

Engineering Policy 149

Managed motorways

May 2014

Amendment Register

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1 Policy statement

The Department of Transport and Main Roads is committed to optimising the safety, reliability and productivity of the motorway network by progressively implementing a managed motorway standard across all state controlled and franchised motorway standard roads in Queensland.

This policy requires:

1. All motorway upgrade projects to include the provision for a managed motorway outcome within the planning and design phases; and the supply and installation of necessary infrastructure and equipment within the delivery, operation and ongoing maintenance phases of the project.
2. Operational strategies to be developed, implemented, maintained and regularly reviewed for all motorways.
3. Intelligent Transport System infrastructure to be maintained and reviewed to optimise motorway performance.

2 Related documents

Engineering & Technology branch has developed operational guidelines, manuals and standards to accompany this policy. These include departmental policies below:

- *Collocation of Gantry Mounted Variable Speed Limit Signs with Static & Dynamic Signs on Motorway* (Section 1.46 of the TRUM)
- *Display of Information on Variable Message Signs Guideline* (Section 2.9 of the TRUM Manual)
- *Variable Message Signs Use and Operation* (Section 2.9 of the TRUM Manual)
- *Guidelines for the Permanent Placement of Variable Speed Limit and Lane Control Signs for Motorways, Long Bridges and Tunnels* (Section 2.18 of the TRUM Manual)
- *Guidelines for the Provision of Ramp Signals* (Section 2.19 of the TRUM Manual)
- *Use Of Permanent Variable Speed Limit And Lane Control Signs In Construction and Maintenance Work Areas On Motorways* (Section 7.6 of the TRUM Manual)

Other related documents include:

- *Best Practice Recommendations for Variable Speed Limits* (Austroads, 2009)
- *Freeway Design Parameters for Fully Managed Operations* (Austroads, 2009)

3 Applicability

In accordance with the department's power as prescribed in the *Transport Infrastructure Act 1994* this policy applies to all state controlled and franchised motorway standard roads in Queensland, and interchanges where necessary for effective management.

The policy does not apply to local government motorway standard roads.

The department's *Road Planning and Design Manual*, defines a motorway as a divided road for through traffic, with full control of access and interchanges provided at points where access to the local road system is required.

This policy includes existing motorways and projects currently underway or planned for the future:

1. For sections of motorway not currently in the capital works program, requirements for a managed motorway standard will be identified for the generation and evaluation of project proposals for inclusion in future programs.
2. For motorway projects currently programmed but not having commenced (that is, the projects in the outer years of the *Queensland Transport and Roads Investment Program* and beyond), the managed motorway standard will be in scope, therefore requiring possible variations to existing plans and designs.
3. For current motorway projects (that is, where construction has commenced), the managed motorway standard will be incorporated and constructed as part of the upgrade. This may involve variations to scope and project costs to accommodate this requirement. In these cases, project managers are to work with the Program Manager (Managed Motorways) to identify and address funding implications for meeting this requirement.

It is essential that existing projects evaluate the impacts of implementing a managed motorway standard. Short sections of motorway where the managed motorway standard has not been included will require an expensive retrofit at a later time. In many cases it will be more cost effective to issue a variation so that provision for a managed motorway outcome is included in the existing project.

This policy recognises that while there will be locations that will be difficult to upgrade in order to deliver a managed motorway, it is not feasible to allow unmanaged access at any location as this will be detrimental to motorway operations and opposes what this policy sets out to achieve; full operational management of motorway access and flows. However, Integrated Transport System facilities defined in Section 4 may be gradually implemented in response to changing traffic conditions.

4 Definition of a managed motorway

A managed motorway is one that has the necessary infrastructure and ITS which enables upstream demand and operations to be managed to meet downstream capacity. The managed motorway standard allows the road operator to dynamically manage operations to minimise congestion due to flow breakdown. Background regarding managed motorway system performance is provided in Appendix A.

A managed motorway standard includes the consideration and provision of the following ITS facilities.

