Cardno Eppell Olsen
Shaping the Future

Surat Gas Impact Assessment Report

Road Impact Assessment

Project Number: CEB06009

Prepared for Arrow Energy via Coffey Environments

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EXECUTIVE SUMMARY

Arrow Energy Pty Ltd (Arrow) is proposing an expansion of its coal seam gas operations in the Surat Basin through the Surat Gas Project. The project development area has been divided into five development regions consisting of Wandoan, Chinchilla, Dalby, Kogan/Millmerran and Goondiwindi for project planning purposes. The project description details the construction and operation of approximately 7,500 production wells, 18 production facilities and five accommodation camps. Arrow hopes to achieve gas production of 1,050 terajoules/day (TJ/day) for 20 years with ramp up and down over a 35 year project life. For traffic modelling; a nominal level of residual traffic activity has been included beyond 35 years.

As part of the Environmental Impact Statement (EIS) preparation, Cardno Eppell Olsen was commissioned to undertake a Road Impact Assessment to assess the significance of the potential traffic impacts associated with the project. For the purposes of the Road Impact Assessment, indicative vicinities for project infrastructure have been assessed, combined with a representative development scenario to establish a reasonable understanding of the significance of the project's impacts on the road network at all stages of the project. The outcomes from the Road Impact Assessment are considered strategic given that facility and infrastructure locations and thus the roads leading to and from these locations, are yet to be determined. The assessed development schedule is based on the best information currently available and represents a comprehensive strategic level assessment (i.e. EIS assessment). Typical of gas projects the proponent should, over the life of the project, provide regular advice to relevant road authorities post completion of the EIS assessment by way of mechanisms such as ongoing Road Use Management Plans and infrastructure agreements.

For the Surat Gas Project, an assessment that utilises sensitivity and magnitude to define the significance of the project's potential impacts has been adopted by applicable studies, including this Road Impact Assessment. In the context of this EIS assessment, an environmental value has been defined as a measure of how we value the environment in which we live and in particular for this assessment, the roads used in the project development area. In this respect, the following road types were identified as values within the project development area: a Highway as a high standard road connecting regional centres; a Regional Connecting Road as a high standard road connecting townships; a Rural Connecting Road as a lower standard road providing connection between higher order roads; and a Rural Access Road providing access to local land uses. Broadly, for a Highway the environmental values have a low sensitivity to changed traffic conditions; for a Regional Connecting Road the environmental values have a moderate sensitivity; and for Rural Connecting Roads and Rural Access Roads the environmental values have a high sensitivity.

Based on information supplied by the proponent, a 35 year project life is considered in this EIS, however for the purposes of the traffic modelling a nominal continuation of project activities past the 35 year project life has conservatively been assessed. Traffic generating project infrastructure broadly includes:

- Production wells and gathering infrastructure (7,500 wells and corresponding gathering infrastructure).
- Integrated processing facilities (6 facilities).
- Central gas processing facilities (6 facilities).
- Field compression facilities (6 facilities).
- Accommodation camps (5 camps).

Based on an understanding of the activities associated with the construction, operation and decommissioning of production facilities, wells and gathering lines, the traffic generating potential was determined including assignment of origins and destinations to inform the modelling process.

The existing traffic conditions have been reviewed to provide context to aid in the identification of the sensitivity of the environmental values to changed traffic conditions. This involved obtaining data from the Department of Transport and Main Roads (TMR) and local council authorities. The existing conditions of the road network reviewed included existing construction standard, functional road hierarchy, existing traffic volumes, multi-combination vehicle routes, school bus routes, rail crossings, stock routes, pedestrian, cycle and public transport networks, motorist rest areas and a road safety assessment of historical crash rates.

Using a strategic modelling process, combined with the estimated traffic generation potential associated with the construction, operation and decommissioning of project facilities and infrastructure, the volume of project traffic on each road link over the project life was estimated. This process identified an average Annual Average Daily Traffic (AADT) volume and a peak year AADT volume on each link over the project life. This process identified the magnitude of potential impacts on the road network to inform the impact significance assessment.

Broadly the strategic modelling indicates that the total travel generated by the project in its peak year is likely to be less than 1% of the total travel currently (2009) occurring across TMR's Darling Downs district road network. At its peak the project is anticipated to increase the extent of heavy vehicle travel occurring on the district's road network by less than 2% of the existing (2009) levels.

With the determination of sensitivity and magnitude, the significance of the project's road use impacts were identified for each development region. Broadly, those regions with a sparse road network and a greater reliance on Rural Connecting Roads and Rural Access Roads were more susceptible to potential impacts of high significance on efficiency, safety and amenity. Regions where Regional Connecting Roads and Highways would more likely be used resulted in moderate and low significance of impacts respectively on efficiency, safety and amenity.

After a review of best-practice literature, management strategies were developed to minimise the significance of project impacts on the assessed road environmental values of safety, efficiency and amenity. The management strategies include typical responses such as developing driver fatigue management strategies and providing improved intersection treatments at higher order roads. The management strategies are considered to provide the principles upon which future Road Use Management Plans and infrastructure agreements will be developed in consultation with the relevant road authorities.

Post implementation of these management strategies, the significance of the project's impact on the safety, efficiency and amenity of the road network was reviewed to assess the effectiveness of the proposed management strategies at reducing the significance of the project's potential impacts. As the significance of an impact is based upon the magnitude of the impact and the sensitivity to traffic conditions, both aspects were reviewed. Given the nature of the project's traffic-generating activities, the magnitude of traffic generated will not typically be reduced by the proposed management strategies. Instead the management strategies generally reduce the sensitivity of the various road types to changed traffic conditions.

For each road type, management strategies were identified with the preferred hierarchy of controls being firstly avoid the impact, then minimise the impact and then manage the impact. For example a Rural Access Road that is highly sensitive to change, may have an alternative route identified to avoid it; may only be trafficked at certain times of day to minimise the impact, or be sealed, widened and have improved intersection treatments to manage the impact. This would result in a road that is less susceptible to changed traffic conditions and hence reduces the significance of the project's impact on safety, efficiency and amenity. Through the application of management strategies it was determined that the overall significance of the project's road impacts would be reduced from a range of negligible to high to a range of negligible to moderate. The developed management strategies are therefore considered effective at reducing the significance of the project's impact on the safety, efficiency and amenity of the road network.

Other projects have been identified that will also result in increased traffic demands, which are envisaged to be manageable. To ensure an equitable outcome for all stakeholders of the road network it is envisaged that Arrow will enter into infrastructure agreements as required with the various road authorities to manage the low and moderate significance residual impacts (i.e. impacts post implementation of management strategies).

This Road Impact Assessment constitutes a strategic assessment of the significance of the road impacts associated with the Surat Gas Project. At the strategic level no high or major residual impacts (post-management strategies implementation) are foreseen on the safety, efficiency and amenity of the assessed road networks. It is anticipated that the proponent will be conditioned to submit Road Use Management Plans regularly (potentially three years) which will include greater detail as specific site locations are identified and developed. Local impacts can be effectively managed through the Road Use Management Plans, consultation with road authorities, and potentially through infrastructure agreements during detailed project planning.

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GLOSSARY

Word, Phrase or Term	Definition
Annual Average Daily Traffic (AADT)	The average traffic volume expected over a 24-hour period in a given year.
Austroads	The association of Australian and New Zealand road transport and traffic authorities that aims to promote improved road transport outcomes and produces nationally accepted guidelines.
AUL	Auxiliary lane treatment for an intersection involving the provision of an auxiliary lane.
Auxiliary lane	The portion of the carriageway adjoining the through traffic lanes, used for speed change or for other purposes supplementary to through-traffic movement.
Background traffic	The expected volume of traffic at a particular point without the addition of the traffic associated with the project under consideration.
BAL	Basic Left turn treatment for an intersection, being a left turn shared with the through lane with shoulder widening. Allows a through vehicle, having slowed, to pass turning vehicles.
BAR	Basic Right turn treatment for an intersection, being a right turn shared with the through lane with shoulder widening. Allows a through vehicle, having slowed, to pass turning vehicles.
CGPF	Central Gas Processing Facility.
Commercial Vehicles (CV)	See heavy vehicles.
Council	Western Downs Regional Council (WDRC), Goondiwindi Regional Council (GRC) or Toowoomba Regional Council (TRC,) as appropriate.
Council-controlled road	Roads which are administered, funded and maintained by local government.
CHR	Channelised right-turn treatment for an intersection, being a separate lane for right turning vehicles.
CHR(s)	Channelised right-turn treatment (short lane length) for an intersection, being a short separate lane for right turning vehicles.
Crash rate	A crash rate is a ratio of the number of crashes to some common denominator, usually vehicle kilometres travelled, head of population or period of time. Crash rates allow more meaningful comparisons to be made between crash locations.
Environmental Impact Statement (EIS)	A structured document which is prepared to identify and assess the environmental impacts of a proposed activity which is either designated as development or 'likely to significantly affect the environment'. It also outlines safeguards to mitigate or control such impacts.
Exposure score (VT)	The product of the daily traffic volume and the daily train volume utilising the rail crossing.
Gathering line	A small diameter pipeline through which either coal seam gas or produced water moves through on a petroleum lease from the wellhead to the processing facility.
GRC	Goondiwindi Regional Council.
Growth rate	The annual percent change in the number of vehicles passing a given point on a road.
Heavy Vehicles (HV)	A heavy vehicle is defined as any vehicle with three or more axles or with dual tyres on the rear axle. Also referred to as commercial vehicles (CV).

Word, Phrase or Term	Definition
Intersection capacity	The maximum sustainable traffic flow rate at which vehicles can reasonably be expected to traverse an intersection under given roadway, geometric, traffic, environmental and control conditions; usually expressed as vehicles per hour.
Interrupted traffic flow	Where the flow of traffic is stopped or interrupted periodically by fixed external elements, such as traffic signals or signage, irrespective of the traffic volume. This traffic engineering term does not describe operating conditions.
Light vehicles (LV)	Cars, motorcycles and cars towing caravans.
LNG	Liquefied Natural Gas.
Mtpa	Million tonnes per annum.
MW	Megawatt = one million (10^6) watts.
Permanent infrastructure	Any infrastructure (roads, tracks, bridges, culverts, dams, bores, buildings, fixed machinery, hardstands areas, airstrips, helipads, pipelines etc), which is to be left by agreement with the landowner.
TJ	Terajoule: equivalent to 10^{12} joules of energy.
TJ/d	Terajoules per day.
Priority-controlled intersection	An intersection where the movement of vehicles is controlled by road rules and traffic signs only, for example stop or give way signs, as opposed to traffic signals or a roundabout.
Project	Surat Gas Project.
Project development area	The area for which Arrow is seeking approval to develop through the EIS assessment process.
Quantitative	An assessment based on the amount or number of something.
Queensland Stock Route	Network of facilities established to facilitate the movement of livestock on foot between grazing areas and markets. The network consists of areas for stock to travel along (often within existing road corridors, adjacent to roadways) as well as areas for livestock to rest overnight including water facilities and holding yards.
Road Impact Assessment	An assessment which identifies the potential road impacts of a proposed development and appropriate mitigation measures in accordance with the requirements of the Department of Transport and Main Roads *Guidelines for Assessment of Road Impacts of Development*.
Sealed Road	Generic terminology adopted within the Road Impact Assessment to identify a road that has generally been constructed using a bituminous material to form a protected road surface.
Sensitive place	A sensitive place means any of the following places: •a dwelling; •a library, childcare centre, kindergarten, school, college, university or other educational institution: •a hospital, surgery or other medical institution; •a protected area or an area identified under a conservation plan as a critical habitat or an area of major interest, under the Nature Conservation Act 1992; •a marine park under the Marine Parks Act 1982; and •a park or garden that is open to the public.
SPA	Sustainable Planning Act.
State-Controlled Road	A road declared to be controlled by the Department of Transport and Main Roads, including all AusLink National Roads in Queensland.

Word, Phrase or Term	Definition
TOR	Terms of Reference.
TMR	Department of Transport and Main Roads. Queensland government department responsible for planning, managing and delivering Queensland's integrated transport environment.
TRC	Toowoomba Regional Council.
Uninterrupted traffic flow	Where the flow of traffic is not stopped or interrupted by any fixed external elements, such as traffic signals. This traffic engineering term does not describe operating conditions.
Unsealed road	Generic terminology adopted within the Road Impact Assessment to identify roads that have been generally constructed to a formed and gravelled standard or a higher quality formed but ungravelled standard. In the context of this assessment the adopted terminology relates to the construction standard of the road not the ownership of the road (i.e. gazetted road versus private access road).
Unsealed track	Generic terminology adopted within the Road Impact Assessment to identify roads that have been generally constructed to an unformed standard. In the context of this assessment the adopted terminology relates to the construction standard of the road not the ownership of the road (i.e. gazetted road versus private access road).
Vehicle Kilometres of Travel (VKT)	A measure of traffic demand and is the length of a section of road in kilometres multiplied by the AADT on it. The yearly VKT is the daily VKT multiplied by the number of days in that year (365 or 366 days).
Vehicles per day (vpd)	The number of vehicles associated with a given location or activity during a 24-hour period.
Vehicles per hour (vph)	The number of vehicles associated with a given location or activity during a one hour period.
WDRC	Western Downs Regional Council.

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1 PROPONENT AND PROJECT OVERVIEW

1.1 PROPONENT INTRODUCTION

Arrow Energy Pty Ltd (Arrow) is an integrated energy company with interests in gas field developments, pipeline infrastructure, electricity generation and a proposed liquefied natural gas (LNG) project.

Arrow has interests in more than 65,000sq.km of petroleum tenures, mostly within Queensland's Surat and Bowen basins. Elsewhere in Queensland, the company has interests in the Clarence-Moreton, Coastal Tertiary, Ipswich, Styx and Nagoorin Graben basins.

Arrow's petroleum tenures are located close to Queensland's three key energy markets; Townsville, Gladstone and Brisbane. The Moranbah Gas Project in the Bowen Basin and the Tipton West, Daandine, Kogan North and Stratheden projects in the Surat Basin near Dalby comprise Arrow's existing coal seam gas production operations. These existing operations currently account for approximately 20% of Queensland's overall domestic gas production.

Arrow supplies gas to the Daandine, Braemar 1 and 2, Townsville and Swanbank E power stations which participate in the National Electricity Market. With Arrow's ownership of Braemar 2 and the commercial arrangements in place for Daandine and Townsville power stations Arrow has access to up to 600MW of power generation capacity.

Arrow and its equity partner AGL Energy have access rights to the North Queensland Pipeline which supplies gas to Townsville from the Moranbah Gas Project. They also hold the pipeline licence for the proposed Central Queensland Gas Pipeline between Moranbah and Gladstone.

Arrow is currently proposing to develop the Arrow LNG Project, which is made up of the following aspects:

- Arrow LNG Plant – the proposed development of an LNG Plant on Curtis Island near Gladstone, and associated infrastructure, including the gas pipeline crossing of Port Curtis.
- Surat Gas Project – the upstream gas field development in the Surat Basin, subject of this assessment.
- Arrow Surat Pipeline Project – (Formerly the Surat Gladstone Pipeline), the 450km transmission pipeline connects Arrow's Surat Basin gas developments to Gladstone.
- Bowen Gas Project – the upstream gas field development in the Bowen Basin.
- Arrow Bowen Pipeline – the transmission pipeline which connects Arrow's Bowen Basin gas developments to Gladstone.

1.2 PROJECT OVERVIEW

Arrow proposes expansion of its gas operations in the Surat Basin through the Surat Gas Project. The need for the project arises from the growing demand for gas in the domestic market, global demands and the associated expansion of LNG export markets. The project development area is shown on Figure 1.1.

The project development area covers approximately 8,500sq.km and is located approximately 160 km west of Brisbane in Queensland's Surat Basin. The project development area extends from the township of Wandoan in the north towards Goondiwindi in the south, in an arc through Dalby. Townships within or in close proximity to the project development area include (but are not limited to) Wandoan, Chinchilla, Kogan, Dalby, Cecil Plains, Millmerran, Miles and Goondiwindi. Project infrastructure including gas production wells and production facilities (including both water treatment and power generation facilities where applicable) will be located throughout the project development area, but not in towns. Facilities supporting the petroleum development activities such as depots, stores and offices may be located in or adjacent to towns.

The conceptual Surat Gas Project design presented in the environmental impact statement (EIS) is premised upon peak gas production from Arrow's Surat Basin gas fields of approximately 1,050 terajoules/day (TJ/d). The peak gas production comprises 970TJ/d for LNG production (including a 10% fuel gas requirement for facility operation) and a further 80TJ/d for supply to the domestic gas market.

Arrow has advised that the project life is expected to be 35 years; however for traffic modelling a nominal level of residual activity beyond 35 years has been included. Residual activity is based on the assumption that each production well (described below and installed over the life of the project) will operate for 20 years. While wells on average will run for this period of time, it is likely that wells commissioned near the end of the project life will remain in operation beyond the project life, hence an extended timeframe has been adopted to conservatively model traffic impacts for this Road Impact Assessment.

Ramp-up to peak production is estimated to take between four and five years, and is planned to commence in 2014. Following ramp-up, gas production will be sustained at approximately 1,050TJ/d for at least 20 years, after which production is expected to decline.

Infrastructure for the project is expected to comprise:

- Approximately 7,500 production wells drilled over the life of the project at a rate of approximately 350 to 400 wells per year.
- Low-pressure gas gathering pipelines to transport gas from the production wells to production facilities.
- Medium-pressure gas pipelines to transport gas between field compression facilities and both central gas processing and integrated processing facilities.
- High-pressure gas pipelines to transport gas from both central gas processing and integrated processing facilities to the sales gas pipeline.
- Water gathering lines (located where possible in a common trench with the gas gathering lines) to transport coal seam water from production wells to transfer, treatment and storage facilities.
- Approximately 18 production facilities across the project development area expected to comprise of six of each of the following:
  - Field compression facilities
  - Central gas processing facilities
  - Integrated processing facilities
- A combination of gas powered electricity generation equipment that will be co-located with production facilities and/or electricity transmission infrastructure that may draw electricity from the grid (via third party substations).

Further detail regarding the function of each type of production facility is detailed below.

Field compression facilities will receive gas from production wells and are expected to provide 30 to 60TJ/d of first stage gas compression. Compressed gas will be transported from field compression facilities in medium pressure gas pipelines to multi-stage compressors at central gas processing facilities and integrated processing facilities where the gas will be further compressed to transmission gas pipeline operating pressure and dehydrated to transmission gas pipeline quality. Produced water will bypass field compression facilities.

Central gas processing facilities will receive gas both directly from production wells and field compression facilities. Central gas processing facilities are expected to provide between 30 and 150TJ/d of gas compression and dehydration. Produced water will bypass central gas processing facilities and be pumped to an integrated processing facility for treatment.

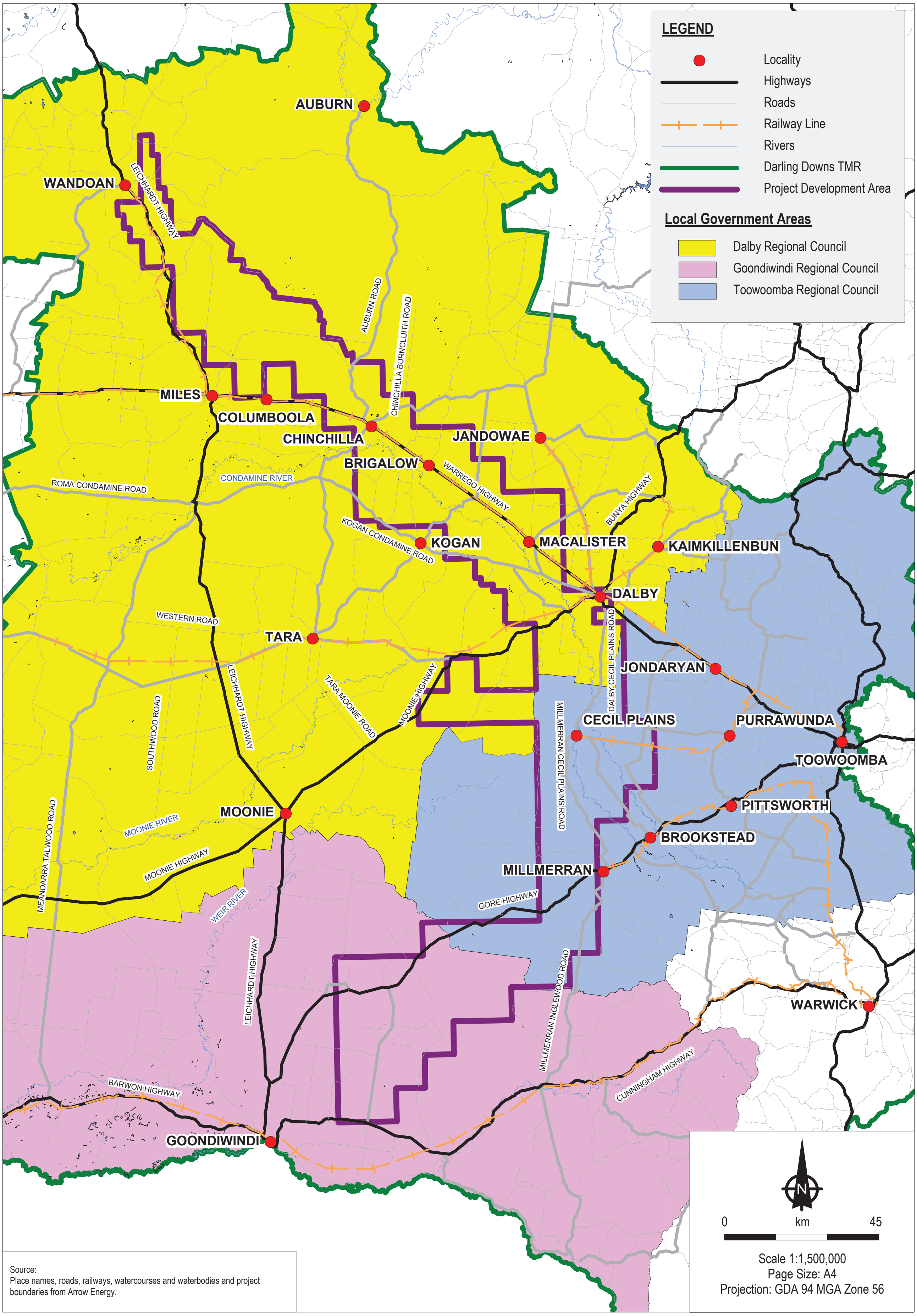
Integrated processing facilities will receive gas from production wells and field compression facilities. Integrated processing facilities are expected to provide between 30 and 150TJ/d of gas compression and dehydration. Produced water received at integrated processing facilities is expected to be predominantly treated using reverse osmosis and then balanced to ensure that it is suitable for the intended beneficial use. Produced water received from the field, treated water and brine will be stored in dams adjacent to integrated processing facilities.

It is envisaged that development of the Surat Gas Project will occur in five development regions: Wandoan, Chinchilla, Dalby, Kogan/Millmerran and Goondiwindi shown on Figure 1.2. Development of these regions will be staged to optimise production over the life of the project.

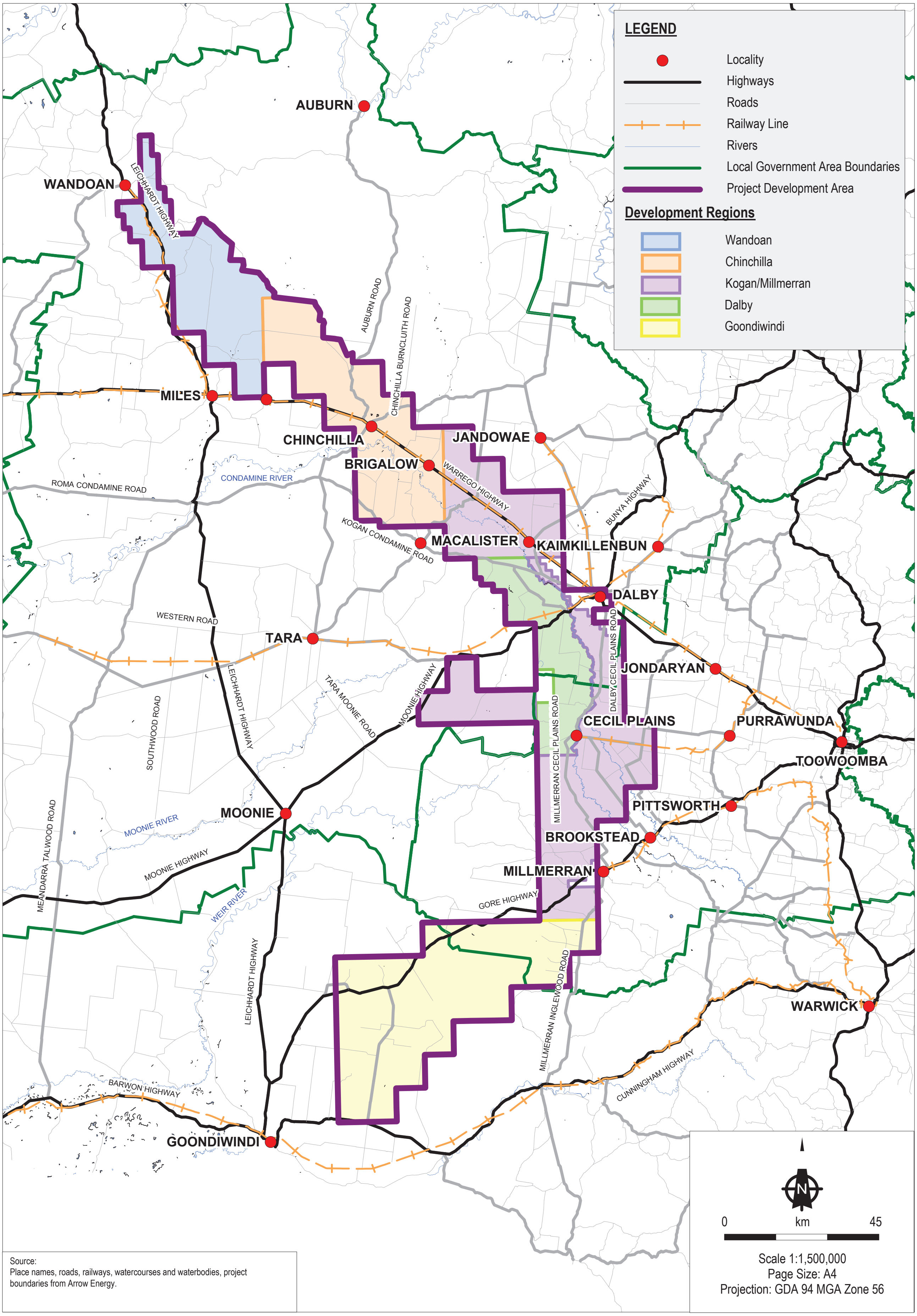
Arrow has established a framework to guide the selection of sites for production wells, production facilities and routes for gathering lines and pipelines. The framework will also be used to select sites for associated infrastructure such as access roads and construction camps. Environmental and social constraints to development that have been identified through the EIS process, coupled with the application of appropriate environmental management controls, will ensure that protection of environmental values (resources) is considered in project planning. This approach will maximise the opportunity to select appropriate site locations that minimise potential environmental and social impacts.

Arrow has identified 18 areas that are nominated for potential production facility development to inform the traffic modelling undertaken as part of the environmental impact assessment. These nominated facility development areas are based on circles of a 12 km radius with a resultant enclosed area of approximately 450 sq.km. In addition, Arrow has identified 116 well parcel areas for modelling purposes. The representative facility development areas and parcel areas are indicated on Figure 1.3 and Figure 1.4 respectively. It is reinforced that while these areas have been defined based on the best information currently available, the areas should be considered representative only for the purpose of facilitating the environmental impact assessment.

Arrow intends to pursue opportunities in the selection of equipment (including reverse osmosis units, gas powered engines, electrical generators and compressors) and the design of facilities that facilitates the cost effective and efficient scaling of facilities to meet field conditions. This flexibility will enable Arrow to better match infrastructure to gas production. It will also enable Arrow to investigate the merits of using template design principles for facility development, which may in turn generate further efficiencies as the gas reserves are better understood, design is finalised, or as field development progresses.

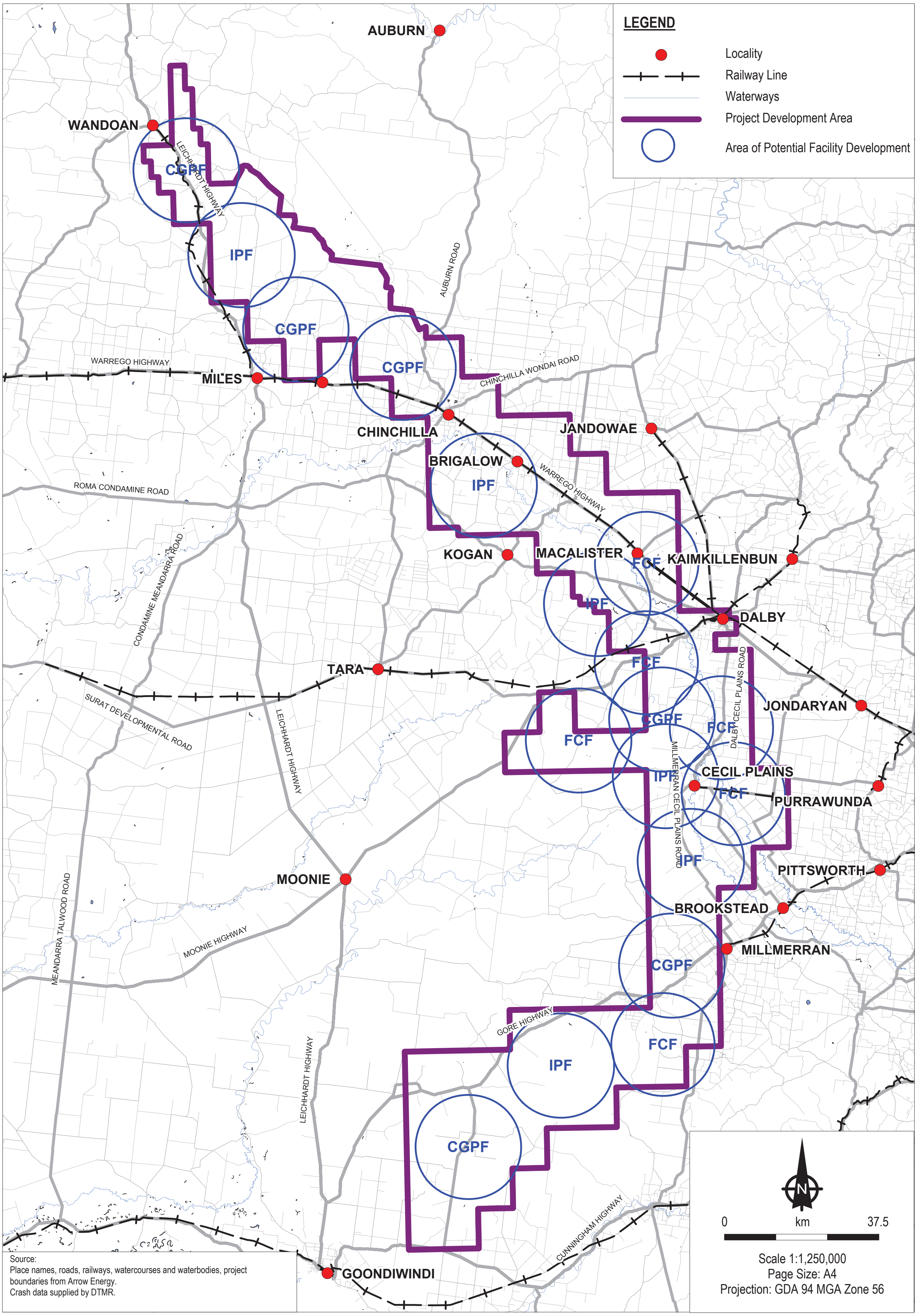


Cardno Eppell Olsen	Date: 19.07.2011 WOR: Figure 1.1 File Name: 6009_Figure 1.1.wor	Arrow Energy Limited Surat Gas Project	arrow energy go further	Locality Map	Figure No: 1.1



Source:
Place names, roads, railways, watercourses and waterbodies, project boundaries from Arrow Energy.

