Reducing congestion from road works: Overview summary document

I Carswell and B Collis

Project Ref: Tfl_SCP_000001_co002

Quality approved:
Ian Carswell
(Project Manager)
Bob Collis
(Technical Referee)
Disclaimer

This report has been produced by the Transport Research Laboratory under a contract with Transport for London. Any views expressed in this report are not necessarily those of Transport for London.

The information contained herein is the property of TRL Limited and does not necessarily reflect the views or policies of the customer for whom this report was prepared. Whilst every effort has been made to ensure that the matter presented in this report is relevant, accurate and up-to-date, TRL Limited cannot accept any liability for any error or omission, or reliance on part or all of the content in another context.

Contents amendment record

This report has been amended and issued as follows:

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Description</th>
<th>Editor</th>
<th>Technical Referee</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>17/1/13</td>
<td>Draft</td>
<td>IC</td>
<td>BC</td>
</tr>
<tr>
<td>1.1</td>
<td>28/1/13</td>
<td>Revised</td>
<td>BC/IC</td>
<td>BC</td>
</tr>
<tr>
<td>1.2</td>
<td>4/2/13</td>
<td>Revised following customer comments</td>
<td>IC</td>
<td>BC</td>
</tr>
</tbody>
</table>
# Contents

Executive summary

1 Introduction 5
2 Use of Road Plates 7
3 Use of Temporary Backfill 13
4 Use of Early Strength Gain (Rapid Cure) Concrete 17
5 Other Techniques 19
6 Economics 21
7 Further Information 23
Executive summary

Nationally, the cost of delays caused by utility and highway works, both in lost time and the additional vehicle operating costs, involved is estimated to be £4.3Bn per year at 2004 prices. In London it is estimated that congestion caused by such works costs the economy about £750M per year. The benefits to be gained from employing innovative methods that reduce the impact of road works on traffic congestion could therefore be substantial.

In June 2012, the Mayor of London and Transport for London (TfL) introduced a lane rental scheme where roadwork contractors could be charged up to £2,500 per day to occupy the carriageway at key points on the road network. It is believed that this could eventually deliver a 40% reduction in disruption from roadworks on the Transport for London Road Network (TLRN) through a step change in approach to undertaking highway and utility works.

In support of this, TfL and the Department for Transport (DfT) jointly commissioned TRL to investigate the feasibility of increasing the use of three technologies that could be used to reduce road traffic congestion on the road network. These are:

- The use of plating and bridging systems over trenches and large openings in the carriageway (access chambers) to allow the carriageway to be opened to traffic during the works period;

- The use of 'faster cure and set' materials for permanent reinstatement of the carriageway to shorten the duration of roadworks by opening of the carriageway to traffic earlier after the completion of the works.

In addition, other technologies and techniques for reducing the duration of roadworks and resulting congestion were considered, including the use of the advanced utility mapping techniques, 'no dig' technologies, 'core and vac' methods of maintaining utility plant, and alternative materials for reinstatement.

The overall aim of the study was to provide the evidence and guidance that would encourage the use of these technologies. The study included the laboratory testing and trialling of road plating products (including the development of new plating systems for large openings), temporary backfill and rapid cure concrete products. It was demonstrated that these products can successfully be used and that user delays and lane rental costs could be reduced as a result.

In addition, the other technologies reviewed could provide savings to both the works contractor and to the broader economy.

This document summarises the research findings and provides a toolkit of options for reducing congestion to be considered by road authorities, utility companies and contractors when planning roadworks. It also references the four detailed reports and the guidance notes (‘QWIRC Notes’) produced under the project.
1 Introduction

Nationally, the cost of delays caused by utility and highway works, both in lost time and the additional vehicle operating costs, involved is estimated to be £4.3Bn per year. In London it is estimated that congestion caused by such works costs the economy about £750M per year. The benefits to be gained from employing innovative methods that reduce the impact of road works on traffic congestion could therefore be substantial.