Table 1 – Mandatory facilities

Mandatory Facilities	Intent
Ramp signalling on all on-ramps	<ul style="list-style-type: none"> • Demand control; harmonisation of the merging condition (automated).
CCTV – Partial coverage at key locations such as the ramp signals (motorway and arterial view)	<ul style="list-style-type: none"> • Reduction in incident duration through manual verification and response from the TMC (e.g. TRU, Emergency Response).

Mandatory Facilities	Intent
Variable Speed Limits (VSL) – High flow, queue detection and protection, weather, planned incident management	<ul style="list-style-type: none"> • Can assist in harmonising flow or controlling the demand. Examples include: <ul style="list-style-type: none"> – Major merge (motorway to motorway interchanges). – Geometric bottlenecks such as lane-drops, poor horizontal & vertical alignment. – Brownfield locations that can't meet ramp signalling design requirements (e.g. the acceleration to mainline speeds). • Supplementary mainline detection in high flow zones, E/VMS, and the provision for enforcement compliance equipment may also be required. • Where there is frequent off-ramp or out-of-system queue spill-over along the Motorway (Supplementary mainline and off-ramp detection where queuing occurs, E/VMS, and the provision for enforcement compliance equipment may also be required). • Where weather events (strong winds, rain, fog, ice, & slippery surfaces) need special speed control. Example locations include bridges. (Supplementary mainline detection where control is desirable, E/VMS, and the provision for enforcement compliance equipment may also be required). • At locations where there are frequent incidents or flow break down on the mainline. • Where frequent and difficult controlled access is required.
Mainline and on-ramp traffic detection	<ul style="list-style-type: none"> • Required to support ramp signalling, and motorway counts.

Provision of the following ITS Facilities shall be made if the following operational outcomes are deemed necessary.

Table 2 – Other ITS Facilities

Other ITS Facilities	Operational Outcomes
Variable Message Signs (VMS) or Enhanced VMS (EVMS)	<ul style="list-style-type: none"> • Improved awareness of downstream incident conditions. • EVMS provides colour coded variable route travel time, in addition to standard variable messages and selected symbolic signs. • Supplemental mainline detection is required to estimate travel time.
Travel Time Sign (TTS), or Arterial Travel Time Sign (ATTS)	<ul style="list-style-type: none"> • TTS – where fixed motorway route travel time information is desirable. • ATTS – where variable motorway route travel time information is desirable. This treatment provides additional demand control as drivers can seek alternative routes prior to the on-ramp. • Supplemental mainline detection is required to estimate travel time.

Other ITS Facilities	Operational Outcomes
Lane Use Management (LUMS)	<ul style="list-style-type: none"> • Where VSL is supported by gantries, LUMS will provide more control for no additional cost. • Where planned or unplanned incident management is frequently required. • Where hard shoulder running is applicable. • Where ongoing operations make it impractical for maintenance and/or incident management e.g. where shoulder widths are constrained.
CCTV – Extensive Coverage	<ul style="list-style-type: none"> • Coverage that supports confirmation of planned and unplanned events and operational responses using VMS, VSL, or LUMS.
Priority Access for High Occupancy Vehicles (HOV), freight, and other special purposes	<ul style="list-style-type: none"> • Where there is a link-level modal plan that outlines specific priority for special vehicle types. Such priority will be afforded through the provision of queue bypass facilities at entry ramps; there may also be circumstances that enable special access arrangement for hard shoulder running.
Help phones	<ul style="list-style-type: none"> • Reduction in incident duration through manual verification and response from the TMC (e.g. TRU, Emergency Response). • In hazard locations where there may be insufficient supporting ITS or Traffic Incident Management Services (TIMS) or poor mobile phone coverage or at locations where it is not in close proximity to accessing help. • Hazard and high risk locations include range crossings, floodway and areas where a high rate of recorded incidents or risk exists.

(The provision of Integrated Transport System facilities is to align with the policy '*Intelligent Transport System Software Applications in Transport and Main Roads*' and must operate in accordance with their relevant guidelines).

The provision of managed motorways is linked to the principles for '*Planning for Operations*', focused on improving reliability and safety, achieved through:

- Analysis
 - understanding network demands, capacity, and constraints
 - understanding safety, community and economic priorities for trip types, mode and access.
- Design
 - providing sufficient queue storage where on-ramp demand is restrained
 - identifying local constraints and limitations that warrant the provision of additional road space or infrastructure works.
- Operations
 - developing and testing operational strategies.

