Resources Rail Lines

Final Report

(Project Phase One)

Great state. Great opportunity.

Queensland Government

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Executive Summary

A key action of the state government's *Moving Freight a strategy for more efficient freight movement* (TMR December 2013) is to "improve regional rail for agricultural and general freight".

In support of this action, the Department of Transport and Main Roads (TMR) has undertaken the Resources Rail Lines – Link Planning study project (the project), focussed on the Central Queensland region (CQ). Improving the supply chain performance of the region's freight network has the potential to contribute to the state government's plan to grow a Four Pillar economy by facilitating the expanded development of agriculture, resources, tourism and construction.

The Transport, Housing and Local Government Committee (THLGC) has recently conducted a parliamentary inquiry into rail freight use by the agricultural and livestock industries. The inquiry included an evaluation of ways to expand the use of rail freight to support the agricultural sector by "planning strategically-located, inter-connected hubs".

This report contains significant technical and other data which has been acquired during the project and the results of a number of detailed evaluations undertaken.

Growing demand for the transport of significant mining input materiel (particularly fuel) to the Bowen and Galilee basins has been identified as presenting a potential opportunity to increase the use of the existing narrow gauge rail infrastructure in the region while also presenting the potential for increased rail use by the agricultural and construction industries.

The region is currently serviced by the connected Blackwater Coal (Aurizon) and the Queensland Rail Central West rail systems. Rail transport services (other than Aurizon coal trains) and the maintenance of the existing Central West rail system are currently supported through the state's Transport Service Contracts (TSC). The opportunities evaluated in this report also have the potential to improve the financial viability of the rail system and the efficiency and effectiveness of government funding in supporting rail access in the region.

During the initial stage of the project TMR worked closely with the Department of State Development, Infrastructure and Planning (DSDIP) to identify future potential transport needs (individually and in aggregate) of mining input materiel to support the operational stages of a number of proposed large scale mine developments in the Galilee Basin. The information gathered indicated the potential for large scale movement of mine freight inputs (fuel in particular) to be transported daily over a distance exceeding 365 kilometres from the coast to prospective inland mine facilities. There are also a number of smaller existing mines which rely on similar transport at present.

The number of daily heavy road vehicle movements, driver fatigue (hours of work) regulations, the distance (time) travelled and a 50/50 loaded/empty movement ratio may present significant challenges to the road transport industry if it were required to exclusively provide the required transport services to the new mine locations.

A key enabler for promoting the increased use of the rail systems is the development of supporting rail terminal handling capability between the ports of Mackay and Gladstone and remotely in areas such as Emerald and Alpha. Such capacity, along with a shift to containerisation of all freight as the corridor standard, may enable the consolidation of freight in sufficient volumes to enable additional rail services to the region.

TMR has undertaken extensive consultation and collaborative discussions with the Central Highlands Regional Council, major fuel importers, agricultural producers, third party terminal operators, and landowners during the project.

The report evaluated:

- The potential impacts of the increased freight task on road safety and level of service on the Capricorn Highway, Gregory Highway and the Gregory Development road.
- The condition and capacity of the rail systems and their potential to support the expanded use of rail to transport mining inputs from regional ports and South East Queensland and agricultural products to the coast.
- Modal contestability of the relevant freight task.
- How an "inland port" could increase the aggregation of select cargo types to support a staged investment strategy using ISO-Tank containers to move fuel on rail from regional ports, before progressing larger scale investment in new tank container farms at or near Alpha.

- The potential to load and transport agricultural freight for export in containers to take advantage of improved rail access via the Port of Gladstone/Brisbane.

The concept for aggregating mining inputs and agricultural outputs to make greater use of existing below rail infrastructure and above rail services provided the catalyst for identifying a suitable location for an Inland Port at the start of this study.

The Central Highlands Regional Council (CHRC) assisted TMR in identifying potential sites for an inland port based on the Central Highlands Strategic Framework (Future Directions for Land Use Planning 2031) which identifies a potential industrial site at Yamala (east of Emerald) with links to both rail and road.

Discussions between TMR, landowners, industry and local government have taken place to facilitate potential investment opportunities to develop below rail infrastructure and an inland port facility that could support additional rail services via the Blackwater system.

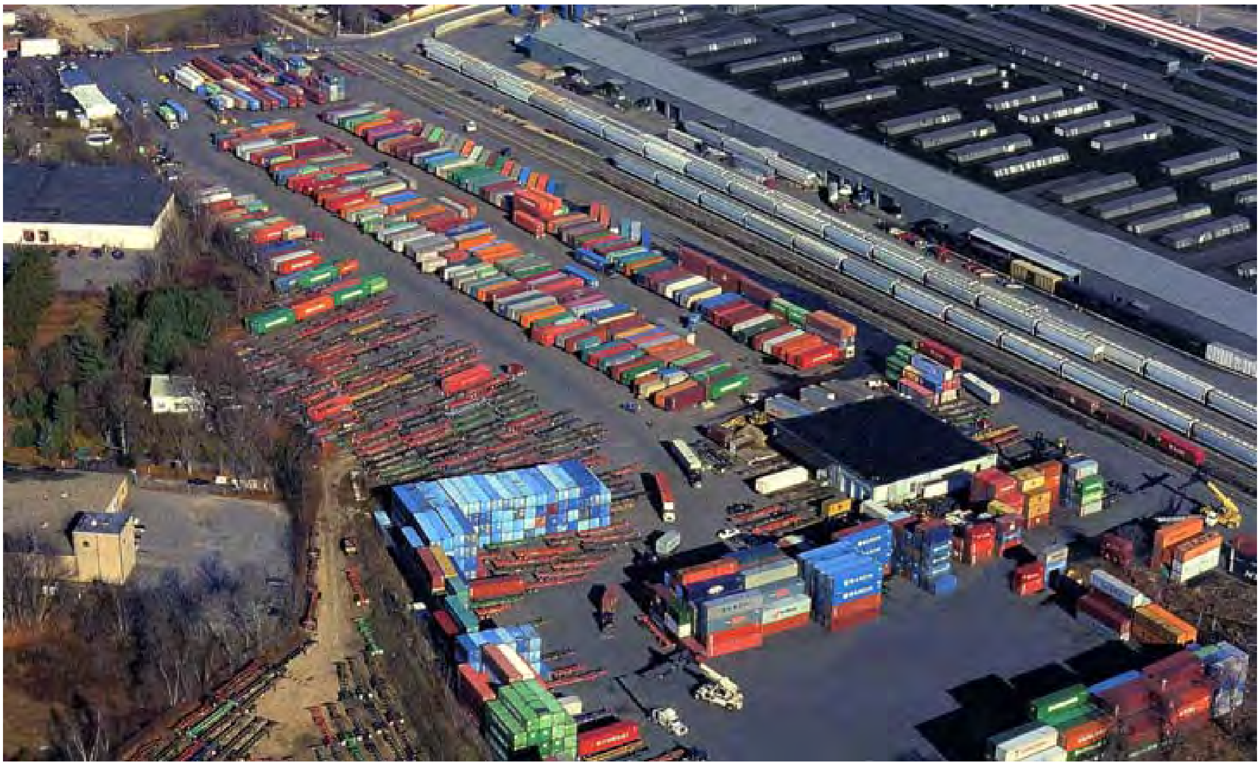
Key observations:

- There is the potential for up to 500,000 tonnes of fuel to be transported annually to the proposed new Galilee basin mines when operational. At 25 tonnes per loaded B-double road vehicle, this would equate to approximately 385 (770 round trip) loaded heavy vehicle movements per week over a distance exceeding 365 kilometres.
- The range of mining inputs extends beyond fuel and includes significant volumes of grinding agents, cement, explosive materials and chemicals.
- The high number of daily heavy road vehicle movements, driver safety (hours of work) regulations, the distance (time) travelled and a 50/50 loaded/empty movement ratio may present significant challenges to the road transport industry if it were to provide the required transport services to the new mine locations.
- The transport of fuel in ISO Tank Containers, and other mine inputs similarly in containers, may present an opportunity for rail to be used for transport to an "inland port" with adjoining road and rail access, and which might serve as a common hub from which industry can service the mines by road.
- A potential inland port site at Yamala (east of Emerald) is being evaluated due to its immediate proximity to existing large grain and cotton export facilities, and its proximity to potential new mine developments, thereby providing additional opportunities for the agricultural industry to also use containers for export (providing freight for the return train service).
- The current condition of the Central West rail system, including its track and bridge infrastructure that connects to Emerald, Alpha and Winton west of Emerald is marginally acceptable for current 15.75 tonnes per axle rail wagon loading (tal), and would need a significant uplift in maintenance to improve its capacity in the event of a moderate increase in rail services operated on the line.
- Significant increases in rail services would likely require that the corridor be upgraded to 20 tal capacity to achieve improved rail freight efficiencies.
- The associated rail investment may be staged based on growth in freight demand (new prospective mines progressively reaching operational stage), but the inland port itself would likely be available for earlier limited use due to the existence of TSC funded rail freight services.
- TMR's Sea Freight Action Plan study project (SFAP) has identified the potential for an Intra-state coastal shipping service to provide a range of supply chain options that support a flexible multi-modal freight system. Should a commercially viable sea freight service emerge in the near future, it may present opportunities for agricultural rail freight to connect with Gladstone port or the Port of Brisbane for export.
- Although speculative at this time, there may also be the potential for smaller coal mining developments to seek access to the existing narrow gauge rail systems for coal transport. In particular, such mines might be those that are not of sufficient scale to make efficient use of future potential larger standard gauge coal rail infrastructure, are not located within efficient transport distance to these new rail corridors, or potentially those that reach operational status prior to the availability of such infrastructure.

Additional consultations would be required to determine the capacity of the Blackwater Coal system to accommodate the additional train paths.

Recommendations

1) Undertake phase 2 of the project in 2014/15 to identify the Inland Port's potential tasks and opportunities
2) Maintain consultation with commercial proponents, local government and above rail operators
3) Develop a master plan for the Yamala site (rail corridor, turn outs, connecting road infrastructure, Performance Based Standards opportunities/assessment requirements to enable higher efficiency heavy vehicles to connect to the road/rail transfer facility)
4) Work with Port Managers to identify connecting rail infrastructure and third party logistics (3PL) service provider options at regional ports.



Terminology and definitions

Abbreviation/Acronym	Meaning
"A Class" track	Defined for this project as the Coal network and the North Coast Line.
ABS	Australian Bureau of Statistics
AUD	Australian Dollar
Aurizon	formerly QRNational - an above rail operator
AQIS	Australian Quarantine and Inspection Service
CHRC	Central Highlands Regional Council
CQRSCS	Central Queensland Resource Supply Chain Study
CQTSCS	Central Queensland Transport Supply Chain Study
DAFF	Queensland Department of Agricultural Forestry and Fisheries
DC	Distribution Centre
DCDB	Digital Cadastral Database
DG	Dangerous goods
DGSMA	Dangerous Goods Safety Management Act
DSDIP	Department of State Development, Infrastructure and Planning
DTC	Direct Traffic Control is a non-signalled absolute block safe working train movement control system
ERP	Estimated resident population
FCL	Full Car/Container Load
FDC	Freight Distribution Centre
FEU	Forty foot Equivalent Unit (sea freight container) – a 12 metres container
Hazchem	Hazardous Chemical
HML	High Mass Limit
IMEX	Import/Export
ITO	Invitation to Offer
JIT	Just in time
JV	Joint venture
LCL	Less than Car/Container Load - small quantities of freight
LGA	Local Government Area
mtpa	million tonnes per annum
OESR	Queensland Office of Economic and Statistical Research
OSOM	Over Size Over Mass (freight loads)
PBS	Performance Based Standards (Road vehicle)
PN	Pacific National - an above rail operator
PUD	Pick-up and delivery
PPP	Public Private Partnership

Abbreviation/Acronym	Meaning
QGAL	Good quality agricultural land
QR	Queensland Rail Limited
RCS	Remote Control Signalling where train movements are controlled by displayed colour light signals
RRL	Resources Rail Lines – Link Planning (CQ Inland Port concept) Study
RRPSM	Roads, Rail and Ports Systems Management
SD	Statistical Division
SLA	Statistical Local Area
tal	Tonne Axle Load
TEU	Twenty foot Equivalent Unit (sea freight container) - a 6 metres container
TMR	Queensland Department of Transport and Main Roads
TSC	Transport Services Contract (rail freight services)
3PL	Third Party Logistics (Provider)

1.0 Introduction

1.1 Purpose

The purpose of the project was to the study the condition and capacity of resource rail lines that connect Gladstone and Mackay ports to the Bowen and Galilee basins, with the view to developing a supply chain optimisation model aimed at facilitating a modal shift from road to rail for certain mining inputs and agricultural outputs. The model is predicated on the concept of an inland port near Emerald or Alpha and a containerised rail and road intermodal logistics platform. Significant consultation with industry has identified two potential inland port locations for consideration.

As depicted in **Figure 1** this project was to focus on option A (Emerald) and option B (Alpha) to determine the optimum location for an inland port based on proximity to commodity clusters, development costs, available land, and rail & road infrastructure.

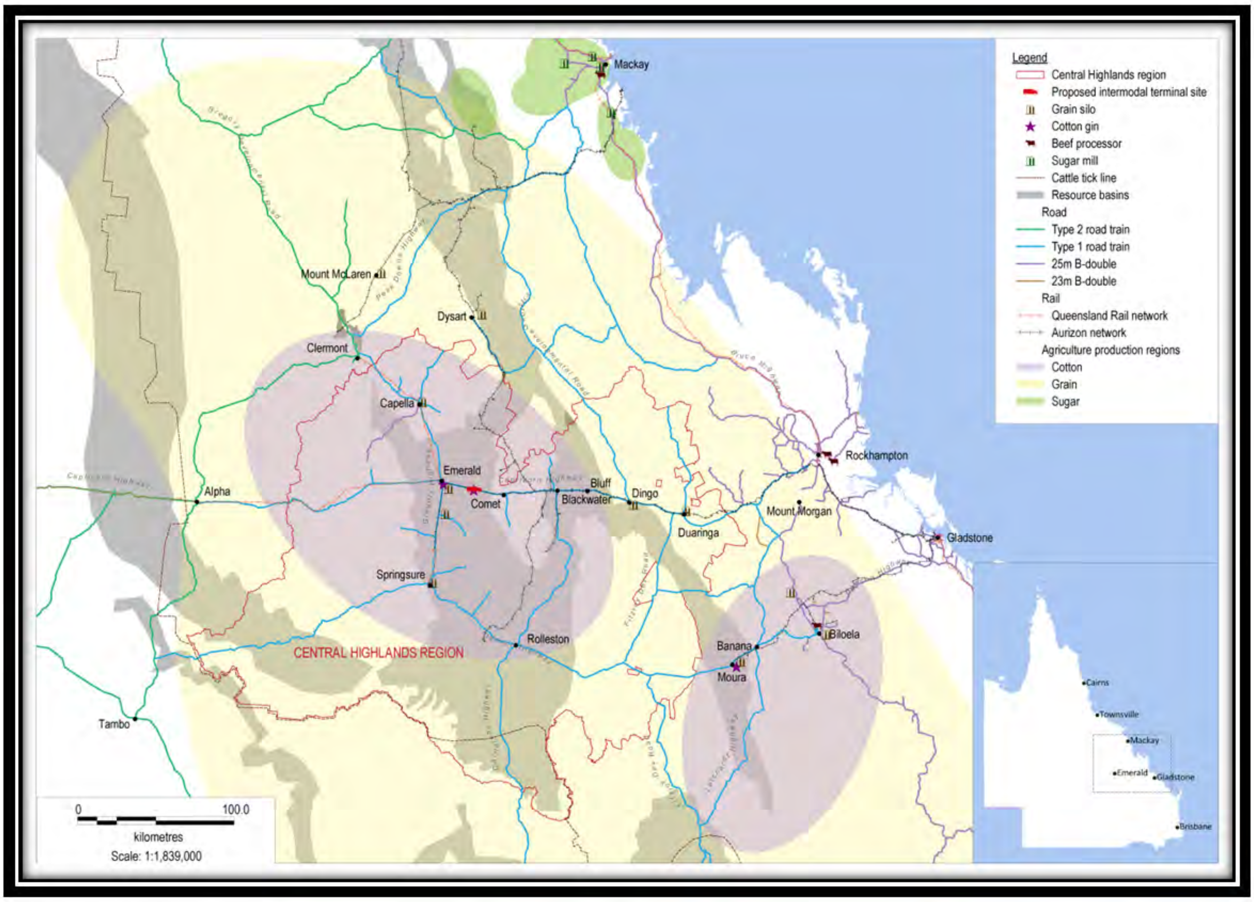


Figure 1 Inland port location options A (Emerald) and B (Alpha)

1.2 Objectives

The project was aimed to:

- Identify below rail infrastructure constraints that may impact on the movement of fuel by rail from the ports of Gladstone and Mackay to an inland port located at/near Emerald or Alpha
- Identify suitable parcel(s) of land at/near Emerald or Alpha where an inland port could be developed
- Source rail freight data to study existing freight flows by commodity, volume, origin and destination
- Using a standard logistics platform based on containerised freight movements in TEU, establish the contestability of grain, cotton, citrus and beef exports.
- Propose a new logistics model to support the efficient movement of mining inputs and agricultural outputs aimed at facilitating a modal shift from road to rail.

1.3 Project background

This study, the Resources Rail Lines – Link Planning (CQ Inland Port concept) Study (RRL) is one of three concurrent studies led by the Roads, Rail and Ports Systems Management (RRPSM) team of the Department of Transport and Main Roads (TMR) to manage freight growth in Queensland in concert with the Queensland Governments overarching “Moving Freight” strategy (Moving Freight). Moving Freight outlines the Queensland Government’s 10 year strategy to develop a multi-modal freight network that is sustainable and productive, to support the Queensland Plan and the Queensland Government’s “Governing for Growth” framework and to contribute to the Government’s broader commitment to developing a four pillar economy.

The other two concurrent studies are:

- Sea Freight Action Plan (Coastal Shipping), and
- Heavy Vehicle Action Plan

The RRL was originally oriented at a higher level as a broader state wide focus on the rail system connecting the ports of Gladstone and Mackay to the resource areas of the Bowen and Galilee basins. The timing of the study Invitation to offer (ITO) coincided with the final stages of the Central Queensland Transport Supply Chain Study (CQTSCS) undertaken by the Department of State Development, Infrastructure and Planning (DSDIP) in partnership with the Department of Transport and Main Roads (TMR), which was one of six major initiatives of the Central Queensland Resources Supply Chain Study (CQRSCS) being developed by DSDIP.

The CQTSCS study was to develop a multi-modal strategy for managing future transport demand within the Galilee and Bowen Basins. The CQTSCS strategy considered the cumulative impacts of the demands across the supply chain of planned resource developments as well as the needs of other industries, such as agriculture and tourism, and the wider community. This strategy identified key transport initiatives to support economic development and growth in Central Queensland.

The CQTSCS study involved the forecasting of inputs and outputs based on projected coal production from developing mines and identifying the impacts of development in the Bowen and Galilee Basins on the transport network. It identified strategies to manage the impact of heavy vehicles including oversize over mass (OSOM) vehicles on the strategic road network as a result of increased resource development. In particular the study investigated the potential benefits of modal shift strategies including the use of rail and coastal shipping as well as alternatives to drive in drive out. It particularly looked at potential locations for intermodal terminals that would facilitate a greater role of rail in transporting resources sector related freight such as fuel into the Bowen and Galilee Basins.

Through consultation with key resource industry stakeholders during the development of the 'Mining inputs and Mode Shift discussion paper' by RRPSM for the CQTSCS, RRPSM refined the RRL project scope and objectives to those detailed in **Section 1.4 Scope of the Stud**y.

It was highlighted in the ‘Mining inputs and Mode shift discussion paper’ that “mining inputs such as fuel may prove to be the catalyst for improved regional logistics, providing a base cargo (fuel) to support an inland port option” and that “an inland port would cater for Performance Based Standards (PBS) approved vehicles, providing greater productivity for regional fuel deliveries aimed at achieving better equipment utilisation from fewer delivery cycles, thereby addressing 'last mile' cost issues and the opportunity to backload agricultural exports in containers".

Furthermore, it has been identified that fatigue management issues are likely to emerge with the development of the Galilee basin associated with the longer road transit from Mackay/Gladstone ports to Alpha in delivering materiel. Rail is advantaged when it comes to longer haul distances and therefore potentially offers opportunity to address this issue.

An inland port is considered to be an emerging requirement to the future development of new mining operations in the Galilee basin area. Initial consultation with rail and fuel companies has revealed that establishing an inland port is central to achieving a modal shift of mining inputs (fuel, cement, chemicals) and agricultural exports (grain, cotton, citrus) from bulk freight movements (on road), to containerised freight movements. This may also leverage rail freight services purchased through the rail freight TSC.

Industry consultation identified two inland port options for consideration and this RRL project was tasked to focus on option A (Emerald) and option B (Alpha) to determine the optimum location for an inland port based on development costs, available land, and rail & road infrastructure.

1.4 Scope of the study

The scope of this RRL study comprised of the following:

- Study resources sector inputs and agricultural freight flows between the ports of Gladstone and Mackay, the mines, and key areas of agricultural production in Central Queensland (CQ)
- Identify suitable sites near Emerald and Alpha for an inland inter-modal freight terminal.
- Using a standard intermodal logistics platform based on containerised freight movements in TEU determine the modal contestability of Grain, Cotton, Citrus and Fuel supported by an inland port near Emerald
- Consider other rail freight options that will improve supply chain performance for agricultural outputs and mining inputs.
- Study rail corridors and below rail infrastructure condition for non "A Class" track, connecting the ports of Gladstone and Mackay to existing and proposed mines in the Bowen and Galilee basin and identify issues associated with and potential strength upgrades required to below rail infrastructure to support the operation of a containerised rail freight service
- Indicative estimates for below rail infrastructure strength upgrades to the Emerald- Alpha section of the Central west line

The following was out of the scope of the study:

- Rail access issues inside port boundaries
- Heavy Vehicle access issues inside port boundaries
- Freight flows associated with coal outputs.

For this study "A Class" track was defined as the coal network and the North Coast Line.

2.0 Study sequencing

The project was broken into two distinct areas of focus, “Rail Infrastructure” and “Logistics and Modelling”.

The existing below rail infrastructure condition and its limitations were assessed to define the existing service level and strength capacity situation. Logistic and Modelling works considered various infrastructure standards in analysing and developing contestability conclusions, and optimisations.

A cost competitive and attractive rail freight solution needs to find an optimal balance between above and below rail operational and capital infrastructure investments. For example, a possible below rail infrastructure strength upgrade to raise axle load limits may be mitigated initially at the expense of less efficient above-rail operation by reducing container ratios per rail wagon or using less than full loads until market share of the modal shift reaches a scale that warrants the below rail infrastructure upgrade. Therefore for greater value project outcomes suitable modelling tasks to understand above rail operational sensitivities were brought forward as reasonably practical, to inform likely infrastructure requirements.

2.1 Work breakdown and working papers

Through the course of the study, working papers were developed, a site visit was undertaken and multiple stakeholder workshop forums were conducted. This final report provides conclusions derived from the findings of these activities to assist informing future more detailed phases.

In the course of the study four (4) Working Papers were developed. With the exception of Working Paper 1 they were developed for study working purposes and have now been incorporated into this final report. A brief description of each Working Paper in the order of their development is as follows.

2.1.1 Working Paper 1 – Rail infrastructure

This working paper studied the non-‘A Class’ track section between Nogoa and Alpha and detailed:

- The existing rail infrastructure condition;
- Constraints to the containerised rail operations of 20tal
- Indicative upgrade costs to 20tal and
- Potential strategies and opportunities for reducing costs of upgrading track to 20tal

Working Paper 1 is attached for reference in **Appendix A** and a summary of relevant points are provided in **Section 3.2**.

2.1.2 Working Paper 2 – Freight market definition

Working Paper 2 was aimed at describing and quantifying the potential freight which might be attracted to and from an inland freight hub. The hub being primarily served by rail from a line haul perspective and by road for local and regional pick-up and delivery legs. Relevant commodity groups identified and profiled were:

- Fuel and Petroleum Products
- Cement and Flyash
- Agriculture – Broadacre Crops
- Other Agriculture
- Building and Construction Materials
- Chemicals
- Quarry Materials
- Pastoral Products
- Store Goods and General Merchandise

Section 4.0 reflects this body of work.

2.1.3 Working Paper 3 - Inland port and property criteria

Working Paper 3 was developed to define the high level criteria used to size and identify potential inland port sites around Emerald and Alpha. The essential contents of this paper along with the site identification methodology are detailed in **Section 5.0**.

2.1.4 Working Paper 4 – Rail freight modelling

Working Paper 4 captured the train operational modelling works that was undertaken to understand the sensitivities of the rail operation with respect to locations of the Inland Port (Emerald or Alpha) and respective rail infrastructure strength upgrades. **Section 6.0** reflects this body of work.

2.2 Industry stakeholders

An industry forum was conducted in Emerald on the 21st February 2014 to engage and consult with members of industry likely to use the inland port facilities proposed by the project and other affected stakeholders. This forum presented the project concept, its purpose and how it supports state government policy objectives. The concurrent related studies of the Sea Freight Action Plan and the Heavy Vehicle Action Plan were also briefly presented.

Questions and feedback from forum participants were captured and incorporated into the study. Follow up meetings were conducted with key interested stakeholders further informing this study. RRPSM continues to conduct ongoing discussion with interested stakeholders.

2.3 Site visit

Two potential inland port development sites where visited. One near the existing Cotton Gin at Yamala, approximately 21km east of Emerald, and another approximately 14km west of Emerald. These are shown in **Figure 23**.

A hyrail inspection of the existing rail line between Nogoa and Alpha was arranged to be conducted on 20 February 2014 with Queensland Rail however due to heavy rains in the Alpha region the evening before, this inspection was not able to be undertaken. Nevertheless, adequate information was obtained from Queensland Rail (Jan 2014) and level crossing line-side observations to inform the study.

3.0 Current situation

3.1 Description of the study area

3.1.1 Geography

This study investigated the resources and agricultural freight flows:

- In the Central Queensland (CQ) region generally defined by the Central Highlands and Barcaldine regional councils
- That fell within the freight catchment of the Blackwater and Central West Rail Lines.

Figure 2 is indicative of the study region.

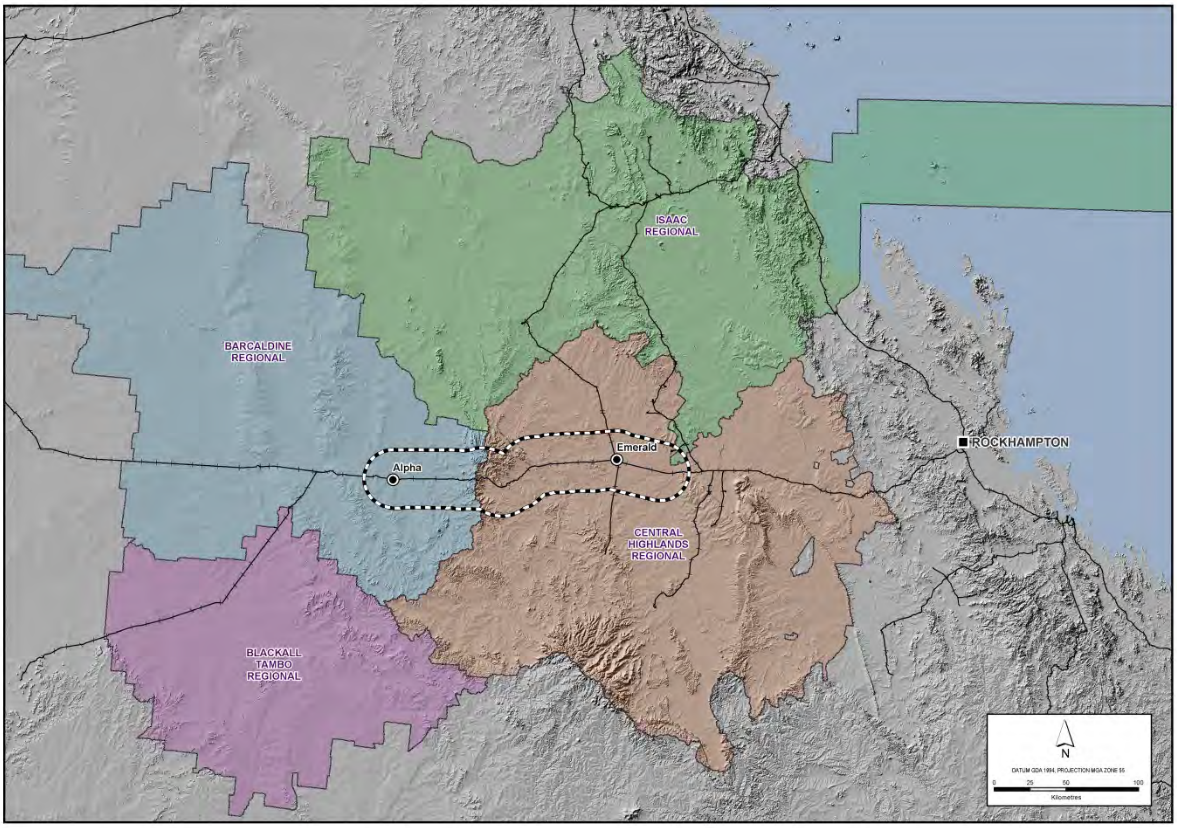


Figure 2 Study area

3.1.1.1 Emerald and Alpha

The nominal inland port site study options were areas around Emerald or Alpha.

Emerald is a large town with an approximate population of 13884 (2011), located approximately 270 km west of Rockhampton situated on the Nogoa River, a tributary of the Fitzroy River. It is located in the southern end of the Bowen coal basin. It is surrounded by agriculture and resource industries, such as livestock, grain, cotton, citrus, and coal. The town arrangement and particular features are shown in **Figure 3**.

Alpha is a small town with an approximate population of 571 (2011 Census), located approximately 172km west of Emerald, adjacent the southern end of the Galilee Coal Basin, and is largely surrounded by livestock grazing. The town of Alpha and some relevant features are shown in **Figure 4**.

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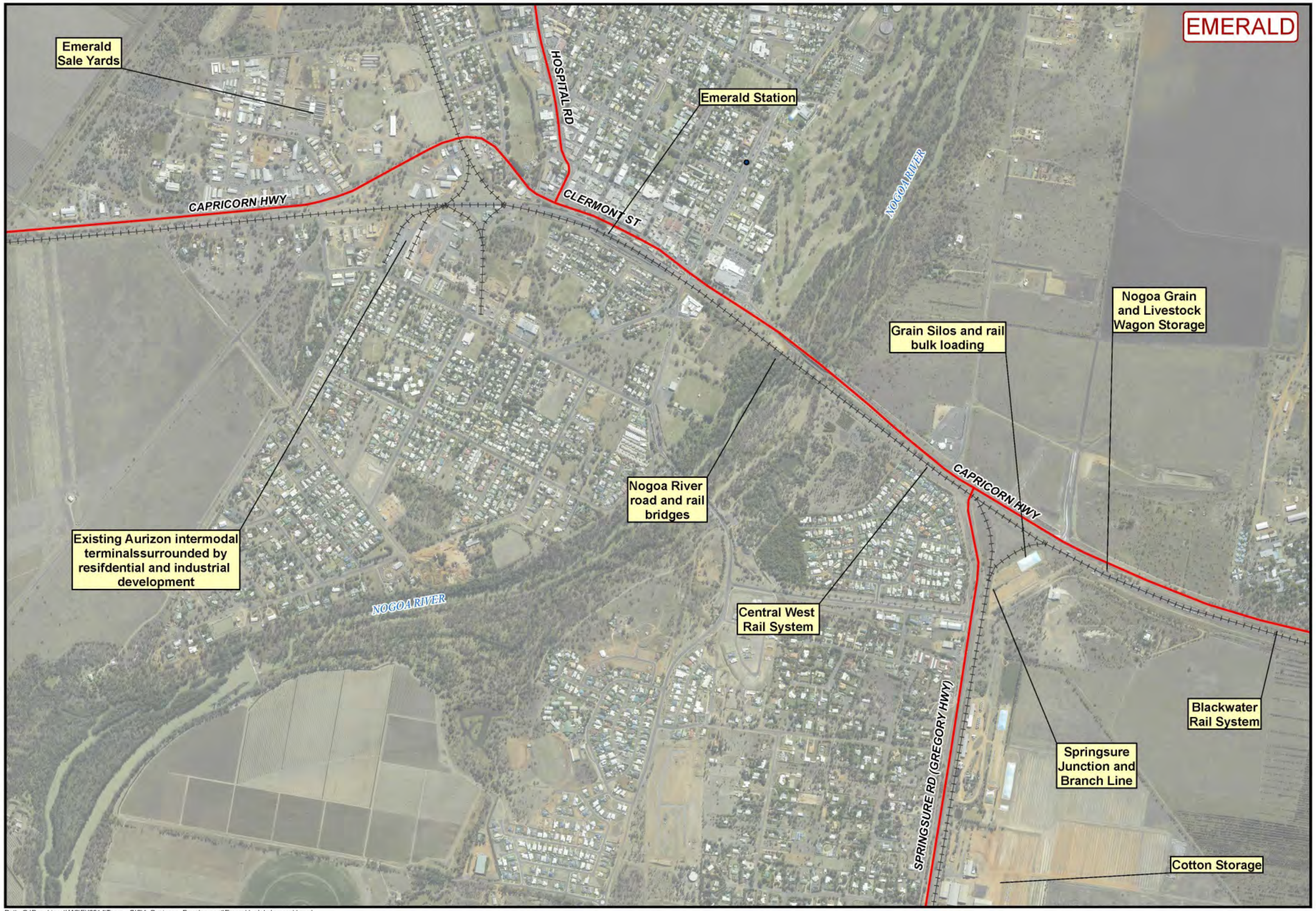

Figure 3 Emerald and select features

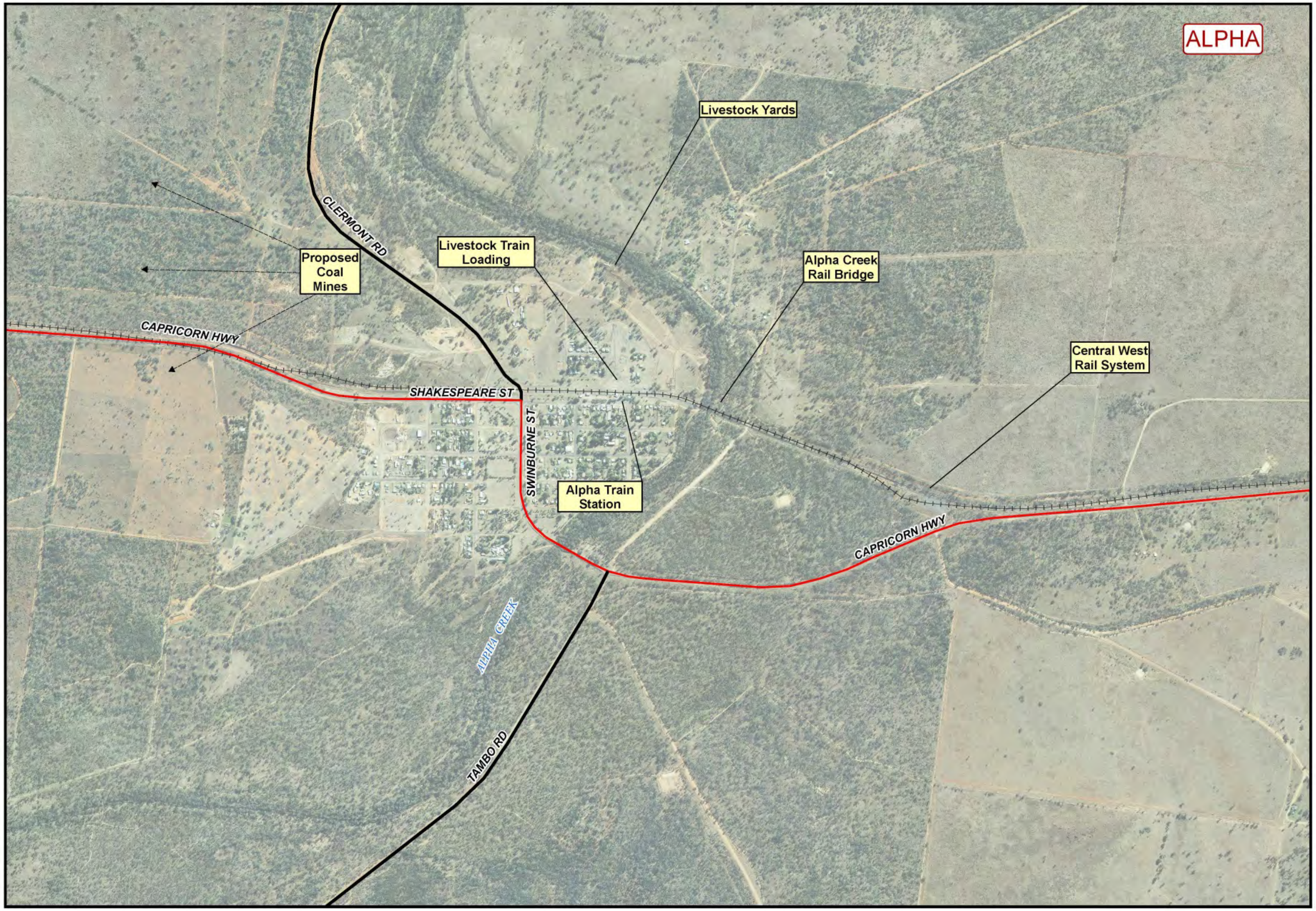

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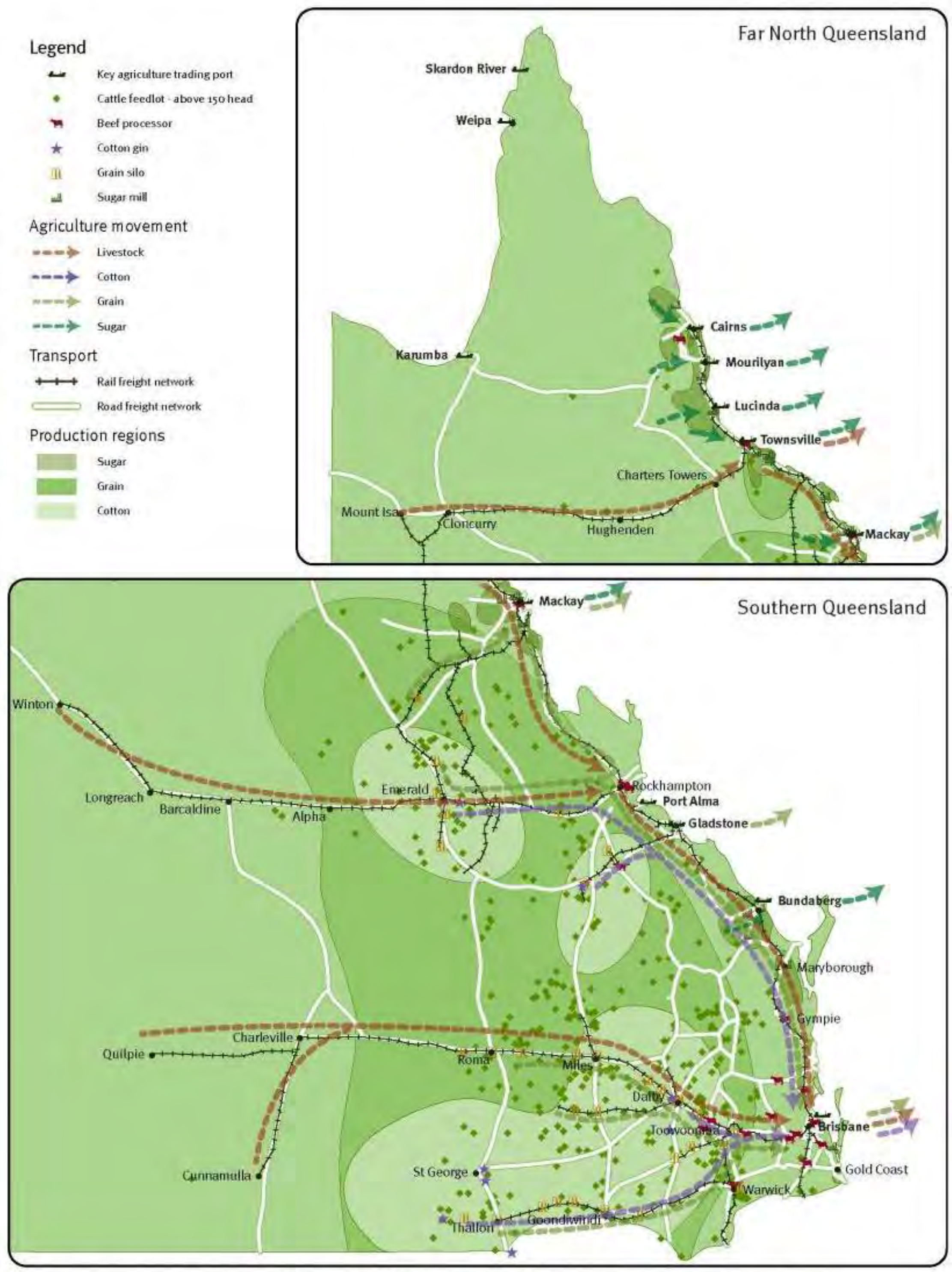
Figure 4 Alpha and select features

3.1.2 Industries

3.1.2.1 Agriculture sector

A high level representation of the Agricultural sector of the study area is shown in **Figure 5**.



Source: Department of Transport and Main Roads (2013), Department of Agriculture, Fisheries and Forestry (2013), Cotton Australia (2013)

Figure 5 Central Queensland agricultural industry

3.1.2.2 Resources sector

A high level representation of the existing and potential resources sector of the study area is shown in **Figure 6.** There are many new mines proposed in the Galilee Coal basin, some of which are relatively close to Alpha.

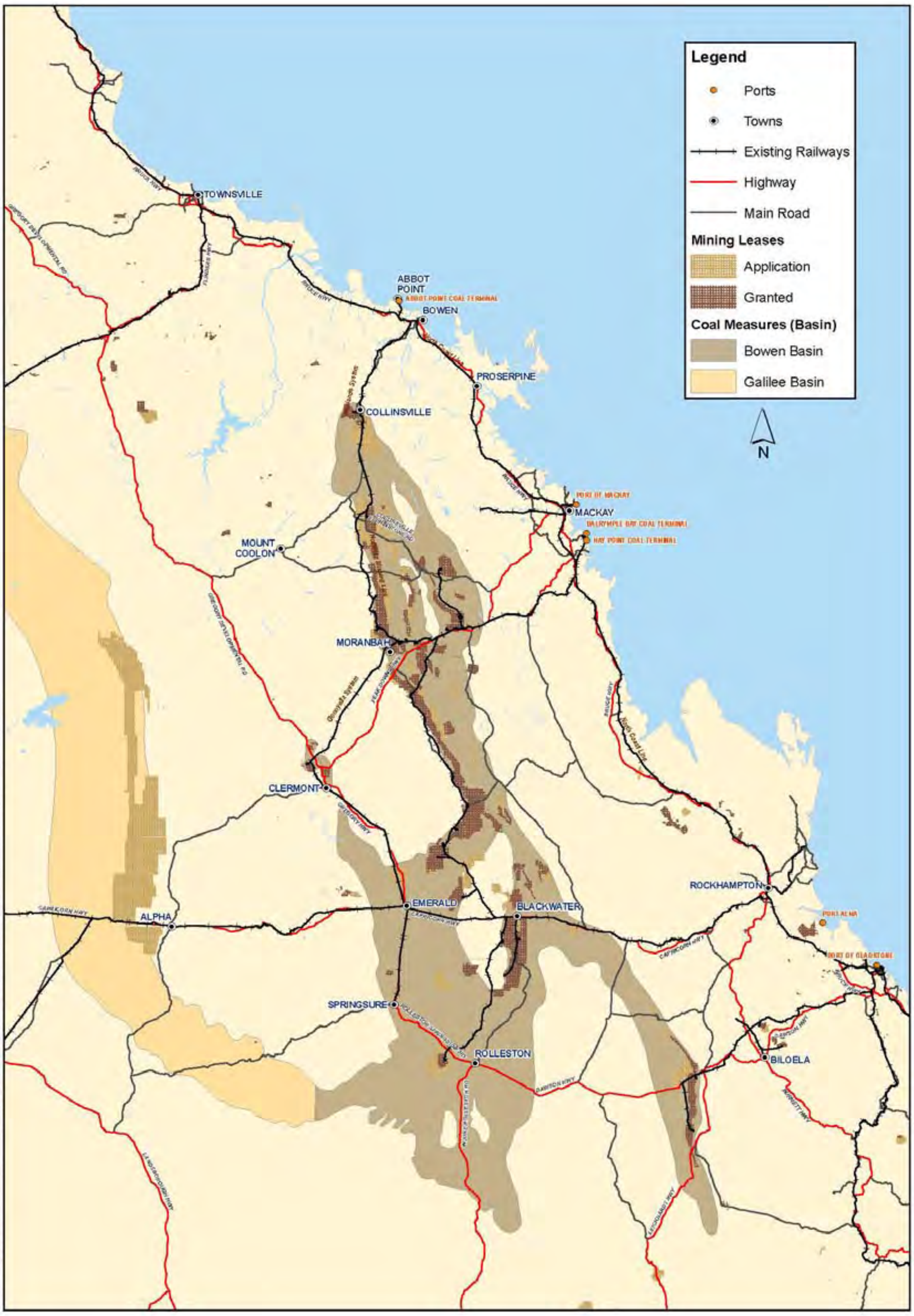


Figure 6 Central Queensland resources industry

3.1.3 Existing major transport infrastructure

3.1.3.1 Rail

As can be seen in **Figure 6**, Alpha and Emerald are situated on the Central West rail line (owned by Queensland Rail) which begins at the interface with the Blackwater rail system (owned by Aurizon) at Nogoa just east of Emerald and the Nogoa river and ends at Winton further west of Alpha. **Section 3.2** examines the Central West Line infrastructure in more detail.

Emerald is also connected to the Blair Athol rail line extending to the north and to the Springsure rail line running to the south.

The Blackwater rail system connects to the North Coast Line (NCL) in the east at Rocklands. The NCL runs north to Cairns and south to Brisbane from the Rocklands junction with connections to the Mackay, Gladstone and Brisbane sea ports and the Rockhampton and Brisbane intermodal terminals.

3.1.3.2 Road

The Capricorn Highway runs east/west and connects Alpha and Emerald to the east coast and the north/south Bruce Highway.

The Gregory Highway runs north/south and connects Emerald to Clermont to the north and Springsure to the south.

Clermont- Alpha Rd connects Alpha to Clermont bypassing Emerald.

3.2 Existing central west rail line

3.2.1 Overview

The Central West Line runs from the end of the Blackwater system (Nogoa) about 2 km east of Emerald, through Emerald and Alpha to Winton in the west. The Central West Line joins the rest of the state rail network through the Blackwater System to the North Coast Line and beyond to connections to coastal ports and other intermodal terminals.

The railway between Nogoa and Alpha is essentially non-electrified single track, with passing loops at a number of locations. The electrical overhead infrastructure extends to Emerald from Nogoa on the Blackwater system however it is understood that this overhead infrastructure is de-energised (isolated) from Comet River bridge (rail chainage 226km) approximately 39km to the east of Emerald on the Blackwater system. There are 88 existing bridges between Nogoa and Alpha. The majority of these are small-span timber structures. There is a range crossing between Emerald and Alpha (Drummond Range) which has steep grades and a tight horizontal curve alignment that constrains locomotive power to train mass ratios and train speeds. At Emerald the operational control system changes from Remote Control Signalling (to the east) to Direct Traffic Control (to the west). The passing loop lengths between Nogoa and Alpha are as short as 280m, constraining train lengths and/or network operational capacity.

In terms of traffic strength loading, the North Coast Line and the Blackwater rail system (from the Rocklands junction to just east of Emerald) is all rated as capable for 20 tonnes axle loads at 100 km/h with areas (where used by coal traffic) rated as 26.5 tonnes axle load at 80 km/h. This is “A Class” track in study terms. Connecting Emerald and Alpha, the Central West Line and its track and bridges infrastructure is nominally strength rated below “A Class” track as 15.75 tonnes axle load and 80 km/h (Posted speed 70km/h). **Figure 8** illustrates this division in strength classification.

Figure 7 Existing line west of Nogoa

Whilst the Central West Line is nominally classified as having track and bridge structures to a strength capacity for 15.75 tonnes axle load, it is in a somewhat dated condition, and is likely to have speed restrictions imposed because of conditions at some locations. Information obtained from level crossing line-side observations and from other records have been sufficient to confirm that the line’s strength capacities west of Nogoa are only marginally acceptable for the existing nominal 15.75tal loading and would need a full upgrade of structure strength should an Inland Port be sited west of Nogoa and be supported by a highly efficient rail operation. A containerised rail operation could occur on the existing infrastructure but at sub-optimal efficiencies.

In terms of traffic volume capacity and train service provision, all of the lines and connections (NCL, Blackwater and Central West Line) are essentially single line route operation. There are some lengths of double track, but the extensive lengths of single line with passing loops dictates the operations and constrains the number and quality of additional freight train services that can be added. Descriptions of operational constraints and potential methods to handle them are provided in **Section 7.4 and Section 7.5.**

Although detailed traffic volume capacity assessments of the rail network routes are beyond the scope of this current study, the Rail freight modelling **Section 6.0** provides some commentary on this with respect to the estimated freight task.

A more detailed asset condition assessment and discussion of strategies to upgrading to 20tal of the Central West Line is provided in **Appendix A** including:

- A summary of relevant infrastructure strength and condition elements: rails, fastenings, joints, sleepers and bridges.
- An assessment of the rail alignment – grades, curves and speeds
- A review of the existing Passing loops and constraints to elongation
- Presentation of alternative concepts for increasing life and capacity of the existing track structure in an effort to minimise costs.

The economic trade-offs between above-rail operational gains and rail infrastructure investment and the warrant for infrastructure enhancements are discussed in **Appendix B**.

3.2.2 Inland port site options

For the study three (3) Inland Port site options were considered:

1) "Alpha"
2) "Emerald East" – A nominal location 20km to the east of Emerald
3) "Emerald West" – A nominal location 10 km to the west of Emerald

Two (2) site options were nominated for the Emerald area due to:

- The change in rail infrastructure characteristics between east and west of Emerald
- The different road haulage patterns and related impacts on the town of Emerald that each site might generate
- The demonstrated industry interest at the time of the study, and
- Constraints to in-town industry development

Furthermore the idea of an Emerald West option (prior to its nominated 10km west of Emerald position) was considered as a potential site close to Alpha, as an Alpha alternative, but to remain on the eastern side of the Drummond Range crossing. Proximity to the township was also an important consideration with aspirations to be far enough away from town so as not to be of nuisance but within a reasonable commuting distance.

3.2.3 Role of central west section with inland port location(s)

Figure 8 is an extract from **Figure 5** and has the Central West Line overlaid in blue.

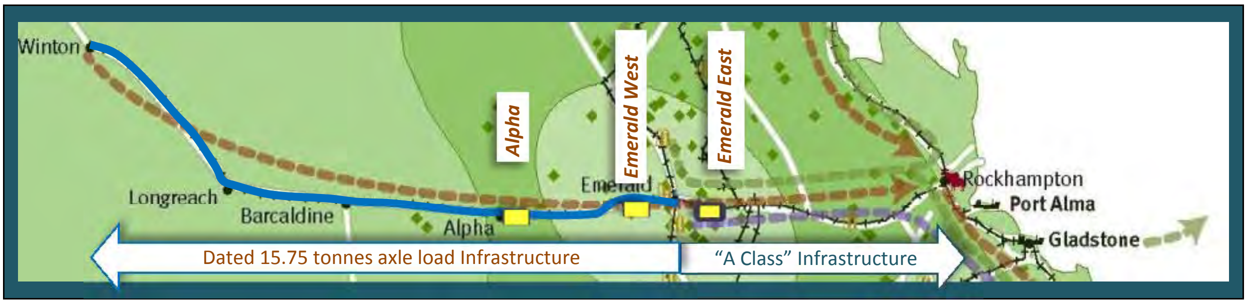


Figure 8 **Inland port sites with respect to class of rail infrastructure**

The key points about **Figure 8** are that for the main rail traffic to and from the coast and the potential Inland Port sites:

- The (most likely) Emerald East site does not require any strength upgrading because it is at the western extremity of the "A Class" structure of the Blackwater System
- The Emerald West (nominal) site will require up to 12 km of track and structure upgrading, including the large bridge structure across the Nogoa river
- The Alpha site would require about 175 km of track and structure upgrading, including:
  - The large bridge structure across the Nogoa river
  - Additional and/or extended passing loops that would be required to carry potentially longer and more frequent trains

The scales of these costs, including possible methods to defer or minimise are identified in **Appendix A**.

Freight traffic volumes west of an Emerald Inland port could (as they do currently) still utilize the existing strength grade of the Central West Line track and bridge infrastructure for some time. Such freight could include freight from the west to possible processing facilities in an Inland Port (such as livestock for processing or gypsum from Winton for use in fertiliser and soil treatment material) as well as new future fuel traffic to new mines in the Galilee Basin.

Therefore, the role and condition of the Central West line does not affect the first establishment of an Inland Port facility at Emerald East. But sites at Emerald West, and particularly at Alpha, would require quite significant advance works to upgrade (12 km and 175 km respectively) track and bridges to satisfy an "A Class" strength requirement.

3.2.4 Route capacity constraints summary

The route capacity constraints of the Central West Line mainly concern the existing single line operation and the lengths and spacing of the passing loops. The track section across the Drummond Range midway between Emerald and Alpha (see **Figure 23**) would also have an effect on capacity because of slow section timings on steep gradients between passing loops.

For existing levels of traffic to and from the west, these constraints will not be influential; they are only influential for Inland Port sites that have some length of Central West Line on the coastal side of their location. Therefore, the Emerald East Inland Port Site is not affected by these constraints.

3.2.5 Infrastructure strength and condition summary

Apart from the design strength of the track and bridges being only 15.75 tonnes axle load, not up to the “A Class” strength standards, the tracks and bridges are not in a very good condition. They appear to be at or beyond their design life and due for renewal or rehabilitation even if continuing at the same 15.75 tonnes axle load rating. It is a characteristic of railway track and structures that renewal costs like-for-like will be very similar to the costs to renew to “A Class” rating. Generally, the infrastructure can continue carrying its current very infrequent traffic, but, irrespective of the Inland Port, it should be expected that this line should soon start to be renewed.

Therefore there are opportunities to undertake any necessary infrastructure upgrades progressively and viably by implementing higher standards for renewal works in areas east of the determined Inland Port location. The current track condition is likely attracting relatively high maintenance costs. Lower maintenance costs resulting from renewal upgrades will go some way to offset any higher costs attributed to renew to “A Class” rating.

3.2.6 Existing intermodal facilities

There is an existing intermodal facility in Emerald owned and operated by Aurizon. However as described elsewhere, this site has now become surrounded by residential areas making it unsuitable for 24 hour operation. The site location and constraints of road usage make it impractical to develop this site further into an Inland Port operation. Furthermore the Central Highlands Regional Council planning policy limits further industry development in this area.

4.0 Freight market definition

This section is aimed at describing and quantifying the potential freight which might be attracted to and from an inland port freight hub near Emerald. A terminal at Alpha has been discounted because of the unknown timing of the development of the Galilee basin which may generate sufficient demand for a terminal at the appropriate time. The port would primarily be served by rail from a line haul perspective and by road for local and regional pick-up and delivery legs. The discussion in this section is generally based on the existing conventional railway and it is clear that rail needs to continue to innovate to maintain its presence.

Section 4.1commences with a discussion of the approach in assessing markets which in turn are based on product groups based around similar products, pack types, materials handling, logistics requirements etc.

Section 0 covers the commodity profiles. The groups are:

- Fuel and Petroleum Products
- Cement and Flyash
- Agriculture – Broadacre Crops
- Other Agriculture
- Building and Construction Materials
- Chemicals
- Quarry Materials
- Pastoral Products
- Store Goods and General Merchandise

One of the challenges has been to address the overlap between categories, for example cement is included in cement rather than building materials.

4.1 Approach

The approach to assessing the freight market is broken down into the following:

- Define the base market
- Define and design the logistics packages
- Appraisal and derivation of rail market share
- Define the target market
- Operational and practical considerations

4.1.1 Define the base market

There are sectors within the freight market that rail cannot realistically capture. In particular, commodity movements based around fine time sensitivities, very short haul and unconsolidated loads, place rail at a competitive disadvantage compared with road transport. The “contestable” market that rail can compete in however, is broad and consists of commodities that are currently (for a range of operational, economic and historical reasons) dominated by the road transport industry. This study has adopted the usual practice of defining the base market by simple segmentation categories:

- Product
- Volume and preferred parcel size
- Pack type
- Potential origin and destination combinations

Knowledge gained from the delivery of CQTSCS assisted in the delivery of this scope.

This is covered in greater detail in the individual commodity group profiles which are described in **Section 0**.

From a logistics perspective the basic area covered by the study corresponds to the Central Highlands Regional Council boundaries.[1] The estimates of market demand and supply data relating to this region are produced by reference to comparisons between the Central Highlands region and the rest of Queensland. All things being equal, local per capita consumption of a particular product (such as food) should not diverge significantly from the state average. This is useful for commodities such as "general freight" which includes a myriad of products and where there is no definitive knowledge source of the market. This approach has been adopted unless better data is available on a commodity basis. The Queensland Government Statistician's regional data material has been used to assist this process.

Geographically Emerald is in a position to serve as an inland port for the Central Highlands region and for points north south and west and thus has a regional significance role far greater than purely as a standalone town. It also has the largest resident population and the most diversified economy in the area. It performs the functions of a de facto regional capital and the major retail, commercial and service centre. The expression "inland port" is intended to be a multimodal terminal performing a hubbing operation. Hence "inland port", "multimodal terminal" and "hub" are interchangeably used throughout this report.

4.1.2 Define target market

Some commodities and their logistics chain demands are clearly more suited to rail than others. At the same time, the freight targeted by the Transport Service Contracts (TSC) fits within a particular niche (non-bulk general freight) of Aurizon Ltd (Aurizon, formerly QR National) who were contracted to provide. In Queensland Aurizon's operation focusses on three product areas, coal, non-coal bulk and intermodal. The first two are basically conveyed in full trainload bulk movements and are therefore of little relevance to this study focused on containerised logistics, however any transfer of non-coal bulk commodities to containerisation is of interest. The third comprises a range of products and includes some travelling along the Central West and Blackwater line (formerly the Central Line) from Rockhampton to Winton via Emerald, Alpha, Barcaldine and Longreach.

In particular this study is concerned with full wagon load or container load movements which can be consolidated into full trainload movements. This study is also concerned with inputs into the mining and agricultural sectors and potentially the outputs from those sectors (excluding for example trainload quantities of bulk grain and block coal trains which are subject to Aurizon's commercial operations). In attempting to define the target market it is necessary to consider the relative strengths and weaknesses of competing modes to assess where one has a comparative advantage which can be converted into market share. For the Rockhampton – Emerald to Winton corridor, road transport is the major competitor. Rail can compete best where there is:

- Long line haul in terms of transit time and distance. Longer hauls allow terminal time to be a less significant component in overall cycle times therefore improving efficiency and reducing operational and capital costs
- Point to point trains – avoid mix and match loading in small quantities with multiple consolidation and deconsolidation points
- Fragile loads – Rail generally offers softer rides and results in less reported breakage/damage/stress
- Very high volume making it easier to consolidate into full train sizes
- Simplified and standardised materials handling e.g. 100% containerisation on flat wagons rather than single purpose customised wagons
- Reduced terminal staffing costs because a train of say 1000 tonnes can be unloaded in a single shift as opposed to 40 semi-trailers randomly presenting over a longer period and forcing 24/7 staffing
- Pre-programmed lead times means containers on wagons can act as mobile storage/warehouses

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[1] See http://statistics.oesr.qld.gov.au/profiles/qrp/time-series/pdf/KC3MNUQO5I3KEC3M5WYYZO00MBIY2FIKHC27KXCOF76ICFSRFY658R06OMKQ998NV5RZAFBK44HC4TS19P3B6JQ5YMYU6KBADXHMV3CJ3OHCKT8YBN1GSZSTSPTG0MUH/qld-regional-profiles-time-series#view=fit&pagemode=bookmarks

- Requirement for campaign freight movements - Rail has considerable capacity to move large volumes when they are required at peak times
- Customer cost constraints – Rail's out of pocket freight rates are normally lower than direct road rates but if pick-up and delivery (PUD) legs are factored in, this margin narrows.

