# A9 Dualling Wider Construction Impacts – A Proactive Approach to Planning for Road Work Disruption

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## 1 Introduction

On the 6th December 2011, the Cabinet Secretary for Infrastructure and Capital Investment launched the Infrastructure Investment Plan (IIP). The plan provides an overview of the Scottish Government's proposals for infrastructure investment over the coming decades, including a commitment to complete the dualling of the A9 between Perth and Inverness by 2025. The IIP commitment builds on work undertaken in the 2008 Strategic Transport Projects Review (STPR) which is the Strategic Business Case for the A9 Dualling Programme.

Since 2011, there has been a renewed focus on developing and promoting economic growth through Scotland's cities and their regions. This is reflected in current thinking for planned development along and the A9 corridor between Perth and Inverness, with a series of Local Development Plans containing ambitious growth aspirations. Connectivity to the central belt of Scotland, the rest of the UK markets, and access to labour force is critical to the success of these plans and the economic development of the wider region.

## 2 Background to this paper

### 2.1 The A9 Dualling Programme

The A9 Trunk Road provides a strategic link between the Scottish Highlands and Central Scotland. It is the longest trunk road in Scotland, with the Perth to Inverness section totalling 177 km (110 miles) in length, of which 48 km (30 miles) are already dualled.

The A9 Dualling Programme is designed to deliver economic growth through improvement to journey times, reliability, road safety and driver stress. Dualling the A9 will provide greater connectivity to communities, businesses and tourists along the corridor and beyond. The programme is divided into 12 projects. These independent projects will keep common objectives, ensuring that the statutory process is as efficient as possible, whilst at the same time achieving the overall programme objectives.

The scale of the programme makes the A9 Dualling one of the biggest infrastructure projects undertaken in Scotland's history. As a result of the anticipated multi-modal and economic synergies along the corridor taking into account the upgrade to the Highland Mainline and the resulting wider benefits, a Case for Investment has been developed considering the whole corridor programme level.

### 2.2 The Case for Investment

The Case for Investment document has been prepared considering a number of factors including the wider economic benefits the dualling would bring to the economy and the quantification on delays due to construction and maintenance over the 60 year appraisal period. This has considered the 'Do Minimum', i.e. no dualling and the 'Do Something', i.e. full dualling of the A9 between Perth and Inverness. Over the 60 year appraisal period there is estimated to be a net benefit to the economy under the category of 'construction and maintenance'. This benefit arises despite disruption during the construction phases as future maintenance will be less disruptive allowing traffic to remain flowing in each direction rather than the current requirements to impose shuttle working on the carriageway.

Overall these maintenance benefits are more significant than the disruption caused during construction.

Despite the overall positive value of construction and maintenance within the A9 Dualling Case for Investment, Transport Scotland recognises that the construction period has the potential to cause significant disruption if not managed appropriately. Transport Scotland is proactively seeking to better understand the scale of the potential disruption and suitable approaches to mitigating these effects and the most appropriate means of communicating with affected road users. A scoping study is currently underway to consider these issues. This paper discusses the work that is being undertaken to consider the potential impacts to the economy as a result of the construction of the A9 Dualling Programme and approaches to mitigating any potentially adverse impacts. As the study is on-going results are indicative only.

## 3 Wider Construction Impacts Scoping Study

### 3.1 Approach and Objectives

Based on current programme data[1] the statutory processes for the projects that make up the A9 Dualling Programme are anticipated to be completed by the end of 2018. Allowing for procurement of construction contracts the main construction period for the Dualling Programme will be 2020 to 2025. As the dualling works will be based on an on-line corridor around the existing road, it will be necessary to have traffic management measures in place to ensure the safety of road users and construction workers. Typically, this would include:

- Narrow lanes;
- Speed restrictions through construction sections;
- Restrictions on overtaking;
- Traffic management at junctions;
- Provision of traffic managed site accesses; and
- Short periods of lane closures or potentially road closures for exceptional works.

As such, traffic management has the potential to affect several aspects of journeys, including journey times, reliability, and driver comfort, which will therefore have impacts on accessibility and travel demand.