Cardno Eppell Olsen	Date: 19.07.2011 WOR: Figure 1.2 File Name: 6009_Figure 1.2.wor	Arrow Energy Limited Surat Gas Project	arrow energy go further	Development Regions	Figure No: 1.2



Source:
Place names, roads, railways, watercourses and waterbodies, project boundaries from Arrow Energy.
Crash data supplied by DTMR.

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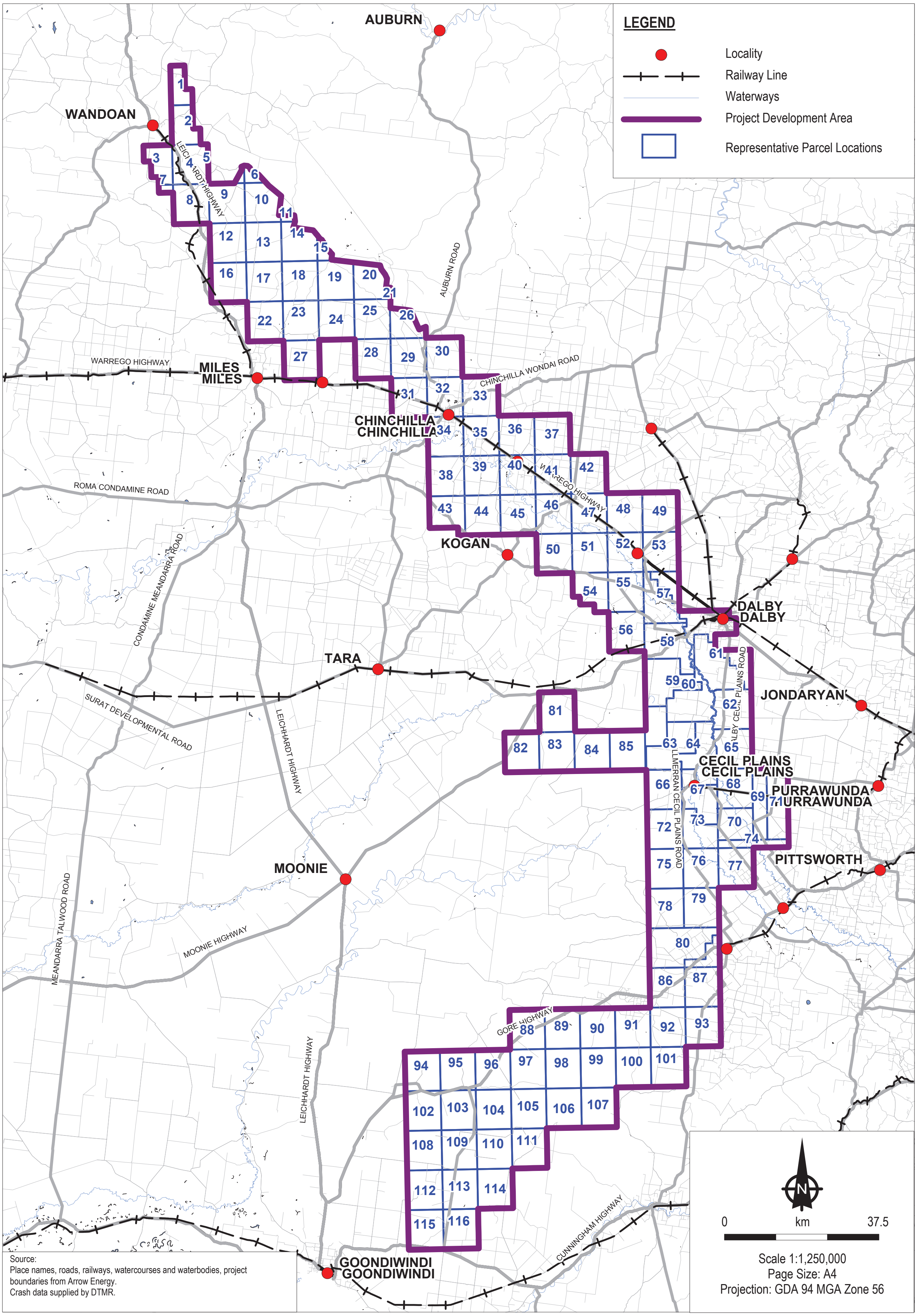
Arrow Energy Limited

Surat Gas Project

arrow energy go further

Representative Facility Locations

Figure No: 1.3



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Arrow Energy Limited

Surat Gas Project

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Representative Parcel Locations

Figure No: 1.4

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2 OBJECTIVES OF THE ROAD IMPACT ASSESSMENT

Cardno Eppell Olsen has been commissioned by Coffey Environments to prepare the Road Impact Assessment component of a voluntary EIS for the proposed Surat Gas Project. The EIS has been prepared on behalf of the development proponent Arrow.

The objectives of the Road Impact Assessment are the following as they relate to road traffic matters:

- Fulfil the requirements of the Final Terms of Reference for the Surat Gas Project EIS.
- Address all reasonable questions or issues that have been, or are likely to be, asked by stakeholders at the strategic EIS assessment stage.
- Identify the key environmental values to be protected based on background research and desktop analysis.
- Determine the traffic-related impact of the project on the key environmental values using a significance assessment approach.
- Development management strategies to inform future planning.
- Present the findings of the study in a report to be appended to the Surat Gas Project EIS.

Typical of a gas project, it is envisaged that as project planning is further progressed, the proponent will need to provide relevant road authorities ongoing advice regarding project activities. This advice is likely to take the form of Road Use Management Plans and is likely to inform discussion regarding potential road infrastructure agreements.

This Road Impact Assessment addresses the Surat Gas Project's road-based transport impacts. Impacts associated with other transport modes, for example air, rail or sea, are beyond the scope of this assessment.

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3 LEGISLATIVE CONTEXT

3.1 LEGISLATIVE CONTEXT

This section outlines the legislative processes and powers utilised by the State and local government road authorities to assess the road impacts of development in Queensland. The information presented herein is a reproduction of the advice presented in the *Guidelines for Assessment of Road Impacts of Development* prepared by the Department of Transport and Main Roads (TMR). The relevant road authorities may use the approval powers identified within the summarised legislation at various stages of the project.

The TMR and local governments have a role in the implementation of the following:

- Sustainable Planning Act 2009.
- State Development and Public Works Organisation Act 1971.
- Environmental Protection Act 1994.
- Mineral Resources Act 1989.
- Transport Infrastructure Act 1994.
- Petroleum and Gas (Production and Safety) Act 2004.
- Transport Operations (Road Use Management – Road Rules) Regulation 1995 (Queensland Road Rules).

3.1.1 SUSTAINABLE PLANNING ACT 2009

The Sustainable Planning Act 2009 (SPA) is the primary, state-wide planning instrument for Queensland. The intention of the SPA is to manage the development process through measures of accountability and efficiency to deliver effective and sustainable outcomes. The SPA does this through the coordination and development of guidelines for planning and development assessment at local, regional and state levels. Particular attention is paid to impacts of development on the environment and mitigation of these impacts.

The key objective and effect of the SPA is to ensure the integration of planning processes and outcomes across the state, as well effective coordination of responses to planning issues and applications. The SPA also sets the framework for the judicial element in the planning system and the powers of the Planning and Environment Court. Other new elements introduced in the SPA include prohibited development provisions, a revised infrastructure charges system and the standardisation of planning scheme provisions.

3.1.2 STATE DEVELOPMENT AND PUBLIC WORKS ORGANISATION ACT 1971

The State Development and Public Works Organisation Act 1971 provides a process to deal with the special requirements of "significant projects". The Coordinator-General determines whether a project should be declared significant, having regard to criteria in the Act.

The Act provides for the conduct of impact assessment through the preparation of an EIS by the proponent. The EIS should include assessment of all impacts of the project, including road impacts. The EIS process requires preparation of Terms of Reference for the EIS and consultation with government agencies, such as TMR, and the community. The Coordinator-General, through the Department of Infrastructure and Planning, has responsibility for the conduct of the EIS. The Coordinator-General evaluates the adequacy of the EIS and prepares an assessment report. The report may direct that conditions be attached to the development approval.

3.1.3 ENVIRONMENTAL PROTECTION ACT 1994

The Environmental Protection Act 1994 aims to protect Queensland's environment while allowing for development that improves the total quality of life. Chapter 3 of the Act sets out the EIS process. This requires proponents of development that may affect the environment (e.g. environmentally relevant activities including mining activities and petroleum activities) to assess those effects.

TMR may have input into an EIS process at the TOR stage, during the drafting of the EIS and following the publication of the finalised EIS. This may occur in the following ways:

- TMR can be an "affected person" if the land subject to the development is on or adjacent to a State-controlled road. As an affected person, TMR is forwarded for comment both the TOR and the EIS. Alternatively, TMR may be referred the EIS or TOR if the proponent classifies the TMR as an interested person.
- The Chief Executive of the Department of Environment and Resource Management (DERM) may require the proponent to notify and forward a copy of the draft TOR to TMR. The public notification stage of an EIS allows any persons to make a submission to the Chief Executive of DERM about an EIS. During any review of EIS process, TMR assesses the impact of the proposed development on affected State-controlled roads using the powers under the Transport Infrastructure Act 1994.

3.1.4 MINERAL RESOURCES ACT 1989

The Mineral Resources Act 1989 regulates mining development. It does not apply to development carried out under the State Development and Public Works Organisation Act 1997. Under the Mineral Resources Act 1989, any holder of a mining tenement must notify TMR when they are carrying out a notifiable road use. A notifiable road use is when the tenement holder hauls more than 50,000 tonne per year of mineral produced from the tenement. Upon receiving such notification, TMR may give a "road use direction" which can tell the tenement holder how they may use the road for the proposed road use. As part of a "road use direction", TMR can request a Road Impact Assessment of the effect of the notifiable road use.

The requirements on this "road use direction" are that it must be reasonable and about preserving the conditions of the road or safety of the road users and other members of the public. In addition to setting conditions, compensation may be payable to mitigate the damage to the road from the proposed haulage.

3.1.5 TRANSPORT INFRASTRUCTURE ACT 1994

The Transport Infrastructure Act 1994 is TMR's primary legislation. It sets out the powers TMR has for managing the State-controlled road network. Under Chapter 6 of the Act, the Department has the following powers to assess and condition for the impacts of development:

- Any power a local government has in its area is also a power TMR has for a State-controlled road in that local government area.
- Works on local roads which have a significant adverse impact on a State-controlled road or would require road works on a State-controlled road.
- Advertising signs that can be seen from a motorway.
- Removal of material from a State-controlled road.
- Damage to roads caused by development other than under the State Development and Public Works Organisation Act 1971 or the SPA and set out in a regulation (at time of writing the regulation has not been written). Under this provision there is also a Memorandum of Understanding between TMR, Department of Primary Industries and the Local Government Association of Queensland to refer forestry activities on State-owned land to TMR for assessment of the road impacts from the activity.
- Ancillary works and encroachment by third parties within the State-controlled road reserve.
- Private and commercial access to and from a State-controlled road.

3.1.6 PETROLEUM AND GAS (PRODUCTION AND SAFETY) ACT 2004

This Act regulates petroleum and gas development and commenced on 1 January 2005. It does not apply to development carried out under the State Development and Public Works Organisation Act 1997. Under this Act, any holder of a petroleum authority must not use a public road for a notifiable road use unless they notify the road authority. A notifiable road use can be:

- The use of public roads in the proponent's area of authority for transport relating to a seismic survey or drilling activity.
- The use of a public road to haul greater than 50,000 tonnes per year of petroleum produced or processed in the area or in the construction of a pipeline.

Regarding receiving such notification, TMR may give a "road use direction" which can involve advice to the petroleum authority holder how they may use the road for the proposed road use. As part of a road use direction, TMR can request a Road Impact Assessment of the effect of the notifiable road use (except where it is for a seismic survey or drilling activity). The requirements of this "road use direction" are that it must be reasonable and relevant about preserving the conditions of the road or safety of the road users or the public. In addition to setting conditions, compensation may be payable to mitigate the damage to the road from the proposed haulage.

Petroleum tenures issued prior to the commencement of the Petroleum and Gas (Production and Safety) Act 2004 may also be subject to a notifiable road use approval. The Petroleum Act 1923, which applies to a number of petroleum tenures granted before 1 January 2005, has identical notifiable road use triggers as those mentioned above.

3.1.7 TRANSPORT OPERATIONS ACT 1995

The Transport Operations (Road Use Management) Act 1995 (Queensland Road Rules) provides broad powers for signage (Traffic Control Devices) that may be placed on roads.

Sections 103 and 104 of the Queensland Road Rules and Section 62D Transport Operations (Road Use Management) Act 1995 allow load limit signs to be placed on a bridge/culvert or a length of road to prohibit access by heavy vehicles weighing above the signed load limits. Limits may apply to specific bridges, culverts, roads or areas which may cause safety or infrastructure damage risks. In proposing the application of any official traffic signs other than warning signs, TMR Districts would be required to have processes in place to determine what the safety and infrastructure damage rules were for the relevant vehicle type.

Section 317 of the Queensland Road Rules allows a Traffic Control Device to contain information that can indicate:

- The times, days or circumstances when a sign applies or does not apply.
- The lengths of road or areas where a sign applies or does not apply.
- The persons to whom it applies or does not apply.
- The vehicles to which it applies or does not apply.
- Other information – such as speed limits.

4 EXISTING ROAD ENVIRONMENT CONDITIONS

4.1 FUNCTIONAL ROAD HIERARCHY

Figure 4.1 identifies the Highways, Regional Connecting Roads, Rural Connecting Roads and Rural Access Roads within the project development area. The function served by each of the four road classification types is identified in Table 5.1.

4.2 ROAD CONSTRUCTION STANDARD

Figure 4.2 summarises the existing construction standard of all roads where made available by the relevant road authorities. The generic terminology for road construction standards (not ownership of the road) used for this assessment is as follows:

- Sealed road has been generally constructed using a bituminous material to form a protected road surface.
- Unsealed road has been generally constructed to a formed and gravelled standard or a higher quality formed but un-gravelled standard.
- Unsealed track has been generally constructed to an unformed standard.

4.3 ROAD VOLUMES

Figure 4.3 summarises the 2009 Average Annual Daily Traffic (AADT) volume data supplied by TMR for all State-controlled roads.

4.4 MULTI-COMBINATION VEHICLE ROUTES

Designated multi-combination routes have been identified from data supplied by TMR and are summarised on Figure 4.4. Multi-combination vehicle routes represent those roads on which the use of B-Doubles or Road Trains is approved.

4.5 SCHOOL BUS ROUTES

School bus route data sourced from TMR is summarised on Figure 4.5. The summarised data broadly indicates that the various school bus routes radiate from the townships of Dalby, Chinchilla, Miles, Tara, Pittsworth, Millmerran, Wandoan and Goondiwindi where education facilities are located. These bus routes are typically found around the major towns and travel on highways and higher-order local roads such as Regional Connecting Roads.

4.6 RAIL CROSSINGS

Rail crossing data supplied by Queensland Rail is summarised on Figure 4.6. The data indicates that the majority of rail crossings incorporate only passive control systems such as signage. Passive crossings do not include active controls such as boom gates to physically restrict vehicles from entering the rail crossing when a train is approaching.

4.7 STOCK ROUTES

Stock route data supplied by the Queensland Government is summarised on Figure 4.7. The Queensland Stock Route Network is a network of facilities established to facilitate the movement of livestock on foot between grazing areas and markets. The network consists of areas for stock to travel along as well as areas for livestock to rest overnight including water facilities and holding yards.

Over time the use of these facilities has evolved and the network is now also used for animal agistment, recreational horse riding and for the provision of services such as electricity or telecommunications. These routes provide other general benefits for the community as they also enable the movement of wildlife and provide a landscape buffer.

4.8 PEDESTRIAN AND CYCLE NETWORKS

The majority of towns within the project development area have basic pedestrian and cycle infrastructure. Roads outside of the townships typically do not include dedicated cycle facilities such as on-road cycle lanes.

4.9 PUBLIC TRANSPORT NETWORKS

Within the project development area, there are no existing intra-city public transport facilities or networks. Greyhound operates long-distance commercial bus services within the project development area with stops located in Dalby, Warra, Chinchilla, Miles, Tara, Millmerran and Goondiwindi, providing connections to Toowoomba, Mt Isa, Cunnamulla and Lightning Ridge. These services travel on highways (i.e. Warrego Highway, Moonie Highway and Gore Highway) within the project development area and bus frequencies vary from twice per week (Toowoomba to Lightning Ridge) to daily (Toowoomba to Mt Isa).

4.10 ROAD SAFETY

Raw crash data was sourced from TMR for the most recent complete available five year period (1 April 2004 through 31 March 2009). In addition, TMR supplied crash rates per 100 million vehicle kilometres travelled (VKT) for key rural roads.

The supplied crash data is graphically summarised on Figure 4.8 and is tabulated in Table 4.1.

Table 4.1 Crashes per 100 Million Vehicle Kilometres Travelled for Key Rural Roads

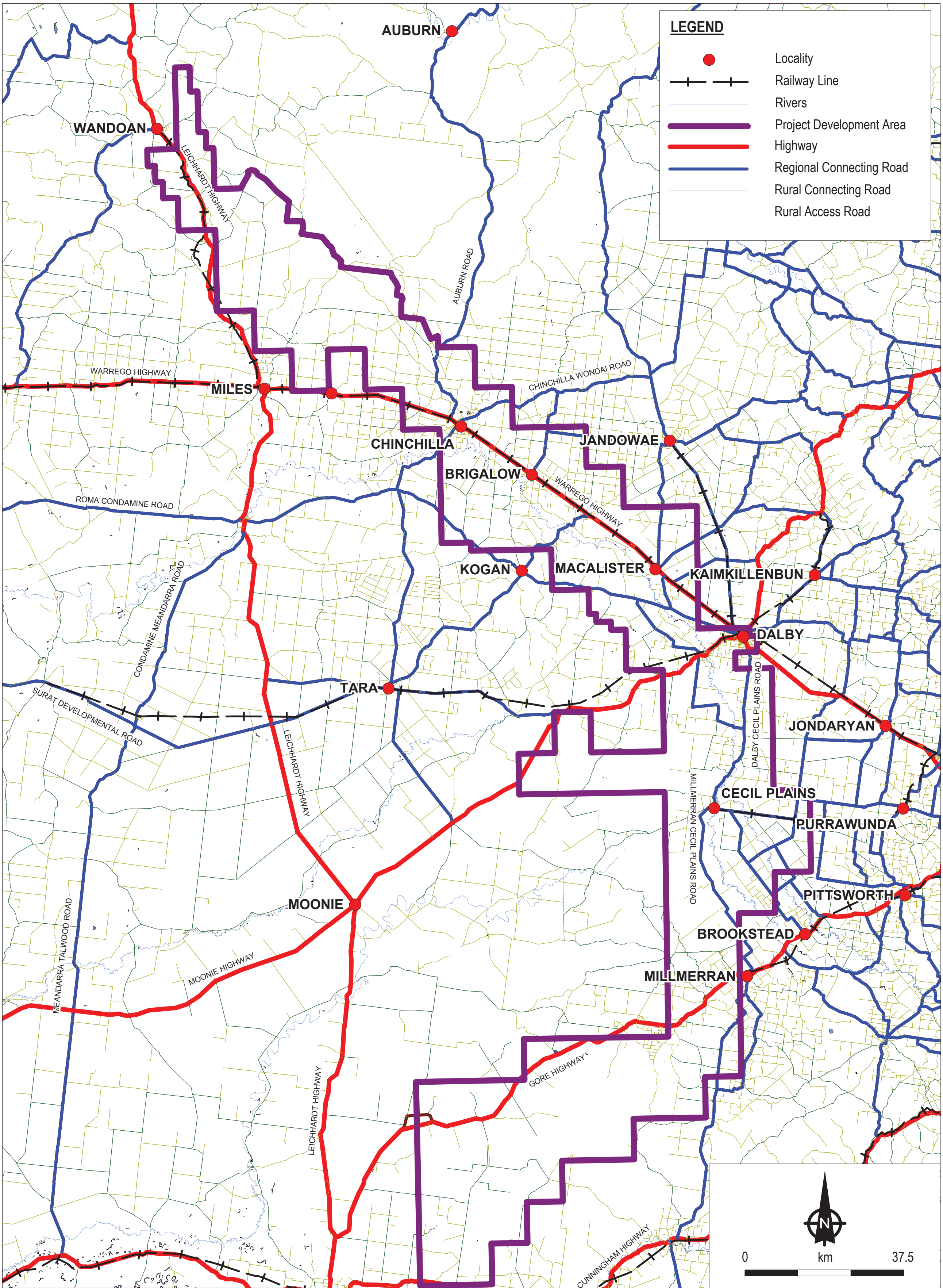
Road	From	To	Crashes	Crashes/ 100 million VKT
Dalby Cecil Plains Road	Dalby	Cecil Plains	6	10
Gore Highway	Pampas-Horrane Rd	Millmerran	14	20
	Millmerran	Leichhardt Hwy	72	23
Leichhardt Highway	Miles	Wandoan	17	23
	Gore Highway	Goondiwindi	10	20
Millmerran Cecil Plains Road	Cecil Plains	Millmerran	7	67
Moonie Highway	Moonie	Kumbarilla	30	28
	Kumbarilla	Dalby	23	31
Warrego Highway	Miles	Chinchilla	34	23
	Chinchilla	Warra	11	9
	Warra	Dalby	26	16
Pampas-Horrane Road	Toowoomba-Cecil Plains Road	Gore Highway	1	13
Average Crash Rate (weighted by VKT)				**21**

Table 4.1 indicates that the recently observed crash rate for the assessed rural road sections varies from nine crashes per 100 million VKT to 67 crashes per 100 million VKT, with a VKT weighted average of 21 crashes per 100 million VKT for the assessed rural roads.

By comparison, Austroad's *Road Safety Engineering Risk Assessment Part 7: Crash Rates Database* indicates that a crash rate of 52 crashes per 100 million VKT is typical for rural roads with undivided sealed carriageways in Queensland. Of the 12 road sections reported in Table 4.1, only Millmerran Cecil Plains Road reported a crash rate above that typically observed in Queensland. The supplied crash rate data therefore indicates that all assessed roads except for Millmerran Cecil Plains Road generally performed well over the recent five year reporting period.

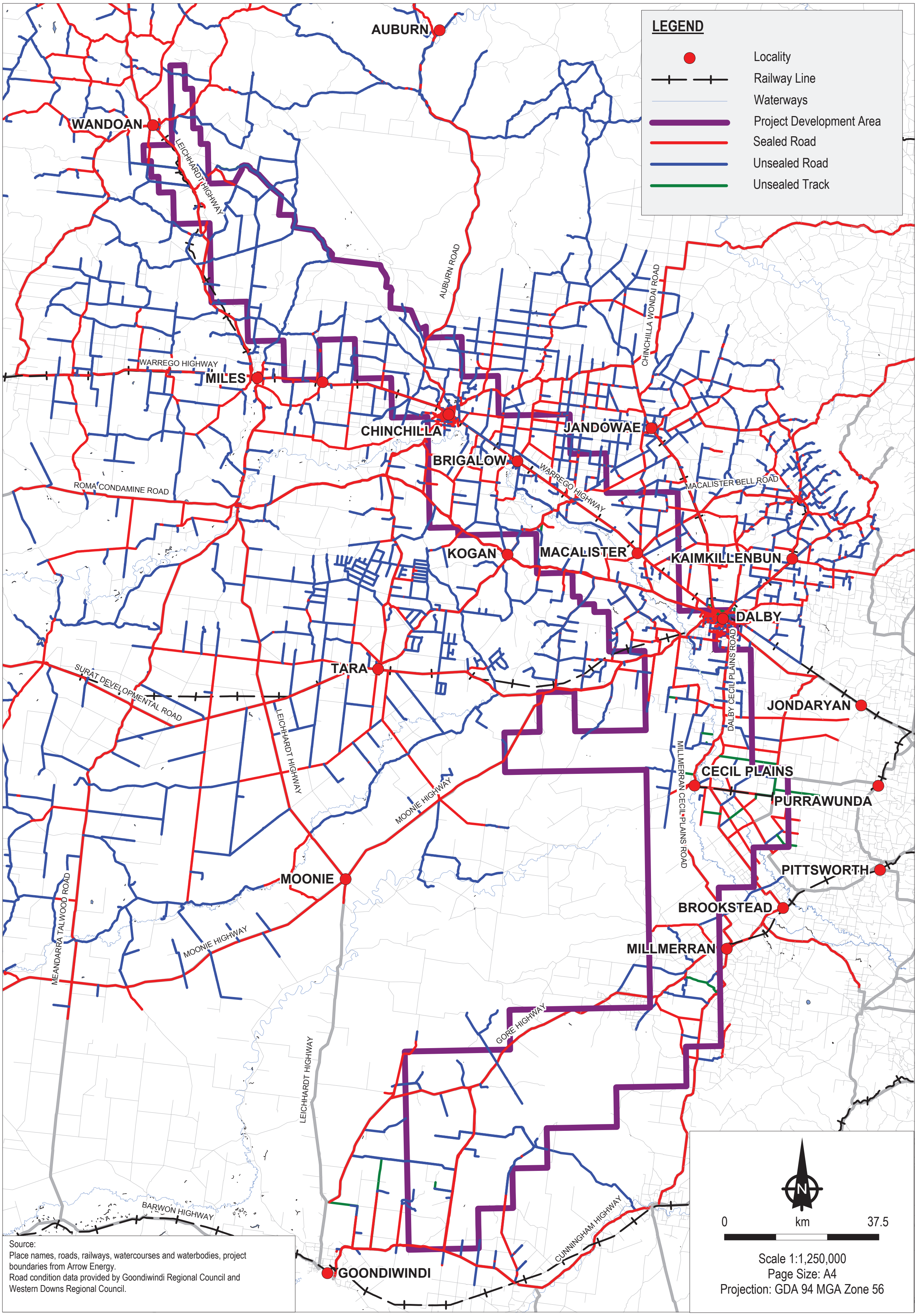
4.11 MOTORIST REST AREAS

Motorist rest area data supplied by TMR is summarised on Figure 4.9. These identified rest areas allow drivers to stop and rest before continuing a drive. Some areas also allow extended rest times including overnight. Additionally, during school holidays and public holiday periods some rest stops operate as 'Driver Reviver' stops.



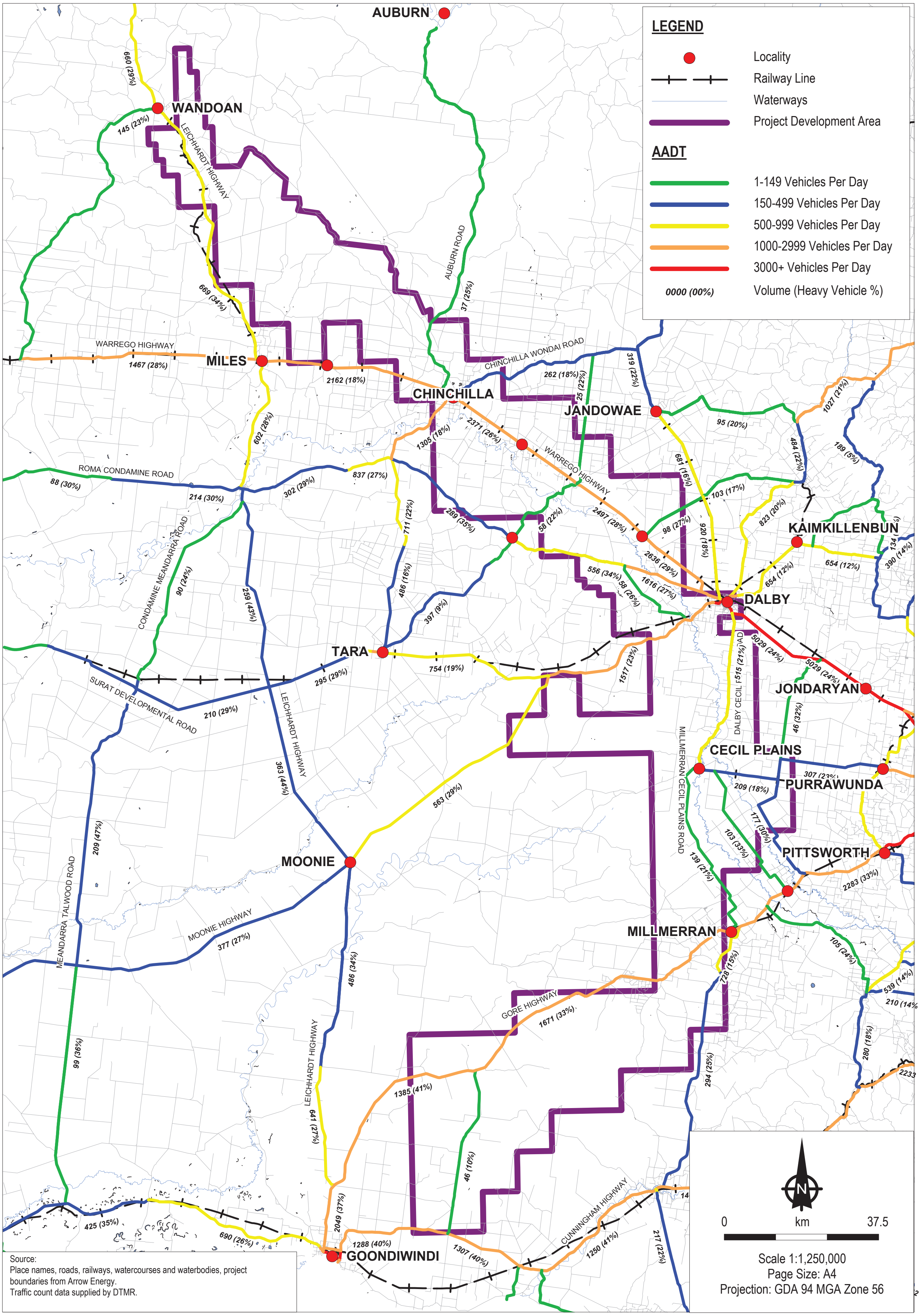
Source:
Place names, roads, railways, watercourses and waterbodies, project boundaries from Arrow Energy.

