P2_037 Transporting Hydrogen by Rail Investigation

Queensland Transport and Logistics Council

Gate 2 Pre-Feasibility Study

16 September 2022

Version history

Version no.	Date	Author	Comment
1.0	22 July 2022	EY	Draft for Proponent review
2.0	16 Sep 2022	EY	Final

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Executive Summary

Table 1 Proposal Summary

Proposal Name	P2_037 Transporting Hydrogen by Rail Investigation
Date and Gate Status	16 September 2022 – Gate 2
Proponents	The Queensland Transport and Logistics Council
Funding required (if available)	Whole of Life costs (nominal, P50, 30-year appraisal period) for the Rail Case are $21.88m which includes $12.13m in capital costs, $9.64m in maintenance and replacement costs, and $0.11m in operating costs.

Proposal description

The Queensland Transport and Logistics Council (QTLC) is a cooperative industry and government advisory body that provides advice to industry stakeholders, state and federal governments on the development, planning, regulation and operation of freight and logistics transport, infrastructure, and services in Queensland. To further their expertise and in line with state and federal policy, the organisation sought to understand the potential to deliver hydrogen via Inland Rail.

Through the Proposal, the Proponent is seeking to better understand the tipping point for the viability of transporting hydrogen by rail, in addition to gaining an understanding of the risks, regulatory issues and the practical operation of the transportation of hydrogen which can act as a flagship for businesses, state governments and federal government to consider when exploring future hydrogen opportunities.

Figure 1 Geographical context of the Proposal

Source: EY

Summary

- The objective of the Proposal is to understand in which circumstances (i.e., volume, distance) transporting hydrogen by rail would be advantageous in relation to road and what (if any) regulatory barriers exist for transporting hydrogen by rail. This analysis helps the Proponent engage with industry, government, and others on behalf of its members.
- The original scope proposed by the Proponent included the development of a pilot hydrogen hub in Toowoomba. From this original scope, it was approved to investigate the opportunities to transport hydrogen by rail.

- A unique characteristic of this project is that there is no existing commercial production of hydrogen in Toowoomba (or Parkes) nor commercial use of hydrogen at scale in Parkes (or Toowoomba) along the Inland Rail alignment. The Proposal is therefore conceptual in nature and explores the potential to utilise the Inland Rail network for transportation of bulk quantities of hydrogen for domestic use.
- Stakeholder consultation within this Proposal included consultation with local governments, organisations, a state government department, local not-for-profit economic development organisations, a national regulatory and standards organisation and rail operators. Stakeholders see the project as useful for the hydrogen industry because it furthers an understanding of the commercial viability of transporting hydrogen by rail and the associated regulatory and safety requirements.
- A transportation cost analysis was developed which considers both production volume and distance to assess the viability of hydrogen transportation using Inland Rail (Rail Case) versus road transportation (Road Case). The analysis identified rail was more cost-effective than road at production volumes over 4500kg/day or transport distances of 850km or longer.
- Due to the conceptual nature of the Proposal, a significant options identification process was undertaken to inform the development of the Road Case and Rail Case which included an assessment of mode of transportation; form of hydrogen; volume of production; route of hydrogen; and method of operations.
- The Road Case transports gaseous hydrogen produced utilising a 10MW electrolyser by road between Toowoomba and Parkes using modular tanktainers[1]. Due to the conceptual nature of the Proposal the Road Case does not currently exist. The Rail Case utilises the same assumptions, but transportation is via rail rather than road.
- An infrastructure technical solution was developed to support the Road Case (transporting hydrogen by road) and Rail Case (transporting hydrogen by rail); it has been assumed that the infrastructure will be co-located with other facilities (for example an intermodal, road logistics facility, the hydrogen production facility, or others) and as such all supporting infrastructure (such as loading equipment, trunk infrastructure, and connecting roads for example) are not included within the analysis. The infrastructure costs include a hardstand, a security gate house and an allowance for security entry and exit.
- P50 costs were developed for each Proposal case. The costs are based on high-level scoping and design and focus on the elements that differ between the Road Case and Rail Case. No specific sources of funding have been identified within the Gate 2 study.
    - Whole of Life costs (nominal, P50, 30-year appraisal period) for the Road Case are $13.54m which includes $7.72m in capital costs, $5.74m in maintenance and replacement costs, and $0.08m in operating costs.
    - Whole of Life costs (nominal, P50, 30-year appraisal period) for the Rail Case are $21.88m which includes $12.13m in capital costs, $9.64m in maintenance and replacement costs, and $0.11m in operating costs.
- The benefits analysis considers one scenario - comparing road transportation of the hydrogen in the Road Case to rail transportation in the Rail Case between the storage facilities at Parkes and Toowoomba. The present value ($2022, real, discounted at 7% p.a.) of estimated benefits associated with the Proposal over a 30-year appraisal period are estimated to be $21.0 million.
- The potential regulatory requirements assessment undertaken as part of this Study focused on two areas: the potential requirements associated with the development of the infrastructure to support the transportation of gaseous hydrogen; and the requirements related with the transportation of gaseous hydrogen via both road and rail. Section 10 provides further detail.

[1] A tanktainer is an intermodal container for the transport of liquids, gases and powders as bulk cargo

Figure 2 Key findings of the Gate 2 Pre-Feasibility Study

Proposal Details

- **Summary**The Proposal considers the transportation of compressed gaseous hydrogen via Inland Rail from Toowoomba to Parkes.
- It builds an understanding of the potential commercial viability of transporting compressed gaseous hydrogen by rail relative to road. In addition, it identifies key safety, regulatory or policy related barriers that would need to be resolved prior to the transportation of hydrogen by rail.
- Other means of transporting gaseous hydrogen are potentially relevant (e.g., pipeline) but are either not within the approved scope or are not technologically mature enough in the rail context (particularly in Australia) to be considered. Other hydrogen transportation methods (e.g., liquid hydrogen, ammonia, Methylcyclohexane (MCH)) exist and are the focus of significant research and investment. However, they are less mature - particularly at scale. It is therefore more difficult to secure reliable technical and cost information (particularly in the Australian context), and these have not been included within the approved scope or progressed in this Proposal.

Problem or Opportunity Definition

Key findings

- The Investment Logic Map (ILM) identified three key opportunities. The first is that hydrogen production, transport and use has the opportunity to spread regionally in Australia providing employment in regional areas. The second opportunity identified was that Government and private businesses are showing substantial interest in hydrogen as part of reducing emissions leading to a substantial growth in the industry. These two opportunities have the following benefits:
    - Production, transport and use of hydrogen in regional areas would provide new and sustainable jobs, skill, opportunities and long-term industry development and diversification.
    - Hydrogen industry growth and co-location with Inland Rail would provide a network to support the development of a sustainable industry and jobs.
- The last opportunity identified in the ILM workshop was that (when produced using renewable electricity) hydrogen is a green fuel with a wide range of potential applications, however potential impediments to transporting it are not fully understood. The benefit for this opportunity is:
    - Understanding potential impediments to transporting hydrogen allows these impediments to be addressed or noted early to maximise the productivity of potential hydrogen production and use particularly in fuelling locomotives and as a fuel at intermodals.

Strategic Fit

Key findings

- The strategic fit of the Proposal has been assessed against local, state, and national economic policy, transport and hydrogen industry priorities and programs and well as the Productivity Enhancement Program (PEP) principles.
- The Proposal is conceptual but is still aligned with the PEP principles. By exploring the viability of rail as a cost-effective method for transport of hydrogen, the potential regional economic gains can be understood.

- The Proposal provides an opportunity to assess the potential participation of rail in the hydrogen supply chain, thereby providing insight that may be used by business and government to progress the development of hydrogen as an alternative fuel.

Stakeholders

Key findings

- Stakeholders see the project as useful for the future hydrogen industry because it furthers understanding of the commercial viability of transporting hydrogen by rail and the associated regulatory and safety requirements.
- Rail is considered a safer option in comparison to road transportation. Rail also has the potential to reduce emissions and reduce the number of trucks on road.
- Safety aspects need to be better understood, especially in the safe handling, refuelling and maintenance of hydrogen systems.
- There are limited standards for the transportation of hydrogen, but safety and regulatory bodies are considering these issues.
- There are many potential end-uses for hydrogen to further de-carbonisation in Australia. However, there will need to be extensive engagement with the community to ensure it can be used safely and effectively.

Demand

Key findings

- Many uncertainties remain with respect to the growth of hydrogen. While hydrogen is currently produced and utilised at scale globally, demand is forecast to accelerate in coming years in Australia. This is a concept study which assesses the volume and distances at which it may be commercial to transport hydrogen via rail over road. The demand analysis also considered the forecast hydrogen growth in Australia as highlighted below.
- The emerging hydrogen market in Australia is rapidly growing with support on the federal level through the National Hydrogen Strategy (2019) and at the state level through various state-based strategies. Since the National Hydrogen Strategy was published in 2019, the Government has taken significant steps to build demand, achieve low-cost hydrogen production at scale and reduce hydrogen delivery costs.
- At an Australian level, the Clean Energy Finance Corporation (CEFC) conducted an economic gap assessment as part of their Australian hydrogen market study in 2021. The study identified that the use of hydrogen to support remote power, return to base vehicles (such as buses), line haul vehicles (such a trucks) and material handling as likely becoming viable for the use of hydrogen-based technology by 2030.
- The New South Wales (NSW) Hydrogen Strategy names multiple 2030 “stretch targets”, one of which is relevant to the opportunities for hydrogen on Inland Rail - to build a hydrogen refuelling network for heavy vehicles along major highways with a target of 100 stations. This includes potential hydrogen refuelling station locations to service a fleet of hydrogen-powered trucks dedicated to import or export freight movements between Brisbane and Melbourne. The Inland Rail corridor could play a critical role in the transportation of large volumes of gaseous hydrogen to supply these fuelling stations.
- A transportation cost analysis has been developed which considers both production volume and distance to assess the viability of hydrogen transportation using Inland Rail versus road

transportation. The analysis identified the potential tipping point for the viability of using rail as being for transporting production volumes of 4500kg/day or greater and a distance of 850km or longer.

Options Identification and Assessment

Key findings

- Due to the conceptual nature of the Proposal, an options identification process was undertaken to inform the development of the Road Case and Rail Case which included an assessment of the following areas:
    - Mode of transportation. The transport modes were assessed against their alignment to the PEP principles which include whether they increase a mode shift from road to rail. It was found that only rail would potentially increase throughput of Inland Rail and that it should be assessed against road to determine when there would be a shift from road to rail from a commercial viability perspective.
    - Form of hydrogen. The form of hydrogen to be transported between Toowoomba and Parkes was assessed using a Multi-Criteria Analysis (MCA). Gaseous hydrogen was found to be the preferred form of hydrogen.
    - Volume of production. The production volume of hydrogen considered under this Proposal is approximately 4.5 tonnes per day using a 10MW electrolyser. This volume is supported by adopting a similar sized electrolyser to recent demonstration projects supported by ARENA.
    - Route of hydrogen. Toowoomba Wellcamp to the Parkes Logistic terminal was identified as the preferred route by the Proponent given the original Expression of Interest (EOI). This distance is also supported by the transport cost analysis undertaken in Section 6 to identify the potential tipping point.
    - Method of operations / storage. To transport compressed hydrogen gas by rail, approved containers for rail traffic will need to be produced and certified. Modular ‘tanktainers’ have therefore been selected as the storage method within this Study.
- The Road Case transports gaseous hydrogen produced utilising a 10MW electrolyser by road between Toowoomba and Parkes using modular tanktainers. Toowoomba and Parkes were identified as the locations for the study by the Proponent. Due to the conceptual nature of the Study the Road Case does not currently exist. The Rail Case utilises the same assumptions with the exception of utilising rail rather than road.
- An infrastructure technical solution for the storage of tanktainers was developed to support the Road Case and Rail Case, it has been assumed that the infrastructure will be co-located with other facilities (for example an intermodal, road logistics facility, the production facility, or others) and as such all supporting infrastructure (such as loading equipment, trunk infrastructure, and connecting roads for example) are not included within the analysis.
- The infrastructure solution is not anticipated to be refined in future Gates (should the proposal proceed) due to the lack of site-specific details.

Costs

Key findings

- P50 costs have been developed for the Road Case and Rail Case. The costs are based on high-level scoping and design for the hard stand infrastructure required. As the study is conceptual in nature, a specific site has not been identified for the infrastructure. However, the solution has assumed the infrastructure identified will be co-located with other facilities and therefore has excluded supporting and trunk infrastructure.
- Initial capital cost estimates (on a P50 basis, in nominal terms) for the two options are as follows:
    - Road Case: $7.72 million.
    - Rail Case: $12.13 million.
- Lifetime operating and maintenance costs (P50, nominal, over the 30-year period of analysis) for the two options are:
    - Road Case: $5.81 million which includes maintenance costs ($5.74million) and operating costs ($0.08million).
    - Rail Case: $9.75million which includes maintenance costs ($9.64million) and operating costs ($0.11million).
- Due to the level of design information available at this stage, a 50% contingency has been applied. This is in keeping with models and suggested parameters used by TfNSW and Queensland Department of Transport and Main Roads (TMR) on road and rail projects at the concept design stage. All capital costs have been escalated by current construction price index value of 3% per annum.
- Due to the conceptual nature of the Proposal, costs are not expected to be materially refined in subsequent Gates, should the Proposal proceed.

Benefits

Key findings

- The Proposal is a conceptual study that investigates the potential to utilise Inland Rail to transport hydrogen against road transportation. The mode shift from road to rail is likely to generate benefits relating to reduced usage of the road network, including reduced road wear and tear, reduction in environmental externalities, reduced likelihood of road accidents and vehicle operating cost savings.
- The benefits analysis considers one scenario - comparing road transportation of the hydrogen in the Road Case to rail transportation in the Rail Case. For full details of the Road Case and Rail Case, see Section 6.
- The benefits analysis of the Proposal only considers the freight movement between the storage facilities at Parkes and Toowoomba and considers the benefits of moving transport from road to rail. The present value ($2022, real, discounted at 7% p.a.) of estimated benefits associated with the Proposal over a 30-year appraisal period are estimated to be $21.0 million. Specifically:
    - Direct benefits are estimated at $13.3 million.
    - Indirect benefits are estimated at $7.7 million.

Funding and Financing

Key findings

- No specific sources of funding have been identified within the Gate 2 analysis.
- From a national funding perspective, the Project may be eligible for funding from the Advancing Hydrogen Fund because it would assist in establishing domestic hydrogen supply chains.
- Potential State funding from the Queensland Government has not been identified for the project as current funding programmes for hydrogen initiatives have either closed or focus on hydrogen generation.
- NSW has a focus on decarbonisation with a hydrogen hub project already receiving funding from the State. Expressions of interest for hydrogen projects closed on 11 February 2022. Due to the timing of the application process, the Proposal is not eligible at this stage however it is unclear if future funding rounds may be available for application.
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Potential Regulatory Requirements

Key findings

The potential regulatory requirements assessment undertaken as part of this Proposal focused on two areas: the potential requirements associated with the development of the infrastructure to support the transportation of gaseous hydrogen; and the requirements related with the transportation of gaseous hydrogen via both road and rail.

A specific site was not selected for the infrastructure development because this is a conceptual study. As a result, this section presents general advice about potentially relevant regulatory pathways associated with the Proposal, without the provision of locations-specific searches (which would be investigated if the Proposal proceeds to Gate 3). Note while the study has identified Toowoomba and Parkes as the locations, specific sites for the infrastructure along the inland rail corridor has not been identified.

The key insights for this section therefore relate to the requirements for transporting hydrogen on road and rail to inform the analysis. The Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG) provides the national standards and requirements for transporting dangerous goods by both road and rail and applies in both NSW and Queensland. The following key considerations from the ADG are noted:

- Hydrogen is classed as a 'Division 2.1 Flammable gas'. The threshold quantity for hydrogen is 50 tonnes, where a facility will automatically be classified as a Major Hazard Facility (MHF). For notifiable quantities (i.e., 5 tonnes of hydrogen) the regulator will make a determination whether the facility is an MHF. Declaration of an MHFs triggers a number of requirements under the WHS Regulation 2011. A facility may apply for an exemption from being labelled an MHF if the chemicals are in intermediate or temporary storage, the maximum package / container size is no more than 500 kg. Therefore, the Proposal may be streamlined if the maximum container size is less than 500kg. The demand analysis assumed a full tanktainer was 4.5 tonnes per Twenty foot Equivalent Unit (TEU).
- The ADG does not limit the quantity of hydrogen that can be transported, however details the minimum packaging requirements to transport hydrogen. Provided all the relevant provisions are observed (i.e., packaging, wagon, truck, rail, and road weight limits etc), there is no upper limit on the amount that can be transported by a single train or on a truck. Limits are imposed by the Road Authority on trucks and limits could be imposed by the rail

operator. Stakeholder consultation did not indicate whether limits would likely be imposed.

- Compressed hydrogen can be transported by rail with other Class 3, 4 or 5 hazardous materials if there is a segregation/separated on a train by at least one intervening load platform. Compressed hydrogen cannot be transported by road with any other Class 3, 4 or 5 hazardous materials.
- Compressed hydrogen must not be transported in the first or last wagon of a train.
- The ADG does not limit the double stacking of compressed hydrogen containers.
- There are no prescribed restrictions on transporting compressed hydrogen through rail tunnels (noting there are not tunnels between Toowoomba and Parkes). However, restrictions may be placed by the rail operators on dangerous goods being transported through rail tunnels.

Specific Considerations for Transport by Rail:

- The ADG provides guidance around incompatible materials. The ADG provides provisions for incompatible materials to be segregated during railway transport.
- The ADG permits the double stacking of freight containers if the freight containers of dangerous goods are of the same UN number (i.e., UN 1049 compressed hydrogen). On this basis there is no restriction to the double stacking of compressed hydrogen containers, but they cannot be stacked with other dangerous goods.
- Dangerous goods licences are not required for train operators or trains.

Specific Considerations for Transport by Road:

- NSW and Queensland regulation prohibits the transport of dangerous goods (such as compressed hydrogen) by road through some specified tunnels, those displaying placard restrictions, and other prohibited areas.
- The ADG does not permit hydrogen to be transported by road with any other incompatible material.
- Transport of hydrogen by road requires the driver to hold a dangerous goods driver licence and the vehicle to have a dangerous goods vehicle licence, where the hydrogen is in a receptacle with a capacity of more than 500L, or more than 500kg of hydrogen is in a receptacle. Licences issued in NSW allow you to drive in Queensland and vice versa.

Introduction and Context

Gate 2 approach

This section outlines the purpose of this Gate 2 Pre-Feasibility study (the "Study") and the methodology used to complete the analysis in accordance with the Gateway Assessment Process.

Purpose

The Australian Government's II Program was established to assist industry, local communities, and government to identify and assess Proposals that could potentially increase and maximise the long-term benefit of Inland Rail's connections to the national freight rail network.

The purpose of this Study is to progress the Transporting Hydrogen by Rail Investigation Proposal through the Department Gateway Assessment Process. This Proposal is being progressed as part of the PEP, under which Proposals are assessed against how they evaluate the costs and benefits of proposed improvements to the interface between supply chains and Inland Rail, with a view to improving community resilience.

The primary focus of this Study is on understanding the potential commercial viability of transportation of hydrogen by rail, with a particular focus on identifying tipping points and key regulatory factors. This process will use supporting information on the demand estimates, in addition to the costs and benefits of each potential solution. Because hydrogen is an emerging industry, the analysis includes a range of sensitivities to inform understanding. This document provides:

- analysis of the demand, costs and benefits used to justify the selection of the preferred option(s);
- an initial examination of the funding and financing of the Proposal, particularly in relation to third party investment or in-kind support;
- potential regulatory requirements which may be triggered by the Proposal; and
- identification of any data gaps that will need to be addressed should this Proposal continue to the Gate 3 Feasibility analysis.

The Department will determine whether the Proposal is eligible to proceed through the Gateway Assessment Process following the agreed feedback and review process[2]. Should the Proposal be eligible to proceed, the results will be investigated in further detail in subsequent Gates.

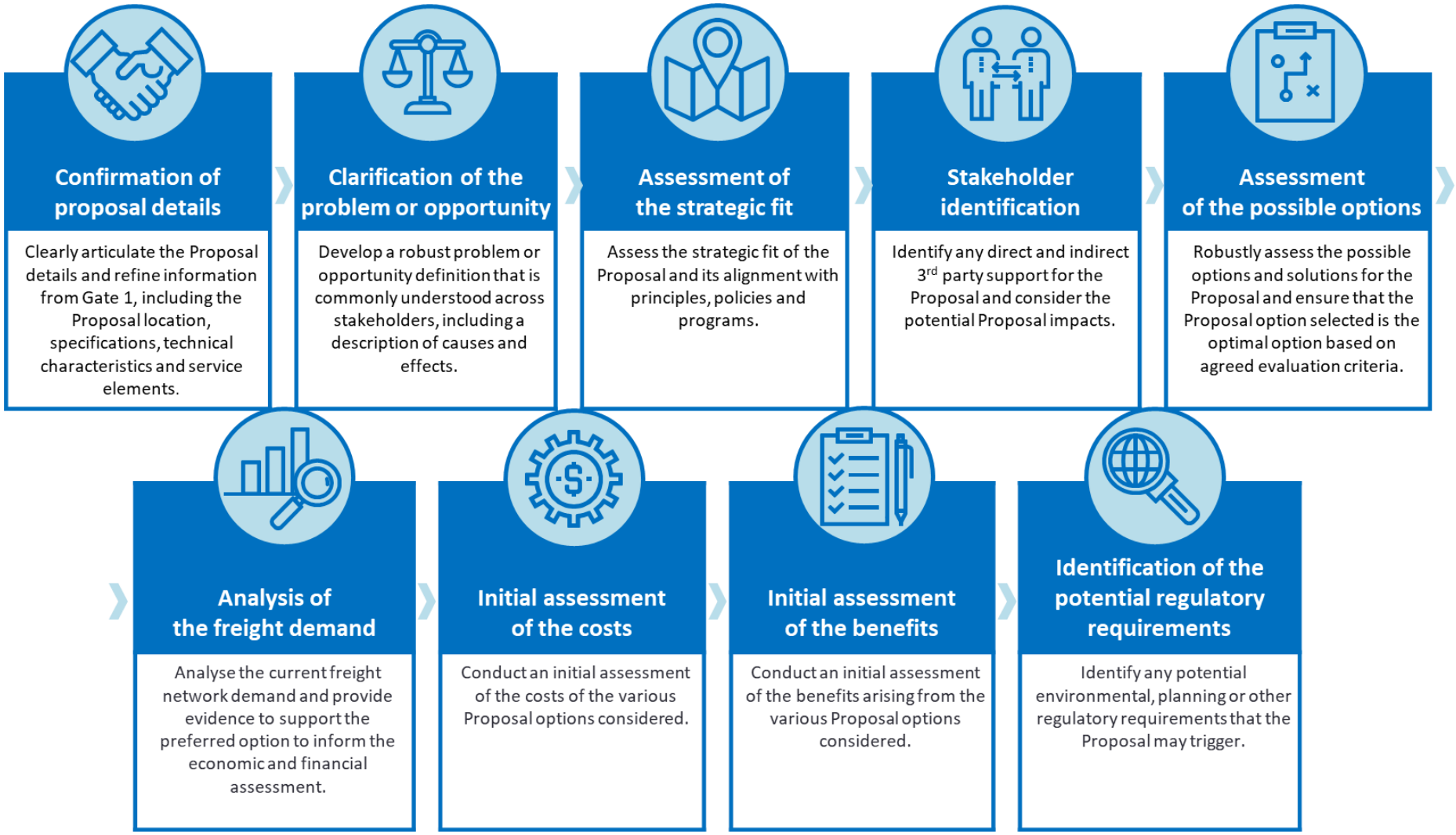
Methodology

The Proponent and EY worked collaboratively in developing this Gate 2 Pre-Feasibility Study in accordance with guidance material pertaining to the Gateway Assessment Process. Please refer to Figure 3 for more detail on the key activities to be undertaken for each Gate study.

An overview of the methodology for developing this Study is provided in Figure 3 below.

[2] As set out in the "*Process Steps*" document as at May 2020, the Department

Figure 3 Methodology in developing the Gate 2 Pre-Feasibility Study



Please refer to:

- Appendix A for more detail on the information sources used including the documents considered.
- Appendix B for more detail on the stakeholders consulted during the development of this document.
- Appendix C for further information on the benefits analysis performed as part of this Study.
- Appendix D for additional costing information about the cost estimation performed as part of this Study.
- Appendix E for a copy of the Investment Logic Map for the Proposal.
- Appendix F for more detail on the key activities at each Gate.
- Appendix G for further information about the technical scope of the preferred option.

1. Proposal Details

Key messages

- The Proposal considers the transportation of compressed gaseous hydrogen via Inland Rail from Toowoomba to Parkes.
- It builds an understanding of the potential commercial viability of transporting compressed gaseous hydrogen by rail relative to road. In addition, it identifies key safety, regulatory or policy related barriers that would need to be resolved prior to the transportation of hydrogen by rail.
- Other means of transporting gaseous hydrogen are potentially relevant (e.g., pipeline) but are either not within the approved scope or are not technologically mature enough in the rail context (particularly in Australia) to be considered. Other hydrogen transportation methods (e.g., liquid hydrogen, ammonia, MCH) exist and are the focus of significant research and investment. However, they are less mature - particularly at scale. It is therefore more difficult to secure reliable technical and cost information (particularly in the Australian context), and these have not been included within the approved scope or progressed in this Proposal.

1.1 Proposal Details

The Proposal explores the potential to transport hydrogen via Inland Rail. The Proponent's original EOI included the opportunity to establish an operation in southern Queensland initially at Wellcamp Intermodal Hub to investigate and pilot the design of the rail infrastructure capable of adopting hydrogen as alternative fuel (compressed gas form) and as an energy carrier (liquid form). The scope of the Proposal was limited by the Department from the broader scope set out in the Proponent's original EOI submission to "investigating the opportunities associated with transporting liquid hydrogen and compressed gaseous hydrogen by rail". While the limited EOI scope approved by the Department includes reference to both liquid and gaseous hydrogen the Proponent advised that their preference was for the study to focus only on compressed gaseous hydrogen from Toowoomba to Parkes. The reasons for this are described later in this section and in Section 6.

The Proposal highlights the potential to utilise rail for cost-effective transport of hydrogen for domestic demand. The availability of a 'hydrogen ready' Inland Rail could support Inland Rail's role as a key enabler of Australia's energy transition. Hydrogen is a key policy priority at state and federal levels in Australia and internationally. It is seen as an important renewable fuel[3] to support decarbonisation of heavy industry and transportation. For the purposes of this Proposal, it is assumed that the hydrogen transported is 'green' (i.e., produced using an electrolyser with renewable electricity). This aligns to hydrogen's potential to contribute to emissions reductions as energy markets continue to evolve[4].

The objective of the Proposal is to understand in which circumstances (i.e., volume, distance) transporting hydrogen by rail would be advantageous in relation to road and what (if any) key regulatory barriers exist for transporting hydrogen by rail. This analysis helps the Proponent engage with industry, government, and others on behalf of its members. A unique characteristic of this Proposal is that there is no existing commercial production of hydrogen in Toowoomba (or Parkes) nor commercial use of hydrogen at scale in Parkes (or Toowoomba) along the Inland Rail alignment. The Proposal is therefore conceptual in nature and explores the potential to utilise the Inland Rail network for transportation of bulk quantities of hydrogen for domestic use.

While a range of potential transport modes were explored, transporting hydrogen by road (Rail Case) was identified as the option to be assessed against transporting hydrogen via Inland Rail (Rail Case), following the ILM workshop. It should be noted that bulk hydrogen is not currently transported

[3] The extent to which hydrogen is renewable depends on the method it is created, and the input fuel used. The 'hydrogen rainbow' reflects the many alternatives available including from renewable energy, gas, coal. Hydrogen as a clean fuel refers to 'green hydrogen' or hydrogen created which has low carbon intensity. This is typically created using electrolysers and renewable electricity.
[4] Australia's National Hydrogen Strategy, COAG Energy Council, 2019, http://www.industry.gov.au/sites/default/files/2019-11/australias-national-hydrogen-strategy.pdf

between Parkes and Toowoomba via road though this is anticipated given the conceptual nature of the Proposal. Road is a relatively common method for transporting compressed gas including hydrogen. Assessing the Road Case and Rail Case allowed the benefits of rail in relation to road to be explored as part of the Proposal. The Proposal did not compare rail to other means of transportation such as pipeline or co-located production due to scope approval limitations and outcomes of the ILM workshop. Further work needs to be undertaken to compare rail to pipeline or co-location before making an investment decision on the optimal mode of transportation.

The purpose of the ILM was to assess the service need, rather than a specific asset solution. As part of the ILM workshop process, different forms of hydrogen and asset solutions were considered. These include liquid hydrogen, pipelines, and other options. No additional quantitative or qualitative evaluation of a pipeline or other forms of transportation occurred following the ILM as the ILM found that to achieve the key performance indicators, rail needed to be compared to road. Further details on the assessment need and the rationale for selecting gaseous hydrogen by rail is explained in Section 6.

The Proposal also considers rollingstock related factors including the types of hydrogen road and rail containers available and requirements for safe storage and handling of hydrogen rail transport containers and loading and unloading of hydrogen gas to rail. The use of hydrogen to power locomotives is out of scope of this project.

Figure 4 Geographical context of the Proposal

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Source: EY

As a nascent industry, understanding the viability of transporting compressed gaseous hydrogen by rail in comparison to road provides valuable insight regarding the potential for Inland Rail to transport hydrogen to meet domestic demand. The green hydrogen market, associated technologies and scale are developing rapidly. The Proposal provides many opportunities, which were identified in the ILM and are listed in the following section. They have arisen due to QTLC's desire to understand the viability of transporting compressed hydrogen via rail. Details of the Proposal are shown in Table 2.

Table 2 Proposal details

Proposal Details	
1.1 Proposal Title	Transporting hydrogen by rail investigation
1.2 Proponent	Queensland Transport and Logistics Council (QTLC)
1.3 Description	QTLC is a cooperative industry and government advisory body that provides advice to industry stakeholders, state and federal governments on the development, planning, regulation and operation of freight and logistics transport, infrastructure, and services in Queensland[5]. To further their expertise and in line with state and federal policy, the organisation sought to understand the potential to deliver hydrogen via Inland Rail. Through the Proposal, the Proponent is seeking to better understand the tipping point for the cost-effectiveness of transporting hydrogen by rail, in addition to gaining an understanding of the risks, regulatory issues and the practical operation of the transportation of hydrogen which can act as a flagship for businesses, state governments and federal government to consider when exploring future hydrogen opportunities.
1.4 Background	**QTLC background** QTLC's mission is to represent the freight transport and logistics industry to influence policy, regulation, infrastructure planning and investment to achieve sustainable and productive supply chains. QTLC aims to support the efficient movement of freight in order to support sustainable and productive economic development and prosperity[6]. For this Proposal, QTLC is supported by a technical working group with members of diverse backgrounds including engineers, academia, and business professionals. **Hydrogen policy background** At the national level, Australia's National Hydrogen Strategy[7] focuses on capitalising Australia's opportunity to deliver clean hydrogen to the global market. The National Strategy identifies 57 joint actions to achieve the policy objective. Actions are themed around national coordination, production capacity, responsive regulation, international engagement, innovation and research and development (R&D), skills and workforce, and community confidence. Targeted support for pilot, trial and demonstrations projects is provided to incentivise growth of hydrogen hubs, develop country to country arrangements, complete the National Hydrogen Infrastructure Assessment and support efficient hub supply chains. The Queensland Hydrogen Industry Strategy focuses on leveraging Queensland's unique position as a major producer of solar energy and proximity to Asia to become a major producer and exporter of green hydrogen[8]. The objective of the strategy is to drive the development of a sustainable and competitive hydrogen industry for the domestic and export market and stimulate the Queensland economy. To accomplish this, the state is looking at five focus areas: 1. Supporting innovation. 2. Facilitating private sector investment. 3. Ensuring and effective policy framework. 4. Building community awareness and confidence. 5. Facilitating skills development for a new technology. The New South Wales Hydrogen Strategy brings together the NSW Government's existing and new policies into a framework to support the development of a commercial hydrogen industry in NSW. The Strategy identifies multiple 2030 stretch targets and three strategic pillars—enable industry development, lay industry foundations, and drive rapid

[5] Queensland Transport and Logistic Council, https://www.qtlc.com.au/about-the-qtlc/
[6] Queensland Transport and Logistic Council, https://www.qtlc.com.au/about-the-qtlc/
[7] Australia's National Hydrogen Strategy, COAG Energy Council, 2019, https://www.industry.gov.au/sites/default/files/2019-11/australias-national-hydrogen-strategy.pdf
[8] Queensland Hydrogen Industry Strategy 2019-2024, Queensland Government, May 2019, https://www.statedevelopment.qld.gov.au/__data/assets/pdf_file/0018/12195/queensland-hydrogen-strategy.pdf

Proposal Details	
	scale, to achieve the goal of 110,000 tonnes of green hydrogen by annum from 700 MW of electrolyser capacity for under $AU2.80 per kg by 2030. Up to $3 billion of incentives will be provided as part of the Strategy to commercialise hydrogen supply chains. Given the significant state, national and global focus on hydrogen, this Proposal provides an opportunity to support these policy efforts by assessing the viability of transporting hydrogen by rail in Australia. **Proposal background** The hydrogen market is rapidly developing both from a technology and demand perspective which will likely further reduce production costs over time. Federal and state governments anticipate high growth rates in the demand for hydrogen, but currently there are limited hydrogen producers and end users within Australia. The Proposal provides a platform to test concepts with a focus on understanding the practical safety and regulatory requirements and broader economic potential of transporting gaseous hydrogen by rail. This includes understanding rollingstock implications (e.g., storage, loading/unloading) specific to the transportation of gaseous hydrogen. In addition, it aims to understand the volume or distance at which transportation by rail becomes more economic than by road between Toowoomba and Parkes and other alternative options that will be developed, as proposed by the Proponent. As the hydrogen market is still emerging, production of hydrogen and end use applications are still being developed. Therefore, the Proposal focuses on potential demand and volume tipping points rather than a study that considers specific volumes and demand based on existing production and demand.

2. Problem or Opportunity Definition

Key messages

- The ILM identified three key opportunities. The first is that hydrogen production, transport and use have the opportunity to spread regionally in Australia providing employment in regional areas. The second opportunity identified was that Government and private businesses are showing substantial interest in hydrogen as part of a reducing emissions leading to a substantial growth in the industry. These two opportunities have the following benefits:
    - Production, transport and use of hydrogen in regional areas would provide new and sustainable jobs, skill, opportunities and long-term industry development and diversification.
    - Hydrogen industry growth and co-location with Inland Rail would provide a network to support the development of a sustainable industry and jobs.
- The last opportunity identified in the ILM workshop was that (when produced using renewables) hydrogen is a green fuel with a wide range of potential applications, however potential impediments to transporting it are not fully understood. The benefit for this opportunity is:
    - Understanding potential impediments to transporting hydrogen allows these impediments to be addressed or noted early to maximise the productivity of potential hydrogen production and use.

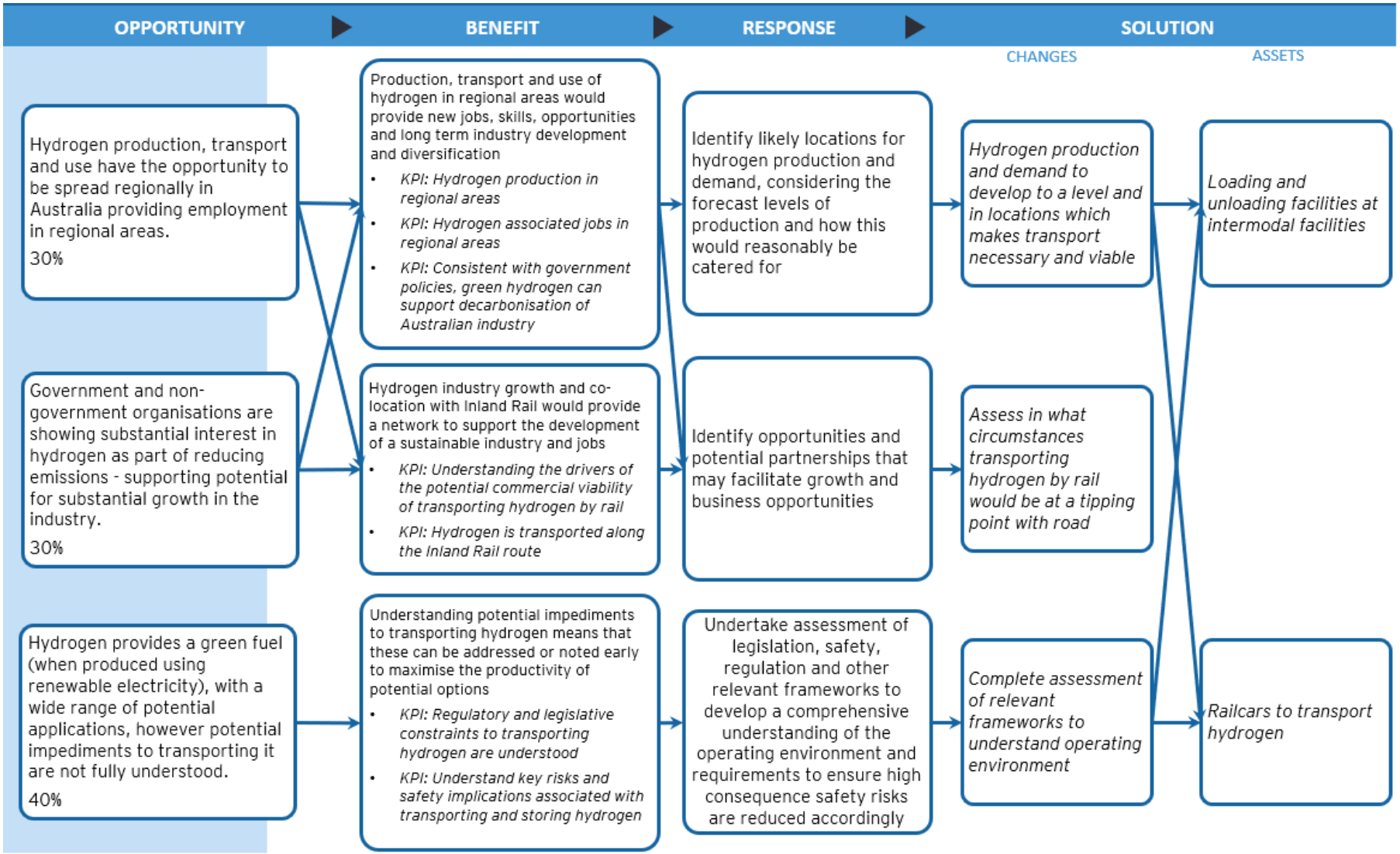
2.1 Description of the constraint or opportunity

This Proposal presents significant opportunities for knowledge sharing with respect to the potential for rail as a means of transporting hydrogen. The findings from the Proposal may become a useful source for businesses, state, and federal governments to refer to as it may be the first Australian focused study on the potential efficiencies which can be achieved by transporting hydrogen via rail.

The Proponent is acting as an advocate to develop a better understanding of the opportunities in transporting hydrogen via Inland Rail. The Proposal presents a unique opportunity to both understand the potential for transporting hydrogen by rail and support the development of the hydrogen industry. The evolving hydrogen market in a domestic transport context provides an opportunity to form an understanding of economic, potential safety, regulatory and network shortcomings.

An ILM workshop was held with the Proponent and the project advisors. This workshop focused on identifying the opportunities that the Project is trying to meet. Figure 5 summarises the outputs of the ILM workshop and the following sections contain further details on each opportunity identified.

Figure 5 ILM Workshop Output



2.2 Opportunity statement 1:

Hydrogen production, transport and use have the opportunity to be spread regionally in Australia providing employment in regional areas

2.2.1 Causes and effects of constraints or opportunities

Opportunity Statement 1: Hydrogen production, transport and use have the opportunity to be spread regionally in Australia providing employment in regional areas.	
Causes:	The ILM workshop focused on the opportunities created from the Proposal. The first opportunity was the ability to create employment in regional areas through the production, use and transportation of hydrogen. This opportunity received a weighting of 30% relative to the weight of the other opportunity statements to be detailed in the following sections.
Evidence of causes:	The opportunity is created through the Proposal as it is exploring the opportunity for a new hydrogen industry which currently does not exist in regional Australia. Hydrogen is a focus for the Australian government because of its potential to support decarbonisation. Bringing a new green hydrogen industry to the regions will increase economic diversification and resilience.
Effects:	There are two key beneficial effects of this opportunity. The development of hydrogen in regional areas will create new jobs, skills opportunities and long-term industry development and diversification. And hydrogen industry co-location with Inland Rail would provide a network to support the development of sustainable industry and jobs.
Evidence of effects:	The green hydrogen industry currently is in its infancy in Australia. There is a range of future opportunities available for green hydrogen both in a domestic use, and export context. Better understanding of domestic transportation options will help further investment in this industry. The development of the green hydrogen industry has the potential to diversify and stimulate the economy in the long run for regional Australia. If demand for green hydrogen emerges at scale in Australia, it will provide for sustainable industry and jobs by supporting emissions reductions as per government policies. Inland Rail has the ability to extend the network of influence of hydrogen by providing a means to transport a green fuel over long distances in Australia to progress decarbonisation efforts.

2.3 Opportunity statement 2:

Government and non-government organisations are showing substantial interest in hydrogen as part of reducing emissions - supporting potential for substantial growth in the industry

2.3.1 Causes and effects of constraints or opportunities

Opportunity Statement 2: Government and non-government organisations are showing substantial interest in hydrogen as part of reducing emissions - supporting potential for substantial growth in the industry	
Causes:	There is significant interest in growing the hydrogen industry from government and private businesses as part of the strategy for reducing emissions in Australia. This opportunity was given a weighting of 30% relative to the other opportunity statements developed in the ILM workshop.
Evidence of causes:	The Proposal provides this opportunity because it furthers Australia's current understanding of the viability of transporting hydrogen by rail from both a commercial and practical perspective. As hydrogen transportation will be better understood, the industry will have a better opportunity to grow.
Effects:	There are two key beneficial effects of this opportunity. The development of hydrogen in regional areas will create new jobs, skills opportunities and long-term industry development and diversification. Secondly, hydrogen industry co-location with Inland Rail would provide a network to support the development of sustainable industry and jobs.
Evidence of effects:	The green hydrogen industry is a focus area for government and private businesses given its potential to support decarbonisation targets. The private sector interest in the hydrogen sector will lead to increased investment which could positively impact industry development and diversification in regional Australia. From a government perspective, financial and/or policy support will be provided to the hydrogen industry and government is likely to support private sector investment. This investment will provide long term industry development and diversify the economy. Inland Rail has the ability to provide connectivity for green hydrogen to support sustainable industry and jobs. If the commercial viability of transporting hydrogen by rail is understood, it can be adopted appropriately in the future when there is green hydrogen production.

2.4 Opportunity statement 3:

Hydrogen provides a green fuel (when produced using renewable electricity), with a wide range of potential applications, however potential impediments to transporting it are not fully understood

2.4.1 Causes and effects of constraints or opportunities

Opportunity Statement 3: Hydrogen provides a green fuel (when produced using renewable electricity), with a wide range of potential applications, however potential impediments to transporting it are not fully understood	
Causes:	The final opportunity identified was understanding the impediments to transporting green hydrogen so that it can be transported when it is eventually produced and used in Australia. This opportunity was given a weighting of 40% relative to the other opportunity statements developed in the ILM workshop.
Evidence of causes:	The Proposal provides this opportunity because a major element of the study will be understanding the regulatory, policy and safety barriers to transporting hydrogen. If these are understood, there is an opportunity for reform to occur to enable the safe transportation of hydrogen.
Effects:	This opportunity has a singular effect: understanding the potential impediments to transporting green hydrogen by rail means that they can be addressed while the industry is in its infancy.
Evidence of effects:	Green hydrogen is yet to be transported by rail in Australia. As a result, there is little understanding of the safety concerns associated with this mode of transport. The Proposal will provide the opportunity to investigate this and will consider items such as how the volume of hydrogen being transported impacts safety or requires additional safety measures. In addition, the Proposal will review current regulatory and legislative constraints to transporting hydrogen and will seek to identify any gaps in legislation. This will inform policy makers where policies may need to be developed to enable the transportation of green hydrogen via rail.

3. Strategic Fit

Key messages

- The strategic fit of the Proposal has been assessed against local, state, and national economic policy, transport and hydrogen industry priorities and programs and well as the PEP principles.
- The Proposal is conceptual but is still aligned with the PEP principles. By exploring the viability of rail as a cost-effective method for transport of hydrogen, the potential regional economic gains can be understood.
- The Proposal provides an opportunity to assess the potential participation of rail in the hydrogen supply chain, thereby providing insight that may be used by business and government to progress the development of hydrogen as an alternative fuel.

3.1 Alignment with II Program Principles

The Proposal supports the PEP principles by exploring the utilisation of rail for cost-effective transportation of compressed gaseous hydrogen. The Proposal will seek to understand what the barriers are to transporting hydrogen by rail, whether it is commercially viable and whether regulatory barriers exist. This will inform potential future use of Inland Rail in the domestic hydrogen supply chain in Australia.

Transportation of hydrogen is potentially a very significant new freight task across Australia, including in regional areas. Understanding the drivers of commercial viability of rail transport in relation versus road to support that freight task is important. This understanding will be informed by technical assessment of the rail infrastructure required, its costs and the key regulatory challenges. Globally, hydrogen is primarily transported by road and pipeline and the prospect of using rail for the domestic freight task provides an opportunity for Australia to optimise supply chain costs. Transporting hydrogen via Inland Rail is a key element of this potential.

Given the forecast increase in demand for hydrogen across new end use applications, understanding the circumstances in which rail presents a compelling alternative to road is critical.

Green hydrogen is likely to be an alternative fuel, chemical feedstock, and energy vector to support Australia's net zero by 2050 ambition[9]. It is likely there will be a need for hydrogen in regional Australia, including in where supply chains interface with Inland Rail. Green hydrogen may also be an export commodity for Australia but will likely be co-located with ports when it is being made for export.

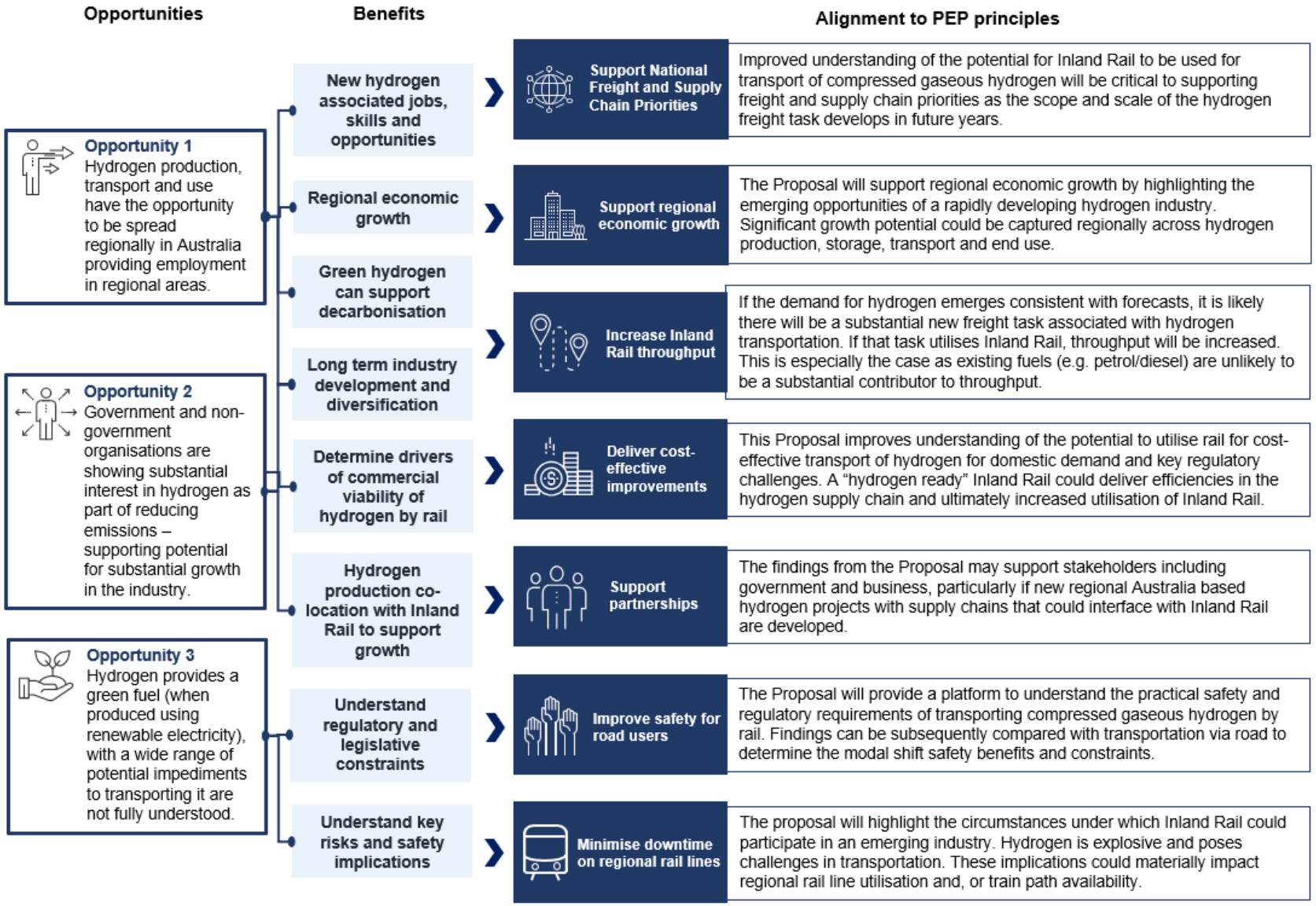
Both Federal and State governments have highlighted hydrogen as a key policy priority in Australia as noted in Section 3.2 below. This, together with increased global attention on hydrogen and decarbonisation priorities, has generated substantial public and private interest in hydrogen as an important renewable fuel.