This study is being undertaken to better understand the wider economic impacts of the construction period. This has sought to quantify the level of delays users might experience, and what the implications of this might be on business operations and travel demand. It is a relatively novel study, and as such has been undertaken using a number of different approaches. These are:

- Literature review, seeking information about:
    - projects that had estimated the wider economic impact of road construction work on local businesses before construction began;
    - projects that had quantified the wider economic impact of road construction work on local businesses during or after the construction period;
    - communication methods used by road construction projects and their effectiveness; and
    - mitigation techniques used by road construction projects and their effectiveness.
- Assessment of journey time impacts:
    - a series of assumptions regarding the deployment of traffic management were developed to allow illustrative phasing arrangements for the A9 Dualling Programme;

[1] http://www.transportscotland.gov.uk/system/files/documents/projects/A9%20Dualling/A9%20Programme-March-2014.pdf

- a spreadsheet analysis was produced which, using distances and speed limits, determined journey time impacts of the works; and
- a number if procurement scenarios were tested to help identify the 'worst case' scenario when construction activity was likely to be at its most intense.

- TMfS modelled flow analysis
  - using the spreadsheet analysis phasing, the strategic multimodal Transport Model for Scotland (TMfS12) was used with the 'worst case' scenario to assess the impact in terms of journey times, rerouting and trip suppression.
  - a range of speed flow curves were considered to show the varying impact as the A9 slows down due to works.
- Business data analysis

  data available from the Scottish Annual Business Survey was used, along with previous analysis undertaken considering growth sectors, to understand the nature of businesses along the route in terms of their profitability, dependence on transport links, and their reliance on cost sensitive customers.
- Consultation
  - representatives within growth sectors, freight representatives and Highlands and Islands Enterprise (HIE) were consulted to obtain industry views on what the impacts might be and what they consider could help to alleviate the impacts.

### 3.2 Literature Review

The literature review was undertaken seeking:

- projects that had estimated the wider economic impact of road construction work on local businesses before construction began;
- projects that had quantified the wider economic impact of road construction work on local businesses during or after the construction period;
- communication methods used by road construction projects and their effectiveness; and
- mitigation techniques used by road construction projects and their effectiveness.

Whilst a number of useful references were found and reviewed, it is considered that the work being undertaken here to estimate and plan for the scale of the impact generated by the A9 Dualling Programme is relatively novel. There is a significant volume of theoretical discussion about the impacts of construction on social and economic factors, and a large body of study which presented the impacts by surveying the impacts during and after construction of specific projects. However, modelling anticipated impacts for a specific project in advance of that project was not found.

In summary, the literature review identified a number of sources of interest, identifying a range of impacts due to road construction on local economic activity. Care must be taken when considering the A9 with these examples as none of the routes considered compares to the A9 in terms of length of construction works (80 miles approximately) or construction timescales (five to seven years).

However some key points have been drawn from the work:

- Business perceptions (even during construction) were usually pessimistic when compared with actual conditions (Young, Wolffing and Tomasini, 2005);
- Sales figures generally rebounded within two years to previous levels (Wolffing, et al, 2004);
- A review of twelve highway construction projects in Wyoming, in towns ranging in size from 807 to 53,011 people showed that business revenues varied between an 8% decrease to 40% increase (Young, Wolffing and Tomasini, 2005);
- Impact mitigation techniques are most successful when businesses and construction parties work together from an early stage (Young, Wolffing and Tomasini, 2005);

- Encouraging businesses to 'own' the project and celebrate the benefits that improvements can deliver through initiatives such as street parties and promotional videos can be beneficial for public relations (Department of Roads, State of Nebraska);
- Access to businesses during construction is a key issue and techniques are available to ensure drivers are still able to distinguish and easily access business premises (Buddemenyer, Young and Vander Giessen, 2008)
- Incorporating payment mechanisms to construction contracts whereby Contractors are awarded bonus payments for positive public survey feedback can help improve operations during construction (Wolffing et al, 2004); and
- Businesses selling exclusive merchandise were not affected as much as those selling readily obtainable products. (Wolffing, et al, 2004)

It is noted that the impact in terms of percentage change in sales varies considerably across the different studies. However, consistent messages were:

- Communication is vital at all stages of the project;
- Community and business involvement and engagement is a useful method to smooth the process; and
- Businesses for where there are few alternative competitors (e.g. retailers selling exclusive products) are likely to be less affected than more general retail businesses.