Compared with road operations, rail has deficiencies in:

- Extra time and expense of PUD legs to provide a door to door service
- Generally less direct routing than road
- Intermodal terminals or private sidings and associated shunting must be provided
- Difficulty and delay in making connecting trains
- Added materials handling if direct intermodal transfers are not made – e.g. direct from wagon to truck rather than wagon to holding area and then later reload to truck
- Special purpose wagons such as bulk grain wagons or fuel tankers are normally difficult to backload
- Cut off times prior to departure and embargoes on arrivals at terminals extend the actual time the freight is out of the client's control
- Australia is a country of small businesses – most of which can't produce or consume large quantities e.g. a container load on a regular basis and most do not have the equipment to perform the materials handling component. This means their demands are generally for consignment sizes more suited to road than rail.

In contrast road's advantages relate to:

- Shorter hauls
- Much higher point to point speeds and therefore better transit times
- Door to door movements can eliminate the need for terminals
- Flexibility and small loads suited to most customers
- Very competitive freight rates
- Flat deck trailers are very versatile and backloading even at reduced rates is normally possible.

To sum up, road and rail both have particular advantages in their respective niches and this partly describes how the market has evolved and why market shares are the way they are. There are strategies which rail can execute to improve its performance and market share as discussed in the following sections.

4.1.3 Define and design the logistic packages

The conventional approach to designing rail market offerings is illustrated in **Figure 9**. Typically the infrastructure which is in place determines what sort of service can operate in terms of capacity, speed, etc. With this service model the customer is at the end of the chain and has to take whatever they are given.

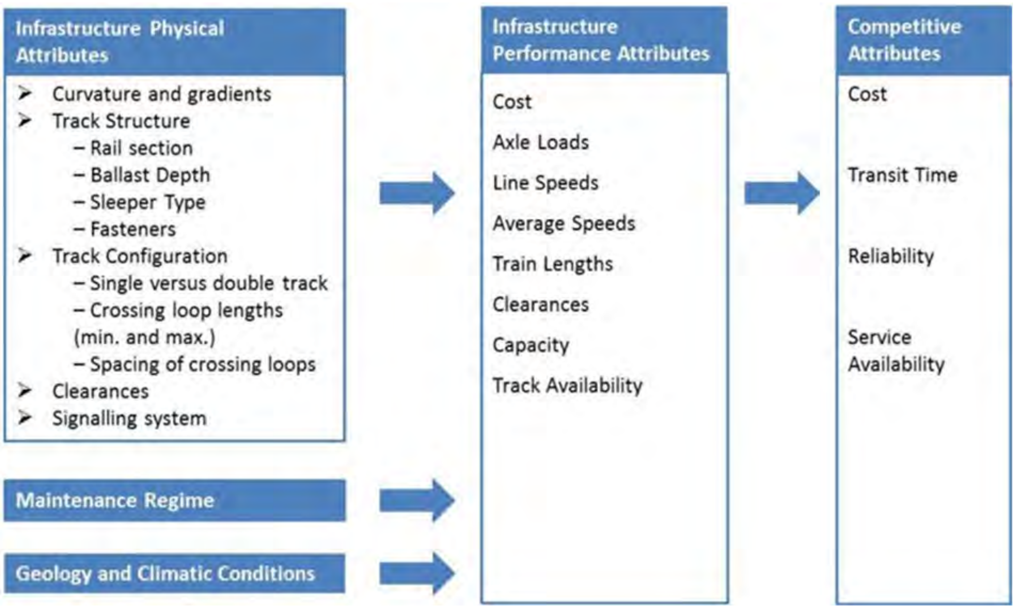

Figure 9 **The conventional link between infrastructure and service**

For rail to be a competitive and integrated modal choice, a combination of price and service elements as a "logistic package" will need to offer benefits to counter the "logistic package" offered by road.

To effect change, rail needs to respond to the reverse process based on customer demands and perceptions dictating the operations and from that determine the necessary supporting rail infrastructure. Basically this involves reversing the direction of arrows from **Figure 9**, as shown in **Figure 10**.

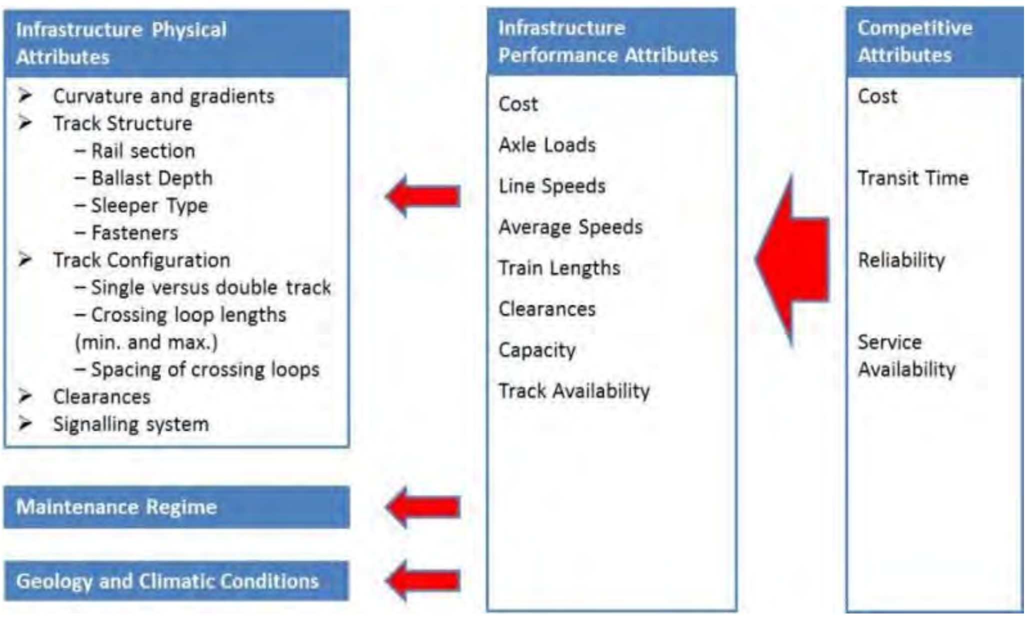

Figure 10 **Customer focussed service specification and infrastructure provision**

This approach treats infrastructure as something malleable and changeable i.e. it is not irrevocably and permanently fixed in time. This allows the logistics packages to be redesigned by and for the potential customer.

This is achieved by bottom up process flow mapping of entire logistics chains from "door to door" on a product by product basis.

There are limitations with an infrastructure-based approach as it is expensive and the ability to fund improvements is contingent on developing a service package to attract additional patronage with a margin above cost.

4.1.4 Operational and practical considerations

A range of risks, opportunities and threats for the potential rail operation need to be considered to appreciate the environmental and full supply chain dynamics. Examples include:

- Regulatory conditions on rail's plans
- Landside capacity at ports to support greater rail activity
- Availability of containers, lifting gear, etc.
- Special approvals to operate inland fuel terminals
- Propensity for above rail operators to enter the market
- Competitive response from road operators

These factors are considered to inform the process of designing the logistics chain based on an inland terminal served primarily by rail.

4.1.5 Derivation of rail market share – current and potential

The purpose of defining and quantifying markets where possible is to give a sense of certainty that investments will not be wasted in providing infrastructure for markets where rail has little prospect of capturing. Thus it is necessary to evaluate rail's chances of viably competing in a market, and its estimated market share. A three step model used to define in turn:

- Total Market
- Captured Market - Mode/Route/Pack type shift
- Contestable Market

These steps draw on work previously outlined in the market definition. The assumption here is that rail can deliver the service as specified.

Demand for rail is a function of a number of elements:

- The characteristics of the mode (operational performance, infrastructure, capacity etc.)
- The competitiveness of the rail option vis-à-vis competing modes and the contestability of markets and transport corridors.
- The actual size and underlying growth of the freight market – i.e. the scope and scale of industrial precincts, intermodal transport hubs and urban developments and the likely future development in these areas of economic activity and estimates of the volumes of inputs and outputs that could make use of a rail operation.

Critical to the success of the rail operation will be the level of performance of the competitive modes and the infrastructure, logistics chain and service attributes which rail can potentially offer in the future.

4.2 Commodity Profiles

This section analyses each commodity group individually using a standardised template to make cross comparisons simpler. The commodity groups are:

- Fuel and Petroleum Products
- Cement and Flyash
- Agriculture – Broadacre Crops
- Other Agriculture
- Chemicals
- Quarry Materials
- Pastoral Products
- Store Goods and General Merchandise

Each profile commences with an outline of the sub-products included in the group. An intermodal hub is generally aimed at containerised freight hence the commodity group is segmented to give an understanding of how suited the product might be for an inland terminal. Where there is little prospect of containerisation, the inland hub may have little appeal.

A general discussion of the product as further refinement and segmentation within the group is undertaken. Following this is an estimate of volumes. This has been referenced to 2014 conditions. Given the Galilee Basin development will create major logistical changes as a result of vastly increased volumes of freight this is listed separately. Generally the optimistic rail market shares quoted in the following tables are predicated on the basis of the addition of an inland port at Emerald. Exceptions to this are noted as required.

An assessment of the future outlook is given along with a discussion of origin/ destination/ pack type combinations. The purpose of this is to give a background to future developments and their impact on freight in the region. This leads into a discussion of logistics chain requirements for the product and concludes with a discussion of what to do to capture this freight on rail.

4.2.1 Fuel & petroleum products

4.2.1.1 Products

The product group includes the following individual commodities and their associated typical pack types as shown in **Table 1.** Containerisation is important because it is the “best fit” for a multimodal operation based on an inland port servicing a large hinterland.

Table 1 Commodities in the fuel and petroleum products group

Bulk	Containerised
Diesel	Packaged Additives
ULP	Packaged Lubricants
AvGas	Packaged Oils
Lubricants	LPG Cylinders
Bitumen	
Oils	
LPG	

4.2.1.2 General discussion

The Emerald/Blackwater Coalfields/Central Highlands is currently supplied by bulk road tankers from the Port of Gladstone. Prior to deregulation in the 1980s a large proportion of the bulk trade was conveyed in block trains by the former QR. The rail tanker fleet is very old and the process has been bypassed technologically, operationally and economically, and is not in a position to compete with modern road tankers. Containerisation solves the significant logistics disruptions associated with a traditional road tanker operation: load at port, decanting at inland hub, bunker storage, reloading to road tankers and transfer to onsite storage.

Packaged oils and lubricants in 200 litre drums are frequently palletised and containerised. These are not considered bulk movements. Anything which can be containerised can be carried equally well on road or rail. The costs in terms of money and time associated with extra handling by rail place it at a disadvantage unless moved by rail to a central warehouse/depot and distributed from there.

4.2.1.3 Volumes

At present there are over 1 million tonnes per year imported through the Port of Gladstone[2]. This serves:

- City of Rockhampton – industrial and domestic consumption
- Agriculture and mining in the Callide and Dawson Valleys
- Agriculture in the Bundaberg region
- City of Gladstone – industrial and domestic consumption
- Agriculture and mining west of Rockhampton

These volumes are depicted in **Figure 11**. It is difficult to estimate how much fuel will be part of the contestable market. In trying to predict future demand it is worth examining potential demand drivers and their relationship with fuel usage. For example, **Figure 12** shows some similarity in trends between coal exports and fuel imports however, flooding in 2011 has significantly disturbed this pattern leaving some questions about how the two variables are related. **Figure 12** also shows that there appears no relationship between fuel consumption and export grain. Even if there is a strong relationship in an input-output sense, there is the difficulty of separating out the Callide and Dawson Valley production and consumption from the Blackwater/Emerald trends.

AECOM has some preliminary high level benchmark input-output data from other central Queensland mines and this has been used to infer the likely fuel consumption in the target area served by the TSC trains. Based on about 50 million tonnes of export coal per year, about 500,000 tonnes of fuel is required for mining and related activity. For Emerald a high estimate of 20 thousand tonnes per year for agricultural and domestic consumption excluding the Minerva Mine (produced 2.5 million tonnes of coal per year) which could hub off an inland port has been made. The estimated market size based on these benchmarks is shown in **Table 2**.

Table 2 Estimate of fuel market size (thousand tonnes per year)

Segment	Gross Market	Target /Contestable Market	Current Rail Market Share	Optimistic Rail Market Share
Emerald	30-50	30	0	25
Blackwater Mines	500	500	0	0
Potential Galilee Basin	400 - 1000	400 - 1000	0	400*

*Based on hubbing off an Inland Port at Alpha

[2] http://content1.gpcl.com.au/viewcontent/CargoComparisonsSelection/CargoOriginDestination.aspx?View=G&Durat=C&Key=2013

The estimate of optimistic rail market share is based on a competitive price and service package using a hypothesised efficient rail service linking port and inland hub seamlessly and effectively. The Blackwater mines are considered too far east to be effectively supplied via Emerald. Volume estimates for the Galilee Basin are based on tonnages reported in the media which vary widely according to ramp up and how many mines come on line whether sequentially or concurrently.

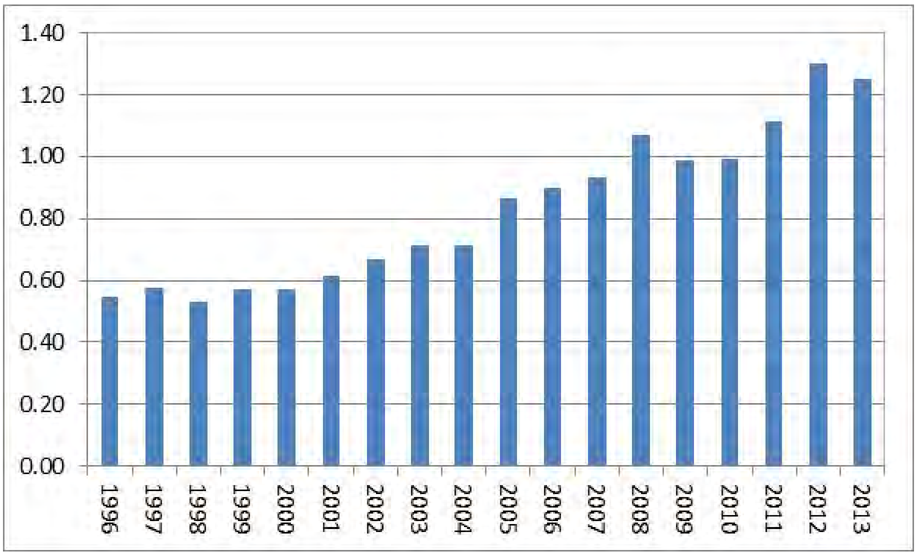

Figure 11 Gladstone Petroleum fuel Imports (million tonnes)[3]

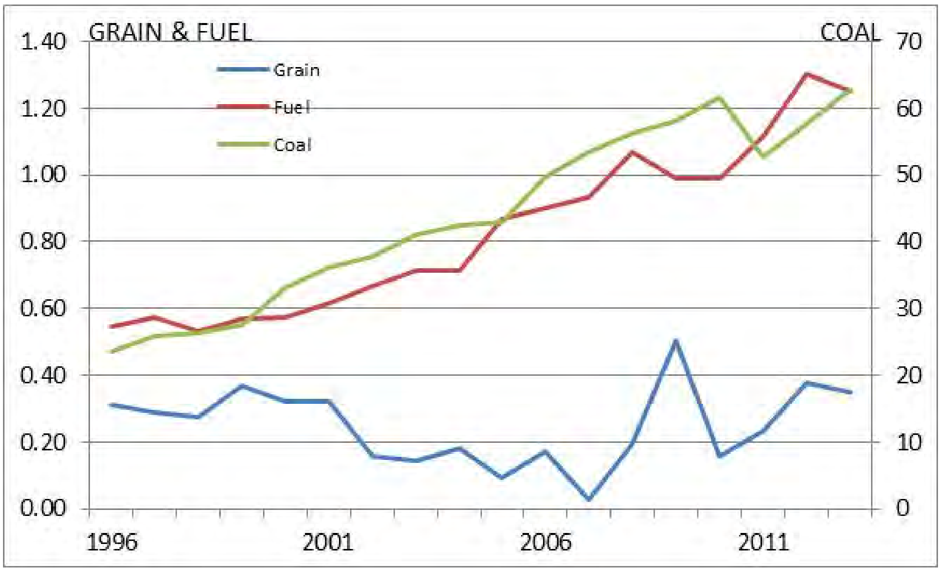

Figure 12 Gladstone Export Coal, Export Grain, Imported Fuel (million tonnes)

[3] Source: Gladstone Port Corporation. See for example: http://content1.gpcl.com.au/viewcontent/CargoComparisonsSelection/CargoOriginDestination.aspx?View=G&Durat=C&Key=2013

4.2.1.4 Market Outlook

Diesel consumption is driven by industrial demand particularly relating to the mining and agricultural sectors which have growth ambitions therefore it is expected demand will continue to increase. Recent volatility in the mining sector makes long term predictions difficult however the long term trend indicates an upward pattern.

The major unknown is when the proposed mines in the Galilee Basin will come on line. These proposed mega mines are many times larger than even the largest existing mines in the Bowen Basin and have the potential to demand input commodities such as fuel, explosives etc. in unprecedented quantities in the region. Based on the quantities proposed, the present trade could double when the operational phase commences and this has the potential to increase pressure on the road system unless rail can make a positive contribution.

It is known for example, that several companies are in discussions about the development of an inland fuel hub but many details are yet to be resolved. An improved role for rail has been mooted as a possible solution to the logistics chain and potentially more economical than an all road operation. Options for fuel on rail in ISO-Tank containers should be considered a longer term strategy for the inland port development as it is not necessarily needed to seed the initial development of an inland port.

In terms of economic drivers, the consumption of petrol products is tied to population patterns and domestic demand. The population is growing in the region, although at different rates in different towns. In the mining towns much depends on whether there is a large resident population or if there is a significant drive in drive out component.

4.2.1.5 Origin-Destination Combinations/Pack types/Optimal parcel size

Larger consumers such as retail service stations consume approximately a semitrailer load per week. This is usually delivered by a combination of methods and truck types:

- Single product in a tanker which may provide “milk run” type services or single destination as required.
- Single truck with multiple compartments delivering several products in a single trip.

Most bulk supplies are drawn from stocks at the Port of Gladstone. The approximate haul by road or rail from Gladstone to Emerald is about 365 km. By rail standards this is a relatively short haul however, rail can compete successfully with road over hauls as short as this as long as there is sufficient volumes. The Blackwater and Southern Bowen Basin mines are serviced by road from Gladstone for fuel deliveries. B-Double road tankers are utilised to service the industry and the use of C-train configurations is imminent.

With the right location, efficient decanting and distribution, the mining industry ought to be able to be serviced by short haul, smaller and flexible fleet of trucks hubbing from a central fuel depot fed by line haul trains carrying entire weeks’ worth of production inputs for the region. For example, after allowing the normal safety margin, a 700 metre train could carry 40 x 15 metre double slot container wagons or 30 x 20 metre triple slot container wagons.

If each wagon carried standard isotankers with about 20 tonnes payload each, the train would total 1600 payload tonnes. This is equal to 64 semi-trailers with 25 tonne payloads. The short distances to the mines could be performed by semitrailers operating as shuttles or alternatively purpose built B- doubles or PBS skeletal wagons at High Mass Limit (HML).

4.2.1.6 Logistics Requirements – intermodal/door to door/ performance characteristics

A combination of factors has assisted the transfer of petroleum products from rail to road over time.

- There was the deregulation of petroleum movements formerly controlled by the permit system until the mid to late 1980s. Road technology, especially higher productivity vehicles such as B-doubles, has advanced much further than rail technology over the same period.
- Rail tanker technology was not advanced and the existing fleet is at or beyond economic life. Older units are of course much more unreliable and prone to higher maintenance costs which impedes cost recovery.
- In the long term truck transit times and safety have improved with the upgrading of the road network.
- Although there has been investment in the rail system, this has been aimed at improving capacity, reliability and reducing maintenance costs and failures rather than generating speed/transit time performance improvements.
- Based on feedback from oil companies in a broad sense, with the introduction of stricter environmental regulations, the cost to oil companies to maintain and operate the hub and spoke distribution system became unsustainable given that road offered full door to door movements which made intermediate handling points redundant as is the need to decant and store fuel at local depots. Emerald is one of a few remaining locations that still have hub and spoke operations.
- A semi-trailer or B- double can perform a Gladstone – Emerald round trip in about 8 - 10 hours. A rail round trip including terminal time is at least 24 hours thus even making comparisons at the truck/wagon capital cost level, road offers much higher efficiency and productivity.

In conclusion, the present market reflects a broken rail operation. Merely reviving a broken obsolete operation will not address the difference between road and rail to the point where rail can compete. Therefore the rail logistics chain has to be redesigned from scratch for the 21st century. This involves new processes, equipment, terminals, work conditions, etc.

4.2.1.7 What Rail must do to improve Market Share

Rail can only match road's door-to-door service by providing PUD (pick-up and delivery) services from the hub. These are not needed in Gladstone if it is assumed trains are loaded at the port.

Rail will be at a considerable disadvantage if traditional rail tankers are used. ISO-Tank containers on container wagons provide a viable logistics medium which can facilitate relatively seamless intermodal transfers. ISO-Tank containers provide a viable storage package which is Dangerous Goods Safety Management Act (DGSMA) compliant.

Viable and efficient terminals are required if intermodal transfers are to be as seamless as possible. This requires optimised layout, storage and handling areas and equipment, convenient road and rail access and the ability to operate 24/7 if required to do so.

Most rail corridors are built to higher flood immunities than road and can offer higher reliability. In some cases, trucks can bypass flooded sections although the impact on the local roads and structures can be severe particularly in "black soil" country.

The trucks handling the PUD leg for rail based intermodal containers avoid extra container handling equipment if they decant direct from the ISO-Tank container on site which is analogous to what a road tanker would do. A container delivered and left at site can perform the function of a low cost warehouse and the customer can draw down on the supply at their own convenience. On site stocks can be modularly increased or decreased, as required, to mitigate against fluctuations in site accessibility caused by seasonal and extreme weather events.

An all truck operation requires the truck to be decanted on site. This is not a quick process and can take an hour. Decanting the truck offers the chance of contamination and possible leakage especially when supplies are drawn from the on-site storage vessel. This step can be avoided using the ISO-Tank container approach.

4.2.2 Chemicals

4.2.2.1 Products

The product group includes the following individual commodities and their associated typical pack types as shown in **Table 3**. Containerisation is important because it is the "best fit" for a multimodal operation based on an inland terminal servicing a large hinterland. The two main products are explosives and fertiliser.

Table 3 Commodities in the Chemicals Group

Bulk	Containerised
Fertilisers	Explosives
Acids	Acids/Paints/Solvents
	Fertilisers
	Other liquids
	Other Powders/solids
	Pesticides, Herbicides, etc.

4.2.2.2 General discussion

Material can be in powder, granulated, pelletised, slurry or liquid form. Bulk material can be handled in road or rail tanker. Rail movements are restricted to siding to siding movements. Road offers much more door to door convenience. This is especially important for deliveries to mines which have dedicated storage areas on site quarantined for safety. Most materials can be containerised and tanker configuration containers are in use.

Material in containers can comprise many forms such as:

- Palletised and bound drums
- Poly tanks and steel drums of up to 200 litres
- Bladders of various sizes.
- Bulkabags of 100kg to 500kg
- Pallets with integrated cages

Rural distributors and 3PL intermediaries such as such as CRT or Elders, are important in the logistics chain because of their role in:

- Coordinating movements from manufacturers
- Indirectly financing various parts of the chain.
- Storage/warehousing and blending function

There may be a role for 3PL to manage a centralised warehouse or even the proposed inland port.

4.2.2.3 Volumes

The grain and cotton sectors are the heaviest users of fertilisers in the region. Based on a web-based desk study with limited consultation, fertiliser consumption in the region is estimated to between 40 and 50 thousand tonnes per year[4]. Given the pack types and the coverage of local Emerald-based distributors, about half of the total could use the TSC services and use Emerald as the inland distribution point. This is because some farmers order direct from the manufacturer and bypass the normal channels. There are also many farms east of Emerald e.g. around Duaringa, Dingo, etc. and it makes no logistical sense to go past them to a terminal and then send the product back to them.

Chemicals are used by mining and agriculture. Quantities are relatively small, estimated at less than 10 thousand tonnes per year, and include products such as pesticides, herbicides, acids etc. This estimate is based on imports through the port of Gladstone.[5]

Explosives are widely used in the coal mines. Based on mining industry data and benchmark consumption rates estimated in other studies such as CQTSCS, about 50 – 60 thousand tonnes per year are used. This estimate does not include material consumed in the Callide and Dawson Valleys which are served by a separate logistics supply chain. From the land transport perspective, the materials come from the Gladstone/Bajool/Port Alma area although some is sourced from Brisbane.

Most of the coal mining activity occurs 100km east of Emerald (with the exception of the Minerva mine). This mining activity could use the Emerald hub but in practical terms would not due to the extra distance and cost involved. Therefore the prospects for rail to capture of Blackwater cluster mines are small.

In the absence of any better data the myriad of smaller unknown products are assumed to add another 10% to the total. With the right logistics package and rail serving a multimodal hub in Emerald rail could capture a larger share of the market than at present.

Table 4 Estimate of Chemicals Markets (thousand tonnes per year)

Segment	Gross Market	Target / Contestable Market	Current Rail Market Share	Optimistic Rail Market Share
Total	100 - 130	45	5	25
Emerald*	45	45	5	25
Blackwater*	55 - 85	0	0	0
Galilee**	35 - 85	25 - 60	0	15 – 40

Emerald* and Blackwater* are treated as standalone nodes and summed to get the total.

Galilee** is treated separately as a hypothetical exercise based on a range of coal output tonnages between 40 and 100mtpa and the optimistic market share is based on hubbing off an inland port at Alpha.

[4] *http://www.fertilizer.org.au/default.asp?V_DOC_ID=1176*
http://www.fertilizer.org.au/files/pdf/publications/Australian%20Fertilizer%20Industry%20Value%20and%20|Issues%20August%202010.pdf
[5] http://content1.gpcl.com.au/viewcontent/CargoComparisonsSelection/CargoOriginDestination.aspx?|View=G&Durat=C&Key=2013

4.2.2.4 Market Outlook

Mining related inputs are expected to grow in line with mining activity. Coal is the major material mined in central Queensland and production in the Bowen Basin is expected to grow in the long terms and Galilee Basin mines will contribute to this growth in the future. The mines in the southern Galilee Basin which could be serviced out of Emerald are expected to be capable of producing double the coal presently produced in the Blackwater region. Potentially this could mean a threefold increase in the demand for mining inputs compared with now.

The agricultural sector is more difficult to assess given the expansion of mining areas consuming good quality agricultural land (QCAL) although as leases/mines expire, the rehabilitated land becomes available again. The long term rise of feedlots in the region is creating new demands for food supplements, antibiotics etc. and replacing some of the traditional plan based inputs. Feedlots represent a much more intense farming activity than traditional grazing methods and therefore impose much higher demands on all stages of the value adding chain.[6]

The major generators/producers are Incitec/Pivot, Impact Fertilisers, Growforce, Westfarmers, Dupont, and Monsanto.

The major consumers are mining companies, grain and oilseed producers, horticultural sector and the pastoral sector. **Figure 13** shows time series data on the relationship between fertiliser consumption and various drivers. It shows a very strong upward trend. Given that there are finite limits on the amount of arable land which can be added for production, increased yields will have to come mainly from technological advances in crop genetics and fertiliser. The chart is based on world-wide trends and there is no reason to expect these would not be replicated in Australia.

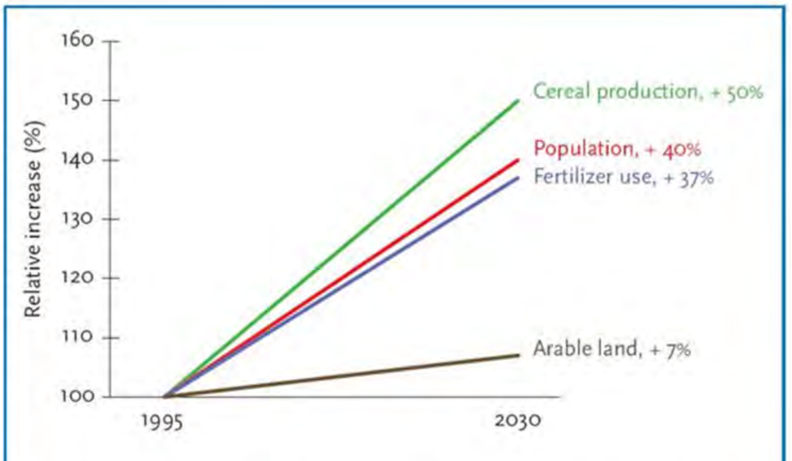

Figure 1. Projected development of cereal production, global population, fertilizer use and arable land (Source: FAO 2003)

Figure 13 Comparison of Fertiliser Use with Other Drivers[7]

4.2.2.5 Origin-Destination Combinations/Pack types/Optimal parcel size

Most products are sourced from overseas or interstate thus Gladstone and Pt Alma/ Bajool have a significant role. Brisbane, Newcastle and Sydney are significant points of origin. However new 3PL opportunities at an inland port may provide options to build capacity closer to consumption point(s). This will deemphasise the importance of Just In Time (JIT) movements and lead to more stable levels rather than the logistic dislocations of alternating peak and trough.

More than 85% of fertilizer is transported and sold as bulk product with less than 15% in bags of between 20Kg and 1t.[8]

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[6] http://www.beefcentral.com/feedlot/article/3568

[7] Source: http://www.fertilizer.org.au/default.asp?V_DOC_ID=1166 accessed 28 Jan 2014

4.2.2.6 Logistics Requirements – intermodal/door to door/ performance characteristics

Many of the products are hazardous or carry dangerous goods (DG)/Hazchem classifications. Safe transport, storage, distribution and use are priorities.

"Hazardous substances are those that, following worker exposure, can have an adverse effect on health. Examples of hazardous substances include poisons, substances that cause burns or skin and eye irritation, and substances that may cause cancer. Many hazardous substances are also classified as dangerous goods."[9]

The safe transport and handling of these commodities is governed by regulations contained in the Dangerous Goods Safety Management Act (DGSMA)[10] and TMR which has licencing centres and accreditation.

4.2.2.7 What Rail must do to improve Market Share

Rail cannot match road's direct door to door transit time or flexibility. From a customer/s perspective, if rail offers an integrated door to door service with reasonable transit times, there is no reason it cannot compete viably. In contrast to warehousing 3PL options, few of the distribution centres operate 24-7 so there is the opportunity to gain back slower transit times by overnight operations – there is no advantage in a truck arriving at night when a depot is closed.

The products within this commodity group range widely in type and value which has a major impact on the relative sensitivity of individual products to freight rates. Very high value products e.g. medical/veterinary supplies can justify expensive air freight in some cases but simple crude fertiliser in bulk cannot. Thus it is difficult to generalise the price sensitivity across the group. If products are low value and therefore price sensitive, there is some scope for rail. Containerisation and double-hull ISO-Tank containers add a security dimension not possible in box wagons or open top wagons. Containerisation also greatly simplifies intermodal transhipping scope while reducing risk of contamination, fugitive emissions, leakages etc.

4.2.3 Cement and flyash

4.2.3.1 Products

The product group includes the following individual commodities and their associated typical pack types as shown in **Table 5**. Containerisation is important because it is the "best fit" for a multimodal operation based on an inland terminal servicing a large hinterland.

Table 5 Commodities in the Cement and Flyash Group

Bulk	Containerised
Cement	Packaged Cement
Flyash	Packaged Flyash
Lime	Packaged Lime
Additives	Packaged Additives
	Packaged Other Powders/solids

[8] http://www.fertilizer.org.au/default.asp?V_DOC_ID=1177
[9] http://www.deir.qld.gov.au/workplace/hazards/hazchem/substances-and-dangerous-goods/index.htm
[10] http://www.deir.qld.gov.au/workplace/law/whslaws/dont-apply/index.htm#danger

4.2.3.2 General discussion

The product ranges from relatively crude unprocessed materials to fully manufactured finished goods in the case of cement. Extensive infrastructure damage resulting from floods has necessitated a larger infrastructure rehabilitation and restoration program since 2011. As some of these works finish, demand will inevitably decline however the development of the Galilee Basin mines will result in high levels of demand during the construction phase, normally estimated at between 2-3 years, depending on the size and complexity of the mine. Apart from the mines there is significant civil infrastructure e.g. upgraded or new rail lines and roads to service the industry, housing and amenities for the workforce. Aurizon is already moving cement in containers to Emerald.

4.2.3.3 Volumes

It is very difficult to estimate a base line market size given the volatility of the economic drivers in the region and the possibility of complete transformation if and when the Galilee Basin occurs.

According to Cement Concrete & Aggregates Australia, “Next to water, it [concrete] is the most consumed substance on the planet. Worldwide, three tonnes of concrete are used per person every year.” [11]

Queensland production of cement is in the order of 4mtpa (plus imports and minus any exports) and with a population over 4.5 million, these numbers tend to support the contention based on “normal” mixing ratios for concrete.

As a ballpark estimate based on these annual consumption rates of about 1 tonne per capita, there are about 32,000 permanent residents in Central Highlands Region plus another 10,000 in the combined Barcaldine and Longreach Regions plus the Winton Shire meaning about 42,000 tonnes per year. Because of the spread of population in the region, it is assumed rail has physical access to about half which defines the contestable market. This is summarised in **Table 6**.

Table 6 Estimate of Cement Markets (thousand tonnes per year)

Gross Market	Target /Contestable Market	Current Rail Market Share	Optimistic Rail Market Share
42	21	<5	10

4.2.3.4 Market outlook

Cement is critical to all sectors in the economy ranging from consumption in domestic housing applications to commercial retail centres, from civil infrastructure to public and private works. Recent flood repair work has created a spike in concrete usage and the construction of the Galilee Basin mines and associated infrastructure will consume additional material. After the mine construction phase, it is normal for demand to decrease in line with the operation/production phase.

With growing populations and demand for expanded airports, there will be continued high demand potentially for decades. TMR has significant planned works in central Queensland and concrete is integral to many of these projects. DSDIP is also examining infrastructure opportunities and regional economic development throughout the region through its relationship with the Galilee Basin development.

The major consumers are mining companies, private developers, consumers, and civil infrastructure providers such as federal state and local government.

[11] CCAA *CONCRETE THE RESPONSIBLE CHOICE* http://www.concrete.net.au/sustainability/documents/concrete%20the%20responsible%20choice.pdf

Without the Galilee Basin coal developments, the market prognosis for Alpha is dismal based on population trends. For the combined Barcaldine, Longreach and Winton local government areas (LGAs), the OESR Regional profiles indicate:

- Estimated resident population (ERP) of 8,974 persons as at 30 June 2012
- Annual average growth rate of 0.1% over five years
- Annual average growth rate of -0.7% over ten years
- Within the region, Longreach (R)[12] LGA had the fastest population growth over five years with 0.5%[13]

4.2.3.5 Origin-destination combinations/ pack types/ optimal parcel size

The major sources are Cement Australia (Gladstone) with lesser volumes from Sunstate Cement (Brisbane). Generally bulk parcel sizes are in truckload quantities. Concrete batching plants are located throughout the region and relatively large amounts of materials are moved and stored on site prior to delivery in mixed form. Even packaged cement is delivered in relatively large consignments to hardware stores and rural suppliers with typical minimum loads being at least several pallets at a time. This very heavy loading is well suited to rail operations.

4.2.3.6 Logistics requirements – intermodal/door to door/ performance characteristics

All weather protection and freedom from contamination is critical to product quality.

In particular packaged material is often sold on the basis of presentation in store therefore the product on display must be clean, free from tears etc. This means relatively gentle materials handling, transport and storage.

The product is normally handled in large quantities and there are generally long lead times thus normally fast transit times are of little importance to the customer. The product is generally of relatively low value, less than $250 per tonne for packaged and $150 per tonne in bulk, and thus price sensitivity is more important than for other higher value products which can better absorb higher logistics costs. Packaged cement as sold in hardware stores commands a much higher retail price but this is a relatively small part of the market and one which might be better served by road rather than rail.

4.2.3.7 What rail must do to improve market share

Rail must provide a service which can match road's performance in the Key areas of:

- Seamless door to door operation
- Zero or minimal product damage
- Attractive pricing.

To sum up: this is a multilayered commodity group which offers scope for rail to increase its market presence. It already has a minor share of the market and if the present constraints on the rail price/service package can be addressed it can do better.

[12] R= Region as defined by ABS/ State Statistician

[13] http://statistics.oesr.qld.gov.au/profiles/qrp/resident/pdf/223AZBXQS5EOFR6G5C25Q1ABJ79B17IOYMQ6KP1HWT2RV1WU10LENAAM9CM0JGFRS5UZG7Y255XM366K8VQOITB8ZC735G9OYXRC9UW65I1QHH6I7CP19QZSH22MO7Q3/qld-regional-profiles-resident#view=fit&pagemode=bookmarks accessed 17 Feb 2014

4.2.4 Quarry materials

4.2.4.1 Products

The product group includes the following individual commodities and their associated typical pack types as shown in **Table 7**. Containerisation is important because it is the "best fit" for a multimodal operation based on an inland terminal servicing a large hinterland.

Table 7 Commodities in the Quarry Materials Group

Bulk	Containerised
Minerals	
Ores/concentrates	
Gravel/Aggregate/road base	
Sand	
Gypsum/Talc/Powders/ Phosphate	Gypsum/Talc/Powders/ Phosphate
Additives	Packaged Additives

4.2.4.2 General discussion

Gypsum is mined near Winton. It is a relatively low value commodity and is therefore price sensitive in terms of freight rates. This material was rail hauled to Townsville (590 km) via Hughenden prior to the rail closure, rail to the coast via Emerald (865km) is now the only viable option.

There is a major quarry at Nerimbera (on the Yeppoon line east of Rockhampton) which is mainly to supply Rockhampton's domestic and industrial needs and QR's needs in central western Queensland. TMR sometimes draws from this supply although there are smaller regional quarries.

Because of its low value, it is important to reduce transport costs as much as possible, hence there are many small quarries operating throughout the region, each operating in their own geographic monopoly.

4.2.4.3 Volumes

From 1998 to 2001 "the per capita consumption of aggregate for Queensland varied from 7.9 to 9.5 Tonnes per annum."[14] It would not be unreasonable to conclude that the per capita consumption rates in central Queensland would be similar. If this is the case, with a population of about 32,000 in the Central Highlands region, plus another 10,000 in the Barcaldine, Longreach and Winton LGAs the market would be about 261 to 314 thousand tonnes per year. This would not include extra material for flood mitigation, and repairs which have been prevalent in the region since 2011 nor the amount Queensland Rail Limited/Aurizon consumes for their own uses.

The gypsum is estimated to be in the range of 400-500 tonnes per week (20 – 25,000 tonnes per year).

Table 8 Estimate of Quarry Material Markets (thousand tonnes per year)

Gross Market	Target /Contestable Market	Current Rail Market Share	Optimistic Rail Market Share
281 - 339	100	25	50

[14] GHD 2005 *Availability of Extractive Resources in Southeast Queensland Summary Report*) https://www.ccaa.com.au/sustainability/documents/GHD%20-%20Final%20Summary%20Report.pdf

4.2.4.4 Market outlook

As for cement and other building materials, domestic demand is driven by population growth and industrial demand is a function of the mining sector, plus public and private infrastructure providers. The general prognosis is for continued growth especially if and when the Galilee Basin mines construction phase is implemented.

4.2.4.5 Origin-destination combinations/ pack types/ optimal parcel size

Major movements over significant distances –such as over 200km, are rarely less than in truckload (say 20tonne) quantities, often there are campaign programs involving several hundred tonnes or even whole trainloads. Trucks completely dominate the short haul and local delivery side of the logistics chain.

4.2.4.6 Logistics requirements – intermodal/door to door/ performance characteristics

Rail is in a good position to provide the basic terminal to terminal haul but poorly equipped to offer the full door to door service.

This is a very low value commodity and best suited to cartage by purpose built bottom or side discharge wagons. Although some of this material could be containerised this would be a less efficient operation because of added loading/unloading difficulty and cost and the containers would be quickly damaged beyond repair.

On rail the material is normally moved in whole trainload quantities and given the need for onsite delivery, transhipping is normally not practical or economical given the relatively low value of the material, hence rail is basically restricted to a niche market.

4.2.4.7 What rail must do to improve market share

Rail has to respond in a more customised way to the respective needs of different market segments. It is not in a position to cover all bases however the following segments are easily defined:

- Whole trainload quantities medium to long haul from siding to siding – should be able to compete
- Whole trainload quantities door to door - cannot compete without PUD legs and suitable terminals for materials transhipping
- Whole wagonload quantities and medium distance – can compete using general purpose trains and coordinated PUD legs and terminals
- Small quantities often called less than car load (LCL) – not really competitive
- Short haul – not really competitive.

This commodity group is normally associated with quite low value market price thus there is limited ability to absorb high freight charges. Companies have got around this where possible by sourcing material locally and although road costs are normally higher than rail's, rail is uncompetitive for really short hauls.

The other thing rail could consider is the construction of its own holding terminals at various locations so that it can efficiently transport from mine or quarry to transhipping point. If a containerised multimodal solution is sought, this would be cleaner and more efficient than a traditional ground-based dump and reload system.

4.2.5 Agriculture – broadacre crops

4.2.5.1 Products

The product group includes the following individual commodities and their associated typical pack types as shown in **Table 9** which is based on DAFF information. Containerisation is important because it is the "best fit" for a multimodal operation based on an inland terminal servicing a large hinterland. The broadacre field crop industry is estimated to be worth about $675 million annually (excluding sugarcane).[15]

Table 9 Commodities in the broadacre crops group

Bulk	Containerised
Grains – Barley, Maize, Sorghum, Wheat, Oats	Grains – Barley, Maize, Sorghum, Wheat, Oats
Lupins/Pulses - Chickpeas, Mung Beans, Navy beans, Soybeans	Lupins/Pulses - Chickpeas, Mung Beans, Navy beans, Soybeans
Oilseeds – Sunflower, Canola, Peanuts	Oilseeds – Sunflower, Canola, Peanuts
Cottonseed	Cottonseed
Cotton fibre	Cotton fibre

[15] http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops

4.2.5.2 General discussion

Large changes are occurring through the industry. Among the major trends are:

- The rise of local and regional feedlotting means there is less grain, particularly sorghum available for traditional export
- Since the early 1990's the operation of rail branch lines has come under increasing economic pressure. In general they operate on lower axle loads meaning the operation is less efficient than a mainline based regime. In line with freight rates to encourage concentration on mainline silos, some of the silos on branch lines became uneconomic for the grain handlers
- With no guarantees for future volumes, fleet replacement imposes significant financial risk on the rail operators. However, many of the present day Aurizon grain wagons are former coal wagons cascaded and life-extended. The fleet is in good condition and well maintained
- Some severe droughts have impacted on tonnage on a year to year basis leading to chronic underutilisation of capacity and equipment. The flip side is that providing sufficient equipment and capacity for bumper harvest is normally uneconomic
- At times there is some difficulty obtaining train paths because of the growth in the number of coal trains which are more financially attractive to rail operators
- There has been significant growth in containerised grain[16.] Increasingly customers are Asian based. Most of these ports e.g. Saigon, Danang, Laemchebang and many others have container handling capacity but many do not have food-grade bulk handling equipment, contamination-free secure storage and the associated logistics chains to support bulk movements
- Cotton has emerged as a major crop particularly since the mid-1980s. Louis Dreyfus Commodities (LDC, formerly Dunavants) and Queensland Cotton dominate the scene [17]
- Lupins and oilseeds have become a major crop consuming land formerly used for grain production[18]
- Most of the products can be handled as easily in containers as in bulk
- LDC had a purpose built rail siding and warehouse complex at Yamala, about 21 km east of Emerald.

4.2.5.3 Volumes

Volumes have been very volatile and are subject to the vagaries of weather. The basic outlook for broadacre crops is favourable although traditional grains may be less dominant in the future based on recent trends.

Figure 14 shows trends for exports via the port of Gladstone. These are primarily bulk rather than containerised movements. This volume also includes crops grown in the Callide and Dawson Valleys which would not use the corridor which is the basis of the study. However based on the available data approximately half the volume is attributable to the Central Highlands area.

The chart shows the extreme volatility in annual crops resulting from drought and flood events. Other events such as consumption by feedlots, the high AUD, deregulation of sale and handling and a greater role of containerised product underpin a fundamental long term change in the market. Feedlotting in the central Highlands and

[16] A review of time series trade data for The Port of Brisbane (the major container port in Queensland) trade statistics show increasing containerisation of grain. Exports are sourced from throughout Queensland and it is expected central Queensland contributed to this growth. Anecdotally there are reports of this occurring based on consultation with the industry and the entry of new traders operating in the non-bulk space..

[17] See for example Port of Brisbane times Series Trade Statistics http://www.portbris.com.au/PortBris/media/General-Files/MTR/2013/June2013-MonthlyTradeReport.pdf

[18] See for example: ABS *Agricultural Commodities, Australia, 2009-10* cat 7121.0

adjoining Isaac Region is much more widespread than in the Dawson and Callide Valleys, a fact which is not obvious when reviewing the export volumes.

Over the 19 year period, wheat has averaged 131 thousand tonnes per year and sorghum 93 thousand tonnes per year. The major growth commodity since 2007 is the emergence of crops such as chick peas which rose to 75 thousand tonnes in 2013.

Anecdotal information indicates there is an estimated 10,000 tonnes per year of cottonseed and a similar amount of cotton fibre exported from the Central Highlands region via Brisbane in containers. This is currently handled by road but was formerly carried by a mix of road and rail. A conservative estimate of 20 thousand tonnes of containerised grains, lupins etc. originating in the Central Highlands and exported through Brisbane has been assumed. With the right logistics package, this could be captured by rail.

One of the difficulties facing rail is that road operators otherwise retuning empty to Brisbane are offering very competitive backload rates. There are recent reports of grain being trucked from Central Queensland to Toowoomba for fumigation and containerisation prior to despatch to Brisbane for export. This demonstrates some of the complexity and expense of the present cumbersome operation without an inland port or coastal shipping which would provide these services.

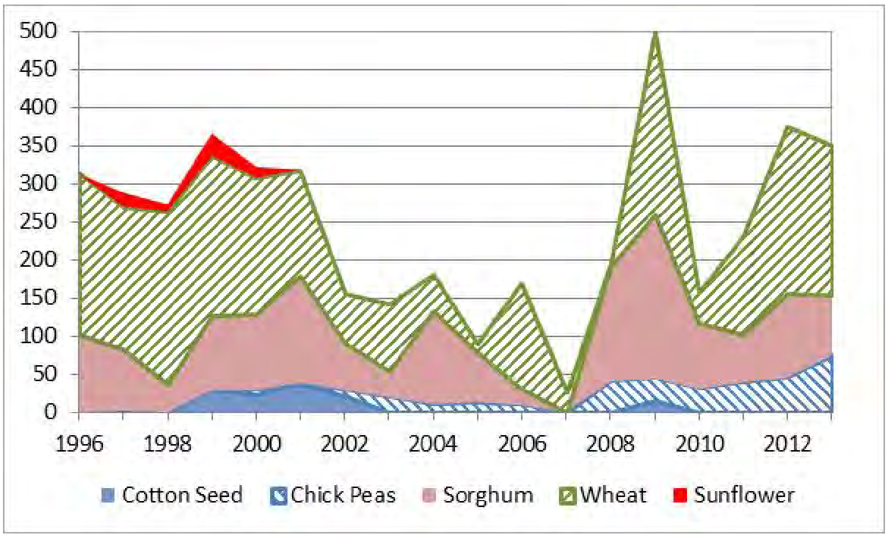

Figure 14 **Broadacre crop exports through Gladstone (thousand tonnes)**

These volumes have been compared with the ABS data for 2010 which is shown in **Table 10**. It shows that there is little production in the Central West which basically covers the area west of Emerald and the Central Highlands. Comparing this data with the Gladstone exports for the same period reveals how much of the product is consumed locally in feedlots or is containerised and exported through Brisbane. The data seems to indicate about 100,000 tonnes per year is used in feedlots. After deducting feedlot usage and bulk movements by rail, the estimated market size applicable to this study is shown in **Table 11.**

Table 10 **Broadacre crop production 2009/10 (tonnes)**

	Fitzroy	Central West	Combined Fitzroy and Central West	Queensland	Fitzroy and Central West % of Qld Total
Cereal	280,463	0	280,463	2,507,424	11%
Cotton	21,440	0	21,440	138,373	15%
Chickpeas	33,937	0	33,937	145,774	23%
Total	335,840	0	335,840	2,791,571	12%

Table 11 Estimate of broadacre crop markets (thousand tonnes per year)

Gross Market	Target /Contestable Market	Current Rail Market Share	Optimistic Rail Market Share
120 - 140	40	2 - 5	20

4.2.5.4 Market outlook

There are opportunities for value adding activities such as the use of 20kg or 50kg bulkabags which make handling for the end user more manageable than full container loads (FCL). The high AUD has made it difficult to compete offshore especially when good prices can be obtained domestically. The four main influences are:

- Relative value of AUD
- Strength of demand in the international market
- Reliable rainfall
- The world supply situation

It is very hard to control any of these drivers.

The outlook is for continued growth in emerging Asian markets which are increasingly transforming away from traditional diets and more toward western tastes which are primarily associated with the young and the increasingly affluent societies. The lack of bulk handling facilities in some foreign ports is offset by relatively modern container handling facilities. The domestic market is relatively low growth however the role of feedlots is becoming increasingly important.

4.2.5.5 Origin-destination combinations/ pack types/ optimal parcel size

There are several identified movements:

- Short haul by road from farm to feedlot – usually on local roads
- For bulk grains, oilseeds, etc. there is the option of rail to Gladstone in bulk for export involving short haul by road from farm to railhead or silo using a mix of local and state roads
- For containers some is railed to Brisbane and some is trucked. At times trucks can offer very competitive backload rates.

Full container-load or truckload seems to be the building block of export parcel size. LCL movements are not practical for rail because of the extra materials handling.

All cotton fibre is exported in 40ft containers. There is no scope to increase the payload of containers even if compaction techniques improve since the current container load mass is on the limit for most roads in Australia and in the export countries. Most cotton is trucked to Brisbane and graded prior to being exported in containers through Brisbane.

4.2.5.6 Logistics requirements – intermodal/door to door/ performance characteristics

The logistics are determined by the product and the market segment it is targeting. The diversity of crops means year round production and harvesting as opposed to the traditional summer grains and winter grains seasons. Deregulation in the market has de-emphasised peak periods and interacting with multiple grain handlers and traders has dispersed the market from the former amorphous bulk shipments via Gladstone approach.

This opens the opportunity for containerisation on an individualised basis. Containers also provide safe, secure and vermin-proof storage which is important in a region where there is insufficient upcountry storage. Rationalisation of the silo storage system and the deactivation of grain sidings means there is a considerable amount of product now excluded from the traditional bulk rail supply chain.

If containerised, this would be suitable for loading from an inland port direct to the port of Brisbane potentially even via coastal shipping.

4.2.5.7 What rail must do to improve market share

A full seamless multimodal farm to port/trader/storage package is required, including more flexibility in arrangements (pick-up and delivery times/quantities, etc.) particularly regarding containerised movements to at least match what road operators have been offering for some time. This means a greater coordination role at regional ports to consolidate single loads from multiple farms/sources.

Rail is most efficient at line haul movements in whole trainload quantities and it is for the rail operators to consolidate optimal loads rather than for customers to do it for them.

4.2.6 Pastoral products

4.2.6.1 Products

The product group includes the following individual commodities and their associated typical pack types as shown in **Table 12**. Containerisation is important because it is the "best fit" for a multimodal operation based on an inland terminal servicing a large hinterland.

Table 12 Commodities in the pastoral products group

Bulk/unitised	Containerised
Cattle	Wool
Sheep/Lambs	Chilled Meat
Pigs	Frozen Meat
Goats	Animal By-products – hides etc.

4.2.6.2 General discussion

After a series of fluctuating droughts and adverse climatic conditions particularly since the 1980s, the pastoral sector has moved towards feedlotting as a way to drought proof itself in the future. In a way this is analogous to the poultry and pork industries which can operate almost independent of weather effects. There are now hundreds of feedlots dispersed throughout Central Queensland and the Central Highlands area.

There are of course many other properties still using traditional methods for cattle and sheep production and these are subject to the extreme volatility noted earlier.

Within the industry there has been considerable penetration from overseas investors both in an equity holder and as operators on exclusive and joint venture (JV) bases. Operationally and commercially these firms operate differently to the traditional Australian practice and often have to fit their Australian operations within a broader international strategic context. For example they may have different strategic timeframes, cost recovery and revenue expectations and completely different financing conditions e.g. much lower interest rates.

4.2.6.3 Volumes

Queensland accounts for half of Australia's 2.2 mtpa beef and veal production and has about 62% of the nation's feedlots.[19] There is some overlap in statistical regions in the ABS data. By combining the Central West with Fitzroy, some useful livestock population data is obtained for 2010 and is summarised in **Table 13**.

[19] http://www.mla.com.au/Cattle-sheep-and-goat-industries/Industry-overview/Cattle

Table 13 Cattle and livestock populations west of Rockhampton 2010 (head)

	Fitzroy	Central West	Combined	Queensland	% Combined of Qld
Sheep & Lambs	29,438	1,852,397	1,881,835	3,622,141	52%
Beef Cattle	1,742,556	1,410,163	3,152,719	11,193,348	28%

There are two large abattoirs near Rockhampton which source a considerable amount of stock from the target area which also supplies abattoirs in south east Queensland. For simplicity it is assumed the cross country movements account for a quarter of the total. Based on uncorroborated information, there could be as much as 150,000 – 200,000 head of cattle travelling between Emerald and Rockhampton/Gracemere per year.

This basically defines the upper bound of the market. Given the range in cattle sizes and ages, each beast has been given a nominal mass of 400 kg, but is often much higher. The sheep market is less clear but it is likely that an estimated 500,000 head could be brought to market. Average mass per sheep/lamb is estimated to be 50 kg.

Estimated market size applicable to this study is shown in **Table 14**.

Table 14 Estimate of livestock markets (thousand tonnes per year)

Gross Market	Target /Contestable Market	Current Rail Market Share	Optimistic Rail Market Share
175 – 225	110 - 168	60 - 70	70 – 80

Rail's market share is solid in the end-to-end market which is based on full trainloads or consolidation from a small number of points and all terminating at a common place, e.g. saleyard/ abattoir. The potential to penetrate markets for other products such as wool or meat provides a potential growth source.

4.2.6.4 Market outlook

The major factors and drivers are the same as those facing the export primary industry:

- Relative value of AUD
- Strength of demand in the international market
- Reliable rainfall
- The world supply situation

Live cattle exports are an emerging market although as yet this mainly affects sheep and cattle from areas further north and west and exporting via Townsville, Mourilyan, Karumba and Darwin. There may be potential for Port Alma to take on an export role.

Periodically the subject of an inland meat processing facility resurfaces based on niche products such as goat or kangaroo however nothing firm has taken place. This will have to compete with the already established Charleville plant which has been operating for several decades. However if the product is containerised this would be a target market for rail to capture.

4.2.6.5 Origin-destination combinations/ pack types/ optimal parcel size

The major movements are from the central west to:

- Gracemere Saleyards
- Dinmore Abattoir
- Rockhampton Abattoirs
- Beenleigh Abattoir

Minor movements (one offs) are from:

- Farm/feedlot to a different farm/feedlot
- Farm/feedlot to abattoir
- Farm/feedlot to saleyard

There are sometimes back movements from the coast/saleyards for restocking purposes.

4.2.6.6 Logistics requirements – intermodal/door to door/ performance characteristics

Stock agents typically consolidate loads especially for trainload quantities. Smaller quantities are arranged individually but normally in whole "deck"[20] quantities and above.

Sales are on nominated days per week therefore patterns are well entrenched and widely known. There are often return movements (east to west) as growers restock their herd.

Trucks have a definite speed advantage over rail which can impact on cattle quality especially if they can avoid heat stress. This door to door transit time advantage is also aided by more direct road routes than are possible by rail. Compare for example Emerald to Dinmore by road (about 850 km via Carnarvon Highway) and by rail, about 925 km. A 900 km rail haul may require spelling en-route which will further lengthen the difference in transit time.

Rail generally provides a more comfortable ride thus cattle arrive in better condition (unless the rail haul is inordinately longer than the road) which is highly prized and regarded in the market.

There is a usually weekly pattern of sales and movements throughout the year but pronounced inactivity over summer when many abattoirs close for the Christmas period – sometimes for up to two months.

For big orders such as to meet live export ship deadlines, rail has the capacity to perform campaign railings at short notice. Similarly, livestock agents/saleyards/abattoirs would prefer to receive 800 head on a train and transhipped or unloaded in an hour rather than handling the random arrivals of 40 decks of cattle by truck.

Realistically rail can only compete for a limited segment of the market based around whole trainloads from point to point. Clearly mixing livestock with general freight on the same train is undesirable since the cattle cannot be loaded and unloaded in the same general purpose freight terminal and this automatically involves extra shunting and cost at both ends. Generally rail can only compete in point to point whole trainloads and this is the market it must pursue. The difficulty with this strategy is that it is often difficult to consolidate and coordinate a whole trainload from multiple different sources.

Although rail has capacity for backloading westwards for restocking purposes, this is a difficult market to serve because quantities are generally smaller and involve multiple destinations.

[20] "deck" is equivalent to a conventional semi-trailer deck (about 12 metres) which fits about 20 fully grown beasts.

Wool is normally scoured locally and then transported to Brisbane for export or processing. Road has offered cheap backload rates which makes it hard for rail to compete on cost grounds. The oil which is extracted locally is palletised and also trucked to Brisbane. This material could be containerised and transported by rail if the price-service package was competitive.

For sheep and goats there is not really a major role for rail in Queensland. Goats travel cross country to the Charleville abattoir – a haul clearly too cumbersome and impractical for rail to be considered a viable option. The volume of sheep movements tends to be smaller than cattle movements and although rail can compete in its niche market, the sheep trade is much harder for rail to access. Relative to livestock, chilled and frozen meat are in very small quantities but could be containerised. A multimodal terminal would require mains power with generator backup to prevent product deterioration.What rail must do to improve market share

Generally rail can only compete in point to point whole trainloads and this is the market it must pursue. The difficulty with this strategy is that it is often difficult to consolidate and coordinate a whole trainload from multiple sources. Over the last 20 years QR/Aurizon has rationalised and modernised its fleet with the new cattle crate container concept. Further innovations are required for rail to maintain and enhance its position given the difficulties involved in upgrading components of its performance package e.g. transit times.

Rail seems to be in a good position to retain its cattle market share albeit given freight rates are suppressed and grandfathered[21] and the TSC provides subsidised capacity. For other products, rail's best prospects are in containerised products such as wool, oil by-products and meat. An abattoir located in central western Queensland might change the composition of the freight traffic task – i.e. less cattle, more meat.[22].

4.2.7 Other agriculture

4.2.7.1 Products

The product group includes the following individual commodities and their associated typical pack types as shown in **Table 15**. Containerisation is important because it is the "best fit" for a multimodal operation based on an inland terminal servicing a large hinterland.

Table 15 Commodities in the other agriculture group

Bulk/unitised	Containerised
Logs & forestry Products	Logs & forestry Products
Woodchip	Woodchip
Citrus	Citrus

4.2.7.2 General discussion

For citrus the ABS data for production in the relevant target area is shown in **Table 16**. From very small beginnings in the 1990s, the industry has expanded considerably in recent years and with irrigation and other improvements, present day yields are expected to be much higher. Practically all of this crop is produced for export via Brisbane, or for domestic consumption in southern markets. The product is eminently suited to rail transport and given the logistics supply chains for fruit and vegetables with their associated long term storage facilities, the journey from the region to storage or packing facility could be performed by rail because extreme time sensitivity is not required. Onsite packing into refrigerated containers would further enhance rail's chances of competing.

[21] A grandfather clause is a provision in which an old rule continues to apply to some existing situations while a new rule will apply to all future cases (Source Wikipedia)

[22] It is noted there is an abattoir at Biloela but this is not relevant to the present study area.

In some ways the expansion of the horticulture industry parallels expansion and development of the cotton crop since the early 1980s. With greater areas coming under irrigation, the growth prospects are good for the future and big crops in the thousands of tonnes per year are possible.