The Proposal may also provide an opportunity to improve road safety by increasing the use of rail over road to transport to transport hydrogen.

Figure 6 provides summary of the alignment between the Proposal and PEP principles.

[9] Australia's Long-Term Emissions Reduction Plan, Australian Government Department of Industry, Science, Energy and Resources, http://www.industry.gov.au/data-and-publications/australias-long-term-emissions-reduction-plan

Figure 6 Alignment with II Program Principles



Addressing the opportunities outlined in Figure 6 will highlight the potential viability of Inland Rail as a key transport provider in the hydrogen supply chain. This may result in productivity and economic gains for both the Toowoomba and Parkes regions and contribute to promoting the transportation of hydrogen by rail.

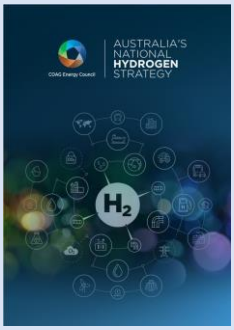
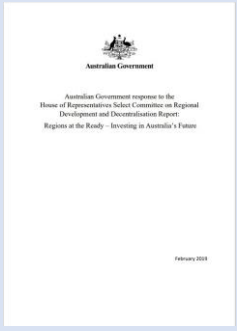
The findings of this Proposal will focus on the tipping point under which a shift from hydrogen transportation by road to rail is more attractive. This may assist private and public decision-making regarding standards, investment, and regulation in a rapidly evolving market.

3.2 Alignment with other policies and programs

The Proposal assesses the viability of gaseous compressed hydrogen transportation by rail between Toowoomba and Parkes. The development of the Proposal has been influenced by local, state, and national economic development, transport and freight priorities and programs.

Ensuring that the Proposal considers broader strategies will help to maximise its benefits. The related Queensland, New South Wales and Commonwealth government policies and strategies which have been considered in the development of the Proposal are displayed in Table 3.

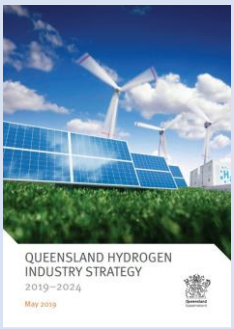
Table 3 Proposal alignment with Federal policies and programs

Policy / Program	Description of how this Proposal aligns
	National Hydrogen Strategy (2019) Australia's National Hydrogen Strategy[10] focuses on capitalising Australia's opportunity to deliver clean hydrogen on the global market by developing 'hydrogen hubs'. The hydrogen hubs will be clusters of large-scale hydrogen production which may be located at ports, cities or regional areas which aim on achieving economies of scale. The strategy also touches on developing clear regulatory frameworks to positively impact energy prices and energy security. The strategy indicates that engagement will also be undertaken on an international scale to develop schemes to track and certify origins of internationally traded, clean hydrogen.
	Australian Government Response – Regions at the Ready (2019) This document outlines the Australian Government's commitment to investing $75 billion in transport infrastructure projects over the next decade to improve economic long-term productivity and to increase and spread Australia's economic growth.
	Technology Investment Roadmap, First Low Emissions Technology Statement (2020) This strategy document seeks to create a strategy which accelerates the development and commercialisation of new and emerging low emissions technologies. This includes the establishment of Australia's first regional hydrogen hub, co-locating domestic hydrogen users with an export focus to create global hydrogen supply chain linkages. The strategy identifies clean hydrogen as a priority low emissions technology due to the high abatement and economic potential of the industry.

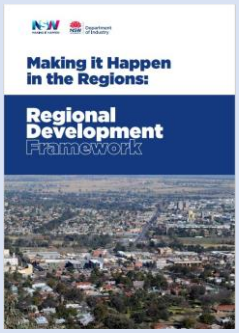
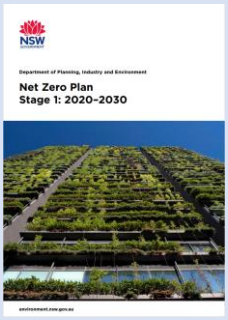
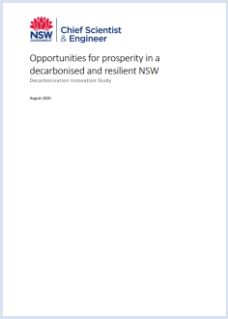
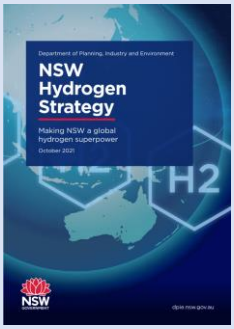
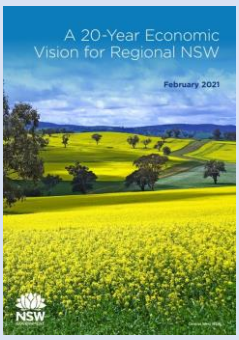
[10] *Australia's National Hydrogen Strategy, COAG Energy Council, 2019*

Policy / Program	Description of how this Proposal aligns
	**Australian Infrastructure Plan (2021)** This plan sets out the infrastructure challenges and opportunities faced in Australia over the next 15 years. It provides a package of reforms focussed on improvement in, delivery and use of Australian infrastructure and assets. The plan has identified hydrogen as a key alternative fuel contributing to Australia's decarbonisation goals. The plan forecasts that the Australian hydrogen industry could create around 7,600 jobs and add approximately $11 billion a year to Australia's Gross Domestic Product by 2050. Additionally, it underscores the need for appropriate regulation and legislation to give investors certainty particularly in developing industries like hydrogen.
	**Australian Hydrogen Market Study, Sector Analysis Summary (2021)** This document outlines the economic gap between hydrogen supply and capacity to pay for demand in 2020 and until 2050. The study identifies end user dynamics and supply side costs as the greatest uncertainty as the industry develops. This Proposal will contribute to an understanding of these supply side costs, specifically the transport of compressed gaseous hydrogen.
	**Australia's Long-term Emissions Reduction Plan (2021)** Australia's whole-of-economy Long-Term Emissions Reduction Plan (the Plan) sets out how Australia will achieve net zero emissions by 2050. The Plan is focused on 'the how': practical action to convert ambition into achievement. The plan is based on five key principles, with an enabling role for government. These principles are: technology not taxes, expand choices, not mandates, drive down the cost of a range of new energy technologies, keep energy prices down with affordable and reliable power and be accountable for progress.

Table 4 Proposal alignment with State policies and programs

Policy / Program	Description of how this Proposal aligns
	**Queensland Hydrogen Industry Strategy (2019)** The Queensland Hydrogen Industry Strategy focuses on Queensland's unique position as a major producer of solar energy and proximity to Asia to become a major producer and exporter of green hydrogen[11]. The objective of the strategy is to drive the development of a sustainable and competitive hydrogen industry for the domestic and export market which stimulates the Queensland economy. To accomplish this, the state is looking at five focus areas: 1. Supporting innovation. 2. Facilitating private sector investment. 3. Ensuring and effective policy framework. 4. Building community awareness and confidence. 5. Facilitating skills development for a new technology. With significant state, national and global focus on hydrogen, this Proposal provides an opportunity to assess and test the viability of transporting hydrogen by rail in Australia.

[11] *Queensland Hydrogen Industry Strategy 2019-2024*

Policy / Program	Description of how this Proposal aligns
	**Making it Happen in the Regions: Regional Development Framework NSW (2020)** This document sets out the framework for the NSW Government's commitment of over $13 billion to revitalising important infrastructure and improving service delivery in regional communities. The NSW Government has also indicated their intention to support emerging alternative industries, potentially hydrogen, where there are consequential increases to employment and economic prospects.
	**NSW Net Zero Plan Stage 1: 2020-2030** This document outlines how NSW plans to fast track emissions reduction over the next decade to achieve their goal of net zero emissions by 2050. The Plan is forecast to deliver a 35% emissions reduction in NSW by 2030 (using 2005 emissions as a baseline). The development, innovation and commercialisation of the hydrogen industry is highlighted as key to progressing goals in the plan. The NSW Government has committed to establishing a Hydrogen Program that will help scale-up the industry as an energy source and feedstock. This plan sets a target of up to 10% hydrogen in the gas network by 2030.
	**NSW Decarbonisation Innovation Study (2020)** This study details the final list of economic opportunities associated with decarbonisation and climate adaptation across all sectors of the NSW economy including services, electricity, industry, the built environment, land, and transport. Growing availability and uptake of decarbonised energy sources, specifically Hydrogen, is identified as a key opportunity for NSW across both transport and industry sectors.
	**NSW Hydrogen Strategy (2021)** The Strategy provides up to $3 billion in support for the hydrogen industry by waiving government charges on green hydrogen production, providing a 90% exemption to network charges for electrolysers that connect to parts of the electricity network with spare capacity, investing $70 million in hydrogen hubs in the Illawarra and Hunter, incentivising green hydrogen production and rolling out hydrogen refuelling stations.
	**20-Year Economic Vision for Regional NSW (2021)** This document is the NSW Government's plan for generating sustainable long-term economic growth in regional NSW. Over $8 billion has been committed to achieving the economic goals set out in this plan. Part of the plan includes removing barriers to investment and innovation in new transport technologies, including hydrogen, to provide cost-competitive clean fuel for road and rail freight. Additionally, the plan supports the NSW Government's commitment to net zero emissions by 2050 by exploring the potential of hydrogen to deliver reliable clean energy.

3.3 Commercial and industry fit

The Proposal has the potential to spur significant economic growth by stimulating public and private interest in an emerging industry. There is not currently an active commercial green hydrogen market in Toowoomba or Parkes. However, a number of reports and forecasts highlight the potential of hydrogen to be a bulk fuel in Australia and internationally.

Hydrogen is a key policy priority at the state and federal levels in Australia and internationally. It is seen as an important renewable fuel to support decarbonisation of heavy industry and transportation. Hydrogen has the potential to contribute to emissions reductions as energy markets continue to evolve[12]. Public sentiment widely acknowledges the need to invest in progressing Australia's energy transition - understanding the potential viability of rail as a key input to the hydrogen supply chain could contribute towards accelerating a low-emissions industry. To illustrate this policy priority, Table 5 below details the carbon targets and committed hydrogen investment in the relevant jurisdictions.

Table 5 Federal and State emissions policy and committed hydrogen investment

Jurisdiction	Emissions Targets	Hydrogen Investment Commitment
Australia	• 5% below 2000 levels by 2020 (under the Kyoto Protocol). • 26-28% below 2005 levels by 2030 (under the Paris Agreement). • Target of net zero emissions by 2050.	• From 2015-2019, the Australian Government has committed over $146 million to hydrogen projects. • As part of the National Hydrogen Strategy plan, the government has invested over $1.3 billion to accelerate domestic hydrogen industry growth[13].
Queensland	• Target of zero net emissions by 2050. • Interim target for at least a 30% reduction in emissions on 2005 levels by 2030.	• Under the Queensland Hydrogen Industry Strategy, the government has committed $19 million toward progressing this emerging industry. • The Queensland government has committed $1.5 billion to increase the previous $500 million Queensland Renewable Energy Fund and establish the $2 billion Queensland Renewable Energy and Hydrogen Jobs Fund.
New South Wales	• Target of zero net emissions by 2050. • Interim target to deliver a 35% reduction in emissions on 2005 levels by 2030.	• The NSW Government has established a $450 million Emissions Intensity Reduction Program to support businesses to transition their plant, equipment, and processes to low emissions alternatives. • The Emissions Intensity Reduction Program is be complemented by the Commonwealth's $450 million commitment to NSW from the Climate Solutions Fund. • The NSW Government has set an aspirational target of up to 10% hydrogen in the gas network by 2030. Funds from both the Emissions Intensity Reduction Program and the Climate Solutions Fund will be committed to this goal.

[12] Australia's National Hydrogen Strategy, COAG Energy Council, 2019, https://www.industry.gov.au/sites/default/files/2019-11/australias-national-hydrogen-strategy.pdf
[13] Global Hydrogen Review, International Energy Agency, 2021, https://iea.blob.core.windows.net/assets/3a2ed84c-9ea0-458c-9421-d166a9510bc0/GlobalHydrogenReview2021.pdf

3.3.1 Public Interest

The Proposal aims to support economic growth in regional by highlighting the emerging opportunities of a rapidly developing hydrogen industry. Significant growth potential could be captured regionally across hydrogen production, storage, transport, and end use. The Australian Infrastructure Plan (2021) states that if hydrogen uptake increased globally, the Australian hydrogen industry could create around 7,600 jobs and add approximately $11 billion a year to Australia's Gross Domestic Product by 2050[14]. By understanding the potential for rail to facilitate the transport of domestic hydrogen demand, development of this industry may be encouraged.

[14] Australian Infrastructure Plan, Australian Government, 2021, https://www.infrastructureaustralia.gov.au/sites/default/files/2021-09/2021%20Master%20Plan_1.pdf

4. Stakeholders

Key messages

- Stakeholders see the project as useful for the future hydrogen industry because it furthers understanding of the commercial viability of transporting hydrogen by rail and the associated regulatory and safety requirements.
- Rail is considered a safer option in comparison to road transportation. Rail also has the potential to reduce emissions and reduce the number of trucks on road.
- Safety aspects need to be better understood, especially in the safe handling, refuelling and maintenance of hydrogen systems.
- There are limited standards for the transportation of hydrogen, but safety and regulatory bodies are considering these issues.
- There are many potential end-uses for hydrogen to further de-carbonisation in Australia. However, there will need to be extensive engagement with the community to ensure it can be used safely and effectively.

4.1 Overview of stakeholder engagement

This section provides an overview of key stakeholders identified for the Proposal and a summary of its third-party support, should it be taken forward to implementation.

As this is a conceptual study on the potential transport of compressed gaseous hydrogen via the Inland Rail there is no existing production or consumption of hydrogen underpinning the analysis. Stakeholder consultation within this Study includes consultation with local governments, organisations, a state government department, local not-for-profit economic development organisations, a national regulatory and standards organisation and rail operators.

4.2 Stakeholders identified

An outline of the key stakeholders that are relevant to this Proposal, including a description of their relationship to the Proposal and the proposed consultation approach in future phases of the Gateway Assessment Process is provided in the table below.

An overview of the known level of support (inclusive of financial and/or in-kind support) for the Proposal at the Gate 2 stage of the Study is also indicated in the Table 6 below. Further information pertaining to the degree of financial support at this time is set out in Section 9 and Appendix B.

Table 6 List of key stakeholders

Stakeholder	Relevance and importance to this Proposal	Consultation approach	Form of support	Indicated level of support	Evidence provided
QTLC working group[15]	The working group supports QTLC and provides industry, technical and expert support, and advice to QTLC.	Consistent with the Proponent's request, key aspects of Proposal were discussed with the QTLC working group.	Positive sentiment	QTLC understand the value of conducting this conceptual study at Gate 2 to further an understanding of the potential transportation of hydrogen, but would unlikely want to progress it to Gate 3	Gate 2 consultation log
Australian Rail Track Corporation (ARTC)	ARTC is responsible for the delivery of Inland Rail, in partnership with the private sector.	ARTC was engaged in an online consultation for Gate 2. ARTC is interested in the safety impacts of the Proposal.	Positive sentiment	ARTC would like to continue to be engaged on the safety findings of the Proposal if it proceeds to Gate 3	Gate 2 consultation log
Aurizon	Aurizon is a rail freight operator in Australia. Aurizon transports more than 250 million tonnes of Australian commodities, connecting miners, primary producers, and industry with international and domestic markets.	Aurizon was engaged in an online consultation for Gate 2. Aurizon has investigated transporting hydrogen by rail (liquid form) in Queensland and they do not know if this transport will add value to the supply chain. Aurizon is looking at emerging markets and they are focused on the niche in bulk mining.	Neutral	Aurizon is interested in understanding the commercial viability of transporting hydrogen. It is recommended to keep Aurizon informed of the Proposal's progress if it proceeds to Gate 3. Note since the completion of the consultation process, Aurizon has announced that they are assessing the use of hydrogen powered trains for bulk freight with Anglo American.	Gate 2 consultation log
Department of Industry, Science Energy and Resources (DISER)	DISER supports economic growth, productivity, and job creation for all Australians by investing in science, technology and commercialisation and growing innovative and	DISER was engaged in an online consultation for Gate 2. DISER is interested in emissions reduction potential of the project from moving from road to rail.	Positive sentiment	DISER would like to continue to be engaged on the Proposal outcomes if it proceeds to Gate 3	Gate 2 consultation log

[15] Organisations that the working group are from the Wellcamp Intermodal facility, Ethical Developments Pty Ltd, Hyzon Motors Australia, Rethink Sustainability, Dr Andrew Dicks, and Protium Logistics.

Stakeholder	Relevance and importance to this Proposal	Consultation approach	Form of support	Indicated level of support	Evidence provided
	competitive businesses, industries, and regions. DISER supports the government's international climate commitments to reduce emissions by 2030 and the government's intention to get to net zero emissions as soon as possible, and preferably by 2050.				
Department of Transport and Main Roads (TMR) and NSW Environment Protection Authority (EPA)	TMR is a department of the Queensland Government which manages and delivers Queensland transport solutions for road, rail air and sea. The NSW EPA is the primary environmental regulator the NSW. They partner with business, government, and the community to prevent the degradation of the environment.	TMR and the NSW EPA were engaged together.	Positive sentiment	Both groups were interested in the safety and regulatory outcomes of the Proposal. It is recommended that they are kept informed of the Proposal's progress.	Gate 2 consultation log
SCT Logistics	SCT Logistics is a national, multi-modal transport and logistics company. SCT has offices in all capital cities across Australia, as well as regional locations in Queensland and NSW.	SCT Logistics was engaged in email communications for Gate 2. Several attempts were made to engage in an online consultation without success.	Neutral	SCT was unable to be engaged so it is recommended that they are consulted if the Proposal proceeds to Gate 3	Gate 2 consultation log
Parkes Shire Council	Parkes Shire Council services the communities of Parkes, Bogan Gate, Peak Hill, Trundle, Tullamore,	Parkes Shire Council was engaged in an online consultation for Gate 2. The Parkes Shire Council is supportive of the proposal to transport hydrogen	Positive sentiment	Further engagement with Parkes Shire Council is recommended at Gate 3 if the Proposal proceeds.	Gate 2 consultation log

Stakeholder	Relevance and importance to this Proposal	Consultation approach	Form of support	Indicated level of support	Evidence provided
	Alectown, and Cookamidgera. The combined population across the council area is 15,000. Key industries across the council area include agriculture, mineral resources, retail, government services, tourism, and transport. The Proposal aligns with Council's policies to utilise alternative fuel sources where possible. The commercial viability of this Proposal, linking and aligning with the Special Activation Precinct (SAP) is of particular interest to Council.	by rail rather than road. The Proposal aligns with the Council's policies to utilise alternative fuel sources where possible.			
Progress Rail	Progress Rail, a Caterpillar company, is one of the largest integrated and diversified providers of rolling stock and infrastructure solutions and technologies for the rail industry globally.	Progress Rail was engaged in a phone consultation for Gate 2. The company is not involved in the logistics and transport of hydrogen products and other commodities.	Neutral	It is recommended Progress Rail is kept informed of the Proposal's progress if it proceeds to Gate 3.	Gate 2 consultation log
Pacific National	Pacific National is the largest interstate rail freight carrier in Australia. Pacific National is Australia's leading intermodal freight and steel freight operator, eastern Australia's top carrier of regional exports, bulk	Pacific National was engaged in a phone consultation for Gate 2. Pacific National is considering hydrogen locomotives in their fleet regeneration, but this is a future strategy. At the moment it is seen as a high risk and Pacific National are	Neutral	It is recommended Pacific National is kept informed of the Proposal's progress if it proceeds to Gate 3.	Gate 2 consultation log

Stakeholder	Relevance and importance to this Proposal	Consultation approach	Form of support	Indicated level of support	Evidence provided
	goods, grain, and agricultural products, the largest transporter of coal in NSW, and the second-largest transporter of coal in Queensland.	seeking to develop their understanding in this area.			
Regional Development Australia (RDA)	RDA Orana covers the central and north-western areas of NSW (over 190,000km^2). The diversity of industries across the region is large and includes agriculture, mining, food and wine, renewable energy, and tourism. The organisation has strong networks across all industry sectors and government and can assist in making connections with local industries and key stakeholders. RDA can also assist in attracting potential investment from stakeholders across the region.	RDA Orana is generally supportive of the Inland Rail. The organisation is supportive of any initiative that would assist with improving efficiencies in logistics and freight and brings benefits to the region. If Inland Rail can remove some of the pressures on existing transport routes, and improve efficiencies and safety, that is a good thing.	Positive sentiment	RDA would like to be kept informed of the Proposal's progress and is happy to be engaged in further consultations as required.	Gate 2 consultation log
Toowoomba and Surat Basin Enterprise (TSBE)	TSBE is an independent, not for profit, member-driven economic development organisation. It links the local business community to opportunities across the Toowoomba, Western Downs, Maranoa, and surrounding areas. TSBE is well placed to partner with private and	The TSBE was engaged in an online consultation for Gate 2. TSBE is supportive of transporting hydrogen by rail rather than by road. The hydrogen sector would benefit from funding to conduct dedicated and focused research into the most efficient and effective way to transport hydrogen from origin to distribution points. TSBE is well placed to lead this	Positive sentiment	Further engagement with TSBE is recommended at Gate 3, should the Proposal proceed.	Gate 2 consultation log

Stakeholder	Relevance and importance to this Proposal	Consultation approach	Form of support	Indicated level of support	Evidence provided
	public research agencies to explore key aspects of the emerging hydrogen sector. TSBE could partner with the proponents to apply for grant funding for further research and development of the emerging hydrogen sector. The organisation is already working on several hydrogen projects in the local region.	research if funding can be sourced to support this work.			
Standards Australia	Standards Australia is an independent, non-government, not-for-profit standards organisation. The organisation represents Australia at the International Organisation for Standardisation (ISO) and International Electrotechnical Commission (IEC) and assists with the development of standards for Australian industries, the development and adoption of international standards and the accreditation of organisations to develop Australian standards. The organisation is developing a technical specification around the storage of liquid and gaseous hydrogen that is due to be released early in 2022. The information	There are currently no standards relating to the transportation of hydrogen by rail. Standards Australia could offer in-kind support to assist with the development of documentation (guidelines) for the transportation of hydrogen by rail. Members of the technical committees could assist in developing such documents. The organisation is developing a technical specification around the storage of liquid and gaseous hydrogen which is due to be released early in the new year. The information contained in these standards would be of interest and could inform the use of rail for transporting hydrogen.	Positive sentiment	Safety implications and requirements are of interest to Standards Australia. In addition, Standards Australia is interested in the learnings from the Proposal.	Gate 2 consultation log

Stakeholder	Relevance and importance to this Proposal	Consultation approach	Form of support	Indicated level of support	Evidence provided
	contained in these standards would be of interest and could inform the use of rail for transporting hydrogen.				
Toowoomba Regional Council	Toowoomba Regional Council provides local government services to communities from north of Yarraman to south-west of Millmerran and includes the city of Toowoomba. Council is keen to understand the potential economic development and commercial viability opportunities and challenges for the local region for this sector.	Toowoomba Regional Council was engaged in an online consultation for Gate 2. Council is supportive of the Proposal and is happy to be engaged in further consultations as required.	Positive sentiment	Further engagement with Toowoomba Regional Council is recommended if the Proposal proceeds to Gate 3.	Gate 2 consultation log
Transport for NSW (TfNSW)	TfNSW is the lead agency for the NSW transport cluster. The organisation leads the development of a safe, efficient, and integrated transport system that ensures people and goods are moved efficiently and communities – metropolitan and regional - are connected.	TfNSW was engaged in an online consultation for Gate 2. TfNSW is supportive of transporting hydrogen by rail relative to road. Safety is a major concern and if this can be improved/increased by transporting products such as volatile gases (i.e., compressed gaseous hydrogen) by rail	Positive sentiment	Further engagement with TfNSW is recommended if the Proposal proceeds to Gate 3.	Gate 2 consultation log
Wagner Corporation	Wagner is a major contributor to the development of Regional Queensland and the wider Queensland economy.	Wagner was engaged in a consultation for Gate 2. Wagner is currently investigating opportunities in hydrogen.	Neutral	Wagner is not interested in being further engaged on the Proposal.	Gate 2 consultation log

4.3 Key themes from stakeholder consultation

At the Gate 2 stage, the majority of engagement participants indicated clear interest in the Proposal. Key findings of stakeholder engagement at the Gate 2 stage include the following:

- Stakeholders are supportive of the transportation of hydrogen by rail, with many stating that any initiative to get bulk goods off the road network is a positive. Rail is considered a safer option for transporting hydrogen.
- The movement of hydrogen by rail will reduce emissions and reduce the number of trucks on road, which ultimately improves the carbon footprint for hydrogen production and distribution.
- Toowoomba Regional Council and Parkes Shire Council are interested to learn more about the potential economic opportunities and benefits for their prospective regions should the Proposal progress.
- Safety aspects that must be considered include safety during transport (particularly through tunnels and with proximity to flammable agents), handling (loading and unloading materials), refuelling and maintenance of hydrogen systems.
- Several stakeholders asked about the movement of hydrogen from the end point on the rail network to other destinations, as well as accessibility to rail networks that are not connected to the Inland Rail route. They asked how these networks would connect to and move gaseous hydrogen from rail carts on the Inland Rail to other rail networks. They observed that infrastructure must be in place to ensure efficient and safe loading and unloading of compressed gaseous hydrogen.
- There are currently no regulations or standards in Australia relating to the transportation of hydrogen by rail. Environmental regulations must also be considered.
- Standards Australia is developing a technical specification around the storage of liquid and gaseous hydrogen that is due to be released by mid-2022. The information contained in these standards would be of interest and could inform the use of rail for transporting hydrogen.
- Managing community perceptions around the safety of transporting hydrogen by rail was raised. A community information campaign may be required to manage perceptions. Using global case studies to showcase how hydrogen is used safely and effectively may be an effective tool.
- Heating households and powering locomotives and vehicles were identified by stakeholders as potential domestic uses for hydrogen.

5. Demand

Key messages

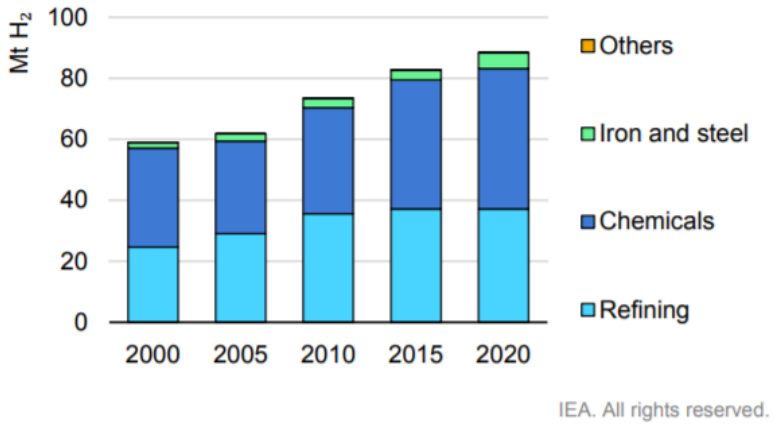
- Many uncertainties remain with respect to the growth of hydrogen. While hydrogen is currently produced and utilised at scale globally, demand is forecast to accelerate in coming years in Australia.
- The emerging hydrogen market in Australia is rapidly growing with support on the federal level through the National Hydrogen Strategy (2019) and at the state level through various state-based strategies. Since the National Hydrogen Strategy was published in 2019, the Government has taken significant steps to build demand, achieve low-cost hydrogen production at scale and reduce hydrogen delivery costs.
- At an Australian level, the CEFC conducted an economic gap assessment as part of their Australian hydrogen market study in 2021. The study identified that the use of hydrogen to support remote power, return to base vehicles (buses), line haul vehicles (such a trucks) and material handling as likely becoming viable for the use of hydrogen-based technology by 2030.
- The NSW Hydrogen Strategy names multiple 2030 "stretch targets", one of which is relevant to the opportunities for hydrogen on Inland Rail - to build a hydrogen refuelling network for heavy vehicles along major highways (including the Hume Highway Initiative) with a target of 100 stations. This includes potential hydrogen refuelling station locations to service a fleet of hydrogen-powered trucks dedicated to import or export freight movements between Brisbane and Melbourne. The Inland Rail corridor could play a critical role in the transportation of gaseous hydrogen to supply these fuelling stations.
- A transportation cost analysis has been developed which considers both production volume and distance to assess the viability of hydrogen transportation using Inland Rail versus road transportation. The analysis identified the potential tipping point for the viability of using rail as being a production volume 4500kg/day or greater and a distance of 850km or longer.

5.1 Demand for Hydrogen use

5.1.1 Global Hydrogen growth

Many uncertainties remain with respect to the growth of hydrogen. While hydrogen is currently produced and utilised at scale globally, demand is forecast to accelerate in coming years. In 2020, approximately 90 Mt of hydrogen was used, mainly in refining, chemical production (mainly ammonia and methanol)[16] and steel production. Hydrogen demand is summarised in Figure 7.

Figure 7 Hydrogen demand by sector, 2000-2020



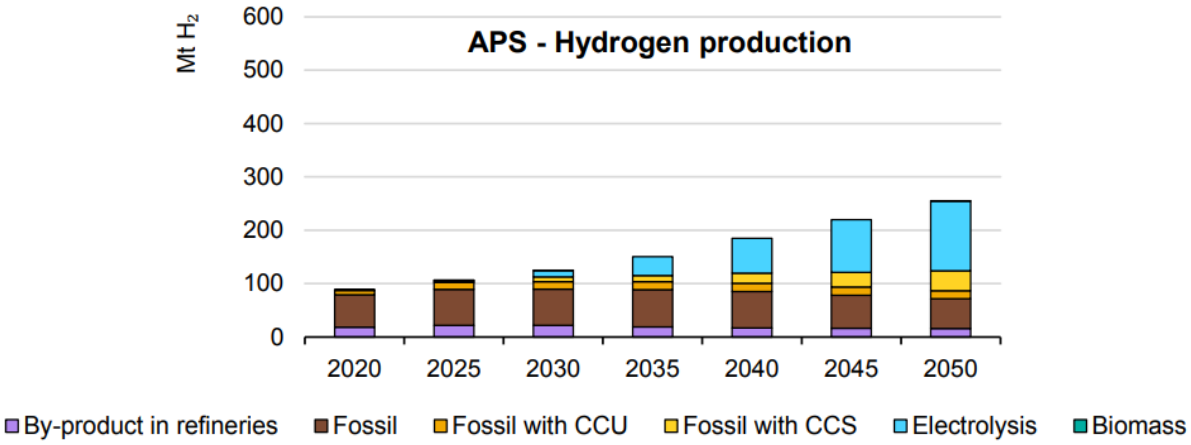
Note: "Others" refers to small volumes of demand in industrial applications, transport, grid injection and electricity generation.

Source: Global Hydrogen Review, International Energy Agency, 2021

[16] Global Hydrogen Review, International Energy Agency, 2021, https://iea.blob.core.windows.net/assets/3a2ed84c-9ea0-458c-9421-d166a9510bc0/GlobalHydrogenReview2021.pdf

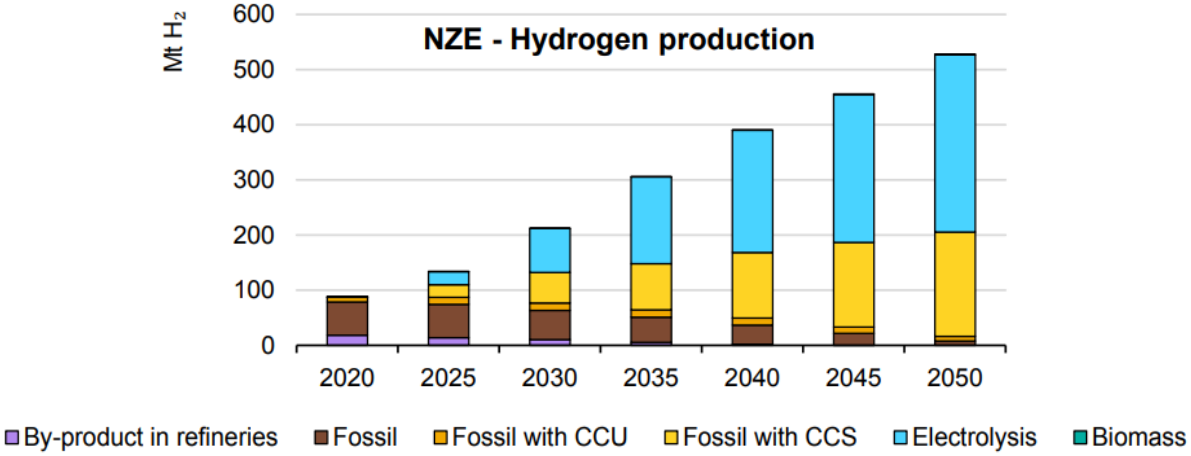
Future demand for hydrogen, particularly the adoption of hydrogen for new applications will in part be driven by future decarbonisation scenarios. The International Energy Agency (IEA) has defined two main decarbonisation scenarios in their forecasting work. The Announced Pledges Scenario (APS) shows a world where current policies are extrapolated, which does not reach net zero emissions by 2050 as announced policies are not sufficient to meet this target. The IEA Net Zero Emissions (NZE) scenario shows a pathway for global net zero emissions. These two scenarios set out high and low projects for hydrogen supply and demand. Figure 8 and Figure 9 show the forecast for hydrogen production by source in both scenarios while Figure 10 shows the projected demand by end use. These scenarios project growth in annual hydrogen supply and demand by between 2.5 and 5 times by 2050.

Figure 8 Global hydrogen production in the APS scenario



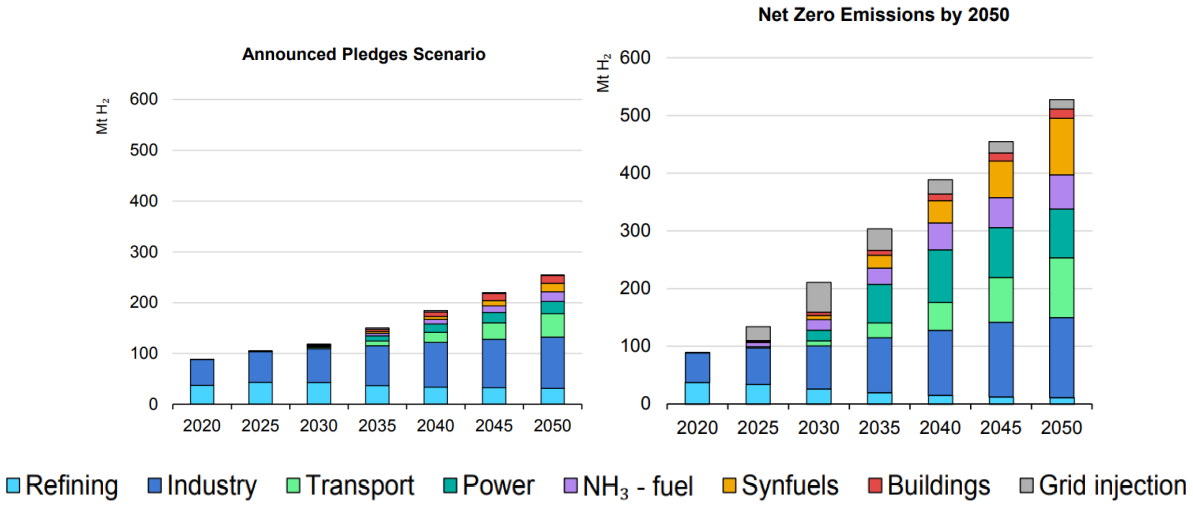
Source: Global Hydrogen Review, International Energy Agency, 2021

Figure 9 Global hydrogen production in the NZE scenario



Source: Global Hydrogen Review, International Energy Agency, 2021

Figure 10 Hydrogen demand by sector in the Announced Pledges and Net zero Emissions scenarios, 2020-2050



Source: Global Hydrogen Review, International Energy Agency, 2021

5.1.2 Australian Hydrogen

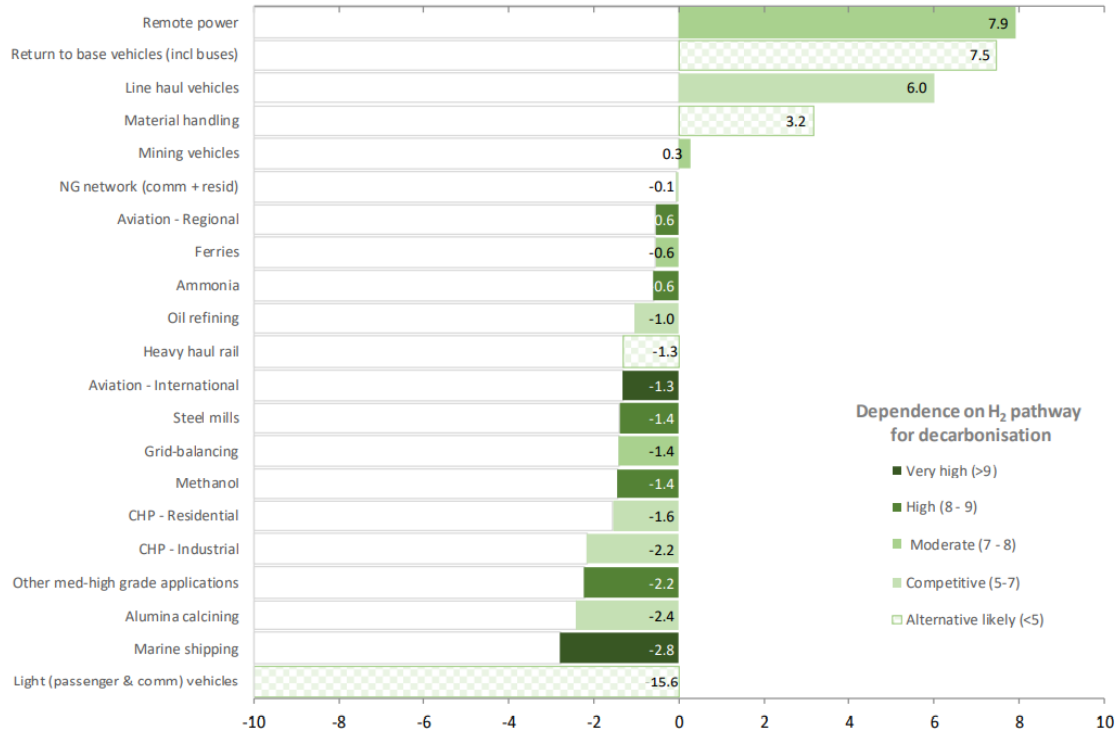
The emerging green hydrogen market in Australia is rapidly growing with support on the federal level through the National Hydrogen Strategy (2019) and at the state level through various state-based strategies. Since the National Hydrogen Strategy was published in 2019, the Government has taken significant steps to build demand, achieve low-cost green hydrogen production at scale and reduce hydrogen delivery costs. This is critical in unlocking Australia's potential both domestically and as an international exporter. The following section summarises the current state of the Australian industry, highlighting the growth horizon for hydrogen demand.

5.1.2.1 Forecast Hydrogen adoption in Australia

At an Australian level, the CEFC conducted an economic gap assessment as part of their Australian hydrogen market study in 2021. Key findings from this assessment are graphically represented in Figure 11 which details the gap assessment by industry in 2030. A positive economic gap indicates the viability of hydrogen-based technology and a negative gap indicating incumbent technology is competitive.

The study identified that the use of hydrogen to support remote power, return to base vehicles (buses), line haul vehicles (such a trucks) and material handling as likely becoming viable for the use of hydrogen-based technology by 2030.

Figure 11 Economic gap (2030) by industry ($/kg)



The costs of electrolysis plants are forecast to decline rapidly as production scale escalates and technology is refined. The study also determined the price per kilogram of types of hydrogen in 2020, 2030 and 2050 under various scenarios of development. The costs identified use a cost decline curve is detailed in Table 7 below. Key findings are that the forecast costs for low carbon hydrogen will not achieve thermal cost parity with natural gas (at $1.1/kg) before 2050. Green hydrogen is expected to reach cost parity with grey hydrogen at around $2.30/kg between 2030 and 2050. Note that the costs presented represent the anticipated cost of hydrogen at the output of the production process, that is electrolyser or gas reformer, and does not consider delivery costs.

Table 7 Forecast hydrogen cost summary

Metric	2020	2030	2050
“Grey” hydrogen production cost ($/kg)	2.20	2.29	2.29
“Blue” hydrogen production cost ($/kg)	3.02	2.80	2.80
“Green” hydrogen production cost ($/kg)	3.88	2.81	2.09

Source: CEFC, Australian Hydrogen Market Study, 2021

In summary, the report identifies the following findings regarding market potentials for hydrogen use within Australia:

- Green hydrogen is already approaching cost competitiveness for heavy trucking, buses, and remote power, with the potential to become commercially viable across other non-transport sectors as early as 2030.
- Parallel advances in production and distribution costs, as well as ongoing technology evolution, will accelerate the commercial attractiveness of green hydrogen across key areas of the economy.
- Large-scale development is critical to driving down installation and commissioning costs. While hydrogen was closest to achieving commercial parity as an alternative to petroleum products, displacing natural gas provides a potential transitional use to reach scale at pace.
- The export of hydrogen is forecast to be a key enabler of the global low carbon economy – however, the inherent low density of hydrogen makes the economics of international export challenging based on current technologies.

5.1.2.2 Current Pledged Australian Hydrogen Projects

Australia's National Hydrogen Strategy was released in 2019, providing a vision for growth in hydrogen and Australia's potential role in that future. The Proposal is complementary to the expected growth and investment in the emerging hydrogen market. Financial support has been provided to hydrogen related investment programs. Since 2018, the financial support includes approximately:

- $1.3 billion of Australian Government Funding[17]. The Australian government continues to invest additional funds in hydrogen development, with an additional $424m allocated for project feasibility studies and pilot projects[18].
- $3 billion of NSW Government funding as part of the NSW Hydrogen Strategy[19].
- $19 million of Queensland Government funding under the Queensland Hydrogen Industry Strategy[20].
- $10 million committed by the Victorian Government as part of the Victorian Renewable Hydrogen Industry Development Plan[21].
- $15 million of WA Government funding delivered through the Renewable Hydrogen Fund, part of the WA Renewable Hydrogen Roadmap[22].

5.2 Opportunities for hydrogen on Inland Rail

There has been increased support on the state and federal level to progress the development of the hydrogen industry in Australia. The NSW Hydrogen Strategy (2021) is a framework to support the development of a commercial hydrogen industry in NSW. Specifically, by providing up to $3 billion of incentives to commercialise hydrogen supply chains and reduce the cost of green hydrogen by an estimated $5.80/kg to $2.80/kg. The strategy is built on three strategic pillars: enable industry development, lay industry foundations, and drive rapid scale.

The strategy names multiple 2030 'stretch targets'. One of these targets is relevant to the opportunities for hydrogen on Inland Rail: to build a hydrogen refuelling network for heavy vehicles along major highways with a target of 100 stations. The Inland Rail corridor could play a critical role in the transportation of gaseous hydrogen to supply these fuelling stations.

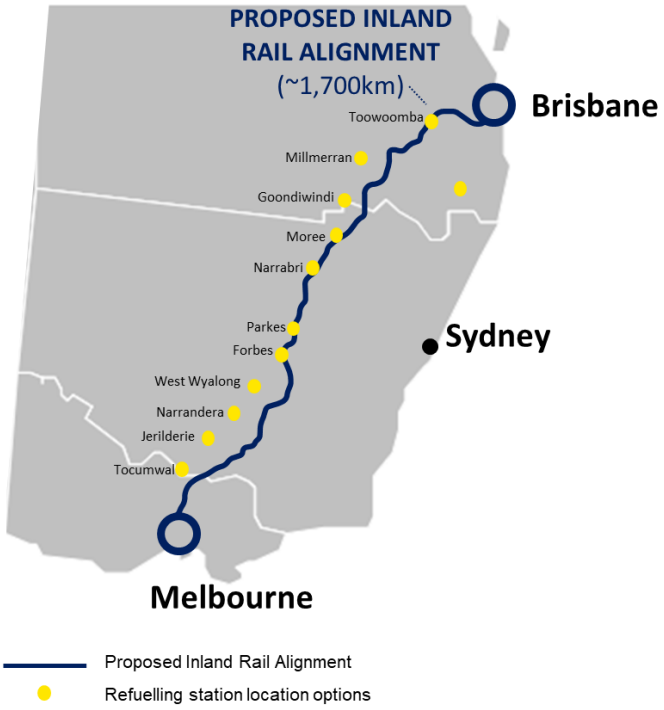
The NSW Hydrogen Strategy anticipates that by 2030 hydrogen will become price competitive against existing carbon-based fuels - especially for diesel heavy transport such as road freight and agricultural machinery. Furthermore, transitioning to hydrogen fuelled heavy vehicles provides numerous co-benefits. The elimination of tailpipe emissions in the heavy transport sector will result in major reductions in public health costs from particulate matter emissions. Additionally, decreased noise pollution will allow off-peak heavy vehicle operation, reducing traffic on major Australian roads.

According to the NSW Department of Planning, Industry and Environment modelling, by 2050 the heavy-duty truck sector in NSW is expected to grow to around 50,000 vehicles. This growth creates a market for up to 500,000 tonnes of hydrogen per annum or 2.6 GW of electrolyser capacity. This must be supported by a hydrogen refuelling network along the major logistics corridors connecting the east coast states. The NSW Hydrogen Strategy has made the rollout of the refuelling network a key priority by making available $175 million in funding under the New Low Carbon Industry Foundations focus area of the Net Zero Industry and Innovation Program.

Hydrogen as a Transport Fuel report (2019) identifies potential hydrogen refuelling station locations to service a fleet of hydrogen-powered trucks dedicated to import or export freight movements between Brisbane and Melbourne[23]. Figure 12 provides a visual representation of the alignment between proposed hydrogen refuelling stations and the Inland Rail corridor. The strong alignment indicates the potential for Inland Rail to play a key role in supplying hydrogen to regional refuelling stations and drive the decarbonisation of the heavy vehicle industry.

[17] Global Hydrogen Review, International Energy Agency, 2021
[18] Future hydrogen industry to create jobs, lower emissions and boost regional Australia
[19] NSW Hydrogen Strategy, NSW Government, October 2021
[20] Queensland Hydrogen Industry Strategy 2019-2024, Queensland Government, May 2019
[21] Victorian Renewable Hydrogen Industry Development Plan, Victoria State Government, 2021
[22] Western Australia Renewable Hydrogen Roadmap, WA Government, November 2020
[23] Hydrogen as a Transport Fuel, BITRE. 2019

Figure 12 Inland rail alignment to proposed refuelling stations



Source: EY

5.3 Hydrogen supply chain cost analysis

A transportation cost analysis has been developed, which considers both production volume and distance, to assess the viability of hydrogen transportation using Inland Rail (Rail Case) versus a road transportation (Road Case). The following section provides an overview of the key assumptions used as well as the outputs of the analysis to identify the potential tipping point in terms of freight costs for transporting hydrogen on road versus rail.

5.3.1 General Production Assumptions

An analysis of generalised rail and road costs provides insights on the comparative cost of these modes over a given pathway. It is used as an indication of the likelihood of freight switching mode, however it does not necessarily reflect market prices as it excludes overheads and margins (which are usually considered commercial in confidence information).

The analysis is based on industry insights and inputs such as distance, train length, mass, and travel times. Key cost components include labour costs, maintenance, fuel, network access, rollingstock capex and finance and operating costs. Unit cost parameters are sourced from the Australian Transport Assessment and Planning (ATAP) guidelines and other State and Territory economic parameter guidance. Note further information on the tanktainers assumed can be found in Section 6.3.

Table 8 General Production Assumptions

Item	Assumption
General Parameters	
Model Year	2022
Inflation Rate	2.5%
Transport route	Toowoomba to Parkes (or Parkes to Toowoomba) ~850 km
Good type	Compressed gaseous hydrogen
Tanktainer Parameters	

Tanktainer CAPEX per unit	$15,000/tanktainer
Economic life	7 years
Maintenance and Finance Cost	10%
Mass (loaded)	4.5t
Mass (empty)	3.9t

5.3.2 Road Case assumptions

Table 9 shows the road operating assumptions used to establish the Road Case. These key assumptions were derived from stakeholder consultation and industry knowledge and used as an input for road transport cost analysis under both volume and distance scenarios.

Table 9 Road Operating Assumptions

Item	Assumptions (Scenarios 1-6)
Operational Cycle Time	
Operating days per year	300 days
Operating hours per day	12 hours
Average trip distance	850 km one way
Transit hours UP	10 hours
Transit hours DOWN	10 hours
Load Origin hours	1 hours
Unload destination hours	1 hours
Non-productive time	3%
Fleet composition	
6 Axle	0%
B-doubles	100%
B-triples/Road Trains	0%
Average vehicle capacity	4 TEUs one way

5.3.3 Rail Case assumptions

Table 10 shows the rail operating assumptions used to establish the Rail Case. These key assumptions were derived from stakeholder consultation and industry knowledge and used as an input for rail transport cost analysis under both volume and distance scenarios.