In June 2012, the Mayor of London and Transport for London (TfL) introduced a lane rental scheme where roadwork contractors could be charged up to £2,500 per day to occupy the carriageway at key points on the road network. Prior to this, in June 2011, Transport for London (TfL) and the Department for Transport (DfT) jointly commissioned TRL to investigate the feasibility of increasing the use of three technologies that could be used by contractors to reduce road traffic congestion on the road network. These three technologies are:

- the use of plating and bridging systems over trenches and large openings in the carriageway (access chambers) to allow the carriageway to be opened to traffic during the works period;
- the use of ‘fast to install and remove’ temporary backfill materials for trenches and access chambers to allow trafficking at certain times during the works; and
- the use of ‘faster cure and set’ materials for permanent reinstatement of the carriageway to shorten the duration of roadworks by opening of the carriageway to traffic earlier after the completion of the works.

In addition, other technologies and techniques for reducing the duration of roadworks and resulting congestion were considered, including the use of the advanced utility mapping techniques, ‘no dig’ technologies, ‘core and vac’ methods of maintaining utility plant, and alternative materials for reinstatement.

The study comprised a number of activities including literature review, industry consultation, and the development of products with road plate manufacturers and laboratory and site testing.

The project was run through Steering and Working Groups with representation from Highway Authorities, Utilities, Materials Suppliers, Plate Manufacturers, Works Contractors, HSE and TRL.

This report summarises a series of four detailed reports describing the research that has been carried out and its findings. The four reports are:

- Part 1, Use of Road Plates;
- Part 2, Use of Temporary Backfill;
- Part 3, Early Strength Gain (Rapid-Cure) Concrete for Reinstatements; and
- Part 4, Other Technologies.

A series of QWIRC Notes (Quick Win Innovation for Reducing Congestion) has also been produced to provide guidance on the above and other topics.
2 Use of Road Plates

There are a number of ways that road plates could be used to temporarily open a road to traffic for a period during the works. These include:

- during each morning and evening peak period;
- from the evening peak to the morning peak when work is during the day;
- from the morning peak to the evening peak when work is at night;
- during weekdays when work is at weekends;
- during weekends, public holidays and special events;
- when there is no planned activity during the work, or if work is delayed;
- when frequent access to apparatus is required and a ‘semi-permanent’ solution is required.

Development of products

The literature review and consultation showed that road plates were being used in a very limited number of situations. They were mainly used at narrow transverse trenches (typically up to 700 mm wide) and at narrow linear trenches to provide access to side roads and properties.

The main types of plate used were plain steel plates, small proprietary steel plates and small proprietary composite plates. There were no readily available products for wide trenches or large openings, although temporary bridge systems were sometimes used over very large openings.

In order to provide evidence that road plates can successfully be used and to thereby maximise the potential to reduce congestion and traffic delays, the project identified the need for new road plate designs for large transverse trenches, large rectangular openings and linear trenches.

Consultation with manufacturers and suppliers of road plates identified a total of six different types of road plate for testing, including three types developed specifically for the project. These products were:

- large 40mm thick plain steel plates;
- small interlocking 12mm steel plates;
- composite plates;
- bridge panels and inset frame;
- concrete filled steel panels and inset frame; and
- specialist hinged steel plates.

Plate Testing

The products were assessed on the TRL test track for the impact of speed, traction and braking. Some plates were instrumented to record strains and displacements; and to assess product durability under repeated dynamic loading (simulating heavy traffic) in TRL’s Pavement Test Facility.

Large 40 mm thick steel plates

Recessed 40 mm thick steel plates with an anti-skid coating were tested over a (simulated) 1 m wide transverse trench. The road plates were very stable when trafficked at speeds up to 60 mph with an HGV. After the TRL testing programme was completed these plates were transferred to Ringway Jacobs for
use on the TLRN and have been used successfully on site.