Cardno Eppell Olsen	Date: 17.06.2011 WOR: Figure 4.1 File Name: 6009_Figure 4.1.wor	Arrow Energy Limited Surat Gas Project	arrow energy go further	Functional Road Hierarchy	Figure No: 4.1



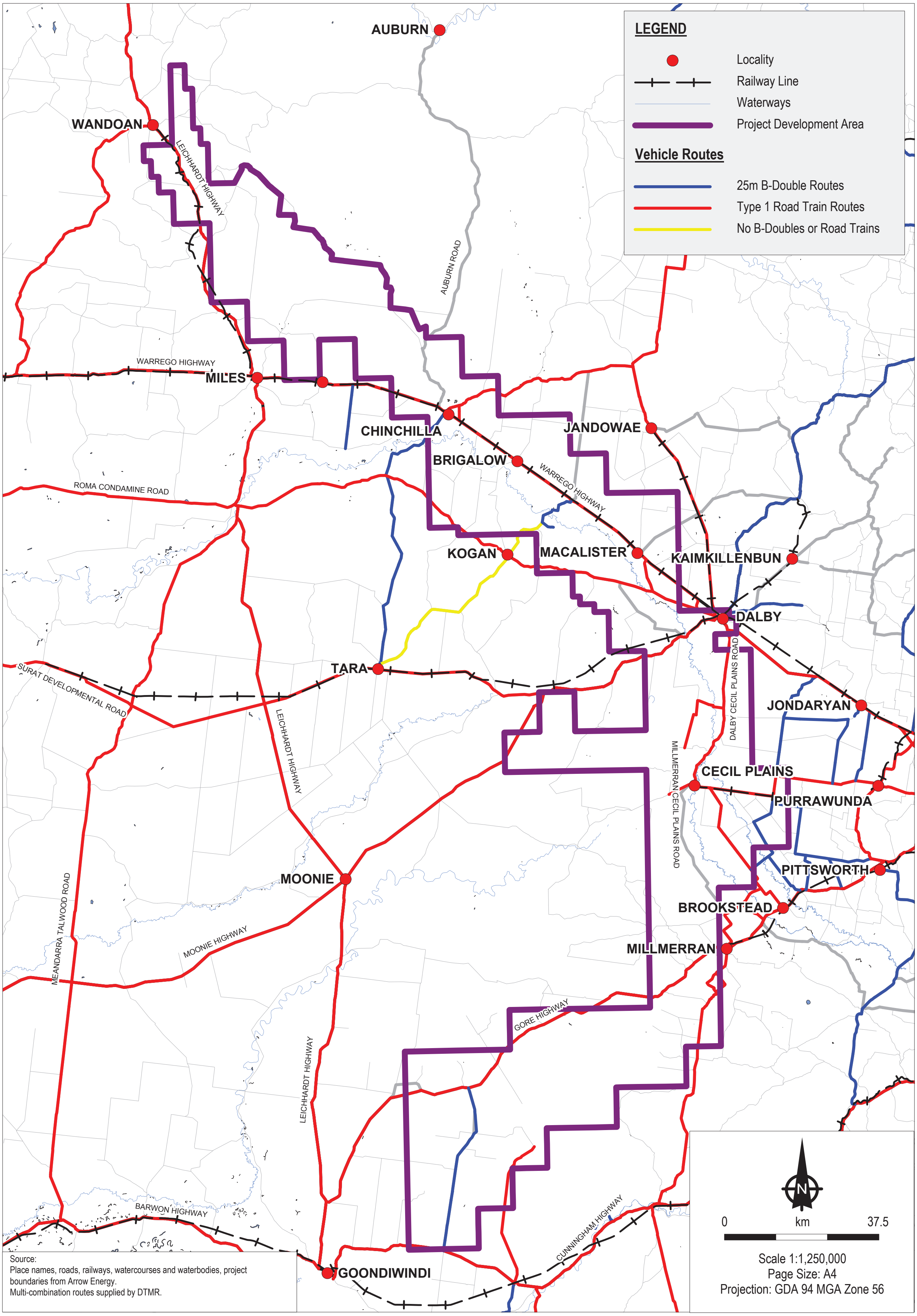
Source:
Place names, roads, railways, watercourses and waterbodies, project boundaries from Arrow Energy.
Road condition data provided by Goondiwindi Regional Council and Western Downs Regional Council.

Cardno Eppell Olsen	Date: 17.06.2011 WOR: Figure 4.2 File Name: 6009_Figure 4.2.wor	Arrow Energy Limited Surat Gas Project	arrow energy go further	Road Construction Standard	Figure No: 4.2

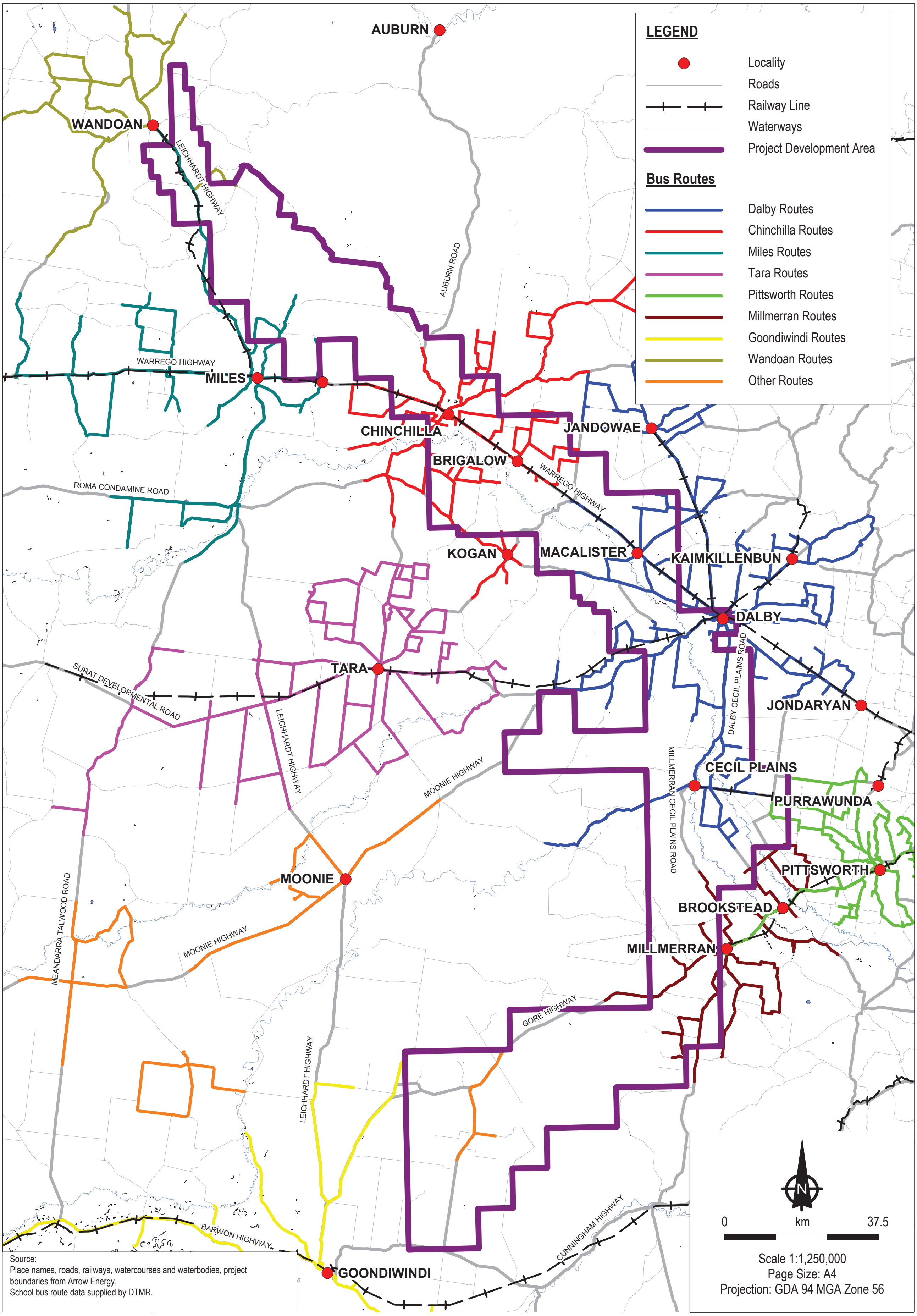


Source:
Place names, roads, railways, watercourses and waterbodies, project boundaries from Arrow Energy.
Traffic count data supplied by DTMR.

Cardno Eppell Olsen	Date: 17.06.2011 WOR: Figure 4.3 File Name: 6009_Figure 4.3.wor	Arrow Energy Limited Surat Gas Project	arrow energy go further	2009 Annual Average Daily Traffic Volumes	Figure No: 4.3

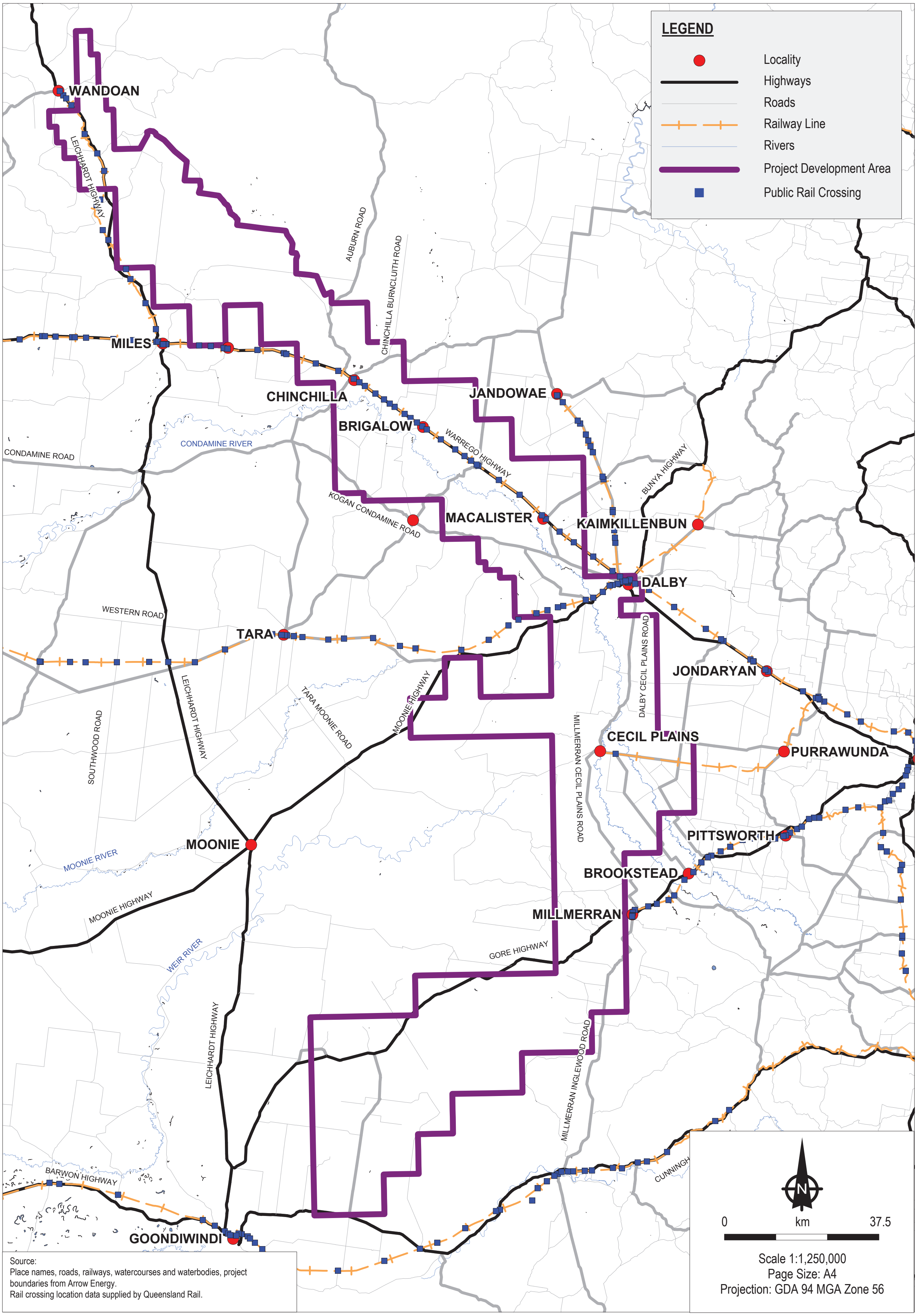


Cardno Eppell Olsen	Date: 17.06.2011 WOR: Figure 4.4 File Name: 6009_Figure 4.4.wor	Arrow Energy Limited Surat Gas Project	arrow energy go further	Multi-Combination Vehicle Routes	Figure No: 4.4



Source:
Place names, roads, railways, watercourses and waterbodies, project boundaries from Arrow Energy.
School bus route data supplied by DTMR.

Cardno Eppell Olsen	Date: 17.06.2011 WOR: Figure 4.5 File Name: 6009_Figure 4.5.wor	Arrow Energy Limited Surat Gas Project	arrow energy go further	School Bus Routes	Figure No: 4.5

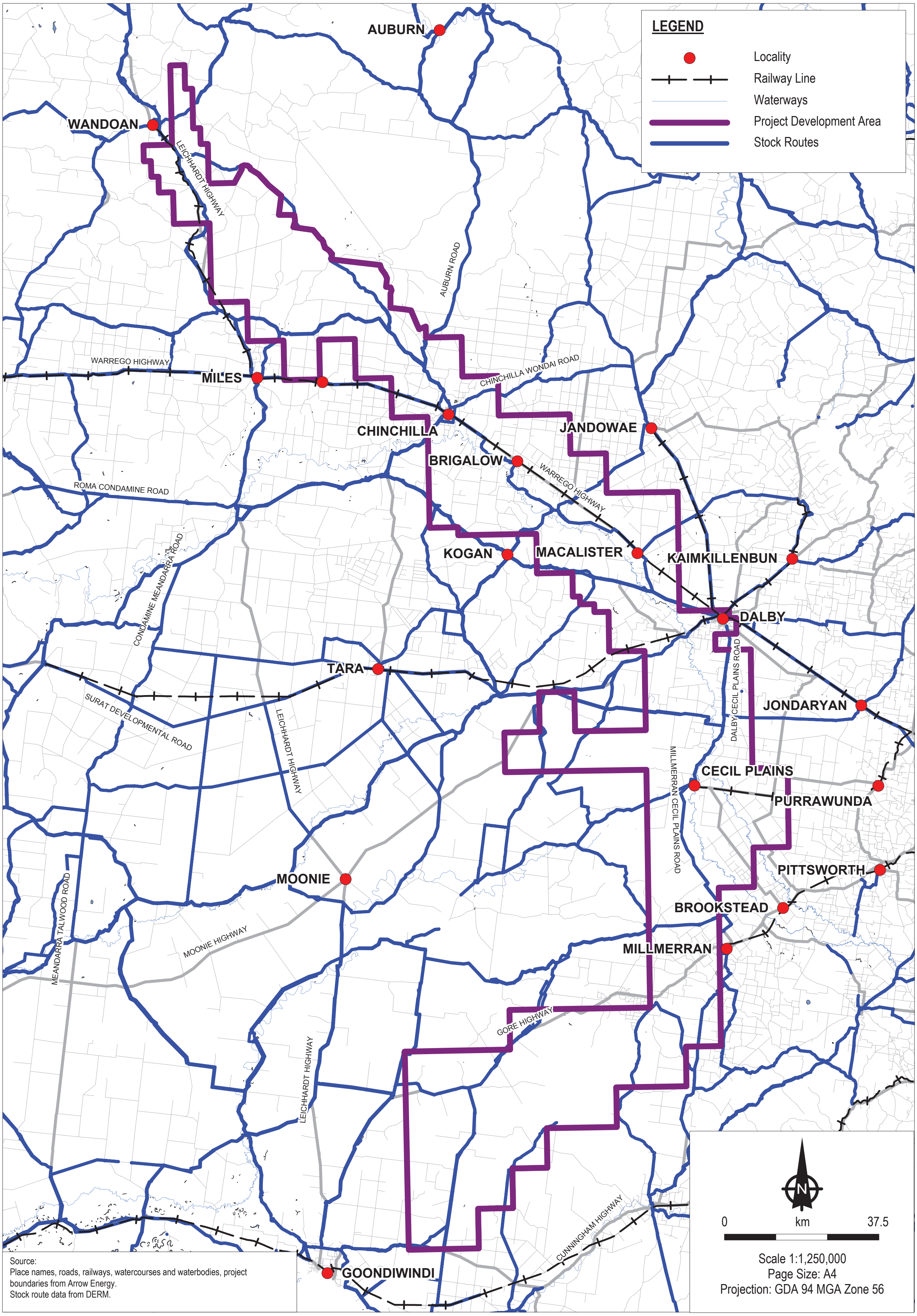


Source:
Place names, roads, railways, watercourses and waterbodies, project boundaries from Arrow Energy.
Rail crossing location data supplied by Queensland Rail.

Cardno Eppell Olsen	Date: 17.06.2011 WOR: Figure 4.6 File Name: 6009_Figure 4.6.wor	Arrow Energy Limited Surat Gas Project	arrow energy go further

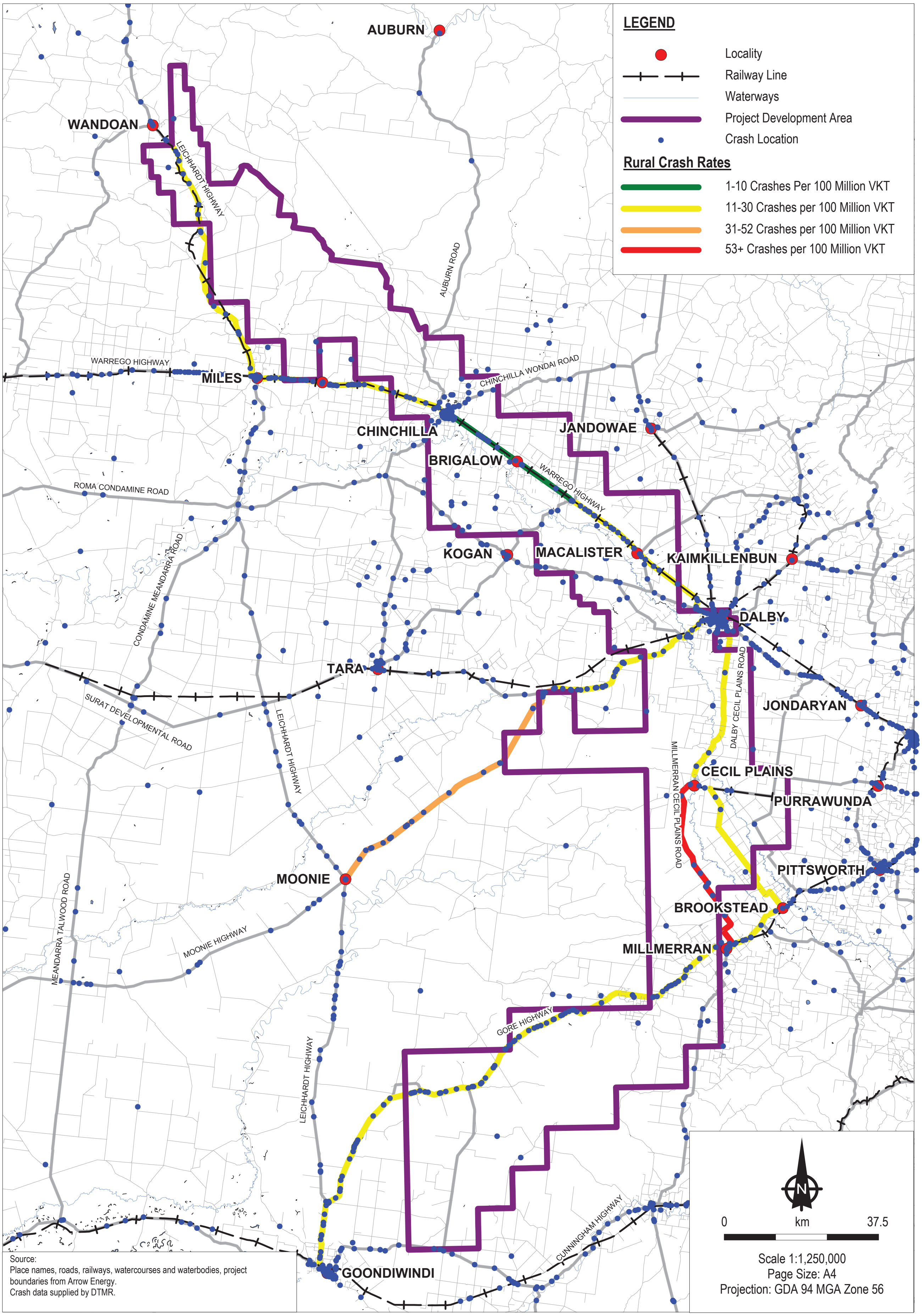
Rail Crossings

Figure No: **4.6**



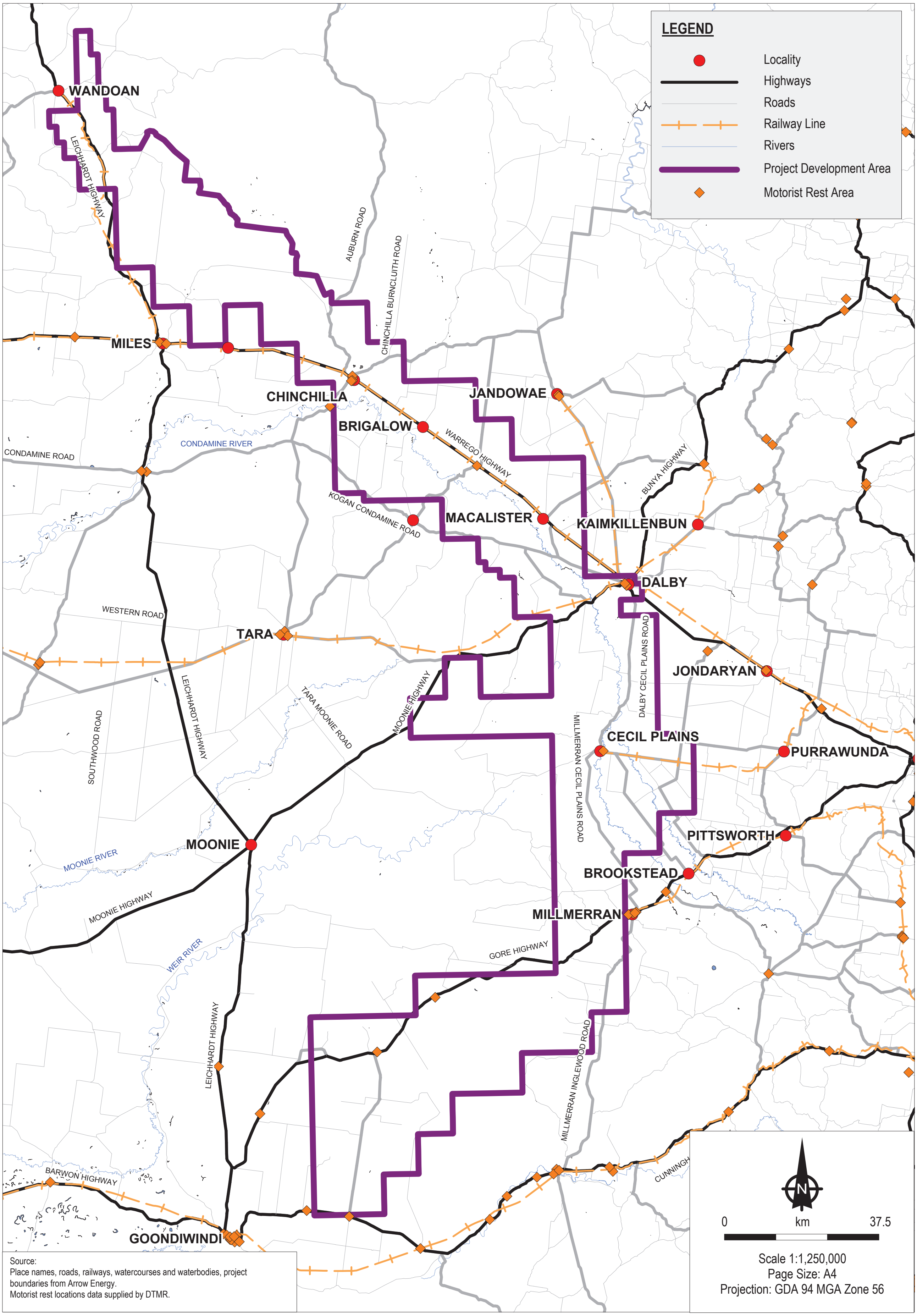
Source:
Place names, roads, railways, watercourses and waterbodies, project boundaries from Arrow Energy.
Stock route data from DERM.

Cardno Eppell Olsen	Date: 17.06.2011 WOR: Figure 4.7 File Name: 6009_Figure 4.7.wor	Arrow Energy Limited Surat Gas Project	arrow energy go further	Stock Routes	Figure No: 4.7



Source:
Place names, roads, railways, watercourses and waterbodies, project boundaries from Arrow Energy.
Crash data supplied by DTMR.

Cardno Eppell Olsen	Date: 17.06.2011 WOR: Figure 4.8 File Name: 6009_Figure 4.8.wor	Arrow Energy Limited Surat Gas Project	arrow energy go further	Historic Crash Locations And Rates (2004 to 2009)	Figure No: 4.8



Cardno Eppell Olsen

Date: 17.06.2011
WOR: Figure 4.9
File Name: 6009_Figure 4.9.wor

Arrow Energy Limited

Surat Gas Project

arrow energy go further

Motorist Rest Areas

Figure No: 4.9

5 ASSESSMENT METHODOLOGY

5.1 PROJECT SCHEDULE

The detailed front-end engineering design phase of the project is expected to commence in mid 2012. Consequently, the exact location of facilities and wells is unknown. To address this issue, a preliminary project development plan has been prepared by Arrow. It details the areas where production facilities are likely to be developed and the number of production wells to be drilled in the project development regions and parcels. Arrow has also provided preliminary advice on the sequence of facility and well development.

This information forms the basis for the Road Impact Assessment. It provides an indication of those parts of the road network likely to be used by Arrow and its contractors, and from the preliminary development sequence, the timing and duration of traffic. Traffic (type and composition) generated by Arrow's current operations has been used as a template in traffic modelling.

Section 5.2 describes the approach to impact assessment, and Section 5.3 describes how, in the absence of detailed information about the location of facilities and wells, impacts to traffic and the road network have been assessed.

5.2 SIGNIFICANCE ASSESSMENT APPROACH

The Terms of Reference for the Surat Gas Project EIS issued under the *Environmental Protection Act 1994* (Qld) require "both the intensity of the impact and the context in which it would occur" to be assessed to determine whether the impact is or is not significant.

There are various approaches to determining the significance or importance of an impact. One approach uses the principles of risk management (likelihood and consequence), another uses predictability and manageability, and a third uses sensitivity and magnitude to assess the significance of an impact. For the Surat Gas Project, an assessment that utilises sensitivity and magnitude to define the significance of the project's potential impacts has been adopted by applicable studies, including this Road Impact Assessment.

Under the adopted approach, the significance of the project's potential impacts are assessed by considering the sensitivity of each environmental value and the magnitude of the project's impact. The sensitivity of an environmental value is determined from its susceptibility or vulnerability to threatening processes or as a consequence of its intrinsic value. The magnitude of a project impact is determined based on consideration of the geographical extent, duration of effect and severity of the project's impact. The significance of the project's impact is considered before and after the application of management measures. This enables the effectiveness of the proposed management measures in reducing the predicted impact to be assessed.

The adopted approach enables the sensitivity of road types (i.e. environmental value sensitivity) to be assessed in the absence of specific information about the roads that will be ultimately used by Arrow and its contractors. Traffic generated as part of Arrow's current operations provides useful data to determine the magnitude of impacts on traffic and the road network thus enabling the significance of potential impacts pre and post mitigation to be effectively assessed.

5.3 IMPACT ASSESSMENT METHODOLOGY

The key steps and processes undertaken in preparing this Road Impact Assessment are outlined below:

- Collection of data pertaining to existing road conditions including traffic volumes, road construction standard, rail crossings, stock routes, vehicle crash history, and school bus routes.
- Identification and evaluation of the road network environmental values and classification of their sensitivity to changed traffic conditions.
- Estimation of the number and type of vehicles likely to be generated during the various phases of the project based on the preliminary project development plan.
- Identification of the magnitude of the project's potential impacts on the various environmental values.
- Determination of the significance of the project's impact on the road network environmental values.
- Development of management strategies for the road network which will ultimately be incorporated into Road Use Management Plans developed by the proponent as project planning is further refined.
- Identification of the significance of residual impacts post implementation of the developed management strategies.
- Analysis of potential cumulative impacts, accounting for other major projects in the vicinity.

The adopted approach enables the significance of the project's traffic impacts to be broadly assessed at the strategic planning stage (i.e. the EIS assessment stage). It also ensures that the specific, location-based traffic impacts of the project can ultimately be identified and mitigated through the development of Road Use Management Plans during detailed engineering design.

6 ROAD ENVIRONMENTAL VALUES AND SENSITIVITY ASSESSMENT

6.1 IDENTIFICATION OF ENVIRONMENTAL VALUES

In the context of this EIS assessment, an environmental value has been defined as a measure of how we value the environment in which we live and in particular for this assessment, the roads used in the project development area. In this respect, the following road types were identified as values within the project development area: Highway, Regional Connecting Road, Rural Connecting Road and the Rural Access Road. For the Road Impact Assessment, this relates to how the road network influences the various users, neighbours and road authorities.

The following aspects of the identified values important to all stakeholders of the road network were then considered to gain an understanding of how sensitive each value (i.e., road type) is to increased traffic volume:

- Efficiency
- Safety
- Amenity

Efficiency describes the aspect of the road network that contributes to function and accessibility which facilitate the efficient operation of the network. This includes consideration of the function of road links, the overall volume of traffic utilising road links and intersection forms.

Safety describes the aspects of the road network relating to the location and provision of physical infrastructure. Physical infrastructure incorporates components such as bridges, rail crossings, cattle grids, pavement and road construction standard. State and Council road authorities have made significant capital investments in developing the road infrastructure so it is important that the existing road infrastructure be managed and utilised in a manner that maximises its service life and maintains the level of quality expected by road users.

Amenity is the experience afforded to the passive participants of the road network. This primarily includes nearby residents and users of adjacent land uses. Receptors that are sensitive include dwellings, schools, hospitals and churches among others. These adjacent users can be affected through issues such as light nuisance, dust nuisance and noise due to changes in traffic volumes or road functionality.

6.2 SENSITIVITY OF ROAD NETWORK

To facilitate classification of the sensitivity of the road network to changed traffic conditions, characteristics were identified that describe the three aspects of efficiency, safety and amenity. These characteristics relate to the more tangible elements of each aspect, which are able to be measured and monitored.

To assess the sensitivity of the road network, each functional road type (Highway, Regional Connecting Road, Rural Connecting Road, Rural Access Road) was considered in relation to its response to changes in the identified characteristics. Following this identification, the sensitivity of each road type to changed traffic conditions was classified as high, moderate or low.

Table 6.1 summarises the road environmental values and resources identified within the Surat Gas Project development area.

Table 6.1 Environmental Values and Sensitivity

		Value			
	Characteristic	**Highway**	**Regional Connecting Road**	**Rural Connecting Road**	**Rural Access Road**
Description	Function	A high order road of a high standard facilitating connectivity between regional centres	A high order road of a high standard facilitating connectivity between townships	Lower order road facilitating connectivity between higher order roads	Low order road predominately facilitating access to local uses
Typical Observations					
Efficiency	Volumes	1000+ vehicles	300+ vehicles	50+ vehicles	1-100 vehicles
	Pavement	Sealed	Sealed	Sealed/unsealed	Unsealed
	Standard of intersection control	High order	Varies	Low order	Low order
Sensitivity of Efficiency		**Low**	**Moderate**	**High**	**High**
Safety	Bridges	Common	Common	Uncommon	Uncommon
	Cattle grids	Uncommon	Uncommon	Common	Common
	Standard of rail crossing control	Active	Passive	Passive	Passive
	School bus route presence	Present	Present	Present	Present
	Composition of traffic	High proportion heavy vehicles	Moderate proportion of heavy vehicles	Low number of heavy vehicles	Low number of heavy vehicles
	Driver fatigue controls	Present	Uncommon	Uncommon	Uncommon
Sensitivity of Safety		**Low**	**Moderate**	**High**	**High**
Amenity	Stock route co-location	Present	Present	Present	Present
	Sensitivity of adjacent land uses	Low	Moderate	Moderate	Moderate
	Potential for dust nuisance issues	Low	Low	Potential	Potential
	Potential for light glare issues	Low	Low	Potential	Potential
Sensitivity of Amenity		**Low**	**Moderate**	**High**	**High**

In summary, the environmental values of Highways have been identified as having a **low** sensitivity to a change in traffic conditions given their existing construction standard and higher order purpose. The environmental values of Regional Connecting Roads have a **moderate** sensitivity while Rural Connecting Roads and Rural Access Roads are considered as having a **high** sensitivity given their existing construction standard and existing usage.