Table 10 Rail Operating Assumptions

Item	Assumptions (Scenarios 1-3)	Assumptions (Scenarios 4-6)
Rail Service Details	**(Part train)**	**(Dedicated train)**
Operating days per year	300 days	250/300 days[24]
Operating hours per day	16 hours	16 hours
Maximum tonne axle load (TAL)	25 TAL	25 TAL
Service distance	850 km one way	850 km one way
Number of Locomotives	2	2-3[25]

[24] 250 operating days per year for a single dedicated service per week (scenario 4), or 300 for multiple.

[25] Number of locomotives are dependent on the number of wagons, under scenario 6 3 locomotives are required.

Item	Assumptions (Scenarios 1-3)	Assumptions (Scenarios 4-6)
Operational Cycle Time		
Transit hours Up	14 hours	13 hours
Transit hours Down	14 hours	13 hours
Load Origin hours	3 hours	5 hours
Unload destination hours	3 hours	3 hours
No-productive time	3%	3%
Crew & Other		
Train crew per shift	2	2

5.3.4 Outputs

This section details the outputs of the transport cost modelling for the Road Case and Rail Case. Analysis has been undertaken to determine the tipping point between road and rail under variable volume and distance scenarios. The volume driven analysis uses a standard distance of Toowoomba to Parkes while the distance analysis uses various distances from Brisbane to Parkes with a standard volume of 4500kg/d.

5.3.4.1 Transport cost analysis by volume

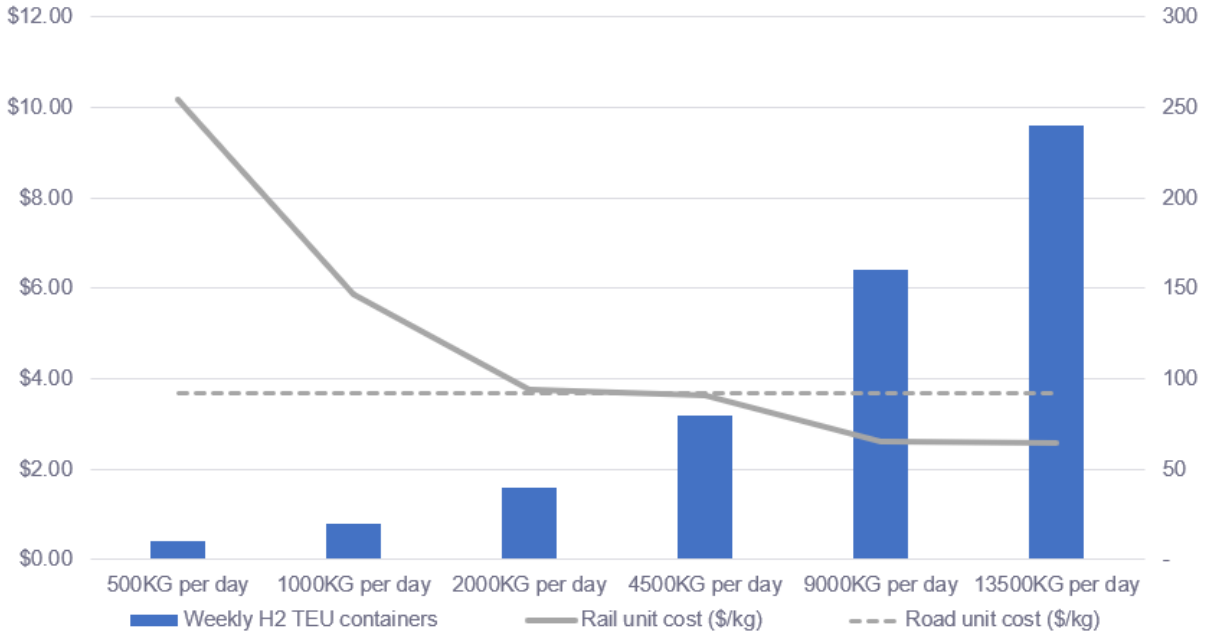
A summary of the transport cost analysis by volume between road and rail is shown in Table 11. Six volume scenarios have been modelled (500kg/day – 13,500kg/day) while keeping the distance travelled constant at 850km (Toowoomba to Parkes) to determine the volume dependent tipping point.

Table 11 Transport cost analysis by volume (850km freight distance) ($FY2022 real)

Item	Road	Rail
Cost per kg of Hydrogen Gas		
Scenario 1 500kg/day	$3.69	$10.17
Scenario 2 1000kg/day	$3.69	$5.87
Scenario 3 2000kg/day	$3.69	$3.75
Scenario 4 4500kg/day	$3.69	$3.62
Scenario 5 9000kg/day	$3.69	$2.63
Scenario 6 13,500kg/day	$3.69	$2.58

Figure 13 highlights the volume tipping point and shows the viability of hydrogen transportation by rail versus road across the six volume scenarios.

Figure 13 Indicative volumes and modal unit costs (by volume scenario)



From the analysis it can be concluded that the volume tipping point in terms of transport costs between Toowoomba and Parkes utilising Rail is 4500kg/day.

The above findings align with the March 2022 Australian Railway Association report developed by GHD Advisory titled “Freight Modal Shift: Mode Shift Impediments and opportunities”. This report identified that longer trains or larger volumes have benefits of greater fixed-cost dilution making each additional wagon load, or container, less expensive to move and therefore more cost competitive. This result can be seen with the significant reduction in rail costs between scenarios 1 – 3 (500kg/day – 2000kg/day) whereby the transport of hydrogen requires less than full train lengths. In comparison reduction in prices between scenarios 3 – 6 (4500kg/day – 13,500kg/day) is plateauing due to these scenarios utilising dedicated services of varying lengths to transport hydrogen.

Therefore, the transportation of hydrogen utilising rail becomes more cost competitive as the train lengths / volumes transported increase to dilute fixed costs.

5.3.4.2 Transport cost analysis by distance

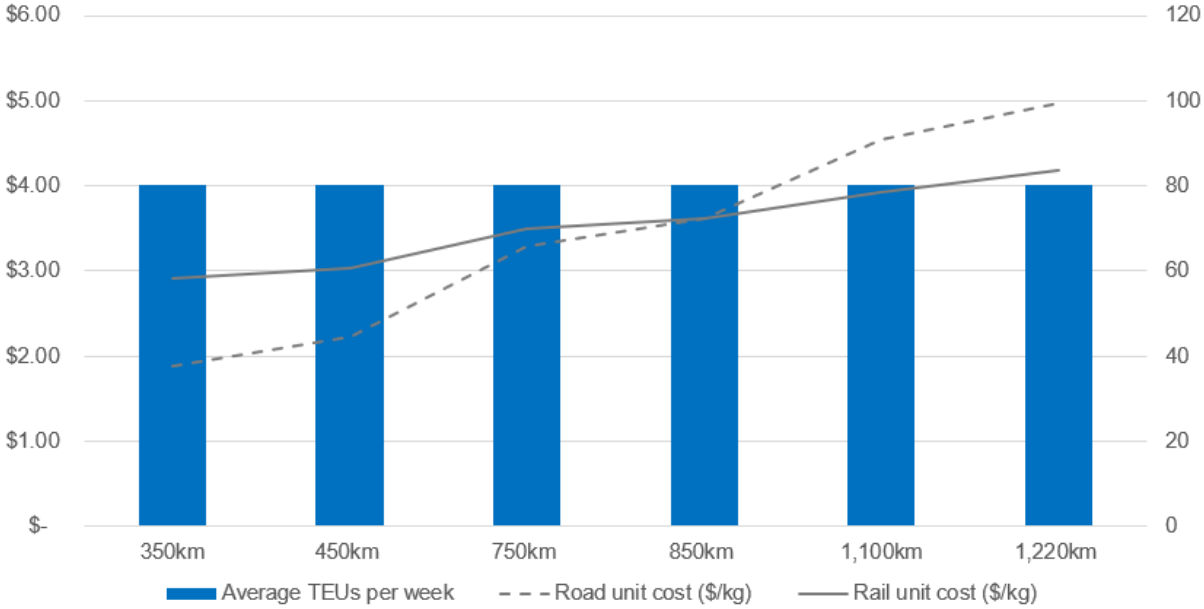
A summary of the transport cost analysis by distance between road and rail is shown in Table 11. Six distance scenarios have been modelled along the Inland Rail Corridor (350kms-1,220kms) while keeping the volume transported constant at 4500kgs per day to determine the distance dependent tipping point.

Table 12 Transport cost analysis by distance (4500kg/day production assumption) ($FY2022 real)

Item	Road	Rail
Cost per kg of Hydrogen Gas		
Scenario 1 350kms (Moree)	$1.89	$2.91
Scenario 2 450kms (Narrabri)	$2.23	$3.03
Scenario 3 750kms (Narromine)	$3.29	$3.50
Scenario 4 850kms (Parkes)	$3.62	$3.62
Scenario 5 1,100kms (Wagga Wagga)	$4.54	$3.93
Scenario 6 1,220kms (Albury)	$4.97	$4.18

Figure 14 highlights the volume tipping point and shows the viability of hydrogen transportation by rail versus road across the six distance scenarios.

Figure 14 Indicative distances and modal unit costs (by distance scenario)



From the analysis it can be concluded that the distance tipping point in terms of transport costs with a transportation volume of 4500kg/day is 850km (Toowoomba to Parkes).

The above findings align with the March 2022 Australian Railway Association report developed by GHD Advisory titled “Freight Modal Shift: Mode Shift Impediments and opportunities”. This report identified that distance is an impediment to mode shift. It was found that rail is less competitive with other modes over shorter distances, The analysis undertaken within this Gate 2 Study shows that as hydrogen is transported further on rail it becomes more competitive, and over distances of 850km, costs less per kg than road transport. It is noted however that this distance is based on the assumptions highlighted earlier in this section and can vary based on several factors including: ‘last mile’ costs, volumes transported, train utilisation, and other factors.

6. Options Identification and Assessment

Key messages

- Due to the conceptual nature of the Proposal a significant options identification process was undertaken to inform the development of the Road Case and Rail Case which included an assessment of the following areas:
    - Mode of transportation. The transport modes were assessed against their alignment to the PEP principles which include whether they increase a mode shift from road to rail. It was found that only rail would potentially increase throughput of Inland Rail and that it should be assessed against road to determine when there would be a shift from road to rail from a commercial viability perspective.
    - Form of hydrogen. The form of hydrogen to be transported between Toowoomba and Parkes was assessed using an MCA. Gaseous hydrogen was found to be the preferred form of hydrogen.
    - Volume of production. The production volume of hydrogen considered under this Proposal is approximately 4.5 tonnes per day using a 10MW electrolyser. This volume is supported by adopting a similar sized electrolyser to recent demonstration projects supported by ARENA.
    - Route of hydrogen. Toowoomba Wellcamp to the Parkes Logistic terminal was identified as the preferred route by the Proponent given the original EOI. This distance is also supported by the transport cost analysis undertaken in Section 6 to identify the potential tipping point.
    - Method of operations / storage. To transport compressed hydrogen gas by rail, approved containers for rail traffic will need to be produced and certified. Modular 'tanktainers' have therefore been selected as the storage method within this Study.
- The Road Case is to transport gaseous hydrogen produced utilising a 10MW electrolyser by road between Toowoomba and Parkes using modular tanktainers. Due to the conceptual nature of the Study the Road Case does not currently exist. The Rail Case utilises the same assumptions with the exception of utilising rail rather than road.
- An infrastructure technical solution was identified to support the Road Case and Rail Case, it has been assumed that the infrastructure will be co-located with other facilities (for example an intermodal, road logistics facility, the production facility, or others) and as such all supporting infrastructure (such as loading equipment, trunk infrastructure, and connecting roads for example) are not included within the analysis.
- The infrastructure solution is not anticipated to be refined in future gates due to the lack of site-specific details.

6.1 Overview

This Proposal has explored the potential to transport hydrogen via Inland Rail. The purpose of assessing the transport options is to support future growth of green hydrogen and decarbonisation. As this is a potential future scenario, the Proposal is conceptual in nature and explores the potential to utilise the Inland Rail network for transportation of bulk quantities of hydrogen for domestic use in a future decarbonised economy.

Through the ILM workshop, the KPIs detailed in Figure 5 were identified. The Proposal sought to identify an appropriate Road Case and Rail Case to assess the viability tipping points from using Inland Rail based on these KPIs.

This section provides an overview of the option identification process utilised to determine the Road Case and Rail Case, as well as the technical infrastructure solution required to support the Proposal. Due to the conceptual nature of the Proposal, this section does not seek to identify site specific solutions and determine a preferred option, but rather identify the assumptions that will underpin the analysis undertaken within this Study.

6.2 Option Identification Approach

Five key input assumptions were analysed to inform the development of the Road Case and Rail Case, including:

- Mode of transportation.
- Form of hydrogen.
- Production volume.
- Route of transportation.
- Method of operations.

The subsequent sections provide an overview of each assumption and the process undertaken to determine the Road Case and Rail Case.

6.2.1 Transportation mode identification

A range of potential transport modes were explored with consideration for the KPIs established in the ILM. The modes were assessed based on their alignment to the PEP principles, or more specifically whether they increase mode shift from road to Inland Rail throughput. The long list of transport modes considered included:

- Road.
- Rail.
- Co-Location of use and production.
- Pipeline.
- Shipping (included based on standard assessment methodologies).

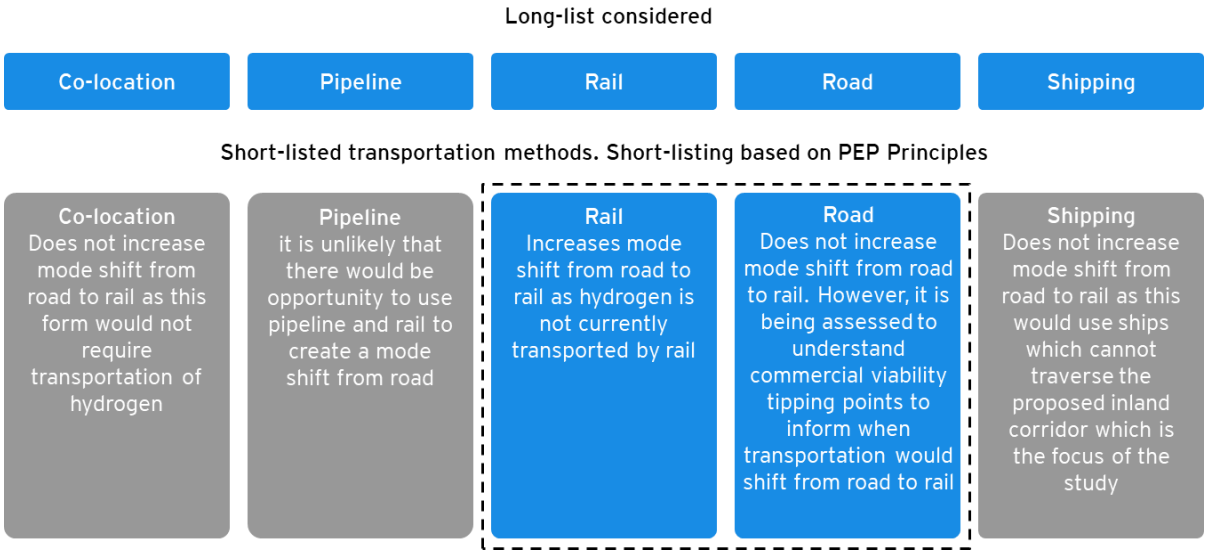
Through this analysis, rail and road were short listed as the target transportation modes. Road does not increase mode shift from road to rail. However, it is being assessed to understand commercial viability tipping points to inform under what conditions rail would be more commercially viable than road. Rail increases mode shift from road to rail as hydrogen is not currently transported by rail.

Co-Location, pipeline and shipping were not considered as modes of transportation for hydrogen assessed under this Proposal due to the following reasons:

- Co-Location was not considered as it does not increase mode shift from road to rail as this would not require transportation of hydrogen.
- Pipeline was not assessed further as it is unlikely that there would be opportunity to use pipeline and rail to create a mode shift from road. Due to the Inland Rail focus of the II Program this Proposal is part of, it was not assessed in any further detail.
- Shipping was included for completeness due to the standard methodology being used. Due to the inland nature of the study route, it was not assessed in any further detail.

The assessment of each transport mode is summarised in Figure 15. It was determined that the Proposal should proceed with the assessment of options utilising both road and rail transportation modes.

Figure 15 Transportation Method Assessment



6.2.2 Form of hydrogen

There are a number of different forms in which hydrogen can be stored with the regulatory and infrastructure requirements potentially differing substantially depending on the form chosen. It is also noted that form of hydrogen suitable for different applications is not settled[26], with different applications currently requiring different forms of hydrogen. The form in which hydrogen is transported is a fundamental underlying assumption for this Study that required appropriate consideration. As a result, an MCA has been conducted to establish the preferred form from the following potential alternatives:

- Gaseous hydrogen.
- Liquified hydrogen.
- Blended with natural gas.
- Ammonia.
- MCH.

While not all forms of hydrogen were in scope by the department, all were still considered in the MCA. This is appropriate for the study given it is a ‘point in time’ study and the preferred form of hydrogen may change as new technology innovations arise.

The following sub-sections provide an overview of the MCA approach and how the preferred form of hydrogen for this Study was identified.

6.2.2.1 Evaluation criteria

Table 13 lists the evaluation criteria that were developed following a consultative process with the Proponent to compare the hydrogen forms for this Proposal. After determining the criterion, each was given a relative importance weighting to allow for the assessment of each option.

[26] International Energy Agency, Global Hydrogen Review, 2021, https://iea.blob.core.windows.net/assets/e57fd1ee-aac7-494d-a351- f2a4024909b4/GlobalHydrogenReview2021.pdf

Table 13 Evaluation criteria – Options Assessment

Criteria	Description	Weighting
Availability of information	This criterion relates to the information available on transporting the form of hydrogen so that it can be benchmarked for assessing cost and safety information	30%
Technology currently available	This criterion looks at the technology currently available to produce hydrogen in this form and to convert it back to pure gaseous hydrogen if required	30%
Applicability to domestic end use	This criterion assesses the applicability of this form of hydrogen for domestic use. The option will receive a high score if there are no changes to form required for domestic use	25%
Safety considerations	This criterion considers the safety implications of the different forms of hydrogen on a relative basis. Where another form of hydrogen is safer, it will receive a higher score. Safety information is qualitative and based on desktop research	15%

6.2.2.2 Scoring

The assessment ratings which were used, and their corresponding values are outlined in Table 14 below. Each form was assessed against the criterion previously listed using the ratings in the table below.

Table 14 MCA Scoring

Assessment rating	Description
Very high (5)	The form achieves a very high contribution towards this evaluation criterion
High (4)	The form achieves a high contribution towards this evaluation criterion
Medium (3)	This form achieves a medium contribution towards this evaluation criterion
Low (2)	This form achieves a low contribution towards this evaluation criterion
Very low (1)	This form achieves a very low contribution towards this evaluation criterion

Scoring system

The weighted scores for each criterion were used to develop a ranking of options in the MCA as follows. For all forms of hydrogen explored in the MCA, each criterion was given an assessment rating of 1 through 5. The assessment rating (1-5) was then multiplied against the criterions' weightings (%) to determine the weighted value for each criterion. The weighted values were then summed to determine the total score for each form of hydrogen.

Weighting system used

The weighting assigned to each of the criteria detailed in table 8 above were decided through consultation with the proponent in combination with desktop research.

Current availability of information and technology were both assigned the highest weighting of 30%. Keeping the objective of the study in mind, commercial viability of a rail transportation solution for hydrogen is contingent upon the ability to produce the preferred form of hydrogen and generate sufficient demand. Hence, both of these criteria are highly important in understanding which forms of hydrogen could be transported in the current road and rail context.

Applicability to domestic end use was given a weighting of 25%. This criterion was weighted marginally lower as domestic hydrogen demand is for a niche market currently as opposed to the potential future market for energy applications. It is expected that this will change in the future. This criterion is also considered to have lower importance as all forms can be converted for desired end use (albeit with cost penalties).

Safety considerations was given the lowest weighting of 15% as while existing regulatory frameworks provide for management of hydrogen hazardous areas and pressure vessels, these frameworks are not fit for purpose for the future of the hydrogen economy. Assessment against current safety

regulations would therefore not be meaningful. Moreover, a preliminary desktop assessment, found that all forms of hydrogen considered had similar safety implications and therefore a higher weighting would not have altered the final score.

6.2.2.3 Option analysis

The following tables detail the rationale behind the assessment of all forms of hydrogen considered in the MCA.

Gaseous hydrogen assessment

The gaseous hydrogen assessment in Table 15 shows the scoring of each criterion as per the MCA and the rationale for each score given.

Table 15 Gaseous hydrogen assessment

Criterion	Score	Rationale
Availability of information	High	The costs associated with transporting gaseous hydrogen are well understood as the containers required are known. In addition, gaseous hydrogen transportation is currently occurring across the globe (primarily by truck)[27,28].
Technology currently available	Very high	Given that hydrogen is produced at relatively low pressures (20- 30 bar), it must be compressed prior to transport. There are many types of compressors available which may be used[29]. Gaseous hydrogen is commonly produced and transported via pipeline and truck globally[30].There has been increased R&D on the modes of gaseous hydrogen transportation, particularly pipeline and tube trailers[31].
Applicability to domestic end use	Very High	Domestic end use is likely to focus on using hydrogen for long-distance heavy-duty transport, industrial feedstock and heating and blending in gas networks[32].This aligns to gaseous hydrogen as it is anticipated to be the dominant delivery method to hydrogen refuelling stations[28]. Similar to natural gas, hydrogen is combustible and can be distributed through the same existing infrastructure networks in some cases making it a quick and viable substitution subject to technical limitations that are being investigated[31,27].
Safety considerations	Medium	The key safety concerns with gaseous hydrogen include detecting leaks and avoiding risk of explosions[33]. Because of its existing use, there is experience managing these safety concerns in traditional hydrogen use-cases.

Liquid hydrogen assessment

The liquid hydrogen assessment in Table 16 below shows the scoring of each criterion as per the MCA and the rationale for each score given.

Table 16 Liquid hydrogen assessment

Criterion	Score	Rationale
Availability of information	Medium	Liquid hydrogen is transported by road in the US when there isn't a pipeline option[34]. Japan is also producing and transporting liquified hydrogen in trailers for trucks[34]. Notwithstanding this, liquid hydrogen is less common than

[27] International Energy Agency, Global Hydrogen Review, 2021
Accessed at: https://iea.blob.core.windows.net/assets/e57fd1ee-aac7-494d-a351-f2a4024909b4/GlobalHydrogenReview2021.pdf
[28] M. Ball, M. Weeda in Compendium of Hydrogen Energy, 2016
Accessed at: https://www.sciencedirect.com/topics/engineering/compressed-gaseous-hydrogen
[29] Office of Energy Efficiency & Renewable Energy, Gaseous Hydrogen Compression
Accessed at: https://www.energy.gov/eere/fuelcells/gaseous-hydrogen-compression
[30] ARENA, Hydrogen: A Renewable Energy Perspective Storing Hydrogen, 2019
Accessed at: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Sep/IRENA_Hydrogen_2019.pdf
[31] COAG Energy Council Hydrogen Working Group, Australian Hydrogen Hubs Study: Technical Study, 2019
Accessed at: nhs-australian-hydrogen-hubs-study-report-2019.pdf (energyministers.gov.au)
[32] COAG Energy Council, Australia's National Hydrogen Strategy, 2019
Accessed at: https://www.industry.gov.au/sites/default/files/2019-11/australias-national-hydrogen-strategy.pdf
[33] ANSI, Guide to Safety of Hydrogen and Hydrogen Systems, 2004
Accessed at: https://arc.aiaa.org/doi/10.2514/4.105197.001
[34] Office of Energy Efficiency & Renewable Energy, Liquid hydrogen delivery
Accessed at: https://www.energy.gov/eere/fuelcells/liquid-hydrogen-delivery

Criterion	Score	Rationale
		compressed gas and availability of key technical and cost information is less relative to gas
Technology currently available	High	Gaseous hydrogen can be liquefied, but this process consumes more than 30% of the energy content of hydrogen and is expensive[35]. Also, hydrogen is lost through evaporation in this form[37]. Liquid hydrogen technology exists but is not commonly used relative to gas and remains a focus of future research and development and pilot projects[26].
Applicability to domestic end use	High	Pilot projects in Australia have focused on transporting of liquified hydrogen for export[32]. Liquid hydrogen may form an economic domestic road/rail transport mechanism in the future. However, liquid is currently considered as a primary option for export rather than domestic end-use due to the difficulties in moving liquid hydrogen[31].
Safety considerations	Medium	Key safety concerns of liquid hydrogen include frostbite burns or hypothermia from direct contact with the skin and ice formation or continuous evaporation creating an explosion [35]. The storage of liquid hydrogen in a vessel introduces the risk of contamination with air when evaporation occurs[36]. In comparison to gas, liquid hydrogen has additional safety hazards because of its ease of evaporation[37].

Hydrogen blended with natural gas assessment

The hydrogen blended with natural gas assessment in Table 17 below shows the scoring of each criterion as per the MCA and the rationale for each score given.

Table 17 Hydrogen blended with natural gas assessment

Criterion	Score	Rationale
Availability of information	Medium	Currently, there isn't research into transporting blended gases by rail. The focus is transporting blended gases by pipeline as a low-cost option for delivering hydrogen[38].
Technology currently available	Medium	Given the preference to transport blended gases by pipeline, Industry is focusing on how to upgrade existing pipelines to be able to include hydrogen. This includes addressing the potential for hydrogen embrittlement of metal pipelines and the need to control pipeline leaks[39].There are multiple demonstration projects underway in Australia exploring the blending of up to 10% renewable hydrogen into existing natural gas networks[40]. Note these projects would use hydrogen as a natural gas blend so they have a different end market. In addition, blending still faces several technical and regulatory barriers including the development of de-blending technology. As a result, this form of hydrogen would change the end market unless de-blending became commercial.
Applicability to domestic end use	Medium	Australia has its first project to pilot hydrogen use in a natural gas blended pipeline where it will be used in a large industrial base in Perth. The results of this pilot project are intended to support further decision making on transition of other pipeline assets to be hydrogen ready[39]. However, this project uses blended hydrogen, not pure hydrogen so it is a different end market than the Proposal

[35] CSPB, Safety Data Sheet Ammonia (Anhydrous), 2017 Accessed at: https://www.csbp.com.au/docs/default-source/msds---products/ammonia-ammonium-nitrateproducts/msds_ammonia-(anhydrous).pdf?sfvrsn=45c56c0d_38
[36] NTC Australia, Australian Code for the Transport of Dangerous Goods by Road & Rail, 2018 Accessed at: https://www.ntc.gov.au/sites/default/files/assets/files/Australian-Code-for-the-Transport-of-Dangerous-Goodsby-Road%26Rail-7.6.pdf
[37] Rigas F., Sklavouonos S, Hydrogen safety in Hydrogen Fuel: Production, Transport and Storage, 2008
[38] Office of Energy Efficiency & Renewable Energy, Hydrogen pipelines Accessed at: https://www.energy.gov/eere/fuelcells/hydrogen-pipelines
[39] APA, APA set to unlock Australia's first hydrogen ready transmission pipeline Accessed at: https://www.apa.com.au/news/media-statements/2021/apa-set-to-unlock-australias-first-hydrogen-ready-transmission-pipeline
[40] Western Australia Renewable Hydrogen Strategy, 2021 Accessed at: https://www.wa.gov.au/sites/default/files/2021-01/WA_Renewable_Hydrogen_Strategy_2021_Update.pdf

Criterion	Score	Rationale
Safety considerations	Medium	If hydrogen is blended with natural gas, there is potential for hydrogen embrittlement of steel pipeline and vessels. The safety impacts of adding low levels of hydrogen to gas pipelines have been assessed as not resulting in a significantly greater risk than the risk of transporting natural gas alone[41]. It is unclear if this applies to other storage vessels.

Ammonia assessment

The ammonia assessment in Table 18 below shows the scoring of each criterion as per the MCA and the rationale for each score given.

Table 18 Ammonia assessment

Criterion	Score	Rationale
Availability of information	High	Ammonia (anhydrous) is already transported by rail in Australia[35].There is also clear legislation and guidelines for its safe handling and transportation[36]. However, ammonia would initially be used to replace ammonia produced by natural gas formation. Other end uses such as combustion or power generation requires further technology development.
Technology currently available	Low	There is technology available to convert ammonia back to pure hydrogen using membrane technology. However, there is still work underway to make the membrane technology commercially viable[42]. A number of feasibility studies and pilot projects are in development to consider the potential for ammonia as a hydrogen energy carrier[41]. In Australia, CSIRO, Hydrogen Utility and Yara/ENGIE partnership are all investing in large-scale ammonia projects[32]
Applicability to domestic end use	Low	Australian legislation is focusing on funding renewable export technologies, including ammonia. As a result, it is seen as a key enabler for exporting renewables rather than consuming them domestically[43]. Conversion of hydrogen to ammonia and back again for end use is almost at a theoretical efficiency limit. As conversion plants need to run continuously and there is an energy penalty for conversion back to hydrogen which makes it more viable for long distance transport[31]
Safety considerations	Medium	Ammonia (anhydrous) is considered a dangerous good as it is flammable, may explode if heated, can be toxic if inhaled and is toxic to aquatic life. However, the safe handling and transporting of ammonia is well understood with supporting legislation[35]

MCH Assessment

The MCH assessment in Table 19 below shows the scoring of each criterion as per the MCA and the rationale for each score given.

Table 19 MCH Assessment

Criterion	Score	Rationale
Availability of information	Low	There is information available on the transportation of MCH and its safe handling and storage[44]. However, there is not any information available specific to transporting it by rail as the focus is maritime transport of it to Japan[45]. Japan's premier energy and materials company, ENEOS has two partnerships with Australian companies (Fortescue and Neoen) to explore the

[41] NREL, Blending Hydrogen into Natural Gas Pipeline Networks: A Review of Key Issues, 2013 Accessed at: https://www.nrel.gov/docs/fy13osti/51995.pdf
[42] CSIRO scope, Hyper for hydrogen: our world first for carbon free fuel, 2018 Accessed at: https://blog.csiro.au/hyper-for-hydrogen-our-world-first-carbon-free-fuel/
[43] Robert Service, Ammonia–a renewable fuel made from sun, air and water-could power the globe without carbon, 2018 Accessed at: https://www.science.org/news/2018/07/ammonia-renewable-fuel-made-sun-air-and-water-could-power-globewithout-carbon
[44] Ministerial Council on Renewable Energy, Hydrogen and Related Issues, 2017 Accessed at: https://www.meti.go.jp/english/press/2017/pdf/1226_003b.pdf
[45] Department for Trade and Investment South Australia, Companies unite to develop a Japan-Australia CO2 free hydrogen supply chain in South Australia, 2021 Accessed at: https://dti.sa.gov.au/articles/co2-free-hydrogen-supply-chain-in-sa

Criterion	Score	Rationale
		development of a Japan-Australia CO_2-free hydrogen supply chain in SA and WA[46].
Technology currently available	Low	There is technology available for the transportation of MCH. However, technologies need to be developed for hydrogenation and dehydrogenation facilities as 30% of the total hydrogen is consumed in dehydrogenation which requires high temperatures[47].
Applicability to domestic end use	Low	MCH is not currently being explored for domestic use. Rather there is a study on the maritime transport of MCH as a form of hydrogen storage and transport from Australia to Japan[45]. Given the energy penalties involved in conversion, it has largely been investigated as a long-distance transport option
Safety considerations	Medium	MCH is liquid at ordinary temperatures and pressures, making it easy for handling and long-term storage. It can use existing transportation loading and unloading infrastructure including tankers and tanks[46]. However, it is a toxic substance and is flammable and explosive[48].

6.2.2.4 Final scores

Table 20 summarises the score of each option. As shown, gaseous hydrogen scored the highest, followed by liquid hydrogen. As a result, gaseous hydrogen was selected as the preferred form of hydrogen for consideration in the Road Case and Rail Case for the Gate 2 assessment.

Table 20 MCA Scoring Outcome

MCA Scoring Options	Weight	Gaseous hydrogen	Liquid hydrogen	Hydrogen blended with natural gas	Ammonia	MCH
Criteria		**Weighted Rank**				
Availability of information	30%	1.20	0.90	0.90	1.20	0.60
Technology currently available	30%	1.50	1.20	0.90	0.60	0.60
Applicability to domestic end use	25%	1.25	1.00	0.75	0.50	0.50
Safety considerations	15%	0.45	0.45	0.45	0.45	0.45
Overall Rank (weighted)		**4.40**	**3.55**	**3.00**	**2.75**	**2.15**

6.2.3 Production Volume

The production volume of hydrogen considered under this Proposal is approximately 4.5 tonnes per day using a 10MW electrolyser. It should be noted that the volume of hydrogen initially stated in the EOI was 270kg per day. However, due to a change in Proposal purpose, this volume was no longer appropriate. As a result, approval was sought from the Department to identify a larger production volume which would align to the Proposal's purpose as identified in the ILM.

The volume of approximately 4.5 tonnes per day is supported by adopting a similar sized electrolyser to recent demonstration projects supported by ARENA. Given the hydrogen would be for domestic use, it was deemed appropriate to use an electrolyser size consistent with recent Australian projects. Recent projects which have been given funding from ARENA are detailed in Table 21.

[46] ENEOS, ENEOS Begins Joint Study with Fortescue for Development of a Japan-Australia CO2-free Hydrogen Supply Chain in Western Australia, 2021 Accessed at: http://www.eneos.co.jp/english/newsrelease/2021/pdf/20210916_01.pdf
[47] Jiang Z, Pan Q, Au J, Fang T, Current situation and prospect of hydrogen storage technology with new organic liquid, 2014 Accessed at: https://www.sciencedirect.com/science/article/abs/pii/S0360319914003139
[48] CSIRO, LOHC: Toluene/methylcyclohexane, 2021 Accessed at: https://www.csiro.au/en/work-with-us/ip-commercialisation/hydrogen-technology-marketplace/lohc-toluenemethylcyclohexane

Table 21 Recent Hydrogen Projects

Project Name	Electrolyser Size	Tonnes Produced
Engie and Yara Pilbara Fertilisers Ammonia Facility	10MW	4t/day
ATCO Clean Energy Park	10MW	4.3t/day
Australia Gas Networks Murray Valley Hydrogen Park	10MW	4.25t/day[49]
Stanwell Corporation Feasibility Analysis	10MW	4.5t/day[50]

6.2.4 Route of hydrogen

Toowoomba Wellcamp to the Parkes Logistic terminal was identified as the preferred route by the Proponent based on the original EOI. Parkes to Toowoomba, Toowoomba to Parkes return and other routes were all considered through the approach and assumptions workshop. The selection of Toowoomba to Parkes aligns with the potential opportunities for Hydrogen on Inland Rail to support the potential hydrogen refuelling station locations identified in the NSW Hydrogen Strategy as highlighted in Section 5.2.

The route must remain consistent between the Road Case and Rail Case to allow commercial viability tipping points to be understood as per the ILM KPIs. However, alternative routes have been considered in the demand analysis to understand the impact of distance on commercial viability. Section 5.3.4.2 provides several comparisons between road and rail transport costs for hydrogen based on differing towns along the Inland Rail Alignment.

6.2.5 Method of operations / storage

To transport compressed hydrogen gas by rail, approved containers for rail traffic will need to be produced and certified. Since the requirements are similar to road traffic and there are currently freight flows of compressed and liquid natural gas by rail in dedicated ISO tanktainers, it is expected that certification for tanktainers for use in transporting gaseous hydrogen by rail in Australia could be obtained in the near future.

Modular ‘tanktainers’ have therefore been selected as the storage method within this Study - noting that a range of other potential options exist including decanting into an alternative storage tank. Tanktainers provide flexibility for multi-modal contexts (e.g., from rail to road), terminal storage and are used for transport of gas and combustible substances currently. The Study assumes that the infrastructure necessary to fill the tanktainers is available at the production location (e.g., Toowoomba), and that tanktainers are assumed to be equivalent to 1 TEU in sizing.

Figure 16 Typical Tanktainers

Source: SNC 2022.

[49] Over $100m to build Australia’s first large-scale hydrogen plants, ARENA, 5 May 2021, https://arena.gov.au/news/over-100-million-to-build-australias-first-large-scale-hydrogen-plants/
[50] Stanwell Hydrogen Project Feasibility Study, Stanwell, October 2020, https://arena.gov.au/assets/2021/05/stanwell-hydrogen-project-feasibility-study.pdf

6.3 Options Identified

As previously highlighted, the key differentiators between the Road Case and Rail Case consists of five main inputs:

- Method of transportation.
- Form of hydrogen.
- Volume of hydrogen.
- Route of transportation.
- Method of operations.

Due to the conceptual nature of the Proposal, it was deemed appropriate that a single Rail Case be identified for consideration against the Road Case.

The following sections provide an overview of the overarching assumptions for each input for the Road Case and Rail Case. The Road Case and Rail Case are consistent except for the means of transportation. Keeping other inputs consistent will best inform commercial viability tipping points between road and rail and allow for analysis of the drivers of those tipping points to understand their materiality.

In addition, the infrastructure requirements identified for the Road Case and Rail Case consider the additional storage required for the transportation of hydrogen, however it has been assumed that the infrastructure will be co-located with other facilities (for example an intermodal, road logistics facility, the production facility, or others) and as such all supporting infrastructure (such as loading equipment, trunk infrastructure, and connecting roads for example) are not included within the analysis. This is a result of the conceptual nature of the study and the intention of providing a direct comparison between road and rail costs, and the volumes transported being unlikely to support a standalone intermodal.

This approach aligns to the ILM where the opportunity statement is to assess the commercial viability drivers and tipping points between road and rail. To achieve that opportunity, rail needs to be assessed against road.

6.3.1 Road Case – Toowoomba to Parkes

The Road Case assumes the transportation of Hydrogen between Toowoomba and Parkes by road. Due to the conceptual nature of the Study the Road Case does not currently exist. The following operations overview forms the assumptions for the Road Case identified within this Study.

6.3.1.1 Road Case – Tanktainer Storage

Typical truck lengths can vary between 19m for a prime mover and semi-trailer (2TEU) and 54m for an A-triple (6TEU).

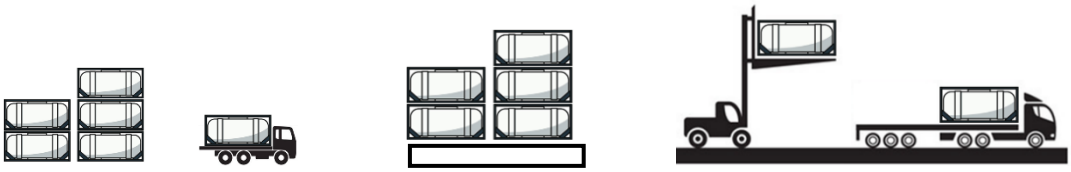
Sizing of a secure storage area for hydrogen therefore assumes that space needs to be allowed for 8 A-triple sized trucks (approx. four days production) of hydrogen tanktainers plus room for empty tanktainers for reverse traffic flow and/or storage pending refilling for future distribution. It is noted however that the make-up of truck sizes may vary depending on the logistics operator which may use B-double sized trucks, however sizing has assumed larger trucks for flexibility.

Due to the highly flammable nature of hydrogen, the secure storage facility has also been scoped to include the ability to fight fires using a locally installed hydrant system.

6.3.1.2 Road Case - Operations

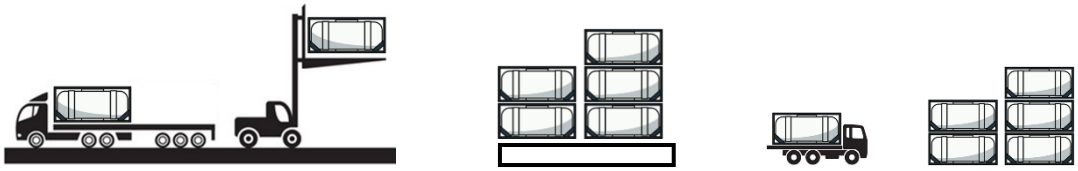
1. Full tanktainers will be transferred from the production plant to the Toowoomba storage facility until there is sufficient volume for transport as part of a full, or part road train.

2. Full tanktainers will be transferred from the Toowoomba storage facility to the Toowoomba intermodal terminal to transit as part of a full, or part road train. It is assumed as part of this Study that the storage facilities are co-located with other facilities (such as the production facility, intermodal, or other facilities).

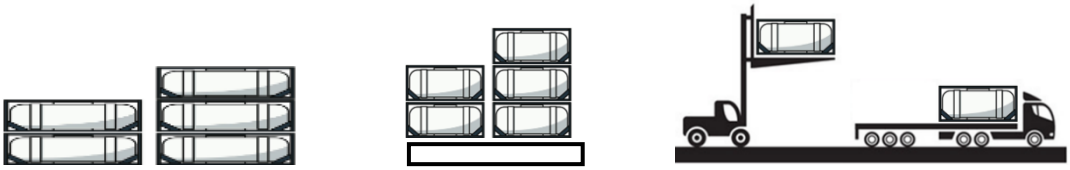


3. Trucks will transfer hydrogen by road between Toowoomba and Parkes.

4. The trucks will be unloaded of full tanktainers which will be transferred from the Parkes intermodal terminal to the Parkes storage facility pending transfer to customers.

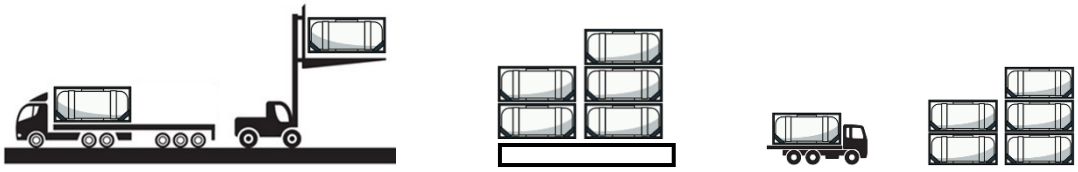


5. Empty tanktainers will be loaded onto trucks for transfer from the Parkes storage facility to the Parkes intermodal terminal to be loaded onto truck for the reverse (empty) flow of tanktainers to Toowoomba.



6. Trucks will transfer empty hydrogen tanktainers by road between Parkes and Toowoomba.

7. The trucks will be unloaded of empty tanktainers which will be transferred from the Toowoomba intermodal terminal to the Toowoomba storage facility pending transfer to the production plant for refilling.



8. Empty tanktainers are transferred to the production plant for refilling and the cycle starts again.

Based on the assumed daily output of a 10MW Electrolyser of 4,000kg of hydrogen per day, and a nominal tanktainer storage capacity of 400kg at 300 bar working pressure, it will take less than 1 day to fill enough tanktainers to service a 54m A-triple (6TEU) road train. Smaller truck configurations can be used.

6.3.1.3 Infrastructure requirements

As highlighted in Section 6.3, it has been assumed that the infrastructure will be co-located with other facilities (for example an intermodal, road logistics facility, the production facility, or others) and as such all supporting infrastructure (such as loading equipment, trunk infrastructure, and connecting roads for example) are not included within the analysis. This is a result of the conceptual nature of the study and the intention of providing a direct comparison between road and rail costs.

The additional infrastructure therefore required to support the Road Case operations is identified in Table 22.

Table 22 Infrastructure Requirements Road

Site component	Description
Toowoomba Secure Hydrogen Store	
Hard stand	4,480m^2 (56m x 80m)
Security fencing	278m
Gatehouse	1
Fire hydrant system	1
Parkes Secure Hydrogen Store	
Hard stand	4,480m^2 (56m x 80m)
Security fencing	278m
Gatehouse	1
Fire hydrant system	1

6.3.2 Rail Case – Toowoomba to Parkes

The Rail Case assumes the transportation of Hydrogen between Toowoomba and Parkes by Rail. The following operations overview forms the assumptions for the Rail Case identified within this Study.

6.3.2.1 Rail Case – Tanktainer Storage

Typical intermodal train lengths start from 600m, which can accommodate 80 tanktainers of container freight. However, 300m part train lengths are also possible if trains are consolidated and deconsolidated at intermodal terminals to form part of larger trains.

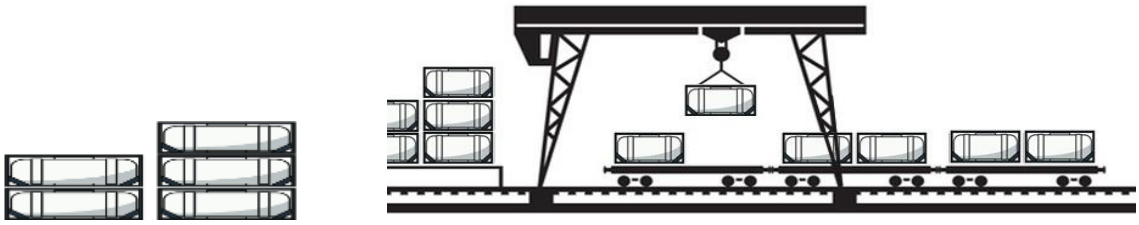
Sizing of a secure storage area for hydrogen therefore assumes that space needs to be allowed for a full 600m train of hydrogen tanktainers plus two further sets of empty tanktainers for reverse traffic flow and/or storage pending refilling for future distribution.

Due to the highly flammable nature of hydrogen, the secure storage facility has also been scoped to include the ability to fight fires using a locally installed hydrant system.

6.3.2.2 Rail Case - Operations

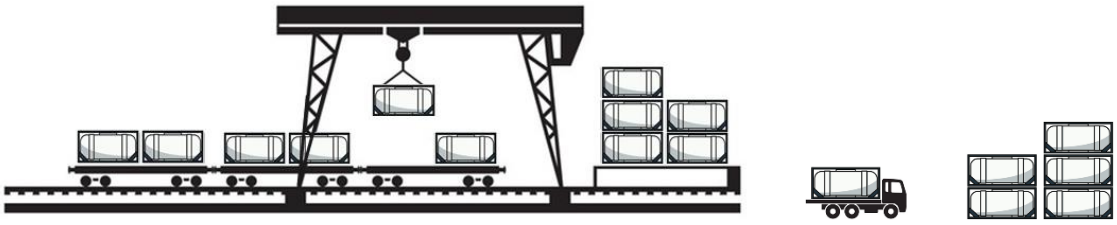
1. Full tanktainers will be transferred from the production plant to the storage facility, until there is sufficient volume to transit as part of a full, or part intermodal freight train.

2. Full tanktainers will be transferred from the Toowoomba storage facility to the Toowoomba intermodal terminal to transit as part of a full, or part, consist intermodal freight train. It is assumed as part of this Study that the storage facilities are co-located with other facilities (such as the production facility, intermodal, or other facilities).

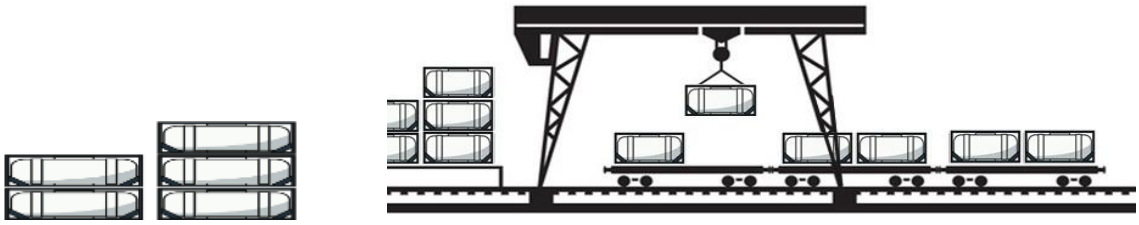


3. The train will transfer hydrogen by rail between Toowoomba and Parkes.

4. The train will be unloaded of full tanktainers which will be transferred from the Parkes intermodal terminal to the Parkes storage facility pending transfer to customers.

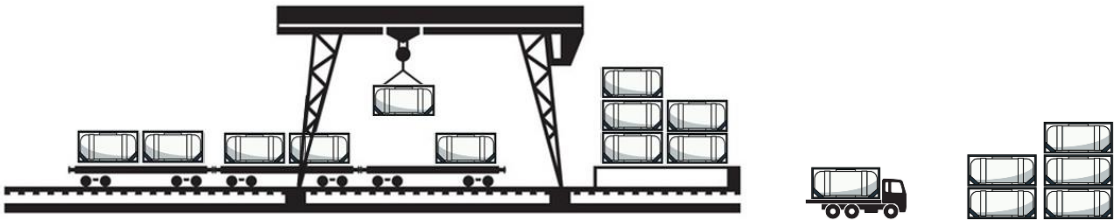


5. Empty tanktainers will be transferred from the storage facility to the Parkes intermodal terminal to be loaded on the freight train for the reverse (empty) flow of tanktainers to Toowoomba.



6. The train will transfer empty hydrogen tanktainers by rail between Parkes and Toowoomba.

7. The train will be unloaded of empty tanktainers which will be transferred from the Toowoomba intermodal terminal to the local storage facility pending transfer to the production plant for refilling.



8. Empty tanktainers are transferred to the production plant for refilling and the cycle starts again.

6.3.2.3 Infrastructure requirements

As highlighted in Section 6.3, it has been assumed that the infrastructure will be co-located with other facilities (for example an intermodal, road logistics facility, the production facility, or others) and as such all supporting infrastructure (such as loading equipment, trunk infrastructure, and connecting roads for example) are not included within the analysis. This is a result of the conceptual nature of the study and the intention of providing a direct comparison between road and rail costs.

