COOMA AND MONARO PROGRESS ASSOCIATION

CONCEPT PLAN FOR CANBERRA TO EDEN RAILWAY

PROJECT RATIONALE

From the earliest days of Canberra's planning it was considered essential, for reasons of economic and military necessity as well as for recreation, for the Federal Capital to have a direct link to the coast by railway. However despite the grand plans of the 1800s, the formidable terrain of the far-south coastal ranges of New South Wales has prevented the construction of significant transportation infrastructure, thus keeping the region relatively isolated from the rest of Australia.

In fact, we have gone backwards since that time. The Queanbeyan-Bombala railway was closed in 1988 (ironically, the centenary of its completion), leaving the freight and passenger travel of the region wholly dependent on road transport. The rail corridor is still there, unused – a familiar story throughout the country.

However, several long-term trends are beginning to turn the tide back in favour of rail transportation.

Sydney's economic dominance, long its greatest strength, is increasingly causing diseconomies of scale. The congestion of its urban road system is legend, and all major transport routes into the city are at or nearing capacity, as well as being slow, expensive, or both. The rugged terrain surrounding the Sydney Basin makes the construction of any new routes a difficult proposition. The glittering harbour of Port Jackson no longer handles a significant freight task, and Port Botany is also at capacity.

Freight customers are looking for alternatives.

Meanwhile Canberra is coming of age as a significant economic centre in its own right, becoming the focal point for regional economic activity throughout the southeast of New South Wales. Canberra Airport is Australia's most modern airport, with significant spare capacity and easy access to major freight routes. And on the coast, Twofold Bay has long been recognized as one of the finest natural deep-water anchorages in Australia, rivalled only by Port Jackson, and perhaps Port Lincoln. The Port of Eden, on the bay's southern shore, is disadvantaged only by the lack of a major freight link to the rest of Australia.

The time has come to revisit the Canberra to Eden Railway.

The completion of such a rail link would enable the Port of Eden to emerge as a first-rate intermodal transport facility. It would redirect millions of tons of freight per year away from the congested Main Southern Railway, the Hume Freeway, and Port Botany. Instead of waiting for a high-speed railway to Sydney, Canberra Airport could position itself as the gateway of choice for both air-freight and passenger travel, for virtually the entirety of southern regional New South Wales, and perhaps much of eastern Victoria.

The extension of the Queanbeyan-Bombala railway to the Port of Eden would realise a century-old dream. This concept study finds that the existing route between Canberra and Bombala could be rebuilt to modern standards at modest cost, and also that the engineering difficulties of a new route descending the South Coast Range between Bombala and Eden are not insurmountable. The next steps are to undertake a detailed engineering study, finalising a preferred route and thus enabling detailed construction cost estimates, which would subsequently facilitate the preparation of a full business case.

RAILWAY SPECIFICATIONS

In general, it is recommended to adopt existing ARTC standards as the governing rail standard, to ensure full interoperability with the wider Australian network.[1] In addition to these standards, critical track geometry is informed by three main criteria:

1. The prevailing characteristics of the existing Canberra to Bombala line;
2. The desired performance of freight operations;
3. The desired performance of passenger operations.

FREIGHT SERVICES

A favourable gradient is the single most important characteristic for a freight railway. The existing track has a ruling gradient of 2.5% (1 in 40), although typical gradients are lower, at 1.5% to 2%. A very small number of sections have a gradient of 1% or less. These gradients cannot be avoided without a very significant re-routing of the corridor, which is impractical on engineering, economic and political grounds. Therefore, the existing gradients shall be adopted as desirable, typical and extreme maxima. Although steeper than the ideal ARTC standard of 1%, these gradients are in accordance with the standards selected for Inland Rail.

For radius of curvature, Inland Rail specifies a general maximum of 800m generally (115km/h speed limit), and 400m in mountainous areas (80km/h speed limit). In areas where speeds are expected to be low anyway (such as within townships or near terminal stations, radii can be as tight as 160m, although 200m is generally the existing minimum on the corridor.

For cant (superelevation, or track banking), the requirements of freight need to be balanced with those of passenger rail. Freight operations require a low cant to ensure heavy wagons do not overturn if stopped on a curve, while passenger trains, with their lower centre of gravity, can tolerate a higher level of track banking, which also facilitates higher allowable speeds. Inland Rail specifies a maximum cant of 125mm; it is recommended to adopt a higher general maximum cant of 150mm, which is the maximum used on mixed-use XPT lines in NSW.

Electrification is unlikely to be economically viable (barring a significant rise in the cost of diesel or vastly higher freight volumes than expected). While it would result in modest operational efficiencies, the up-front infrastructure cost of several million dollars per kilometre would be prohibitive, especially for a single-track railway. The World Bank suggests that electrification of freight railways only becomes economic at annual volumes of 40 million gross tons and above, and even then only in countries with high diesel costs.[2] For context, 40 million tons annually would entail at least 35 full-sized freight movements per day (3000 gross tons, 1800m long). Inland Rail expects freight volumes of only about 25 million tons by 2030. The Canberra-Eden railway is unlikely to reach such volumes in the foreseeable future.