Table 16 Citrus production 2009/2010 (tonnes)

	Fitzroy	Queensland	% of Total
Oranges	151	6288	2%
Mandarins	657	62281	1%
Totals	808	68569	1%

Logs and forestry products are a difficult market for rail to penetrate for a number of reasons. The most obvious is that these are difficult to handle, generally loaded in relatively remote areas, normally difficult to tranship and short haul. The adage "it's on a truck so it might as well stay on a truck" sums up the particularly difficult barrier to entry faced by rail. This material is eminently unsuited to containerisation so the prospects for capture are bleak.

In contrast woodchip is often conveyed in containers. Because of its low density usually over-height (9'6") containers are used. Most woodchip is exported and Gladstone port has been active in this trade for over 20 years handling whole trainload volumes. It may be difficult for Emerald based producers to generate sufficient volumes and even if they do, it might only be one train per month.

4.2.7.3 Volumes

Table 17 Estimate of fruit and vegetable markets (tonnes per year)

Gross Market	Target /Contestable Market	Current Rail Market Share	Optimistic Rail Market Share
1000 - 2000	800 - 1600	<200	600 - 1200

Given that there is more scope for rail participation than for many other markets, with the right logistics chain rail could capture half of the market.

4.2.7.4 Market outlook

The outlook is generally favourable as indicated by expansion in the industry. Trade liberalisation and the opening up of foreign markets presents new opportunities for the future – however, the volumes are tiny. The estimated 600 - 1200 tonnes only represents one large or two medium trains per year.

4.2.7.5 Origin-destination combinations/ pack types/ optimal parcel size

The citrus cropping area is around Emerald thus a transport hub there would support the industry. Fruit is packed on site and then palletised. The pallets can easily be carried by road or rail. Containerisation represents both a storage medium and a secure weather and vermin proof transport vessel. Most of the crop matures around the same time so a seasonal peak is expected with low or zero volumes the rest of the time.

4.2.7.6 Logistics requirements – intermodal/door to door/ performance characteristics

The basic movement is from farm gate to long term storage centre (in Brisbane, Sydney, Melbourne for domestic consumption or distribution) or to the Port of Brisbane for export. While the transport task can be performed easily by trucks, given the lack of extreme time sensitivity, a local pick up leg from farm gate to rail terminal by truck, line-haul from terminal to terminal by rail followed by a local delivery leg performed by trucks offers the prospect of a slower but low damage option, which if attractively priced, could change the dynamics of the market.

4.2.7.7 What rail must do to improve market share

Road currently owns this market on the basis of perceived advantage in its package offering. It offers flexible fast secure transport at a competitive price. In return, rail is perceived as offering a lesser package mainly at freight rates not greatly lower than road's. The road industry is very competitive with low barriers to entry without which premium freight rates much above rail freight rates would prevail.

Many of the difficulties rail faces are based on entrenched stereotypical perceptions many of which are not only relatively unimportant but can be addressed by rail. For example, many products are not particularly time sensitive yet this is often cited as a reason not to use rail. Trains are not particularly scalable thus where there are difficulties in organising whole trainloads, this is usually achieved by reducing the number of services on offer which reduces customer convenience and flexibility because they must fit the rail operation and not the other way round, which road can easily offer.

Rail must demonstrate it can perform a reliable seamless multimodal door to door service. To compete effectively, it must at least match road's performance package. There is no infrastructure solution which will improve rail's point to point transit time to match road's but there is more to a logistics chain than just transit time. Road cannot normally match rail's smooth ride, safety record or cost (given trainload volumes).

Rail will find it difficult to compete for forestry products. For woodchips there is no operational barrier to entry for rail but the issue of volumes and the ability to convey these economically without a lot of high cost underutilised equipment on standby limit rail's penetration.

4.2.8 Store goods/ general freight

4.2.8.1 Products

The product group includes the following individual commodities and their associated typical pack types as shown in **Table 18**. Containerisation is important because it is the "best fit" for a multimodal operation based on an inland terminal servicing a large hinterland. General freight represents the great unknown – whatever is not easily categorised in the other more narrowly defined groups.

Table 18 Commodities in the store goods/ general freight group

Bulk/unitised	Containerised
Foods/Groceries	Foods/Groceries
Furniture/Removals	Furniture/Removals
Appliances/white goods/brown goods/electronics	Appliances/white goods/brown goods/electronics
Alcohol/cigarettes	Alcohol/cigarettes
General Merchandise	General Merchandise

4.2.8.2 General discussion

Some of the products are delicate high value e.g. computers, TVs, etc. which require secure weather-proof transport and storage. Many of the goods are sold on the basis of appearance on the shop floor hence they must be completely untainted and free from damage. This necessitates "gentle" handling.

Food products are perishable and require correct temperature control and management with secure weatherproof handling demands. The perishability of many items means transit times are critical and faster transport can command a premium.

A semi-trailer carrying high value product such as alcohol or cigarettes could have over $1,500,000 of stock in a single shipment. Security in transit of high value products is an important consideration in mode choice.

Many products are marketed nationally through online and paper catalogues. A store without the advertised stock would be poorly regarded and reflect badly on the company. Therefore timely co-ordinated national distribution can be an import factor in mode choice.

Some parts of the local retail trade are under significant pressure from online retailers/wholesalers both domestic and foreign. They need more than dependable logistics chains, they need infallible supply lines.

The two big grocery retailers are locked in intense competition with each other and coming under increasing pressure from smaller arguably lower cost competitors such as IGA, Foodworks and others.

Big W, Kmart and other retailers see their logistics chains as differentiators and sources of competitive advantage. For Queensland trade, Big W's freight distribution centre (FDC) is based near Warwick and is a totally road based supply chain. Coles and Woolworths have several FDC in the Brisbane area and regional ones upcountry. They use a mix of internal logistics units, outsourcing to freight forwarders/load consolidators such as Toll Holdings, using a mix of road and rail for line haul to regional areas. Linfox mainly involves itself in short PUD style hauls from FDC direct into store, rather than line hauls.

4.2.8.3 Volumes

The major freight generators, the big retailers and big box outlets, represent the largest part of the retail spend. However often retail spend share of these companies is not proportional with the freight generation share. AECOM has attempted to estimate the freight generated by assembling a simple bottom up model using the little amount of data which is available either from anecdotal and unattributed sources or from best guesses. These estimates are to be used with caution and are an attempt to quantify a largely unknown volume.

For general freight much of which is carried by semi-trailer, it is assumed there is about 22 - 24 tonne payload. In container terms this is approximately equal to 11 – 12 tonnes payload per TEU.

The major retailers in the target area are Woolworths x 2 stores, Coles, IGA, Foodworks, Mitre 10, Crazy Clarks, Harvey Norman, and Target. We estimate these account for about 94 TEUs per week. The great unknown is what all the other retailers and places such as the hospital, schools etc. generate. For the purposes of this exercise it is assumed these “other generators” match the major retailers such that there are about 10,000 TEU per year and about 110,000 tonnes of freight. Many of these products are very low density for their volumetric capacity often attracting a mass penalty when less than 250 kg per cubic metre (m^3). A simple scan of retail prices in March 2014 revealed the following data summarised in **Table 19**.

The same data (except the pharmaceutical outlier) is depicted graphically in **Figure 15**. Basically there is little correlation between the value of a product and the mass of the product. In turn the fact that Woolworths and Coles account for the lion’s share of retail sales doesn’t necessarily mean they account for most of the retail mass unless all retailers carry a similar range of products in the same proportions, which they do not of course.

Table 19 Relationship between various products and their value per kg (March 2014)[23]

Commodity	Pack	Mass	$			
		(kg)	Low	Mid	High	Average price/kg
Softdrink	1.5 Litre	1.5	0.79	1.5	2	1.00
Milk	2 Litre	2	2	2.5	3.5	1.25
Baked Beans	Can	0.45	0.79	0.99	1.3	2.20
Potatoes		1	1.5	3	8	3.00
Bread	Loaf	0.68	0.99	2.5	4	3.68
Tomatoes		1	2	5	8	5.00
Dry Pasta	Pack	0.38	0.99	2	3.5	5.33
Laundry Powder	Box	1	5	8	10	8.00
Cheese	Pack	0.6	5	6	9	10.00
Butter	Tub	0.45	3	5	8	11.11
Crisps	Pack	0.25	3	3.5	4	14.00
Shampoo	Pack	0.25	3	6	11	24.00
Steak	unit	1	15	25	35	25.00
Coffee	Jar	0.25	4	7	16	28.00
Pharmaceuticals	Pack	0.05	10	20	35	400.00

[23] Consultant’s survey of current prices conducted 2 March 2014 at mainly Coles Newmarket (Qld) and supported by junk mail catalogues.

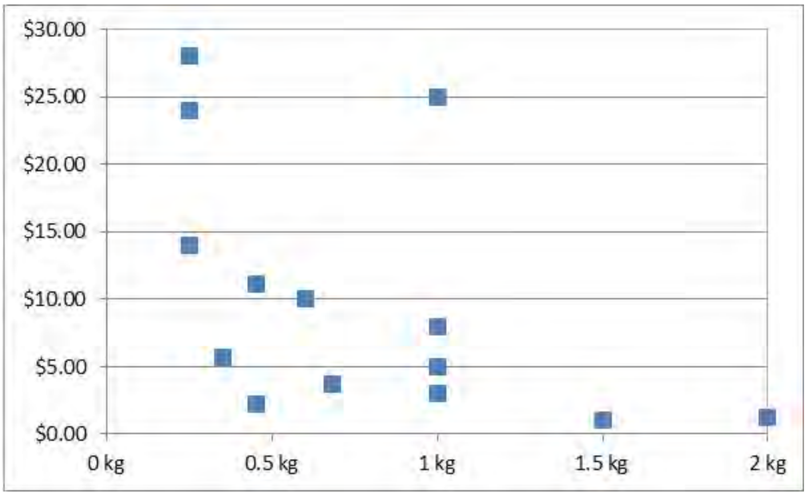

Figure 15 Scatterplot of Sample Retail Price and Mass Combinations

Table 20 Estimate of General Freight Markets (thousand tonnes per year)

Gross Market	Target /Contestable Market	Current Rail Market Share	Optimistic Rail Market Share
100 - 120	75 - 90	<20	40 - 60

NB Does not include items previously counted in other commodity groups

4.2.8.4 Market Outlook

The main drivers are:

- Population growth
- Technological and physical obsolescence
- Disposable income
- Personal tastes - consumerism

These factors impact on different submarkets within this group in quite different ways. For example increased income probably has little impact on the gross consumption of groceries but may well impact on demand for clothes, electronics etc. Population growth is generally considered the main driver of domestic demand. Personal tastes have the potential to alter the mix of what is consumed at a qualitative level. More discerning consumers may favour gourmet products or name brands rather than lower cost mass market targeted products. This can have an impact on the volume of freight transported. For example, consumers may choose to buy 2 upmarket items which cost the same as 5 lower cost items.

Some of these drivers are working in opposite directions. For example population growth means more mouths to feed therefore more food would be demanded and freighted. Higher disposable incomes over time imply the ability to consume more. However, once basic food necessities are met, nobody is going to keep consuming more loaves of bread no matter how relatively affordable they become. Personal tastes seem to be the strongest counter-growth force and the increased share of discretionary income after basic necessities are met makes any predictions hazardous.

4.2.8.5 Origin-Destination Combinations/Pack types/Optimal parcel size

The major retailers are firmly locked into relatively fixed logistics chains hubbing from operationally centralised Freight Distribution Centres (FDCs). Others may have firm arrangements at the wholesale level often in Brisbane or somewhere remote from the region. Other more specialised businesses might have closer relationships with manufacturers in the southern states or with importers. Because of all of these factors, it is very difficult to generalise across such a diverse group of businesses and transport users/generators. For retailers deliveries are rarely in less than full semi-trailer loads. Chilled and freezer units are used for some products and the balance is delivered in curtain sided trailers.

Removalists normally consolidate loads from a number of customers and perform prearranged block movements from depot to depot. Removalists use a mix of containers, high cube trailers and other custom made configurations.

For beer, the normal arrangement is from brewery to off-site storage facility then line-haul to destination depot. Or alternatively direct to the Coles or Woolworth's FDCs prior to line-haul to retail outlet. Round town deliveries are normally performed by light truck. Almost everything is palletised.

Big box retailers outsource their transport needs and the majority of road carriers favour standard semitrailers although some use B-doubles for the longer hauls.

4.2.8.6 Logistics Requirements – intermodal/door to door/ performance characteristics

Many storegoods are shrink-wrapped and palletised. Most products can readily be containerised which provides an added layer of defence against damage, weather and potentially theft. Containers also offer a convenient packing and transport module to reduce materials handling and damage.

For retail goods, appearance is everything and any blemishes/damage will result in the product being discounted or held back with consequent financial loss. Supermarkets for example operate on such slender margins; there is little room for error.

Perishables, chilled and frozen products must be temperature and status monitored enroute to prevent deterioration in the event of equipment failure such as thermostats switching off chiller units. Reduced transit times gives reduced opportunity for things to go wrong and even if they do, time to launch corrective action.

High value products must be protected from theft and damage so security is important.

4.2.8.7 What Rail must do to improve Market Share

Rail traditionally targets wagonload or whole container load quantities. While big companies often buy consignments of that size, most smaller customers cannot. However if there was a way of consolidating the smaller customers consignments into wagonloads or container loads, this would enable rail to capture a larger share of the market. The problem therefore is one of consolidation at origin and destination. Rail companies allegedly make all of their money from their core activity – line haul. Some rail operators interstate (for example Freight Australia, now part of PN) evolved into purely hook and pull operators.

Rail operators are often criticised for treating terminals as unavoidable complications to an otherwise smooth operation. Terminals are of course vital to the logistics chain and far from being a burden should be seen as offering powerful value adding services. This paradigm change is the driving force behind the inland port and perhaps the range of skills to grow and manage a terminal is beyond the traditional rail operations.

4.2.9 Building and Construction Materials

4.2.9.1 Products

The product group includes the following individual commodities and their associated typical pack types as shown in **Table 21**. Containerisation is important because it is the "best fit" for a multimodal operation based on an inland terminal servicing a large hinterland.

Table 21 Commodities in the Building and Construction Materials Group

Bulk/unitised	Containerised
Steel Rod and Bar	
Steel Sheet	
Brick, Tiles, and Pavers	Brick, Tiles, and Pavers
Concrete Products	Concrete Products

4.2.9.2 General discussion

Many of the products e.g. pavers and bricks are relatively low value for their size. Generally they have lower security requirements than many other products.

Appearance is important and chipped tiles or bricks are unsaleable thus "gentle" materials handling is required even though the products are tough, they are not invulnerable to damage, particularly from equipment such as forklifts etc.

4.2.9.3 Volumes

One of the major difficulties in making estimates for this market segment is to avoid double counting items already included in other segments such as cement. The approach taken here is to estimate the building materials consumed on a per year basis to define the total market. QGSO[24] data provides a guide in number and cost of building approvals at the local level.

AECOM has averaged these and has built a simple model to estimate the volume of materials required for a very simple rectangular 15x 10 metre house with concrete slab and steel roof. The QGSO divides construction into three categories: new houses, other residential and commercial building.

Based on this simple model it is assumed the following are required: steel reinforcing - 7.5tonnes, steel roof - 1.1 tonnes, timber - 4 tonnes, linings, windows and doors, etc. - 2 tonnes, bricks/tiles - 19.6 tonnes. A 10% contingency was added to give about 27.5 tonnes in total. The "Other residential" category (units and suchlike) was estimated on a prorated basis equivalent to three houses.

There was little information on commercial construction other than the value of building approvals. Although there may be some differences between the materials consumed and cost per metre squared (m^2) of residential and commercial properties, this cannot be quantified in this instance. If it is assumed that the basic parameters for residential construction e.g. reinforcing steel are the same for commercial buildings then some inferences can be drawn.

OESR has information on the value of building approvals for residential and non-residential activity and given that the mass and cost of a brick is the same regardless of the purpose of the building into which it is inserted it is possible to estimate the materials used for commercial buildings based on prorating the materials used for residential construction. This gives an estimate of the present market at about 46,300 tonnes for residential and

[24] Queensland Government Statistician's Office – formerly OESR (Office of economic and Statistical Research

33,600 tonnes for commercial. These calculations do not include items of civil infrastructure such as concrete culverts, concrete railway sleepers etc.

Table 22 Estimate of Building Materials Markets (thousand tonnes per year)

Gross Market	Target /Contestable Market	Current Rail Market Share	Optimistic Rail Market Share
80	60	5	25

4.2.9.4 Market Outlook

The main drivers are:

- Population growth
- Regional economic development
- Disposable income

4.2.9.5 Origin-Destination Combinations/ Pack types/ Optimal parcel size

Most products are palletised or bundled prior to loading on trucks or into containers. Concrete/clay products tend to be very heavy for their volume.

4.2.9.6 Logistics Requirements – intermodal/door to door/ performance characteristics

There are several types of movements

- From Brisbane or Rockhampton depots to regional depots or direct into shops and hardware stores. These are generally not time sensitive movements. These tend to be at the "bulk" end of the market comprising several trucks/wagons/containers at a time.
- From Brisbane or Rockhampton depots direct to end users. These are generally time sensitive movements and normally in quantities of truckload or smaller.

Some loads are consolidated by in-house or outsourced logistics companies e.g. One Steel or Toll who might load a whole container with various products, hardware etc. for a single customer.

Door to door performance is important however most companies have their own trucks and many have forklifts which can perform their own pick-up and delivery (PUD) legs and deliver to their end customers.

4.2.9.7 What Rail must do to improve Market Share

Rail traditionally targets wagonload or whole container load quantities. While big companies often buy consignments of that size, most smaller customers cannot. However if there was a way of consolidating the smaller customers consignments into wagonloads or container loads, this would enable rail to capture a larger share of the market. The problem therefore is one of consolidation at origin and destination. Rail companies allegedly make most of their money from their core activity – line-haul. Some rail operations interstate have evolved into purely hook and pull operators.

Rail operators are often criticised for treating terminals as unavoidable complications to an otherwise smooth operation. Terminals are of course vital to the logistics chain and far from being a burden should be seen as offering powerful value adding services. This paradigm change is the driving force behind the Emerald freight terminal.

5.0 Inland port concept and potential sites identification

5.1 Inland port vs general multimodal terminal

An Inland Port will indeed perform as a general multimodal terminal, but by having additional facilities (particularly customs and bonded warehousing) it can serve to relieve connected sea ports of space requirements by having some of the usual (non-transport) port activities performed at an inland site away from the port. Simply, an Inland Port is a general multi-modal terminal with the addition of:

a) Import/Export (IMEX) facilities including:

- Customs facilities and bonded warehousing
- Australian Quarantine and Inspection Service (AQIS) fumigation and other treatment facilities as may be required for imported commodities or (by receiving countries) for exported commodities
- Facilities to consolidate outbound containers bound for the same overseas port or ship
- Facilities to enable distribution of inbound containers to domestic destinations (after clearing the on-site customs facilities)

b) A reliable rail link connecting the relevant sea port(s) and the Inland Port. The reliability of this rail link is essential to the ability to perform as an inland port and reliability will depend on capacity of the rail link. In these terms, the capacity of the rail link needs to be regarded not as adequate capacity but rather as "*a rail link having easily more than enough capacity*".

5.2 Additional opportunity/support facilities

As a collection and distribution location, the Inland Port/Terminal area can also usefully act as a central location for providing additional services depending on the commodities concerned. Examples of potential support facilities could be:

- Secondary support facilities
  - Inspection and certification of commodities. (Aiming, for example, to reduce abortive transport cost risks for local producers.)
  - Secure storage for high risk goods such as explosives, chemicals, acids
  - Distribution centre for freight forwarders and major suppliers such as fuel companies, LPG cylinders, supermarkets, etc.
  - Value-add or treatment activities such as:
    - ✓ Livestock pens with feed and watering (while concentrating to train loads or while distributing concentrated train loads)
    - ✓ Abattoir
    - ✓ Bagging and packaging of goods
    - ✓ Manufacturing, assembling and/or mixing to create goods and products
- Tertiary (support-to-support) facilities (within Inland Port area or nearby locale)
  - Train /locomotive provisioning
  - Transport vehicle fuelling, maintenance and spares warehousing
  - Refrigeration repairs and maintenance
  - Accommodation
  - Food, shops, etc

5.3 Example layouts of inland ports

A range of planned and operating inland ports were examined and critiqued for benchmarking purpose as follows:

5.3.1 Moorebank, Sydney

The Moorebank site is comprised of 220 hectares and 2 km length (as stated, but overall is closer to 3 km).

The planned Moorebank Inland Port described below illustrates the Import/Export (IMEX) features, but will differ in characteristics from the Central West Queensland inland port because Moorebank is a city associated inland port rather than having country-side associated characteristics.

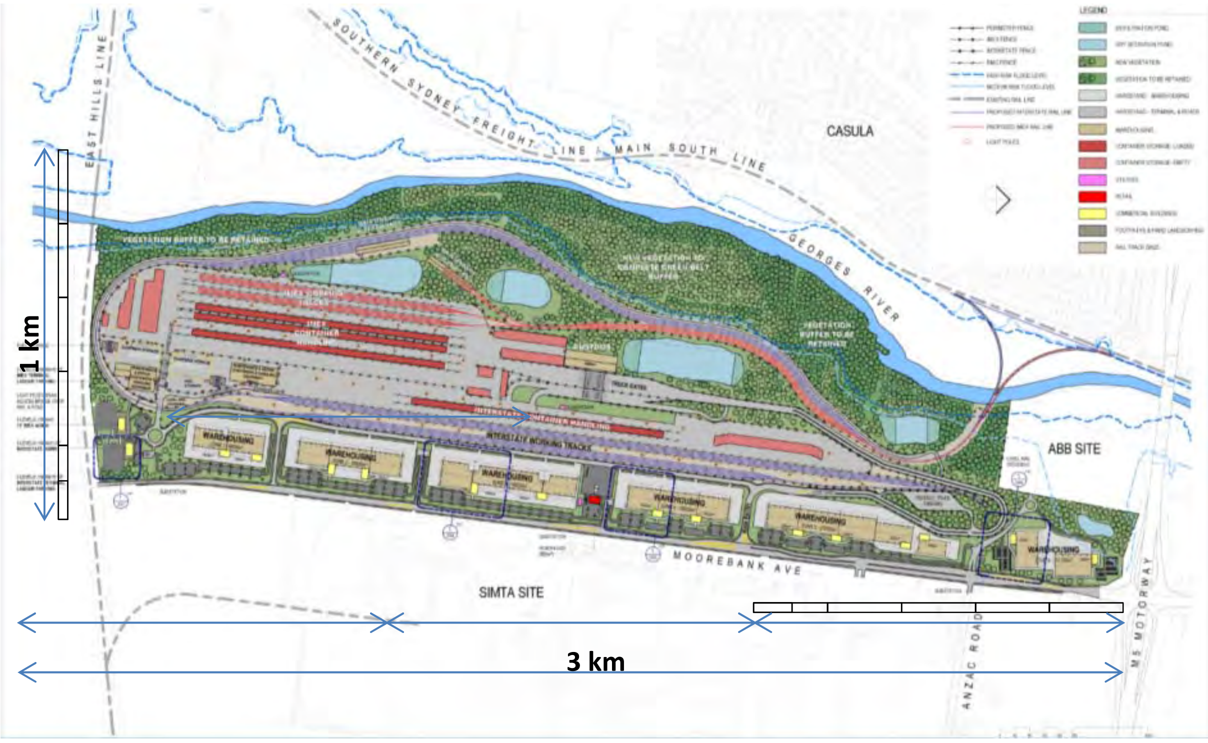

Figure 16 Moorbank intermodal freight terminal[25]

5.3.2 Virginia Inland Port, USA

The Virginia site is comprised of 161 acres, of the order of 1.5 km long and 0.5 km wide.

Descriptions from web-site (http://www.portofvirginia.com/media/124268/VIP_2012.pdf) are as follows:

- *Norfolk Southern provides rail service five days a week between VIP and NIT only; the trip to NIT is 220 miles from VIP by rail. VIP is located close to two major highways. Interstate 66 is less than a mile from VIP and provides east-west service towards the Washington, DC metropolitan area, I-95 and the east coast. Interstate 81 is within 5 miles and provides north-south highway connections along a major trade corridor.*
- *All freight at VIP is international, with an approximately equal split of imports and exports. Exports are typically agricultural and natural resource products, while retail products are a majority of imports. The key commodities shipped through VIP include: poultry, logs and lumber, paper products, autoparts, rubber, plastics, and retail items. Poultry, logs, and lumber are a major part of VIP's export business. Poultry is a significant export business line, with VIP moving 2,500 poultry containers annually. With the weakening of the dollar in the 2000s, exports of both lumber and poultry from West Virginia through VIP have increased significantly.*

[25] Extract from http://www.finance.gov.au/property/property/moorebank-intermodal-freight-terminal/information_paper.html

- *VIP's total throughput in 2009 was approximately 24,500 international containers, a fairly significant reduction from the prior year when VIP handled 33,600 containers. This drop in trade activity was consistent with the global economic recession and is expected to rebound as world trade increases.*
- *For 2009, container traffic from the ports to VIP reduced truck vehicle miles of travel (VMT)11 in Virginia by approximately 5.4 million, which in turn reduced highway maintenance and repair costs and provided environmental benefits to Virginia through reduced truck emissions. Reducing truck traffic could reduce CO2 emissions as much as 3,100 tons annually, which in monetary terms equates to approximately $105,000. Additionally, VIP's rail connection significantly reduces physical stress on the highway system, as heavier loads can now be placed on rail to and from marine ports. These heavy loads can then be repacked at VIP to reduce the volume of heavier/overweight truckloads on the highway network.*

Figure 17 Virginia Inland Port, USA[26]

[26] Extract from http://www.portofvirginia.com/media/124268/VIP_2012.pdf

5.3.3 Shepparton Inland Port (Goulburn Valley Freight and Logistics Centre (GVFLC)

The Shepparton site is comprised of 331 hectare site of the order of 2.5 x 1.5 km

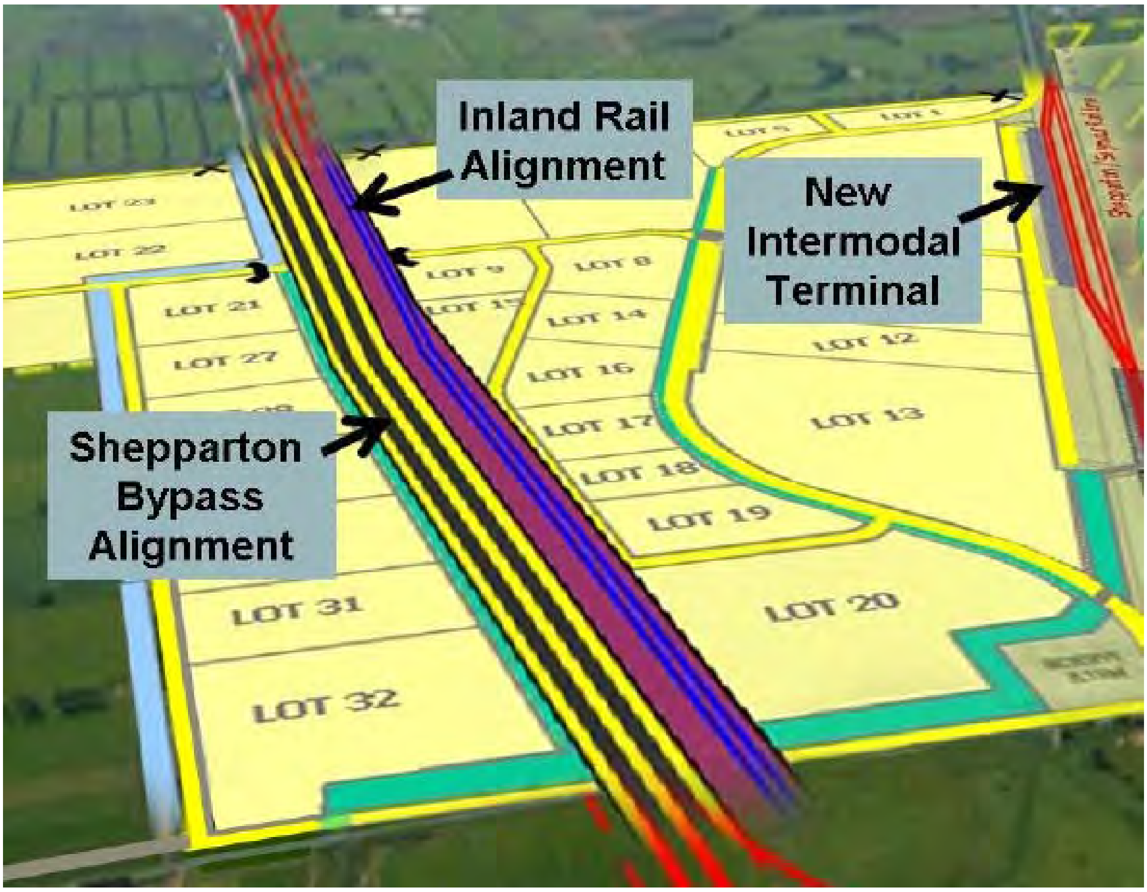

Figure 18 Shepparton[27]

Extracts from "Greater Shepparton Infrastructure Priorities" 10th October 2008 for Greater Shepparton City Council by Alan Talbot:

- *The GVFLC will be built on a 331 hectare site ... in Mooroopna ... 180km north of Melbourne. The location coincides with the alignment of the proposed Shepparton Bypass and the existing railway line linking Shepparton and Tocumwal to Melbourne via Seymour*
- *It is anticipated that the GVFLC will incorporate an intermodal terminal linking producers/importers to the Port of Melbourne by rail, a Container Park, Container Services (eg cleaning and repair), distribution centres, warehouses, trucking depots, trucking facilities (eg. maintenance, tyres and re-fuelling) and associated businesses.*
- *Greater Shepparton comprises an area with a robust and growing economy based largely on irrigated agriculture and widely known as the foodbowl of Australia. In addition to primary agriculture, the region has a high density of food processing facilities resulting in significant outbound freight generation, much of it for export via the Port of Melbourne.*
- *... commercial vehicles, mostly semi-trailers or B-doubles, make up 25-30 per cent of all traffic on the Goulburn Valley Highway, almost double the State average (source: RACV)*

[27] Extracts from "Greater Shepparton Infrastructure Priorities" 10th October 2008

5.3.4 Lyndhurst

The Lyndhurst site is comprised of 180 hectares. 2.4km x 0.7km

Extracts from presentation titled "METROPOLITAN INTERMODAL SYSTEM (MIS): FULLY INTEGRATED LOGISTIC HUBS" by QUBE and SALTA in August 2012 are:

- *QUBE - SALTA ALLIANCE Committed to establishing a series of open access metropolitan intermodal road and rail terminals connected to the port.*
- *Proximity to key customers*
- *Midway between Port of Melbourne and Port of Hastings*
- *Easy access to road and rail networks*
- *Major warehousing & Distribution Hub*
- *Rail Terminal – Open access*
- *Fully integrated logistics service to be added in response to demand, including:*
  - *Freight forwarding, import/export*
  - *Processing, hard stand storage, empty*
  - *Park, staging facilities, pack/unpack,*
  - *Bonded customs and quarantine services*

Figure 19 Lyndhurst[28]

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[28] Extracts from presentation titled "METROPOLITAN INTERMODAL SYSTEM (MIS): FULLY INTEGRATED LOGISTIC HUBS" by QUBE and SALTA in August 2012

5.3.5 Somerton, Victoria

The Somerton site size as stated in Sydney Morning Herald is 65 hectares, but current train working area appears to be about 30 hectares with approximately 1. 0km x 0.3km

Extracts from http://www.qube.com.au/logistics/facilities/victoria are:

Figure 20 Somerton[29]

- ❖ *Services:*
  - *Port Logistics Services*
  - *Transport*
  - *Warehousing & Distribution*
  - *Container Hire & Sales*
  - *Supply Chain Management*
  - *Rail Services*
  - *Intermodal Terminal*
  - *Container Parks*
  - *Container Freight Station*
- ❖ *Activities:*
  - *AQIS Services*
  - *Customs Bonded Facility*

This site is designed to alleviate some of the pressures and congestion within the Port of Melbourne precinct, by transporting import and export containers via rail to/from Somerton. Trucks are then used to transport the containers to/from the customer. The Somerton intermodal terminal has the following features:

- ❖ *Six 750m rail sidings;*
- ❖ *Hardstand and container loading capability;*
- ❖ *Secure storage facility for approximately 10,000 containers;*
- ❖ *B-triple capable weighbridges and high tech security gatehouse facility;*
- ❖ *Proximity to the Hume Freeway to enable efficient access to the Melbourne and regional Victoria road network.*

[29] Extracts from http://www.qube.com.au/logistics/facilities/victoria

5.4 Siting requirements/ objectives for Central-West inland port

5.4.1 Essential siting requirements/objectives (for any inland port)

Essential requirements for selecting sites will include:

a) Land availability

Siting to avoid areas that contain or are within locations that could compromise acquisition, construction and operations

b) Convenience to producing and/or consuming commodity markets being served.

Both the Emerald and Alpha areas required by the terms of reference for investigation cover this requirement, but to different degrees as will be assessed later for particular site options identified.

c) Rail links: Primary link and hinterland links

Reasonably connectable to a primary rail link to relevant port(s) and other relevant domestic market centres. Might not be alongside an existing rail route, but connectable.

Hinterland rail link(s) used for collection of outbound commodities or distribution of inward commodities from sea port may be of different standard and capacity to the primary link.

d) Rail connection gradient and curves

Gradient of rail connection track not greater than 1% and curve radii not less than 300 m. Better than these is desirable.

e) Road links

Reasonably connectable to (freight) road network that serves the relevant hinterland of producing and/or consuming commodity markets.

f) Lengths of rail track facilities. Core sidings in the order of 2 km length and track layout 3 km length

Rail track layout areas that are generally flat and able to handle and manoeuvre the longest trains likely to be used. On current paradigm of single track rail links, intermodal trains within Australia are of 1,500 m and 1,800 m lengths. Allowing for possible separate track layouts for IMEX and domestic container trains and for ladder track connections, this will need lengths of the order of 3 km.

g) Accessible working population. Residential areas

Operations likely to be 24/7, so personnel sources need to be within a practical distance (but segregated by buffer zones).

h) Down-wind of residential areas (assuming some malodorous activities or commodities)

Agricultural commodities and activities (in this Central-West case with probable livestock and abattoir facilities) could be malodorous. So avoid siting up-wind of significant residential areas.

5.4.2 Secondary siting requirements/objectives (for any inland port)

In this case, “secondary” means requirements that might not necessarily exist at a site, but which could be created by some means. For example, a particular site option might be markedly superior in terms of some essential requirements, but poor in some secondary respects that might still be resolved by additional work or investment.

a) Flood immunity

High degree of flood immunity of facilities needed; of the degree of the order of 1000-year ARI or 2000-year ARI envisaged. Technically could be built-up, but preferably a natural topographical immunity.

b) Rail link reliability and capacity

For long term reliability, the rail link must have “more than adequate capacity” for the traffic, including peak season traffic levels. This might require additional infrastructure work on existing rail link(s), even remote from the inland port, but affecting the functionality of the inland port.

c) Buffer zones from residential areas for light, visual and noise impacts, and potential catastrophic hazards such as explosives, and toxic gases.

Operations likely to be 24/7, so natural or created buffer zones on relevant sides of the Inland Port will be desirable.

5.4.3 Size and shape estimation (by benchmarking comparison)

The size and shape for a Central-West Inland Port will ultimately be determined by spatial requirements for all activities, facilities and commodity volumes involved. However for this high level study, those parameters still have a very high degree of variance, so despite detailed calculations it could still have possible sizes ranging from 1/3rd to 3-times a derived base area between most pessimistic and most optimistic. For the purposes of this current high level planning and for searching for potential land sites, a quicker estimate can be derived from comparing and benchmarking to other Inland Port projects that are described in **Section 5.3**.

5.4.3.1 Comparison of inland port projects

Section 5.3 provides descriptions of a small range of Inland Port projects for which sizes are available and which are based on having a high capacity rail link to sea ports. All Inland Ports have their own differing characteristics and a brief comparison table is provided below. (Note that actual Inland Ports in operation are few, so examples are mostly in terms of project concepts with few details of internal infrastructure sizing.)

Table 23 Comparisons of inland port project examples

Example Inland Port	Size and shape of example	Differences relative to Central-West Inland Port
Moorebank, Sydney, NSW	3 km x 1 km 220 hectares (540 acres)	- Essentially Moorebank is a city inland port dealing with city products and consumable distribution - Includes Bonded Customs and Quarantine Services - Track as a folded half-balloon with very small track radii - Larger areas likely to be needed for bulk agricultural commodities
Virginia Inland Port, USA	1.5 km x 0.5 km 65 hectares (161 acres)	- Commodities handled (outbound) do include agricultural products: poultry, timber and paper products identified - NOT including Bonded Customs and Quarantine Services - Virginia IP appears to be essentially a container transhipping facility and does not appear to include any significant support or secondary facilities - So, size represents only the core terminal size portion of a Central-West Inland Port application • and suspect that train lengths shorter than the current use of 1.5 and 1.8 km intermodal trains in Australia
Shepparton Inland Port (Goulburn Valley Freight and Logistics Centre (GVFLC)	2.5 km x 1.5 km 331 hectares (820 acres)	Shepparton has similarities to Central-West in terms of: comprising country-based rather than city-based activities, although differing agricultural commodities including opportunities for significant support and secondary facilities Includes Bonded Customs and Quarantine Services Note that rail facilities and intermodal yard are located on one edge of the site – avoids severance effects within the site – but note other severance issues of by-pass road through "support facility area"
Lyndhurst, Melbourne, VIC	2.4 km x (0.7 km) 180 hectares (450 acres)	- including opportunities for significant support and secondary facilities - Includes Bonded Customs and Quarantine Services - (unclear on commodity range)
Somerton, Melbourne	Core 1.0 km x 0.3 km 30 hectares Site 65 hectares	- including opportunities for significant support and secondary facilities - Includes Bonded Customs and Quarantine Services - Four 750m rail sidings plus 2 loco run-round tracks; - (unclear on commodity range) Appears to serve businesses in the area rather than country product handling, but has country potential

5.4.3.2 Concept size configuration for Central-West site finding exercise

A concept size and configuration developed for "site finding" is shown in **Figure 21.** This has been primarily based on the simple comparisons to other Inland Port projects described above and comprises:

a) 250 hectares (620 acres) as an offset (relatively rigid and unbendable) "core" for the rail freight terminal which is the primary function of the Inland Port. This is sized based on:

- Primarily for length based on existing intermodal trains used in Australia being 1,500 m and 1,800 m long
- Width from a minimum 0.5 km to a planning width of 1 km to allow for:-
  - segregation of bonded containers and trains from domestic market containers and trains
  - space for directly supporting freight terminal facilities including: Customs and AQIS; Train provisioning; container handling equipment maintenance; etc
- Note that width will eventually relate to volume of freight throughput and would be expected to be much narrower at early stages (<0.5 km), but with a view to the long-term and the underlying objective to encourage freight to rail, the 1 km planning width has been applied.

b) The rigid "core" is offset to one side of the overall envelope because it will be a relatively impassable area and the layout should avoid creating inadvertent severance between all the facilities.

c) Up to 600 hectares (1500 acres) as a flexible shaped outer envelope of nominally 3 km length by 2 km width, encompassing the core. This quite large (initial) allowance is made:

- For compatibility with a countryside (rather than city-side) application allowing for natural incursions into the area such as by creek high water land or higher ground as well as to enable planning to include significant areas of vegetation to satisfy visual impact issues
- To enable distinct segregation of areas containing fuel, hazardous and toxic commodities from agricultural (livestock and crop) commodity areas that are sensitive to contamination risks.
- To provide local planning with distinct areas to enable the location of tertiary support facilities that may grow around a successful Inland Port operation.

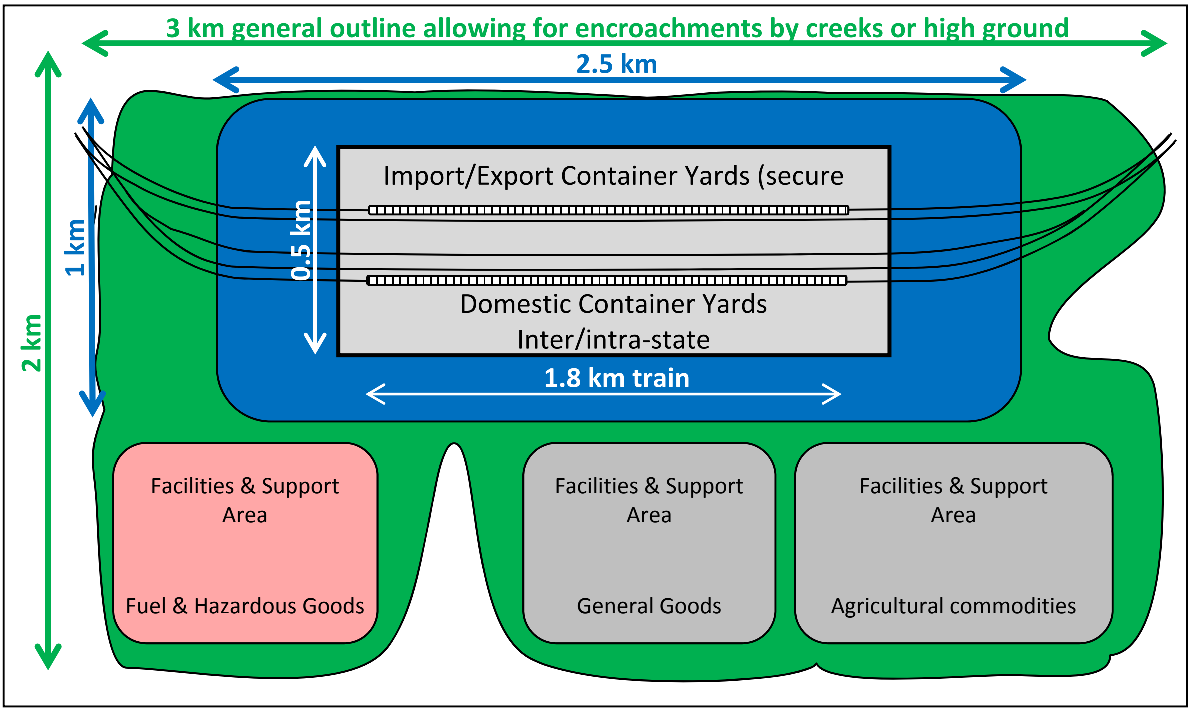


Figure 21 Nominal size and configuration for "site finding" activities.

5.4.4 General support facilities

These “general support facilities” are general to the Inland Port’s overall working and do not include particular facilities associated with particular commodities or products (which would be included in other particular areas and depots within the inland port). It is expected that some particular commodity facilities will perform all their own supplementary activities such as container maintenance and cleaning, but that some may contract such activities to specialist service providers that may evolve with growth of activities in the Inland Port area. General support facilities envisaged are:

- Required/Essential Facilities:
  - Customs facilities
  - AQIS facilities
  - Inland Port Authority and Facility Management
  - IMEX Container Train Terminal
  - Inter/IntraState Container Train Terminal
  - Utility Support: Electricity Sub-station(s) and emergency generators
  - Utility Support: Water Supply
  - Utility Support: Water Treatment plant(s)
  - Rail train/locomotive Provisioning and fuelling
  - Rail operators facilities: offices, control, drivers facilities, maintenance
  - Rail cripple sidings
  - Container handling equipment storage , maintenance and repair workshops
- Evolving Facilities: If the Inland Port is located remote from existing towns and facilities, then the following would need to be in an “Inland Port Planning Area”. However, if a town is relatively close, then some of the more general facilities could develop within that town, and help to grow that town:
  - Empty container exchange
  - Container maintenance and cleaning services
  - Freight forwarders and distributors
  - Gas stations: truck and car
  - Road transport vehicle maintenance and spares warehousing
  - Refrigeration repairs and maintenance
  - Accommodation
  - Catering and retail
- Value-add facilities. Value-add facilities are linked with the commodities to be handled, and so are identified in **Section 5.2** above and not as General Support Facilities. But also note that as with “Evolving Facilities”, the value-add facilities might be a development of nearby existing facilities and not necessarily inside the Inland Port area itself.

5.5 Potential sites identification

5.5.1 Spatial opportunity and constraints analysis process

The site selection of suitable sites for an inland port in Central Queensland was derived from the desktop analysis of geospatial data from a range of sources, applied in a virtual context through the use of Geographic Information Systems (GIS). This involved a detailed desktop study to identify and shortlist potential sites. Following the acquisition and storage of the required geospatial data, a desktop assessment was carried out to determine environmental values within a nominal 40km wide (20km offset either side of the rail line) study corridor taking into consideration the site selection requirements and objectives as detailed in **Section 5.4** above . In order to identify potential locations for the site, the GIS team worked with the engineers and TMR to understand the physical, environmental and social constraints and physical requirements for the Inland port. The following steps were undertaken as part of the constraint analysis process across the Emerald and Alpha areas to identify land parcels that may be suitable for development.

Data Preparation:

- Created a 40km wide study area (20km either side of the Emerald to Alpha rail line)
- Selected all the DCDB land parcels intersecting the newly created buffer – the selection returned more than 15,000 land parcels
- In order to accommodate the 3km x 2km required area - all parcels over 600ha in size were selected. This process significantly reduced the number of parcels to 370.

Detailed geospatial, environmental and technical analysis of the 370 shortlisted potential sites was then undertaken. The following constraints and opportunities within the 40km wide study corridor were considered to eliminate unsuitable sites.

Geospatial Constraints:

- Interim Floodplain Assessment Overlay
- Protected Areas and Nature Refuges
- Mining Leases
- Presence of ecological constraints such as regional ecosystems, protected areas, high value regrowth, etc.
- Strategic Cropping land
- 2009 Land Use Categories
- Topography
- Proximity to Rail Line

The constraints analysis generated a short list of 31 land parcels that may potentially meet the requirements of the inland port facility. From these short listed land parcels further internal review and engineering scrutiny was undertaken in relation to:

- Rail and road access, connections and conflicts
- Land parcel topography and grades
- Land parcel frontage to the existing rail line

This narrowed the number of potential sites to 16 that were then presented and workshopped with TMR to further eliminate parcels down to a top ten (10) potential sites. 6 of the previous 16 sites were eliminated based on one or more of the following:

- Overlapping of strategic cropping land
- Significant distance from town accommodation
- Undesirable topography of the site, and

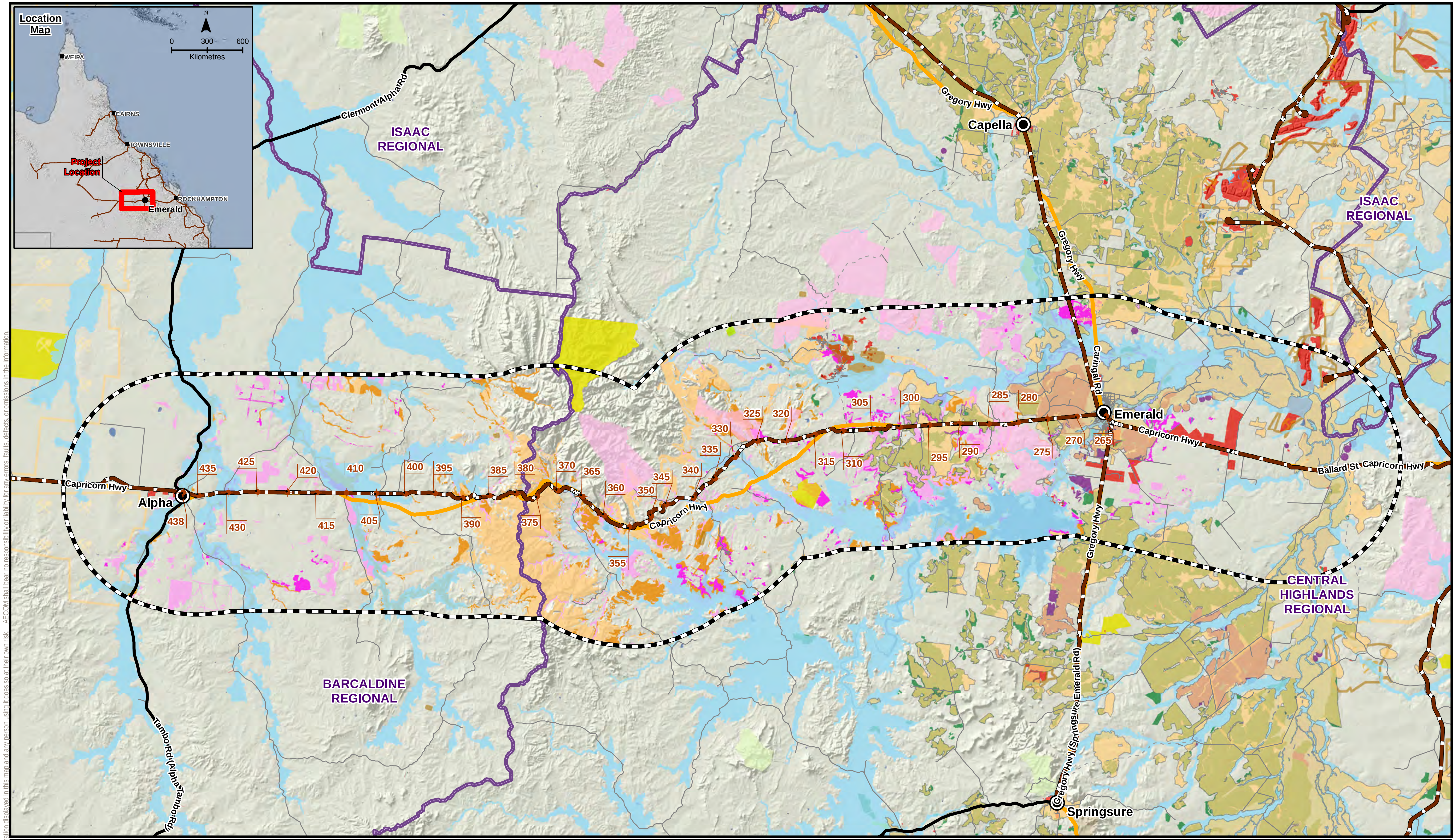
The results of these works are shown in **Figure 23**. Two of these sites are adjacent the Springsure branch line.

It was assumed that a single land parcel complying with the aspirational Inland Port requirements would be preferred over multi-land parcel sites due to the additional complications potentially arising from multiple land owners and tenure. Additional potential Inland Port locations could be generated by removing this constraint if these identified short listed sites result in being unsuitable.

Figure 22 shows the 40km wide study corridor established and the mapped geospatial constraints. **Figure 23** also shows the two land sites that TMR had become aware of during the course of stakeholder consultations and which where visited. It is worth noting that the eastern site is directly adjacent to a number of the top ten 10 sites.

Table 24 Site options identification summary

Step	Criteria	Results
1	Created 40km Wide Study Corridor – No contraints	15,000
2	Applied land size constraint to be greater than 600ha	370
3	Applied Geospatial Constraints	31
4	Engineering Review	16
5	Workshop with TMR	10



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DATUM GDA 1994, PROJECTION MGA ZONE 55

0 5 10 20
Kilometres

1:600,000 (when printed at A3)

Legend

- Chainage 5km
- Towns
- Highway
- Freeway
- Main Road
- Railways
- Study Area Corridor Offset
- Local Government Boundary
- Strategic Cropping Land
- Interim Floodplain Assessment

Mining Leases (Status)

- Application
- Granted
- Nature Refuges

Land Use (2009)

- Conservation and natural environments
- Production from relatively natural environments
- Production from dryland agriculture and plantations
- Production from irrigated agriculture and plantations
- Intensive uses
- Water

Regional Ecosystems

- Endangered - Sub-dominant
- Endangered - Dominant
- Of Concern - Sub-dominant
- Of Concern - Dominant

Protected Areas of Queensland (estate)

- National Park (scientific)
- National Park
- National Park (Cape York Peninsula Aboriginal Land)
- National Park (recovery)
- Conservation Park
- Resources Reserve
- Forest Reserve
- State Forest
- Timber Reserve

Data sources:

Base Data: (c) 2011 (ESRI_Imagery_World_2D)
QLD Railways: (c) 2011 (StreetPro Australia)
QLD Highways: (c) 2011 (StreetPro Australia)
QLD Drainage: (c) 2011 (StreetPro Australia)
DCDB: (c) 2014 (DLGP)
Hillshade, based on the 25m DEM; DNRM 2005

RESOURCES RAIL LINES
Central Queensland Inland Port Concept

40km Wide Study Corridor
and Constraints Map

PROJECT ID: 60311326
CREATED BY: VV
LAST MODIFIED: VV - 07 Aug 2014
VERSION: B

Figure 22

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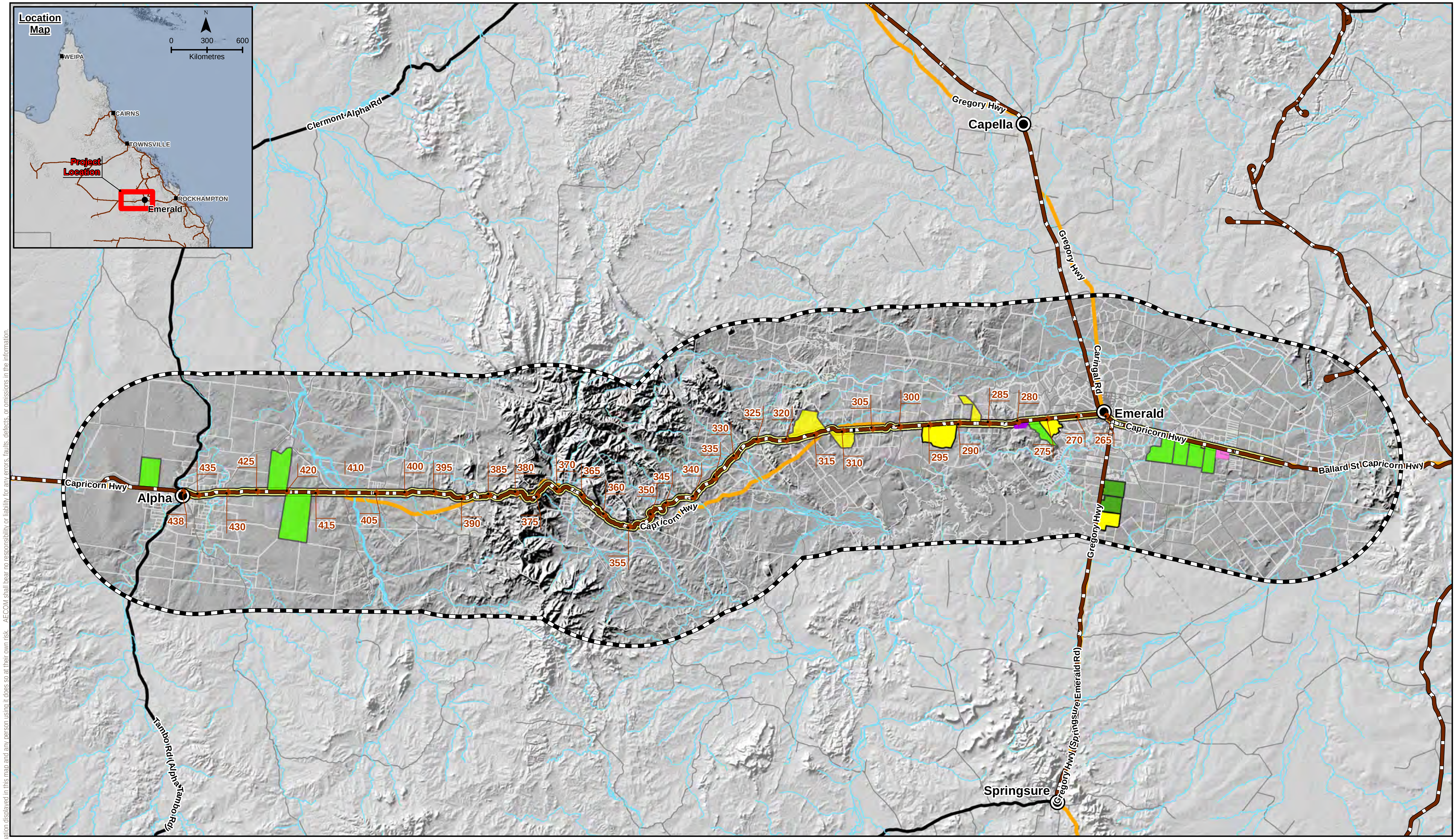

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Kilometres

1:600,000 (when printed at A3)

Legend

- Chainage 5km
- Towns
- Highway
- Freeway
- Main Road
- Connector Road
- Local road
- Selected Rail Section
- Railways
- Drainage Line
- DCDB
- Study Area Corridor Offset
- TMR Western Site Visited
- TMR Eastern Site Visited

Site Selection Criteria

- Good Rail Frontage 2km+ Central West/Blackwater Line
- Good Rail Frontage 2km + Springsure Line
- Eliminated in TMR Workshop

Data sources:

Base Data: (c) 2011 (ESRI_Imagery_World_2D)
QLD Railways: (c) 2011 (StreetPro Australia)
QLD Highways: (c) 2011 (StreetPro Australia)
QLD Drainage: (c) 2011 (StreetPro Australia)
DCDB: (c) 2014 (DLGP)
Hillshade, based on the 25m DEM; DNRM 2005

RESOURCES RAIL LINES
Central Queensland Inland Port Concept

Potential Port Site Identification

PROJECT ID: 60311326
CREATED BY: VV
LAST MODIFIED: VV - 07 Aug 2014
VERSION: B

Figure 23

Filename: P:\Projects\60311326\4. Tech Work Area\4.99 GIS\02_mxds\Report_Maps\Figure2_PotentialPortSiteIdentification.mxd

A3 size

6.0 Rail freight modelling

6.1 Overview

Modelling was undertaken at several levels but for interrelated purposes and included:

- Train operations modelling
- Logit model to assist in estimation of hypothetical market share and modal shift
- Train cost modelling
- Network capacity modelling

AECOM modelled 163 train configurations carrying a variety of commodities to and from a variety of inland port locations. The trains combine a mix of present day operational scenarios along with hypothetical trains operating under current and hypothetical infrastructure regimes. The aim was to see:

- What the productivity gains are under a variety of operational scenarios
- If the productivity gains under revised operations and infrastructure would be able to underwrite the costs of a capital enhancement program
- If the volumes modelled reflect what can reasonably be generated
- To reveal sensitivities and inform the logit model and estimates of rail market share and hence what could be attracted through a local inland port

For simplicity each train has been modelled on the basis of a single generic commodity and configuration e.g. petroleum or grain because the high volume "campaign style" railings can require full trainload quantities. All of the single commodity trains are loaded in the forward direction and return empty. Other general purpose trains were modelled with a 2/3 loaded 1/3 empty (in each direction) configuration to simulate particular operational conditions. These general purpose trains conventionally have all sorts of mix and match loading which are typical of intermodal container trains and difficult to model except by taking an averaging approach. This is reasonable given the complicated nature of general freight.

The hypothetical trains include 104, 156 and 208 round trips per year. It is highly probable that a two day cycle from Gladstone to Alpha and back is not achievable but it provides a reference as the high point in efficiency against which the performance and cost efficiency of other trains can be benchmarked. Various infrastructure configurations considered include 15.75, 18, 20 and 26 tonnes axle load. The results are predictable and big heavy hard worked trains work better than light loaded trains where the assets are not sweated. Within the bounds of what is reasonably achievable, better performing trains can offer up for 40% efficiency gains over the existing situation.

Although these cost savings are significant, unless there are very large volumes, certainly much larger than the present, there will be insufficient surplus to finance large scale track upgrades such as 20 tonne axle load all the way to Alpha. Even Emerald West upgrades, although only a nominal 30 km west of Emerald East, pose some significant financial and sustainability problems. The Nogoa River bridge presents challenges structurally and financially.

Emerald East is already capable of supporting 20 tonne axle loads and when comparing what is technically possible now with what is possible at Emerald West and Alpha, it has a clear cost advantage for many commodities, especially the ones which can take advantage of triple slot container wagons. This greatly adds to its strategic advantages over the other centres as the preferred point for an inland port. Based on this finding alone, it provides advantages the others cannot match.