The infrastructure required to support the Rail Case operations is identified in Table 23.

Table 23 Infrastructure Requirements Rail

Site component	Description
Toowoomba Secure Hydrogen Store	
Hard stand	8,960m^2 (56m x 160m)
Security fencing	438m
Gatehouse	1
Fire hydrant system	1
Parkes Secure Hydrogen Store	
Hard stand	8,960m^2 (56m x 160m)
Security fencing	438m
Gatehouse	1
Fire hydrant system	1

6.4 Identified policy and/or regulatory solutions

This study is conceptual in nature as there is no current hydrogen demand in Parkes nor production in Toowoomba. The Proposal is solving for a hypothetical opportunity in the event it becomes commercially viable to transport hydrogen along this route. As a result, there are no policy alternatives to be explored. However, infrastructure related regulatory and policy requirements will be explored further in Section 10.

6.5 Deliverability

Deliverability in the context of this Proposal has focused on the technology enabling transportation of hydrogen by road and rail. As this is conceptual study, it is also important to understand the technological requirements if the hydrogen industry were to evolve in Australia to the point in which transporting hydrogen by road or rail were to be considered. Desktop research has been conducted to inform the potential deliverability of transporting hydrogen in the Road Case and Rail Case.

In numerous feasibility studies, hydrogen technology has been discussed from a lifecycle perspective including production, storage, transportation, and end use. In the context of this Proposal, research into technologically viable transportation options for hydrogen in gaseous form will inform deliverability. Currently, technology exists enabling the road and rail transportation of hydrogen in gaseous form[51]. Storage requirements vary depending on the form of hydrogen being transported, pressurised cylindrical containers are a long-established method for storage of gaseous hydrogen. Academic and feasibility studies have shown that road or rail transportation may be an appropriate solution for domestic applications and the delivery distance and volume will be key in dictating which method is technologically and economically feasible[52].

The hydrogen industry will continue to evolve, as evidenced by significant increases to public and private funding over the past decade as well as a development of federal and state strategies. As the cornerstone of achieving production at scale, storage and transport capabilities, technology will be a key focus to enable industry progression.

The relative ease of delivery of all options under consideration for this Proposal is set out in Table 24.

Table 24 Deliverability of the road case and rail case

Option	Description – relative ease of deliverability	Key issues for implementation
Road Case	Gaseous hydrogen can be transported by road. It is currently the method used for distribution of hydrogen commercially. However, hydrogen is currently not distributed at the volumes envisaged in this Proposal.	Implementation will depend on industry expansion supported by continued public and private financial interest and viable end use applications.
Rail Case	Gaseous hydrogen can be transported by rail. Despite this being technologically possible, the scale of production and demand in Australia has not required this transportation method to be commercially utilised	Implementation will depend on industry expansion supported by continued public and private financial interest and viable end use applications.

6.6 Sources of funding

There is currently no committed funding for the transportation of hydrogen between Toowoomba and Parkes. However, several state and federal hydrogen strategies have committed funding to progressing the hydrogen industry in Australia. Additionally, multiple individual hydrogen projects at similar production volumes have received regulatory body funding indicating the potential funding sources.

State based funding relevant to this Proposal includes the Queensland Hydrogen Industry Strategy[53] and the NSW Hydrogen Strategy[54]. As part of the Queensland strategy, the state government has committed $19 million, and the NSW strategy has committed up to $3 billion in support for the hydrogen industry. Between 2015 and 2019, the Australian Government committed over $146 million to hydrogen projects. In 2020, the Federal Government established a $300 million Advancing Hydrogen Fund that will be administered by the CEFC in order to finance projects aligned with the priorities of the National Hydrogen Strategy[55].

[51] Optimizing hydrogen transportation system for mobility via compressed hydrogen trucks, Amin Lahnaoui, Christina Wulf, Heidi Heinrichs, Didier Dalmazzone, 2017. The Future of the Hydrogen Economy: Bright or Bleak? Ulf Bossel Ph.D., Baldur Eliasson Ph.D. & Gordon Taylor, 2003.
[52] An outlook towards hydrogen supply chain networks in 2050 — Design of novel fuel infrastructures in Germany, Anton Ochoa Bique & Edwin Zondervan, 2017. Techno-economic analysis of conventional and advanced high-pressure tube trailer configurations for compressed hydrogen gas transportation and refuelling, Krishna Redd, Amgad Elgowainy, Neha Rustagi and Erik Gupta, 2017.
[53] QLD Hydrogen Industry Strategy, Queensland Government Department of State Development, Manufacturing, Infrastructure and Planning, May 2019, https://www.statedevelopment.qld.gov.au/__data/assets/pdf_file/0018/12195/queensland-hydrogen-strategy.pdf
[54] NSW Hydrogen Strategy, NSW Government Department of Planning, Industry and Environment, October 2021, https://www.energy.nsw.gov.au/sites/default/files/2021-10/govp1334-dpie-nsw-hydrogen-strategy-fa2_accessible_final.pdf
[55] Australia's National Hydrogen Strategy, COAG Energy Council, 2019, https://www.industry.gov.au/sites/default/files/2019-11/australias-national-hydrogen-strategy.pdf

In 2020, projects with similar production volumes to this Study have received funding through ARENA's $70 million Hydrogen Deployment Competitive Funding round.[56]

The potential sources of funding for the options under consideration for this Proposal is set out in Table 25.

Table 25 Deliverability of the road case and rail case

Option	Potential sources of funding	Funding required
Road Case	State and federal funding options are available for hydrogen related projects as listed above (e.g., Advancing Hydrogen Fund). However, specific funding sources cannot be determined for this Project at this stage because it is a concept study.	The funding required for this Project at this stage cannot be determined because it is a concept study
Rail Case	State and federal funding options are available for hydrogen related projects as listed above (e.g., Advancing Hydrogen Fund). However, specific funding sources cannot be determined for this Project at this stage because it is a concept study.	The funding required for this Project at this stage cannot be determined because it is a concept study

[56] ARENA opens $70 million hydrogen deployment funding round, ARENA, 15 April 2020, https://arena.gov.au/news/arena-opens-70-million-hydrogen-deployment-funding-round/

7. Costs

Key messages

- P50 costs have been developed for the Road Case and Rail Case. The costs are based on high-level scoping and design for the hard stand infrastructure required. As the study is conceptual in nature, a specific site has not been identified for the infrastructure. However, the solution has assumed the infrastructure identified will be co-located with other facilities and therefore has excluded supporting and trunk infrastructure.
- Initial capital cost estimates (on a P50 basis, in nominal terms) for the two options are as follows:
    - Road Case: $7.72 million.
    - Rail Case: $12.13 million.
- Lifetime operating and maintenance costs for the hardstand infrastructure (P50, nominal, over the 30-year period of analysis) for the two options are:
    - Road Case: $5.81 million which includes maintenance costs ($5.74million) and operating costs ($0.08million).
    - Rail Case: $9.75million which includes maintenance costs ($9.64million) and operating costs ($0.11million).
- The transportation operating costs were assessed in the demand analysis in Section 5 where road and rail transportation costs were compared.
- Due to the level of design information available at this stage, a 50% contingency has been applied. This is in keeping with models and suggested parameters used by TfNSW and TMR on road and rail projects at the concept design stage. All capital costs have been escalated by current construction price index value of 3% per annum.
- Due to the conceptual nature of the Proposal, costs are not expected to be materially refined in subsequent Gates, should the Proposal proceed.

The cost estimates within this section provide an overview of capital, operating and maintenance costs for Road Case and Rail Case identified in Section 6. It is noted within Section 6 that due to the conceptual nature of the Proposal the Road Case and Rail Case both do not current exist. Therefore, the costs within this section seek to represent the key differences between the two cases. This approach assists with identifying the potential commercial tipping point between road and rail transportation of hydrogen.

The costs therefore apply identical assumptions as presented in Section 6. Specifically it has been assumed that the infrastructure will be co-located with other facilities (for example an intermodal, road logistics facility, the production facility, or others) and as such all supporting infrastructure (such as loading equipment, trunk infrastructure, and connecting roads for example) are not included within the analysis.

7.1 Capital Costs

7.1.1 Capital Cost Summary

Capital costs have been provided based on the high-level scope of given in section 6. The rates used are composite all-in rates and benchmarked from recent projects. The database uses first principles estimating where design information allows and provisional cost assessments for scopes of work that have not yet been fully defined.

All costs are presented at FY2022 prices and have been escalated to reflect a construction programme assumed to commence in FY2027. Escalation was applied to these costs based on current anticipated market indices. Table 26 provides an overview of the capital costs by asset category for the Road Case and Rail Case.

Table 26 Capital costs by asset category ($m)

Description	Road Case	Rail Case
Rail Works	N/A	By others
Road Works	By others	N/A
Building works	1.43	2.78
Infrastructure works	1.27	1.47
Other works	Excl.	Excl.
Direct Costs	**2.70**	**4.24**
Preliminaries, overheads, consultant, and client costs	1.74	2.73
Base Estimate	**4.44**	**6.98**
P50 Contingency	2.22	3.49
Total (real)	**6.66**	**10.46**
Escalation	1.06	1.67
Total (Nominal)	**7.72**	**12.13**

Source: WT 2022, numbers may not sum due to rounding

The details of the Building works costs are summarised below. A further breakdown can be found in Appendix D.

Table 27 Capital costs by asset category ($m)

Description	Road Case	Rail Case
Toowoomba		
Hardstand	0.67	1.34
Gatehouse	0.03	0.03
Allowance for boom gate and CCTV	0.02	0.02
Parkes		
Hardstand	0.67	1.34
Gatehouse	0.03	0.03
Allowance for boom gate and CCTV	0.02	0.02

Source: WT 2022, numbers may not sum due to rounding

Inclusions and exclusions directly related to the infrastructure technical solution are provided below, with general costing assumptions provided in Section 7.5.

Inclusions

- Capital costs have been provided based on the infrastructure technical solution identified in Section 6, with the addition of gatehouse and security (CCTV) requirements.
- Client costs have been assumed at 10% and consultant costs at 15%. These have been benchmarked against other similar projects.
- Preliminaries (i.e., contractor site set up, overheads etc) have been benchmarked at 30%, in line with the direction taken on other projects in the II Program.

Exclusions

- The costs do not include road. intermodal or rail facilities, it is assumed these will be constructed by others and are beyond the scope of this Proposal.
- Tanktainer loading / unloading equipment has been excluded based on the assumption the infrastructure will be co-located with other appropriate facilities with existing equipment.

- Fire hydrant works will be co-ordinated with the construction of the hard stand, excluding the requirement for additional trenching.
- Earthworks at the site are excluded, as there is insufficient design detail/ scope definition to address this requirement. Consequently, there has also been no allowance made for the removal / treatment of hazardous / contaminated soil.
- Property / land acquisition costs have been excluded as site specific details are not available at this stage.
- Additional works due to the classification of the facility as an MHF.
- Trunk utility infrastructure costs (except for the fire hydrant) have been excluded and assumed to be available at the selected site.
- The capital cost for purchasing tanktainers has been excluded as these costs were considered in the demand analysis as part of the rail cost model
- At this stage, no specific direction has been given on the likely procurement route for the delivery of this Proposal.
- Geotech investigations have not been undertaken at this early stage of the design process and the site location and therefore soil condition is not known.

Contingency

Due to the level of design information available at this stage and considering the need to reach a P50 level of certainty around the costs, a 50% contingency to the Gate 2 has been applied to the base estimate to reach a P50 cost for the project. A combination of benchmarking of other recent infrastructure projects, in-house experience, and knowledge of infrastructure cost planning, has been used to decide the appropriate contingency. Internal benchmarks include the More Trains More Services (MTMS) Program and a high-level cost estimate for a large-scale infrastructure project of a similar nature for a Tier 1 contractor, with comparable design effort. Reference has also been made to published guidelines such as suggested parameters used by TfNSW Roads and Maritime estimating guidelines, TfNSW Project Cost Estimating for Heavy Rail and Light Rail infrastructure and TMR guidelines to inform the contingency.

7.2 Maintenance costs

There are a number of alternative industry accepted approaches to develop whole-of-life maintenance costs. It should be noted that maintenance costs differ depending on the strategy of the asset owner and idiosyncratic project factors. Approaches to risk assessment can also influence maintenance cost estimates.

With this in mind, the cost estimates below are based on knowledge of the industry current best practice, including the quality and appropriateness of delivery solutions, knowledge libraries and actual cost data obtained from Inland Rail.

The components modelled in the maintenance cost modelling and the development approach for these are summarised in Table 28.

Table 28 Maintenance cost components

Maintenance cost	Approach to development
Replacement costs (MPM)	MPM and renewal tasks have been developed using: • Design information provided at that time which may not include specific individual asset information, design specifications, design configurations and materials selected. In these instances, a generic approach to cost modelling based on previous project benchmark data has been adopted. • Standard asset renewal and replacement cycles applied from guidance material, knowledge libraries and industry good practice processes. • Replacement of assets on a like for like in terms of performance and quality. • Renewal tasks such as an overhaul or upgrade to meet the design life.

Maintenance cost	Approach to development
Annual maintenance costs (RMR)	Generally, RMR has been developed using the following methods: • Benchmark maintenance cycles and rates from other similar projects prorated to reflect units in the cost plans. • A percentage of capital cost benchmarked against knowledge libraries to reflect a reasonable level of planned and unplanned maintenance needs; and • Unit rates (where individual assets are easily identified).

Source: WT 2022

7.2.1 Maintenance Cost Summary

Maintenance costs for each option are summarised below, including real and nominal costs over the 30-year appraisal period. Note these maintenance costs are for the hardstand infrastructure.

Table 29 30-year maintenance costs ($m, FY2022 real)

Cost category	Road Case	Rail Case	
		$m	Δ to Road Case
MPM	1.79	3.11	+1.32
RMR	1.07	1.67	+0.60
Total	**2.86**	**4.78**	**+1.92**

Source: WT 2022, numbers may not sum due to rounding

Table 30 30-year escalated maintenance cost ($m, nominal - 3% escalation rate)

Cost category	Road Case	Rail Case	
		$m	Δ to Road Case
MPM	3.75	6.54	+2.79
RMR	1.99	3.09	+1.11
Total	**5.74**	**9.64**	**+3.90**

Source: WT 2022, numbers may not sum due to rounding

The maintenance costs of the Road Case are lower than the maintenance costs of the Rail Case. This is due to a reduced level of scope required for the Road Case. Please refer to Section 6.3 for details on the differences in infrastructure required for each case.

7.3 Operating costs

Operating cost allowances for network operation generally include utility costs and statutory expenses but exclude maintenance costs. The operating costs anticipated for this Proposal include:

- Power usage from gatehouse and security requirements.

A summary of annual operating cost allowance per option in real dollars and comparison to the Road Case is included in Table 31.

Table 31 Annual operating costs for the road case and rail case ($, FY2022 real)

Cost category	Road Case	Rail Case	
		$	Δ to Road Case
Operating cost	1,400	2,000	600

Source: WT 2022

Table 32 30-year escalated operating costs for the road case and rail case ($m, nominal – 3% escalation rate)

Cost category	Road Case	Rail Case	
		$	Δ to Road Case
Operating cost	$0.08	$0.11	$0.03

Source: WT 2022

7.4 Whole of life costs

A summary of the total whole of life costs for each option is shown below in nominal terms for the 30-year analysis period.

Table 33 Whole of life cost for the road case and rail case ($m, nominal – 3% escalation rate)

Cost category	Road Case	Rail Case
Capital Cost	7.72	12.13
Replacement Cost (MPM)	3.75	6.54
Annual Maintenance (RMR)	1.99	3.09
Operating Cost	0.08	0.11
Total	**13.54**	**21.88**

Source: WT 2022

The whole life costs for the Rail Case are greater than the whole life costs of Road Case. This can be attributed to the greater scope requirement included the Road Case.

7.5 Key assumptions and reliability of the estimates

7.5.1 Capital Cost Assumptions

The key assumptions used in development of the cost estimates for the Proposal are as follows:

- The rates used are composite all-in rates and are benchmarked from recent projects.
- All costs have been escalated to reflect an FY27 construction date for the project.
- The capital costs for the Road Case and Rail Case cover all plant, labour and materials associated with the construction.
- Nominal capital costs, estimates have been escalated by the current construction price Index value of 3% per annum.

The following costs have been excluded:

- The removal/treatment of hazardous contaminated soil, ballast, etc.
- Property/land acquisition costs.
- GST.
- Staging costs (if any).
- Easements and any protection work to avoid damaging the adjacent properties and assets.
- Out of hours working.
- Modifications to existing network (unless specifically stated).
- Costs arising from inclement weather.
- Cost arising through delay or demand due to current Covid-19 pandemic.

7.5.2 Operations and Maintenance Whole of Life Cost Assumptions

The following input parameters have been used in the whole of life cashflow analysis.

Table 34 Summary of input parameters

Input	Value
Analysis period	30 years
Operations Start year	FY28
Base cost year	FY22
Operations and maintenance contingency	10%
Escalation rate (for nominal costs)	3%
Discount rate	7%

Source: WT 2022

A comprehensive operations and maintenance (or whole of life) cost Excel model has been used to develop the whole of life maintenance costs. The methodology for estimating the maintenance costs is as follows:

- The future operations and maintenance cost profile is calculated as a factor of the base capital cost estimates without escalation.
- A 10% O&M contingency has been built into estimates for RMR, MPM and operating costs.
- Cost escalation is applied to the operations and maintenance cost profile and then discounted.

In developing the operating and maintenance cost estimates, the following aspects of the Proposal were considered:

- The costs have been estimated based on the base capital costs.
- The hours of operation and subsequent duty/use of key plant and equipment.
- The quality of finishes, their durability, and the required performance.
- Design life considering the level of duty expected of each asset.
- The expectations that some assets may not be fully replaced in full at the end of design life.
- Procurement of specialist service via sub-contract rather than in-house delivery requiring additional management time.
- Replacement costs assume:
    - Asset design lives will be achieved even though component life and degradation will vary according to location, prevailing weather, duty and usage and satisfactory maintenance.
    - Installation is in accordance with relevant codes, to manufacturer's recommendations or accepted practice.
    - Maintenance is assumed to be carried out in accordance with relevant codes or accepted practice and adequate to optimise the service life of the asset.
- In some cases, assets are not replaced but renewed to provide extended design life.
- Ground preparation and earthworks are fit for purpose and as a result there are no ground movements (including settlement or vibration) or failure, cracking structural elements that would give rise to premature renewal or replacement tasks.

Key points to note about the nature of the operations and maintenance cost estimates are:

- Estimated operational costs only for the items listed in the capital cost estimates. It is a provisional cost due to limited information availability at this stage.

- This high-level model does not account for the increasing maintenance cost requirements due to ageing of assets. Costs should not be compared with any historic expenditure as it is unlikely that assets will have been maintained on a like for like basis with good practice. Costs should be updated once detailed design is available.

The following costs have been excluded from operations and maintenance whole of life costs:

- Vegetation maintenance.
- Replacement of items due to technical obsolescence.
- Depreciation, write-down, and amortisation costs (such costs are used for financial and taxation purposes only).
- Insurance.
- Vandalism.
- Currency fluctuations and financing costs.
- Unknown or adverse site conditions during the 30-year operational term.
- Operational mobilisation and transitioning costs.
- Recoverable GST.

The costs also exclude warranty benefits as the extent of these vary significantly between products and services.

7.5.3 Reliability of Estimates

These cost estimates were prepared in April 2022 in line with the methodology and assumptions outlined in this section. Where possible, costs have been sourced costs from recent projects and recent market data for the supply and installation of materials such as rail, sleepers. The costs exclude estimates for property acquisitions on the basis that the Proposal is a concept study and specific sites have not been assumed for the study. This is subject to further analysis at future gates (subject to the Proposal proceeding).

8. Benefits

Key messages

- The Proposal is a conceptual study that investigates the potential to utilise Inland Rail to transport hydrogen against road transportation. The mode shift from road to rail is likely to generate benefits relating to reduced usage of the road network, including reduced road wear and tear, reduction in environmental externalities, reduced likelihood of road accidents and vehicle operating cost savings.
- The benefits analysis considers one scenario - comparing road transportation of the hydrogen to rail transportation. For full details of the Road Case and Rail Case, see Section 6.
- The benefits analysis of the Proposal only considers the potential freight movement between the storage facilities at Parkes and Toowoomba. The present value ($2022, real, discounted at 7% p.a.) of estimated benefits associated with the Proposal over a 30-year appraisal period are estimated to be $21.0 million. Specifically:
    - Direct benefits are estimated at $13.3 million.
    - Indirect benefits are estimated at $7.7 million.

8.1 Summary of results

This appraisal uses a rail freight CBA framework to assess the incremental change in economic value attributable to the Proposal. Benefits are derived from the transportation from freight volumes and include the following benefit drivers:

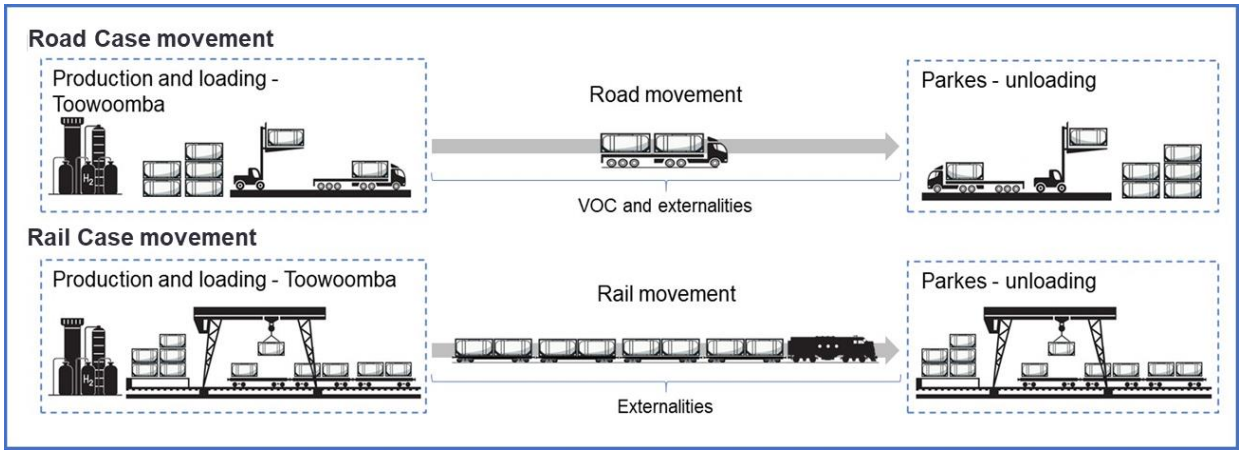
- Rail benefits – benefits associated with improvements to rail operations.
- Road benefits – benefits associated with mode shift of freight from road to rail.

The Proposal results in a number of direct and indirect operating benefits by facilitating mode shift from road to rail through the creation of an alternative pathway (Proposal pathway) to the long-haul road solution for hydrogen transport between Toowoomba and Parkes.

The benefits analysis considered one scenario where hydrogen produced by one electrolyser is transported between Toowoomba and Parkes with road transport in the Road Case and rail transport in the Rail Case. For full details regarding the inclusions within the Road Case and Rail Case see Section 6.3.

The benefits analysis of the Proposal only considers the freight movement between the storage facilities at Parkes and Toowoomba. The analysis does not consider short haul road movements and Pick-up and Delivery (PUD) services out of Toowoomba or Parkes. This is demonstrated in Figure 17.

Figure 17 Freight movement under the road case and rail case



Source: EY analysis, 2022.

Whist the Proposal pathway results in rail externalities resulting from increased rail usage, these are offset by Vehicle Operating Cost (VOC) savings and externality reduction arising from reduced long haul road movements.

Table 35 summarises the results of the benefits appraisal, including a comparison with Gate 2 estimates. Rows highlighted in green show direct benefits and rows highlighted in light grey show indirect benefits.

Table 35 Benefits results (PV, $m, FY2022 real, discounted at 7%)

	Gate 2 analysis $FY2022 real Toowoomba to Parkes
Rail benefits	
Rail environmental impacts	(2.0)
Total rail benefits	**(2.0)**
Road benefits	
VOC savings (resource correction)	13.3
Road damage cost savings	4.0
Road environmental impacts	5.2
Road crash costs	0.5
Total road benefits	**23.0**
Total benefits	**21.0**

Source: EY analysis 2022.

As shown in Table 35, the Proposal results in VOC savings and reduced externalities associated with road usage. The Proposal results in negative rail environmental externalities resulting from increased rail usage, however these disbenefits are offset by benefits associated with reduced road usage.

For further information on the benefits assessed as part of this Proposal, including a detailed methodology, see Appendix C.

8.2 Direct operating benefits

Direct operating benefits reflect the incremental value that the Proposal will deliver for users such as freight producers and freight operators. For this Proposal, the key direct quantified operating benefits are achieved by shifting freight from road to rail and delivering road VOC savings.

Table 36 Direct operating benefits (PV 2022$, $m, FY2022 real, discounted at 7%)

Benefit	Description and drivers for this benefit	Method of quantification	Data Gaps
Road vehicle operating cost savings *Estimated benefit of $13.3 million*	Road VOC reflect the user cost of operating a road vehicle and include fuel, tyres, oil, and maintenance. VOC cost savings result from fewer resources being used in the economy and reflect differences in resources costs (i.e., excluding excise and GST) between the Road Case and Rail Case. The Proposal is expected to result in road VOC savings through modal shift diverting freight from road to rail.	Estimation of road VOC savings is based on the approach outlined in TfNSW' s *Technical Note on Calculating Road Vehicle Operating Costs* (2020). As the road network is treated as 'parallel infrastructure' (in line with the NGTSM), only the resource cost correction component is captured in the analysis.	Refinement of Proposal technical solutions and service outcomes. Refinement of demand estimates.

8.3 Indirect operating benefits

Indirect operating benefit reflect the incremental value that the Proposal will deliver for non-users. Indirect operating benefits identified include environmental impacts, road damage cost savings, safety impacts and intermodal terminal access externalities.

The Proposal will deliver indirect operating benefits by reducing long haul heavy vehicle movements. This results in benefits associated with the road network, including:

- **Environmental impacts –** rail transport has lower environmental costs than road transport. By increasing the proportion of freight borne by the rail network, the Proposal will result in environmental cost savings.
- **Road damage** – heavy vehicles contribute heavily to the wear and tear of road infrastructure. By reducing the number of heavy vehicles on the road network, the Proposal will result in road damage cost savings.
- **Safety –** conflicts between heavy vehicles and pedestrian result in poor safety outcomes. By reducing the number of heavy vehicles on the road network, the Proposal will result in safety benefits.
- **Rail access externalities –** transporting freight to a rail loading point generates a range of externalities. As demonstrated in Table 37, the Proposal is expected to result in road access externalities from short haul road freight movements to and from rail access points.

Table 37 presents an overview of the indirect operating benefits

Table 37 Indirect operating benefits (PV 2022$, $m, FY2022 real, discounted at 7%)

Benefit	Description and drivers for this benefit	Method of quantification	Data Gaps
Environmental impacts *Estimated benefit of $3.2 million*	Environmental impacts relate to externalities generated by road and rail freight. Environmental externalities include air pollution, green greenhouse gas emissions, noise, water, nature, and urban separation. Rail environmental externalities tend to be lower than road externalities, as do rural compared to urban areas. The Proposal is expected to result in environmental benefits by reducing the amount of freight being transported by road, given the anticipated mode shift, and diverting freight from road to rail. The environmental benefits associated with decreased road usage are partially offset by environmental externalities resulting from increased rail usage.	Environmental impacts have been estimated by applying unit parameter values for rail and road freight environmental externalities to changes in GTKs and Vehicle Kilometre Travelled (VKT's) respectively. A distinction is also made between kilometres travelled in urban versus rural areas. Values are based on the TfNSW *Economic Parameter Values* (2020).	Refinement of Proposal technical solutions and service outcomes. Refinement of demand estimates.
Road damage costs *Estimated benefit of $4.0 million*	As the CBA includes ongoing rail maintenance costs, it is relevant to also consider any change in road damage or maintenance costs between the Road Case and Rail Case. The Proposal is expecting to result in road damage cost savings from less wear and tear on road infrastructure due to modal shift from road to rail.	Road damage cost savings have been estimated by applying unit parameter values for road damage to the change in VKTs between the Road Case and Rail Case. These values are based on the TfNSW *Economic Parameter Values* (2020).	Refinement of Proposal technical solutions and service outcomes. Refinement of demand estimates.
Safety benefits *Estimated benefit of $0.5 million*	Rail freight has a lower accident rate than road. Safety benefits arise from reduced crashes on the rail and road network. The Proposal is expected to result in road safety benefits	Safety benefits have been estimated by applying unit parameter values for rail and road crash rates to changes in GTKs and VKT's respectively. These values are based on the TfNSW *Economic Parameter Values* (2020).	Refinement of Proposal technical solutions and service outcomes. Refinement of demand estimates.

Benefit	Description and drivers for this benefit	Method of quantification	Data Gaps
	through mode shift from road to rail.		

8.4 Other benefits

A further benefit typically considered, relevant to this Proposal is residual value of assets including hardstand developed through the Proposal. This has been summarised in Table 38.

Table 38 Other benefits

Benefit	Description and drivers for this benefit	Method of quantification	Data Gaps
Residual value	Assets created as part of this Proposal have economic lives that extend beyond the final year of the evaluation period. In Line with ATC guidance, a residual value was assigned to fixed infrastructure where asset lives extend beyond the final evaluation period.	Residual value can be estimated following the straight-line depreciation method as recommended in the TfNSW Economic Parameter Values (2020).	Refinement of costing and determination of asset useful life.

8.5 Key assumptions and reliability of the estimates

The identification and assessment of benefits associated with the Proposal has been undertaken in accordance with the following guidelines:

- Nine-Squared 'Guidance on Economic Analysis' (2020).
- Transport for NSW ("TfNSW") 'Cost-Benefit Analysis Guide' (2019).
- Infrastructure Australia ("IA") 'Assessment Framework' (2018).
- NSW Treasury 'TPP17-03 NSW Guide to Cost Benefit Analysis' (2017).
- Queensland Treasury 'Project Assessment Framework: Cost-benefit analysis' (2015).
- Victorian Department of Treasury and Finance 'Economic Evaluation for Business Cases Technical guidelines' (2013).
- Australian Transport Assessment and Planning ("ATAP") 'National Guidelines for Transport System Management in Australia' (2006).

Note that benefit estimates are highly sensitive to the demand estimates including forecasts of induced demand. Benefit accuracy is therefore subject to the same limitations and risks that underpin the demand analysis.

In addition, benefits are based on service outcomes that will be delivered by the Proposal including train operations and track technical standards. Deviations in service outcomes from those forecasted will affect the realisation of the benefits quantified.

In the absence of consistent guidance at the state and/or national level, a significant portion of this analysis has relied on TfNSW assumptions and parameter values to estimate benefits associated with rail operating costs. These parameters have been adapted to reflect the Queensland context to the extent possible, based on discussions with QR, TMR and Neil Matthews Consulting.

9. Funding and Financing

Key messages

- No specific sources of funding have been identified within the Gate 2 analysis.
- From a national funding perspective, the Project may be eligible for funding from the Advancing Hydrogen Fund because it would assist in establishing domestic hydrogen supply chains.
- Potential State funding from Queensland has not been identified for the project as current funding programmes for hydrogen initiatives have either closed or focus on hydrogen generation.
- NSW has a focus on decarbonisation with a hydrogen hub project already receiving funding from the State. However, it is unknown whether this Project will be eligible for this funding.

9.1 Sources of project funding and project financing options

The potential sources of funding for the Proposal are set out below. These are largely high-level at this stage, and overall do not pertain to specific commitments. Desktop analysis has identified several potential sources of Australian Government and State Government funding that could be available to support this Proposal.

9.1.1 Australian Government Funding

Advancing Hydrogen Fund

The Advancing Hydrogen Fund was established by the Australian Government in May 2020 to support hydrogen projects. Eligible projects can include advancing hydrogen production, developing export and domestic hydrogen supply chains and establishing hydrogen hubs. The fund can also consider investment in infrastructure for a hydrogen export industry as well as projects that assist in building domestic demand for hydrogen. The $300 million Advancing Hydrogen Fund is administered by the CEFC.

The Advancing Hydrogen Fund will seek to invest in projects identified in the ARENA Renewable Hydrogen Deployment Funding Round. Thirty-six expressions of interest have been received from across Australia, and ARENA has conditionally approved $103.3 million towards three commercial-scale projects. Applications for this fund are now closed.

The CEFC hydrogen strategy overcomes barriers to adoption by investing in the roll-out of hydrogen end-use technologies and supporting infrastructure such as for long haul transport). As the Proposal focuses on the transport of hydrogen to regional areas, the Proposal could be eligible for this fund funding.

National Energy Resources Australia (NERA) Funding

NERA is a federally funded not-for-profit organisation that works with partners in government, research, science, and industry to help decarbonise Australia's energy sector. NERA is accelerating the hydrogen supply chain through the Regional Hydrogen Technology Cluster Seed Funding Program. The program will provide seed funding of up to $100,000 to develop hydrogen technology clusters.

The program seeks to develop a network of hydrogen technology clusters across Australia - providing seed-funding in partnership with governments and industry to build the skills, capability, and commercialisation opportunities in the emerging hydrogen industry The investment to date from NERA, state governments and industry across the 18 hydrogen technology clusters in the network is $2.165 million.

The program focuses on hydrogen technology clusters rather than the transportation method of hydrogen to regional areas. Hence, the Proposal would not be eligible for this funding at this stage.

Building Our Future – Infrastructure Investment Program

The Australian Government has announced a $10 billion increase in investment for road, rail, and community infrastructure projects across Australia in the 2022-23 Federal Budget. This brings the

total investment in the program, which is considered a key component of meeting the national freight challenge, from $110 billion to $120 billion over the coming 10 years. A major component of this plan is the Infrastructure Investment Program, whereby the Department is collaborating with all Australian States and Territories to develop much needed infrastructure across Australia.

Funding for Interface Improvements

Building on the success of the II Program, the Australian Government has also allocated $150 million to fund the delivery of priority infrastructure projects through the II Program in the 2022/23 Budget. This funding is restricted to projects that have completed a Strategic Business Case through the Inland Rail Interface Improvement program.[57] More details will be provided by the Government soon and will be explored in Gate 3, should the Proposal proceed.

Federal Consolidated Revenue Fund

Federal consolidated revenue could be a source of Australian Government funding for the Proposal, given its investigation through the Department's Inland Rail Interface Improvement Program. The Consolidated Revenue Fund is established by section 81 of the Constitution. All monies received by the Commonwealth must be paid into the Consolidated Revenue Fund. It is a constitutional requirement that, before the Government may spend any monies, an Act of the Parliament providing for an appropriation must authorise the release of the necessary monies from the Consolidated Revenue Fund. While high-level, this is included here as a potential funding source, as the Australian Government could consider funding towards this Proposal through a program that could deliver funding towards selected projects assessed as feasible under the II Program.

9.1.2 State Government Funding

Queensland Hydrogen Industry Development Fund[58]

As part of the Queensland Hydrogen Industry Strategy, the Queensland Government established the Hydrogen Industry Development Fund (HIDF) to drive investment and accelerate development of hydrogen projects in Queensland.

A first round of funding under the program closed in 2019, resulting in four projects being funded. The approved projects are:

- Australian Gas Networks Limited - up to $1.78 million to build a renewable hydrogen production facility and undertake a gas blending trial of up to 10% hydrogen into the Gladstone City gas distribution network.
- Jilrift Pty Limited - up to $0.94 million to build a renewable hydrogen plant and demonstrate use of low-pressure hydride remote power systems at its eco-camps within the Spicers Resorts Scenic Rim trail.
- Sun Metals Corporation - up to $5 million for integration of renewable hydrogen into potential applications including remote area power, transport, and heavy industry.
- University of Queensland - up to $4.85 million to build a renewable hydrogen plant and refuelling facility to service inter-campus hydrogen buses between St Lucia and Gatton.

In late 2020, the Queensland Government committed a further $10 million for hydrogen industry development activities. Round 2 grant applications closed on 2 June 2021.

Due to the timing of the first two Rounds, the Proposal is not eligible at this stage however it is unclear if future funding rounds may be available for application.

Queensland Hydrogen and Renewable Energy Jobs Fund[59]

The Queensland Renewable Energy and Hydrogen Jobs Fund allows government-owned energy corporations to increase ownership of commercial renewable energy and hydrogen projects and supporting infrastructure. This includes partnership with the private sector.

The key investment criteria for the funding include:

- Renewable energy and hydrogen. The fund will consider investment proposals that support additional renewable energy generation and storage capacity in Queensland, and the transition to

[57] https://www.inlandrail.gov.au/for-business/interface-improvement-program/funding-for-interface-improvements
[58] https://www.statedevelopment.qld.gov.au/industry/priority-industries/hydrogen-industry-development
[59] https://www.treasury.qld.gov.au/programs-and-policies/queensland-renewable-energy-and-hydrogen-jobs-fund/

Queensland's 50 per cent Renewable Energy Target by 2030. This includes, but is not limited to, solar, wind, pumped hydroelectric storage, hydrogen and supporting network infrastructure.
- Commerciality. Investment proposals must demonstrate commercial value.
- Employment and jobs. Investments must create new and ongoing employment opportunities in Queensland consistent with the government's employment and procurement policies.

Similar to Commonwealth funding programs, the program focuses on hydrogen generation rather than the transportation method of hydrogen to regional areas. Hence the Proposal would not be eligible for this funding at this stage.

NSW Net Zero Industry and Innovation[60]

The Net Zero Industry and Innovation Program is the NSW Government's plan to support and partner with industry to reduce emissions and help NSW businesses prosper in a low carbon world. By accelerating the development of clean technology and decarbonisation, the government plans to grow the economy, support jobs, and significantly reduce emissions.

This program is part of the NSW Net Zero Plan Stage 1: 2020-2030 to reduce emissions by 50 percent by 2030 and achieve net zero by 2050. The program has 3 focus areas:

- Clean technology innovation - Supporting the development and continued innovation of emerging clean technologies.
- New low carbon industry foundations - Laying the foundations for low emissions industries by: building enabling infrastructure and increasing capability of our supply chains and fostering/supporting emerging clean manufacturing precincts in NSW.
- High emitting industries – helping high emitting industries shift to net zero and deliver significant emissions reduction by 2030.

As part of the new low carbon industry foundations focus area, a $70 million hydrogen hub initiative was developed - supporting the development of hydrogen hubs in the Hunter and Illawarra regions. Expressions of interest for hydrogen projects closed on 11 February 2022.

Due to the timing of the application process, the Proposal is not eligible at this stage however it is unclear if future funding rounds may be available for application.

9.2 Third-party support

At Gate 2, the Proposal is at an early stage of maturity, and the extent to which risks, and funding / financing conditions can be accurately identified is limited. The scope of financial commitments and support by stakeholders will be further developed at later Gates should the Proposal proceed. Future Gates will involve a more detailed cost and benefit analysis, allowing for an analysis of financial viability of the Proposal, including sensitivity analysis and sources of project financing and funding.

[60] https://www.energysaver.nsw.gov.au/reducing-emissions-nsw/net-zero-industry-and-innovation

10. Potential Regulatory Requirements

Key messages

The potential regulatory requirements assessment undertaken as part of this Study focused on two areas: the potential requirements associated with the development of the infrastructure to support the transportation of gaseous hydrogen; and the requirements related with the transportation of gaseous hydrogen via both road and rail.

Due to the location agnostic approach for the infrastructure development, this section presents general advice about potentially relevant regulatory pathways associated with the Proposal, without the provision of locations-specific searches (which would be investigated if the Proposal proceeds to Gate 3).

The key insights for this section therefore relate to the requirements transporting hydrogen on road and rail to inform the analysis. The ADG provides the national standards and requirements for transporting dangerous goods by both road and rail and applies in both NSW and Queensland. The following key considerations from the ADG are noted:

- Hydrogen is classed as a 'Division 2.1 Flammable gas'. The threshold quantify for hydrogen is 50 tonnes, where a facility will automatically be classified as an MHF. For notifiable quantities (i.e., 5 tonnes of hydrogen) the regulator will make a determination whether the facility is an MHF. MHF's trigger a number of requirements under the WHS Regulation 2011. A facility may apply for an exemption from being labelled a MHF if the chemicals are in intermediate or temporary storage, the maximum package / container size is no more than 500 kg. Therefore, the Proposal may be streamlined if the maximum container size is less than 500kg.
- The ADG does not limit the quantity of hydrogen that can be transported, however details the minimum packaging requirements to transport hydrogen. Provided all the relevant provisions are observed (i.e., packaging, wagon, truck, rail, and road weight limits etc), there is no upper limit on the amount that can be transported by a single train or on a truck. Limits are imposed by the Road Authority on trucks and limits could be imposed by the rail operator.
- Compressed hydrogen can be transported by rail with other Class 3, 4 or 5 hazardous materials if there is a segregation/separated on a train by at least one intervening load platform. Compressed hydrogen cannot be transported by road with any other Class 3, 4 or 5 hazardous materials.
- Compressed hydrogen must not be transported in the first or last wagon of a train.
- The ADG does not limit the double stacking of compressed hydrogen containers.
- There are no prescribed restrictions on transporting compressed hydrogen through rail tunnels. However, restrictions may be placed by the rail operators on dangerous goods being transported through rail tunnels.

Specific Considerations for Transport by Rail:

- The ADG provides guidance around incompatible materials. The ADG provides provisions for incompatible materials to be segregated during railway transport.
- The ADG permits the double stacking of freight containers if the freight containers of dangerous goods are of the same UN number (i.e., UN 1049 compressed hydrogen). On this basis there is no restriction to the double stacking of compressed hydrogen containers, but they cannot be stacked with other dangerous goods.
- Dangerous goods licences are not required for train operators or trains.

Specific Considerations for Transport by Road:

- NSW and Queensland regulation prohibits the transport of dangerous goods (such as compressed hydrogen) by road through some specified tunnels, those displaying placard restrictions, and other prohibited areas.
- The ADG does not permit hydrogen to be transported by road with any other incompatible material.

- Transport of hydrogen by road requires the driver to hold a dangerous goods driver licence and the vehicle to have a dangerous goods vehicle licence, where the hydrogen is in a receptacle with a capacity of more than 500L, or more than 500kg of hydrogen is in a receptacle. Licences issued in NSW allow you to drive in Queensland and vice versa.

Following the ILM and MCA two options were carried forward for assessment, this includes:

- Road Case: Transporting gaseous hydrogen, stored in existing tanktainers from Toowoomba to Parkes, **by rail.**
- Rail Case: Transporting gaseous hydrogen, stored in existing tanktainers from Toowoomba to Parkes, **by road.**

For this Proposal, specific laydown yard locations for storing and transporting hydrogen in the Parkes Shire and Toowoomba region have not been provided, therefore this report follows a 'location agnostic' approach. This report presents general advice about potentially relevant regulatory pathways associated with the Proposal, without the provision of locations-specific searches, which would be investigated if the Proposal proceeds to Gate 3.

Preliminary stakeholder consultation with the following organisations has been undertaken to help frame the relevant safety and regulatory challenges and opportunities presented by the Proposal and highlighted in this chapter. The following organisations were contacted and provided inputs:

- NSW EPA.
- Safework NSW.
- TMR.
- Queensland Department of Environment and Science.
- Workplace Health and Safety Queensland.
- Office of the National Rail Safety Regulator (ONRSR).

Once the Proposal locations, construction methodology, Delivery Proponent and overall cost estimate of the Proposal have been provided, the environmental, planning, and other regulatory requirements would need to be reassessed. There is the potential for the planning pathways and approvals to change as the design and proposal scope progresses. Further detailed analysis of the environmental findings applicable to the Proposal will be undertaken in Gate 3 (if required), should the Proposal proceed.

The scope of the project does not include the hydrogen generation facility. The scope of review is limited to the laydown yard infrastructure for the storage of hydrogen containers and the loading and unloading of containers onto the train or truck. The transport of containers by road or train between Parkes and Toowoomba has been reviewed within this scope.

The structure of this section is the following:

- Section 10.1 outlines the environmental and planning regulations relevant to the Proposal where:
    - Section 10.1.1 outlines specific environmental and planning regulations in NSW.
    - Section 10.1.2 outlines specific environmental and planning regulations in Queensland.
- Section 10.2 outlines other regulatory requirements relevant to the Proposal where:
    - Section 10.2.1 other regulatory requirements relevant in NSW.
    - Section 10.2.2 other regulatory requirements relevant in Queensland.

10.1 Environmental and Planning regulations

The tables in this section provide a summary of the potential environmental and planning regulatory requirements that may be applicable to the Proposal. In the absence of specific site locations, general comments around the relevance and potential implications for the Proposal are made.

10.1.1 New South Wales

The potential environmental and planning regulatory requirements applicable for the Parkes, New South Wales portion of this Proposal are set out in Table 39.

Table 39 Potential environment and planning regulatory requirements – New South Wales

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential Implications for the ease of Delivery of the Proposal	Potential Mitigation and Management Measures
Commonwealth				
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities, and heritage places - defined in the EPBC Act as Matters of National Environmental Significance (MNES). The EPBC Act requires the assessment of whether the Proposal is likely to significantly impact on MNES or Commonwealth land. Section 18 and 18A outlines a person must not take action that has, will or is likely to have a significant impact on a listed threatened species. Section 25 outlines the requirement for approval of prescribed actions. Section 26 and 27A outlines the protection of the environment from actions involving Commonwealth land and offences relating to Commonwealth land. Section 28 identifies the requirement for approval of activities of Commonwealth agencies significantly affecting the environment.	A preliminary search for Protected Matters listed under the EPBC Act will be conducted once the Proposal locations for laydown and loading facilities have been determined. If potential MNES, including listed threatened ecological communities are identified, threatened species and migratory species or marine species, within the Proposal search areas, then an ecological assessment is required to determine the significance of any impacts of the Proposal on the MNES.	If potential impacts to MNES are identified, commence early consultation with Commonwealth Department of Agriculture, Water and the Environment (DAWE) to determine significance of impacts and potential approval pathway.	As part of any development application, undertake ecological assessment to determine significance of potential impacts under the provisions of the EPBC Act on the identified MNES.

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential Implications for the ease of Delivery of the Proposal	Potential Mitigation and Management Measures
State				
Planning				
Environmental Planning and Assessment Act 1979 (EP&A Act)	Part 4, of the EP&A Act identifies the requirements for development assessment and consent. Division 4.1 Section 4.2 specifies that development consent is required to carry out any development that an environmental planning instrument specifies may not be carried out except with development consent. Division 4.2 prescribes that the consent authority for development is the council of the area for which the development is proposed, other than for state significant, regionally significant, or development that is declared to be determined by a public authority other than the council. Division 4.3 addresses the process for development that needs consent. This includes in Section 4.10, development that is declared designated development by an EPI or the regulations. Division 4.5 addresses complying development and specifies that complying development that complies with the standards applicable to the development may be carried out with the issue of a complying development certificate. Division 4.7 addresses state significant development (SSD), which is development declared to be state significant under a SEPP or Ministerial planning order.	For the implementation of the Proposal by a public or private company, the development of laydown and storage facilities would be subject to the development assessment and consent requirements of Part 4 of the EP&A Act. If the Proposal triggers any of the requirements of designated development in Schedule 3 of the EP&A Regulation, then an Environmental Impact Statement (EIS) would need to be prepared to accompany the Development Application (DA) to Parkes Shire Council. Part 5 may apply to the Proposal if TfNSW or ARTC propose to carry out rail infrastructure enabling works to assist in the delivery of the Proposal.	A Statement of Environmental Effects (SEE) would be required to accompany a DA, or an EIS would be required for designated development A Review of Environmental Factors or an EIS would be required to be prepared to accompany an application by a public authority (i.e., TfNSW or ARTC) for any works associated with the Proposal. These requirements would have significant time and cost implications for the Proposal.	Develop cost estimates for the Proposal to determine if triggers SSD provisions. Undertake consultation with both Parkes Shire Council to determine if the Proposal would be declared designated development.

