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Inland Rail Supply Chain Mapping

Parkes to Narromine Pilot

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The analysis and findings contained in this report do not represent government policy

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Executive summary

Inland Rail is a major national infrastructure project that will deliver direct and indirect benefits to regional producers and industries. Capitalising on Inland Rail's full potential to support these industries requires a robust understanding of the characteristics of local supply chains, including transport distribution patterns.

The Parkes to Narromine Inland Rail Supply Chain Mapping pilot project was designed to apply the capability of CSIRO's Transport Network Strategic Investment Tool (TraNSIT) to the underlying data to identify and assess any competitiveness improvements in certain supply chains due to Inland Rail.

A baseline of existing freight movements associated with the study area (Figure 1) was established using TraNSIT, with input from stakeholders, to model any potential transport cost savings for supply chains should they use Inland Rail. The pilot project sought to demonstrate the effectiveness of TraNSIT as a means of modelling complex supply chains at the national and local level.

While some further refinements will be made to the analysis as the project is rolled out along the Inland Rail corridor, the pilot demonstrated:

- the ability of TraNSIT to identify potential supply chains that might benefit from Inland Rail
- the relative significance of the potential transport savings, and
- the potential for modal shift from road to rail as a consequence of lower transport costs.

The results of this pilot are preliminary and will be tested further in subsequent phases of the project.

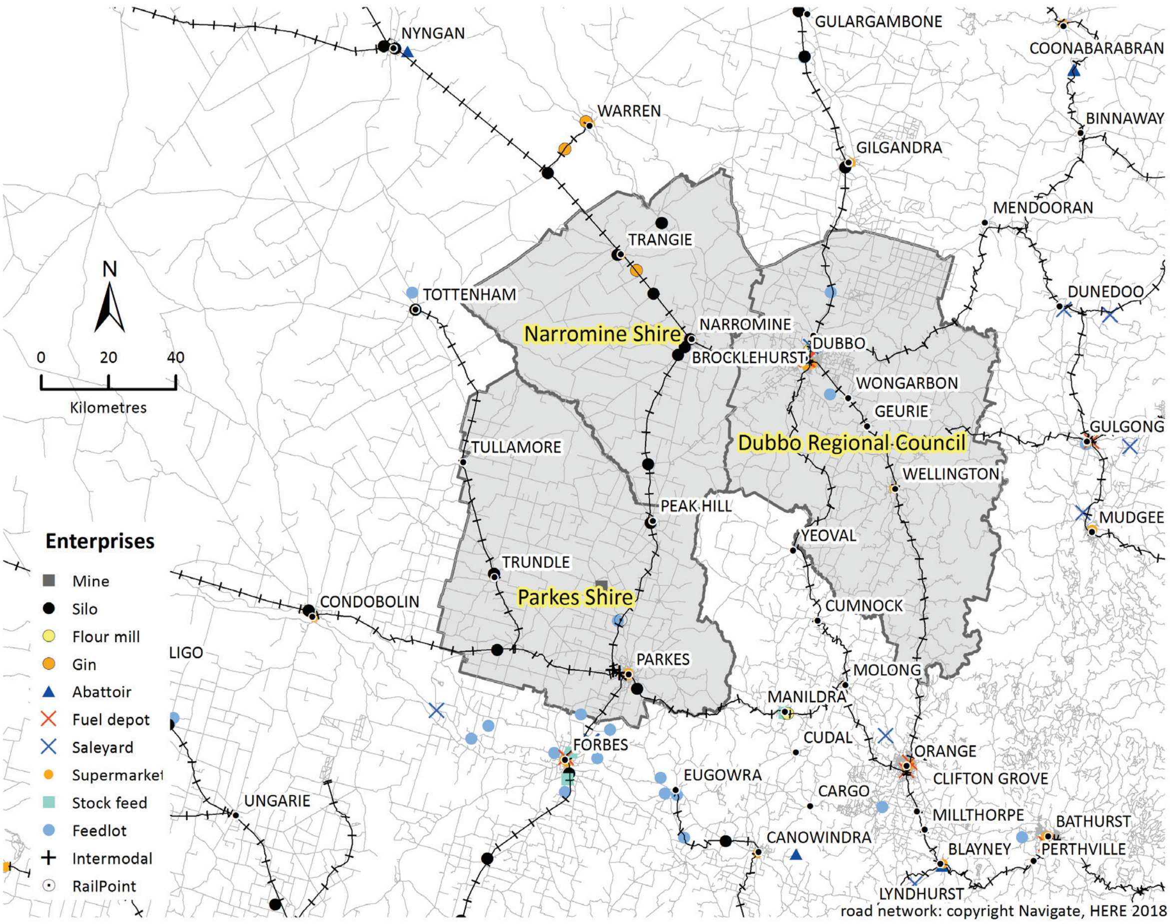


Figure 1: The study area rail network and major industrial enterprises of interest

Key insights on the potential benefit of Inland Rail to regional industries

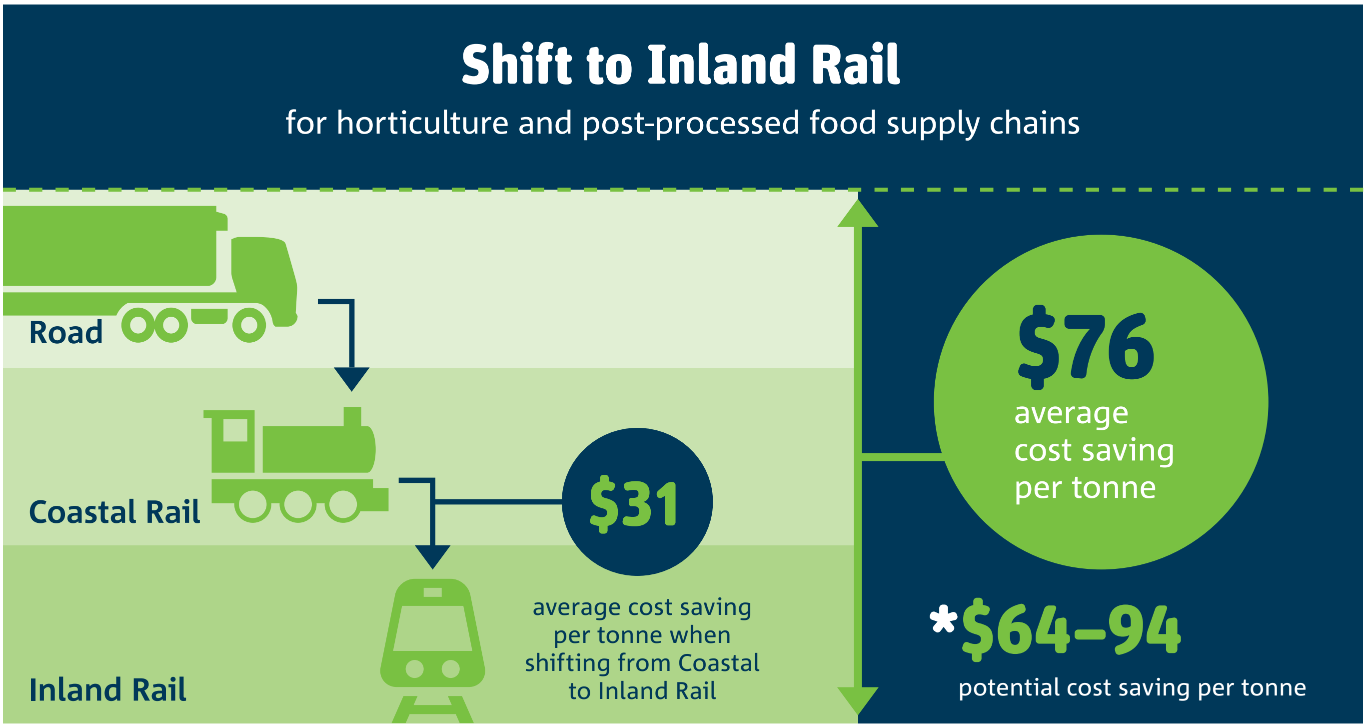
1

For this pilot study, the majority of the transport movements identified and modelled using TraNSIT are not related to local supply chains (defined as having an origin or destination within the region) but are those that have the potential to use the majority of Inland Rail to move freight between Victoria and Queensland and beyond:

a. The analysis suggests a potential average transport cost saving of $76 per tonne for horticulture products and post-processed food road trips shifted to Inland Rail. The analysis is sensitive to different backloading scenarios, but it is expected that the majority of products in the two supply chains have the potential to save between $64 per tonne and $94 per tonne in transport costs by shifting from road to Inland Rail.

   On average, these supply chains currently have a road transport leg of over 2000 kilometres, which is approximately 20 per cent further than the commonly used road distance between Melbourne and Brisbane. Many of these trips will be from a farm or processor, along local and regional roads that incur a marginally higher road transport cost per kilometre due to lower transport efficiencies.

b. For horticulture products currently transported by rail on the coastal line, the modelling suggests a potential average transport cost saving of $31 per tonne by shifting to Inland Rail. This result is also sensitive to different backloading scenarios, but it is expected that the majority of these products have the potential to save between $28 per tonne and $36 per tonne in transport costs by using Inland Rail.



*Depending on back loading

2

Should these potential transport cost savings result in a shift from road to Inland Rail, the analysis indicates a substantial benefit to the community in the study area through a reduction of up to 63,000 heavy vehicle trips per year along various segments of the Newell Highway:

a. While there is a reduction in total heavy vehicle trips in the study area, there is a degree of concentration of heavy vehicles on particular sections of the national road network. This outcome reflects a redistribution of existing truck trips to intermodal terminals in order to access Inland Rail. Further analysis will be conducted to determine the level of concentration around certain nodes and corridors.

63,000 fewer heavy vehicle trips per year along sections of the Newell Highway

Lower congestion on regional roads

3

The modelling is based on existing supply chain channel structures and intermodal facilities.
The degree of benefit for local supply chains is highly dependent upon the length of Inland Rail that can be used in meeting the needs of the supply chain:

a. For the pilot study area, most local supply chains are oriented perpendicular to the Inland Rail corridor, supported by a substantial existing road and rail network to move product to and from the Newcastle, Sydney and Wollongong metropolitan markets and associated ports, and therefore will not use much of the Inland Rail line.

b. On average, the supply chains modelled in TraNSIT for this pilot study currently have a road transport leg of more than 2000 kilometres and many of these trips will be from a farm or processor, along local and regional roads that incur a marginally higher road transport cost per kilometre due to lower transport efficiencies.

c. The analysis did not consider new opportunities Inland Rail might deliver for local industries; however, preliminary counterfactual scenarios of new processing facilities at Parkes and Dubbo were tested. They showed that the use of Inland Rail to Brisbane (including transfers from Acacia Ridge to distribution centres) had a similar cost per tonne to supplying markets in Newcastle and Sydney via road. The market-diversifying potential of Inland Rail will be explored further through more counterfactual scenarios as the project is rolled out along the corridor.

It should be noted that TraNSIT uses operating cost models for heavy vehicles and trains rather than actual freight rates (prices) charged by transport service providers. As TraNSIT is a knowledge-based tool, the analytical capacity of the tool increases as more data becomes available. The next phase of the project will include a more extensive definition of the study area for TraNSIT to model the potential transport cost savings for more local supply chains along the Inland Rail corridor.

The potential transport cost savings modelled using TraNSIT generally only relate to the freight movement. The multitude of logistical, relational and behavioural decisions throughout the supply chain will determine whether Inland Rail is used and how and whether potential benefits are captured.

The results of this pilot should not be inferred as occurring elsewhere. Every region and supply chain will be different due to differences in the type and distribution of industrial activity relative to the Inland Rail corridor. The next phase of the supply chain mapping project will focus on the southern half of the Inland Rail corridor between the Narromine and Seymour regions.

The complexity of the local road and rail network, and the many and dispersed freight-related enterprises in the study area meant that the pilot did not specifically seek to identify potential locations for Inland Rail complementary infrastructure investments:

- Local stakeholders are best placed to consider and pursue options for complementary projects and policies to leverage the benefits of Inland Rail for local industry.
- By undertaking this pilot, the evidence base has been improved for third parties to approach CSIRO to model options using TraNSIT. This benefit will be enhanced as the project is rolled out along the Inland Rail corridor and more supply chains are added to the model.

Contents

1 Introduction

1.1 About Inland Rail

Inland Rail is a major national infrastructure project designed to provide fast, cheap, reliable and safe freight rail transport solutions. While the primary purpose of Inland Rail is to reliably connect Melbourne and Brisbane suppliers and customers in less than 24 hours, it will also provide new opportunities for regional industries to better access domestic and international markets.

The Inland Rail project will deliver direct long-term and sustainable economic outcomes for local and regional industries. The project will also produce multiple indirect and complementary benefits to regional Victoria, New South Wales and Queensland communities more broadly.

The Australian Government has committed $9.3 billion in grant and equity funding to the Australian Rail Track Corporation (ARTC) for the full delivery of Inland Rail, with the first train to run between Melbourne and Brisbane by the mid-2020s.

1.2 Purpose of the Parkes to Narromine Pilot Project

The Australian Government acknowledges that a 'one-size-fits-all' approach to regional policy development does not work. Decisions about the future of regions should be made by local people and supported by government, not the other way around. The Parkes to Narromine (P2N) Inland Rail Supply Chain Mapping pilot project was designed to provide the underlying data to assist regional industries to improve the competitiveness of their local supply chains.

The Department of Infrastructure, Regional Development and Cities has worked closely with the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to apply CSIRO's Transport Network Strategic Investment Tool (TraNSIT)[1] to improve the operational evidence base for local supply chain stakeholders. TraNSIT has been used in previous research to test the benefits of transport infrastructure upgrades and calculate transport benefits for industry and various levels of government.

The pilot considered the supply chains in the P2N region to identify a baseline of existing supply chains that have the potential to benefit from Inland Rail. TraNSIT was then used to model the potential direct transport savings from using Inland Rail.[2]

The outputs from TraNSIT form the operational evidence base to:

- estimate the expected freight transport related regional benefits of Inland Rail;
- test, by third parties, potential complementary investments that may leverage off Inland Rail; and
- inform post-project evaluation of the freight transport related benefits of Inland Rail.

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1 See Attachment A for a description of the Transport Network Strategic Investment Tool.
2 Attachment B provides an overview of the steps involved in the project.

The project team has worked closely with local supply chain stakeholders, the NSW state government and local councils within the P2N region, and the team is grateful for the support and input it has received.

As part of the roll out of TraNSIT to the broader Inland Rail corridor, the P2N study area for this pilot will be revisited as part of the larger project.

1.3 Study area

The first step of the pilot was to define the study area around the P2N section of the proposed Inland Rail corridor[3]. A geographically broader area (Parkes, Narromine and Dubbo local government areas, as shown in Figure 1) was defined for the purpose of the stakeholder stocktake and supply chain mapping phase of the project.

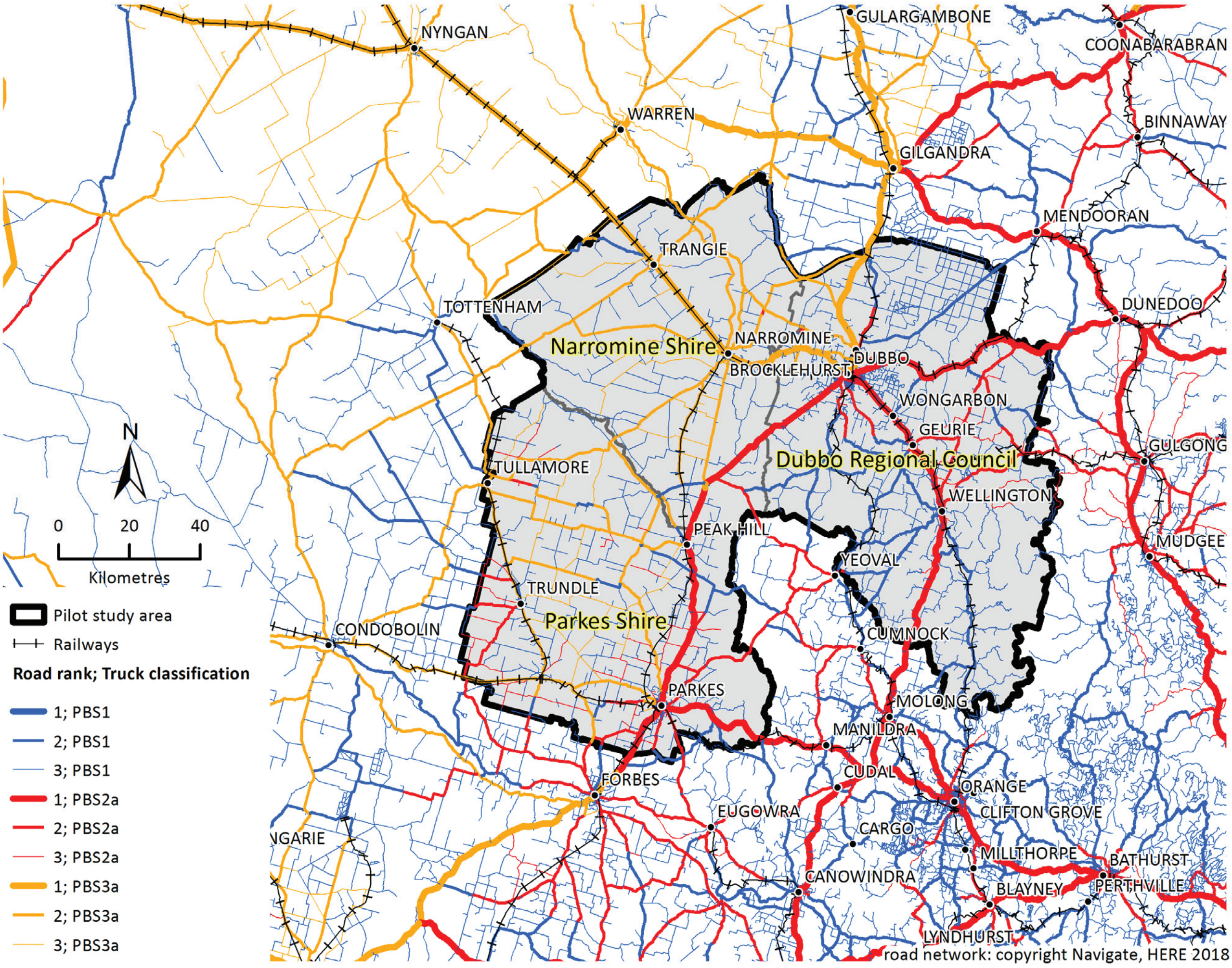

Figure 1: The pilot study area and surrounds

[3] The Melbourne-Brisbane Inland Rail Programme consists of 13 separate construction projects.