The study showed that plain steel plates can be designed using well established principles. It is recommended that when used they are recessed plates (as shown below) so they are level with the road surface, although surface mounted plates will work at lower traffic speeds when adequately fixed.

The tests and trials demonstrated the additional benefits of using ‘thick’ plain steel recessed plates; the plates being thicker than those commonly used by contractors. Based on the findings from the tests, plate thicknesses have been recommended for different sized openings.

*Small 12mm thick interlocking ‘Delta’ plates*

Some small, thin, surface mounted steel plates were assessed over a narrow linear trench. The plates were designed to be easy to handle and installed manually. Excessive movements and deformations resulting in instability and edge loading on the trench itself were recorded during the trials. This highlighted the need to use plates of sufficient thickness and size.

*Composite plates*

Trafficking tests in the linear and transverse directions were carried out on a composite plate (plastic reinforced with steel) over a 600 mm wide trench. They were easy to handle by two persons and easy to fix using a locking mechanism that engaged with the side of the trench rather than fixings in the road surface.

The plates could be surface mounted (with side ramps as above) or be recessed (no side ramps as below). The height of the centre of the plate above the road surface was 80mm surface mounted and 25mm recessed. The plates are easier to install if they are surface mounted but the speed at which they can be trafficked may need to be reduced.
Initial testing of these plates under repeated dynamic loading highlighted some deficiencies requiring further development of the plate by the manufacturer to increase its robustness. The modifications included strengthening the plate and an improved interlocking mechanism (illustrated below) to provide better load sharing between plates. The testing highlighted that repeated dynamic loading needed to be considered for this type of plate and that simply using the maximum load as an indicator could lead to problems on site.

![Interlocking mechanism](image)

**Bridge panels and inset frame**

Bridge panels (of the type used for temporary bridges) were tested over a 2m by 2m trench opening and performed very well under trafficking and repetitive wheel loading tests. The panels were mounted on a ‘seating system’ within a modular frame designed specifically for use over large openings in the carriageway. This made the panels easy to install, remove and replace.

The panels were stable under trafficking along the length of the panels at speeds up to 60 mph. The plates were also very stable in repeated dynamic loading tests using a super single wheel loaded to 55kN.

The panels can be used in their current form but require a 220 mm deep recess and a pavement of deep construction. There is a potential for developing thinner panels that could then be used in a shallower recess.

**Concrete filled steel panels with inset frame**

A frame system with support beams and nine concrete filled covers was tested over a 2m by 2m opening. It took some time to install the frame and it was difficult to ensure that it was uniformly supported on the bedding material. After the frame was installed, the beams and covers were easy to install, remove and replace.

The frame, beams and covers survived repeated dynamic loading using a super single wheel loaded to 55kN.
Testing of both the bridge panel system and concrete filled steel panels highlighted the need to adequately support the frames to maintain stability during service.

This type of design was thought to be a suitable candidate for locations where frequent interventions are required and a permanent access cover would provide a cost effective solution.

Specialist hinged ramped plates

A set of hinged ramped road plates for 2m wide transverse openings at bridge expansion joints was included in the study. The plates would allow access to the joints for maintenance works via the hinged mechanism. They were assessed only for speed impacts and were crossed safely by vehicles up to the design speed of 70 km/h (43 mph). An installation of similar, but shorter plates, owned by the Highways Agency, was also monitored. By the end of the project, the plates had performed satisfactorily over a 5 month period. It was noted that the design of these plates incorporated large openings containing lugs for handling purposes (see above). These could represent a safety issue for two wheeled road users (particularly pedal cyclists) and it should be ensured that when using such plates all road users can cross safely with minimum risk.

Findings

The laboratory testing and trials showed that several forms of road plate can be considered for reducing the impact of roadworks on congestion, and are practical to use. Whilst a few plate designs already existed, such as the thick steel plates often used across side roads and driveways, manufacturers are willing to develop new types of plates such as some of those included in this study.