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential Implications for the ease of Delivery of the Proposal	Potential Mitigation and Management Measures
	Part 5, Division 5.1 identifies the infrastructure and environment impact assessment and planning approval requirements for development by public authorities, which may occur as 'development without consent'. Schedule 3 of the EP&A Regulation 2021 lists as designated development - 'railway freight terminals', which includes any associated spur lines, *freight handling facilities, truck or container loading or unloading facilities, container storage, packaging, or repackaging facilities*)— (a) that involve more than 250 truck movements per day, or (b) that involve the clearing of more than 20 hectares of native vegetation, or (c) that are located— (i) within 40 metres of a natural water body, wetland, or environmentally sensitive area, or (ii) within 500 metres of a residential zone or dwelling not associated with the development and, in the opinion of the consent authority, having regard to topography and local meteorological conditions, are likely to significantly affect the amenity of the neighbourhood by reason of noise, odour, dust, lights, traffic or waste.			
State Environmental Planning Policy (Transport and Infrastructure) 2021	The Transport and Infrastructure SEPP is a key environmental planning instrument which, in large part determines the permissibility of an infrastructure proposal	The vast majority of the Inland Rail corridor outside of Parkes township and land adjoining is zoned RU1 (Primary Production) and not a prescribed zone under this SEPP. In such circumstances	This SEPP imposes consultation requirements for the consent authority with the rail authority in respect of	Consultation with ARTC to address any impacts of the Proposal on the efficient operation of the Inland

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential Implications for the ease of Delivery of the Proposal	Potential Mitigation and Management Measures
	and under which part of the EP&A Act an activity or development may be assessed. Section 2.90 provides the definition of 'rail infrastructure facilities'. Section 2.93 provides for development of rail freight terminals, rail freight sidings or rail freight intermodal facilities to be carried out by any person with consent on land in a prescribed zone (which includes RU2, RU4, RU6, B4, SP1, SP2). Sections 2.97 and 2.98 address requirements for the consent authority to consult with the rail authority before determining a development application For any part of the Proposal that may be carried out by a public authority, Section 2.91 allows for the development of a railway or 'rail infrastructure facilities' by or on behalf of a public authority without consent on any land (i.e., the development is assessable under Part 5 of the EP&A Act). Division 1, Section 2.10 to 2.15 outlines requirements for public authorities carrying out development to consult with councils and other public authorities. Consultation with councils is required where the development impacts on council related infrastructure or services, locally listed heritage items, or flood liable land. Consultation with the State Emergency Services (SES) is required in respect of flood prone land.	this SEPP is not relevant in enabling the development of rail infrastructure facilities by a Proponent other than a public authority. The requirements under Sections 2.97 and 2.98 for the consent authority to consult with the rail authority on any development application adjacent to or within the rail corridor would apply Section 2.91 would apply if any rail infrastructure development is to be undertaken by a public authority in association with this Proposal and could be carried out as development without consent under Part 5 of the EP&A Act.	an application by the Proponent that is likely to have an adverse impact on rail safety and infrastructure. This would have time implications. If TfNSW or ARTC were to carry out any works associated with the rail infrastructure facility, Section 2.91 provides for the development without consent under the self-assessment by a public authority provided for in Part 5 of the EP&A Act.	Rail corridor that may need to be addressed before any development application could be determined.
State Environmental Planning Policy (Planning Systems) 2021)	Sections 89C(2) and 115U(2) of the EP&A Act provide that a SEPP may declare any development, or any class or description of	The Proposal is likely to be permissible with development consent under Part 4 of the EP&A Act (refer to Parkes LEP	No implications anticipated.	No implications anticipated.

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential Implications for the ease of Delivery of the Proposal	Potential Mitigation and Management Measures
	development, to be State Significant Infrastructure (SSI) or State Significant Development (SSD). The Planning Systems SEPP provides definitions of SSI and SSD. Section 2.6 of the Planning Systems SEPP states that development is SSD if the development on the land concerned is, by the operation of an environmental planning instrument, not permissible without development consent under Part 4 of the Act, and the development is specified in Schedule 1 or 2 of the SEPP. Schedule 1 (item 19) provides the following Rail infrastructure definition as an SSD: (1) Development that has a capital investment value of more than $30 million for any of the following purposes— (a) heavy railway lines associated with mining, extractive industries or other industry, (b) railway freight terminals, sidings, and inter-modal facilities. (2) Development within a rail corridor or associated with railway infrastructure that has a capital investment value of more than $30 million for any of the following purposes— (a) commercial premises or residential accommodation, **(b container packing, storage, or examination facilities,** (c) public transport interchanges.	below), and as such this SEPP will not apply. The Proposal is not proposed on behalf of ARTC and would not fall within the definition of rail infrastructure that is SSI under this SEPP. The Proposal does not directly form part of the Inland Rail project and as such is not CSSI under Schedule 5 Item 7.		If the Proposal is not permissible with consent under Part 4 of the EP&A Act and over $30 million consult with DPIE to obtain the SEARs for the development of an EIS as part of an SSD application.

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential Implications for the ease of Delivery of the Proposal	Potential Mitigation and Management Measures
	Section 2.13 of the Planning Systems SEPP states that development is SSI if it is wholly or partly permissible without development consent under Part 4 of the Act (by virtue of the operation of a SEPP) and it meets the definitions provided in Schedule 3 to the Planning Systems SEPP. Schedule 3 (item 3) of the Planning Systems SEPP includes the following definition of 'rail infrastructure' - Development for the purpose of rail infrastructure by or on behalf of the Australian Rail Track Corporation that has a capital investment value of more than $50 million.' Schedule 5 Critical State significant infrastructure, Item 7 Inland Rail, states that the objective of the Section is to declare the development that forms part of the Inland Rail project to be Critical State Significant Infrastructure (CSSI).			
Roads Act 1993	The *Roads Act 1933* outlines the procedures for opening and closing public roads, as well as the regulations for carrying out various works and activities on public roads. Part 1 Section 7 prescribes that the council of the local government area is the roads authority for all public roads within the area, other than any freeway or Crown road, or road for which some other public authority is declared by regulations to be the roads authority. Part 2 Division 1 outlines the methods of opening public roads.	The proposed development of laydown and storage facilities may require an access road and/or upgrading and widening existing roads to facilitate access for heavy vehicles such as construction machinery and b-double trucks. These works will require collaboration with, and approval from Parkes Shire Council for public roads, and from TfNSW for highways or other classified roads. The regulation of traffic in connection with any road works would be governed by this Act and powers exercised by the roads authority such as Road Occupancy	The introduction of new public roads or changes to existing roads will require approval of the road's authority. Potential impacts to state roads will trigger consultation with TfNSW for Parkes Shire Council in determining a development application, which may have	Consultation with the respective road authority, Parkes Shire Council for local roads and TfNSW for state roads.

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential Implications for the ease of Delivery of the Proposal	Potential Mitigation and Management Measures
	Part 4 prescribes the processes for the closing of public roads. Part 5 Division 3 Section 61 prescribes that it is the exclusive function of RMS (now TfNSW) to make decisions as to what road work is to be carried out on any freeway, highway or metropolitan main road or any other classified road (addressed by virtue of an agreement under this Division). And it is exclusively the function of RMS (now TfNSW) to construct and maintain State works. Section 115 addresses the road authority's powers to regulate traffic in connection with road work, and the exercise of powers by TfNSW (former RMS). Section 138 requires consent from the relevant road authority for the carrying out of work in, on or over a public road	Licences (ROLs) for construction work that may impact the operations of public roads (e.g., lane closures). The ROLs would be obtained prior to the commencement of construction. Note: if the Proposal were declared SSD as per section 4.42(1) of the EP&A Act, consent under s138 of the Roads Act cannot be refused and must be granted on terms that are substantially consistent with the approval for the State significant infrastructure.	significant time and cost implications. If extensive ROLs with restrictive conditions are required, this may result in additional impact on the delivery timeline.	
Biodiversity				
Biosecurity Act 2015	The *Biosecurity Act 2015* provides a framework for the prevention, elimination and minimisation of biosecurity risks posed by biosecurity matter. The Act also provides a framework for the effective management of threats to terrestrial and aquatic environments arising from pests, diseases, contaminants, and other biosecurity matter.	NSW WeedWise indicates that there are over 100 Priority Weeds identified in the North-west region. Some of these weeds are listed as Prohibited Matters The control of biosecurity risks, most notably plant pests (weeds) would need to be managed during the construction and operational phases of laydown and loading facilities. The extent will be determined based on final Proposal location.	Provision of relatively minor costs may be required for weed management during construction and operational activities.	As part of any development application, Undertake a weed assessment as part of the ecological assessment.
Biodiversity Conservation Act 2016 (BC Act)	The BC Act is to maintain a healthy, productive, and resilient environment for the greatest well-being of the community,	A preliminary search using the Department of Planning, Industry and Environment's (DPIE) BioNet Species	Significant impacts to threatened species listed under the BC Act would	As part of any development application, undertake

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential Implications for the ease of Delivery of the Proposal	Potential Mitigation and Management Measures
	now and into the future, consistent with the principles of ecologically sustainable development. The Act applies to animals and plants, but not in relation to fish and marine vegetation. The BC Act established the NSW Biodiversity Offsets Scheme (BOS), which applies to both local development and SSD (under Part 4 of the EP&A Act) or SSI projects (under Part 5 of the EP&A Act. Part 2, Division 1 outlines the offences associated with harming or attempting to harm an animal or plant that is of a threatened species, part of a threatened ecological community or protected, without authorisation. Part 6, Division 1 outlines biodiversity offsets scheme. Section 6.3 outlines the impacts of actions on biodiversity values that are subject to assessment and offset under the BOS. These include impacts of the clearing of native vegetation and the loss of habitat, and the impacts of action that are prescribed by the regulations. Part 7 outlines the biodiversity assessment and approvals under EP&A Act. Section 7.3 provides the test for determining whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats. Section 7.7 states that if the proposed development is likely to significantly affect threatened species, the application for development consent is to be accompanied by a	Sighting database would be conducted once the Proposal locations for laydown and loading facilities are determined. If the search identified species listed as threatened or protected under the BC Act, a test of significance of any impacts on threatened species would need to be conducted. If the Proposal is identified to have a significant impact on threatened species, the Proponent would need to prepare a biodiversity development assessment report (BDAR). Clearing of vegetation may be required. The extent will be determined based on final Proposal location and construction methodology. If vegetation removal exceeds the BOS thresholds, potential offset sites and/or opportunities to purchase biodiversity credits would be required.	trigger the requirement to prepare a BDAR to accompany a development application. If a BDAR is required, this would have cost implications and may result in additional impact on the delivery timeline of the Proposal. If biodiversity offsets are required, this may result in additional impact on the delivery timeline and potential cost implications.	an ecological assessment to assess the significance of any potential impacts under the provisions of the BC Act. Consultation with DPIE to determine potential approval pathway and any potential offset requirements.

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential Implications for the ease of Delivery of the Proposal	Potential Mitigation and Management Measures
	Biodiversity Development Assessment Report (BDAR).			
Local Land Services Act 2013	Land management (native vegetation) is outlined under Part 5A of this Act. Native vegetation means the following types of plants native to NSW: • Trees (including any sapling or shrub or any scrub). • Understorey plants. • Groundcover (being any type of herbaceous vegetation). • Plants occurring in a wetland. A plant is native to New South Wales if it was established in New South Wales before European settlement. Under section 60N, it is an offence to clear native vegetation in a regulated rural area without the authorisation or the approval of Division 4, 5 and 6 of the Policy. If clearing of native vegetation is required, under section 60O, the approval for clearing of native vegetation can be authorised under other legislation, in particular, the clearing can be authorised by development consent under Part 4 or carried out in compliance with an approval of a determining authority under Part 5 of the EP&A Act.	A preliminary search using the Native Vegetation Regulatory Map will be conducted once the Proposal locations for laydown and loading facilities have been determined. Such a search would identify any Regulated Land, if present. Clearing of some vegetation is expected to be required for any location. However, clearing of regulated land would need to be specifically addressed under a development consent.	If clearing of regulated land is required, this may constitute a reason for refusal of the development consent, and/or may result in additional impact on the delivery timeline and cost of the Proposal to provide alternatives or mitigation measures.	As part of any development application, undertake a potential vegetation clearing survey to identify any Regulated Land and the significance of any potential impacts.
State Environmental Planning Policy (Biodiversity and Conservation) 2021	SEPP (Biodiversity and Conservation) 2021 includes the aim to encourage the conservation and management of areas of natural vegetation that provide habitat for koalas and reverse the current trend of koala population decline. Under Part 4.2, the Policy applies to land that has been	A preliminary search will be conducted once the Proposal locations for laydown and loading facilities have been determined and will identify whether SEPP (Biodiversity and Conservation) 2021 applies.	Additional impacts on the delivery timeline and costs may occur for the assessment of koala habitat. If koala habitat is confirmed following	As part of any development application, undertake a potential koala habitat assessment as part of any ecological assessment.

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential Implications for the ease of Delivery of the Proposal	Potential Mitigation and Management Measures
	identified on the Koala Development Application Map.	If the proposed development has a spatial footprint of less than 1 hectare, then the SEPP (Biodiversity and Conservation) 2021 does not apply.	assessment, the drafting, approval, and implementation of the management plan would have time and cost implications. A Koala Management Plan requires a public exhibition and approval of the Planning Secretary.	If koala habitat confirmed, commence the preparation of a Koala Management Plan(s) prior to the commencement of construction.
Fisheries Management Act 1994	The *Fisheries Management Act 1994* objectives are to conserve, develop and share the fishery resources of the State for the benefit of present and future generations. Part 7a states the conditions for threatened species conservation and specifically states that the Act is to ensure that the impact of any action affecting threatened species, populations and ecological communities of fish and marine vegetation is properly assessed. Permits under section 201, 205 and 219 of the FM Act may be applicable to the Proposal, and include: • 201 – Permit to carry out works or dredging or reclamation. • 205 – Permit to harm (cut, remove, damage destroy, shade etc) marine vegetation. • 219 – Permit to obstruct the free passage of fish.	A search of the Fisheries NSW Spatial Data Portal and identification of intersected or potentially affected waterbodies will be conducted once the Proposal locations for laydown and loading facilities have been determined. The search may reveal threatened fish species within waterbodies that are within the search area. Based on final Proposal location and construction methodology, permits may be required. Note: if the Proposal is considered SSD, then as per section 4.41 of the EP&A Act a permit under section 201, 205 or 219 does not apply.	If permits under the FM Act are required, this may result in additional impacts on the delivery timeline and costs of the Proposal. If impacts to riparian vegetation are anticipated, specific mitigation measures would be implemented during construction and may result in additional impacts on the delivery timeline and costs of the Proposal.	As part of any development application, undertake an ecological assessment to determine the significance of any potential impacts under the FM Act. Consultation with DPIE and/or Department of Primary Industries (DPI) to determine potential licencing and/or permit requirements. Implement erosion and sedimentation control measures during construction to protect any surrounding waterways and aquatic ecosystems.
Heritage				

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential Implications for the ease of Delivery of the Proposal	Potential Mitigation and Management Measures
Heritage Act 1977	The *Heritage Act 1977* provides conservation of buildings, work, relics, and places that are of historic, scientific, cultural, social, archaeological, architectural, natural, or aesthetic significance to the State. Matters protected under the Act include items subject to an Interim Heritage Order and items listed on the State Heritage Register, the heritage schedules of local council LEPs, and the heritage and conservation registers established under section 170 of the Heritage Act by NSW state government agencies (section 170 Registers). Approval must be gained from the Heritage Council when making changes to a heritage place listed on the State Heritage Register, or when excavating any land in NSW where an archaeological relic might be disturbed. Under Part 4, sections 57 and 60 of this Act, approval is required for works which may have an impact upon items listed on the State Heritage Register. Sections 139 and 140 similarly require approval where relics are likely to be exposed. For any works which may have an impact upon items listed on the section 170 heritage register, notification to the Heritage Division may be required where demolition to the item is proposed, or where the item will no longer be occupied.	Preliminary searches for NSW Heritage will be conducted once the Proposal location has been determined. If heritage items are located within the search area, the level of impact on these items would be further assessed in the Gate 3 report if the Proposal is successful at the Gate 2 stage. If potential impacts to known heritage items are expected to occur, permits or approvals may be required. Note: if the Proposal is considered SSD, then as per section 4.41 of the EP&A Act , an approval under Part 4 of the Heritage Act, or an excavation permit under section 139 is not required.	Potential impacts to heritage items may impact the ease of delivery, through additional assessments, approval requirements and mitigation measures. In particular potential impacts to state heritage items will require Parkes Shire Council to refer any development application to the Heritage Council for concurrence. Any unexpected heritage finds discovered during construction would require stop work proceedings and notification to Heritage NSW.	As part of any development application, undertake heritage assessment to determine the significance of any potential impacts on listed heritage items and identify recommended mitigation measures for construction and operation of the Proposal. Consultation with the relevant regulatory bodies including Council officers and Heritage NSW regarding potential approvals / permits. Adopt an unexpected finds protocol for the construction phase of the Proposal.
National Parks and Wildlife Act 1974 (NP&W Act)	The objects of this Act are to conserve nature and to conserve objects, places, or features of cultural value within the landscape.	A search of National Parks listed on the NSW National Parks and Wildlife Service database will be conducted once the Proposal location has been determined.	If approvals/permits (particularly an AHIP) are required, additional impacts on the delivery	Where Aboriginal sites are identified or likely to be encountered commence early consultation with NPWS

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential Implications for the ease of Delivery of the Proposal	Potential Mitigation and Management Measures
	The NP&W Act is the primary legislation dealing with Aboriginal cultural heritage in NSW. Items of Aboriginal cultural heritage (Aboriginal objects) or Aboriginal places (declared under section 84) are protected and regulated under the NP&W Act. Aboriginal objects are protected under section 86 of the Act. Under section 89A, there is a requirement that if any unexpected Aboriginal objects are discovered the Chief Executive must be notified.	A search of the Aboriginal Heritage Information Management System (AHIMS) database will also be conducted once the Proposal location has been determined. Harm to Aboriginal objects and declared Aboriginal Places should be avoided. If harm cannot be avoided, an Aboriginal Heritage Impact Permit (AHIP) under section 90 of N&PW Act would be required. Note: if SSD pursuant to section 4.41 of the EP&A Act an Aboriginal heritage impact permit under section 90 is not required.	timeline and costs of the Proposal may occur.	and Aboriginal Land Council. As part of any development application, undertake an Aboriginal Cultural Heritage Assessment to determine if harm cannot be avoided to identified sites. Any unexpected finds of Aboriginal sites discovered would require stop work proceedings and notification to NPWS and Heritage NSW.
Water				
Water Management Act 2000 (WM Act) *Water Management (General) Regulation 2018*	Approvals under sections 89, 90 and 91 of the WM Act are required for certain types of developments and activities that involve the use of water, are carried out in or near a river, lake, or estuary, or may intersect groundwater.	Upon disclosure of the Proposal location, nearby or intersecting waterways can be identified. A search of groundwater dependent ecosystems will also be conducted for the Proposal search area. Water use approvals under section 89 (for example, to use a pump, bore or well), a water management work approval under section 90 or an activity approval (other than an aquifer interference approval) may be required under section 91 of the WM Act. Note: if SSD pursuant to section 4.41 of the EP&A Act A water use approval under section 89, a water management work approval under section 90 or an activity approval under section 91 (other	Requirements to obtain water use or aquifer interference approvals may result in additional impacts on the delivery timeline and costs of the Proposal.	Consultation with the Natural Resources Access Regulator (NRAR) to determine if an approval is required followed detailed design or during construction.

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential Implications for the ease of Delivery of the Proposal	Potential Mitigation and Management Measures
		than an aquifer interference approval), is not required.		
Water Act 1912	The *Water Act 1912* controls the extraction of water and use of extracted water. If during construction, temporary dewatering of groundwater (from an excavation) is deemed necessary, then: • A licence to carry out such activity will be required under Part 5, Division 3 of this Act. • Contractor must provide DPI Water with details on the volume of groundwater that is encountered and the duration of pumping. It is a legal requirement for any take of groundwater to be authorised by a *Water Act 1912* licence (in the case of dewatering activity) or a Water Access Licence (for onsite reuse) unless an exemption applies.	Water for construction would most likely be sourced from non-potable sources including existing dams or groundwater bores.	If extraction from a watercourse or groundwater bore is required, a permit for extraction would be required under the *Water Act 1912*. If permits and/or approvals are required, this may result in additional impacts on the delivery timeline and costs of the Proposal.	Consultation with Water NSW and Natural Resources Access Regulator (NRAR) to determine if licences are required.
Contamination				
Contaminated Land Management Act 1997 (CLM Act)	The CLM Act regulates significantly contaminated land through requirements for notification to the NSW EPA, investigation, remediation, and recovery of costs from the person responsible. The NSW EPA must be notified by the property owner in writing of any contamination identified within the Proposal in accordance with the requirements of Section 60.	A search of the EPA List of Notified Sites and the EPA Contaminated Land Record will be conducted once the Proposal location has been determined. Identification of recorded contaminated sites might limit use of the site and may require remediation.	Identification of any contamination sources on the sites or migration of contamination may require remediation and have impacts on the delivery timeline and costs of the Proposal. In case that there were no sites identified, there is still a chance to find contamination during construction. This is much more likely if the Proposal site was located within an existing rail	Undertake further preliminary site investigations as the designs progress to assess the significance of any potential impacts of the CLM Act.

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential Implications for the ease of Delivery of the Proposal	Potential Mitigation and Management Measures
			corridor caused by rail activities (refuelling and potential use of asbestos containing materials). Unexpected finds of contamination may require remediation and have impacts on the delivery timeline and costs of the Proposal. If a change in land use zone is to be sought as part of the Proposal, it may trigger SEPP - No.55 Remediation of Land requirements.	
State Environmental Planning Policy (Resilience and Hazards) 2021	SEPP Resilience and Hazards provides a state-wide approach to the remediation of contaminated land for the purpose of minimising the risk of harm to the health of humans and the environment.	The provisions of SEPP Resilience and Hazards would be considered in any Part 4 of the EP&A Act development assessment.	If remediation work was required, additional impacts on the delivery timeline and costs of the Proposal may occur.	As part of any development application, undertake a Phase I Environmental Site Investigation to assess the significance of any potential impacts of contamination.
Construction				
Protection of the Environment Operations Act 1997 (PoEO Act)	The PoEO Act is administered by the NSW Environmental Protection Agency (EPA) and regulates activities which may result in	The proposed development of laydown and storage facilities is unlikely to fall under the definition in *33 for railway infrastructure construction* as a facility is unlikely to meet the requirement for	The storage of compressed hydrogen will likely trigger an EPL. Time and cost would need to be allowed to	Once the Proposal design and construction methodology are further progressed, determine if the Proposal triggers

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential Implications for the ease of Delivery of the Proposal	Potential Mitigation and Management Measures
	pollution impacts (e.g., land, air, water, and noise pollution). Part 3.2 of the PoEO Act requires an Environment Protection Licence) for scheduled development work and to carry out scheduled activities as identified in Schedule 1 of the PoEO Act. The definitions of scheduled activities provided in Schedule 1 include, but are not limited to: *33 Railway activities – railway infrastructure construction* *33A Railway activities – railway infrastructure operations* *33B Railway activities—rolling stock operations* *35 Road Construction* For the storage of chemicals Schedule 1 includes: 9 Chemical Storage Where 'General Chemicals Storage' is defined as the storage or packaging in containers, bulk storage facilities or stockpiles of any chemical substance classified as a dangerous good in the Transport of Dangerous Goods Code. Hydrogen is a Class 2.1 Dangerous Good and therefore meets this requirement. The PoEO Act also defines thresholds for Schedule 1 – Chemical Storage activities. For Hydrogen the relevant details include: • Capacity to store more than 20 tonnes (pressurised gases).	construction of 5 kilometres or more of length of new railway track. The proposed development of laydown and storage facilities is unlikely to fall under the definition 33A *railway infrastructure operations* as a facility would be likely to meet the requirement for a continuous or connected length of track greater than 30 kilometres that is operated by the same person. The future rolling stock operations may need to be included under existing EPLs. Note if SSD as per section 4.42 of the EP&A Act, an EPL cannot be refused and must be granted on terms that are substantially consistent with the approval for the SSD. The Proposal will likely fall under the definition of *9 Chemical Storage* where the storage of 20 tonnes of pressurised gas will meet the minimum threshold and trigger EPL for the scheduled activity.	obtain an EPL prior to commencement of scheduled activities.	the need for an EPL for construction activities and operations. Consultation with NSW Environment Protection Authority (EPA) and rail operators regarding inclusion of activities under existing EPLs or the application and issuing of EPLs.

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential Implications for the ease of Delivery of the Proposal	Potential Mitigation and Management Measures
	• Capacity to store 200 tonnes liquefied gases. For compressed hydrogen, storing more than 20 tonnes of pressurised hydrogen will qualify as a Schedule 1 activity.			
Rural Fires Act 1997	The objectives of the *Rural Fires Act 1997* include the prevention, mitigation, and suppression of bush and other fires in local government areas and rural fire districts. It is also for the protection of the environment by requiring certain activities to be carried out having regard to the principles of ecologically sustainable development described in section 6 (2) of the *Protection of the Environment Administration Act 1991.* Part 4 outlines the prevention and minimisation of the spread of bush fires throughout the State. Division 1 identifies the duty of public authorities and owners and occupiers of land to prevent bushfires. Division 5 identifies the permits and notice requirements for lighting fires. A bushfire safety authority, under section 100B of the Rural Fires Act 1997, must be obtained from the NSW Rural Fire Service for subdivision and special fire protection developments on bushfire prone land.	A preliminary search of NSW Rural Fire Services bush fire prone land mapping tool will be conducted once the Proposal location has been determined. Proposal activities located within bush fire prone land must meet the requirements of Planning for Bush Fire Protection (PBP) 2019 which were legislatively adopted in the Environmental Planning & Assessment Regulations, unless the consent authority has consulted with the NSW Rural Fire Service. PBP requires certain building construction levels to be met so that life safety is improved, and the building will be less likely to burn down or be damaged by bush fires. If burning activities are required, a fire permit is required during the Bush Fire Danger Period from 1 October to 31 March.	Bushfire risk may impose additional cost to building compliance and additional time in design and consultation.	Consider the requirements and guidance of PBP 2019 during design development. Consultation with the NSW Rural Fire Service (RFS) to determine if permits are required.
Local				
Parkes Shire Local Environment Plan 2012 (Parkes Shire LEP)	The Proposal is located within the Parkes Shire LGA. The aim of the Parkes Shire LEP is to make local environmental planning provisions for land in the area. However, the Transport and Infrastructure SEPP prevails over all other environmental	The Parkes Shire LEP provides for 'freight transport facilities' to be permitted with consent in both the SP1 and RU1 zones. 'Freight transport facilities' include:	It is more than likely the site will be zoned SP1 or RU1, where development for freight transport facilities is permitted with consent.	Consultation with Parkes Shire Council to seek to address the objectives and policies, and relevant development standards of the LEP and seek

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential Implications for the ease of Delivery of the Proposal	Potential Mitigation and Management Measures
	planning instruments (such as LEPs) except where there is an inconsistency with *State Environmental Planning Policy (State Significant Precincts) 2005* or certain provisions of *State Environmental Planning Policy (Coastal Management) 2018*.	*means a facility used principally for the bulk handling of goods for transport by road, rail, air, or sea, including any facility for the loading and unloading of vehicles, aircraft, vessels, or containers used to transport those goods and for the parking, holding, servicing or repair of those vehicles, aircraft, or vessels or for the engines or carriages involved.* The Proposal would fall within this definition and those parts of the Proposal on land zoned SP1 or RU1 are permitted with consent of the Parkes Shire Council. Upon determining the location for laydown and loading facilities, searches of the Parkes Shire LEP will confirm the following: • Zoning of the Proposal area. • Heritage items or Places of Aboriginal Cultural Significance. whether the Proposal is situated within a Flood Planning Area.	This enables a development application to be made to Parkes Shire Council under Part 4 of the EP&A Act that addresses the policies, objectives, and relevant development standards of the SP1 and RU1 zones.	support for the Proposal prior to lodgement of a development application.

10.1.2 Queensland

The potential environmental and planning regulatory requirements applicable for the Toowoomba, Queensland portion of this Proposal are set out in Table 40.

Table 40 Potential environment and planning regulatory requirements – Queensland

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
Commonwealth				
Biodiversity				
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities, and heritage places - defined in the EPBC Act as MNES. The EPBC Act requires the assessment of whether the Proposal is likely to significantly impact on MNES or Commonwealth land. Section 18 and 18A outlines a person must not take action that has, will or is likely to have a significant impact on a listed threatened species. Section 25 outlines the requirement for approval of prescribed actions. Section 26 and 27A outlines the protection of the environment from actions involving Commonwealth land and offences relating to Commonwealth land. Section 28 identifies the requirement for approval of activities of Commonwealth agencies significantly affecting the environment.	A preliminary search for Protected Matters listed under the EPBC Act will be conducted once the Proposal locations have been determined. If potential MNES, including listed threatened ecological communities, threatened species and migratory species or marine species, are identified within the Proposal search areas, then an ecological assessment is required to determine the significance of any impacts of the Proposal on the MNES.	If potential impacts to MNES are identified, commence early consultation with Commonwealth Department of Agriculture, Water and the Environment (DAWE) to determine significance of impacts and potential approval pathway.	As part of any development application, undertake ecological assessment to determine significance of potential impacts under the provisions of the EPBC Act on the identified MNES.

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
State				
Biodiversity				
Environmental Protection Act 1994 (EP Act) Environmental Protection Regulation 2019	The EP Act is administered by the Department of Environment and Science. The objective of the EP Act is to protect Queensland's environment while allowing for ecologically sustainable development. Chapter 2 of the EP Act provides for the Minister to make Environmental Protection Policies (EPPs) to enhance or protect Queensland's environment and provides direction on what the policies might address. Chapter 1, Subdivision 4 Clause 19 provides for Environmentally Relevant Activities (ERAs) to be prescribed: *A regulation may prescribe an activity as an environmentally relevant activity if the Governor in Council is satisfied—* *(a) that—* *(i) a contaminant will or may be released into the environment when the activity is carried out; and* *(ii) the release of the contaminant will or may cause environmental harm; or* *(b) the activity will or may otherwise adversely affect an environmental value of the marine environment.* Chapter 3, Part 1 applies if an EIS process is required, and the Project is not a coordinated project. The chapter also	The following EPPs have been developed and may be relevant to the Proposal during the construction and operation of the Proposal: • *Environmental Protection (Air) Policy 2019.* • *Environmental Protection (Noise) Policy 2019.* • *Environmental Protection (Water and Wetland Biodiversity) Policy 2019.* The Environmental Protection Regulation 2019 lists the ERA's which require approval under the *Planning Act 2016* (refer below). Storage of 50 tonnes of hydrogen in containers of at least $10m^3$ requires a concurrence ERA, which would be referred to SARA. The EIS requirement under the EP Act is generally used for mining and resource projects, however, an EIS process may be required for the Proposal under the following triggers: • Commonwealth EPBC Act. • *State Development and Public Works Organisation Act 1971.* • Under the decision of the chief executive. If the Proposal and/or the proposed location for laydown and loading facilities is defined as a railway yard (including goods handling yards, workshops, and maintenance areas) then it would trigger a notifiable activity under Schedule 3.	Compliance requirements and licensing associated with ERAs may result in additional impact on the delivery timeline and cost of the Proposal. Furthermore, costs and delays to delivery may occur if a Schedule 3 notifiable activity is identified during the construction of the Proposal. Fees apply for the issue of EIS Terms of Refence (ToRs) and lodgement of EIS.	As part of any development application, undertake a detailed ecological assessment. Define the activities likely to be carried out on site Commence consultation with Department of Environment and Science if a notifiable activity is required during the construction or operation of the Proposal. Consult SARA as early as possible and seek advice on potential ERAs that may apply for the storage and transport of hydrogen.

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
	describes the purpose of an EIS and the EIS process. Under Chapter 7, a process is outlined for identifying, recording, and managing land that is affected by contaminants that are likely to cause serious or material environmental harm if improperly treated, stored, disposed of, or otherwise managed. Under Schedule 3, certain activities (including operating a railway yard) are defined as notifiable activities. If the owner or occupier of land becomes aware a notifiable activity is being carried out on the land, the owner or occupier must give notice to the Department of Environment and Science. Under Schedule 2 of the Environmental Protection Regulation 2019 storage of 50 tonnes or more of class 2 chemicals or dangerous goods in containers of at least $10m^3$ is an ERA.	Use of railway yard site will require a site investigation and assessment of contamination Standalone ERAs can be applied for directly to the Department of Environment and Science (DES). Where hydrogen production or storage is proposed as part of an existing development (with current ERAs), it is possible that this new activity may fit into existing approvals.		
Vegetation Management Act 1999 (VM Act)	The purpose of the VM Act is to regulate the clearing of vegetation, primarily by setting assessment benchmarks and matters to be considered under the *Planning Act 2016* (below). The VM Act requires the preparation of maps to identify areas of high conservation value and remnant vegetation and provides for a classification system for vegetation in regional ecosystems of endangered, of concern, or of least concern. Division 2, Clause 10 outlines 'significant community projects', which include	Once the Proposal location for laydown and loading facilities is determined, a preliminary search for native regulated vegetation will be conducted using Biomaps. Clearing of vegetation may be required. The extent of clearing will be determined based on final Proposal location and construction methodology. Significant clearing of native vegetation would trigger the requirement for approval and may trigger the preparation of an EIS.	If approvals for clearing, or if the Project is referred for an EIS, it may result in additional impact on the delivery timeline of the Proposal and incur additional costs. Clearing may also trigger environmental offsetting requirements which will increase cost and impact on delivery timing of the Proposal. (Refer to the	As part of any development application, undertake a detailed vegetation clearing survey to assess details of the species, extent of clearing and understand the significance of any potential impacts.

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
	essential infrastructure that serves an essential need of the community. Division 4B outlines provisions relating to accepted development, with various accepted development vegetation clearing codes apply to particular low risk clearing activities.		*Environmental Offsets Act 2014* below).	
Nature Conservation Act 1992 (NC Act)	A framework is established by the NC Act for the creation and management of protected areas (such as National Parks (NPs)) and the protection of native flora and fauna (protected wildlife). The objective of the NC Act is to conserve nature through an integrated and comprehensive conservation strategy. The NC Act provides licences, permits and approvals for disturbance of protected flora, fauna, and areas under the NC Act. The NC Act also requires permits to be obtained for taking of protected plants and the moving of protected animals.	Once the Proposal location for laydown and loading facilities has been determined, a search using the WildNet Layer in Biomaps will be conducted. The search may identify the following: • Sightings of fauna and flora species protected by the NC Act. • Protected areas of Queensland (i.e., National Park, Conservation Parks, Resource Parks, Forest Reserves, State Forest, and Timber Reserves). Permits or licences may be required if clearing of native plants, impacting on animal breeding places and catching and releasing wildlife. Exemptions apply, depending on the activity being engaged in and the categorisation of the plants or wildlife. If the clearing activity is not permitted under other clearing options (such as exemptions), clearing may be allowable under a development approval.	Impacts to, or use of, NPs or Conservation Reserves would be problematic and represent significant barriers/delays to the Proposal (e.g., If there are changes to NP land boundaries then re-gazetting, would be required via an act of parliament). If a permit for clearing, or impacting on protected plants or wildlife is required, this may impact the costs, timeline, and approval pathway for the Proposal. Clearing may also trigger the requirement for environmental offsetting, which may increase costs and delay delivery of the Proposal.	Avoid NPs and Conservation Reserves in site selection. If protected species or areas have been identified by the search, a detailed ecological survey to assess species and habitats in the search area should be undertaken to determine the significance and conservation status of the area and to determine any potential impacts. Commence early consultation with Department of Environment and Science to determine potential licencing and/or permit requirements.
Fisheries Act 1994 (Fisheries Act)	The Fisheries Act provides for the use, conservation and enhancement of fisheries resources and fish habitats in a way that	Once Proposal locations for laydown and loading facilities are determined,	If the work is considered to be 'waterway barrier work', this may result in additional impacts on the	If waterways are near or intersecting the Proposal, undertake a detailed ecological

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
	seeks to promote, apply, and balance the principles of ecologically sustainable development (Section 3). The Fisheries Act is administered by the Department of Agriculture and Fisheries (DAF). Where proposed waterway barrier works cannot comply with the relevant code for self-assessable development, a development permit under the *Planning Act 2016* will be required.	waterways near and intersecting the proposal will be identified. The requirement for an approval will be determined as the Proposal progresses to detailed design. Specific works may be considered 'waterway barrier work' and may require approval from DAF.	delivery timeline and costs of the Proposal.	assessment as part of any development application to assess the significance of any potential impacts under the Fisheries Act. Commence early consultation with DAF to determine licencing and/or permit requirements and/or compliance with the Accepted Development Requirements for operational works like construction or raising waterway barrier works. Avoiding and/or minimising creation of waterway barriers should be considered during the detailed design and construction of the Proposal.
Biosecurity Act 2014	The *Biosecurity Act 2014* provides a framework for an effective biosecurity system for Queensland to minimise biosecurity risk and to provide comprehensive biosecurity measures to safeguard our economy, agricultural and tourism industries, environment, and way of life, from: • Pests (e.g., wild dogs and weeds). • Diseases (e.g., foot-and-mouth disease).	Once Proposal locations for laydown and loading facilities are determined, Biosecurity Queensland's weed map will be searched to identify the presence of weed species within the search area. Weeds would be managed in accordance with relevant legislation, including the *Biosecurity Act 2014* during construction activities.	Provision of relatively minor costs may be required for weed management and use of herbicides during construction activities.	Undertake a detailed weeds assessment as part of the ecological assessment to assess the significance of any potential impacts under the *Biosecurity Act 2014*. If potential impacts from weeds are identified, consult with the relevant regulatory bodies, including

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
	• Contaminants (e.g., lead on grazing land).			Toowoomba Regional Council and Biosecurity Queensland (as part of DAF).
Nature Conservation (Koala) Conservation Plan 2017	The main purposes of *the Nature Conservation (Koala) Conservation Plan 2017* are to promote the continued existence of viable koala populations in the wild; and to prevent the decline of koala habitats. Part 2 Division 2 outlines the koala priority areas and habitat areas with the aim to avoid impacts on koala habitat to ensure the long-term persistence of koala populations in the wild.	Once Proposal locations for laydown and loading facilities are determined, search of the Queensland Globe will be searched for koala districts, priority areas and habitat Areas and species sightings. Sequential clearing protocols as detailed in Part 3 of the Conservation Plan apply in koala district A and B. Clearing in a koala habitat area may require offsets according to the *Environmental Offsets Regulation 2014*, schedule 2.	If any part of the Proposal is found to be within a koala habitat area, management plans and potential offset requirements would impact the delivery timeline and cost.	Further assessment is required in Gate 3 (if the Proposal is successful at Gate 2) of the locations with respect to koala habitat and populations.
Planning				
Planning Act 2016	The purpose of the *Planning Act 2016* is to establish an efficient, effective, transparent, integrated, coordinated, and accountable system of land use planning, development assessment and related matters that facilitates the achievement of ecological sustainability. The *Planning Act 2016* establishes the system, including the roles and responsibilities of government, industry, and community. The Act also outlines the 'rules' for assessing development applications. The Act is supported by the *Planning Regulation 2017,* the State Planning Policy (SPP), regional plans and local planning instruments.	A local categorising instrument is prohibited from stating development for transport infrastructure (i.e., railways) supported by government is assessable development. Therefore, development permits from local Councils are not required for such works by government. Development adjacent to or outside of a State road or rail corridor may be subject to local planning instruments and development permits assessed by Council and may require concurrence from QR as the rail manager. For private party development, the land would also need to be appropriately zoned in the Local Planning Scheme - the project would be assessable development under the Act, unless QR	Development of the storage and loading/unloading facilities by a Proponent other than a public authority would be assessable development and subject to the local planning instrument requiring development permits, consistency with zoning and development standards, and public notification. If the proposal will have a significant impact on the environment, and an EIS required, then this will have a significant impact	Consultation with Toowoomba Regional Council Consultation with QR.

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
	Local Government planning schemes provide the majority of detailed land use and development regulation; however, regional plans will override local government planning schemes to the extent of any inconsistency. The Queensland Government established the SPP under this Act to define the specific matters of state interest in land use planning and development. Matters of State Environmental Significance (MSES) are a component of the biodiversity state interest that is defined under the SPP. MSES areas are used to guide and assist planning and development assessment decision-making.	undertook the project (note, TMR can undertake projects on QRs behalf, but some of QRs exemptions then do not apply). In accordance with the SPP, the Proposal is to be located in areas that avoid and/or minimise adverse impacts and where adverse impacts cannot be reasonably avoided, they are minimised.	on both the delivery timeframe and the costs of the Proposal. Any development undertaken by or on behalf of QR and TMR would be carried out in accordance with the detailed environmental impact assessment procedures included in their Environmental and Planning Processes Manual (QR) and Environmental Processes Manuals (TMR).	
Planning Regulation 2017	The *Planning Regulation 2017* supports Queensland's principal planning laws by outlining the mechanics for the operation of the *Planning Act 2016*. Part 3 prohibits a local categorising instrument from declaring particular development as 'assessable development'. This includes operational work performed by a railway manager (Schedule 6 Part 3) and development for government supported infrastructure activities including road transport and transport infrastructure (Schedule 6 Part 5). Accepted development is outlined in Schedule 7, assessable development in Schedule 9 and 10 and prohibited development in Schedule 10. Clearing of native vegetation is allowed on prescribed land if the development is an	The *Planning Regulation 2017* states which entity is responsible for assessing and deciding the application. The assessment manager for development within the State road and rail corridors is the Director-General TMR. The assessment manager for development outside of the State road and rail corridors will generally be Councils (i.e., Toowoomba Regional Council), but may also require concurrence assessments and approvals from State government or other entities. Schedule 10 of the Planning Regulation 2017 prescribes that a material change of use for hazardous chemical facility is assessable development. A proponent for a hazardous chemical facility is therefore required to make an application to SARA	Development undertaken by or on behalf of QR and TMR will be determined by the Director-General of the TMR and subject to their respective detailed environmental assessment procedures. Local planning scheme may require amending or land rezoned to enable development by the Proponent. Hydrogen storage and transport may initiate a material change of use based on ERAs or a	Examine land tenure and determine Proponent(s) and assessment manager for the development options. Assume that for works within the existing rail corridor that QR will become the Proponent and therefore the QR internal processes will apply to the assessment and approvals process. As the Proposal is defined, engage in consultation with Toowoomba Regional

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
	assessable development, in which a code assessment is required when the chief executive is the prescribed assessment manager Schedule 10 – Development Assessment, includes triggers for activities relevant to storage of hydrogen. These may include: • Part 5, Division 2 – Material Change of use for an environmentally relevant activity (ERA). This would include chemical storage, chemical production, and energy production. • Part 7 – Hazardous Chemical Facilities.	in accordance with the development assessment process established under the *Planning Act 2016*. The definition of 'hazardous chemical facilities' (HCF) is contained in the definitions of this regulation as *the use of premises for a facility at which a prescribed hazardous chemical is present or likely to be present in a quantity that exceeds 10% of the chemical's threshold quantity under the Work Health and Safety Regulation, schedule 15 a*.	Hazardous Chemical Facility classification. A material change of use may delay timelines with applications. Applications will also have associated fees. A HCF (including an MHF) will need to comply with State Code 21: Hazardous Chemical Facilities which outlines the assessment benchmarks and relevant standards for design, siting, and risk mitigation for proposed facilities. State Code 21 includes So Far as Reasonably Practicable (SFARP) requirements. Significant specialist engineering hours are likely required to complete a Hazard Assessment Report in line with State Code 21. Hazardous chemical facilities are managed by the Office of Industrial Relations (OIR) within Queensland Workplace Health and Safety (Worksafe Queensland). Facilities determined as a major hazard facility on	Council and QR to determine potential approvals required. Early engagement with Worksafe Queensland to determine whether storage and transport will classify the proposal as an MHF. Ensure risk assessments in accordance with the State Code 21 detail. Early engagement with SARA to streamline submission (if required).

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
			inquiry must prepare a safety case and be licenced (see Work Health and Safety legislation below for further requirements).	
State Development and Public Works Organisation Act 1971 (SDPWO Act)	The SDPWO Act is the Act used by the State Government to facilitate large projects. Part 4 Division 2 allows the coordinator-General to declare a project to be a coordinated project in which either an EIS or an IAR is required. A Project is usually declared as a 'coordinated project' based on one or more of the following: • Complex local, state or Commonwealth approval requirements. • Strategic significance to the locality, region, or State significant positive or negative impacts on infrastructure, the economy or the social or physical environments. The EIS process for a coordinated project is outlined in Part 4 Division 3 Subdivision 1. The IAR process for a coordinated project is outlined in Part 4 Division 3 Subdivision 2. Part 4 Division 3A allows either the Proponent or the Coordinator-General to make changes to the Project. The Act provides extensive powers under Sections 82 and 125 to the coordinator-General to take land, including for the	The coordinator-General may declare a project to be a coordinated project for which an IAR is required, only if the coordinator-General is satisfied that the environmental effects of the project do not require assessment through the EIS process. An EIS for a coordinated project must address the terms of reference approved by the coordinator-General. In preparing the terms of reference, the coordinator-General may seek public comment on a draft. At the end of the impact assessment process for an EIS or an IAR, the Coordinator-General releases an evaluation report either approving (with or without conditions) or refusing the project. Under the SDPWO Act, the Proponent must pay fees to the coordinator-General to cover the management and assessment costs of the impact assessment process. Schedule 1B of the Act sets out the amount of the fee payable. The fee is dependent on the project scope.	The proposed storage and laydown area is unlikely to be declared a co-ordinated project. The SDPWO Act is unlikely to have significant implications for the Proposal.	Unlikely to be applicable, however, further assessment of impacts under the SDPWO should be undertaken as the project scope develops.

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
	purposes of works undertaken by a local body or department of government, rural or urban development recommended by the coordinator-General and approved by the Governor Council, and for a private infrastructure facility.			
Environmental Offsets Act 2014 (Offsets Act)	Offsets are regulated under the Offsets Act and the accompanying regulation and policy. The Offsets Act states that offsets are required to counterbalance the significant residual impacts of prescribed activities on prescribed environmental matters, including MSE defined under the SPP. A proponent with an offset requirement may deliver the environmental offset in the following three ways: • Financial settlement offsets. • Proponent-driven offsets which includes land-based offsets. • Delivery of actions under a Direct Benefit Management Plan. Or a combination of the three environmental offset methods.	Once Proposal locations for storage and laydown areas are determined, a search of the SPP Interactive Mapping System (IMS) will be conducted to identify MSES. The search may identify: • Protected areas, such as declared fish habitats, wetland values and wildlife habitat. • Regulated Vegetation.	If an environmental offset agreement or additional assessments are required, this may impact the delivery timeline and cost of the Proposal.	As part of a development application, conduct detailed analysis of potential impacts on prescribed environmental matters through additional environmental assessments and ecological surveys to determine if an environmental offset is required. Commence consultation with the Department of Environment and Science, as to an environmental offset agreement being required for the Proposal.
Transport Planning and Coordination Act 1994	The objectives of this Act are to improve the economic, trade and regional development performance of Queensland and to improve the quality of life of Queenslanders by achieving overall transport effectiveness and efficiency through strategic planning and management of transport resources.	The TMR have developed a transport coordination plan in accordance with the requirements of the *Transport Planning and Coordination Act 1994*. The Transport Coordination Plan 2017-2027 (TCP) provides a strategic framework for the planning and management of transport resources in	May impact the delivery timeline and cost of the Proposal if the Proposal does not align with the objectives of the TCP.	As part of a development application, undertake a consistency assessment with the TCP and early and frequent consultation

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
		Queensland over a 10-year time frame. The TCP includes high-level objectives for Queensland's transport system across the following five key areas: • Customer experience and affordability. • Community connectivity. • Efficiency and productivity. • Safety and security. • Environment and sustainability.		on the Proposal with TMR.
Regional Planning Interests Act 2014 (RPI Act) Regional Planning Interests Regulation 2014	The purposes of the RPI Act are to identify areas of Queensland that are of regional interest because they contribute, or are likely to contribute, to Queensland's economic, social, and environmental prosperity. Part 3 of the RPI Act outlines the development approval for areas of regional interest.	Searches for areas of regional interest would be undertaken once the Proposal locations have been determined. The RPI Act restricts the carrying out of resource or regulated activities where the activity is not exempt from the provisions of the RPI Act, or a regional interests development approval (RIDA) has not been granted. Each proposed regulated activity will be considered on its merits and is a standalone process, separate from the *Planning Act 2016* and the EP Act. The chief executive of the Department of State Development, Infrastructure, Local Government and Planning must consider and decide the application based on advice of assessing agencies. Regional Planning in Queensland is governed by: • Planning Act 2016. • The Regional Planning Interests Regulation 2014. • Regional Planning Interests Act 2014 (RPI Act).	A RIDA will not be required for the Proposal as the Proposal does not involve a resource activity and is not a 'regulated activity' as defined by the Act and Regulations. Regional Plans may offer opportunities to locate and site hydrogen generation and laydown areas close to renewable energy infrastructure.	It is recommended State Regional Plans are regularly reviewed, particularly plans for the Southern QREZ to identify opportunities that may align with the citing of hydrogen generation, storage, and transport.