RAILWAY SPECIFICATIONS

PASSENGER SERVICES

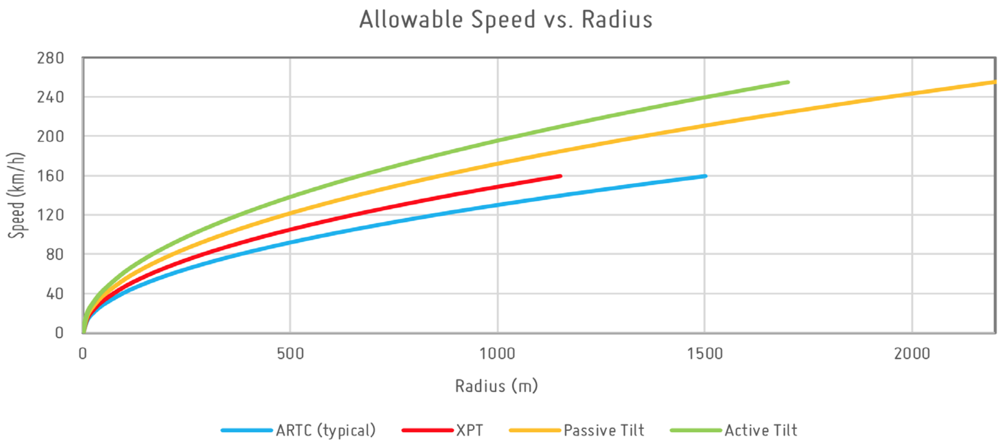
A fast passenger rail service is desired between Canberra Airport and Cooma, ie, facilitating significantly faster door-to-door travel than offered by any existing travel mode. Currently the trip is 112km on the Monaro Highway, taking about 73 minutes (averaging 92km/h). The railway's distance is almost exactly the same; therefore in order to achieve significant travel time savings, the passenger railway will have to operate much faster than highway speeds.

At the high end of conventional rail speeds, there are basically two design speeds to consider: 160km/h and 200km/h. 160km/h is considered "medium-speed rail", and entails significant operational advantages over "high-speed rail" - Significantly smaller radius curves, conventional signalling, level crossings permitted, a wide selection of suitable rollingstock, and operational experience in most states of Australia (XPT, V-locity, QR Tilt Train, TransWA).

A 160km/h design speed could easily be achieved on most if not all of the existing Queanbeyan-Bombala rail corridor with modest works to ease curvature. With active-tilting trains similar to those used in the UK and Europe, such speeds could be achieved with a curve radius of about 650m. Passive-tilting or regular trains would require larger curve radius.

A higher design speed would obviously offer further travel time improvements, but at a significantly higher cost. Curve radii are much larger at 200km/h (>1000m even for tilting trains), and full grade-separation is required as well as in-cab signalling. Additionally, Australia's lack of any existing regulatory framework for such speeds raises uncertainty about the approval process. It is not considered practical to adopt a design speed any higher than 200km/h due to the limitations of the existing railway corridor.

It is therefore recommended to adopt a design speed of 160km/h. However a desirable design speed of 200km/h should be adopted where it is practical and inexpensive to do so, with an eye to potential future speed increases.



RAILWAY SPECIFICATIONS

GENERAL CHARACTERISTICS

- Gauge: 1435mm (Standard Gauge)
- Tracks: Single
- Corridor width 40m (typical)
- Clearance Envelope: 4.8m wide x 6.5m high (single-stacked containers)

GRADIENT

- Desirable maximum: 1.5% (1 in 66)
- General maximum: 2% (1 in 50)
- Extreme maximum: 2.5% (1 in 40)
- At sidings: 0.1% (1 in 1000)

RADIUS OF CURVATURE

- Desirable minimum: 800m (throughout)
- General minimum: 650m (Canberra to Bombala)
- 400m (Bombala to Eden)
- Extreme minimum: 200m (on approach to major stations)

CANT (SUPERELEVATION)

- Desirable maximum: 110mm (where radius = 800m or greater)
- General maximum: 150mm (where radius < 800m)
- At platforms: 75mm

MAXIMUM TRAIN LENGTH

- Freight trains: 1800m
- Passenger trains: 150m (length of Cooma platform)

TRACK FORMATION

- ARTC Class: 1C
- Axle Loading: 25 tons max, 22 tons typical
- Rail type: 60kg/m standard carbon steel, head-hardened, continuously welded
- Sleepers: Concrete, 600mm centres (1660 per km)
- Ballast type: 60mm nominal size, properties as per AS2758.7
- Ballast depth: 270 cm depth below sleepers
- Capping: Compacted gravel/soil blend, properties as per AS2758.7

PROPOSED ROUTE

CANBERRA AIRPORT TO COOMA

With the exception of a new spur between Queanbeyan and Canberra Airport, and a few short deviations, this section utilizes the existing railway for its entire length. The existing gradients and curvature are quite suitable for the most part; the prevailing radius is generally 600m–1000m, with some curves much gentler, and some limited sections as tight as 200m. In most cases the tight sections are relatively simple to reshape to ease curvature, or bypass entirely. The major exception to this is a large viaduct required at Tuggeranong, approximately 1400m in length and up to 90m high.

