5 BASE CASE, OPTIONS ANALYSIS AND RECOMMENDED SOLUTION

CHAPTER SUMMARY AND CONCLUSIONS:

- The existing integrated transport system includes the Mount Isa Line and North Coast Line linked to the Port via Abbott Street and the Jetty Branch. Queensland Rail (QR) has in place a committed upgrade plan for the Mount Isa line. The PoT is developing the first stage of the PEP with the channel-widening project. Future stages of the PEP are in concept development.
- The Mount Isa Line, North Coast Line and the Port are an integrated freight transport system. The DBC demand forecast shows longer trains (1,400m) are not required. Given the aforementioned, the Mount Isa line is not included for the DBC evaluation. As the PoT is managing a separate PEP, the PoT is not included in the DBC evaluation.
- The Base Case scope includes the rail infrastructure from the Sun Metals Branch Line, via the North Coast Line to the Jetty Branch and associated road infrastructure. The Base Case excludes the Mt Isa Line to Townsville, the North Coast Line south of the Sun Metals Branch Line and north of the Jetty Branch. It also excludes the PoT to the port boundary.
- Four potential strategic alignment options for the TEARC were initially identified for assessment. Two of the four options are similar, branching off the North Coast Line at Cluden (Options A and B). The other two alignments branch off the North Coast Line near the Stuart Industrial Precinct (Option D) and further south near the Sun Metals Branch Line (Option C) respectively.
- The Reference Project recommended branches off the North Coast Line at Cluden, traversing the northern part of the TSDA, and broadly following the Southern Port Road alignment to the east of the road and the Ross River bridge connecting into the port minerals loops only.
- The Reference Project for the TEARC will provide port access redundancy for rail, increase operational flexibility and reduce the level of interaction between rail and road traffic thereby improving urban amenity, safety and traffic flows.
- TEARC has also been designed to minimise the interaction between the road and rail network in order to maximise network efficiency and safety outcomes. The design includes several grade separated crossings where road and rail intersect and road intersection realignments.
- TEARC is largely aligned with the existing transport corridor through the TSDA that was established previously to support the Southern Port Road. Some land acquisitions at the Cluden Y-junction, along Racecourse Road and within the port precinct are likely to be required.
- The risk adjusted capital cost for the project is: P50 risk adjusted $368,736,292, P90 risk adjusted $391,729,775 based on an estimate base date of July 2017 and design and construct delivery. Anticipated operating costs for the project including risk contingency and escalation are: P50 Risk Adjusted $32,637,788 and P90 risk adjusted $36,080,084 based on a 30-year evaluation from 2022.

This section provides an overall description of the existing integrated transport system for the rail, road and port. The scope of the Base Case is described which provides the starting point for the options assessment process for TEARC. It includes a discussion of the comparative benefits and constraints of the various alignment options considered, together with the rationale for the preferred option (the Reference Project).

5.1 Description of the Existing Integrated Transport System

5.1.1 Introduction

The PoT is connected and serviced by a network of existing rail and road infrastructure that is important for exports and imports in North Queensland and west to Mount Isa. Approximately 70% to 80% of the freight tonnage in and out of the port is transported by rail as compared to road, with rail being preferred for longer hauled bulk materials.

The existing narrow-gauge rail infrastructure in Townsville comprises of two main rail corridors owned and managed by QR, North Coast Line and the Mount Isa Line which connect to the PoT as shown in Figure 5.1.

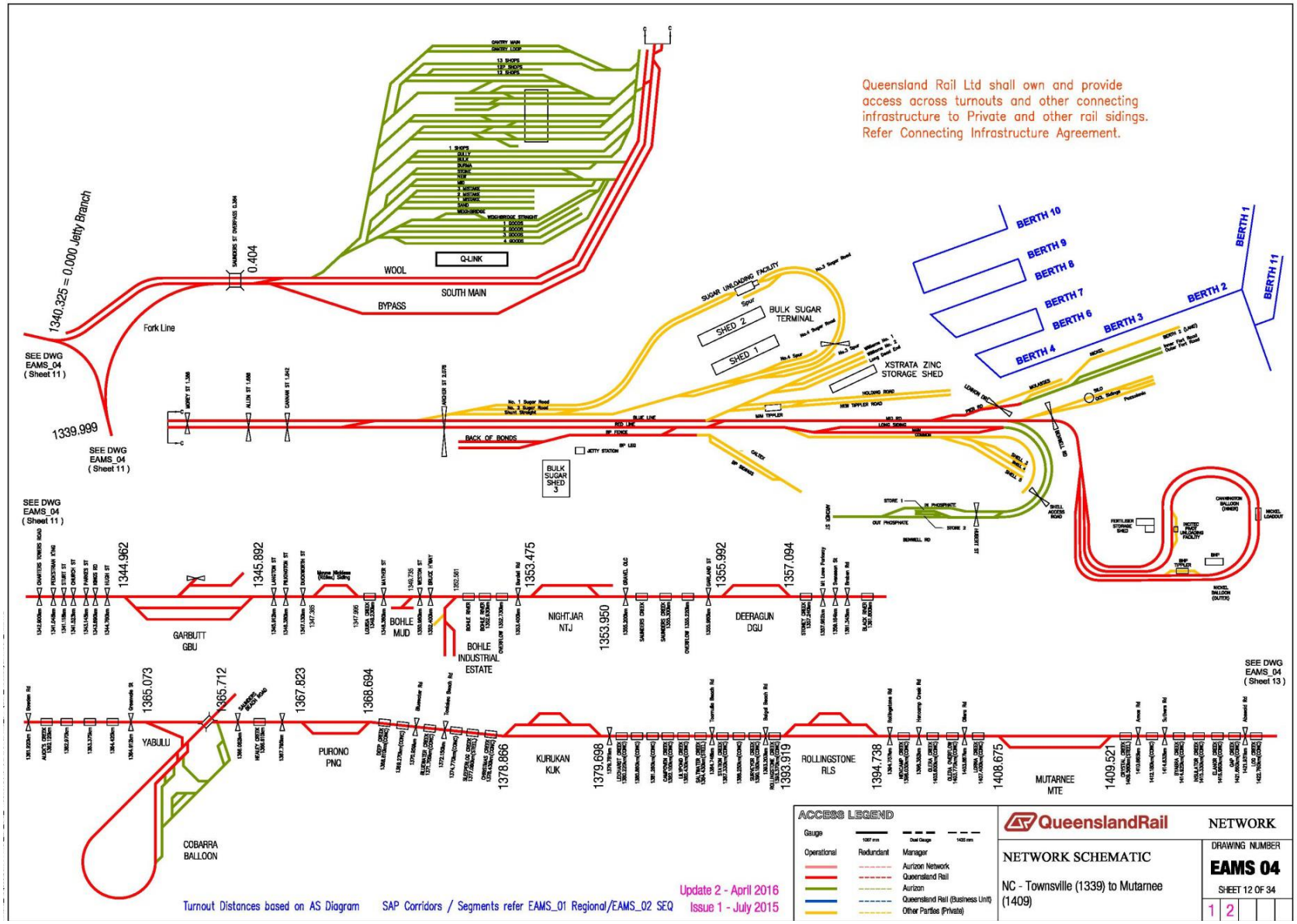
In addition to the main rail corridors connecting Townsville, rail infrastructure within the Townsville area includes:

- the Jetty Branch connecting with the sidings, cargo handling and storage facilities within the port
- Stuart-Townsville rail corridor (along Abbott Street)
- the refinery branch rail line connecting with the Sun Metals zinc refinery and a livestock facility, both located within the TSDA
- Yabulu Nickel Refinery rail loops owned by Aurizon, and QR owned track connecting the North Coast Line to the rail loops
- two intermodal rail terminals at Stuart, one linked to the North Coast Line and the other to the Mount Isa Line
- rail siding into the Glencore copper refinery at Stuart linked to the North Coast Line
- multiple road to rail access points providing intermodal connections along the rail lines.

QR and other third parties own the track infrastructure (below rail) with Aurizon and Pacific National providing rail freight services (above rail) in the area. QR operates a limited number of passenger services on the lines to Cairns, Brisbane and Mount Isa.

Although the Mount Isa Line, North Coast Line and the Port are an integrated freight transport system, the DBC demand forecast shows longer trains (1,400m) are not required. As longer 1,400m trains are no longer required the Mount Isa line is not included for the DBC evaluation. The PoT is managing a separate PEP and hence the PoT is not included in the DBC evaluation.

Figure 5.1 Network Schematic for the Port of Townsville



5.1.2 Existing Rail Infrastructure at the Port of Townsville

The Jetty Branch, which branches off the North Coast Line at Boundary Street, provides access to the PoT. Within the port there are a number of separate terminal facilities for loading and unloading trains, with some shared track sections and private sidings owned by customers or Aurizon. The rail infrastructure is nominally capable of handling 20 tonne axle loads, with a permitted maximum speed of 15 km/h.

The Jetty Branch crosses several roads on the approach to the port and within the port, which with train movements and shunting practices delays local traffic around, into and out of the port.

The following rail load-out and unload facilities located within the port are under control of the PoT:

- sugar balloon loop with sugar dumper on dedicated sidings
- molasses unloading facility at Berth 4
- Glencore tippler facility
- nickel loader on the Nickel balloon loop, currently not in use
- South 32 tippler on the Cannington balloon loop
- Incitec fertiliser dumper on the Cannington balloon loop
- cement loading facility on dedicated sidings
- fuel loading facility on sidings owned by Shell and BP
- two intermodal rail lines at the port intermodal terminal are available for loading/unloading containerised freight trains.

The bulk sugar terminal comprises of a balloon loop and two through-sidings. These sidings are either side of the bottom dump un-loader for the queuing of loaded and empty trains, and the stowage of wagons during the non-crush sugar season. Rail operations within the terminal do not impact external rail operations; however, shunting movements associated with unloading operations at the Glencore tippler can block access to and from the terminal.

A combined sugar and molasses train arrives at Stuart yard where it is split in to two rakes. The sugar rake is hauled to the sugar balloon loop for unloading and returns to the same yard following completion of the unloading process. The molasses rake is hauled separately to the Cannington balloon group to turn the train after which it is shunted back into Berth 4 siding for unloading.

The Glencore terminal area consists of five short dead-end holding roads, including the tippler road used to unload concentrates originating from Mount Isa and Cloncurry. Due to the configuration of the jetty rail infrastructure, and the requirement to align the wagons for operating through the tippler, most Glencore concentrate trains must be run around the Cannington balloon loop on arrival to re-orientate the train. The train is then broken into shorter wagon rakes, and shunted into the short dead-end sidings for the progressive unloading of wagons on each rake.

The Nickel and Cannington balloon consists of two balloon loops. The outer track is utilised for loading nickel ore (currently unused), and the inner track is used for unloading both Cannington concentrate and Incitec Pivot Limited (IPL) fertilizer trains. The inner track (Cannington) has an off-line wagon tippler for South32 concentrates, and an off-line bottom dump pit for unloading IPL fertilizer. On the inner track an overhead chute is used for loading containers with bulk sulphur to return on the Mount Isa Line.

Cement Australia have three sidings for loading cement and fly ash. Empty trains are hauled from the Partington yard and run around the Cannington balloon loop to allow the train to be correctly orientated before being shunted into the cement loading siding.

The BP and Shell fuel sidings consist of eight sidings. The sidings are short and only suitable for storage or loading individual wagons. Significant shunting is required to make and/or break wagons, and wagon rakes into combination trains for the line haul task.

Berth 2 also has a short dead-end siding currently utilised for handling in-bound zinc concentrate railed to Sun Metals refinery.

Trains arriving from Mount Isa are handled within the port by an additional shunting locomotive to the intermodal terminal.

There are two tracks running parallel to Benwell Road that connect to private sidings associated with the previous phosphate balloon loop. These two dead end sidings are primarily used for the arrival, shunting and make up of outgoing combination trains, bulk trains from the Glencore tippler and wagon storage.

5.1.3 Discussion on Port Rail Infrastructure

The existing port rail infrastructure meets current demand and requirements although it is not operationally efficient[23]. The PoT manages the movement of freight through the terminal by providing preferred access to berths for the current private leaseholders and scheduling other shipping as required improving berth utilisation.

The existing rail infrastructure requires trains to use the North Coast Line and Jetty Branch that have become surrounded by urban development as Townsville has grown.

The current infrastructure does not readily provide for the PEP, where new loops are intended to be built on reclaimed land to the east of the current facility.

Although the Mt Isa line can handle 1,000m length trains they cannot be handled at the port due to the limitations of the rail infrastructure. The rail services into the port are either operating shorter length trains or the train is split at Partington Yard Stuart to enable shorter shunt transfer operations to the port.

The overall productivity of the PoT is constrained by the existing infrastructure.

5.1.4 North Coast Line Improvements

The QR Annual Report 2015-2016 states: “The North Coast line extends from South East Queensland to Cairns. Each year QR spends approximately $86.91m maintaining the line. This year a further $100m of expenditure was allocated as part of the North Coast Line Capacity Improvement project to enhance connections between South East Queensland and communities in the north. The project will increase the capacity of the North Coast line by improving infrastructure that will allow increased train lengths to be used. The North Coast line upgrade project will ensure that the line can accommodate a growth in demand on this vital part of the freight network.”

No further details are available on the North Coast Line upgrades specific to this base case.

[23] NBQ Report Infrastructure Capacity Audit 2013.

5.1.5 Mount Isa and Stuart to Townsville Rail Corridor

This 9km section of the North Coast Line is double track from Stuart through to Boundary Street where it splits to the Jetty Branch and the PoT. It includes Aurizon's south yard freight terminal and workshop facilities.

North of Boundary Street, the North Coast Line heads to Townsville Station for passenger train services to Cairns. The Stuart to Townsville track section is shared with domestic freight, passenger train movements on the North Coast Line corridor, and other local train operations.

The track standard and structures allow 20 tonne axle load, with track comprising 60 kg/m rail on concrete sleepers (track will be QR Type 50-6). The corridor interfaces with five level crossings with half-boom and flashing light protection.

The Mount Isa Line joins the North Coast Line 10km south of Stuart and the Partington yard. The line continues 1,032km to Mount Isa and includes the Phosphate Hill branch line. This is a single line narrow gauge system with 46 passing loops providing for 1,000m length trains, and incorporates balloon loops at Yurbi, Phosphate Hill and Mount Isa.

During the resource sector growth in 2011 to 2013 QR and the Department of State Development, Infrastructure and Planning (DSDIP) undertook Master Planning[24] and capacity reviews of the existing system respectively. The DSDIP reviews[25] included the rail infrastructure (below rail assets) capacity audit and rail operations. Rail operations covers loading and unloading facilities, train cycle times, rollingstock in use, operating practices and co-ordination of the supply chain links.

The reviews have provided QR and DSDIP with a pathway to progressively upgrade the Mount Isa Line if the demand requires it.

The QR Annual Report 2015-2016 states:

"The Mount Isa Line extends from Townsville to Mount Isa and each year, QR spends approximately $50m maintaining the line to ensure its ongoing safety and reliability. In 2015-16 QR announced an additional $25m investment in the line to replace 41km of sleepers at high priority locations between Richmond and Julia Creek. Work commenced in May 2016 and will ensure QR delivers a more stable and reliable track structure for freight services, by replacing steel sleepers with concrete. Other works throughout the year included an upgrade of the Acid Junction to Mount Isa section of track, with new rail, ballast and concrete sleepers. This also includes a full track relay of the Cape River Bridge between Homestead and Pentland, and a one kilometre of full track relay between Cloncurry and Marimo."

QR has developed a planning program of works to upgrade the infrastructure of the network to increase long-term stability of the line, and to bring the line up to a consistent standard that includes:

- replacing steel sleepers with concrete sleepers
- replacing light rail with heavy 60kg/m rail
- improving safety at grade level crossings
- replacement of older steel bridges.

[24] Queensland Rail Mount Isa Line Rail Infrastructure Master Plan 2012
[25] NQRSC 2013 Reports (Rail Infrastructure Capacity Assessment and Rail Operations Assessment)

QR aims to continue the replacement of steel sleepers and light rail program to complete the transformation of the entire system. The current timing of the program is dependent on sufficient growth occurring on the line to provide the additional funding of these works. Should significant additional tonnes be contracted on the network, the works program will need to be accelerated to coincide with the increased traffic.[26]

The works do not provide for any increase in train lengths above 1,000m but seek to reduce speed restrictions and increase safety.

5.1.6 Existing Road Infrastructure

Road connectivity and freight corridors for the PoT are provided through a number of primary and secondary roads (Figure 5.2) which includes:

- Primary road corridors:
  - Southern Port Road—provides access to the port for over-size and over-mass vehicles that include B-Triples and Road Trains from the Ring Road and areas south of Townsville. There is a road-train de-coupling site at the start of the Southern Port Road (Bruce Highway end) for vehicles coming from the Flinders Highway. Southern Port Road becomes Benwell Road as it enters the PoT.
  - Bruce Highway (North of Townsville)—connects the port to industry and freight generators/users in northern Queensland.
  - Bruce Highway (South of Townsville)—connects the port to industry and freight generators/users in central Queensland.
  - Flinders Highway—links the port to agricultural and resource activities at sites located to the west of Townsville to Mount Isa. It is a heavy vehicle combination route with vehicles up to 53.5m in length permitted.
  - Townsville Ring Road (Deeragun to Cluden)—an important road for freight vehicles with origins to the north and south of Townsville accessing the port.
- Secondary road corridors:
  - Duckworth Street and Nathan Street—links Woolcock Street in the north to the Townsville Ring Road in the south, and provides access to a light industrial, retail and commercial precinct along Duckworth Street (northern half).
  - Woolcock Street—connects existing industrial users to the ring road and the port.
  - Abbott Street—connects from Woolcock Street through to the ring road. This is not the primary heavy vehicle corridor for entering the port but in connection with Boundary Street, provides alternative access to the port.
  - Boundary Street—in conjunction with Abbott Street, provides an important alternative road connection to the Port.
  - Archer Street—provides access to the northern side of the Port and connects with the Southern Port Road and Benwell Road. Different sections of Archer Street are currently managed by different agencies (TCC and PoT).
  - Hubert Street—provides access from Archer Street for heavy vehicles servicing port users in the central area of the Port.

Completed in 2016 -17 was Section 4 of the Townsville Ring Road and a heavy vehicle uncoupling pad on the Southern Port Road.

[26] Queensland Rail Mount Isa System Information Pack Version 3.1: 20/02/2017

Figure 5.2 Existing Road Infrastructure

5.2 Base Case

The Base Case scope for the rail and road infrastructure is generally confined to the area shown in Figure 5.2. Specific elements are:

- The Jetty Branch connecting with the sidings, cargo handling and storage facilities to the port boundary.
- Stuart-Townsville rail corridor (North Coast Line along Abbott Street) connecting to the Jetty Branch.
- The refinery branch rail line connecting with the Sun Metals zinc refinery and a livestock facility, both located within the TSDA.
- Two intermodal rail terminals at Stuart, one linked to the North Coast Line and the other to the Mount Isa Line.
- Rail siding into the Glencore copper refinery at Stuart linked to the North Coast Line.
- Multiple road to rail access points providing intermodal connections along the rail lines.

The Base Case scope does not include:

- The Mt Isa line from Mt Isa to Townsville where it joins to the North Coast Line.
- The North Coast Line south of the Sun Metals Branch.
- The North Coast Line north of the Jetty Branch.
- The PoT to the port boundaries.

- The Base Case rail configuration restricts the ability of the PoT to fully utilise the existing berth capacity, especially for bulk commodities and to effectively operate trains to handle this.
- The Base Case will not be able to effectively support the PEP in the longer term as the PEP high-level plans have new rail loops in the Eastern Reclaim Area (ERA). The Base Case rail configuration does not provide an efficient connection to the ERA loops as train lengths and operations are still compromised.
- The existing road and rail network within the Base Case project area is generally not subject to delays from flooding apart from extreme weather events such as cyclones. However, Abbott Street is subject to flooding in major rainfall events at the southern end between Oonoonba and the Bruce Hwy due to a break out of Gordon Creek.
- In 2014, there was 12.7mtpa throughput at the port, which has since reduced to 8.5mtpa in 2016, representing a reduction of 4.2mtpa. The change to the demand profile includes small increases in the volume of sugar (0.1mtpa), fertiliser (0.1mtpa), freight (0.1mtpa) and a decline in volumes of minerals (0.4mtpa), shunts (0.3mtpa), bulk (0.5mtpa), coal (0.3mtpa) and nickel (3.0mtpa).

5.3 Options Evaluation

A Multi Criteria Analysis (MCA) was utilised to provide an agreed approach to re-assessing TEARC options identified from the Preliminary Evaluation (PE), together with any new options and changes. Under the Building Queensland Detailed Business Case Guidelines, the options considered and evaluated during the PE phase are to be reviewed and formally re-evaluated. Building Queensland also needed to redefine the Reference Projects' scope to ensure it represented the requirements of stakeholders QR, PoT, Department of Transport and Main Roads.

5.3.1 Multi-Criteria Analysis Methodology

The MCA options assessment was undertaken over a number of methodology stages, with key stakeholders engaged throughout the process to help inform the progression through to a preferred TEARC alignment option.