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
		• Regional Planning Interests Regulation 2014. Regional plans may have policies that are relevant to hydrogen activities. For example, the North Queensland Regional Plan identifies Renewable Energy Investigation Areas (REIAs) as locations that are considered most suitable for new commercial-scale solar and wind farms. The plan also includes a specific regional policy. Similar Regional Plans will be released for Southern and Central Queensland Renewable Energy Zones (QREZ). While the REIAs provide guidance on suitable locations for large scale solar or wind farms, these types of activities may also be associated with green hydrogen. Whilst little detail has been released for the Southern REIA it is recommended that regional plans are regularly reviewed to identify whether they offer opportunities for siting of hydrogen generation facilities, laydown yards and proximity to the inland rail infrastructure.		
Transport Infrastructure Act 1994 (TI Act)	The objective of the TI Act is to provide a regime that allows for and encourages effective integrated planning and efficient management of a system of transport infrastructure, which includes both road and rail infrastructure. Chapter 7 of the TI Act is related to rail transport infrastructure and other matters. The TI Act addresses powers to undertake railway works, such as the authority to enter land for railway works, compensation and diverting waterways. The TI Act also	Provisions of this Act provide for access to the rail network and allow the railway manager to carry out construction and maintenance work. The TMR holds the perpetual lease over the rail corridor in Queensland and are therefore the 'Owner' of railway land. TMR 'sub-leases' the rail transport corridors to QR, under the *Transport Infrastructure Act.* QR are the 'Railway Managers' under the Act.	The Act provides for the regime of approvals and permissions relating to rail (and other) infrastructure. If the Proponent for the approvals and construction phase becomes QR, this process is streamlined and simplified.	Commence early consultation with relevant authorities (TMR and/or QR) to determine potential approval and/or permit requirements. Commence discussion with QR regarding QR becoming the

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
	addresses land for railway purposes and outlines works on existing railways.	Section 255 of the TI Act requires the Railway Manager's approval for works in or on the railway corridor. QR is therefore required to assess proposals for development in a railway environment to ensure that all the obligations are met, including environmental, safety and that there will be minimal interruption to rail services. The Proponent will require approval to interfere with a railway as works will be undertaken within existing rail corridor.	However, if the Delivery Proponent is not a public authority, additional approvals will be required (including from QR and TMR, and the Proposal will not be assessed under the QR internal process.	Proponent for aspects of the Proposal. Investigation is required to determine specific permissions and approvals that will be required in relation to undertaking work within the railway corridor.
Heritage				
Queensland Heritage Act 1992	The *Heritage Act 1992* provides for the conservation of Queensland's cultural heritage through measures including: • Establishment of the Queensland Heritage Council. • Keeping of registers of places and areas of State cultural heritage • Requiring reporting of heritage finds. • Management of heritage places. • Regulating development in conjunction with other legislation. • Heritage agreements. • Providing enforcement powers. Section 71 addresses development by the State. Section 89 specifies the requirements to notify an archaeological find and Section 90 that it is an offence to interfere with an archaeological artefact.	Preliminary searches for Queensland Heritage will be conducted once the Proposal location for storage and loading facilities has been determined. If heritage items are located within the search area, the level of impact on these items would be further assessed in the Gate 3 report if the Proposal is successful at the Gate 2 stage. If potential impacts to known heritage items are expected to occur, permits or approvals may be required.	Potential impacts to heritage items may impact the ease of delivery, through additional assessments, approval requirements and mitigation measures. In particular potential impacts to state heritage items will require Toowoomba Regional Council to refer any development application to the Heritage Council for concurrence. Any unexpected heritage finds discovered during construction would require stop work proceedings and notification to the Department of	As part of any development application, undertake heritage assessment to determine the significance of any potential impacts on listed heritage items and identify recommended mitigation measures for construction and operation of the Proposal. Consultation with the relevant regulatory bodies including Council officers and Department of Environment and Science regarding potential approvals / permits.

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
			Environment and Science.	Adopt an unexpected finds protocol for the construction phase of the Proposal.
Water				
Water Act 2000	The purpose of the *Water Act 2000* is to provide a framework for the sustainable management of Queensland's water resources, the sustainable and secure water supply and demand management and the management of impacts on underground water. Clause 27 outlines the use of water by authorising persons allowed by the State through legislation, statutory instruments, or any of the following authorisations under the *Water Act 2000:* *i. water allocations;* *ii. water licences;* *iii. water permits;* *iv. seasonal water assignment notices;* *v. resource operations licences;* *vi. distribution operations licences;* vii. *operations licences*. The Act also outlines water use plans and water management protocols. Clause 365 outlines the cumulative management areas when an area containing two or more resource tenures may be affected by the exercise of underground water rights by the tenure holders.	Once Proposal locations for storage and loading facilities are determined, waterways near and intersecting the proposal, as well as groundwater dependent ecosystems (using the Groundwater Dependent Ecosystem Atlas) within the search area will be identified. A Riverine Protection Permit may be required which is triggered by the removal of vegetation, excavating, or placing fill in a watercourse, lake, or spring. Exemptions apply where the actions are necessary as part of a permitted activity.	If permits and/or approvals are required for construction, this may result in additional impacts on the delivery timeline and costs of the Proposal.	Commence early and frequent consultation with the relevant regulatory bodies to determine if permits and/or approvals are required.

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
Construction				
Fire and Emergency Services Act 1990	Fire management is principally concerned with preventing fire entirely or controlled burning to reduce the fire hazard to property and livestock. The Act regulates fire safety and the use of fire. It also provides for the declaration of local fire bans when there is a high fire risk. The Queensland Fire Service administers the Act, and a volunteer network of Local Fire Wardens issue permits for controlled burning. Part 7, Control and Prevention of Fires, Clause – Granting of Permits outlines that *'a person may apply to the commissioner (orally or in writing) for a permit to light a fire on any land'.*	Once Proposal locations for storage and loading facilities are determined, a search of the SPP IMS will be conducted to identify bushfire prone land. If burning activities are required, a fire permit may be required, and conditions or directions contained in this permit must be followed.	If consent and/or approvals are required, this may impact the delivery timeline and costs of the Proposal.	Consider the requirements of *Bushfire Resilient Communities Technical Reference Guide for the State Planning Policy State Interest 'Natural Hazards, Risk and Resilience - Bushfire' 2019* and consult with Queensland Fire and Emergency Services during design development. Consult with the Queensland RFS to determine if consent or permits are required.
Local				
Toowoomba Regional Council Planning Scheme	The Toowoomba Regional Council Planning Scheme is a document which sets out the controls and use of land that apply to land in the region. The *Planning Act 2016 and State Planning Policy* have pathways for development by State and government bodies that prevail over local planning instruments. Development adjacent to or outside of a State road or rail corridor. would be subject to the considerations in this Scheme.	Once Proposal locations for storage and loading facilities are determined, the Toowoomba Regional Council Planning Scheme will be used to identify: • Land Zone. • Flood prone land.	Development approval required under the Toowoomba Regional Council Planning Scheme, would have costs and timing implications for delivery of the Proposal.	Identify the potential impacts of the Proposal on existing and future land uses. Consultation with Toowoomba Regional Council to determine development application requirements. Flood mitigation requirements should be taken into consideration

Applicable environmental and planning regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
				during the detailed design stage.

10.2 Other regulatory requirements

The tables in this section provide a summary of the other potential regulatory requirements that may be applicable to the Proposal. In the absence of specific site locations, general comments around the relevance and potential implications for the Proposal are made.

10.2.1 New South Wales

Other potential regulatory requirements applicable for the Parkes, New South Wales portion of this Proposal are set out in Table 41.

Table 41 Other potential regulatory requirements – New South Wales

Other potential regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
Commonwealth				
Native Title Act 1993	The Commonwealth *Native Title Act 1993* provides the legislative framework that: • Recognises and protects native title. • Establishes ways in which future dealings affecting native title may proceed. • Establishes the National Native Title Tribunal. Extinguishment, or partial extinguishment, of native title (s 237A), occurs as the result of certain past Acts of Government (generally prior to 1 January 1994 when the NTA came into force), through actions such as granting of freehold land, granting of leases, or the construction or establishment of public works.	Searches of the National Native Title Tribunal database will be undertaken once the Proposal location for storage and loading facilities is determined. If an application is registered, the applicants have procedural rights and other benefits, including the right to negotiate with governments or the right to be consulted about proposed developments. They may also oppose non-claimant applications that seek a determination as to whether or not native title exists in a certain area. If the Proposal is situated on freehold title land or within the rail corridor where public works were established prior to the NTA coming into force, any native title rights have been extinguished.	It is likely that for most sites Native title has been extinguished. However, if land is subject to Native Title Claim there are likely to be significant impacts on the delivery timeline for the Proposal.	Locate the Proposal on freehold land or where public works have been constructed prior to 1 January 1994. Where land affected by Native Title, consultation with the National Native Title Tribunal.

Other potential regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
State				
Crown Land Management Act 2016 No 58 *Crown Land Management Regulation 2018*	The *Crown Land Management Act 2016* and *Crown Land Management Regulation 2018* regulates the ownership, use and management of Crown Land in NSW.	A search of the Crown Land Manager Reserves Portal will be undertaken once the Proposal location for storage and loading facilities is determined. If the Proposal site was situated on Crown Land or involves Crown Roads, it is possible that a lease or permit may be required from DPIE-Crown Lands as part of the proposed works.	If a lease or licence was required to occupy Crown Land, additional impacts on the delivery timeline and costs of the Proposal may occur.	Consultation with DPIE-Crown Lands to determine potential requirements.
Transport Administration Act 1988	The *Transport Administration Act 1998* provides administration and management of transport infrastructure and transport agencies in NSW. Section 99AA states, a rail infrastructure owner must not sever, or fail to maintain, a connection between any part of the NSW rail network for which it is the rail infrastructure owner and any other part of the NSW rail network without the consent of the rail infrastructure owner of the other part of the NSW rail network. Section 99B, a rail infrastructure owner may close any level crossing provided that, prior to closing the crossing, it notifies TfNSW and the local council and receives Ministerial approval. TfNSW reviews all applications for level crossing closures before they are submitted to the Minister for Transport, to ensure that the relevant issues have been considered, and adequate consultation has been undertaken.	Once the Proposal location for storage and loading facilities is determined, the following will be identified: • Affected level crossings within the Proposal area. • Any change that was required to existing level crossings. • Any new level crossings required by the Proposal. Any interruptions to existing railway lines caused by the Proposal.	If level crossings are required to be closed, they must be approved by the Minister of Transport, which may impact the delivery timeline and have potential cost implications.	Consultation with the ARTC and TfNSW on activities likely to affect the function of the rail network.
	The *Work Health and Safety Act 2011* provides a framework to protect the health,	Depending on the quantity of hydrogen being held at the proposed storage and	Classification as an MHF will slow delivery based	Confirm with regulator whether the major

Other potential regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
Work Health and Safety Act 2011 Work Health and Safety Regulation 2017	safety and welfare of all workers and others in relation to NSW workplaces and work activities. Under Part 9.2 Section 536(1) of the Work Health and Safety Regulations 2017, the operator of a facility at which Schedule 15 chemicals are present or likely to be present in a quantity that exceeds 10% of their threshold quantity must notify the regulator of this circumstance in accordance with this Part.	loading facilities, this may result in the facility being classed as an MHF. As per Schedule 15 the threshold quantity for hydrogen is 50 tonnes. The notifiable quantity is 5 tonnes (or 10%). Storage or 50 tonnes or more a facility would be declared an MHF. Above the notifiable quantity the regulator may also determine that a facility is an MHF.	on project needing to meet all hazard facility requirements.	hazard facility definition is likely to apply to the vehicle transporting hydrogen.
	Where facilities meet the MHF requirements, the Work Health and Safety Regulation 2017 require a more rigorous approach when undertaking risk assessments as outlined in Section 554 and Section 556. Section 554 (1): The operator of a determined major hazard facility must identify— (a) all major incidents that could occur in the course of the operation of the major hazard facility, and (b) all major incident hazards for the major hazard facility, including major incident hazards relating to the security of the major hazard facility Section 556(1) The operator of a determined major hazard facility must implement control measures that: (a) eliminate, so far as is reasonably practicable, the risk of a major incident occurring; or	For a facility determined to be a major hazard facility, control measures must be implemented to manage risks SFARP. In NSW the definition of SFARP can be informed by the NSW: Hazardous Industry Planning Advisory Paper No 4 – Risk Criteria for Land Use Safety Planning.	During future delivery stages Quantitative Risk Assessments (QRAs) and other detailed risk assessments may be required to comply with SFARP requirements.	Plan during later phases of the project to undertake risk assessments (including QRAs) in line with the level of detail. Confirm whether Inland Rail have defined acceptable risk limits to public and workers.

Other potential regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
	(b) if it is not reasonably practicable to eliminate that risk — minimise that risk so far as is reasonably practicable.			
	The Work Health and Safety Regulation 2017 do allow exemptions to facilities being classified as a major hazard facility. Section 689 outlines: (1) The regulator must not grant an exemption under clause 688 unless satisfied that— (a) 1 or more Schedule 15 chemicals are present or likely to be present at the facility, and (b) the quantity of the Schedule 15 chemicals exceeds the threshold quantity of the Schedule 15 chemicals periodically because they are solely the subject of intermediate temporary storage, and (c) the Schedule 15 chemicals are in 1 or more containers with the capacity of each container being not more than a total of 500 kilograms, and (d) granting the exemption will result in a standard of health and safety in relation to the operation of the facility that is at least equivalent to the standard that would be achieved by compliance with the relevant provision or provisions	A facility may apply for an exemption if the chemicals are in intermediate or temporary storage, the maximum package / container size is no more than 500 kg and granting the exemption will result in a level of health and safety (in relation to the operation of the facility) that is at least equivalent to that which would be achieved by compliance with the relevant provisions of the WHS Regulations. Note the volume of 500 kg of compressed hydrogen depends on the container pressure: • 200 bar (14.5 kg/m^3) = 34.47 m^3 • 300 bar (20.7 kg/m^3) = 23.96 m^3 • 400 bar (26.2 kg/m^3) = 19.08 m^3 • 500 bar (31.2 kg/m^3) = 16.00 m^3	The delivery of the project may be streamlined from a regulatory point of view if containers were less than 500 kg. However, noting the proposal will still need to meet WHS requirements.	During the design and procurement of the tanktainers there may be an opportunity to seek exemption from the major hazard facility requirements. Stakeholder engagement with Safework NSW to determine whether an exemption may be granted for the transport of hydrogen.
	Schedule 15 of the Work Health and Safety Regulation 2017 provides a list of chemicals and their threshold quantity. Hydrogen is listed as item 24 (United Nations (UN) Number 1049) with a threshold quantity of 50 tonnes.	For the transport of hydrogen, the regulation identifies temporary storage ‘while in transit by road or rail’ may not form part of the hazardous chemical threshold calculation.	The delivery of the project will be streamlined from a regulatory point by remaining under the threshold 50 tonne quantity for a MHF at the	Stakeholder engagement with Safework NSW to determine threshold quantities and any potential exemptions.

Other potential regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
	If the threshold quantity is met, the facility or plant will be defined as a major hazard facility. However, there are additional certain situations as outlined in Schedule 15, Section 4 where compressed hydrogen may not be considered as part of the threshold determination, this includes: • Hazardous chemicals that are solely the subject of intermediate temporary storage, while in transit by road or rail (unless it is reasonably foreseeable that, despite the transitory nature of the storage, hazardous chemicals are or are likely to be present frequently or in significant quantities). • A hazardous chemical is present or likely to be present in an isolated quantity, if its location at the facility is such that it cannot, on its own, act as an initiator of a major incident.	The train itself during transport operations would not constitute a HCF or MHF. However, containers, including those on a train where commonly stored at a facility would be included in the threshold quantity. For the laydown area where pressurised hydrogen containers are stored the regulation does introduce the definition of 'isolated quantities' where the location of the pressurised containers may exclude it from the threshold calculation.	storage and loading facilities.	
	Schedule 5 of the Work Health and Safety Regulation 2017 Registration of plant and plant designs identifies specific registration requirements for pressure vessels. Schedule 5 Part 2 – Items of plant requiring registration 3.2 Pressure vessels categorised as hazard level A, B or C according to criteria in Section 2.1 of AS4343:2014 (Pressure Equipment – Hazard Levels, except – a) gas cylinders, and	Each compressed hydrogen gas pressure vessel is required to be registered with NSW WH&S. Note there is a registration cost per vessel. Note based on a review of AS4343 2014: the hazard level for transport of hydrogen is dependent on quantity transported: • 1 L = hazard C. • 7 L = hazard B. • 22,0000 L = hazard A.	Additional complexity around registration and management of documentation. Cost of registration in NSW.	Modelling team to allow for cost of registration and estimate of hours for managing documentation and accreditation.

Other potential regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
	b) LP Gas fuel vessels for automotive use, and c) serially produced vessels			
Dangerous Goods (Road and Rail Transport) Act 2008 Dangerous Goods (Road and Rail Transport) Regulation 2014 ADG 7.7_0	The *Dangerous Goods (Road and Rail Transport) Act 2008* makes provision for safety in the transport of dangerous goods by road and rail as part of the system of nationally consistent road and rail transport laws. Under the NSW Act the ADG is given legal force. The ADG sets out the requirements for transporting dangerous goods by road and rail. The ADG classes hydrogen as a 'Division 2.1 Flammable gas'. Table 3.2.3: Dangerous Goods List provides details and packaging requirements for hydrogen: 1049 Hydrogen, Compressed: Class = 2.1 Limited Quantities = 0 Excepted Quantity = E0 Packing Instruction = P200	Part 18 of the Dangerous Goods (Road and Rail Transport) Regulation 2014 addresses requirements for licences for both road vehicles and road drivers where dangerous goods are in a receptacle with a capacity of more than 500L, or more than 500kg of dangerous goods in a receptacle. Compressed hydrogen is a Class 2.1 flammable gas. Table 3.2.3 details the transport and packaging requirements for compressed hydrogen. Table 3.2.3 identifies that there are no limited or excepted quantities for compressed hydrogen. P200 references the types of containers which are acceptable for hydrogen, this includes: • Cylinders. • Tubes. • Pressure drums. • Bundles of cylinders. • MEGs. For P200 packaging test periods for the packaging must be undertaken every 10 years.	No licencing requirements for rail versus driver and vehicle licences may apply for transportation by road Packaging for compressed hydrogen must meet requirements stated in ADG 7.7. This will be reflected in the vessel selection / design. Note cost associated with 10-year test period for each vessel. However, this is different to *AS3788:2006.* The more onerous inspection and test frequency is recommended.	Design of transport container to comply with ADG requirements.
	Chapter 4.2.4.7 of the ADG states: Empty MEGCs that have not been cleaned and purged must comply with the same requirements as MEGCs filled with the previous substance.	All ADG requirements that are met when transporting compressed hydrogen to Toowoomba will also apply to 'empty' vessels returning to Parkes.	No relaxation in classification or method of transport can be permitted unless vessels are cleaned and purged	Design of transport container to comply with ADG requirements.

Other potential regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
			with associated certificates.	
	Chapter 6.2.1.1.2 of the ADG states: In Australia, the manufacture, verification, filling, inspection, testing and maintenance of gas cylinders must comply with AS2030.	Compliance with AS2030.	This will be reflected in the vessel selection / design.	Review of AS2030 to ensure compliance.
	Chapter 6.2.1.3.4 of the ADG states: Individual pressure receptacles must be equipped with pressure relief devices as specified in AS2030, P200(1)	Compliance with AS2030 and ADG	This will be reflected in the vessel selection / design.	Review of AS2030 and P200(1) to ensure compliance.
	Chapter 6.2.1.3.6.5.1 of the ADG states: The pressure-relief device must open automatically at a pressure not less than the MAWP and be fully open a pressure equal to 110% of the MAWP. It must, after discharge, close at a pressure not lower than 10% below the pressure at which discharge starts and must remain closed at all lower pressures.	Compliance with ADG and relevant safety standards.	This will be reflected in the vessel selection / design.	Design of transport container to comply with ADG requirements.
	Chapter 6.2.1.3.6.5.4 of the ADG states: The required capacity of the pressure-relief devices must be calculated in accordance with an established technical code recognised by the competent authority[1]. Note 1 – see for example CGA Publications S-1.2-2003 “Pressure Relief Device Standards – Part 2 Cargo and Portable Tanks for Compressed Gases” and 2-1.1-2003 “Pressure Relief Device Standards – Part 1 – Cylinders for Compressed Gases”.	Compliance with ADG and relevant safety standards.	This will be reflected in the vessel selection / design.	Designer to review CGA Publications
	Chapter 6.2.1.4 of the ADG states: The conformity of pressure receptacles must be assessed at time of manufacture	Compliance with ADG and relevant safety standards.	This will be reflected in the vessel selection / design.	Review Section 6.2.1.4 for all QA requirements.

Other potential regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
	as required by the competent authority. Pressure receptacles must be inspected, tested, and approved by an inspection body…(cont.)			
	Chapter 9.1.2 Table 9.1 of the ADG gives an indication of dangerous goods compatibility for land transport purposes, based on Classes, Divisions, Subsidiary Hazards, and some specific types of goods. Class 2.1 (Compressed hydrogen) is **NOT** compatible with: 2.2 Non-flammable non-toxic gas (where gas has a subsidiary Hazard 5.1 except when all packed in cylinders or pressure drums not exceeding 500 L capacity) 4.1 – Flammable solids 4.2 – Spontaneously combustible 4.3 – Dangerous when wet 5.1 – Oxidising substances 5.2 – Organic peroxides	Incompatibility of materials may reduce the flexibility of transporting hydrogen.	Potential implications are low for this option; however, this may reduce the flexibility to transport hydrogen on trains with other dangerous incompatible goods.	Review of other dangerous goods likely to be transported by rail should be undertaken.
	Chapter 9.2.1.3 of the ADG states: Dangerous goods must not be transported on the same road vehicle or train with incompatible goods unless the dangerous goods and the incompatible goods: a) Are segregated in accordance with this chapter Are otherwise allowed under this Code to be transported together.	Note there is less flexibility with transport of hydrogen by road in comparison to rail where hydrogen can be suitably separated from incompatible goods by locating on separate rail wagons. This is a possible opportunity for rail.	This may need to be reflected in modelling.	Consideration and review of other materials needs to be undertaken

Other potential regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
	Chapter 9.2.2.2 'Separate rail wagons or load platforms' states: Except where otherwise specified in Section 9.2.3 or 9.2.4, dangerous goods are segregated on a train from incompatible goods in accordance with this Code if the dangerous goods and the incompatible goods are carried on separate rail wagons or load platforms.	Represents an opportunity for hydrogen to be suitably segregated from other incompatible materials by locating on separate rail wagons.	Potential implications low.	Recommend awareness of this requirement.
	Chapter 9.2.3 'Special Segregation Provisions' states: Despite 9.2.2.1, 9.2.2.2 and 9.2.2.3, some goods which react dangerously must not be transported on the same road vehicle or combination road vehicle or, when transported by rail must be separated by intervening wagons or load platforms, in accordance with Table 9.3. Table 9.3: Goods A: Any dangerous goods of Division or Subsidiary Hazard 2.1 (>500L) and Goods B: Any dangerous goods of Class or Subsidiary Hazard 3,4 or 5. Will be subject to the following restrictions: • Road: Dangerous goods mentioned in the column headed Goods A must not be transported on any road vehicle at the same time as goods described as Goods B in the same numbered row of this table, even if the Goods A and Goods B are in different freight containers, bulk containers, portable tanks, or different vehicles making up a combination vehicle.	Based on this special provision, compressed hydrogen cannot be transported by road with any other Class 3,4 or 5 hazardous materials. However compressed hydrogen can be transported by rail with other Class 3, 4 or 5 hazardous materials if the segregation requirements are met. This reflects an opportunity for rail when transporting multiple materials in comparison to road.	Potential implications low.	Recommend awareness of this requirement.

Other potential regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
	• Rail: A freight container or wagon transporting a placard load that includes dangerous goods described as Goods A must be separated on a train from a freight container or wagon transporting a placard load that includes Goods B in the same row of this table by at least one intervening load platform that may, subject to the other segregation provisions of this Chapter, be loaded with other dangerous goods.			
	Chapter 9.2.4.1 of the ADG states: Except for transport in a rail tank wagon or where 9.2.4.7 applies, dangerous goods must not be transported in the nearest cargo transport unit to either end of the train.	This is a restriction on location or placement of hydrogen cargo and may influence the quantity of hydrogen that can be transported.	Potential implications low.	Recommend awareness of this requirement.
	Chapter 9.2.4.8.1 of the ADG states: Where double stacking of freight containers is permitted by the rail track owner, the following may be loaded in a vertical stack: (a) freight containers of dangerous goods of the same UN Number;	For inland rail the ADG does not limit the double stacking of compressed hydrogen containers.	No implication.	Recommend awareness of this requirement.
Road Transport Act 2013 No 18 Road Rules 2014 – Reg 300-2 NSW	NSW rule: carriage of dangerous goods in prohibited areas. 300-2 NSW rule: carriage of dangerous goods in prohibited areas: the driver of a dangerous goods transporter must not use the vehicle on or in any road or tunnel (or part of a road or tunnel) specified in the Table to this rule (a "prohibited area")	In NSW compressed hydrogen (classified as a dangerous good – Class 2.1) cannot be transported by road through numerous tunnels in Sydney and specific locations on the M1 Pacific Highway , which are all specified as prohibited areas in Road Rules 2014 – Reg Part 18 Division 1, section 300-2.	No prohibited areas are specified between Parkes and Toowoomba, but this is a restriction for road transport in certain areas of NSW.	No mitigations required as no prohibited areas are likely to be involved in the Proposal.

10.2.2 Queensland

Other potential regulatory requirements applicable for the Toowoomba, Queensland portion of this Proposal are set out in Table 42.

Table 42 Other potential regulatory requirements – Queensland

Other potential regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
Commonwealth				
Refer to Commonwealth references in Table 41 as equally apply in Queensland as in NSW				
State				
Acquisition of Land Act 1967	Under this Act, land may be taken by either the Crown, local government or construction authority for any purpose listed in Schedule 1 of the Act which includes: Railways and related purposes.	The Proposal consists of the construction of new rail loading and unloading infrastructure. Land required for the Project must be acquired and/or access must be permitted. This includes land controlled by authorities and private and State-owned land. Provisions of the Act apply if negotiated acquisition fails and compulsory acquisition is required. Although specific land parcels are yet to be identified for the options, it is assumed that some of the land will be owned by private land holders and require acquisition or, depending on use required, access arrangements negotiated.	The provisions of this Act are unlikely to be relevant to the current Proponent but may be exercised by TMR. If land would need to be acquired for the Proposal, this would have time and cost implications.	Unlikely to be relevant. Identify any aspects of the Proposal during detailed design that may trigger a requirement to widen the rail or a road corridor and acquire land. Obtain land titles records for the specific land affected by the Proposal to identify the landowner. Commence negotiation or acquisition process as soon as possible.
Aboriginal Cultural Heritage Act 2003 (ACH Act)	The main purpose of ACH Act is to provide effective recognition, protection, and conservation of Aboriginal cultural heritage. The collection and management of aboriginal cultural heritage information is in the form of the Aboriginal Cultural Heritage	Once the Proposal locations for storage and loadings facilities are determined, a search of the Aboriginal Cultural Heritage Database and Register is to be undertaken using the Aboriginal and	If a Cultural Heritage Management Plan is required, this may impact the delivery timeline of the Proposal.	Commence early and frequent consultation with relevant regulatory bodies to determine if a Cultural Heritage

Other potential regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
	Database and Aboriginal Cultural Heritage Register as outlined in Part 5. Part 6 of the ACH Act outlines the preparation and carrying out of cultural heritage studies, if required. Part 7 of the ACH Act outlines the Cultural Heritage Management Plan requirements and the preparation. Under the ACH Act, proponents have a 'cultural heritage duty of care' to take all reasonable and practicable measures to ensure their development activities do not harm Aboriginal cultural heritage. A proponent will be taken to have complied with their duty of care in relation to particular Aboriginal Cultural Heritage if it is acting under an approved Cultural Heritage Management Plan that applies to the Aboriginal Cultural Heritage, or a native title agreement, such as an ILUA for the area. A Cultural Heritage Management Plan is needed if an EIS is required for the project or other forms of an environmental assessment is required for the project. Unless the project is part of an existing agreement or a native title agreement.	Torres Strait Islander Cultural Heritage Database Search Request Form. If an EIS or other form of an environmental assessment is required, a Cultural Heritage Management Plan will be needed, unless the Proposal is part of an existing agreement or a native title agreement.		Management Plan is required.
Work Health and Safety Act 2011 Work Health and Safety Regulation 2011	The *Work Health and Safety Act 2011* provides a framework to protect the health, safety and welfare of all workers and others in relation to Queensland workplaces and work activities. Under Part 9.2 Section 536(1) of the Work Health and Safety Regulations 2011, the operator of a facility at which Schedule 15 chemicals are present or likely to be present in a quantity that exceeds 10% of	Depending on the quantity of hydrogen being transported, this may result in the transport being classed as an MHF. As per Schedule 15 the threshold quantity for hydrogen is 50 tonnes. The notifiable quantity is 5 tonnes (or 10%) Meeting the threshold quantity for hydrogen will also trigger the Planning	Classification as a MHF will slow delivery based on project needing to meet all hazard facility requirements. Significant specialist engineering hours are likely required to complete a Hazard	Early engagement with WHS to understand whether this project is classified as a major hazard facility.

Other potential regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
	their threshold quantity must notify the regulator of this circumstance in accordance with this Part. Where facilities meet the MHF requirements, the Work Health and Safety Regulation 2017 require a more rigorous approach when undertaking risk assessments as outlined in Section 554 and Section 556. Section 554 (1): The operator of a determined major hazard facility must identify— (a) all major incidents that could occur in the course of the operation of the major hazard facility, and (b) all major incident hazards for the major hazard facility, including major incident hazards relating to the security of the major hazard facility Section 556(1) The operator of a determined major hazard facility must implement control measures that: (a) eliminate, so far as is reasonably practicable, the risk of a major incident occurring; or (b) if it is not reasonably practicable to eliminate that risk — minimise that risk so far as is reasonably practicable.	Regulation 2017 material change of use and require application to SARA.	Assessment Report in line with State Code 21. Engaging with the State Assessment and Referral Agency may delay project delivery schedule	
	The Work Health and Safety Regulation 2011 do allow exemptions to facilities being classified as a major hazard facility. Division 3 – Major hazard facilities, Section 689 outlines:	A facility may apply for an exemption if the chemicals are in intermediate or temporary storage, the maximum package / container size is no more than 500 kg and granting the exemption will result in a level of health and safety (in relation to the operation of the facility)	The delivery of the project may be streamlined from a regulatory point of view if containers were less than 500 kg.	During the design and procurement of the tanktainers there may be an opportunity to seek exemption from the major hazard facility

Other potential regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
	(1) The regulator must not grant an exemption under clause 688 unless satisfied that— (a) 1 or more Schedule 15 chemicals are present or likely to be present at the facility, and (b) the quantity of the Schedule 15 chemicals exceeds the threshold quantity of the Schedule 15 chemicals periodically because they are solely the subject of intermediate temporary storage, and **(**c) the Schedule 15 chemicals are in 1 or more containers with the capacity of each container being not more than a total of 500 kilograms, and (d) granting the exemption will result in a standard of health and safety in relation to the operation of the facility that is at least equivalent to the standard that would be achieved by compliance with the relevant provision or provisions	that is at least equivalent to that which would be achieved by compliance with the relevant provisions of the WHS Regulations. Note the volume of 500 kg of compressed hydrogen depends on the container pressure: • 200 bar (14.5 kg/m^3) = 34.47 m^3 • 300 bar (20.7 kg/m^3) = 23.96 m^3 • 400 bar (26.2 kg/m^3) = 19.08 m^3 • 500 bar (31.2 kg/m^3) = 16.00 m^3	However, noting the proposal will still need to meet WHS requirements.	requirements based on the Stakeholder engagement with WH&S Queensland to determine whether an exemption may be granted for the transport of hydrogen.
	Schedule 15 of the Work Health and Safety Regulation 2011 provides a list of chemicals and their threshold quantity. Hydrogen is listed as item 24 (UN 1049) with a threshold quantity of 50 tonnes. If the threshold quantity is met, the facility or plant will be defined as a major hazard facility. However, there are additional certain situations as outlined in Schedule 15, Section 4 where compressed hydrogen may not be considered as part of the threshold determination, this includes: • Hazardous chemicals that are solely the subject of intermediate	For the transport of hydrogen, the regulation identifies temporary storage 'while in transit by road or rail' may not form part of the hazardous chemical threshold calculation. The train itself during transport operations would not constitute a HCF or MHF. However, containers, including those on a train where commonly stored at a facility would be included in the threshold quantity. For the laydown area where pressurised hydrogen containers are stored the regulation does introduce the definition of	The delivery of the project will be streamlined from a regulatory point by remaining under the threshold 50 tonne quantity for a MHF at the storage and loading facilities.	Stakeholder engagement with WH&S Queensland to determine whether an exemption may be granted for the transport of hydrogen.

Other potential regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
	temporary storage, while in transit by road or rail (unless it is reasonably foreseeable that, despite the transitory nature of the storage, hazardous chemicals are or are likely to be present frequently or in significant quantities). • A hazardous chemical is present or likely to be present in an isolated quantity, if its location at the facility is such that it cannot, on its own, act as an initiator of a major incident.	'isolated quantities' where the location of the pressurised containers may exclude it from the threshold calculation.		
	Schedule 5 of the Work Health and Safety Regulation 2011, registration of plant and plant designs identifies specific registration requirements for pressure vessels. Schedule 5 Part 2 – Items of plant requiring registration 3.2 Pressure vessels categorised as hazard level A, B or C according to criteria in Section 2.1 of AS4343:2014 (Pressure Equipment – Hazard Levels, except – a) gas cylinders, and b) LP Gas fuel vessels for automotive use, and c) serially produced vessels	Each compressed hydrogen gas pressure vessel is required to be registered with NSW WH&S. Note there is a registration cost per vessel. Note based on a review of AS4343 2014: the hazard level for transport of hydrogen is dependent on quantity transported: • 1 L = hazard C. • 7 L = hazard B. • 22,0000 L = hazard A.	Additional complexity around registration and management of documentation. Cost of registration in Queensland	Modelling team to allow for cost of registration and estimate of hours for managing documentation and accreditation.
Petroleum and Gas (Production and Safety) Act 2004 (P&G Act) *Queensland* Petroleum and Gas (General Provisions)	The main purpose of this Act is to facilitate and regulate the carrying out of responsible petroleum activities and the development of a safe, efficient, and viable petroleum and fuel gas industry.	The P&G Act may trigger a number of additional requirements which include: • Section 694A: Information notices (safety executives, plant commissioning).	Additional complexity to meet and comply with P&G Act safety requirements. During future delivery stages QRAs and other detailed risk	Plan during later phases of the project to undertake risk assessments (including QRAs) in line with the level of detail.

Other potential regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
Regulation 2017 Queensland	The P&G Act 2004 is administered by Resources Safety and Health Queensland (RSHQ). RSHQ regulates gas safety for: • Pipelines and distribution of hydrogen for use as a fuel. • Hydrogen refuelling stations. • Hydrogen gas appliances (using hydrogen blends or pure hydrogen). • Fuel cells in hydrogen vehicles and other applications. Under the P&G Act 2004, distribution of hydrogen as a fuel gas (including fuel stations) and in pipelines triggers 'operating plant' obligations including: • Section 694A: Information notices (safety executives, plant commissioning). • Section 674 – A safety management system. • Section 699 – keeping risk to an acceptable level. • Section 699 and 708A – compliance with relevant safety requirements. • Section 706 – incident reporting.	• Section 674 – A safety management system • Section 699 – keeping risk to an acceptable level. • Section 699 and 708A – compliance with relevant safety requirements. • Section 706 – incident reporting. The P&G Act 2004 requires formal safety assessments and brings in concepts such as 'as low as reasonably practicably' (ALARP) and SFARP. These concepts are further informed by Queensland planning documents: • Queensland: Planning guideline State code 21: Hazardous chemical facilities; and • The P&G Act directly calls for plant to be designed to 'safety standards'. Therefore, compliance with relevant standards (standards identified in this table are listed below) is mandatory.	assessments may be required to comply with SFARP requirements.	Confirm whether inland rail have defined acceptable risk limits to public and workers? Stakeholder engagement with P&G Inspectorate to confirm requirements.
	The Petroleum and Gas (General Provisions) Regulation 2017 identifies inspection requirements for pressure vessels. Table 4.1 Row 15.1.1.2: Transportable Pressure Vessels – Very Harmful Commissioning Inspection Required – Y	Inspection frequency, auditing, certification, and document management will increase the operating cost of pressure vessels and needs to be accounted in life cost.	Cost of inspection frequency and certification.	Modelling team to allow for cost of registration and estimate of hours for managing documentation and accreditation.

Other potential regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
	First Yearly Inspection Required – Y External Inspection Period – 1 year Internal Inspection Period – 5 Years Appendix E – Inspection and repair of transportable vessels			
Petroleum and Gas (Production and Safety) Act 2004 Petroleum and Gas (Safety) Regulation 2018 Queensland	**b** 1) For Section 670(5)(a) of the Act, the following fuel gas delivery networks are prescribed – A network that includes the delivery or supply of fuel gas in a tanker	Based on the definition that 'operating plant' is a network that includes the delivery or supply of fuel gas (hydrogen) in a tanker, this requires 'operating plant' to comply with Section 670.	Additional complexity to meet and comply with P&G safety requirements.	Stakeholder engagement with P&G Inspectorate to confirm requirements.
Transport Infrastructure Act 1994 (Rail) Transport Infrastructure (Dangerous Goods by Rail) Regulation 2018	The object of this Act is to encourage effective integrated planning and efficient management of a system of transport infrastructure, which includes efficient and safe railways and roads. Chapter 14 addresses transporting dangerous goods by rail, providing for regulations to address dangerous goods, exemptions, approvals, and offences.	The Transport Infrastructure (Dangerous Goods by Rail) Regulation 2018 established under this Act gives legal effect to the ADG as it relates to transport of dangerous goods by rail. Refer to Table 41 for relevant ADG Sections which apply in Queensland as in NSW.	Refer to Table 41 for relevant ADG implications which apply in Queensland as in NSW.	Refer to Table 41for relevant ADG mitigations which apply in Queensland as in NSW.
Transport Operations (Road Use Management) Act 1995 Transport Operations (Road Use Management—Dangerous Goods) Regulation 2018	The object of this Act is to provide for effective and efficient management of roads in the State and provide a scheme for managing the use of roads that will among other things promote efficient movement of people, goods, and services, and improve safety and environmental impact.	The Transport Operations (Road Use Management—Dangerous Goods) Regulation 2018 established under this Act gives legal effect to the ADG as it relates to transport of dangerous goods by road. Part 18 of the Regulation addresses requirements for licences for both vehicles and drivers where dangerous	Driver and vehicle licences may apply for transportation by road, (versus no requirements for rail). Hydrogen transportation that requires a placard about the load to be on the road vehicle or load cannot be transported	Refer to Table 41 for relevant ADG mitigations which apply in Queensland as in NSW.

Other potential regulations	Specific items which apply	Relevance to the Proposal	Potential implications for the ease of delivery of the Proposal	Potential mitigation and management measures
	Chapter 5A addresses transporting dangerous goods by road, providing for regulations to address dangerous goods, exemptions, and offences. Chapter 5, Part 3, Section 84A outlines in part that:- a person must not drive a motor vehicle carrying a placard load in a tunnel that has a sign (a placard load prohibited sign) complying with subsection (2) at or before the entrance. Placard load means a load of dangerous goods, explosives or radioactive substances that may be transported by a motor vehicle only if a placard about the load is placed on the vehicle or on a thing carried by the vehicle.)	goods are in a receptacle with a capacity of more than 500L, or more than 500kg of dangerous goods in a receptacle. Refer to Table 3 (above) for relevant ADG Sections which apply in Queensland as in NSW.	through a tunnel that displays a placard load prohibited sign. This is unlikely to have implications for the Proposal as no placard prohibited areas are likely to be involved Refer to Table 41 for relevant ADG implications which apply in Queensland as in NSW.	

Next Steps

This document will be submitted to the Department for review and feedback in accordance with the agreed review process[61] as noted in the Project Plan.

Gate 3 specific activities

Given the project is conceptual in nature, a specific site will need to be selected for the Proposal to allow for more detailed analysis in Gate 3.

Should the Department assess the Proposal as suitable for moving to Gate 3, the key tasks to be undertaken during the Gate 3 Feasibility Study are described in the table below.

Table 43 Gateway information requirements[62]

No.	Topic Area	Gate 3	Specific activities
1.0	Proposal details	No additional information required. Update only if assessment feedback requires amendments to be made or if new information is available.	No specific activities required
2.0	Problem or opportunity definition	No additional information required. Update only if assessment feedback requires amendments to be made or if new information is available.	
3.0	Strategic fit	No additional information required. Update only if assessment feedback requires amendments to be made or if new information is available.	
4.0	Stakeholders	Further analysis required as input to assessing deliverability of the Proposal.	The stakeholder engagement will seek to find potential interested parties or partners for the Proposal, progression in the regulation of hydrogen and any other impacts to the Proposal.
5.0	Options identification and analysis	No additional information required. Update only if assessment feedback requires amendments to be made or if new information is available.	No specific activities required
6.0	Demand	Required for rapid CBA of the preferred option(s).	Review the demand analysis undertaken and update for any new information.
7.0	Costs	Required for rapid CBA of the preferred option(s).	Update estimates to a greater level of confidence and make them site specific.
8.0	Benefits	Required for rapid CBA of the preferred option(s).	Review and update the benefits analysis as required.

[61] As set out in the "*Proposal Steps*" document as at May 2020, the Department
[62] "*II Programd Gateway Road Map: Assessment Information v2"* as at March 2020, the Department

No.	Topic Area	Gate 3	Specific activities
9.0	Cost-benefit analysis, wider economic benefits	Rapid CBA required for evaluation.	Undertake cost benefit analysis based on revised benefits analysis and more detailed cost analysis.
10.0	Funding and financing	Further consideration of potential sources of funding and initial consideration of the proposal's financial viability.	Determine whether there are any new funding opportunities for the Proposal.
11.0	Regional economic impact assessment	Initial qualitative consideration of the Proposal's impact on economic output.	Confirm Proposal locations and undertake the assessment.
12.0	Potential regulatory requirements	What is the regulatory assessment pathway? Required for the evaluation of ease of delivery.	Identify the regulatory pathway and timeframes to enable the Proposal
13.0	Environmental, heritage and planning assessment	Subject to Section 12.0, what is the environmental and planning regulatory pathway?	Confirm Proposal locations and undertake the assessment.
14.0	Property strategy	Initial consideration of potential property impacts, and response strategies required for the evaluation of the Proposal's potential to be delivered.	Confirm Proposal locations and develop the strategy for any property impacts.
15.0	Risk management	Initial consideration of potential sources of risk and response strategies required for evaluation of the Proposal's potential to be delivered.	Undertake qualitative risk analysis for the Proposal
16.0	Governance, management, and outcomes monitoring and evaluation	Initial consideration of key performance indicators and post-implementation evaluation strategies.	Review key performance indicators from ILM exercise and evaluate against

Appendix A Information Sources

Documents considered

Table 44 Key documents considered

Document	Description
Relevant Strategies	
Australia's National Hydrogen Strategy	This document sets out the national strategy sets a path to build Australia's hydrogen industry.
Technology Investment Roadmap, First Low Emissions Technology Statement - 2020	This strategy document seeks to create a strategy which accelerates the development and commercialisation of new and emerging low emissions technologies.
Australian Hydrogen Market Study, Sector Analysis Summary	This document outlines the economic gap between hydrogen supply and capacity to pay for demand.
Queensland Hydrogen Industry Strategy	This strategy focuses on capitalising on Queensland's proximity to Asia and renewable energy potential to lead the international export of hydrogen.
NSW Hydrogen Strategy	The NSW Hydrogen Strategy sets out the vision and path for developing a thriving hydrogen industry in NSW.
Victorian Renewable Hydrogen Industry Development Plan	The Victorian Renewable Hydrogen Industry Development Plan sets out a blueprint to capitalise on renewable hydrogen's economic opportunity, including creating long-term jobs and new career pathways and enabling the state's transition to net-zero emissions.
Western Australia Renewable Hydrogen Roadmap	The Renewable Hydrogen Strategy sets out the Western Australian Government's strategic areas of focus for the development of the hydrogen industry. The Renewable Hydrogen Roadmap outlines how the WA Government is supporting the development of the renewable hydrogen industry.
Proposal related information	
QTLC EOI	This document outlines the original intended scope for the Proposal.
Data	
Queensland Transport and Logistic Council	Provided information about QTLC's background and mission.
Australian Government Department of Industry, Science, Energy and Resources	Provided information about Australia's net zero by 2050 ambition.
Global Hydrogen Review, International Energy Agency, 2021	Provided information about hydrogen sector in Australia.
Australian Infrastructure Plan, Australian Government, 2021	Provided information about the numbers of jobs and the GDP that hydrogen industry could create by 2050.
CEFC, Australian Hydrogen Market Study, 2021	Provided information about the forecast cost for hydrogen.
BITRE, Hydrogen as a Transport Fuel	Provided information about potential hydrogen refuelling station locations from Brisbane to Melbourne.
Compendium of Hydrogen Energy, 2016	Provided information about the costs associated with transporting gaseous hydrogen.

Document	Description
Office of Energy Efficiency & Renewable Energy, Gaseous Hydrogen Compression	Provided information about the technology currently available for hydrogen production and compression.
Hydrogen: A Renewable Energy Perspective Storing Hydrogen, 2019	Provided information about hydrogen transportation and recent hydrogen projects.
Energy Council Hydrogen Working Group, Australian Hydrogen Hubs Study: Technical Study, 2019	Provided information about hydrogen transportation and domestic end use.
ANSI, Guide to Safety of Hydrogen and Hydrogen Systems, 2004	Provided information about safety considerations in hydrogen transportation.
CSPB, Safety Data Sheet Ammonia (Anhydrous), 2017	Provided information about safety considerations in hydrogen transportation.
NTC Australia, Australian Code for the Transport of Dangerous Goods by Road & Rail, 2018	Australian Code for the Transport of Dangerous Goods by Road & Rail
CSIRO, Hyper for hydrogen: our world first for carbon free fuel, 2018	Provided information about the technology currently available for hydrogen production.
Ministerial Council on Renewable Energy, Hydrogen and Related Issues, 2017	Information about transportation of MCH and its safe handling and storage
ENEOS Begins Joint Study with Fortescue for Development of a Japan-Australia CO2-free Hydrogen Supply Chain in Western Australia, 2021	Information about the development of a Japan-Australia CO2-free hydrogen supply chain in SA and WA
Stanwell Hydrogen Project Feasibility Study, October 2020	Provided information about a recent hydrogen feasibility analysis
Potential regulatory requirement documents	
Commonwealth	
Biodiversity	
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities, and heritage places - defined in the EPBC Act as MNES. The EPBC Act requires the assessment of whether the Proposal is likely to significantly impact on MNES or Commonwealth land. Details on this document's relevance to the Proposal is provided in Section 10
State	
Crown Land Management Act 2016 No 58	The Crown Land Management Act 2016 and Crown Land Management Regulation 2018 regulates the ownership, use and management of Crown Land in NSW. Details on this document's relevance to the Proposal is provided in Section 10

Document	Description
Crown Land Management Regulation 2018	
Transport Administration Act 1988	The Transport Administration Act 1998 provides administration and management of transport infrastructure and transport agencies in NSW. Details on this document's relevance to the Proposal is provided in Section 10
Planning	
Environmental Planning and Assessment Act 1979 (EP&A Act)	Part 4 of the EP&A Act identifies the requirements for development assessment and consent. Details on this document's relevance to the Proposal is provided in Section 10
State Environmental Planning Policy (Transport and Infrastructure) 2021	The Infrastructure SEPP is a key environmental planning instrument which, in large part determines the permissibility of an infrastructure proposal and under which part of the EP&A Act an activity or development may be assessed. Details on this document's relevance to the Proposal is provided in Section 10
Roads Act 1993	The Roads Act 1933 outlines the procedures for opening and closing public roads, as well as the regulations for carrying out various works and activities on public roads. Details on this document's relevance to the Proposal is provided in Section 10
Biodiversity	
Biosecurity Act 2015	The Biosecurity Act 2015 provides a framework for the prevention, elimination and minimisation of biosecurity risks posed by biosecurity matter. The Act also provides a framework for the timely and effective management of threats to terrestrial and aquatic environments arising from pests, diseases, contaminants, and other biosecurity matter. Details on this document's relevance to the Proposal is provided in Section 10.
Biodiversity Conservation Act 2016 (BC Act)	The BC Act is to maintain a healthy, productive, and resilient environment for the greatest well-being of the community, now and into the future, consistent with the principles of ecologically sustainable development. The Act applies to animals and plants, but not in relation to fish and marine vegetation. Details on this document's relevance to the Proposal is provided in Section 10.
Local Land Services Act 2013 (LLS Act)	Land management (native vegetation) is outlined under Part 5A of this Act. Native vegetation means the following types of plants native to NSW: • Trees (including any sapling or shrub or any scrub). • Understorey plants. • Groundcover (being any type of herbaceous vegetation). • Plants occurring in a wetland. A plant is native to New South Wales if it was established in New South Wales before European settlement. Details on this document's relevance to the Proposal is provided in Section 10 .
State Environmental Planning Policy (Biodiversity and Conservation) 2021	SEPP (Biodiversity and Conservation) 2021 includes the aim to encourage the conservation and management of areas of natural vegetation that provide habitat for koalas and reverse the current trend of koala population decline. Details on this document's relevance to the Proposal is provided in Section 10 .
Fisheries Management Act 1994	The Fisheries Management Act 1994 objectives are to conserve, develop and share the fishery resources of the State for the benefit of present and future generations. Details on this document's relevance to the Proposal is provided in Section 10.
Heritage	
Heritage Act 1977	The Heritage Act 1977 provides conservation of buildings, work, relics, and places that are of historic, scientific, cultural, social, archaeological, architectural, natural, or aesthetic significance to the State. Details on this document's relevance to the Proposal is provided in Section 10.