If the Galilee Basin takes off as has been predicted, and fuel transfers to rail, then even if there are insufficient funds to upgrade axle loads west of Emerald, this may not matter. Double slot containers are capable of conveying 2 x 24 tonne containers relatively competitively on the existing infrastructure and light weight locomotives can be used. In which case, from a resource-only perspective, Alpha might be the preferred site to serve that market because generally rail is more competitive over longer rather than shorter distances. Emerald is much closer to Gladstone and Rockhampton than is Alpha which may give rail a greater role in supporting Alpha rather than Emerald for these movements. But as the objective is to service both the resources and the agricultural sectors and given the uncertainty of the timing and staging of the Galilee Basin development, initial siting of a single inland port at Alpha is difficult to justify. Thought needs to be given to multiple multimodal terminal sites tailored for their respective markets. The detail of the modelling works is provided in **Appendix B**.

7.0 Analysis

7.1 Inland port sites: Why Emerald East?

From the beginning of the study there have been three nominal locations for an Inland Port as: Emerald East, Emerald West and Alpha. The Alpha location included mainly because of potential expansion of mining in the Galilee Basin and the fuel traffic which that would generate. There are some commodities other than fuel consumption in the Alpha direction and beyond, including pastoral (livestock cattle) and quarry (gypsum), but Emerald is regarded as more of a "centre" for agricultural products needing transport and as the major commercial and retail centre for receiving consumer goods etc.

The potential long term fuel volumes required to be moved to the Alpha area over such long haul distances are sufficient to consider siting an inland port at Alpha, but in the immediate future there isn't the demand. Therefore siting of a port at Emerald at this point in time would likely:

- Capture a greater volume of freight to support inland port development costs
- Better serve growth in the current market, and
- Act as an interim development platform that supports the containerisation of the fuel logistic supply chain.

A second intermodal hub could be developed at Alpha at some point further into the future specifically tailored for that market.

The Emerald area also lies on the proposed inland North/South road freight corridor which currently places it at a strategic advantage.

Using the Emerald area as a general base, and the existing Central West Railway as the connecting corridor, the choice then is between Emerald East or Emerald West (noting that neither is within Emerald itself, but about 14 to 20 km distance from the town so as not to be a nuisance, yet close enough to benefit the town's employment and businesses). The continued use and expansion of existing rail yard facilities in Emerald itself has been discounted as described separately below. In terms of the strength capacity of the existing railway to connect from the Inland Port to the ports and to the North Coast Line, it happens that from the NCL:

- The strength capacity of the 202.3 km of railway from Rocklands (on the NCL) to Burngrove is:
  - 26.5 tonnes axle-load for speeds up to 80 km/h
  - Freight with axle-loads up to 20 tonnes permitted to travel at 100 km/h
- The strength capacity of the 60.8 km of railway from Burngrove to Nogoa (just east of Emerald) is:
  - 20 tonnes axle-load for speeds up to 80 km/h for all traffic including freight
  - 20 tonnes axle-load for speeds up to 80 km/h also applies on the branch from Nogoa to Springsure as far as Minerva mine
- The strength capacity of the 2km from Nogoa to Emerald and beyond is:
  - 15.75 tonnes axle-load with trains speeds subject to restrictions below 70 km/h because of track condition

In the simulation works (further discussed in **Section 6.0 and Appendix B**) it was identified that when using like for like train configurations there was little difference in operational cost per tonne or TEU in travelling the additional distance between Emerald East and Emerald West.

Since a location "Emerald East" would also be east of Nogoa (or potentially between Nogoa and Minerva), then the existing track structure strength capacity would be adequate for existing common Queensland 80-tonne (20tal) container flat wagons without constraints on container loading. However, an "Emerald West" option (and an Alpha option) would either: (a) have limited container loads per wagon to comply with the 15.75tal track strength limits; or (b) need to have the track between the Inland Port site and Nogoa removed and replaced with higher strength track. An Emerald East location would not have those constraints or additional setting-up costs, and is thus a natural preference in the circumstances.

The Emerald East location also fits with the Central Highlands Regional Council defined Industrial Activity centre located at Yamala.

As it happens, there are already considerations by other parties for possibilities of rail facilities in the area of Yamala (about 21 km east of Nogoa), so the Emerald East option is in line with separate but related events.

Out of the three site options investigated Emerald East appears to be most suitable at this point in time for the development of an inland port.

An Emerald East Inland port would likely result in less train movements through Emerald compared with an Emerald West but in terms of reducing potential truck movements of containerised fuel to Galilee through Emerald, Emerald West location would be better, however continued railing of fuel beyond an Emerald East port would negate this effect.

Why not the existing Emerald rail station area?

In the manner which is common to pioneering single line railways, Emerald township has grown around the railway station and its railway yard facilities. The growth around the railway facilities now constrains yard area from introducing large modern materials handling facilities. Moreover, 24-hour operations on such facilities would now be undesirable with residential areas having been built in close proximity. Expanding and upgrading the existing rail facilities to an Inland Port style of operation would also introduce greater volumes of heavy road freight traffic into what is now the centre of Emerald. Generally, times have moved on, and although past residents and businesses found benefits in being close to the railway yard facilities, that is no longer the case.

The need to relocate freight away from the site of existing facilities is expressed in the Central Highlands Strategic Framework with statements:

- Development that includes land uses and activities related to or ancillary to the rail network is encouraged where appropriately located.
- The development of new commodity loading facilities and other non-passenger rail related infrastructures is (should be) located outside urban areas and is (should be) appropriately separated from sensitive land uses to minimise adverse amenity impacts.
- Significant rail-related facilities and industries are (should be) generally located in strategic locations which provide high levels of access between mines and road freight routes.

Therefore, locating an Inland Port facility out-of-town (but within value reach in terms of employment and business services) is in line with existing planning.

7.2 Fuel's influence on port siting

Because fuel for future mines in the Galilee basin is a main driver for an Alpha Inland Port option, if an Inland Port was sited Emerald East, there is then the question of what would happen with fuel if Galilee mines did indeed begin to develop.

From **Section 4.0** the figures for fuel freight were as tabulated below, on the assumption that fuel from the coast/east would not back-track to Blackwater mines if an Inland Port is past those sites at Emerald:

Table 25 Emerald location Fuel (Thousands of Tonnes)

	Gross Market	Target / Contestable Market	Current Rail market Share	Optimistic Rail market Share
Emerald	30-50	30	0	25
Blackwater Mines	500	500	0	0
Potential Galilee basin	400 - 1000	400 - 1000	0	400

An Emerald East Inland Port might manage to include some fuel distribution to a few of the more nearby Blackwater mines and may serve to initiate a logistics shift to containerisation. But even with such an enhanced fuel volume for Emerald East, a Galilee Basin demand could still be many times the Emerald East business.

Now, this generates a sequence of questions as follows:

a) Would high Galilee fuel volumes influence a change of Inland Port location from Emerald East to Alpha?

Although fuel is dominant and not entirely seasonal, it is not likely to change the choice of location for near term Inland Port development, because:

- So many other commodities favour the Emerald location;
- An Alpha location would be too far west of the main agriculture growth area; and
- An Alpha location is constrained to 15.75tal for all trains unless significant infrastructure upgrades are undertaken on a high proportion of the 175 km between Nogoa and Alpha.

Therefore Galilee fuel is very unlikely to influence a change of Inland Port from Emerald East, but then further questions arise about fuel transport as follows:

b) Would Galilee fuel volume use road transport from the coast to Galilee without using the Emerald East Inland Port fuel facility?

c) Would this large Galilee fuel volume be distributed by road from the Emerald East Inland port to Galilee mines? Or

d) Would there be a case for another fuel rail terminal (not Inland Port) near Alpha (with trains from the coast passing the Emerald East Inland Port)? Or

e) Would there be sustainable, competitive and practical rail services (comprising locomotives and wagons not greater than existing infrastructure strength capacity of 15.75 axle-loads) to Galilee mines from the Emerald East Inland Port?

Galilee fuel will not be a full instantaneous market; there will be some shape of stepped growth from construction through to commissioning of various mines with different starts. Therefore, it is possible that the fuel transport industry to Galilee/Alpha could develop and ramp-up with growth in the same sequence as the questions (b), (c), (d) and (e). From that point, if the Galilee Coal output uses the Central West rail corridor, then a final step could involve a coal driven strengthening of the railway to higher axle-load strength benefiting both the coal and fuel trains.

The main point will be to endeavour to avoid industry continuing step (b) with road transport of fuel from the coast to Alpha throughout the basin development.

7.3 Rail's prospects with inland port

Traditionally rail dominates market share in high-volume low-value commodities. Based on very high point to point volumes it offers economies of scale not matched by road transport. Conversely road transport dominates particular market segments and commodities in which it has a comparative advantage. There are major difficulties in determining the market share for many products which are not as clearly aligned to either mode and which are at least to some extent subject to competition between the modes. There is of course no reason why one mode cannot penetrate the other's markets but usually market share is determined by a number of complex inter-related factors. There is also the competitive response from the defending mode to consider and what it is prepared to offer operationally and commercially to retain business if it deems that the best course of action.

This report is predominately about the ability of the rail mode to support an inland port in Central Queensland and proactively take freight off the already stressed road network. At the moment, for a variety of reasons including a series of historical events and circumstances, rail mode share is very low across the board.

Section 4.0 aimed to describe and quantify the potential freight which might be attracted to and from an inland freight hub at Emerald or perhaps Alpha primarily served by rail from a line haul perspective and by road for local and regional pick-up and delivery legs.

There are sectors within the freight market that rail cannot realistically capture. In particular, commodity movements based around fine time sensitivities, very short haul and unconsolidated loads, place rail at a competitive disadvantage compared with road transport.

An important but frequently overlooked issue which has a crucial impact on intermodal competition and relative overall costs is that trucks are much more competent in obtaining backloads than is rail. Rail is much more competitive with road in markets where there is no backload available e.g. petroleum products, export grain etc. Road is able to offset rails' single direction cost efficiency by spreading its revenue and costs over two legs rather than one. To an extent this explains road's and rail's relative market shares in the much contested general freight market. The "contestable" market that rail can compete in however, is broad and consists of commodities that are currently (for a range of operational, economic and historical reasons) dominated by the road transport industry.

The design of logistics packages, service offerings and price are the key parameters in determining freight demand and mode share. Logistics packages themselves are complex processes and operate on many levels as do service offerings which many have qualitative subtleties to differentiate between alternatives. The relativities between each class of variable will be different for each commodity and freight customer and this adds to the complexity in assessing the market at a macro level. Further, the interplay of variables is dynamic and frequently does change over time as do the demands of freight customers. Thus the estimates in **Section 4.0** are based on a snap shot at one point in time and compare the existing market with what could potentially be achieved with an improved rail performance and package.

7.3.1 Commodity summaries

7.3.1.1 Fuel and petroleum products

The task is currently dominated by road transport using a mix of hub and spoke distribution and direct door to door deliveries. Prior to deregulation in the 1980s a large proportion of the bulk trade was conveyed in block trains by the former QR. The rail tanker fleet is very old and major investment is required if traditional tankers are to be used. ISO-Tank containers offer a potential solution for rail to haul from sea port to inland port with local distribution by road. This commodity has no backloads therefore rail is better placed to compete with road transport. The market at Emerald is relatively small (30ktpa) compared to the demands of the Blackwater mines (400-500ktpa) and the potential Galilee Basin mines (400-1000ktpa). The market is currently dominated by the oil companies, and a mix of their own downstream logistics companies or other 3PL providers.

Road's continued dominance in Emerald is based around the continued operation of tank farms and depots in the rail precinct in central Emerald. It is unknown how sustainable this 24/7 operation will be in the long term given the incompatible land use and emerging urban amenity issues.

The oil companies have become accustomed to around the clock JIT deliveries either to depot or to end user and it may be hard for rail to break this pattern and return to the traditional arrangements which operated prior to deregulation in the 1980s when depot stockpiles were topped up daily using scheduled trains.

AECOM's cost modelling indicated even after allowing for additional costs such as terminals and pick-up and delivery (PUD) legs, rail is cost competitive. Thus changing the mode share is as much about displacing an entrenched operational and commercial regime as it is about rail providing a competitive service offering through an inland port. The key for rail is having seamless intermodal interfaces and a well-resourced truck fleet to provide "to door" deliveries.

Although some fuel is delivered direct door to door in Emerald from Gladstone a significant part is still directed through the terminal system. Under the terminal system, fuel is decanted from road tankers into local storage and then later reloaded to other road tankers for eventual delivery to the end customer. From the end customer's perspective, it makes no difference whether the line haul is performed by road or rail. The challenge for rail is to match road's performance.

Although not necessarily labour intensive, the task of pumping out tankers and tanks is time consuming – most pumps are rated in the 1000 to 2000 litres per minute range. There is also the time to provide safe and secure seals and connections. The process is not only time consuming but relatively costly as well. As an alternative to this process, ISO Tank containers can simply be stored on site (no transhipping) until they are ready to go to the end user which is when they would be pumped out. There is no reason why rail cannot provide a viable alternative to road for the line haul component of the logistics chain. Most fuel contracts are signed for the medium to long term - usually 2 to 5 years. For many companies it is a major task to change suppliers and operations to adapt to a new arrangement. Similarly a change from road to rail also has some complexities which should not be treated lightly. Road tankers are specialised pieces of equipment with few – if any - alternative uses. It is expected that the existing operators will fight hard to keep market share and keep their costly assets productive.

7.3.1.2 Chemicals

Products include: explosives, acids/paints/solvents, fertilisers, other liquids, other powders/solids, pesticides, herbicides, etc. This product group is very diverse and operates in clearly defined and separate markets but is eminently suited to containerisation and therefore potentially attracted to an inland port. Rural distributors and 3PL intermediaries dominate the market although some use rail for line haul purposes. Even if they use rail, these organisations go beyond pure logistics and include financing, marketing etc. which may be beyond the scope of a port operator or line haul provider. Some of the products are dangerous goods and others are strictly non-backloadable which offers rail some prospect of penetrating the market given rail's freight rates are known to be much cheaper than road operators'. The key for rail is having seamless intermodal interfaces and a well-resourced truck fleet to provide "to door" deliveries.

Emerald is perhaps too far away from Blackwater (and potentially Galilee) to play a meaningful role in mining support however it is the hub of a vibrant agricultural community and this may be its greatest role. Given these factors it is assumed the port can take an optimistic outlook on its prospects. A terminal located away from urban areas would add to the attractiveness of rail since there would be minimal urban interaction and impact. Container storage in a secure environment will also add to the attractiveness of rail's package.

7.3.1.3 Cement and Flyash

Containerisation is important because it is the "best fit" for a multimodal operation based on an inland terminal servicing a large hinterland. Again this is a single direction commodity with no opportunity for backloading and where product purity is essential. Aurizon is already moving cement in containers to Emerald.

The major unknown is the timing and development of the Galilee Basin mines which will be major cement users in the construction phase. Not only will the mines be consumers but the supporting civil infrastructure e.g. rail lines/bridges/ concrete sleepers will also be important. With containerisation, product integrity is guaranteed to site which overcomes a major competitive disadvantage rail would have based on conventional wagons and the need to tranship by unpacking and repacking. The key for rail is having seamless intermodal interfaces and a well-resourced truck fleet to provide "to door" deliveries. Overall rail's prospects can be considered optimistic.

7.3.1.4 Quarry materials

Containerisation simplifies the transhipping difficulties associated with traditional road-rail-road interfaces. The product is generally low value and therefore often better suited to rail than road however, inevitably quarries are located away from rail corridors and the road leg can often be so expensive it is better to avoid rail and perform a direct service. But this will depend on a number of factors such as volume, overall length of the haul, terrain, cost pressures, etc.

Backloading opportunities are minimal because of the specialised nature of the product and the relative isolation of either part of the origin-destination combination. Rail's prospects are reasonable for simple mass market movements of aggregate and sand.

7.3.1.5 Agriculture – Broadacre Crops

This commodity group includes grains, lupins/pulses, oilseeds, cotton fibre and seed. Traditional rail has carried these products to export ports in high volume bulk wagons from silos in full trainload quantities. A series of droughts, changes in markets and international prices, the rise in local feedlots, collection and distribution arrangements, entry of third party traders, "boutique grains" etc. has altered these patterns. Many of the silos and depots including large ones such as at Springsure have been closed or mothballed and probably will not reopen.

The product is food grade and must be free from contamination so backloading without the proper sanitation arrangements is not possible. Generally it is impossible to backload. Often the product is fumigated locally although anecdotally there are reports of product being consigned to Toowoomba for treatment. It is alleged that many farmers are dissatisfied with traditional logistics chains and commercial arrangements and are looking at alternatives. This includes containerisation, which gives on farm product storage in a clear uncontaminated condition, and finding spot markets or alternative intermediaries all independent of traditional arrangements. AECOM modelling indicates there is considerably higher cost in containerised movements to port compared with the bulk whole trainload approach hence the container market will probably only apply to a particular niche.

The main production area is north, east and south of Emerald, there is very little to the west and basically zero beyond about 20km west of Emerald. The current cotton fibre truck operation based on Yamala provides a good example of the efficiency possible with a seamless transfer from farm gate to terminal and could serve as the model for other commodities. The major threat to this commodity is not road freight but rather a competitive response from the existing bulk terminal logistics provider who could potentially eliminate the alternatives with the "right" package.

7.3.1.6 Pastoral Products

Typically this is not big at present even though cattle are conveyed by rail in semi-skeletal cattle containers. Livestock loading from Emerald is not in great quantities and existing arrangements are probably adequate into the future, all other livestock merely passes through the corridor. An inland port at or near Emerald with meat processing facilities could offer a greater role to and capture of this passing through traffic. The main potential for an inland rail port at Emerald comes about through the prospect of a containerised goat meat from a proposed local abattoir. At this stage, this is highly speculative however, with the addition of a powered hardstand, there is no reason an inland terminal could not support this activity. Again, contaminant free food grade containers are required so backloading is probably not feasible, which gives rail a better chance than otherwise possible.

7.3.1.7 Other Agriculture

This commodity group includes: logs & forestry products, woodchip and citrus. These are very small markets at present although there are good prospects for growth given the large amount of irrigated land in the vicinity of Emerald. Citrus is highly seasonal but other year round products could provide filler loading on general purpose trains. Woodchip and logs are generally low value commodities and often find road's higher freight rates difficult to absorb. Citrus is higher value but with all fresh and perishable products, there is always an imperative to get to market or storage as quickly as possible. Rail has the complication of changing trains at Rockhampton for Brisbane, which delays the process. For southern markets, the transhipment at Acacia Ridge grossly exacerbates rail's transit time disadvantage. There are also cheap backloads on road which further adds to road's attractiveness.

7.3.1.8 Store Goods and General Freight

This is a massive amorphous product group which covers dozens of generally undefined sub-products, niches and segments. The product group includes: foods/groceries, furniture/removals, appliances/white goods/brown goods/electronics, alcohol/cigarettes, general merchandise and everything which cannot be classified elsewhere.

Some of the products are delicate high value e.g. computers, TVs, medical equipment, etc. which require secure weather-proof transport and storage. Many of the goods are sold on the basis of appearance on the shop floor hence they must be completely untainted and free from damage. This necessitates "gentle" handling. Extra handling/transhipping is to be avoided wherever possible, yet is unavoidable by rail which cannot offer door to door services.

Food products are perishable and require correct temperature control and management with secure weatherproof handling demands. The perishability of many items means transit times are critical and faster transport can command a premium.

The major freight generators the big retailers and big box outlets represent the largest part of the retail spend. However often retail spend share of these companies is not proportional with the freight generation share. AECOM has attempted to estimate the freight generated by assembling a simple bottom up model using the little amount of data which is available either from anecdotal and unattributed sources or from best guesses. These estimates are to be used with caution and are an attempt to quantify a largely unknown volume.

Even the growth drivers for this market segment are more complex than for homogeneous products such as cement. Some of these drivers are working in opposite directions. For example population growth means more mouths to feed therefore more food would be demanded and freighted. Higher disposable incomes over time imply the ability to consume more product. However, once basic food necessities are met, nobody is going to keep consuming more loaves of bread or whatever no matter how relatively affordable they become. Personal tastes seem to be the strongest counter-growth force and the increased share of discretionary income after basic necessities are met makes any predictions hazardous.

Although highly unbalanced, there is some backloading and road seems far better at securing this than rail. In part this is because of road's flexible pricing e.g. they will carry spot loads for "petrol money" or they have a round-trip pricing arrangement. This greatly erodes rail's ability to compete when its freight rate is based on the assumption of empty running almost all of the time.

To gain greater market share rail must more evenly match road's service and pricing. By definition it has extra parts and complexity in its logistics chain and its main area of competitive advantage lies in the efficiency of its line hauls. Rail must attempt to mitigate its relative disadvantages to the point where lines are blurred between the modes.

7.3.1.9 Building and Construction Materials

The product group includes the following individual commodities: steel rod and bar, steel sheet, brick, tiles, and pavers, clay and concrete products. AECOM has estimated the size of the market by building a simple model to estimate the volume of materials required for a very simple rectangular 15x 10 metre house with concrete slab and steel roof and comparing this against housing approvals and construction data in the Emerald area. The QGSO divides construction into three categories: new houses, other residential and commercial building. There was little information on commercial construction other than the value of building approvals. Although there may be some differences between the materials consumed and cost per m2 of residential and commercial properties, this cannot be quantified in this instance. This gives an estimate of the present annual market centred on Emerald at about 46,300 tonnes for residential and 33,600 tonnes for commercial. These calculations do not include other items of civil infrastructure such as concrete culverts and pipes, bridge spans, concrete railway sleepers etc. which will come into play if and when the Galilee Basin construction phase commences.

The two main types of movements can be characterised as follows:

- From Brisbane or Rockhampton depots to regional depots or direct into shops and hardware stores. These are generally not time-sensitive movements. These tend to be at the "bulk" end of the market comprising several trucks/wagons/containers at a time.
- From Brisbane or Rockhampton depots direct to end users. These are generally time sensitive movements and normally in quantities of truckload or smaller.

Some loads are consolidated by in-house or outsourced logistics companies e.g. One Steel or Toll/NQX who might load a whole container with various products, hardware etc. for a single customer. Rail traditionally targets wagonload or whole container load quantities. While big companies often buy consignments of that size, most smaller customers cannot. However if there was a way of consolidating the smaller customers consignments into wagonloads or container loads, this would enable rail to capture a larger share of the market. The problem therefore is one of consolidation at origin and destination. This function is addressed by 3PL companies and organisations like Elders and rural suppliers in their niche markets and this approach could be adopted for building products. Rail is price competitive and once again this market is not acutely impacted by backloading. This indicates the road service and catering to generally smaller individual movements is more customer orientated than the traditional "big rail" approach and this explains the relative market shares.

7.4 Influence of route configuration, operations and TSC(s)

7.4.1 Existing route from Emerald East to NCL with respect to high reliability

It is part of the generally accepted definition of an Inland Port that it has a "highly reliable railway connection" to the sea port(s). Now, although the existing route between an Emerald East Inland Port site and the North Coast Line (and destinations beyond) is already heavily trafficked with high value Blackwater coal trains and thus has some real issues concerning the level of reliability afforded by operations to freight (non-coal) traffic, 2/3 of this connecting route is already double track.

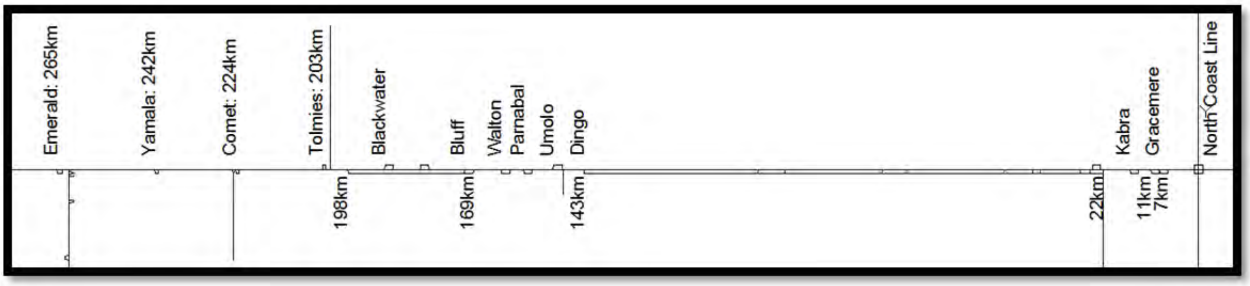

Figure 24 Blackwater System – Central line Single and Double Track

In the longer-term life of the Inland Port, instead of a single-track route, a double track connecting route configuration will create an entirely different operation on this connecting route. Besides markedly increased potential reliability, the change from a single line "lattice capacity railway"[30] to a double track "headway capacity railway"[31] will change priorities about train lengths, high cost locomotive power, fleet size, on-demand accessibility, and perceived values of train paths. The dramatic changes are likely to increase natural attraction of rail for freight mode-choices and thus also likely to change the parameters on which Transport Services Contracts are managed or are even required.

The following notes describe the constraints of the common single-track railway paradigms prevalent on railways in Queensland and how headway based operations of a double track railway can change the services offered by rail; all without detrimental effect on valuable coal traffic.

7.4.2 Drawbacks of current rail operations focus

Rail freight operations in Queensland and Australia are strongly targeted in a particular focus on maximum payload per route path and ultimate efficiencies of each train in terms of fuel consumption and crewing. The valid reasons for this single strong focus lay in the continued use of single line railway configurations for routes, but it needs to be recognised that this focus:

- Can lead to rail only pursuing freight that already fits its ideal. Only seeking the "cream" and not fulfilling the Government's objectives of relieving freight loading on road
- Can work against rail's ability to capture other areas of freight traffic which have priorities other than absolute minimum cost.

Road and highways always have the ability to "load and go", providing a virtual "on-demand" access to the highway corridor for all customers large and small. But rail, particularly with its current target focus on long trains and high payload trains can:

- Tend to serve large customers only and be difficult for smaller customers to use
- Have customers delivering to a terminal and the load not starting to move until a whole long train is loaded with other loads and not until a rare train path is available. Note that the existing service scenarios of 2, 3 and 4 round-trip trains per week mean that loads could be waiting up to 3 days before the path is available.

On top of the above drawbacks, there is then the issue of the reliability of the train paths. Parts of the rail network are dominated by high value coal traffic and there are common anecdotes from freight customers of paths being lost (or even crews being lost) to higher priority coal trains. The definition of an Inland Port contains the proviso of a "highly reliable rail connection to the (sea) port".

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[30] Refer to Figure 25 Single line "lattice" with empty train paths
[31] Refer to Figure 26 Double track with 15 minute headways and same reserved paths

Therefore, even though an Emerald East Inland Port may be able to commence first operations on the basis of the existing route path capacity, the Inland Port's continued growth and long-term success will depend on the operations and infrastructure of the rail connection to the NCL and destinations beyond having:

- High reliability of train paths provided for the freight traffic
- The ability to accommodate train services that satisfy other mode-choice factors (or customers' other priorities) besides minimum cost.

In the past, there have been attempts to make services more friendly to a wider base of freight customers, but these attempts have been discontinued and it is suspected that some prime reasons will be found in the current operations being: locked into maximising train size to suit rail operators rather than rail customers; and locked in the perception that freight railways are always single line railway operation without having a targeted development towards a fully functional double track railway.

This latter point is crucial for general freight traffic, not coal and minerals, because there is a tendency for single line to be self-destructive by gaining enough traffic that it becomes so un-reliable that the demand drops away and then investment in the necessary duplication is not forthcoming because the demand is in a falling direction.

7.4.3 Different operational mindsets for single and double line operation

7.4.3.1 Value/ cost of a train path

Fundamentally, the value/cost of a train path should be a derivative of the capex interest and opex of the rail infrastructure relative to the number of train paths enabled by that infrastructure.

However, in the Queensland paradigm of single line operations and high value coal trains consuming the majority of rail paths, infrastructure operators' perception of the value of a train-path (quite understandably) changes to become that of the price that coal customers will pay for the access. Therefore, operators can be tempted to willingly forfeit compensation costs to lower "value" freight, and transfer the freight's path to be used by a higher "priority/value" coal train which might be delayed or early running.

Double track can have capacities in terms of train paths per day from 4x to perhaps 10x the capacity of a single line. This means that any apparent "high value" of a train path relating to the "richest" traffic is suddenly not relevant and reverts to its fundamental CAPEX and OPEX cost/value.

7.4.3.2 Using strict slot management

An equitable method to overcome some of this problem would be to ensure that all train paths are rigidly managed and enforced, and thus not having "valuable" coal trains running outside their allocated path or "slot". This should then remove the value-dilemma from the daily operator, and render all trains (both coal and freight trains) with reliable train paths. However, a coal customer will naturally pressure to be provided with a train path on demand, even if their loading has been delayed and missed the strictly allocated train path.

Note as a reference QTLC Freight in Focus: Seminar Series: "Unlocking efficiency and productivity through supply chain coordination" which contained, "The concept of 'slot management' was introduced in Live Run during 2013, with trains working to specific 'slots' from the mine to the Port. These slots can be interchanged as needed to isolate and minimise the impact of delays and maximise throughput. Throughput loss rates have dropped to unprecedented lows since the introduction of slot management and on-time performance has improved significantly."

This strict slot/path management will be an essential requirement for the railway for the Inland Port concept to succeed, if the connecting route is a single track operation. This might mean some increase in power-to-weight ratios of trains to ensure that trains can overcome some delays and run more reliably. In such cases, each train configuration might be less efficient theoretically, but the overall rail route mechanism becoming highly reliable and more efficient overall.

In a double track operation, where operations are headway based and not lattice based, there is more scope for flexibility of train paths. So, double track can be much more favourable to coal customers who may have missed an allocated slot because of delays in loading. This is illustrated in the two diagrams below.

For example **Figure 25** shows a red empty path just missed by a delayed loaded train at "A". With strict slot management, that train has to wait 7 hours until "B" even though only 3 other trains are in the way. Hence the result in high pressure from the customer (and from train fleet round trip control) to send "A" earlier therefore disrupting all subsequent services and their related productivities.

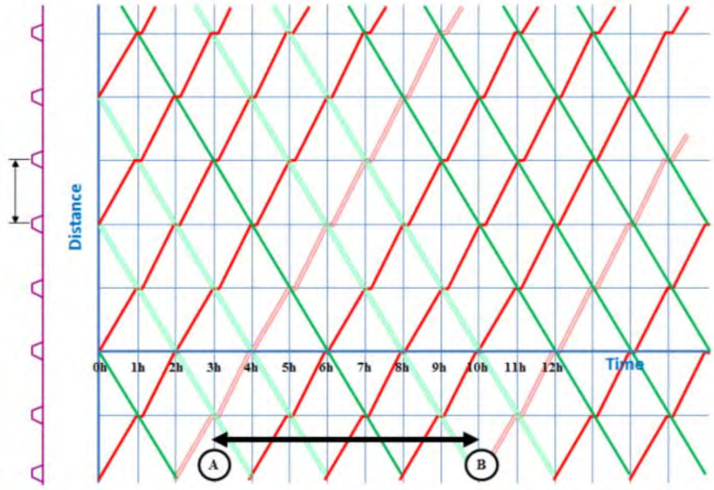


Figure 25 Single line "lattice" with empty train paths[32]

However, with a double track railway signalled for 15 min headways and with the same "occupied paths" **Figure 26** shows there is no need to wait for a path that also fits with trains in the opposite direction. The (delayed) train wanting to enter at "A" can enter almost immediately without disruptions to other trains in either direction. Moreover, that delayed train might even be able to catch-up its delayed time so that its return journey fits into the timetabled train diagrams.

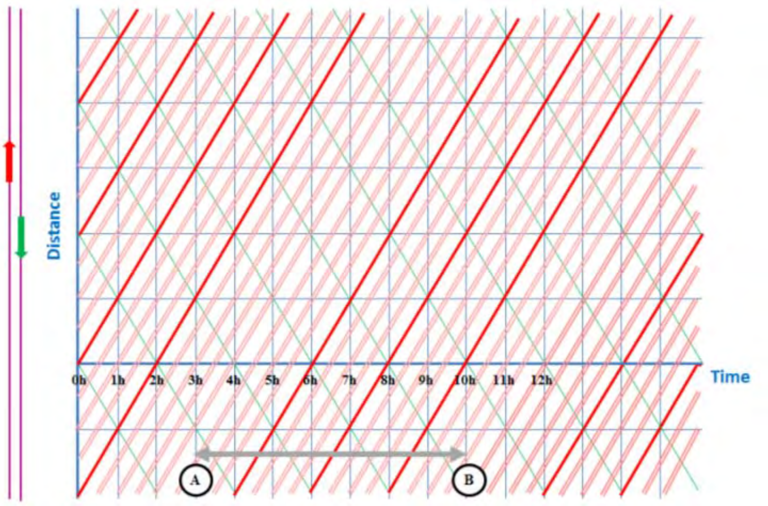


Figure 26 Double track with 15 minute headways and same reserved paths[33]

7.4.4 Comparing single and double track capacity

For single line railways, the theoretical capacity in terms of the number of train paths in both directions is a basic arithmetical function depending on the time taken to travel between passing loops. This is a fixed lattice shape, where the distance (time) between passing loops on a single track railway sets an arithmetical maximum capacity

[32] Extract from AECOM internal document
[33] Extract from AECOM internal document

for the number of trains each way (Scott's Formula). **Figure 28** shows a simple example for perfect operation with 60km between passing loops and average 60km/h speed gives 24 trains per day. That is 12 train (paths) one way, 12 train (paths) the other way.

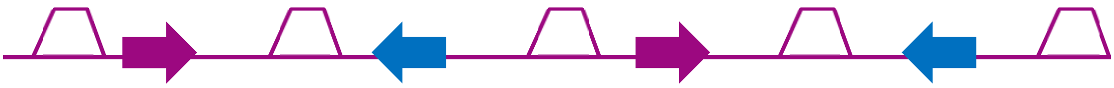


Figure 27 Single line with passing loops [34]

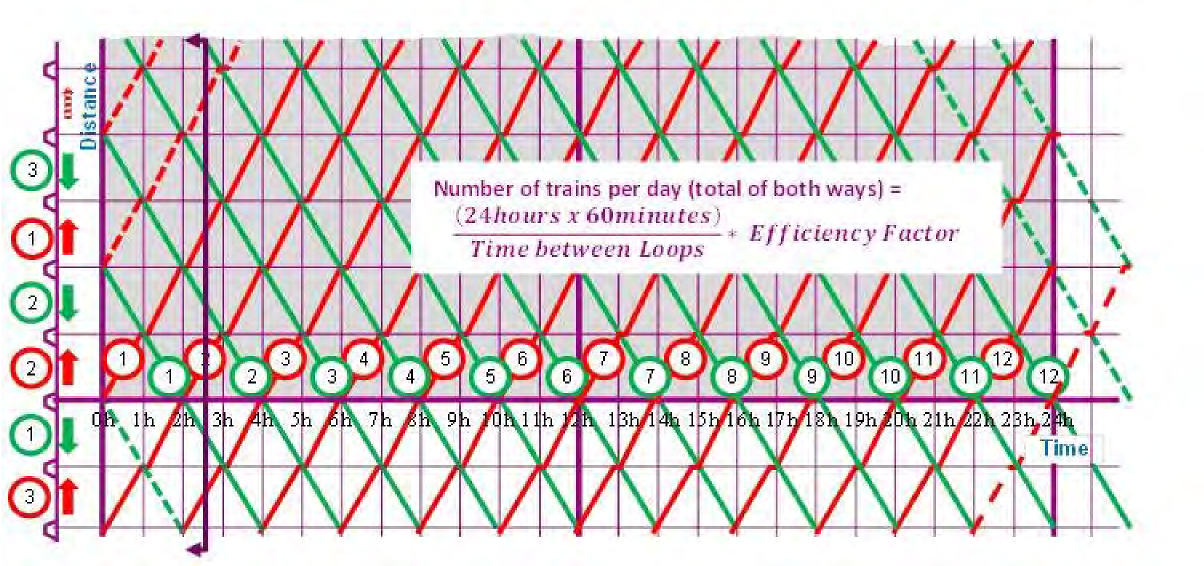


Figure 28 Single track operation and pathing example[35]

In contrast, for a double track railway, the number of train paths depends on headway between the trains in one direction on one track; the trains in the opposite direction have no influence (until reaching junctions at the end of the lines and depending on the layout of those junctions).

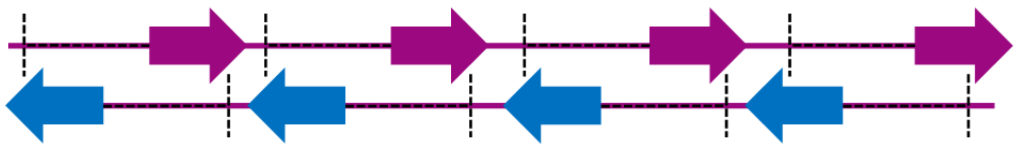


Figure 29 Double track [36]

[34] Extract from AECOM internal document
[35] Extract from AECOM internal document
[36] Extract from AECOM internal document

Double track capacities derived from the headway, or safe distance between trains, can be a remarkable step change as illustrated in the table below. Single line track with passing loop spacing as frequent as 10 km can have theoretical capacities of the order of 120 trains (60 trains each way), but that has a highly unreliable density compared to double track where that density would have a huge (and reliable) headway of 24 minutes between trains. Double track can have increased densities to 288 trains (144 each way) still with comfortable freight headways of 10 minutes.

Table 26 Capacity comparison

Single track with passing loops			Double track	
Km distance between loops	Nominal "ideal" max **Trains per day capacity** (1440/time between loops)		Headway	Nominal max **Trains per day capacity** (2*1440/headway)
	(High) average speed of 60km/h	More normal average 50km/h	*Speed not so critical a factor until close headways, when that prefers uniform speed of trains*	
60	24 (12 each way)	20 (10 each way)	*2hr 24 mins*	*20 (10 each way)*
50	28 (14 each way)	24 (12 each way)	*2hr*	*24 (12 each way)*
40	36 (18 each way)	30 (15 each way)	*1hr 36 mins*	*30 (15 each way)*
30	48 (24 each way)	40 (20 each way)	*1hr 12 mins*	*40 (20 each way)*
20	72 (36 each way)	60 (30 each way)	*48 mins*	*60 (30 each way)*
15	**96 (48 each way)**	**80 (40 each way)**	**36 mins**	**80 (40 each way)**
10	**144 (72 each way)**	**120 (60 each way)**	**24 mins**	**120 (60 each way)**
Not really sensible to have line with loops less than 15KM or 10km apart, because special trackwork and signalling costs getting higher than double track option anyway.			20 mins	144 (72 each way)
			15 mins	192 (96 each way)
Headways below 10mins mostly for passenger systems, but could contemplate for short/light freight trains			10 mins	288 (144 each way)
			5 mins	576 (288 each way)

7.4.5 Summary comparison of double track to single line paradigms

7.4.5.1 "On-demand access" by customers

The difference between single line and double track, in the case of "on-demand" access by a train or freight customer is dramatically different. As illustrated in **Figure 25** and **Figure 26** , even with a very long headway distance of 15 minutes, on a double track, trains in the reverse direction do not interfere with access as illustrated in **Figure 26**, so much easier to accept "on-demand access" by customers without disruption of route services.

7.4.5.2 Effects on train lengths. Less need for long trains

Changing from single line "lattice based capacity" to double track "headway based capacity" has a dramatic change to the operational planning of train consists. On single line railways, once train path capacity has been reached, the only methods to increase "through-put capacity" are:

- To add more passing loops. But not more frequent than 10 km spacing
- Have faster trains. To squeeze the lattice as right hand of **Figure 30** to increase trains per day. But this is not a practical proposition for rolling stock. (Only limited use in shortening section times for particularly slow sections.)

- Increasing payload per train path as left hand of **Figure 30** to increase payload throughput by:
  - Increasing length of train. However, very long trains can increase risks of derailments and can often increase consequences in derailments
  - Increasing load per wagon by increasing axle-loads. But only valid if load is dense and there is spare space in loading-gauge cross-section of train. (Can work for dense loads like ores. Less effective for coal traffic and irrelevant for much less dense commodities.)
  - Double stacking of containers. But only if track gauge stability and route clearances allow. Unlikely to be practical for Queensland. Can also involve higher risks and reliability issues.

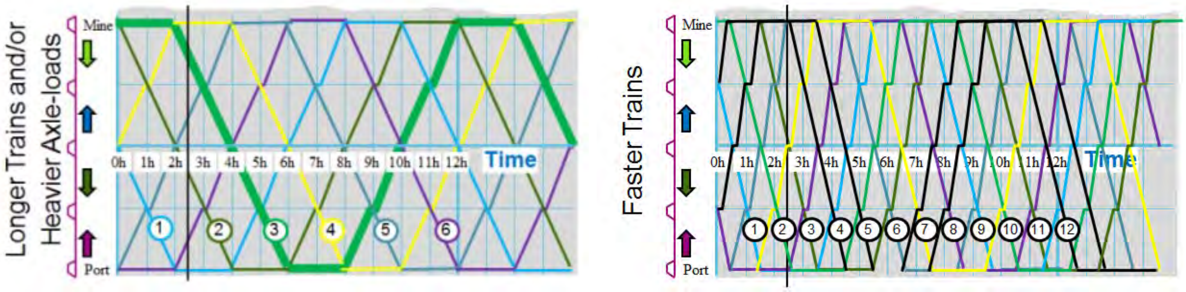


Figure 30 **Increase capacity through-put options** [37]

With double track railways, there is less drive for longer trains, and this can be of more value to a wider range of freight customers who prefer more "on-demand" access to the railway and timely transport as higher priority than price.

7.4.5.3 Effects on train fleet sizes

Shorter trains and shorter loading times can result in smaller fleet sizes (or more productivity per train-set). The potential depends on the round-trip lengths, but the example below shows a fleet size reduced from a 2km long train fleet of 12 km wagons and 24 locomotives, to short 500m long rapid turn-around trains totalling just 7 km of wagons and 14 locomotives for the same product throughput. A 42% reduction of fleet size and higher productivity rate for the fleet is used, but crews increase from 6 to 14. This is a significant point as, can be seen in the estimated cost distributions of **Figure 39** and **Figure 40 (Appendix B)** from train cost modelling works, rolling stock capital is a major contributor (in this instance of the order 50%) to the overall cost.

The following extract from an internal AECOM document is an idealised example, but clearly illustrates that:

1) Very long trains do not necessarily reflect efficient railway operations

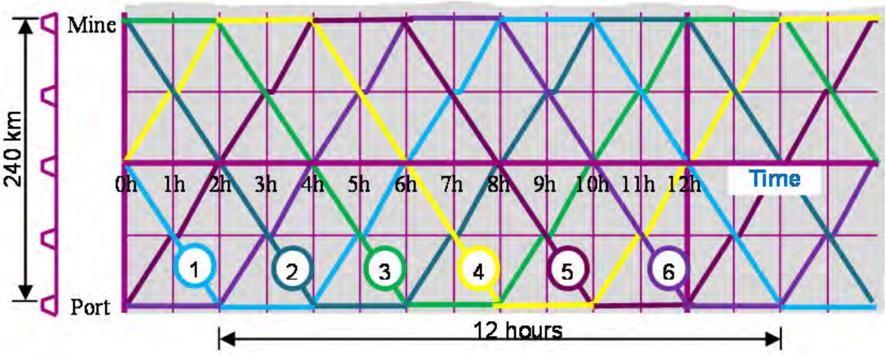
2) Very long trains do not necessarily reflect the lowest freight cost

Note that single bulk commodities even in double track operations have interest in using long trains, but can keep to less than say 1 km or 1.5 km to minimise risks and derailment consequences that are increased in very long trains.

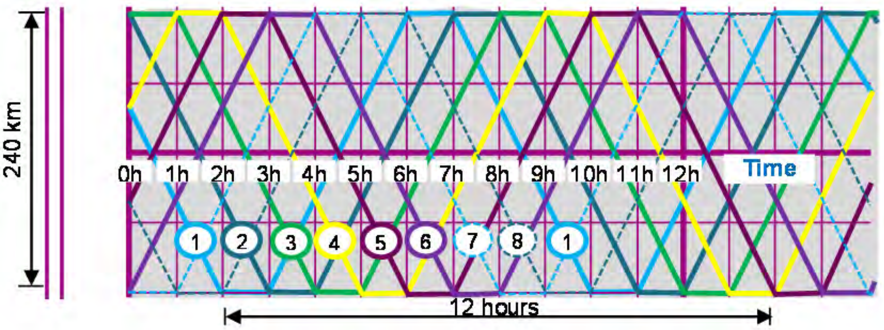
[37] Extract from internal AECOM document

Extract from an internal AECOM document:

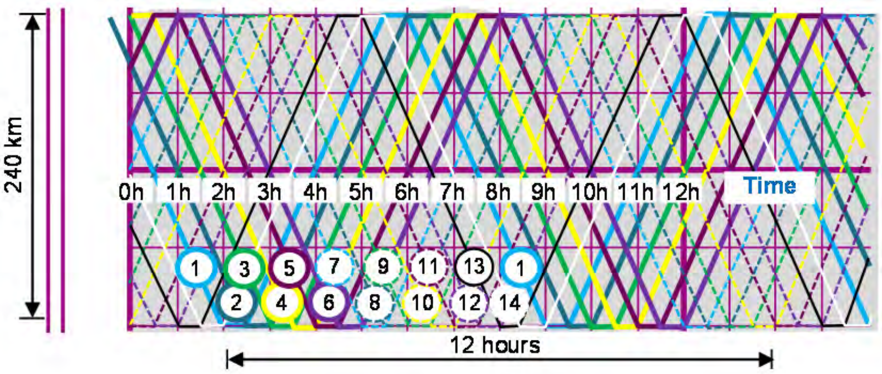
a) Single line case with 6 trains of 2 km length each and 4 locos each moving 12 km of product in 12 hours. Fleet = 12 km wagons + 24 locomotives



b) Double track case with 8 trains of 1 km wagons and 2 locos each moving same 12km of product in 12 hours. Fleet = 8 km of wagons + 16 locos



c) Double track case with 14 trains of 0.5 km wagons and 1 locos each moving same 12km of product in 12 hours. Fleet = 7 km of wagons + 14 locos



7.4.6 Conclusions on route configuration, operations and TSC(s) for inland port

The Inland Port needs highly reliable connections to coastal ports and destinations on the NCL, but with respect to this current study scope that means the connection to the NCL. Conclusions for the route configuration and operations (with likely effects on Transport Services Contracts) are:

- While initially as a freight collection and distribution terminal for bulk and low perishable commodities, the inland port can start operations with the existing single line operation connecting it to the NCL. But for the required high reliability, that single line operation must operate using strict path/slot management as described in **Section 7.4.3.2 "Using strict path/slot management"**
    - Note that after changing to double track operation with direction controls, some relaxation of path/slot management can be considered relative to spare capacity in headway based system
- To enable growth of the rail share of the market by offering more frequent train services, closer to "on-demand access" to the route, and to qualify status as an Inland Port, with highly reliable rail connection, the existing route to the NCL should (over the longer term) be converted to double track progressively from the east end in steps as:
    - The 6.5 km and 9.5 km lengths either side of Gracemere. And this to include NCL junction designs for Rockhampton destination and for south and Gladstone destinations
    - The 26 km section connecting Dingo and Bluff which will result in almost 200 km of double track route operations covering a high proportion of the coal mine traffic
    - Finally the remaining 5.5 km to Tolmies; 20 km to Comet; and 18 km to Yamala (Emerald East) in a progression in advance of growing traffic from the Inland Port

The arrangements of the relevant Transport Services Contracts will need to be reviewed to suit the targeted traffic and styles of attractive freight services needed to attract the freight volumes. Such potential rail service styles and opportunities are described in **Section 7.5**.

Rail traffic to and from the west of the Inland Port at Emerald East could continue to utilising existing tracks with 15.75 tonne axle loading constraints until potential Galilee Basin traffic shows signs of development.

7.5 Opportunities to grow market and benefits

7.5.1 Start-up case - Using existing reserved train paths: Constraints on attraction/services

The rail freight modelling work has identified that the existing railway could handle potential rail share of the market. If it is assumed that each train carries 1,000 tonnes of product, two trains per day amounts to about 700,000 tonnes of commodity per year, compared to approximately 600,000 tonnes contestable market and 300,000 tonnes assumed rail market share as tabulated below.

Table 27 Summary of Section 5 data

Commodity Groups	Contestable Market	Optimistic Rail Share
Fuel	50,000	25,000
Chemicals	45,000	25,000
Cement	21,000	10,000
Quarry	100,000	50,000
Broadacre	40,000	20,000
Pastoral	168,000	80,000
Other Agricultural	1,600	1,200
General Freight	90,000	60,000
Building Construction	60,000	25,000
Totals	**600,000 (575600)**	**300,000 (296200)**

In terms of very basic measurements, this indicates that an Inland Port facility can at least be started without immediate very large investment in the railway corridor(s) connecting the Inland Port to the North Coast Line (and thence to other inland terminals, Rockhampton, Port of Gladstone and Port of Brisbane, etc).

Section 6.0 and ***Appendix B*** concentrates on "price" as being a dominant mode-choice factor (particularly for the bulk and low perishable commodities of fuel, grain, cotton and some mixed commodities enabled by containerisation). This results in relatively infrequent hypothesised train services of 104, 156 and 208 round-trip trains per year. (2, 3 and 4 round-trip trains per week) This is suitable for bulk and low-perishable commodities ("price" dictated mode-choice commodities), and fits with the single line railway operation paradigm of maximising loadings and efficiencies of what would be not very frequent trains.

Therefore, **Section 6.0** and ***Appendix B*** establishes that an Emerald East Inland Port can be started on the existing basis of single line operations and on that basis can serve the existing demands for bulk low-perishable commodities of fuel, grain and cotton with some mixed commodity containers.

7.5.2 Limitations of start-up case and looking beyond existing paradigms

Infrequent trains will not necessarily enable the railway to offer services that would be more attractive and able to:

a) Grow rail's market share of all existing commodity volumes (and creating other benefits)

b) And more ambitiously achieve the government's aims to encourage expansion of agriculture and other industries in the area to grow from existing production volumes

To achieve these eventual aims, the longer term development of the Inland Port needs to look in further detail at the mode-choice factors for all the remaining commodities; and from this identify the train operating methods and associated infrastructure to enable those operating methods and create opportunities for increasing the rail freight share of the market. In looking at the longer term development of the Inland Port, it is essential to look beyond the current prevailing paradigms of single line operation and very long freight trains; to look more towards satisfying customers objectives as a first priority and (although a valid activity) not to assume that rail operation efficiency is the primary task.

The primary tasks are: (i) to get more freight on rail; and (ii) that attractive rail services can help to grow businesses and freight in the area. The single line operation paradigm currently in use on the rail corridor between the Emerald East Inland Port and the NCL and sea ports will be a hindrance to achieving the necessary high reliability required of an Inland Port corridor.

7.5.3 Creating opportunities for growth: Other operating styles and other mode-choice factors

Creating opportunities to grow the market and increase benefits will involve first looking to satisfy other mode-choice factors besides "price"; and then to look at changes to infrastructure, other rail operating styles, and other train types and rolling stock. This is summarised in **Figure 35** "Additional mode-choice factors to rail service requirements/opportunities".

At this stage this represents a "vision" beyond the current prevailing paradigms of single line operation and very long freight trains, identifying opportunities for rail services that can be investigated to grow the market share and to grow the market itself. The workability, viability and schedule for introducing these visions would obviously need greater investigation in later more detailed study, but some explanations and examples of these visions are provided below.

7.5.4 Rail, road and coastal: competition and mutual service

It should be noted that the "vision" takes on board the potential for "mutual service" between the different modes of rail, road and coastal shipping. There will always be a strong element of competition for market share, but when markets are large there can be an increasing tendency for each mode to utilize another to overcome difficulties. Therefore, rail's nominal competitors in the form of road hauliers and coastal shipping can also be customers.

Road hauliers as customers: In Europe, and to some extent in the USA, road hauliers are beginning to turn to rail to relieve truck drivers of long haul work and fatigue issues. In the USA this seems to be mostly as swap-body movements, but in Europe there is a growing use of roll-on/roll-off trains carrying full trucks with rest coaches for drivers. There are even designs for side loading for use at intermediate stops without facilities as by Kockums Industrier (See **Figure 31** to **Figure 33**).

Figure 31 Trucks-on-trains. Photo by RAlpin AG[38]

[38] http://www.ralpin.com/?pageID=23&lng=en

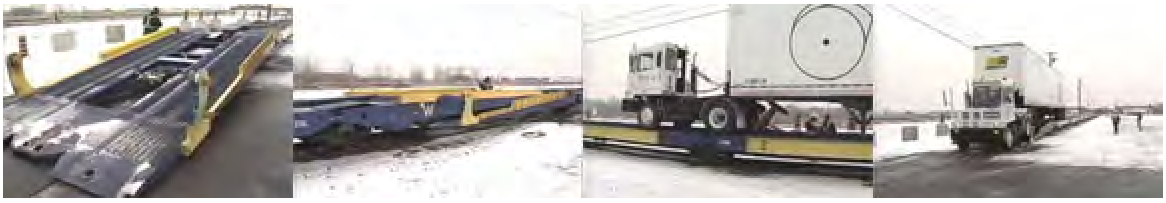


Figure 32 Trucks-on-trains. Roll-on/Roll-off. Images from Ettamogah Rail Hub[39]

The roll-on/roll-off arrangements above would be mainly for train loads of diverse hauliers' trucks between collection and distribution locations. The side loading wagon arrangement developed by Kockums Industrier illustrated below further widens the field of potential road haulier transfers to rails to include wagon-load and less than train load traffic without the shunting delays and shunting yard costs that have caused railways to lose that market in the past. Intermodal containerisation is the usual method for rail to handle wagon-load and less than train load traffic, but containerisation and its terminal costs does not suit all types of freight customers. The abilities to carry trucks on trains and for side loading of road trailers on and off trains can mean that efforts to increase freight on rail are not necessarily confined to the use of containerisation as a single solution/opportunity.

These kinds of potential solutions are not without their drawbacks, and in the Queensland case there will be issues concerning the track gauge and stability; but those are not likely to be more significant than those faced when running double-stack containers on standard (1435 mm) gauge track. The main prerequisite for such opportunities to stand a reasonable chance of success is that the train services must be extremely reliable and frequent enough, which reverts to previous comments about operation paradigms and strict time-table management.

Figure 33 Side loading wagon for full size road trucks[40]

Coastal shipping as customers: Plans for coastal shipping can be regarded as competition for the North Coast (Rail) Line, but as illustrated in **Figure 34** the coastal shipping could possibly be a mutual service, particularly when considering the difficulties of trains from the north accessing the Port of Brisbane through Brisbane's constraints on rail freight services through the city. Conversely, for freight carried by coastal shipping, the ports could still prefer a rail connection to inland distribution/collection terminals when there is limited space in the ports for road trucks.

The Port of Brisbane constraint leads to potential extreme visions of trains from the north accessing the Port of Brisbane either:

- Via train ferries from Mackay and or Gladstone
- Or train barges across the Brisbane River mouth from the northern river bank to the Port of Brisbane to avoid the Brisbane City constraints and to minimise load transfers.

Train ferries and train barges are still a valid mode in several countries as can be found from the websites:

- http://en.wikipedia.org/wiki/Train_ferry and
- http://www.seaspan.com/photos/

[39] http://www.ettamogah-hub.com.au/innovation/
[40] ©Kochums Industrier (http://www.kockumsindustrier.se/en-us/our-products/productdetail/?categoryid=3&productid=11)

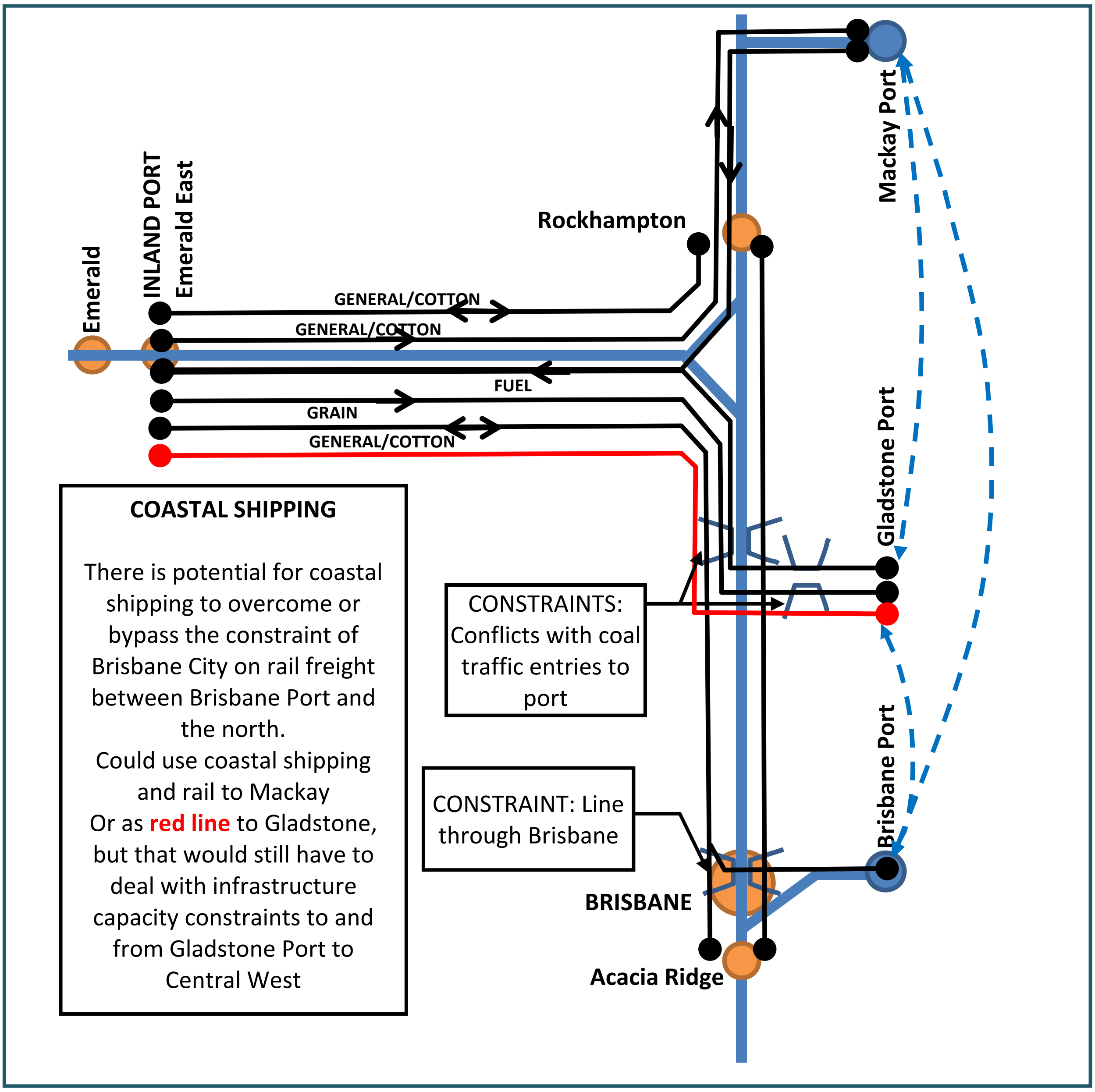


Figure 34 Potential for mutual service with coastal shipping relative to NCL constraints at Brisbane

7.5.5 Additional mode-choice factors (besides price)

Where **Section 6.0** concentrated on "price" as being a dominant mode-choice factor for the bulk and low perishable commodities of fuel, grain, cotton and some mixed commodities enabled by containerisation, other customers will have different preferences (or mode-choice factors) such as those included in **Figure 35**.

Reliability is a clear factor, but often expressed anecdotally in negative terms with respect to rail transport. This is a leading reason for attention paid above to problems of single-line railway operations and the need to break that paradigm and progress to double track railway operation. In terms of Emerald East working as an Inland Port, the reliability for export commodities has a separate element in relation to connections with the Ports of Gladstone and of Brisbane.

On-demand access" to rail corridors for transit. This is in answer to the well perceived advantage of road transport in that a road can be entered at any time and the road service is virtually "load-and-go". Again, this is where a double track railway (headway capacity railway) is the preferred railway concept with train paths limited only by headway and not by trains in the opposite direction. This cannot fully match road's ability, but does open up a big door to sectors of the market not feasible to a "lattice capacity" single line railway operation.

Low harm and low "breakage" from smoothness of transport. Some commodities are vulnerable to damage during transport, and in the transit portion rail has a distinct advantage over road. Livestock is a commodity where rail has a clear advantage in this respect, but customers with general goods and shop-wares can greatly value having contents of containers arrive in good order and not have costly individual items damaged in transit. Transhipping still has risks, but rail has a distinct advantage for transit condition.