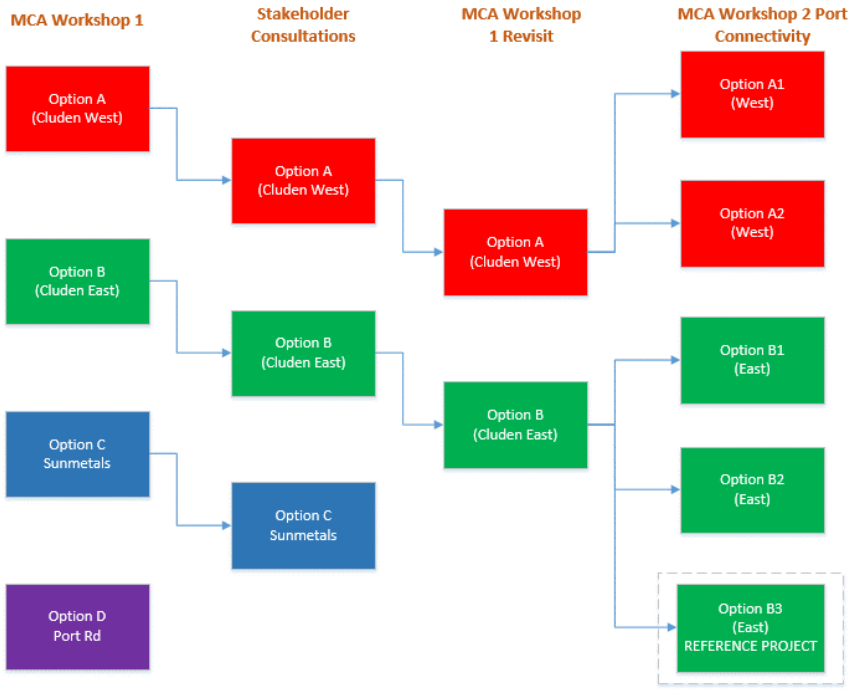
The MCA process steps utilised in the workshop were:

- Key criteria and sub-criteria developed to consider economic, social, environment and engineering. The overarching key criteria and their sub-criteria were developed during the development of the DBC. Generally the key criteria capture triple bottom line needs as well as engineering needs.
- Criteria were developed to address port connectivity issues for options north of the Ross River.
- A workshop was subsequently held with key representatives from Building Queensland, QR, PoT, Department of Transport and Main Roads (DMR) and subject matter experts. The workshop agreed the prioritisation of criteria to guide the Multi-Criteria Analysis, and identified preferred alignment options for more detailed investigation and assessment.
- Subject matter experts presented the rationale behind their scores for individual sub-criteria.
- The results of the prioritisation process were used to develop weightings that were applied to the scores provided by the subject matter experts for each of the sub-criteria.
- An overall weighted score for each of the four alignment options was then calculated.

The PE initially considered four strategic alignment options, which were narrowed to three alignments after the first workshop. The three alignment options were then canvassed with a range of external stakeholders.

A further round of assessments narrowed the focus down to two strategic alignments, with five detailed sub-alignment options. These were assessed to identify a preferred alignment option (the Reference Project), as illustrated in Figure 5.3.

Figure 5.3 MCA Assessment and Stakeholder Engagement Process to Identify a Preferred Option



5.4 TEARC Alignment Options

Four potential strategic alignment options for TEARC were initially identified for assessment. Two of the four options are similar, branching off the North Coast Line at Cluden (Options A and B). The other two branch off the North Coast Line near the Stuart Industrial Precinct (Option D) and further south near the Sun Metals Branch (Option C) respectively. The four options are shown in Figure 5.4.

- Option A:

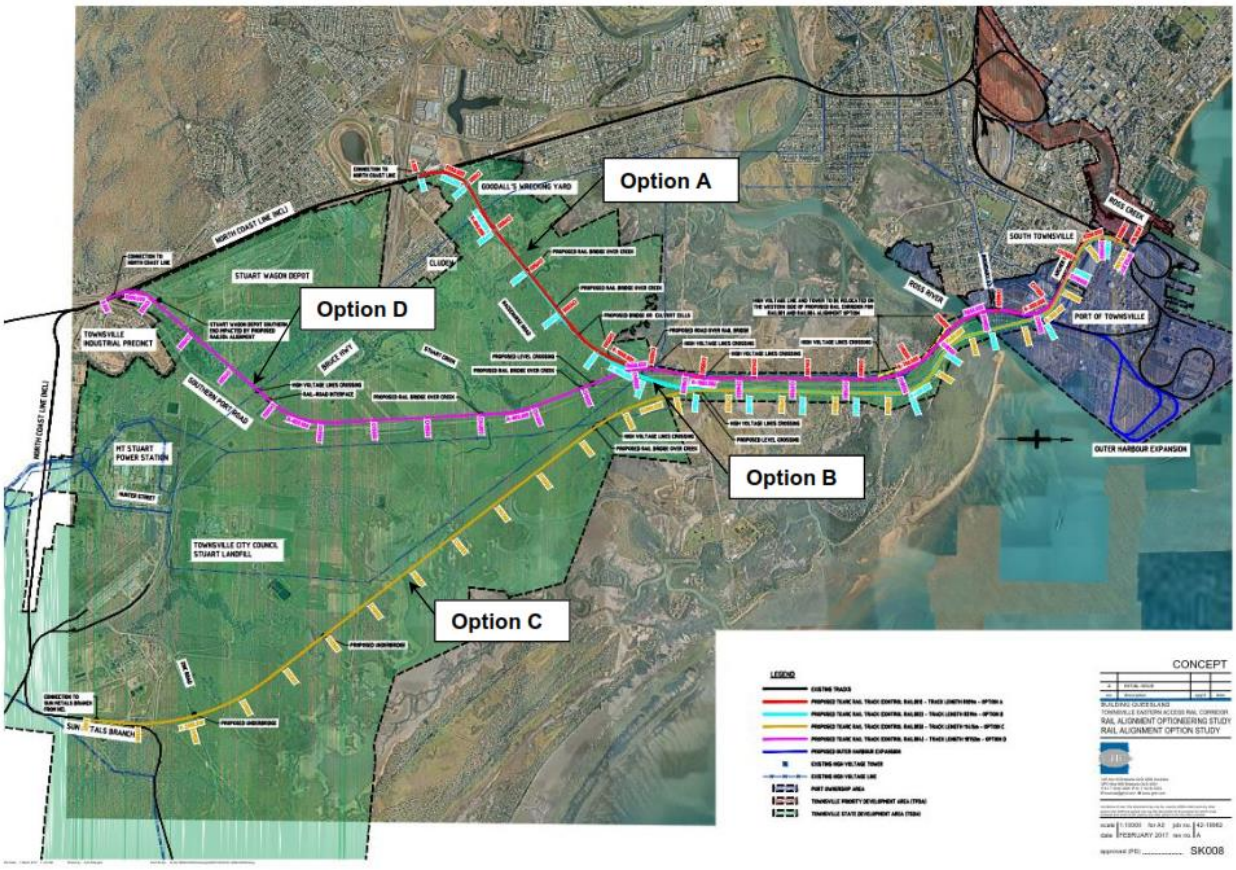
  Branching off the North Coast Line at Cluden, traversing the northern part of the TSDA, and broadly following the Southern Port Road alignment to the west of the Southern Port Road.

- Option B:
  Branching off the North Coast Line at Cluden, traversing the northern part of the TSDA, and broadly following the Southern Port Road alignment to the east of the Southern Port Road.

- Option C:
  Branching off the North Coast Line at the Sun Metals Branch and traversing the southern part of Townville SDA, before linking up to follow on the eastern of the Southern Port Road.

- Option D:
  Branching off the North Coast Line near the Stuart Industrial Precinct and broadly following Flinders Highway and the Southern Port Road alignment.

Figure 5.4 TEARC Alignment Options A to D



5.4.1 Assessment and Shortlisting of Capital Investment Options

Subject matter experts assessed each option against economic, social, environment and engineering criteria and sub-criteria. Key stakeholders discussed the assessments with minor refinements being made to some of the scores to reflect discussion outcomes.

The first workshop concluded Options A and B were preferred, with Options D and C ranked third and fourth respectively.

Option D was discounted from further consideration, as it presented a number of engineering challenges and did not meet operational requirements.

More specifically Option D constraints included:

- Engineering:
  - Requires a major road bridge at the Bruce Hwy.
  - Requires relocation of HV power line on the western side of the Southern Port Road close to the Ross River.
  - Requires re-signalling of North Coast Line into Stuart Yard.
- Operations:
  - Operationally constricts Stuart Depot (reverse shunt moves would be required).
  - New cord line required from Stuart Deport onto realigned North Coast Line.
  - Would result in increased complexity of signalling.
- Constructability and cost:
  - Longer than Options A and B, would be more expensive in terms of route kilometres.
  - Construction of major structure to cross Bruce Hwy, including realignment would require complex delivery arrangements.
  - Estimated to be higher cost, given the need for grade-separated crossing over Bruce Hwy, reconfiguration of signals and HV line relocation.

Option C was less desirable for a number of reasons including:

- Significantly higher cost, given the required track length is nearly double the length of Options A and B.
- Cultural sensitivities associated with an aboriginal burial ground that intersected with the proposed alignment.
- Operational issues, including required realignment of existing Sun Metal loop, Mount Isa – North Coast Line junction which will adversely affect the local community and re-signaling of existing infrastructure. Access to Stuart Yard would also have to be retained.
- Potential negative impacts on the Bruce Hwy bridge crossing. A new level crossing would be required on Racecourse Road.
- Unproven option with risk attributed to construction difficulties through greenfield and wetlands involving the crossing of numerous creeks, extensive soft soils areas and roads requiring significant geotechnical investigation.
- The longest construction timeframe and greatest risk of complex construction due to poor ground conditions and environmental constraints.

Options A and B are similar, differentiated by east vs. west trade-offs:

- Options A and B are both scalable and able to accommodate forecast demand.
- Social benefits are expected to be higher for an eastern alignment (Option B), particularly with respect to noise, vibration and visual amenity.
- Option A was expected to be lower cost due to a shorter bridge span.

It was noted during the workshop, careful planning was needed to consider how the line connects to the port from the east (B), or west (A) as trains coming over Ross River would need to be considered in future port expansion plans.

Although Option C was ranked last, it was assessed as likely to have the fewest adverse social impacts. For this reason, it was retained as an option for further investigation.

Table 5.1 summarises the results of the MCA assessment for the four strategic alignments Options A through D.

Table 5.1 MCA TEARC Alignment Options Assessment by Weighted Sub-criteria (Workshop 1)

CRITERIA	Sub Criteria Wtg (%)	STRATEGIC OPTIONS			
		A - WESTERN CLUDEN	B - EASTERN CLUDEN	C - SUN METALS	D - FOLLOW PORT ROAD
		Rating 1 -4	Rating 1 -4	Rating 1 -4	Rating 1 -4
ENGINEERING					
Rail Engineering	2.9%	4	3	1	2
Road Engineering	2.2%	2	1	4	2
Constructability	3.7%	4	3	1	2
Operations	3.7%	4	4	1	3
Flooding	6.6%	2.5	3	4	1.5
Geotechnical	2.2%	4	2	1	3
ENVIRONMENT					
Flora and Fauna	6.6%	4	2.5	1	2
Land use and Approvals	5.2%	4	4	1	2.5
Noise, Air and Vibration	8.1%	1	1	4	2.5
SOCIAL					
Cultural Heritage	10.3%	2.5	1	1	2.5
European Heritage	3.7%	2.5	2.5	4	1
Visual Amenity	2.2%	2.5	2.5	4	3
Property Acquisition	3.7%	2.5	4	2.5	2.5
Public Safety and Congestion	11.8%	4	2.5	2.5	1
ECONOMIC					
Cost	7.4%	4	3	1	2
Benefits	11.0%	4	3	1	3
Supply/Demand	8.8%	3	3	3	3
	SCORE	**3.23**	**2.57**	**2.09**	**2.23**
	RANK	**1**	**2**	**4**	**3**

- Feedback from Stakeholder Engagement Session

Options A, B and C were considered at an engagement session with key stakeholders groups including Mount Isa Rail System operators, users, customers, government[27] and community representatives.

At the engagement session Option C was identified preferred option. The key reasons for promoting Option C included:

- aligned with the TSDA master plan and could potentially cater for future growth and higher demand
- could provide Townsville with a flood levy.

The Option C alignment was also perceived as having a lesser social impact on South Townsville communities such as Cluden. There was a suggestion the Option it could prevent residential growth in communities, such as Elliott Springs. Some participants argued that constructing rail through the TSDA would isolate this community, or discourage residential growth through the area.

Outcomes of MCA Workshop 1 - Revisit

Further consultations and investigations regarding Option C found:

- Option C cannot traverse an approved solar farm.
- QR advocated for a variation to Option C by moving to the south of the existing Option C and paralleling the Southern Port Road corridor sooner.
- Option C was more flood prone, higher cost and is not within existing Townville SDA transport corridors ($30m sunk cost in existing corridor preservations, i.e. corridor aligning with Options A and B).

Flooding—The baseline flood assessments have considered TEARC in isolation and as a combined TEARC and TSDA joint development outcome. The inclusion of TSDA, results in higher flood levels due to the constriction of the flood plains with the TSDA filling.

There are marginal differences in structure provisioning between TEARC, and the TEARC and TSDA combined option. If the flood infrastructure provisions for TSDA and TEARC were planned jointly, there are opportunities for rationalisation, specifically one of the major drainage structures (CH1730 20 x 15m span) could in combination with other related mitigation works be significantly reduced in size and delivering cost savings.

The floodplain area is low lying, and significant fill will be required to support both TEARC and the future development of the TSDA. Inclusion of floodplain filling (both TEARC and TSDA) changes the flood characteristics in the floodplain and has the potential to impact existing sensitive areas (i.e. reserve and caravan park), with the potential for adverse flood impacts. Flood impacts have been appropriately managed through structure provisioning and the inclusion of related mitigation works, with opportunities for further optimisation through the future TEARC detailed design.

The natural flood flows north to northwest direction, to both the Ross River and eastern coastal fringe areas. The TEARC line would traverse across the major Stuart Creek floodplain, with structure provisioning included managing flow distributions to the north, and the Townsville CBD via several major bridge structures. Options A & B traverse the same major Stuart Creek floodplain and are subject to similar major bridge structure provisions.

Option C is now least preferred, flood provisioning requirements would be higher given the alignment is longer and traverses a considerably wider cross section of the floodplain.

[27] Relevant government stakeholders were from all levels of government, including Townsville City Council, Department of State Development, and Department of Defence.

Costing—Option A (west) originally scored over Option B (east), as the additional bridge over Southern Port Road and the longer bridge to the east of the existing road bridge was thought to make B the higher cost option. This was subsequently reassessed due to the cost impact of relocating the power link on the west (previously underestimated), Option A now outweighs the cost of Option B.

Option C Remained Least Preferred

Option C is not aligned with the existing TSDA master plan, which has already secured transport corridors aligned with proposed Options A, B and D, but not Option C.

A detailed flood impact assessment indicates that Option C is unlikely to deliver expected flood levy functionality, and would likely increase flood impacts as it would impede water flowing east to the coast.

Much like Option D, Option C does not link to the existing Stuart Yards, and does not achieve any greater level of rail service than can be accommodated by A and B with spur lines. The proposed alignment would intersect a planned solar farm under construction by Sun Metals.

Given the significant constraints identified with alignment Option C, the second MCA Options Analysis concluded that Option C should be discounted from further consideration.

provides a high level “traffic light” summary of the outcomes of the second MCA options analysis, showing that Options A and B were ranked above Option C

The recommendation was to carry forward Options A and B into the detailed assessment of rail connections into the port.

Table 5.2 MCA TEARC Alignment Options Assessment by Weighted Sub-criteria (revisit following Workshop 1)

CRITERIA	SUB CRITERIA Wtg (%)	A - WESTERN CLUDEN	B - EASTERN CLUDEN	C - SUN METALS
ENGINEERING				
Rail Engineering	3.7%	4	3	1
Road Engineering	3.2%	2	1	4
Constructability	3.7%	4	3	1
Operations	3.7%	4	4	4
Flooding	6.3%	4	2.5	1
Geotechnical	3.2%	4	2	1
ENVIRONMENT				
Flora and Fauna	6.3%	4	2.5	1
Land use and Approvals	4.7%	4	4	1
Noise, Air and Vibration	5.8%	1	1	4
SOCIAL				
Cultural Heritage	8.4%	2.5	1	1
European Heritage	4.7%	2.5	2.5	4
Visual Amenity	1.6%	2.5	2.5	4
Property Acquisition	2.6%	2.5	4	2.5
Public Safety and Congestion	10.0%	4	2.5	2.5
ECONOMICS				
Cost	6.8%	2.5	4	1
Benefits	9.5%	4	3	1
Supply/Demand	6.8%	3	3	3
SUSTAINABILITY				
Townsville City Deal Delivery	3.7%	2.5	4	1
Townsville Growth (e.g. Elliott Springs)	2.1%	2.5	2.5	2.5
Future Development Opportunities TSDA	3.2%	4	4	1
	SCORE	**3.24**	**2.71**	**1.93**
	RANK	**1**	**2**	**3**

5.5 Further Rail Connection Options to the Port of Townsville

To the north of the Ross River, all of the initial alignment options investigated ran parallel to the Archer Street corridor. It was agreed at the first MCA workshop further investigation would be undertaken into additional refined alignment options north of the Ross River in order to address port-rail-road interface requirements and, where possible minimise likely social and environmental impacts.

Further detailed examination of five different alignment options north of the Ross River was undertaken.

The main drivers influencing the alignment of the sub-options north of the Ross River are:

- Ensuring an effective port-rail-road interface.
- Minimising social impacts for residents who live along Archer St (e.g. noise, vibration etc.).
- Environmental issues.
- Cost, including capital costs of new infrastructure, potential property acquisition and land reclamation.

Key considerations focus on whether the preferred alignment should:

- run to the east or to the west of the existing Southern Port Road
- run parallel to Archer Street, or follow an alternate alignment through the port precinct
- close the Abbott St line and reroute all North Coast Line traffic via the port loop and TEARC.

The rail connection options to the Port were reviewed at a second MCA options assessment workshop. The assessment criteria considered engineering, environmental, social impacts, sustainability issues, additional criteria to assess port-rail-road interfaces and customer requirements.

5.5.1 Options A1 and A2 Ross River to the Port of Townsville

Options to the west of the Southern Port Road are effectively an extension of Option A, whereas options to the east of the Southern Port Road are effectively an extension of Option B. The western options are defined as A1, A2, and eastern options are defined as B1, B2, and B3.

The following sections summarise the relative merits of western versus eastern alignment options.

Figure 5.5 shows Option A1 that provides a new rail line in Archer Street to connect to the Jetty Branch and the nickel, fertiliser and South 32 loops while being able to connect to a new port loop.

This option allows:

- sugar trains to enter and exit the port via TEARC
- molasses trains to enter and exit the port via TEARC
- Glencore trains to enter and exit the port via TEARC
- North Coast Line trains to bypass the port loops.

Figure 5.6 shows Option A2 which provides a new rail line in Archer Street to connect to the Jetty Branch and the nickel, fertiliser and South 32 loops while being able to connect to a new port loop.

This option allows:

- sugar trains to enter and exit the port via TEARC with a new unloading facility and conveyor to the existing storage sheds
- removal of the existing sugar rail loop
- molasses trains to enter and exit the port via TEARC
- Glencore trains to enter and exit the port via TEARC
- North Coast Line trains to bypass the port loops.

In terms of planning precedents, it is important to note, corridor planning for the Southern Port Road was undertaken on the basis that any future rail connection would be to the east of the road corridor. Subsequent planning decisions (e.g. location of HV lines) have also assumed the rail corridor would be placed west of the Southern Port Road Ross River bridge.

Table 5.3 and Table 5.4 outline the benefits and constraints of Options A1 and A2.

Figure 5.5 Option A1 Alignment

Continues from Option A, crossing the Ross River to the west of the Southern Port Road, crossing Boundary Street as rail over road.

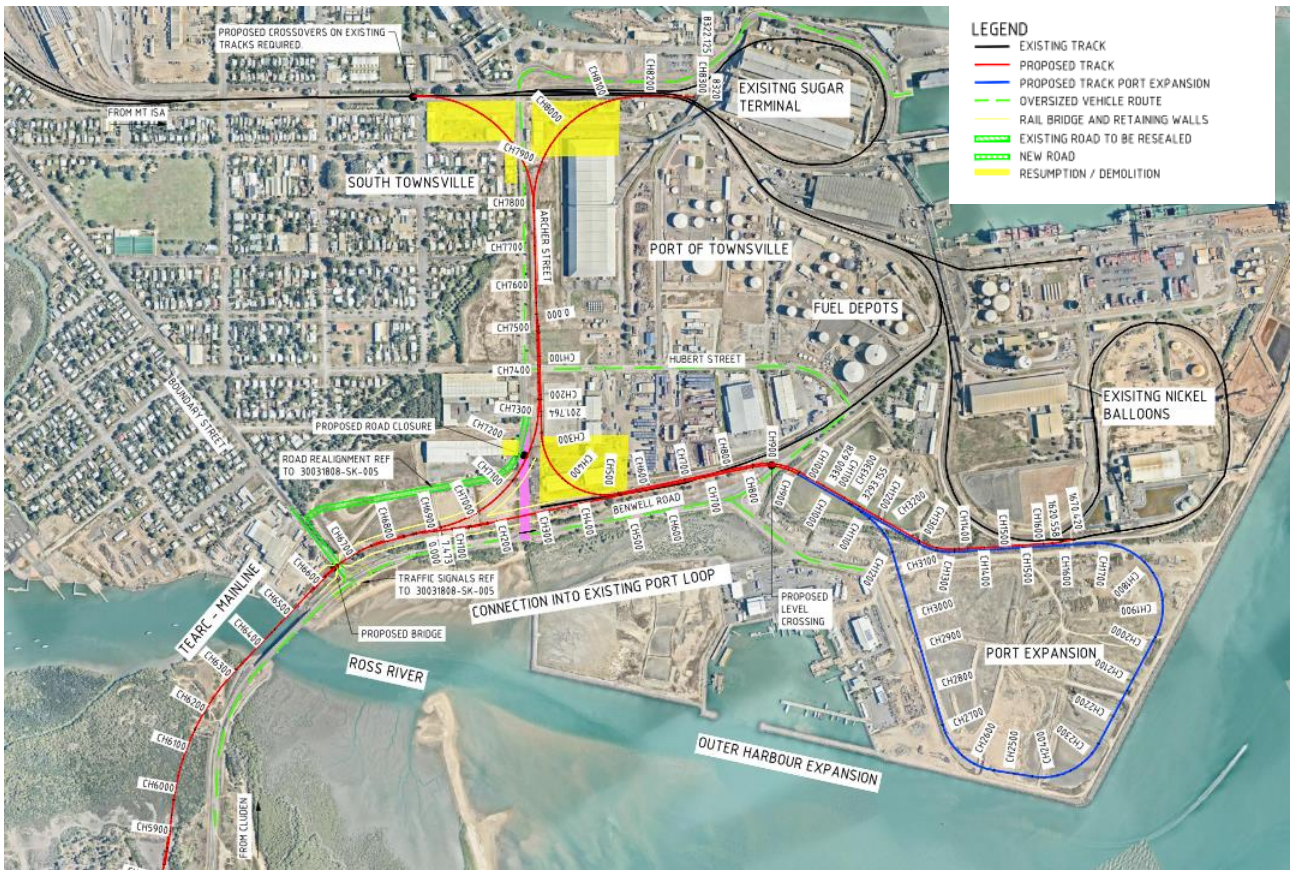


Table 5.3 Summary of Major Advantages and Constraints (Option A1)

ADVANTAGES	CONSTRAINTS
Shorter bridge span across Ross River	Higher cost
Connects to existing port infrastructure (ore loop and sugar loop)	Does not support optimal future port expansion layout
North Coast Line passenger services do not run through port	Rail over road crossing at Boundary Street
Supports potential North Coast Line relocation	Higher social impacts due to closer proximity to residents on Archer Street
Operational flexibility	Higher road impacts with major road reconfiguration at intersection of Boundary Street and Southern Port Road, and reconfiguration of Hubert Street
	Requires HV line relocation
	Property acquisition impacts

Figure 5.6 Option A2 Alignment

Continues from Option A, crossing the Ross River to the west of the Southern Port Road, crossing Boundary Street as Rail over Road, continuing along the existing Benwell Road stabling siding, with a proposed conveyor to the sugar shed.