### 3.3 Spreadsheet Analysis

A spreadsheet based analysis was undertaken to understand the phasing and hence the initial intensity of works over the construction period. This work was based on an agreed set of assumptions about how the roadworks would be deployed and considered a range of procurement scenarios. The key assumptions are shown in Table 1

**Table 1: Agreed roadworks assumptions**

| Criteria | Core Assumption | Sensitivities |
|---|---|---|
| Length of roadworks | 10km | 4km and 20km |
| Construction programme | 24 months (per 10km section) | 18 months (for 4km sections) and 36 months (for 20km sections) |
| Speed Limit through roadworks | 40mph (with national speed limit returned between works sections) | 30mph, 50mph |
| Length between roadworks | 10km | - |

The A9 Dualling Programme is divided into twelve individual projects. There are various ways those projects may be combined for procurement purposes. Two core options, already used successfully by Transport Scotland to deliver various roads programmes over the last 20 years, have been considered within this work:

- Design and Build (D&B)
- Design, Build, Finance, Operate (DBFO)

The assumptions defined in Table 1 were applied to each of the procurement scenarios. The analysis undertaken involved estimating journey times by roadwork sections and by phase.

Total journey time values have been estimated by phase of construction in order to understand which phase will have the greatest impact on travel times. A year-by-year comparison has also been undertaken in order to compare each of the procurement options.

There is a tipping point during the construction period whereby the journey time benefits of completed dual sections outweigh the delays caused by sections still under or awaiting construction for a journey along the entire length of the A9 from Perth to Inverness. The analysis undertaken for the different procurement options show that impacts on journey times will reach a peak in 2023 for the base case of fifteen to twenty minutes. From 2023 onwards, journey time will experience a reduction along the A9 route due to the benefits gained from the completed sections of dualling. It is important to note that this scenario is for illustrative purposes only and has been developed with the intention of helping to inform this study. A range of other factors will be considered by Transport Scotland that are not captured within this high level assessment, such as the relationship between projects in terms of materials (for example, on project may generate a substantial amount of cut material and another a substantial amount of fill materials – there are clear synergies here), special events and other factors.

The breakdown of delays by section of the A9 would vary, and hence some journeys would be subject to a larger percentage delay, and others to a lower percentage delay.

TMfS12 has been used to further explore the possible impacts of the A9 Dualling works. This is a novel use of TMfS12 and as such results are indicative only. Taking the most intense period of construction in the base case scenario, TMfS12 has been employed to understand possible rerouting and trip suppression that may occur. TMfS12 has also provided an independent assessment of the journey time impacts of the works.

### 3.4 Modelling Assumptions and Methodology

Construction sites were added to TMfS12 networks based on the initial high level analysis of potential construction phasing set out in the spreadsheet analysis discussed in the previous section.

For each of the construction sites, the link class attribute of each of the links used was changed from “Rural Single – ‘A’ Road, low hilliness low bendiness” – to a link class with a slower free-flow speed. As the speed-flow curve for links in TMfS12 is selected according to the link class attribute, this results in a reduction in speed on each of the links broadly in line with what would be expected at a construction site. Figure 1 shows the speed-flow curves at 1600 PCU/hour for each of the link classes used in this analysis, along with link class “Rural Dual” – as this is the class associated with dual carriageway A9 links.

“Rural Dual” has a free flow speed of over 100kph (63mph) whilst ”Rural Single – ‘A’ Road, low hilliness, low bendiness” has a free flow speed of around 90kph (56mph). The base case scenario has a free flow speed of around 60kph (38mph) operating through construction sites and considers two other slower link classes to model the impact of slower speeds on the route.