1.3.1 The road network within the study area[4]

Figure 1 shows the road network in the vicinity of the study area that was used for the analysis, and highlights the differences in the Performance Base Standards (PBS) categories across the region:

- The road network east of the Newell Highway between Dubbo and Parkes is limited to PBS Level 2A (B-Double) access;
- The Newell Highway north of Dubbo and most roads west of the Newell Highway are PBS Level 3A (Type 1) road train access;
- The northern half of the study area between Parkes and Narromine is accessible by PBS Level 3A vehicles;
- The southern half of the study area is a mix of PBS Level 3A and 2A access.

Roads are also classified in terms of their relative importance, where a ranking of 1 represents major roads such as highways, a ranking of 2 represents significant local roads and a ranking of 3 represents roads mainly used for local travel. These rankings are also shown in Figure 1.

1.3.2 The rail network within the study area

Figure 2 shows the existing rail network relevant to the pilot study area. The network consists of ARTC's Kalgoorlie-Cootamundra and Hunter Valley leased corridors, and the NSW Country Rail lines. Figure 2 also shows the identified industrial enterprises of interest in and around the study area.

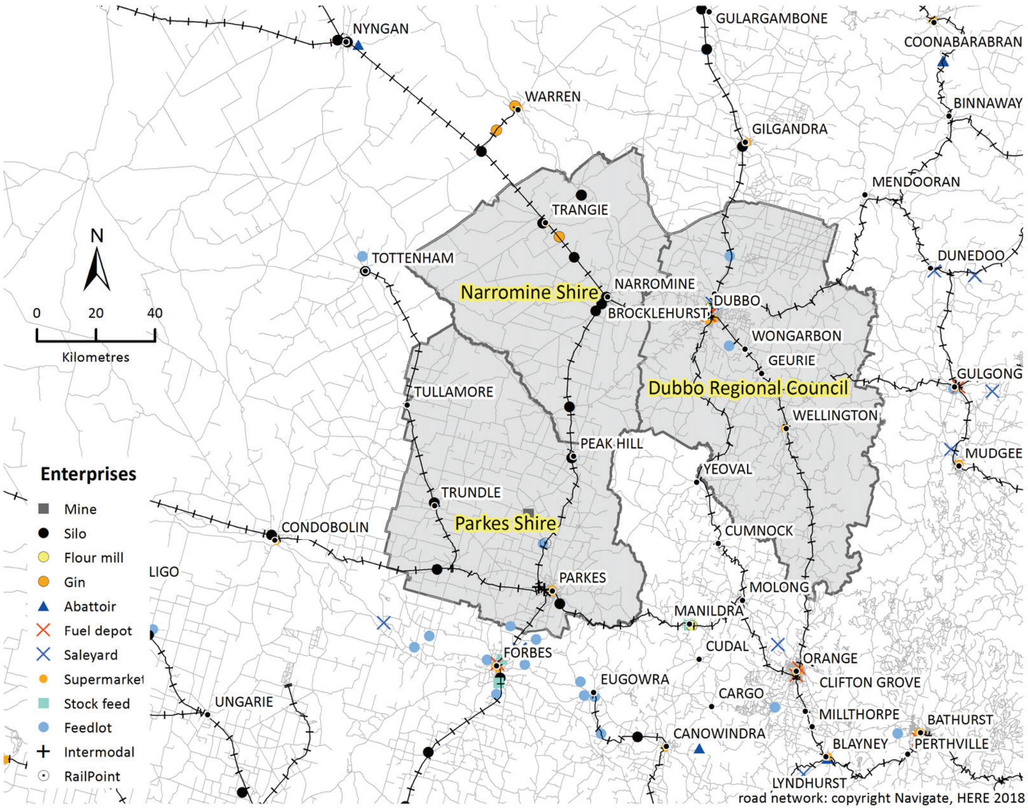

Figure 2: The study area rail network and major industrial enterprises of interest

[4] The road network used in TraNSIT is based on a commercial HERE road network (www.HERE.com).

2 The Parkes to Narromine supply chain stocktake

In consultation with regional supply chain participants and community leaders, a supply chain stocktake was undertaken to determine those supply chains that have the potential to benefit from Inland Rail (the potential “target supply chains”) and those unlikely to utilise the new rail corridor.

The potential target supply chains were those either originating or terminating within the study area. This included commodities already incorporated within TraNSIT as well as others that needed to be added based on their potential to utilise Inland Rail. Table 1 contains a summary of the type of stakeholders identified through the consultation meetings, along with the number of stakeholders contacted during the project.

Table 1: Summary of stakeholders identified and contacted for the pilot project

Sector	Number of organisations identified	Number contacted
Agriculture	17	11
Industry	6	6
Government	19	11
Transport	13	7
Mining	9	5

Through the supply chain stocktake, 64 organisations with an interest in supply chains within the study area were identified. Based on discussions with stakeholders, it is estimated that these supply chains represent at least 80 percent of the total movement of freight (measured in tonnes) within or through the study area.

2.1 Potential target supply chains and data gathered

As a result of the supply chain stocktake, the following potential target supply chains were initially included in the baseline TraNSIT modelling.

2.1.1 Grains[5]

Within the study area grain (predominately wheat, barley and canola) is transported from farms to handling facilities by road. Bulk transport to port for export is mostly by rail and usually through the ports of Newcastle and Port Kembla, while some containerised grain is railed to Port Botany (Sydney).

Some grain is also transported to flour mills by rail (e.g. at Manildra). Transport to other domestic markets (e.g. feedlots and stock feed manufacturers) is usually by road due to a lack of rail infrastructure at the destination and the smaller volumes required to be transported.

[5] Agriculture production and supply chain data as used in the application of TraNSIT to the Agriculture White Paper initiative and outlined in Higgins et al. (2017) was updated and used for this pilot project.

The annual volume of grain that requires handling is dependent upon growing and harvesting conditions and consequently can vary significantly each year (often by over 50 percent on a year-on-year basis).

For TraNSIT modelling purposes, grain *production* locations and volumes were inferred from the 2010/11 Australian national land use map (ALUM) and for this study updated to 2018 using more recent and higher-resolution catchment-level ABARES[6] data.

Grain volumes *transported* to silos are based on the 2016 calendar year for GrainCorp data, and for the 2015/16 financial year for data for other grain handlers.

The movement of on-farm stored grain was considered for this project and it is estimated this element of the grain supply chain consists of approximately 400,000 tonnes per season for the entire study area. However, about 75 percent of on-farm grain storage will pass through commercial storage facilities before being transported to port by rail and the remainder is supplied to the domestic market via road. That is, on-farm stored grain is already included in TraNSIT (via movements through commercial facilities) and so was not separately included.

2.1.2 Cotton

There are six cotton gins[7] in NSW with supply chains associated with the study area.

Raw cotton is transported by road from farm to gin, and the resulting cotton lint is transported to port (for export in containers) by either road or rail depending on the company and location of the gin. However, supply chain paths and transport modes vary each year depending on market conditions.

Cotton production areas were mapped using farm boundary information produced by Cotton Australia for the 2011 to 2018 growing seasons. From these farm boundary data, de-identified farm locations and production areas (hectares) were derived, with the 2018 harvest, bale production and supply chain paths used for this pilot project.[8]

2.1.3 Backloaded materials[9]

Through industry consultation up to 35 percent of backloading was identified at some locations where grain is handled, and higher percentages at other locations where general freight is handled (e.g. Parkes).

The principle backloaded commodities identified were cement and mining parts. Fertiliser was often mentioned as a possibility for backloading and will be considered in the future as the TraNSIT model is rolled out along the Inland Rail corridor, where the likely additional costs of double-handling (rail to road) would be considered.

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6 Australian Bureau of Agriculture and Resource Economics and Sciences

7 A cotton gin is a machine that separates cotton fibres from their seeds.

8 Data obtained from individual cotton ginners.

9 Backloading relates to freight being transported on the return trip.

2.1.4 Minerals

Minerals from seven major mines have supply chains that pass through the study area. Data has been included in the baseline for five of these mines.

Coal is by far the largest mineral supply chain in NSW, and the world's largest export coal network (i.e. the Hunter Valley) is near the study area. However, Inland Rail within the study area is unlikely to be used for coal and therefore coal is not included in the supply chain mapping and baseline analysis.

2.1.5 General freight

Most of the general freight associated with the study area passes through the region rather than having an origin or destination within the region.

For example, major national service providers SCT Logistics and Linfox have a large intermodal hub at Parkes with Pacific National providing regular train services between Brisbane (via Sydney) and Melbourne, Perth and other locations. Also, the Newell Highway is a major arterial road servicing national north-south freight flows.

2.1.6 Fuels

Transport of fuel from ports and refineries to depots was considered in the modelling, initially using publicly available data sets. However, due to the lack of appropriate infrastructure at the destination points within the study area it is unlikely that Inland Rail would be used in the short term.

2.2 Additional potential supply chains

Livestock and forest products are not currently transported by rail in NSW due to the additional double handling costs, biosecurity risks, lack of backloading options and/or lack of suitable handling facilities. Nonetheless, these commodities were explored for their potential to switch to Inland Rail.

2.2.1 Livestock

Rail transport of livestock is currently uncompetitive compared to road transport due to the higher capacity of road vehicles availed from double stacking[10], flexibility of the road sector to effectively deal with seasonal demand and animal welfare, and double handling.

However, (as shown in Figure 2 earlier) there is a large number of saleyard and feedlot facilities near the rail network in the study area and the use of rail in the future remains a possibility.

Within TraNSIT, the modelled cattle and sheep volumes and their supply chains were based on National Livestock Identification System (NLIS) data for 2014 to 2016.

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[10] Double stacking of livestock on rail would exceed the normal operating standards for keeping space between the train and track surrounds.

Pork production locations and supply chains were mapped using 2014/15 data provided by Australian Pork Limited. The data comprised of the number of pigs moved from each property to export and domestic market abattoirs, saleyards and to other properties.

A national map of poultry and meat infrastructure (sourced from NSW Department of Primary Industries) was used to identify the location of poultry meat farms, breeder farms, feed mills, hatcheries and processing plants.

2.2.2 Forest products

Currently TraNSIT outputs indicate that harvested timber and forest products from primary processing sites pass through the pilot study area. However, the modelling for NSW is based on publicly available information and more granular information could be included in the model in the future if made available from NSW forest companies.

2.3 Data gaps

As TraNSIT is rolled out along the Inland Rail corridor, further data will be required. The identified data gaps from the pilot project are:

- General freight: Although meetings with major transport providers are continuing to remedy this data gap it is likely that many transport providers will only make aggregated data available due to commercial sensitivities.
- Minerals: Data from six mines (five from the stocktake and an additional mine from information available online) were incorporated and meetings with mining companies are ongoing. Some mining companies were either not able to provide granular data in time for the pilot project or the data provided were aggregated.

TraNSIT is a knowledge-based tool, meaning that the analytical capacity of the tool increases as more data becomes available. For TraNSIT to model the transport cost savings for more local supply chains along the Inland Rail corridor, the next phase of the project will include a more extensive data gathering exercise appropriate to the additional supply chains.

3 Baseline analysis – Australia

Using the updated data gathered through this pilot study, along with existing commodity and supply chain data, a baseline analysis was produced for all Australian commodities.

The baseline for all Australian commodities was modelled to provide the context for understanding the significance of the pilot study area's supply chains, and it demonstrated that supply chains from across Australia pass through the study area.

Table 2 contains a summary of the Australia-wide baseline analysis for all commodities currently included in TraNSIT. The shown transport costs are largely affected by distance, location and type of vehicle. For example, horticulture and post-processed food have high costs per trailer due to the long distances from points of production to domestic markets across Australia. The transport costs shown in Table 2 and throughout the report were calculated in TraNSIT using detailed operating costs models for different types of road vehicles and trains. They are not based on the freight rates or prices transport operators charge customers. See Higgins et al (2018) for further information about TraNSIT and the use of the vehicle operating cost models.

Table 2: Summary of the baseline analysis of TraNSIT commodities for all Australia – road transport

Commodity	Tonnes/head	Annual trailers	Total transport cost	Cost per trailer[1]	Average distance (km)
Cattle	27,891,844	589,600	$729,219,803	$1,237	346
Buffalo	20,028	331	$834,796	$2,522	644
Chicken	536,673,576	111,808	$33,681,975	$301	61
Cotton-farm to gin	2,524,038	201,705	$134,880,281	$669	192
Cotton-gin to port	749,300	32,919	$69,731,597	$2,118	611
Cotton seed	379,585	24,813	$27,934,336	$1,126	298
Milk farm to processor	9,740,520	359,360	$220,865,320	$615	122
Forestry	25,654,742	916,097	$802,391,815	$876	166
Fuel[2]	52,045,662	1,927,607	$2,710,162,275	$1,405	392
Grains-property	46,571,259	1,664,663	$1,270,034,951	$763	177
Grains-from silo	34,482,688	1,263,070	$1,261,118,412	$998	180
Horticulture	4,103,932	186,322	$729,885,817	$3,917	1223
Lamb	49,629,571	248,057	$234,135,873	$944	238
Pigs	6,256,800	28,620	$36,458,509	$1,274	320
Post-processed food – to port[3]	2,316,567	115,828	$140,273,090	$1,211	369
Post-processed food – to domestic[3]	7,713,506	378,160	$1,241,206,104	$3,282	979
Sugar	2,247,833	97,731	$26,162,562	$268	51
Sugarcane	2,992,000	129,391	$30,412,233	$235	25
Minerals[4]	602,000	22,296	$8,109,934	$364	61
Rice - to storage	1,161,200	29,850	$30,386,896	$1,018	220
Rice - to port	628,020	25,120	$39,342,548	$1,566	478
Total		8,353,348	$9,777,229,127		

Notes: 1. Semi-trailer equivalents; 2. Only retail fuel was included rather than fuel used for primary production and aviation; 3. Post-processed food includes milk, cheese, processed horticulture, flour, boxed meat; 4. only includes limited number of mines west of Parkes and Narromine.

For containerised post-processed food and horticulture, an average payload 22 tonnes per standard 40ft container[11] was assumed based on 22 pallets per refrigerated container and a total pallet weight of 995kg (McEvilly 2005).

Transport costs assumed no backloading; however, trips for non-bulk products (e.g. dry groceries) would likely have significant backloading tasks, particularly between major cities or towns. For these commodities the actual cost per trailer will likely be lower.

Of the commodities included in the TraNSIT baseline analysis, grain is the largest user of rail (as shown in Table 3). The transport of cattle and sugar shown in Table 3 occurs in Queensland and is outside the current study area of Inland Rail. They will be considered in the future when the analysis is extended to other parts of the Inland Rail corridor.

For horticulture, 78,397 tonnes of the 286,619 tonnes shown in Table 3 are transported from NSW to WA, and 38,623 tonnes are transported on the return trip. From Victoria to Queensland, 111,798 tonnes of horticulture are transport by rail and 36,477 tonnes are transported on the return trip.

Table 3: Summary of the baseline analysis of TraNSIT commodities for all Australia – rail transport

Commodity	Tonnes or head	Annual wagons	Transport costs	Cost per wagon	Cost per payload tonne/head	Average distance (km)
Cattle	243,600	12,180	$27,826,933	$2,284	$114	734
Cotton	435,170	18,366	$33,857582	$1843	$78	613
Grains	20,426,389	370,567	$545,014,419	$1470	$27	391
Horticulture	286,619	12,539	$62,096,730	$5,150	$138	2565
Sugar	1,235,172	30,879	$15,910,388	$532	$13	85
Flour	429,240	21,462	$32,788,204	$1,491	$76	642
Minerals[1]	402,000	7,444	$20,874,131	$3,188	$51	679

Note: 1. Limited to a few mines west of Parkes of Narromine

Figure 3 shows the output from the TraNSIT modelling, providing traffic volumes along the road network for the commodities listed in Table 2. Vehicle numbers are semi-trailer equivalents and do not include the return trip of empty trailers when there is no backloading.

Figure 4 shows output from the TraNSIT modelling, providing rail movements for the commodities listed in Table 3. For minerals, only rail movements related to mines in the vicinity of the study area were included. Figures 3 and 4 illustrate that for the commodities shown in Tables 2 and 3, the pilot study area is associated with some of the busiest road movements in Australia.

[11] In the freight sector, the basic unit of measurement for containerised freight is the 20ft container; usually referred to as one TEU (twenty foot equivalent unit). In practice, there is a broad range of containers from which to choose and a supply chain manager's choice will depend on the type of commodity and logistical requirements of the supply chain. One of the difficulties in modelling freight movements is converting that broad range into a standard unit.