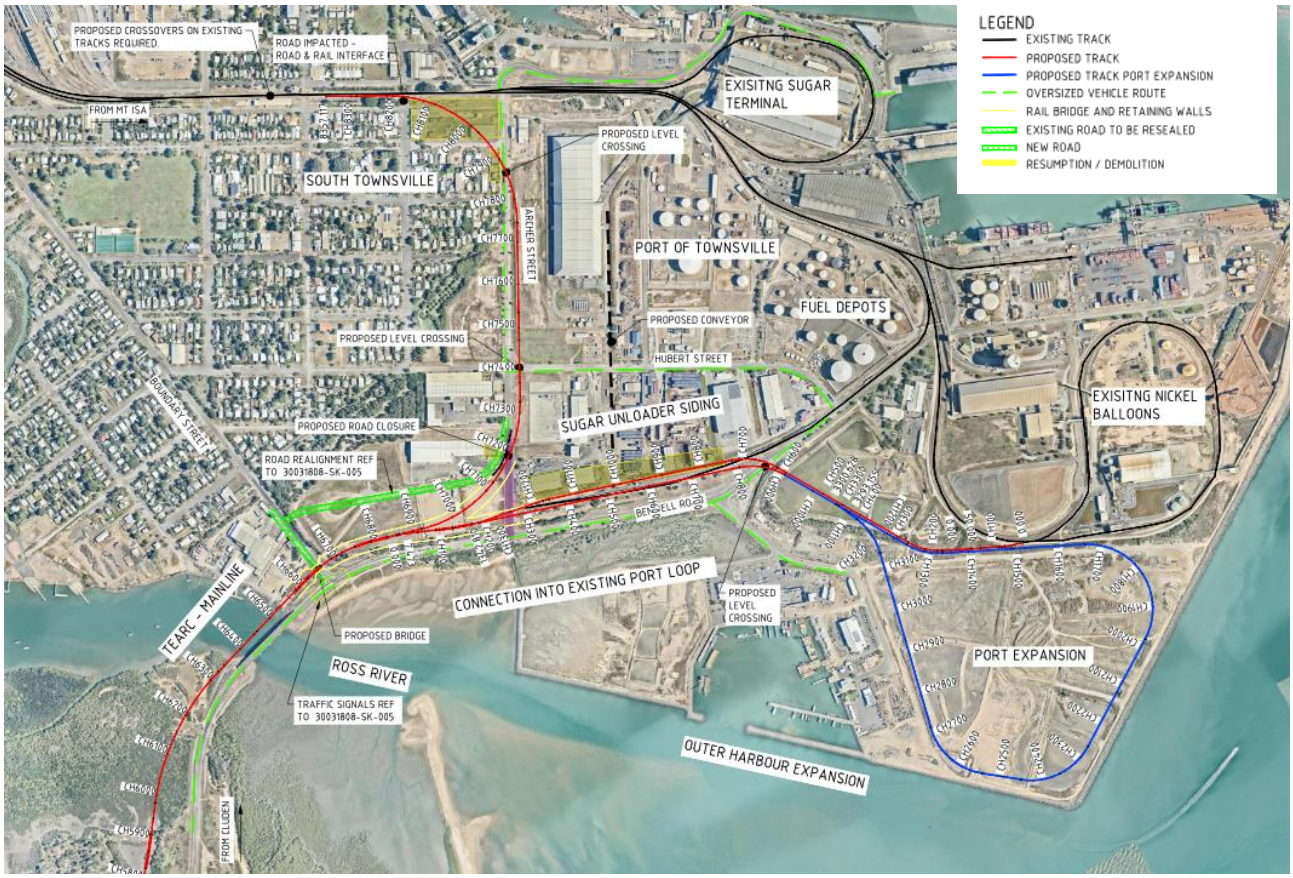


Table 5.4 Summary of Major Advantages and Constraints (Option A2)

ADVANTAGES	CONSTRAINTS
Shorter bridge span across Ross River	Higher cost
Connects to existing port infrastructure (ore loop)	Does not support optimal future port expansion layout
North Coast Line passenger services do not run through port	Rail over road crossing at Boundary Street
Supports potential North Coast Line relocation	Higher social impacts due to closer proximity to residents on Archer Street
New sugar unloading facility and transfer conveyor allows removal of the existing sugar unloading loop	Rail/road crossing at Benwell Avenue
	Higher road impacts with major road reconfiguration at intersection of Boundary Street and Southern Port Road, and reconfiguration of Hubert Street
	Requires HV line relocation
	Property acquisition impacts

5.5.2 Options B1, B2, B3 north of Ross River

The general functionality for Option B1 (Figure 5.7) compares to A1 and similarly B2) to A2. Option B3 (Figure 5.9) simplifies the connection into the port without requiring a new line down Abbot Street. Table 5.5, Table 5.6 and Table 5.7 outline the benefits and constraints of Options B1, B2 and B3.

Figure 5.7 Option B1 Alignment

Continues from Option B, crossing the Ross River to the east of the Southern Port Road, crossing Benwell Road as Rail over Road, turning into Archer Street, then out of Archer Street via a 'Y' connection that facilitates continuation to the Sugar Loop and the North Coast Line.

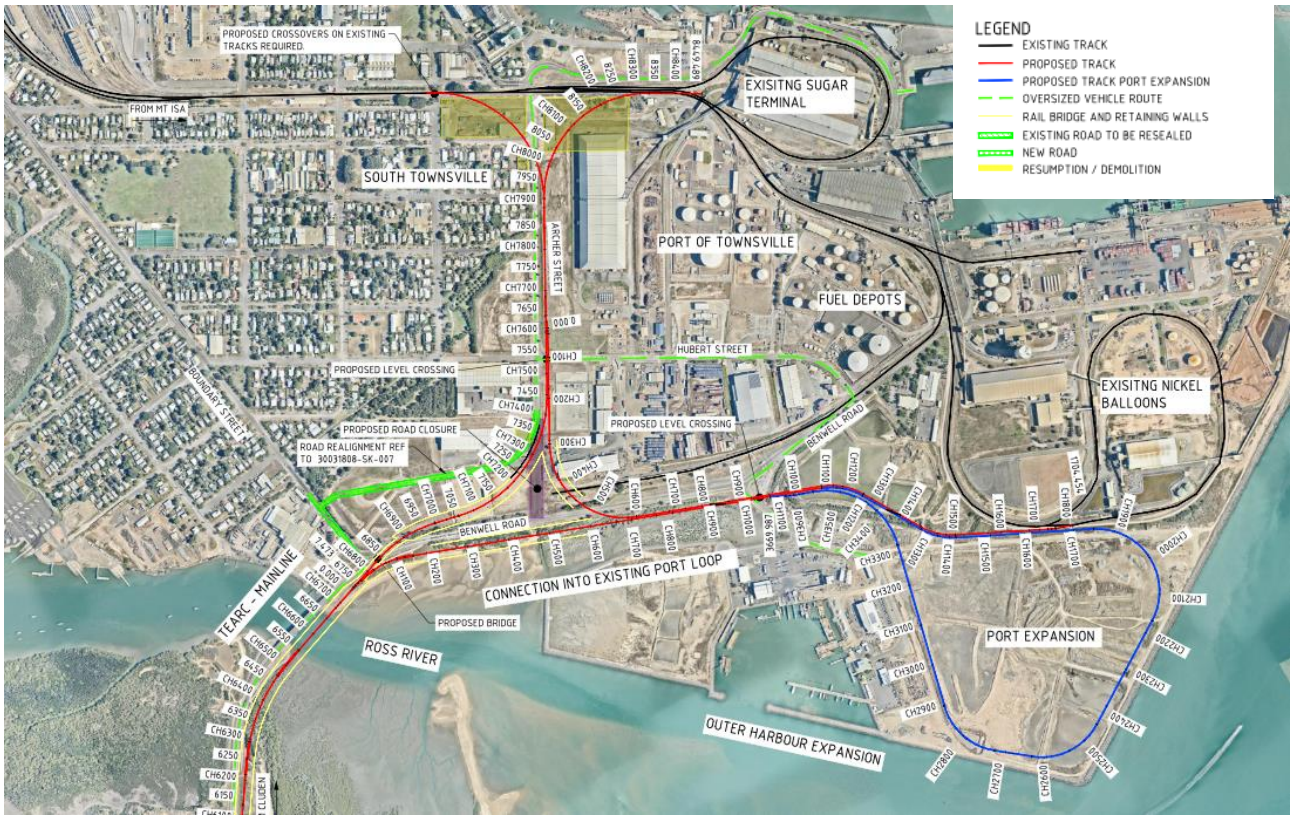


Table 5.5 Summary of Major Advantages and Constraints (Option B1)

ADVANTAGES	CONSTRAINTS
Connects to future port expansion loop	Higher cost
Connects to existing sugar loop	Longer bridge span across Ross River
North Coast Line passenger services do not run through port	Higher social impacts due to closer proximity to residents on Archer Street
Supports potential North Coast Line relocation	Higher road impacts with major road reconfiguration at intersection of Boundary Street and Southern Port Road, and reconfiguration of Hubert Street
Does not require HV line relocation	Higher social impacts due to closer proximity to residents on Archer Street
	Rail over road structures for connection of the southern wye to Abbott Street
	Grade separated road over rail crossing required where alignment intersects the Southern Port Road

Figure 5.8 Option B2 Alignment

Continues from Option B, crossing the Ross River to the east of the Southern Port Road Crosses Benwell Road as rail over road, then crosses Archer Street.

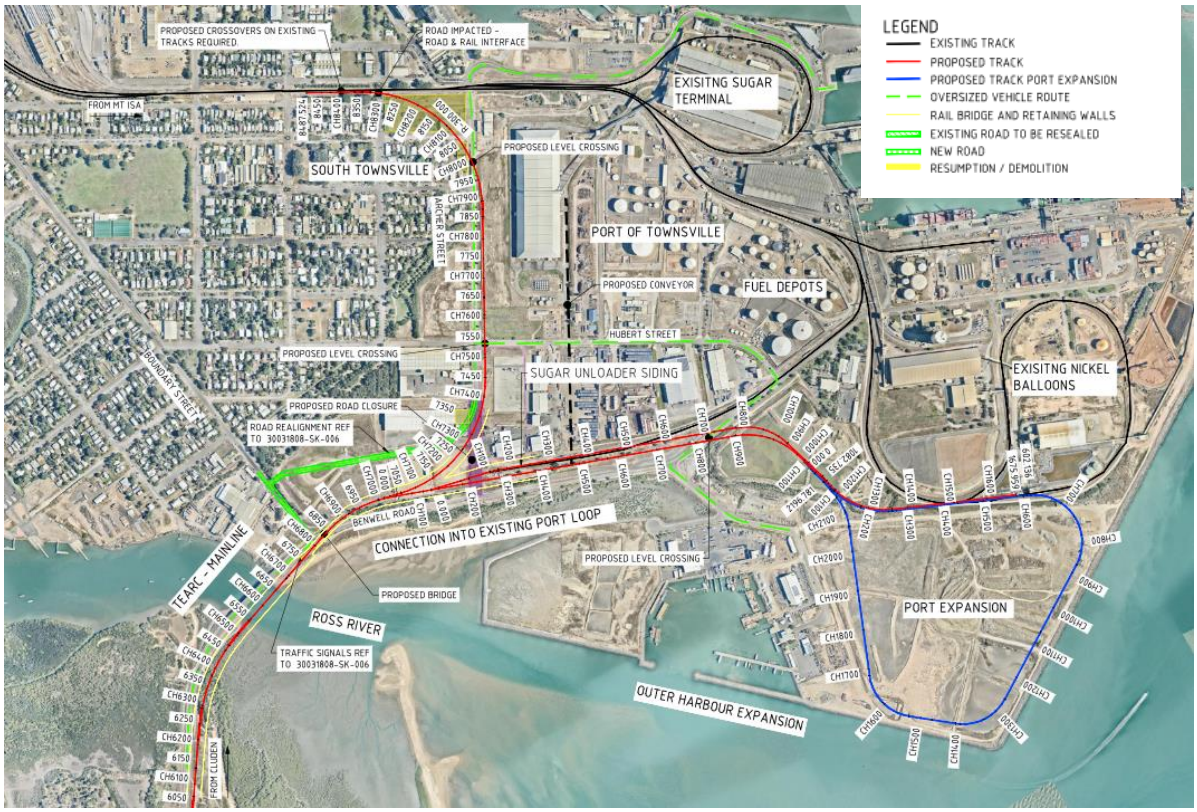


Table 5.6 Summary of Major Advantages and Constraints (Option B2)

ADVANTAGES	CONSTRAINTS
Connects to future port expansion loop	Higher cost
North Coast Line passenger services do not run through port	Longer bridge span across Ross River
Supports potential North Coast Line relocation	Higher social impacts due to closer proximity to residents on Archer Street
Does not require HV line relocation	Higher road impacts with major road reconfiguration at intersection of Boundary Street and Southern Port Road, and reconfiguration of Hubert Street
New sugar unloading facility and transfer conveyor allows removal of the existing sugar unloading loop	Grade separated rail over road crossing of Benwell Road
	Grade separated road over rail crossing required where alignment intersects Southern Port Road.

Figure 5.9 Option B3 Alignment

Continues from Option B, crossing the Ross River to the east of the Southern Port Road, remaining east of Benwell Road. Crosses Windlass Crossing at grade and connects to both the existing ore and future extension loops. Conveyor to sugar shed.

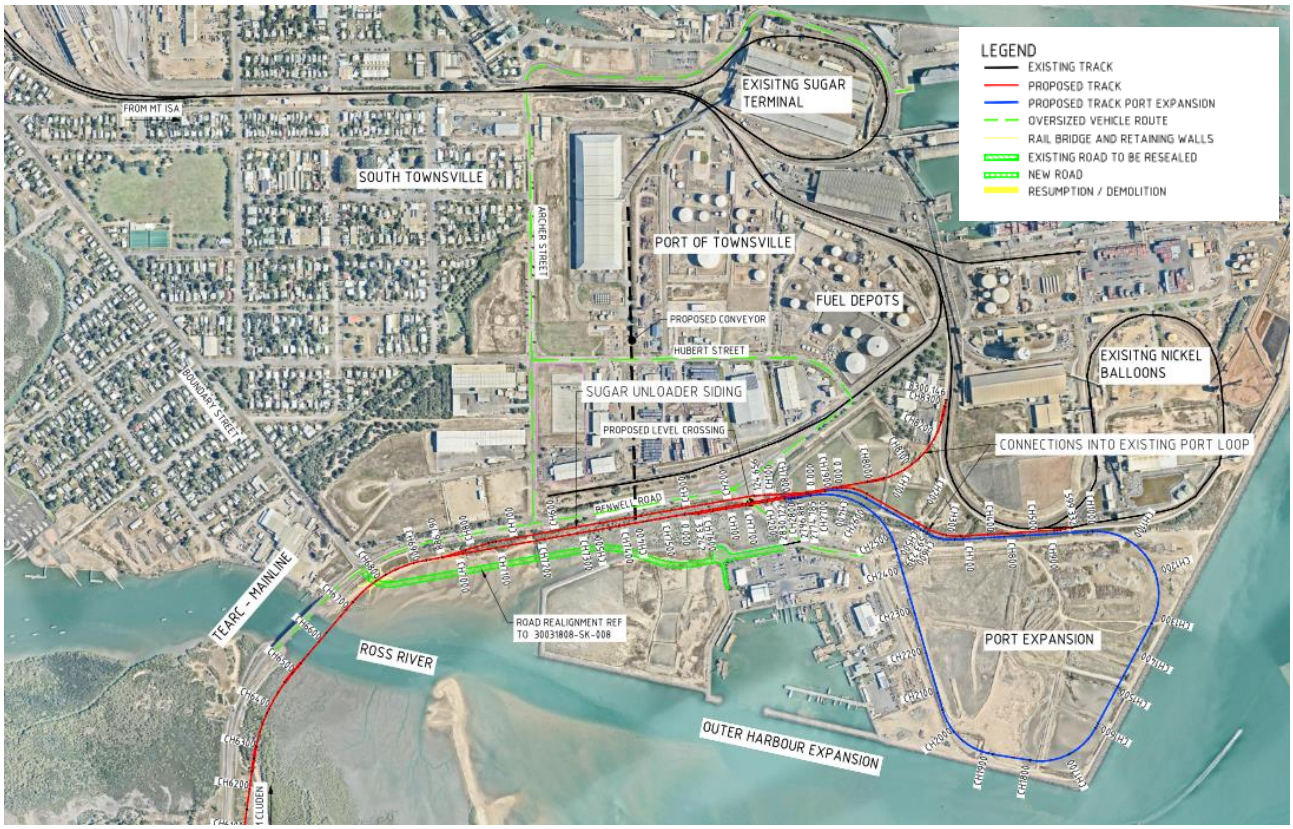


Table 5.7 Summary of Major Advantages and Constraints (Option B3)

ADVANTAGES	CONSTRAINTS
Lowest cost Supports optimal future port expansion layout Connects to existing port infrastructure (ore loop) Lower social impacts, given located away from residents on Archer Street Lowest impacts on road network Does not require grade separated rail over road crossings inside port Does not require HV line relocation New sugar unloading facility and transfer conveyor allows removal of the existing sugar unloading loop	Longer bridge span across Ross River North Coast Line passenger services would need to run through port or continue via North Coast Line Grade separated road over rail crossing required where alignment intersects Southern Port Road.

5.5.3 Preferred Connection Option to the Port

Table 5.8 summarises the outcomes of the second MCA workshop for sub-alignment options.

Option B3 was identified as the preferred alignment solution.

Table 5.8 MCA Sub-Alignment Options Assessment by Weighted Sub-criteria (Workshop 2)

CRITERIA	Sub Criteria Wtg (%)	A1	A2	B1	B2	B3
ENGINEERING						
Geotechnical	2.9%	2.5	3	2	3	1.5
Constructability	6.6%	2	2	1	1	3
Road/Rail Interfaces	5.9%	2.5	2.5	2	1.5	3.5
Rail Ops (Current/Future)	8.1%	4	2.5	2.5	2.5	1
ENVIRONMENT						
Noise + Air+Vib'n	9.6%	1	1	1	1	2.5
Port Land Use + Approvals	2.2%	1	2.5	2.5	2.5	4
Flora and Fauna	5.9%	4	4	1	1	1
ECONOMICS						
Cost	2.9%	1	4	1	2.5	4
Benefits	10.3%	2.5	2.5	2.5	2.5	2.5
Supply/Demand	7.4%	2.5	2.5	2.5	2.5	2.5
SOCIAL						
Visual Amenity	2.9%	1.5	1.5	3	3	3.5
Property Acquisition	4.4%	2	3	2	3	2
Road Interfaces (Safety)	10.3%	2.5	2.5	2.5	1.5	3.5
SUSTAINABILITY						
NCL Relocation	6.6%	4	4	4	4	4
Perkins St Removal	2.2%	1	1	1	1	1
Port Customers - Road	5.1%	2.5	2.5	2	2	3.5
Port Customers - Rail	6.6%	4	2.5	2.5	2.5	4
	SCORE	**2.57**	**2.53**	**2.11**	**2.10**	**2.76**
	RANK	**2**	**3**	**4**	**5**	**1**

5.5.4 Supplementary Reference Design Work

Following the identification of the reference project (Option B3), supplementary options, A3 and Option B4 were developed as shown in Figure 5.10 and Figure 5.11. The proposed alignments would follow the corridor which runs parallel and to the north of the sugar shed, with connections to the existing sugar loop and future port expansion loop.

These alignments offer similar advantages to Option B3 (e.g. improved social outcomes by locating freight rail movements further away from Archer Street). From an operational perspective, the proposed B4 Option would facilitate relocation of North Coast Line, with passenger services running through the port, rather than continuing on the existing North Coast Line corridor along Abbott Street. The achievable return rail radii connection to the Jetty Branch would limit North Coast Line passenger train operating speeds.