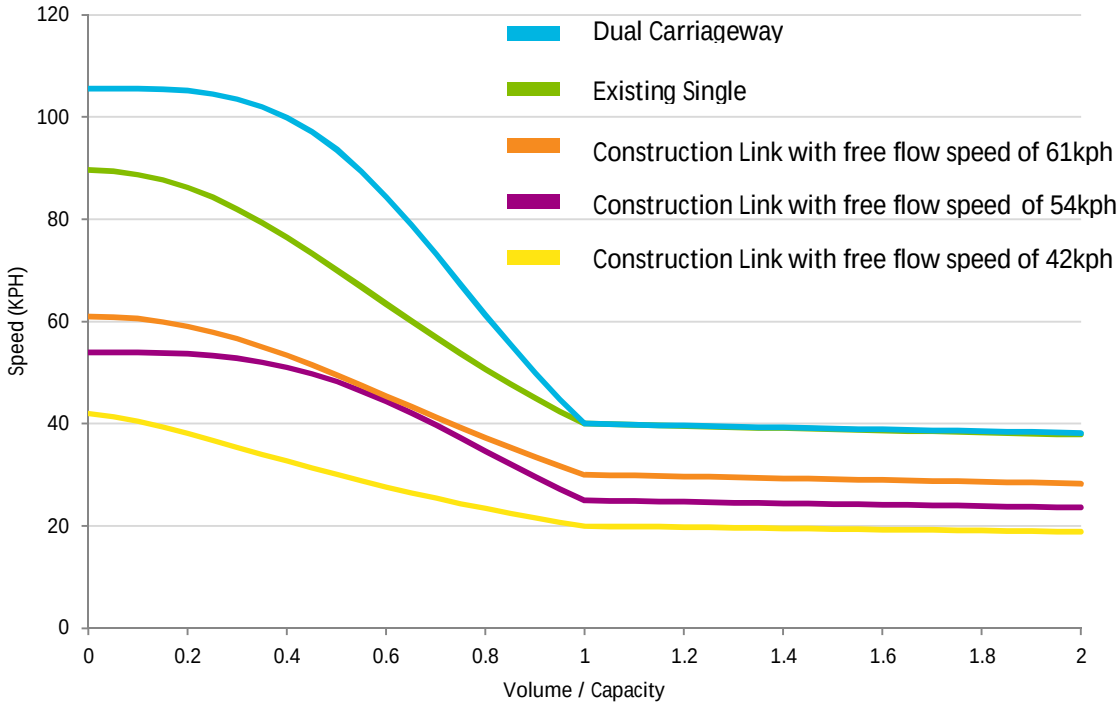


**Figure 1: Example TMfS Speed-Flow Curves at 1600 PCU/hour (each line shows a separate speed-flow curve)**

A number of scenarios have been modelled to offer a broad range of comparisons. The first is the standard TMfS12 Do Minimum scenario. A series of scenarios have then been created to use each of the speed-flow curves shown in **Figure 1.**

For each of these scenarios, there are two distinct sets of outputs. Firstly, there are those for which the same matrices as used in Do Minimum were applied. This allows rerouting to be examined, i.e. people make the same journey but may choose a different route. Secondly, there are those for which a demand response in the matrices has been allowed, reflecting both rerouting and destination choice changes as a result of the additional construction; i.e. people may choose to make the same journey but reroute or alternatively they may change / cancel their trip instead.

The outputs from this exercise show that whilst there is some small level of travel change, overall travel demand is relatively unaffected and diverted travel is in the region of 500 vehicles per day in each direction in the base case. The impact of the works will vary according to which sections of the corridor are travelled with some short distance trips being faster, some slower, and some with little net difference.

Key points to note from the TMfS analysis are:

- Overall traffic volumes were not significantly reduced by the disruption; and
- Rerouting was likely to occur where alternatives exist with the main rerouting being:
    - Traffic to and from the Moray coast rerouting via the A93 Braemar route instead of using the A9 via Inverness or the A95/A9 route via Grantown-on-Spey;
    - Traffic to and from west of Perth using routes through Blairgowrie to avoid southern sections of the A9 and instead joining or leaving at the A924 at Pitlochry; and
    - Traffic to and from Aberfeldy using the A822/A826 route joining or leaving at Birnam instead of Ballinluig.

### 3.5 Business and Behavioural Responses along the corridor

The period of construction will span several years. Over this period some sections will be under construction, resulting in reductions in levels of service, while others will either not have been started or will have been completed. Impacts on businesses will therefore vary both by year and by location.

The economic impacts of additional travel time on the A9 due to construction activities will depend on the behavioural responses to it. The simplest behavioural response is for users of the A9 to simply continue with their current behaviour and to incur any time penalties that this will bring about.

However, there are also different ways in which people could change their travel behaviour and travel patterns. Transport decisions, such as whether or not to travel, reflect wider decisions about what activities to undertake, where and when, and these decisions can affect businesses and the local economy. For example, if a business trip is cancelled, this may be because business practices are changed so that the interaction happens by telephone, video conference or email, or it may represent a reduction in business activity as that business interaction no longer takes place. A summary of key potential behavioural responses are shown in Table 2.