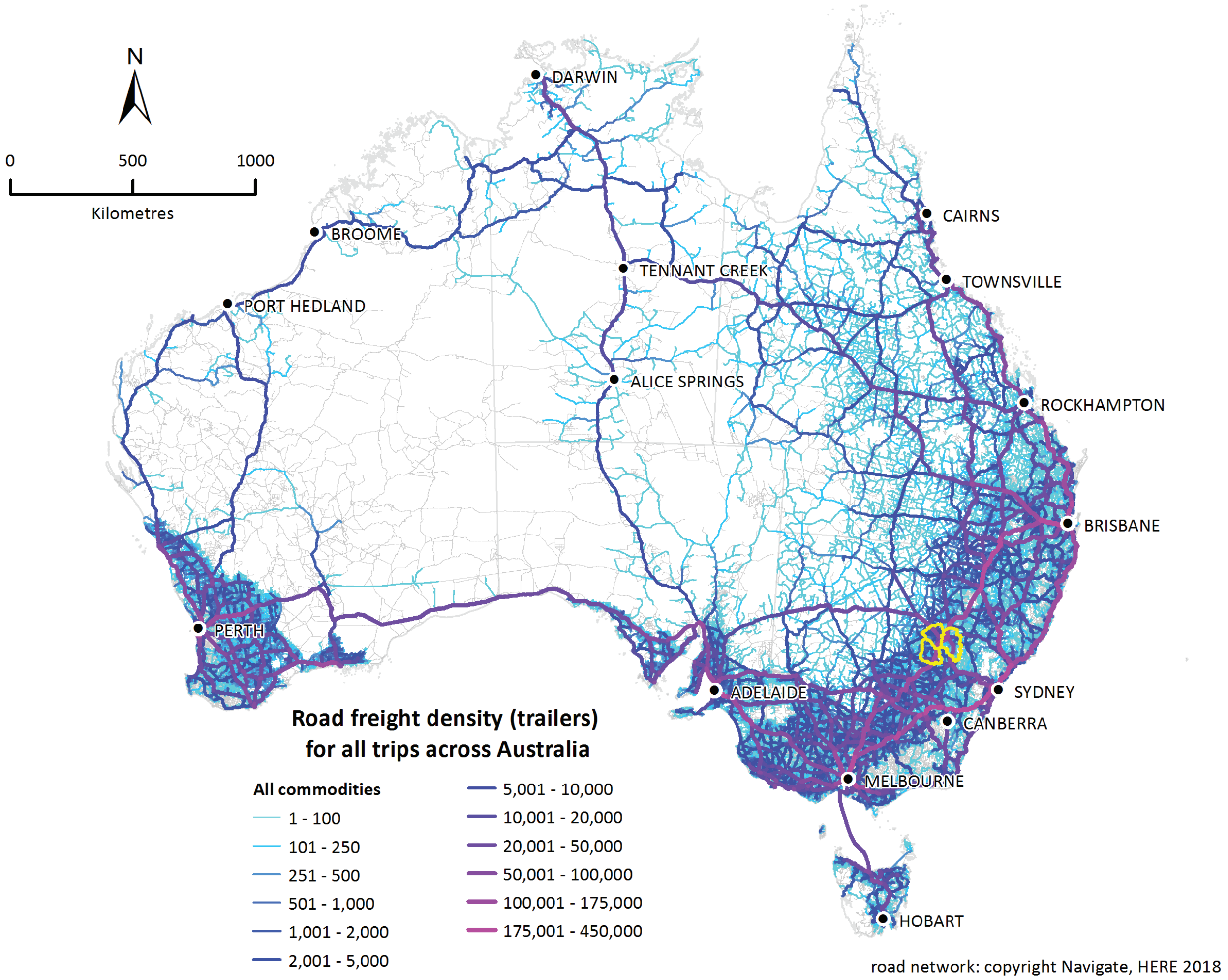

Figure 3: Annual number of trailers (semi-trailer equivalents) for all commodities shown in Table 2

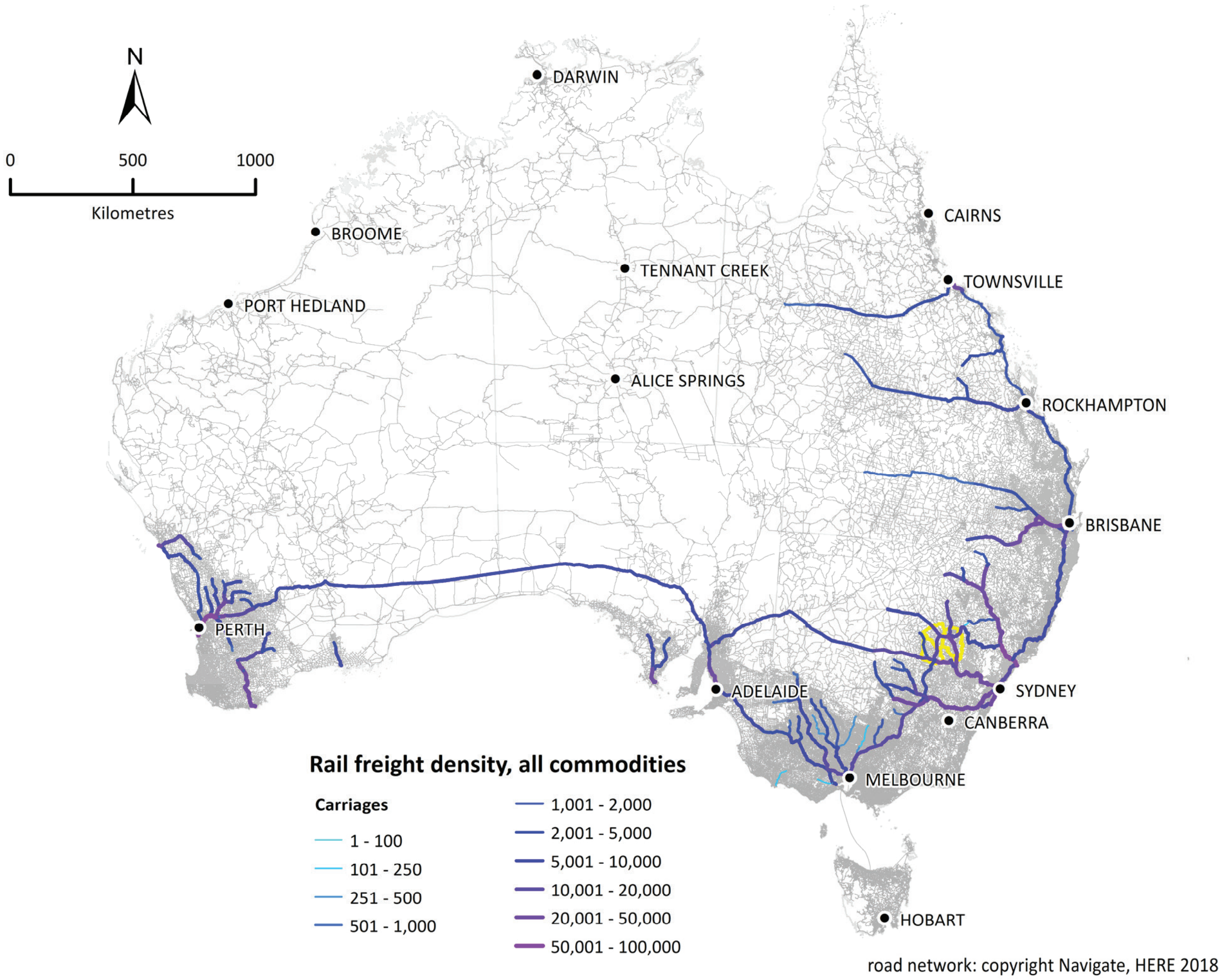

Figure 4: Annual number of wagons along each rail segment for all commodities shown in Table 3

4 Baseline analysis – supply chain study area

From the baseline for all Australian commodities currently modelled in TraNSIT, supply chains that passed through or had an origin or destination in the study area were extracted from the model. Of the 8.35 million annual freight vehicle trips for all Australia (Table 2), 5 percent (419,857 trailer equivalents per year) relate to the study area (see Table 4). Horticulture and sheep/goat comprised the largest proportion of movements, followed by post-processed food to the port.

The total cost of trips related to the study area ($1.17 billion) is about 12 percent of national road transport costs, largely due to long-distance trips passing through the study area using the Newell Highway - particularly fuels, horticulture and post-processed food. Some commodities listed in Table 2 (e.g. sugar, buffalo, chickens, rice to storage or port) did not have supply chains in the vicinity of the study area.

In Table 4, the short list of target commodities analysed in Inland Rail pilot study are highlighted in bold font. These commodities represent 4.4 percent of the total number of freight movements of all supply chains identified in Table 4. Fuels were initially included due to the large number of vehicles and long distance supply chains but ultimately excluded from the Inland Rail baseline due to the lack of suitable fuel storage and handling facilities in the study area.

Movements from farm (e.g. grains to silos, cattle to abattoirs) were also not included since the road transport element is usually a short distance, geographically dispersed and generally not suited to an intermodal solution.

Tables 5 to 7 show a disaggregation of trips presented in Table 4: trips with an origin in the study area (Table 5), trips with a destination in the study area (Table 6), and trips that pass through the study area (Table 7).

Table 5 shows that 14.9 percent of total freight for the study area has an origin within the study area. Grains and fuels are the most significant commodities in absolute terms. The large number of fuel movements relates to the redistribution of a significant volume of inbound fuel (see Table 6) from centralised storage centres.

Table 5 also indicates that the movement of post-processed food is reasonably evenly distributed between the domestic and export markets. However, Table 6 indicates that approximately 40 percent more post-processed food is destined for the study area's market than leaves for domestic locations elsewhere.

While Tables 5 and 6 indicate significant movements of horticulture into and out of the study area, these moves represent less than 20 percent of all horticultural movements associated with the study area as most movements pass through the study area (see Table 7). Table 7 also shows that 71 percent of all freight movements associated with the study area (as shown in Table 4) pass through the study area.

Table 4: Summary information of each commodity for the study area. Target commodities for the Inland Rail study are highlighted in bold font.

Commodity	Annual trailers	% of Australia annual trailers	Total transport cost	% of Australia transport costs	Average travel distance (km)
Cattle	26,264	4.5	$37,687,246	5.2	474
Cotton-farm to gin	15,348	7.6	$21,011,496	15.7	286
Cotton-gin to port	**2,295**	**4.0**	**$2,433,129**	**3.5**	**611**
Cottonseed	180	0.7	$331,182	1.2	295
Milk farm to processor	5,560	1.5	$9,661,682	4.4	474
Forestry	5,617	0.6	$9,564,638	1.2	697
Grains-to silo	102,311	6.1	$69,861,175	5.5	200
Grains - from silo	**21,853**	**1.7**	**$29,414,417**	**2.3**	**295**
Fuels	***121,107***	***6.3***	***$455,458,929***	***8.7***	***670***
Horticulture	**34,139**	**18.3**	**$267,776,329**	**36.7**	**2687**
Lamb	40,176	16.2	$41,583,831	17.8	303
Pigs	647	2.3	$2,659,121	7.3	1240
Post-processed food – to port	**1,524**	**1.3**	**$2,797,024**	**2.0**	**486**
Post-processed food – to domestic	**35,248**	**9.3**	**$221,919,131**	**17.9**	**1405**
Total	369,937	4.4	$1,172,159,330	12.0	

Table 5: Summary information for each target commodity where trips have an origin# within the study area.

Commodity	Annual trailers	% of region trailers	Total transport cost	% of region costs	Average travel distance (km)
Cotton-gin to port	936	40.8	$816,520	33.6	72
Grains-from silo	6,149	28.1	$8,336,174	28.3	211
Fuels	5,582	4.6	$3,165,984	6.9	153
Horticulture	2,883	8.4	$6,884,465	2.6	732
Post-processed food – to port	1,420	93.2	$2,552,255	91.2	397
Post-processed food – to domestic	1,132	3.2	$2,841,710	1.3	442
Total	18,102	16.5^	$24,597,108	15.6	

#Includes local trips (have an origin and destination within the study area), ^Total includes commodities not considered for Inland Rail. All other percentages relate to the proportion of total movements for that particular commodity.

Table 6: Summary information for each target commodity where trips have a destination# within the study area.

Commodity	Annual trailers	% of region trailers	Total transport cost	% of region costs	Average travel distance (km)
Fuel	9,850	8.1	$20,105,718	4.4	724
Grains-from silo	158	0.7	$131,425	0.4	163
Horticulture	3,791	11.1	$23,304,991	8.7	1161
Post-processed food – to domestic	1,584	4.5	$2,393,667	1.1	165
Total	15,383	16.5^	$45,935,801	13.7	

#Includes local trips (have an origin and destination within the study area), ^Total includes commodities not considered for Inland Rail. All other percentages relate to the proportion of total movements for that particular commodity.

Table 7: Summary information for each target commodity where trips pass through the study area.

Commodity	Annual trailers	% of region trailers	Total transport cost	% of region costs	Average travel distance (km)
Cotton-gin to port	1,359	59.2	$1,616,608	66.4	248
Grains-from silo	14,351	65.7	$23,742,082	80.6	243
Fuel	108,584	89.0	$432,294,171	95.0	670
Horticulture	27,470	80.5	$259,880,330	97.0	2183
Post-processed food – to port	103	6.8	$244,769	8.7	508
Post-processed food – to domestic	32,545	92.3	$216,687,500	97.6	1617
Total	184,412	71.2^	$934,465,460	75.6	

^Total includes commodities not considered for Inland Rail. All other percentages relate to the proportion of total movements for that particular commodity.

5 Baseline freight mapping

Freight maps were produced to show the modelled number of vehicles using the road and rail network for all commodities shown in Table 4 (Figures 5 and 6) and those commodities of interest to this study as shown in bold in Table 4 (Figures 7 to 11)[12].

Table 8 also provides the annual movements, by type of trip, for those commodities of interest to this study.

Table 8: Summary of freight movements of the target commodities for the pilot study area

	Origin Movements		Destination Movements		Through Movements		Total Movements
Commodity	Trailers	% of total	Trailers	% of total	Trailers	% of total	Trailers
Cotton – Gin to port	936	41	0	0	1359	59	2,295
Grains – from silo	6,149	28	158	1	14,351	66	21,853
Horticulture	2,883	8	3,791	11	27,470	81	34,139
Post-processed food – to port	1,420	93	0	0	103	7	1,524
Post-processed food – to domestic	1,132	3	1,584	4	32,545	93	35,248
Total	12,520	14	5,533	6	75,828	80	95,059

Figure 5 shows the modelled annual vehicle numbers across the road network in the vicinity of the study area. It includes all freight vehicle trips for the target commodities in Table 8 (those that pass through, start and stop in the study area). By far the largest volumes of traffic are along the Newell Highway with up to 200,000 semi-trailer equivalents per year. Major feeder roads such as the Mitchell Highway, Golden Highway and Tomingley Road also had high numbers of freight vehicle movements.

By removing the trips that pass through the study area (i.e. those not starting or stopping in the study area), Figure 6 shows a significant reduction of vehicle numbers compared to Figure 5, particularly along the Newell Highway.

Disaggregating by commodity shows some significant differences in freight movements between commodities:

- Grains (Figure 7) had a large number of supply chain paths between farm and storage and from storage to the different markets. Thus, there is a large volume of grain movements across the local road network throughout the study area.
- Like grains, cotton movements (Figure 8) use many local and minor roads. The largest volumes of cotton are from farms to cotton gins west and north-west of Dubbo, and from various gins to rail loading points in Dubbo and other locations in the vicinity of the study area.
- Of all the commodities, the largest volume of traffic along the Newell Highway was due to horticulture (Figure 9), with 80.5 percent passing through the study area (see Table 8). This mostly represents movements between Queensland and Victoria.

[12] Excluding fuels for the reason further investigation suggests this supply chain is unlikely to use Inland Rail.

- Post-processed food movements (Figure 10) originating in, or in the vicinity of, the study area are largely from abattoirs around Dubbo and Orange to Sydney.

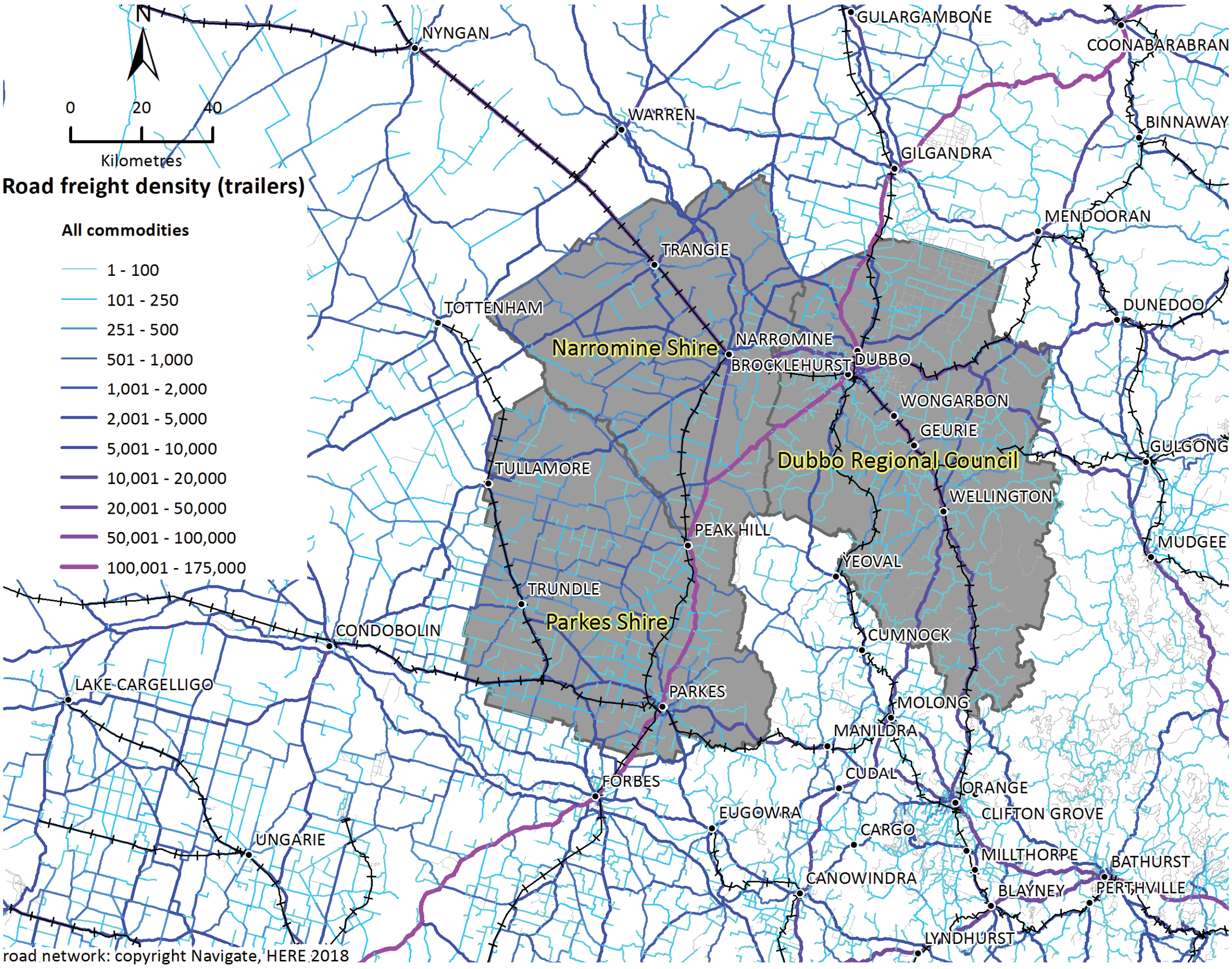

Figure 5: Annual trailer numbers across the road network in the study area for all target commodities in Table 8 combined