The existing track formation is no longer in a condition suitable for restoration to regular use; it is expected that the ballast and sleepers will require 100% renewal. Some percentage of the rails, to be determined by a detailed condition report, may be able to be reused. Additionally, all wooden bridges and culverts will have to be replaced by new concrete structures. There are eight major bridges on the route, the most significant being a 390m causeway over the Numeralla River at Chakola. It is expected that existing brick or concrete structures can be retained at a modest refurbishment cost.

In addition to existing bridges, there are three locations where the Monaro Highway impinges on the corridor that will need to be grade-separated (it is assumed that level crossings will be unacceptable on such a high-volume road). All minor road crossings can be at-grade, belled and lighted at minimum.

COOMA TO BOMBALA

Between Cooma and Bombala, the curvature is significantly more restrictive. There are extensive sections of successive 200m-radius curves, particularly after Nimmitabel. Although easing of curvature is possible, the engineering works required are far greater than for the previous section (most significantly a series of four viaducts to bypass the curvature at Maclauchlan).

Particularly towards the Bombala end, the existing corridor is quite unsuitable. It is an open question whether the curvature south of Jincumbilly can be effectively eased, or whether a totally new corridor would be more economic for the final 20km into Bombala.

As with the previous section, the track and any wooden structures will require complete replacement; in fact most of the track has already been removed. There are only three major bridges (greater than 30m in length) and four crossings of the Monaro Highway (two of which are within Bombala township).

BOMBALA TO EDEN

Between Bombala and Eden there is no existing rail corridor. The principle engineering challenge is the need to descend the South Coast Range, from an elevation of approximately 800m to sea level, at a gradient under 2% and with minimal tunnels or viaducts.

The most promising route is through the Towamba Valley, broadly similar to that proposed by the government surveyor Charles Scrivener in 1905.[3] It would depart south from Bombala alongside the Monaro Highway, crossing the escarpment near Bondi Forest at 774 metres above sea level. It then proceeds downhill through the valleys of the White Rock River and Wog Wog Creek, eventually emerging into the Towamba River near Burragate at 60 metres altitude, following the river to its mouth near Boydtown. The railway terminates at the Port of Eden, on Twofold Bay's southern shore.

PROPOSED ROUTE

ADVANTAGES OF TOWAMBA VALLEY ROUTE

- Favourable ruling gradient of 1.5% (1 in 66) appears feasible.
- Relatively short at 106km (rhumb-line distance is 65km).
- Few tunnels required, none exceeding 1km in length.
- Significant length in state-owned plantation forest minimizes environmental impact.
- Potential for future link to Gippsland, Melbourne.

DISADVANTAGES:

- No significant intermediate townships served.
- Proximity to Towamba River and conservation areas may engender community opposition.
- Numerous bridges, viaducts and earthworks required:
- At least three large bridges (approx. 1km with 80m+ mainspan), and perhaps half a dozen smaller viaducts (approx. 250m, 30m high) to descend the range
- Will likely need at least half a dozen bridges across the Towamba River or significant tributary valleys regardless of the precise route chosen. Scale 500-1000m in length, maximum span 50m