**Table 2: Summary of key potential behavioural changes**

<table>
<tr><th></th><th>No change in behaviour</th><th>Change route</th><th>Change mode of transport</th><th>Change origin</th><th>Change destination</th><th>Cancel trip</th></tr>
<tr><td>Business travellers</td><td colspan="3" rowspan="2">Additional business cost</td><td colspan="2" rowspan="2">Business function relocation / change of suppliers / change of customers</td><td rowspan="2">Re-organisation of business activities or loss of business</td></tr>
<tr><td>Freight</td><td></td></tr>
<tr><td>Commuters</td><td rowspan="4">Additional personal cost</td><td rowspan="4">Additional personal cost. Potential to redistribute some roadside expenditure</td><td rowspan="4">Additional personal cost. Potential to substitute roadside expenditure for expenditure at public transport hubs</td><td>Move house to make commute easier</td><td>Change jobs to make commute easier</td><td></td></tr>
<tr><td>Leisure travellers</td><td rowspan="2"></td><td colspan="2">Choose a different leisure activity</td></tr>
<tr><td>Retail customers</td><td>Shop in different places and redistribute retail expenditure</td><td>Shop online or redistribute expenditure away from retail</td></tr>
<tr><td>Tourists</td><td colspan="2">Visit different areas and redistribute tourism expenditure</td><td>Redistribute expenditure away from tourism sector</td></tr>
</table>

These behavioural responses are a summary and there may be many other subtle responses, such as changing times of travel to favour less busy periods or chaining trips.

There is relatively little research addressing temporary changes in transport levels of service, most of which addresses much shorter periods of disruption caused by strikes or natural events. The evidence from longer term disruption, e.g. from major infrastructure failures such as bridge collapses, or from construction disruption is very limited.

There is a theme in the transport literature that suggests that temporary changes in transport provision are associated with periods of discovery and habit forming which can have longer term effects. It may be, for example, that disruption on the A9 causes someone to change their behaviour in a way that becomes permanent. A commuter may experiment with working from home and stick with it, or a regular tourist to the Highlands may experiment with holidaying on the West coast instead and reorient their future trips there as well.

Some of the behavioural changes above are amenable to transport modelling using a strategic transport model such as TMfS12. This captures changes in route choice and additional transport costs due to changes in the level of service offered by the A9. It then calculates changes in the pattern of transport demand between different origins and destinations as a result of these cost changes. However, TMfS12 does not represent the underlying economic behaviour which lies behind these changes in transport demand.

The impact on economic activity due to disruption will vary between different types of business activity. Based on theory, evidence from elsewhere, and from the traffic modelling work, we have identified criteria which help to identify potentially vulnerable businesses:

- **Transport intensive sectors:** Sectors which have high numbers of trips to or from their premises, or spend disproportionately on road transport are likely to be more vulnerable to changes in transport costs.
- **Dependency on cost sensitive customers:** Some sectors can be dependent on a type of customer that is very sensitive to changes in cost. A good example of this is tourism activity. Tourists have a wide variety of potential holiday destinations. This range of choice can increase their sensitivity to costs and may result in more significant changes in demand due to increases in costs during construction activity.
- **Low margin sectors:** In some sectors where businesses are operating on low margins there may not be much opportunity to absorb changes in costs.

In addition to sectoral differences, there are likely to be very significant differences in the degree of disruption in different geographic areas along the A9 corridor, reflecting the distribution of trips to and from different origins and destinations. The northern areas of the corridor are likely to be most affected.

For many businesses, the additional costs of delays are likely to be small. However, in some cases these additional costs could be more significant, particularly if:

- Businesses have heavy expenditure on road transport (such as the food and drink or forestry sectors) or generate a high number of trips by customers (such as the retail sector); or
- Businesses have very cost sensitive customers, perhaps because those customers have a range of other options (such as in parts of the tourism sector).

Analysis of a range of case studies suggests that firms at the northern end of the route are more likely to be impacted than businesses at the southern end because a higher share of trips will use the A9 sections which are disrupted.