5 Context

The objectives of this policy are consistent with objectives of the *Transport and Main Roads Strategic Plan 2013–2017*:

- Objective 1 – Integrated transport system that supports the safe, efficient and reliable movement of people and goods.
- Objective 2 – Safe and cost-efficient transport infrastructure that meets the current and future needs of Queensland.

Links with other Transport and Main Roads and other government strategies include:

- *Department of Transport and Main Roads Transport Co-ordination and Delivery Plan (2013)*
 - Efficient and Reliable
 - Maintain or improve the existing transport network infrastructure.
 - Maintain or improve system operation and reliability.
 - Deliver the necessary system capacity required to meet demand.
 - Integrated
 - Improve access options to essential goods and services.
 - Improve the connectivity for freight supply chains.
 - Safe and Secure
 - Reduce transport-related fatalities, serious injuries and criminal or terrorist incidents.
- *South-east Queensland Regional Plan 2009–2031 (Part D–12.4)*
 - Transport System Efficiency
 - Maximise the use of existing transport assets and services by effective transport investments and policies, demand management and the use of new technologies.
- *Connecting South-east Queensland 2031 (Part B)*
 - One network – integrated management of state and local government-owned roads to maximise performance.
 - Information and communication technology – use of new technology to maximise throughput on the road and rail networks, improve safety and enhance traveller information.
 - Incident response – faster and more efficient management of incidents to reduce delays.
 - Climate change adaptation and mitigation – support transport planning, building and operations that take climate change impacts into account.

6 Objectives and benefits of managed motorways

The objectives of the policies mandatory requirements are to:

1. Improve motorway safety. This is achieved by the following:
 - Reducing the occurrence of flow breakdown and allowing mainline speeds to be more consistent.
 - Assisting merge and weaving movements and minimising lane changing in the vicinity of the merge.
 2. Optimise motorway throughput and reliability. This is achieved by the following:
 - Managing motorway demand such that the mainline operates at near capacity, but not at the point of flow breakdown.
 - Achieving evenly distributed flow of on-ramp traffic onto the mainline by dispersing on-ramp platoons.
- Reduce overall vehicle emissions.
 - Reduce driver frustration with lost productive and/or social time.
 - Achieve best use of existing motorway capacity.
 - Improve performance data collection (for traveller information services and modelling).

The policy also ensures that the department implements the most cost-effective traffic management and capacity solutions which have a lasting effect on managing traffic demand along key transport routes.

7 Policy impacts

- Experience with implementing managed motorways has provided increased throughput at critical locations, and generally increased the productivity of the overall motorway system. However, on-ramp signalling will create varying levels of delay at entry ramps to maintain stable motorway flows. Generally, it is considered that this delay effect on the local/adjacent network will not be significant in comparison with the current unmanaged scenario, where vehicles in flow breakdown conditions access the motorway in a zipper-like fashion (be it at much lower speeds) and queuing forms on both the ramp and motorway. At locations of excessive demand, more restrictive on-ramp signal phasing will be required to achieve the desired motorway operation.
- When employing on-ramp signalling to manage access, as far as possible adequate storage should be provided for approach queues. However, these queues may extend beyond the length of the ramp and impact on the operation of the local/adjacent network. Implementing strategies or treatments to reduce or mitigate this impact is highly desirable to the success of the initiative. Projects are required to identify areas where there are local impacts and provide a suitable response to ensure that motorway operations can be fully managed. Typical mitigation measures include maximising the width and length of ramp storage, and separate motorway feeder lanes on the local network with accompanying traveller information.

- The full benefit of managed motorways will not be realised if there are locations where managing demand is compromised. Therefore, achieving a managed motorway outcome depends on complete sections being adequately designed and constructed to the managed motorway standard.
- Operational budgets for the ongoing maintenance and operation of ITS infrastructure will need to increase to meet requirement 3 of the policy statement.
- Driving on a managed motorway will be a new driving experience for many motorists, therefore requiring public education to the use and benefits of managed motorways. Public education will be delivered through the Managed Motorways Program.
- Demand modelling at the concept planning stage needs to be sufficiently robust to inform managed motorways requirements, such as ramp storage, to ensure land requirements are identified and acquired for operational outcomes.
- Transport and Main Roads will operate managed motorways from a common ITS platform (STREAMS, as per the ITS Software Applications Policy), therefore requiring all projects to ensure ITS facilities integrate into the adjoining network.
- The inclusion of clear operational strategies at project concept stage will inform ITS infrastructure needs for project scoping.