ALTERNATIVE ROUTES BETWEEN BOMBALA AND EDEN

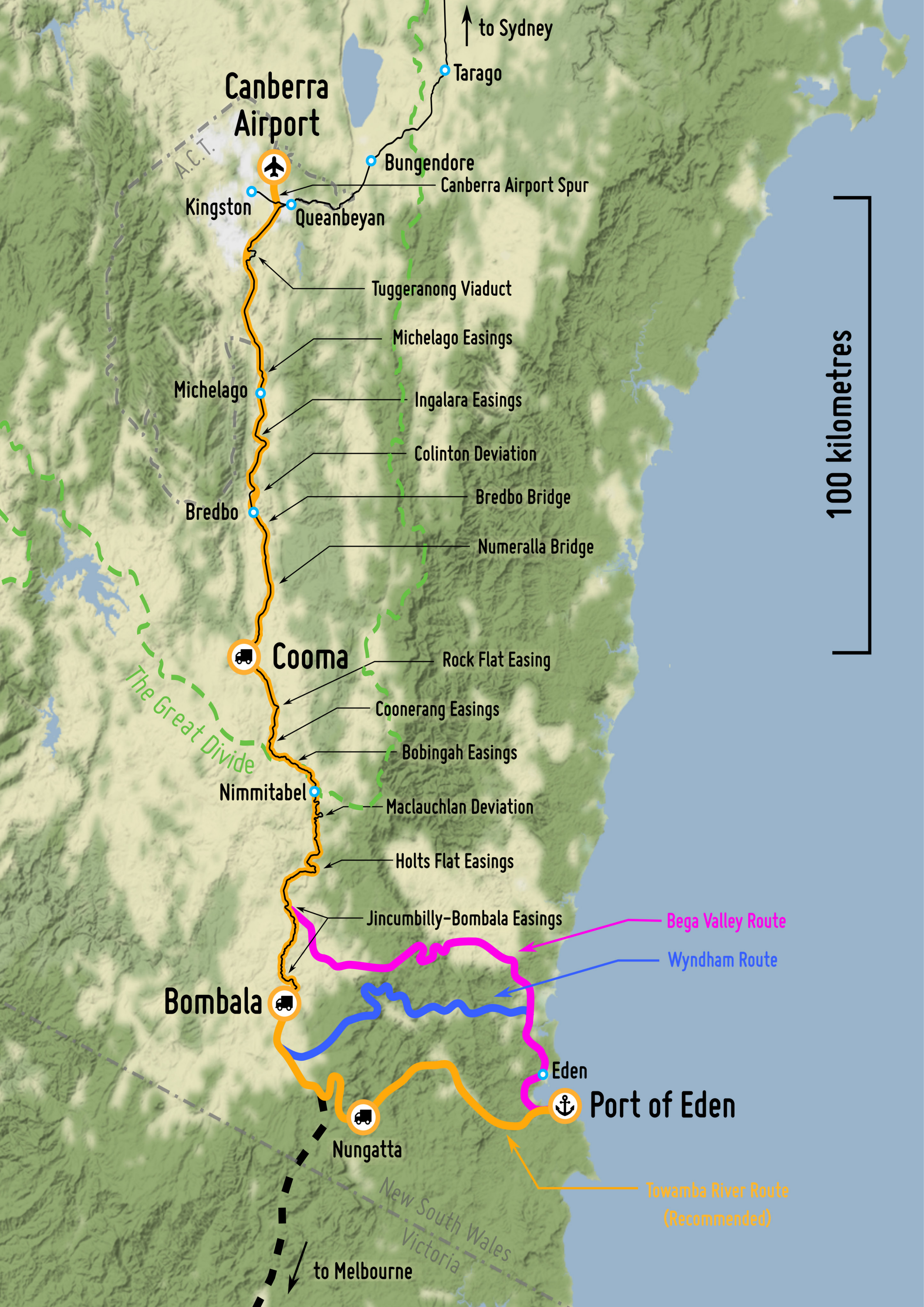
There are two plausible alternative routes to consider, one through the Bega Valley, and one encompassing the small township of Wyndham.

The Bega Valley route is broadly similar to one proposed by a Mr Arnheim in the 1800s.[4] It would proceed through Cathcart northeast of Bombala, descending the ridgelines to the north side of Mt Darragh. Once on the Bega Valley bottom, it would pass close to the townships of Candelo, Wolumla, and Pambula, using the surveyed but unbuilt Bega-Eden Railway. It would have the advantage of being able to serve several townships and a potential spur to Bega. However it would be disadvantaged by increased distance (in the order of 120km), and a less favourable grade (surveys in the early 1900s suggested a gradient of 2.5% would be achievable).

The second would proceed due east from Bombala through Coolangubra State Forest, descending the spurs surrounding Rocky Hall, then through the townships of Wyndham and Lochiel to Pambula, thereafter also using the surveyed Bega-Eden railway. Although achieving a gradient under 2% appears plausible, it is no shorter than the Towamba Valley route, and the number of tunnels and viaducts required would likely render construction prohibitively expensive.