Document	Description
National Parks and Wildlife Act 1974 (NP&W Act)	The NP&W Act is the primary legislation dealing with Aboriginal cultural heritage in NSW. Items of Aboriginal cultural heritage (Aboriginal objects) or Aboriginal places (declared under section 84) are protected and regulated under the NP&W Act. Details on this document's relevance to the Proposal is provided in Section 10.
Water	
Water Management Act 2000 (WM Act) Water Management (General) Regulation 2018	Approvals under sections 89, 90 and 91 of the WM Act are required for certain types of developments and activities that involve the use of water, are carried out in or near a river, lake, or estuary, or may intersect groundwater. Details on this document's relevance to the Proposal is provided in Section 10.
Water Act 1912	The Water Act 1912 controls the extraction of water and use of extracted water. Details on this document's relevance to the Proposal is provided in Section 10.
Contaminated Land Management Act 1997 (CLM Act)	The CLM Act regulates significantly contaminated land through requirements for notification to the NSW EPA, investigation, remediation, and recovery of costs from the person responsible. The NSW EPA must be notified by the property owner in writing of any contamination identified within the Proposal in accordance with the requirements of section 60. Details on this document's relevance to the Proposal is provided in Section 10.
State Environmental Planning Policy No 55 - Remediation of Land (SEPP 55)	SEPP 55 provides a state-wide approach to the remediation of contaminated land for the purpose of minimising the risk of harm to the health of humans and the environment. Details on this document's relevance to the Proposal is provided in Section 10.
Contamination	
Contaminated Land Management Act 1997 (CLM Act)	The CLM Act regulates significantly contaminated land through requirements for notification to the NSW EPA, investigation, remediation, and recovery of costs from the person responsible. The NSW EPA must be notified by the property owner in writing of any contamination identified within the Proposal in accordance with the requirements of section 60. Details on this document's relevance to the Proposal is provided in Section 10.
State Environmental Planning Policy No 55 - Remediation of Land (SEPP 55)	SEPP 55 provides a state-wide approach to the remediation of contaminated land for the purpose of minimising the risk of harm to the health of humans and the environment. Details on this document's relevance to the Proposal is provided in Section 10.
Construction	
Protection of the Environment Operations Act 1997 (PoEO Act)	The PoEO Act is administered by the NSW EPA and regulates activities which may result in pollution impacts (e.g., land, air, water, and noise pollution). Details on this document's relevance to the Proposal is provided in Section 10.
Rural Fires Act 1997	The objectives of the Rural Fires Act 1997 include the prevention, mitigation, and suppression of bush and other fires in local government areas and rural fire districts. It is also for the protection of the environment by requiring certain activities to be carried out having regard to the principles of ecologically sustainable development described in section 6 (2) of the Protection of the Environment Administration Act 1991. D Details on this document's relevance to the Proposal is provided in Section 10.
Local	
Parkes Shire Local Environment Plan 2012 (Parkes Shire LEP)	The Proposal is located within the Parkes Shire LGA. The aim of the Parkes Shire LEP is to make local environmental planning provisions for land in the area. Details on this document's relevance to the Proposal is provided in Section 10.

Appendix B Stakeholder Consultation

Stakeholder consultation log

Table 45 Log of stakeholder consultations

Consultation date	Stakeholder	Discussion
During Gate 2	QTLC working group	The Queensland Transport and Logistics Council's Mission is to represent the freight transport and logistics industry to influence policy, regulation, infrastructure planning and investment to achieve sustainable and productive supply chains. QTLC aims to support the efficient movement of freight in order to support sustainable and productive economic development and prosperity. For this Proposal, QTLC is supported by a technical working group with diverse backgrounds including engineers, academia, and business professionals. QTLC supports the Proposal to understand the commercial viability tipping points between road and rail and to understand the regulatory barriers to transporting hydrogen via rail.
10 December 2021	ARTC	ARTC is responsible for the delivery of Inland Rail, in partnership with the private sector. ARTC considers hydrogen to be a commodity but are mostly considering the transport of ammonia. This includes understanding the production and supply chain for domestic export. They want to see how rail can form part of that supply chain. It was noted that bulk volumes of the good will assist with making the rail economics better than road. The safety impacts are of particular interest to ARTC, but it is viewed that it would be simple to operate if a tanktainer approach was used. To better understand the safety implications, it may be useful to develop a risk profile with mitigations for each risk. ARTC would like to continue to be engaged on the safety aspects of the Proposal.
20 December 2021	Aurizon	Aurizon is a rail freight operator in Australia. Aurizon transports more than 250 million tonnes of Australian commodities, connecting miners, primary producers, and industry with international and domestic markets. Aurizon has been considering how hydrogen will be transported for the potential hydrogen hub to be developed in North Queensland. However, the current view is that it is too light for typical rail operation charges. Also, the tanktainers were noted as a significant cost due to the inventory requirements. Safety is a big concern for Aurizon. However, it was seen that it is likely safer to transport it on rail than road. It was also viewed that other dangerous goods have been transported on rail so they will likely be able to do this when the market needs it, they will just have to invest the time to understand how to do it safely. Aurizon would like to continue to be engaged on this Proposal and other Inland Rail Proposals.
13 December 2021	DISER	DISER supports economic growth, productivity, and job creation for all Australians by investing in science, technology and commercialisation and growing innovative and competitive businesses, industries, and regions. DISER supports the government's international climate commitments to reduce emissions by 2030 and the government's intention to get to net zero emissions as soon as possible, and preferably by 2050. DISER was interested in the emissions reduction potential of the Proposal. They noted one of their projects in the Future Fuels Fund will include funding for hydrogen refuelling projects. The locations will be determined by ARENA.

Consultation date	Stakeholder	Discussion
		DISER would also like to learn more about the future hydrogen supply chain and how rail may play a role in it. As a result, they would like to continue to be engaged on the Proposal.
13 December 2021	TMR, NSW EPA	TMR is a department of the Queensland Government which manages and delivers Queensland transport solutions for road, rail air and sea. The NSW EPA is the primary environmental regulator the NSW. They partner with business, government, and the community to prevent the degradation of the environment. TMR work with Workplace health and Safety and the Office of the National Safety regulator to ensure the safe transportation of dangerous goods. There are limited guidelines around the safe transport of hydrogen, but these can develop as the industry seeks to transport it. TMR and the NSW EPA both sit on a panel which occurs monthly to review regulatory and safety issues such as the transportation of hydrogen. If required in the future, this panel can advise on safety considerations for the Proposal.
December 2021	SCT Logistics	SCT Logistics was engaged in email communications, but the team was unable to secure a time to engage in consultation regarding the Proposal. Key points/questions raised in email correspondence by SCT Logistics include: • Safety and compliance to regulatory requirements for the transportation of gaseous hydrogen. • Scope of volume (weekly) of hydrogen to be transported. • Location of the Toowoomba rail siding.
17 December 2021	Parkes Shire Council	Parkes Shire Council services the communities of Parkes, Bogan Gate, Peak Hill, Trundle, Tullamore, Alectown, and Cookamidgera. The combined population across the council area is 15,000. Key industries across the council area include agriculture, mineral resources, retail, government services, tourism, and transport. The Parkes Shire Council is supportive of the proposal to transport hydrogen by rail rather than road. The Proposal aligns with the Council's policies to utilise alternative fuel sources where possible. The Parkes Special Activation Precinct (SAP) sits within the guidelines of the United Nations Industrial Development Organisation (UNIDO), with the requirement for green credentials; fundamental renewables are critical to the SAP. The Council has a fundamental bias towards solar, hydrogen and the conversion of hydrogen to methane. The stakeholder commented they are past the philosophical stage; they need to have alternatives to service the SAP. The commercial viability of this Proposal, linking and aligning with the SAP is of particular interest to Council. Council said it needs to be mindful and consider the volumes being moved to ensure natural resources are not being depleted. Council said well-designed rail networks are safer than roads for the transportation of hydrogen. There is also the assumption that transport by rail would be cheaper (cost per tonne) compared to road transport. Other benefits include the reduction in emissions using trains compared to trucks and road transport. Biofuels and renewables are seen as the future for rail transport, converting locomotives to be powered by hydrogen rather than batteries or electricity. The same could be done with long-haul trucks. Hydrogen could be used for dispatchable power for industrial use within the SAP.

Consultation date	Stakeholder	Discussion
		The main challenge seen for the use of rail to transport hydrogen compared to other modes of transport is the movement from a fixed point to a fixed destination. Trucks are generally still required to move products 'the last mile' to their destination. It is critical the infrastructure is in place to ensure efficient loading and unloading of compressed gaseous hydrogen. There was discussion around the potential opportunity to pipe hydrogen gas within the rail easement. Refuelling stations could be installed along the line and gas sales could also occur. They questioned if this may be a more efficient option longer term. Hydrogen could be converted to renewable clean natural gas, tapping into the existing network. Parkes' location (road/rail interface) is ideal for the transport of hydrogen via both rail and road to other destinations as required. The SAP may have an internal usage driver for hydrogen, and/or could also be a point for the generation and transport of hydrogen. The Council is comfortable with the regulations for moving dangerous goods and products. There are several regulations already in place, with various regulatory bodies already stipulating requirements and standards. The Council does not believe the community would have issues with the perception of safety and transportation of hydrogen. The community sees other gases transported (via road), so the perceived risks are already seen and addressed. Technology is changing rapidly and what may be the challenges of today may not be the challenges of tomorrow. A generic approach should be taken – if something else were to replace hydrogen into the future, it will most likely have similar requirements and regulations for transportation and safe handling and storage.
10 January 2022	Progress Rail	Progress Rail, a Caterpillar company, is one of the largest integrated and diversified providers of rolling stock and infrastructure solutions and technologies for the rail industry globally. Progress Rail manufacture locomotives, engines, technologies, and railcars. The company is not involved in the logistics and transport of hydrogen products and other commodities. As such, further engagement is not recommended. Progress Rail would, however, like to be kept informed of the proposal's progress. Progress Rail recommended engagement with Fortescue Future Industries (FFI). The is a global green energy and product company committed to producing zero-emission green hydrogen from 100% renewable sources. FFI is building a portfolio of renewable hydropower, geothermal, wind and solar assets globally, targeting 15 million tonnes of green hydrogen to the world by 2030.
9 December 2021	Pacific National	Pacific National is the largest interstate rail freight carrier in Australia. Pacific National is Australia's leading intermodal freight and steel freight operator, eastern Australia's top carrier of regional exports, bulk goods, grain, and agricultural products, the largest transporter of coal in NSW, and the second-largest transporter of coal in Queensland. Pacific National is considering hydrogen locomotives in their fleet regeneration, but this is a future strategy that they will need to transition to. At the moment it is seen as a high risk, but Pacific National don't have a great understanding of it. Pacific National would like to be kept up to date on the Proposal's progress.
16 December 2021	RDA	RDA Orana covers the central and north-western areas of NSW (over 190,000 km_2). The diversity of industries across the region is large and

Consultation date	Stakeholder	Discussion
		includes agriculture, mining, food and wine, renewable energy, and tourism. The gross regional product for RDA Orana is around $8 billion. RDA Orana is generally supportive of the Inland Rail. The organisation is supportive of any initiative that would assist with improving efficiencies in logistics and freight and brings benefits to the region. If Inland Rail can remove some of the pressures on existing transport routes, and improve efficiencies and safety, that is a good thing. RDA would however like to see further detail around the Proposal and the route for transport, as well understanding any potential negative impacts and/or benefits to the Local Government Areas (LGA) through which hydrogen would be transported. RDA does not provide financial support. The organisation has strong networks across all industry sectors and government and can assist in making connections with local industries and key stakeholders. RDA can also assist in attracting potential investment from stakeholders across the region. Some communities across the region are already divided in regard to renewable energies (i.e., Dubbo, Mudgee and up to Coonabarabran). While some negative views are still held amongst communities, RDA commented there is a positive shift starting to occur, with people seeing the benefits and boost to the local economy. Barriers to the transportation of hydrogen by rail include commercial, economic, safety and political barriers. RDA has some questions relating to the volume of hydrogen to be transported and the loading and unloading of tanktainers. • Where would the loading and unloading of tanktainers occur along the inland rail route? • What is required for this process? • What are the storage and handling requirements and regulations? RDA would like to be kept informed of the Proposal's progress and is happy to be contacted if further discussion and connections are required.
11 January 2022	TSBE	The TSBE is an independent, not for profit, member-driven economic development organisation. It links the local business community to opportunities across the Toowoomba, Western Downs, Maranoa, and surrounding areas. TSBE takes pride in encouraging major investment and promoting the vital need for new and upgraded infrastructure in the region. TSBE invests in activities that: • Attract new businesses and create growth in the region. • Grow the region and a skilled workforce. • Generate increased investment. • Advocate for the region with all levels of government. TSBE is focused on current and emerging opportunities in key sectors such as Energy and Infrastructure, Health, Food and Export with subject matter experts who can help businesses achieve specific goals. TSBE has over 450 corporate members. There are several hydrogen projects/ initiatives underway in the region. TSBE received seed funding from the Federal Government to establish a hydrogen cluster in the region to carry out industry involvement initiatives. TSBE is supportive of transporting hydrogen by rail rather than by road. Hydrogen is a bulk commodity like coal or grain, therefore these options will be compared and considered. Using efficient rail networks to transport hydrogen is preferable, rather than further contributing to congestion on roads. More detailed and sophisticated research is needed into supply chain and logistical management of hydrogen distribution.

Consultation date	Stakeholder	Discussion
		Aspects of hydrogen production such as technical considerations, design, sourcing water, building solar farms, promoting green initiatives, and the use of skip mounted pressurised containers are all being considered simultaneously. The organisations early to market for managing production and demand requirements (e.g., BP, CS Energy) will solve the technical, production exploration and transport aspects. They will also solve the safety considerations. The sector would benefit from funding to conduct dedicated and focused research into the most efficient and effective way to transport hydrogen from origin to distribution points. TSBE is well placed to lead this research if funding can be sourced to support this work. TSBE would not be in a position to invest in this research. As a not-for-profit organisation, it relies on funding from government or private enterprise to conduct its work. TSBE has a commercial model charging for its services to pay for staff and other overheads/ costs. The next step would be to prepare grant applications for funding to support research into supply chain. TSBE could work with CSIRO or Universities on funded research to support this important aspect of the emerging hydrogen sector, as TSBE are based in industry and know the players in renewable solar and wind farming. TSBE referred to pressurised containers/vessels containing hydrogen being loaded onto trucks for transportation. Inland Rail may represent an opportunity for moving hydrogen from origin to central or rural areas of Australia as well as to Ports. More research would be needed to determine the safety elements of this scenario. CS Energy is working with the Queensland University of Technology (QUT) regarding technical aspects of its hydrogen project. Its focus is on production so funded research focused on the logistical elements of distributing the product would benefit the project. It is inevitable that hydrogen production will reach the volumes required for rail transportation. Questions requiring consideration include safety (especially through tunnels and with proximity to flammable agents) and the most effective/efficient logistical transport networks depending on the end destination (e.g., transporting hydrogen to bowsers located throughout regional and rural Australia for fuelling heavy vehicles, or to Ports for global export purposes). TSBE referred to a feasibility study being conducted by Aurizon into using locomotives for transporting commodities in central Queensland. TSBE is working on the CSM project at Chinchilla. This project is producing hydrogen for fuelling vehicles. Hydrogen will be transported via pressurised vessels (nine to ten metre vessels per truck on skip mounts). Trucks will take hydrogen to the refuelling station and swap out empty cannisters. Used cannisters will return to site via road to be refilled. One question relates to trucks that have been converted to hydrogen; Will they be able to travel through tunnels when they are carrying compressed vessels on them? This demonstration project has no tunnels on its transport route. It is envisaged there will be bowser incentives (similar to those offered for ethanol) to support the uptake of hydrogen in heavy vehicles. Hydrogen will need to be transported from its production point to various hubs for bowser access by trucks. A question raised was whether semi-trailers provide the volumes needed to service the network. Rail would be better for large volumes. In that scenario it would be transported to a site, then stored and transported by truck for distilling to the bowser. Local production will support a network approach given the sum of the parts in terms of volumes produced. The current demo project is producing less than 4.25T per day. There are five individual projects proposed in the region. One is already funded. If three of the five get up in the next 12 months, it will drive higher volumes. Initially hydrogen will be used domestically for heavy vehicles, and in time it will be transported via rail like other commodities.

Consultation date	Stakeholder	Discussion
		Technically, natural gas and hydro can be blended to a percentage quite easily. Using pipelines for hydrogen may also work for distribution, but TSBE questions if this would cause degradation to the pipeline. There is currently a trial of domestic gas infused with 15% hydrogen to be used in 15,000 homes by the South Australian gas network utility AGIG. The sector is relatively immature and needs support to help the broader community to understand and gain confidence around the opportunities and benefits of hydrogen.
20 December 2021	Standards Australia	Standards Australia is an independent, non-government, not-for-profit standards organisation. The organisation represents the ISO and IEC and assists with the development of standards for Australian industries, the development and adoption of international standards and the accreditation of organisations to develop Australian standards. More detail is required for the organisation to fully understand and support the transportation of hydrogen by rail. The question was asked whether the materials (that line the containers) used to transport hydrogen by road are the same materials that would be used for transportation of hydrogen by rail. There are currently no standards relating to the transportation of hydrogen by rail. Standards Australia could offer in-kind support to assist with the development of documentation (guidelines) for the transportation of hydrogen by rail. Members of the technical committees could assist in developing such documents. For guidelines and reference documents to be developed, Standards Australia would need to see evidence of the issue and potential solutions. If there is a need from industry and the information/evidence is available, Standards Australia would be happy to be involved. End uses for hydrogen could include heating. It could also be used for fuelling vehicles and powering locomotives in the rail system. Converting locomotives to be powered by hydrogen could see greenhouse gas emissions reduced compared to locomotives powered by diesel or other carbon intensive fuels. One of the biggest challenges/issues for the use of rail to transport hydrogen is leakage and leak detection. Hydrogen gas is not odourised making leaks hard to detect. If leaks are not detected there are large risks with flammability. Questions were raised around how leaks would be detected; and what the process would be. There was discussion around the cost of transporting hydrogen by rail. Hydrogen can be quite expensive to transport by road (in gaseous form), which ultimately affects and/or limits the volume that can be transported. Safety implications and requirements are of interest to Standards Australia. In addition, Standards Australia is interested in the learnings from the Proposal. They asked what the process is and what steps and sequences are involved in transporting hydrogen by rail. The organisation is developing a technical specification around the storage of liquid and gaseous hydrogen which is due to be released early in the new year. The information contained in these standards would be of interest and could inform the use of rail for transporting hydrogen. Standards Australia will provide a list of organisations that sit on its technical committees, that could be engaged as the Proposal progresses. Further engagement with Standards Australia is recommended to understand the relevant safety and regulatory challenges and opportunities.
13 December 2021	Toowoomba Regional Council	Toowoomba Regional Council provides local government services to communities from north of Yarraman to south-west of Millmerran and includes the city of Toowoomba.

Consultation date	Stakeholder	Discussion
		The stakeholders from Toowoomba Regional Council had reviewed the high-level information they had been provided about the proposal to transport hydrogen by rail. They asked if the stakeholder engagement activity for this proposal would include the TSBE, as previously recommended by Council. They have considerable expertise around the subject matter. The stakeholders fully support transporting hydrogen by rail rather than road. Any initiative to get bulk goods off the road network would be positive. Rail is considered a safer option for transporting hydrogen. Rail represents a more efficient mode of transport and increases the commercial viability for hydrogen given the price sensitivities involved. There's an assumption producers will need to subsidise the costs to make hydrogen a worthwhile proposition, at least in the short term. Council is not able to financially support the proposal. It is not the role of Local Government to support transportation of one particular energy source. It doesn't support the movement of other commodities. This is consistent with Council's position on other initiatives such as electric charging stations. If it was relevant, Council might be able to assist with the proposal from a planning point of view. For example, if there were any planning/ zoning/ approval processes required to support the initiative, then Council may be able to assist the process that way. The Council's views would not be impacted by changes in volume of hydrogen being moved. The stakeholders identified getting goods off the road network and increasing the safety of moving hydrogen, as opportunities that would stem from the proposal. Council assumes that hydrogen would be produced outside Toowoomba (access to large solar facilities and better water supply) and that road would be used to deliver it to a rail connection. For example, if hydrogen was produced at Kogan, there would be an element of road as well as rail. There was a question about efficiency if both truck and train movements are required for transporting hydrogen. They questioned whether, if it is already loaded on a truck and travelling to its destination, it is viable to interrupt that movement to load it onto rail. Multiple touch points in transporting freight increase costs. Potential uses identified included heavy transport and injection into reticulated gas. One project Council is aware of is being managed by CSM Energy, which is producing hydrogen from wastewater treatment. The hydrogen will then be used to power that facility. The process produces oxygen, which is then fed back into the sewage treatment plant. This avoids the need to spend $20 million to upgrade the sewage treatment plant. They only need to invest $4 million in the short term to delay the requirement for a big upgrade for a further decade. It is expected the output would be local and low volume. At this stage, there is not a manufacturer making significant input in terms of hydrogen supply in the region. Most hydrogen related announcements to date relate to exporting hydrogen. Gladstone will be the centre of hydrogen production in Queensland for quite a while. Domestic demand for production would follow export success. Toowoomba does not have a lot of water to use for producing hydrogen. There is lots of space to produce green energy, but supply of water is harder to come by. Council does have a proponent talking about manufacturing electrolysers (the system that uses electricity to break water into hydrogen and oxygen in the process called electrolysis). A lot of Gladstone activity is focused around producing electrolysers rather than hydrogen. There are five projects ready

Consultation date	Stakeholder	Discussion
		to be announced that have support from state government incentives, infrastructure, and access to water. A Council Advisory Committee is supporting the trial of a local electrolyser and a push to trial vehicles powered by hydrogen. There is already a gas pipeline linking Toowoomba (including areas further west) through to Brisbane and Gladstone. It would be relatively simple to add another corridor. The issue is how to balance the drive to stimulate local demand, when there is uncertainty around production. They see this as a chicken and egg scenario. Currently it costs more to produce hydrogen than it can earn. It is assumed production in the short term will be underwritten to build the demand case and demonstrate the value proposition. Producing it is easy – using it locally might be the challenge. For example, they see challenges in getting McCafferty's to transition their fleet of coaches from diesel to hydrogen. The stakeholders are very interested in all aspects of the Proposal, especially from an economic development perspective and commercial viability. The Council is interested to understand the potential attractiveness of the local region for this sector. A key aspect will be proposed upgrades to supporting rail infrastructure, including the West Moreton line. It is critical that a holistic approach is taken to planning the supporting rail and road network. Looking at various sections of track in isolation will not work. The implications for the whole network of proposed upgrades in various areas needs to be considered and carefully planned to optimise efficiencies and benefits. There is an overlap with interests of stakeholders out west using rail. The proposals for Moreton and West Moreton lines call for higher load capacity, safer modes of transport and predictable schedules for moving agricultural produce. The New Acland coal mining operation is currently under a bit of a cloud which has impacts for the rail network. Alternative freight demand for transporting Hydrogen into Inland Rail and the Ports is of considerable interest to Councils to the West of Toowoomba. Driving this type of freight network improvements provides general uplifts to the viability of those communities. The key message is the need for a holistic approach to planning rail and road transport networks. Transporting hydrogen by rail is considered safer than petroleum or other gaseous substances. There was a question about whether rail carrying hydrogen would be able to use the tunnels down the range due to the hazardous nature of material. They asked what type of ventilation would be needed. Another consideration is the community perception regarding the safety of the proposal. A community information campaign may be required to manage perceptions. This could include case studies from other parts of the world where hydrogen is being used safely and effectively. Another issue is differing gauge standards that would prevent hydrogen being sent south. Materials can come from the West and on to Brisbane but going south would be an issue. They asked if a gas line could be installed along the Inland Rail route to capitalise on the activity planned through that corridor. Running a pipeline through the tunnels might be an issue. The stakeholders requested confirmation that TSBE would be consulted as part of the engagement activity.

Consultation date	Stakeholder	Discussion
13 December 2021	TfNSW	Transport for NSW TfNSW is the lead agency for the NSW transport cluster. The organisation leads the development of a safe, efficient, and integrated transport system that ensures people and goods are moved efficiently and communities – metropolitan and regional, are connected. The responsibility for strategy, planning, policy, regulation, funding allocation and other non-service delivery functions for all modes of transport in NSW (rail, road, ferry, light rail, regional air, cycling and walking) lies with TfNSW. TfNSW is supportive of transporting hydrogen by rail relative to road. Safety is a major concern and if this can be improved/increased by transporting products such as volatile gases (i.e., compressed gaseous hydrogen) by rail, the organisation is supportive. Sustainability was a key issue raised by TfNSW. Emissions would be reduced with rail transport, and the number of trucks on the road would also be reduced. There was discussion around rolling stock and the potential need to purchase new rolling stock, due to the age of the current (existing) rolling stock in Australia. New rolling stock would improve the Carbon footprint, increase reliability across the network and result in less disruptions along the supply chain. The other major benefit of moving to rail transportation includes the benefits to communities such as increased safety and reduced congestion on roads. The NSW DPIE Hydrogen strategy, launched in October 2021, has several initiatives that potentially align with this Proposal. The strategy looks to develop hydrogen hubs (Pillar 2 of the strategy) initially in the Illawarra and Hunter regions, concentrating capital, infrastructure, and skills in strategic regions of NSW, creating the foundation for the development of a green hydrogen industry. TfNSW spoke about the hydrogen train feasibility being managed in partnership with Alstrom (a rolling stock manufacturer in France), to see if it is feasible to bring the train (driven by a hydrogen cell) to Australia and run a trial. The study is focussed on passenger trains not freight. Currently there are no Australian standards for using hydrogen powered trains. The study will explore the accreditation needed (regulatory and environmental), assess the risks (safety and logistics), identify workforce capability requirements for maintenance and refuelling of hydrogen trains, and investigate customers attitudes to the use of hydrogen powered trains. The need to engage with the EPA in regard to this Proposal was raised. The EPA will need to be involved in relation to the environmental responsibilities around the transportation of hydrogen by rail. The ONRSR was also mentioned as a key stakeholder for consultation relating to the Proposal. When asked about the potential end use of domestic hydrogen, TfNSW commented that all freight rail operators it has engaged with are interested in gaining a better understanding of the benefits of hydrogen powered locomotives and operations. Lessons could be shared across industries. Rail customers are particularly keen to understand what the opportunities may be into the future. Green hydrogen is the ultimate product for domestic end use, but they believe the industry has a way to go before green hydrogen becomes the preferred choice by consumers. TfNSW mentioned the work being done by the Cooperative Research Centre (CRC) around hydrogen powered vehicles and the possibility to explore links with the CRC. They commented it is a chicken and egg argument; hydrogen hubs will not be built if there is not a business case presented, but the business case for hydrogen use will not be developed until the infrastructure and demand for hydrogen presents.

Consultation date	Stakeholder	Discussion
		Potential challenges when transporting hydrogen by rail rather than other transport modes include the large upfront cost to purchase new rolling stock and access/connections. Accessibility to rail networks that are not connected to the inland rail route need to be considered. They asked how these networks would connect to and move gaseous hydrogen from rail carts on the inland rail to another rail network. Refuelling, safety regulations and maintenance of hydrogen systems are the key issues that need to be addressed. There was discussion around the already heavily congested metro networks and the regulatory requirements that would also need to be addressed. Interoperability between networks is topical at present, and the rail system is more regulated and slower to change compared to road. TfNSW noted that people are waiting to see what is happening; they are waiting for others to do the 'heavy lifting'. Time is money and people are looking to use the findings and outcomes from other industry sectors to benefit and improve the rail industry and their organisations. In discussing the most suitable form of hydrogen for transport, TfNSW said trains will be designed to carry whatever form of the product (hydrogen) is to be transported. The price of hydrogen is high, but as demand increases the price will decrease. People are starting to look for alternatives to diesel and as the demand increases, the technology will also grow and improve, which will assist in driving prices down. There are opportunities for private-public partnerships to assist the private sector to work towards more innovative solutions. They questioned how the Proposal could inform the demand for green hydrogen – what it will look like and how the demand could be met. TfNSW would like to be kept informed of the Proposal's progress and are happy to engage further.
9 December 2021	Wagner Corporation	Wagner is a major contributor to the development of Regional Queensland and the wider Queensland economy. Wagner is aware of the growing interest in hydrogen projects in Queensland. As a result, they are seeking to upgrade their fleets to be hydrogen powered. This will require refuelling stations to make them operable, but it will be sustainable. Wagner is not interested in further engagement on this Proposal.

Appendix C Additional Benefits Information

This appraisal uses a rail freight CBA framework to assess the potential change in economic resource costs attributable to the Proposal. Benefits are derived from the transportation of freight volumes and include the following benefit drivers:

- **Rail benefits** – benefits associated with improvements to rail operations.
- **Intermodal terminal benefits** – benefits associated with intermodal terminal operations and the facilitation of freight onto rail.
- **Road benefits** – benefits associated with mode shift of freight from road to rail.
- **Wider & non-transport benefits** – benefits associated with improvements to the wider community and non-transport benefits.

Induced demand definitions

This appraisal follows the ATAP Guidelines terminology concerning induced, generated, and diverted demand as follows:

- **Diverted demand** – refers to demand that is diverted from other sources. For example, mode shift from road to rail.
- **Generated demand** – refers to altogether new demand resulting from an initiative.
- **Induced demand** – refers to the sum of generated and diverted demand.

As per these definitions, when the formulae outlined below refers to induced demand it means that it can be applied to diverted and generated demand (unless otherwise indicated).

Rail benefits

Rail benefits for the Proposal.

Rail environmental impact

Rail environmental impacts relate to environmental externalities generated by rail freight. Benefits result from a reduction in GTKs, or from more freight being transported through rural as opposed to urban areas. These include reductions in air and noise pollution, greenhouse gas emissions and urban separation.

The general formula is: Gross Tonne Kilometres (by rail) x Externality Costs

Environmental impacts can be calculated as follows:

Equation 1 Rail environmental impact cost savings

$$Rail\ environmental\ impacts^{\ t} = \sum_{V} \sum_{ij} \sum_{L} \frac{\left(GTK_{ij}^{B,V,L,t} - GTK_{ij}^{P,V,L,t}\right) \times rail\ ext^{L}}{1000}$$

Where:

- $GTK_{ij}^{X,V,t}$ is the gross tonne kilometres from (Origin) i to (Destination) i in scenario X (B = Road Case and P = Rail Case), by freight type V, in location L (U = urban and R = rural), in year t
  - $\mathrm{GTK}_{\mathrm{ij}}^{\mathrm{X,V,t}} = \sum_{\mathrm{S}} \mathrm{tonnes}_{\mathrm{ij}}^{\mathrm{X,V,t}} \times \mathrm{dist}_{\mathrm{ij}}^{\mathrm{B,V,t}} \times \mathrm{gross\ weight}_{\mathrm{ij}}^{\mathrm{B,V,S,t}} / \mathrm{capacity}_{\mathrm{ij}}^{\mathrm{X,V}}$
  - $\mathrm{tonnes}_{\mathrm{ij}}^{\mathrm{X,V,t}}$ is the total freight tonnes transported by rail from (Origin) i to (Destination) j in scenario X (B = Road Case, P = Rail Case), by freight type V, and in year t
  - $\mathrm{dist}_{\mathrm{ij}}^{\mathrm{X,V}}$ is the one-way distance travelled per service in kilometres from (Origin) i to (Destination) j in scenario X (B = Road Case, P = Rail Case), and by freight type V

- $\text{gross weight}_{ij}^{X,V,S}$ is gross weight per train consist from (Origin) i to (Destination) j in scenario X (B = Road Case, P = Rail Case), by freight type V, and by service load S (W = full service load, U = empty service load)
- $\text{capacity}_{ij}^{X,V}$ is net capacity per train consist from (Origin) i to (Destination) j in scenario X (B = Road Case, P = Rail Case), and by freight type V

- $rail\ ext^{L}$ is the total externality unit costs per GTK for rail freight in location L (U = urban and R = rural)

Table 46 Key parameters used in rail environmental impact cost savings calculation

ASSUMPTION DETAIL	VALUE	UNIT	SOURCE
Rail freight externality – Urban	Air pollution: $4.90 GHG emission: $0.44 Noise: $2.08 Water pollution: $0.15 Nature & landscape: $1.18 Urban separation: $1.18 Total: $9.94	$FY2022/000' GTK	Transport for NSW (2019), Economic Parameter Values, Table 44
Rail freight externality – Rural	GHG emission: $2.13 Water pollution: $0.15 Nature & landscape: $1.18 Total: $3.47	$FY2022/000' GTK	Transport for NSW (2019) Economic Parameter Values, Table 45

Road benefits

Road benefits for the Proposal. The following treats the road network as parallel infrastructure from which freight is diverted as a result of the initiative.

Vehicle operating costs

The general formula is: Vehicle Kilometres Travelled (by road) x Operating Costs

Vehicle operating cost savings can be calculated as follows:

Equation 2 Vehicle Operating Cost savings

$$Vehicle\ operating\ cost\ saving^{t} = \sum_{V}\sum_{ij}\left(VKT_{ij}^{B,V,t} - VKT_{ij}^{P,V,t}\right) \times \left(VOC_{ij}^{Re} - VOC_{ij}^{Pe}\right)$$

Where:

- $VKT_{ij}^{X,V,t}$ is the vehicle kilometres travelled from (Origin) i to (Destination) i in scenario X (B = Road Case and P = Rail Case), by freight type V, in year t
  - $\text{VKT}_{ij}^{X,V,t} = \text{tonnes}_{ij}^{X,V,t} \times \text{dist}_{ij}^{X,V} \times 2/\text{capacity}_{ij}^{X,V}$
  - $\text{tonnes}_{ij}^{X,V,t}$ is the total freight tonnes transported by road from (Origin) i to (Destination) j in scenario X (B = Road Case, P = Rail Case), by freight type V, and in year t
  - $\text{dist}_{ij}^{X,V}$ is the one-way road distance travelled per vehicle in kilometres from (Origin) i to (Destination) j in scenario X (B = Road Case, P = Rail Case), and by freight type V
  - $\text{capacity}_{ij}^{X,V}$ is the average net vehicle capacity weighted by vehicle type from (Origin) i to (Destination) j in scenario X (B = Road Case, P = Rail Case), and by freight type V
- VOC_{ij}^{Xe} is the VOC per kilometre by Xe (Re = resource VOC and Pe = perceived VOC)

Table 47 Key parameters used in vehicle operating costs calculation

ASSUMPTION DETAIL	VALUE	UNIT	SOURCE
Resource VOC	Toowoomba to Parkes: $1.77	$FY2022 / km	EY assumption based on Transport for NSW Economic Parameter Values
Perceived VOC	Toowoomba to Parkes: $0.87	$FY2022 / km	EY assumption based on Transport for NSW Economic Parameter Values

Road damage cost savings

Cost savings from reduction in damage to road infrastructure.

The general formula is: Vehicle Kilometres Travelled (by road) x Cost of Road Damage

These can be calculated as follows:

Equation 3 Road damage cost savings

$$Road\ damage\ cost\ savings^{t} = \sum_{V}\sum_{ij}\left(VKT_{ij}^{B,V,t} - VKT_{ij}^{P,V,t}\right) \times \sum_{x}\left(DC^{x} \times \%^{x}\right)$$

Where:

- $VKT_{ij}^{X,V,t}$ is the vehicle kilometres travelled from (Origin) i to (Destination) i in scenario X (B = Road Case and P = Rail Case), by freight type V, in year t
- DC^{x} is the cost of road damage per kilometre for vehicle type x
- $\%^{x}$ is the proportion of freight travelling by vehicle type x

Table 48 Key parameters used in road damage cost savings

ASSUMPTION DETAIL	VALUE	UNIT	SOURCE
Cost of road damage	Light commercial: $0.05 Light rigid: $0.05 Medium rigid: $0.11 Heavy rigid: $0.16 4 Axle: $0.16 5 Axle: $0.18 6 Axle: $0.21 B-Doubles: $0.27 B-Triples / Road trains: $0.38	$FY2022 / VKT	Transport for NSW (2019), Economic Parameter Values, Table 50

Road environmental impacts

Road users also generate externalities on third parties and the community. Environmental impacts per VKT can be calculated using TfNSW parameters. Externalities usually captured include:

- Air pollution.
- Greenhouse gas emissions.
- Noise and water pollution.

- Nature and landscape.
- Urban separation.
- Upstream and downstream costs.

The general formula is: Vehicle Kilometres Travelled (by road) x Externality Costs

These can be calculated as follows:

Equation 4 Road environmental impact cost savings

$$Road\ environmental\ impacts^{t} = \sum_{V}\sum_{ij}\sum_{L}\left(VKT_{ij}^{B,V,L,t} \times road\ ext^{B,L}\right) - \left(VKT_{ij}^{P,V,L,t} \times road\ ext^{P,L}\right)$$

Where:

- $VKT_{ij}^{X,V,L,t}$ is the vehicle kilometres travelled from (Origin) i to (Destination) i in scenario X (B = Road Case and P = Rail Case), by freight type V, in location L (U = urban and R = rural), in year t
  - $\mathrm{VKT}_{\mathrm{ij}}^{\mathrm{X,V,t}} = \mathrm{tonnes}_{\mathrm{ij}}^{\mathrm{X,V,t}} \times \mathrm{dist}_{\mathrm{ij}}^{\mathrm{X,V}} \times 2/\mathrm{capacity}_{\mathrm{ij}}^{\mathrm{X,V}}$
  - $\mathrm{tonnes}_{\mathrm{ij}}^{\mathrm{X,V,t}}$ is the total freight tonnes transported by road from (Origin) i to (Destination) j in scenario X (B = Road Case, P = Rail Case), by freight type V, and in year t
  - $\mathrm{dist}_{\mathrm{ij}}^{\mathrm{X,V}}$ is the one-way road distance travelled per vehicle in kilometres from (Origin) i to (Destination) j in scenario X (B = Road Case, P = Rail Case), and by freight type V
  - $\mathrm{capacity}_{\mathrm{ij}}^{\mathrm{X,V}}$ is the average net vehicle capacity weighted by vehicle type from (Origin) i to (Destination) j in scenario X (B = Road Case, P = Rail Case), and by freight type
- $road\ ext^{X,L}$ is the total externality unit costs for road freight weighted by vehicle type in scenario X (B = Road Case and P = Rail case), in location L (U = urban and R = rural)

Table 49 Key parameters used in road environmental impact cost savings calculation

ASSUMPTION DETAIL	VALUE	UNIT	SOURCE
Road freight externality – Urban Light Commercial	Air pollution: $0.08 GHG emission: $0.03 Noise: $0.01 Water pollution: $0.01 Nature & landscape: $0.01 Urban separation: $0.01 Upstream & downstream costs: $0.08	$FY2022/VKT	Transport for NSW (2019), Economic Parameter Values, Table 41
Road freight externality – Urban Rigid Trucks	Air pollution: $0.18 GHG emission: $0.04 Noise: $0.03 Water pollution: $0.03 Nature & landscape: $0.00 Urban separation: $0.02 Upstream & downstream costs: $0.16	$FY2022/VKT	Transport for NSW (2019), Economic Parameter Values, Table 41

ASSUMPTION DETAIL	VALUE	UNIT	SOURCE
Road freight externality – Urban Articulated Trucks	Air pollution: $0.71 GHG emission: $0.01 Noise: $0.05 Water pollution: $0.00 Nature & landscape: $0.03 Urban separation: $0.03	$FY2022/VKT	Transport for NSW (2019), Economic Parameter Values, Table 41
Road freight externality - Rural Light Commercial	GHG emission: $0.03 Water pollution: $0.00 Nature & landscape: $0.00 Upstream & downstream costs: $0.08	$FY2022/VKT	Transport for NSW (2019), Economic Parameter Values, Table 42
Road freight externality – Rural Rigid Trucks	Air pollution: $0.00 GHG emission: $0.04 Noise: $0.00 Water pollution: $0.01 Nature & landscape: $0.01 Upstream & downstream costs: $0.16	$FY2022/VKT	Transport for NSW (2019), Economic Parameter Values, Table 42
Road freight externality – Rural Articulated Trucks	Air pollution: $0.01 GHG emission: $0.16 Noise: $0.01 Water pollution: $0.04 Nature & landscape: $0.12	$FY2022/VKT	Transport for NSW (2019), Economic Parameter Values, Table 42

Road safety benefits

Road safety benefits arise from reduced crashes on the road network. Reducing the amount of VKT's or transporting more freight through rural as opposed to urban areas will result in road safety benefits.

The general formula is: Vehicle Kilometres Travelled (by road) x Accident Costs

These can be calculated as follows:

Equation 5 Road safety benefits

$$Road\ safety\ benefits^{t} = \sum_{V}\sum_{ij}\sum_{L}\left(VKT_{ij}^{B,V,L,t} - VKT_{ij}^{P,V,L,t}\right) \times safety^{L}$$

Where:

- $VKT_{ij}^{X,V,L,t}$ is the vehicle kilometres travelled from (Origin) i to (Destination) i in scenario X (B = Road Case and P = Rail Case), by freight type V, in location L (U = urban and R = rural), in year t
- $safety^{L}$ is the weighted average safety cost for road in location L (U = urban and R = rural)

Table 50 Key parameters used in road safety benefits calculation

ASSUMPTION DETAIL	VALUE	UNIT	SOURCE
Freight road safety - urban	$0.08	$FY2022/VKT	Transport for NSW: Economic Parameter Values, Table 27
Freight road safety - rural	$0.04	$FY2022/VKT	EY analysis based on Transport for NSW: Economic Parameter Values, Table 27, 30 & 31

Appendix D Additional Costing Information

EY – INLAND RAIL INTERFACE IMPROVEMENT PROGRAM

TRANSPORTING HYDROGEN BY RAIL - GATE 2 CAPEX/OPEX ESTIMATE - REV0

21 April 2022

CONTENTS

APPENDICES

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1 PROJECT OVERVIEW

WT have been appointed by EY to provide Capex and Opex estimating support to the proposals being put forward to meet the Inland Rail interface requirements. This report details the estimated capital construction, operational & maintenance costs for proposals to transport hydrogen by rail at Toowoomba, located in Queensland (QLD) and at Parkes, located in New South Wales (NSW) including loading and unloading respectively.

Base case (transporting hydrogen by road) and option 1 (transporting hydrogen by rail) have been considered at Gate 2, with base case having less scope than option 1. Both options include the scope of hardstand, security fencing around hydrogen compound hardstand, 1no gatehouse, and associated fire hydrant system. As advised by SNC, the scope of base case (transporting hydrogen by road) has been assumed to be 50% of the facilities required under the option 1 (transporting hydrogen by rail), which includes 4,480m2 of hardstand (56m x 80m), fencing that would reduce by 160m (2 x 80m), 1no gatehouse, and a fire hydrant system that would be half of the size.

2 ESTIMATE SUMMARY

A summary of the Capex and Opex cost estimates is tabled below, the full detailed breakdown of the Capex & Opex costs can be found in the Appendices of this report.

CAPEX SUMMARY OF COSTS:

CAPEX COSTS	**$**	**$**
	Base Case (Transporting Hydrogen by Road)	Option 1 (Transporting Hydrogen by Rail)
RAIL WORKS	n/a	n/a
ROAD WORKS	n/a	n/a
BUILDING WORKS	1.43	2.78
INFRASTRUCTURE WORKS	1.27	1.47
OTHER WORKS	Excl.	Excl.
DIRECT COSTS	**2.70**	**4.24**
PRELIMINARIES, OVERHEADS CONSULTANT AND CLIENT COSTS	1.74	2.73
BASE ESTIMATE	**4.44**	**6.98**
P50 CONTINGENCY	2.22	3.49
TOTAL (REAL)	**6.66**	**10.46**
ESCALATION	1.06	1.67

TOTAL (NOMINAL)	**7.72**	**12.13**

The following table shows the whole life costs for the Roma East option over a 30 year period from FY28.

Whole life cost by option ($m, nominal – 3% escalation rate):

CATEGORY	BASE CASE (TRANSPORTING HYDROGEN BY ROAD)	OPTION 1 (TRANSPORTING HYDROGEN BY RAIL)
Capital Cost (Excl. Land/ Property Acquisition)	7.72	12.13
Replacement Cost	3.75	6.54
Annual Maintenance	1.99	3.09
Operating Cost	0.08	0.11
Total	**13.54**	**21.88**

Note: numbers may not sum due to rounding

3 CAPEX METHODOLOGY AND APPROACH

WT have been appointed by EY to provide Capex and Opex estimating support to the proposals being put forward to meet the Inland Rail Interface Improvement Program requirements. The scope is to provide facilities to facilitate the loading and unloading for transporting and processing of hydrogen.

This report details the estimated Capex costs, as well as the anticipated ongoing Opex costs to run and maintain that infrastructure over a 30 year period. This report supports EY's Gate 2 submission of the business case for this infrastructure.

It should be noted that no site visit was conducted at Gate 2, therefore this estimate is a desktop based estimate and assumptions have been made as to the current condition of the site. It is understood that a site visit may be undertaken for future gateways.

QUANTITIES

The quantities for each item were derived from the design data provided within the SNC Lavalin report where available, some assumptions were made where design information was not readily available but required cost input to fill the gaps.

TRADE/DIRECT COST

WT have used first principles estimating where design information allows and have made provisional cost assessments of scopes of work that have not yet been fully defined.

- Where possible a first principles approach has been used, with consideration given to the amount of labour, plant and materials that would be required to undertake the works under considerations.
- Composite rates. These are rates per units of quantity which include all the labour, materials and plant costs within them, such as a $/m2 for hardstand. These rates were obtained from WT cost database benchmarking.

WT estimates of the project capital costs cover all plant, labour and materials associated with the construction. Due to the nature of the Gate 2 design, WT have provided all in composite rates for items such as hardstand. WT have, at this stage, excluded costs for earthworks to the site, as there is insufficient design detail/ scope definition to address this. It is currently assumed existing infrastructure will be re-used. The contingency applied is intended to cover these unknown costs.

Two options have been considered; transporting hydrogen by road and transporting hydrogen by rail. Both these options include the scope of hardstand, security fencing around hydrogen compound hardstand, 1no gatehouse, and associated fire hydrant system. As advised by SNC, the option of transporting hydrogen by road has been assumed to be 50% of the facilities required under the option of transporting hydrogen by rail. It includes 4,480m2 of hardstand (56m x 80m), fencing that would reduce by 160m (2 x 80m), 1no gatehouse, and a fire hydrant system that would be half of the size.

CONTRACTOR PRELIMINARIES

The contractor's preliminaries allow for contractor's costs to establish, operate, and supervise the site and include such items as project management/ supervision, labour, insurances, site facilities and major plant such as cranes. Preliminaries cost have been calculated using benchmark percentages of recent of WT projects. These are set at 30%.

CONSULTANT'S COSTS

These have been calculated based on a percentage of the capital costs including preliminaries, overheads and margin. The percentage (15%) is based on benchmarked cost data.

CLIENT'S COSTS

These have been calculated based on a percentage of the capital costs including preliminaries, overheads, margin, and consultant costs. The percentage (10%) is based on benchmarked cost data.

CONTINGENCY

Due to the level of design information available at this stage and considering the P50 level of certainty around the costs, a 50% contingency to the Gate 2 project cost has been applied. This 50% is applied to the total project costs (direct costs plus preliminaries, overheads, margin, consultant costs and client costs).

A combination of benchmarking of other recent infrastructure projects, in-house experience and knowledge of infrastructure cost planning, have been used to decide the appropriate contingency levels. This is consistent with the models and suggested parameters used by TfNSW and Queensland Department of Transport and Main Roads (TMR). Internal benchmarks include the More Trains More Services (MTMS) Program and a strategic level cost estimate for a large-scale infrastructure project of a similar nature for a Tier 1 contractor, with comparable design effort to the Gate 2 assessment undertaken for this Proposal whereby a 50% contingency amount was reviewed and approved by the contractor's estimating review team. Reference has also been made to published guidelines such as suggested parameters used by TfNSW Roads and Maritime estimating guidelines and TfNSW Project Cost Estimating for Heavy Rail & Light Rail infrastructure and Queensland Department of Transport and Main Roads (TMR) guidelines to inform this contingency level.

ESCALATION

As noted, the Capex estimates have been based on FY2022 prices. These costs have been escalated in line with the anticipated construction programme of FY2027. WT note that no other allowance or adjustment to pricing due to the current Covid-19 pandemic has been made. This is considered a potential risk item and is assumed to be included within the 50% contingency allowance previously discussed.

4 CAPEX ASSUMPTIONS/EXCLUSIONS

The following assumptions and exclusions have been used in the production of the estimates:

- The rates used are composite all-in rates and are benchmarked from recent project within the WT cost database.
- All costs have been escalated to reflect FY2027 anticipated market prices.
- The capital costs for the project options cover all plant, labour and materials associated with the construction.
- Assumed gatehouse to be single person demountable.
- Assumed fire hydrant works will be coordinated with hardstand construction in avoiding the need for additional trenching, backfill etc.
- Assumed boom gates and CCTV system to gatehouse.
- The scope for base case (transporting hydrogen by road) is assumed to be based on SNC's advice as per email dated 4 April 2022
- For nominal capital costs, estimates have been escalated by the current construction price Index value of 3% per annum.
- Assumed fire service connection required.

The following costs have been excluded:

- Rail or road works (no requirement identified in scope).
- Classification of area as major hazard facility (MHF).
- Hydrogen containers.
- Reach stacker (Assumed a reach stacker already present on site).
- All other services and utility connection except fire main connection to site.
- Provision of Hydrant water tank.
- Straddle carrier.
- The removal/treatment of hazardous contaminated spoil, ballast, etc.
- Earthworks to site.
- Property/land acquisition costs.
- GST
- Staging costs (if any)
- Easements and any protection works to avoid damaging the adjacent properties and assets.
- Out of hours working.
- Modifications to existing network (unless specifically stated).
- Works outside site boundary.
- Costs arising from inclement weather.
- Cost arising through delay or demand due to current Covid-19 pandemic.