The feasibility of using plates for a particular scenario will, however, also depend on the likely impact on congestion and the costs and benefits involved, taking into account any direct costs from lane rental charges and traffic delay costs.

When a decision has been taken to use plates, seven main requirements should be satisfied, as follows:

- the use of plates must be in accordance with the current legislation and standards;
- there must be sufficient time to install the plates so the works can be completed without significantly increasing their duration;
- the plates must be able to carry the traffic without being displaced by the traffic that crosses them;
- the excavation must not be at risk of collapse from the impact of the traffic loading that is applied through the plate near the edges of the excavation;
- all road users must be able to cross the plates safely at the designated speed limit (plus a margin for error), including pedal and motor cyclists;
- noise levels and other environmental impacts must be acceptable;
• it must be possible to inspect and maintain the installation when required.

Development of guidance

There is no UK standard for using road plates for temporary installations. In order to encourage and facilitate the wide use of the systems trialled in this study, and the development of further innovative road plating systems, it is necessary to establish a set of performance requirements against which all plates can be designed, tested and/or approved.

Although there are no formal standards for using road plates, sufficient information has been obtained during this study to enable guidance to be developed for designing and using road plates confidently and safely. The guidance should include the following factors:

• Size and weight and plates and effect on handling and stability under trafficking;
• Surface mounting and recessing and effect on crossing speed and fixing;
• Wheel loading and deflection criteria;
• Horizontal forces;
• Skid resistance;
• Shoring excavations;
• Effect of road profile and need for bedding;
• Pedal and motor cyclist needs;
• Size of openings in plates, and gaps between plates and the finishing of plate runs;
• Winter service issues;
• Signing, lighting and markings;
• Noise and environmental factors;
• Inspection and maintenance.

As a result of this study there is already greater enthusiasm amongst contractors and manufacturers to increase plate usage and to continue developing new plating solutions. This needs to be supported by highway authorities. As a result, the increased use of plates is likely to stimulate a market for their manufacture.

The use of plates on the TLRN is likely to increase their use in the rest of London and the UK, and stimulate competition between manufacturers. More case studies and site trials would, therefore, be beneficial in promoting the use of plates.

Full details of the research and trials are given in PPR 654 Reducing Congestion from Roadworks: Part 1, Use of Road Plates. General guidance is given in QWIRC Note 3 on use of road plates to reduce congestion.
3 Use of Temporary Backfill

Using temporary backfill to fill openings when no works are taking place would allow a carriageway to be opened to traffic thereby reducing congestion. It would also be appropriate for use when there is insufficient time available to complete the permanent reinstatement or where it is not possible to use road plates.

In general, temporary backfill should only be used if it is cost effective. There are two aspects to consider; saving road user delay costs which can be considerable during peak periods, and the extra cost to the contractor of installing and removing the temporary backfill, taking into account any potential lane rental charges.

Temporary backfill is potentially the most versatile of the three main techniques considered in this study. It should not require the use of special materials (such as road plates or rapid curing materials) and it can be handled using the plant that is normally available on site. However, the additional time required to install and remove temporary backfill could limit it to small excavations or to excavations that can remain backfilled for several days.

Examples of longer term usage include:

- During delays encountered during emergency and planned works;
- On (some) weekdays, including when there is only weekend working;
- At weekends (for example, during special events);

Therefore, the most likely scenarios for temporary backfill would appear to be one, or a combination of, the following:

- To allow small trenches to be trafficked in peak periods;
- After the permanent backfill has been placed and there is a delay in completing the permanent reinstatement;
- When there is a long time delay during the works, e.g. from the morning to the evening peak period, weekdays, weekends, and special events.

It was concluded that temporary backfill is best suited for use in immediate reinstatements. According to the Specification for the Reinstatement of Openings in Highways (SROH) an immediate reinstatement may be completed using excavated or other materials, properly compacted in 100mm layers, with a minimum surfacing thickness of 40mm of bituminous material. It is normally necessary to replace an immediate reinstatement within 10 working days.