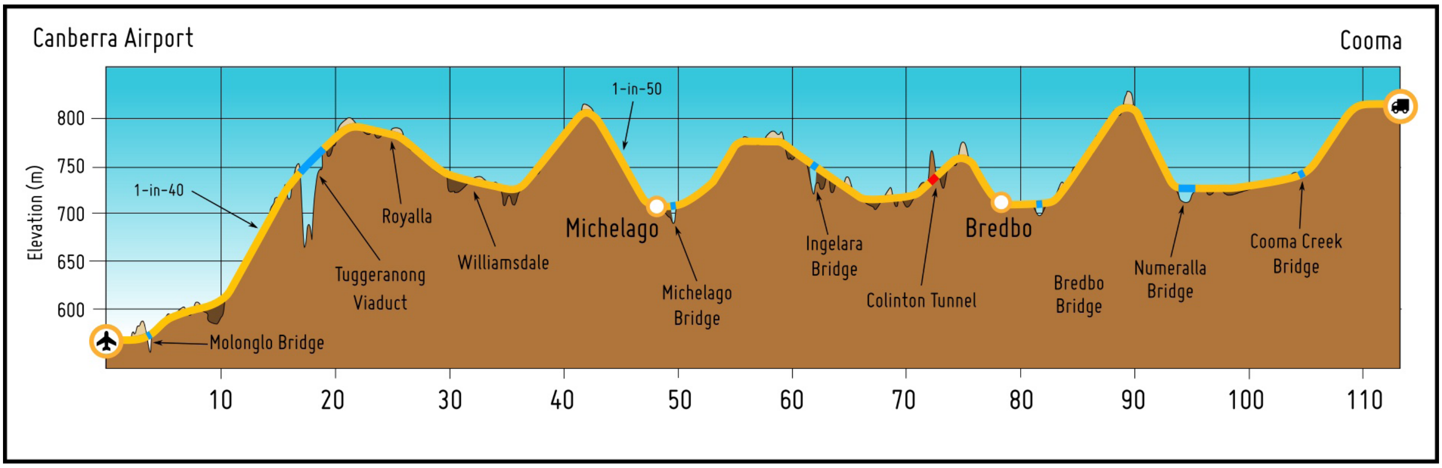
Further to the routes described above, there may be some limited options for descending the South Coast Range south of Nimmitabel, possibly encompassing the townships of Bemboka and Bega. However this is route not recommended due to bypassing the significant township of Bombala. Additionally, the route options prior to Bombala appear unlikely to yield a favourable grade, nor to have reasonable construction costs.

There is no possibility of descending the escarpment north of Nimmitabel; the Great Divide exceeds 1100m in this area and the subsequent terrain is formidable.

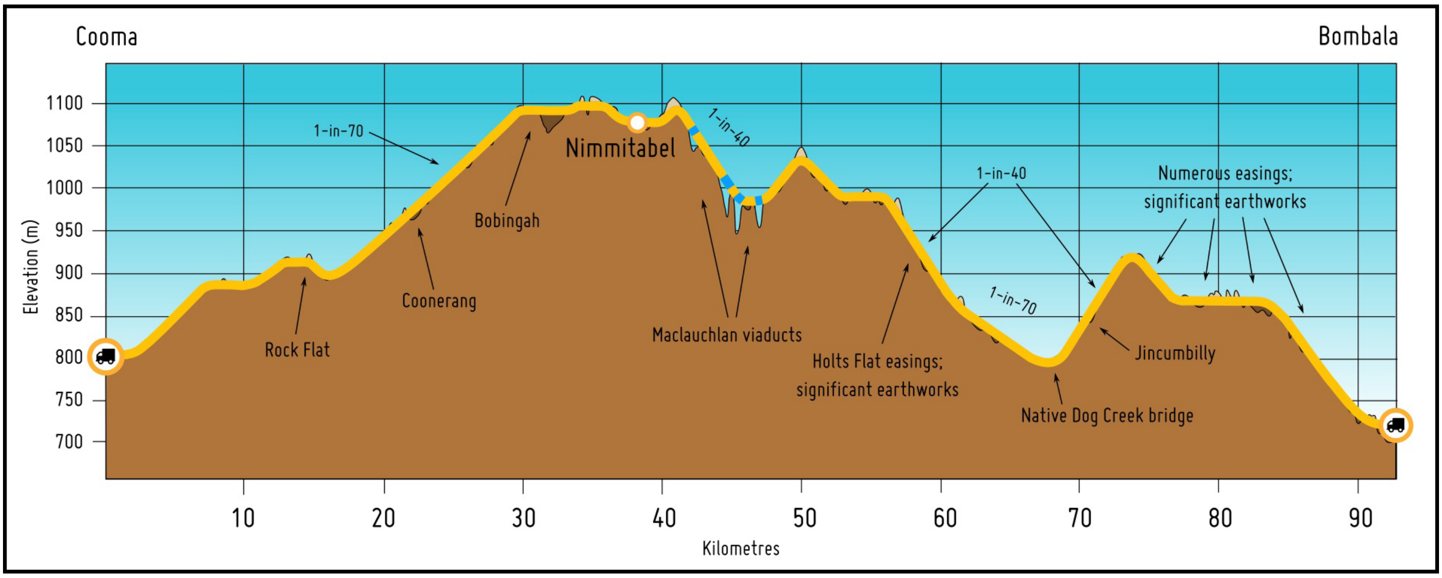

to Sydney
Tarago
Canberra Airport
A.C.T.
Bungendore
Canberra Airport Spur
Kingston
Queanbeyan
Tuggeranong Viaduct
Michelago Easings
Michelago
Ingalara Easings
Colinton Deviation
Bredbo Bridge
Bredbo
Numeralla Bridge
100 kilometres
Cooma
Rock Flat Easing
The Great Divide
Coonerang Easings
Bobingah Easings
Nimmitabel
Maclauchlan Deviation
Holts Flat Easings
Jincumbilly-Bombala Easings
Bega Valley Route
Wyndham Route
Bombala
Eden
Port of Eden
Nungatta
Towamba River Route
(Recommended)
New South Wales
Victoria
to Melbourne