### 3.6 Consultation

Consultation was undertaken with businesses as part of the A9 Case for Investment and the Design Consultants have stakeholder managers in place who are undertaking consultation as part of the wider programme. This study concentrated on representative organisations concerned with the key sectors along the A9. The key sectors identified by the A9 Dualling Assessment of Advance Wider Economic Benefits Study (Optimal Economics, 2013) as those most likely to be affected by the dualling of the A9 are considered to be:

- Food and Drink;
- Tourism;
- Energy;
- Life Sciences; and
- Forestry

The Advance Wider Economic Benefits Study identified these sectors as being significant employers in the area that have a high dependency on strategic transport links.

The focus of the consultation was to understand the sector's use of the road, identify what concerns they may have about the construction works and get their input and ideas for communication and mitigation measures that they consider may help alleviate the impacts.

The most consistent and strongest message emerging from the consultation was the need for good quality communication of the impacts. As a result of the consultation initiated by Transport Scotland some guiding principles have been able to be developed which are intended to meet businesses' requirements in relation to the construction period.

- Begin ***at least*** 12 months before work begins providing details of planned works in terms of location, restrictions and anticipated delays;
- Be updated as and when necessary;
- Include real time information when the works go live informing of where the delays are and the journey time implications of these delays;
- Include information about any impacts on diversionary routes in terms of delays;
- Be disseminated by a wide variety of methods; and
- Be proactive – negative headlines about the impacts of the works could adversely affect the attractiveness of the Highlands for business.

Efficiency of traffic through road work sites was another common theme with points being raised that included frustration at being restricted to 40mph when it is perceived that 'nothing is happening', although this may not be the case as some construction activities are not visible from driving along the road. The work undertaken as part of the delay analysis suggests that longer sections of works will be essential to help deliver the programme within the published timeframe and hence works sections of 10km or more will be most likely deployed. This may lead to sections of works seeing little or no activity for periods of the day. Whilst there may be a sound reason for operating in this manner due to the practical constraints of construction there is likely to be frustration if it is considered that unnecessary delays are being imposed on road users.

Suggestions included variable speed limits through the works using intelligent transport systems and, if traffic lights are to be deployed, ensuring they are calibrated to deal efficiently with the flow which can be tidal particularly at the northern and southern end of the route.

The importance of the rail line was another common theme with key points including:

- a number of consultees stressed that the upgrade to the Highland Mainline Improvement works should be accelerated to allow an improved service to be operational before road construction works begin;
- improved services should include earlier services to allow travel to and from morning meetings in Inverness and the Central Belt to be undertaken by train;
- Park and Ride opportunities along the route should be improved and marketed; and
- that whilst the transfer of freight from road to rail is aspirational for a number of consultees, it is not viewed as a short term fix in response to possible road delays caused by the works. Rail freight has

a number of background systemic issues that result in the vast majority of freight being transported along the corridor by road.

There is a mix of traffic and goods travelling along the corridor and journey time impacts will affect all trips.

## 4 Conclusions

Overall the benefits of the A9 Dualling during periods of maintenance outweigh the delays imposed during construction. However in the interests of taking a proactive approach to managing those impacts, Transport Scotland is seeking to better understand the likely scale of delay the construction works may impose and to use this information to help inform future work packages. This study is bringing together a number of strands of work to help inform these objectives. Key points to note from this study thus far include:

- Whilst travel demand along the corridor will remain largely unaffected, some trip rerouting is likely to occur with vehicles making use of other key strategic routes as well as more local diversions;
- Businesses will be impacted to varying degrees depending on their location and sector with transport intensive sectors, low margin sectors and those dependent on cost sensitive customers being most vulnerable and those further north likely to experience a greater impact;
- Consultation has provided many positive views of proactive steps that can be taken to communication throughout the construction and in recommendations for steps that may help mitigate any impacts.

## 5 References

Buddemenyer, Young and Vander Giessen (2008) Highway reconstruction near Dubois, Wyoming to Jackson Hole and Yellowstone National Park (38 miles)

Department of Roads, State of Nebraska, 'In this Together' leaflet and video (http://www.roads.nebraska.gov/)

*Optimal Economics & Jacobs on behalf of Transport Scotland, (2013), A9 Dualling Assessment of Advance Wider Economic Benefits Final Report, Optimal Economics*

Solinihac and Harrison (1993 Analysis of effects of Highway rehabilitations on business (Houston - 11 miles scheme)

Wolffing et all (2004), Highway Construction Related, Business Impacts: Phase I

Young, Wolfing and Tomasini (2005) Highway Construction Impacts on Wyoming Businesses

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