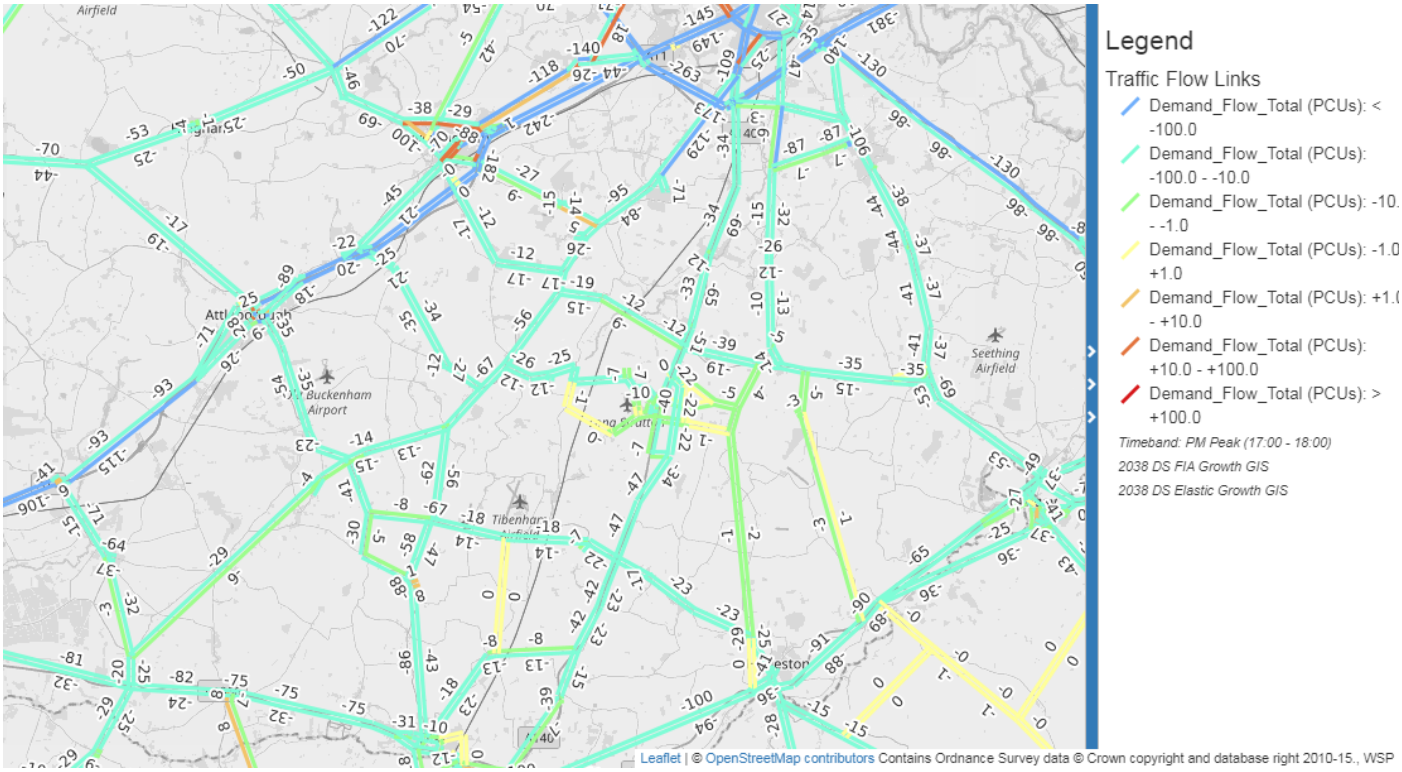

Figure 24: 2038 Do Something Elastic – Fixed Demand (incl. Fuel and Income Factors) - PM peak change in demand (PCUs)