EXISTING QUEANBEYAN TO BOMBALA RAILWAY – SECTION

CANBERRA to COOMA – SECTION DETAIL

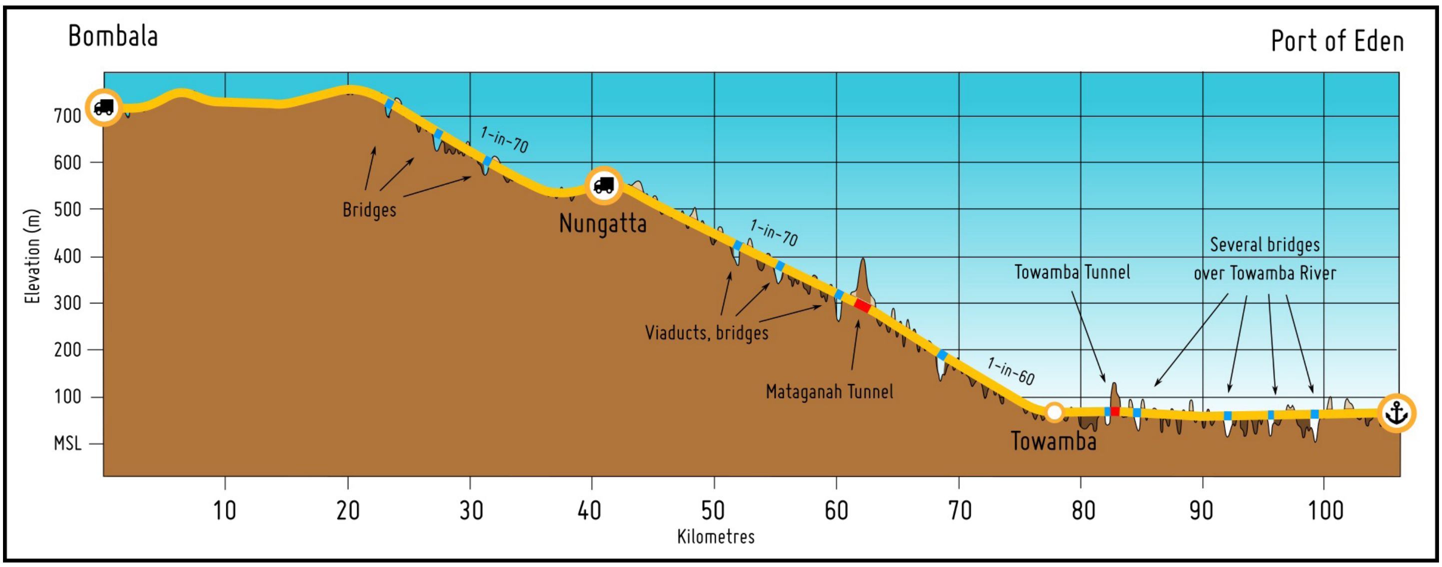


COOMA to BOMBALA – SECTION DETAIL



BOMBALA TO EDEN — DETAIL OF POSSIBLE ROUTES

TOWAMBA VALLEY ROUTE – SECTION DETAIL



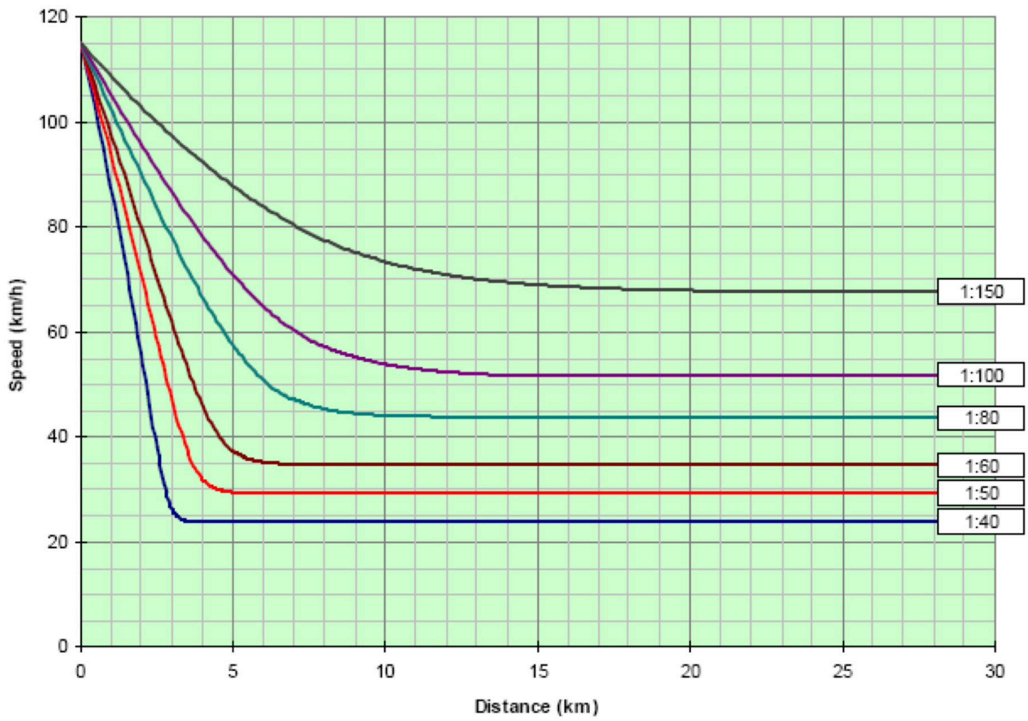
RAILWAY PERFORMANCE

FREIGHT

Freight performance will be principally limited by the long climb of 1.5% (1-in-66) gradient between the coast and the Monaro High Plains, about 55km in total. The balancing speed (steady-state uphill speed at full throttle) is approximately 40km/h. There is a 6km flat section about two-thirds of the way up the gradient, at Nungatta, which allows an uphill train to reach its top speed of 115km/h again before the second half of the ascent, substantially improving average speed.

Once on the Monaro, the existing railway has steeper gradients of up to 1-in-40. Although of much shorter length than the main climb, the frequency of uphill gradients still puts a significant dent in average speed.

		Southbound		Northbound	
	Distance (km)	Time (min)	Average Speed (km/h)	Time (min)	Average Speed (km/h)
Canberra to Cooma	114	104	66	84	81
Cooma to Bombala	93	72	78	87	64
Bombla to Eden	105	61	103	100	63
TOTAL	**312km**	**237 min** (3:57 hrs)	**79km/h**	**271 min** (4:31 hrs)	**69km/h**



Steady state "balancing speed" at various gradients for typical freight train, beginning at top speed of 115km/h . Source: ARTC 2010

RAILWAY PERFORMANCE

PASSENGER RAIL

Unlike freight rail, modern passenger railcars generally have a high power-to-weight ratio, enabling them to achieve their maximum speed when going uphill (at least at gradients up to 2-4%). However even at high maximum speeds, rail travel time is a trade-off between average speed and number of stops; the more locations served, the more frequently the train has to stop, and the lower the average speed.