8 Consultation

- Department of Transport and Main Roads Senior Management Group
- Department of Transport and Main Roads Regional and District Directors
- Department of Transport and Main Roads Major Projects Office Steering Committee
- Department of Transport and Main Roads STREAMS Functional Strategy Group

9 Evaluation and review

This policy will be reviewed on an as needed basis by Network Operations and Performance Unit (Engineering & Technology Branch).

10 Definitions

Term	Definition
ATTS	Arterial Travel Time Sign
CCTV	Closed Circuit Television
DTMR	Department of Transport and Main Roads
EVMS	Enhanced Variable Message Sign
HOV	High Occupancy Vehicle
ITS	Intelligent Transport System
LUMS	Lane Use Management Sign
Motorway	A divided road for through traffic, with full control of access and interchanges provided at points where access to the local road system is required.
TMC	Traffic Management Centre

Term	Definition
TTS	Travel Time Sign
VSL	Variable Speed Limit
VMS	Variable Message Sign

11 References

- *Transport and Main Roads Strategic Plan 2013 – 2017*
- *Road Operations and Use Action Plan 2013/2014 – 2016/2017 (Draft)*
- *Road Planning and Design Manual*
- *South-east Queensland Regional Plan 2009 – 2031*
- *Connecting South-east Queensland 2031*
- *Transport Infrastructure Act 1994*

Appendix A

1 Background

Sustained performance of the Queensland economy in recent years, combined with population growth and development impacting the motorway network, has placed greater pressures on the operation of the state's motorway network. With increased traffic growth comes increased exposure to traffic risks, travel time variability and vehicle emissions, all of which pose significant costs on the Queensland community.

Currently, in large urban networks, unconstrained access to key transport links is likely to always exceed available capacity in peak periods. When traffic demand exceeds the capacity of road space, motorway flow breaks down reducing the operational capacity and increasing variability in travel times, safety risks and uncontrolled queuing across the road network. For motorway users, flow break down manifests itself as ad-hoc, start-stop conditions with significant delays and congestion costs. In addition, the loss of capacity due to incidents requires a managed response to ensure minimum impacts and earliest recovery.

Figure 1 simply illustrates the cause of flow breakdown. A motorway has a design capacity, indicated by V_{MAX} . V_U indicates traffic volume upstream and V_{R1} , V_{R2} and V_{R3} indicate the demand on motorway entry ramps. If $V_U + V_{R1} + V_{R2} + V_{R3}$ (minus the off-ramp traffic) is greater than V_{MAX} , then flow will break down as demand is greater than available capacity. Congestion resulting from flow breakdown usually promulgates in the form of shock waves and research indicates that this travels upstream against the traffic flow at approximately 15 – 20 km/hr. This causes a reduction in flow (throughput) which represents a loss of productivity and inefficient utilisation of the motorway.