These supplementary options were not adopted for the reference project.

Figure 5.10 Option A3 Alignment

Continues from Option A, crossing the Ross River to the west of the Southern Port Road, remaining west of Benwell Road. Connects to both the existing sugar loop and future extension loops.

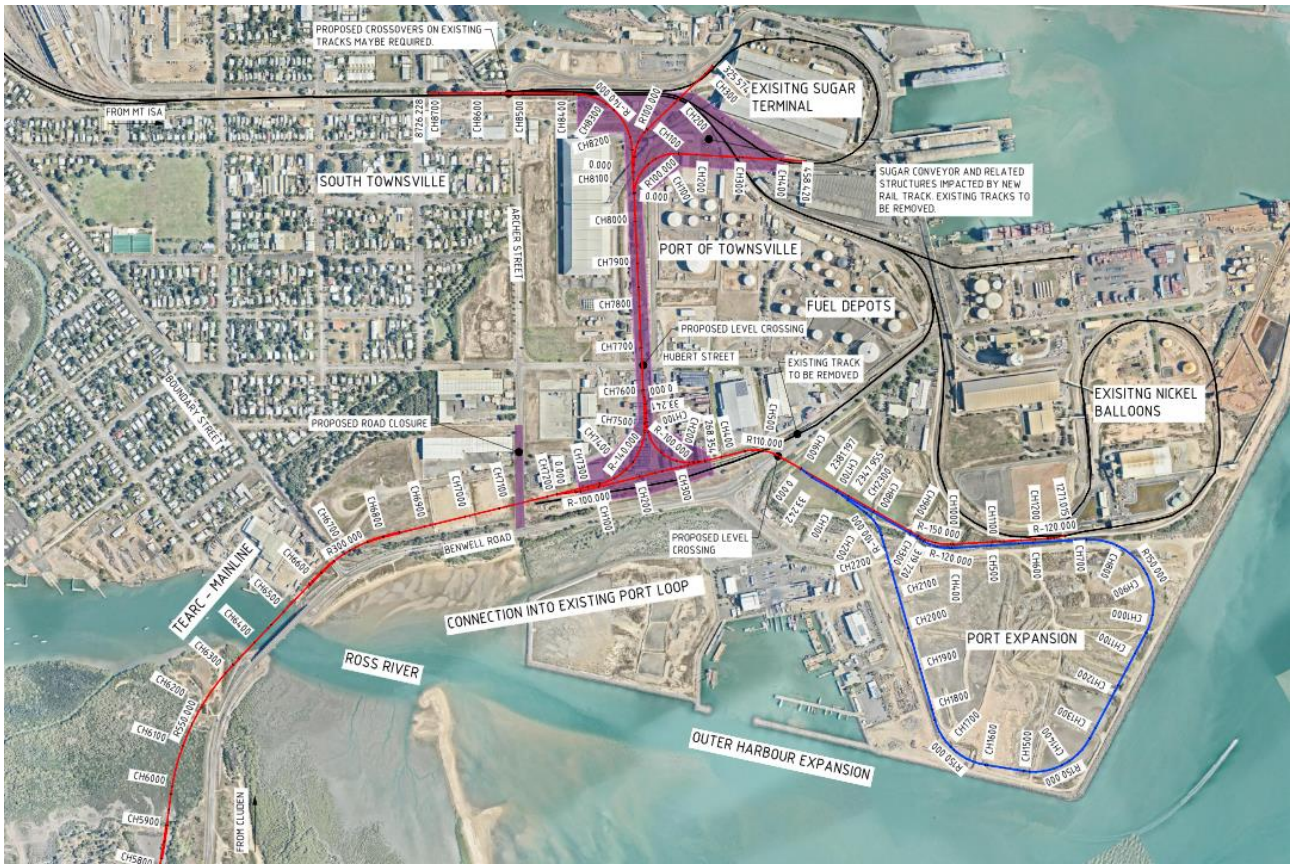
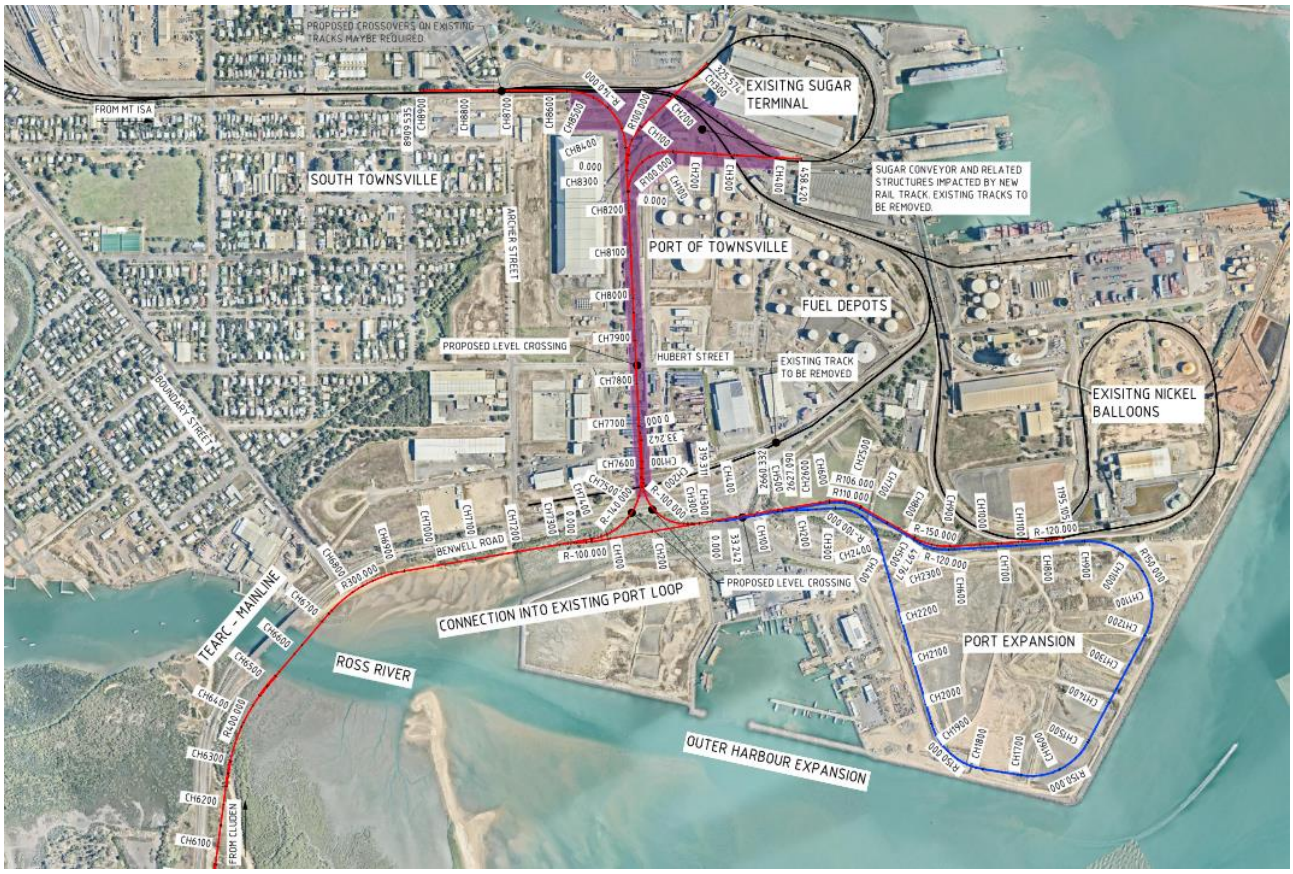


Figure 5.11 Option B4 Alignment

Continues from Option B, crossing the Ross River to the east of the Southern Port Road, remaining east of Benwell Road. Connects to both the existing sugar loop and future extension loops.



5.5.5 Concepts for Removal of part of the North Coast Line and Jetty Branch

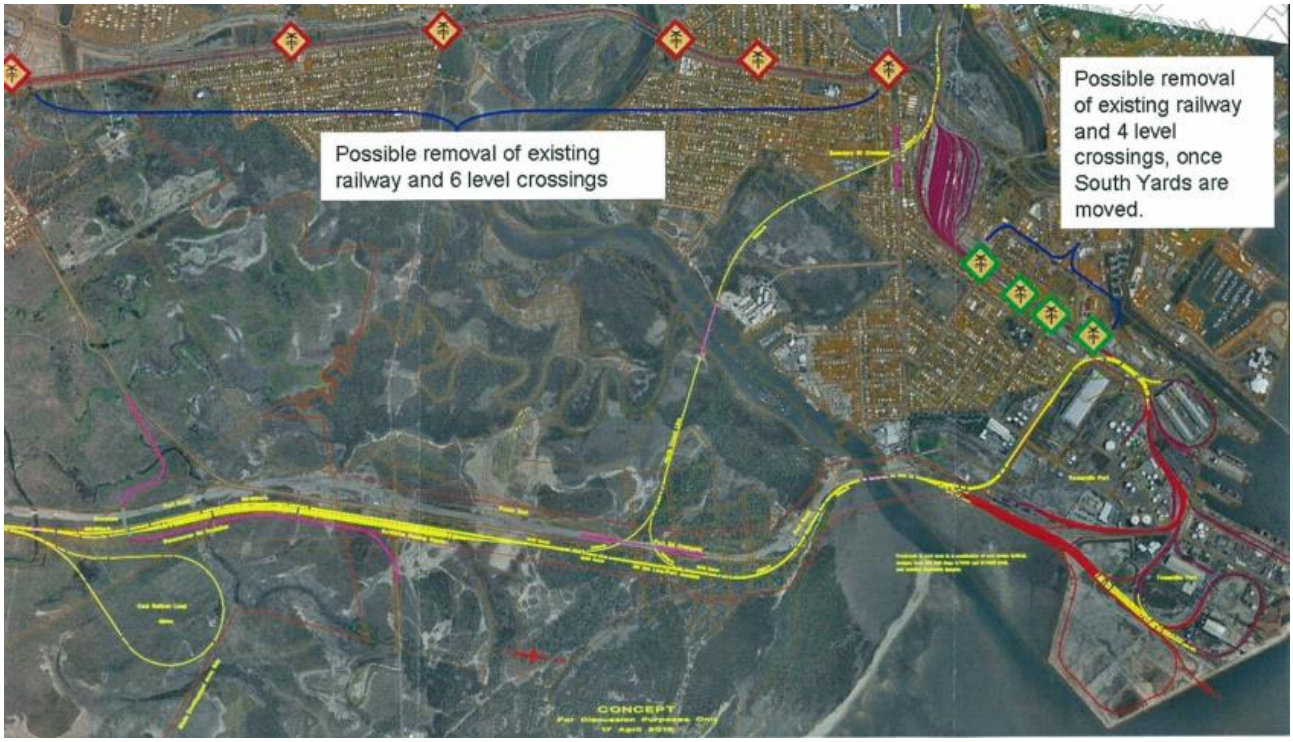
Additional ideas were discussed on the future opportunities that TEARC may provide in reconfiguring the North Coast Line and Jetty Branch to provide additional benefits to the Townsville community.

The analysis of alignment options included a high-level feasibility assessment of:

- Removing the section of the North Coast Line along Abbott Street (between the Bruce Highway at Cluden and Boundary Street), and/or
- Removing the section of rail that runs parallel to Perkins Street back the North Coast Line.

Refer to Figure 5.12 for an overview of the concept.

Figure 5.12 Alternative Alignment to allow the removal of Jetty Branch and section North Coast Line



QR developed this concept sketch for an alternate alignment that would connect from the proposed future TEARC connection to the North Coast Line in 2013. The configuration would potentially facilitate the removal of the North Coast Line and Jetty Branch. Assessing the feasibility of this option was not considered within the scope of this business case. This option would involve significant additional costs, as it would require an additional rail bridge across the Ross River. The additional bridge would be further inland with the alignment passing through the land that surrounds the defence base, and connecting to the North Coast Line near to the existing North Coast Line/Jetty Branch junction. It would also require grade-separated crossings where it intersects with the Southern Port Road.

The potential benefits of removing a section of the North Coast Line include reduced freight movements through southern Townsville suburbs, and the elimination of up to five level crossings with flow on benefits for safety, congestion and urban amenity.

The potential benefits of Jetty Branch removal include reducing social impacts on residents that live near the Jetty Branch, removal of up to three level crossings and the potential to support future urban renewal along this corridor.

Alternative Scenarios:

- Rerouting of the North Coast Line traffic is potentially feasible under the sub-alignment options considered as part of this business case, provided the Jetty Branch rail connection is maintained to allow through movements on the North Coast Line. In this scenario the section of North Coast Line from Cluden to Boundary Street may be removed.
- If the North Coast Line section were to be removed, the preferred alignment B3 would require passenger services and north south freight movements to run through the port. A safety case would be required on the routing of passenger services through the port loops.
- The North Coast Line could be retained for passenger services with freight movements diverted via TEARC, through the port and Jetty Branch connections. This alternative assumes the sugar unloading

facilities would be modified to bring sugar trains in and out of TEARC. Under this scenario, the North Coast Line would continue to operate as a port by-pass for passenger movements. Given there are only a few passenger services a week, this would still lead to reduced impacts on residents in Southern Townsville located along Abbott Street, it would mean higher operational costs associated with the maintenance of two lines.

- If the Jetty Branch connection were removed and the North Coast Line was retained, based on the alignments considered as part of this business case, the proposed TEARC connection would effectively need to operate as a two-way spur connection from the junction at Cluden to and from the port.
- Given the need to maintain north-south through movements on the North Coast Line, removal of the Jetty Branch would require the Abbott Street section of the North Coast Line to be retained in order to service passenger and freight movements which travel north along the Abbott Street corridor. This could in turn diminish some of the expected benefits of TEARC. Further investigation of engineering and operational constraints would need to be undertaken to fully understand the impacts of removing the Jetty Branch would potentially have on future North Coast Line operations.

These alternative scenarios were not considered to form part of the business case or reference project.

5.5.6 Conclusion

Option B3 was identified as the preferred alignment solution to be used for the Reference Project. The North Coast Line along Abbott Street and the Jetty Branch remain in use for the Reference Project.

Option B3 requires grade separation for Abbott Street and the Southern Port Road with an underpass at Boundary Street.

The relative advantages and constraints of each of the alignments compared to the Base Case are summarised in Table 5.9 to Table 5.12.

Table 5.9 Summary of Advantages and Constraints (Base Case)

DESCRIPTION	ADVANTAGES	CONSTRAINTS	UNLOADING STRATEGY
Base Case			
▪ Continued train movements through South Townsville.	▪	▪ Three heavily used open level crossings and one pedestrian crossing in residential areas. ▪ Approximately 140 dwellings noise affected. ▪ Operational impacts (delays) on road network. ▪ Existing open level crossings delay vehicle movements. ▪ Bottlenecks at port.	Existing arrangements

Table 5.10 Summary of Advantages and Constraints (Option A – Cluden West)

DESCRIPTION	ADVANTAGES	CONSTRAINTS	UNLOADING STRATEGY
Option A			
▪ Connects to the existing North Coast Line north of Cluden, traverses northeast towards the Southern Port Road and runs parallel to the port along the western side of the Southern Port Road to the Ross River. ▪ Option A is 6km in length from North Coast Line connection to Ross River.	▪ Does not have to cross the North Coast Line at approx. CH3000. ▪ Sets up for a reduced bridge crossing of the Ross River to the west of the existing highway bridge. ▪ Aligns with existing TSDA corridors. ▪ Reduced environmental footprint within the Ross River marine environment than Option B.	▪ Would require the relocation of the 132kV HV power line to the west of the Ross River bridge. ▪ Higher social impacts due to railway being closer to the residential areas on Archer Street. ▪ Potential for greater social impacts due to railway being closer to the residential areas of South Townsville (Macrossan Street and Eighth Avenue) and Cluden (Racecourse Road).	Refer to options A1 and 2
Option A1			
▪ Continues from Option A, crossing the Ross River to the west of the Southern Port Road, crossing Boundary Street as Rail over road. ▪ The alignment turns into Archer St, runs along Archer St with a 'Y'	▪ Good through rail access and operational efficiency. ▪ Shorter bridge crossing and reduced environmental footprint within Ross River. ▪ Utilises existing rail land to the west of Benwell Road ▪ Approximately 8 adjacent dwellings noise affected (lower than base case of 140).	▪ Rail over road bridge required at Boundary Street. ▪ Slightly more land take requirement when compared to Option B around the Archer Street/Benwell Road area. ▪ Relocation of the 132kV HV Power Lines parallel to the bridge. ▪ Higher social impacts due to railway being closer to the residential areas on Archer Street and Eighth Avenue.	Bottom discharge at existing sugar loop

DESCRIPTION	ADVANTAGES	CONSTRAINTS	UNLOADING STRATEGY
connection linking both the Sugar Loop and the North Coast Line. ▪ Access to the port expansion loop would be facilitated, via connection to the Benwell Road stabling track. ▪ 'Y' connection required to both the east and west of Archer Street.		▪ Requires major reconfiguration of Boundary Street/Archer Street intersection. Large impacts/constraints to the road network created due to the Archer Street Link. Archer Street severed from Benwell Road Boundary Street/ TPAR connection required with signals. Hubie Taylor Place extension to Boundary Street OLCs at Hubert Street and north of port gates. O/size vehicles connected via Hubert Street.	
Option A2			
▪ Continues from Option A, crossing the Ross River to the west of the Southern Port Road, crossing Boundary Street as rail over road, continuing along the existing Benwell Road stabling siding. ▪ The unloading point located along Benwell Road with transfer via belt conveyor to bulk sugar shed 3.	▪ Good through rail access and operational efficiency with regards port expansion. ▪ Shorter bridge crossing and reduced environmental footprint within Ross River. ▪ Utilises existing rail land to the west of Benwell Road. ▪ Reduced impacts due to the removal of the proposed 'Y' connection around Archer Street. ▪ Approximately 8 adjacent dwellings noise affected (lower than base case of 140).	▪ Rail over road bridge required at Boundary Street. ▪ Requires major reconfiguration of Boundary Street/Archer Street intersection. Large impacts/constraints to the road network created due to the Archer Street Link. ▪ Archer Street severed from Benwell Road Boundary Street/ TPAR connection required with signals. Hubie Taylor Place extension to Boundary Street. OLCs at Hubert Street and north of port gates. O/size vehicles connected via Hubert Street. ▪ Relocation of the 132kV HV Power Lines parallel to the bridge ▪ Higher social impacts due to railway being closer to the residential areas on Archer Street and Eighth Ave.	Bottom discharge at proposed Benwell Road, with conveyor transfer to sugar shed 3 ▪

Table 5.11 Summary of Advantages and Constraints (Option B – Cluden East)

DESCRIPTION	ADVANTAGES	CONSTRAINTS	UNLOADING STRATEGY
▪ Option B – Cluden East			
▪ Connects to the existing North Coast Line north of Cluden, traverses north east towards the Southern Port Road, crosses the Southern Port Road at approx. CH3000, and runs parallel to the port along the eastern side of the Southern Port Road. ▪ Option B is approximately 6km in length from North Coast Line connection to Ross River.	▪ Would not impact the 132kV HV power lines to the west of the existing road bridge. ▪ Approximately 8 adjacent dwellings noise affected (lower than base case of 140). ▪ Lower social impacts than western options, due to being approximately 100m further away from residential areas of South Townsville (Eighth Ave). ▪ Would ease curves required for 'Archer Street' option B1 ▪ Aligns with existing TSDA corridors and Port land use plan (Marine Industry areas within the Ross River North Precinct).	▪ Would require a grade separated crossing, most likely road over rail, at approx. CH3000. ▪ Would require a longer bridge crossing of the Ross River. ▪ Eastern alignments will result in a larger environmental footprint within the Ross River estuary than Options A. ▪ Potential for greater social impacts due to railway being closer to the residential areas on Archer Street (Macrossan Street) and Cluden (Racecourse Road).	▪ Refer to Options B1, 2 and 3
▪ Option B1			
▪ Continues from Option B, crossing the Ross River to the east of the Southern Port Road, crossing Benwell Road as Rail over Road, turning into Archer Street, out of Archer St via a 'Y' connection allowing continuation to the Sugar Loop and the North Coast Line. ▪ Onward access to the proposed port extension and the existing Ore loop. ▪ In summary a 'Y' connection would be required to the east and west of Archer Street.	▪ Good through rail access and operational efficiency. ▪ Avoids the need to relocate the 132kV power supply to the west of the Ross River road bridge. ▪ Approximately 8 adjacent dwellings noise affected (lower than base case of 140). ▪ Lower social impacts than western options, due to being approximately 100m further away from residential areas of South Townsville (Eighth Ave). ▪	▪ Large impacts/constraints to the road network created due to the Archer Street Link. ▪ Larger bridge structure required to cross the Ross River to the East of the existing road bridge and require disturbance to exposed tidal mudflat. ▪ Eastern alignments will result in a larger environmental footprint within the Ross River estuary than Options A. ▪	▪ Bottom discharge at existing sugar loop
▪ Option B2			