7 FUTURE BASELINE CONDITIONS

7.1 HISTORIC TRAFFIC GROWTH

Traffic growth on roads within the project development area has varied widely depending on proximity to Dalby and other urban areas and on the period over which the observation has been made, with higher growth generally observed in recent years. The volume of traffic on roads within the project development area has typically changed by between -1%p.a. (decline) and 3%p.a. (growth) over the past ten years. Higher annual growth rates between 4% and 8% have, however, been observed at a few isolated locations.

7.2 OTHER PROJECTS IN VICINITY

There are a number of other significant projects currently underway or under investigation in the vicinity of the Surat Gas Project. These projects are summarised in Table 7.1. The location of the projects is shown at Appendix A.

Table 7.1 Projects in Surat Gas Project Development Area

Proposed Project	Proponent	Estimated Start Date	Estimated Duration of Project
Arrow Surat Pipeline	Arrow Energy Pty Ltd	2013	35 years
Australia Pacific LNG Project	Origin Energy and Conoco Phillips	2012	35 years
Bloodwood Creek Queensland – Stage 2	Carbon Energy (Operations) Pty Ltd.	Unknown	40 – 50 years
Cameby Downs Expansion Project	Syntech Resources Pty Ltd	2014	30 years
CS – Energy – Kogan Creek Solar Boost Project	CS Energy Qld AREVA Solar	2013	Unknown
Elimatta Coal Project	Taroom Coal Proprietary Limited	2013	25 years
Emu Swamp Dam Project	Southern Downs Regional Council (SDRC)	Unknown	15 - 18 months
Felton Clean Coal Demonstration Project	Ambre Energy (Felton) Pty Ltd	Unknown	Unknown
Gladstone Liquefied Natural Gas (GLNG) Project	Santos Ltd E	2011	35 years
Nathan Damand Nathan Pipeline	Sunwater	2012	2 years
New Acland Coal Mine Stage 3 Expansion Project	New Hope Coal Australia	2010	30 years
Queensland Curtis LNG Project (QCLNG)	QGC Pty Ltd (BG Group Business)	2011	35 years
Queensland Hunter Gas Pipeline Project	Hunter Gas Pipeline Pty Ltd	2012	Unknown
Wandoan Coal Project	Xstrata Coal Queensland Pty Ltd	2012	Unknown

Of the projects listed in Table 7.1, those with a higher traffic generating potential over an extended period of time are the larger resource projects (predominately gas and coal production). These projects have 20 to 40 year timeframes and are likely to significantly contribute to additional background growth on the road network. The potential effect of these projects on the road network in combination with the Surat Gas Project is discussed in Section 14 (Cumulative Impacts).

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8 PROJECT ACTIVITIES AND TRAFFIC GENERATION

The key traffic generating activities undertaken as part of the Surat Gas Project have been classified by grouping project activities into four phases of the project's lifecycle. Distinct activities will be undertaken concurrently across different development regions of the project development area. For example, exploration wells may be installed in one development region while construction and operation of production wells occurs in a neighbouring development region. Similarly, installation of wells will be occurring in the same development region as wells that are being decommissioned. The development regions are shown on Figure 1.2.

Based upon Arrow's existing operations and strategic planning, the key traffic generating activities likely to be associated with the Surat Gas Project are as follows:

- Exploration phase
  - Seismic data collection
  - Exploration well installation including core and stratigraphic well installation
  - Pilot well installation
- Construction phase
  - Production well installation
  - Gas and water gathering infrastructure installation
  - Water transmission infrastructure
  - High-pressure gas pipeline construction
  - Facility construction (integrated processing facilities, central gas processing facilities and field compression facilities)
  - Road construction for integrated processing facilities, central gas processing facilities and field compression facilities
  - Dam construction associated with each integrated processing and central gas processing facility
  - Accommodation camp construction
- Operation and maintenance phase
  - Well site operation and maintenance including well workovers
  - Gathering infrastructure operation and maintenance
  - Production facility operation and maintenance
- Decommissioning and rehabilitation phase
  - Well site decommissioning and rehabilitation
  - Production facility site decommissioning and rehabilitation

The nature and traffic generating characteristics of each project activity is summarised at Appendix B. It is anticipated that all deliveries will be co-ordinated from three central depots located in Dalby, Miles and Millmerran with materials transported from these locations to project activity sites. Logistics staff at each location will manage the transportation of materials to and from the depots. Furthermore, all operation and maintenance deliveries will be co-ordinated from these depots. It has been recognised however, that some construction materials and equipment will be transported directly to site where appropriate.

8.1 SUMMARY OF PROJECT TRAFFIC GENERATION

Table 8.1 provides a summary of the traffic expected to be generated by each project activity and Table 8.2 provides a summary of the workforce numbers, shifts and rosters that have been applied throughout this technical study. Detailed descriptions of each phase and associated assumptions made are included at Appendix B.

For this assessment, the classification of light vehicles (LVs) includes sedans, wagons, vans, utilities, 4WDs and motorcycles. Anything else has been considered a heavy vehicle (HV).

Table 8.1 Summary of Project Traffic Generation

Activity	Quantity	Activity Duration	Traffic Generation		
			HV Trips (two way)	Bus Trips (two way)	LV Trips (two way)
Exploration Phase					
Seismic Data Collection	-	-	limited		
Exploration Wells	50 wells	-	limited		
Pilot Wells	50 wells	-	limited		
Construction Phase					
Production Wells	7,500 wells	10 days	50 HV/well	n/a	91 LV/well
Gathering Infrastructure	7,500 sections	3 days	13 HV/section	n/a	14 LV/section
High Pressure Pipeline	-	-	limited		
IPFs	6 facilities	55 weeks	1,700 HV/IPF	1,048 buses/IPF	3,491 LV/IPF
CGPFs	6 facilities	50 weeks	1,130 HV/CGPF	798 buses/CGPF	2,660 LV/CGPF
FCFs	6 facilities	28 weeks	500 HV/FCF	212 buses/FCF	706 LV/FCF
Construction Camps	5 facilities	4 weeks	600 HV/camp	n/a	n/a
Operation and Maintenance Phase					
Production Wells	7,500 wells	20 years	9 HV/well/year	n/a	17 LV/well/year
Gathering Infrastructure	7,500 sections	20 years	limited		
IPFs	6 facilities	25 years	2,345[1] HV/IPF/year	n/a	5,200 LV/IPF/year
CGPFs	6 facilities	25 years	260 HV/CGFP/year	n/a	3,900 LV/CGPF/year
FCFs	6 facilities	25 years	156 HV/FCF/year	n/a	156 LV/FCF/year
Construction Camps	5 facilities	3 years	936 HV/camp/year	n/a	5,200 LV/camp/year
Decommissioning and Rehabilitation Phase					
Production Wells	7,500 wells	2 days	10 HV/well	n/a	10 LV/well
Gathering Infrastructure	7,500 sections	2 days	2 HV/section	n/a	limited
IPFs	6 facilities	8 months	600 HV/IPF	784 buses/IPF	2,613 LV/IPF
CGPFs	6 facilities	8 months	600 HV/CGPF	490 buses/CGPF	1,633 LV/CGPF
FCFs	6 facilities	4 months	201 HV/CGPF	119 buses/FCF	397 LV/FCF
Construction Camps	5 facilities	4 weeks	600 HV/camp	n/a	400 LV/camp

Notes:
HV = heavy vehicle; LV = light vehicle
[1] Includes 1,825 HV trips that are associated with brine removal from year 10 onwards
Further details included at Appendix B

Table 8.2 Summary of Workforce Shifts and Rosters

Activity	Number of Personnel	Hours worked per day (hours)	Days worked per week (days)
Exploration Phase			
Seismic Data Collection	-	10	5
Exploration Wells	-	10	5
Pilot Wells	-	10 - 12	7 (21 on / 7 off)
Construction Phase			
Production Wells	10	10 - 12	7 (21 on / 7 off)
Gathering Infrastructure	7	10 - 12	7 (21 on / 7 off)
High Pressure Pipeline	-	10 - 12	7 (21 on / 7 off)
IPFs	90 (68 onsite)	10 - 12	7 (21 on / 7 off)
CGPFs	75 (57 onsite)	10 - 12	7 (21 on / 7 off)
FCFs	35 (27 onsite)	10 - 12	7 (21 on / 7 off)
Construction Camps	-	10 - 12	7 (21 on / 7 off)
Operation and Maintenance Phase			
Production Wells	-	10	Up to 12 times / year
Gathering Infrastructure	-	10	5
IPFs	20	10	5 (plus on call)
CGPFs	15	10	5 (plus on call)
FCFs	1	Unmanned (serviced 3 times a week)	Unmanned (serviced 3 times a week)
Construction Camps	-	10 - 12	7 (21 on / 7 off)
Decommissioning and Rehabilitation Phase			
Production Wells	5	10 - 12	7 (21 on / 7 off)
Gathering Infrastructure	NA (inc. in wells)	10 - 12	7 (21 on / 7 off)
IPFs	80	10 - 12	7 (21 on / 7 off)
CGPFs	50	10 - 12	7 (21 on / 7 off)
FCFs	25	10 - 12	7 (21 on / 7 off)
Construction Camps	30	10 - 12	7 (21 on / 7 off)

Note: further details included at Appendix B

9 STRATEGIC TRAFFIC MODELLING

9.1 TRAFFIC MODELLING METHODOLOGY

A strategic traffic model was developed to forecast the traffic volume increases likely to be associated with the Surat Gas Project. This tool was used to inform categorisation of the magnitude of the project's potential impact in order to facilitate an informed assessment of the significance of the project's impacts on the safety, efficiency and amenity of the road network.

The forecasting methodology adopted for this assessment utilises the same principles as typically adopted for the strategic modelling of major urban areas. That is, when developing an urban strategic model, the precise land parcels that will be developed during the assessed period are typically unknown. Instead, land with similar characteristics is grouped together such that reasonable predictions can be made about the level of activity likely to be generated by the land in aggregate at the future design horizon. By aggregating the land parcels, it is possible to make reasonably accurate predictions about the level of development likely to occur and in turn the likely traffic generation of the aggregated lands at the future design year.

A similar situation exists for the Surat Gas Project. While Arrow has a reasonable understanding of the total extent of infrastructure likely to be developed across the project development area and in each of the five development regions, they do not yet know precisely where each component of project infrastructure will be located. It is however known that the production wells will have a relatively constant spacing within each of the 116 well parcel areas and that all other project infrastructure will effectively service the wells. It is therefore possible to make fairly accurate predictions about the level of activity likely to be generated by the project across a broad area. This is generally consistent with the approach commonly adopted when strategically modelling urban areas.

The following methodology was utilised to forecast future design horizon traffic volumes:

- The infrastructure likely to be constructed, operated and decommissioned within each activity zone (i.e. well parcel or facility) (identified on Figure 1.3 and Figure 1.4) was identified for each year of the project life based on the development schedule provided by Arrow (summarised at Appendix C).
- The traffic generation of each activity zone was forecast utilising the traffic generation rates identified in Section 8.
- The generated traffic from each activity zone was assigned to the network consistent with the origin/destination data presented in Section 8 (i.e. trips to accommodation camps, trips to nearest depot). Traffic from each activity zone was loaded onto the external road network at a single point nearest the centroid of the activity zone using a representative centroid connector.
- Traffic volumes on each road link were identified for each year of the project.

Figure 9.1 illustrates the adopted representative locations of project infrastructure. The representative locations have a relatively high level of disaggregation, which facilitates reasonably accurate forecasts particularly on the higher order road links.

9.2 FORECAST TRAFFIC VOLUMES

The total transport task associated with the Surat Gas Project has been forecast based on the trip generation rates and trip origins/destinations identified in Section 8. The total transport task represents the total number of vehicle kilometres likely to be travelled by traffic associated with the project on the State controlled road network, Council controlled road network and the access networks internal to private land over the full life of the project. The spatial extents of the road network assessed are those bound by the Darling Downs Region TMR district shown on Figure 1.1. The total transport task statistic provides a strategic overview of the extent of traffic activity generated by the project over its life.

Table 9.1 summarises the total VKT estimated for the project life and Chart 9.1 shows the VKT across the project life.

Table 9.1 Surat Gas Project Total Transport Task

Vehicle	Transport Task (VKT)
Light Vehicle	224 million
Heavy Vehicle including Buses	392 million
TOTAL	616 million

VKT = vehicle kilometres travelled

Chart 9.1 Vehicle Kilometres Travelled (VKT) Across Assessed Road Network by Vehicle Type

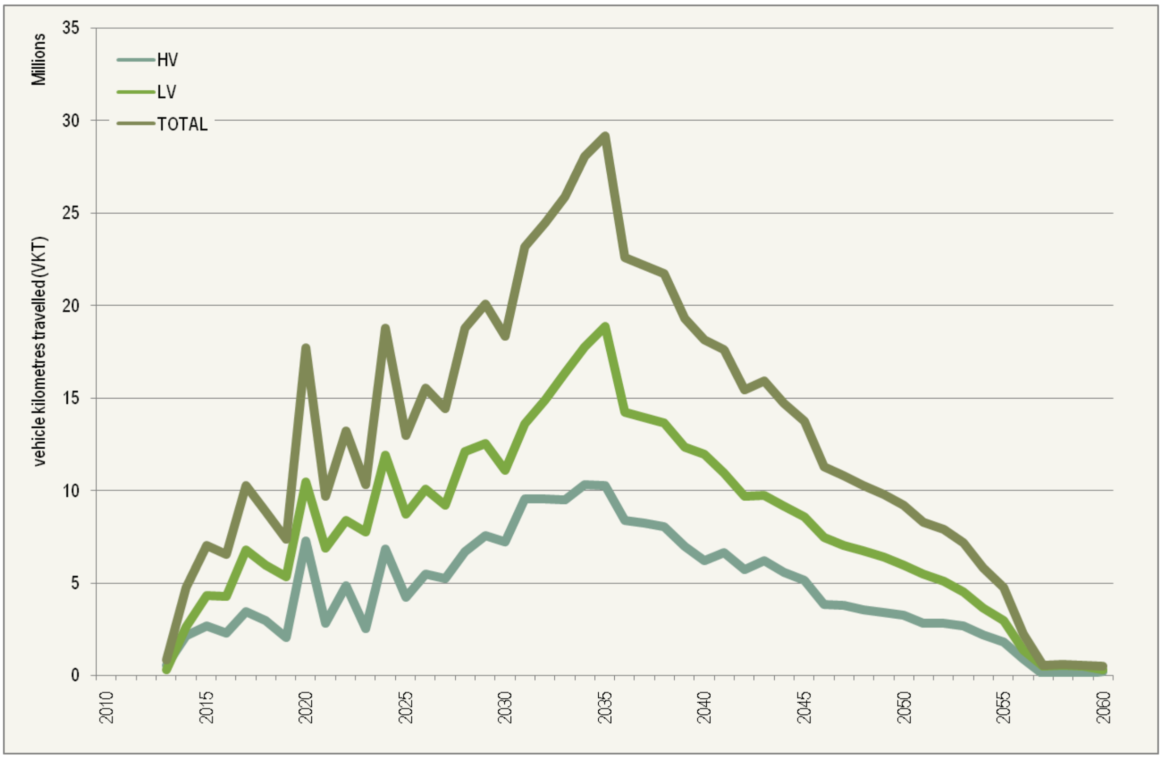


Chart 9.1 indicates that the project's VKT generation is anticipated to peak at 29,130,000 VKT around 2035. Chart 9.2 summarises the VKT that is anticipated to occur on TMR's, Western Downs Regional Council's (WDRC), Goondiwindi Regional Council's (GRC) and Toowoomba Regional Council's (TRC) road networks. In addition, Chart 9.2 includes an estimate of the extent of travel anticipated to occur on private access roads.

Chart 9.2 Vehicle Kilometres Travelled (VKT) Across Assessed Road Network by Road Authority

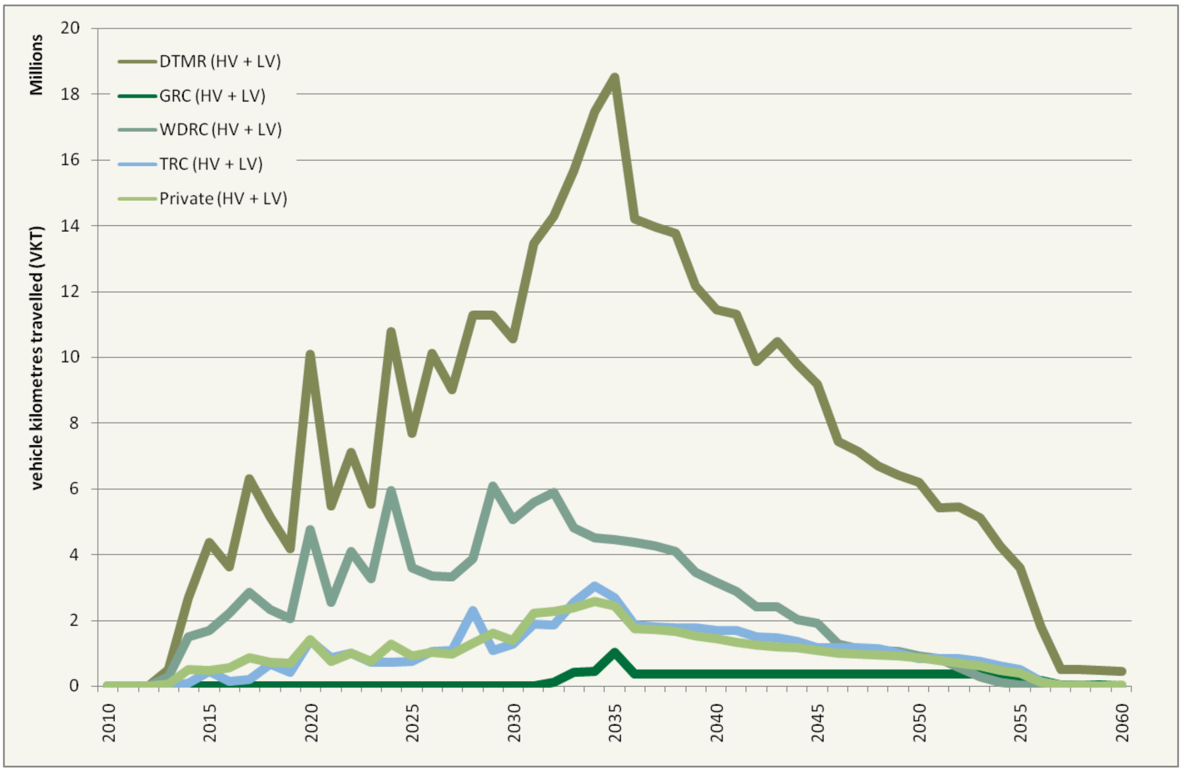


Chart 9.2 indicates that approximately 60% of the total project travel is anticipated to occur on TMR's network, 20% on WDRC's network, 10% on private access roads and the remaining 10% split between TRC's and GRC's road network. Chart 9.3 provides a summary of the project generated VKT on TMR's road network over the project life by vehicle type.

Chart 9.3 Vehicle Kilometres Travelled (VKT) on TMR Roads across Assessed Road Network by HV and LV

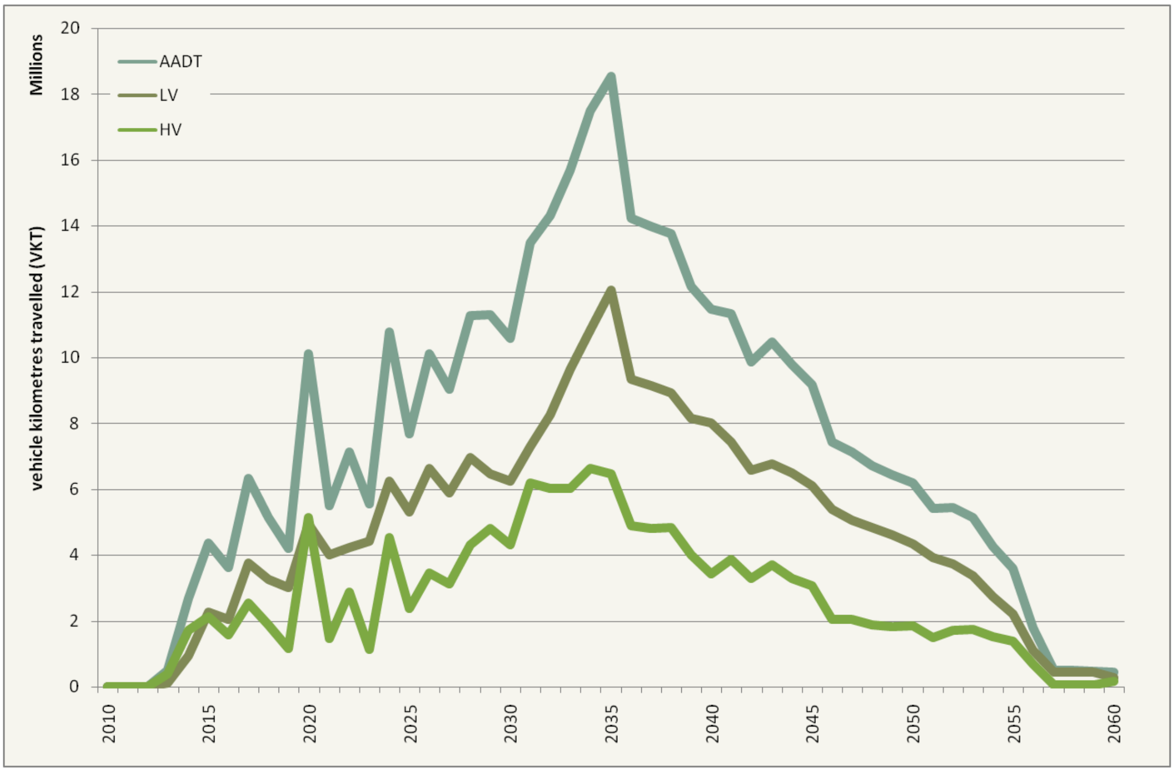


Chart 9.3 indicates that around 2035 the project is anticipated to generate 18,500,000 VKT on TMR's road network comprising 12,000,000 light vehicle VKT and 6,500,000 heavy vehicles VKT. To provide context to this travel forecast, the total VKT that occurred on TMR's Darling Downs district road network during 2010 has been estimated based on data supplied by the district. This data indicates that in 2009 approximately 1,929,000,000 VKT occurred across the district's road network. Of this approximately 381,000,000 VKT was associated with heavy vehicle travel while the remaining 1,547,000,000 VKT was associated with light vehicle travel.

Chart 9.4 summarises the project's forecast VKT generation on TMR's road network for each project year as a percentage of the travel which occurred on the district's road network in 2009 by vehicle class. This provides an indication of the broad proportional impact of travel associated with the project on the district's road network by vehicle class.

Chart 9.4 Vehicle Kilometres Travelled (VKT) on TMR Roads across Assessed Road Network as Percentage of 2009 VKT in Darling Downs region

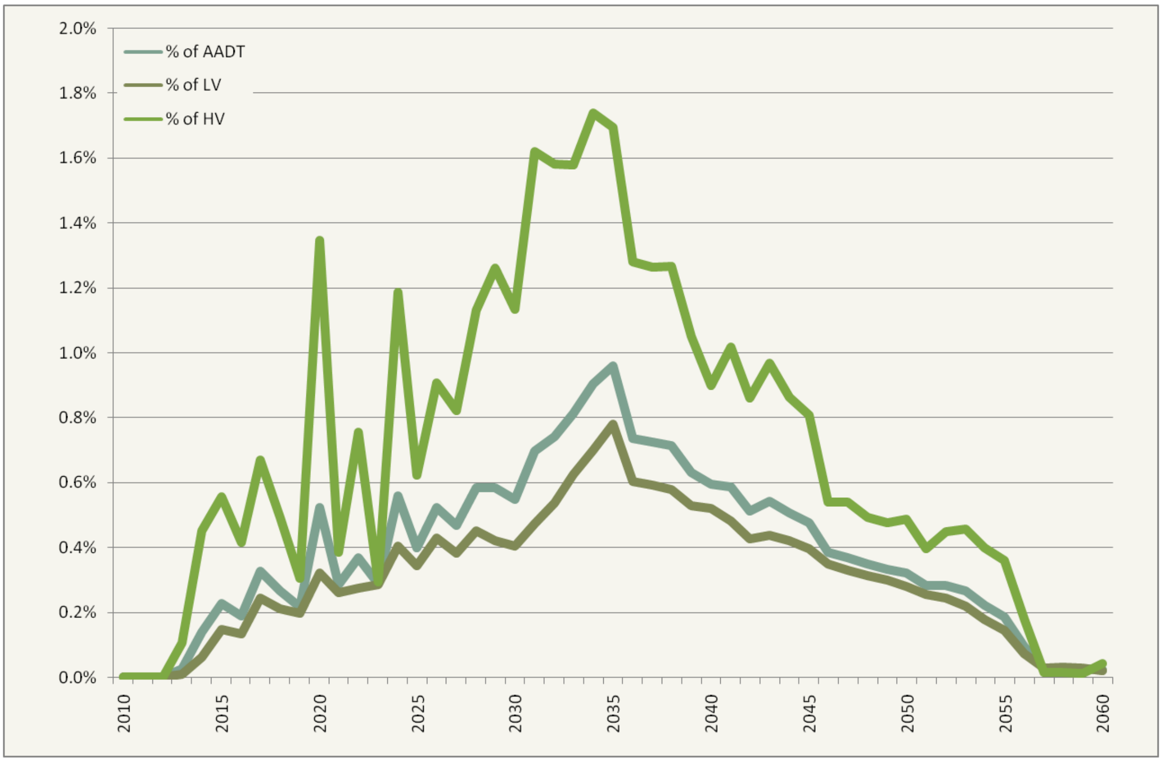


Chart 9.4 indicates that at its peak (around 2035) the project is anticipated to increase the level of total travel occurring on the TMR Darling Downs District road network by approximately 0.96% beyond the level of total travel that occurred on the district's road network in 2009. Chart 9.4 also indicates that the extent of heavy vehicle travel generated by the project across the district is likely to peak around 2034 at approximately 1.74% of the heavy vehicle travel that occurred on the district's road network in 2009.

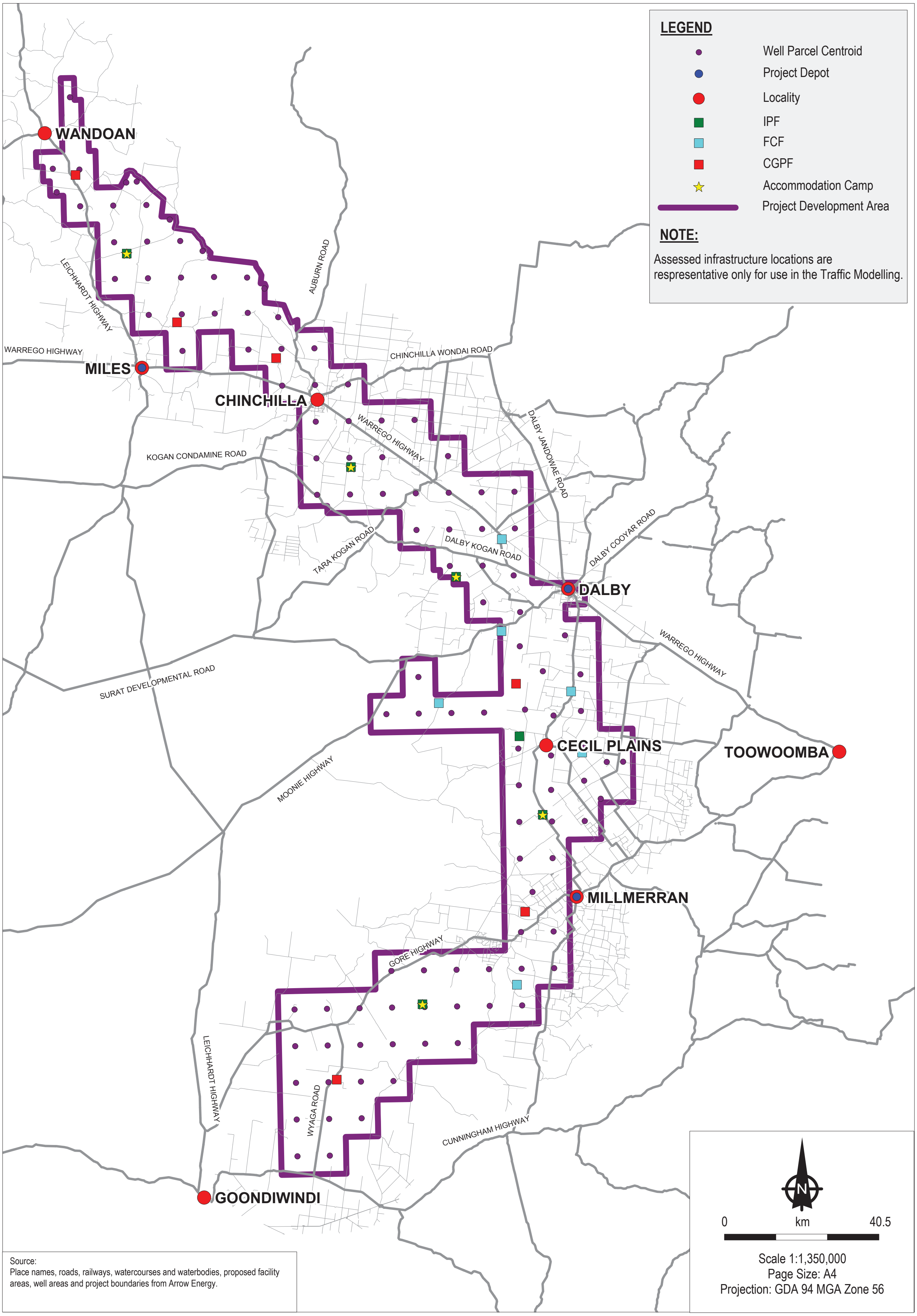
These findings are very important as they indicate that at the district level the total travel generated by the project is likely to be less than 1% of the total travel currently (2009) occurring on the district's road network. Furthermore, even at its peak the project is anticipated to increase the extent of heavy vehicle travel occurring on the district's road network by less than 2% of existing (2009) levels.

With regards to the spatial traffic volumes, Figure 9.2 summarises the transport task performed by each road link for the full life of the Surat Gas Project. Figure 9.3 indicates the AADT generated by the project on each link on average for the full project life. Figure 9.4 summarises the highest AADT increase anticipated to be experienced in any year of the project on each link.