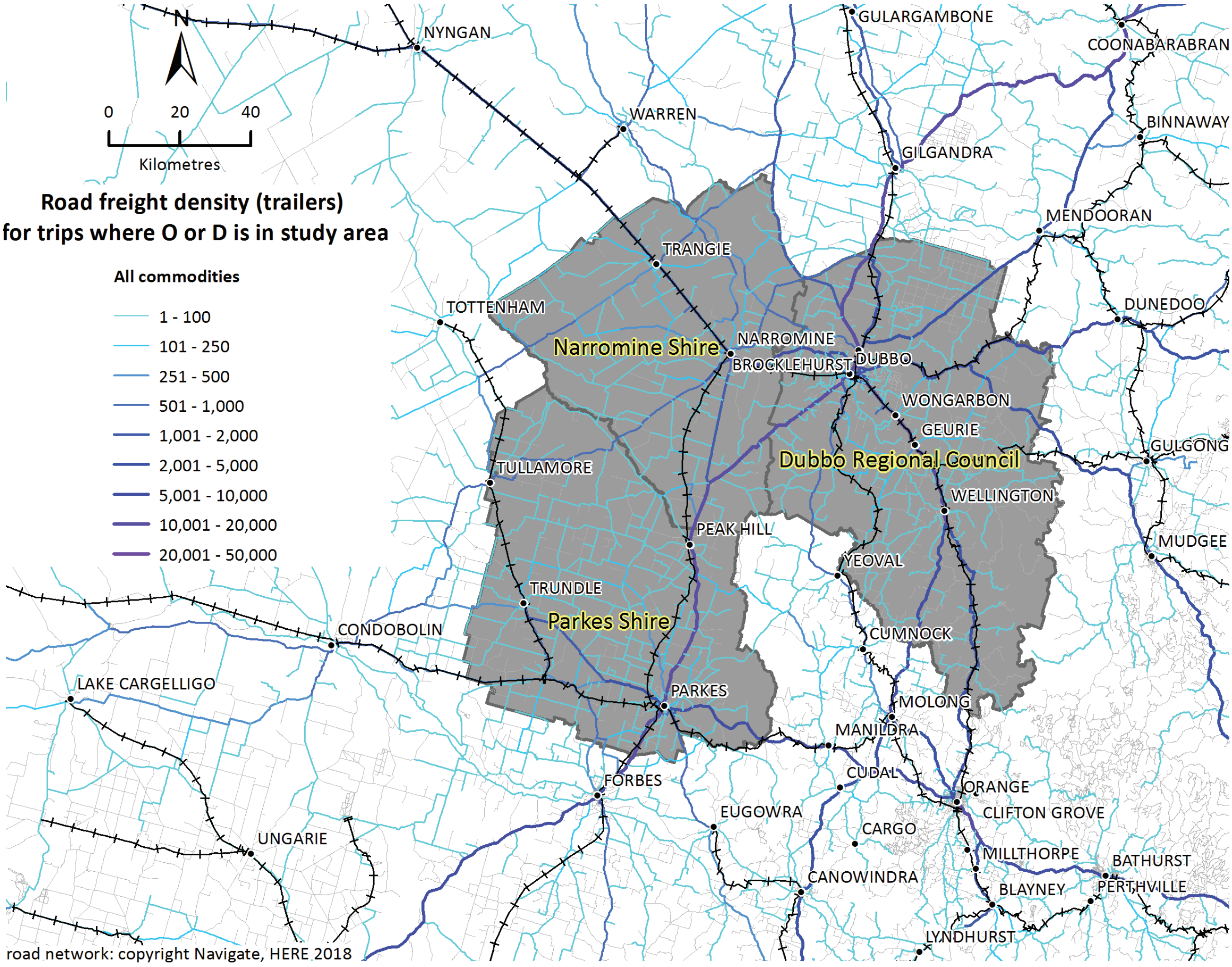

Figure 6: Annual trailer numbers across the road network where Origin or Destination are in the study area for all target commodities in Table 8 combined.

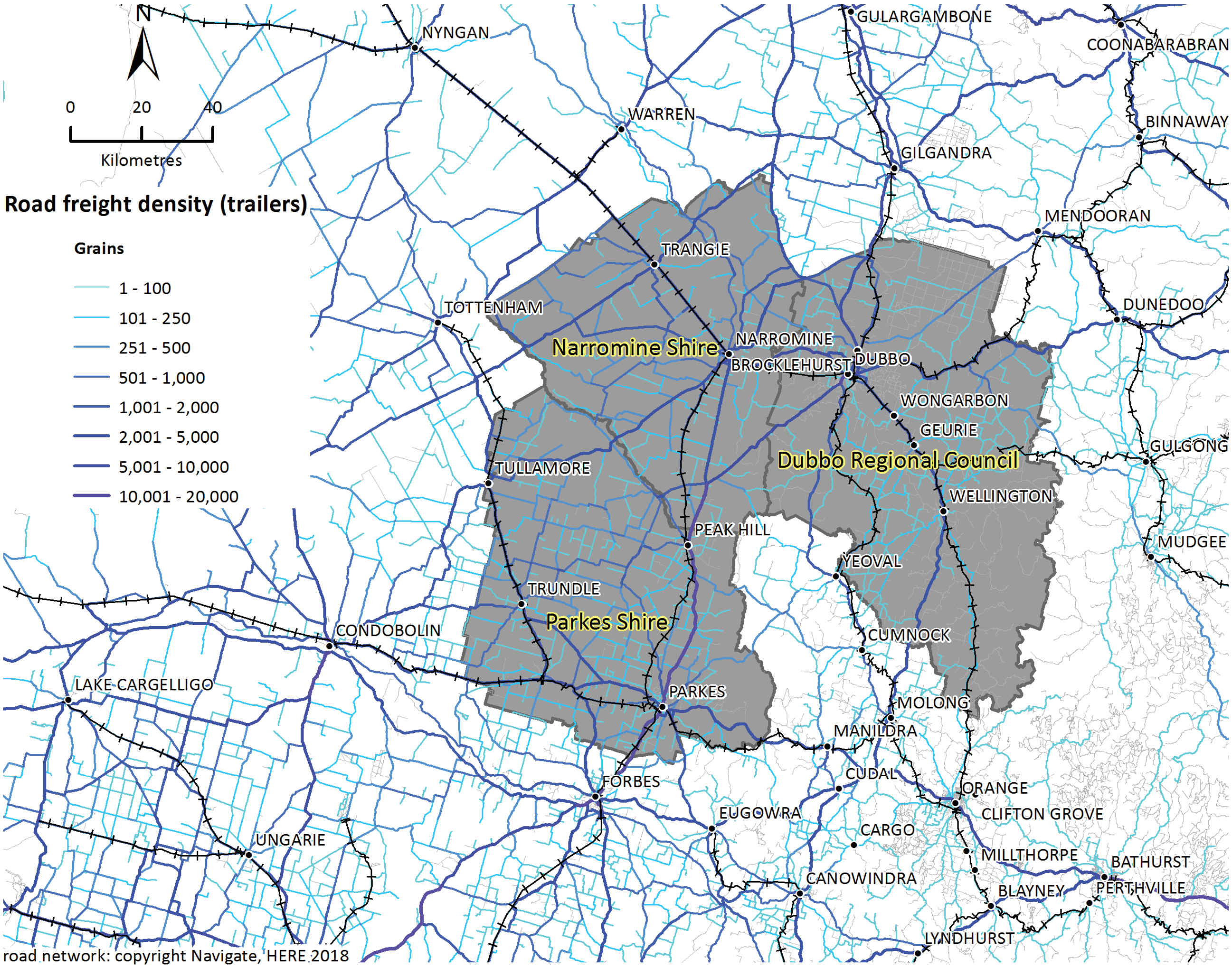

Figure 7: Annual trailer numbers across the road network in the study area for grains (see Table 8 for the underlying data)

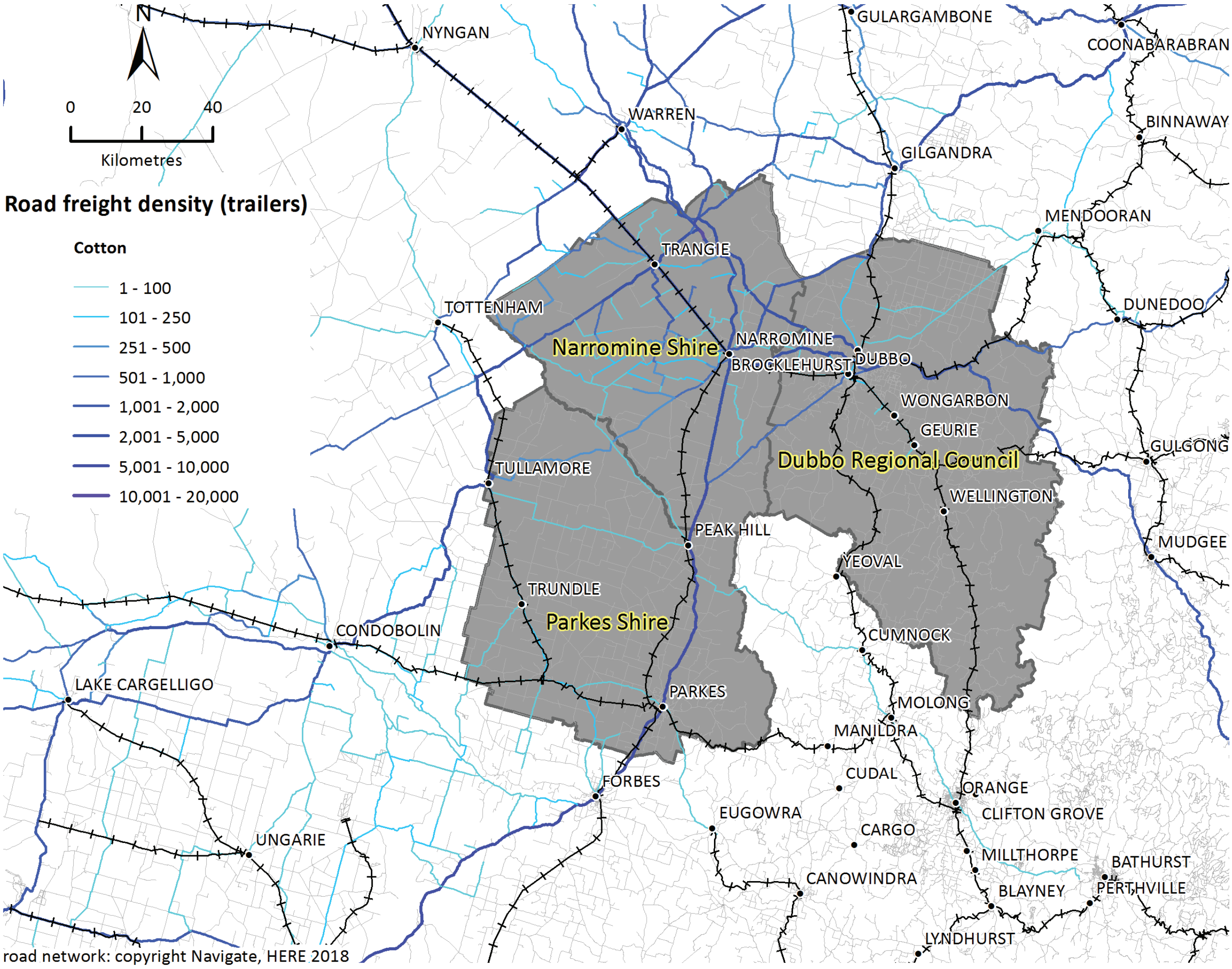

Figure 8: Annual trailer numbers across the road network in the study area for cotton (see Table 8 for the underlying data)

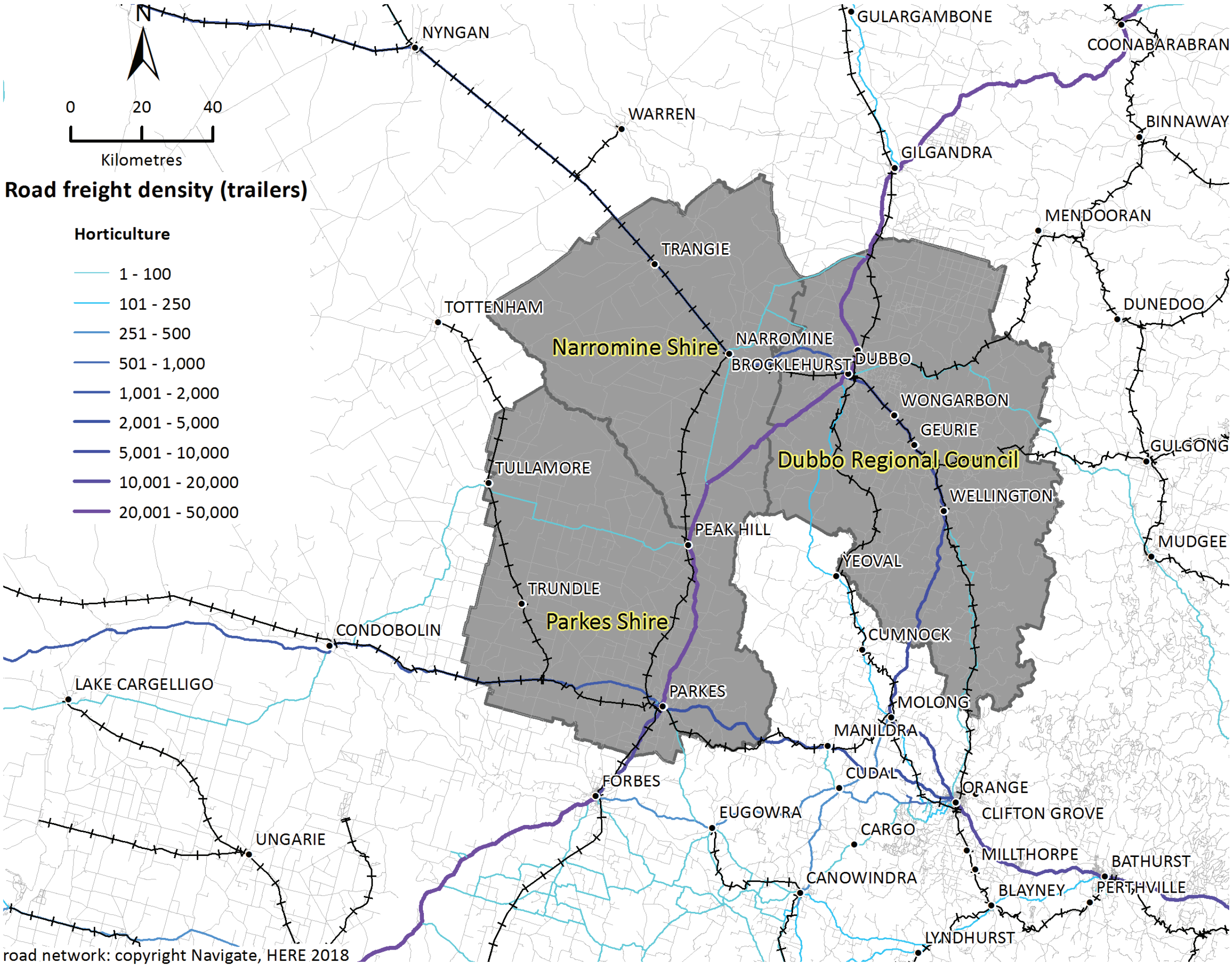

Figure 9: Annual trailer numbers across the road network in the study area for horticulture (see Table 8 for the underlying data)

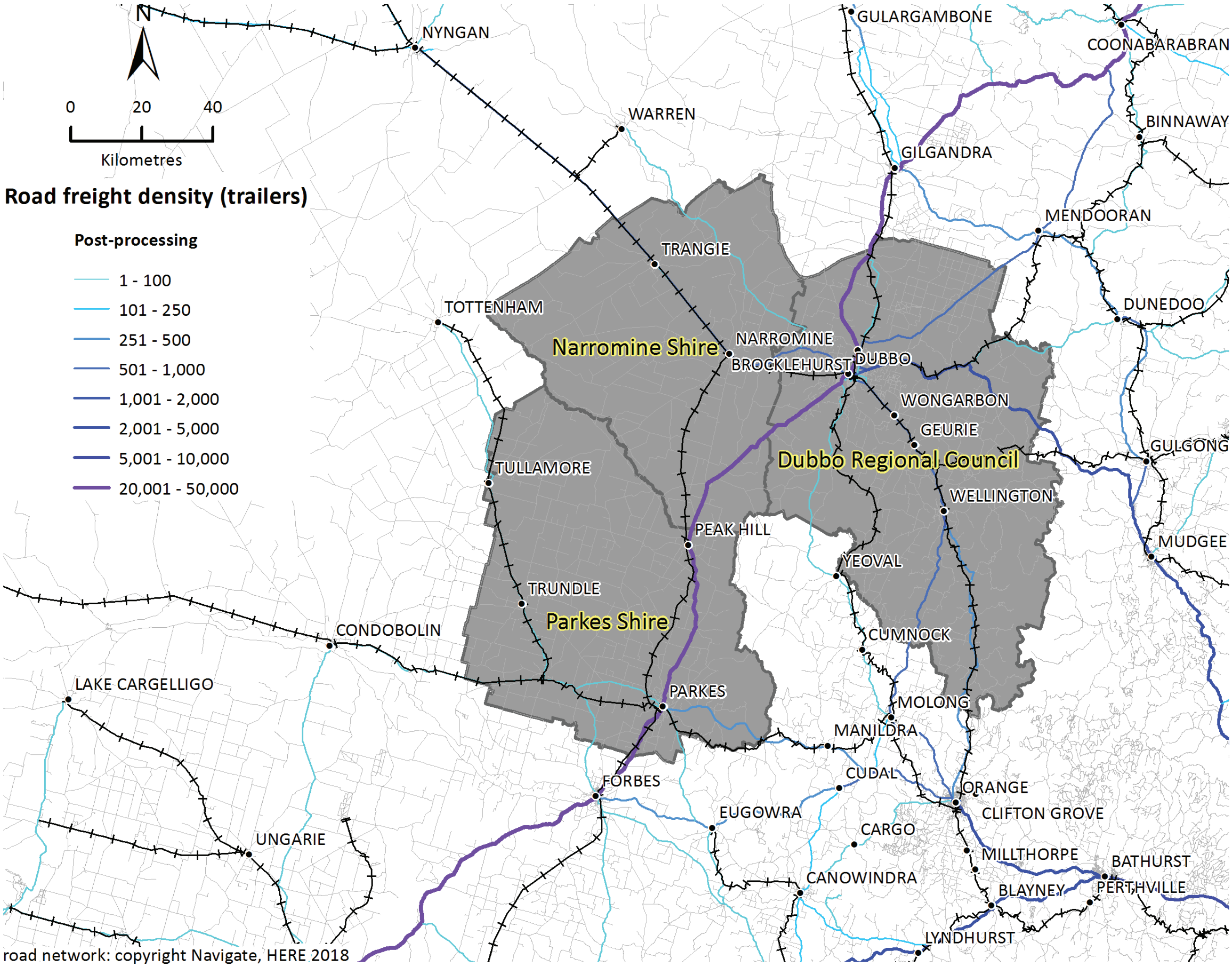

Figure 10: Annual trailer numbers across the road network in the study area for post-processed food (see Table 8 for the underlying data)

5.1 National view of study area target supply chains

Using the current baseline outputs from TraNSIT, freight maps were produced for target commodity trips associated with the study area to show their geographical extent, complexity of the regional freight demand, and the potential suitability of different commodities for transport by Inland Rail.