DESCRIPTION	ADVANTAGES	CONSTRAINTS	UNLOADING STRATEGY
▪ Continues from Option B, crossing the Ross River to the east of the Southern Port Road. ▪ Crosses Benwell Road as Rail over Road, crossing Archer Street. ▪ The alignment utilises the existing Benwell Road siding, continuing on to both the existing Ore loop and proposed expansion loop. ▪ A 'U' connection would be required, along Archer St, to ensure adequate route option for through traffic onto the North Coast Line.	▪ Utilises the existing Benwell Stabling formation base. ▪ Reduced construction requirements along Archer Street (when compared to B1). ▪ Approximately 8 adjacent dwellings noise affected (lower than base case of 140). ▪ Lower social impacts than western options, due to being approximately 100m further away from residential areas of South Townsville (Eighth Avenue). ▪	▪ Archer Street would require extensive modifications and would become a cul de sac with rail crossing road. ▪ A 'U' connection would be required to accommodate through traffic for the North Coast Line. ▪ Eastern alignments will result in a larger environmental footprint within the Ross River estuary than Options A.	▪ Bottom discharge at proposed Benwell Road, with conveyor transfer to sugar shed 3 ▪
▪ Option B3			
▪ Continues from Option B, crossing the Ross River to the east of the Southern Port Road, remaining east of Benwell Road. ▪ Crosses Windlass Crossing at grade and connects to the existing Ore and future Extension loops.	▪ Eliminates road interfaces along Benwell Road. ▪ Creates a direct connection to Ore and extension loops. ▪ Lower social impacts than all other options due to being located away from residential areas on Archer Street.	▪ Stabilisation works required to the east of Benwell Road (noting land reclamation already proposed as part of future port expansion). ▪ Eastern alignments will result in a larger environmental footprint within the Ross River estuary than Option A.	▪ Bottom discharge at proposed Benwell Road, with conveyor transfer to sugar shed 3

Table 5.12 Summary of Advantages and Constraints (Option C – Sun Metals)

DESCRIPTION	ADVANTAGES	CONSTRAINTS	UNLOADING STRATEGY
Option C			
▪ Option C connects to the existing North Coast Line railway network at the Sun Metals branch. ▪ The proposed alignment traverses northwest to join what would also be option B at approximate chainage 7000. ▪ This option continues, as per Option B, to the Ross River crossing on the Eastern Side. ▪ Option C is approximately 9.5km from North Coast Line connection to Ross River.	▪ Would create a direct linear connection from the North Coast Line to the Ross River crossing point. ▪ Would better serve industry in and around the Sun metals area. ▪ Potential to link to common user facility with slightly amended alignment. ▪ Will not result in amenity impacts to residents in the Cluden area.	▪ Highest cost, additional 3.5km in track compared to Options A and B leading to additional costs. ▪ Operationally, and assuming the North Coast Line would be taken off line between Stuart Industrial precinct and South Townsville, would create operational issues with Stuart yard becoming single rather than double ended and would require reverse shunting and re-signalling. ▪ Cultural heritage concerns have been raised around the indigenous burial site located near to Sandfly Creek that the rail line would cross. ▪ Does not align with existing transportation corridors with the potential to reduce proposed developable precincts of the TSDA. ▪ Bisects Sun Metals approved solar farm within TSDA. ▪ Flood impacts, Option C alignment traverses several existing major drainage features which includes Sandfly Creek and several existing tributaries of Stuart Creek that generally flow in an easterly direction to discharge to the coast. All existing flows associated with the Sandfly Creek catchment would be effectively blocked resulting in considerable ponding and elevated upstream flood levels. ▪ Environmental constraints due to alignment traversing greenfield wetland environment through TSDA. ▪ Eastern alignments will result in a larger environmental footprint within the Ross River estuary than Options A.	Refer to Options B1, 2 and 3

- **Assumptions and Clarifications**

- Conveyor unloading will commence on the return/exit i.e. not on entry to the port precinct. This accommodates greater train length and avoids being under compression as a result of vertical geometry constraints
- Staging ponds at the junction of Benwell Road and Windlass Crossing have not been avoided during alignment development. They will be removed prior to rail construction.
- It is understood the staging of TEARC will be implemented prior to the port expansion loop
- Options A, B and C from the North Coast Line to Ross River are within the Townsville SDA
- The existing North Coast Line between the take off at Cluden (Stuart Yard for Option C) connection for the proposed TEARC and Townsville South may be decommissioned

5.6 Recommended Solution

The recommended alignment option (Reference Project), branches off the North Coast Line at Cluden, traversing the northern part of the TSDA, and then broadly follows the Southern Port Road alignment to the east of the road and the Ross River bridge connecting into the port minerals loops. Figures 5.13 provides a general layout arrangement for the Reference Project Alignment and Figures 5.14, 5.15 and 5.16 provide details of the Reference Project.

Figure 5.13 – Reference Project Alignment – General Layout Arrangement

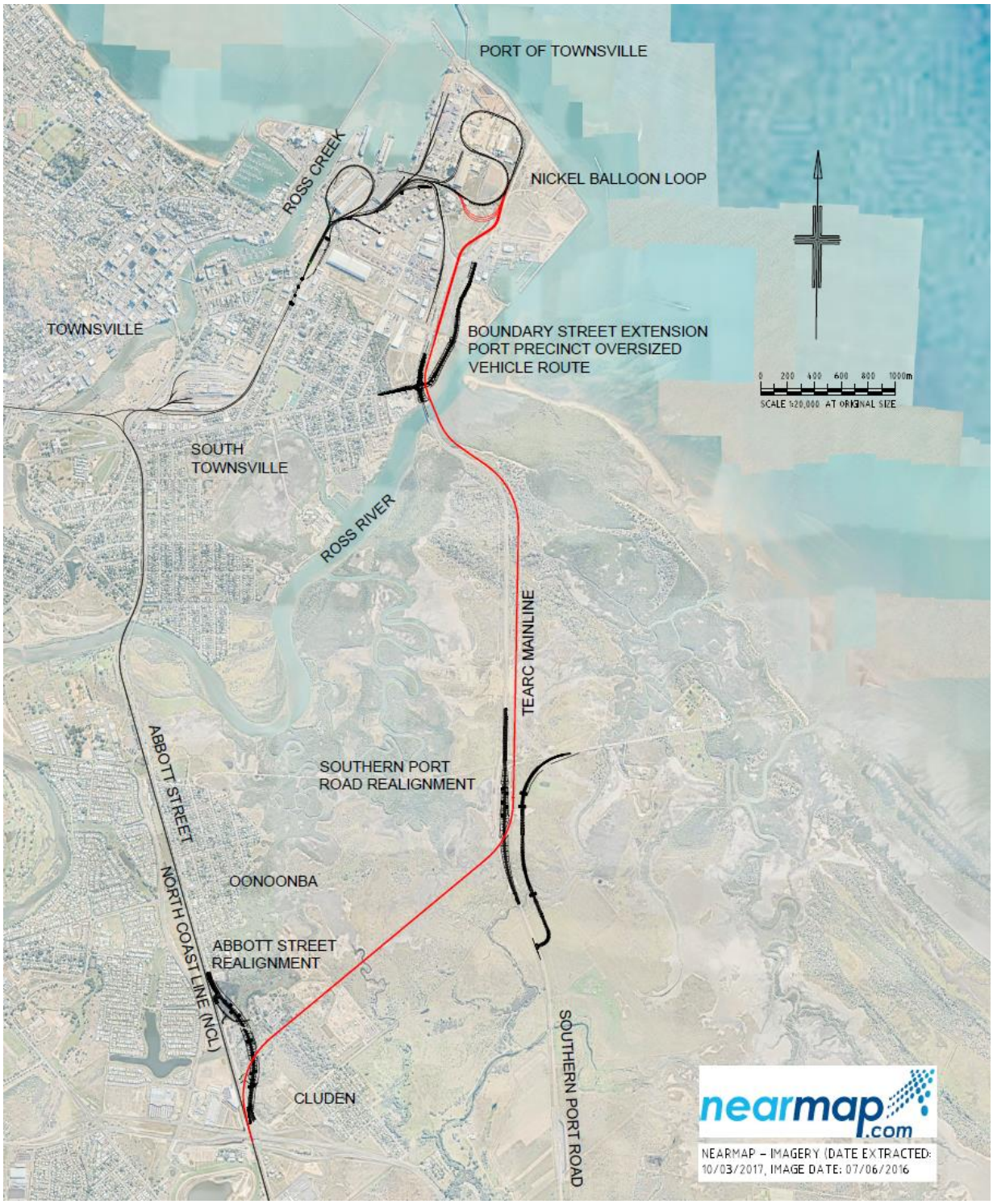


Figure 5.14 – Reference Project Alignment – Southern Connection

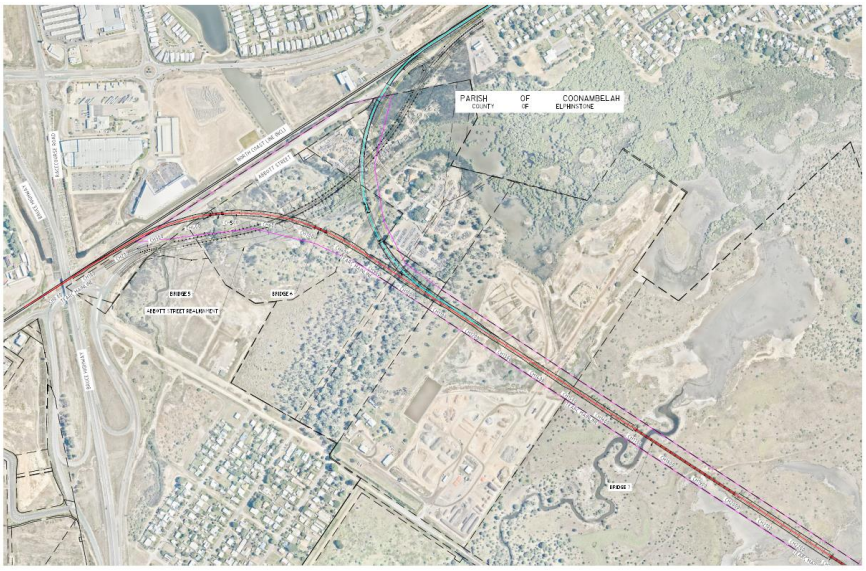


Figure 5.15 – Reference Project Alignment – Eastern Access Road Section

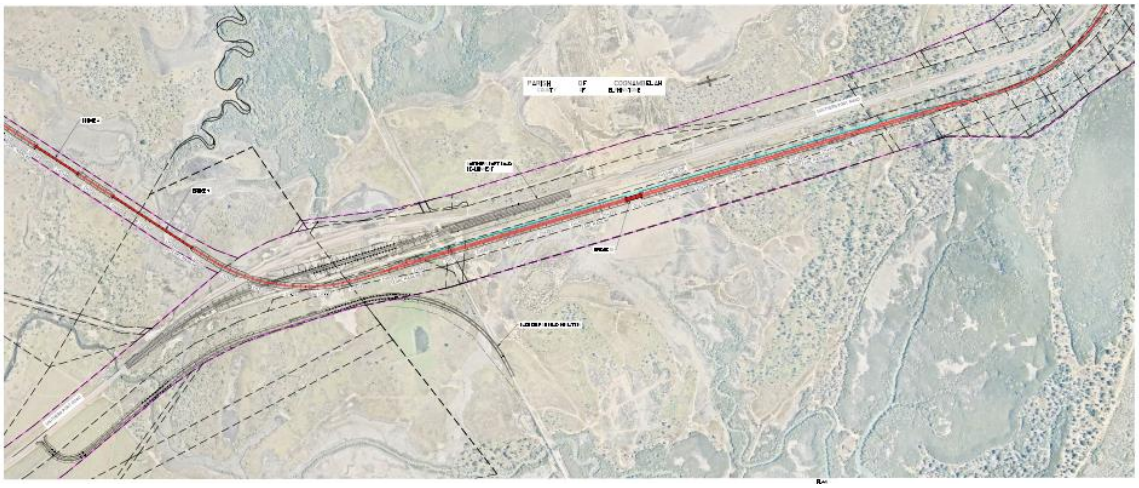


Figure 5.16 – Reference Project Alignment – Northern Connection to the PoT

5.7 Reference Project

TEARC is a proposed new 8.3km freight rail link, branching off the North Coast Line at Cluden and connecting directly to the PoT. The alignment broadly follows the eastern side of the Southern Port Road, crossing near the mouth of the Ross River and connecting to the existing inner (Cannington) and outer (Nickel) balloon loops within the PoT. Refer to Figure 5.17. Refer to Table 5.13 for a summary comparison to the Base Case.

TEARC has been designed to facilitate future staged infrastructure upgrades, including the proposed port expansion. The design also responds to strategic needs and aims to maximise project benefits that include:

- Providing additional rail capacity and ability to accommodate longer trains to support the efficiency of the resources sector.
- Providing additional access capacity to support new operations at the PoT. There is some latent capacity within the port but not sufficient space for new entrants, which impinges growth and potentially constrains future throughput volumes.
- Improving freight efficiency and boosting capability of the Port by removing bottlenecks caused by road and freight movement conflicts through at grade crossings.
- Supporting the activation of the Townsville SDA by providing a strategic freight link with direct access to the PoT, Mount Isa and North Coast Lines.
- Diverting freight rail movements away from the North Coast Line, helping to address road network impacts associated with at-grade crossing and urban amenity impacts from freight rail operations within the urban areas of Townsville.

Table 5.13 Comparison of Base Case and Reference Project

DESCRIPTION	BASE CASE	REFERENCE PROJECT
New Rail Line and associated signalling	Nil	8.3km narrow gauge from Cluden to PoT modified balloon loops
New Road/Rail Grade Separations	Nil	Abbott St, SPR and Boundary St
Removal of Jetty Branch	Nil	Not in scope

Methodology

The design for TEARC was undertaken engaging a wide range of stakeholders between January and September 2017. The objective of the engineering component of the study is to provide sufficient definition of the project scope and estimate to support the business case.

Stakeholder inputs have included:

- Queensland Rail
- Transport and Main Roads
- Department of State Development
- Port of Townsville Limited
- Other consultants, including finance and economics
- Community engagement.

The design of the alignment has been influenced and guided by various factors as the project has progressed which include:

- Operational efficiency
- Value for money
- Community impacts
- Environmental impacts
- Stakeholder requirements
- Economic and financial viability.

The engineering team has worked in collaboration to take the existing design, stakeholder inputs and workshop outputs to develop the design through the phases and assessing the various options. The discipline inputs include the following:

- Alignment design
- Road impact design
- Hydrology and Drainage
- Bridges and structure
- Geotechnical design
- Environmental
- Cultural and Indigenous Heritage
- Public utilities and general civil engineering.

Ancillary discipline inputs also included modelling of the rail and road infrastructure, which provided guidance to the discipline leads during the design process and informed the economic analysis.

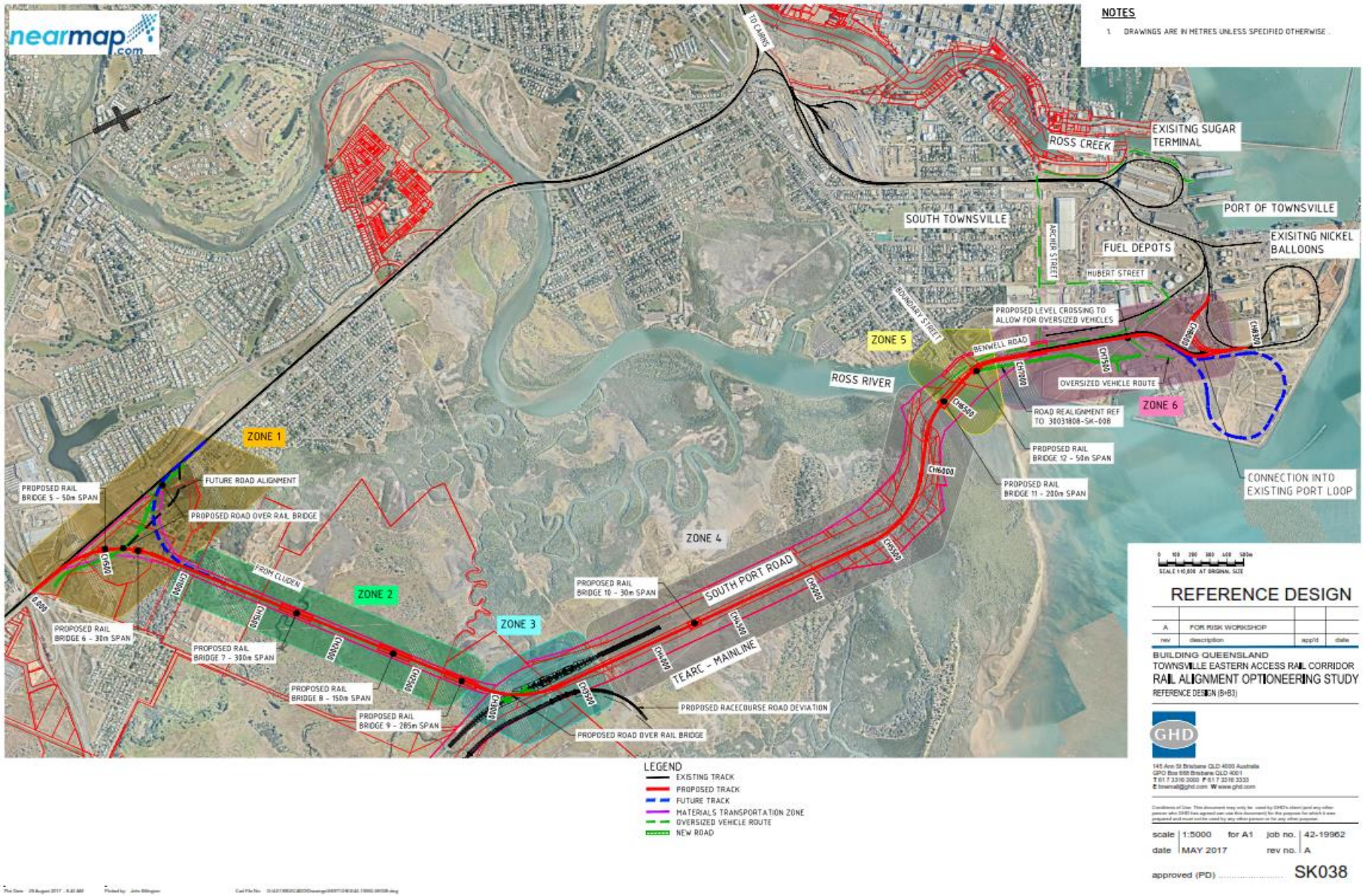
The following sections provide a summary of the project, including design scope, key technical features for each discipline, functionality, operations, services, inclusions and exclusions.

The project commences at the North Coast Line approximately 6km south of Townsville and consists of the following major components:

- Construction of 8.3km single-track narrow gauge (1067mm) rail line from Cluden to PoT with a new embankment, maintenance access road, bridge and drainage structures.
- Realignment and grade separation of Abbott Street.
- Realignment and grade separation of the Southern Port Road.
- Realignment of Racecourse Road to the sewerage treatment plant.
- Extension of Boundary Street from Benwell Street to Windlass Crossing.
- Integration with existing and planned future PoT expansion.

The following sections provide further detail on the design scope and considerations for each of technical disciplines.

Figure 5.17 TEARC Reference Design Project Zones



5.7.1 Rail Infrastructure

5.7.1.1 Scope Overview

The total length of TEARC, excluding passing loops and mainline duplication, is 8.281km (rounded to 8.3km for discussion).

TEARC will be predominantly single track with a passing loop accommodating a 1,000m train south of Ross River (with the provision for up to 1,400m trains in future), a single track across Ross River and then double track to connect to the existing port minerals loops.[28]

TEARC will branch off the North Coast Line at Cluden, via a southern access leg, with an allowance for connection of a northern leg in the future, if required.

TEARC will be grade separated after it crosses Ross River, and run along the southern side of Benwell Road.

The rail is 60kg/m standard carbon with concrete sleepers, and contains 14 turnouts of the following type: (3 x 1 in 25; 3 x 1 in 16; 8 x 1 in 8.25). Top of the embankment formation to head of rail is a minimum of 658mm.

The mainline is predominantly on fill with embankment heights ranging from 1.5m to 2m above the proposed access road, with 1 in 2 embankment slopes and an average formation level of 4.85m. The minimum radius curve is 300m, and the maximum radius is 550m. In the port precinct, the minimum radius is 140m to accommodate QR's maintenance plant capacity.

The maintenance access road provides for a 3m wide Type 2 at natural surface level (where possible).

Maintenance access road entry points have been allowed for at the following locations:

- Cluden connection; joining onto the existing access road via Abbott Street.
- Racecourse Road; joining at nominated locations along Southern Port Road.
- Port Precinct; via Benwell Road.

Signalling system for the TEARC mainline to the port boundary will be an extension of the current QR system. Train control within the port precinct is proposed to be under the PoT manual system.

5.7.1.2 Limits of Project Scope

- There will not be any relocation or removal of the North Coast Line as part of the project (Abbott Street).
- There will not be any removal of the Jetty Branch as part of the project.
- TEARC does not rely upon any upgrades to the Mount Isa Line and hence Mount Isa Line upgrades are not included in the project scope.
- No work within the PoT precinct past connecting TEARC into the existing minerals loops.

[28] Modelling of the alignment for the project case has stress tested the corridor. This has not highlighted the need for full duplication of track (i.e. current single track with passing loops is sufficient). Road over rail bridges as currently designed would not facilitate future track duplication

5.7.1.3 Rail Embankments

The TEARC design planning levels for flood immunity (vertical grade provisions) were established based on the following criteria:

- Rail embankments will generally meet 1% Average Exceedance Probability (AEP) flood requirements.
- Within the coastal areas, design level criteria are based on the adopted Design Storm Tide (DST) event levels in accordance with the Townsville City Council City Plan 2014. Current City Plan 2014 provisions necessitate higher design-planning levels compared to those applied under the former 2005 scheme.
- In floodplain areas, design-planning levels are based on the TCC Defined Flood Event (DFE), but also include conservative allowances for climate change (within a 2100 planning timeframe), unmitigated catchment development and inclusion of the ultimate Townsville SDA strategy.