Figure 1 – Illustration of motorway capacity with on and off ramps

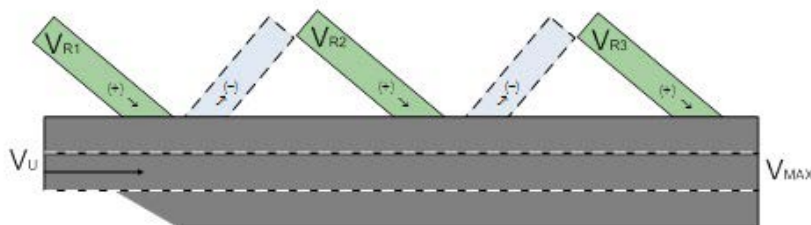


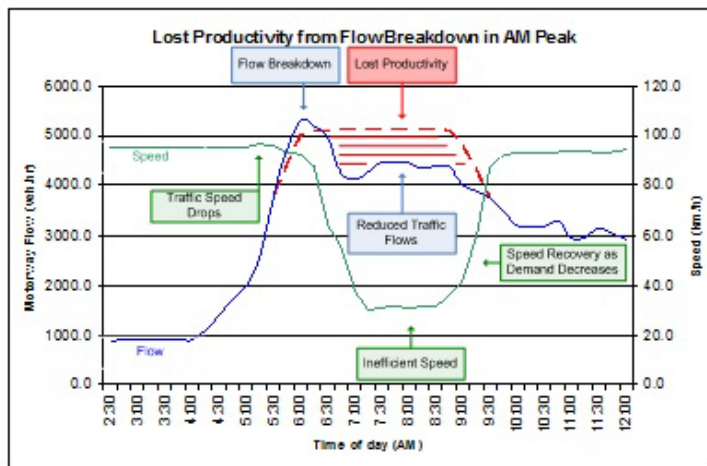
Figure 2 illustrates the effect of flow breakdown on motorway productivity. In this example motorway flows peak at around 5200 vehicles/hour, then collapses to around 4100 vehicles/hour. This flow collapse corresponds with a dramatic reduction in travel speeds of around 70%. Reduced speeds and flows remain for the peak period until demand eases. The shaded red area illustrates the productivity potential that managed motorway operations offer by managing the demand onto the motorway and by controlling speeds along the motorway.

It is recognised that increasing road capacity through the addition of new lanes is a high cost solution (with diminishing marginal benefits) to managing the impacts of traffic growth, particularly in urban areas. Accommodating continued traffic growth through construction of additional lanes is difficult because of:

- adverse social impacts associated with resuming land (in some cases, the additional land requirement is too costly)
- escalating costs for building additional capacity

- increases in road capacity being quickly consumed by extra road use (generated traffic reduces predicted benefits of capacity expansion and induced travel imposes additional external costs)
- long lead times required, and
- localised capacity improvements provided.

Figure 2 – Lost productivity from flow breakdown



These factors highlight that the provision of extra lanes to increase supply (capacity) does not always provide a practical solution to manage traffic demand. Without enhanced ability to manage traffic demands in real time, flows keep increasing until capacity is exceeded. It is not possible to cater for projected traffic growth with capacity initiatives only, nor is it sound policy to do so.

The department is seeking to manage its motorway network such that motorway flows do not exceed the capacity of the motorway. A key component in achieving this is the ability to control motorway access through the use of on-ramp signalling installed at each entry point. The integration of technology along with road operational strategies, targeted capital enhancements and active traffic management has the greatest potential to provide a lasting impact on achieving these outcomes, with a corresponding reduction in operational costs of the network, including vehicle emissions. Numerous economic analyses have concluded favourably where motorways operate in a managed motorway environment.

Implementing managed motorways forms part of the Queensland Government's urban congestion management response. This is because increasing transport efficiency is particularly important for long-term economic development as it provides savings and benefits that disperse throughout the economy. For example, reducing travel time and vehicle operating costs help workers access better jobs, saves households money and expands labour supply, raising productivity.

The positive outcomes of implementing managed motorways also benefits the arterial road network. Without managed motorways, motorways operate at typically 20% below capacity. By allowing the motorway network to operate closer to its capacity, in a more reliable and consistent manner, motorists confidence in using the motorway will be increased, and there is less tendency for 'rat-running' to occur on the adjacent network. This reduces the impact of peak flows on the arterial road network.

Schedule A: List of motorways that must include the managed motorway standard in all upgrade works

- Gateway Motorway (including the Gateway Extension)
- Port of Brisbane Motorway (at Major Merge with Gateway Motorway Only)
- Bruce Highway (Beams Road to Caboolture)
- Pacific Motorway
- South-east Freeway
- Ipswich Motorway
- Logan Motorway
- Western Freeway
- Sunshine Motorway
- Houghton Highway

Schedule B: List of motorways which must make provision for managed motorway standard in the future (i.e. Identify land requirements or 'footprint' for ramp storage)

- Bruce Highway (Caboolture to Sippy Downs)
- Warrego Highway
- Cunningham Highway