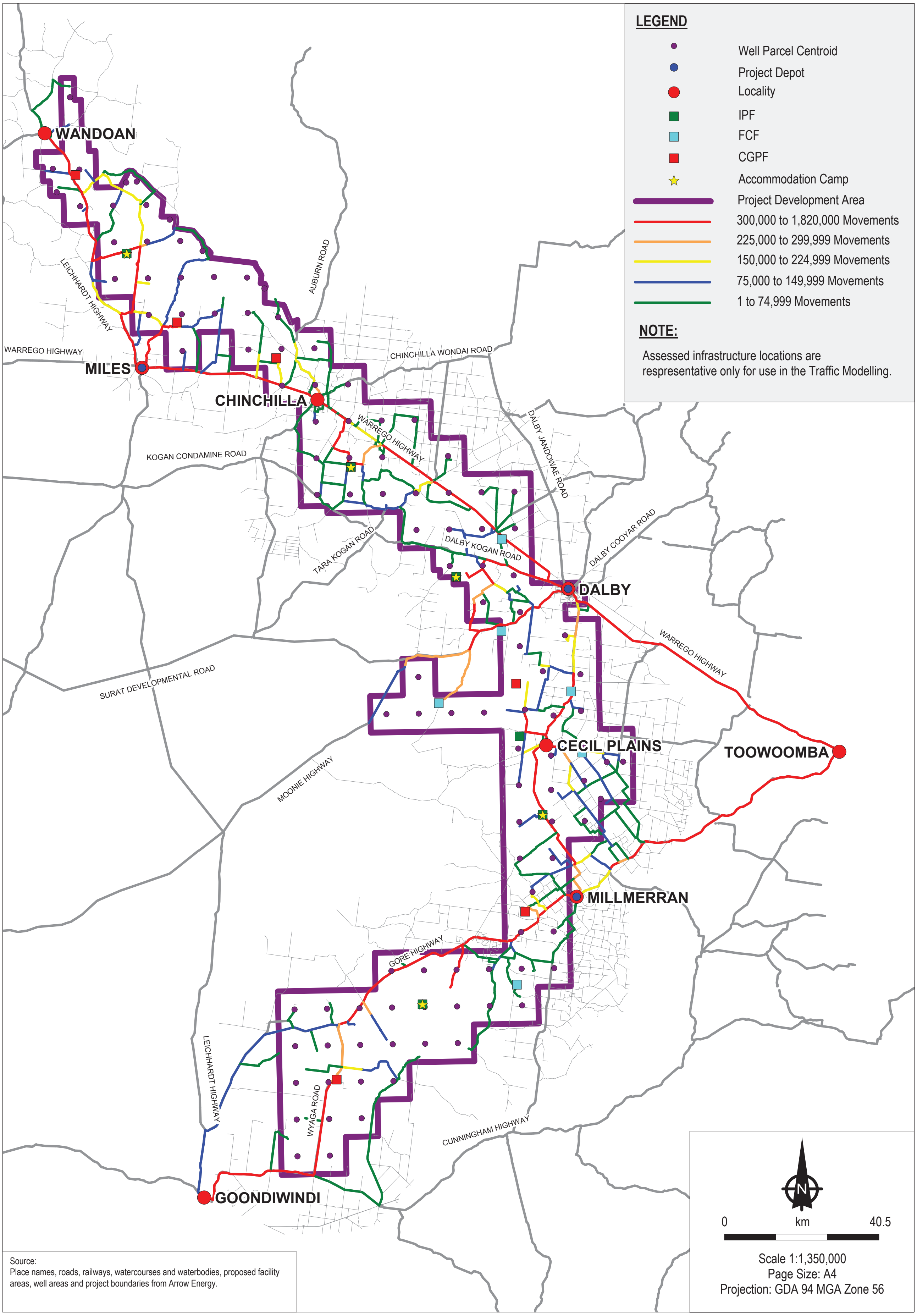
The implications of the AADTs shown on Figures 9.3 to 9.4 are discussed in Section 10 of the report with respect to the magnitude and therefore significance of impact.

9.3 FORECAST PEDESTRIAN VOLUMES

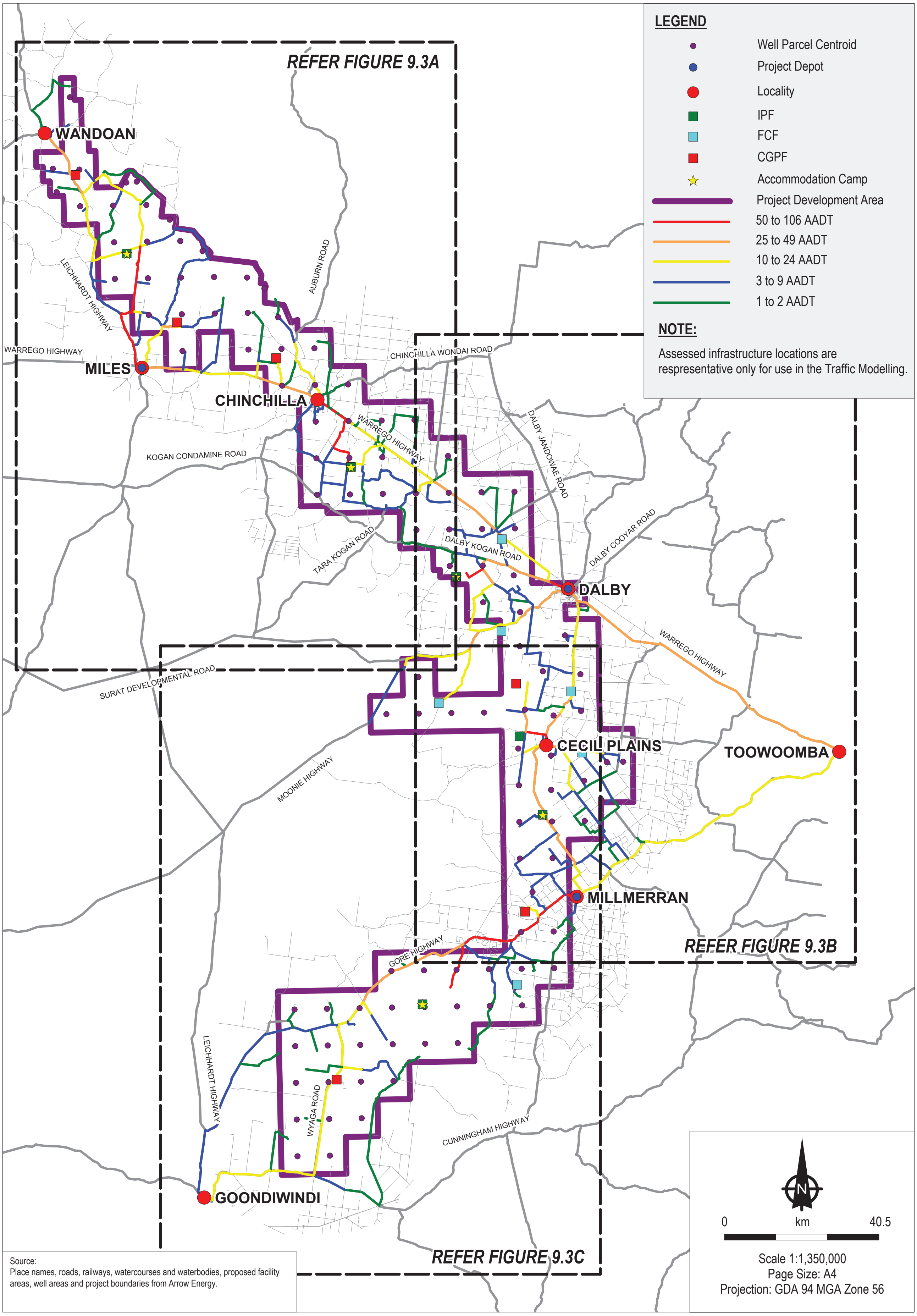
The Surat Gas Project is not anticipated to increase existing pedestrian or cycle demands on a broad scale and therefore modelling of pedestrian or cycle demands associated with the project has not been undertaken.



Cardno Eppell Olsen	Date: 19.07.2011 WOR: Figure 9.1 File Name: 6009_Figure 9.1.wor	Arrow Energy Limited Surat Gas Project	arrow energy go further	Traffic Model Elements	Figure No: 9.1



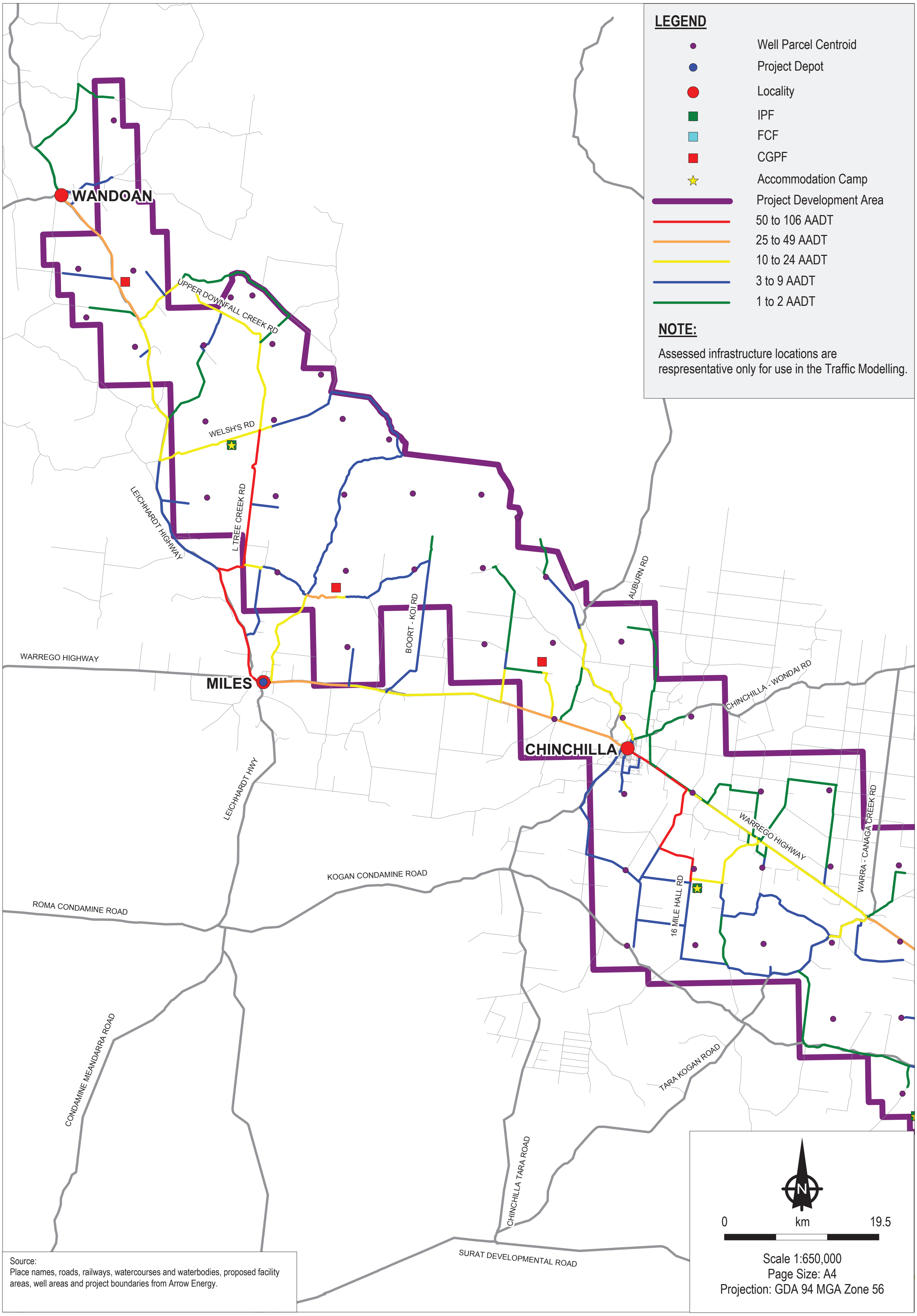
Cardno Eppell Olsen	Date: 19.07.2011 WOR: Figure 9.2 File Name: 6009_Figure 9.2.wor	Arrow Energy Limited Surat Gas Project	arrow energy go further	Total Transport Task (Full Project Life)	Figure No: 9.2



Cardno Eppell Olsen	Date: 19.07.2011 WOR: Figure 10.3 File Name: 6009_Figure 9.3.wor	Arrow Energy Limited Surat Gas Project	arrow energy go further

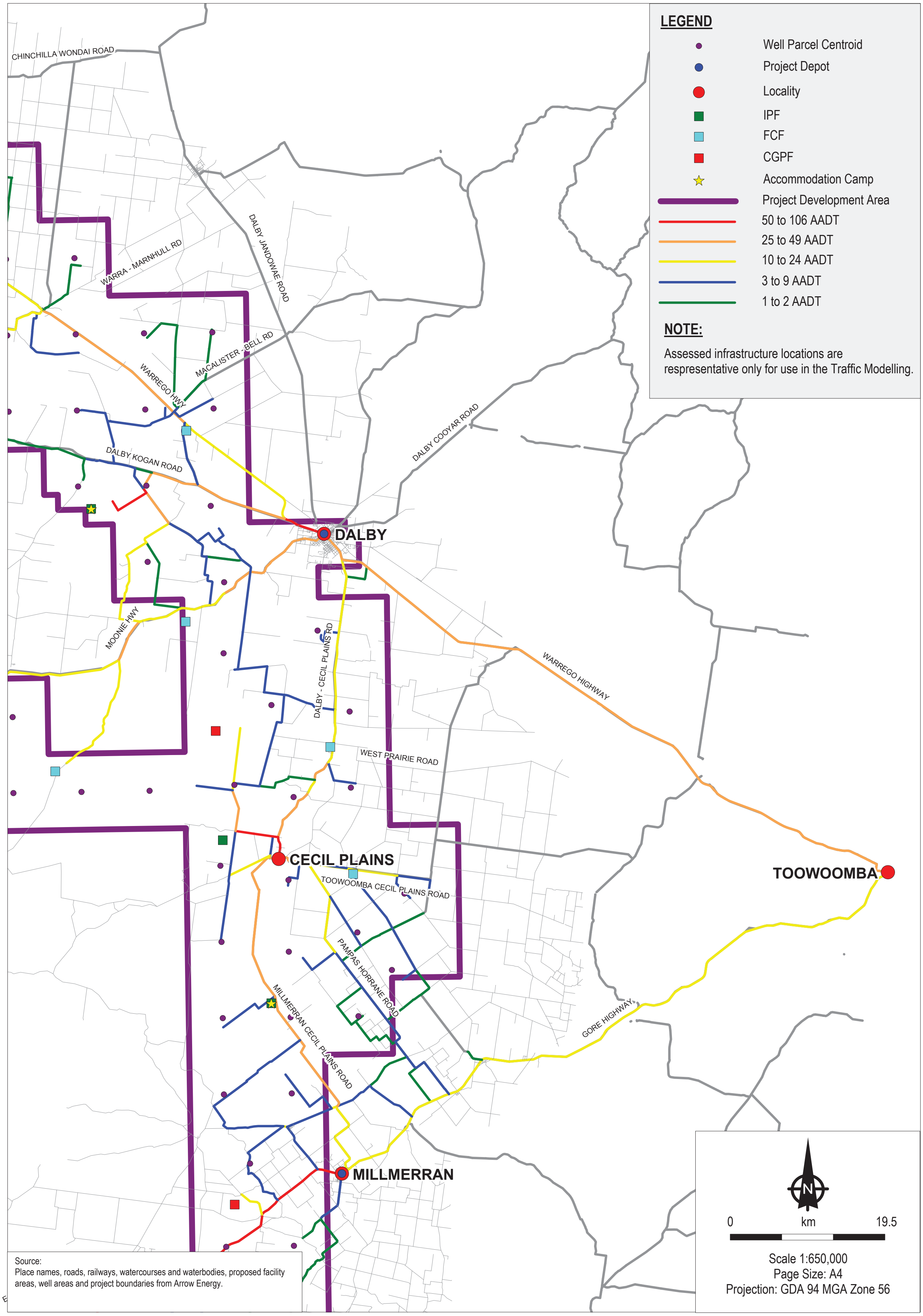
Average Project Life AADT

Figure No: 9.3



Source:
Place names, roads, railways, watercourses and waterbodies, proposed facility areas, well areas and project boundaries from Arrow Energy.

Cardno Eppell Olsen	Date: 19.07.2011 WOR: Figure 10.3A File Name: 6009_Figure 9.3A.wor	Arrow Energy Limited Surat Gas Project	arrow energy go further	Average Project Life AADT (Northern)	Figure No: 9.3A



Source:
Place names, roads, railways, watercourses and waterbodies, proposed facility areas, well areas and project boundaries from Arrow Energy.

Cardno Eppell Olsen

Date: 19.07.2011
WOR: Figure 10.3B
File Name: 6009_Figure 9.3B.wor

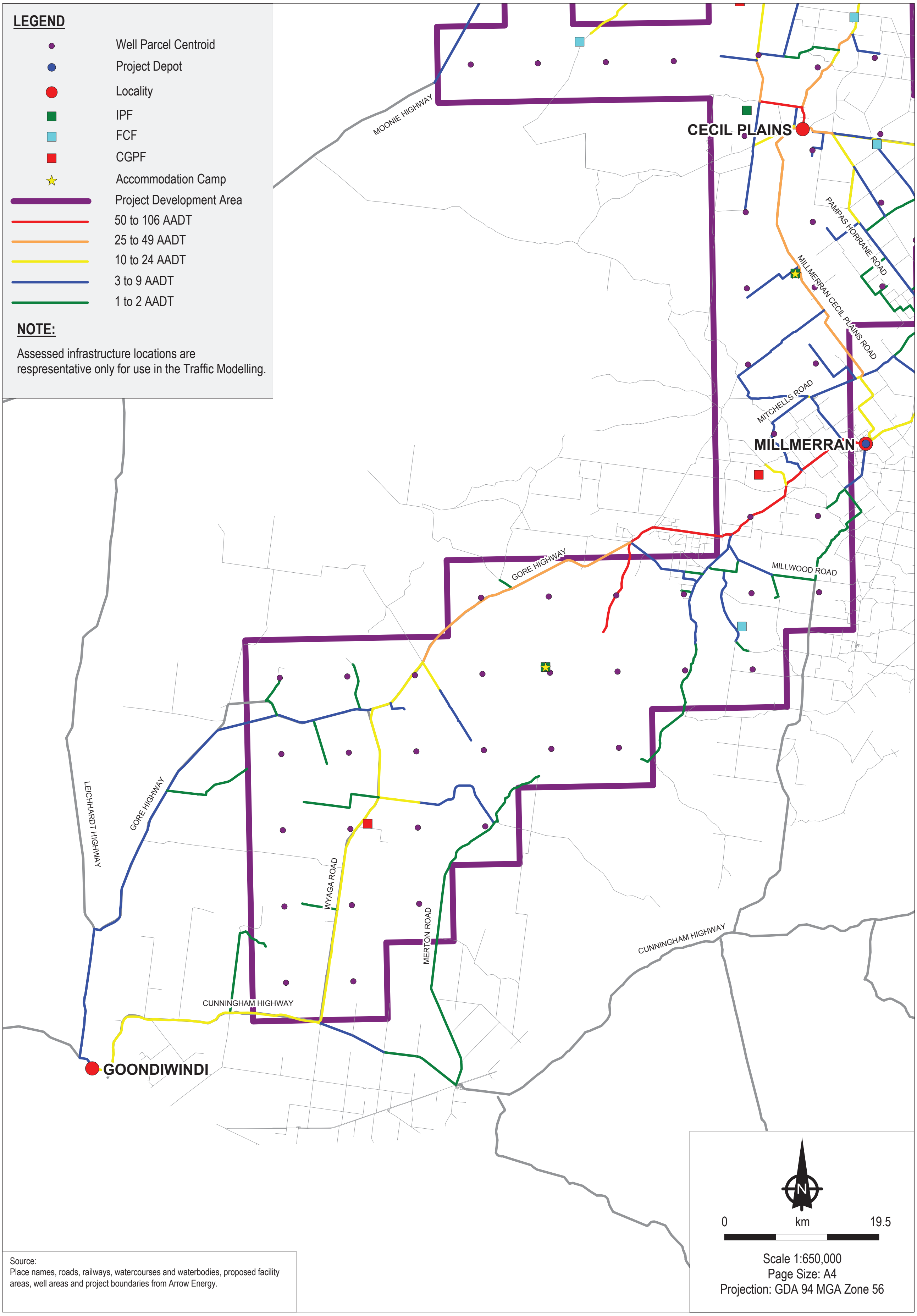
Arrow Energy Limited

Surat Gas Project

arrow energy go further

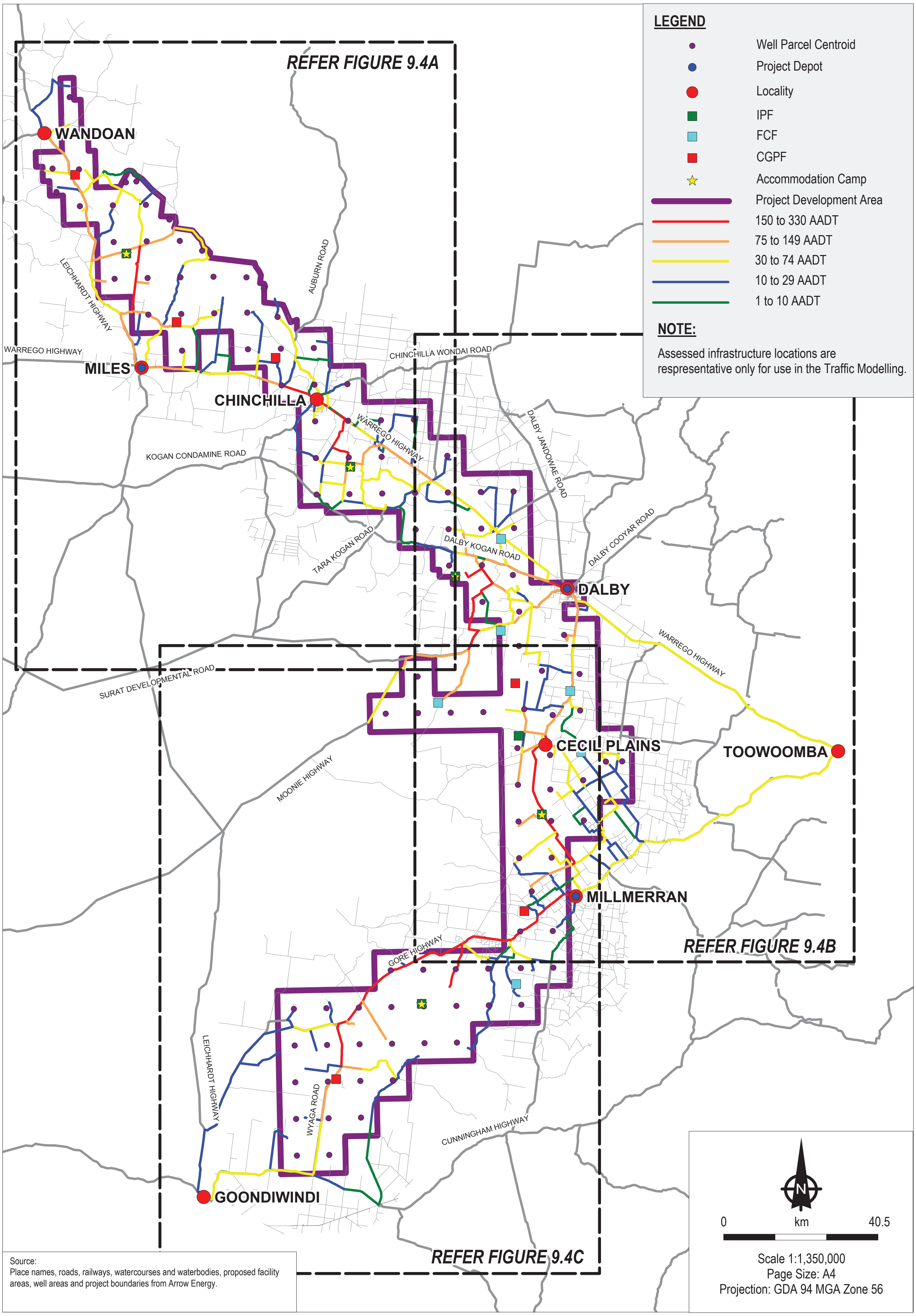
Average Project Life AADT (Central)

Figure No: 9.3B



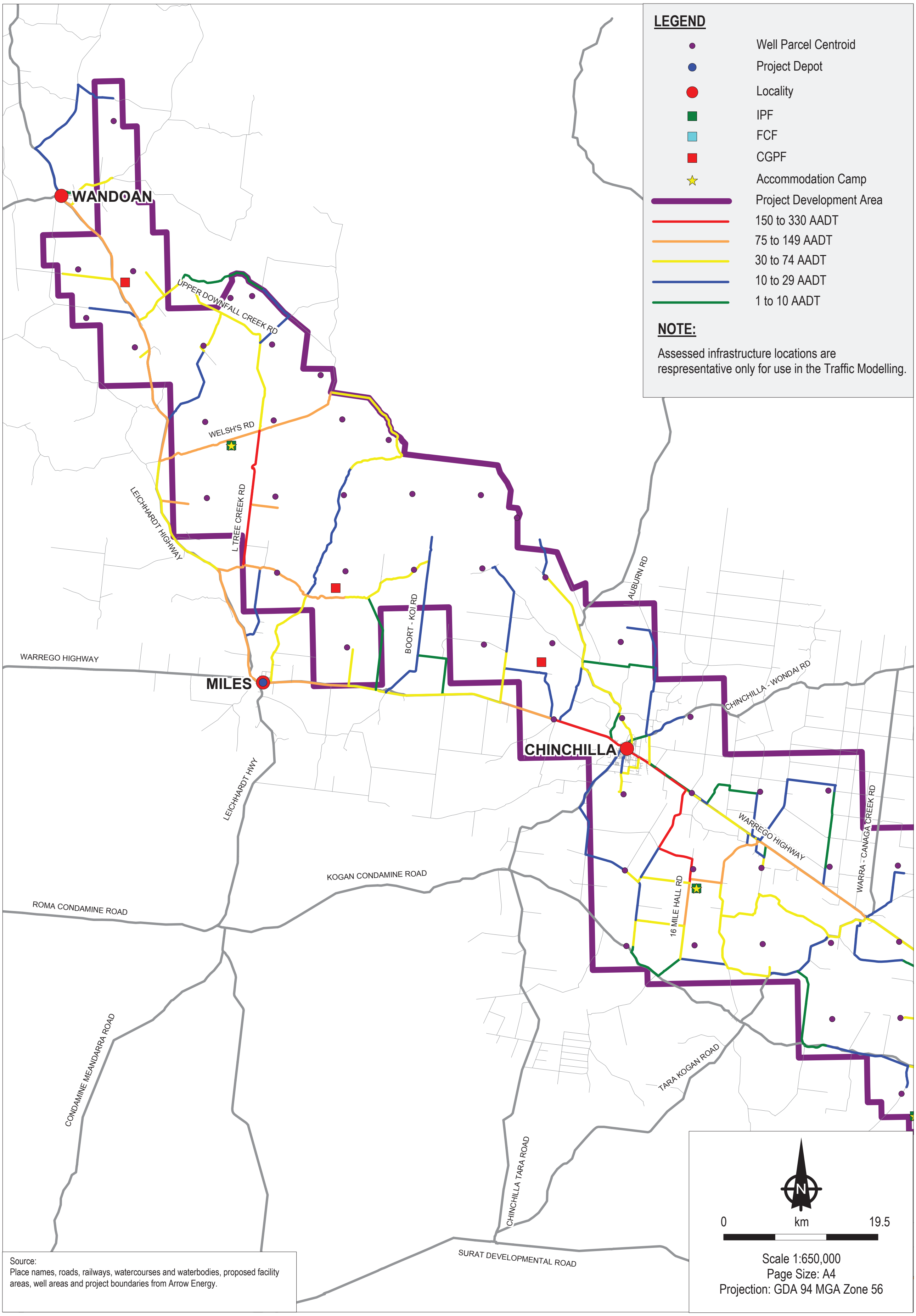
Source:
Place names, roads, railways, watercourses and waterbodies, proposed facility areas, well areas and project boundaries from Arrow Energy.

Cardno Eppell Olsen	Date: 19.07.2011 WOR: Figure 10.3C File Name: 6009_Figure 9.3C.wor	Arrow Energy Limited Surat Gas Project	arrow energy go further	Average Project Life AADT (Southern)	Figure No: 9.3C

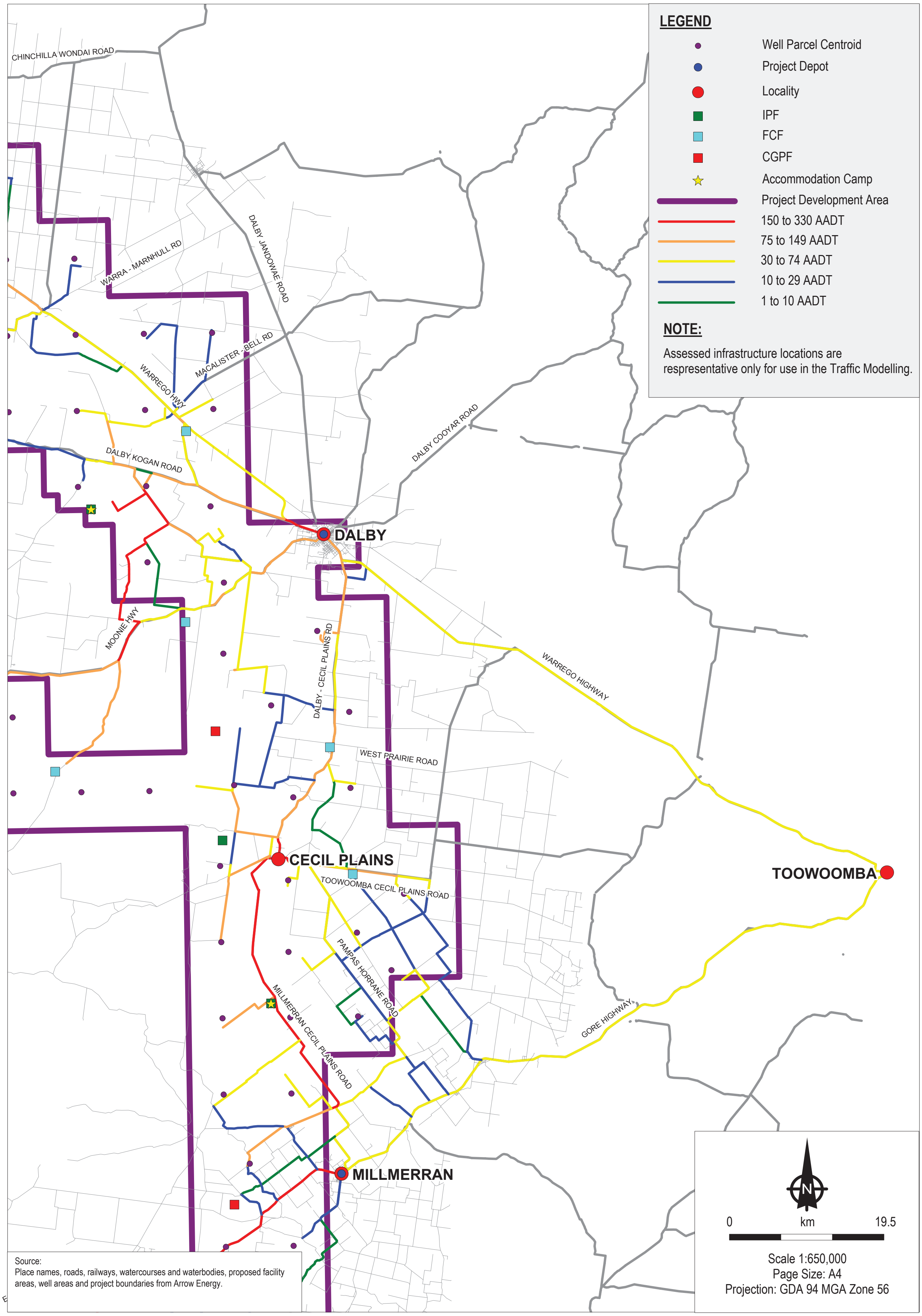


Source:
Place names, roads, railways, watercourses and waterbodies, proposed facility areas, well areas and project boundaries from Arrow Energy.