5.7.1.4 Bridges

In total, twelve bridges (eight for railway and four for road) have been proposed along the rail and road alignments between North Coast Line across Ross River to the PoT. Due to the complex hydrology of the area, many of these bridges have significant spans and embankments. While bridges have been used to provide appropriate waterway openings in this design, structures providing water openings may be optimised during the detailed design phase and some (or all) of these bridges may be more cost effectively provided as large banks of culverts. Maintenance access has been assumed to be at grade without any cross-drainage provision. Refer to the Section 5.2.6 for further information regarding drainage structures.

Rail bridges include:

- BR05 – CH450: 2 x 15m span bridge for cross drainage provision
- BR06 – CH720: 2 x 15m span bridge for cross drainage provision
- BR07 – CH1700: 20 x 15m span bridge over Gordon Creek
- BR08 – CH2300: 10 x 15m span bridge for cross drainage provision
- BR09 – CH2580: 19 x 15m span bridge for cross drainage provision
- BR10 – CH4260: dual 3 x 15m span bridges for cross drainage provision
- BR11 – CH6470: 6 x 32m span bridge over Ross River
- BR12 – CH6740: 2 x 24m span over the Boundary Street connection.

The road works require the following new bridges:

- BR01 (RB – BR01) – single span road over rail for southern leg North Coast Line connection
- BR02 (RB – BR02) – single span road over rail for future northern leg North Coast Line connection
- BR03 (RB – BR03) – single span road over rail for realigned Southern Port Road
- BR04 (RB – BR04) – 3 x 18m span for realigned access of Racecourse Road for access to Cleveland Bay Purification Plant.

As a result of the road alignment relative to TEARC, the road over rail bridges (BR01, BR02, and BR03) are at a very large skew, which requires complex bridge geometry and design. In future design development stages, the road alignment should be optimised to reduce skew angles with TEARC.

5.7.1.5 Signalling

QRs Townsville rail network is controlled by Remote Controlled Signalling (RCS), the junction to the North Coast Line will be signalised, using RCS and to the port including; signalling, powered connections and turnouts. The project is not advocating any new technology, but additions to the existing RCS System using approved QR and existing design standards.

There is no RCS in place inside the port borders, and none will be introduced through this project. The PoT will continue to operate under its current signalling arrangements, a combination of mimic panels, numbered stop boarders and cameras. The manipulation of points against the "normal" direction of travel will continue to be manually undertaken, requiring shunting/operational staff on the ground, as and when required.

5.7.1.6 Integration with PoT

There will be two tracks connecting to the ore loops at the PoT from the single track over Ross River. This will alleviate blocking of access and egress for TEARC to and from the existing tracks and terminal infrastructure for trains unloading at the dump shed in the ore loop.

The two tracks leading into the port will be capable of holding 1,000m trains each, but may allow for provision to scale to longer trains if required in future.

There will be an additional crossover between the loops to provide operational flexibility, particularly with loop track selection. This will enable trains to pass through to the western side of the port via TEARC if trains are dumping at the IPL fertiliser and South 32 unloading facilities.

In terms of integration with the North Coast Line, existing QR vertical track levels have been 'tied into' at the North Coast Line and the port area. The design level for the top of the embankment for TEARC is based on the TCC DST level of 4.5m AHD in coastal areas and a TCC DFE 1% AEP flood level. These levels are higher than the current track levels for the North Coast Line and the port.

Sugar traffic and port intermodal trains will continue to enter and exit the port on the current North Coast Line alignment and proceed along the Jetty Branch to the PoT.

Mount Isa Line traffic will use TEARC, though some of these trains may also use the North Coast Line alignment, especially those trains that need to re-orientate within the port, including Glencore and molasses, cement and fuel

The development timing of the TSDA development is currently unknown. Both TEARC and TSDA would benefit from coordination, particularly in terms of managing flood infrastructure and cross drainage requirements.

Descriptions of the applied operating rules for trains under TEARC and Base Case infrastructure are provided in Table 5.14 for each train type.

Table 5.14 Train Movement Impacts of Proposed TEARC Arrangement

TRAIN TYPE	EXISTING OPERATIONS BASE CASE (NO TEARC)	OPERATIONS WITH TEARC REFERENCE PROJECT
A. Sugar train	A.1 Sugar train enters port via the Jetty Branch and proceeds to dedicated Sugar Balloon Loop. A.2 It takes about 1.7 hours on average to unload, the train leaves the port via the Jetty Branch. A.3 Sugar trains do not interfere with other rail traffic at the port due to complete separation of Sugar Balloon loop from the rest of port infrastructure	A.1 No change A.2 No change A.3 No change
B. Sugar-Molasses train	B.1 A combination sugar and molasses train (about 9 wagons molasses and 18 wagons sugar) will arrive at Stuart Yard where it will be split into 2 rakes. B.2 A sugar rake will be shunted to the Sugar Balloon Loop at the port and back to Stuart yard after unload. B.3 The molasses rake will be shunted to the port via the Jetty Branch, proceed to Cannington Balloon loop to realign direction, run back to port exit signals and pushed back onto Berth 4 molasses unloading facility behind Xstrata Shed. B.4 It will take approximately 1.3-1.6 hours to unload and empty rake shunted back to Stuart yard. B.5 At Stuart yard empty Sugar and Molasses rakes are reassembled into full consist and exits South along NCL line.	B.1 No change B.2 No Change B.3 The molasses rake will be shunted to port via TEARC, proceed to Nickel Balloon loop to enter port, run back to port exit signals and pushed back onto Berth 4 molasses unloading facility behind Xstrata Shed. B.4 No change B.5 No change
C. Cement Train	C.1 Empty train shunted from Partington Yard to PoT and enters port via the Jetty Branch. C.2 It realigns direction by going via Cannington Balloon Loop and back to the port exit signals and push back onto Cement Loading siding. C.3 It takes about 1.5 hours on average to load, train is shunted back to Partington via the Jetty Branch. C.4 It is assumed the rail operator (Pacific National) will route cement wagons as part of bigger combinational train later from Partington Yard.	C.1 Empty train shunted from Partington Yard to PoT and enters port via TEARC. C.2 Train runs via Nickel Balloon Loop to the port exit signals and then pushed back onto Cement Loading siding. C.3 No Change C.4 No Change
D. Fuel Train	D.1 Empty train shunted from Partington Yard to PoT and enters port via the Jetty Branch. D.2 It realigns direction by going via Cannington Balloon Loop and back to port exit signals and pushed back onto Shell sidings. D.3 It takes about 3.8 hours on average to load, train is shunted back to Partington via the Jetty Branch. D.4 It is assumed the rail operator (Pacific National) will route fuel wagons as part of a bigger combinational train later from Partington Yard.	D.1 Empty train shunted from Partington Yard to PoT and enters port via TEARC. D.2 Train runs via Nickel Balloon Loop to the port exit signals and then pushed back onto Shell sidings. D.3 No Change D.4 No Change
E. Containerised Freight train	E.1 Train originated from Mt Isa Line. E.2 Train enters port via the Jetty Branch and proceeds straight to one of two available intermodal sidings within port Intermodal terminal. E.3 It is assumed; intermodal trains do not require realignment by going via Cannington Balloon Loop, if any realignment is required it will be provided by means of spare shunting loco available for intermodal operations.	E.1 No Change E.2 No Change E.3 No Change E.4 No Change

TRAIN TYPE	EXISTING OPERATIONS BASE CASE (NO TEARC)	OPERATIONS WITH TEARC REFERENCE PROJECT
	E.4 On average, it will take about 2.5 hours to load/unload containerised train at the port intermodal terminal.	
F. Nickel train	F.1 Nickel train originates at the Nickel refinery facility north of Townsville. F.2 It enters port via the Jetty Branch and proceeds toward the Nickel Balloon Loop and exits port back to Nickel refinery facility after unloading. F.3. It takes about 1.8 hours on average to load Nickel train at Nickel loading facility. F.4 Note: currently Nickel imports and Nickel refinery facility is not operational due to closure of Nickel Refinery Facility. F.5 Nickel rail operations were enabled only in scenario 4 (High High), where for scenarios 1, 2 and 3 Nickel traffic was disabled.	F.1 No Change F.2 No Change F.3 No Change F.4 No Change F.5 No Change
G. South32 (Cannington Concentrate train)	G.1 Train originated from Mt Isa Line. G.2 Train Enters port via the Jetty Branch and proceeds to South32 dumper on the Cannington Balloon Loop. G.3 It takes about 3 hours on average to unload Cannington Concentrate train. G.4 Train exits port to Mt Isa via the Jetty Branch.	G.1 No Change G.2 Train Enters port via TEARC and proceeds to South32 dumper on the Cannington Balloon Loop. G.3 No Change G.4 Train exits port to Mt Isa via TEARC.
H. Fertiliser Train	H.1 Train originated from Mt Isa Line. H.2 Train Enters port via the Jetty Branch and proceeds to IPL dumper on the Cannington Balloon Loop. H.3 It takes about 2.5 hours on average to unload Cannington Concentrate train H.4 Train exits port to Mt Isa via the Jetty Branch.	H.1 No Change H.2. Train Enters port via TEARC and proceeds to IPL dumper on the Cannington Balloon Loop. H.3 No Change H.4 Train exits port to Mt Isa via TEARC.
I. Glencore (Zinc Concentrate and Magnetite) Train	I.1 Train originated from Mt Isa line. I.2 Train arrives first to Partington Yard from Mt Isa Line where it is split into two 45 wagon rakes. I.3 Every rake is shunted from Partington to the port sequentially and back to Partington where unloaded rakes are reassembled back into full length consist to depart to Mt Isa. I.4 Every Glencore rake enters port via the Jetty Branch. I.5 It is required to realign train orientation by going via Cannington Balloon Loop and back to port exit signal. I.6 Train is pushed back into Xstrata Tippler Shed. I.7 There are two dead end sidings behind Xstrata Shed utilised during unload. I.8 When unloaded, two short rakes are combined together and a 45 wagon rake is shunted back to Partington Yard via the Jetty Branch. I.9 Note: a 45 wagon Glencore rake may be unloaded in one go without additional shunting and will not interfere with other trains at the port once unloading process started.	I.1 No Change. I.2 No Change. I.3 No Change I.4 Every Glencore rake enters port via TEARC. I.5 Train runs via Nickel Balloon Loop to port exit signals. I.6 No Change I.7 No Change I.8 No Change I.9 No Change.

5.7.2 Road Realignments

The proposed alignment of TEARC has required the realignment or extension of a number of existing roads, including:

- Realignment of Abbott Street to allow grade separation (road over rail) from TEARC.
- Realignment of Southern Port Road; grade separation (road over rail) from TEARC.
- Extension and realignment of Racecourse Road. The proposed Racecourse Road intersection and road realignment have been located to accommodate future Townsville SDA master planning requirements, including connection to form part of a future major industrial collector road.
- Extension of Boundary Street to connect with Windlass Crossing, including a new intersection with Benwell Road. Planning for the Boundary Street/Benwell Road intersection (including extension of Boundary Street) does not preclude changes to the intersection configuration to suit future TMR planning requirements.
- The existing access road to the marina and dog beach on the southern side of the port will be re-routed to provide continued access.

The concept design of all new proposed roads has been developed using standards from Austroads and Department of Transport and Main Roads. The new roads all utilise the Normal Design Domain, except for elements of the existing Boundary Street and Benwell Road intersection, whereby safe intersection sight distance is impeded by the position of proposed new bridge piers and abutments.

A number of opportunities and issues regarding the road realignments proposed in this design have been considered, as shown in Table 5.15.

Table 5.15 Road Realignment Opportunities and Issues

OPPORTUNITIES	ISSUES
Alignment refinement to reduce road width (and potentially bridge width). Staging of the North Coast Line connection may allow the proposed Abbott Street realignment to be re-configured to avoid resumption requirements, and complex access arrangement to the existing freehold property. Applying design exceptions to Racecourse Road to reduce horizontal geometry, which in turn may avoid resumption for connection to the existing Racecourse Road. Alternate drainage solutions, such as realignment of channels to cross at low embankments.	High embankments required in soft soil areas which will result in extensive ground improvement works by excavation, backfill and pre-load. Land resumptions to accommodate realigned or extended roads. Freehold property access near Abbott Street. Marine environment at Boundary Street.

5.7.2.1 Abbott Street

The Abbott Street realignment is approximately 1.4km long and provides for grade separation (road over rail) over the southern and northern leg connections of TEARC to the existing North Coast Line at Cluden. The road has high embankment requirements due to the vertical clearance requirements for TEARC (6.4m), and traverses mostly undisturbed low lying marsh land offline from the existing Abbott Street alignment.

The proposed realignment has considered access requirements to the existing TCC pump station, which is located between the car wreckers and the Vantassel-Cluden interchange on the existing Abbott Street alignment. Access to the freehold property located adjacent to the proposed realignment has also been considered. The only online portions are the connections to the existing road network. The proposed road

alignment will require some resumption of freehold and TCC property; however, most of the alignment is contained within the corridor previously designated for TEARC.

5.7.2.2 Southern Port Road

The Southern Port Road realignment is approximately 1.3km long and provides for grade separation (road over rail) over the proposed TEARC. This road also has high embankment requirements due to the vertical clearance requirements for TEARC (6.4m), and traverses mostly undisturbed low-lying marshland offline from the existing road alignment. The horizontal geometry of the proposed realignment was previously considered as part of the original Southern Port Road design, which means the works can largely be completed without impact to existing road operations. There are no resumptions required as part of this proposed realignment.

5.7.2.3 Racecourse Road

Racecourse Road extension is required to avoid a level crossing with TEARC. Racecourse Road provides access to the existing Cleveland Bay Purification Plant. The extension is approximately 1.7km long and traverses mostly undisturbed low-lying marshland. The realignment has been positioned on the easternmost edge of the materials transportation/services corridor to avoid multiple crossings of future utility services, and requires bridging to cross Stuart Creek. The road length is required to avoid conflict with the proposed Southern Port Road realignment and TEARC, and to tie-in with an agreed future intersection point. In order to maintain compliant horizontal geometry for the proposed design speed, land resumption will be required for a small portion at the connection to the existing Racecourse Road.

5.7.2.4 Boundary Street

The extension of Boundary Street is required, as the proposed TEARC alignment will sever access to Windlass Crossing from Benwell Road. The extension will connect the Boundary Street/Benwell intersection to Windlass Crossing across the existing marine area near the port. To provide continuity of service, TEARC will be grade separated (rail over road) from the proposed extension. The vertical clearance to TEARC will be 5.2m (minimum), which is equivalent to a highway standard level of clearance. To accommodate oversize-overmass vehicles, the existing intersection between Benwell Road and Windlass Crossing will be maintained with a level crossing added for TEARC. Manually operated control gates will be provided to prevent access during normal operations.

5.7.2.5 Design Optimisation Analysis

A number of design elements (e.g. grade separated crossings and road/intersection realignments) have been included in the Reference Project in order to maximise network efficiencies and safety.

As these design elements typically increase overall project costs, each has been assessed against the alternative ‘do minimum’ scenario, in order to identify its incremental costs, value and benefits.

In all cases, the recommendation is that these design elements be included in the Reference Design.

Table 5.16 summarises the design optimisation analysis and data for traffic volumes.

Table 5.16 Optimisation analysis of key design elements

LOCATION OF ROAD /RAIL INTERFACE	OPTIONS	DESCRIPTION	ISSUES/IMPACTS	RISKS OF ADOPTING DO-MINIMUM OPTION	REFERENCE PROJECT PREFERRED SOLUTION
Abbott Street	Do Minimum Open Level Crossing (OLC)	Signalised rail crossing at the locations where the proposed southern (reference project) and northern (possible future need) legs cross the existing road.	Introduces an additional OLC on the Townsville rail network. Reduces safety and efficiency of Abbott Street. Significant disruption to City inbound/outbound traffic, including heavy vehicles. Negligible land resumption needed.	Increased safety risk due to presence of crossing and additionally the skew nature of crossing.	Grade Separation
	Grade Separation	Realign Abbott Street to provide grade separation between TEARC and Abbott Street.	Land resumption required Additional costs associated with providing access to freehold property and existing TCC pump station. Additional costs to control settlements on high fills	Abbott St is a high-volume traffic route with up to 16,000 two-way traffic flows, with up to 6% heavy vehicles in 2037 Refer to Tables 5.17 and 5.18 for AADT forecasts	
Southern Port Road	Do Minimum - OLC	Signalised rail crossing at the location where TEARC crosses the existing Southern Port Road.	Introduces an additional OLC on the Townsville rail network. Reduce safety and efficiency of Southern Port Road. Significant disruption to Port inbound/outbound, large combination vehicles (LCV) requiring long slow acceleration and decelerations. Negates benefit of LCV travel time savings from existing advance	Increased safety risk due to presence of crossing and additionally the skew nature of crossing. Isolated OLC crossing on the Townsville – Mount Isa road corridor is	Grade Separation

			detection traffic signal arrangements at the Bruce Highway/ Southern Port Road intersection.	inconsistent with driver expectations.	
	Grade Separation	Realign Southern Port Road to provide grade separation between TEARC and Southern Port Road.	Additional costs associated with providing access to freehold property and existing TCC pump station Additional costs to control settlements on high fills.	High volume traffic route with up to 21,000 two-way traffic flows, with up to 9% heavy vehicles in 2037. Refer to Table 5.17 and Table 5.18 for AADT forecast on Southern Port Road.	
Racecourse Road	Do Minimum - OLC	Provide open level crossing at Racecourse Road crossing TEARC line and south-of-river holding loop line.	Reduce the safety and efficiency of access to the Cleveland Bay Purification Plant, albeit low road traffic volumes. Location of the holding loop results in trains stored across this crossing at regular intervals during the day with unpredictable stopping times. Road access must be available at all times for emergency vehicles as Purification Plant is a no through road.	Increased safety risk due to presence of crossing Solution is intolerable for unfettered emergency services access.	Road Realignment
	Road Realignment	Extend Racecourse Road by 1.7km to the south to remove OLC and avoid interaction with TEARC. Locate new intersection consistent with agreed Townsville SDA/ Southern Port Road access location to avoid introducing a new	Land resumption. Additional costs associated with providing access to the Purification Plant.	Refer to Table 5.17 and Table 5.18 for AADT on Southern Port Road (which intersects with Racecourse Road)	

		intersection on Southern Port Road			
Boundary Street Extension	Do Minimum	Provide level crossing (signalised) at Windlass Crossing to avoid construction of Boundary Street Extension.	Limits work in marine areas. Reduced safety and efficiency of the port operations, specifically for operations that must access Windlass Crossing (currently commercial marina operators plus future Eastern Reclaim Area (ERA) industrial uses). With TEARC in operation, Windlass Crossing will be cut for frequent and extended periods of time, which will be intolerable for emergency services commercial marina operators and customers.	Increased safety risk due to presence of crossing. Solution is intolerable for unfettered access for emergency services and commercial providers. Refer to Table 5.17 and Table 5.18 for AADT on Southern Port Road (which intersects with Boundary Street).	Grade Separation and Road Realignment.
	Grade Separation and Road Realignment	Provide rail over road separation near Boundary Street with minimum clearance as per Austroads requirements. Extend Boundary Street across marine area to connect to Windlass Crossing to provide unimpeded access to port operations. Provide level crossing at Windlass Crossing, with access controlled by locked manual gates, to cater for infrequent	Works in marine area. Additional costs associated with providing unfettered access to the Commercial Marina industries which commensurately provides excellent access to future industrial users in the ERA and future Port Expansion Project zones. Additional costs to control settlements on moderate fills on tidal zones.		

		oversize-overmass vehicles.			

#Basis of Incremental Costs
Abbott Street
A number of cost deductions and additions were made to the total estimated cost for the Abbott Street realignment grade separated design (Reference Project Preferred Solution) to determine an order of magnitude (OoM) cost difference between a grade separated solution and an at grade option. This was achieved by deducting the cost of approach embankment earthworks (including pre-loading and ground treatment), the two bridges over rail and underpass access to Goodall property and adding the cost of two signalised rail crossings. Costs that are deemed to be common to both solutions were not considered. (Excludes land costs).
Southern Port Road
A number of cost deductions and additions were made to the total estimated cost for the Southern Port Road realignment grade separated design (Reference Project Preferred Solution) to determine an OoM cost difference between a grade separated solution and an at grade option. This was achieved by deducting the cost of approach embankment earthworks (including pre-loading and ground treatment), the road bridge over rail and adding the cost of a signalised rail crossing. Costs that are deemed to be common to both solutions were not considered.
Racecourse Road
This OoM differential is essentially the cost of a signalised rail crossing compared with the full cost of realignment of Racecourse Road. (Excludes land costs).
Boundary Street Extension
A number of cost deductions and additions were made to the total estimated cost for the Boundary Extension grade separated design (Reference Project Preferred Solution) to determine an OoM cost difference between a grade separated solution and an at grade option. Boundary Street currently forms a T-intersection with Southern Port Road and traffic has to travel along Benwell Road to gain access to Windlass Crossing. If Boundary Street was not extended there would be no requirement for a rail bridge over the Boundary Street extension and it would be replaced by rail embankment. The cost difference was achieved by deducting the full cost of Boundary Street Extension works (including rock wall) and the rail over road bridge and adding the cost of a signalised rail crossing at Windlass Crossing.

Table 5.17 Traffic Volumes and Forecasts Annual Average Daily Traffic (AADT)

LINK AADT	2017		2027		2037	
	NORTHBOUND	SOUTHBOUND	NORTHBOUND	SOUTHBOUND	NORTHBOUND	SOUTHBOUND
Southern Port Road	1,294	1,022	5,855	8,468	6,291	14,384
Abbott St	2,365	2,643	7,833	5,505	8,747	7,101

Table 5.18 Share of Heavy Vehicles

SHARE OF HEAVY VEHICLES	2017		2027		2037	
	NORTHBOUND	SOUTHBOUND	NORTHBOUND	SOUTHBOUND	NORTHBOUND	SOUTHBOUND
Southern Port Road	12%	20%	7%	5%	9%	7%
Abbott St	3%	3%	4%	7%	5%	6%

5.7.3 Allowance for Future Staged Infrastructure Upgrades

TEARC has been designed to allow for the provision of future staged infrastructure upgrades. Future infrastructure upgrades may include:

- Connection to the future planned port expansion loop (ERA balloon loop) to accommodate changes and improvements in port operations. While the ERA is not part of the infrastructure configuration for the Reference Project, TEARC enables a connection to it.
- Provision of a future Y-junction at Cluden to facilitate future freight access to and from the north.
- Accommodation of up to 1,400m trains.