The main factors that need to be considered when using temporary backfill as an immediate reinstatement are:

- Trench volume, depth and shoring;
- Availability;
- Placement and compaction;
- Bearing capacity;
- Effect on apparatus;
- Removal;
- Asphalt specification and layer thickness.

To test the performance of temporary backfill, trials were undertaken in TRL’s Pavement Test Facility to assess the robustness of several temporary backfill options in a 2m x 2m x 1.5m deep opening. Materials used in the trials included:

- Type 1 with hot and cold lay asphalt surfacing options,
• Sharp sand in combination with a thinner layer of Type 1 and thin hot mix asphalt surfacing.
• Pea shingle in combination with a thinner layer of Type 1 and thin hot mix asphalt surfacing.

The trials simulated 5 days trafficking on Type 0 roads (30-125 million standard axles) carrying at least 50 million standard axles (most utility works are undertaken on Type 1 – 4 roads which carry far less traffic; that is less than 30 million standard axles).

With the granular Type 1 backfill, the hot mixed asphalt surface course performed much better than the cold lay material. The cold lay asphalt surfacing was more prone to secondary compaction under trafficking conditions, whereas the hot mix surfacing provided an immediate stability on completion of compaction.

With Type 1 materials and a nominal 50mm hot mix asphalt surfacing, the settlement was less than 1mm. When sharp sand and 10mm pea shingle were used in combination with a 300mm thick layer of granular Type 1 material, settlement was 15 and 26mm, respectively.

All these settlements were less than the 35mm maximum specified in the SROH for openings of greater than 1m. The materials with the higher deformations were, however, quicker to install so consideration needs to be given to the time required for the temporary backfill to be in place, and the amount of settlement that could be tolerated taking into account the traffic volumes and mix involved, as well as the importance of the road.

In addition, consideration should be given to using temporary backfill in off-carriageway situations where a lane closure would be needed because of the proximity of the trench. For example, where works are being undertaken in the footway or central reserve and the integrity of the surface needs to be maintained in case a vehicle leaves the live traffic lane. The opening itself would therefore take limited, if any,
traffic and not require compaction of the placed material.

Full details of the research and trials are given in PPR 655 Reducing Congestion from roadworks: Part 2, Use of temporary backfill. General guidance is given in QWIRC Note 6 on using temporary backfill to reduce congestion.
4 Use of Early Strength Gain (Rapid Cure) Concrete

The use of rapid cure concrete should help to reduce the duration of road and street works. The earlier re-opening of the road should produce a reduction both in user delays and in works contractor operating costs, as well as in any lane rental charges.

In order to assess the potential time savings that could be gained from using rapid cure concrete, laboratory testing was undertaken on cementitious materials provided by suppliers, as well as on samples taken during site works.

The testing showed that the strength gain of various cementitious mixtures can be accelerated so as to provide early age strengths without an excessive final strength. However, the extent of any accelerated strength gain and of the final increase varied considerably, showing that the performance depends on many factors.

The laboratory test programme undertaken showed that most mixtures reach their 7-day and 28-day strengths before those times, which would be expected in order to ensure regular compliance. Furthermore, an early strength gain of concrete can be successfully achieved by the use of admixtures, although with variability in effect, and that warmer curing conditions will speed that gain. It is also known that the strength gain will be affected by changes in the mixture’s composition, in particular increasing the cement content or reducing the water / cement ratio.

Visits to site works where materials were sampled, showed that the early-age strengths are not necessarily achieved on site even when rapid cure concrete is claimed to be used. In many cases, a standard concrete had been installed and extra water was added to help the mixture flow, which is detrimental to strength gain of the concrete. For these, the strength at 28 days was less than would be ideal in all but one case. Therefore, better control of the material supplied, together with some form of monitoring of the strength of the concrete used in reinstatements is needed. One step towards these goals would be clearer definition of what is required and a better specification for rapid cure material.