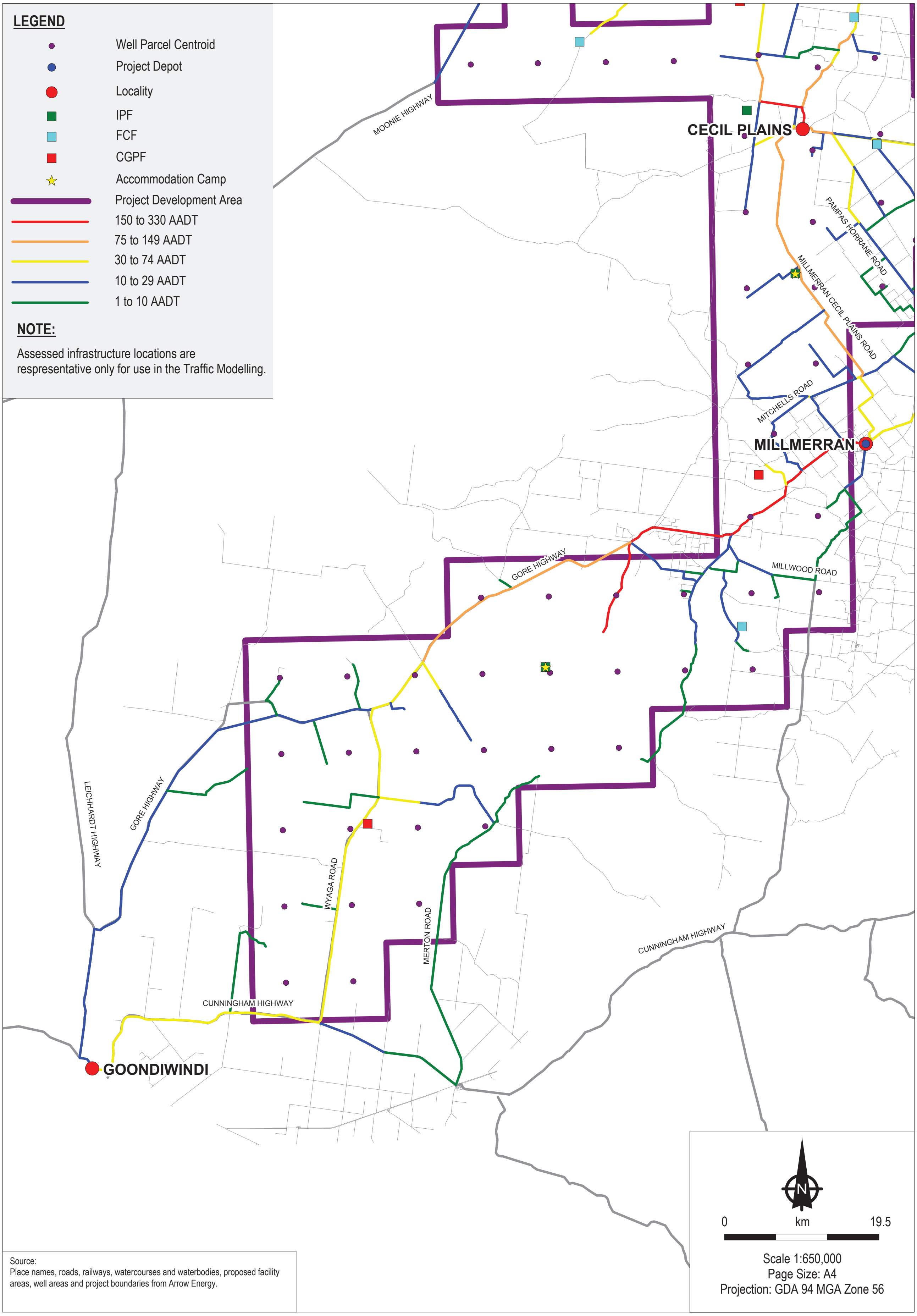
Cardno Eppell Olsen	Date: 19.07.2011 WOR: Figure 10.4 File Name: 6009_Figure 9.4.wor	Arrow Energy Limited Surat Gas Project	arrow energy go further	Maximum Project AADT (Peak Year For Individual Links)	Figure No: 9.4



Cardno Eppell Olsen	Date: 19.07.2011 WOR: Figure 10.4A File Name: 6009_Figure 9.4A.wor	Arrow Energy Limited Surat Gas Project	arrow energy go further	Maximum Project AADT (Peak Year For Individual Links) (Northern)	Figure No: 9.4A



Cardno Eppell Olsen	Date: 19.07.2011 WOR: Figure 10.4B File Name: 6009_Figure 9.4B.wor	Arrow Energy Limited Surat Gas Project	arrow energy go further	Maximum Project AADT (Peak Year For Individual Links) (Central)	Figure No: 9.4B



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Page Size: A4
Projection: GDA 94 MGA Zone 56

Source:
Place names, roads, railways, watercourses and waterbodies, proposed facility areas, well areas and project boundaries from Arrow Energy.

Cardno Eppell Olsen	Date: 19.07.2011 WOR: Figure 10.4C File Name: 6009_Figure 9.4C.wor	Arrow Energy Limited Surat Gas Project	arrow energy go further	Maximum Project AADT (Peak Year For Individual Links) (Southern)	Figure No: 9.4C

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10 MAGNITUDE OF IMPACTS AND PRE-MANAGEMENT STRATEGY SIGNIFICANCE OF IMPACTS

10.1 SIGNIFICANCE OF IMPACTS APPROACH AND DEFINITIONS

The significance of impacts associated with the Surat Gas Project has been assessed by considering the sensitivity of each of the three aspects associated with each of the identified environmental values (road types) in combination with the magnitude of the project's potential impacts. To enable the effectiveness of the proposed mitigation measures to be assessed, the significance of potential impacts has been assessed both before and after the application of mitigation measures. This section details the magnitude of impacts and significance of impacts pre-implementation of management strategies.

The significance of impacts on an environmental value is determined by the sensitivity of the value itself to change and the magnitude of the change it experiences. Table 10.1 summarises the significance of impact given the sensitivity of an environmental value and the magnitude of impact.

Table 10.1 Assessment of Significance of Impacts

		Sensitivity of Environmental Value		
Magnitude of Impact		**High**	**Moderate**	**Low**
	High	Major	High	Moderate
	Moderate	High	Moderate	Low
	Low	Moderate	Low	Negligible

Major Impact: Occurs when impacts will potentially cause irreversible or widespread harm to an environmental value that is irreplaceable because of its uniqueness or rarity. Avoidance through appropriate design responses is the only effective mitigation.

High Impact: Occurs when the proposed activities are likely to exacerbate threatening processes affecting the intrinsic characteristics and structural elements of the environmental value. While replacement is possible, avoidance through appropriate design responses is preferred to preserve its intactness or conservation status.

Moderate Impact: Occurs where, although reasonably resilient to change, the environmental value would be further degraded due to the scale of the impacts or its susceptibility to further change. The abundance of the environmental value ensures it is adequately represented in the region, and that replacement, if required, is achievable.

Low Impact: Occurs where an environmental value is of local importance and temporary and transient changes will not adversely affect its viability provided standard environmental controls are implemented.

Negligible Impact: A degraded (low sensitivity) environmental value exposed to minor changes (low magnitude impact) will not result in any noticeable change in its intrinsic value and hence the proposed activities will have negligible impact. This typically occurs where the activities occur in industrial or highly disturbed areas.

Each development region has been considered using the sensitivity of the environmental values (Section 6) and the modelled traffic volumes (Section 9) for each region as follows.

10.2 SIGNIFICANCE OF IMPACTS ASSESSMENT

The following sections detail the level of significance of potential impacts on roads in the project development area for each development region.

For each region, the sensitivity of the road types has been identified in Section 6. In Section 9, an average number of movements on each road link for the project life has been identified as well as peak year movements for each link. The peak movements for a road link do not necessarily relate to a particular phase, but rather a peak accumulation of various components being constructed and operated in a particular year that utilise the same road link. In summary, as similar activities are occurring concurrently, for the purposes of the Road Impact Assessment, the road impacts are assessed for each project year to understand total impacts on each road link rather than by project phase.

10.2.1 WANDOAN DEVELOPMENT REGION

The Wandoan development region is located in the north-western section of the project development area. The representative development scenario outlined in the project description, includes an integrated processing facility (with an associated accommodation camp) and two central gas processing facilities are anticipated within the Wandoan development region. Within the region, the key high order roads are the Warrego and Leichardt Highways. No Regional Connecting Roads have been identified, meaning the remainder of roads in the area are Rural Connecting Roads and Rural Access Roads.

Within the development region, a high magnitude impact is anticipated on the roads connecting the integrated processing facility with Miles. Moderate magnitude impacts of traffic volumes are anticipated on roads connecting the central gas processing facilities with Miles. Moderate magnitude impacts of trips are also anticipated from the production facilities to Wandoan. Other project roads have a low magnitude impact of volumes experienced on the road network, predominately anticipated to be associated with well development.

Table 10.2 broadly summarises the significance of impacts to roads within the Wandoan development region. It is noted that the roads upon which impacts are experienced, are not necessarily the roads that will be ultimately impacted by project development. It is also noted that the following table is not meant to form a comprehensive list of roads likely to be impacted but rather provide examples of what significance of impacts may be experienced in the absence of mitigation measures. The impacts are based upon a representative scenario of development which has been assessed for the purposes of developing mitigation strategies aligned to the potential impacts to the existing road network.

Table 10.2 Wandoan Development Region Significance of Impacts

Road	Sensitivity	Magnitude	Significance of Impacts
Leichardt Highway	Low	High	Moderate
Warrego Highway	Low	Moderate	Low
Pelham Road	High	Moderate	High
Old Forest Road	High	Moderate	High
Welsh's Road	High	Moderate	High
Myall Park to Hookswood Road	High	Low	Moderate
Hookswood Pelham Road	High	Low	Moderate
L Tree Creek Road	High	Moderate	High
Downfall Creek Road	High	Moderate	High
Upper Downfall Road	High	Moderate	High

Note: based on indicative facilities locations. Impacts based on a representative case for EIS purposes only. Actual roads affected may differ.

In the absence of effective management strategies, the project has the potential to generate impacts of **low** to **high** significance on the efficiency, safety and amenity of the central Wandoan region network due to increased volumes on the roads and the existing sensitivity of the road types. This occurs predominately where links facilitate movement between the key project facilities and the Leichardt or Warrego Highways. Higher order roads such as the Leichardt and Warrego Highways are built and operate at a standard that is likely to accommodate changed traffic conditions. Lower order roads are constructed for and operate with much lower traffic volumes, meaning increases in volumes can have a high significance of impact.

10.2.2 CHINCHILLA DEVELOPMENT REGION

The Chinchilla development region is located around the town of Chinchilla. The representative development scenario includes an integrated processing facility (with an associated accommodation camp) and a central gas processing facility in the region. The Warrego Highway runs approximately east-west through the development region providing connection to Miles in the east and Warra to the west. From Chinchilla there are Regional Connecting Roads to Auburn in the north, Wondai to the north-east and Kogan to the south. Other roads are Rural Access Roads and Rural Connecting Roads.

The highest magnitude impacts in the Chinchilla development region, identified through the modelling in Section 9, are experienced on roads connecting Chinchilla to the integrated processing facility including the Warrego Highway. Moderate magnitude effects are experienced on the roads to the central gas processing facility, and on the Warrego Highway connecting to Miles and Warra. Other roads in the area, which facilitate access to production wells and associated infrastructure, have low magnitude impacts.

Table 10.3 summarises the significance of impacts on certain roads within the Chinchilla development region. It is noted that the roads upon which impacts are experienced, are not necessarily the roads that will be ultimately impacted by project development. It is also noted that the following table is not meant to form a comprehensive list of roads likely to be impacted but rather provide examples of what significance of impacts may be experienced in the absence of mitigation measures.

Table 10.3 Chinchilla Development Region Significance of Impacts

Road	Sensitivity	Magnitude	Significance of Impacts
Warrego Highway	Low	High	Moderate
Auburn Road	Moderate	Moderate	Moderate
Chinchilla-Wondai Road	Moderate	Low	Low
Chinchilla Road South	Moderate	Low	Low
Chinchilla Kogan Road	Moderate	High	High
Boort-Koi Road	High	Low	Moderate
Cameby Road	High	Moderate	High
A Graham's Road	High	Low	Moderate
Burncluith Road	High	Low	Moderate
16 Mile Hall Road	High	Moderate	High

Note: based on indicative facilities locations. Impacts based on a representative case for EIS purposes only. Actual roads affected may differ.

The significance of impacts on the efficiency, amenity and safety of the road network in the Chinchilla development region range from **low** to **high**.

10.2.3 KOGAN/MILLMERRAN DEVELOPMENT REGION

The Kogan/Millmerran development region extends from Warra to Millmerran, predominately on the eastern side of the Condamine River. An additional section to the west is included in the Kogan/Millmerran development region.

For discussion purposes, the region has roughly been split up into northern, western and southern areas. The northern area is the area surrounding the township of Warra, Dalby and Cecil Plains, east of the Condamine River. The western area is the disconnected area to the west of the Dalby development region. The southern area incorporates the area from approximately Cecil Plains to Millmerran.

The road network in the northern area consists of higher order Regional Connecting Roads radiating from Dalby, being a key regional centre in the Darling Downs. The southern area, whilst it does not have any highways, is well serviced via Regional Connecting Roads including Millmerran Cecil Plains Road, Toowoomba Cecil Plains Road and Pampas Horrane Road. The western region however, does not have any Regional Connecting Roads and only one Rural Connecting Road that connects to the Moonie Highway.

The representative development scenario for Kogan/Millmerran includes an integrated processing facility (with an associated accommodation camp), a central gas processing facility and four field compression facilities.

In the northern area, moderate magnitude traffic impacts are experienced associated with a field compression facility in the area. These impacts are mainly on the Warrego Highway between one of the field compression facilities, Warra and Dalby. Dalby-Cecil Plains Road also experiences moderate impacts via the connection of another field compression facility with Dalby and traffic to Cecil Plains.

Moderate magnitude impacts are anticipated to be experienced in the western area associated with a field compression facility in the area, with low magnitude impacts associated with the production well construction and operations.

In the southern area, high magnitude impacts are anticipated on the Gore Highway connecting Millmerran with Goondiwindi. Moderate magnitude impacts are anticipated on those roads facilitating connection from field compression facilities and the central gas processing facility to the nearest towns and depots. Other impacts on the road network are anticipated to be of a low magnitude in providing access to production wells.

Table 10.4 summarises the significance of impacts on certain roads within the Kogan/Millmerran development region. It is noted that the roads upon which impacts are experienced, are not necessarily the roads that will be ultimately impacted by project development. It is also noted that the following table is not meant to form a comprehensive list of roads likely to be impacted but rather provide examples of what significance of impacts may be experienced in the absence of mitigation measures.

Table 10.4 Kogan/Millmerran Development Region Significance of Impacts

Road	Sensitivity	Magnitude	Significance of Impacts
Warrego Highway	Low	Moderate	Low
Moonie Highway	Low	Moderate	Low
Gore Highway	Low	High	Moderate
Macalister Bell Road	Moderate	Low	Low
Dalby-Cecil Plains Road	Moderate	Moderate	Moderate
Dalby-Kogan Road	Moderate	Moderate	Moderate
Toowoomba-Cecil Plains Road	Moderate	Moderate	Moderate
Pampas-Horrane Road	Moderate	Moderate	Moderate
Warra-Kogan Road	Moderate	Moderate	Moderate
Millmerran Cecil Plains Road	Moderate	High	High
Millmerran-Inglewood Road	Moderate	Low	Low

Note: based on indicative facilities locations. Impacts based on a representative case for EIS purposes only. Actual roads affected may differ.

The significance of impacts in the Kogan/Millmerran region are anticipated to range from **low** to **high** as shown in Table 10.4. The highest significance impacts are where lower order roads are used to access production facilities.

10.2.4 DALBY DEVELOPMENT REGION

The Dalby development region is bounded by the Kogan/Millmerran development region, with its eastern boundary set by the Condamine River. The representative development scenario anticipates two integrated processing facilities (one with an associated accommodation camp), a central gas processing facility and a field compression facility. Within the region, there are higher order roads including the Moonie Highway, and various Regional Connecting Roads between townships.

Within the development region, moderate magnitude impacts are anticipated on roads that connect the facilities with the highway and local townships. Moderate magnitude impacts are also expected on the Moonie Highway and some Regional Connecting Roads. Low magnitude impacts are expected on lower order roads that provide access to well sites and gathering infrastructure.

Table 10.5 summarises the significance of impacts on certain roads within the Dalby development region. It is noted that the roads upon which impacts are experienced, are not necessarily the roads that will be ultimately impacted by project development. It is also noted that the following table is not meant to form a comprehensive list of roads likely to be impacted but rather provide examples of what significance of impacts may be experienced in the absence of mitigation measures.

Table 10.5 Dalby Development Region Significance of Impacts

Road	Sensitivity	Magnitude	Significance of Impacts
Moonie Highway	Low	Moderate	Low
Dalby-Cecil Plains Road	Moderate	Moderate	Moderate
Dalby-Kogan Road	Moderate	Moderate	Moderate
Daandine-Nandi Road	Moderate	Moderate	Moderate
Nandi Road	Moderate	Low	Low
Springvale Road	Moderate	Low	Low
Wanka Road	High	Low	Moderate
Wilkins Road	High	Moderate	High
Grassdale Road	High	Low	Moderate

Note: based on indicative facilities locations. Impacts based on a representative case for EIS purposes only. Actual roads affected may differ.

The significance of impacts in the Dalby region is anticipated to range from **low** to **high**. As the Dalby development region is well serviced by higher order Regional Connecting Roads with good connectivity to other regions, the impacts are mostly moderate.

Although there are a higher number of facilities proposed in the Dalby development region, the types of facilities proposed are likely to have a reduced traffic generating potential.

10.2.5 GOONDIWINDI DEVELOPMENT REGION

The Goondiwindi development region is located to the south-west of Millmerran. This region is likely to be developed towards the end of the development sequence. The estimate of well production and parcel allocation in this development region holds a much greater degree of uncertainty in comparison to other development regions. The road network in the region is sparse with only one higher order road present, being the Gore Highway. Other roads in the area comprise Rural Connecting Roads and Rural Access Roads and therefore have a high sensitivity to changed traffic conditions.

Facilities anticipated in the Goondiwindi development region shown in the representative development scenario include an integrated processing facility, central gas processing facility and a field compression facility. High magnitude impacts are experienced on the roads connecting the integrated processing facility and Millmerran including part of the Gore Highway. Moderate magnitude impacts are experienced on the remainder of the Gore Highway in the region associated with project traffic travelling to Goondiwindi. Moderate magnitude impacts are also experienced on Rural Connecting Roads in the area and the Cunningham Highway from the central gas processing facility to Goondiwindi. Other low magnitude impacts are anticipated on other roads associated with production wells and the field compression facility.

Table 10.6 summarises the significance of impacts on certain roads within the Goondiwindi development region. It is noted that the roads upon which impacts are experienced, are not necessarily the roads that will be ultimately impacted by project development. It is also noted that the following table is not meant to form a comprehensive list of roads likely to be impacted but rather provide examples of what significance of impacts may be experienced in the absence of mitigation measures.

Table 10.6 Goondiwindi Development Region Significance of Impacts

Road	Sensitivity	Magnitude	Significance of Impacts
Gore Highway	Low	Moderate	Low
Cunningham Highway	Low	Moderate	Low
Leichardt Highway	Low	Low	Negligible
Milwood Road	High	Low	Moderate
Wyaga Road	High	Moderate	High
Merton Road	High	Low	Moderate
Cypress Avenue	High	Low	Moderate
Kelmans Road	High	Low	Moderate

Note: based on indicative facilities locations. Impacts based on a representative case for EIS purposes only. Actual roads affected may differ.

In the absence of effective management strategies, the Goondiwindi development region has the potential to experience impacts on the efficiency, safety and amenity of the road network ranging in significance from **negligible** to **high**. The highest significance of impacts occurs where facilities are located away from the Moonie Highway. The impact on the region can be reduced through locating facilities in closer proximity to higher order roads.

10.3 SUMMARY OF SIGNIFICANCE OF IMPACTS

The significance of impacts for each region pre-mitigation have been summarised in the previous sections. It should be noted that the impacts identified above are in the absence of any mitigation measures. The following Section 11 includes a literature review of best practice standards to inform the development of management strategies in Section 12. The impact of the project on the road network post-implementation of mitigation strategies is discussed in Section 13.

11 LITERATURE REVIEW

The following sections identify the best practice standards for aspects of the road environment to inform the development management strategies. These standards will also ultimately inform the Road Use Management Plans developed to support the project.

11.1 ROAD FACILITIES

Road facilities are typically classified into two broad categories being:

- Uninterrupted Road Facilities
  Uninterrupted flow road facilities are categorised as those on which traffic conditions are the result of interactions between vehicles in the traffic stream and the geometric and environmental characteristics of the road. Uninterrupted flow road facilities have no fixed elements external to the traffic stream such as traffic signals which cause interruption to the traffic flow. Rural roads are typically categorised as uninterrupted flow facilities.
- Interrupted Road Facilities
  Interrupted flow road facilities are categorised as those on which traffic conditions are the result of fixed elements such as traffic control signals, roundabouts, stop signs or other types of control which cause traffic to stop periodically, irrespective of the total amount of traffic utilising the facility. Urban roads are predominately categorised as interrupted flow facilities.

It is reinforced that uninterrupted and interrupted in this context are traffic engineering terms used to categorise road facilities and they do not describe the actual quality of travel on a road.

The typical traffic volume thresholds where detailed assessment is required for these road types are discussed in detail in the following sections.

11.1.1 UNINTERRUPTED SINGLE LANE SEALED ROAD THRESHOLDS

Rural Road Design: A Guide to the Geometric Design of Rural Roads published by Austroads is considered a best practice manual. This manual states that where traffic volumes are less than 150 vehicles per day (vpd) and particularly where terrain is open, single lane carriageways are acceptable.

The width of the traffic lane on a single lane road should be at least 3.5m, as a width less than this can result in excessive shoulder wear. A width greater than 4.5m but less than 6.0m may lead to opposing vehicles trying to pass on the seal, increasing the potential for head-on collisions. A width of 3.5m ensures that one or both opposing vehicles must have their outer wheels on the shoulders while passing.

Table 11.1 details the minimum design standards recommended for single lane sealed roads.

Table 11.1 Volume Thresholds for Uninterrupted Single Lane Sealed Roads

Element	Design AADT (vpd)
	1-150
Traffic Lane Widths (m)	3.5 (1 x 3.5) (minimum) 4.5 (1 x 4.5) (maximum)
Shoulder Seal (m)	0.5
Total Shoulder (m)	2.0

11.1.2 UNINTERRUPTED TWO LANE SEALED ROAD THRESHOLDS

Table 11.2 details the uninterrupted two lane sealed road capacity thresholds at which a detailed assessment of the project's traffic impacts are warranted. The threshold capacity values are based on guidance presented in both *Rural Road Design: A Guide to the Geometric Design of Rural Roads* and *Guide to Traffic Engineering Practice: Part 2 Roadway Capacity,* both published by Austroads.

Table 11.2 Volume Thresholds for Uninterrupted Two Lane Sealed Roads

Element	AADT (vpd)				
	150-500	500-1,000	1,000-3,000	3,000-5,000	5,000-7,900
Traffic Lane Widths (m)	6.2 (2 x 3.1)	6.2 (2 x 3.1) (min) 7.0 (2 x 3.5) (desirable)	7.0 (2 x 3.5)	7.0 (2 x 3.5)	7.4 (2 x 3.7)
Shoulder Seal (m)	0.5	0.5	1	1.5	4
Total Shoulder (m)	1.5	1.5	2	2.5	4

At each volume level in Table 11.2, the cross-section of the existing road should be assessed against the cross-section recommended by Austroads.

11.1.3 UNINTERRUPTED TWO LANE UNSEALED ROAD THRESHOLDS

TMR's *Road Planning and Design Manual* states that the theoretical capacity of an unsealed gravel surface road is approximately 50% of that of a comparative sealed road (similar carriageway cross-section, etc). Further, the TMR's manual states that the theoretical capacity of a natural earth surfaced road is approximately 40% of that of a comparative sealed road. These theoretical capacity reduction factors however, do not account for environmental considerations such as dust nuisance and safety. It is these amenity factors, as opposed to capacity constraints, which typically prompt a road authority to seal a road.

The *Unsealed Roads Manual Guidelines to Good Practice* prepared by ARRB Transport Research Ltd, which is referenced extensively in the *Road Planning and Design Manual*, is considered to provide best practise guidance for the design of Australian unsealed roads. The manual states that typically it is difficult to justify sealing a road carrying less than 100vpd and that sealing is usually justified when traffic volumes exceed 250vpd. The guide states that between these threshold vehicle volumes, an economic assessment of the benefit of sealing a road is usually warranted.

Table 11.3 summarises the adopted threshold volumes for unsealed roads.

Table 11.3 Volume Thresholds for Uninterrupted Two Lane Unsealed Roads

AADT (vpd)		
<100	**100-250**	**>250**
Unsealed appropriate	Economic benefit assessment of sealing warranted	Sealing typically warranted

11.1.4 UNINTERRUPTED MULTI-LANE ROAD THRESHOLDS

There are no uninterrupted multi-lane roads within the project development area, therefore thresholds have not been developed for this type of facility.

11.1.5 INTERRUPTED FLOW ROAD FACILITY

The project is not anticipated to generate significant traffic volumes in urban areas, therefore thresholds have not been derived for interrupted flow facilities.

11.2 INTERSECTIONS

The geometry and control of intersections significantly utilised by project traffic should be appropriate to safely and efficiently accommodate traffic demands. These thresholds are applicable to intersections on the external road network and at site access locations.

The geometry of priority-controlled intersections is typically driven by safety and design vehicle considerations as opposed to capacity constraints. For example, protected short right turn lanes are usually provided to reduce the incidence of rear end crashes, rather than to allow more vehicles to pass through the intersection (i.e. to allow greater capacity).

Table 11.4 details the threshold intersection volumes at which various intersection turn treatments are warranted. These treatments are only considered applicable to intersections at which the project is forecast to have a significant impact for a significant period of time (i.e. increases vehicle volumes by greater than 5% for at least one year).

To facilitate a practical tool mindful of data limitations, the intersection turn treatment thresholds are based on daily volumes as opposed to peak hour volumes. The volume thresholds are conservatively based on the turn treatment warrants presented in the *Road Planning and Design Manual* prepared by TMR.

Table 11.4 Intersection Turn Treatment Thresholds (Volume >5% for >1 year)

Minor Approach AADT (vpd)	Major Approach AADT (vpd)		
	<2,000	**2,000-4,000**	**>4,000**
<100	BAL/BAR	BAL/BAR	BAL/BAR
>100	BAL/BAR	AUL(S)/CHR(S)	CHR

Note: Refer to glossary for detailed definition

11.3 SCHOOL BUS ROUTES

The TMR *Guide for the Road Safety Management of Rural School Bus Routes and Bus Stops* identifies that it is difficult to define specific quantitative thresholds for the provision of bus facilities and that discretion and engineering judgement should be exercised. It recognises that many factors influence the choice of treatment in a given situation. Further, the guideline recognises that due to the transient nature of school bus stops in rural areas, the provision of formalised school bus stops is typically not warranted.

The following strategic planning guidance is provided by the guideline to assist in reducing the potential for conflict between project traffic, school bus vehicles and students:

- School bus routes should be suitable for bus performance under all weather conditions.
- School bus routes should only be signed where, for safety reasons, it is necessary to warn motorists of the possible presence of the school bus or students on the road.
- School bus stops and their activities should be adequately visible in all relevant lighting and weather conditions.

11.4 RAIL CROSSINGS

Rail crossings may be treated with a hierarchy of control dependant on the prevailing conditions. The *Road Planning and Design Manual* and the *Manual of Uniform Traffic Control Devices: Part 7 – Railway Crossings* provide detailed guidance on how to appropriately treat rail crossings, considering the specifics of each individual location. The detailed design guidance presented within these manuals has been summarised into a simplified framework for strategic planning purposes (i.e. the EIS assessment and project planning).

The treatment and control devices provided at rail crossings can be broadly defined into three categories, described in the following sections:

- Passively protected level crossings (least cost).
- Actively protected level crossings (moderate cost).
- Grade-separated railway crossings (high cost).

Due to the existing and future traffic volumes, grade-separated railway crossings are not expected to be warranted for the project development area. Therefore, they have not been considered or discussed herein.

11.4.1 PASSIVE PROTECTION

Passive protection at a rail crossing is the control of road vehicles by devices that do not activate during the approach or passage of a train. Passive protection requires drivers to detect the approach or presence of a train by direct observation.

Typical methods of passive protection are summarised in Table 11.5

Table 11.5 Summary of Passive Rail Crossing Devices

Device	Use
Give way signs	The minimum level of control at any railway level crossing on public roads
Stop signs	Used in situations where all vehicles are required to stop at the crossing because approaching vehicles have restricted sight distance to approaching trains
Advance warning signs	An additional advance warning device

The majority of rail crossings within the project development area currently have passive protection.

11.4.2 ACTIVE PROTECTION

Active protection at a rail crossing is the control of road vehicles by devices such as flashing lights, gates or barriers or a combination of these, where the devices are activated prior to and during the passage of a train, by the train. Active protection does not require drivers to directly detect the approach or presence of a train.

Typical methods of active protection are summarised in Table 11.6.

Table 11.6 Summary of Active Rail Crossing Devices

Device	Use
Flashing signals	Standard sign and signal assembly is used at actively protected level crossings
Gates	Used in conjunction with the flashing light assembly for increased protection
Boom barriers	Used in conjunction with the flashing light assembly for increased protection

11.4.3 THRESHOLDS FOR LEVEL OF RAIL PROTECTION

Table 11.7 details the exposure levels at which the three different levels of rail crossing protection should be implemented on the rural roads likely to be significantly utilised by project traffic. The Exposure Score (VT) is the product of the daily road traffic volume (V) and the daily train volume (T) utilising the crossing.

Table 11.7 Exposure Thresholds for Rail Crossing Protection

Passive Protection	Active Protection	Grade-Separated Protection
VT <50,000	VT >50,000	Unlikely to be warranted as a result of project traffic

11.5 ROAD DESIGN GUIDELINES

There are a number of different road design guidelines and standards that can be adopted and applied to the roads within the project development area. These are summarised in the following sections.

11.5.1 AUSTROADS ROAD DESIGN GUIDELINES

Table 11.8 summarises the road dimensions recommended by Austroads in the *Rural Road Design Manual* for undivided sealed roads based upon design Annual Average Daily Traffic (AADT) volumes.

Table 11.8 Austroads Recommended Rural Road Widths

Design AADT Volume (vpd)	No. of Lanes	Road Seal Width	Shoulder Seal Width	Total Shoulder Width
1 – 150	1	3.5m	0.5m	2.0m
150 – 500	2	6.0m	0.5m	1.5m
500 – 1,000	2	6.0m (minimum) 7.0m (desirable)	0.5m	1.5m
1,000 – 3,000	2	7.0m	1.0m	2.0m
3,000+	2	7.0m	1.5m	2.5m

Note: vpd = vehicles per day

11.5.2 TMR ROAD DESIGN GUIDELINES

The TMR *Road Planning and Design Manual* specifies the required road widths of traffic lanes and sealed shoulders for two lane, two-way rural roads. The required road widths are based on AADT volumes and expected traffic growth and are summarised in Table 11.9.

Table 11.9 TMR Recommended Rural Road Widths

Road Seal Width	Expected Growth Rates (vpd)		
	Low Growth (<3%p.a.)	Reasonable Growth (3-6%p.a.)	High Growth(>6%p.a.)
6.0m (minimum)	<700vpd	6.0 m (minimum)	<700vpd
6.5m (minimum)	700 – 1,700vpd	6.5 m (minimum)	700 – 1,700vpd
7.0m (minimum)	>1,700vpd	7.0 m (minimum)	>1,700vpd

Note: vpd = vehicles per day

The required shoulder seal width is based upon AADT volumes with the minimum widths as follows:

- 0.5m shoulder seal width for AADT <2,000vpd.
- 1.0m shoulder seal width for AADT >2,000vpd.

12 MANAGEMENT STRATEGIES

12.1 PRIORITY ORDER OF STRATEGIES

There are a number of management strategies by which to manage the project's potential impacts on the road network. Management measures should be selected based on the following hierarchy:

- Avoid
- Minimise
- Manage

Strategies to avoid, minimise and manage impacts include the following:

- Highly sensitive roads should be avoided where possible by adopting an alternative route or implementing escorted travel protocols.
- Implementation of traffic controls including signage (e.g. reduced speed limits, warning signs) and restrictions of movements (e.g. no travel during school bus pick up and set down times). Traffic controls should be the primary mitigation for temporary works including well establishment, gathering line installation, rehabilitation and decommissioning, and in some instances construction of facilities e.g. field compression facilities.
- Maintenance regimes including watering, grading and resheeting to ensure that roads can cope with relatively short peaks in construction traffic and be serviceable throughout the operational phase.
- Provision of protected turning lanes for permanent facilities to address road safety issues.
- Upgrading of unsealed roads by widening and reinforcing the pavement and maintaining the gravel road, or by widening and sealing the road. Such works are likely to be done in consultation with Council and/or TMR.
- Sealing and upgrading of specific sections of feeder roads where a clear impact is identified and attributable to the project activities e.g. upgrading of intersections, widening of roads on corners and crests.
- Sealing and upgrading of feeder roads where they are substandard and road safety issues negate other options.