A 160km/h service, if the track were upgraded and curvature eased to eliminate speed-restricted sections, would give a travel time of 52 minutes to Cooma (versus 72 minutes by car with no traffic), 93 minutes to Bombala, and 139 minutes to Eden. Such travel times are highly competitive with road transport, being about 30% faster typically. However the main benefit is in offering an entirely new mode of transport between Canberra and the towns of the Monaro and far south coast regions.

A 200km/h service would offer moderately shorter travel times again - 44 minutes to Cooma, 78 to Bombala and 116 to Eden, a typical 40% time saving compared to driving. Yet construction cost would be disproportionately higher. The 1000m minimum curve radius required for such speeds would render much of the existing corridor unsuitable, necessitating more frequent and longer deviations, and far higher lengths of embankment, cutting, viaduct and tunnel. Additionally, Australia's lack of any existing regulatory framework for such speeds raises additional uncertainty about the approval process. 200km/h is therefore not recommended.

Although the client has only requested an analysis of passenger performance between Canberra and Cooma, it is recommended to offer a passenger service all the way to Eden, for several reasons. One, it will open up additional sites for potential residential or industrial development and associated value capture, improving the potential return for the railway consortium. Two, it can be achieved at low marginal cost due to the low service frequencies anticipated (only a single trainset is likely to be required). Third (and most importantly), it reduces the political risk of the project. A new freight railway through the isolated Towamba Valley, and nearby National Parks, is likely to meet universal opposition from the local community, as well as the wider environmental movement. A railway offering a passenger service on the other hand, is likely to gain a substantial level of support. Robust debate is seldom fatal to major infrastructure projects; universal condemnation usually is.