Harm from delays to perishable products is still a risk in current single track "lattice capacity" railway operations. This is a further reason for emphasising the benefits of double track headway capacity railway operations; whilst delays might still occur, the delays should be much less severe and more akin to traffic jams on roads rather than delays of the order of 12 or 24 hours. Therefore, this is a mode-choice factor on which rail fails under current railway operation paradigms, but which can be overcome by a double track railway.

Safe transport with respect to public. Road transport is subject to an enormous range of risks compared to railway operations; even when a road haulier's equipment and operation is of a very high standard for carrying hazardous materials, there are still high risks from other road users and road events. Moving hazardous goods from road to rail is a general public desire. Railways still have risks with respect to higher potential consequences from whole train-loads of hazardous products, but these are manageable within common railway precautions.

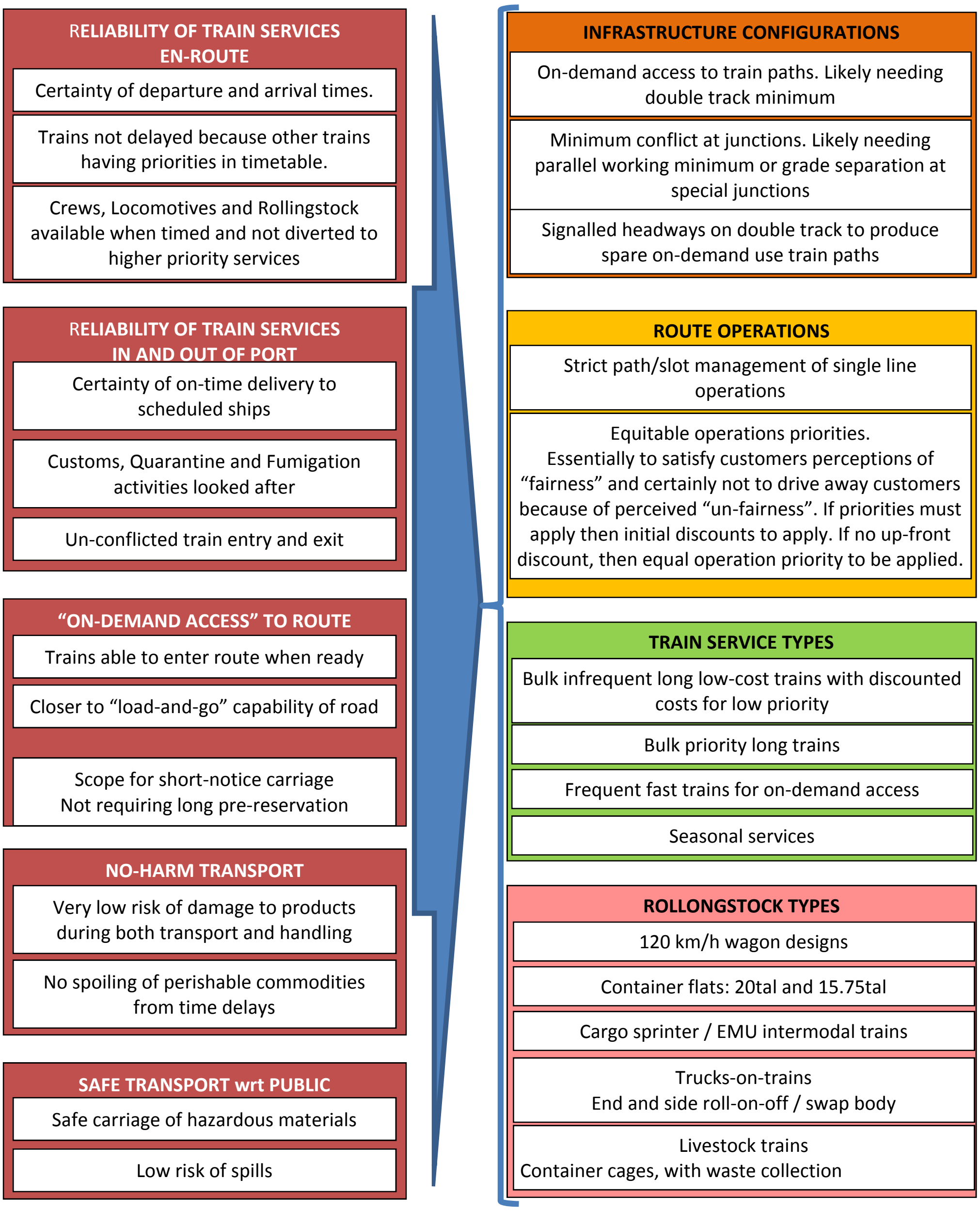


Figure 35 **Additional mode-choice factors to rail service requirements/opportunities**

7.5.6 Further visions in Above-Rail and Below-Rail fields

The need to expand from current railway paradigms to strict path/slot management and thence to double track rail routes has been described in detail. To complete the picture, the following are a few sample illustrations of the Rail Service Requirements/Opportunities which are derived in the diagram in **Figure 35**.

- **Rolling stock designed speeds increased to 120 km/h**: Current rolling stock uses bogies designed for 80 km/h and some for 100 km/h, but internationally most freight rolling stock designed for use at 120 km/h (70 mph) or more in some cases. This is not intended to mean changing existing alignments, but rather to:
  - Take advantage of the many places where higher speed is possible
  - Take advantage of the fact that lines already have to be maintained to passenger train standards, and are thus of geometric quality for higher speeds
  - Ultimately gain benefits in shorter round trip times and possibly smaller fleets of wagons required.
- **Trucks on Rail**: This has been described in “Road hauliers as customers” under **Section 7.5.4** and train types are shown in **Figure 31 to Figure 33.**
- **Fast Intermodal Trains**: These can be relatively short trains and are used where customers’ requirements outweigh the need for operators to attempt very long trains for full fuel and cost efficiencies. The service provided being of higher priority to the diverse container customers than the minimising of train costs. Examples of Fast Intermodal Trains are:
  - Cargo Sprinter: As shown in **Figure 36**, these trains have power units and cabs at each end and are planned to generally work in fixed train-set units (rather like modern MRT passenger trains) for fast turn-around.

Figure 36 Cargo Sprinter: Images from Ettamogah Rail Hub[41]

  - Japanese M250 EMU container train. Similar in principle to the Cargo Sprinter, but electric powered. These M250 trains operate with 16 cars per train-set and a maximum speed 130 km/h on a 1067 mm track gauge, which is the same as Queensland, as shown in **Figure 37 and Figure 38.**

[41] http://www.ettamogah-hub.com.au/innovation/

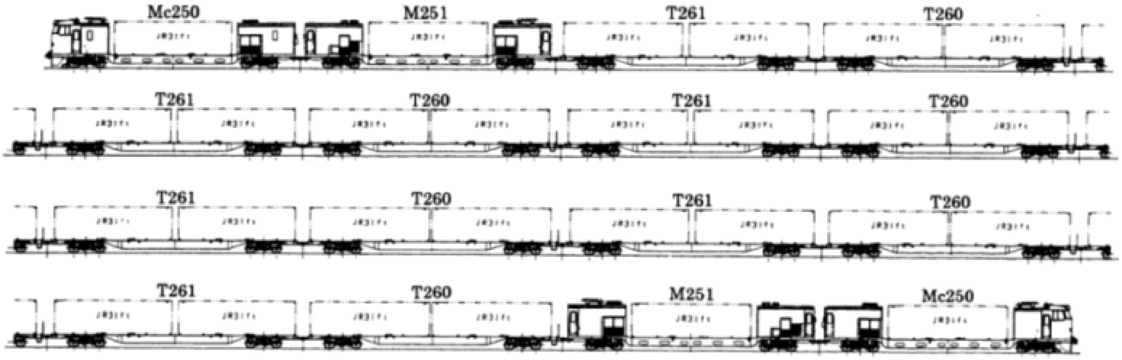


Figure 37 M250 Contrainer EMU: Extract from "Development of Super Rail Cargo" by Morita et al Japan Rail Freight Company

Figure 38 M250 express container train, 'Super Rail Cargo'[42]

To summarise, for growing the rail freight market and for attracting customers to rail rather than overloading roads, there is a strong case to look beyond the existing rail freight assumptions of very long trains and high axle-loads. Long heavy trains have a role, but only satisfy a limited part of the potential/contestable market. The application of strict timetable controls and frequent services with appropriate types of trains (as identified in this section) can capture a wider freight market, even to the extent of providing services to road hauliers.

[42]Picture from Japan Rail Freight Company website

Appendix A

Rail infrastructure

Resources Rail Lines

Existing Track Infrastructure And Upgrade Assessment

Resources Rail Lines

Existing Track Infrastructure And Upgrade Assessment

Client: Department of Transport and Main Roads

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08-Aug-2014

Job No.: 60311326

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Quality Information

Document	Resources Rail Lines
Ref	60311326
Date	08-Aug-2014
Prepared by	Stephen Brandis & John Martin
Reviewed by	Michael Allt

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
A	03-Mar-2014	Draft Working Paper 1	Michael Allt Project Manager	
B	1-Apr-2014	Draft Working Paper 1 with TMR comments incorporated	Michael Allt Project Manager	
C	13-Jun-2014	Final Working Paper 1	Michael Allt Project Manager	
D	08-Aug-2014	Final Working Paper 1	Michael Allt Project Manager	

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Executive Summary

A desktop condition assessment and high level indicative cost estimate of upgrading the track section from Nogoa (2km east of Emerald) to Alpha of Queensland Rail's Central West rail line from 15.75 tonne axle load (tal) to 20 tonne axle load was undertaken for the purpose of understanding potential infrastructure upgrades required to support a containerised rail line haul to a potential inland port.

A design criterion consistent with current Queensland Rail track standards was used in order to determine the suitability of the existing track for a range of scenarios.

A high level cost exercise was undertaken to illustrate an indicative cost accumulation profile from east to west to upgrade the axle load strength of the line.

Relative to "A Class" track (Defined for this project as the Coal network and the North Coast Line comprised of 20tal at 80kmph speed capacity or greater), the existing track between Nogoa and Alpha can only be described as significantly low grade, even with respect to existing 15.75 tal traffic. Irrespective of rail size, the track is jointed at what appears to be a very old standard of 24 ft (approx. 7.3 m) rail lengths and is held on timber sleepers with single spikes per side of the rail. In light of the very frequent joint spacing, this arrangement requires considerable manual maintenance.

There are 88 existing bridges between Nogoa and Alpha. The majority of these are small-span timber structures which are well dated.

There are a large number of curves (94) with a radius less than 300 m, which is a significant restraint for speeds along the corridor. From Bogantungan to Drummond (368-388 km), due to the Drummond Range the horizontal alignment is extremely poor. There are a large number of curves with a radii of 80.467 m. This is the absolute minimum to allow for 25 km/h running speeds. Many of these are also reverse curves and on a steep vertical grade (3%; 1 in 33).

Generally, the tracks in Queensland have been designed around a 2% maximum gradient with trains and locomotives set up to cope with those 2% gradients. For the route west of Emerald, there are some gradients that are above 2%, and even reaching 3%. But usually the lengths of such steep gradients are quite short relative to the length of a train, and so have only a partial effect on a whole train. The average length of gradients steeper than 2.5% in the study area is less than 200 m.

Constraints to the elongation of existing passing loops to accommodate longer trains have been identified and summarised. Level crossing, grades and track curvature are constraining factors to five (5) of the six (6) passing loops examined.

In strict terms of track material standards, the existing 24 ft jointed 60 lb rail on timber sleepers (interspersed with steel) is only marginally acceptable for the current 15.75 tal at 800 km/h. In terms of materials standards, it is not appropriate (nor permitted by Queensland Rail standards) to carry 20 tal traffic and is probably at or approaching its limit of working life even under the existing 15.75 tal traffic (albeit quite infrequent existing traffic). The proximity of the track to the end of its working life will vary along the length of the 174 km long section and would strictly be measured as Million Gross Tonnes life remaining. If the longest life remaining is taken (for example) as 15-years, then to maintain the existing track section it would require an annual relaying of about 15 track-km per year.

Since the existing track structure form is not able nor permitted by Queensland Rail standards to be up-graded to 20 tal capacity with existing materials, the first 20 tal traffic would incur a very significant prior investment cost of either full track renewal with modern track materials, or at least full re-railing with a larger rail. The re-railing with larger rail option may not be able to achieve a satisfactory result without the addition of new rail seating and fastening arrangements.

Some strategies for spreading and/or reducing these costs have been explored.

The main points arising, in general terms are:

1) In conventional measures, the track and structures are approaching the end of their working life (prior to renewal). With very infrequent traffic, the Million Gross Tonne (MGT) based remaining working life might amount to a decade or more as years remaining, but at the high cost of maintenance attention.

2) The existing route needs extensive work before it can carry 20 tal traffic. By Queensland Rail standards, 97% of the route should not have axle loads increased above 15.75 tal with the existing rail size. And even the 15.75 tal loading is only marginally acceptable on 30kg/m rail because it is existing. New rails would need to be a larger rail section even if keeping the 15.75 tal loading. Commonly available track materials and methods (such as concrete sleepers and welding) are likely to be cheaper than direct like-for-like renewals (such as timber sleepers and fish-plated joints). So, renewals will tend to result in a natural upgrading of the track and its loading capacity, as well as reduced maintenance attention.

3) Item (2) above means that upgrading costs might not be offset by spending renewal costs, but with Item (1), there should be savings compared to existing maintenance costs.

4) The orders of route upgrading costs as in **Figure 10**, indicate that accepting lower train efficiency with containers spread to retain 15.75 tal infrastructure loading should be considered. But noting that such acceptance will depend on whole train trip parameters, not just this section of route.

5) The low cost upgrade, assumed to simply re-rail with larger rail section, could be very sensitive to supplementary issues such as: rail fastening and seating; limits on Continuously Welded Rail (CWR) with timber sleepers; and distribution of sleepers needing replacement

6) Some alternative concepts for increasing life and capacity of the existing track structure are identified in an effort to minimise initial costs, but are very unconventional and need further investigation.

1.0 Methodology

The methodology for this high level track infrastructure and upgrade assessment was as follows:

1) A desktop study of the available information was undertaken, and design criteria used that are in line with current Queensland Rail track alignment standards.

2) Track alignment information was collated in a digital format. The existing Working Plan and Section drawings are old (circa 1960-70s) and detailed in imperial units (chains, feet). Track alignment information from these drawings was converted and hand inputted into digital spreadsheets, and should be treated as approximate only. This is suitable for the high level nature of this review.

3) A review and analysis of the available track alignment data was undertaken. This included a comparative review between the existing track geometry, and established design criteria, to determine the suitability of the existing track for a range of scenarios.

4) A high level indicative cost exercise was undertaken to illustrate cost accumulation profile to upgrade the axle load from 15.75tal(Tonne Axle Loads) to 20tal between Nogoa (Just east of Emerald) to Alpha, and

5) An analysis of upgrading track from 15.75tal to 20tal was undertaken.

2.0 Definitions

Table 1 Definition of acronyms and terms

Acronym or Term	Definition
“A Class” track	Defined for this project as the Coal network and the North Coast Line.
CETS	Civil Engineering Track Standards
CWR	Continuously Welded Rail
Horizontal Geometry	The horizontal geometry (or horizontal alignment) is the plan view of the alignment and particularly concerns the sharpness of the curves with respect to the speeds at which the trains can be run. Freight rolling-stock in Queensland (and even generally in Australia) is designed for an 80 km/h maximum speed.
LWR	Long Welded Rail
MGT	Million Gross Tonne
OLC: Occupation Level Crossing	Provided for and used by only occupiers of land on both sides of the railway.
PLC: Public Level Crossing	Provided for public road crossing the railway.
tal	Tonne Axle Load
TSC	Transport Service Contract
Vertical Geometry	The vertical geometry (or alignment) is the vertical profile of the railway and particularly concerns the steepness of slopes with respect to the heaviness of the trains climbing those slopes, and how much the speed may be reduced depending on the amount of locomotive power on the trains.

3.0 Existing conditions assessment

3.1 General

The section of railway track under assessment for this study is between Nogoa (near Emerald) and Alpha on Queensland Rail's Central West System in Central Queensland. **Figure 1** Provides an overview of the assessment area and relevant rail infrastructure references. Aurizon's Blackwater System connects the Central West System at Nogoa. This track section under assessment is considered non "A-Class" track and is being assessed to support the identification of potential Inland Port locations. Existing passing loop locations of Yamala at approximately 20 km east of Nogoa will be included in the scope of site-finding for an Inland Port, but are part of the Aurizon coal network designed for coal train loading and therefore is excluded from this assessment.

The railway between Nogoa and Alpha is non-electrified and single track, with passing loops at a number of locations (refer to **Section 3.5**). Between Nogoa and Emerald the overhead electrification infrastructure is installed however de-energised.

Figure 1 shows the alignment of the track between Emerald and Alpha, the major creek/waterway crossings, the topography and the rail chainages at 5km increments.

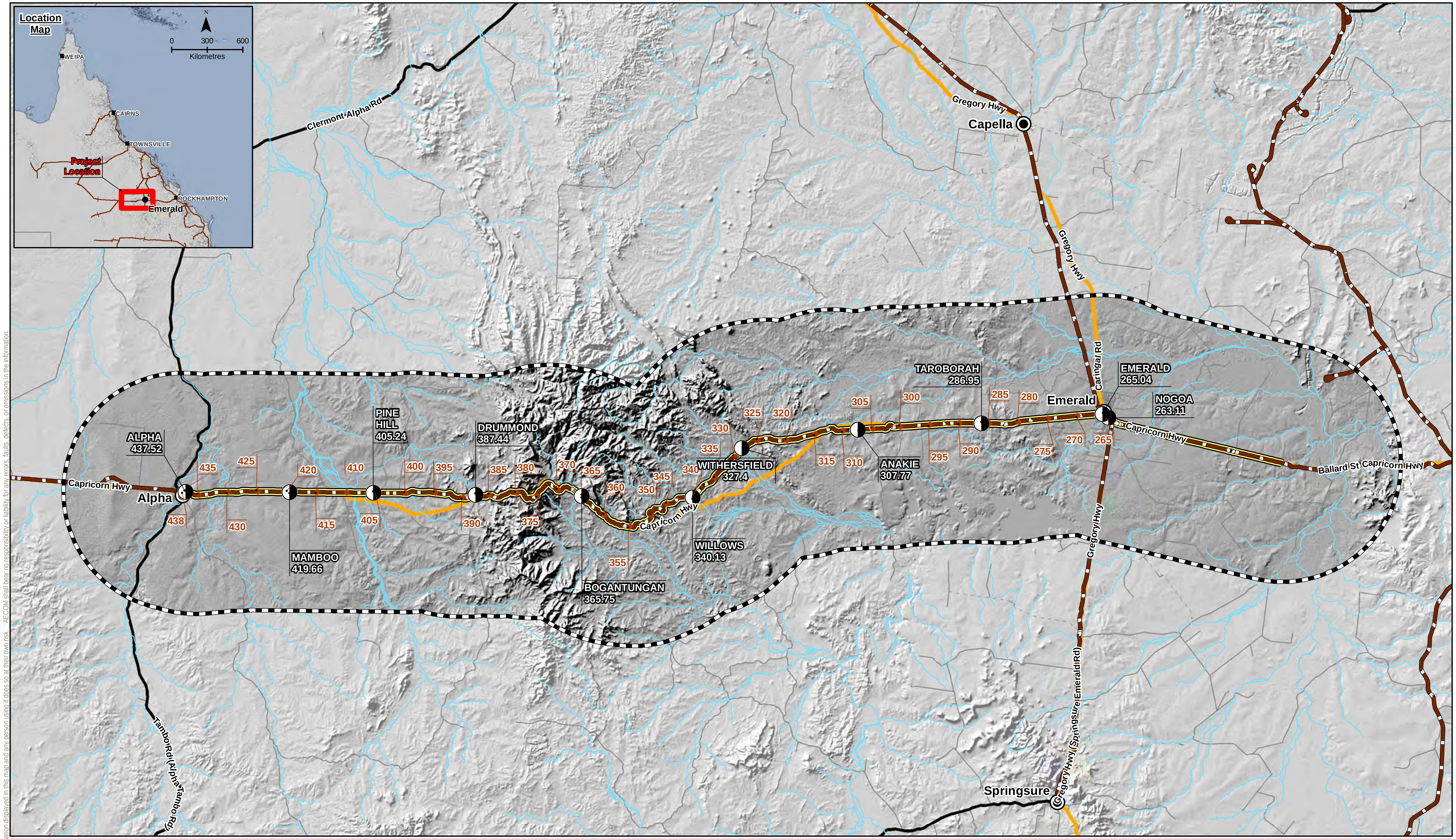
3.2 Data references

The data utilised was based on the following references, as provided by Queensland Rail:

- Central West System Information Pack, Issue 2, April 2008
- Track Data and Grade Diagrams: Rockhampton to Emerald, Emerald to Longreach
- Existing speed board information
- Working Plan and Section Drawings, C3-C6

Track alignment was analysed, based on the current Queensland Rail track standards:

- SAF/STD/0077/CIV – Civil Engineering Track Standard Module 8 – Track Alignment (Version 1.2)



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DATUM GDA 1994, PROJECTION MGA ZONE 55

0 5 10 20

Kilometres

1:600,000 (when printed at A3)

Legend

- Chainage 5km
- Towns
- Passing_Loops
- Highway
- Freeway
- Main Road
- Connector Road
- Local road
- Selected Rail Section
- Railways
- Drainage Line
- Study Area Corridor Offset

Data sources:

Base Data: (c) 2011 (ESRI_Imagery_World_2D)
QLD Railways: (c) 2011 (StreetPro Australia)
QLD Highways: (c) 2011 (StreetPro Australia)
QLD Drainage: (c) 2011 (StreetPro Australia)
DCDB: (c) 2014 (DLGP)
Hillshade, based on the 25m DEM; DNRM 2005

RESOURCES RAIL LINES
Central Queensland Inland Port Concept

Rail Infrastructure

PROJECT ID:	60311326
CREATED BY:	VV
LAST MODIFIED:	VV - 07 Aug 2014
VERSION:	B

Figure 1

Filename: P:\Projects\60311326\4. Tech Work Area\4.99 GIS\02_mxds\Report_Maps\Figure1_Rail_Infrastructure.mxd

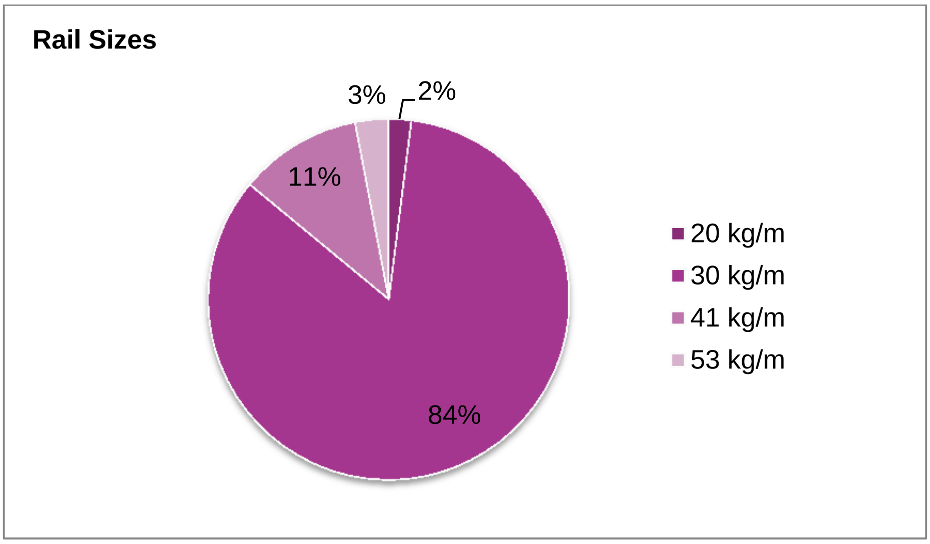
A3 size

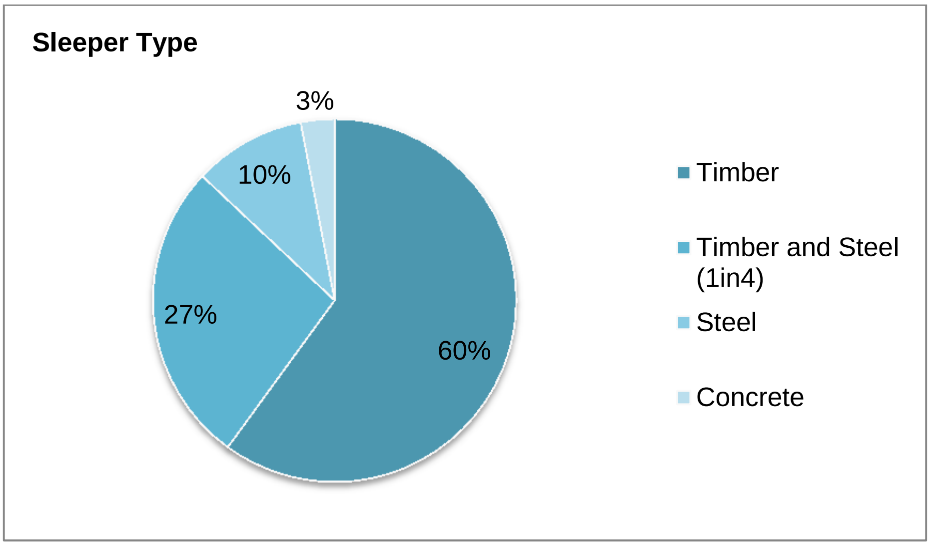
3.3 Rail infrastructure

3.3.1 Track structure

The current maximum allowable axle load is 15.75 tal. The track structure consists of multiple rail sizes (20, 30, 41, and 53 kg/m) and different sleeper types (timber, steel, and concrete), on crushed rock ballast. The rail size 20 kg/m is technically not capable of the route's 15.75 tal loading, but may be located in sidings for slow speed and/or unloaded use.

Between Emerald and Jericho (55km West of Alpha) track element types and percentage are as follows:





A photo of the track structure is shown in **Figure 2**

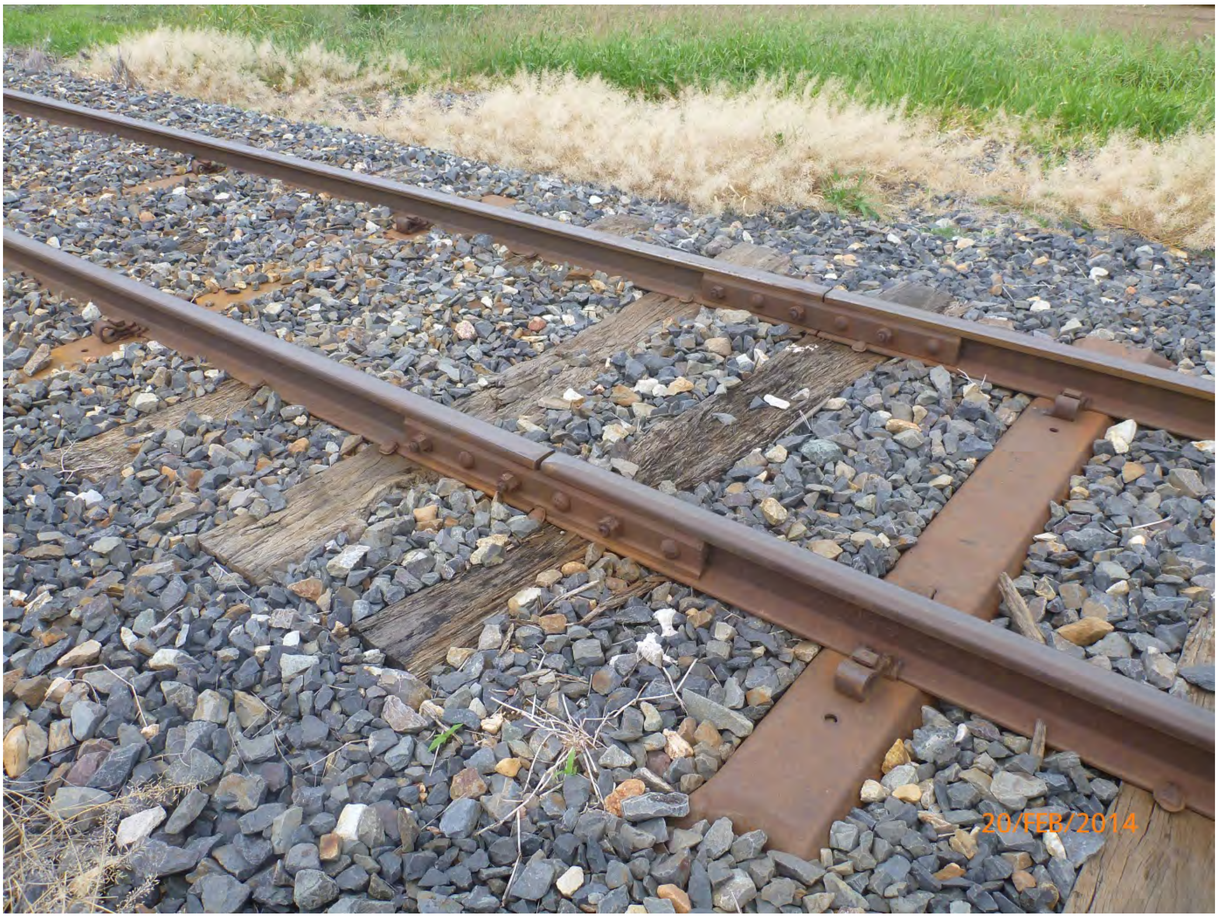


Figure 2 Timber sleepers interspersed with steel sleepers (1 in 4) - Central West System

3.3.2 Bridges

There are 88 existing bridges between Nogoa and Alpha. The majority of these are small-span timber structures.

The major bridge structures (> 40 m) along the corridor are detailed in **Table 2**. Chainages have been converted from the imperial units provided on the working plan and section drawings (miles and chains) and should be treated as approximate.

Table 2 Bridge structures greater than 40 m in length (Nogoa to Alpha)

Chainage (km)	Name	Bridge Number	Span Arrangement (No. of/span length ft)	Metric Length (m; approx.)
264.86	Nogoa River (Steel Truss and Girder)	250	1/31', 1/50', 4/101', 6/50', 4/31'	277
330.39	North Creek	317	5/14', 1/15', 7/14'	98
365.64	Glass Tree Creek	353	2/14', 2/22', 5/14'	43
366.99	Medway Creek	354	1/14'3", 1/13'6", 1/20'6", 1/21'9", 1/22', 1/22'9", 1/16', 1/21'9", 1/22', 1/14', 1/14', 1/10'	65
379.20	Tipperary Creek	364	1/19'9", 2/20, 1/19'9", 1/20'3", 1/20', 1/19'9"	42.5
382.20	Tipperary Creek	366	2/18'9", 1/20'3", 4/20'	42
403.60	Pine Hill Creek	386	1/12'9", 4/14', 1/22', 3/14', 1/13'9", 1/14'	48.9

Chainage (km)	Name	Bridge Number	Span Arrangement (No. of/span length ft)	Metric Length (m; approx.)
408.58	Belyando River	391	1/13'9", 1/14'3", 1/14', 1/13'9", 1/14', 1/14'3", 1/13'9", 1/14'3", 1/13'9", 3/14', 1/14'3", 1/14'	59.7
408.66	Belyando River	392	1/13'9", 1/14', 1/14'3", 3/14', 1/13'6", 1/13'9", 1/14'6", 1/13'9", 1/14'3", 5/14", 1/14'3", 1/13'9", 2/14"	85.3
409.05	Belyando River	393	2/13'9", 1/14'3", 1/13'9", 1/14'3", 1/13'6", 1/14'3", 3/14', 1/13'9", 5/14', 2/13'9"	73.5
430.53	Native Companion Creek	399	1/13'9", 1/13'3", 1/22', 1/22'3", 2/22', 1/21', 1/14', 1/14'3", 1/13'9", 1/13'6"	58.4
436.80	Unknown	402	1/18'9", 1/20'3", 1/20', 1/19'9", 1/20'3", 1/20', 1/19'9", 1/20', 1/20'3, 1/19'9"	60.6
437.02	Alpha Creek	403	1/18'6", 1/20'3", 1/19'9", 1/26'6", 1/25'3", 1/26'9", 2/26', 1/20', 1/19'6", 1/20'3", 3/20', 1/19'9", 1/20'3"	106.3

There is also a large number of small bridges, with spans under 10 m (e.g. with spans of 1/12', 1/14', or 2/14')

3.3.3 Speed boards

An overview of the existing line speed, as per the existing speed boards, is shown in **Figure 3.** Line speed effects the section run times of trains which effects cycle times and network capacity.

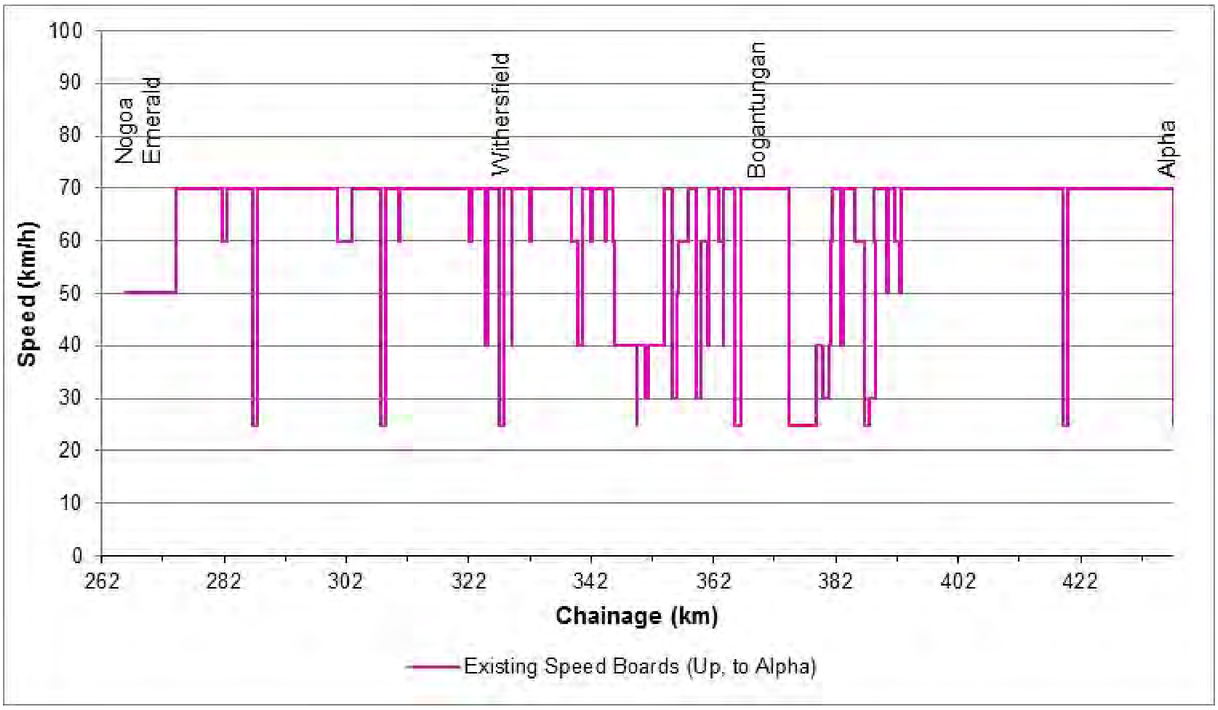


Figure 3 Existing Posted Line Speed

3.4 Track alignment assessment

3.4.1 Horizontal alignment

The horizontal alignment is the plan view of the alignment. The sharpness of the curves with respect to the speeds at which the trains can be run is of interest. Freight rolling-stock in Queensland (and even generally in Australia) is designed for an 80 km/h maximum speed. In European countries with standard gauge, freight wagons are often designed for speeds of the order of 120 km/h.

A summary of the existing horizontal alignment, from Nogoa to Alpha, is provided in **Table 3**. This provides a percentage breakdown of horizontal curves based on their existing radii. There are a large number of curves (94) with a radius less than 300 m, which is a significant restraint for speeds along the corridor. Note that the sharper curves are usually a result of hilly and variable terrain where the horizontal alignment winds around hills to avoid construction of large earthworks and to keep gradients as flat as possible. At the time of construction, gradient and reduced excavation will have been of higher priority than speed on the section.

Table 3 Overview of horizontal curve radii (Nogoa to Alpha)

Track type	Radius of curve (m)	Number of curves	Combined length (km)	Proportion of total length
Straight	-	-	130	75%
Curve – 80 km/h	≥542	79	19	11%
Curve – 70 km/h	≥415 and <542	9	2	1%
Curve – 60 km/h	≥300 and <415	44	9	5%
Curve – ≤50 km/h	<300	94	14	8%

Figure 4 shows a breakdown of the horizontal alignment, by length, from Nogoa to Alpha. There are 13.88 km of curves with a suggested running speed of less than 60 km/h. The length of affected track is greater than this, as train stop/start times also need to be considered.

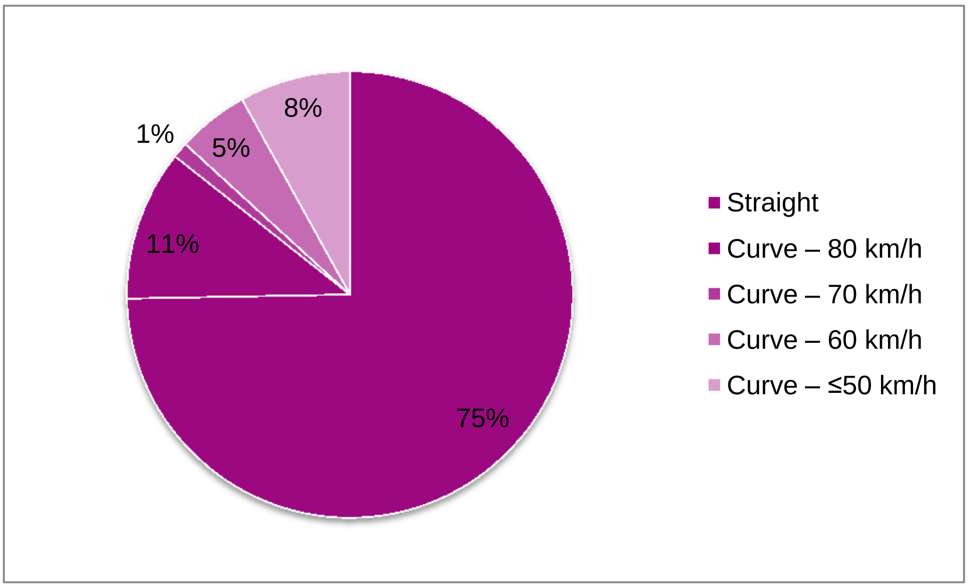


Figure 4 Track length by type.

Figure 5provides a visual comparison of the existing curve radii and the minimum curve radii required for different design speeds. This figure plots only the curves and not straights

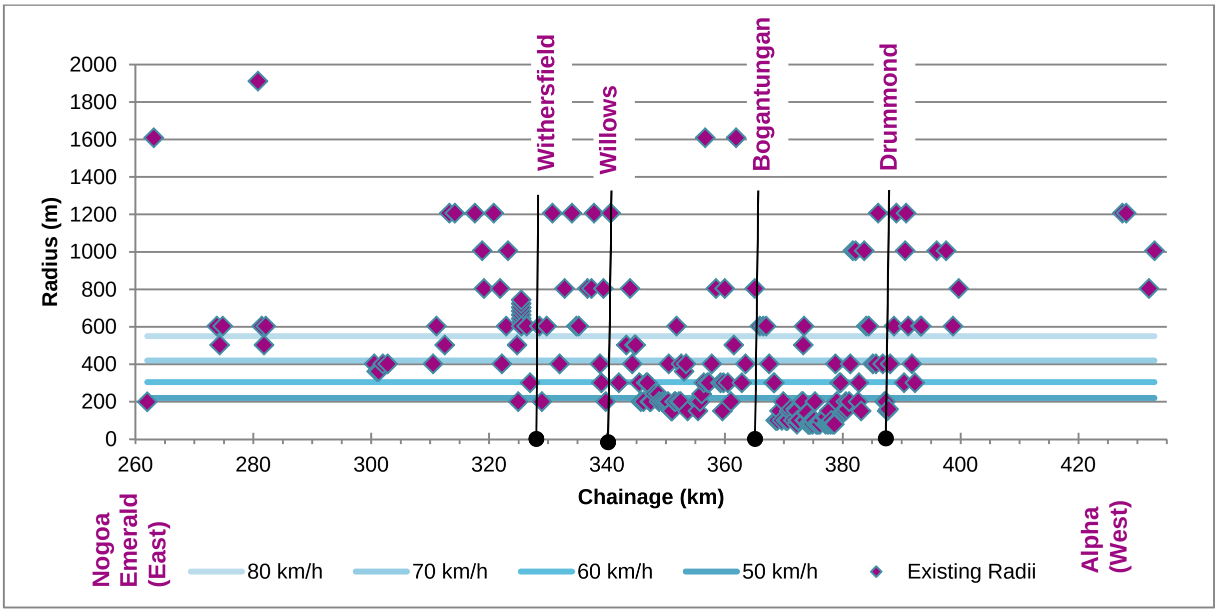


Figure 5 Existing radii against criteria limits for various speeds

A number of conclusions can be drawn from this data:

- From Emerald to the western side of Willows (chainage 262km -345km), the horizontal alignment is generally suitable for running at 60 km/h. It is suitable for 80 km/h in many sections. There are three curves that require greatly reduced running speeds: approximately at 325 km, 329 km, and 340 km. These were designed with a radius of 10 chains, which equates to 201.2 m. A maximum speed of 40 km/h is allowable through these curves, based on the current standards, which is adopted by the existing speed boards.
- From the western side of Willows to Bogantungan (chainage 345km -368 km), the horizontal alignment is suitable for higher running speeds (60-80 km/h) only periodically. There are a large number of tight radius curves in this section, with radii of 201.2 m and 150.876 m, through which a maximum speed of 40 km/h is specified. The existing speed boards in this section vary between 25-70 km/h.
- From Bogantungan to Drummond (chainage 368km -388 km), due to the Drummond Range the horizontal alignment is extremely poor. There are a large number of curves with a radii of 80.467 m. This is the absolute minimum to allow for 25 km/h running speeds. Many of these are also reverse curves and on a steep vertical grade (3%; 1 in 33), both of which should also be taken into consideration.
- From Drummond to Alpha (chainage 388km- 422 km), higher running speeds are mostly achievable. The horizontal alignment is suitable for a line speed of 70-80 km/h, with the exception of three curves between 391km - 393 km (radii of 301.8 m and 402.3 m). Following this, there are a number of long straights and broad radius curves. The existing running speed is 70 km/h, which is the current maximum for the line, with the exception of the mentioned curves, where it dips to 50-60 km/h.

3.4.2 Vertical alignment

The vertical alignment is the vertical profile of the railway and particularly concerns the steepness of slopes with respect to the heaviness of the trains climbing those slopes, and how much the speed may be reduced depending on the amount of locomotive power on the trains. Also, the gradients (slopes) must not be so steep that a stopped train cannot start to move on the gradient. Generally, the tracks in Queensland have been designed to a 2% maximum gradient with trains and locomotives set up to cope with those 2% gradients. For the route west of Emerald, there are some gradients that are above 2%, and even reaching 3%. But usually the lengths of such steep gradients are quite short relative to the length of a train, and so have only a partial effect on a whole train. The average length of gradients steeper than 2.5% is less than 200 m whereas trains would be expected to be longer than 500 m

A summary of the existing vertical alignment is provided in **Table 4**, with a visual breakdown presented in **Figure** 6. This provides an overview of the vertical grades currently present throughout the track section, and their level of prevalence.

Table 4 Summary of existing track grades

Grade	Length (km)	Percentage of total length
> 2%	8.6	4.9%
1 to 2%	43.9	25.2%
0 to 1%	28.3	16.2%
0%	30.7	17.6%
0 to -1%	22.1	12.7%
-1% to -2%	40.2	23.0%
< -2%	0.8	0.5%

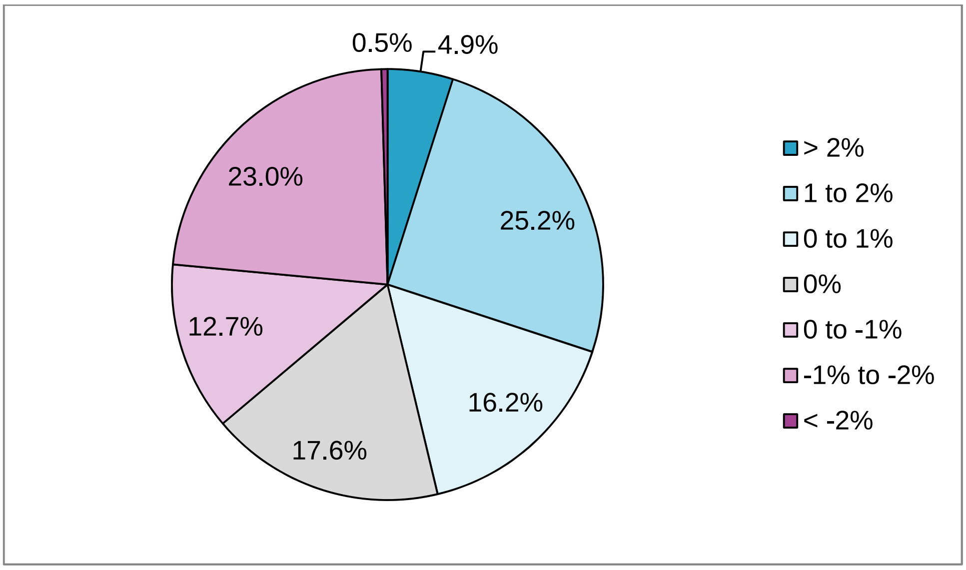


Figure 6 Distribution of existing track grades

To review the physical location of track sections steeper than 2%, the vertical alignment was plotted with these locations highlighted, as can be seen in **Figure 7**. The height information was calculated from the grades, and should be treated as indicative only.

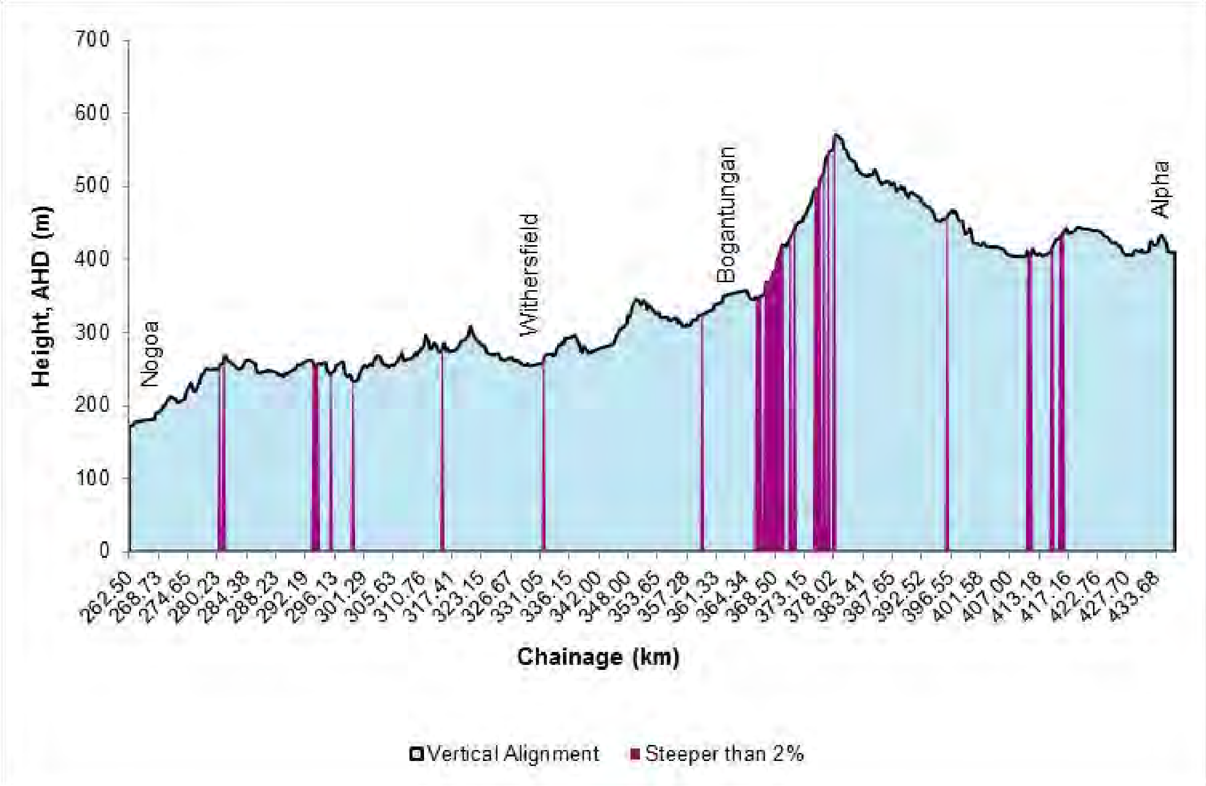


Figure 7 **Existing vertical alignment and location of grades steeper than 2%**

This visualisation can be read with reference to **Figure 8** which compares the existing vertical grades with a desirable grade of 2%.

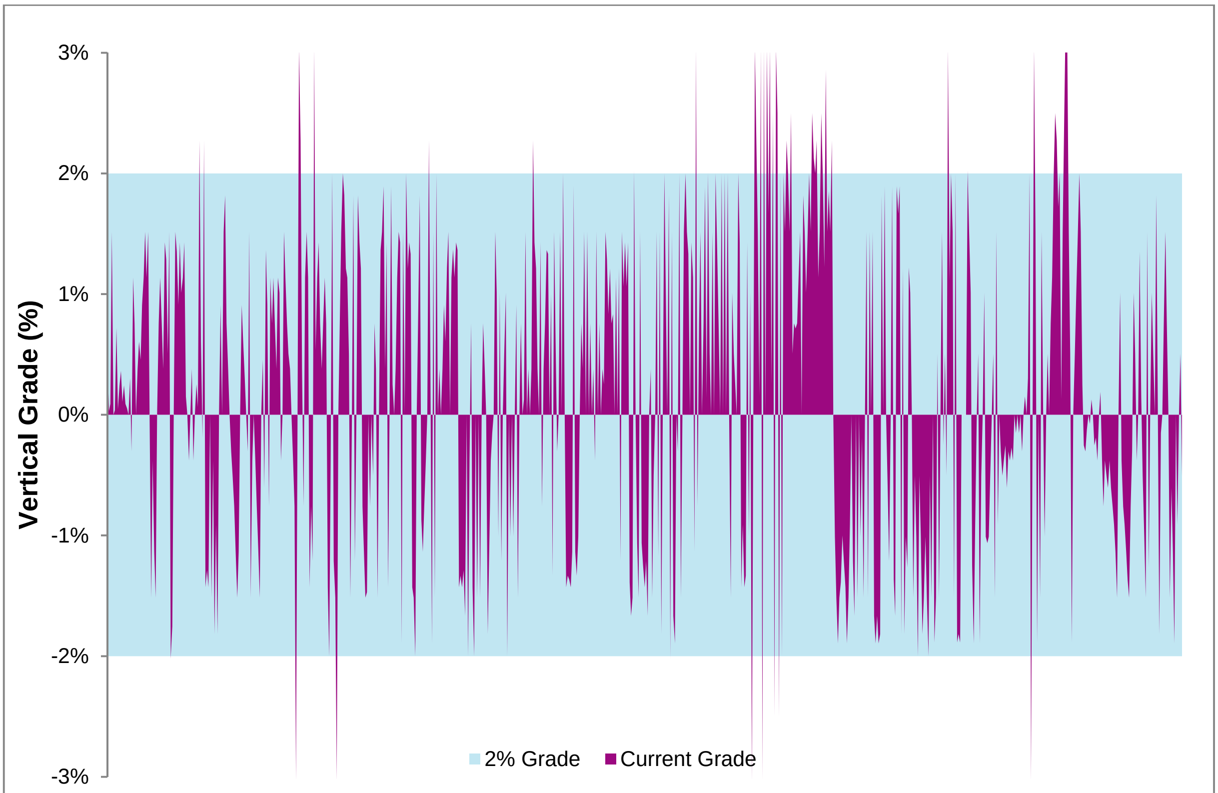


Figure 8 **Comparison of existing grades and 2% (desirable) grade**

A number of conclusions can be drawn from this data:

- From 262-360 km, from Nogoa to east of Bogantungan, there are number of grades steeper than 2%. These are generally isolated, and of short duration (maximum length 440 m, average length 215 m, total length 2.15 km). The maximum existing grade is 3.03 % (1 in 33).
- From 366-379 km, from Bogantungan to Hannam's Gap, the alignment climbs a steep range. As a result, there are a large number steep grades present. This amounts to a total length of 5.55 km with grades of greater than 2%. The maximum existing grade is 3.03 % (1 in 33). This section coincides with a large number of small radius curves, which is expected to compound the issue.
- From 411-416 km, west of Pine Hill and east of Mamboo, there are a number of short steep grades used. This is for a total length of 1.120 km (average length 160 m). The maximum existing grade is 3.33% (1 in 30).

3.5 Passing loops

There are a number of existing passing loops in this section of corridor, as summarised in **Table 5**. Generally, a maximum vertical track grade of 1:200 is adopted for new passing loops. This is for operational and safety reasons (e.g. it facilitates locomotives stopping/starting, and allows drivers to leave a stationary locomotive).

Table 5 Passing Loops (Emerald to Alpha)

Passing Loop	Chainage (km)		Clear Length (m)	Switch/Points	Alignment at Current Standard?
	Toe of Switch (East)	Toe of Switch (West)			
Toroborah	286.648	287.348	544	Trailable points (right hand running)	No. Steeper grades than 1:200.
Anakie	307.838	308.477	508	Trailable points (right hand running)	Yes (level).
Withersfield	327.140	327.586	314	NR (set for mainline)	No. Grades steeper than 1:200.
Willows	339.999	340.458	352	NR (set for mainline)	Yes (level).
Bogantungan	365.434	366.030	521	Trailable points (set for mainline)	No. Grades steeper than 1:200.
Drummond	386.770	387.549	638	Trailable points (right hand running)	No. Grades steeper than 1:200.
Pine Hill	405.050	405.439	280	NR (set for mainline)	Primarily. Largely on 1:300 grade, but 1:165 at TOS.
Mamboo	419.216	419.892	537	Trailable points (right hand running)	Yes (1:792).

An example passing loop arrangement in plan is shown in the following **Figure 9**

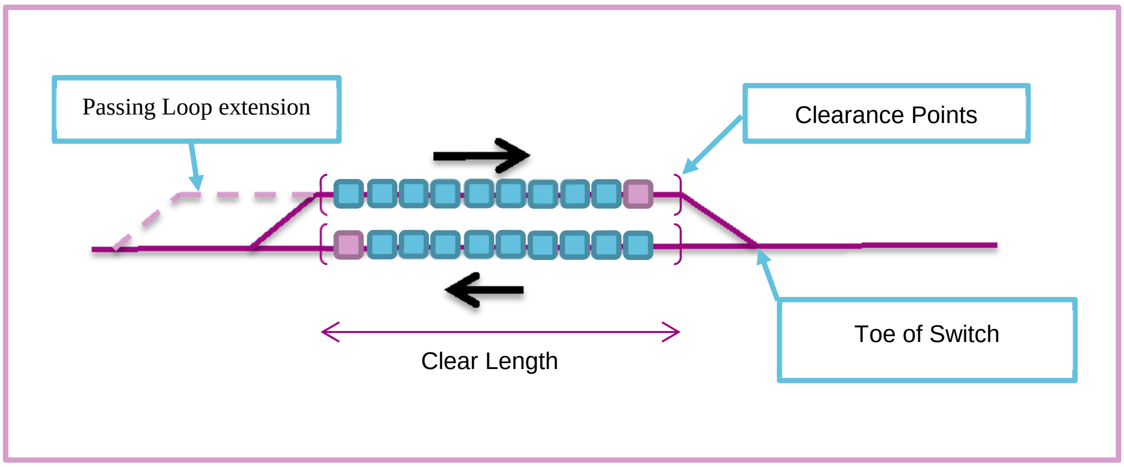


Figure 9 **Example Passing Loop**

A high level review of the passing loops, and the surrounding constraints, is summarised below:

- Toroborah:
  - Single passing loop, south of the mainline.
  - Existing speed boards: 25 km/h.
  - The current vertical alignment is unsuitable for an extension of the existing passing loop. There are a number of short steep grades both to the east and west (1:110, 1:66). There are also frequent vertical curves, which affect where a turnout can be placed. (Note that turnouts, in particular the switch length, must not have a vertical curve because the switch rails slide from side to side without rail fastenings, and so must always be laid flat without bending up or down.)
- Anakie:
  - Passing loop plus siding (livestock), north of the mainline.
  - Existing speed boards: 25 km/h.
  - The existing passing loop is located on a level grade, but there are short steep grades both east and west of this (1:70, 1:52.8). This would make a passing loop extension on the existing vertical alignment unsuitable.
  - There are public and occupation crossings in the immediate vicinity, including Anakie-Springsure Road.
- Withersfield:
  - Single passing loop, north of the mainline
  - Existing speed boards: 25 km/h.
  - The existing vertical alignment contains steep grades (1:50, 1:99) which are unsuitable for a passing loop. There are numerous steep short grades in this area and frequent vertical curves, making any extensions problematic.
  - There is a level crossing immediately to the west of the existing toe of switch.
- Willows:
  - Passing loop, north of the mainline, and a siding, south of the mainline.
  - Existing speed boards: 40 km/h.
  - The existing passing loop is located on a level grade. The adjacent grades are steeper than desirable for a passing loop extension (1:99, 1:132).

- There is a level crossing immediately to the east, and a drainage crossing (originally a bridge, replaced with culverts) to the west.

- Bogantungan:
    - Two passing loops, to the north and south, and a turning angle.
    - The existing alignment is unsuitable for an extension, with numerous vertical curves and steep grades (1:33, 1:99).
    - There is an occupation level crossing to the east, and a bridge (Grass Tree Creek) to the west.
- Drummond:
    - Single passing loop, north of the mainline.
    - The passing loop is located on a bridge.
    - There are a number tight radius curves on and near the passing loop (201 m radii).
    - While much of the passing loop is on a level grade, the existing vertical alignment in unsuitable for an extension, with steep grades adjacent (1:82.5, 1:52.8).
    - There is an occupation crossing immediately to the west of the passing loop.
- Pine Hill:
    - Single passing loop, south of the mainline.
    - The east approach is located on a 1:165 grade. The west approach, and much of the passing loop, is located on a 1:330 grade, which appears suitable for a passing loop extension.
    - There is an occupation level crossing to the west.
- Mamboo:
    - Single passing loop, north of the mainline.
    - The passing loop is located on a long section of straight track.
    - The existing vertical alignment appears suitable for an extension, with flat grades (1:797, 1:1320).

There is also a redundant private siding at Glendarriwill (Grainco), a siding at Hannam's Gap, and a turning angle between Pine Hill and Drummond.

4.0 Indicative high level cost estimates

A high level costing exercise was undertaken to demonstrate the indicative cost of upgrading the railway, between Nogoa and Alpha, from 15.75 tal to 20 tal.

The following assumptions have been applied:

- Only track structure and bridge structure costs were considered. These are considered the major cost items.
- It has been assumed that all bridges will require replacement.
- Standard costs were used throughout. These are indicative only.
- In reference to **Figure 10** the "High" accumulated upgrade cost assumes:
  - Full removal and replacement of the track structure (rail, clips/fastenings, insulators, pads, sleepers) and an allowance for testing and commissioning.
  - Removal of bridge structures, and replacement with new bridges.
- In reference to **Figure 10** the "Low" accumulated upgrade cost assumes:
  - Removal and replacement of the rail, fastenings, insulators, and pads, but not the sleepers.
  - Removal of bridge structures, and replacement with culverts only.

The following exclusions should be noted:

- No upgrades to the subgrade, or any other earthworks, have been considered.
- No upgrades to existing culverts have been considered.
- No upgrades to the track drainage have been considered.
- No track easing, deviations, or other track changes have been considered.
- No upgrades to occupation crossings have been considered.
- Passing loops have not been considered.
- The costing does **not** include:
  - main contractor's overhead and margin
  - necessary temporary works
  - associated signalling and telecommunication costs
  - design
  - clients costs
  - contingency
  - escalation
  - GST

This cost is provided for indicative purposes only. It is used to illustrate the increasing accumulative cost as the extents of upgrade move further west.