5.7.3.1 Port Expansion Project

Under the future port expansion scenario, the following assumptions have been made:

- Sugar access in the medium term will remain unchanged via the Jetty Branch.
- The ERA loop would require multiple tracks, to allow for the efficient handling of train arrivals for presentation at dump sheds with minimal delays.
- Removal of track within the PoT, including removal of sections of the existing Cannington and Nickel ore loops to facilitate the expansion and development of container storage facilities within the port. Essentially, the ERA would be flipped and inverted (to the east) of the Cannington and Nickel ore loops.
- The existing outer nickel loop would need to be retained, but the nickel loader would need to be removed.
- Any consideration of the removal of the existing track within the PoT and/or the Jetty Branch would be the subject of future port operations and considerations.

5.7.3.2 Cluden Y-Junction

The northern access leg at Cluden is not included in the Reference Project scope, however enabling infrastructure works to provide this link in future are included, as follows:

- Realignment of Abbott Street at the Cluden Y-junction, including minimum property acquisition and property access requirements.
- Grade separated road over rail bridges to facilitate both the northern and southern access legs at the Cluden Y-junction.

The provision of the northern leg may be required in the event that QNI nickel operations are recommissioned, or new customers wish to access the Port via TEARC from the north.

5.7.3.3 Provision for Longer Trains

TEARC effectively forms part of a ‘last mile’ solution for the Mount Isa Line connection to the PoT. TEARC will accommodate 1,000m trains; provision for train lengths of up to 1,400m can be accommodated to service future increase in demand. Accommodating 1,400m trains in the future would require significant upgrades to the Mount Isa Line with longer passing loops and new load-out facilities at the port.

Upgrades to the Mount Isa Line are not included in the TEARC design scope.

5.8 Site Investigations

The following sections summarise the outcomes of site investigations undertaken to inform the Reference Project design, including:

- Geotechnical and groundwater
- Hydraulics
- Public utilities.

5.8.1 Geotechnical, Survey and Groundwater Investigations

The main objective of the geotechnical assessment is to highlight any constraints relating to the proposed construction. The scope of work included:

- examining the subsurface and groundwater conditions encountered within the proposed rail corridor
- developing foundation systems for a number of the rail and road bridges proposed
- assessing the settlement caused by embankment construction on soft soils and identifying geotechnical risks pertaining to the stability of the embankments
- preparing potential ground improvement concepts
- providing advice on the likely presence of Acid Sulfate Soils (ASS) and soil aggressivity.

Geotechnical inputs for TEARC are based on available historical and recent geotechnical investigation data within vicinity of the project. This existing information has facilitated an understanding of the subsurface conditions to develop a ground model that enabled input into the evaluation of options and to substantiate proposed bridge structures and embankments for the project. The reference design (model topography) is based on the latest available Airborne Laser Survey (LIDAR) data collected by TCC in December 2016.

Following a gap analysis of available geotechnical information, additional geotechnical investigations of four boreholes and geophysical investigation between the North Coast Line and Southern Port Road were carried out. As conclusions were largely derived from inferred geotechnical models based on available data, additional investigation and verification will be required during future stages of project delivery.

The Townsville regional geological maps indicate the surface geology to comprise of Quaternary Alluvium. Current and previous investigations indicate the alluvium clays to be frequently overlain by a sand layer (mostly south of Ross River) and man-made fill (in the port area), although the origin of the fill is difficult to confirm.

5.8.1.1 Inferred Geology

In general, the following stratigraphy is noted:

- Firm to stiff clay or dense sand/fill soils layers of about 1m to 1.5m thick have been observed at most of the previous investigated locations. The clays found near surface are likely to be reactive based on the findings of historic investigations.
- A soft (marine) clay of Holocene age with thickness varying up to 7m has been observed and this layer appears to be continuous along the proposed alignment. A significantly thick layer of these compressible materials has been found around the Southern Port Road intersection.
- Closer to south of Ross River area, the near-surface material consists of medium dense to dense fine to medium sand overlain by the soft/firm Holocene clay layer, which appears to be thinner than inland of the river.

- As noted in previous investigations, the proposed rail alignment north of Ross River appears to be spanning on mostly reclaimed land, often comprised loose sand potentially from harbour and channel dredging. Distinguishing this material from underlying soft mud has been found difficult, as the dredge spoil appears quite sandy.
- Underlying these units is very stiff to hard clay and sandy clay and dense to very dense clayey sand layer of Pleistocene age often displaying Standard Penetration Test values greater than 20 or cone resistance larger than 4MPa.

The Holocene layers are generally found to be slightly over consolidated based on the available geotechnical information. Generally, these soils will move to a normally consolidated state due to high embankment loading proposed once the embankment is in place resulting in consolidation settlement. In addition, the proposed high embankment overlying the soft materials also introduces stability risks into the project.

5.8.1.2 Acid Sulfate Soils

Review of the available details of acid sulfate in the form of maps and assessments by others indicates that acid sulfate is likely to be present in the site and may be impacted by construction. Acid sulphate soils (ASS) generally require seawater (with its sulphur) to form. They thus generally occur below an RL of 3m AHD (but up to RL 5m) where tidal inundation occurs or has occurred. Actual ASS (AASS) generally occur above the water table, especially in sandy soils in which oxygen can rapidly diffuse. Potential ASS (PASS) generally occur below the water table or where the soil cover has restricted oxygen diffusion into the soil mass. For TEARC, the ASS is most likely to present as soft marine clays. The overlying soils are likely to be Aeolian sands not ASS.

5.8.1.3 Design considerations

A detailed acid sulphate soil management plan will be required depending on the proposed construction activities. The stiff to very stiff clay crust found at number of investigated locations is likely to be highly reactive and shall require further investigation to confirm and manage in the construction. In addition, the exposure conditions of the piles in soil were also assessed and inferred to be “very severe”, being at the coastal environment and therefore, buried structures shall be treated accordingly in the detailed design.

Preloading time of up to 4 months will be required for sections of the rail and road embankments.

5.8.2 Hydraulics

TEARC traverses the low-lying Stuart Creek floodplain and the associated coastal areas. The area is highly flood prone from both riverine flooding and coastal inundation, including storm tide (cyclonic) events. The major catchments intersected by the TEARC alignment include Stuart Creek, Sandfly Creek and Gordon Creek, as well as the larger Ross River. Each of these floodplains will require significant waterway provisions to support the Reference Project design, and have been sized through hydraulic investigations.

Flood and hydraulic assessments undertaken for this project have utilised previous hydraulic models that have been sourced from Townsville City Council (TCC). The TCC models have been subsequently refined and revised to aid in investigations for this Project. There is significant history associated with the previous modelling prepared for the Stuart Creek floodplain.

The TCC adopted model was developed previously to inform the proposed TSDA strategy. The model has also been updated to incorporate the most recent topographical LiDAR data collected by TCC in 2016. The current hydraulic model represents the best available modelling for the greater floodplain area and is the most appropriate basis for flood assessments for the TEARC design.

The updated hydraulic model has been assessed for a range of design flood event scenarios and durations to quantify existing flood characteristics throughout the floodplain. The 24-hour storm duration was assessed to be the critical duration for the proposed TEARC alignment. Flood characteristics considered the TCC adopted Defined Flood Event (DFE) represented by the 1% Average Exceedance Probability (AEP) event, in addition to a more frequent event.

The flood provisioning requirements outlined in this report have been determined based on design criteria which considers the DFE scenario at a low tail water condition. This is consistent with previous instructions and advice provided by TCC in respect to the technical requirements pertaining to flood impact assessments.

The specific criteria applied in respect to flood impacts are summarised as follows:

- Tolerable flood afflux allowable up to a maximum of 300mm in areas already subject to riverine and coastal flooding constraints and for which there is no existing infrastructure or development.
- No adverse impacts (actionable nuisance) to existing residential and since development areas. Effectively, this means maintaining zero afflux (or reduced flood levels) for existing development.
- No adverse impacts (actionable nuisance) to the existing Southern Port Road.
- No adverse impacts (actionable nuisance) to the proposed TSDA fill precincts. That is, freeboard provisions for all proposed TSDA precincts comply with the requirements outlined in the City Plan 2014.

The cross drainage and infrastructure provisions necessary to support the TEARC business case are summarised in Table 5.19.

The cross-drainage provisions include a mixture of culverts and bridges at specific locations along the TEARC alignment that have been determined and sized via detailed flood modelling to meet the above design criteria. In addition to the cross-drainage provisions outlined, some discrete flood mitigation works will also be required to support the TEARC business case. These related works are summarised as follows:

- Zone 1 - Localised channel excavation works to be provided in combination with the cross-drainage provisions. The channel works provides a formalised channel connection that extends from Abbott Street to the lower Stuart Creek floodplain via the proposed TEARC alignment. The channel provides the necessary additional conveyance and supports both the inclusion of the TEARC southern and future northern track extensions.
- Zone 2 – A discrete flood levee is to be included extending from the TEARC formation to extend to the boundary of Lot 33 SP192632. This discrete levee functions to preclude inundation extending into the upstream lot given the raised water levels associated with the provision of the TEARC alignment.

The infrastructure provisions outlined have been provided to cater for TEARC only. The timing and associated delivery of either or both the TEARC and TSDA projects is not known, nor is the sequencing upon which these major projects may proceed in the future. There is a potential strategic opportunity for TEARC to be delivered and considered in conjunction with the proposed Townsville SDA, providing mutual benefit to both, as well as the potential rationalisation of infrastructure and subsequent cost savings.

In the context of the TEARC design, consideration of this potential risk has been partially mitigated through investigation of a combined TEARC and TSDA joint design outcome. The investigation has identified the infrastructure provisioning determined for the TEARC design would need to be revised to enable both projects to be jointly delivered. Specifically, this would likely include a significant reduction in one of the Stuart Creek floodplain bridges and extension of a new localised levee to mitigate adverse impacts. These changes would likely result in a reduction of infrastructure costs compared to the current TEARC business case.

Table 5.19 TEARC Reference Design Cross Drainage Infrastructure Provisions

TEARC ZONE REFERENCE	ZONE DESCRIPTION	PEAK DISCHARGE (M3/S) (APPROX.)	TEARC CHAINAGE (M)	STRUCTURE SIZE AND DIMENSIONS
1	TEARC connection with North Coast Line	200	ch0480	2 x 15m span bridge
			ch0650	2 x 15m span bridge
			ch0830	Nominal Size Culvert
			ch0420 (Future Track)	5 x 15m span bridge
			ch0680 (Future Track)	5 x 15m span bridge
			ch0770 (Future Track)	Nominal Size Culvert
2	Stuart Creek Floodplain	565	ch1730	20 x 15m span bridge
			ch2300	10 x 15m span bridge
			ch2800	19 x 15m span bridge
			ch3000	Nominal Size Culvert
3	TEARC / Southern Port Road Junction	25	ch3300	20 No. 1200mm Reinforced Concrete Pipe (RCP)
			ch3300	20 No. 1200mm RCP
			ch3480	25 No. 900mm RCP
			ch3480	25 No. 900mm RCP
4	Southern Port Road Alignment	6	ch4270	2 No. 18m Span Bridges
			ch4740	3 No. 600mm RCP
			ch4860	3 No. 600mm RCP
			ch5110	2 No. 1200mm RCP & 1350mm RCP
			ch5210	1 No. 1200mm x 1200mm Reinforced Concrete Box Culvert (RCBC)
			ch5300	1 No. 600mm RCP
			ch5360	2 No. 600mm RCP
			ch5690	1 No. 1200mm x 1200mm RCBC
			ch5760	2 No. 600mm RCBC
			ch5850	1 No. 600mm RCP
			ch5990	1 No. 600mm RCP
5	Ross River Crossing	740	ch6600	200m total width span bridge
6			ch8230	3 No. 1800mm x 2100mm RCBC

TEARC ZONE REFERENCE	ZONE DESCRIPTION	PEAK DISCHARGE (M3/S) (APPROX.)	TEARC CHAINAGE (M)	STRUCTURE SIZE AND DIMENSIONS
	Townsville Port Area	Less than 30m3/s (Port area local drainage)	ch7700	2 No. 900mm x 1200mm RCBC
			ch8100	4 No. 2100mm x 2400mm RCBC

5.8.3 Public Utilities

A review of TEARCs rail and road alignment revealed a number of clashes between existing and future Public Utility Plant (PUP) and services. These potential clashes have been captured within the PUP register, and factored into capital cost estimates. The PUP register includes advice as to whether relocation or protection of the service is required. Further consideration will be required during detailed design in consultation with authorities to develop optimum solutions for protection or relocation.

Some of the larger services that may be impacted by the construction work include existing:

- existing 132kV high voltage line owned by Powerlink
- existing DN600PVC relined
- existing twin DN900 (1xRCP and 1xPoly) pressure sewer mains
- existing DN500DiCL pressure sewer main
- existing DN375AC/FR pressure sewer main along Abbott Street
- existing multiple 11kV and 66kV overhead power line crossing the road and rail alignments at various locations
- future DN710PE & DN450PE pressure sewer mains along the Ron Mclean Road corridor.

The location of the services has been determined based on available Dial Before You Dig and TCC Mosaic Mapping information.

On site potholing and specific service locating will be required during detailed design and more potential clashes may arise following this process.

5.9 Land Acquisition

The Reference Design identifies the potential need for land acquisition in the following locations:

- At the northern leg of the Y-junction at Cluden where TEARC branches off the North Coast Line.
- Near the junction of Racecourse Road and the Southern Port Road, in order to accommodate a realignment of Racecourse Road.
- Within the port precinct.

A number of these land acquisitions may be reduced or eliminated through further design refinements. However, for the purposes of costing, they have been included as part of the Reference Project. The following section identifies and summarises the main impacts and affected properties.

5.9.1 Cluden Y-Junction

The reference design for TEARC at the connection to the North Coast Line provides for both southern and northern access legs branching off the North Coast Line at Cluden. These access legs, forming the Y-junction connection to the existing North Coast Line, their clearance offsets and the Abbott Street road realignment, traverse nine parcels of land, as described in Table 5.20.

Table 5.20 Summary of Affected Lots

LOT	IMPACT
Lot 31 SP273629	This lot was specifically acquired as part of the previous planning works for a future TEARC rail alignment and road diversion. It will be utilised by both the northern and southern branches of the 'Y' connection, in addition part of the road deviation will also utilise this property.
Lot 2 RP725280	The lot will be impacted by the northern branch of the 'Y' connection and part of the road deviation will also impact this property. Lot 2 is 13.47Ha with the project impacting approximately 30% of this property.
Lot 1,2 and 3 RP717802	There is no designated use at present. However, it appears there are several underground services through the lots. Further consultation with TCC is required to confirm if the land is proposed to be used for future development.
Lot 22 SP261125	It is understood this property was acquired specifically for a potential realignment of Abbott Street as part of a proposed TEARC connection to the existing NCL line.
Lots 2, 3 and 4 RP716809	Further design refinements may reduce or eliminate the need for land resumption on these lots.

5.9.1.1 Racecourse Road Realignment

The extension and realignment of Racecourse Road is proposed to avoid a level crossing with TEARC, crossing the existing road near the intersection with the Southern Port Road as described in Figure 5.18. The horizontal geometry also accommodates required separation distance (clear zone separation) between the road and the existing high voltage power tower. Land resumption will be required for a small portion at the connection to the existing Racecourse Road as indicated by the hashed area.

The proposed road geometry is based on a design speed of 70km/h for a posted speed of 60km/h. In order to maintain compliant road geometry at the connection to the existing Racecourse Road, a 380m horizontal curve is required, which means some land resumption is required in order to accommodate the proposed realignment.

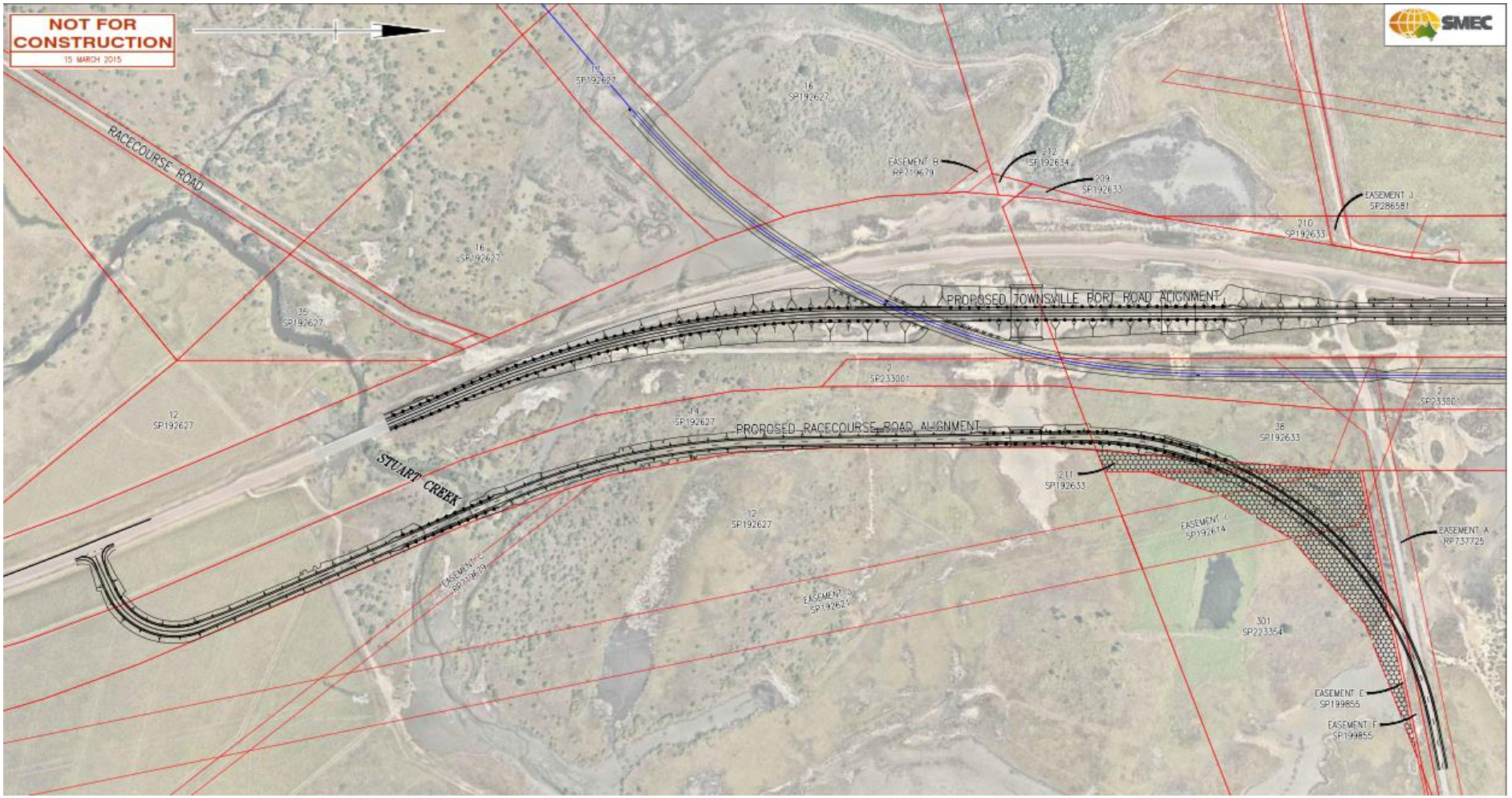
The following constraints were considered as part of the road extension concept design:

- The alignment of the proposed new road was to be kept as close as practical to the existing corridor boundary to allow for a potential future services corridor which was planned as part of the initial Southern Port Road corridor to allow for connection between TSDA and the port (for example, an overland conveyor).
- There are existing overhead high voltage power lines and towers at the location where the proposed new road connects to the existing Racecourse Road.
- The proposed extents of TEARC and the realignment of the Southern Port Road.

Given the access road connects to critical community infrastructure (i.e. Cleveland Bay Purification Plant), it is considered prudent to provide safe and compliant access that has a flood immunity level commensurate with that provided for the Southern Port Road.

The proposed road length is driven by the need to avoid intersecting with the raised realignment of the Southern Port Road. The proposed new intersection is located to provide compliant intersection sight distance, as well as tie into future intersections as planned as part of the Townsville SDA.

Figure 5.18 Land Acquisition for Transport Purposes at Racecourse Road



5.9.2 Port Precinct

The reference design for the TEARC is required to integrate with existing rail infrastructure in the PoT. To facilitate rail connection to the existing port infrastructure, three parcels of land are impacted.

Table 5.21 identifies the land requirement within the PoT.

Table 5.21 Land Requirements in PoT

LOT ON PLAN	AREA (HA)	OWNERSHIP	EXTENT OF ACQUISITION	TENURE	LOCALITY	APPROX. CHAINAGE
773SP223346	40.45	PoT	Partial (10.0)	Lands Lease	South Townsville	6650-7600
302SP223346	1.28	PoT	Full	Lands Lease	South Townsville	6650-7600
791EP2348	97.32	PoT	Partial (3.5)	Freehold	South Townsville	7600-8200

The land requirements for TEARC will impact existing port operations and reduce the area available to the port for customers. The key impact identified relates to lot on plan 791EP2348. The rail realignment and subsequent land requirements are to provide for operational movements. The realignment is required to provide crossover for six turnouts to facilitate movements in and out of the port.