The use of rapid cure or early strength gain concrete is neither explicitly permitted nor banned in the SROH, so it could therefore be considered a suitable material (there is no reference to ‘normal’ concrete either).

The only strength requirement currently given for concrete in the SROH is for rigid surface slabs. Where the cementitious layer is at a lower level in the pavement there is more comprehensive guidance in the Design Manual for Roads and Bridges (DMRB).
In current terminology the concrete strengths required before the application of the next layer or at opening to traffic are:

- C32/40 concrete, 25.0 N/mm²
- C20/25 concrete, 20.0 N/mm²
- C16/20 concrete or Cement Bound Granular Material (CBGM) B, 15.0 N/mm²
- C12/15 concrete or CBGM B, 10.0 N/mm²
- C8/10 concrete or CBGM B, 7.0 N/mm²
- C5/6 concrete or CBGM B, 4.5 N/mm²

A margin of safety needs to be applied in practice to ensure that the required strength is achieved.

In order to simplify the process, it is recommended that the categories for early strength (rapid cure) concrete (ES) should be rationalised so as to give a range varying from a standard 7 day curing regime with other categories based upon a reduction in the time required before application of the next layer or opening to traffic. The categories proposed are as follows:

- ES60 Semi-rapid 60 hours / 2½ days before opening to traffic
- ES36 Near rapid 36 hours / 1½ days before opening to traffic
- ES24 Rapid 24 hours / 1 day before opening to traffic
- ES12 Very rapid 12 hours before opening to traffic
- ES6 Ultra rapid 6 hours before opening to traffic.

A number of options for materials approval were reviewed as part of the study, including Self Certification; the development of a Palette of Materials and either a national or local specification for materials. The advantage of having a specification would be that it would be easier for new materials to be introduced. One approach to producing this, that should be acceptable by all parties, would be through reference to the 1000 series of the Specification for Highway Works (SHW) when the Specification for Reinstatement of Openings in the Highway is next revised. A specification has, however, been prepared under this project and this has been issued by TfL to contractors for use on the TLRN.

Full details of the research and trials are given in PPR 656 Reducing Congestion from roadworks: Part 3, Rapid Cure Concrete; and general guidance is given in QWIRC Notes 2, 4 and 7 (see Section 7, Further Information).
5 Other Techniques

There are many other techniques which could be used to reduce the congestion caused by roadworks, and each technique will be appropriate for different situations. Options that can be considered when planning road or street works include:

- organisational issues - co-ordination, extended working hours, permits and lane rental, traffic easing and public information;
- surveys - methods and asset locating tags;
- minimising excavation - no dig technologies, keyhole maintenance, vacuum extraction, “Core & Vac” and micro-trenching;
- the use of alternative materials; and
- common utility ducts

Co-ordination and planning

The need for adequate and consistent co-ordination of the works is well established, particularly in London where regular meetings take place between the parties involved in the co-ordination and planning of works. Where in place, a permit scheme would help to control the number of works taking place at any one time. The co-operation of all parties in this process is important.

Extended hours working should also be considered when the operations will not inconvenience local residents, businesses or the travelling public. Each location will be different but factors such as noise, lighting and vibration associated with the works should be taken into account together with the overall impact of works duration. Further guidance is given in QWIRC Note 8.

Surveys

Ideally a central database of detailed underground services maps would enable the works contractor to carry out a ‘right first time’ excavation coupled with minimal disturbance of other services. Current levels of surveys are graded and vary from a desktop search of existing records (Grade 4) up to Grade 1 which includes ground penetrating radar, AutoCAD drawings and full geophysical and topographical surveys. Further guidance is given in QWIRC Note 5.