The outcomes of this high level costing exercise can be seen in **Figure 10**.

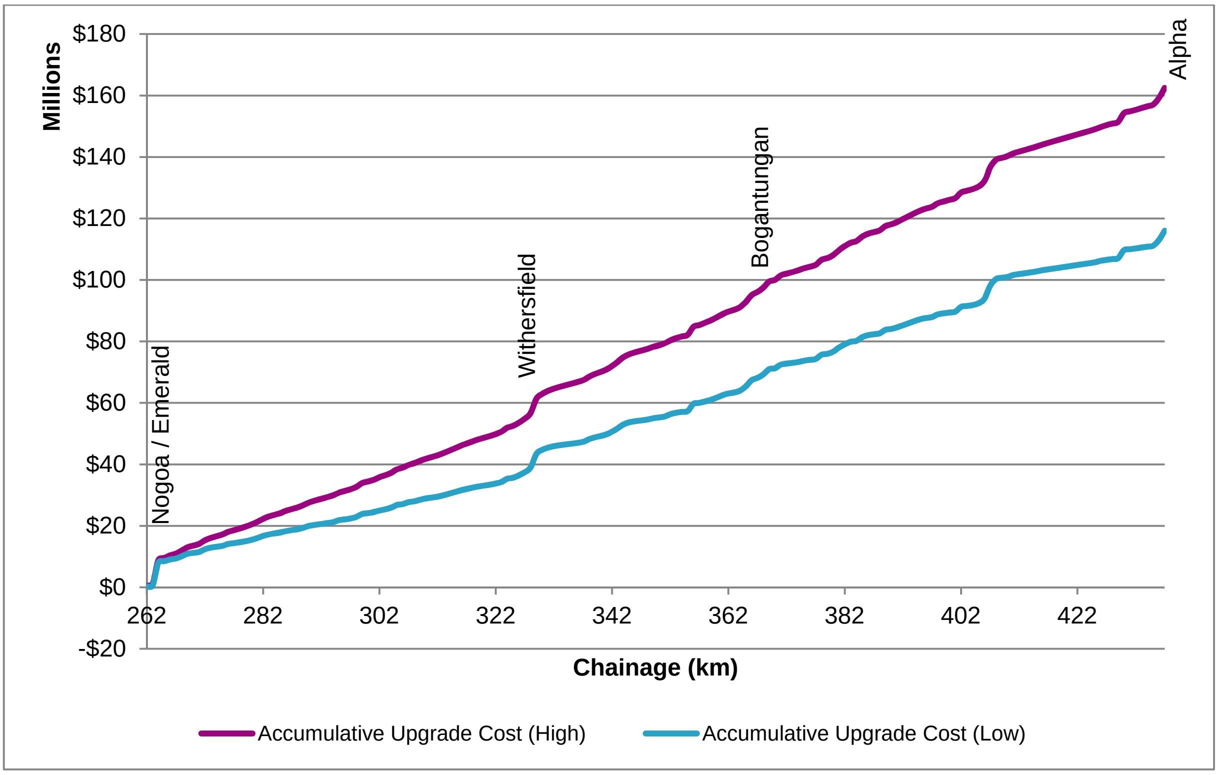


Figure 10 **Accumulative cost to upgrade track and structures (Nogoa to Alpha)**

This illustrates that the cost to upgrade the Central West system will progressively increase as the extents move further west. These costs are generally steady, with stepped increases in areas with multiple and/or large bridge structures. **Figure 11** shows the indicative cost on a per kilometre basis. This illustrates the influence of bridge structures on the cost, and the variability of this across the railway.

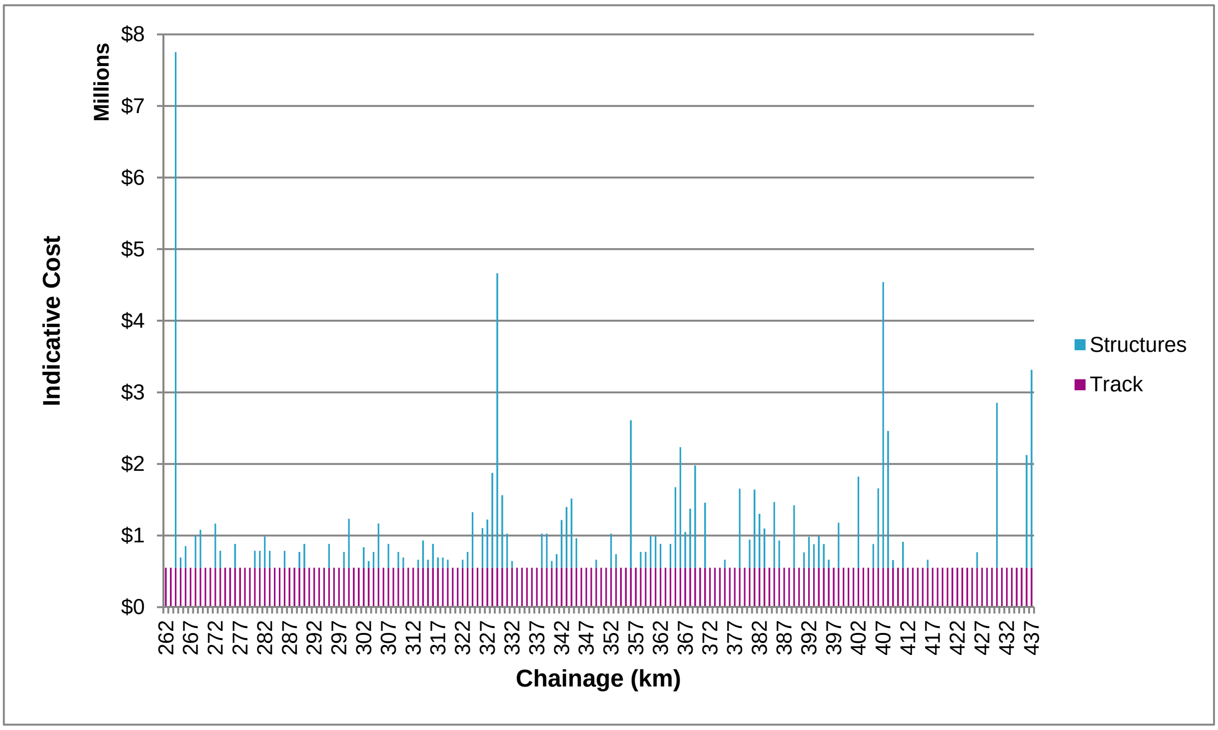


Figure 11 **Cost per kilometre, track and structures (Nogoa to Alpha)**

5.0 Upgrading track from 15.75 tal to 20 tal

5.1 Existing track condition

5.1.1 General and jointed/CWR status

Relative to the image of a “Class-A” track, the existing track can only be described as significantly low grade, even with respect to existing 15.75 tal traffic. Irrespective of rail size, the track is jointed at what appears to be a very old standard of 24 ft (approx. 7.3 m) rail lengths , and is held on timber sleepers with single spikes per side of the rail. In light of the very frequent joint spacing, this arrangement requires considerable manual maintenance. There are no signs of any raised spikes, not even where commonly found at the joints. (See below **Section 5.1.4** regarding track running quality and safety issues.)

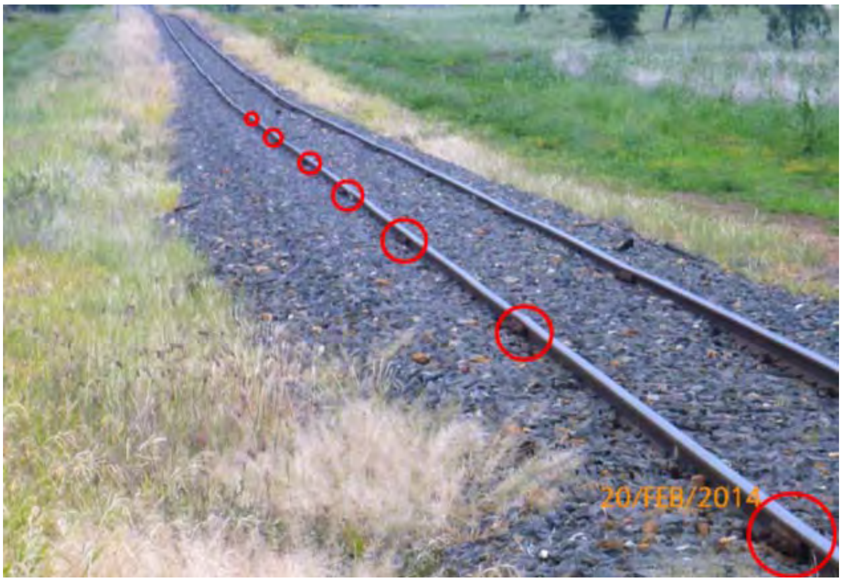


Figure 12 Very short rail lengths between fish-plated joints. 24ft (7.3m)

There are definitely some 6-hole fishplates on joints as seen near level crossings, but (not clearly discernable in the **Figure 13** photo) it is suspected that there are also a predominance of 4-hole baseplates which was the original standard for the 60 lb/yard (30 kg/m) rail. The very short rail lengths and the short fishplates at joints in the existing will impinge on the other parameters of existing condition as illustrated in the **Figure 13** photo showing effects of jointing on longitudinal surface smoothness.

Figure 13 Poor longitudinal surface smoothness because of frequent rail joints

This situation means that there will be little point in considering the common approach to reducing maintenance and improving running performance by welding joints into either Long Welded Rail (LWR) or preferably into full Continuous Welded Rail (CWR). On site rail welding, even with minimal cropping of poor rail ends and utilizing mobile flash-butt welding, would likely be more expensive than replacing with longer rails and then welding to CWR. To remove the maintenance work load that the current track structure must be incurring, the immediate thought (discussed below) is to re-rail.

Note that even re-railing with second-hand (longer length and larger size) rails from elsewhere would be an immediate benefit. Second-hand larger section rail might further reduce the Low Cost Upgrade in **Figure 10**, but would depend on availability and might only be possible on a small proportion of the overall 174 km length.

5.1.2 Rail size status

The rail size is the key part of the rail structure affecting the ability to raise the loading capacity from 15.75 tal to 20 tal. The Information Pack for the Emerald to Jericho section has rail section sizes recorded as: 2% at 20 kg/m; 84% at 30 kg/m; 11% at 41 kg/m and 3% at 53 kg/m. In terms of axle loading, an old rule of thumb for slow speeds would produce axle loads for these rails of the order of:-

- 20 kg/m rail giving 9tal (2 % of route)
- 30 kg/m rail giving 13tal (84 % of route)
- 41 kg/m rail giving 17tal (11 % of route)
- 53 kg/m rail giving 22tal (3 % of route)

Alternatively, using the Table 2.1 in Queensland Rail's CETS Section 2.3.2 produces:-

- 20 kg/m rail giving <=11tal (at 60 km/h) (2 % of route)
- 30 kg/m rail giving 12.2~16tal (84 % of route)
- 41 kg/m rail giving 12.2~16tal (11 % of route)
- 53 kg/m rail giving 20~26tal (3 % of route)

Although the old rule of thumb is probably less valid for larger axle loads and rail section sizes, the two sets of values are sufficiently close to confirm that the CETS values are a reasonable basis for assessing capabilities and are not overly conservative.

This means that for 20 tal axle load traffic, 97 % of the route section will need to be at least re-railed to a larger rail section,

Relating such re-railing to existing wear conditions and remaining rail life, measurements are not available but comparing a design rail section to photographs in **Figure 14**, it does appear that there is an appreciable degree of rail head wear, visually between 5 mm and 10 mm "Table Wear" on the top surface.

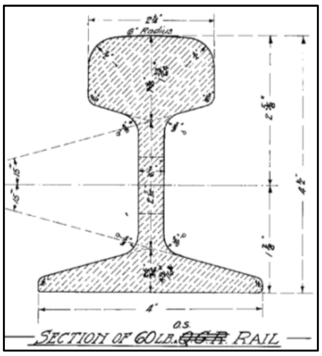


Figure 14 Visually comparing new and existing rail head depths for wear

According to Queensland Rail's CETS-2 Appendix-F, table wears of 5 mm and 10 mm on 30 kg/m rail represent 21 % and 38 % of head wear respectively. Referring then to CETS 2.12.2 and its Table 2.12, a 10 mm table wear would indicate that the wear has reached its full limit of 38% maximum, even on straight track. Thus, if the general table wears are between 5 mm and 10 mm (and closer to the latter), then even for the existing 15.75 tal traffic, the existing rails are approaching their usable life and re-railing activities will be due for scheduling.

Therefore regarding the existing 15.75 tal traffic and the proposed 20 tal traffic, it can be said that:-

a) 86% of the route (with 30 kg rail and less) is only marginally adequate for 15.75tal traffic at 80km/h

b) For the proposed 20 tal traffic:-

- Could possibly run on the existing rails, but a speed much reduced below the 70 km/h stated in the Information Pack data sheet for this section of the Central West System. Such a speed will need to be determined relative to other aspects of track condition, but not likely to be greater than 40 km/h and could be as low as “yard track” 25 km/h if approvals procedures dictate. (Note that such axle loads on 30 kg/m rail are not permitted in the CETS-2 document except at yard speeds of 25km/h.)
- Up-grading for speeds of 70 to 80 km/h would require 50 kg/m rail as a minimum. But if re-railing with new manufactured procurement, availability and common production would probably mean that 60 kg/m would likely be the most practical and economic size to procure.

5.1.3 Fastening arrangement status (and rail inclination/rail cant)

Modern rail tracks have elastic rail fastenings and if timber sleepers the rail is held to gauge with steel baseplates. The existing tracks are extremely basic arrangements as illustrated in **Figure 15** as:-

- rail fastened using only dog-spikes or screw-spikes
- no rail baseplates
- rail installed vertical with no rail inclination to match wheel profiles.

Figure 15 Simple fastenings with dog-spikes (left) and screw-spikes (right)

If the existing rails are replaced with larger sized rails on the existing timber sleepers, then such works will need to consider the following points:-

a) CWR and even LWR may require the addition of rail baseplates with elastic fastenings. Also some increasing of lateral stability against thermal effects.

b) If larger sized rail installed directly on the existing sleepers, then:-

- old rail seatings will need machined adzing to a level seating
- would be preferable to use some form of elastic fastening screw-spike

c) This is dependent on the condition of the existing sleepers. A quite high proportion of sleeper renewals should be anticipated, either using new timber sleepers, or using serviceable sleepers recovered from other portions of work on the route.

5.1.4 Running quality condition status

For this old form of track structure, short rail jointed rails with a mixture of screw-spikes and dog-spikes to timber sleepers, the usual critical parameters are "track twist" and "wide gauge" because these influence safety as well as smoothness of ride. The track appears to be in good geometrical condition relative to track gauge and possibly twist, but the longitudinal surface smoothness is not at all good because of the fish-plated short (24 ft) rails. It is assumed that the use of 1-in-4 steel sleepers is a measure introduced to gain control of track gauge because of unreliability of (single) direct spikes onto timber sleepers (with no baseplates).

Generally, if track twist values are poor and tending to higher risks for derailments, then this would be easily remedied by track tamping. However in this case, it is likely that the dipped rail ends have become partially set in the rail shape. This would mean that tamping could remove the safety issue from the twist parameter, but would be unlikely to fully correct without rail end-straightening by hydraulic rail end straighteners; in which case it would be probable that re-railing would be the cheaper option.

Joints are approximately square (not greatly staggered) which will partially help to limit twist, but the very poor top and likelihood of voids at joints means that track twist could quickly develop unless the route is tamped frequently. The very poor longitudinal surface condition (lack of smoothness) will be tending to increase resistance and increase the fuel consumption for traffic on the line in these conditions.

Figure 16 Illustrations of longitudinal surface condition

5.1.5 Formation and ballast condition status

Although the underlying ground conditions in the area (black soils) are not good, and the formation condition cannot be properly assessed visually, there are no immediate signs of problems such as pumping or washing joints or highly contaminated ballast. However, that can be a reflection of the very low traffic frequency rather than of the basic condition.

It is possible that the existing formation and ballast conditions can be taken as adequate provided that not imposing very high frequencies of train traffic. However, for portions of the track which are decided to be fully renewed with concrete sleepers, then those lengths should consider ballast cleaning and formation treatment.

5.2 Strategies and opportunities for upgrading track to 20 tal

5.2.1 Starting point(s)

In strict terms of track material standards, the existing 24 ft jointed 60 lb rail on timber sleepers is only marginally acceptable for the current 15.75 tal at 80 km/h. In terms of materials standards, it is not appropriate (nor permitted by Queensland Rail standards) to carry 20 tal traffic and is probably at or approaching its limit of working life even under the existing 15.75 tal traffic (albeit quite infrequent existing traffic). The proximity of the track to the end of its working life will vary along the length of the 174 km long section and would strictly be measured as Million Gross Tonnes life remaining. However, if the longest life remaining is taken (for example) as 15-years, then that would be an annual relaying of about 15 track-km per year.

Since the existing track structure form is not able nor permitted by Queensland Rail standards to be up-graded to 20 tal capacity with existing materials, the first 20 tal traffic would incur a very significant prior investment cost of either full track renewal with modern track materials, or at least full re-railing with a larger rail. The re-railing with larger rail option may not be able to achieve a satisfactory result without the additional of new rail seating and fastening arrangements also being added as described in **Section 5.1.3**. To tackle this issue of very significant prior investment cost, some strategies for spreading and/or reducing these costs need to be investigated, such as:-

a) An initial period where intermodal/container wagon loadings are limited to 15 tal. This should not be limiting the use of container traffic, but rather a matter of limiting the distribution of containers on the train wagons. It may be less capacity in terms of per metre of train length, but might not affect the number of trains overall. This needs to consider the whole route of such trains, not just this 174 km long section, but increases of costs per train might be of a different magnitude to the scale of track upgrading costs.

b) Opportunities to reduce costs of track maintenance should be targeted as a means of offsetting the initial up-grading costs. This should not necessarily mean increasing the initial upgrading costs, but rather taking into account the fact that renewing the existing on a like-for-like basis (jointed rails on timber sleepers) is likely to be more expensive than using materials, methods and equipment that are in common use in the current market. For example: timber sleepers with baseplates may be more expensive than concrete sleepers; and drilling and installing fish-plated joints may be more expensive than flash-butt welding of rails.

c) Other opportunities to reduce costs and/or increase benefits. Two examples identified and described below are:-

    - Renewing (track and structures) adjacent to existing and retaining existing to produce double track route capacity
    - Altering track structure mechanism to reduce bending load and fatigue on existing rails to enable 20 tal on existing 30 kg/m rails

The latter two opportunities are outlined below.

5.2.2 Renewing (track and structures) adjacent to existing to form double track route/sections

Renewals of existing single track lines have to be performed with rapid progress so that the line is not blocked to traffic for very long periods. This means that such full track renewals are performed using highly sophisticated track relaying machines and ballast cleaners, all fed by trains of rails, sleepers and ballast to enable the fast progress. Thus, although extremely effective, the method involves high costs and organisation demands on equipment availability and reliability. Note that ballast cleaning and formation treatment is most likely to be added to track relaying because necessary to sustain the use of concrete sleepers.

Figure 17 Current corridor width available, and follows ground profile

As shown in **Figure 17**, the current route largely follows the general ground profile with no cuttings or embankments, and has no constraints against installing a track alongside. If a new track and formation is constructed alongside, then it is possible that cost savings and efficiencies might occur as follows:

a) Existing track not closed during construction, and can be used to assist construction

b) No dismantling and removal costs of the existing track

c) New track formation (for concrete sleepered track) can be created with general civil plant and does not require ballast cleaning machines and trains for spent ballast.

d) New track can be installed without tight time constraints and main installation work can be performed using more commonly available general civil equipment. Although still requiring track tamping machine equipment, that equipment does not need to be of the expensive high performance types and smaller equipment can be more than adequate because not having to work to short occupation times.

e) After installation of the new track, the existing track remains and:

- can be kept available for double track running (helping towards an "on-demand" availability of the railway which is a major road transport benefit)
- can be used to enable maintenance based on rail mounted maintenance inspections and servicing
- can be used by empty return trains if traffic loading is largely directional
- could be upgraded progressively over an extended period of time

Overall, the opportunity is to result in two tracks available, one at full loading and speed capacity, at a cost less than single track renewal and without closure of the route during the construction work. This technique of producing double track route would increase the accessibility of the route for any train services, freight and passenger.

5.2.3 Changing mechanism of track structure to continue 30 kg/m rails with 20 tal

Queensland Rail standards preclude the use of 20 tal traffic on 30 kg/m rail track. This means that the only path to keeping the existing track materials (as much as possible), whilst enabling higher axle load traffic, will be to make some addition to alter the way that the track structure works in carrying and distributing the loads.

Track design is based on the theory of an (infinitely) long beam on a continuous elastic support. In the existing common ballasted track case, the rails are the long beam on an elastic support of earth and ballast. In effect, as illustrated in **Figure 18**. the rail beam spreads/distributes the wheel load longitudinally over several sleepers. In its life, the rail will be bending for millions of axles and has to have a certain strength so that the stresses do not lead to yielding but mostly so that stresses remain inside a bending fatigue limit. Hence the reason for 20 tal loadings requiring a larger rail section than the existing 60 lb/yard (30 kg/m) rail.

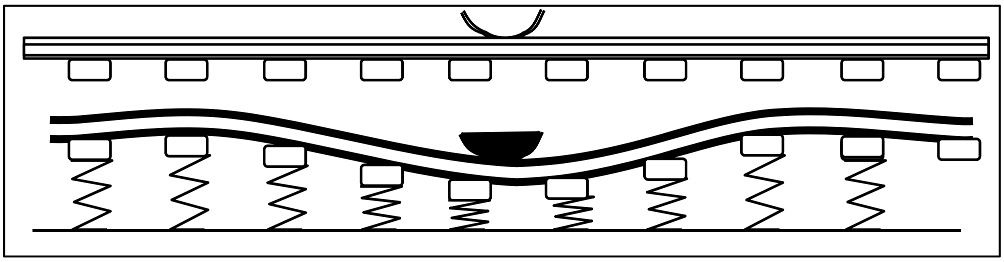


Figure 18 Existing track structure mechanism with rails as main beam

The basis of the alternative concept discussed here is to try to relieve these bending loads on the 30 kg/m rail by adding an additional/alternative beam effect into the existing track structure. The concept being that, although the existing rail is still carrying and guiding the axles, the additional bending imposed by higher axle loads (and more) is carried by the additional beam in the structure. Ideally for effectiveness, and to not require alteration to existing regular maintenance equipment such as tampers, the ideal position would be under the sleepers under the rails as shown in **Figure 19**. Depending on the fixing methods, such an arrangement could combine with the existing rail to produce a very significant increase in moment of inertia (I_{xx}) and has the additional benefit of providing significant extra lateral resistance against thermal distortion of the track. Preferably, keeping the ballast support at the bottom of sleeper as on the right in **Figure 19**. But this underneath position is not easy to add to existing.

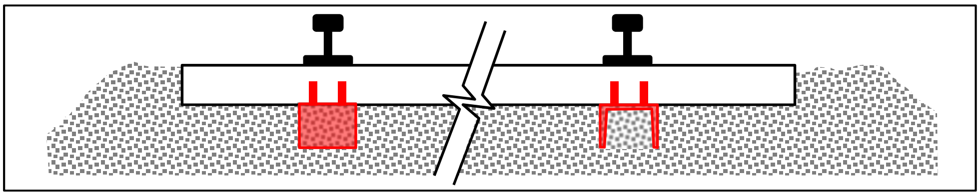


Figure 19 Ideal supplementary bean under sleeper under rails

Some alternative positions might be as illustrated below in **Figure 20**, bearing in mind that, prior to fixing, the additional “beams” must bend sufficiently like normal rails so that they can be fitted to horizontally and vertically curved track.

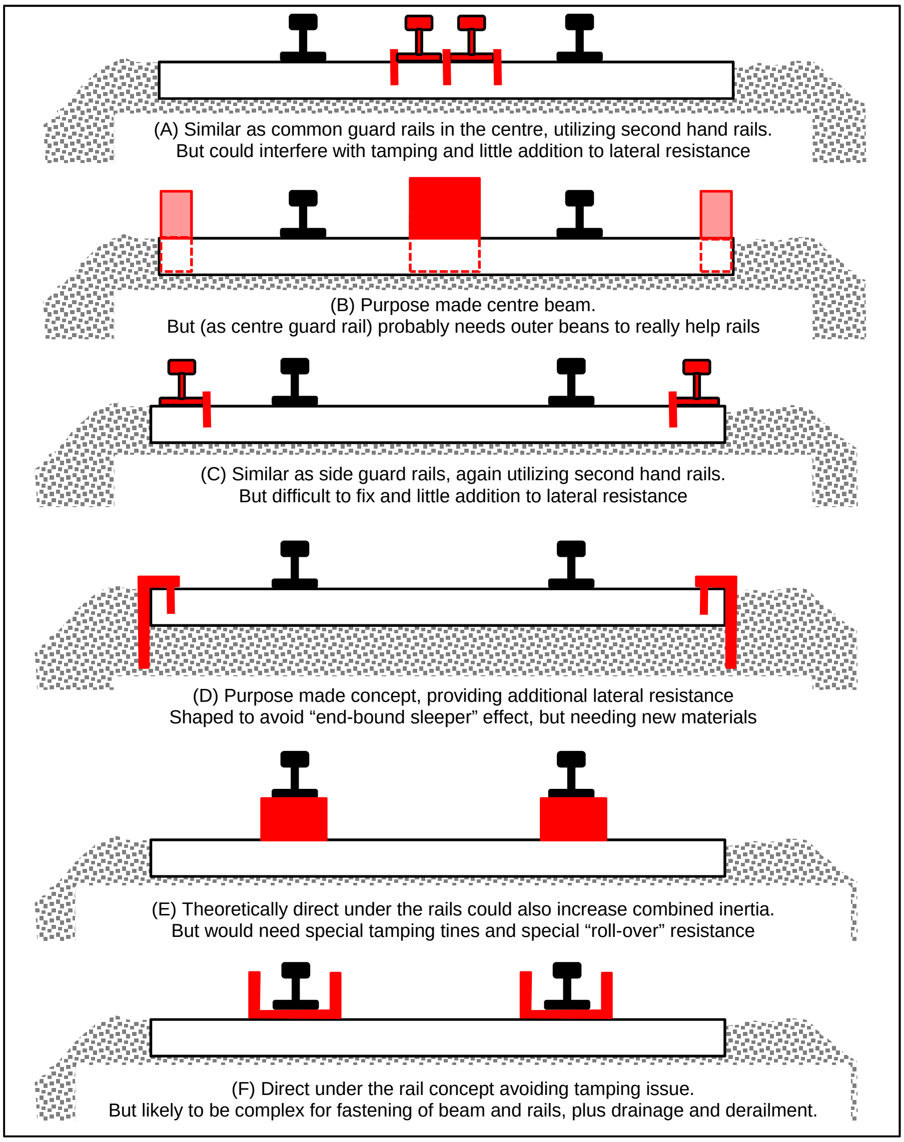


Figure 20 Alternatives for supplementary beam positions and arrangements

This is a very early stage of concept needing much more evaluation and development. Several points come to immediate attention such as the following:

- What is the increase in bending relative to bending fatigue stress limits created by the increased axle load?
- How much bending relief can be achieved on the running rails?
- What beam to sleeper fixing is needed for beam to be effecting from the running rail load?

This concept will not be competing with cases where the work involves simple re-railing to a larger rail, but can have supplementary benefits from its increased load spreading such as:

- reduced tamping frequency, and
- reduced risk of point soft spots developing in formation, and existing point soft spots less critical

6.0 Conclusions

The main points arising are,:

1) The track and structures are approaching the end of their working life (prior to renewal). With very infrequent traffic, the MGT based remaining working asset life might amount to a decade or more as years remaining, but at the high cost of maintenance attention.

2) The existing route needs extensive work before it can carry 20 tal traffic. By Queensland Rail standards, 97% of the route should not have axle loads increased above 15.75 tal with the existing rail size. And even the 15.75 tal loading is only marginally acceptable on 30kg/m rail because it is existing. New rails would need to be a larger rail section even if keeping the 15.75 tal loading. Commonly available track materials and methods (such as concrete sleepers and welding) are likely to be cheaper than direct like-for-like renewals (such as timber sleepers and fish-plated joints). So, renewals will tend to result in a natural upgrading of the track and its loading capacity, as well as reduced maintenance attention.

3) Item (2) above means that upgrading costs might not be offset by spending renewal costs, but with Item (1), there should be savings compared to existing maintenance costs.

4) The orders of route upgrading costs as in **Figure 10**, indicate that accepting lower train efficiency with containers spread to retain 15.75 tal infrastructure loading should be considered. But noting that such acceptance will depend on whole train trip parameters, not just this section of route.

5) The low cost upgrade, assumed to simply re-rail with larger rail section, could be very sensitive to supplementary issues such as: rail fastening and seating; limits on CWR with timber sleepers; and distribution of sleepers needing replacement

6) Some alternative concepts for increasing life and capacity of the existing track structure are identified in an effort to minimise initial costs, but are very unconventional and need further investigation.

Appendix B

Rail freight modelling

Appendix B Rail freight modelling

B.1 Network capacity optimisation

In the course of the study it became apparent that capacity strains on the network would not eventuate given the generally low estimated volumes of rail's share of freight (as discussed in **Section 0**), and the relatively low number of trains possibly required moving it. For example 2 trains per day could support 0.73 mpta in the dominant direction based on 1000 tonnes payload each train. This is considerably in excess of current rail volumes. The Central West line and Blackwater system currently service regionally destined train frequencies on average just over 1 train per day in the peak season. The Central West line has considerably underutilised latent train path capacity to support any growth. Also according to Aurizon's 2013 Network Development Plan[43] the Blackwater line also has uncommitted track capacity of 20-30mtpa on its most constrained sections which is considerably in excess of estimated growth requirements. Therefore network capacity optimisation has not been considered for the non "A class" rail infrastructure under investigation.

There are notable network capacity constraints identified on the North Coast Line between Rocklands and Gladstone Port that may in the long term impinge on reliably servicing the Central West rail corridor. Non-containerised freight flow movements along this section of the network are unlikely to change dramatically in the near term due to the existing Gladstone port facilities and related shipping arrangements. A shift towards a containerised logistics platform will enable alternative rail route options to export/import markets, such as via NCL to the north to Mackay to connect with potential Coastal shipping services linking to the Brisbane port, however it is not clear at this stage if these could be more economical alternatives compared with capacity enhancements of the North Coast Line.

B.2 Train operations optimisation

It is possible to optimise train sizes to provide more cost effective ways of transporting freight. For example, larger more efficient locomotives and wagons can be used on heavier track but this operating change is not possible on parts of the network constructed to lighter standards. Operations in areas west of Emerald can be made more efficient if the track is upgraded, probably at considerable cost.

With respect to optimising train sizes, there are several approaches however, given the available traffic task, maximum train sizes are not required. The alternative is to downwards optimise by configuring trains to the expected traffic task. In this instance there is insufficient work to keep a single train busy on a relatively frequent two day turnaround. Therefore the balance in optimising is between operating smaller but expensive trains which offer customers a daily or twice weekly service or once a week larger more efficient cheaper train which gives customers poor services in terms of frequency and flexibility Some trade-offs are involved in operating smaller, possibly technically less efficient trains than conventional maximum train size philosophy. For example, the smaller train may have higher variable costs (e.g. labour) which are offset by avoiding unnecessary fixed infrastructure upgrades or rolling stock capital to support slower cycle times. More rapid turnarounds of smaller trains will result in higher wagon and terminal productivity and better service to customers. However in the context of the larger containerised supply chain including road and ship movements, this arguably less efficient smaller train operation could imping on the other mode efficiencies and competitiveness. General freight rail services currently run on the Central West line about once a week. The most efficient method of moving large volumes of freight by rail is based on:

- Single point origin to destination trains
- Single commodity
- Standardised wagons to ease handling costs and ensure seamless equipment interchangeability
- Fixed train configurations to ensure rapid turnarounds and minimising inter-cycle downtime

[43] http://www.aurizon.com.au/Downloads/Aurizon%20Network%20Development%20Plan%202013.pdf

- There is usually no backload and it is normally not worth disturbing an efficient cycle attempting to arrange a backload.
- The size of trains is based on optimising a combination of cycle time, payloads and tare mass, locomotive power, energy costs, size and placement of crossing loops, curves and grades, unit costs of labour, rolling stock capital, access charges or track costs, reliability etc.

This has been proven around the world in all heavy haul mineral operations. The same can be said of many other operations including intermodal container trains. However, in the case of containers, locational imbalance of container populations is generated unless backloads are arranged. There is no doubt this backloading hampers overall cycle time however the operation would grind to a halt without it.

B.3 Product segmentation

The focus of this report is firmly on intermodal container movements of the commodities discussed in **Section 4.0**:

- Fuel and Petroleum Products
- Cement and Flyash
- Agriculture – Broadacre Crops
- Other Agriculture
- Chemicals
- Quarry Materials
- Pastoral Products
- Store Goods and General Merchandise

While some commodities are moved in large quantities, arguably only fuel can command a whole trainload in their own right. Thus for many commodities general purpose trains have been modelled to comprise of a blend of products. From the train's perspective, basically double slot containers wagons (holding 2 x 6metre (TEUs) are used and it does not matter operationally what product is inside the container whether there is 15 tonnes of chemicals or 15 tonnes of furniture. Thus for the general purpose trains modelled an averaging process taking a blend of heavy/medium and light loaded containers plus some empty containers to balance container fleet numbers has been used.

It is assumed that the operation is based on balanced loads in the sense of containers (loaded and empty) forward is matched by the return leg. There will always be empty containers regardless of the operation because of load incompatibilities such as the extra requirements for handling "food grade" loads etc. For generic commodities general purpose trains comprising a mix of two thirds loaded and one third empty in each direction has been modelled to simulate a wide variety of piecemeal freight. For the fuel trains it is assumed operationally there is a full load out and a train full of empty containers returning.

For particular commodities e.g. grain, whole trainloads of loaded and empty returns have been simulated for a variety of destination ports (Gladstone and Brisbane). There are some capital and operating economies of scale associated with using triple slot container wagons instead of doubles. However there are several obstacles to more widespread usage of triples as follows:

- Although numerically TEUs vastly outnumber FEUs, the latter are growing as a proportion of the container fleet although it is highly unlikely they will ever outnumber the former.
- A FEU on a triple slotter represents a wasted slot except under exceptional circumstances. FEUs are generally light loaded (18 tonne per 6metres) compared to a TEU (say 24 tonne per 6 metres) so it would be difficult to find a compatible TEU which would not upset the balance of the wagon. The use of different container sizes on the same wagon presents problems for material handling when lifting frames etc. must be attached to or detached form container handling equipment like reach stackers.
- Apart from conveying empty containers, triple slotters have limited application on light (15.75 tonne axle load) track.

B.4 Operational scenarios

Just as the strength of a chain is defined by the strength of its weakest link, the same can be said for a rail operation. The following table summarises the present axle load compatibility situation.

	15.75 tonnes	18 tonnes	20 tonnes	26 tonnes
Brisbane - Gladstone	✓	✓	✓	
Gladstone – Rocklands	✓	✓	✓	✓
Rocklands - Rockhampton	✓	✓	✓	✓
Rockhampton - Burngrove	✓	✓	✓	✓
Burngrove – Nogoa	✓	✓	✓	
Nogoa – Emerald	✓			
Emerald - Alpha	✓			

Because of the significance of Alpha in the future development of the Galilee basin, trains have also been simulated for upgraded track scenarios allowing for upgrades to 18, 20 and 26 tonne axle loads. The significance of this is that larger higher productivity locomotives can be used. Depending on the mass of containers, the heavier axle mass may allow triple slot container wagons to be used in place of double slotters, although this typically only applies to lighter commodities.

A 63 tonne rated double slot container wagon can hold 2 TEUs each with a gross mass of 24 tonnes (15.75 tonne axle load). A 72 tonne or 80 tonne rated double slot wagon (although not used to full capacity) can equally perform the same task on 15.75 tonne axle load limited track – there is NO advantage in having heavier track in this case which also applies to the vast majority of commodities which are less than 24 tonnes gross mass per TEU.

The justification for heavier axle loads for low volume railways with generally light container loads is based on locomotive design, configuration and tractive effort. Indeed it is difficult to find existing locomotives compatible with 15.75t axle loads. Heavier mass allows larger more powerful locomotives to be used such that a 3000 hp locomotive can perform the work of two 1500 hp locomotives. Such are the economies of scale that there is obviously considerable maintenance cost savings. A very simple proof of this is 8 wheels and brakes to maintain not 16. One of the benefits of the simulation modelling is a gained an understanding of the sensitivities and relativities between the major variables.

Train configurations are based on a number of sources including Aurizon/QR load tables. Transit times are based on data contained within the Aurizon/QR Network Access Data Packages.

The consumption of resources e.g. fuel, is based on benchmarked rates for similar train/locomotive/wagon/and load combination collected over a long period of time based on rail operations in Queensland, NSW, Victoria, Tasmania, WA, NT, SA plus overseas work in NZ and South Africa.

Present day trains

The present day hypothetical trains modelled attempt to provide an approximation of current operational conditions. These trains bear little resemblance to the potential ones outlined below which feature much higher productivity and efficiency. With such heavy capital investments, rail is a sector acutely impacted by economies of scale and as the following results show, a large scale efficient rail operation can produce significant cost reductions for operators, customers and the community generally. It is expected that if the inland port is run as a cost centre and is responsible for generating business rather than merely handling one end of the logistics chain, there will be considerably more volume than at present. This translates to a more frequent, flexible and economic service than at present and can be expected to generate mode shift and because of the circularity of events, this will help reinforce a competitive low cost operation. At the moment there are only a couple of trains per week and these trains are of relatively small size. In fact such is the general freight market share loss on rail over the last twenty years that formerly several trains per day operated on the route.

Potential

Some sample train configurations are set out below in Section 8. As a starting point a combination of trains based on current equipment and infrastructure has been simulated along with potential upgrades. For example, west of Emerald, the axle load limit is 15.75 tonnes - there is no ability to handle 18 or 20 tonnes axle loads, but this situation has been simulated to give an understanding of the potential operating costs savings if the track is upgraded.

Train optimisation

This paper starts with the prospect of an inland port at one of three locations.

- Alpha (to serve the potential Galilee Basin expansion)
- Emerald East (nominally somewhere near Yamala, 20 km east of the Emerald city centre)
- Emerald West (nominally somewhere 10 km west of the Emerald city centre)

A separate infrastructure paper has been prepared, discussing the potential for the rail infrastructure to support the inland port and is provided in Error! Reference source not found.**Appendix A.** Emerald East already has 20 tonne axle load strength capacity rail infrastructure and therefore can support all but the heaviest locomotives and will support all double slot container wagons. It is questionable whether it can support triple slot container wagons which are potentially game changers for rail and offer considerable productivity improvements for particular traffics.

West of Emerald and Alpha are confined to 15.75 tonne axle loads and although this is suitable for most double slot container wagons, modern high efficiency 3000hp locomotives are too heavy. This imbalance may create an incompatibility between locomotives and wagons combinations leading to sub-optimal train configurations. The volumes of freight are generally too low to pay for the required upgrade even if a surcharge was levied. The other problem is that freight volume is too low to demand good service frequency e.g. daily based on normal operating practices. An alternative smaller train based on the Cargo Sprinter concept is worthy of consideration of however it is likely the high cost of train paths through the Blackwater coal network would make this unviable.

B.5 Model methodology

Introduction

For this work AECOM has taken the standard practice of developing a series of operational simulations and then applied costs to various steps in the logistics chain. The starting point was to define a series of train configurations based on 15.75, 18, 20 and 26 tonne axle loads.

The locomotive fleet was based on existing 1500hp locomotives, 2000 hp locomotives and 3000 hp locomotives. The hauling capacity of locomotives over different terrains was sourced form QR “supplement to the working Timetable” which sets out trailing loads for each class of locomotive. Where there are no matches a calculated guess has been made.

AECOM has developed a series of benchmarked train operating cost models based on actual rail practice in Queensland, NSW, Victoria, South Australia, Northern Territory, Western Australia, NZ and South Africa under a range of operational scenarios with similar and different equipment and commodities hauled.

The trains modelled represent a mix of actual and hypothetical train configurations. The purpose of this is to test what might be the effect for example, if the track form Emerald to Alpha was upgraded to a higher standard such as 20 tonne axle load.

Train scheduling and sectional running times have been sourced from QR Network Access Information Packs where possible and applied here. A nominal 4 hour turnaround at terminals has been allowed for all container trains regardless of size. The reason for this is that although larger trains require more container handling, at the busier terminals, extra gear will always be made available. No other assumptions have been made about the terminals or activities such as storage or double-handling, only the point to point terminal operation has been assessed.

Activity Based Costing (ABC)

The model is based around the methodology contained in the NFG2[44] Costing Convention. This provides an allocative mechanism for equitably apportioning joint costs on an individual basis. The main costs covered are:

a) Crew Costs

b) Fuel /Energy Costs

c) Locomotive Maintenance and Repairs

d) Carriage and Wagon Maintenance and Repairs

e) Shunting Costs

f) Passenger and Goods Handling and Clerical Costs

g) Track Maintenance

h) Electric Overhead Facilities Maintenance

i) Signalling and Communications Maintenance Costs

j) Signalling, Safe-working and Train Control Costs

k) Costs of renewable capital assets

l) Costs of non-renewable capital assets

m) Business Overheads

n) Corporate Overheads

Not all of these costs (e.g. those relating to passenger movements) are applied in this study.

Cost assumptions

Input cost assumptions are summarised as follows:

- Fuel price is $1.60 per litre. Fuel consumed per kilometre is derived from the number of locomotives per train and average consumption.
- Crew cost is $200.00 per train hour.
- Maintenance and servicing of locomotives is applied on the basis of train hours and number of locomotives at a rate of $18.00 per locomotive hour plus $1.50 per km.
- Wagon maintenance is calculated at 5 cents per wagon kilometre.
- Locomotive capital is set at $2.0 million per thousand horsepower depending on configuration.
- Container Wagon capital is $140,000 per wagon.
- Container transfer is $60.00 per TEU.
- Overheads are 30%.

[44] Railways of Australia (ROA), National Freight Group (NFG) 1990, *National Freight Group Costing Convention*.

Track infrastructure costs, variable and fixed maintenance and capital are excluded from the operating costs. These items are separately considered and based on the Aurizon tariffs[45] for the Blackwater system shown below.

Price Component		Unit	$
Incremental. Maintenance Charge	[AT1]	$ / '000gtk	0.86
Incremental Capital Charge	[AT2]	$ / rtp	2,019.37
All. Component 1	[AT3]	$ / '000ntk	4.36
All. Component 2	[AT4]	$ / nt	1.52
Electric Traction	[AT5]	$ / '000egtk	3.49
Electric Energy	[EC]	$ / '000egtk	0.86
QCA Levy		$ / nt	0.03416

B.6 Results and findings

There is very little difference in cost per tonne or TEU between Emerald East and Emerald West. Emerald East is slightly cheaper but this slight advantage might be eroded by longer and more costly road hauls to perform the PUD leg although this will vary on a case by case basis. Beyond Emerald, there are some minor cost savings associated with higher axle load scenarios mainly through the use of heavier more powerful locomotives.

There is comparatively little lightweight loading beyond Emerald so triple slot wagons have little application for the Alpha loads. The tabulated results are shown in **Section B.8**. They compare commodities being moved under a number of different operational scenarios, train configurations etc.

About 163 train configurations have been simulated on the basis of 104 round trips per year, (two per week); 156 round trips per year (three per week) and 208 round trips per year (four per week). Of course it may not be possible to perform 4 trips per week particularly for Gladstone - Alpha combinations, but the trains have been modelled to give a sense of the hypothetical cost outcomes. In part this is to test the cost sensitivity for the CAPEX component by working the assets harder, because in general terms the variable costs are similar on a train by train basis.

After sifting through all of this experimental data some selected movements have been summarised in **Table 28**. This table compares the current cost per TEU and per tonne for selected commodities and matches this against hypothetical estimate of costs under a revised operating regime based on higher volumes and higher productivity operations and equipment. As such this table assumes no infrastructure upgrades in the sense of axle load increases, extra or extended crossing loops etc. so it provides a direct comparison.

[45] http://www.aurizon.com.au/Downloads/Aurizon%20Network%20Reference%20Tariffs%2001072013%20to%2030062014.pdf Accessed 10/04/14

Table 28 **Comparison of selected movements**

Origin	Destination	Commodity	Cost/ TEU 104 trips	Cost/ Tonne 104 trips	Current Cost/TEU Round Trip	Current Round Trip $ Tonne	Min Saving per tonne	Min Saving %
Alpha	Gladstone	Grain	1,338	67	1,881	94	27	29%
Brisbane	Rockhampton	General	783	65	1,557	130	65	50%
Brisbane	Rockhampton	Mixture 2/3	1,239	83	1,884	126	43	34%
Emerald East	Gladstone	Grain	865	43	1,490	74	31	42%
Emerald East	Rockhampton	Cotton	650	30	1,054	48	18	38%
Emerald West	Gladstone	Grain	1,103	55	1,559	78	23	29%
Emerald West	Rockhampton	Cotton	810	37	1,108	50	14	27%
Gladstone	Alpha	Petrol	1,055	56	1,873	99	43	44%
Gladstone	Emerald East	Petrol	841	44	1,484	78	34	43%
Gladstone	Emerald West	Petrol	877	46	1,553	82	36	44%
Rockhampton	Alpha	General	794	66	1,354	113	47	41%
Rockhampton	Alpha	Mixture 2/3	1,215	81	1,265	84	3	4%
Rockhampton	Brisbane	Cotton	1,190	54	1,586	72	18	25%
Rockhampton	Emerald East	General	618	52	1,054	88	36	41%
Rockhampton	Emerald East	Mixture 2/3	680	45	1,232	82	37	45%
Rockhampton	Emerald West	General	647	54	1,107	92	38	42%
Rockhampton	Emerald West	Mixture 2/3	967	64	1,017	68	3	5%

Table 28 shows significant savings are possible. However there is a "chicken and egg" component to this analysis. Unless there is a very significant increase in freight, there will be no need to work the assets hard enough to achieve the productivity gains and cost reductions.

It is noted that even without infrastructure improvements, the use of more appropriate rollingstock can offer significant operational advantages. For example, the Gladstone to Emerald East track currently supports at least 20 tonne axle loads. The use of heavier and larger wagons can offer productivity gains. At present general freight uses double slot container wagons rated to 15.75 tonne axle load and uses "90 tonne" locomotives.

Train 22 Grain from Emerald East – to Gladstone has been modelled under the current operational scenario using 2 x 1500 hp locomotives and hauling 28 double slot containers. The round trip cost per container is $915 and the estimated itemised costs indicated from bottom up modelling are shown in **Figure 39**.

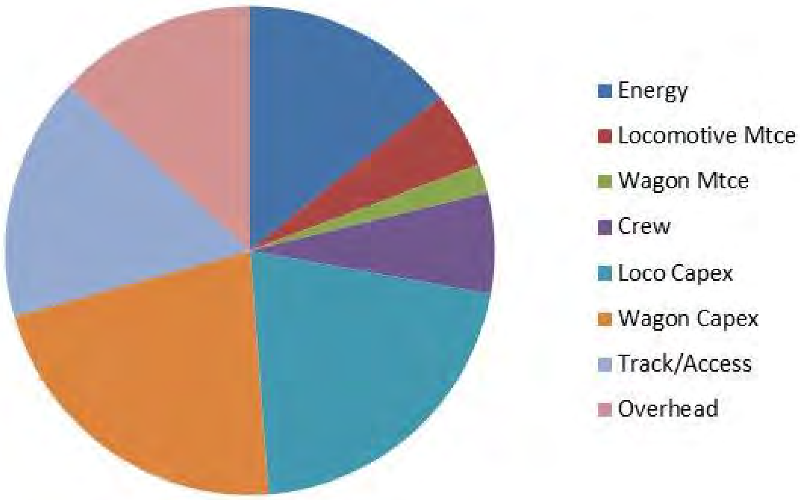


Figure 39 Train 22 grain from Emerald East to Gladstone estimated current cost distribution

Train 29 is a similar train but using triple slot container wagons and taking advantage of higher axle loads has a round trip container cost of $689 based on a two day cycle and 3 round trips per week. Individual cost elements are shown below in **Figure 40**. The direct comparison between the two operating regimes is shown in **Table 29**. In reality performance could be expected to be considerably better than that shown here because:

- Technological advances in locomotives provide:
  - A.C traction motors offer considerable additional hauling power than older style DC traction motors – therefore much higher payloads possible.
  - New locos are much more fuel efficient (30%-40%) better than 1970's style locos presently used.
- New wagons:
  - Lighter tare mass through higher tech materials
  - Experimental designs: articulated bogies and other innovation to improve efficiency, ride quality, tare mass etc.
- Signalling systems, reduced headway, better train pathing etc.

Table 29 Comparison of costs Emerald - Gladstone

	Train 22		Train 29	
	$ per tonne	%	$ per tonne	%
Energy	6.49	14%	5.69	17%
Locomotive Mtce	2.32	5%	1.97	6%
Wagon Mtce	0.87	2%	0.58	2%
Crew	3.06	7%	2.60	8%
Loco Capex	9.58	21%	8.13	24%
Wagon Capex	10.01	22%	3.43	10%
Track/Access	7.38	16%	6.78	20%
Overhead	6.04	13%	5.28	15%
Total	**45.75**	**100%**	**34.45**	**100%**

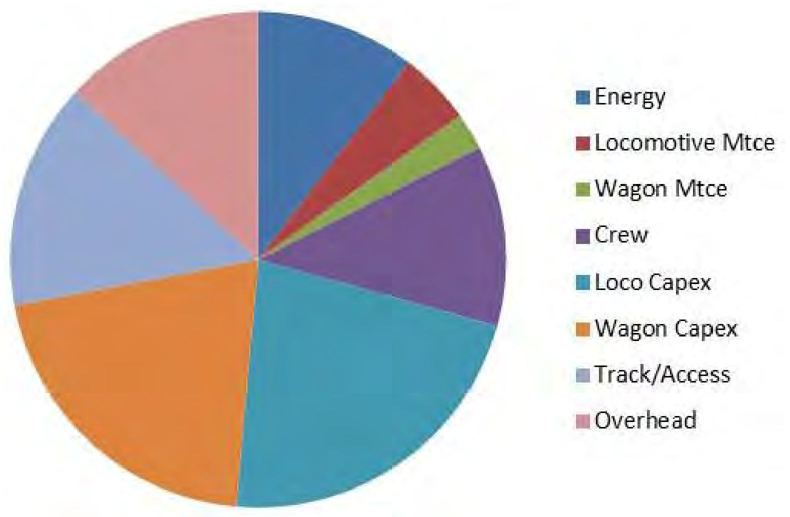


Figure 40 Train 29 Grain from Emerald East to Gladstone estimated potential cost distribution

It is important to note that it is not possible to replicate these sorts of savings west of Emerald without substantial track upgrades. Further, based on [say] 1 million tonnes per year even a $10 per tonne saving will only generate $114.7 million over the next 20 years at a 6% discount rate. This may assist in financing upgrades to Emerald West but look quite insufficient to extend as far as Alpha. It is also possible the savings must be transferred to customers as a way to facilitate mode shift or to maintain market share.

From an infrastructure and operational perspective, Emerald East is currently in a position to take larger locomotives and wagons with almost no additional track or bridge expense. Export coal hauls from the Minerva mine on the Springsure branchline are currently operated by 4000 class locomotive further confirming the 20 tonne axle loads infrastructure rating given in Aurizon publications. For a triple slot container wagon, three 6.1 metre containers each with gross mass of 21 tonnes can be carried. This is a medium to heavy mass for a 6.1m container and would cover the majority of commodities.

However triple slot container wagons are not suited to all commodities. For example grains and other materials, possible some liquids can reach up to 26 tonnes per TEU and three of these would overload an 80 tonne gross mass wagon. Instead a double slot container wagon giving a gross mass of say 68 tonnes would be suitable. This is of course unsuitable for track rated to 15.75 tonnes axle load but would be compatible with 18 tonne axle loads (72 tonne gross mass wagons). Very light products, such as cotton, are always carried in 12m FEUs which are better suited to double slot container wagons because of the difficulty in finding a suitable load for the remaining slot on a triple slot wagon.

The Emerald West nominal terminal would require an upgraded Nogoa Bridge and about 12 km of upgraded track. If permanently constrained by the 15.75 tonne axle loads, the existing track cannot take new bigger locomotives but this may not necessarily be a problem since it can easily handle most of the demands of 63 tonne double slot wagons which would form the majority of the traffic task. In other words the low cost solution – zero upgrades will not provide any performance enhancements over the present situation.

Further there may be a lower cost transitional upgrade from 15.75 tonne axle load to 20 tonnes perhaps via 18 tonnes. Larger locomotives (than those presently used) for example, similar to the 2800 class might be able to be used in place of 4000 class locos currently hauling Minerva coal which might assist in increasing hauling power and efficiency. By way of comparison, in the 1990s the 2800 class locomotives were hauling the equivalent of 2 x 90 tonners on the North Coast Line.

For an Alpha terminal, the track between Emerald and Alpha is configured similar to Emerald West thus the same comments apply. A couple of additional points worth consideration are:

- The shortness and lack of suitable crossing loops west of Emerald,
- The Drummond Range is the major topographical influence on train size. Any improvements west of emerald would be considerably enhanced by a crossing loop here as well as any gradient reduction which would improve train hauling capacity and efficiency.

Sample results

A major reason for modelling so many train configurations was to assess the cost sensitivity to changes in particular elements of the train composition. While it is not intended to discuss each train individually, selected trains and origin-destination combinations for particular combinations will prove useful particularly since one of the purposes of this study is to optimise the location of an inland port and what corridor enhancements are necessary to support the port.

Petroleum product from Gladstone to Alpha

Table 30 sets out details for Alpha fuel trains based on efficient train configurations for a variety of axle load, locomotives and wagons. Containerised fuel containers are relatively heavy and triple slot container wagons only have effect at high axle loads e.g. 26 tonnes. It is assumed there is no opportunity for backloads and all return containers are empty.

Between train 97 and 98 there is no change in train configuration therefore the costs are the same despite a higher axle load in 98. This is because 2 x 23-24 tonne containers plus 14 - 15 tonnes wagon tare is near the optimal load for 15.75 tonne axle loads but suboptimal for 18 tonne axle loads.

If however larger locomotives – are used e.g. train 99, there is approximately a 7% cost reduction but this is a function of the locomotive hauling power than wagons optimised for the infrastructure. The point in comparing these three trains is that unless the rolling stock is optimised to the infrastructure, there is no productivity gain and therefore any investment made in upgraded infrastructure would be rendered ineffective. Comparing trains 100 and 102 provide further evidence of this. Based on this analysis, if investment funding is tight, there is little advantage in upgrading to 20 tonne axle load over 18 tonnes based on the performance of train 99. The big question is however, what does it cost to upgrade from 15.75 t to 18 tonnes and is the $4 per tonne enough to make a difference.

Table 30 Fuel from Gladstone to Alpha

Scenario	Axle load	No x type Locos	No x type Wagons	Forward Tonnes per Train	Forward Containers per Train	Cost TEU	Cost Tonne
97	15.75	2 x 1500hp Diesel	29x80 t Double	1102	58	1,055	56
98	18	2 x 1500hp Diesel	29x80 t Double	1102	58	1,055	56
99	18	2 x 2000hp Diesel	33x80 t Double	1254	66	992	52
100	20	2 x 1500hp Diesel	29x80 t Double	1102	58	1,055	56
101	20	2 x 2000hp Diesel	33x80 t Double	1254	66	992	52
102	20	1 x 3000hp Diesel	25x80 t Double	950	50	982	52
103	26.5	1 x 3000hp Diesel	25x80 t Double	950	50	982	52
104	26.5	2 x 1500hp Diesel	23x100 t Triple	1311	69	936	49
105	26.5	2 x 2000hp Diesel	26x100 t Triple	1482	78	867	46
106	26.5	1 x 3000hp Diesel	20x100 t Triple	1140	60	853	45

Since the hypothetical Emerald West terminal shares the same track infrastructure as Alpha, the same comments about track and train configuration also apply.

General freight from Rockhampton to Alpha

Containerised general freight is very heterogeneous in terms of gross mass ranging from very light to very heavy. The normal approach is that loads tend to even out. Store goods for example are normally around 11-12 tonne payload per TEU, industrial equipment could be much heavier – 24 tonnes. A nominal gross mass per TEU of 14.7 tonnes has been modelled.

It is assumed there is no opportunity for backloads and all return containers are empty.

Details of the trains modelled are summarised in **Table 31**. The major difference between general freight and petroleum products in terms of container carrying ability is that triple slot container wagons are fully useable for general freight at more moderate track strength ratings. But fuel containers would be too heavy to place three on a triple slot wagon.

This is clearly shown by the major cost savings with train 109 compared with train 107. There is no real advantage in 20 tonne axle load except for train 117 which uses a larger and more powerful locomotive to gain a slight cost advantage. Because fuel is a relatively heavy commodity, thus well suited to rail, the cost per tonne is substantially below the costs estimated for similar train configurations but different commodities such as general freight and mixed loads.

Table 31 General freight from Rockhampton to Alpha

Scenario	Axle load	No x type Locos	No x type Wagons	Forward Tonnes per Train	Forward Containers per Train	Cost TEU	Cost Tonne
107	15.75	2 x 1500hp Diesel	38x80 t Double	912	76	794	66
108	18	1 x 1500hp Diesel	19x80 t Double	456	38	952	79
109	18	2 x 1500hp Diesel	31x80 t Triple	1116	93	660	55
110	18	1 x 2000hp Diesel	21x80 t Double	504	42	907	76
111	18	2 x 2000hp Diesel	35x80 t Triple	1260	105	632	53
112	20	1 x 1500hp Diesel	19x80 t Double	456	38	952	79
113	20	1 x 1500hp Diesel	15x80 t Triple	540	45	806	67
114	20	1 x 2000hp Diesel	21x80 t Double	504	42	907	76
115	20	1 x 2000hp Diesel	17x80 t Triple	612	51	760	63
116	20	1 x 3000hp Diesel	34x80 t Double	816	68	714	59
117	20	1 x 3000hp Diesel	27x80 t Triple	972	81	602	50

Mixed loads from Rockhampton to Alpha

As noted above, containerised general freight is very heterogeneous in terms of gross mass and commodity carried. The previous two train types assume loaded containers in one direction and all empty containers in the return direction. Thus a third class of freight has been included to address this deficiency and better reflect some real life situations. Generally it is difficult to balance forward and return loads e.g. food grade containers cannot be contaminated with other material so quite a lot of containers return empty or are despatched empty with the intention of picking up a load to bring back. This situation applies particularly to agricultural commodities. The approach taken here is to even things out by averaging.

To simulate this situation the model has been set up to assume partial backloads with 2/3 loaded containers and 1/3 empty containers in each direction. It could as easily been set up as 50:50 or 75:25 but a middle course has been assumed since this is only a model and should be treated as supplying indicative rather than definite answers. The weighted average gross mass per TEU under this assumption is 17.1 tonnes based on the combination of 2 x 24 tonnes + 1 x empty container. Details of the trains modelled are summarised in **Table 32**.

The 2/3 1/3 configuration is better suited to triple slot container wagons than to doubles since some wagons could be carrying 2 loaded containers, others with 2 empties and yet others with a mix of loaded and empty. For triple slot wagons the 2/3 1/3 mix would work well as long as the axle loads are capable of handling the gross mass of the wagons. Thus three fully loaded 25 tonne containers will not work on 20 tonne axle loads.

The results show relatively high cost reductions over the base (train 133) are possible with train 136 and 138 with triple slot container wagons which for these loads is optimised on 18 tonne axle load track.