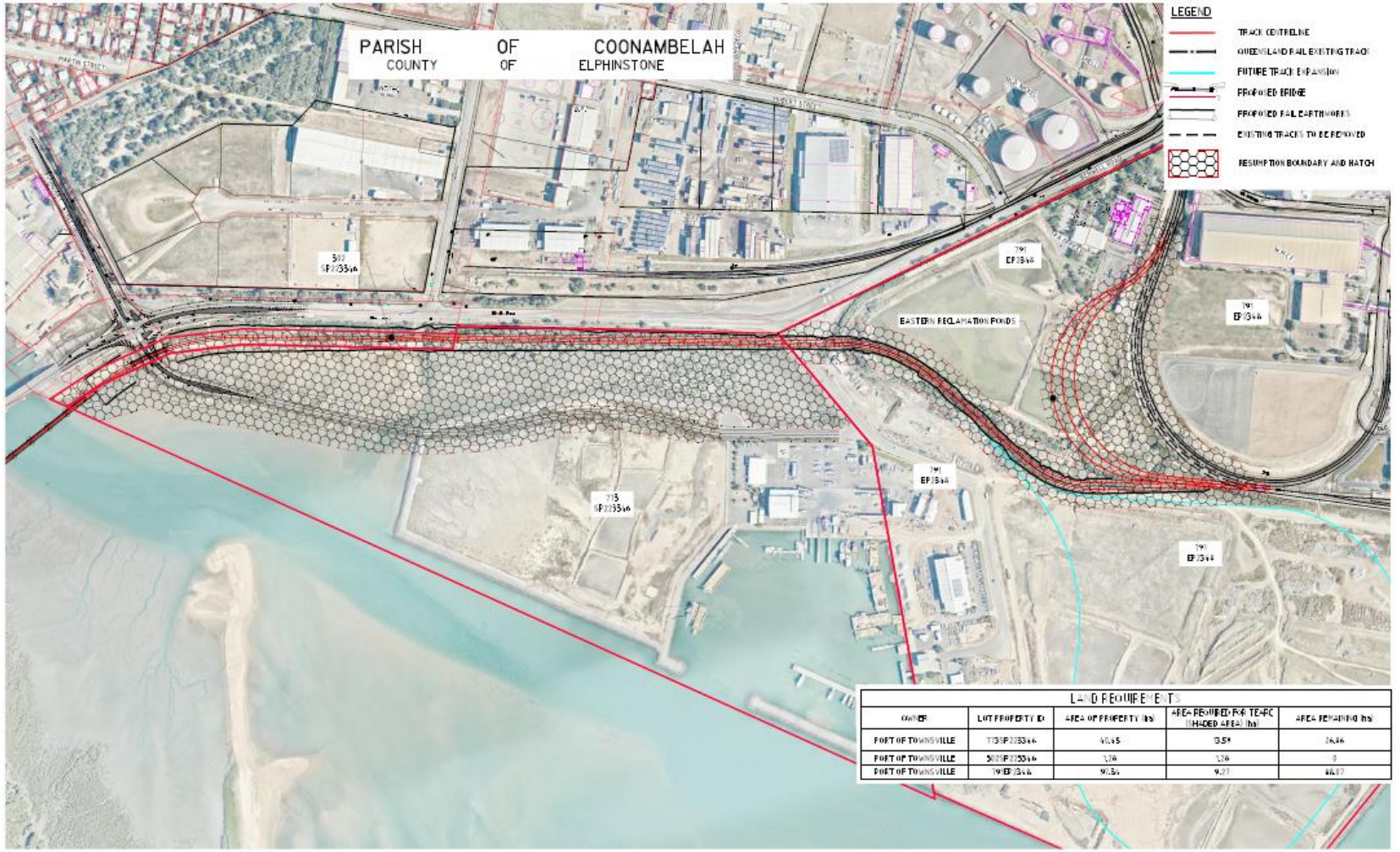
The location of the cross-overs is currently a hardstand area used as a layover for the importation of vehicles. The hardstand area was constructed by the port in recent history and currently no commercial leases reside over this portion of Lot on plan 791EP2348. Due to the impacts of rail realignment, an alternative area of 0.9ha has been shown in Figure 5.19.

The connection of TEARC to the existing port rail also impacts the existing ponds located on Lot on plan 791EP2348. These ponds are used for drying purposes for the Eastern Reclaim Area.

The land requirement for Lot on plan 773SP223346 is extended to include the extension of Boundary Street and connection to Windlass Crossing. The connection is required to avoid the introduction of an open level crossing.

Figure 5.19 shows port land requirements for transport purposes.

Figure 5.19 Land Acquisition for Transport Purposes at PoT



5.9.3 Corridor Protection

Apart from the land lots that will require potential acquisition for transport purposes the DBC recommends preservation of the overall identified TEARC Project – Reference Project Alignment Corridor Land.

A complete listing of land lots affected is provided in Table 5.22.

Table 5.22 TEARC Project property tenure

Lot on plan	Area (Ha)	Ownership	Extent of Acquisition	Tenure	Locality	Approx. Rail Chainage	Drawing Ref
Rail Alignment							
41SP130009	4.6	Queensland Rail Limited	Partial (0.3)	Lands Lease (North Coast Railway)	Cluden	0-300	42-19962-C001 42-19962-C050 (Rail)
Abbott Street	N/A			Road Reserve	Cluden	300-400	42-19962-C001 42-19962-C050 (Abbott St / Rail)
22SP261125	1.671	Department of Transport and Main Roads	Partial (0.7237)	Freehold	Cluden	400-450	42-19962-C001 42-19962-C050 (Abbott St)
31SP273629	14.17	Co-ordinator General	Partial (10.33)	Freehold	Cluden	440-1100	42-19962-C002 42-19962-C050 (Abbott St / Rail)
34SP192632	2.535	Co-ordinator General	Full	Freehold	Cluden	1100-1500	42-19962-C002
18SP192627	7.032	Co-ordinator General	Full	Freehold	Cluden	1500-2700	42-19962-C003 42-19962-C004
17SP192627	1.911	Co-ordinator General	Full	Freehold	Stuart	2700-3000	42-19962-C005
Southern Port Access Road	N/A			Road Reserve	Stuart	3000-3200	42-19962-C005
2SP233001	12.75	Co-ordinator General	Partial (12.465)	Freehold	Stuart	3200-5800	42-19962-C005 42-19962-C006 42-19962-C007 42-19962-C008 42-19962-C009
105SP217641	0.1373	Co-ordinator General	Partial (0.012)	Freehold	Stuart	5000-5100	42-19962-C008
54SP192636	0.87	Co-ordinator General	Partial (0.07)	Freehold	Stuart	5100-5200	42-19962-C008
43SP192635	0.47	Co-ordinator General	Partial (0.06))	Freehold	Stuart	5200-5300	42-19962-C008

Lot on plan	Area (Ha)	Ownership	Extent of Acquisition	Tenure	Locality	Approx. Rail Chainage	Drawing Ref
46SP192635	0.5	Co-ordinator General	Partial (0.136)	Freehold	Stuart	5300-5400	42-19962-C008
63SP192639	0.6	Co-ordinator General	Partial (0.237)	Freehold	Stuart	5400-5460	42-19962-C008
66SP192639	0.6095	Co-ordinator General	Partial (0.15)	Freehold	Stuart	5460-5560	42-19962-C009
108SP217641	0.1343	Co-ordinator General	Partial (0.049)	Freehold	Stuart	5560-5580	42-19962-C009
69SP192639	0.6097	Co-ordinator General	Partial (0.1)	Freehold	Stuart	5580-5580	42-19962-C009
72SP192639	0.779	Co-ordinator General	Partial (0.08)	Freehold	Stuart	5580-5580	42-19962-C009
75SP192639	0.6575	Co-ordinator General	Partial (0.007)	Freehold	Stuart	5580-5580	42-19962-C009
Southern Port Access Road	N/A			Road Reserve		5800-6100	42-19962-C009
4SP236063	1.378	Co-ordinator General	Partial (1.26)	Freehold	Stuart	5820-6200	42-19962-C009
86SP192640	0.54	Co-ordinator General	Partial (0.018)	Freehold	Stuart	5820-6200	42-19962-C009
3SP192640	0.34	Co-ordinator General	Partial (0.028)	State Land	Stuart	5820-6200	42-19962-C009
93SP240551	0.1459	Co-ordinator General	Full	Freehold	Stuart	6200-6230	42-19962-C009
2SP192640	0.1251	Department of Natural Resources and Mines	Full	Freehold	Stuart	6200-6230	42-19962-C010
92SP240551	0.322	Department of Natural Resources and Mines	Full	Freehold	Stuart	6230-6320	42-19962-C010
91SP240551	0.228	Department of Natural Resources and Mines	Partial (0.09)	Freehold	Stuart	6230-6320	42-19962-C010
Ross River	N/A			Unallocated State Land			
773SP223346	40.45	Port of Townsville	Partial (13.59)	Lands Lease	South Townsville	6650-7600	42-19962-C010 42-19962-C011 42-19962-C012 42-19962-C013 42-19962-C055 (Road/Rail)
302SP223346	1.28	Port of Townsville	Full	Lands Lease	South Townsville	6650-7600	42-19962-C055 (Rail)
791EP2348	97.32	Port of Townsville	Partial (9.27)	Freehold	South Townsville	7600-8200	42-19962-C055 (Rail)
Abbott Street Realignment							
2RP725280	13.4625	Freehold	Partial (4.01)	Freehold	Cluden	N/A	42-19962-C002 42-19962-C050 (Abbott St/Rail)

Lot on plan	Area (Ha)	Ownership	Extent of Acquisition	Tenure	Locality	Approx. Rail Chainage	Drawing Ref
3RP717802	0.7512	Townsville City Council	Partial (0.6474)		Oonoonba	N/A	42-19962-C050 (Abbott St)
2RP717802	0.1654	Townsville City Council	Partial (0.0732)		Oonoonba	N/A	42-19962-C050 (Abbott St)
1RP717802	0.3642	Townsville City Council	Partial (0.1452)		Oonoonba	N/A	42-19962-C050 (Abbott St)
Ireland Street	N/A			Road Reserve			42-19962-C050 (Abbott St)
2RP716809	0.1624	Ergon Energy Limited	Partial (0.0515)		Cluden	N/A	42-19962-C050 (Abbott St)
3RP716809	0.0857	Ergon Energy Limited	Partial (0.0207)		Cluden	N/A	42-19962-C050 (Abbott St)
4RP716809	0.0857	Townsville City Council	Partial (0.0129)		Cluden	N/A	42-19962-C050 (Abbott St)
Racecourse Road Realignment							
211SP192633	0.2799	Co-ordinator General	Full	Freehold	Stuart	N/A	42-19962-C056 (Racecourse Rd)
301SP223354	285	Department of National Parks Sport and Racing	Partial (1.7484)	Freehold	Stuart	N/A	42-19962-C056 (Racecourse Rd)
38SP192633	10.93	Co-ordinator General	Partial (1.11)	Freehold	Stuart	N/A	42-19962-C056 (Racecourse Rd)
14SP192627	9.902	Co-ordinator General	Partial (7.11)	Freehold	Stuart	N/A	42-19962-C056 (Racecourse Rd)

Red - requires external stakeholder engagement

Blue - requires inter agency MOU transfer agreement

5.10 Cost Estimation

The estimated Project Capital and Operating Cost for TEARC include the following major components:

- construction of 8.3km single track narrow gauge rail line from Cluden to PoT
- realignment and grade separation of Abbott Street
- realignment and grade separation of Southern Port Road
- realignment of Racecourse Road to Cleveland Bay Purification Plant
- extension of Boundary Street from Benwell Street to Windlass Crossing
- land acquisition.

5.10.1 Project Capital Costs

The risk adjusted capital cost for the project is based on the following:

- estimate base date of July 2017
- a design and construct delivery in accordance with the Transport Infrastructure Contract (TIC)
- planned and unplanned risk contingency
- escalation
- DBC Reference Design.

The anticipated capital cost for the project including risk contingency (and escalation) is shown in Table 5.23.

Table 5.23 Project Capital Cost Summary

	P50 RISK ADJUSTED (LIKELY)	P90 RISK ADJUSTED (UPPER)
TOTAL PROJECT COST	$368,736,292	$391,729,775

Project Capital Cost Assumptions

Key assumptions relied upon in the development of this cost estimate report are as follows:

- The project is a Type 2 as defined in the TMR Project Cost Estimating Manual (PCEM).
- The project will be delivered as a standard TIC Design and Construct.
- The EIS process will commence in June 2018, with approval anticipated by Oct 2019.
- The construction delivery timeframe is January 2020 to March 2022.
- Administration of the construction contract will be undertaken by a TMR contract administrator.

Limitations of Estimate

The following limitations should be noted:

- The design is currently at Reference Design stage and the estimate is limited by the level of design definition and available information

Future comparisons with this estimate should take into account any design changes, the project start date, the contract delivery method, cost rates prevailing at the time, construction program and the current risk profile associated with the construction market at the time.

5.10.2 Operating Costs

Anticipated operating costs for the project including risk contingency and escalation are shown in Table 5.24.

Table 5.24 Operating Cost Summary

	P50 RISK ADJUSTED (LIKELY)	P90 RISK ADJUSTED (UPPER)
TOTAL PROJECT OPEX COST	$32,637,788	$36,080,084

Operating Cost Assumptions

Key assumptions relied upon in the development of this cost estimate report are as follows:

- Incremental costs only from Base Case (No TEARC) to Project Case (With TEARC) considered.
- Below rail maintenance costs only (both fixed and variable).
- Above rail maintenance not included (considered by others as part of the business case).
- Queensland Competition Authority (QCA) reference tariff for below rail variable maintenance costs.
- Evaluation period is 30 years from 2022.

5.10.3 Stakeholders

The TEARC DBC Project Steering Committee (PSC) was established at the commencement of the DBC. It is the key body informing the development of the DBC by Building Queensland for the State Agency who has been nominated by the Government as the project owner, TMR along with key stakeholders such as QR and the PoT. It will include Building Queensland and the Australian Department of Infrastructure and Regional Development as full members and Infrastructure Australia as an observer.

The purpose of the TEARC Project Control Group (PCG) is to ensure delivery of the TEARC DBC for the Reference Project in accordance with the Template and the PAF. The PCG will also ensure that the DBC meets overall state objectives and strategic plans, customer needs, value for money requirements, and project budget and timing requirements. The PCG members represent the stakeholders from an operational perspective. Table 5.25 outlines the overall view of the stakeholders and interest in the eventual project.

Table 5.25 Reference Project Stakeholders

STAKEHOLDER	PSC	PCG	OPERATIONS	COMMUNITY
Deputy Director-General, Department of Transport and Main Roads	Yes	Yes		
Executive General Manager Projects, QR	Yes	Yes		
Chief Executive Officer, Building Queensland	Yes	Yes Project Director		
Chief Executive Officer, PoT	Yes	Yes		
Department of the Premier and Cabinet	Yes	Yes		
Queensland Treasury	Yes	Yes		
Department of Infrastructure, Local Government and Planning	Yes	Yes		
Department of State Development	Yes	Yes		

STAKEHOLDER	PSC	PCG	OPERATIONS	COMMUNITY
Australian Department of Infrastructure and Regional Development	Yes	-		
Regional Director (North Queensland), Department of Transport and Main Roads (Observer)	Yes	-		
Regional General Manager, North Queensland, QR (Observer)	Yes	-		
Queensland Treasury (Observer)	Yes	-		
Infrastructure Australia (Observer)	Yes	-		
Business Case Advisors		Yes		
Cluden, South Townsville and Townsville Residents	-	-	-	Yes
Port Customers (e.g. South 32, Cement)	-	-	Yes	-
Rail Operators (Aurizon, Pacific National, Glencore)	-	-	Yes	-
Key local stakeholders (e.g. Townsville City Council, Townsville Enterprise Limited, MITEZ, State elected representatives, Townsville Chamber of Commerce)	-	-	Yes	Yes

Outside of the PSC and PCG, a number of stakeholder and community engagement sessions were held in Townsville. The details of the methodology and findings are discussed in detail in Chapter 12.

The first stakeholder engagement session was held on Thursday 6th April 2017. The session was conducted to brief all relevant key stakeholders on the project, and to gain important insights for inclusion into the MCA options assessment. The stakeholder engagement session included current Mount Isa Rail System operators, users, customers and local community representatives.

A second stakeholder engagement session was held on Tuesday 27th June 2017 to present the preferred alignment to the key stakeholders, allow stakeholders to ask project questions and obtain feedback. This session included:

- providing participants with maps of the proposed corridor and a detailed summary of the preferred alignment
- presentation of the proposed corridor and reasoning behind alignment selection
- Q&A session with key stakeholders
- feedback activity where concerns and positive attributes were noted by stakeholders.

Overall, the most frequently cited stakeholder concerns related to potential social impacts to residents at Cluden and the port (in terms of noise, air, vibration and visual amenity). The potential loss of access to the dog beach near the port was also raised. Stakeholders identified potential improvements to public safety and congestion as positive attributes of the proposed project alignment.

Stakeholder feedback has been taken in account, both in informing the options assessment process and in shaping the Reference Design.

5.10.4 Implications of Not Proceeding

The main implications of not proceeding with TEARC Reference Project are:

- Growing Impacts on Urban Amenity

As Townsville City and the surrounding population centres grow, it is increasingly important to plan to maintain, and where possible improve amenity and safety for residents and the commercial interests of the city and CBD.

The existing rail corridors of the North Coast Line along Abbott Street and the Jetty Branch connection currently form the sole point of access and egress for rail to the port. These corridors run through the heart of Townsville suburbs, with rail movements resulting in interaction and amenity impacts for adjoining urban areas. Future growth in road traffic and rail freight will further exacerbate these impacts, and limit potential urban renewal opportunities in the Townsville City Waterfront Priority Development Area (PDA). The PDA is planned to accommodate an additional 30,000 people and mixed-use development, as an extension to the existing CBD.

TEARC offers the potential to divert a proportion of freight rail movements away from residential areas and is a key enabler to making longer-term improvements to Townsville City for the benefit of residents. This would help to reduce pressure on the road network, improve freight efficiency, support urban growth and deliver improvements to amenity and safety.

- Increasing Impacts on Road Safety and Network

  Projected population growth in southern Townsville suburbs is expected to lead to increased road demand. Increasing road demand, coupled with potential increased freight rail movements along the North Coast Line and the Jetty Branch will in turn lead to increasing road safety risk, decreasing efficiency and capacity of the road network, particularly at four of the level crossings (Oonoonba Road, Lakeside Drive, Queen Street/Putt Street and Boundary Street intersections).

  Modelling results show by 2027 the current road network configuration will have difficulties in serving the expected traffic demand for the South Townsville area, especially during AM and PM peak hours. This will result in some traffic congestion on Abbott Street and Railway Avenue, with queue lengths of 12 vehicles at the Lakeside Drive Intersection, and 19 to 25 vehicles at other intersections (Oonoonba Road, Queen Street/Putt Street and Boundary Street intersections), with Queen Street/Putt Street being the most pronounced.

  Developed traffic models for 2037 show significant delay and congestion for the extended south Townsville road network, which is mainly due to increased traffic demand and the inability of the road network to service this future demand. It is expected the Boundary Street intersection will be the most critical, with a Level of Service F and Queen Street/Putt Street and Lakeside Drive intersections operating at Level of Service E for the AM peak hour in the 2036 horizon year.[29]

  In summary, the current road network configuration of south Townsville does not appear to be able to meet expected traffic demand for 2036 without intervention, there will be non-responded demand during both the AM and PM peak hours.

  As a result, TEARC is expected to provide an improvement in road safety and network efficiency and capacity, with the benefits increasing with upward road demand. By providing additional rail connecting infrastructure, which bypasses the urban population centres, the effect of diverting a significant proportion of the rail freight movements away from suburban sections of the North Coast Line, will see a reduction in the interaction at-grade crossings, and therefore, network impact from interrupted traffic flow.

[29] The estimated traffic delay per vehicle on Abbott Street will increase up to 98 seconds per vehicle on the south bound direction of Lakeside Drive intersection.

- Port Operational Efficiency will Continue to be Constrained

  TEARC is a key enabling piece of infrastructure for the PEP, particularly for developments on the eastern side of the port.

  The first stage of the PEP is channel widening to cater for larger ships, which mean the establishment of new berths and landside infrastructure.

  The landside infrastructure layout and land allocation study identifies the construction of TEARC is a critical enabler for the optimal port layout and PEP with new balloon loops and sidings. Moreover, any new freight users or exporters requiring rail terminal and loading/unloading facilities would be developed on the eastern side. These new developments would subsequently be connected via TEARC, thereby minimising or eliminating incremental rail movements through the suburban areas of Townsville.

  Without TEARC in place the subsequent stages of the PEP may not be realised and any future consideration of removing either the Abbott Street or the Jetty Branch to improve urban amenity cannot occur.

- Townsville's Competitive Advantage will be impacted

  With the ongoing trend towards increasing containerisation, larger vessels, and potential new cargo types that may require specialised handling requirements. There is the need for the capability, capacity and operational efficiency of the port, its channels and hinterland connectivity (rail and road) to be fit for purpose, and aligned with the needs of the freight task to both maintain and improve Townsville's competitive position for access to markets. In summary, if TEARC does not proceed the:

  - proposed port expansion will need to consider an optimal port-rail interface to enable the port to facilitate large volumes of new trade
  - ability to generate economies of scale will be limited, which will in turn affect competitiveness, and potentially volume throughput for current port users
  - PoT may struggle to attract to new customers and growth that would also improve competitiveness.

- Federal and State Regional Economic Objectives

  The Australian Federal Government, the Queensland Government and the Townsville City Council have committed to the *Townsville City Deal (2016)* with the goals as outlined in Chapter 2.

  TEARC is nominated as key project in this deal and not proceeding will likely reduce the longer-term economics benefits.

5.10.5 Future Activities

Refer to Chapter 19 for further detail.