12.2 OUTLINE MANAGEMENT STRATEGIES

Tables 12.1 to 12.9 outline management strategies developed to manage the project's potential impacts on the values of the road network (road type), based on construction, operation and decommissioning of project facilities (including production facilities, accommodation camps and production wells and gathering lines). Such strategies will be applied to parts of the road network impacted by the Surat Gas Project, taking into consideration the management measure hierarchy outlined above.

Table 12.1 Efficiency: Sealed Roads Management Strategies

Facility	Highway	Regional Connection Road	Rural Connecting Road	Rural Access Road
IPFs, CGPFs and Accommodation Camps	▪ Road may require widening to two lane seal width with sealed shoulders and centre and edge line marking. ▪ Contribution may be required towards more frequent pavement maintenance as a result of increased heavy vehicle movements. ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.			
FCFs	▪ Turn lanes may be required at field compression facility access points. ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.			
Well Sites and Gathering Infrastructure	▪ Temporary road management measures to be implemented, for example temporary road signs advising of reduced speed limits. ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.			

Table 12.2 Efficiency: Unsealed Roads Management Strategies

Facility	Highway	Regional Connection Road	Rural Connecting Road	Rural Access Road
IPFs, CGPFs, and Accommodation Camps	▪ n/a	▪ Typically preferred strategy is sealing of unsealed roads however well maintained gravelled road may be adequate in certain instances if mutual agreement is reached with Council. ▪ Likely sealed form would be two lane seal width with sealed shoulders and centre and edge line marking. ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.		
FCFs	▪ n/a	▪ Temporary traffic management to be implemented, for example road signs stipulating reduced speed limits. ▪ Unsealed road surface may require more frequent maintenance as a result of increased traffic, particularly during the construction and rehabilitation phases. ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.		
Well Sites and Gathering Infrastructure	▪ n/a	▪ Temporary traffic management to be implemented, for example road signs stipulating reduced speed limits. ▪ Unsealed road surface may require more frequent maintenance as a result of increased traffic, particularly during the construction and rehabilitation phases. ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.		

Table 12.3 Safety: Access Roads Management Strategies

Facility	Highway	Regional Connection Road	Rural Connecting Road	Rural Access Road
IPFs, CGPFs and Accommodation Camps	▪ Turn lanes and acceleration lanes may be required at facility accesses. ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.	▪ Turn lanes and acceleration lanes may be required at facility accesses. ▪ Upgrades at nearest highway intersection may be necessary (turn lanes, signage, line marking, etc). ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.	▪ Turn lanes and acceleration lanes may be required at facility accesses. ▪ Upgrades at nearest regional connecting road or highway intersection may be necessary (turn lanes, signage, line marking, etc). ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.	▪ Upgrades at nearest rural connecting road or highway intersection may be necessary (turn lanes, signage, line marking, etc). ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.
FCFs	▪ Turn lanes and acceleration lanes may be required at access. ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.	▪ Turn lanes and acceleration lanes may be required at accesses. ▪ Upgrades at nearest highway intersection may be necessary (turn lanes, signage, line marking, etc) ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.	▪ Turn lanes and acceleration lanes may be required at accesses. ▪ Upgrades at nearest regional connecting road or highway intersection may be necessary (turn lanes, signage, line marking, etc). ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.	▪ Upgrades at nearest rural connecting road or highway intersection may be necessary (turn lanes, signage, line marking, etc). ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.
Well Sites and Gathering Infrastructure	▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.	▪ Upgrades at nearest highway intersection may be necessary during construction phase (turn lanes, signage, line marking, etc). ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.	▪ Upgrades at nearest regional connecting road or highway intersection may be necessary during construction phase (turn lanes, signage, line marking, etc). ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.	▪ Ensure appropriate sight distance at access driveway. ▪ Upgrades at nearest connecting road or highway intersection may be necessary during construction phase (turn lanes, signage, line marking, etc). ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.

Table 12.4 Safety: Bridges Management Strategies

Facility	Highway	Regional Connection Road	Rural Connecting Road	Rural Access Road
IPFs, CGPFs and Accommodation Camps	▪ Facilities may require frequent and long-term use of heavy vehicles, it is recommended that routes avoid substandard bridges. ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.			
FCFs	▪ Alternative routes may need to be investigated to avoid use of sub standard bridges. ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.			
Well Sites and Gathering Infrastructure	▪ Alternative routes may need to be investigated to avoid use of sub standard bridges. ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.			

Table 12.5 Safety: School Bus Routes Management Strategies

Facility	Highway	Regional Connection Road	Rural Connecting Road	Rural Access Road
IPFs, CGPFs, FCFs	▪ High volumes of heavy vehicles may be associated with the facilities and therefore use of school bus routes should be avoided if possible, or carefully managed to avoid conflicts. ▪ Consideration should be given to limiting facility traffic on school bus routes during pick-up and set-down times on school days, alternatively appropriate school bus infrastructure could be installed. ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.			
Accommodation Camps	▪ High volumes of vehicles are associated with the accommodation camps therefore use of school bus routes needs to be avoided if possible, or carefully managed to avoid conflicts. ▪ Consideration should be given to limiting camp traffic on school bus routes during pick-up and set-down times on school days. ▪ Workers residing at accommodation camps should be made aware of school bus routes as well as typical pick-up and drop-off times in the vicinity of the accommodation. ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.			
Well Sites and Gathering Infrastructure	▪ Consideration should be given to limiting project traffic on school bus routes during pick-up and set-down times on school days. ▪ Workers should also be made aware of school bus routes as well as typical pick-up and drop-off times in the vicinity of the work sites. ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.			

Table 12.6 Safety: Rail Crossings Management Strategies

Facility	Highway	Regional Connection Road	Rural Connecting Road	Rural Access Road
IPFs, CGPFs, FCFs and Accommodation Camps	▪ Increase in traffic associated with the project is likely to increase vehicle exposure at rail crossings. ▪ Thresholds assessment to be undertaken to determine if upgrading of the rail crossing is warranted. ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.			
Well Sites and Gathering Infrastructure	▪ Increase in traffic associated with the project is likely to increase vehicle exposure at rail crossings; ▪ Thresholds assessment to be undertaken to determine if upgrading of the rail crossing is warranted. Given the short-term duration of the impact, temporary traffic control may be an alternative mitigation measure; ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.			

Table 12.7 Safety: Drive Fatigue Management Strategies

Facility	Highway	Regional Connection Road	Rural Connecting Road	Rural Access Road
IPFs, CGPFs, FCFs, Accommodation Camps, Well Sites and Gathering Infrastructure	▪ Fatigue management measures should be introduced and enforced for all workers. ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.			

Table 12.8 Amenity: Stock Routes Management Strategies

Facility	Highway	Regional Connection Road	Rural Connecting Road	Rural Access Road
IPFs, CGPFs, FCFs, Accommodation Camps, Well Sites and Gathering Infrastructure	▪ Where there are to be permanent disruptions to the stock route network, DERM requires realignment or replacement of corridors of similar width and suitable country type to allow for the uninterrupted flow of travelling stock. ▪ The stock route network (all or part) disturbed or affected by the proposed works should be rehabilitated upon completion of the project. Where revegetation is required, native vegetation, including pastures, must be used to return the area to its natural state. ▪ Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.			

13 POST-MANAGEMENT STRATEGY SIGNIFICANCE OF RESIDUAL IMPACTS

13.1 IMPACT ON MAGNITUDE POST-MANAGEMENT STRATEGY

It is expected that the magnitude of the project activities will not change with the implementation of management strategies. The magnitude is intrinsically linked to the extent of production which is not likely to be affected by the implementation of road use management strategies.

13.2 IMPACT ON SENSITIVITY POST-MANAGEMENT STRATEGY

It is expected that through the application of management strategies, the sensitivity of road environmental values will be changed, resulting in a change to the significance of impacts.

To gauge the effectiveness of the proposed management strategies, the sensitivity values determined in Section 6 were revisited. The typical characteristics of the road hierarchy types have been reassessed taking into consideration measures that would be implemented on project roads leading to production facilities and accommodation camps. The reassessed typical observations are summarised in Table 13.1.

Table 13.1 Sensitivity Values Post-Management Strategies Implementation

		Value			
	Characteristic	**Highway**	**Regional Connecting Road**	**Rural Connecting Road**	**Rural Access Road**
Description	Function	A high order road of a high standard facilitating linkage between regional centres	A high order road of a high standard facilitating linkage between townships	Lower order road providing links between higher order roads	Low order road providing access to local uses
Typical Observations					
Efficiency	Volumes	1000+ vehicles	300+ vehicles	50+ vehicles	1-100 vehicles
	Pavement	Sealed with improvements	Sealed with improvements	Sealed with improvements	Sealed with improvements
	Standard of intersection control	High order	High order	Low order with improvements	Low order with improvements
Sensitivity of Efficiency		**Low**	**Low**	**Moderate**	**Moderate**
Safety	Bridges	Frequent and high standard	Frequent and high standard	Infrequent and high standard	Infrequent and some works
	Cattle grids	Uncommon	Uncommon	Frequent and higher standard	Frequent and higher standard
	Standard of rail crossing control	Active	Investigate exposure threshold	Investigate exposure threshold	Investigate exposure threshold
	School bus route presence	Present with improved awareness	Present with improved awareness	Present with improved awareness	Present with improved awareness
	Composition of traffic	High proportion of heavy vehicles	Moderate proportion of heavy vehicles	Higher number of heavy vehicles	Higher number of heavy vehicles
	Drive fatigue controls	Present plus driver fatigue management plan	Uncommon plus driver fatigue management plan	Uncommon plus driver fatigue management plan	Uncommon plus driver fatigue management plan
Sensitivity of Safety		**Low**	**Low**	**Moderate**	**Moderate**
Amenity	Stock route co-location	Present but disturbances managed	Present but disturbances managed	Present but disturbances managed	Present but disturbances managed
	Sensitivity of adjacent land uses	Low	Low	Moderate	Moderate
	Potential for dust nuisance issues	Low but managed	Low but managed	Potential but managed	Potential but managed
	Potential for light glare issues	Low but managed	Low but managed	Potential but managed	Potential but managed
Sensitivity of Amenity		**Low**	**Low**	**Moderate**	**Moderate**

In summary, Table 13.1 shows that the sensitivity of the safety, efficiency and amenity of a Highway to changed traffic conditions remains low following implementation of the identified management strategies. The sensitivity of the safety, efficiency and amenity to changed traffic conditions of a Regional Connecting Road is, however, reduced from moderate to low and the sensitivity of a Rural Connecting Road and a Rural Access Road is reduced from high to moderate. **This reduces the significance of the project's impacts from a range of negligible to high to a range of negligible to moderate.**

The adopted significance assessment approach constitutes a strategic assessment of the project's road impacts consistent with the level of project development schedule certainty available at the EIS planning approval stage. This report has identified that there are no impacts so significant (high or major) that they cannot be effectively managed through the implementation of appropriate management strategies. It is recognised that at this strategic level, specific mitigation works cannot be identified. During the detailed project planning phase, consultation will be undertaken with Councils and TMR to identify works at specific locations. Through conditioning the preparation of Road Use Management Plans and the requirement to enter into infrastructure agreements, the road impacts associated with the project can be effectively managed.

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14 CUMULATIVE IMPACTS

To enable stakeholders to make informed decisions, consideration needs to be given to the potential impacts of other major projects in the area to ensure that the combined impacts of the projects are accounted for. Section 7 outlines other projects planned in the wider region with their locations shown on the figure included at Appendix A. Aside from planned infrastructure projects that consist of only a construction phase over a short timeframe, the most significant planned projects in the area will have operations and construction which occur over 30 years or more with most projects intending on commencing construction and production within the next decade.

It is envisaged that a proportion of the other major projects will access their development regions via Gladstone and Rockhampton and therefore their road impacts will occur on roads outside of the project development area. The major projects that are likely to use the road network in and adjacent to the project development area have a combined area of approximately 8,000sq.km to 10,000sq.km. Other major projects in the wider area are assumed to use similar methods and technology to the Surat Gas Project meaning it is likely that their production methods and facilities will generate a similar traffic generation. Therefore, given that the scale of operations of other gas projects is assumed to be similar to the Surat Gas Project, it is likely that over the project life a similar traffic generation is expected assuming similar levels of operation.

With respect to the roads in the project development area, most of the traffic generation by other projects will contribute to traffic volumes on 'through routes' (i.e. only highways) towards the development areas of other projects. There would be negligible cumulative impact on Rural Connecting Roads and Rural Access Roads in the project development area, as these are not typically anticipated to service facilities associated with other projects. Given the previous assumptions and an appreciation of the location of other projects, the following Highways and Regional Connecting Roads within the project development area may experience a cumulative impact:

- Warrego Highway from Toowoomba to Miles.
- Chinchilla-Tara Road south west of Chinchilla to Kogan Condamine Road.
- Dalby-Kogan Road from Dalby to Kogan.
- Kogan Condamine Road to Chinchilla-Tara Road.
- Moonie Highway south-west of Dalby to Surat Developmental Road.

The increase of traffic on these roads over the life of and directly associated with the Surat Gas Project is expected to average 1% to 4% in addition to background traffic volumes. This average maximum of 4% growth will not occur straightaway and is expected to occur over an extended ramp-up period of over a decade. In assuming other projects in the area would generate a similar increase on the road network, the total increase that may be experienced on these roads is 2% to 8%. This equates to approximately two to four years of historical traffic growth.

When considering the impact to the road network and the responsibility of Arrow to contribute to the management of impacts, TMR's position has been extracted from TMR's *Guidelines for Assessment of Road Impacts on Development*, as follows overleaf:

> *Main Roads uses its best endeavours to accommodate development by planning and investing in the road network for expected growth. Main Roads gives high priority to meeting road needs identified in formal planning documents.*

> *It is obviously in the interest of industry and Main Roads if road requirements for development projects are identified and taken into account as part of forward road planning by the department. To this end, Main Roads has regular consultation with industry representatives through future road planning, including annual development of the rolling, five year RIP[1]. However some projects cannot be anticipated – because of the size of the proposed project, short lead times or uncertain start times – and are therefore not included in the department's forward planning.*
>
> *There may already be funds committed as a result of earlier financial planning for the provision for roadworks to accommodate, partly or fully, the road needs of specific development proposals. The prospects of this are enhanced if development proponents consult Main Roads early on their development intentions. However despite best planning endeavours, Main Roads is not always able to provide roadworks as and when required by a specific development proposal because of available funding and competing roadwork priorities.*
>
> *If a development is one of many expected traffic generators that all contribute to the need for roadworks (high mix of users / high growth areas) then development contributions are not generally required. However, if the traffic generated by a development forms a high proportion of total traffic, the development may attract the need for development conditions and/or a contribution for its impacts.*

The above extract summarises TMR's commitment to planning for foreseeable growth on the road network. As discussed before, the anticipated cumulative growth is not unmanageable, being within the range typically accommodated within standard road scheduling practice. To ensure an equitable outcome for all stakeholders of the road network it is envisaged that Arrow will enter into infrastructure agreements with the various road authorities to manage the low and moderate significance residual impacts (i.e. impacts post-implementation of management strategies). Arrow will commit to informing road authorities of planned growth-generating activities via various mechanisms including provision of regular Road Use Management Plans and infrastructure agreements. It is therefore considered that the overall significance of the safety, efficiency and amenity impacts associated with the Surat Gas Project can be effectively managed.

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[1]Refers to 'Queensland Transport and Roads Investment Program' formerly known as 'Roads Implementation Program' (RIP)

15 CONCLUSIONS

- Pre-management strategy impacts analysis indicated that where Rural Access Roads and Rural Connecting Roads are utilised to access production facilities and accommodation camps high significance safety, efficiency and amenity impacts are anticipated. With the application of management strategies this is likely to reduce to moderate significance impacts on these type of roads, due to achieving a reduction in road sensitivity.
- Regional Connecting Roads are anticipated to experience moderate significance safety, efficiency and amenity impacts pre-management strategies. With implementation of management strategies this is likely to reduce to low significance impacts.
- Highways are anticipated to have a low significance of impacts both pre- and post-management strategy implementation. However improvements are still achieved as part of the management strategies.
- Management strategies provide localised treatments to reduce sensitivity of the road network types with a preference towards avoiding the impact, then minimising the impact and then managing the impact.
- Contribution may still need to be made to road authorities to manage moderate and low safety, efficiency and amenity impacts. This will be further investigated once project planning is further progressed via the development of Road Use Management Plans and potential infrastructure agreements.

This Road Impact Assessment constitutes a strategic assessment of the significance of the road impacts associated with the Surat Gas Project. At the strategic level no high or major residual impacts (post-management strategies implementation) are foreseen on the road networks. Local impacts can be managed via consultation with road authorities, preparation of Road Use Management Plans and potentially through infrastructure agreements.

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16 REFERENCES

Guide for the Road Safety Management of Rural School Bus Routes and Bus Stops (Department of Main Roads, 2002)

Guide to Road Safety Part 5: Road Safety Rural and Remote Areas (Austroads, 2006)

Guide to Traffic Engineering Practice Part 2: Roadway Capacity (Austroads, 1999)

Guide to Traffic Management Part 3: Traffic Studies and Analysis (Austroads, 2009)

Guidelines for Assessment of Road Impacts of Development (Department of Main Roads, 2006)

Manual of Uniform Traffic Control Devices Part 7: Railway Crossings (Queensland Government, 2009)

Notes for Contribution Calculations (TMR Central District, 2008)

Road Planning and Design Manual (TMR, 2009)

Road Safety Engineering Risk Assessment Part 7: Crash Rates Database (Austroads, 2009)

Roads Implementation Program 2009-10 to 2013-14 (TMR, 2009)

Rural Road Design: A Guide to the Geometric Design of Rural Roads (Austroads, 2003)

Unsealed Roads Manual: Guidelines to Good Practice (ARRB Transport Research Ltd, 2000)

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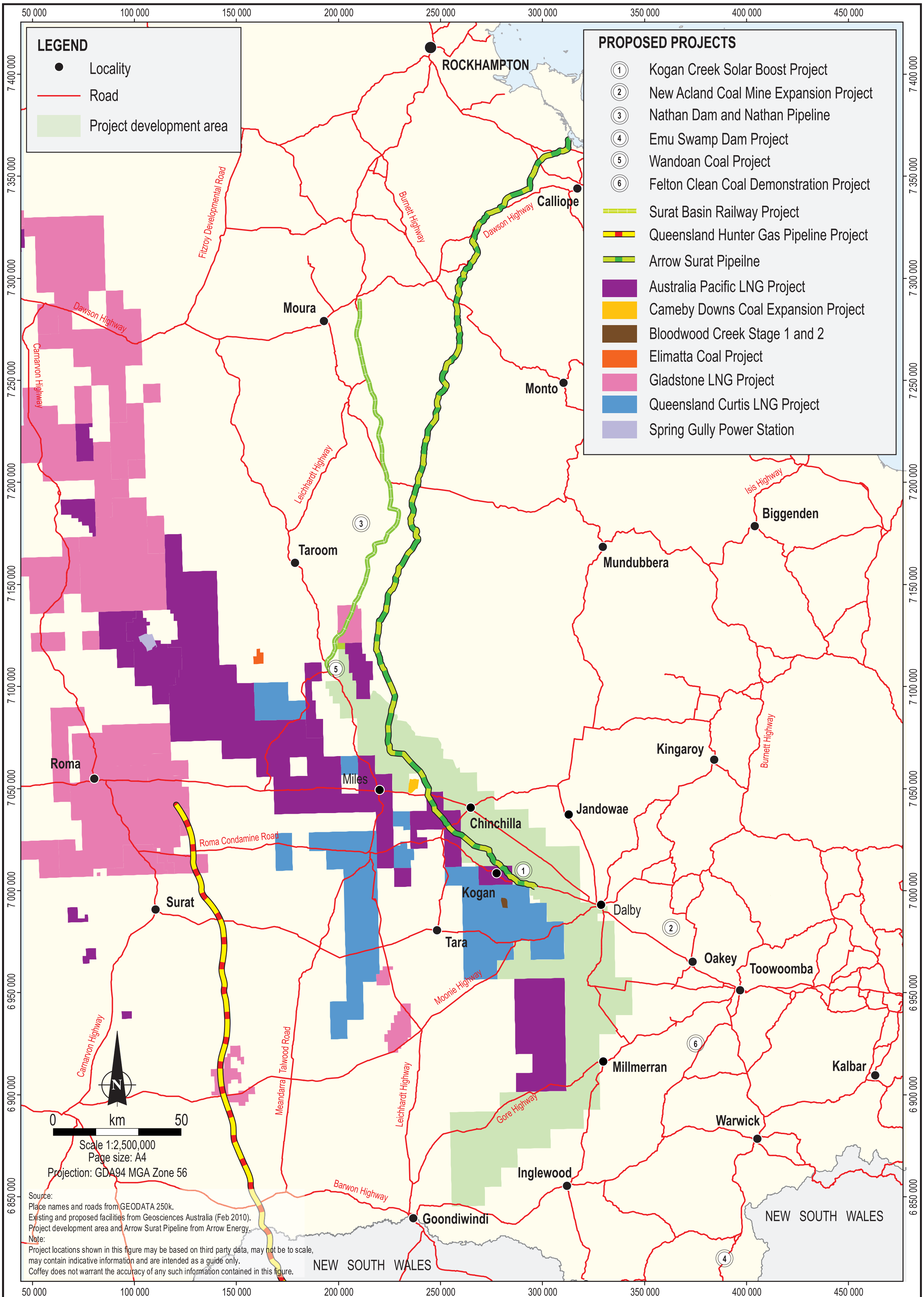
Appendix A

Approximate Locations of Other Projects



coffey environments	Date: 27.04.2011 MXD: 7040AC_04_GIS039_v1_1 File Name: 7040_TS_F001_GIS_GL	Arrow Energy Surat Gas Project	arrow energy go further	Approximate locations of projects to be considered in cumulative impact assessment	Figure No: 1

Appendix B

Project Activities and Traffic Generation

B.1 EXPLORATION PHASE ACTIVITIES

The key traffic generating activities associated with exploration are detailed in the following sections.

B.1.1 COLLECTION OF SEISMIC DATA

Seismic data will be collected by purpose designed vehicles which will, where possible, traverse investigation areas in a straight line grid pattern recording sound waves reflected through the ground from noise generating shot points. In some instances, small shallow wells (upholes) will be drilled although no spoil will be transported on the public road network. Access roads will typically not be established during the collection of seismic data.

Traffic generated during the collection of seismic data will be associated with the movement of sampling vehicles from the Council and State-controlled road networks to and from investigation areas.

The traffic associated with the collection of seismic data will be limited as compared to the quantum of traffic generated by other activities undertaken as part of the Surat Gas Project.

B.1.2 EXPLORATION WELLS (STRATIGRAPHIC HOLES AND CORE SAMPLING)

Exploration wells will be drilled by rigs similar to, but slightly larger than, a standard water bore rig. Prior to exploration well drilling, access roads, flat drilling pads and water handling facilities will be established at each investigation site. Exploration wells comprise stratigraphic holes and core sampling and this phase is expected to be complete within two to five years from commencement of the Surat Gas Project. Establishment of exploration wells will include staff movements as well as transport of materials to and from the wells.

The mix of vehicles generated during the installation of exploration wells will be broadly similar to the vehicle mix generated during the establishment of production wells. A total of approximately 50 exploration wells will be installed as part of the Surat Gas Project over a period of approximately two to five years. The traffic generation of this activity will be limited as compared to other project activities such as the installation of production wells.

As part of the exploration drilling, core samples will be collected by purpose designed vehicles across the extents of the Surat Gas Project typically on a grid spacing of five kilometres. At each investigation site, sampling is likely to take three to ten days dependent upon site conditions. Core sampling is likely to occur for ten hours a day, five days a week.

Traffic generated during the exploration drilling will predominately be associated with the movement of the purpose sampling vehicles, the movement of staff and the movement of core samples to the central laboratory. The level of traffic generated during the collection of samples will be limited compared to the scale of traffic generated by other project activities.

B.1.3 INSTALLATION OF PILOT WELLS

Pilot wells will be installed during the exploration phase to rapidly assess the production levels of the larger gas reserves being targeted. Typically, five to six clustered pilot wells will be located about 200m apart, although this may vary depending on site conditions. Small temporary dams will be constructed at each investigation site to store produced water (except on intensively farmed areas where water will be piped off-site to an existing or new dam away from the intensively farmed area). Fluid pumping will typically occur for three to six months during which time gas flow data will be recorded to confirm the presence or otherwise of a viable gas resource.

A pilot well program comprising five wells will typically take up to 60 days to install. Approximately 50 pilot wells will be installed as part of the overall Surat Gas Project. Pilot testing will typically be conducted for a period of 6 to 24 months.

The nature and quantum of traffic generated during the installation of each pilot well will be broadly similar to that associated with the installation of a production well. The generation of this activity will be limited as compared to other project activities such as the installation of production wells.

B.2 CONSTRUCTION PHASE ACTIVITIES

The key traffic generating activities associated with construction are summarised in the following sections.

B.2.1 INSTALLATION OF PRODUCTION WELLS

The Surat Gas Project will involve the installation of approximately 7,500 production wells dependent upon various environmental, safety and landowner constraints. Under the development scenario presented in the project description, Arrow anticipates that approximately 350 to 400 production wells will be installed on average per year over a 22 year period. The Field and Facility Development Sequence (Reference Case) has been reproduced in Appendix A. As the 'Reference Case' only includes sequencing of 6,270 wells until 2030, the remaining production wells have been averaged across any undeveloped parcels for modelling purposes. These estimated parcels have been evenly allocated for the years 2031 to 2035 in sequential order by parcel number.

During production well installation, a 70m by 70m drilling pad will typically be established which will involve the clearing of vegetation, pad levelling and excavation of temporary pits. A single 32tonne load of aggregate will typically be dispersed during the establishment of each drilling pad to provide basic ground support, where required. Where practical, existing farm access tracks will be utilised to access the well pads although some new unformed roads may need to be cleared and graded on private property. Aggregate will typically not be utilised during the establishment of the private property access roads, unless otherwise agreed with the landholder. This practice is to minimise the impact of Arrow's operations on the existing land uses and is consistent with Arrow's current practices.

Production wells will typically be drilled 150m to 750m deep, dependant on the geology of the individual site. Top drive electric motors will pump produced water out of the well via the inner water tube. This will reduce the static pressure on the coal seam, thereby releasing gas. The material removed from the borehole, referred to as drill cuttings, will be stockpiled onsite.

Once a well becomes operational, the well site footprint will be reduced to a size sufficient to enclose the well infrastructure (approximately 10m x 10m).Operational well sites will be fenced and signposted to prevent public, stock or wildlife access to the wellhead. Produced water will be transported to storage dams and waste liquids will be removed for reuse or disposal. Excavated pits will be backfilled and levelled. Stockpiled soil and rock cuttings will, dependent upon composition, be dispersed across the well site or transported offsite during the initial site rehabilitation.

Field maintenance technicians will, on average, visit each production well daily for the first two weeks after installation. This requirement will reduce over time as the wells become self-sufficient and the well telemetry becomes operational.

Drilling of production wells will typically be conducted in 10 to 12 hour shifts, seven days per week with an average of ten personnel per shift. It is anticipated that it will take ten days on average to install a production well, including drilling, completion works and connection of the well. When forecasting the transport task associated with the project it has been assumed that 100% of the construction phase drilling workforce will be based at construction camps and will travel in light vehicles with 1.5 occupants per vehicle. Occasionally small mobile drilling camps will be constructed depending on the proximity to construction camps however, for the purposes of traffic generation; no mobile camps have been considered.

For the waste generated by drilling, Arrow has estimated that approximately 75cu.m of residual muds will be produced. Assuming a typical density of 1.7tonnes/cu.m and a truck capacity of 20 tonnes; seven heavy vehicle trips have been estimated. It is also assumed that three heavy vehicle trips will be needed for other wastes, resulting in ten heavy vehicle trips associated with the waste component of production well installation. It is assumed that the residual muds will be transported to the nearest Arrow dam (assumed to be located at an integrated processing facility).

Table B.1 summarises the typical heavy and light vehicle generation associated with the establishment of a production well. The traffic generation presented in Table B.1 has assumed that not all construction vehicles move on the external road network; as depending on the property size, there is likely to be multiple well sites per property. This means some construction vehicles move directly between the production well sites on private access roads without actually needing to utilise the public road network. In addition, it has been assumed that some construction material will travel directly from Toowoomba or Brisbane to the construction sites.

Table B.1 Traffic Generation per Production Well Installed

Vehicle Type and Origin	Item	Assumptions	Vehicles per Well
Heavy Vehicles	Construction Materials (including surface equipment)	32 tonnes of aggregate for pad, 10cu.m concrete, 17t of gravel for access roads, 600m of 80mm tubing, 600m of 25mm sucker rods, 600m of casing, wellhead, well separator, associated pumps and generators, 18,000L of fuel	10 *(2 from depot & 8 from Toowoomba/ Brisbane)*
	Construction Vehicles and Equipment *(5 from depot)*	Dozer, grader, excavator, drill rig, support vehicles, amenity huts, water truck, work-over rig, concrete delivery, logging unit	30
	General Wastes *(to IPF)*	Drill cuttings& residual mud, waste drilling water, packaging, pipe racks, consumables, human waste	10
TOTAL HEAVY VEHICLES PER PRODUCTION WELL			**50**
Light Vehicles *(nearest camp)*	Drilling and Completion Workforce	Average of 10 staff per shift travelling in light vehicles (1.5 occupants per vehicle x 10 days per well installed)	67
		Average of 7 'once off' staff(1.5 occupants per vehicle x 2 days per well installed)	10
	Technician Inspections	Daily inspections for first two weeks following installation	14
TOTAL LIGHT VEHICLES PER PRODUCTION WELL			**91**

B.2.2 INSTALLATION OF GATHERING INFRASTRUCTURE

Water and gas gathering lines in addition to electrical and communication connections will be installed to link each production well to a central gas processing facility. The water and gas gathering lines will be constructed of high-density polyethylene pipe (HDPE) of varying diameters between 100mm and 630mm.

Civil machinery will be utilised to undertake the required earth works including excavating the trenches in which the gathering pipelines and conduits will be laid. Pipes will be deployed from a purpose vehicle and joined with a welding solution. Once the gathering system is connected and tested, the trenches will be backfilled. Spoil will not be transported on the external road network.

It has been assumed that 2,200m of water and gas gathering pipe (1,100m for water and 1,100m for gas) will be installed per production well on average, resulting in a total project gathering pipeline requirement of approximately 16,500km of pipe over the life of the project. It is assumed that gathering pipe will be transported from Toowoomba or Brisbane in 20m lengths by extendable vehicles. Each vehicle is assumed to have an average capacity of 400m of pipe based on the forecast pipe diameter mix.

The installation of gathering infrastructure is anticipated to be conducted in 10 to 12hour shifts, seven days a week on a 21 days-on 7 days-off rotation. A gathering installation crew of seven personnel will take on average three days to install 2,200m of gathering pipeline plus the electrical and communication connections. When forecasting the transport task associated with the project, it has been assumed that the gathering installation crews will commute to the gathering infrastructure installation sites in light vehicles with 1.5 occupants per vehicle.

Table B.2 summarises the typical traffic generation associated with the installation of 1,100m of gas and 1,100m of water gathering pipeline (the average gathering pipeline length to be installed) per production well. Similar to production well construction, not all construction vehicles will travel back to the depot, i.e., some will travel on private access roads.