Table 32 Mixed loads from Rockhampton to Alpha

Scenario	Axle load	No x type Locos	No x type Wagons	Forward Tonnes per Train	Forward Containers per Train	Cost TEU	Cost Tonne
133	15.75	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	1,215	81
134	18	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	1,215	81
135	18	2 x 1500hp Diesel	34x80 t Heavy Double	1020	68	1,026	68
136	18	2 x 1500hp Diesel	27x80 t Triple	1215	81	904	60
137	18	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	1,157	77
138	18	1 x 2000hp Diesel	15x80 t Triple	675	45	1,009	67
139	20	2 x 1500hp Diesel	34x80 t Heavy Double	1020	68	1,026	68
140	20	2 x 1500hp Diesel	34x80 t Triple	1530	102	820	55
141	20	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	1,157	77
142	20	1 x 2000hp Diesel	15x80 t Triple	675	45	1,009	67
143	26.5	1 x 3000hp Diesel	29x80 t Heavy Double	870	58	965	64
144	26.5	1 x 3000hp Diesel	24x80 t Triple	1080	72	815	54

The outcome of this modelling is that there are no conclusive results covering all freight for all ports. This is because there is no generic homogenous “freight” unit. The critical factor in optimisation relates to the individual properties and proportional make up of all of the commodities on offer. Thus if predominant freight is petroleum product to Alpha, this will be optimised on a different operation to grain from Gladstone. Ultimately the aim is to get the best blend which optimises the operation based on the commodity and infrastructure combination. Of course this is a dynamic situation and given market dynamics, seasonality and other many other factors, nothing is permanent, at the same time infrastructure is ultimately a very long term product which is not easily tweaked. This places major stress on the planning function which can only future-proof to a limited extent.

B.7 Implications for market share

This section builds on a large body of work AECOM has over a number of projects and is used to estimate mode share. Since the present study is mainly focused on rail, “market share” might be an expression which can be used interchangeably.

The ‘Four Step’ modelling process

The four step transportation modelling process was first developed in the United States in the 1950s and has since become the traditional method of forecasting demand when multiple modes need to be considered. Models of this type typically represent the land-use of a region as a collection of zones and the different transport networks as links and nodes. Information can be attributed to each of the zones, links and nodes. The amount of information used to describe the land use and transport networks varies widely between models and depends on purpose of the model, that is whether it is for large area strategic analysis or small area detailed analysis.

The four steps of the classical transportation planning system model are:

- **Trip Generation**, which determines the number of trip origins or destinations in each zone by trip purpose. This is generally calculated as a function of land uses and population demographics, industrial and economic activity and other socio-economic factors;
- **Trip Distribution**, which matches the zone origins with zone destinations, often using a gravity model where the number of trips between two zones is dependent on the trip origins and destinations from and to the zones, and number of trips decreases as the cost of transport between the zones increases;
- **Mode Choice**, which calculates the proportion of trips between each origin and destination that use a particular transportation mode. This model is often of the logit form, which determines the proportion of trips in each mode as a function of the differences in cost of transport.
- **Route Assignment**, which allocates trips between an origin and destination by a particular mode to a route. Wardrop's principle of user equilibrium is often used for highway assignments, wherein each transport user chooses the least cost path.

One of the complexities of using the four step process as described above is that the cost of transport is a function of demand; however, the level of demand is a function of the cost of transport. Therefore, modelling process generally operates with a feedback loop where the cost of transport is fed back to the Trip Distribution, Mode Choice and Route Assignment stages until equilibrium is met.

Figure 41 shows the four step process with the transport costs that are derived from the route assignment being fed back into the trip distribution stage where the number of trips between zone pairs is a function of the transport cost between the zones. The mode split and the route assignment also vary with changes in the cost of transport.

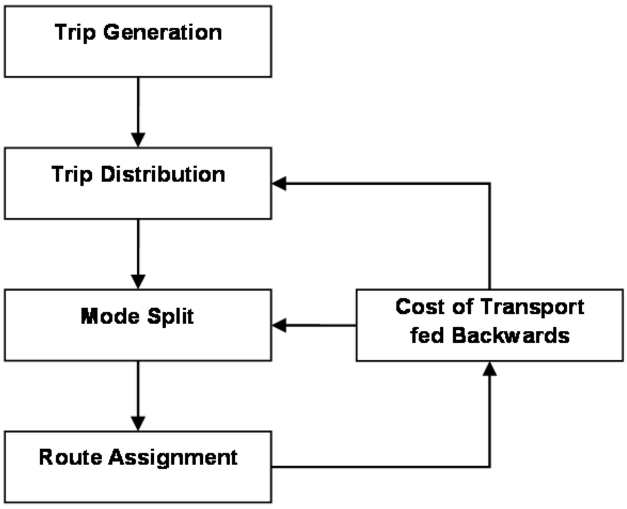


Figure 41 The Four Step Modelling Process

The cost of transport as referred to above is the perceived cost of transport and can include both monetary and non-monetary elements and is sometimes referred to as the generalised cost of transport or the disutility of transport (the utility being the activity undertaken at the destination). The generalised cost of truck transport and rail transport usually takes the following forms:

For road transport

$$GC_{Road} = travel\,time \times VOT + travel\,dist \times VOC + \alpha \times predeparture\,time + \beta \times postarrival\,time + \chi \times Consignment\,value$$

Equation 1

Where:

GC_{Road} = the generalised cost of road transport

VOT = the Value of Time from despatch at Origin to receipt at destination point, i.e. door to door elapsed time

VOC = the perceived Vehicle Operating Cost

α = weighting factor for the predeparture time (generally > 1)

β = weighting factor for the time waiting from delivery until access (generally > 1)

χ = weighting factor for the value of the consignment (generally = 1)

For rail transport, the function is more complicated by the addition of terminals and pick-up and delivery (PUD) legs

$$GC_{Rail} = travel\,time \times VOT + travel\,dist \times VOC + \alpha \times predeparture\,time + \beta \times postarrival\,time + \chi \times Consignment\,value$$

Equation 2

Where:

GC_{Rail} = the generalised cost of rail transport

VOT = the Value of Time from despatch at Origin to receipt at destination point, i.e. door to door elapsed time

VOC = the perceived Vehicle Operating Cost plus surcharges such as cranage for containers, demurrage, storage, pick-up and delivery legs etc.

α = weighting factor for the time to for the pick up to terminal leg (generally > 1)

β = weighting factor for the time waiting from the arrival at the destination terminal until final delivery is met (generally > 1)

χ = weighting factor for the value of the consignment (generally = 1)

In addition to the generalised cost components for rail transport listed above, costs penalties for transferring from service to service or for delays in service can also be added.

As these costs are used to predict freight demand behaviour, they are perceived costs not resource costs. Therefore, for example in **Equation 1**, the perceived vehicle operating cost generally does not include non-fuel components for transport. The weighting factors used for the different components of rail time are used to take into account the users relative dislike for additional waiting/delay time e.g. at a rail terminal pre departure or the delay in accessing freight in arriving at the destination rail terminal compared to truck time travelling door to door. An alternative method that would give the same result would be to use different values of time for the different components of the rail trip. The mode specific constant in the rail generalised cost equation (**Equation 2**) is designed to take into account factors such as all the intangible factors that make one mode more or less attractive than the others.

The generalised cost functions shown in **Equation 1** and **Equation 2** are expressed in monetary units; however, they could also be expressed as generalised time by dividing by the value of time. This methodology is often preferred by transport planners, although in theory it should not matter which method is use as long as the units are consistently observed.

Estimation of mode split

The determination of the mode split in four step models is generally based on economic choice theory that uses Random Utility Models (RUM), which is most commonly expressed as a multinomial logit model (MNL). These models are based on the premise that we make choices that maximise the utility that we derive from the choices.

In the context of transport demand, the utility we derive from transport is the activity we want to go to. If the cost of getting to the destination (the disutility) is greater than the utility gained by the activity at the destination then the trip will not take place. In the case where a destination is chosen and the choice is now between which mode to use to get there, the mode theory states that the mode with the lowest disutility will be chosen.

Freight is an interesting variation to traditional demand patterns in that it displays “derived” rather than normal demand. That is, the normal down sloping demand function means we buy more and more transport as the price/cost falls. In the case of freight, for example, once the farmer has sent all his produce to market, he has no capacity to buy more units of transport no matter how low the price is.

The disutility of transport can be expressed as the generalised cost of transport as shown in **Equation 1** and **Equation 2**. The mode choice between rail and road use for any given origin destination then becomes dependent on the difference between the generalised cost of transport between truck and train. That is, if the generalised cost of rail transport is greater than that of truck then the truck will be chosen and vice versa. This concept is shown in **Figure 42**, where the probability of using the road or rail is plotted against the difference in disutility of using the road or rail. Here it can be seen that when the disutility of truck use is greater than that of train use 100% of people would use rail transport.

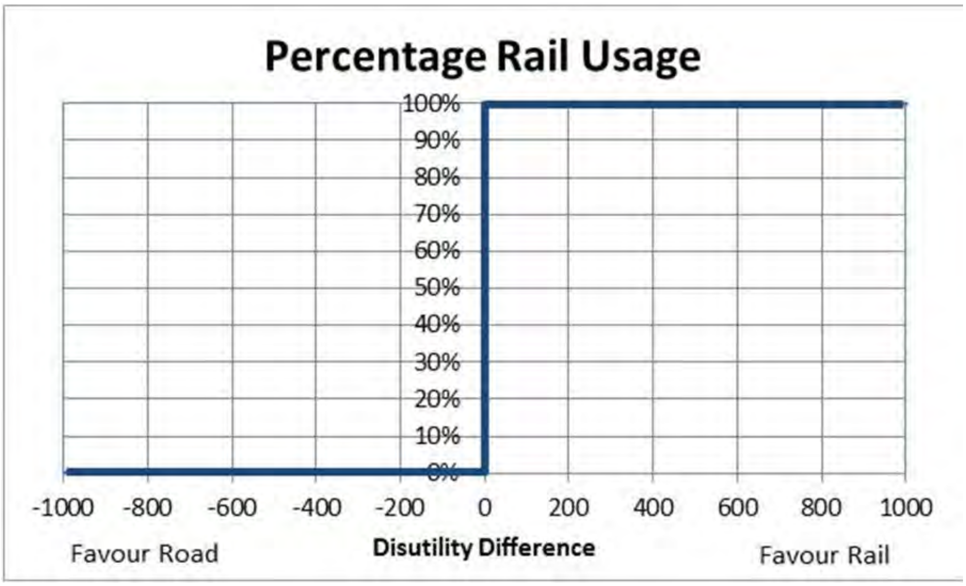


Figure 42 Mode choice and difference in Disutility

However, when considering utility economists express the theoretical utility as:

Theoretical utility = observed utility + random term, or

U = V + e

Equation 3

The random term is included to reflect the uncertainty associated with the estimated utility value. If it is assumed that the random terms are independently and identically distributed then analysts tend to use the multinomial logit model to model the uncertainty. The framework for the multinomial logit model is shown in **Equation 4**.

$$\Pr_{ij}^{K} = \frac{T_{ij}^{K}}{T_{ij}} = \frac{\exp\left(\lambda V_{ij}^{k}\right)}{\sum_{k} \exp\left(\lambda V_{ij}^{k}\right)}$$

Equation 4

Where:

$\Pr_{ij}^{K}$ = the probability of using mode K between points i and j;

T_{ij}^{K} = the number of trips between i and j on mode K;

T_{ij} = the total number of trips between i and j;

V_{ij}^{k} = the generalised cost of transport between i and j on mode K;

λ = a scaling factor that measures the sensitivity to the generalised cost

For the example of the binomial choice between road and rail transport **Equation 4** can be expressed as:

$$\Pr_{Rail} = \frac{1}{1 + \exp\left(\lambda\left(GC_{Rail} - GC_{Road} + \Delta\right)\right)}$$

Equation 5

Where:

GC_{PT}	=	the generalised cost of rail transport
GC_{Car}	=	the generalised cost of road transport
$\Pr_{PT}$	=	the probability of using rail transport
λ	=	a scaling factor for the sensitivity of generalised cost
Δ	=	an alternative specific constant

Equation 5 can be plotted and is shown in **Figure 43**. This shows that when the generalised cost of travel for road and rail transport is equal there is a 50% mode split between road and rail transport and that as the difference in generalised cost favours trucks the proportion of train users decreases. However, **Figure 43** shows that even when the generalised cost of rail transport is greater than that for truck a proportion of people will still chose to use rail transport. This is due to the random term in **Equation 3** and the degree of sensitivity the generalised cost has on mode choice as dictated by λ in **Equation 5**.

Figure 43 shows that for low values of λ the choice of mode is less sensitive to generalised cost and for high values of λ the choice of mode is more sensitive to generalised cost.

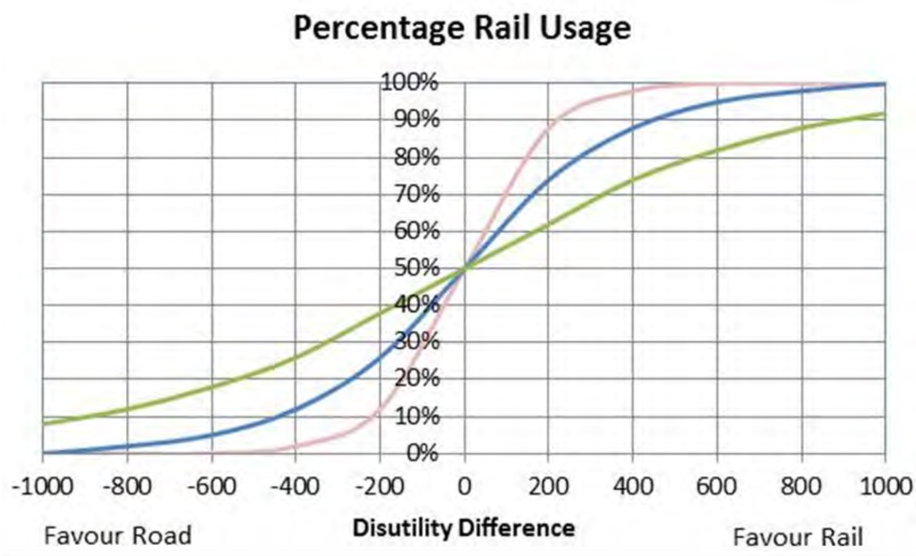


Figure 43 **Mode Split Logit Curve**

This is an important concept to understand when considering economic evaluation of projects that involve a transfer of road trips to rail transport. **Figure 43** shows that a proportion of people will choose to use rail transport even though the generalised cost of travel is higher for rail transport than truck. While the resource cost of trucks is generally higher than the perceived cost, it is likely that the above indicates that it is possible to have an increase in the total resource cost by the addition of a rail service that has a higher resource cost than the existing truck based alternative. This is especially the case when there are low volumes of freight.

This problem can to a certain extent be addressed by careful market segmentation. There will always be a degree of uncertainty in the utility function due to our inability to measure all of the influencing factors of generalised cost and also due the distribution of behavioural characteristics that exits in the logistics and associated industry. To overcome this problem in economic evaluation it is recommended that the rule of half approach is used rather than the global resource cost approach.

The message therefore is that although rail freight rates are lower than road's, road's superior service allows it to gain the lion's share of the market. There are however many customers for who price is the bottom line and these will remain on rail. The aim to increase market share is not only to keep freight rates low or at least competitive but to improve quality of service such that rail's main selling point (low cost freight rates) is not seen purely as compensation for poor quality service.

The series of logit curves are analogous to people's preferences generally and how they weight the various factors in a transport service. For some freight customers, "cost is king" so low price is the main determinant of mode choice, and this is particularly the case for low value products which have difficulty absorbing high transport costs in their eventual price. There is no single logit curve rather there are a series of curves and in part this explains the complexity in estimating market share.

The "mode specific factor" is critical to understanding how the mode split actually occurs when there are differential prices. Road transport is able to charge a premium on the basis of a perceived higher quality of service. These quality of service factors include: speedier transport hence stock is available quicker, flexible arrival and departure times, less materials handling giving reduced damage and potential theft, seamless door to door operation, security – whereabouts of the cargo is known at all times. It is difficult for rail operating current paradigms to match many of these features however, the cash cost of transport should not be completely overlooked.

Furthermore there are a wide variety of commercial arrangements in place covering logistic chains. For most larger companies, many contracts are arranged by head office on a bulk arrangement e.g. daily or three deliveries per week or whatever. In general there is a preference to reduce risk for both parties by locking in long term agreements. There is often a blend of in-house and outsourced service providers. For most of these companies, it is a major task to change suppliers or logistics arrangements and the modus operandi to adapt to a new arrangement. Similarly a change from road to rail also has some complexities which should not be treated lightly. It is expected that the existing operators will fight hard to keep market share and keep their costly assets productive.

Coexisting with this market is the "spot market" which dominates particular market niches – e.g. fresh or perishable foods, etc. Road operators are very skilful in acquiring these loads and offer attractive backloaded rates to entice customers. From the operator's perspective, extra revenue is a bonus for trucks otherwise returning empty. It is very hard for rail to adopt similar flexible arrangements.

B.8 Simulation outputs

The first group of simulations (**Table 33** to **Table 37**) are based on 104 round trips per year – 2 per week.

The second group (**Table 38** to **Table 42**) are the same trains but at a higher utilisation of 162 round trips per year – 3 per week

The third series (**Table 43** to **Table 47**) are based on 4 trips per week for Emerald freight, this is probably not possible for Alpha freight.

Table 48 is a consolidated summary of (**Table 33** to **Table 47**).

Table 49 is a standalone table estimating costs under the assumed current operating regime and load configuration.

Table 50 is a standalone table comparing relative costs between different train sizes.

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Table 33 Full Trainloads of Petroleum Product 104 trips per year

Scenario	Origin	Destination	Commodity	Axleload tonnes	No x type Locos	No x type Wagons	Forward Payload Tonnes per Train	Forward Containers per Train	TEUs per year	Tonnes per year	Cost/TEU Forward	Cost/TEU Return	Cost/TEU Round Trip	Forward $ Tonne	Return $ Tonne	Round trip $ Tonne
1	Gladstone	Emerald East	Petrol	15.75	2 x 1500hp Diesel	29x80 t Heavy Double	1102	58	6032	114608	494	347	841	26	18	44
2	Gladstone	Emerald East	Petrol	18	2 x 1500hp Diesel	29x80 t Heavy Double	1102	58	6032	114608	494	347	841	26	18	44
3	Gladstone	Emerald East	Petrol	18	2 x 2000hp Diesel	33x80 t Heavy Double	1254	66	6864	130416	469	326	794	25	17	42
4	Gladstone	Emerald East	Petrol	20	2 x 1500hp Diesel	29x80 t Heavy Double	1102	58	6032	114608	494	347	841	26	18	44
5	Gladstone	Emerald East	Petrol	20	2 x 2000hp Diesel	33x80 t Heavy Double	1254	66	6864	130416	469	326	794	25	17	42
6	Gladstone	Emerald East	Petrol	20	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	5200	98800	449	328	777	24	17	41
7	Gladstone	Emerald East	Petrol	26.5	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	5200	98800	449	328	777	24	17	41
8	Gladstone	Emerald East	Petrol	26.5	2 x 1500hp Diesel	29x80 t Heavy Double	1102	58	6032	114608	494	347	841	26	18	44
9	Gladstone	Emerald East	Petrol	26.5	2 x 2000hp Diesel	33x80 t Heavy Double	1254	66	6864	130416	469	326	794	25	17	42
10	Gladstone	Emerald East	Petrol	26.5	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	5200	98800	449	328	777	24	17	41
49	Gladstone	Emerald West	Petrol	15.75	2 x 1500hp Diesel	29x80 t Heavy Double	1102	58	6032	114608	516	360	877	27	19	46
50	Gladstone	Emerald West	Petrol	18	2 x 1500hp Diesel	29x80 t Heavy Double	1102	58	6032	114608	516	360	877	27	19	46
51	Gladstone	Emerald West	Petrol	18	2 x 2000hp Diesel	33x80 t Heavy Double	1254	66	6864	130416	490	338	827	26	18	44
52	Gladstone	Emerald West	Petrol	20	2 x 1500hp Diesel	29x80 t Heavy Double	1102	58	6032	114608	516	360	877	27	19	46
53	Gladstone	Emerald West	Petrol	20	2 x 2000hp Diesel	33x80 t Heavy Double	1254	66	6864	130416	490	338	827	26	18	44
54	Gladstone	Emerald West	Petrol	20	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	5200	98800	470	342	812	25	18	43
55	Gladstone	Emerald West	Petrol	26.5	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	5200	98800	470	342	812	25	18	43
56	Gladstone	Emerald West	Petrol	26.5	2 x 1500hp Diesel	23x100 t Triple	1311	69	7176	136344	457	321	777	24	17	41
57	Gladstone	Emerald West	Petrol	26.5	2 x 2000hp Diesel	26x100 t Triple	1482	78	8112	154128	436	289	724	23	15	38
58	Gladstone	Emerald West	Petrol	26.5	1 x 3000hp Diesel	20x100 t Triple	1140	60	6240	118560	416	290	706	22	15	37
97	Gladstone	Alpha	Petrol	15.75	2 x 1500hp Diesel	29x80 t Heavy Double	1102	58	6032	114608	630	425	1,055	33	22	56
98	Gladstone	Alpha	Petrol	18	2 x 1500hp Diesel	29x80 t Heavy Double	1102	58	6032	114608	630	425	1,055	33	22	56
99	Gladstone	Alpha	Petrol	18	2 x 2000hp Diesel	33x80 t Heavy Double	1254	66	6864	130416	595	396	992	31	21	52
100	Gladstone	Alpha	Petrol	20	2 x 1500hp Diesel	29x80 t Heavy Double	1102	58	6032	114608	630	425	1,055	33	22	56
101	Gladstone	Alpha	Petrol	20	2 x 2000hp Diesel	33x80 t Heavy Double	1254	66	6864	130416	595	396	992	31	21	52
102	Gladstone	Alpha	Petrol	20	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	5200	98800	575	408	982	30	21	52
103	Gladstone	Alpha	Petrol	26.5	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	5200	98800	575	408	982	30	21	52
104	Gladstone	Alpha	Petrol	26.5	2 x 1500hp Diesel	23x100 t Triple	1311	69	7176	136344	557	379	936	29	20	49
105	Gladstone	Alpha	Petrol	26.5	2 x 2000hp Diesel	26x100 t Triple	1482	78	8112	154128	529	337	867	28	18	46
106	Gladstone	Alpha	Petrol	26.5	1 x 3000hp Diesel	20x100 t Triple	1140	60	6240	118560	508	344	853	27	18	45

Table 34 Full Trainloads of Grain or Cotton 104 trips per year

Scenario	Origin	Destination	Commodity	Axleload tonnes	No x type Locos	No x type Wagons	Forward Payload Tonnes per Train	Forward Containers per Train	TEUs per year	Tonnes per year	Cost/TEU Forward	Cost/TEU Return	Cost/TEU Round Trip	Forward $ Tonne	Return $ Tonne	Round trip $ Tonne
22	Emerald East	Gladstone	Grain	15.75	1 x 1500hp Diesel	14x80 t Heavy Double	560	28	2912	58240	596	457	1,053	30	23	53
23	Emerald East	Gladstone	Grain	18	2 x 1500hp Diesel	28x80 t Heavy Double	1120	56	5824	116480	510	355	865	25	18	43
24	Emerald East	Gladstone	Grain	18	1 x 2000hp Diesel	16x80 t Heavy Double	640	32	3328	66560	558	425	983	28	21	49
25	Emerald East	Gladstone	Grain	18	2 x 2000hp Diesel	32x80 t Heavy Double	1280	64	6656	133120	482	332	815	24	17	41
26	Emerald East	Gladstone	Grain	20	2 x 1500hp Diesel	28x80 t Heavy Double	1120	56	5824	116480	510	355	865	25	18	43
27	Emerald East	Gladstone	Grain	20	1 x 2000hp Diesel	16x80 t Heavy Double	640	32	3328	66560	558	425	983	28	21	49
28	Emerald East	Gladstone	Grain	20	2 x 2000hp Diesel	32x80 t Heavy Double	1280	64	6656	133120	482	332	815	24	17	41
29	Emerald East	Gladstone	Grain	26.5	2 x 1500hp Diesel	22x100 t Triple	1320	66	6864	137280	453	304	758	23	15	38
30	Emerald East	Gladstone	Grain	26.5	1 x 2000hp Diesel	12x100 t Triple	720	36	3744	74880	508	376	883	25	19	44
31	Emerald East	Gladstone	Grain	26.5	2 x 2000hp Diesel	25x100 t Triple	1500	75	7800	156000	431	286	718	22	14	36
32	Emerald East	Gladstone	Grain	26.5	1 x 3000hp Diesel	19x100 t Triple	1140	57	5928	118560	414	287	700	21	14	35
33	Emerald East	Rockhampton	Cotton	15.75	1 x 1500hp Diesel	20x80 t Heavy Double	880	40	4160	91520	438	332	769	20	15	35
34	Emerald East	Rockhampton	Cotton	18	2 x 1500hp Diesel	41x80 t Heavy Double	1804	82	8528	187616	378	272	650	17	12	30
35	Emerald East	Rockhampton	Cotton	18	1 x 2000hp Diesel	23x80 t Heavy Double	1012	46	4784	105248	413	307	720	19	14	33
36	Emerald East	Rockhampton	Cotton	20	1 x 3000hp Diesel	36x80 t Heavy Double	1584	72	7488	164736	348	242	590	16	11	27
70	Emerald West	Gladstone	Grain	15.75	1 x 1500hp Diesel	14x80 t Heavy Double	560	28	2912	58240	625	478	1,103	31	24	55
71	Emerald West	Gladstone	Grain	18	2 x 1500hp Diesel	28x80 t Heavy Double	1120	56	5824	116480	533	369	902	27	18	45
72	Emerald West	Gladstone	Grain	18	1 x 2000hp Diesel	16x80 t Heavy Double	640	32	3328	66560	585	444	1,028	29	22	51
73	Emerald West	Gladstone	Grain	18	2 x 2000hp Diesel	32x80 t Heavy Double	1280	64	6656	133120	504	345	849	25	17	42
74	Emerald West	Gladstone	Grain	20	2 x 1500hp Diesel	28x80 t Heavy Double	1120	56	5824	116480	533	369	902	27	18	45
75	Emerald West	Gladstone	Grain	20	1 x 2000hp Diesel	16x80 t Heavy Double	640	32	3328	66560	585	444	1,028	29	22	51
76	Emerald West	Gladstone	Grain	20	2 x 2000hp Diesel	32x80 t Heavy Double	1280	64	6656	133120	504	345	849	25	17	42
77	Emerald West	Gladstone	Grain	26.5	2 x 1500hp Diesel	22x100 t Triple	1320	66	6864	137280	474	316	790	24	16	39
78	Emerald West	Gladstone	Grain	26.5	1 x 2000hp Diesel	12x100 t Triple	720	36	3744	74880	532	392	924	27	20	46
79	Emerald West	Gladstone	Grain	26.5	2 x 2000hp Diesel	25x100 t Triple	1500	75	7800	156000	451	297	747	23	15	37
80	Emerald West	Gladstone	Grain	26.5	1 x 3000hp Diesel	19x100 t Triple	1140	57	5928	118560	433	299	732	22	15	37
81	Emerald West	Rockhampton	Cotton	15.75	1 x 1500hp Diesel	20x80 t Heavy Double	880	40	4160	91520	462	348	810	21	16	37
82	Emerald West	Rockhampton	Cotton	18	2 x 1500hp Diesel	41x80 t Heavy Double	1804	82	8528	187616	398	284	682	18	13	31
83	Emerald West	Rockhampton	Cotton	18	1 x 2000hp Diesel	23x80 t Heavy Double	1012	46	4784	105248	435	322	757	20	15	34
84	Emerald West	Rockhampton	Cotton	20	1 x 3000hp Diesel	36x80 t Heavy Double	1584	72	7488	164736	366	253	620	17	12	28

Table 35 Full Trainloads of General Freight (to coordinate with trains from Brisbane) 104 trips per year

Scenario	Origin	Destination	Commodity	Axleload tonnes	No x type Locos	No x type Wagons	Forward Payload Tonnes per Train	Forward Containers per Train	TEUs per year	Tonnes per year	Cost/TEU Forward	Cost/TEU Return	Cost/TEU Round Trip	Forward $ Tonne	Return $ Tonne	Round trip $ Tonne
11	Rockhampton	Emerald East	General	15.75	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7904	94848	341	277	618	28	23	52
12	Rockhampton	Emerald East	General	18	1 x 1500hp Diesel	19x80 t Heavy Double	456	38	3952	47424	399	335	735	33	28	61
13	Rockhampton	Emerald East	General	18	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7904	94848	341	277	618	28	23	52
14	Rockhampton	Emerald East	General	18	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	4368	52416	382	321	703	32	27	59
15	Rockhampton	Emerald East	General	18	2 x 2000hp Diesel	43x80 t Heavy Double	1032	86	8944	107328	326	265	590	27	22	49
16	Rockhampton	Emerald East	General	20	1 x 1500hp Diesel	19x80 t Heavy Double	456	38	3952	47424	399	335	735	33	28	61
17	Rockhampton	Emerald East	General	20	1 x 1500hp Diesel	15x80 t Triple	540	45	4680	56160	341	279	620	28	23	52
18	Rockhampton	Emerald East	General	20	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	4368	52416	382	321	703	32	27	59
19	Rockhampton	Emerald East	General	20	1 x 2000hp Diesel	17x80 t Triple	612	51	5304	63648	322	265	587	27	22	49
20	Rockhampton	Emerald East	General	20	1 x 3000hp Diesel	34x80 t Heavy Double	816	68	7072	84864	306	248	554	25	21	46
21	Rockhampton	Emerald East	General	20	1 x 3000hp Diesel	27x80 t Triple	972	81	8424	101088	262	204	466	22	17	39
59	Rockhampton	Emerald West	General	15.75	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7904	94848	358	289	647	30	24	54
60	Rockhampton	Emerald West	General	18	1 x 1500hp Diesel	15x80 t Triple	540	45	4680	56160	360	292	652	30	24	54
61	Rockhampton	Emerald West	General	18	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7904	94848	358	289	647	30	24	54
62	Rockhampton	Emerald West	General	18	1 x 2000hp Diesel	17x80 t Triple	612	51	5304	63648	339	277	617	28	23	51
63	Rockhampton	Emerald West	General	18	2 x 2000hp Diesel	35x80 t Triple	1260	105	10920	131040	289	227	515	24	19	43
64	Rockhampton	Emerald West	General	20	1 x 1500hp Diesel	19x80 t Heavy Double	456	38	3952	47424	420	352	772	35	29	64
65	Rockhampton	Emerald West	General	20	1 x 1500hp Diesel	15x80 t Triple	540	45	4680	56160	360	292	652	30	24	54
66	Rockhampton	Emerald West	General	20	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	4368	52416	402	336	738	34	28	62
67	Rockhampton	Emerald West	General	20	1 x 2000hp Diesel	17x80 t Triple	612	51	5304	63648	323	261	585	27	22	49
68	Rockhampton	Emerald West	General	20	1 x 3000hp Diesel	34x80 t Heavy Double	816	68	7072	84864	321	259	581	27	22	48
69	Rockhampton	Emerald West	General	20	1 x 3000hp Diesel	27x80 t Triple	972	81	8424	101088	275	213	489	23	18	41
107	Rockhampton	Alpha	General	15.75	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7904	94848	444	350	794	37	29	66
108	Rockhampton	Alpha	General	18	1 x 1500hp Diesel	19x80 t Heavy Double	456	38	3952	47424	523	429	952	44	36	79
109	Rockhampton	Alpha	General	18	2 x 1500hp Diesel	31x80 t Triple	1116	93	9672	116064	376	285	660	31	24	55
110	Rockhampton	Alpha	General	18	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	4368	52416	499	409	907	42	34	76
111	Rockhampton	Alpha	General	18	2 x 2000hp Diesel	35x80 t Triple	1260	105	10920	131040	358	274	632	30	23	53
112	Rockhampton	Alpha	General	20	1 x 1500hp Diesel	19x80 t Heavy Double	456	38	3952	47424	523	429	952	44	36	79
113	Rockhampton	Alpha	General	20	1 x 1500hp Diesel	15x80 t Triple	540	45	4680	56160	449	357	806	37	30	67
114	Rockhampton	Alpha	General	20	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	4368	52416	499	409	907	42	34	76
115	Rockhampton	Alpha	General	20	1 x 2000hp Diesel	17x80 t Triple	612	51	5304	63648	422	338	760	35	28	63
116	Rockhampton	Alpha	General	20	1 x 3000hp Diesel	34x80 t Heavy Double	816	68	7072	84864	399	315	714	33	26	59
117	Rockhampton	Alpha	General	20	1 x 3000hp Diesel	27x80 t Triple	972	81	8424	101088	343	259	602	29	22	50

Table 36 North Coast Line connecting Trains to Brisbane 104 trips per year

Scenario	Origin	Destination	Commodity	Axleload tonnes	No x type Locos	No x type Wagons	Forward Payload Tonnes per Train	Forward Containers per Train	TEUs per year	Tonnes per year	Cost/TEU Forward	Cost/TEU Return	Cost/TEU Round Trip	Forward $ Tonne	Return $ Tonne	Round trip $ Tonne
145	Brisbane	Rockhampton	General	15.75	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7904	94848	532	407	939	44	34	78
146	Brisbane	Rockhampton	General	18	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7904	94848	532	407	939	44	34	78
147	Brisbane	Rockhampton	General	18	2 x 1500hp Diesel	31x80 t Triple	1116	93	9672	116064	452	331	783	38	28	65
148	Brisbane	Rockhampton	General	18	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	4368	52416	588	469	1,056	49	39	88
149	Brisbane	Rockhampton	General	18	1 x 2000hp Diesel	17x80 t Triple	612	51	5304	63648	499	389	889	42	32	74
150	Brisbane	Rockhampton	General	20	1 x 3000hp Diesel	34x80 t Heavy Double	816	68	7072	84864	475	365	841	40	30	70
151	Brisbane	Rockhampton	General	20	1 x 3000hp Diesel	27x80 t Triple	972	81	8424	101088	411	301	711	34	25	59
152	Brisbane	Rockhampton	General	20	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7904	94848	532	407	939	44	34	78
153	Brisbane	Rockhampton	General	20	2 x 1500hp Diesel	31x80 t Triple	1116	93	9672	116064	452	331	783	38	28	65
154	Brisbane	Rockhampton	General	20	2 x 2000hp Diesel	43x80 t Heavy Double	1032	86	8944	107328	504	387	891	42	32	74
155	Brisbane	Rockhampton	General	20	2 x 2000hp Diesel	35x80 t Triple	1260	105	10920	131040	430	320	749	36	27	62
160	Brisbane	Rockhampton	Mixture 2/3	15.75	2 x 1500hp Diesel	34x80 t Heavy Double	1020	68	7072	106080	594	645	1,239	40	43	83
161	Brisbane	Rockhampton	Mixture 2/3	18	2 x 1500hp Diesel	27x80 t Triple	1215	81	8424	126360	514	584	1,098	34	39	73
162	Brisbane	Rockhampton	Mixture 2/3	18	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	3952	59280	651	726	1,377	43	48	92
156	Rockhampton	Brisbane	Cotton	15.75	1 x 1500hp Diesel	20x80 t Heavy Double	880	40	4160	91520	696	494	1,190	32	22	54
157	Rockhampton	Brisbane	Cotton	18	2 x 1500hp Diesel	41x80 t Heavy Double	1804	82	8528	187616	608	407	1,015	28	18	46
158	Rockhampton	Brisbane	Cotton	18	1 x 2000hp Diesel	23x80 t Heavy Double	1012	46	4784	105248	655	453	1,109	30	21	50
159	Rockhampton	Brisbane	Cotton	20	1 x 3000hp Diesel	36x80 t Heavy Double	1584	72	7488	164736	560	358	918	25	16	42

Table 37 Full Trainloads of Mixed Freight (2/3 loaded containers and 1/3 empty containers) 104 trips per year

Scenario	Origin	Destination	Commodity	Axleload tonnes	No x type Locos	No x type Wagons	Forward Payload Tonnes per Train	Forward Containers per Train	TEUs per year	Tonnes per year	Cost/TEU Forward	Cost/TEU Return	Cost/TEU Round Trip	Forward $ Tonne	Return $ Tonne	Round trip $ Tonne
37	Rockhampton	Emerald East	Mixture 2/3	15.75	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	3536	53040	442	474	916	29	32	61
38	Rockhampton	Emerald East	Mixture 2/3	18	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	3536	53040	442	474	916	29	32	61
39	Rockhampton	Emerald East	Mixture 2/3	18	2 x 1500hp Diesel	34x80 t Heavy Double	1020	68	7072	106080	377	400	777	25	27	52
40	Rockhampton	Emerald East	Mixture 2/3	18	2 x 1500hp Diesel	27x80 t Triple	1215	81	8424	126360	324	356	680	22	24	45
41	Rockhampton	Emerald East	Mixture 2/3	18	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	3952	59280	421	454	875	28	30	58
42	Rockhampton	Emerald East	Mixture 2/3	18	1 x 2000hp Diesel	15x80 t Triple	675	45	4680	70200	362	396	758	24	26	51
43	Rockhampton	Emerald East	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Heavy Double	1020	68	7072	106080	377	400	777	25	27	52
44	Rockhampton	Emerald East	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Triple	1530	102	10608	159120	288	326	615	19	22	41
45	Rockhampton	Emerald East	Mixture 2/3	20	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	3952	59280	421	454	875	28	30	58
46	Rockhampton	Emerald East	Mixture 2/3	20	1 x 2000hp Diesel	15x80 t Triple	675	45	4680	70200	362	396	758	24	26	51
47	Rockhampton	Emerald East	Mixture 2/3	26.5	1 x 3000hp Diesel	29x80 t Heavy Double	870	58	6032	90480	346	380	726	23	25	48
48	Rockhampton	Emerald East	Mixture 2/3	26.5	1 x 3000hp Diesel	24x80 t Triple	1080	72	7488	112320	292	319	611	19	21	41
85	Rockhampton	Emerald West	Mixture 2/3	15.75	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	3536	53040	466	501	967	31	33	64
86	Rockhampton	Emerald West	Mixture 2/3	18	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	3536	53040	466	501	967	31	33	64
87	Rockhampton	Emerald West	Mixture 2/3	18	2 x 1500hp Diesel	34x80 t Heavy Double	1020	68	7072	106080	397	422	818	26	28	55
88	Rockhampton	Emerald West	Mixture 2/3	18	2 x 1500hp Diesel	27x80 t Triple	1215	81	8424	126360	341	376	717	23	25	48
89	Rockhampton	Emerald West	Mixture 2/3	18	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	3952	59280	443	480	923	30	32	62
90	Rockhampton	Emerald West	Mixture 2/3	18	1 x 2000hp Diesel	15x80 t Triple	675	45	4680	70200	381	419	800	25	28	53
91	Rockhampton	Emerald West	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Heavy Double	1020	68	7072	106080	397	422	818	26	28	55
92	Rockhampton	Emerald West	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Triple	1530	102	10608	159120	303	345	648	20	23	43
93	Rockhampton	Emerald West	Mixture 2/3	20	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	3952	59280	443	480	923	30	32	62
94	Rockhampton	Emerald West	Mixture 2/3	20	1 x 2000hp Diesel	15x80 t Triple	675	45	4680	70200	381	419	800	25	28	53
95	Rockhampton	Emerald West	Mixture 2/3	26.5	1 x 3000hp Diesel	29x80 t Heavy Double	870	58	6032	90480	364	401	765	24	27	51
96	Rockhampton	Emerald West	Mixture 2/3	26.5	1 x 3000hp Diesel	24x80 t Triple	1080	72	7488	112320	307	337	645	20	22	43
133	Rockhampton	Alpha	Mixture 2/3	15.75	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	3536	53040	582	633	1,215	39	42	81
134	Rockhampton	Alpha	Mixture 2/3	18	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	3536	53040	582	633	1,215	39	42	81
135	Rockhampton	Alpha	Mixture 2/3	18	2 x 1500hp Diesel	34x80 t Heavy Double	1020	68	7072	106080	494	532	1,026	33	35	68
136	Rockhampton	Alpha	Mixture 2/3	18	2 x 1500hp Diesel	27x80 t Triple	1215	81	8424	126360	426	478	904	28	32	60
137	Rockhampton	Alpha	Mixture 2/3	18	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	3952	59280	551	606	1,157	37	40	77
138	Rockhampton	Alpha	Mixture 2/3	18	1 x 2000hp Diesel	15x80 t Triple	675	45	4680	70200	476	533	1,009	32	36	67
139	Rockhampton	Alpha	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Heavy Double	1020	68	7072	106080	494	532	1,026	33	35	68
140	Rockhampton	Alpha	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Triple	1530	102	10608	159120	379	442	820	25	29	55
141	Rockhampton	Alpha	Mixture 2/3	20	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	3952	59280	551	606	1,157	37	40	77
142	Rockhampton	Alpha	Mixture 2/3	20	1 x 2000hp Diesel	15x80 t Triple	675	45	4680	70200	476	533	1,009	32	36	67
143	Rockhampton	Alpha	Mixture 2/3	26.5	1 x 3000hp Diesel	29x80 t Heavy Double	870	58	6032	90480	454	510	965	30	34	64
144	Rockhampton	Alpha	Mixture 2/3	26.5	1 x 3000hp Diesel	24x80 t Triple	1080	72	7488	112320	385	430	815	26	29	54

Table 38 Full Trainloads of Petroleum Product 156 trips per year

Scenario	Origin	Destination	Commodity	Axleload	No x type Locos	No x type Wagons	Forward Payload Tonnes per Train	Forward Containers per Train	TEUs per year	Tonnes per year	Total Cost/TEU Forward	Total Cost/TEU Return	Total Cost/TEU Round Trip	Forward $ Tonne	Return $ Tonne	Round trip $ Tonne
1	Gladstone	Emerald East	Petrol	15.75	2 x 1500hp Diesel	29x80 t Heavy Double	1,102	58	6,032	171,912	469	322	790	25	17	42
2	Gladstone	Emerald East	Petrol	18	2 x 1500hp Diesel	29x80 t Heavy Double	1,102	58	6,032	171,912	469	322	790	25	17	42
3	Gladstone	Emerald East	Petrol	18	2 x 2000hp Diesel	33x80 t Heavy Double	1,254	66	6,864	195,624	444	301	744	23	16	39
4	Gladstone	Emerald East	Petrol	20	2 x 1500hp Diesel	29x80 t Heavy Double	1,102	58	6,032	171,912	469	322	790	25	17	42
5	Gladstone	Emerald East	Petrol	20	2 x 2000hp Diesel	33x80 t Heavy Double	1,254	66	6,864	195,624	444	301	744	23	16	39
6	Gladstone	Emerald East	Petrol	20	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	5,200	148,200	428	303	731	23	16	38
7	Gladstone	Emerald East	Petrol	26.5	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	5,200	148,200	428	303	731	23	16	38
8	Gladstone	Emerald East	Petrol	26.5	2 x 1500hp Diesel	29x80 t Heavy Double	1,102	58	6,032	171,912	469	322	790	25	17	42
9	Gladstone	Emerald East	Petrol	26.5	2 x 2000hp Diesel	33x80 t Heavy Double	1,254	66	6,864	195,624	444	301	744	23	16	39
10	Gladstone	Emerald East	Petrol	26.5	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	5,200	148,200	428	303	731	23	16	38
49	Gladstone	Emerald West	Petrol	15.75	2 x 1500hp Diesel	29x80 t Heavy Double	1,102	58	6,032	171,912	491	335	826	26	18	43
50	Gladstone	Emerald West	Petrol	18	2 x 1500hp Diesel	29x80 t Heavy Double	1,102	58	6,032	171,912	491	335	826	26	18	43
51	Gladstone	Emerald West	Petrol	18	2 x 2000hp Diesel	33x80 t Heavy Double	1,254	66	6,864	195,624	464	313	777	24	16	41
52	Gladstone	Emerald West	Petrol	20	2 x 1500hp Diesel	29x80 t Heavy Double	1,102	58	6,032	171,912	491	335	826	26	18	43
53	Gladstone	Emerald West	Petrol	20	2 x 2000hp Diesel	33x80 t Heavy Double	1,254	66	6,864	195,624	464	313	777	24	16	41
54	Gladstone	Emerald West	Petrol	20	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	5,200	148,200	449	317	765	24	17	40
55	Gladstone	Emerald West	Petrol	26.5	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	5,200	148,200	449	317	765	24	17	40
56	Gladstone	Emerald West	Petrol	26.5	2 x 1500hp Diesel	23x100 t Triple	1,311	69	7,176	204,516	434	295	729	23	16	38
57	Gladstone	Emerald West	Petrol	26.5	2 x 2000hp Diesel	26x100 t Triple	1,482	78	8,112	231,192	413	266	678	22	14	36
58	Gladstone	Emerald West	Petrol	26.5	1 x 3000hp Diesel	20x100 t Triple	1,140	60	6,240	177,840	396	267	663	21	14	35
97	Gladstone	Alpha	Petrol	15.75	2 x 1500hp Diesel	29x80 t Heavy Double	1,102	58	6,032	171,912	605	399	1,004	32	21	53
98	Gladstone	Alpha	Petrol	18	2 x 1500hp Diesel	29x80 t Heavy Double	1,102	58	6,032	171,912	605	399	1,004	32	21	53
99	Gladstone	Alpha	Petrol	18	2 x 2000hp Diesel	33x80 t Heavy Double	1,254	66	6,864	195,624	570	371	941	30	20	50
100	Gladstone	Alpha	Petrol	20	2 x 1500hp Diesel	29x80 t Heavy Double	1,102	58	6,032	171,912	605	399	1,004	32	21	53
101	Gladstone	Alpha	Petrol	20	2 x 2000hp Diesel	33x80 t Heavy Double	1,254	66	6,864	195,624	570	371	941	30	20	50
102	Gladstone	Alpha	Petrol	20	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	5,200	148,200	553	382	935	29	20	49
103	Gladstone	Alpha	Petrol	26.5	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	5,200	148,200	553	382	935	29	20	49
104	Gladstone	Alpha	Petrol	26.5	2 x 1500hp Diesel	23x100 t Triple	1,311	69	7,176	204,516	534	353	887	28	19	47
105	Gladstone	Alpha	Petrol	26.5	2 x 2000hp Diesel	26x100 t Triple	1,482	78	8,112	231,192	506	314	821	27	17	43
106	Gladstone	Alpha	Petrol	26.5	1 x 3000hp Diesel	20x100 t Triple	1,140	60	6,240	177,840	488	321	809	26	17	43

Table 39 Full Trainloads of Grain or Cotton 156 trips per year

Scenario	Origin	Destination	Commodity	Axleload	No x type Locos	No x type Wagons	Forward Payload Tonnes per Train	Forward Containers per Train	TEUs per year	Tonnes per year	Cost/TEU Forward	Cost/TEU Return	Cost/TEU Round Trip	Forward $ Tonne	Return $ Tonne	Round trip $ Tonne
22	Emerald East	Gladstone	Grain	15.75	1 x 1500hp Diesel	14x80 t Heavy Double	560	28	2,912	87,360	578	432	1,010	29	22	51
23	Emerald East	Gladstone	Grain	18	2 x 1500hp Diesel	28x80 t Heavy Double	1,120	56	5,824	174,720	485	330	815	24	17	41
24	Emerald East	Gladstone	Grain	18	1 x 2000hp Diesel	16x80 t Heavy Double	640	32	3,328	99,840	539	400	939	27	20	47
25	Emerald East	Gladstone	Grain	18	2 x 2000hp Diesel	32x80 t Heavy Double	1,280	64	6,656	199,680	457	307	765	23	15	38
26	Emerald East	Gladstone	Grain	20	2 x 1500hp Diesel	28x80 t Heavy Double	1,120	56	5,824	174,720	485	330	815	24	17	41
27	Emerald East	Gladstone	Grain	20	1 x 2000hp Diesel	16x80 t Heavy Double	640	32	3,328	99,840	539	400	939	27	20	47
28	Emerald East	Gladstone	Grain	20	2 x 2000hp Diesel	32x80 t Heavy Double	1,280	64	6,656	199,680	457	307	765	23	15	38
29	Emerald East	Gladstone	Grain	26.5	2 x 1500hp Diesel	22x100 t Triple	1,320	66	6,864	205,920	430	282	712	22	14	36
30	Emerald East	Gladstone	Grain	26.5	1 x 2000hp Diesel	12x100 t Triple	720	36	3,744	112,320	490	353	843	25	18	42
31	Emerald East	Gladstone	Grain	26.5	2 x 2000hp Diesel	25x100 t Triple	1,500	75	7,800	234,000	408	263	672	20	13	34
32	Emerald East	Gladstone	Grain	26.5	1 x 3000hp Diesel	19x100 t Triple	1,140	57	5,928	177,840	394	264	658	20	13	33
33	Emerald East	Rockhampton	Cotton	15.75	1 x 1500hp Diesel	20x80 t Heavy Double	880	40	4,160	137,280	417	307	724	19	14	33
34	Emerald East	Rockhampton	Cotton	18	2 x 1500hp Diesel	41x80 t Heavy Double	1,804	82	8,528	281,424	353	245	598	16	11	27
35	Emerald East	Rockhampton	Cotton	18	1 x 2000hp Diesel	23x80 t Heavy Double	1,012	46	4,784	157,872	392	282	674	18	13	31
36	Emerald East	Rockhampton	Cotton	20	1 x 3000hp Diesel	36x80 t Heavy Double	1,584	72	7,488	247,104	325	217	542	15	10	25
70	Emerald West	Gladstone	Grain	15.75	1 x 1500hp Diesel	14x80 t Heavy Double	560	28	2,912	87,360	607	452	1,059	30	23	53
71	Emerald West	Gladstone	Grain	18	2 x 1500hp Diesel	28x80 t Heavy Double	1,120	56	5,824	174,720	508	344	852	25	17	43
72	Emerald West	Gladstone	Grain	18	1 x 2000hp Diesel	16x80 t Heavy Double	640	32	3,328	99,840	565	418	984	28	21	49
73	Emerald West	Gladstone	Grain	18	2 x 2000hp Diesel	32x80 t Heavy Double	1,280	64	6,656	199,680	479	320	799	24	16	40
74	Emerald West	Gladstone	Grain	20	2 x 1500hp Diesel	28x80 t Heavy Double	1,120	56	5,824	174,720	508	344	852	25	17	43
75	Emerald West	Gladstone	Grain	20	1 x 2000hp Diesel	16x80 t Heavy Double	640	32	3,328	99,840	565	418	984	28	21	49
76	Emerald West	Gladstone	Grain	20	2 x 2000hp Diesel	32x80 t Heavy Double	1,280	64	6,656	199,680	479	320	799	24	16	40
77	Emerald West	Gladstone	Grain	26.5	2 x 1500hp Diesel	22x100 t Triple	1,320	66	6,864	205,920	451	293	744	23	15	37
78	Emerald West	Gladstone	Grain	26.5	1 x 2000hp Diesel	12x100 t Triple	720	36	3,744	112,320	514	369	883	26	18	44
79	Emerald West	Gladstone	Grain	26.5	2 x 2000hp Diesel	25x100 t Triple	1,500	75	7,800	234,000	428	274	701	21	14	35
80	Emerald West	Gladstone	Grain	26.5	1 x 3000hp Diesel	19x100 t Triple	1,140	57	5,928	177,840	413	276	689	21	14	34
81	Emerald West	Rockhampton	Cotton	15.75	1 x 1500hp Diesel	20x80 t Heavy Double	880	40	4,160	137,280	441	323	764	20	15	35
82	Emerald West	Rockhampton	Cotton	18	2 x 1500hp Diesel	41x80 t Heavy Double	1,804	82	8,528	281,424	373	257	630	17	12	29
83	Emerald West	Rockhampton	Cotton	18	1 x 2000hp Diesel	23x80 t Heavy Double	1,012	46	4,784	157,872	414	297	711	19	13	32
84	Emerald West	Rockhampton	Cotton	20	1 x 3000hp Diesel	36x80 t Heavy Double	1,584	72	7,488	247,104	344	228	572	16	10	26
156	Rockhampton	Brisbane	Cotton	15.75	1 x 1500hp Diesel	20x80 t Heavy Double	880	40	4,160	137,280	675	469	1,144	31	21	52
157	Rockhampton	Brisbane	Cotton	18	2 x 1500hp Diesel	41x80 t Heavy Double	1,804	82	8,528	281,424	583	379	962	26	17	44
158	Rockhampton	Brisbane	Cotton	18	1 x 2000hp Diesel	23x80 t Heavy Double	1,012	46	4,784	157,872	634	428	1,062	29	19	48
159	Rockhampton	Brisbane	Cotton	20	1 x 3000hp Diesel	36x80 t Heavy Double	1,584	72	7,488	247,104	537	333	870	24	15	40

Table 40 Full Trainloads of General Freight (to coordinate with trains from Brisbane) 156 trips per year

Scenario	Origin	Destination	Commodity	Axleload	No x type Locos	No x type Wagons	Forward Payload Tonnes per Train	Forward Containers per Train	TEUs per year	Tonnes per year	Cost /TEU Forward	Cost /TEU Return	Cost /TEU Round Trip	Forward $ Tonne	Return $ Tonne	Round trip $ Tonne
11	Rockhampton	Emerald East	General	15.75	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7,904	142,272	316	250	566	26	21	47
12	Rockhampton	Emerald East	General	18	1 x 1500hp Diesel	19x80 t Heavy Double	456	38	3,952	71,136	379	311	690	32	26	57
13	Rockhampton	Emerald East	General	18	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7,904	142,272	316	250	566	26	21	47
14	Rockhampton	Emerald East	General	18	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	4,368	78,624	362	296	658	30	25	55
15	Rockhampton	Emerald East	General	18	2 x 2000hp Diesel	43x80 t Heavy Double	1,032	86	8,944	160,992	301	238	538	25	20	45
16	Rockhampton	Emerald East	General	20	1 x 1500hp Diesel	19x80 t Heavy Double	456	38	3,952	71,136	379	311	690	32	26	57
17	Rockhampton	Emerald East	General	20	1 x 1500hp Diesel	15x80 t Triple	540	45	4,680	84,240	326	259	584	27	22	49
18	Rockhampton	Emerald East	General	20	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	4,368	78,624	362	296	658	30	25	55
19	Rockhampton	Emerald East	General	20	1 x 2000hp Diesel	17x80 t Triple	612	51	5,304	95,472	306	245	551	26	20	46
20	Rockhampton	Emerald East	General	20	1 x 3000hp Diesel	34x80 t Heavy Double	816	68	7,072	127,296	283	223	506	24	19	42
21	Rockhampton	Emerald East	General	20	1 x 3000hp Diesel	27x80 t Triple	972	81	8,424	151,632	244	184	428	20	15	36
59	Rockhampton	Emerald West	General	15.75	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7,904	142,272	333	262	595	28	22	50
60	Rockhampton	Emerald West	General	18	1 x 1500hp Diesel	15x80 t Triple	540	45	4,680	84,240	344	272	616	29	23	51
61	Rockhampton	Emerald West	General	18	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7,904	142,272	333	262	595	28	22	50
62	Rockhampton	Emerald West	General	18	1 x 2000hp Diesel	17x80 t Triple	612	51	5,304	95,472	323	257	580	27	21	48
63	Rockhampton	Emerald West	General	18	2 x 2000hp Diesel	35x80 t Triple	1,260	105	10,920	196,560	269	205	473	22	17	39
64	Rockhampton	Emerald West	General	20	1 x 1500hp Diesel	19x80 t Heavy Double	456	38	3,952	71,136	400	327	727	33	27	61
65	Rockhampton	Emerald West	General	20	1 x 1500hp Diesel	15x80 t Triple	540	45	4,680	84,240	344	272	616	29	23	51
66	Rockhampton	Emerald West	General	20	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	4,368	78,624	382	311	693	32	26	58
67	Rockhampton	Emerald West	General	20	1 x 2000hp Diesel	17x80 t Triple	612	51	5,304	95,472	312	247	559	26	21	47
68	Rockhampton	Emerald West	General	20	1 x 3000hp Diesel	34x80 t Heavy Double	816	68	7,072	127,296	299	234	533	25	20	44
69	Rockhampton	Emerald West	General	20	1 x 3000hp Diesel	27x80 t Triple	972	81	8,424	151,632	258	193	451	21	16	38
107	Rockhampton	Alpha	General	15.75	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7,904	142,272	419	322	741	35	27	62
108	Rockhampton	Alpha	General	18	1 x 1500hp Diesel	19x80 t Heavy Double	456	38	3,952	71,136	503	404	906	42	34	76
109	Rockhampton	Alpha	General	18	2 x 1500hp Diesel	31x80 t Triple	1,116	93	9,672	174,096	355	262	618	30	22	51
110	Rockhampton	Alpha	General	18	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	4,368	78,624	478	383	861	40	32	72
111	Rockhampton	Alpha	General	18	2 x 2000hp Diesel	35x80 t Triple	1,260	105	10,920	196,560	338	252	590	28	21	49
112	Rockhampton	Alpha	General	20	1 x 1500hp Diesel	19x80 t Heavy Double	456	38	3,952	71,136	503	404	906	42	34	76
113	Rockhampton	Alpha	General	20	1 x 1500hp Diesel	15x80 t Triple	540	45	4,680	84,240	433	336	769	36	28	64
114	Rockhampton	Alpha	General	20	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	4,368	78,624	478	383	861	40	32	72
115	Rockhampton	Alpha	General	20	1 x 2000hp Diesel	17x80 t Triple	612	51	5,304	95,472	405	318	724	34	27	60
116	Rockhampton	Alpha	General	20	1 x 3000hp Diesel	34x80 t Heavy Double	816	68	7,072	127,296	376	290	666	31	24	55
117	Rockhampton	Alpha	General	20	1 x 3000hp Diesel	27x80 t Triple	972	81	8,424	151,632	325	239	564	27	20	47

Table 41 North Coast Line connecting Trains to Brisbane 156 trips per

Scenario	Origin	Destination	Commodity	Axleload	No x type Locos	No x type Wagons	Forward Payload Tonnes per Train	Forward Containers per Train	TEUs per year	Tonnes per year	Cost /TEU Forward	Cost /TEU Return	Cost /TEU Round Trip	Forward $ Tonne	Return $ Tonne	Round trip $ Tonne
145	Brisbane	Rockhampton	General	15.75	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7,904	142,272	506	379	885	42	32	74
146	Brisbane	Rockhampton	General	18	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7,904	142,272	506	379	885	42	32	74
147	Brisbane	Rockhampton	General	18	2 x 1500hp Diesel	31x80 t Triple	1,116	93	9,672	174,096	431	309	740	36	26	62
148	Brisbane	Rockhampton	General	18	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	4,368	78,624	567	443	1,010	47	37	84
149	Brisbane	Rockhampton	General	18	1 x 2000hp Diesel	17x80 t Triple	612	51	5,304	95,472	483	369	852	40	31	71
150	Brisbane	Rockhampton	General	20	1 x 3000hp Diesel	34x80 t Heavy Double	816	68	7,072	127,296	453	340	793	38	28	66
151	Brisbane	Rockhampton	General	20	1 x 3000hp Diesel	27x80 t Triple	972	81	8,424	151,632	393	280	673	33	23	56
152	Brisbane	Rockhampton	General	20	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7,904	142,272	506	379	885	42	32	74
153	Brisbane	Rockhampton	General	20	2 x 1500hp Diesel	31x80 t Triple	1,116	93	9,672	174,096	431	309	740	36	26	62
154	Brisbane	Rockhampton	General	20	2 x 2000hp Diesel	43x80 t Heavy Double	1,032	86	8,944	160,992	479	359	838	40	30	70
155	Brisbane	Rockhampton	General	20	2 x 2000hp Diesel	35x80 t Triple	1,260	105	10,920	196,560	409	297	707	34	25	59
160	Brisbane	Rockhampton	Mixture 2/3	15.75	2 x 1500hp Diesel	34x80 t Heavy Double	1,020	68	7,072	159,120	568	614	1,182	38	41	79
161	Brisbane	Rockhampton	Mixture 2/3	18	2 x 1500hp Diesel	27x80 t Triple	1,215	81	8,424	189,540	494	556	1,050	33	37	70
162	Brisbane	Rockhampton	Mixture 2/3	18	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	3,952	88,920	631	695	1,326	42	46	88
156	Rockhampton	Brisbane	Cotton	15.75	1 x 1500hp Diesel	20x80 t Heavy Double	880	40	4,160	137,280	675	469	1,144	31	21	52
157	Rockhampton	Brisbane	Cotton	18	2 x 1500hp Diesel	41x80 t Heavy Double	1,804	82	8,528	281,424	583	379	962	26	17	44
158	Rockhampton	Brisbane	Cotton	18	1 x 2000hp Diesel	23x80 t Heavy Double	1,012	46	4,784	157,872	634	428	1,062	29	19	48
159	Rockhampton	Brisbane	Cotton	20	1 x 3000hp Diesel	36x80 t Heavy Double	1,584	72	7,488	247,104	537	333	870	24	15	40