			160km/h		200km/h	
	Distance km	Time by car min	Time min	Average speed km/h	Total time min	Average speed km/h
Canberra Airport	0	0	0	0	0	0
Michelago	49	42	20	147	17	173
Bredbo	79	62	35	135	29	163
Cooma	114	76	52	132	44	155
Nimmitabel	152	110	71	128	60	152
Bombala	207	133	93	134	78	159
Towamba	284	207	125	136	104	164
Eden	312	191	139	135	116	161

FREIGHT SIDINGS AND INTERMODAL TRANSFER STATIONS

The siting of freight hubs is more restricted than for passenger stations because of the spatial requirements of sidings. They not only need to be at least as long as the maximum train length, they also need to be on a near-zero gradient (ARTC standards specify a maximum of 1-in-150, although British standards are for 1-in-500).[5, 6]

For this reason there are surprisingly few suitable locations between Canberra and Eden. The potential sites are:

- Fairbairn
- Fyshwick / Kingston
  - Possibly also Oaks Estate, Royalla or Williamsdale
- Cooma
- Bombala
- Nungatta
- Port of Eden

Notably absent is Hume, which was assumed to be the logical location for an intermodal hub due to the existing industrial and logistics infrastructure located there. Unfortunately, the railway adjacent Hume industrial park is on a gradient of 1-in-40 (2.5%) — far too steep for a freight siding. It may be possible to build a facility in the adjacent NSW suburb of Environa, or possibly at the southern end of the industrial park, however both locations are restricted by their topography and potential planning difficulties

The Fyshwick or Fairbairn sites are recommended for the Canberra freight hub. Fyshwick has the advantage of being an existing rail freight facility in an established industrial area. Fairbairn would be a greenfield site, increasing construction cost but also increasing the potential for the client to maximise value capture by developing a wholly-owned industrial park. Royalla and Williamsdale also have suitable space and gradient for a freight facility, however their distance from established logistics hubs counts against the selection of either location.

The existing railway precincts at Cooma and Bombala are ideally suited for smaller freight facilities, as the railway corridor within each township has substantial spare room for additional tracks.

There is an ideal location for a siding at Nungatta, between Eden and Bombala, adjacent Imlay Road and with good access to numerous forestry sites. Located on a section of flat ground about two thirds of the way up the climb, it is has a downhill run-out in both directions, giving a fully-loaded freight consist an easy start. However its location within the South East Forests National Park could make for an approval process fraught with difficulty.

Finally, the Port of Eden has ample room to accommodate trains up to and even exceeding the ARTC typical maximum of 1800m.

PROPOSED ROLLINGSTOCK

There are three extant locomotive manufacturers in Australia: Downer Rail (with sites in NSW, VIC and QLD), Bombardier (with sites in VIC and QLD) and UGL Rail (with sites in NSW, VIC and WA).

While obviously the sites in NSW would be preferable, all three companies could potentially manufacture suitable rollingstock for either the freight or passenger operation, whether of their own design or under license.

FREIGHT

The demands of a general container and bulk freight railway would be met by a conventional diesel-electric locomotive, in the order of 3000kW and 130 tons. Two appropriate models currently in Australian production include:

- UGL C44aci, a design based on the classic NR series with modern General Electric powertrain, manufactured in Broadmeadows
- Downer Rail GT46C, manufactured in Newcastle

PASSENGER RAIL

The passenger trainset selected must be able to achieve 160km/h on non-electrified track with minimum radius of 650m and cant of 150mm. To do this, the required tilt is at the high end of engineering capabilities — approximately 280 to 300mm of cant deficiency (7-8 degrees of tilt). No suitable trainsets have yet been manufactured in Australia; the Queensland Rail Diesel Tilt Train, based on the Hitachi A-Train design, can only achieve 5 degrees of tilt. However the following models could be manufactured in Australia under license, or alternatively imported (which may be more economic due to the small number of trainsets required):[7]

- British Rail Class 221 "Super Voyager", last manufactured in 2002 by Bombardier, in Bruges, Belgium. Its successor, the Class 222, is not equipped with tilting technology but a future tilting variant is a possibility (the Super Voyager was in fact a tilting variant of the Class 220).

- Deutsche Bahn Class 612, last manufactured in 2003 by Adtranz (later acquired by Bombardier) in Heinigsdorf, Germany.

- The Hitachi AT300, currently in service as the British Rail Class 800 and 802 and based on Hitachi's versatile Hitachi A-Train system, could be a suitable design to develop a local variant from under license. Although capable of higher speeds than necessary and not yet produced in a tilting variant, the angled sides of the car body suggest the possibility of equipping the train with a tilting bogie system.

Spanish company Talgo has recently been promoting its passive tilting train technology for the NSW government's XPT fleet replacement program. Unfortunately this passive tilt technology can achieve only 5 degrees of tilt, and is therefore unable to achieve 160km/h on 650m radius curves.

The number of trainsets required is dependent on service frequency. A single trainset could reasonably complete 3 return trips between Canberra and Eden in a day; service more frequent than once every 6 hours in each direction would require a second trainset.

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