Figure 11 shows the annual number of target commodity trailers across the Australian road network for trips that have at least part of their journey in the study area. The largest density of these trips was along the Newell Highway between Melbourne and Brisbane, though there are also over 15,000 trailers per year that move to the southern states from north Queensland (many of which would utilise the Newell Highway for part of their journey).

In Figure 12, the vehicle trips that passed through the study area (without starting or stopping) were removed to highlight the significance of the national road network to local supply chains in the study area.

Disaggregating Figure 11 by commodity shows that grains and cotton supply chains (Figures 13 and 14) have road movements that are highly concentrated on the local network reflecting the

transport task from farm to primary processing or storage (noting rail is the major mode for moving these commodities out of the region). Long distance trips associated with the study area are dominated by horticulture and post-processed food (Figures 15 and 16).

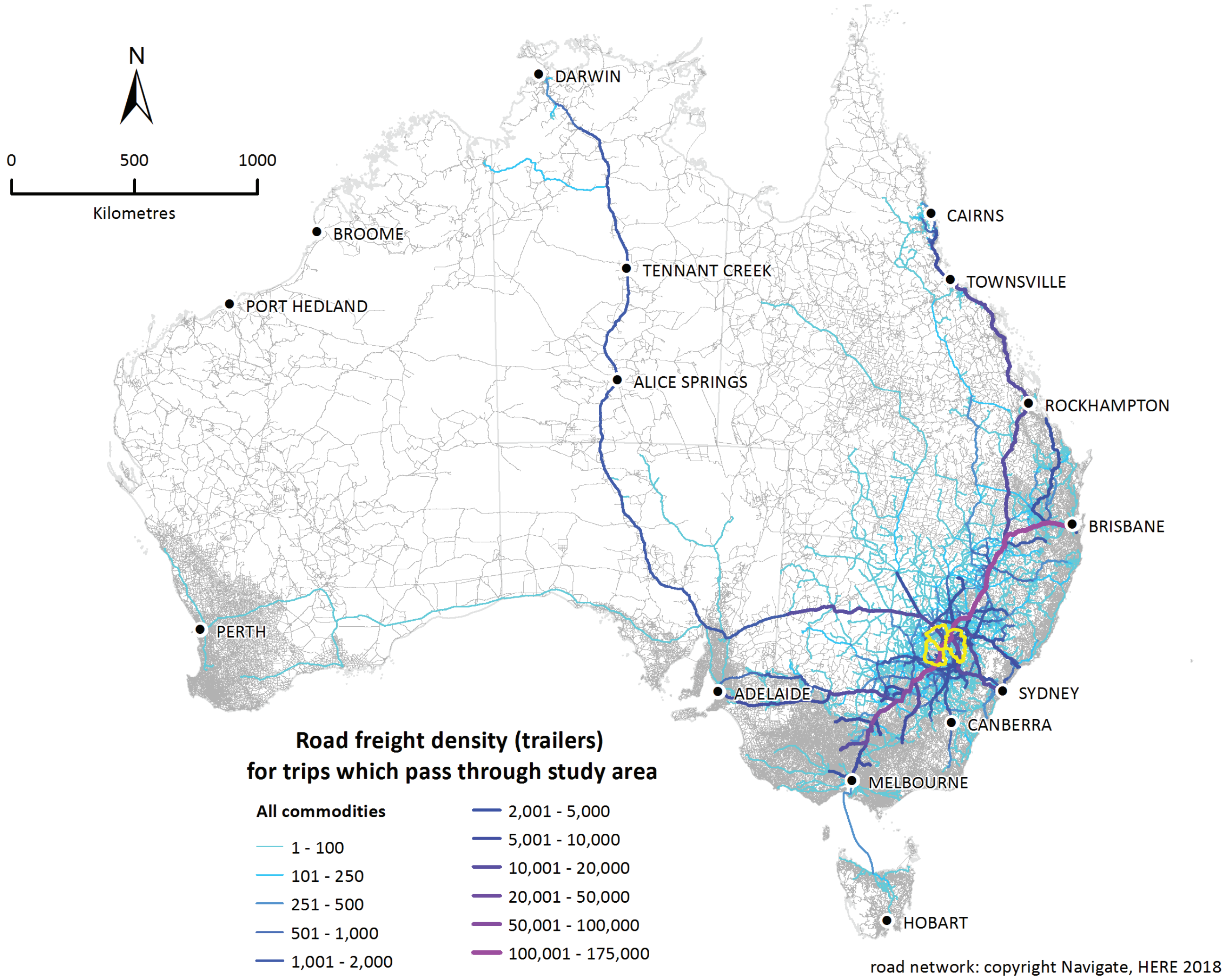

Figure 11: National freight density of annual trailer numbers of all target commodities (in Table 8) with trips using the study area

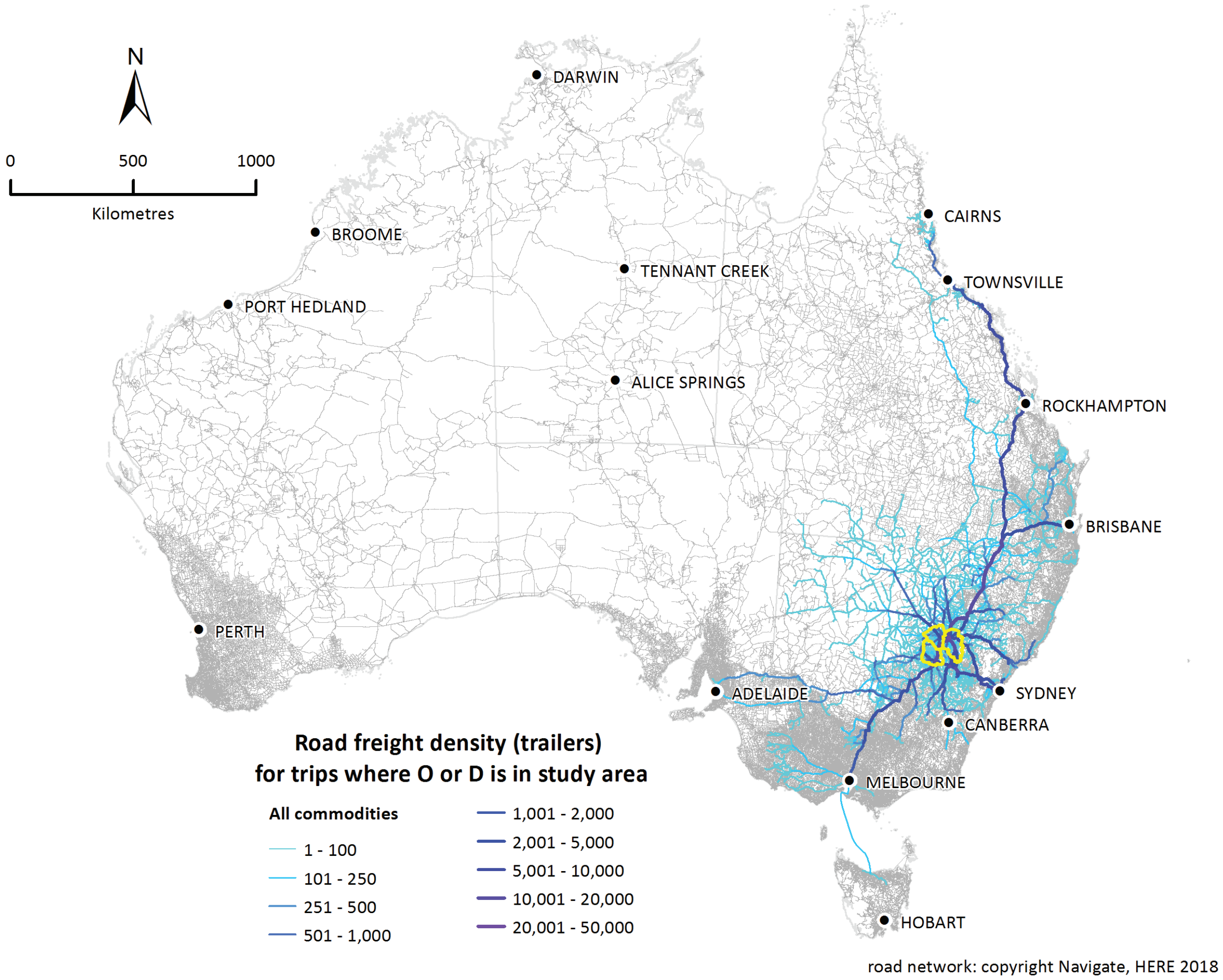

Figure 12: National freight density of annual trailer numbers of all target commodities in Table 8 for trips with an origin or destination in the study area

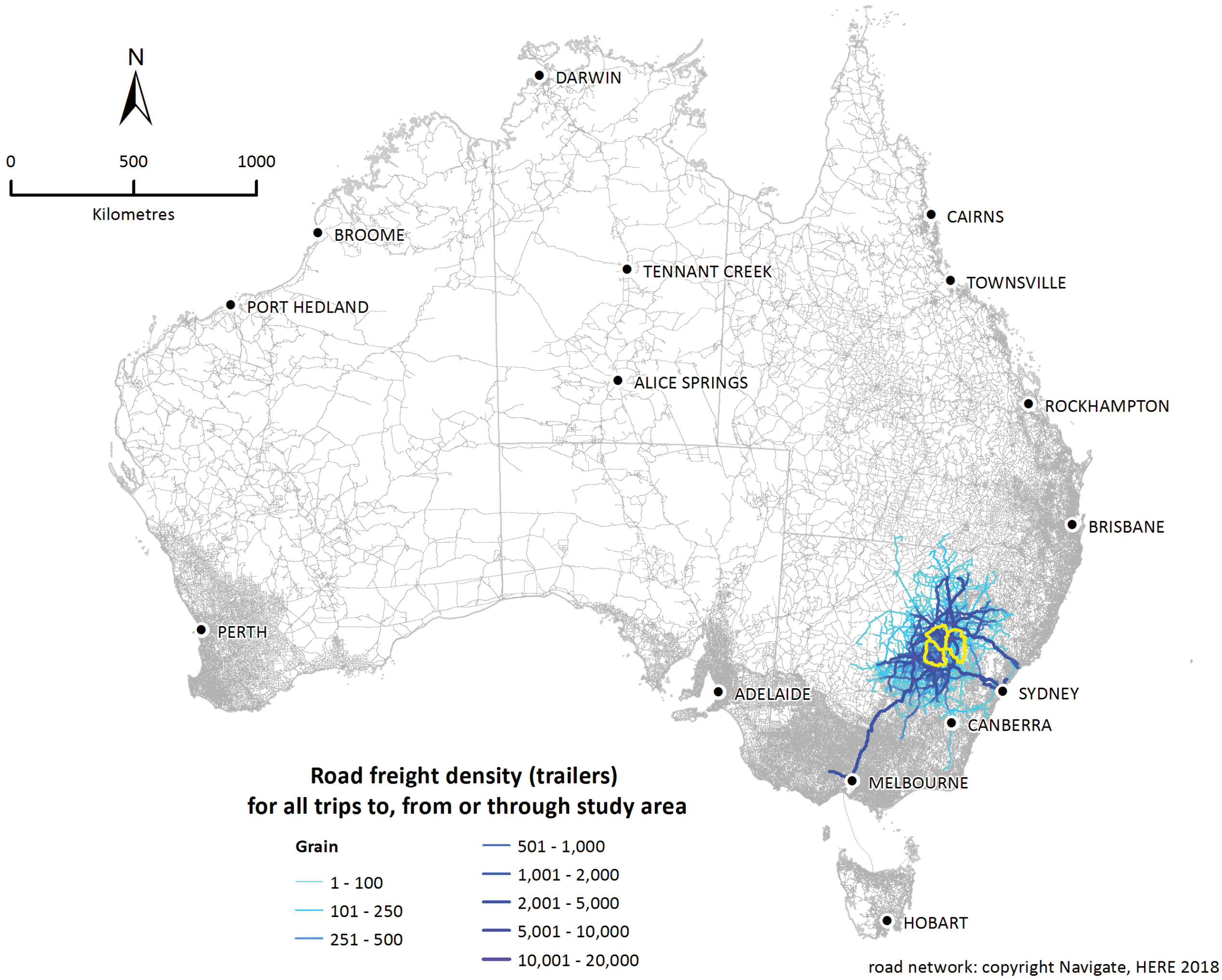

Figure 13: National freight density of annual trailer numbers of grain trips with an origin or destination in the study area plus trips that pass through

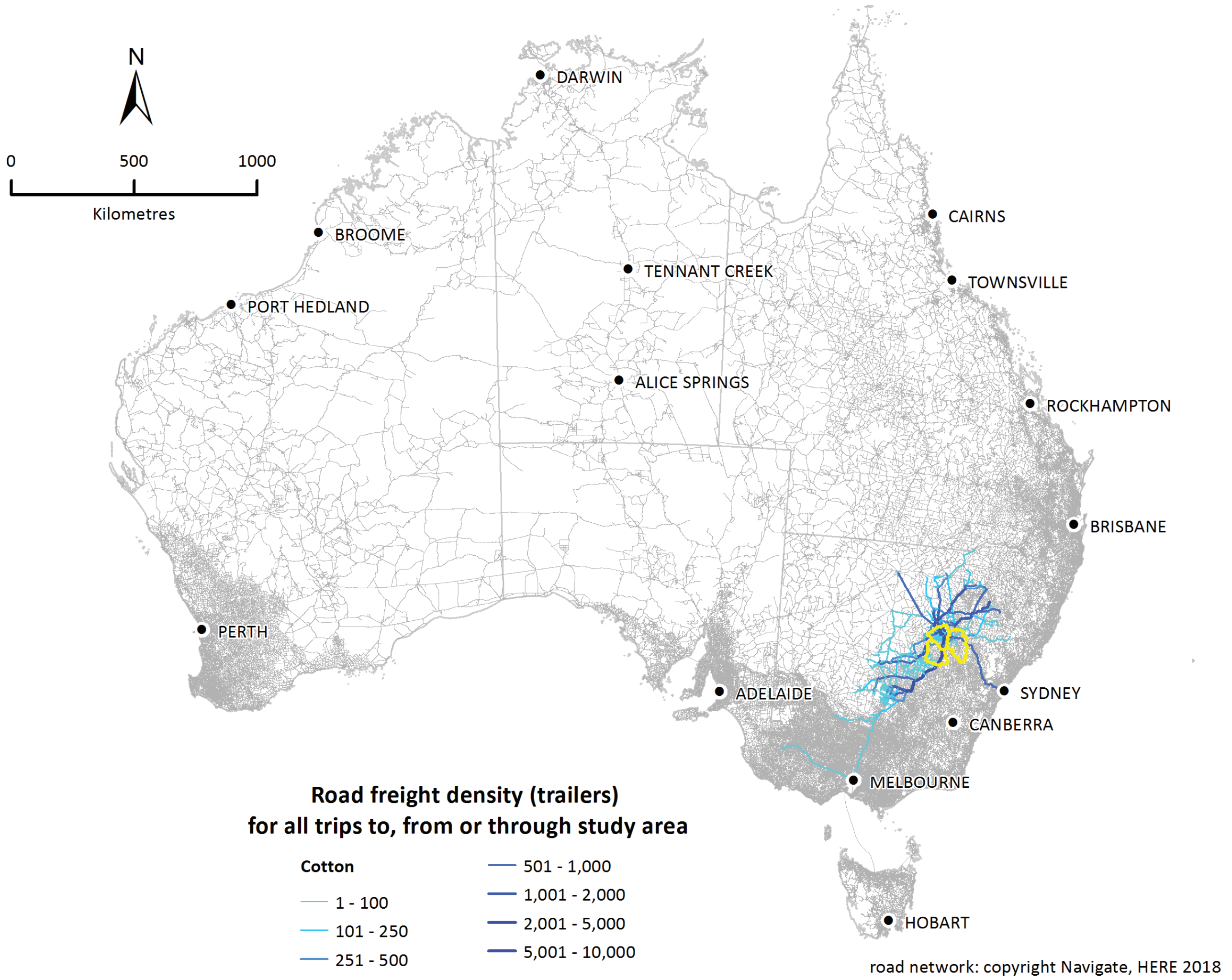

Figure 14: National freight density of annual trailer numbers of cotton trips with an origin or destination in the study area plus trips that pass through

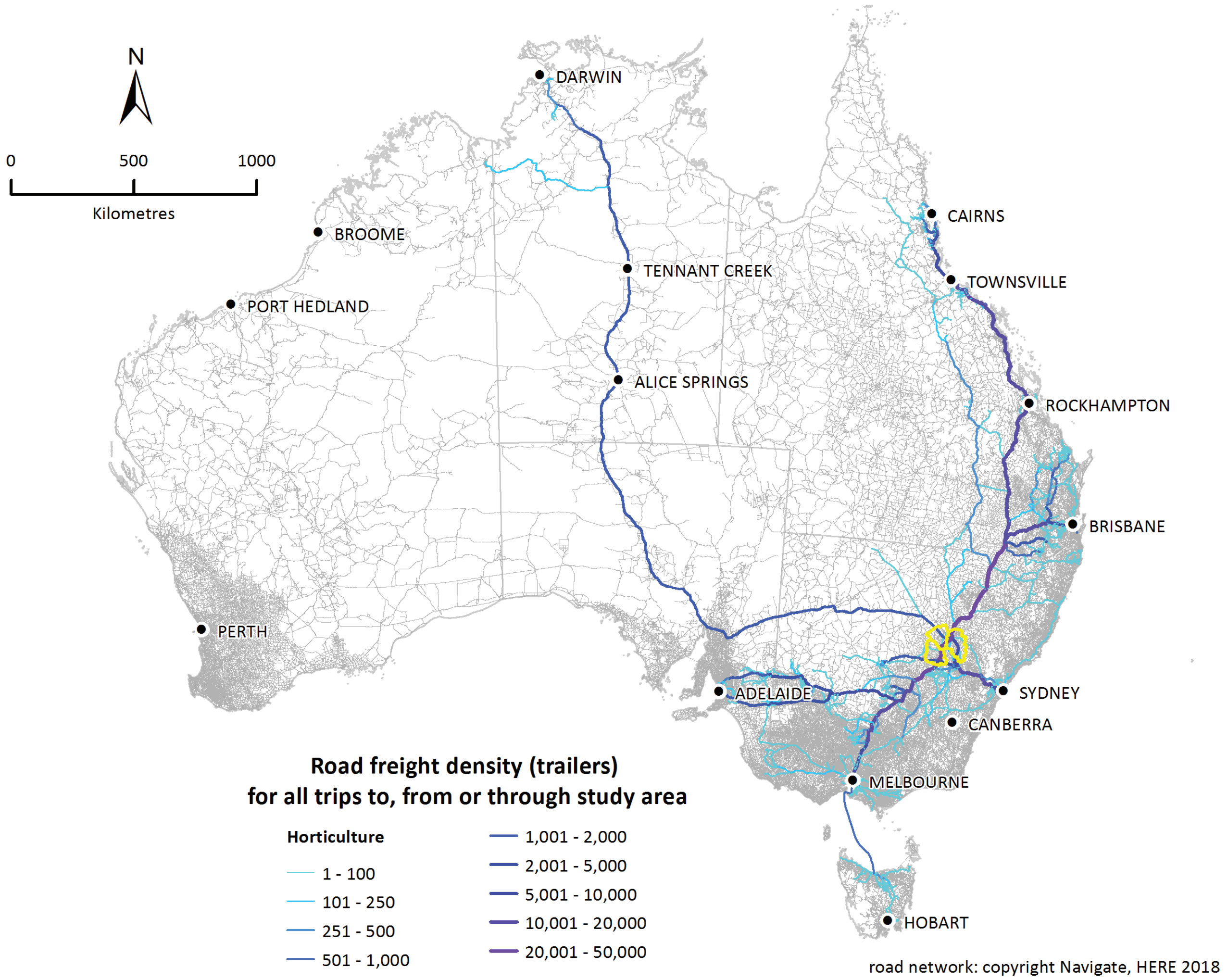

Figure 15: National freight density of annual trailer numbers of horticulture trips with an origin or destination in the study area plus trips that pass through