Table B.2 Traffic Generation for Gathering Infrastructure Installation

Vehicle Type and Origin	Item	Assumptions	Vehicles per Well
Heavy Vehicles	Construction Materials *(from Toowoomba/Brisbane)*	1,100m gas pipeline, 1,100m water pipeline, pipe fittings, valves, drains	6
	Construction Vehicles	Purpose 'welding' vehicle, civil machinery (dozer, grader, tractor, gravel truck, water truck & roller, excavator, trencher)	7 *(2 to depot)*
TOTAL HEAVY VEHICLES PER PRODUCTION WELL			**13**
Light Vehicles *(nearest camp)*	Gathering Installation Workforce	7 staff per shift travelling in light vehicles (1.5 occupants per vehicle) x 3 days per 1,100m of gas and 1,100m of water pipeline installed	14
TOTAL LIGHT VEHICLES PER PRODUCTION WELL			**14**

B.2.3 CONSTRUCTION OF HIGH PRESSURE PIPELINE

It is understood that the high-pressure gas pipeline connections from the production facilities to the sales gas pipeline (either the Surat Header or Arrow Surat Pipeline) will be short (on average five kilometres each) in comparison with gathering lines and medium-pressure gas pipelines that will be constructed as part of the Surat Gas Project. The number of vehicle trips anticipated to be associated with the construction of up to 12 high-pressure gas pipeline connections (which fall within the scope of this EIS) are considered limited and have not been considered.

B.2.4 CONSTRUCTION OF FACILITIES

Arrow has proposed three different types of facilities for gas field development:

- Integrated processing facilities (IPF) – 60 to 150TJ/d capacity
- Central gas processing facility (CGPF) – 60 to 150TJ/d capacity
- Field compression facilities (FCF) – 30 to 60TJ/d capacity

Six of each type of facility will be constructed across the project development area, however, the capacity of each facility will vary. An integrated processing facility will be constructed in each development region (two in the Kogan/Millmerran development region) with central gas processing facilities and field compression facilities constructed across the development area, dependant on development needs and constraints. Arrow envisages the construction of approximately one facility per year from 2014 (with two facilities being built in some years and none in others). The assumed vicinity of facilities is shown on Figure 1.3

With the three production facilities described above varying in their capacity, construction schedules will vary accordingly e.g., a 120TJ/d integrated processing facility will require approximately 50 weeks for construction whereas a 150TJ/d integrated processing facility would require approximately 65 weeks. For the purposes of traffic assessment, the construction periods for erecting an integrated processing facility and a central gas processing facility are based on a 120TJ/d capacity, estimated at 55 and 50 weeks respectively. For each facility, an average workforce for the entire construction period has been calculated to allow for the varying workforce numbers over the construction period.

B.2.4.1 Integrated Processing Facility

Integrated processing facilities will receive gas from either medium-pressure gas pipelines from field compression facilities or directly from low-pressure gathering systems. The integrated processing facilities will compress and dehydrate gas in order to be discharged to the high-pressure pipelines at a sales specification. In addition, they will also have water treatment facilities and storage ponds onsite to treat groundwater produced as part of the gas extraction. Six integrated processing facilities will be constructed as part of the Surat Gas Project, with one in each of the development regions (two in the Dalby development region) shown on Figure 1.2.

The construction of an integrated processing facility will typically be conducted in 10 to 12 hour shifts, on a 21 days-on 7 days-off cycle. It is predicted that an integrated processing facility construction workforce will range from 15 to 20 personnel in the first few months, gradually increasing to a peak construction workforce at around 140 personnel and tail off again in the last few months to approximately 30 personnel. Based on this trend, an average workforce for construction of a 120TJ/d integrated processing facility has been estimated to be 90 personnel, comprising mixed trades and disciplines and scheduled to take 55 weeks to construct. For the purposes of traffic generation, it has been assumed that only 75% of the average construction workforce (i.e., 68 personnel) will be onsite and therefore generating traffic movements at any one time given the proposed 21 days-on, 7 days-off cycle.

When forecasting the light vehicle transport task associated with construction of an integrated processing facility, it has been assumed that construction personnel will be housed onsite in construction camps where possible. Five integrated processing facilities will have an associated construction camp which will be in the vicinity of Wandoan (IPF#1), Chinchilla (IPF#1), Millmerran (IPF#1), Dalby (IPF#1) and Goondiwindi (IPF#1). As Dalby IPF#2 will not have an associated construction camp, a provision for light vehicles has been made in Table B.3 for light vehicle and bus trips required for the construction of this integrated processing facility only. It is assumed that 80% of the workforce will come from the nearest construction camp in buses and 20% from the nearest town in light vehicles. Table B.3 summarises the vehicle trips associated with the construction of an integrated processing facility.

Table B.3 Traffic Generation per Integrated Processing Facility Constructed (based on a 120TJ/d facility)

Vehicle Type and Origin	Item	Assumptions	Vehicles per IPF
Heavy Vehicles	Construction Machinery *(nearest depot)*	Excavator, bulldozer, grader, side boom, heavy lift cranes, fuel trucks, pump trucks, scraper, bobcats	25
	Quarry Materials *(nearest depot)*	5,000 cu.m	375
	Construction Materials *(Toowoomba/Brisbane)*	Compressors, power generation equipment, transformers, coolers, dehydration packages, etc	850
	Dam Construction *(nearest depot)*	HDPE, construction equipment, fuel	450
TOTAL HEAVY VEHICLES PER IPF CONSTRUCTED			**1,700**
Buses *(nearest camp)*	IPF Construction Workforce *for Dalby IPF#2 only*	68personnel x 80% (20 seat bus) x 7 days per week x 55 weeks	1,048
TOTAL BUSES PER IPF CONSTRUCTED			**1,048**
Light Vehicles *(nearest town)*	IPF Construction Workforce *for Dalby IPF#2 only*	68 personnel x 20% of workforce x 7 days per week x 55 weeks x (1.5 occupants per light vehicle)	3,491
TOTAL LIGHT VEHICLES PER IPF CONSTRUCTED			**3,491**

B.2.4.2 Central Gas Processing Facility

Central gas processing facilities will receive and process gas in the same manner as an integrated processing facility, however, they will not have water treatment facilities. Central gas processing facilities will have water transfer stations and surge dams. Water received from pipelines or wells will be piped to a water transfer station and pumped to an integrated processing facility. Therefore the construction workforce size will be slightly less than that for an integrated processing facility. For the purposes of the traffic assessment, the average central gas processing facility construction workforce size, 75 personnel, is based on the average workforce required for the duration of the construction period for a 120TJ/d facility. Construction is anticipated to take 50 weeks with personnel working 10 to 12 hour shifts, seven days a week on a 21 days-on 7 days-off cycle. For the purposes of traffic generation, it has been assumed that only 75% of the average construction workforce (i.e., 57 personnel) will be onsite at any one time given the proposed 21 days-on, 7 days-off cycle. Based on the prediction that 20% of the construction workforce will be sourced locally, it is assumed that 80% of the construction workforce will be based at camp and will travel by bus to site each day. Table B.4 summarises the heavy vehicle, bus and light vehicle trips associated with the construction of a central gas processing facility.

Table B.4 Traffic Generation per Central Gas Processing Facility Constructed (based on a 120TJ/d facility)

Vehicle Type and Origin	Item	Assumptions	Vehicles per CGPF
Heavy Vehicles	Construction Machinery *(nearest depot)*	Excavator, bulldozer, grader, side boom, heavy lift cranes, fuel trucks, pump trucks	25
	Quarry Materials *(nearest depot)*	5,000 cu.m	375
	Construction Materials *(Toowoomba/Brisbane)*	Compressors, power generation equipment, transformers, coolers, dehydration equipment, building materials	680
	Dam Construction (*nearest depot)*	HDPE, construction equipment, fuel	50
TOTAL HEAVY VEHICLES PER CGPF CONSTRUCTED			**1,130**
Buses *(nearest camp)*	CGPF Construction Workforce	57 personnel x 80% (20 seat bus) x 7 days per week x 50 weeks	798
TOTAL BUSES PER CGPF CONSTRUCTED			**798**
Light Vehicles *(nearest town)*	CGPF Construction Workforce	57 personnel x 20% of workforce x 7 days per week x 50 weeks x (1.5 occupants per light vehicle)	2,660
TOTAL LIGHT VEHICLES PER CGPF CONSTRUCTED			**2,660**

B.2.4.3 Field Compression Facility

Field compression facilities will be located between wells and central gas processing facilities or integrated processing facilities where wellhead pressure is not sufficient to transport the gas the required distance. The average construction workforce size is based on construction of the 60TJ/d size facility. The average workforce size for the duration of the construction period is predicted to be approximately 35 personnel, with construction lasting 28 weeks. The construction workforce will work 10 to 12 hour shifts, seven days a week on a 21 days-on 7 days-off cycle. For the purposes of traffic generation, 75% of the average workforce size has been assumed to be onsite at any one time (given the proposed 21 days-on, 7 days-off cycle) resulting in an estimated 27 persons onsite. Based on the prediction that 20% of the construction workforce will be sourced locally, it is assumed that 80% of the construction workforce will be based at camp and will travel by bus to site each day.

Table B.5 summarises the heavy vehicle, bus and light vehicle movements associated with the construction of an field compression facility.

Table B.5 Traffic Generation per Field Compression Facility Constructed (based on a 60TJ/d facility)

Vehicle Type and Origin	Item	Assumptions	Vehicles per FCF
Heavy Vehicles	Construction Machinery *(nearest depot)*	Excavator, bulldozer, grader, side boom, heavy lift cranes, fuel trucks, pump trucks	25
	Quarry Materials *(nearest depot)*	1,500cu.m	125
	Construction Materials *(Toowoomba/Brisbane)*	Compressors, power generation equipment, transformers, building materials	350
TOTAL HEAVY VEHICLES PER FCF CONSTRUCTED			**500**
Buses *(nearest camp)*	FCF Construction Workforce	27 personnel x 80% (20 seat bus) x 7 days per week x 28 weeks	212
TOTAL BUSES PER FCF CONSTRUCTED			**212**
Light Vehicles *(nearest town)*	FCF Construction Workforce	27personnelx 20% of workforce x 7 days per week x 28 weeks per year(1.5 occupants per light vehicle)	706
TOTAL LIGHT VEHICLES PER FCF CONSTRUCTED			**706**

B.2.5 CONSTRUCTION OF CONSTRUCTION WORKERS' CAMPS

Camps will be established to accommodate the construction workforces associated with construction of the production wells, gathering infrastructure and processing facilities. Arrow proposes that these camps be located adjacent to integrated processing facility construction sites to minimise the extent of commuting. Five integrated processing facilities will have an associated construction camp; these will be in the vicinity of Wandoan IPF#1, Chinchilla IPF#1, Millmerran IPF#1, Dalby IPF#1 and Goondiwindi IPF#1.

The construction camps will be purpose-built for the construction phase which will prevail over most of the project life, with production wells continually being drilled. Initially, each campsite will be developed over four weeks to accommodate approximately 150 to 300 workers for approximately five years at each camp. Following the peak construction period within each development region, camps will be maintained to accommodate the production well drillers and camp sizes will be reduced for the rest of the project life to accommodate approximately 70 workers who will be focussed on field development works (pipelines and drilling). It is anticipated that each camp will accommodate an average of 100 workers over the life of the camp.

The movement of heavy vehicles associated with the establishment of the construction camps is summarised in Table B.6. The quantum of light vehicle traffic generated during establishment of the accommodation facilities will be limited as compared to other project activities.

Table B.6 Traffic Generation per Construction Camp Established

Vehicle Type and Origin	Item	Assumptions	Vehicles per Camp
Heavy Vehicles *(nearest depot)*	Quarry Materials	2,000cu.m	150
	Modular Buildings	Accommodation rooms, mess, offices, communal facilities	450
TOTAL HEAVY VEHICLES PER CONSTRUCTION CAMP ESTABLISHED			**600**

B.3 OPERATION AND MAINTENANCE PHASE ACTIVITIES

The key traffic generating activities undertaken during the operation and maintenance phase of the Surat Gas Project are summarised in the following sections.

B.3.1 PRODUCTION WELL OPERATION AND MAINTENANCE

The production wells established as part of the Surat Gas Project are anticipated to operate for 15 to 20 years following installation, although individual wells may experience shorter or longer lives. For the purposes of the Road Impact Assessment it has been assumed that each production well will operate for 20 years on average.

Engine servicing and maintenance will occur up to 12 times per year on average via heavy vehicles, for the first eight years of well life. A limited number of non-routine intervention maintenance visits will be required per year across the extents of the project development area. Approximately one operator has been allowed per 50 wells, and as they will work five days a week, it has been assumed that each well will have approximately five days of maintenance a year.

In addition to maintenance activities, production wells will also need to be 'worked over' on average once every three years. Well workovers will involve the re-installation of the downhole pump and tubes to ensure continued free flow of gas and water. Well workovers will be undertaken by a rig similar to the initial installation rig and will generate a similar level of traffic to well installation, including water truck, material delivery and waste removal. Each workover is estimated to take four days utilising seven staff. It has been assumed that staff will travel from the nearest town.

The movement of vehicles associated with the operation and maintenance of production wells is summarised in Table B.7.

Table B.7 Annual Traffic Generation per Production Well

Vehicle Type and Origin	Item	Assumptions	Vehicles per Well
Heavy Vehicles *(nearest IPF)*	Engine Servicing and Maintenance	Up to 12 HV a year for 8 years	5 (average)
	Well workovers	Well work-over vehicles and materials	4
TOTAL ANNUAL HEAVY VEHICLES PER PRODUCTION WELL			**9**
Light Vehicles *(nearest town)*	Inspection and Maintenance	5 days of maintenance by 1 operator	5
	Workover	7staff for 4 days every 3 years	12
TOTAL ANNUAL LIGHT VEHICLES PER PRODUCTION WELL			**17**

B.3.2 GATHERING INFRASTRUCTURE OPERATION AND MAINTENANCE

The traffic generating activities associated with operation of gathering infrastructure will be isolated to periodic adjustment of valves, vents and drains and pipeline route management.

Regular inspections of the pipeline routes will be undertaken to monitor and manage vegetation and erosion. As the majority of the production well access tracks will utilise pipeline routes, this activity will typically be performed concurrently with production well site inspections. Periodic checks of the pipeline infrastructure will also be undertaken to ensure that deterioration of the pipeline has not occurred, and to conduct maintenance of vegetation (e.g. weed control) and erosion control along the easement. In the unlikely event that an issue occurs a response crew would need to conduct repairs.

The quantum of heavy vehicle traffic associated with the maintenance and operation of gathering infrastructure will be limited as compared to the heavy vehicle traffic generated by other project activities. Light vehicle traffic is accounted for under production well operation and maintenance because Arrow intends to inspect gathering systems at the same time as inspecting the wells.

B.3.3 FACILITY OPERATION AND MAINTENANCE

The vehicle movements for each type of facility are discussed in the following sections.

B.3.3.1 Integrated Processing Facilities

Integrated processing facilities will operate continuously, although typically the facilities will only be staffed for ten hours a day, five days per week, with monitoring conducted from a remote facility outside staffed periods. Depending on the level of automation ultimately implemented, the daily workforce will comprise approximately 15 to 20 personnel. These personnel are likely to travel to the integrated processing facilities at the start and end of each shift in single occupant light vehicles from nearby townships. The integrated processing facilities are likely to operate at full capacity for an effective period of 20 years on average. This assumes that there will be a period of ramping up and ramping down of operation at the integrated processing facilities as a result of wells coming online at the start of the project and wells being decommissioned at the end of their life. The overall life of an IPF for modelling purposes has been assumed to be 25 years including allowance for ramping up and ramping down.

The integrated processing facilities will generate an average of two heavy vehicles for five days each week associated with the delivery of consumables and with the removal of waste (other than brine). Whilst the preferred solution for brine disposal is to treat it for beneficial use (as salt or soda ash), a worst case scenario whereby brine is transported to a registered landfill has been considered. Arrow has advised that this worst case scenario would commence 10 years after the first integrated processing facility comes online and will continue for the life of the project. After an integrated processing facility has been operating for 10 years, it would produce four (average production) to six (peak production) trucks per day per integrated processing facility. For modelling purposes, it has been assumed that an average of five trucks per day per integrated processing facility will be generated after 10 years of operation. In addition it has been nominally assumed that brine will be transported to Swanbank as this is the nearest registered landfill for brine disposal. For the purposes of modelling however, only the component of travel within the Darling Downs Region (bounded by Toowoomba to the east) has been included.

Table B.8 summarises the typical vehicle generation associated with the operation and maintenance of an integrated processing facility.

Table B.8 Annual Traffic Generation per Integrated Processing Facility

Vehicle Type and Origin	**Item**	**Assumptions**	**Vehicles per IPF**
Heavy Vehicles	Consumables and Wastes *(nearest depot)*	2 per day x 5 days per week x 52 weeks	520
	Brine Removal *(Swanbank)*	5 per day x 365 days (*after 10 years of operation)*	1,825
TOTAL ANNUAL HEAVY VEHICLES PER IPF			**2,345**
Light Vehicles *(nearest town)*	IPF Operation Workforce	20 personnel x 260 days	5,200
TOTAL ANNUAL LIGHT VEHICLES PER IPF			**5,200**

B.3.3.2 Central Gas Processing Facilities

Central gas processing facilities will operate in a similar fashion to an IPF, although with an assumed smaller workforce and hence smaller consumables and waste production. The daily workforce will comprise approximately 10 to 15 personnel, dependant on the level of automation ultimately implemented. The CGPFs will generate an average of one heavy vehicle associated with the delivery of consumables and with the removal of waste each day, five days a week. The central gas processing facilities are likely to operate at full capacity for an effective period of 20 years on average, however, including allowance for ramping up and ramping down the overall life of a central gas processing facility has been assumed as 25 years for modelling. Table B.9 summarises the typical vehicle generation associated with the operation and maintenance of a central gas processing facility.

Table B.9 Annual Traffic Generation per Central Gas Processing Facility

Vehicle Type and Origin	Item	Assumptions	Vehicles per CGPF
Heavy Vehicles *(nearest depot)*	Consumables and Wastes	1 per day x 5 days per week x 52 weeks	260
TOTAL ANNUAL HEAVY VEHICLES PER CGPF			**260**
Light Vehicles *(nearest town)*	CGPF Operation Workforce	15 personnel x 260 days	3,900
TOTAL ANNUAL LIGHT VEHICLES PER CGPF			**3,900**

B.3.3.3 Field Compression Facility

Field compression facilities will be operated remotely with manning for maintenance purposes only and staff will be on call to respond to emergency situations. The quantum of trips to and from field compression facilities is assumed to be limited over their operating lifetime. The field compression facilities are likely to operate at full capacity for an effective period of 20 years on average, however, including allowance for ramping up and ramping down, the overall life of a field compression facility has been assumed as 25 years for modelling. Table B.10 summarises the typical vehicle generation associated with the operation and maintenance of field compression facilities.

Table B.10 Annual Traffic Generation per Field Compression Facility

Vehicle Type and Origin	Item	Assumptions	Vehicles per FCF
Heavy Vehicles *(nearest IPF)*	FCF Operation Workforce	1 vehicle x 3 days per week x 52 weeks	156
TOTAL ANNUAL HEAVY VEHICLES PER FCF			**156**
Light Vehicles *(nearest IPF)*	FCF Operation Workforce	1 vehicle x 3 days per week x 52 weeks	156
TOTAL ANNUAL LIGHT VEHICLES PER FCF			**156**

B.3.4 CONSTRUCTION CAMP OPERATION AND MAINTENANCE

The traffic generation associated with the on-going operation and maintenance of the construction camps has been considered to occur as part of the project's construction phase; as the camps will operate predominantly during the construction of adjacent integrated processing facilities and other facilities, and the construction camps will be decommissioned once the associated construction activities are completed. The traffic generation for the construction camps has, however, been considered on a per annum basis as the camps are likely to operate for an extended period of time. Trips for the start and end of roster have been assumed to be to and from Toowoomba for traffic modelling purposes. In addition, a nominal allowance for recreational trips to the nearest town has been included.

Table B.11 summarises the typical traffic generation associated with the ongoing operation and maintenance of the integrated processing facility construction camps.

Table B.11 Annual Traffic Generation per Construction Camp

Vehicle Type and Origin	Item	Assumptions	Vehicles per Camp
Heavy Vehicles *(nearest depot)*	Consumables and Wastes (local landfill)	3 per day x 6 days per week x 52 weeks	936
TOTAL HEAVY VEHICLES PER CAMP			**936**
Light Vehicles	Recreational Trips *(to nearest town)*	100 staff x 3 trips per 21 days on x 13times per year (based on a 21 days on/7 days off roster)	3,900
	Roster Start/End Trips *(to Toowoomba/Brisbane)*	100 staff x 13 times per year (based on a 21 days on/7 days off roster)	1,300
TOTAL LIGHT VEHICLES PER CAMP			**5,200**

B.4 DECOMMISSIONING AND REHABILITATION PHASE ACTIVITIES

The key traffic generating activities undertaken during the decommissioning phase of the Surat Gas Project are detailed in the following sections.

B.4.1 PRODUCTION WELL DECOMMISSIONING AND REHABILITATION

The 7,500 production wells installed as part of the Surat Gas Project are anticipated to have an average life of 20years after which time they will be decommissioned. Decommissioning will involve the removal of all surface infrastructure and rehabilitation of the well site. A drill rig will be utilised to cut the well casing off approximately 1m below the ground surface. The remnant well will be plugged with concrete. During rehabilitation, drainage lines and pasture species will be re-established. Well sites will be rehabilitated to a standard consistent with surrounding land uses or as agreed with the landholder.

During the decommissioning and rehabilitation of production well sites; graders, excavators, tip trucks, low loaders, rough terrain cranes, fuel delivery trucks and coaster buses are likely to be utilised dependant on site conditions. Table B.12 summarises the typical traffic generation associated with the decommissioning of production wells. Teams of five personnel from the local area are anticipated to decommission each production well, however, all trips are assumed to originate from the nearest depot.

Table B.12 Traffic Generation per Production Well Decommissioned

Vehicle Type and Origin	Item	Assumptions	Vehicles per Well
Heavy Vehicles *(nearest depot)*	Rehabilitation Vehicles	Decommissioning rig, support vehicles	6
	Infrastructure Removal	Wellhead, well separator, fencing, etc	4
TOTAL HEAVY VEHICLES PER PRODUCTION WELL DECOMMISSIONED			**10**
Light Vehicles *(nearest depot)*	Production Well Decommissioning Workforce	5 personnel x 2 days	10
TOTAL LIGHT VEHICLES PER PRODUCTION WELL DECOMMISSIONED			**10**

B.4.2 GATHERING INFRASTRUCTURE DECOMMISSIONING AND REHABILITATION

The gathering infrastructure will be decommissioned once the production wells reach the end of their effective life. Decommissioning will include flooding and capping of gathering infrastructure. Table B.13 summarises the typical heavy vehicle traffic generation associated with the decommissioning of 1,100m of gas and 1,100m of water gathering infrastructure. Light vehicle traffic generation is anticipated to be limited as compared to other project activities.

Table B.13 Traffic Generation for Gathering Infrastructure Decommissioning

Vehicle Type and Origin	Item	Assumptions	Vehicles per Gathering Infrastructure Section
Heavy Vehicles *(nearest depot)*	Rehabilitation Vehicles	Backhoe, support vehicle	2
TOTAL HEAVY VEHICLES PER PRODUCTION WELL DECOMMISSIONED			**2**

B.4.3 FACILITY SITE DECOMMISSIONING AND REHABILITATION

Decommissioning and rehabilitation of each facility is likely to occur as a combined project activity. Major plant and equipment such as compressors, gas engines, reverse osmosis units and transfer pumps will, wherever practical, be reused elsewhere in Arrow's developments across the Surat Basin or elsewhere. Following removal of all equipment and surface features, the site will be graded and levelled or contoured as appropriate. Topsoil will be spread and the land will be seeded. Earthmoving and construction equipment such as graders, excavators, tip trucks, low loaders, rough terrain cranes, fuel delivery trucks and coaster buses will be utilised. It has been assumed that all light vehicle trips to facilities for decommissioning will occur from the nearest depot with 1.5 occupants per vehicle.

B.4.3.1 Integrated Processing Facilities

The decommissioning of an integrated processing facility will involve up to 80 persons from the local area for a period of eight months.

Dams will be rehabilitated unless other arrangements are made with future landowners. Table B.14 summarises the typical traffic generation associated with the decommissioning of an integrated processing facility.

Table B.14 Traffic Generation per Integrated Processing Facility Decommissioned

Vehicle Type and Origin	Item	Assumptions	Vehicles per IPF
Heavy Vehicles *(nearest depot)*	Rehabilitation Vehicles	Decommissioning rig, support vehicles	25
	Infrastructure Removal	Facilities, gathering lines, fencing, etc	575
TOTAL HEAVY VEHICLES PER IPF DECOMMISSIONED			**600**
Buses *(nearest camp)*	Rehabilitation Workforce	80 personnel x 80% x 7 days per week x 35 weeks (20 persons/bus)	784
TOTAL BUSES PER IPF DECOMMISSIONED			**784**
Light Vehicles *(nearest depot)*	Rehabilitation Workforce	80 personnel x 20%x 7 days per week x 35 weeks (1.5 persons/vehicle)	2,613
TOTAL LIGHT VEHICLES PER IPF DECOMMISSIONED			**2,613**

B.4.3.2 Central Gas Processing Facilities

The decommissioning process for a central gas processing facility will be similar to that of an integrated processing facility. It is anticipated that up to 50 persons for a period of eight months will be required to decommission a central gas processing facility. Table B.15 summarises the vehicle movements associated with the decommissioning of a central gas processing facility.

Table B.15 Traffic Generation per Central Gas Processing Facility Decommissioned

Vehicle Type and Origin	Item	Assumptions	Vehicles per CGPF
Heavy Vehicles *(nearest depot)*	Rehabilitation Vehicles	Decommissioning rig, support vehicles	25
	Infrastructure Removal	Facilities, gathering lines, fencing, etc	575
TOTAL HEAVY VEHICLES PER CGPF DECOMMISSIONED			**600**
Buses *(nearest camp)*	Rehabilitation Workforce	50 personnel x 80% x 7 days per week x 35 weeks (20 persons/bus)	490
TOTAL BUSES PER CGPF DECOMMISSIONED			**490**
Light Vehicles *(nearest depot)*	Rehabilitation Workforce	50 personnel x 20%x 7 days per week x 35 weeks (1.5 persons/vehicle)	1,633
TOTAL LIGHT VEHICLES PER CGPF DECOMMISSIONED			**1,633**

B.4.3.3 Field Compression Facility

It is anticipated that up to 25 persons for a period of four months will be required to decommission a field compression facility. Table B.16 summarises the estimated movements associated with the decommissioning of a field compression facility.

Table B.16 Traffic Generation per Field Compression Facility Decommissioned

Vehicle Type and Origin	Item	Assumptions	Vehicles per FCF
Heavy Vehicles *(nearest depot)*	Rehabilitation Vehicles	Decommissioning rig, support vehicles	9
	Infrastructure Removal	Facilities, gathering lines, fencing, etc	192
TOTAL HEAVY VEHICLES PER FCF DECOMMISSIONED			**201**
Buses *(nearest camp)*	Rehabilitation Workforce	25 personnel x 80% x 7 days per week x 17 weeks (20 persons/bus)	119
TOTAL BUSES PER FCF DECOMMISSIONED			**119**
Light Vehicles *(nearest depot)*	Rehabilitation Workforce	25 personnel x 20% x 7 days per week x 17 weeks (1.5 persons/vehicle)	397
TOTAL LIGHT VEHICLES PER FCF DECOMMISSIONED			**397**

B.4.4 CONSTRUCTION CAMP DECOMMISSIONING

Table B.17 summarises the typical heavy vehicle generation anticipated to be associated with decommissioning of construction workforce accommodation. It is anticipated that the decommissioning will involve up to 30 persons from the local area for a period of one month.

Table B.17 Traffic Generation per Construction Camp Decommissioned

Vehicle Type and Origin	Item	Assumptions	Vehicles per Camp
Heavy Vehicles *(nearest depot)*	Infrastructure Removal	Quarry materials, modular buildings	600
TOTAL HEAVY VEHICLES PER CAMP DECOMMISSIONED			**600**
Light Vehicles *(nearest depot)*	Rehabilitation Workforce	30 personnel x 5 days per week x 4 weeks (1.5 persons/vehicle)	400
TOTAL LIGHT VEHICLES PER CAMP DECOMMISSIONED			**400**

Appendix C

Development Schedule

Table 2.1 Field and Facility Development Sequence (Reference Case)

Year	Parcel numbers developed	Development Region	Facility	Facility capacity (TJ/d)	Cumulative installed capacity (TJ/d) †	Total wells commissioned for year	Cumulative total gas production (TJ/d)
2013	–	–	–	–	–	–	0
2014	22, 12	Wandoan	Wandoan IPF1#	120	120	174	0
2015	63, 8, 60	Dalby/Wandoan	Dalby IPF2	90	210	233	119
2016	4, 56	Wandoan/Dalby	Wandoan CGPF1# and Dalby IPF1	150 150	360 510	365	300
			*Full Length of Arrow Surat Pipeline commissioned				
2017	64, 55, 59, 16, 27	Wandoan/Dalby	Wandoan CGPF2	150	660	386	490
2018	23, 67, 66	Dalby/Wandoan/ Millmerran	Dalby FCF1#	60	660	497	676
2019	57, 58	Dalby/Millmerran	Dalby CGPF1 Millmerran FCF2	150 60	810 810	196	866
2020	3, 9, 72, 73, 85, 17, 13, 24	Millmerran/Wandoan /Chinchilla	Millmerran IPF1	120	930	456	970
2021	75, 76	Millmerran	Chinchilla IPF1	150	1,080	464	
2022	44, 45, 78, 38, 39, 43	Chinchilla/ Millmerran	Chinchilla CGPF1	150	1,230	382	
2023	34	Chinchilla	-	-	1,230	166	
2024	2, 18, 28, 29, 31, 46	Wandoan/Chinchilla /Kogan	-	-	1,230	351	
2025	61	Millmerran	Millmerran FCF3	60	1,230	311	
2026	62, 65, 68, 70	Millmerran	-	-	1,230	305	

Table 2.1 Field and Facility Development Sequence (cont'd)

Year	Parcel numbers developed	Development Region	Facility	Facility capacity (TJ/d)	Cumulative installed capacity (TJ/d)	Total wells commissioned for year	Cumulative total gas production (TJ/d)
2027	69, 71	Millmerran	-	-	1,230	152	970 TJ/d maintained
2028	74, 79, 80, 81	Millmerran	Millmerran CGPF1	90	1,320	440	
2029	10, 32, 35, 82, 83, 84	Millmerran/Wandoan /Chinchilla	Millmerran FCF4	30	1,320	361	
2030	40, 47, 51, 52, 53	Chinchilla/Kogan	Millmerran FCF1	30	1,320	733	
2031	Parcels beyond 2030 yet to be defined	Goondiwindi	Facilities anticipated beyond 2030 Goondiwindi IPF1	120	1,440	308	
2032		Goondiwindi			1,440		
2033		Goondiwindi	Goondiwindi FCF1	30	1,440		
2034		Goondiwindi					
2035		Goondiwindi	Goondiwindi CGPF1	90	1,530		

Note[#]: FCF = field compression facility, CGPF = central gas processing facility, IPF = integrated processing facility.
Note*: High pressure pipeline infrastructure (as yet undefined) will be installed to ensure that gas from the facilities that are developed before 2016 can be distributed for use.
Note[†]: Cumulative installed capacity may grow as indicated, but operational capacity will likely be maintained at 1,100 TJ/d.

Table 2.2 Summary of Facilities by Development Region

Development Region	Integrated processing facilities	Central gas processing facilities	Field Compression facilities
Dalby	2	1	1
Wandoan	1	2	0
Chinchilla	1	1	0
Millmerran/Kogan	1	1	4
Goondiwindi	1	1	1
Total number of facilities	**6**	**6**	**6**