Table 42 Full Trainloads of Mixed Freight (2/3 loaded containers and 1/3 empty containers) 156 trips per year

Scenario	Origin	Destination	Commodity	Axleload	No x type Locos	No x type Wagons	Forward Payload Tonnes per Train	Forward Containers per Train	TEUs per year	Tonnes per year	Cost /TEU Forward	Cost /TEU Return	Cost /TEU Round Trip	Forward $ Tonne	Return $ Tonne	Round trip $ Tonne
37	Rockhampton	Emerald East	Mixture 2/3	15.75	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	3,536	79,560	423	444	867	28	30	58
38	Rockhampton	Emerald East	Mixture 2/3	18	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	3,536	79,560	423	444	867	28	30	58
39	Rockhampton	Emerald East	Mixture 2/3	18	2 x 1500hp Diesel	34x80 t Heavy Double	1,020	68	7,072	159,120	352	370	722	23	25	48
40	Rockhampton	Emerald East	Mixture 2/3	18	2 x 1500hp Diesel	27x80 t Triple	1,215	81	8,424	189,540	304	329	633	20	22	42
41	Rockhampton	Emerald East	Mixture 2/3	18	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	3,952	88,920	401	424	825	27	28	55
42	Rockhampton	Emerald East	Mixture 2/3	18	1 x 2000hp Diesel	15x80 t Triple	675	45	4,680	105,300	346	372	718	23	25	48
43	Rockhampton	Emerald East	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Heavy Double	1,020	68	7,072	159,120	352	370	722	23	25	48
44	Rockhampton	Emerald East	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Triple	1,530	102	10,608	238,680	268	299	568	18	20	38
45	Rockhampton	Emerald East	Mixture 2/3	20	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	3,952	88,920	401	424	825	27	28	55
46	Rockhampton	Emerald East	Mixture 2/3	20	1 x 2000hp Diesel	15x80 t Triple	675	45	4,680	105,300	346	372	718	23	25	48
47	Rockhampton	Emerald East	Mixture 2/3	26.5	1 x 3000hp Diesel	29x80 t Heavy Double	870	58	6,032	135,720	324	351	676	22	23	45
48	Rockhampton	Emerald East	Mixture 2/3	26.5	1 x 3000hp Diesel	24x80 t Triple	1,080	72	7,488	168,480	275	296	571	18	20	38
85	Rockhampton	Emerald West	Mixture 2/3	15.75	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	3,536	79,560	447	470	917	30	31	61
86	Rockhampton	Emerald West	Mixture 2/3	18	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	3,536	79,560	447	470	917	30	31	61
87	Rockhampton	Emerald West	Mixture 2/3	18	2 x 1500hp Diesel	34x80 t Heavy Double	1,020	68	7,072	159,120	372	391	763	25	26	51
88	Rockhampton	Emerald West	Mixture 2/3	18	2 x 1500hp Diesel	27x80 t Triple	1,215	81	8,424	189,540	321	349	670	21	23	45
89	Rockhampton	Emerald West	Mixture 2/3	18	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	3,952	88,920	423	450	873	28	30	58
90	Rockhampton	Emerald West	Mixture 2/3	18	1 x 2000hp Diesel	15x80 t Triple	675	45	4,680	105,300	365	395	760	24	26	51
91	Rockhampton	Emerald West	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Heavy Double	1,020	68	7,072	159,120	372	391	763	25	26	51
92	Rockhampton	Emerald West	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Triple	1,530	102	10,608	238,680	283	318	601	19	21	40
93	Rockhampton	Emerald West	Mixture 2/3	20	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	3,952	88,920	423	450	873	28	30	58
94	Rockhampton	Emerald West	Mixture 2/3	20	1 x 2000hp Diesel	15x80 t Triple	675	45	4,680	105,300	365	395	760	24	26	51
95	Rockhampton	Emerald West	Mixture 2/3	26.5	1 x 3000hp Diesel	29x80 t Heavy Double	870	58	6,032	135,720	342	373	715	23	25	48
96	Rockhampton	Emerald West	Mixture 2/3	26.5	1 x 3000hp Diesel	24x80 t Triple	1,080	72	7,488	168,480	290	315	605	19	21	40
133	Rockhampton	Alpha	Mixture 2/3	15.75	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	3,536	79,560	562	602	1,164	37	40	78
134	Rockhampton	Alpha	Mixture 2/3	18	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	3,536	79,560	562	602	1,164	37	40	78
135	Rockhampton	Alpha	Mixture 2/3	18	2 x 1500hp Diesel	34x80 t Heavy Double	1,020	68	7,072	159,120	469	501	969	31	33	65
136	Rockhampton	Alpha	Mixture 2/3	18	2 x 1500hp Diesel	27x80 t Triple	1,215	81	8,424	189,540	406	450	856	27	30	57
137	Rockhampton	Alpha	Mixture 2/3	18	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	3,952	88,920	531	575	1,106	35	38	74
138	Rockhampton	Alpha	Mixture 2/3	18	1 x 2000hp Diesel	15x80 t Triple	675	45	4,680	105,300	460	508	968	31	34	65
139	Rockhampton	Alpha	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Heavy Double	1,020	68	7,072	159,120	469	501	969	31	33	65
140	Rockhampton	Alpha	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Triple	1,530	102	10,608	238,680	359	414	772	24	28	51
141	Rockhampton	Alpha	Mixture 2/3	20	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	3,952	88,920	531	575	1,106	35	38	74
142	Rockhampton	Alpha	Mixture 2/3	20	1 x 2000hp Diesel	15x80 t Triple	675	45	4,680	105,300	460	508	968	31	34	65
143	Rockhampton	Alpha	Mixture 2/3	26.5	1 x 3000hp Diesel	29x80 t Heavy Double	870	58	6,032	135,720	432	482	914	29	32	61
144	Rockhampton	Alpha	Mixture 2/3	26.5	1 x 3000hp Diesel	24x80 t Triple	1,080	72	7,488	168,480	367	407	775	24	27	52

Table 43 Full Trainloads of Petroleum Product 208 trips per year

Scenario	Origin	Destination	Commodity	Axleload	No x type Locos	No x type Wagons	Forward Payload Tonnes per Train	Forward Containers per Train	TEUs per year	Tonnes per year	Cost /TEU Forward	Cost /TEU Return	Cost /TEU Round Trip	Forward $ Tonne	Return $ Tonne	Round trip $ Tonne
1	Gladstone	Emerald East	Petrol	15.75	2 x 1500hp Diesel	29x80 t Heavy Double	1,102	58	6,032	229,216	456	309	765	24	16	40
2	Gladstone	Emerald East	Petrol	18	2 x 1500hp Diesel	29x80 t Heavy Double	1,102	58	6,032	229,216	456	309	765	24	16	40
3	Gladstone	Emerald East	Petrol	18	2 x 2000hp Diesel	33x80 t Heavy Double	1,254	66	6,864	260,832	431	288	719	23	15	38
4	Gladstone	Emerald East	Petrol	20	2 x 1500hp Diesel	29x80 t Heavy Double	1,102	58	6,032	229,216	456	309	765	24	16	40
5	Gladstone	Emerald East	Petrol	20	2 x 2000hp Diesel	33x80 t Heavy Double	1,254	66	6,864	260,832	431	288	719	23	15	38
6	Gladstone	Emerald East	Petrol	20	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	5,200	197,600	415	290	706	22	15	37
7	Gladstone	Emerald East	Petrol	26.5	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	5,200	197,600	415	290	706	22	15	37
8	Gladstone	Emerald East	Petrol	26.5	2 x 1500hp Diesel	29x80 t Heavy Double	1,102	58	6,032	229,216	456	309	765	24	16	40
9	Gladstone	Emerald East	Petrol	26.5	2 x 2000hp Diesel	33x80 t Heavy Double	1,254	66	6,864	260,832	431	288	719	23	15	38
10	Gladstone	Emerald East	Petrol	26.5	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	5,200	197,600	415	290	706	22	15	37
49	Gladstone	Emerald West	Petrol	15.75	2 x 1500hp Diesel	29x80 t Heavy Double	1,102	58	6,032	229,216	479	322	801	25	17	42
50	Gladstone	Emerald West	Petrol	18	2 x 1500hp Diesel	29x80 t Heavy Double	1,102	58	6,032	229,216	479	322	801	25	17	42
51	Gladstone	Emerald West	Petrol	18	2 x 2000hp Diesel	33x80 t Heavy Double	1,254	66	6,864	260,832	452	300	752	24	16	40
52	Gladstone	Emerald West	Petrol	20	2 x 1500hp Diesel	29x80 t Heavy Double	1,102	58	6,032	229,216	479	322	801	25	17	42
53	Gladstone	Emerald West	Petrol	20	2 x 2000hp Diesel	33x80 t Heavy Double	1,254	66	6,864	260,832	452	300	752	24	16	40
54	Gladstone	Emerald West	Petrol	20	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	5,200	197,600	436	304	740	23	16	39
55	Gladstone	Emerald West	Petrol	26.5	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	5,200	197,600	436	304	740	23	16	39
56	Gladstone	Emerald West	Petrol	26.5	2 x 1500hp Diesel	23x100 t Triple	1,311	69	7,176	272,688	422	284	706	22	15	37
57	Gladstone	Emerald West	Petrol	26.5	2 x 2000hp Diesel	26x100 t Triple	1,482	78	8,112	308,256	401	254	656	21	13	35
58	Gladstone	Emerald West	Petrol	26.5	1 x 3000hp Diesel	20x100 t Triple	1,140	60	6,240	237,120	385	255	640	20	13	34
97	Gladstone	Alpha	Petrol	15.75	2 x 1500hp Diesel	29x80 t Heavy Double	1,102	58	6,032	171,912	605	399	1,004	32	21	53
98	Gladstone	Alpha	Petrol	18	2 x 1500hp Diesel	29x80 t Heavy Double	1,102	58	6,032	171,912	605	399	1,004	32	21	53
99	Gladstone	Alpha	Petrol	18	2 x 2000hp Diesel	33x80 t Heavy Double	1,254	66	6,864	195,624	570	371	941	30	20	50
100	Gladstone	Alpha	Petrol	20	2 x 1500hp Diesel	29x80 t Heavy Double	1,102	58	6,032	171,912	605	399	1,004	32	21	53
101	Gladstone	Alpha	Petrol	20	2 x 2000hp Diesel	33x80 t Heavy Double	1,254	66	6,864	195,624	570	371	941	30	20	50
102	Gladstone	Alpha	Petrol	20	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	5,200	148,200	553	382	935	29	20	49
103	Gladstone	Alpha	Petrol	26.5	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	5,200	148,200	553	382	935	29	20	49
104	Gladstone	Alpha	Petrol	26.5	2 x 1500hp Diesel	23x100 t Triple	1,311	69	7,176	204,516	534	353	887	28	19	47
105	Gladstone	Alpha	Petrol	26.5	2 x 2000hp Diesel	26x100 t Triple	1,482	78	8,112	231,192	506	314	821	27	17	43
106	Gladstone	Alpha	Petrol	26.5	1 x 3000hp Diesel	20x100 t Triple	1,140	60	6,240	177,840	488	321	809	26	17	43

Table 44 Full Trainloads of Grain or Cotton 208 trips per year

Scenario	Origin	Destination	Commodity	Axleload	No x type Locos	No x type Wagons	Forward Payload Tonnes per Train	Forward Containers per Train	TEUs per year	Tonnes per year	Cost /TEU Forward	Cost /TEU Return	Cost /TEU Round Trip	Forward $ Tonne	Return $ Tonne	Round trip $ Tonne
22	Emerald East	Gladstone	Grain	15.75	1 x 1500hp Diesel	14x80 t Heavy Double	560	28	2,912	116,480	565	420	985	28	21	49
23	Emerald East	Gladstone	Grain	18	2 x 1500hp Diesel	28x80 t Heavy Double	1,120	56	5,824	232,960	472	318	790	24	16	39
24	Emerald East	Gladstone	Grain	18	1 x 2000hp Diesel	16x80 t Heavy Double	640	32	3,328	133,120	526	388	914	26	19	46
25	Emerald East	Gladstone	Grain	18	2 x 2000hp Diesel	32x80 t Heavy Double	1,280	64	6,656	266,240	445	295	740	22	15	37
26	Emerald East	Gladstone	Grain	20	2 x 1500hp Diesel	28x80 t Heavy Double	1,120	56	5,824	232,960	472	318	790	24	16	39
27	Emerald East	Gladstone	Grain	20	1 x 2000hp Diesel	16x80 t Heavy Double	640	32	3,328	133,120	526	388	914	26	19	46
28	Emerald East	Gladstone	Grain	20	2 x 2000hp Diesel	32x80 t Heavy Double	1,280	64	6,656	266,240	445	295	740	22	15	37
29	Emerald East	Gladstone	Grain	26.5	2 x 1500hp Diesel	22x100 t Triple	1,320	66	6,864	274,560	419	270	689	21	14	34
30	Emerald East	Gladstone	Grain	26.5	1 x 2000hp Diesel	12x100 t Triple	720	36	3,744	149,760	479	341	820	24	17	41
31	Emerald East	Gladstone	Grain	26.5	2 x 2000hp Diesel	25x100 t Triple	1,500	75	7,800	312,000	397	252	649	20	13	32
32	Emerald East	Gladstone	Grain	26.5	1 x 3000hp Diesel	19x100 t Triple	1,140	57	5,928	237,120	382	253	635	19	13	32
33	Emerald East	Rockhampton	Cotton	15.75	1 x 1500hp Diesel	20x80 t Heavy Double	880	40	4,160	137,280	417	307	724	19	14	33
34	Emerald East	Rockhampton	Cotton	18	2 x 1500hp Diesel	41x80 t Heavy Double	1,804	82	8,528	281,424	353	245	598	16	11	27
35	Emerald East	Rockhampton	Cotton	18	1 x 2000hp Diesel	23x80 t Heavy Double	1,012	46	4,784	157,872	392	282	674	18	13	31
36	Emerald East	Rockhampton	Cotton	20	1 x 3000hp Diesel	36x80 t Heavy Double	1,584	72	7,488	247,104	325	217	542	15	10	25
70	Emerald West	Gladstone	Grain	15.75	1 x 1500hp Diesel	14x80 t Heavy Double	560	28	2,912	116,480	594	440	1,034	30	22	52
71	Emerald West	Gladstone	Grain	18	2 x 1500hp Diesel	28x80 t Heavy Double	1,120	56	5,824	232,960	495	331	827	25	17	41
72	Emerald West	Gladstone	Grain	18	1 x 2000hp Diesel	16x80 t Heavy Double	640	32	3,328	133,120	553	406	959	28	20	48
73	Emerald West	Gladstone	Grain	18	2 x 2000hp Diesel	32x80 t Heavy Double	1,280	64	6,656	266,240	466	307	774	23	15	39
74	Emerald West	Gladstone	Grain	20	2 x 1500hp Diesel	28x80 t Heavy Double	1,120	56	5,824	232,960	495	331	827	25	17	41
75	Emerald West	Gladstone	Grain	20	1 x 2000hp Diesel	16x80 t Heavy Double	640	32	3,328	133,120	553	406	959	28	20	48
76	Emerald West	Gladstone	Grain	20	2 x 2000hp Diesel	32x80 t Heavy Double	1,280	64	6,656	266,240	466	307	774	23	15	39
77	Emerald West	Gladstone	Grain	26.5	2 x 1500hp Diesel	22x100 t Triple	1,320	66	6,864	274,560	440	282	721	22	14	36
78	Emerald West	Gladstone	Grain	26.5	1 x 2000hp Diesel	12x100 t Triple	720	36	3,744	149,760	503	357	860	25	18	43
79	Emerald West	Gladstone	Grain	26.5	2 x 2000hp Diesel	25x100 t Triple	1,500	75	7,800	312,000	416	262	678	21	13	34
80	Emerald West	Gladstone	Grain	26.5	1 x 3000hp Diesel	19x100 t Triple	1,140	57	5,928	237,120	402	264	666	20	13	33
81	Emerald West	Rockhampton	Cotton	15.75	1 x 1500hp Diesel	20x80 t Heavy Double	880	40	4,160	137,280	441	323	764	20	15	35
82	Emerald West	Rockhampton	Cotton	18	2 x 1500hp Diesel	41x80 t Heavy Double	1,804	82	8,528	281,424	373	257	630	17	12	29
83	Emerald West	Rockhampton	Cotton	18	1 x 2000hp Diesel	23x80 t Heavy Double	1,012	46	4,784	157,872	414	297	711	19	13	32
84	Emerald West	Rockhampton	Cotton	20	1 x 3000hp Diesel	36x80 t Heavy Double	1,584	72	7,488	247,104	344	228	572	16	10	26

Table 45 Full Trainloads of General Freight (to coordinate with trains from Brisbane) 208 trips per year

Scenario	Origin	Destination	Commodity	Axleload	No x type Locos	No x type Wagons	Forward Payload Tonnes per Train	Forward Containers per Train	TEUs per year	Tonnes per year	Cost /TEU Forward	Cost /TEU Return	Cost /TEU Round Trip	Forward $ Tonne	Return $ Tonne	Round trip $ Tonne
11	Rockhampton	Emerald East	General	15.75	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7,904	189,696	304	237	541	25	20	45
12	Rockhampton	Emerald East	General	18	1 x 1500hp Diesel	19x80 t Heavy Double	456	38	3,952	94,848	367	298	665	31	25	55
13	Rockhampton	Emerald East	General	18	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7,904	189,696	304	237	541	25	20	45
14	Rockhampton	Emerald East	General	18	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	4,368	104,832	349	284	633	29	24	53
15	Rockhampton	Emerald East	General	18	2 x 2000hp Diesel	43x80 t Heavy Double	1,032	86	8,944	214,656	288	225	513	24	19	43
16	Rockhampton	Emerald East	General	20	1 x 1500hp Diesel	19x80 t Heavy Double	456	38	3,952	94,848	367	298	665	31	25	55
17	Rockhampton	Emerald East	General	20	1 x 1500hp Diesel	15x80 t Triple	540	45	4,680	112,320	316	249	564	26	21	47
18	Rockhampton	Emerald East	General	20	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	4,368	104,832	349	284	633	29	24	53
19	Rockhampton	Emerald East	General	20	1 x 2000hp Diesel	17x80 t Triple	612	51	5,304	127,296	296	235	531	25	20	44
20	Rockhampton	Emerald East	General	20	1 x 3000hp Diesel	34x80 t Heavy Double	816	68	7,072	169,728	271	210	481	23	18	40
21	Rockhampton	Emerald East	General	20	1 x 3000hp Diesel	27x80 t Triple	972	81	8,424	202,176	234	174	408	20	14	34
59	Rockhampton	Emerald West	General	15.75	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7,904	189,696	320	250	570	27	21	48
60	Rockhampton	Emerald West	General	18	1 x 1500hp Diesel	15x80 t Triple	540	45	4,680	112,320	334	262	596	28	22	50
61	Rockhampton	Emerald West	General	18	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7,904	189,696	320	250	570	27	21	48
62	Rockhampton	Emerald West	General	18	1 x 2000hp Diesel	17x80 t Triple	612	51	5,304	127,296	313	247	560	26	21	47
63	Rockhampton	Emerald West	General	18	2 x 2000hp Diesel	35x80 t Triple	1,260	105	10,920	262,080	259	195	453	22	16	38
64	Rockhampton	Emerald West	General	20	1 x 1500hp Diesel	19x80 t Heavy Double	456	38	3,952	94,848	388	314	702	32	26	59
65	Rockhampton	Emerald West	General	20	1 x 1500hp Diesel	15x80 t Triple	540	45	4,680	112,320	334	262	596	28	22	50
66	Rockhampton	Emerald West	General	20	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	4,368	104,832	369	299	668	31	25	56
67	Rockhampton	Emerald West	General	20	1 x 2000hp Diesel	17x80 t Triple	612	51	5,304	127,296	305	239	544	25	20	45
68	Rockhampton	Emerald West	General	20	1 x 3000hp Diesel	34x80 t Heavy Double	816	68	7,072	169,728	286	222	508	24	18	42
69	Rockhampton	Emerald West	General	20	1 x 3000hp Diesel	27x80 t Triple	972	81	8,424	202,176	248	183	431	21	15	36
107	Rockhampton	Alpha	General	15.75	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7,904	142,272	419	322	741	35	27	62
108	Rockhampton	Alpha	General	18	1 x 1500hp Diesel	19x80 t Heavy Double	456	38	3,952	71,136	503	404	906	42	34	76
109	Rockhampton	Alpha	General	18	2 x 1500hp Diesel	31x80 t Triple	1,116	93	9,672	174,096	355	262	618	30	22	51
110	Rockhampton	Alpha	General	18	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	4,368	78,624	478	383	861	40	32	72
111	Rockhampton	Alpha	General	18	2 x 2000hp Diesel	35x80 t Triple	1,260	105	10,920	196,560	338	252	590	28	21	49
112	Rockhampton	Alpha	General	20	1 x 1500hp Diesel	19x80 t Heavy Double	456	38	3,952	71,136	503	404	906	42	34	76
113	Rockhampton	Alpha	General	20	1 x 1500hp Diesel	15x80 t Triple	540	45	4,680	84,240	433	336	769	36	28	64
114	Rockhampton	Alpha	General	20	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	4,368	78,624	478	383	861	40	32	72
115	Rockhampton	Alpha	General	20	1 x 2000hp Diesel	17x80 t Triple	612	51	5,304	95,472	405	318	724	34	27	60
116	Rockhampton	Alpha	General	20	1 x 3000hp Diesel	34x80 t Heavy Double	816	68	7,072	127,296	376	290	666	31	24	55
117	Rockhampton	Alpha	General	20	1 x 3000hp Diesel	27x80 t Triple	972	81	8,424	151,632	325	239	564	27	20	47

Table 46 North Coast Line connecting Trains to Brisbane 208 trips per year

Scenario	Origin	Destination	Commodity	Axleload	No x type Locos	No x type Wagons	Forward Payload Tonnes per Train	Forward Containers per Train	TEUs per year	Tonnes per year	Cost /TEU Forward	Cost /TEU Return	Cost /TEU Round Trip	Forward $ Tonne	Return $ Tonne	Round trip $ Tonne
145	Brisbane	Rockhampton	General	15.75	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7,904	142,272	506	379	885	42	32	74
146	Brisbane	Rockhampton	General	18	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7,904	142,272	506	379	885	42	32	74
147	Brisbane	Rockhampton	General	18	2 x 1500hp Diesel	31x80 t Triple	1,116	93	9,672	174,096	431	309	740	36	26	62
148	Brisbane	Rockhampton	General	18	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	4,368	78,624	567	443	1,010	47	37	84
149	Brisbane	Rockhampton	General	18	1 x 2000hp Diesel	17x80 t Triple	612	51	5,304	95,472	483	369	852	40	31	71
150	Brisbane	Rockhampton	General	20	1 x 3000hp Diesel	34x80 t Heavy Double	816	68	7,072	127,296	453	340	793	38	28	66
151	Brisbane	Rockhampton	General	20	1 x 3000hp Diesel	27x80 t Triple	972	81	8,424	151,632	393	280	673	33	23	56
152	Brisbane	Rockhampton	General	20	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	7,904	142,272	506	379	885	42	32	74
153	Brisbane	Rockhampton	General	20	2 x 1500hp Diesel	31x80 t Triple	1,116	93	9,672	174,096	431	309	740	36	26	62
154	Brisbane	Rockhampton	General	20	2 x 2000hp Diesel	43x80 t Heavy Double	1,032	86	8,944	160,992	479	359	838	40	30	70
155	Brisbane	Rockhampton	General	20	2 x 2000hp Diesel	35x80 t Triple	1,260	105	10,920	196,560	409	297	707	34	25	59
160	Brisbane	Rockhampton	Mixture 2/3	15.75	2 x 1500hp Diesel	34x80 t Heavy Double	1,020	68	7,072	159,120	568	614	1,182	38	41	79
161	Brisbane	Rockhampton	Mixture 2/3	18	2 x 1500hp Diesel	27x80 t Triple	1,215	81	8,424	189,540	494	556	1,050	33	37	70
162	Brisbane	Rockhampton	Mixture 2/3	18	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	3,952	88,920	631	695	1,326	42	46	88
156	Rockhampton	Brisbane	Cotton	15.75	1 x 1500hp Diesel	20x80 t Heavy Double	880	40	4,160	137,280	675	469	1,144	31	21	52
157	Rockhampton	Brisbane	Cotton	18	2 x 1500hp Diesel	41x80 t Heavy Double	1,804	82	8,528	281,424	583	379	962	26	17	44
158	Rockhampton	Brisbane	Cotton	18	1 x 2000hp Diesel	23x80 t Heavy Double	1,012	46	4,784	157,872	634	428	1,062	29	19	48
159	Rockhampton	Brisbane	Cotton	20	1 x 3000hp Diesel	36x80 t Heavy Double	1,584	72	7,488	247,104	537	333	870	24	15	40

Table 47 Full Trainloads of Mixed Freight (2/3 loaded containers and 1/3 empty containers) 208 trips per year

Scenario	Origin	Destination	Commodity	Axleload	No x type Locos	No x type Wagons	Forward Payload Tonnes per Train	Forward Containers per Train	TEUs per year	Tonnes per year	Cost /TEU Forward	Cost /TEU Return	Cost /TEU Round Trip	Forward $ Tonne	Return $ Tonne	Round trip $ Tonne
37	Rockhampton	Emerald East	Mixture 2/3	15.75	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	3,536	106,080	410	431	842	27	29	56
38	Rockhampton	Emerald East	Mixture 2/3	18	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	3,536	106,080	410	431	842	27	29	56
39	Rockhampton	Emerald East	Mixture 2/3	18	2 x 1500hp Diesel	34x80 t Heavy Double	1,020	68	7,072	212,160	340	357	697	23	24	46
40	Rockhampton	Emerald East	Mixture 2/3	18	2 x 1500hp Diesel	27x80 t Triple	1,215	81	8,424	252,720	294	319	613	20	21	41
41	Rockhampton	Emerald East	Mixture 2/3	18	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	3,952	118,560	388	412	800	26	27	53
42	Rockhampton	Emerald East	Mixture 2/3	18	1 x 2000hp Diesel	15x80 t Triple	675	45	4,680	140,400	336	362	698	22	24	47
43	Rockhampton	Emerald East	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Heavy Double	1,020	68	7,072	212,160	340	357	697	23	24	46
44	Rockhampton	Emerald East	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Triple	1,530	102	10,608	318,240	258	289	548	17	19	37
45	Rockhampton	Emerald East	Mixture 2/3	20	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	3,952	118,560	388	412	800	26	27	53
46	Rockhampton	Emerald East	Mixture 2/3	20	1 x 2000hp Diesel	15x80 t Triple	675	45	4,680	140,400	336	362	698	22	24	47
47	Rockhampton	Emerald East	Mixture 2/3	26.5	1 x 3000hp Diesel	29x80 t Heavy Double	870	58	6,032	180,960	312	339	651	21	23	43
48	Rockhampton	Emerald East	Mixture 2/3	26.5	1 x 3000hp Diesel	24x80 t Triple	1,080	72	7,488	224,640	265	286	551	18	19	37
85	Rockhampton	Emerald West	Mixture 2/3	15.75	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	3,536	106,080	434	458	892	29	31	59
86	Rockhampton	Emerald West	Mixture 2/3	18	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	3,536	106,080	434	458	892	29	31	59
87	Rockhampton	Emerald West	Mixture 2/3	18	2 x 1500hp Diesel	34x80 t Heavy Double	1,020	68	7,072	212,160	359	379	738	24	25	49
88	Rockhampton	Emerald West	Mixture 2/3	18	2 x 1500hp Diesel	27x80 t Triple	1,215	81	8,424	252,720	311	339	650	21	23	43
89	Rockhampton	Emerald West	Mixture 2/3	18	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	3,952	118,560	410	437	848	27	29	57
90	Rockhampton	Emerald West	Mixture 2/3	18	1 x 2000hp Diesel	15x80 t Triple	675	45	4,680	140,400	355	385	740	24	26	49
91	Rockhampton	Emerald West	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Heavy Double	1,020	68	7,072	212,160	359	379	738	24	25	49
92	Rockhampton	Emerald West	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Triple	1,530	102	10,608	318,240	273	308	581	18	21	39
93	Rockhampton	Emerald West	Mixture 2/3	20	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	3,952	118,560	410	437	848	27	29	57
94	Rockhampton	Emerald West	Mixture 2/3	20	1 x 2000hp Diesel	15x80 t Triple	675	45	4,680	140,400	355	385	740	24	26	49
95	Rockhampton	Emerald West	Mixture 2/3	26.5	1 x 3000hp Diesel	29x80 t Heavy Double	870	58	6,032	180,960	330	360	690	22	24	46
96	Rockhampton	Emerald West	Mixture 2/3	26.5	1 x 3000hp Diesel	24x80 t Triple	1,080	72	7,488	224,640	280	305	585	19	20	39
133	Rockhampton	Alpha	Mixture 2/3	15.75	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	3,536	79,560	562	602	1,164	37	40	78
134	Rockhampton	Alpha	Mixture 2/3	18	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	3,536	79,560	562	602	1,164	37	40	78
135	Rockhampton	Alpha	Mixture 2/3	18	2 x 1500hp Diesel	34x80 t Heavy Double	1,020	68	7,072	159,120	469	501	969	31	33	65
136	Rockhampton	Alpha	Mixture 2/3	18	2 x 1500hp Diesel	27x80 t Triple	1,215	81	8,424	189,540	406	450	856	27	30	57
137	Rockhampton	Alpha	Mixture 2/3	18	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	3,952	88,920	531	575	1,106	35	38	74
138	Rockhampton	Alpha	Mixture 2/3	18	1 x 2000hp Diesel	15x80 t Triple	675	45	4,680	105,300	460	508	968	31	34	65
139	Rockhampton	Alpha	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Heavy Double	1,020	68	7,072	159,120	469	501	969	31	33	65
140	Rockhampton	Alpha	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Triple	1,530	102	10,608	238,680	359	414	772	24	28	51
141	Rockhampton	Alpha	Mixture 2/3	20	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	3,952	88,920	531	575	1,106	35	38	74
142	Rockhampton	Alpha	Mixture 2/3	20	1 x 2000hp Diesel	15x80 t Triple	675	45	4,680	105,300	460	508	968	31	34	65
143	Rockhampton	Alpha	Mixture 2/3	26.5	1 x 3000hp Diesel	29x80 t Heavy Double	870	58	6,032	135,720	432	482	914	29	32	61
144	Rockhampton	Alpha	Mixture 2/3	26.5	1 x 3000hp Diesel	24x80 t Triple	1,080	72	7,488	168,480	367	407	775	24	27	52
160	Brisbane	Rockhampton	Mixture 2/3	15.75	2 x 1500hp Diesel	34x80 t Heavy Double	1,020	68	7,072	159,120	568	614	1,182	38	41	79
161	Brisbane	Rockhampton	Mixture 2/3	18	2 x 1500hp Diesel	27x80 t Triple	1,215	81	8,424	189,540	494	556	1,050	33	37	70
162	Brisbane	Rockhampton	Mixture 2/3	18	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	3,952	88,920	631	695	1,326	42	46	88

Table 48 Consolidated Model Results

Scenario	Origin	Destination	Commodity	Axleload	No x type Locos	No x type Wagons	Forward Payload Tonnes per Train	Forward Containers per Train	Cost TEU 104 trips	Cost Tonne 104 trips	Cost TEU 156 trips	Cost Tonne 156 trips	Cost TEU 208 trips	Cost Tonne 208 trips
1	Gladstone	Emerald East	Petrol	15.75	2 x 1500hp Diesel	29x80 t Heavy Double	1102	58	841	44	790	42	765	40
2	Gladstone	Emerald East	Petrol	18	2 x 1500hp Diesel	29x80 t Heavy Double	1102	58	841	44	790	42	765	40
3	Gladstone	Emerald East	Petrol	18	2 x 2000hp Diesel	33x80 t Heavy Double	1254	66	794	42	744	39	719	38
4	Gladstone	Emerald East	Petrol	20	2 x 1500hp Diesel	29x80 t Heavy Double	1102	58	841	44	790	42	765	40
5	Gladstone	Emerald East	Petrol	20	2 x 2000hp Diesel	33x80 t Heavy Double	1254	66	794	42	744	39	719	38
6	Gladstone	Emerald East	Petrol	20	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	777	41	731	38	706	37
7	Gladstone	Emerald East	Petrol	26.5	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	777	41	731	38	706	37
8	Gladstone	Emerald East	Petrol	26.5	2 x 1500hp Diesel	29x80 t Heavy Double	1102	58	841	44	790	42	765	40
9	Gladstone	Emerald East	Petrol	26.5	2 x 2000hp Diesel	33x80 t Heavy Double	1254	66	794	42	744	39	719	38
10	Gladstone	Emerald East	Petrol	26.5	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	777	41	731	38	706	37
11	Rockhampton	Emerald East	General	15.75	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	618	52	566	47	541	45
12	Rockhampton	Emerald East	General	18	1 x 1500hp Diesel	19x80 t Heavy Double	456	38	735	61	690	57	665	55
13	Rockhampton	Emerald East	General	18	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	618	52	566	47	541	45
14	Rockhampton	Emerald East	General	18	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	703	59	658	55	633	53
15	Rockhampton	Emerald East	General	18	2 x 2000hp Diesel	43x80 t Heavy Double	1032	86	590	49	538	45	513	43
16	Rockhampton	Emerald East	General	20	1 x 1500hp Diesel	19x80 t Heavy Double	456	38	735	61	690	57	665	55
17	Rockhampton	Emerald East	General	20	1 x 1500hp Diesel	15x80 t Triple	540	45	620	52	584	49	564	47
18	Rockhampton	Emerald East	General	20	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	703	59	658	55	633	53
19	Rockhampton	Emerald East	General	20	1 x 2000hp Diesel	17x80 t Triple	612	51	587	49	551	46	531	44
20	Rockhampton	Emerald East	General	20	1 x 3000hp Diesel	34x80 t Heavy Double	816	68	554	46	506	42	481	40
21	Rockhampton	Emerald East	General	20	1 x 3000hp Diesel	27x80 t Triple	972	81	466	39	428	36	408	34
22	Emerald East	Gladstone	Grain	15.75	1 x 1500hp Diesel	14x80 t Heavy Double	560	28	1,053	53	1,010	51	985	49
23	Emerald East	Gladstone	Grain	18	2 x 1500hp Diesel	28x80 t Heavy Double	1120	56	865	43	815	41	790	39
24	Emerald East	Gladstone	Grain	18	1 x 2000hp Diesel	16x80 t Heavy Double	640	32	983	49	939	47	914	46
25	Emerald East	Gladstone	Grain	18	2 x 2000hp Diesel	32x80 t Heavy Double	1280	64	815	41	765	38	740	37
26	Emerald East	Gladstone	Grain	20	2 x 1500hp Diesel	28x80 t Heavy Double	1120	56	865	43	815	41	790	39
27	Emerald East	Gladstone	Grain	20	1 x 2000hp Diesel	16x80 t Heavy Double	640	32	983	49	939	47	914	46
28	Emerald East	Gladstone	Grain	20	2 x 2000hp Diesel	32x80 t Heavy Double	1280	64	815	41	765	38	740	37
29	Emerald East	Gladstone	Grain	26.5	2 x 1500hp Diesel	22x100 t Triple	1320	66	758	38	712	36	689	34
30	Emerald East	Gladstone	Grain	26.5	1 x 2000hp Diesel	12x100 t Triple	720	36	883	44	843	42	820	41
31	Emerald East	Gladstone	Grain	26.5	2 x 2000hp Diesel	25x100 t Triple	1500	75	718	36	672	34	649	32
32	Emerald East	Gladstone	Grain	26.5	1 x 3000hp Diesel	19x100 t Triple	1140	57	700	35	658	33	635	32
33	Emerald East	Rockhampton	Cotton	15.75	1 x 1500hp Diesel	20x80 t Heavy Double	880	40	769	35	724	33	724	33
34	Emerald East	Rockhampton	Cotton	18	2 x 1500hp Diesel	41x80 t Heavy Double	1804	82	650	30	598	27	598	27
35	Emerald East	Rockhampton	Cotton	18	1 x 2000hp Diesel	23x80 t Heavy Double	1012	46	720	33	674	31	674	31
36	Emerald East	Rockhampton	Cotton	20	1 x 3000hp Diesel	36x80 t Heavy Double	1584	72	590	27	542	25	542	25
37	Rockhampton	Emerald East	Mixture 2/3	15.75	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	916	61	867	58	842	56

Scenario	Origin	Destination	Commodity	Axleload	No x type Locos	No x type Wagons	Forward Payload Tonnes per Train	Forward Containers per Train	Cost TEU 104 trips	Cost Tonne 104 trips	Cost TEU 156 trips	Cost Tonne 156 trips	Cost TEU 208 trips	Cost Tonne 208 trips
38	Rockhampton	Emerald East	Mixture 2/3	18	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	916	61	867	58	842	56
39	Rockhampton	Emerald East	Mixture 2/3	18	2 x 1500hp Diesel	34x80 t Heavy Double	1020	68	777	52	722	48	697	46
40	Rockhampton	Emerald East	Mixture 2/3	18	2 x 1500hp Diesel	27x80 t Triple	1215	81	680	45	633	42	613	41
41	Rockhampton	Emerald East	Mixture 2/3	18	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	875	58	825	55	800	53
42	Rockhampton	Emerald East	Mixture 2/3	18	1 x 2000hp Diesel	15x80 t Triple	675	45	758	51	718	48	698	47
43	Rockhampton	Emerald East	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Heavy Double	1020	68	777	52	722	48	697	46
44	Rockhampton	Emerald East	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Triple	1530	102	615	41	568	38	548	37
45	Rockhampton	Emerald East	Mixture 2/3	20	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	875	58	825	55	800	53
46	Rockhampton	Emerald East	Mixture 2/3	20	1 x 2000hp Diesel	15x80 t Triple	675	45	758	51	718	48	698	47
47	Rockhampton	Emerald East	Mixture 2/3	26.5	1 x 3000hp Diesel	29x80 t Heavy Double	870	58	726	48	676	45	651	43
48	Rockhampton	Emerald East	Mixture 2/3	26.5	1 x 3000hp Diesel	24x80 t Triple	1080	72	611	41	571	38	551	37
49	Gladstone	Emerald West	Petrol	15.75	2 x 1500hp Diesel	29x80 t Heavy Double	1102	58	877	46	826	43	801	42
50	Gladstone	Emerald West	Petrol	18	2 x 1500hp Diesel	29x80 t Heavy Double	1102	58	877	46	826	43	801	42
51	Gladstone	Emerald West	Petrol	18	2 x 2000hp Diesel	33x80 t Heavy Double	1254	66	827	44	777	41	752	40
52	Gladstone	Emerald West	Petrol	20	2 x 1500hp Diesel	29x80 t Heavy Double	1102	58	877	46	826	43	801	42
53	Gladstone	Emerald West	Petrol	20	2 x 2000hp Diesel	33x80 t Heavy Double	1254	66	827	44	777	41	752	40
54	Gladstone	Emerald West	Petrol	20	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	812	43	765	40	740	39
55	Gladstone	Emerald West	Petrol	26.5	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	812	43	765	40	740	39
56	Gladstone	Emerald West	Petrol	26.5	2 x 1500hp Diesel	23x100 t Triple	1311	69	777	41	729	38	706	37
57	Gladstone	Emerald West	Petrol	26.5	2 x 2000hp Diesel	26x100 t Triple	1482	78	724	38	678	36	656	35
58	Gladstone	Emerald West	Petrol	26.5	1 x 3000hp Diesel	20x100 t Triple	1140	60	706	37	663	35	640	34
59	Rockhampton	Emerald West	General	15.75	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	647	54	595	50	570	48
60	Rockhampton	Emerald West	General	18	1 x 1500hp Diesel	15x80 t Triple	540	45	652	54	616	51	596	50
61	Rockhampton	Emerald West	General	18	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	647	54	595	50	570	48
62	Rockhampton	Emerald West	General	18	1 x 2000hp Diesel	17x80 t Triple	612	51	617	51	580	48	560	47
63	Rockhampton	Emerald West	General	18	2 x 2000hp Diesel	35x80 t Triple	1260	105	515	43	473	39	453	38
64	Rockhampton	Emerald West	General	20	1 x 1500hp Diesel	19x80 t Heavy Double	456	38	772	64	727	61	702	59
65	Rockhampton	Emerald West	General	20	1 x 1500hp Diesel	15x80 t Triple	540	45	652	54	616	51	596	50
66	Rockhampton	Emerald West	General	20	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	738	62	693	58	668	56
67	Rockhampton	Emerald West	General	20	1 x 2000hp Diesel	17x80 t Triple	612	51	585	49	559	47	544	45
68	Rockhampton	Emerald West	General	20	1 x 3000hp Diesel	34x80 t Heavy Double	816	68	581	48	533	44	508	42
69	Rockhampton	Emerald West	General	20	1 x 3000hp Diesel	27x80 t Triple	972	81	489	41	451	38	431	36
70	Emerald West	Gladstone	Grain	15.75	1 x 1500hp Diesel	14x80 t Heavy Double	560	28	1,103	55	1,059	53	1,034	52
71	Emerald West	Gladstone	Grain	18	2 x 1500hp Diesel	28x80 t Heavy Double	1120	56	902	45	852	43	827	41
72	Emerald West	Gladstone	Grain	18	1 x 2000hp Diesel	16x80 t Heavy Double	640	32	1,028	51	984	49	959	48
73	Emerald West	Gladstone	Grain	18	2 x 2000hp Diesel	32x80 t Heavy Double	1280	64	849	42	799	40	774	39
74	Emerald West	Gladstone	Grain	20	2 x 1500hp Diesel	28x80 t Heavy Double	1120	56	902	45	852	43	827	41
75	Emerald West	Gladstone	Grain	20	1 x 2000hp Diesel	16x80 t Heavy Double	640	32	1,028	51	984	49	959	48

Scenario	Origin	Destination	Commodity	Axleload	No x type Locos	No x type Wagons	Forward Payload Tonnes per Train	Forward Containers per Train	Cost TEU 104 trips	Cost Tonne 104 trips	Cost TEU 156 trips	Cost Tonne 156 trips	Cost TEU 208 trips	Cost Tonne 208 trips
76	Emerald West	Gladstone	Grain	20	2 x 2000hp Diesel	32x80 t Heavy Double	1280	64	849	42	799	40	774	39
77	Emerald West	Gladstone	Grain	26.5	2 x 1500hp Diesel	22x100 t Triple	1320	66	790	39	744	37	721	36
78	Emerald West	Gladstone	Grain	26.5	1 x 2000hp Diesel	12x100 t Triple	720	36	924	46	883	44	860	43
79	Emerald West	Gladstone	Grain	26.5	2 x 2000hp Diesel	25x100 t Triple	1500	75	747	37	701	35	678	34
80	Emerald West	Gladstone	Grain	26.5	1 x 3000hp Diesel	19x100 t Triple	1140	57	732	37	689	34	666	33
81	Emerald West	Rockhampton	Cotton	15.75	1 x 1500hp Diesel	20x80 t Heavy Double	880	40	810	37	764	35	764	35
82	Emerald West	Rockhampton	Cotton	18	2 x 1500hp Diesel	41x80 t Heavy Double	1804	82	682	31	630	29	630	29
83	Emerald West	Rockhampton	Cotton	18	1 x 2000hp Diesel	23x80 t Heavy Double	1012	46	757	34	711	32	711	32
84	Emerald West	Rockhampton	Cotton	20	1 x 3000hp Diesel	36x80 t Heavy Double	1584	72	620	28	572	26	572	26
85	Rockhampton	Emerald West	Mixture 2/3	15.75	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	967	64	917	61	892	59
86	Rockhampton	Emerald West	Mixture 2/3	18	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	967	64	917	61	892	59
87	Rockhampton	Emerald West	Mixture 2/3	18	2 x 1500hp Diesel	34x80 t Heavy Double	1020	68	818	55	763	51	738	49
88	Rockhampton	Emerald West	Mixture 2/3	18	2 x 1500hp Diesel	27x80 t Triple	1215	81	717	48	670	45	650	43
89	Rockhampton	Emerald West	Mixture 2/3	18	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	923	62	873	58	848	57
90	Rockhampton	Emerald West	Mixture 2/3	18	1 x 2000hp Diesel	15x80 t Triple	675	45	800	53	760	51	740	49
91	Rockhampton	Emerald West	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Heavy Double	1020	68	818	55	763	51	738	49
92	Rockhampton	Emerald West	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Triple	1530	102	648	43	601	40	581	39
93	Rockhampton	Emerald West	Mixture 2/3	20	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	923	62	873	58	848	57
94	Rockhampton	Emerald West	Mixture 2/3	20	1 x 2000hp Diesel	15x80 t Triple	675	45	800	53	760	51	740	49
95	Rockhampton	Emerald West	Mixture 2/3	26.5	1 x 3000hp Diesel	29x80 t Heavy Double	870	58	765	51	715	48	690	46
96	Rockhampton	Emerald West	Mixture 2/3	26.5	1 x 3000hp Diesel	24x80 t Triple	1080	72	645	43	605	40	585	39
97	Gladstone	Alpha	Petrol	15.75	2 x 1500hp Diesel	29x80 t Heavy Double	1102	58	1,055	56	1,004	53	1,004	53
98	Gladstone	Alpha	Petrol	18	2 x 1500hp Diesel	29x80 t Heavy Double	1102	58	1,055	56	1,004	53	1,004	53
99	Gladstone	Alpha	Petrol	18	2 x 2000hp Diesel	33x80 t Heavy Double	1254	66	992	52	941	50	941	50
100	Gladstone	Alpha	Petrol	20	2 x 1500hp Diesel	29x80 t Heavy Double	1102	58	1,055	56	1,004	53	1,004	53
101	Gladstone	Alpha	Petrol	20	2 x 2000hp Diesel	33x80 t Heavy Double	1254	66	992	52	941	50	941	50
102	Gladstone	Alpha	Petrol	20	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	982	52	935	49	935	49
103	Gladstone	Alpha	Petrol	26.5	1 x 3000hp Diesel	25x80 t Heavy Double	950	50	982	52	935	49	935	49
104	Gladstone	Alpha	Petrol	26.5	2 x 1500hp Diesel	23x100 t Triple	1311	69	936	49	887	47	887	47
105	Gladstone	Alpha	Petrol	26.5	2 x 2000hp Diesel	26x100 t Triple	1482	78	867	46	821	43	821	43
106	Gladstone	Alpha	Petrol	26.5	1 x 3000hp Diesel	20x100 t Triple	1140	60	853	45	809	43	809	43
107	Rockhampton	Alpha	General	15.75	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	794	66	741	62	741	62
108	Rockhampton	Alpha	General	18	1 x 1500hp Diesel	19x80 t Heavy Double	456	38	952	79	906	76	906	76
109	Rockhampton	Alpha	General	18	2 x 1500hp Diesel	31x80 t Triple	1116	93	660	55	618	51	618	51
110	Rockhampton	Alpha	General	18	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	907	76	861	72	861	72
111	Rockhampton	Alpha	General	18	2 x 2000hp Diesel	35x80 t Triple	1260	105	632	53	590	49	590	49
112	Rockhampton	Alpha	General	20	1 x 1500hp Diesel	19x80 t Heavy Double	456	38	952	79	906	76	906	76
113	Rockhampton	Alpha	General	20	1 x 1500hp Diesel	15x80 t Triple	540	45	806	67	769	64	769	64

Scenario	Origin	Destination	Commodity	Axleload	No x type Locos	No x type Wagons	Forward Payload Tonnes per Train	Forward Containers per Train	Cost TEU 104 trips	Cost Tonne 104 trips	Cost TEU 156 trips	Cost Tonne 156 trips	Cost TEU 208 trips	Cost Tonne 208 trips
114	Rockhampton	Alpha	General	20	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	907	76	861	72	861	72
115	Rockhampton	Alpha	General	20	1 x 2000hp Diesel	17x80 t Triple	612	51	760	63	724	60	724	60
116	Rockhampton	Alpha	General	20	1 x 3000hp Diesel	34x80 t Heavy Double	816	68	714	59	666	55	666	55
117	Rockhampton	Alpha	General	20	1 x 3000hp Diesel	27x80 t Triple	972	81	602	50	564	47	564	47
118	Alpha	Gladstone	Grain	15.75	1 x 1500hp Diesel	14x80 t Heavy Double	560	28	1,338	67	1,293	65	1,293	65
119	Alpha	Gladstone	Grain	18	2 x 1500hp Diesel	28x80 t Heavy Double	1120	56	1,087	54	1,036	52	1,036	52
120	Alpha	Gladstone	Grain	18	1 x 2000hp Diesel	16x80 t Heavy Double	640	32	1,244	62	1,198	60	1,198	60
121	Alpha	Gladstone	Grain	18	2 x 2000hp Diesel	32x80 t Heavy Double	1280	64	1,018	51	967	48	967	48
122	Alpha	Gladstone	Grain	20	2 x 1500hp Diesel	28x80 t Heavy Double	1120	56	1,087	54	1,036	52	1,036	52
123	Alpha	Gladstone	Grain	20	1 x 2000hp Diesel	16x80 t Heavy Double	640	32	1,244	62	1,198	60	1,198	60
124	Alpha	Gladstone	Grain	20	2 x 2000hp Diesel	32x80 t Heavy Double	1280	64	1,018	51	967	48	967	48
125	Alpha	Gladstone	Grain	26.5	2 x 1500hp Diesel	22x100 t Triple	1320	66	950	48	903	45	903	45
126	Alpha	Gladstone	Grain	26.5	1 x 2000hp Diesel	12x100 t Triple	720	36	1,116	56	1,074	54	1,074	54
127	Alpha	Gladstone	Grain	26.5	2 x 2000hp Diesel	25x100 t Triple	1500	75	895	45	849	42	849	42
128	Alpha	Gladstone	Grain	26.5	1 x 3000hp Diesel	19x100 t Triple	1140	57	884	44	841	42	841	42
129	Alpha	Rockhampton	Cotton	15.75	1 x 1500hp Diesel	20x80 t Heavy Double	880	40	1,008	46	962	44	962	44
130	Alpha	Rockhampton	Cotton	18	2 x 1500hp Diesel	41x80 t Heavy Double	1804	82	847	38	794	36	794	36
131	Alpha	Rockhampton	Cotton	18	1 x 2000hp Diesel	23x80 t Heavy Double	1012	46	939	43	893	41	893	41
132	Alpha	Rockhampton	Cotton	20	1 x 3000hp Diesel	36x80 t Heavy Double	1584	72	769	35	722	33	722	33
133	Rockhampton	Alpha	Mixture 2/3	15.75	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	1,215	81	1,164	78	1,164	78
134	Rockhampton	Alpha	Mixture 2/3	18	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	1,215	81	1,164	78	1,164	78
135	Rockhampton	Alpha	Mixture 2/3	18	2 x 1500hp Diesel	34x80 t Heavy Double	1020	68	1,026	68	969	65	969	65
136	Rockhampton	Alpha	Mixture 2/3	18	2 x 1500hp Diesel	27x80 t Triple	1215	81	904	60	856	57	856	57
137	Rockhampton	Alpha	Mixture 2/3	18	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	1,157	77	1,106	74	1,106	74
138	Rockhampton	Alpha	Mixture 2/3	18	1 x 2000hp Diesel	15x80 t Triple	675	45	1,009	67	968	65	968	65
139	Rockhampton	Alpha	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Heavy Double	1020	68	1,026	68	969	65	969	65
140	Rockhampton	Alpha	Mixture 2/3	20	2 x 1500hp Diesel	34x80 t Triple	1530	102	820	55	772	51	772	51
141	Rockhampton	Alpha	Mixture 2/3	20	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	1,157	77	1,106	74	1,106	74
142	Rockhampton	Alpha	Mixture 2/3	20	1 x 2000hp Diesel	15x80 t Triple	675	45	1,009	67	968	65	968	65
143	Rockhampton	Alpha	Mixture 2/3	26.5	1 x 3000hp Diesel	29x80 t Heavy Double	870	58	965	64	914	61	914	61
144	Rockhampton	Alpha	Mixture 2/3	26.5	1 x 3000hp Diesel	24x80 t Triple	1080	72	815	54	775	52	775	52
145	Brisbane	Rockhampton	General	15.75	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	939	78	885	74	885	74
146	Brisbane	Rockhampton	General	18	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	939	78	885	74	885	74
147	Brisbane	Rockhampton	General	18	2 x 1500hp Diesel	31x80 t Triple	1116	93	783	65	740	62	740	62
148	Brisbane	Rockhampton	General	18	1 x 2000hp Diesel	21x80 t Heavy Double	504	42	1,056	88	1,010	84	1,010	84
149	Brisbane	Rockhampton	General	18	1 x 2000hp Diesel	17x80 t Triple	612	51	889	74	852	71	852	71
150	Brisbane	Rockhampton	General	20	1 x 3000hp Diesel	34x80 t Heavy Double	816	68	841	70	793	66	793	66
151	Brisbane	Rockhampton	General	20	1 x 3000hp Diesel	27x80 t Triple	972	81	711	59	673	56	673	56

Scenario	Origin	Destination	Commodity	Axleload	No x type Locos	No x type Wagons	Forward Payload Tonnes per Train	Forward Containers per Train	Cost TEU 104 trips	Cost Tonne 104 trips	Cost TEU 156 trips	Cost Tonne 156 trips	Cost TEU 208 trips	Cost Tonne 208 trips
152	Brisbane	Rockhampton	General	20	2 x 1500hp Diesel	38x80 t Heavy Double	912	76	939	78	885	74	885	74
153	Brisbane	Rockhampton	General	20	2 x 1500hp Diesel	31x80 t Triple	1116	93	783	65	740	62	740	62
154	Brisbane	Rockhampton	General	20	2 x 2000hp Diesel	43x80 t Heavy Double	1032	86	891	74	838	70	838	70
155	Brisbane	Rockhampton	General	20	2 x 2000hp Diesel	35x80 t Triple	1260	105	749	62	707	59	707	59
156	Rockhampton	Brisbane	Cotton	15.75	1 x 1500hp Diesel	20x80 t Heavy Double	880	40	1,190	54	1,144	52	1,144	52
157	Rockhampton	Brisbane	Cotton	18	2 x 1500hp Diesel	41x80 t Heavy Double	1804	82	1,015	46	962	44	962	44
158	Rockhampton	Brisbane	Cotton	18	1 x 2000hp Diesel	23x80 t Heavy Double	1012	46	1,109	50	1,062	48	1,062	48
159	Rockhampton	Brisbane	Cotton	20	1 x 3000hp Diesel	36x80 t Heavy Double	1584	72	918	42	870	40	870	40
160	Brisbane	Rockhampton	Mixture 2/3	15.75	2 x 1500hp Diesel	34x80 t Heavy Double	1020	68	1,239	83	1,182	79	1,182	79
161	Brisbane	Rockhampton	Mixture 2/3	18	2 x 1500hp Diesel	27x80 t Triple	1215	81	1,098	73	1,050	70	1,050	70
162	Brisbane	Rockhampton	Mixture 2/3	18	1 x 2000hp Diesel	19x80 t Heavy Double	570	38	1,377	92	1,326	88	1,326	88
163	Brisbane	Rockhampton	Mixture 2/3	18	1 x 2000hp Diesel	15x80 t Triple	675	45	1,208	81	1,167	78	1,167	78

Table 49 Estimated Present Day Costs

Scenario	Origin	Destination	Commodity	Axleload tonnes	No x type Locos	No x type Wagons	Forward Payload Tonnes per Train	Forward Containers per Train	TEUs per year	Tonnes per year	Cost/TEU Forward	Cost/TEU Return	Cost/TEU Round Trip	Forward $ Tonne	Return $ Tonne	Round trip $ Tonne
1	Gladstone	Emerald East	Petrol	15.75	1 x 1500hp Diesel	9x80 t Heavy Double	342	18	1872	26676	822	662	1,484	43	35	78
11	Rockhampton	Emerald East	General	15.75	1 x 1500hp Diesel	12x80 t Heavy Double	288	24	2496	22464	567	488	1,054	47	41	88
22	Emerald East	Gladstone	Grain	15.75	1 x 1500hp Diesel	9x80 t Heavy Double	360	18	1872	28080	828	662	1,490	41	33	74
33	Emerald East	Rockhampton	Cotton	15.75	1 x 1500hp Diesel	13x80 t Heavy Double	572	26	2704	44616	587	467	1,054	27	21	48
37	Rockhampton	Emerald East	Mixture 2/3	15.75	1 x 1500hp Diesel	11x80 t Heavy Double	330	22	2288	25740	616	616	1,232	41	41	82
49	Gladstone	Emerald West	Petrol	15.75	1 x 1500hp Diesel	9x80 t Heavy Double	342	18	1872	26676	862	691	1,553	45	36	82
59	Rockhampton	Emerald West	General	15.75	1 x 1500hp Diesel	12x80 t Heavy Double	288	24	2496	22464	596	511	1,107	50	43	92
70	Emerald West	Gladstone	Grain	15.75	1 x 1500hp Diesel	9x80 t Heavy Double	360	18	1872	28080	868	691	1,559	43	35	78
81	Emerald West	Rockhampton	Cotton	15.75	1 x 1500hp Diesel	13x80 t Heavy Double	572	26	2704	44616	619	489	1,108	28	22	50
85	Rockhampton	Emerald West	Mixture 2/3	15.75	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	3536	39780	491	526	1,017	33	35	68
97	Gladstone	Alpha	Petrol	15.75	1 x 1500hp Diesel	9x80 t Heavy Double	342	18	1872	26676	1,051	823	1,873	55	43	99
107	Rockhampton	Alpha	General	15.75	1 x 1500hp Diesel	12x80 t Heavy Double	288	24	2496	22464	738	617	1,354	61	51	113
118	Alpha	Gladstone	Grain	15.75	1 x 1500hp Diesel	9x80 t Heavy Double	360	18	1872	28080	1,059	823	1,881	53	41	94
129	Alpha	Rockhampton	Cotton	15.75	1 x 1500hp Diesel	13x80 t Heavy Double	572	26	2704	44616	772	593	1,365	35	27	62
133	Rockhampton	Alpha	Mixture 2/3	15.75	1 x 1500hp Diesel	17x80 t Heavy Double	510	34	3536	39780	607	658	1,265	40	44	84
145	Brisbane	Rockhampton	General	15.75	1 x 1500hp Diesel	12x80 t Heavy Double	288	24	2496	22464	861	697	1,557	72	58	130
156	Rockhampton	Brisbane	Cotton	15.75	1 x 1500hp Diesel	13x80 t Heavy Double	572	26	2704	44616	913	674	1,586	41	31	72
160	Brisbane	Rockhampton	Mixture 2/3	15.75	1 x 1500hp Diesel	11x80 t Heavy Double	330	22	2288	25740	942	942	1,884	63	63	126

Table 50 Minimum Savings

Origin	Destination	Commodity	Potential Cost TEU 104 trips	Potential Cost Tonne 104 trips	Potential Cost/TEU Round Trip	Current Round Trip $ Tonne	Potential Minimum Saving per tonne	Potential Minimum Saving %
Alpha	Gladstone	Grain	1,338	67	1,881	94	27	29%
Alpha	Rockhampton	Cotton	1,008	46	1,365	62	16	26%
Brisbane	Rockhampton	General	783	65	1,557	130	65	50%
Brisbane	Rockhampton	Mixture 2/3	1,239	83	1,884	126	43	34%
Emerald East	Gladstone	Grain	865	43	1,490	74	31	42%
Emerald East	Rockhampton	Cotton	650	30	1,054	48	18	38%
Emerald West	Gladstone	Grain	1,103	55	1,559	78	23	29%
Emerald West	Rockhampton	Cotton	810	37	1,108	50	14	27%
Gladstone	Alpha	Petrol	1,055	56	1,873	99	43	44%
Gladstone	Emerald East	Petrol	841	44	1,484	78	34	43%
Gladstone	Emerald West	Petrol	877	46	1,553	82	36	44%
Rockhampton	Alpha	General	794	66	1,354	113	47	41%
Rockhampton	Alpha	Mixture 2/3	1,215	81	1,265	84	3	4%
Rockhampton	Brisbane	Cotton	1,190	54	1,586	72	18	25%
Rockhampton	Emerald East	General	618	52	1,054	88	36	41%
Rockhampton	Emerald East	Mixture 2/3	680	45	1,232	82	37	45%
Rockhampton	Emerald West	General	647	54	1,107	92	38	42%
Rockhampton	Emerald West	Mixture 2/3	967	64	1,017	68	3	5%