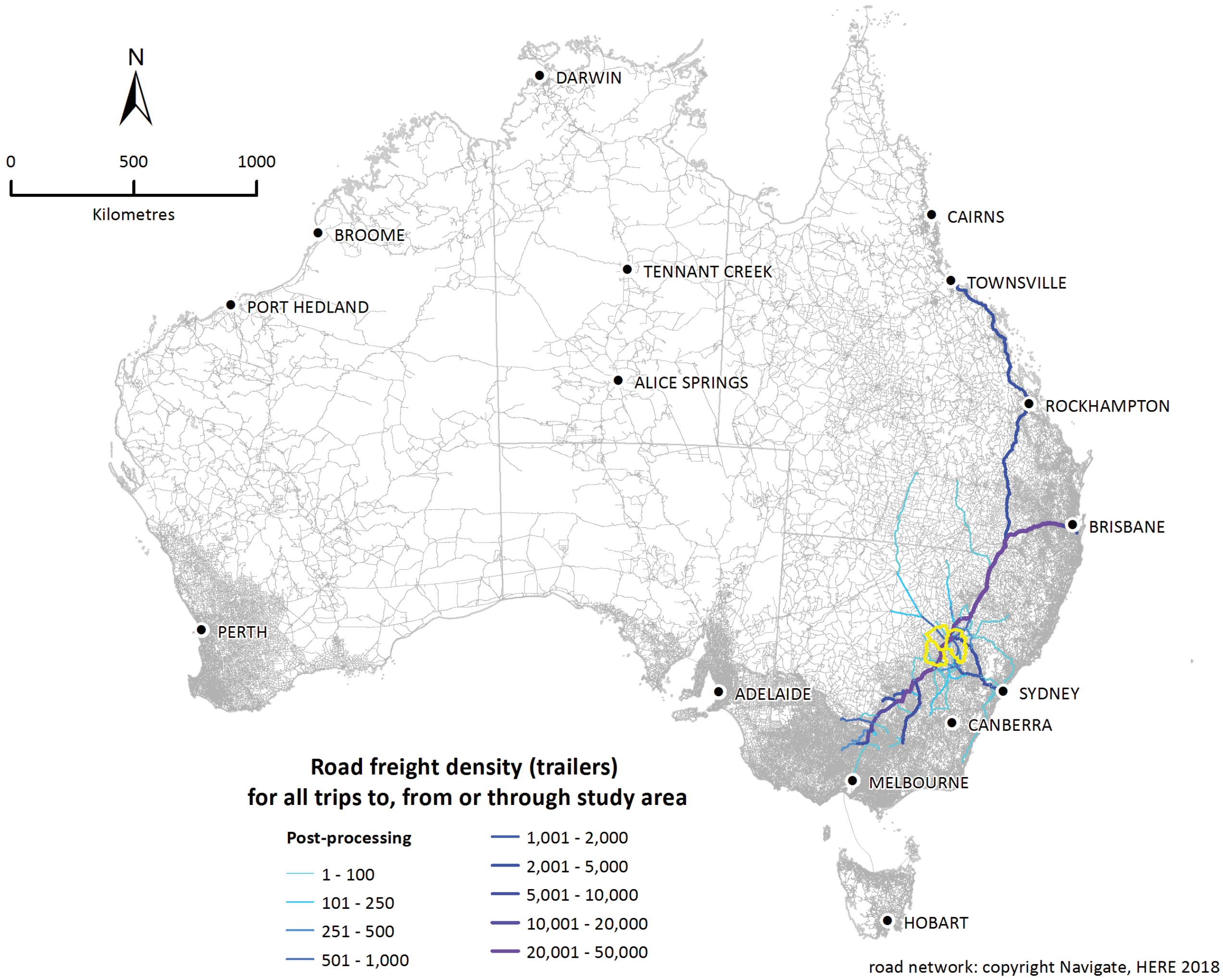

Figure 16: National freight density of annual trailer numbers of post-processed food trips with an origin or destination in the study area plus trips that pass through

6 Inland Rail baseline

6.1 Mapping of supply chains relevant to Inland Rail

The target supply chains within the Parkes-Narromine pilot study area that are likely to, or have the potential to gain benefit from Inland Rail are[13]:

- Horticulture
- Post-processed food
- Grains
- Cotton

Table 9 provides the estimated volume of each supply chain of interest to this study.

Table 9: Source of potential Inland Rail freight volumes of the supply chains of interest to this study (tonnes)

	Horticulture	Post-processed food#	Grain	Cotton
Shift from road to rail	457,974	677,974	175,588	28,700
Existing coastal rail to Inland Rail	154,600	0	0	0
Existing rail – Parkes to Narromine	0	0	1,813,781	0

#Agriculture only (milk, cheese, rice, boxed meat)

In practice, not all the volumes of freight shown in Table 9 can be practically or economically transported using Inland Rail. Ultimately the estimates included in the Inland Rail TraNSIT baseline modelling are based on the following considerations:

- All existing rail trips in the TraNSIT baseline data that use part of the Parkes to Narromine rail corridor were included. These were limited to grains since the existing cotton and mineral rail trips do not traverse that section of the rail network.
- Existing rail trips in the TraNSIT baseline between Brisbane (Acacia Ridge or Bromelton) and Melbourne (Altona) via Sydney were also included.
- All road trips (particularly between Queensland and Victoria) that could use Inland Rail without excessive detours are included. These trips are summarised in Table 10.
  - Not all of the through vehicle trips were selected. Many had origins or destinations that would require excessive detours (in terms of cost and/or time) to use Inland Rail.
  - North-south road movements between Queensland and Victoria that did not pass through the study area (e.g. via Pacific Highway) were included in the Inland Rail baseline as it was assumed that they would not require excessive detours to use Inland Rail.
- The Inland Rail baseline for this pilot project assumed no change in destination for each supply chain. For example, there was no change in the destination port, even if the Inland Rail scenario would allow a lower cost travel to an alternative port. These additional savings will be considered in a future analysis of the broader Inland Rail.

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13 Whilst fuels was originally a target commodity for the Inland Rail baseline, it was not included in the final analysis for this pilot project. Shifting road vehicle trips of fuel to rail would require a large fuel storage and handling facility on a rail link. None of the fuel depots in the study area are co-located with rail or have rail to road handling facilities, and handling costs was unknown. Also, existing intermodal operators within the study area do not handle fuel.

- Not all of the supply chains presented in Table 9 achieved a cost saving under the Inland Rail baseline. Movements without a saving under Inland Rail were excluded from the results as there would be no change to the transport characteristics for these products.

As shown in Table 10, there is an estimated total of 51,634 vehicle trips (semi-trailer equivalents carrying 1.202 million tonnes of freight) that are expected to make a modal shift from road to rail and are included in the Inland Rail baseline. To shift a road trip to rail, the trip is split into three components:

- Road trip from origin to nearest intermodal hub;
- Rail trip from the initial intermodal hub to intermodal hub nearest to the destination; and
- Road trip from the destination hub to the destination of the trip.

As a result of these assumptions, and due to the constrained study area, only horticulture and post-processed food supply chains were identified as benefiting from Inland Rail in this pilot study and subsequently modelled in TraNSIT. Additional supply chains are more likely to be identified as the study area is significantly enlarged while TraNSIT is rolled out along the Inland Rail corridor.

Table 10: Number of annual trailers shifted from road to rail, as a result of Inland Rail, disaggregated by route

	Horticulture	Post-processed food	Total
Queensland to Victoria	6,954	0	6,954
Victoria to Queensland	2,776	24,117	26,893
Queensland to NSW	2,777	0	27,77
NSW to Queensland	4,009	6,244	10,253
Queensland to WA	0	419	419
WA to Queensland	84	0	84
Queensland to SA	2,108	0	21,08
SA to Queensland	2,109	37	21,46
Total	20,817	30,817	51,634

Figure 17 shows a freight density map (number of semi-trailer equivalents on each road segment) for the vehicle trips presented in Table 10, before they are shifted to Inland Rail. Most of the freight movements are along the Newell and Gore Highways between Queensland and Victoria and include a large amount of horticulture and post processed food transported from farms and processors from north Queensland, regional Victoria and southern New South Wales. Trips from farms and processors often involve some travel along local roads before reaching a major freight corridor.

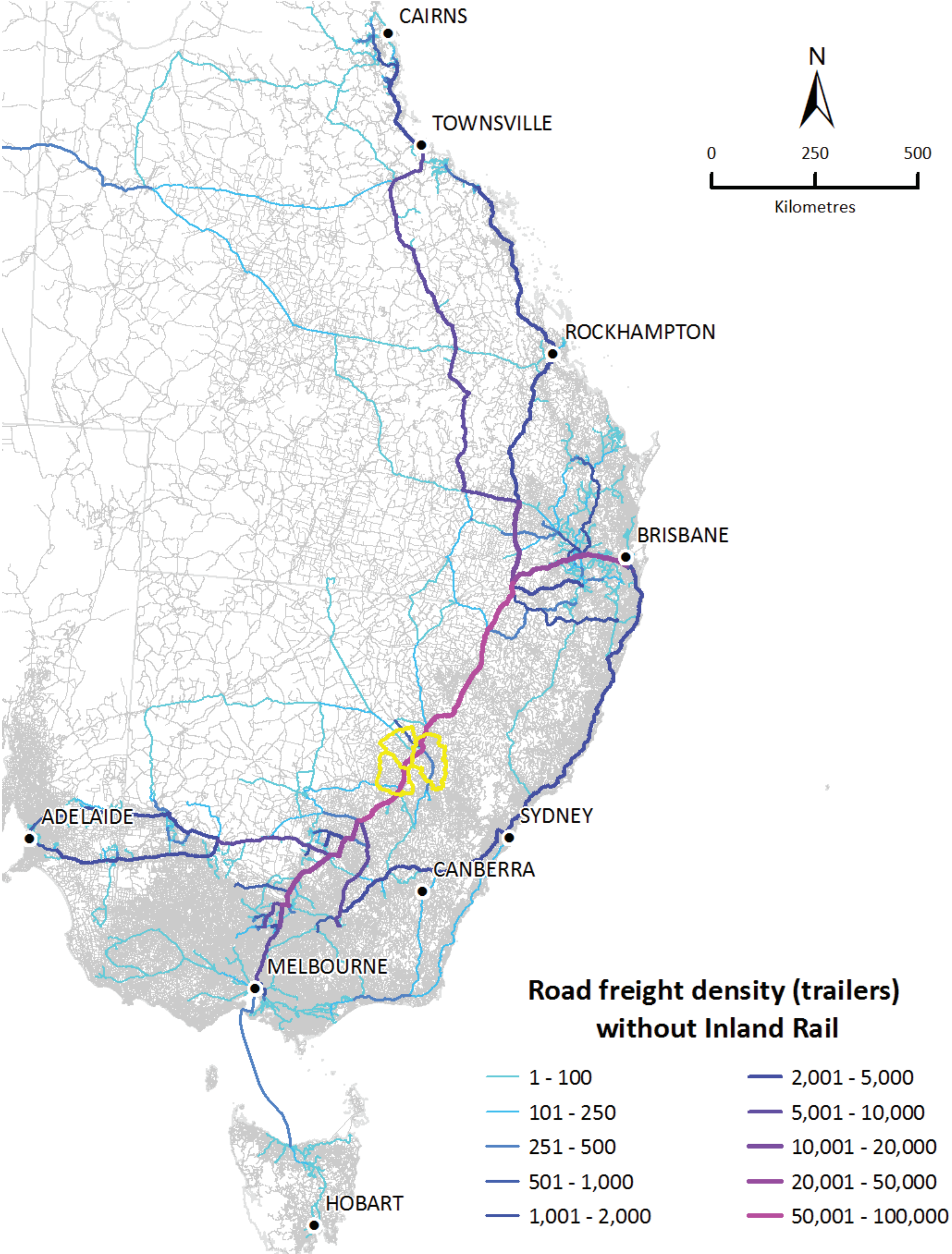

Figure 17: Road freight movements of supply chains of interest (Table 10) prior to the shift to Inland Rail

6.2 Inland Rail baseline

6.2.1 Intermodal operating assumptions

Disaggregating the 154,600 tonnes of coastal rail to Inland Rail from Table 9, there are 1682 wagons (35,757 tonnes) of horticulture products transported by rail via Sydney from Brisbane to Melbourne and 4614 wagons (118,843 tonnes) from Melbourne to Brisbane. Under the Inland Rail baseline scenario, these trips will be moved from the coastal route to Inland Rail.

Table 11 contains the current train configurations for inter-city intermodal trips used in TraNSIT for the Inland Rail baseline. Average travel speed along most lines was estimated at 50km/h, accommodating stoppages at passing loops.

Table 11: Current Intermodal train configurations between major centres used for baseline

	Locomotives	Wagons (40ft)	% backload	Coastal Distance km
Melbourne (Altona) to Brisbane (Bromleton) via Sydney	3	80	35-50	1868 (1907 to Acacia Ridge)
Parkes to Perth	3	100	35	3505
Parkes to Adelaide	2	60	50	1226

For the purposes of the Inland Rail TraNSIT modelling[14], the reference[15] train was assumed to have the following characteristics[16]:

- 1800 metres long with 3 locomotives trailing a maximum of 3900 tonnes with an 80 percent load efficiency.
- 50 percent backloading and 33 percent double stacking utilising an average of 60 wagons (40 foot flat for single stacking) plus 6 by 5-pack Bogie Well wagons (30 wagon equivalents) for double stacking.
  - The backloading percentage was selected based on existing backloading data from Table 11 and discussions with stakeholders.
  - For intermodal trips, the same backloading percentage was applied to both the road and rail components, to ensure a fair comparison between road and rail.
- The same track access charges (GTK Rate and TKM Rate) were used for coastal rail and Inland Rail. Road access costs were covered by registration costs along with fuel excise by vehicle type used for each trip.

These train parameters only apply to the new trips (road to rail) along Inland Rail between the intermodal points (Acacia Ridge, Bromelton, Altona and Parkes), as well as the existing coastal trip between Melbourne and Brisbane shifted to Inland Rail. Parameters for all other rail trips remain the same as the original baseline.

[14] Note: The rail cost module used in TraNSIT for the Inland Rail baseline is based on ARTC parameters. These are not presented due to commercial sensitivities.

[15] These characteristics are slightly different than the characteristics of the Inland Reference train used in the 2015 Inland Rail Programme Business Case which, for example used 40 percent double stacking as an assumption. The differences are not significant and relate to variations in the assumptions of locomotive power and rollingstock configurations. Throughout this report the term "Inland Rail reference train" is used to distinguish between Inland Rail and Coastal rail services.

[16] The assumed parameters can be adjusted for the different trains and efficiency improvements at intermodal facilities.

Under the Inland Rail scenarios, the average speed of all segments of the Inland Rail corridor was increased from 50km/h to 75km/h, which includes stoppages at passing loops. This resulted in a total travel time of 22.6 hours from Brisbane to Melbourne.

Loading and unloading times were not changed from the baseline:

- At intermodal hubs, the average time to load or unload a train was, based on discussions with stakeholders, assumed to be 10 hours including time for shunting and storage, and dwell time while the freight sits waiting to be loaded or unloaded.
- Loading and unloading costs for a 40ft container were each assumed at $80, which includes any storage costs at the intermodal hub.

6.2.2 Expected transport cost reductions

Table 12 shows the expected transport cost savings from using Inland Rail for the supply chains presented in Table 9. It should be noted that:

- For trips shifted from road to Inland Rail where there was a benefit, the existing average cost per payload tonne was $3.67 per km travelled. This is based on a weighted average travel distance of 2005 km, and the freight density of these movements are shown in Figure 17. The total cost reductions for trips shifted from road to Inland Rail, can be broken down into two components: shift from road to coastal rail, then a shift from coastal rail to Inland Rail. Both components are shown in Table 12.
- Existing rail (Parkes to Narromine) only contained grain movements (Table 9). This was not included in the Inland Rail transport cost savings in this report since the Parkes to Narromine segment only represented a small portion of the grain transport network. Inland Rail benefits for grain transport will be considered in the next phase of the project.
- The expected transport cost savings shown in Table 12 generally only relate to the freight movement. Whether Inland Rail is used in the identified potential supply chains will depend on a multitude of logistical, relational and behavioural decisions throughout the supply chain.
- Savings in one element of the supply chain might only be realised by incurring a cost elsewhere (hence reducing the overall saving to the supply chain). Alternatively, realised transport savings may be negated by changes in costs elsewhere (e.g. increased congestion, higher distribution costs).
- A payload of 22 tonnes for a semi-trailer equivalent (33 tonnes for a B-Double) or a 40ft container was used, based on palleting and temperature control requirements for refrigerated frozen freight (McEvilly 2005). This is less than payloads (e.g. 28 tonnes per semi-trailer equivalent) achievable for other commodities.
- Additional benefits may also occur such as reduced road maintenance, accidents or environmental impacts. These benefits have not been modelled as part of this study.
- Every region will be different due to differences in the type and distribution of industrial activity relative to the Inland Rail corridor.
- The savings from Inland Rail for long distance supply chains such as horticulture and post-processed food are sensitive to parameters such as backloading at different locations, which will be explored further in future phases of the project.