Keyhole maintenance

The use of coring and vacuum extraction techniques together with a toolkit for undertaking works within the excavation from the surface are an excellent way of minimising the size of excavation and reducing the time required for the works. This approach can reduce the time required for a typical works from 4 or 5 days to less than half a day, which means all the works can be carried out in the off-peak. This particular technique has demonstrated major savings for the gas industry and further guidance is given in QWIRC Note 1.
Alternative materials

These can include hydraulically bound mixtures with recycled aggregates and alternative binders which can be beneficial environmentally. They are included in the SROH and covered in the SHW. Other products that can be considered are natural cement with lightweight aggregate, high-strength resin foam, and warm and semi-warm asphalt.

Manhole replacement

Manholes form an intrusion into the highway and are constructed from different materials to that of the pavement around it. Failure of a manhole can disrupt ride quality and create higher impact loadings on the surrounding carriageway. Damaged manholes need to be repaired rapidly and effectively, and systems have been developed to undertake the complete repair of manholes (including lining the interior of the manhole) quickly and efficiently; enabling earlier opening to traffic and minimising the likelihood of the need for repeat maintenance.

Common utility ducts

These are also known as ‘pipe subways’ and are permanent passages or covered ways under the street surface that carry cables and pipes, allowing easy access to them without the need for surface disruption. Generally these subways have been installed when new highways or developments were being built. To retrofit utility ducts, particularly at busy junctions, would be beneficial but also costly, and might only be justified where a concentration of utilities could be reliably predicted. For instance, there is the possibility of installing a new pipe subway at Liverpool Street (London) as part of the Cross Rail project; and there may also be opportunities during the Thames Tideway Tunnel Scheme. In addition, the possibility of converting existing disused subways into pipe subways should be considered.

Full details of the research are given in PPR 657 Reducing Congestion from roadworks: Part 4, Other possible techniques.
6 Economics

User delays are a considerable cost to the UK economy and reducing the congestion from roadworks can therefore be highly beneficial. In addition, the introduction of a lane rental charge in London provides an incentive to highways works and utility contractors to consider alternative approaches to working that will minimise the occupation of the carriageway at peak times.

Each site’s working arrangement will be different but by way of guidance a broad illustration of the user delay savings that could arise has been estimated using the Department for Transport’s QUADRO program. The roadworks assumed in this example is for a short length of closure for one day covering peak periods on a single 2 way all-purpose road with an Annual Average Daily Traffic (AADT) volume of 20,000 vehicles per day. By opening up the road to traffic during the peaks, the user delay costs that could be saved are approximately £80,000 per day. Similarly, for a dual carriageway with an AADT of 45,000 vehicles per day the potential user delay savings are £30,000 per day.

It is recommended that a review of all the potential options for reducing congestion delay costs should be undertaken at the planning stage of any job. The works contractor makes its own estimate of costs and savings when planning roadworks options. These might include lane rental charges, which will vary depending on the importance and location of the road. At present these can be up to £2,500 per day in London.
7 Further Information

More detailed information on each of the technologies included in this study are available separately in the following four detailed technical reports which are free to download from the TRL website (www.trl.co.uk/library):

PPR 654 Reducing Congestion from roadworks: Part 1, Use of road plates;
PPR 655 Reducing Congestion from roadworks: Part 2, Use of temporary backfill;
PPR 656 Reducing Congestion from roadworks: Part 3, Early strength gain (rapid-cure) concrete for reinstatements
PPR 657 Reducing Congestion from roadworks: Part 4, Other possible techniques.

In addition to these reports, QWIRC (Quick Win Innovation to Reduce Congestion) Notes that provide guidance on techniques for reducing congestion are also available for download. These are:

QWIRC Note 1: Core and Vac
QWIRC Note 2: Rapid Cure
QWIRC Note 3: Use of road plates
QWIRC Note 4: Requirements for trafficking of cementitious mixtures
QWIRC Note 5: Mapping the Underworld
QWIRC Note 6: Temporary Backfill
QWIRC Note 7: Rapid cure foam
QWIRC Note 8: Extended working hours
QWIRC Note 9: Hydraulically bound mixtures.