Table 12: Inland Rail baseline – annual expected transport cost reductions

Supply chains	Total Savings	Tonnes benefitting	Average savings per payload tonne	Average Inland Rail utilisation (km)
Shift from road to rail	$70,351,962	922,981	$76.22	1,569
Existing coastal rail shift to Inland Rail	$4,753,034	150,636	$31.55	1,708
Total	$75,104,996	1,073,617		

It is important to note that the savings shown in Table 12 are based on the Parkes to Narromine pilot, and will be expanded further in the Phase 1 (southern corridor from Narromine to Seymour) and Phase 2 (northern corridor from Narromine to Toowoomba) projects.

The largest savings were for supply chains shifted from road to rail, with 922,981 tonnes out of the 1.2 million tonnes of freight shown in Table 9 benefitting. These savings were across the whole trip from origin to destination, where the rail scenario includes the road components at either end of the intermodal and the associated additional loading and unloading costs.

For supply chains shifted from road to rail, and assuming 50 percent backloading, the expected annual transport cost savings for each commodity were as follows:

- Horticulture $25,927,486 or $73.30 per tonne; and
- Post-processed food - $44,424,475 or $78.04 per tonne.

This equates to a potential average transport cost saving of $76 per tonne, with most of the horticulture and post-processed food products having a potential transport cost saving between $64.34 per tonne[17] and $93.56 per tonne[18].

Whilst fuels were not included as a target commodity, indicative savings from a shift from road to rail was about $41 per tonne for trips between Brisbane and Parkes; however, this did not include additional storage and handling costs. The lower savings per tonne for fuel were due to the short-distance intermodal trips (e.g. Brisbane to Parkes) relative to the longer usage of Inland Rail by horticulture and post-processed food supply chains.

For horticulture products currently transported by rail on the coastal line, the modelling suggests a potential average transport saving of $31 per tonne by shifting to Inland Rail, with most of these products having a potential transport cost saving between $28.06 per tonne[19] and $35.75 per tonne[20] by using Inland Rail.

Based on Table 12, the modelling suggests that 42,000 full heavy vehicle trips[21] per year would be removed from roads in the study area. While this is not a direct benefit to industry, it does represent a significant community benefit through reduced congestion and emissions and improved road safety outcomes.

- While there is a reduction in total heavy vehicle trips in the study area, there is a degree of concentration of heavy vehicles on particular sections of the road network. This outcome

17 Assuming 70 percent backloading. See Table 16.

18 Assuming 30 percent backloading. See Table 16.

19 Assuming 70 percent backloading. See Table 16 and Figure 19.

20 Assuming 30 percent backloading. See Table 16 and Figure 19.

21 Semi-trailer equivalents. A further 21,000 empty heavy vehicle trips would be removed based on an assumption of 50 percent backloading.

reflects a redistribution of existing truck trips to intermodal terminals in order to access Inland Rail. Further analysis will be conducted to determine the level of concentration around certain nodes and corridors.

6.2.3 Travel times

For some commodities, particularly perishable products, travel time is also a critical factor along with travel costs. Table 13 shows a comparison of travel distances and travel times for road only versus road plus rail. The results are for horticulture products and post-processed food trips shifted from road to rail as presented in Table 9:

- Values for “Road only” are the original trip between the origin and destination enterprises. Values for “Road and Rail” include the road trip from the enterprise origin to the intermodal hub, the rail trip between intermodal hubs, and the road trip from the destination intermodal hub to the destination enterprise.
- For road, the travel times did not include driver rest stops in accordance with driver fatigue guidelines. For rail, travel times did not include the time between arrival of the container at the intermodal hub and the departure of the train.
  - The latter would include the time containers are stored at the intermodal hub and the loading and unloading of the train. The additional time components of the road and rail travel will be considered in Phase 1 of the project.

For the travel component only, Table 13 shows a slightly longer travel distance for “Road and Rail” versus “Road only” for most routes except Parkes to Brisbane where the travel distances are quite similar. The longer the distance, the larger the travel time gap between “Road only” and “Road and Rail”, usually due to the detour of using rail and using some of the slower non-Inland Rail network.

Table 13: Comparison of average travel times, not including loading and unloading times or driver stops

		Road only		**Road and Inland Rail**	
Route Queensland[A] to/from	**Commodity**	**Av Distance (km)**	**Av Travel time (hrs)**	**Av Distance (km)**	**Av Travel time (hrs)**
Parkes	Horticulture	1710	20.86	1693	22.26
	Post-processed food[B]	1835	22.43	1785	23.10
Adelaide	Horticulture	3080	35.56	3197	49.54
	Post-processed food				
Melbourne	Horticulture	2730	33.38	2916	38.36
	Post-processed food	2156	25.92	2516	32.33

Notes: A. All of Queensland, i.e. the travel times shown are unrelated to the Inland Rail service offering of less than 24 hours between Melbourne and Brisbane. B. Post-processed food is agriculture only

6.3 Sensitivity analyses[22]

6.3.1 Alternative train configurations

A sensitivity analysis was conducted for the backloading and double stacking parameters of the Inland Rail reference train. Table 14 contains the parameters for the train configurations modelled for the Inland Rail baseline.

Table 14: Variations Inland Rail train configurations tested with the reference baseline (scenario 5) in bold

Train configuration	Backloading % (road and rail)	Double stack %	Wagons Single	Wagons Double
1	0	0	100	0
2	30	0	100	0
3	50	0	100	0
4	70	0	100	0
5	0	33	60	30
6	30	33	60	30
7 (reference train)	**50**	**33**	**60**	**30**
8	70	33	60	30
9	50	66	25	50

Each of the Inland Rail configurations of Table 14 were tested through the road and rail modules of TraNSIT, and applied to trips shifted from road to rail as well as existing rail trips (intermodal) shifted from the east coast to Inland Rail.

Figure 18 summarises the total expected transport cost savings under each Inland Rail train configuration (see Table 15 for the underlying data). The savings included the intermodal cost (storage and handling) of $80 per container at the origin and destination Intermodal facilities.

Transport cost savings per payload tonne decreased with increased backloading due to the greater cost efficiency of increased backloading for road only trips. For example, a 50 percent backloading versus zero percent backloading had a greater percentage cost reduction for road than for road and rail, due to the higher fixed costs of an intermodal trip.

- Unlike road, rail has a track access charge based on a gross tonne kilometres, which significantly increases the cost of operating an 1800 meter train with a full payload versus an empty payload, i.e. total track access costs increase the more freight (by weight) is carried.
- Also, the ratio of fuel costs for a fully loaded train versus an unloaded train is higher than that for a loaded or empty truck.

[22] Analysis of the sensitivity of the results to alternative train configurations and triangulation are reported here. Changes in the fuel price assumption was also tested and found to have a negligible impact on the results.

Figure 18: Total expected annual savings for all freight shifting to Inland Rail versus savings per payload tonne for each train configuration (see also Table 15). BL – Backload, DS – Double Stack (50%BL & 33%BL is the reference train).

Table 15 summarises the transport cost savings for trips shifted from coastal rail or road to Inland Rail via the closest intermodal facilities.

Table 15: Summary of annual savings for trips shifted from road or coastal rail to Inland Rail. BL – Backload, DS – Double Stack

Train configuration	Total Savings	Tonnes benefitting	Savings per payload tonne	% saving for trips benefitting
0%BL, 0%DS	$109,752,607	1,009,215	$109.08	83.96
30%BL, 0% DS	$77,792,902	1,074,181	$72.42	89.37
50%BL, 0%DS	$65,579,117	1,068,766	$61.55	88.92
70%BL, 0%DS	$56,775,614	1,063,369	$53.39	88.47
0%BL, 33%DS	$123,820,282	1,158,114	$106.92	96.35
30%BL, 33%DS	$95,958,068	1,118,716	$85.77	93.07
50%BL, 33%DS	**$75,104,995**	**1,073,617**	**$69.96**	**89.32**
70%BL, 33%DS	$63,130,379	1,066,175	$59.12	88.70
50%BL, 66%DS	$78,339,437	1,074,544	$72.90	89.40

The key points from Table 15 are:

- At 33 percent double stacking, transport cost savings increased by about 20 percent versus the corresponding non-double stack configuration with the same backloading.
- A 66 percent double stacking configuration resulted in about a 10 percent increase in transport cost savings compared to the corresponding 33 percent double stack scenario with 50 percent backloading.

- Not all of the 1.2 million tonnes of freight shown in Tables 9 and 10 benefitted from Inland Rail, with the (0% BL, 0%DS) configuration having the lowest degree of benefit (83.96 percent of freight) and (0%BL, 33%DS) having the largest degree of benefit (96 percent of freight).

Table 16 shows the summary of savings disaggregated by existing horticulture and post-processed food rail movements between Brisbane and Melbourne shifted from the coastal route to the Inland Rail, along with trips shifted from road to rail. The backloading percentages and train configurations of Table 14 only applied to intermodal trips between Melbourne and Brisbane.

In Table 16, transport cost savings of existing rail trips shifted to Inland Rail increase with increased backloading. This reflects the road component being excluded from the modelling on the basis that the road task is the same regardless of the rail corridor used; the origin and destination intermodal terminals, and the pick-up and delivery locations are assumed to be the same. For horticulture products currently transported by rail on the coastal line, the modelling suggests a potential average transport saving of $31 per tonne by shifting to Inland Rail. This result is also sensitive to different backloading scenarios, but it is expected that the majority of these products have the potential to save between $28 per tonne (70% backload) and $36 per tonne 30% backload) in transport costs by using Inland Rail.

Table 16: Summary of annual savings disaggregated by existing rail trips (horticulture only) and shift road to rail (horticulture and post-processed food only). BL = Backload, DS = Double Stack

	Existing coastal rail shift to Inland Rail		Shift road to rail	
Train configuration	**$ Savings**	**$ saving per t**	**$ Savings**	**$ saving per t**
0%BL, 0%DS	$0	$0	$109,752,607	$109.08
30%BL, 0%DS	$1,811,603	$12.03	$75,981,299	$82.27
50%BL, 0%DS	$3,308,146	$21.96	$62,579,117	$68.16
70%BL, 0%DS	$4,497,706	$29.86	$52,277,908	$57.39
0%BL, 33%DS	$515,779	$3.42	$123,304,503	$122.39
30%BL, 33% DS	$5,384,711	$35.75	$90,573,357	$93.56
50%BL, 33%DS	**$4,753,034**	**$31.55**	**$70,351,962**	**$76.22**
70%BL, 33%DS	$4,226,144	$28.06	$58,904,235	$64.34
50%BL, 66%DS	$5,251,882	$34,86	$73,087,556	$79.11

Current rail backloading percentages highlighted in Table 11 for different major intercity routes may change after the construction of Inland Rail as additional customers use the rail. Figure 19 shows a comparison of transport cost savings per payload tonne of Melbourne to Brisbane trips for the Inland Rail reference train versus the existing coastal rail. As backloading reduces, transport cost savings for Inland Rail increase at a “non-linear” rate because there is increased fuel consumption and track access charges for a return trip with larger backloading. As a comparison, the cost per payload tonne for a coastal train between Melbourne and Brisbane with 100 percent backload is 56.6 percent of that when the train has 0 percent backloading. For the Inland Rail reference train, the corresponding percentage is 58.5 percent.

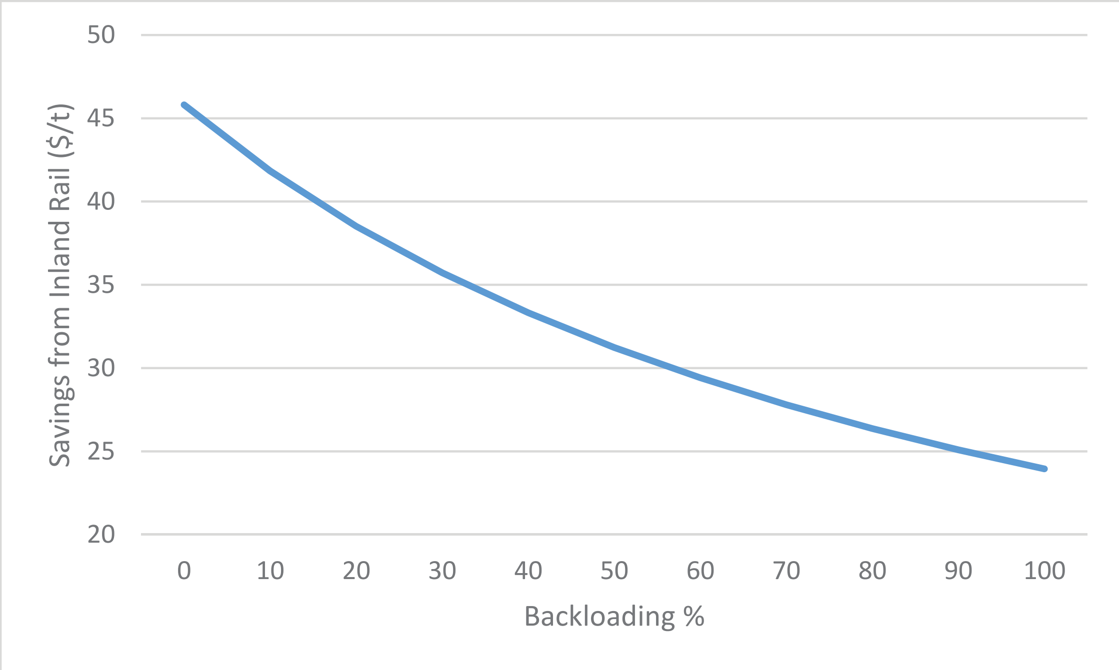

Figure 19: Savings ($) per payload tonne for shift from coastal rail to Inland Rail (Melbourne to Brisbane) versus backload percentage

6.3.2 Triangulation

Under the Inland Rail baseline scenario, the backloading percentage was assumed the same for road and rail. The backloading for road assumed vehicles will travel back to the origin with backloaded freight after finishing at the destination, which is the most efficient form of backloading. In practice, the backload can be a different supply chain path requiring the vehicle to travel empty for a percentage of the trip before picking up the next load.

Discussions with freight operators and drivers revealed up to 40 percent of a backload journey can be spent travelling to the next pick up point, though most freight operators will minimise the trip to the next pick up. Using the Inland Rail TraNSIT baseline, the impact of different percentages of the backload trip that is spent travelling to the next pick up was tested.

For road trips shifted to rail, Figure 20 shows the impact of transport cost savings to the percentage of the forward or backload trip spent travelling to a different pick up point. The Inland Rail reference baseline with $70,351,962 per year has a 0 percentage of the trip travelling to an alternative point to pick up a backload, i.e.:

- Even though the Inland Rail baseline is based on a 50 percent backload, those backload trips assume a return trip to origin without a pick up from a different location.

Figure 20 shows that the savings to Inland Rail is very sensitive to the efficiency of road backload, though the savings per payload tonne increased at a slower rate to the total savings.

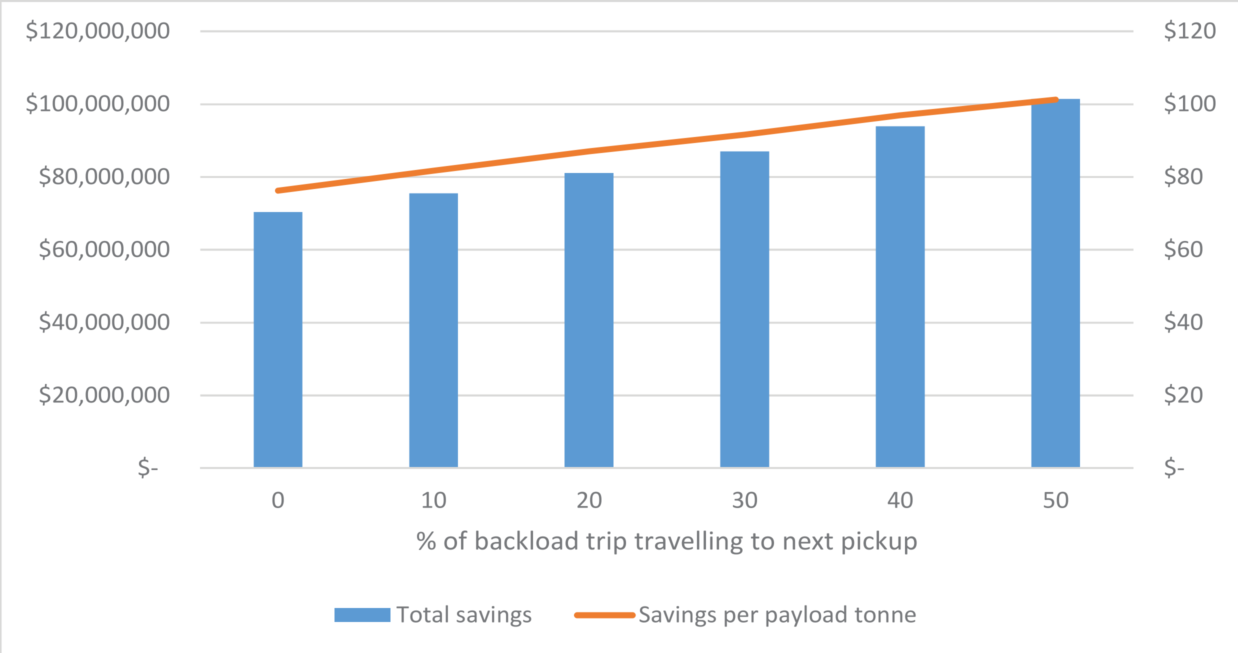

Figure 20: Sensitivity of annual transport cost savings of Inland Rail to percentage of backload trip spent driving to next pick up point (x axis)

7 Counterfactual Scenarios

A major infrastructure investment that produces a lower cost freight route to major markets is also likely to create new supply chains along this path. Here, two hypothetical counterfactual scenarios are used to test the transport cost and travel time impacts of Inland Rail supplying to new markets in Brisbane.

7.1 Processor at Dubbo

A food processor in the pilot study area, at a Dubbo industrial area near the centre of town and adjacent to the rail network (co-ordinates -32.246769, 148.6192) is used for the scenario. For this scenario, the food processor is diary, predominately producing milk and some yoghurt products. Annual production is about 40,000 kilolitres of milk per year, and currently supplies markets in Sydney (70%), Newcastle (25%) and local markets in Dubbo and Parkes (5%). Transport to major markets in Sydney is via road to major supermarket distribution centres and then to supermarkets.

The milk processor is considering entering into a new contract to supply a major customer in the Brisbane metropolitan market. The supplier has not previously serviced the Brisbane metropolitan market due to high transport costs compared to existing markets. Road travel to markets in Brisbane would require 850km of travel in B-Double vehicles to distribution centres at Heathwood, near Acacia Ridge south of Brisbane, taking nearly 10 hours. Travel to Brisbane via Inland Rail would require a short 45km (40 minute) road trip (A-Double vehicle) to a loading facility to Narromine, followed by an 867km rail trip (11.56 hours) to Acacia Ridge. From Acacia Ridge, the product could be transported to the distribution centres (12km or 15 minutes to Heathwood) or direct to retail from Acacia Ridge.

Current travel by semi-trailer road vehicle to Sydney distribution centres is 352 km (4.2 hours) to Eastern Creek, and 377 km (4.4 hours) direct to markets at Newcastle via B-Double vehicle. Dairy products are transported in 40 foot refrigerated containers with 22 pallets per container and a net payload of 22 tonnes. Loading and unloading costs at an intermodal facility are $40 per container including any storage requirements.

Here, the following comparisons were made:

1. Road transport to existing markets in Sydney and Newcastle by road
2. Road transport direct from the milk processor to the distribution centre in Brisbane using B-Double vehicles
3. Rail transport to Brisbane using the Inland Rail reference train, including a short road trip to a loading facility at Narromine, and a short road trip (semi-trailer) from Acacia Ridge and the distribution centre at Heathwood.

Freight paths are shown in Figure 21. For rail transport to Brisbane, the Inland Rail reference train was used - 1800 metres long with 3 locomotives trailing a maximum of 3900 tonnes. It has 33 percent double stacking utilising an average of 60 wagons (40 foot flat for single stacking) plus 6 by 5-pack Bogie Well wagons (30 wagon equivalents) for double stacking.

Figure 21: Comparison of indicative freight paths (road and rail) between the processor at Dubbo and the market options

7.1.1 Results

Road trip from Dubbo to Brisbane DC at Heathwood (including loading and unloading) and assuming 50% backload) and one hour to load or unload = $95.04 per payload tonne (Table 17)

Road trip from Dubbo to Narromine = $6.46 per payload tonne

Rail trip from Narromine to Acacia Ridge via Inland Rail = $39.11 per payload tonne

Road trip from Acacia Ridge to DC at Heathwood = $2.72 per payload tonne

Road trip from Dubbo to Sydney DC in semi-trailers= $50.24 per payload tonne

Road trip from Dubbo to Newcastle markets in B-Doubles = $42.67 per payload tonne

Table 17: Cost comparison of paths to markets

Trip	Travel road (km)	Travel rail (km)	Cost per payload tonne
Dubbo to Sydney	352		$50.24
Dubbo to Newcastle	377		$42.67
Dubbo to Brisbane (road)	850		$95.04
Dubbo to Brisbane (Inland Rail)	57	867	$51.92

7.2 Processor at Parkes

A second hypothetical milk processor, based at Parkes, is considering entering into a new contract to supply a major customer in the Brisbane metropolitan market. The processor is based adjacent to the Intermodal facility at Parkes, and would not require any road travel to the rail loading point. The supplier has not previously serviced the Brisbane metropolitan market due to high transport costs compared to existing markets. Road travel to markets in Brisbane would require a 961km travel in B-Double vehicles to distribution centres at Heathwood, near Acacia Ridge south of Brisbane, taking nearly 11 hours.

Travel to Brisbane via Inland Rail would require direct loading onto rail at Parkes, followed by a 986km rail trip (13.2 hours) to Acacia Ridge. From Acacia Ridge, the product could be transported to the distribution centres (12km or 15 minutes to Heathwood) or direct to retail from Acacia Ridge.

Current travel by semi-trailer road vehicle from Parkes to Sydney distribution centres is 322 km (4.1 hours) to Eastern Creek, and 477 km (5.5 hours) direct to markets at Newcastle via B-Double vehicle. Dairy products are transported in 40 foot refrigerated containers with 22 pallets per container and a net payload of 22 tonnes. Loading and unloading costs at an intermodal facility are $40 per container including any storage requirements.

Here, the following comparisons were made:

1. Road transport to existing markets in Sydney and Newcastle by road
2. Road transport direct from the milk processor to the distribution centre in Brisbane using B-Double vehicles
3. Rail transport to Brisbane using the Inland Rail reference train, including a short road trip (semi-trailer) from Acacia Ridge and the distribution centre at Heathwood.

For rail transport to Brisbane, the Inland Rail reference train was used - 1800 metres long with 3 locomotives trailing a maximum of 3900 tonnes. It has 33 percent double stacking utilising an average of 60 wagons (40 foot flat for single stacking) plus 6 by 5-pack Bogie Well wagons (30 wagon equivalents) for double stacking.

7.2.1 Results

Road trip from Parkes to Brisbane DC at Heathwood (including loading and unloading) and assuming 50% backload) and one hour to load or unload = $103.70 per payload tonne (Table 18)

Rail trip from Parkes to Acacia Ridge via Inland Rail = $45.24 per payload tonne

Road trip from Acacia Ridge to DC at Heathwood = $2.72 per payload tonne

Road trip from Parkes to Sydney DC in semi-trailers= $47.22 per payload tonne

Road trip from Parkes to Newcastle markets in B-Doubles = $52.95 per payload tonne

Table 18: Cost comparison of paths Parkes to markets

Trip	Travel road (km)	Travel rail (km)	Cost per payload tonne
Parkes to Sydney	322		$47.22
Parkes to Newcastle	477		$52.95
Parkes to Brisbane (road)	961		$103.70
Parkes to Brisbane (Inland Rail)	15	986	$51.57

8 Next Steps

The Parkes to Narromine Inland Rail Supply Chain Mapping pilot project applied CSIRO's Transport Network Strategic Investment Tool (TraNSIT) to provide the underlying data to inform and assist local industries to assess and improve the competitiveness of their supply chains.

As TraNSIT is a knowledge-based tool, the analytical capacity of the tool increases as more data becomes available. The preliminary results of this pilot project will be tested further in the next phases of the Inland Rail Supply Chain Mapping Project:

- Phase 1: Southern Corridor (Narromine to Seymour)
- Phase 2: Northern Corridor (Narromine to Toowoomba).

The proposed study area for the Southern Corridor (see Figure 22) is significantly wider west of the Inland Rail alignment, particularly in New South Wales, reflecting the prevailing west-east flow of freight.

The Southern Corridor study will commence in April 2019 and is likely to take a year to complete due to the substantial stakeholder consultation requirement. The Northern Corridor study is likely to commence in early 2020.

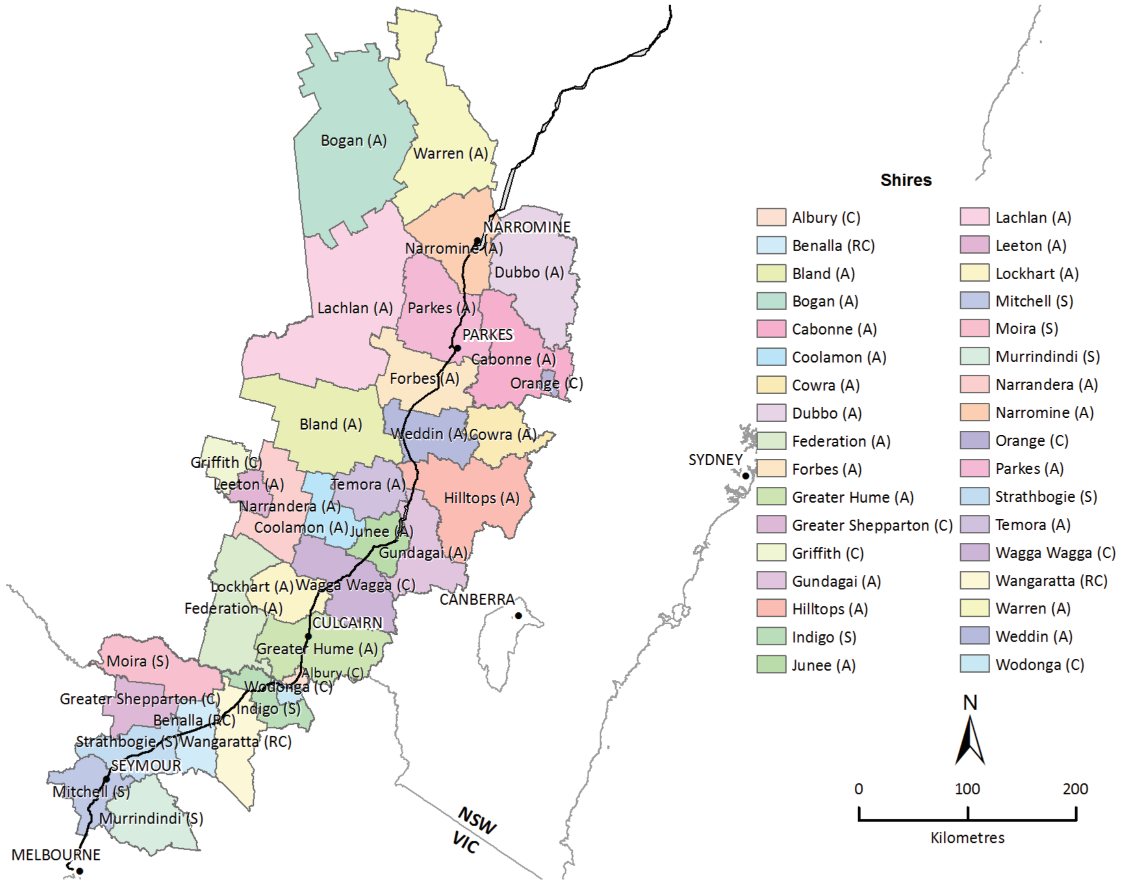

Figure 22: Proposed study area for southern corridor phase of the Inland Rail Supply Chain Mapping Project

Attachment A: The Transport Network Strategic Investment Tool

CSIRO developed TraNSIT to provide a comprehensive assessment of transport logistics costs and benefits due to infrastructure investments and policy changes in agriculture supply chains in Australia.

TraNSIT is a ground up approach that optimises transport routes between enterprises and their markets – a key consideration in Australia, which is characterised by long supply chains with large distances between production, processing and markets. The tool's outputs inform operational, investment and regulatory decisions and freight supply chain strategies from local to national scale.

TraNSIT was initially built in 2012/13 to model livestock supply chains in northern Australia, through an initiative of the Office of Northern Australia and with co-funding from the Northern Territory, Western Australian and Queensland Governments. In 2014, the tool was extended to all beef transport in Australia through a Meat and Livestock Australia initiative (Higgins et al., 2015).

In 2014/2015, the tool was used to inform various road upgrades and regulatory changes for the beef industry, most notably the Northern Australia Beef Roads Programme. The Beef Roads Programme was the first of its type in Australia to use an optimisation tool like TraNSIT to evaluate the transport cost savings for a large number of submissions. TraNSIT evaluated 60 road upgrade submissions, where the total construction cost was estimated to exceed $3 billion. A report outlining the application of TraNSIT to the Beef Roads Programme and the resultant transport cost savings for each road upgrade can be accessed via www.csiro.au/transit.

Through an initiative for "Building the infrastructure of the 21st Century" under the Agricultural Competitiveness White Paper (http://agwhitepaper.agriculture.gov.au/), TraNSIT was recently applied to 98% (by volume) of agricultural and horticultural supply chains across Australia. The final report (accessible from www.csiro.au/transit) was announced by Assistant Minister Luke Hartsuyker in November 2017. Additional applications in recent years have included assessment of sealing of roads in north Queensland and assessment of tick clearing regulations for transport of cattle direct to abattoirs.

The range of scenarios TraNSIT can examine includes:

- Analysing the impact of road upgrades, e.g. sealing, widening, first/last mile, improving roads for higher productivity vehicles and bridges;
- Testing potential outcomes for changes in policy, e.g. driver fatigue, changed truck limitations for road classes;
- Comparing infrastructure investment and regulatory-change opportunities that maximise transport cost reductions for a given investment budget;
- Assessing potential for incorporation of rail transport in to commodity value chains.

This pilot project will develop a spatial mapping and transport analysis of existing freight supply chains along the Parkes to Narromine section of the proposed Inland Rail corridor. This project will pilot the appropriateness of using TraNSIT for estimating the regional supply chain benefits along the whole Inland Rail corridor. It will also test a range of investments and policies that complement the Inland Rail investment.

Attachment B: Project method

The phases and methods of the pilot project, as outlined in the original proposal are:

1. Definition of the study area

   The Inland Rail programme consists of 13 projects along the corridor, with the Parkes to Narromine project the first to commence construction in 2018. While the pilot study will be based on this project, in practice, to capture conditions and movements in the wider region that impact upon this project, the pilot project's study area will be much larger and may incorporate other sections of Inland Rail (e.g. Narromine to Narrabri in the north and Stockinbingal to Parkes in the south).

2. Stocktake of major freight supply chains in the study area

   The target supply chains are those either originating or terminating within the study area.[23] This will include commodities already incorporated within TraNSIT as well as others that need to be added based on their likelihood or potential to utilise the Inland Railway. These will be determined in consultation with local supply chain participants, local councils and regional development agencies, and through the identification of major centres of freight generation (e.g. a mine) or attraction (e.g. a distribution centre) within the study area.

   The stocktake will enable supply chains appropriate to Inland Rail to be identified for further investigation. Appropriateness in this case is likely to be based on one or more products in the supply chain being suitable for rail transport.

3. Data gathering

   Data will be collected via:

   – Field interviews with supply chain participants and regional stakeholders (e.g. local government, TfNSW);
   – Discussions with supply chain representative bodies;
   – Discussions with representatives from government agencies – e.g. TfNSW, NSW Department of Planning and Environment, Australian Government Border Force customs data, ABS, ABARES
   – Analysing results of previous surveys and studies.

   The project team (The Department of Infrastructure, CSIRO) will hold a meeting with key stakeholders early in the project, to identify sources and providers of data, timing of supply and confidentiality agreement requirements. CSIRO already has data on agriculture and forestry, some of which will be updated.

   During the data gathering phase, views of stakeholders will be sought on potential constraints to using Inland Rail and on possible interventions to remove those constraints. Information on

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[23] The original intention of the project was to focus on local supply chains only; however, the TraNSIT model is also able to provide data on movements through the study area (i.e. not stopping) for the same commodities with an origin or destination within the study area. The pilot project team decided to include the through movements output to broaden the analysis. As the data on local supply chains was limited to the constrained pilot study area, the results risk being misinterpreted as representing the broader region. Conversely, the data for the through movement of horticultural products and post-processed foods is more complete and provides greater confidence as being reflective of the supply chains of these products.

constraints outside the study area (e.g. port access) that are considered to affect the usage of Inland Rail will also be sought and considered.

Data to be collected include:

– Bulk commodity freight transport routes, modes and volumes, with origins or destinations within the pilot study area;
– General freight and mixed commodity movements, with origins or destinations within the pilot study area;
– On farm storage of grains (location, volume) within the study area;
– Local road network from relevant local governments for the study area;
– Current storage and handling costs within the study area.

In the event of data gaps or low granular data, a method will be developed to integrate the different available data sources to achieve the best usable information. These methods will be documented, along with actions for acquiring improved information.

4. Baseline validation

Initial results of the "current system" (baseline) modelling will be presented to key stakeholders and data providers for their analysis and feedback, to ensure validity of the baseline. This includes validating supply chains paths, tonnes transported by commodity, transport mode, transport costs and freight routes. The TraNSIT model and baseline will be updated as a result of the validation.

5. Expected regional benefits of Inland Rail as a standalone investment

Based on the freight movements and broader supply chains identified through the supply chain stocktake, TraNSIT will model the direct expected benefits of Inland Rail to supply chains in the study area.

In doing so, TraNSIT will be used to produce an Inland Rail baseline by firstly identifying freight movements and broader supply chains that could benefit from utilising Inland Rail, followed by remapping the supply chains accordingly.

The Inland Rail baseline will show the transport cost savings and changes in freight volumes on the road and rail network as a result of Inland Rail. It will be based on typical train configurations that would be used for each specific supply chain.

The sensitivity of the Inland Rail baseline results will be tested under a variety of scenarios (e.g. low / high uptake of demand, low / high production years).

This baseline will undergo extensive validation from all key stakeholders, including a round table workshop) where views or issues can be raised. A revised Inland Rail baseline will be produced as a result.

6. Potential additional regional benefits from further intervention

Based on the views of stakeholders and data providers, TraNSIT will be used to assess the additional regional benefits from complementary investments and policies. Depending on the interventions proposed, testing is likely to be aimed at the most 'reasonable' suggestions, however some sensitive suggestions may be tested to demonstrate their feasibility.

The testing of the interventions will also include an assessment against the “Inland Rail” baseline. Within the pilot project, up to 8 scenarios (e.g. road upgrades, regulatory, storage or loading improvements, train configurations, structural adjustment of businesses (e.g. relocation)) will be tested depending on the complexity to implement within TraNSIT.

7. Reporting of final results

   The initial results of the pilot project will be reported to the Executive Director, Inland Rail and Rail Policy Division, prior to being provided to key stakeholders and data providers for comment.[24]

The final results will be reported in terms of:

- The expected direct benefits of Inland Rail to regional supply chains within the study area;
- Changes in freight volumes along the road and rail network, which can be used to identify additional impacts (e.g. road maintenance);
- The relative merits of potential interventions and structural adjustments in terms of cost savings to regional supply chain participants; and
- Residual issues and observations such as potential secondary benefits (e.g. improved supply chain resilience to flooding).

These results will be reported in the form of spatial maps and tables that best convey the benefits.

A final report and Executive Summary will be produced highlighting methods, assumptions, full results, limitations and recommendations for a full Inland Rail Supply Chain study. Additional outputs will be provided in the form of maps, tables, spreadsheets, and shape files (e.g. KMZ or GIS files depending on confidentiality restrictions).

[24] During the validation of the results, stakeholders were consulted further to assure the accuracy of the inputs to the model. By undertaking this pilot, the evidence base has been improved for third parties to approach CSIRO to model specific scenarios using TraNSIT. CSIRO is also in the process of enabling TraNSIT to be more broadly available via the internet.

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