5 DOCUMENTATION USED

- P2_037 Transporting Hydrogen – Scope for Cost Estimate V1
- SNC's Email – Details of Base Case Scope (emailed 22 March 2022)
- SNC's Email – Assumption on Construction Period (emailed 22 March 2022)
- EY's Email – Clarification of Scope for Base Case and Project Case (emailed 4 April 2022)

6 OPEX & MAINTENANCE COSTS SUMMARY

APPROACH

There are a number of alternative industry accepted approaches to develop whole-of-life maintenance costs. These approaches are based on individual corporate strategies and experiences. The approach to risk assessment can also vary.

With this in mind, the views and opinions below (including cost estimates) constitute WT's judgment as at the date indicated and based on knowledge of the industry and current best practices, including the quality and appropriateness of delivery solutions, knowledge libraries and actual cost data obtained from Inland Rail.

The components modelled in the maintenance cost modelling and the development approach for these are summarised in the below table.

MAINTENANCE COST TYPE	APPROACH TO DEVELOPMENT
Replacement Costs (MPM)	MPM and renewal tasks have been developed using: • Design information provided at that time which may not include specific individual asset information, design specifications, design configurations and materials selected. In these instances, WT has adopted a generic approach to cost modelling based on previous project benchmark data. • Standard asset renewal and replacement cycles has been applied from guidance material, knowledge libraries and industry good practice processes. • Replacement of assets on a like for like in terms of performance and quality. • Programmed maintenance activities such as grinding and resurfacing of tracks. • Renewal tasks such as an overhaul or upgrade to meet the design life.
Annual Maintenance Costs (RMR)	Generally, RMR has been developed using the following methods: • Benchmark maintenance cycles and rates from other similar projects prorated to reflect units in the cost plans. • A percentage of capital cost benchmarked against knowledge libraries to reflect a reasonable level of planned and unplanned maintenance needs; and • Unit rates (where individual assets are easily identified).

MAINTENANCE COSTS SUMMARY

Maintenance costs for each option are summarised below, including real and nominal costs over the 30-year appraisal period.

The incremental costs are also detailed in the below tables (real and nominal). These costs are the different between the option maintenance cost and the base case maintenance costs.

30-year maintenance costs (Real, FY22) $m

COST CATEGORY	BASE CASE (TRANSPORTING HYDROGEN BY ROAD)	OPTION 1 (TRANSPORTING HYDROGEN BY RAIL)	
		$M	Δ TO BASE CASE
Replacement Cost (MPM)	1.79	3.11	+1.32
Annual Maintenance (RMR)	1.07	1.67	+0.60
Total	**2.86**	**4.78**	**+1.92**

Note: numbers may not sum due to rounding

30-year escalated maintenance costs (nominal – 3% escalation rate) $m

COST CATEGORY	BASE CASE (TRANSPORTING HYDROGEN BY ROAD)	OPTION 1 (TRANSPORTING HYDROGEN BY RAIL)	
		$M	Δ TO BASE CASE
Replacement Cost (MPM)	3.75	6.54	+2.79
Annual Maintenance (RMR)	1.99	3.09	+1.11
Total	**5.74**	**9.64**	**+3.90**

Note: numbers may not sum due to rounding

The maintenance costs of base case (transporting hydrogen by road) are lower than the maintenance costs of option 1 (transporting hydrogen by rail). This is due to a reduced level of scope required for the base case.

OPERATING COSTS

Operating cost allowances for network operation generally include utility costs, staff costs and statutory expenses (excluding maintenance costs). The operating costs anticipated for this Proposal include:

- Power usage from gatehouse and security requirements

A summary of annual operating cost allowance for each option in real dollars is included in table below.

Annual operating costs for Option 1 (real FY22)

CATEGORY	BASE CASE (TRANSPORTING HYDROGEN BY ROAD)	OPTION 1 (TRANSPORTING HYDROGEN BY RAIL)	
		$M	Δ TO BASE CASE
OPERATING COST	**1,400**	**2,000**	**600**

Source WT estimates 2022

WOL COSTS SUMMARY

A summary of the total whole of life costs for each option is shown below in nominal terms for the 30 year analysis period.

Whole life cost by option ($m, nominal – 3% escalation rate):

CATEGORY	BASE CASE (TRANSPORTING HYDROGEN BY ROAD)	OPTION 1 (TRANSPORTING HYDROGEN BY RAIL)
Capital Cost	7.72	12.13
Replacement Cost	3.75	6.54
Annual Maintenance	1.99	3.09
Operating Cost	0.08	0.11
Total	**13.54**	**21.88**

Note: numbers may not sum due to rounding

The whole life costs for option 1 are higher than the whole life costs of option 2. This can be attributed to the greater scope requirement included the option 1 compared to base case.

METHODOLOGY/ OVERVIEW OF ESTIMATING APPROACH

INPUT PARAMETERS

The following input parameters are used in the operational and maintenance cashflow analysis:

INPUT	VALUE
Analysis Period	30 years
Start Year	FY28
Base cost year	FY22
O&M contingency	10%

Escalation rate (for nominal costs)	3%
Discount Rate	7%
Sensitivity rate	3%

Source: WT 2022

WOL COST MODELLING

WT has developed a comprehensive maintenance (or whole-of-life) cost modelling system using a Microsoft Excel application program which has been tested on numerous major infrastructure project business cases. The methodology for estimating the maintenance costs is as follows:

- The model has been developed using capital cost estimates for the proposed option.
- The future cashflow is based on the base capital cost estimates and no escalation rate (CPI) has been applied to the future cashflow for the base model.
- Separate models for cost escalation and discounted cashflow are developed using the base model for analysis purposes.
- A 10% O&M contingency has been built into estimates for RMR, MPM and operating costs.
- The same cost assumptions are applicable to all Proposal options.

The following cost components are modelled using cashflow analysis on a yearly basis.

REPLACEMENT COSTS (MPM)

Major Periodic Maintenance and renewal tasks have been developed using:

- Design information provided at that time which may not include specific individual asset information, design specifications, design configurations and materials selected. In these instances, WT has adopted a generic approach to cost modelling based on previous project benchmark data.
- Standard asset renewal and replacement cycles has been applied from guidance material, knowledge libraries and industry good practice processes.
- Replacement of assets on a like for like in terms of performance and quality.
- Programmed maintenance activities such as grinding and resurfacing of tracks.
- Renewal tasks such as an overhaul or upgrade to meet the design life.

ANNUAL MAINTENANCE (RMR) COST

Generally, RMR has been developed using the following methods:

- Benchmark maintenance cycles and rates from other similar projects prorated to reflect units in the cost plans.
- A percentage of capital cost benchmarked against knowledge libraries to reflect a reasonable level of planned and unplanned maintenance needs; and
- Unit rates (where individual assets are easily identified).

OPEX ESTIMATE ASSUMPTIONS

In developing the maintenance cost estimate, the following aspects of the Proposal were considered:

- The costs have been estimated based on the capital costs prepared by WT.
- The anticipated time-based activities are applied.
- Core hours of operation and subsequent duty/use of key plant and equipment anticipated.
- Quality of finishes, durability and performance requirements anticipated.
- Design Life Requirements considering the level of duty expected of each asset.
- The realistic expectations that some assets may not be fully replaced in full at the end of its design life (e.g., tracks).
- Outsourced contracts anticipated including managing maintenance contractors supported by specialist sub-contractors.
- The applied replacement costs assume:
    - Asset design lives will be achieved even though component life and degradation will vary according to location, prevailing weather, duty and usage and satisfactory maintenance.
    - Installation is assumed to be in accordance with relevant codes, to manufacturer's recommendations or accepted practice.
    - Maintenance is assumed to be carried out in accordance with relevant codes or accepted practice and adequate to optimise the service life of the asset.
- In some cases, assets are not replaced but renewed to provide extended design life.
- Costs should not be compared with any historic expenditure as it is unlikely to be maintained on a like for like basis with good practice. Costs will be updated once detailed design is available.
- No replacement of items due to technical obsolescence is considered.
- No warranty benefits have been considered as the extent of these vary significantly between products and services.
- Works are assumed to be fit for purpose and as a result assume no ground movements (including settlement or vibration) or failure, cracking structural elements that would give rise to premature renewal or replacement tasks.
- Estimated operational costs only for the items listed in the capital cost estimates. It is a provisional cost, and we have no detailed information at this stage.
- No vegetation maintenance allowance has been included.
- This high-level model does not account for the increasing maintenance cost requirements due to ageing of assets.

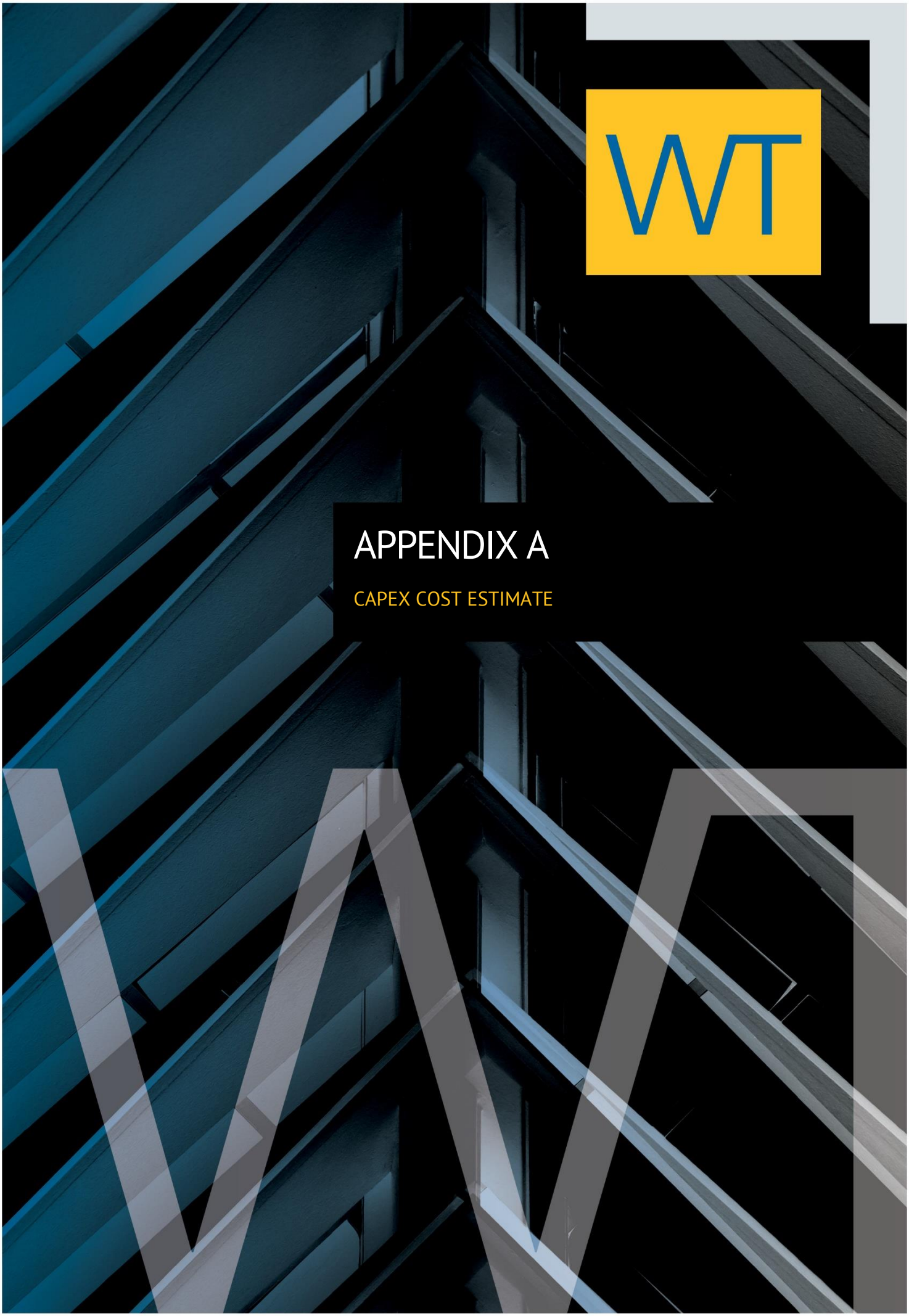
The following costs have been excluded:

- Depreciation, write-down and amortisation costs. Such costs are used for financial and taxation purposes only.
- Insurance.

- Vandalism – since this event may not occur or the cost of fixing items after vandalism (if any) is unknown.
- Currency fluctuations and financing costs that would affect plant and equipment procurement costs have not been considered.
- Any maintenance savings that would be realised as a result of less breakdowns / failure of equipment when compared to the existing assets.
- Unknown or adverse site conditions during the 30-year operational term.
- Operational mobilisation and transitioning costs.
- Energy saving from solar panels installation.
- Earthworks (within the direct capital costs).
- Recoverable GST.

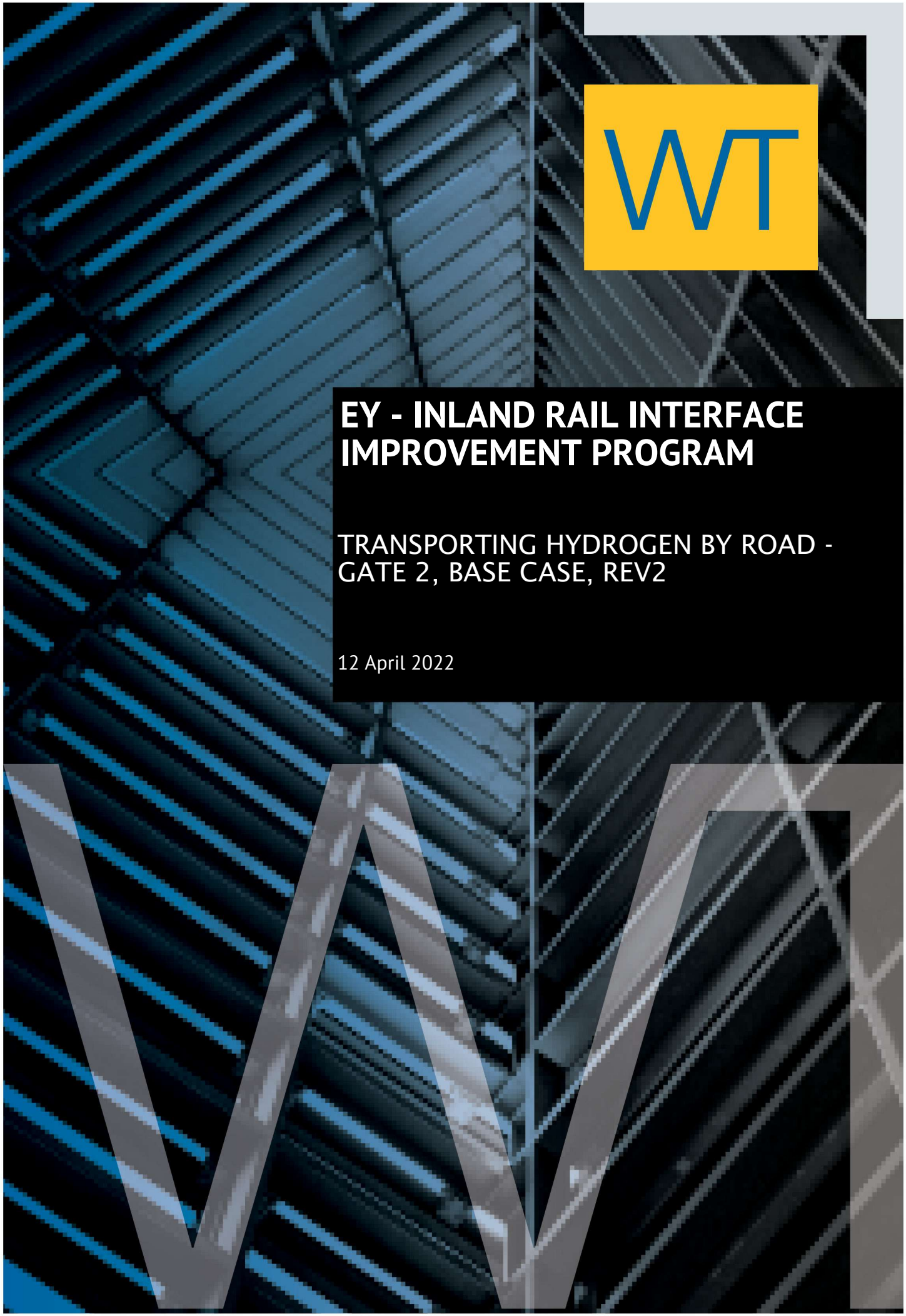
7 RELIABILITY OF ESTIMATES

WT prepared these cost estimates in April 2022 in line with the methodology and assumptions outlined in this section. Where possible, WT has sourced costs from recent projects and recent market data for the supply and installation of materials such as rail, sleepers and the like. The costs exclude estimates for property acquisitions on the basis that the current designs indicate no acquisitions will be required, nothing this is subject to further analysis at future gates (subject to the Proposal proceeding).



APPENDIX A

CAPEX COST ESTIMATE



EY - INLAND RAIL INTERFACE IMPROVEMENT PROGRAM

TRANSPORTING HYDROGEN BY ROAD - GATE 2, BASE CASE, REV2

12 April 2022

EY - INLAND RAIL INTERFACE IMPROVEMENT

TRANSPORTING HYDROGEN- GATE 2 BASE CASE REV2

Estimate Summary **12 April 2022**

REF	DESCRIPTION	QUANTITY	UNIT	RATE	TOTAL
	Inland Rail Interface Integration Program				
	Gate 2				
	Transporting hydrogen by rail (Toowoomba / Parkes by Road)				
	Base Case, Rev2				
	06/04/2022				
1/A	Rail works	1	item		n/a
1/B	Road works	1	item		n/a
1/C	Building works	1	item	1,431,820.00	1,431,820
1/D	Infrastructure works	1	item	1,268,473.36	1,268,473
1/E	Other works	1	item		Excl.
	Sub-total of Direct Costs				**2,700,293**
1/F	Prelims, overheads & margin	30	%		810,088
	Sub-total Contract costs				**3,510,381**
1/G	Consultant costs	15	%		526,557
1/H	Client costs	10	%		403,694
	Sub-total Project cost				**4,440,632**
1/J	Contingency	50	%		2,220,316
	Escalation (to FY2027)				1,060,916
	TOTAL OF ESTIMATE				**7,721,865**
	Assumptions/ Exclusions				
	No rail or road works - No requirement identified in scope				
	Classification of area as major hazard facility (MHF) excluded				
	Hydrogen containers excluded				
	Assumed gatehouse to be single person demountable type				
	Assumed fire hydrant works will be coordinated with hardstand construction- Therefore avoiding the need for additional trenching, backfill etc				
	Assumed a requirement for boom gates and CCTV to gatehouse				
	Based on storage compound for containers with the containers being moved from the compound to the rail frontage when required and classed as "in transit".				
	Assumed a reach stacker already present on site to transfer direct from storage compound to wagon. Therefore cost for reach stacker not included in this estimate				

REF	DESCRIPTION	QUANTITY	UNIT	RATE	TOTAL
	Provisional allowance included for Utility connection - fire main connection to site only - Assumed requirement due to Fire Hydrants. All other services and utility connections excluded. Provision of a hydrant water tank excluded - Advised not required due to provision of fire service connection Excludes a straddle carrier The removal/ treatment of hazardous/ contaminated spoil, ballast etc, has been excluded Excavation to site Property/ Land Acquisition costs have been excluded from these estimates GST excluded Assumed escalation to FY2027 - 3% per year escalation rate applied Staging costs (if any) have been excluded No allowance has been made for easements and any protection works to avoid damaging the adjacent properties and assets No out of hours working is included, assumed all works in normal hours Modifications to the existing network unless stated otherwise Costs for works outside the site boundary Costs arising from inclement weathers have not been allowed Costs arising through delay or demand due to current Covid-19 pandemic have not been considered				
	Total Cost				**7,721,865**

EY - INLAND RAIL INTERFACE IMPROVEMENT

TRANSPORTING HYDROGEN- GATE 2 BASE CASE REV2

Estimate Details **12 April 2022**

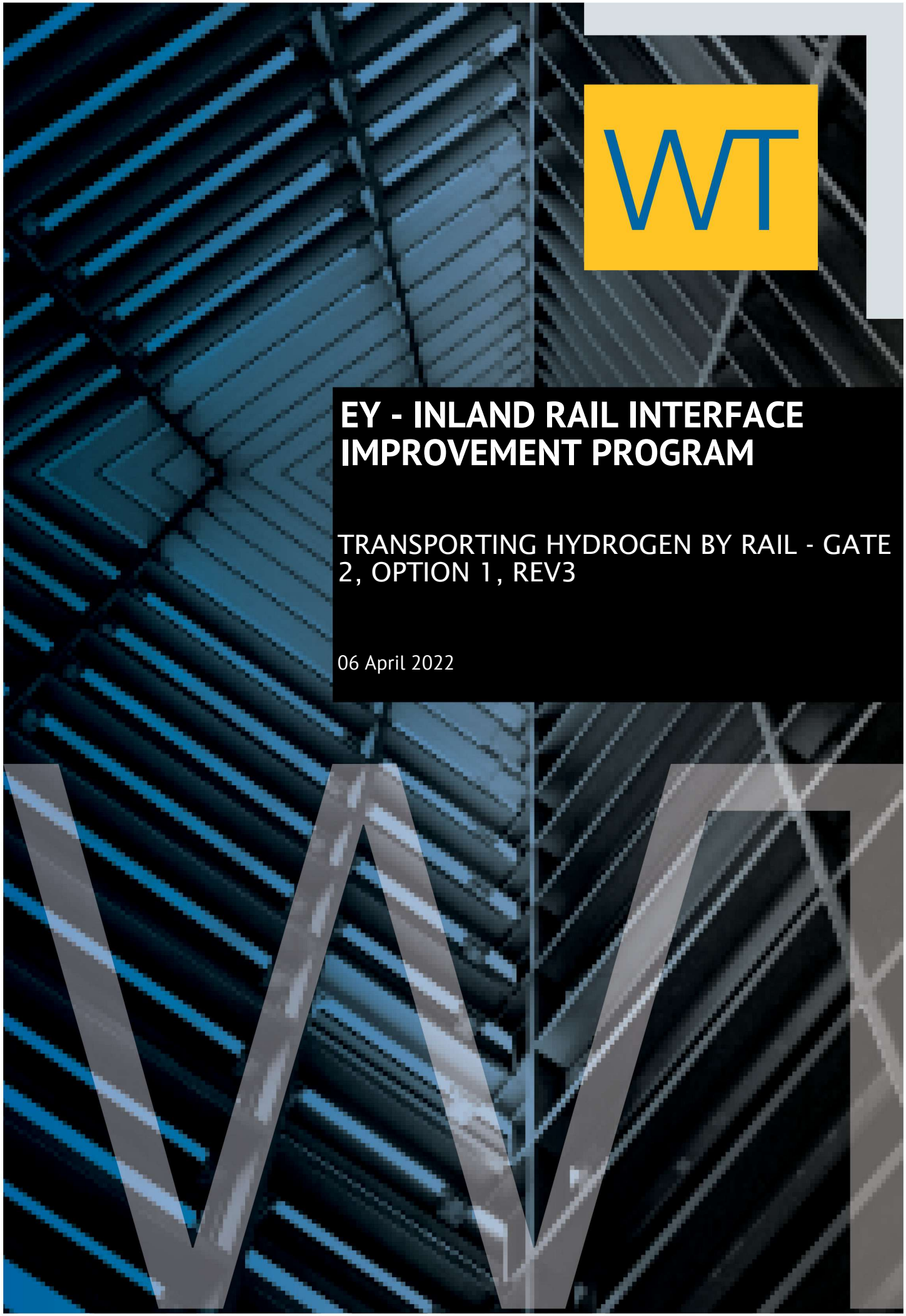
REF.	DESCRIPTION	QUANTITY	UNIT	RATE	TOTAL
	BUILDING WORKS				
	Toowoomba				
3/A	Hardstand - To store 1no full trains worth (80TEU) of full containers plus 2 trains worth of empty containers.	4,480	m2	150.00	672,000
3/B	Gate house - Allowance for single person, demountable type	1	item	26,900.00	26,900
3/C	Allowance for boom gate and CCTV to entrance/exit	1	PSum	17,010.00	17,010
	Parkes				
3/D	Hardstand - To store 1no full trains worth (80TEU) of full containers plus 2 trains worth of empty containers.	4,480	m2	150.00	672,000
3/E	Gate house - Allowance for single person, demountable type	1	item	26,900.00	26,900
3/F	Allowance for boom gate and CCTV to entrance/exit	1	PSum	17,010.00	17,010
	Total - Building Works				**1,431,820**

EY - INLAND RAIL INTERFACE IMPROVEMENT

TRANSPORTING HYDROGEN- GATE 2 BASE CASE REV2

Estimate Details **12 April 2022**

REF.	DESCRIPTION	QUANTITY	UNIT	RATE	TOTAL
	INFRASTRUCTURE WORKS				
	Toowoomba				
4/A	Boundary fencing	278	m	250.00	69,500
4/B	Fire Hydrant System	1	PSum	64,736.68	64,737
4/C	Utilities / services connections - Fire main connection only	1	PSum	500,000.00	500,000
	Parkes				
4/D	Boundary fencing	278	m	250.00	69,500
4/E	Fire Hydrant System	1	PSum	64,736.68	64,737
4/F	Utilities / services connections - Fire main connection only	1	PSum	500,000.00	500,000
	Total - Infrastructure Works				**1,268,473**



EY - INLAND RAIL INTERFACE IMPROVEMENT PROGRAM

TRANSPORTING HYDROGEN BY RAIL - GATE 2, OPTION 1, REV3

06 April 2022

EY - INLAND RAIL INTERFACE IMPROVEMENT

TRANSPORTING HYDROGEN BY RAIL- GATE 2, OPTION 1, REV3

Estimate Summary **06 April 2022**

REF	DESCRIPTION	QUANTITY	UNIT	RATE	TOTAL
	Inland Rail Interface Integration Program				
	Gate 2				
	Transporting hydrogen by rail (Toowoomba / Parkes facilities by Rail)				
	Option 1, Rev3				
	06/04/2022				
1/A	Rail works	1	item		n/a
1/B	Road works	1	item		n/a
1/C	Building works	1	item	2,775,820.00	2,775,820
1/D	Infrastructure works	1	item	1,466,279.76	1,466,280
1/E	Other works	1	item		Excl.
	Sub-total of Direct Costs				**4,242,100**
1/F	Prelims, overheads & margin	30	%		1,272,630
	Sub-total Contract costs				**5,514,730**
1/G	Consultant costs	15	%		827,209
1/H	Client costs	10	%		634,194
	Sub-total Project cost				**6,976,133**
1/J	Contingency	50	%		3,488,067
	Escalation (to FY2027)				1,666,676
	TOTAL OF ESTIMATE				**12,130,875**
	Assumptions/ Exclusions				
	No rail or road works - No requirement identified in scope				
	Classification of area as major hazard facility (MHF) excluded				
	Hydrogen containers excluded				
	Assumed gatehouse to be single person demountable type				
	Assumed fire hydrant works will be coordinated with hardstand construction- Therefore avoiding the need for additional trenching, backfill etc				
	Assumed a requirement for boom gates and CCTV to gatehouse				
	Based on storage compound for containers with the containers being moved from the compound to the rail frontage when required and classed as "in transit".				
	Assumed a reach stacker already present on site to transfer direct from storage compound to wagon. Therefore cost for reach stacker not included in this estimate				
	Provisional allowance included for Utility connection - fire main connection to site only - Assumed requirement due to Fire Hydrants. All other services and utility connections excluded.				
	Provision of a hydrant water tank excluded - Advised not required due to provision of fire service connection				

EY - INLAND RAIL INTERFACE IMPROVEMENT

TRANSPORTING HYDROGEN BY RAIL- GATE 2, OPTION 1, REV3

Estimate Summary **06 April 2022**

REF	DESCRIPTION	QUANTITY	UNIT	RATE	TOTAL
	Excludes a straddle carrier The removal/ treatment of hazardous/ contaminated spoil, ballast etc, has been excluded Excavation to site Property/ Land Acquisition costs have been excluded from these estimates GST excluded Assumed escalation to FY2027 - 3% per year escalation rate applied Staging costs (if any) have been excluded No allowance has been made for easements and any protection works to avoid damaging the adjacent properties and assets No out of hours working is included, assumed all works in normal hours Modifications to the existing network unless stated otherwise Costs for works outside the site boundary Costs arising from inclement weathers have not been allowed Costs arising through delay or demand due to current Covid-19 pandemic have not been considered				
	Total Cost				**12,130,875**

EY - INLAND RAIL INTERFACE IMPROVEMENT

TRANSPORTING HYDROGEN BY RAIL- GATE 2, OPTION 1, REV3

Estimate Details **06 April 2022**

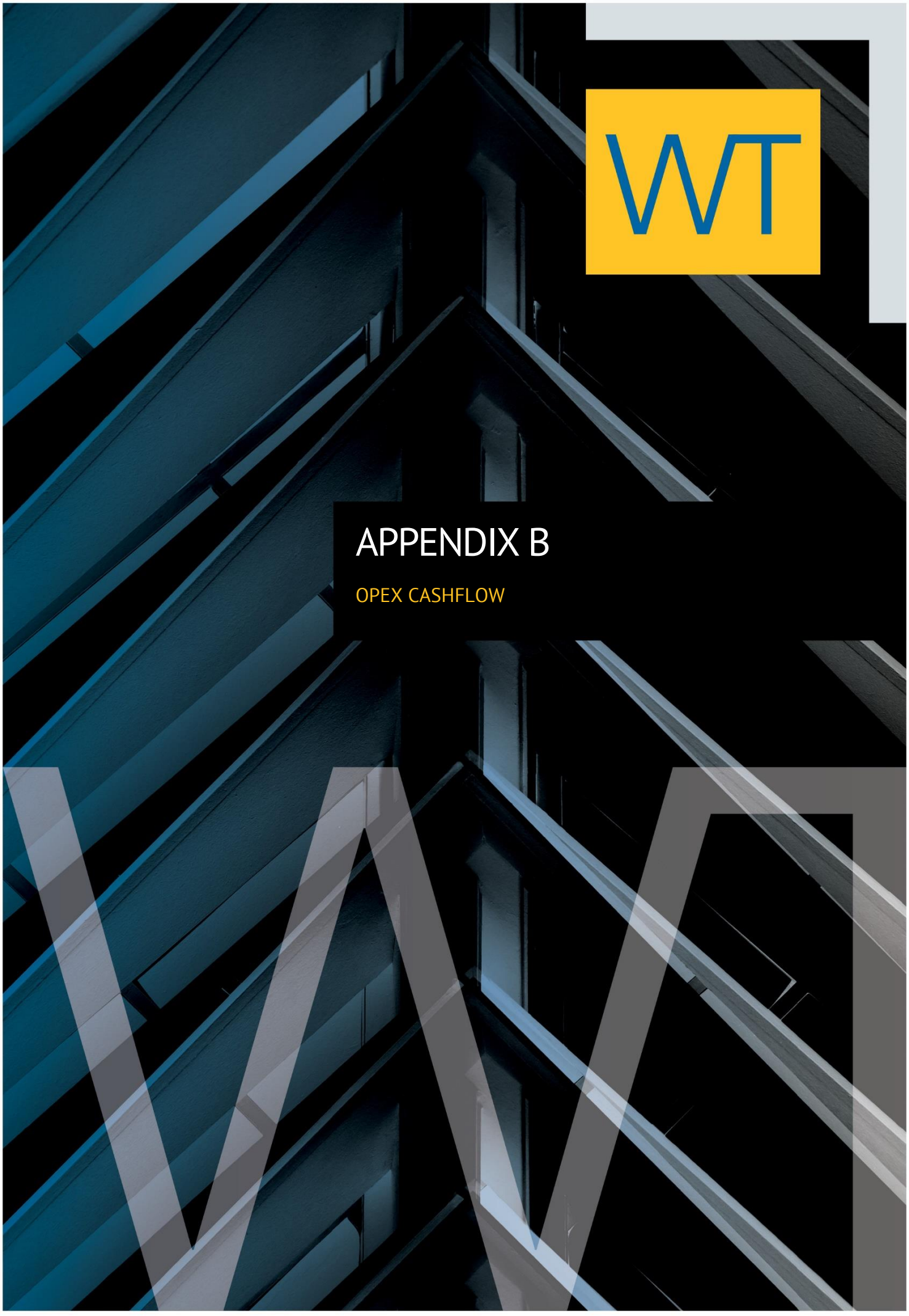
REF.	DESCRIPTION	QUANTITY	UNIT	RATE	TOTAL
	BUILDING WORKS				
	Toowoomba				
3/A	Hardstand - To store 1no full trains worth (80TEU) of full containers plus 2 trains worth of empty containers.	8,960	m2	150.00	1,344,000
3/B	Gate house - Allowance for single person, demountable type	1	item	26,900.00	26,900
3/C	Allowance for boom gate and CCTV to entrance/exit	1	PSum	17,010.00	17,010
	Parkes				
3/D	Hardstand - To store 1no full trains worth (80TEU) of full containers plus 2 trains worth of empty containers.	8,960	m2	150.00	1,344,000
3/E	Gate house - Allowance for single person, demountable type	1	item	26,900.00	26,900
3/F	Allowance for boom gate and CCTV to entrance/exit	1	PSum	17,010.00	17,010
	Total - Building Works				**2,775,820**

EY - INLAND RAIL INTERFACE IMPROVEMENT

TRANSPORTING HYDROGEN BY RAIL- GATE 2, OPTION 1, REV3

Estimate Details **06 April 2022**

REF.	DESCRIPTION	QUANTITY	UNIT	RATE	TOTAL
	INFRASTRUCTURE WORKS				
	Toowoomba				
4/A	Boundary fencing	438	m	250.00	109,500
4/B	Fire Hydrant System	1	PSum	123,639.88	123,640
4/C	Utilities / services connections - Fire main connection only	1	PSum	500,000.00	500,000
	Parkes				
4/D	Boundary fencing	438	m	250.00	109,500
4/E	Fire Hydrant System	1	PSum	123,639.88	123,640
4/F	Utilities / services connections - Fire main connection only	1	PSum	500,000.00	500,000
	Total - Infrastructure Works				**1,466,280**



APPENDIX B

OPEX CASHFLOW

Inland Rail - Transporting Hydrogen

Gate 2 - Options Assessment Rev 2

April 19, 2022

Options Cashflow Summary	Unit	Sum	Check	01-Jul-27 30-Jun-28	01-Jul-28 30-Jun-29	01-Jul-29 30-Jun-30	01-Jul-30 30-Jun-31	01-Jul-31 30-Jun-32	01-Jul-32 30-Jun-33	01-Jul-33 30-Jun-34	01-Jul-34 30-Jun-35	01-Jul-35 30-Jun-36
1 Base Case												
REAL - USED FOR ECONOMIC OUTPUTS												
1.01 Operations and Maintenance Costs				**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
Base CaseREAL - USED FOR Rail Works	*$m real 2022*	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseREAL - USED FOR Road Works	*$m real 2022*	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseREAL - USED FOR Building Works	*$m real 2022*	$ 0.52		$ 0.01	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02
Base CaseREAL - USED FOR Infrastructure Works	*$m real 2022*	$ 0.49		$ 0.01	$ 0.01	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02
Base CaseREAL - USED FOR Other Works	*$m real 2022*	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseREAL - USED FOR Contingency	*$m real 2022*	$ 0.10		$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00
Sub-total: O&M costs	*$m real 2022*	$ 1.12		$ 0.03	$ 0.03	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04
1.02 Lifecycle Costs												
Base CaseREAL - USED FOR Rail Works	*$m real 2022*	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseREAL - USED FOR Road Works	*$m real 2022*	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseREAL - USED FOR Building Works	*$m real 2022*	$ 0.92		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseREAL - USED FOR Infrastructure Works	*$m real 2022*	$ 0.71		$ -	$ -	$ -	$ -	$ 0.00	$ -	$ -	$ -	$ -
Base CaseREAL - USED FOR Other Works	*$m real 2022*	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseREAL - USED FOR Contingency	*$m real 2022*	$ 0.16		$ -	$ -	$ -	$ -	$ 0.00	$ -	$ -	$ -	$ -
Sub-total: Lifecycle costs	*$m real 2022*	$ 1.79		$ -	$ -	$ -	$ -	$ 0.00	$ -	$ -	$ -	$ -
Total of estimate	*$m real 2022*	$ 2.90	TRUE	$ 0.03	$ 0.03	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04
Nominal - USED FOR FINANCIAL OUTPUTS												
1.03 Operations and Maintenance Costs				**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
Base CaseNominal - USED FO Rail Works	*$m nominal*	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseNominal - USED FO Road Works	*$m nominal*	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseNominal - USED FO Building Works	*$m nominal*	$ 0.97		$ 0.01	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.03	$ 0.03
Base CaseNominal - USED FO Infrastructure Works	*$m nominal*	$ 0.91		$ 0.01	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02
Base CaseNominal - USED FO Other Works	*$m nominal*	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseNominal - USED FO Contingency	*$m nominal*	$ 0.19		$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.01
Sub-total: O&M costs	*$m nominal*	$ 2.06		$ 0.03	$ 0.04	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.06
1.04 Lifecycle Costs												
Base CaseNominal - USED FO Rail Works	*$m nominal*	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseNominal - USED FO Road Works	*$m nominal*	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseNominal - USED FO Building Works	*$m nominal*	$ 1.87		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseNominal - USED FO Infrastructure Works	*$m nominal*	$ 1.54		$ -	$ -	$ -	$ -	$ 0.00	$ -	$ -	$ -	$ -
Base CaseNominal - USED FO Other Works	*$m nominal*	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseNominal - USED FO Contingency	*$m nominal*	$ 0.34		$ -	$ -	$ -	$ -	$ 0.00	$ -	$ -	$ -	$ -
Sub-total: Lifecycle costs	*$m nominal*	$ 3.75		$ -	$ -	$ -	$ -	$ 0.00	$ -	$ -	$ -	$ -
Total of estimate	*$m nominal*	$ 5.81	TRUE	$ 0.03	$ 0.04	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.06

Inland Rail - Transporting Hydrogen

Gate 2 - Options Assessment Rev 2

April 19, 2022

2 Option 1

REAL - USED FOR ECONOMIC OUTPUTS

2.01 Operations and Maintenance Costs

				2028	2029	2030	2031	2032	2033	2034	2035	2036
Option 1REAL - USED FOR EC	Rail Works	$m real 2022	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1REAL - USED FOR EC	Road Works	$m real 2022	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1REAL - USED FOR EC	Building Works	$m real 2022	$ 0.94	$ 0.02	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03
Option 1REAL - USED FOR EC	Infrastructure Works	$m real 2022	$ 0.64	$ 0.01	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02
Option 1REAL - USED FOR EC	Other Works	$m real 2022	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1REAL - USED FOR EC	Contingency	$m real 2022	$ 0.16	$ 0.00	$ 0.00	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01
	Sub-total: O&M costs	$m real 2022	$ 1.73	$ 0.04	$ 0.05	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06

2.02 Lifecycle Costs

Option 1REAL - USED FOR EC	Rail Works	$m real 2022	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1REAL - USED FOR EC	Road Works	$m real 2022	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1REAL - USED FOR EC	Building Works	$m real 2022	$ 1.69	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1REAL - USED FOR EC	Infrastructure Works	$m real 2022	$ 1.14	$ -	$ -	$ -	$ -	$ 0.00	$ -	$ -	$ -	$ -	$ -
Option 1REAL - USED FOR EC	Other Works	$m real 2022	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1REAL - USED FOR EC	Contingency	$m real 2022	$ 0.28	$ -	$ -	$ -	$ -	$ 0.00	$ -	$ -	$ -	$ -	$ -
	Sub-total: Lifecycle costs	$m real 2022	$ 3.11	$ -	$ -	$ -	$ -	$ 0.00	$ -	$ -	$ -	$ -	$ -
	Total of estimate	$m real 2022	$ 4.84	TRUE	$ 0.04	$ 0.05	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06

Nominal - USED FOR FINANCIAL OUTPUTS

2.03 Operations and Maintenance Costs

				2028	2029	2030	2031	2032	2033	2034	2035	2036
Option 1Nominal - USED FOR	Rail Works	$m nominal	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1Nominal - USED FOR	Road Works	$m nominal	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1Nominal - USED FOR	Building Works	$m nominal	$ 1.73	$ 0.03	$ 0.03	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.05	$ 0.05	$ 0.05
Option 1Nominal - USED FOR	Infrastructure Works	$m nominal	$ 1.18	$ 0.02	$ 0.02	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03
Option 1Nominal - USED FOR	Other Works	$m nominal	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1Nominal - USED FOR	Contingency	$m nominal	$ 0.29	$ 0.00	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01
	Sub-total: O&M costs	$m nominal	$ 3.21	$ 0.05	$ 0.06	$ 0.07	$ 0.07	$ 0.08	$ 0.08	$ 0.08	$ 0.08	$ 0.08	$ 0.09

2.04 Lifecycle Costs

Option 1Nominal - USED FOR	Rail Works	$m nominal	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1Nominal - USED FOR	Road Works	$m nominal	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1Nominal - USED FOR	Building Works	$m nominal	$ 3.43	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1Nominal - USED FOR	Infrastructure Works	$m nominal	$ 2.52	$ -	$ -	$ -	$ -	$ 0.01	$ -	$ -	$ -	$ -	$ -
Option 1Nominal - USED FOR	Other Works	$m nominal	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1Nominal - USED FOR	Contingency	$m nominal	$ 0.59	$ -	$ -	$ -	$ -	$ 0.00	$ -	$ -	$ -	$ -	$ -
	Sub-total: Lifecycle costs	$m nominal	$ 6.54	$ -	$ -	$ -	$ -	$ 0.01	$ -	$ -	$ -	$ -	$ -
	Total of estimate	$m nominal	$ 9.75	TRUE	$ 0.05	$ 0.06	$ 0.07	$ 0.07	$ 0.08	$ 0.08	$ 0.08	$ 0.08	$ 0.09

END

Inland Rail - Transporting Hydrogen

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Options Cashflow Summary	01-Jul-36 30-Jun-37	01-Jul-37 30-Jun-38	01-Jul-38 30-Jun-39	01-Jul-39 30-Jun-40	01-Jul-40 30-Jun-41	01-Jul-41 30-Jun-42	01-Jul-42 30-Jun-43	01-Jul-43 30-Jun-44	01-Jul-44 30-Jun-45	01-Jul-45 30-Jun-46	01-Jul-46 30-Jun-47	01-Jul-47 30-Jun-48
1 Base Case												
REAL - USED FOR ECONOMIC OUTPUTS												
1.01 Operations and Maintenance Costs	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**
Base CaseREAL - USED FOR Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseREAL - USED FOR Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseREAL - USED FOR Building Works	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02
Base CaseREAL - USED FOR Infrastructure Works	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02
Base CaseREAL - USED FOR Other Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseREAL - USED FOR Contingency	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00
Sub-total: O&M costs	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04
1.02 Lifecycle Costs												
Base CaseREAL - USED FOR Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseREAL - USED FOR Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseREAL - USED FOR Building Works	$ 0.02	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.88	$ -
Base CaseREAL - USED FOR Infrastructure Works	$ 0.01	$ -	$ -	$ -	$ -	$ 0.00	$ -	$ -	$ -	$ -	$ 0.35	$ -
Base CaseREAL - USED FOR Other Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseREAL - USED FOR Contingency	$ 0.00	$ -	$ -	$ -	$ -	$ 0.00	$ -	$ -	$ -	$ -	$ 0.12	$ -
Sub-total: Lifecycle costs	$ 0.03	$ -	$ -	$ -	$ -	$ 0.00	$ -	$ -	$ -	$ -	$ 1.36	$ -
Total of estimate	$ 0.07	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 1.40	$ 0.04
Nominal - USED FOR FINANCIAL OUTPUTS												
1.03 Operations and Maintenance Costs	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**
Base CaseNominal - USED FO Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseNominal - USED FO Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseNominal - USED FO Building Works	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.04	$ 0.04
Base CaseNominal - USED FO Infrastructure Works	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03
Base CaseNominal - USED FO Other Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseNominal - USED FO Contingency	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01
Sub-total: O&M costs	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.07	$ 0.07	$ 0.07	$ 0.07	$ 0.07	$ 0.08	$ 0.08
1.04 Lifecycle Costs												
Base CaseNominal - USED FO Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseNominal - USED FO Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseNominal - USED FO Building Works	$ 0.03	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.80	$ -
Base CaseNominal - USED FO Infrastructure Works	$ 0.02	$ -	$ -	$ -	$ -	$ 0.00	$ -	$ -	$ -	$ -	$ 0.71	$ -
Base CaseNominal - USED FO Other Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseNominal - USED FO Contingency	$ 0.00	$ -	$ -	$ -	$ -	$ 0.00	$ -	$ -	$ -	$ -	$ 0.25	$ -
Sub-total: Lifecycle costs	$ 0.05	$ -	$ -	$ -	$ -	$ 0.00	$ -	$ -	$ -	$ -	$ 2.76	$ -
Total of estimate	$ 0.10	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.07	$ 0.07	$ 0.07	$ 0.07	$ 0.07	$ 2.84	$ 0.08

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2 Option 1

REAL - USED FOR ECONOMIC OUTPUTS

2.01 Operations and Maintenance Costs

	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Option 1REAL - USED FOR EC Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1REAL - USED FOR EC Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1REAL - USED FOR EC Building Works	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03
Option 1REAL - USED FOR EC Infrastructure Works	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02
Option 1REAL - USED FOR EC Other Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1REAL - USED FOR EC Contingency	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01
Sub-total: O&M costs	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06

2.02 Lifecycle Costs

Option 1REAL - USED FOR EC Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1REAL - USED FOR EC Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1REAL - USED FOR EC Building Works	$ 0.02	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.65	$ -
Option 1REAL - USED FOR EC Infrastructure Works	$ 0.02	$ -	$ -	$ -	$ -	$ 0.00	$ -	$ -	$ -	$ -	$ 0.47	$ -
Option 1REAL - USED FOR EC Other Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1REAL - USED FOR EC Contingency	$ 0.00	$ -	$ -	$ -	$ -	$ 0.00	$ -	$ -	$ -	$ -	$ 0.21	$ -
Sub-total: Lifecycle costs	$ 0.04	$ -	$ -	$ -	$ -	$ 0.00	$ -	$ -	$ -	$ -	$ 2.34	$ -
Total of estimate	$ 0.10	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 2.39	$ 0.06

Nominal - USED FOR FINANCIAL OUTPUTS

2.03 Operations and Maintenance Costs

	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Option 1Nominal - USED FOR . Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1Nominal - USED FOR . Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1Nominal - USED FOR . Building Works	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.07
Option 1Nominal - USED FOR . Infrastructure Works	$ 0.03	$ 0.03	$ 0.03	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.05
Option 1Nominal - USED FOR . Other Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1Nominal - USED FOR . Contingency	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01
Sub-total: O&M costs	$ 0.09	$ 0.09	$ 0.09	$ 0.10	$ 0.10	$ 0.10	$ 0.11	$ 0.11	$ 0.11	$ 0.12	$ 0.12	$ 0.12

2.04 Lifecycle Costs

Option 1Nominal - USED FOR . Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1Nominal - USED FOR . Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1Nominal - USED FOR . Building Works	$ 0.03	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.36	$ -
Option 1Nominal - USED FOR . Infrastructure Works	$ 0.02	$ -	$ -	$ -	$ -	$ 0.01	$ -	$ -	$ -	$ -	$ 0.96	$ -
Option 1Nominal - USED FOR . Other Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1Nominal - USED FOR . Contingency	$ 0.01	$ -	$ -	$ -	$ -	$ 0.00	$ -	$ -	$ -	$ -	$ 0.43	$ -
Sub-total: Lifecycle costs	$ 0.06	$ -	$ -	$ -	$ -	$ 0.01	$ -	$ -	$ -	$ -	$ 4.75	$ -
Total of estimate	$ 0.15	$ 0.09	$ 0.09	$ 0.10	$ 0.10	$ 0.11	$ 0.11	$ 0.11	$ 0.11	$ 0.12	$ 4.87	$ 0.12

END

Inland Rail - Transporting Hydrogen

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Options Cashflow Summary	01-Jul-48 30-Jun-49	01-Jul-49 30-Jun-50	01-Jul-50 30-Jun-51	01-Jul-51 30-Jun-52	01-Jul-52 30-Jun-53	01-Jul-53 30-Jun-54	01-Jul-54 30-Jun-55	01-Jul-55 30-Jun-56	01-Jul-56 30-Jun-57	01-Jul-57 30-Jun-58	01-Jul-58 30-Jun-59
1 Base Case											
REAL - USED FOR ECONOMIC OUTPUTS											
1.01 Operations and Maintenance Costs	**2049**	**2050**	**2051**	**2052**	**2053**	**2054**	**2055**	**2056**	**2057**	**2058**	**2059**
Base CaseREAL - USED FOR Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseREAL - USED FOR Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseREAL - USED FOR Building Works	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ -	$ -
Base CaseREAL - USED FOR Infrastructure Works	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ -	$ -
Base CaseREAL - USED FOR Other Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseREAL - USED FOR Contingency	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ -	$ -
Sub-total: O&M costs	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ -	$ -
1.02 Lifecycle Costs											
Base CaseREAL - USED FOR Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseREAL - USED FOR Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseREAL - USED FOR Building Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.02	$ -	$ -
Base CaseREAL - USED FOR Infrastructure Works	$ -	$ -	$ -	$ 0.33	$ -	$ -	$ -	$ -	$ 0.01	$ -	$ -
Base CaseREAL - USED FOR Other Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseREAL - USED FOR Contingency	$ -	$ -	$ -	$ 0.03	$ -	$ -	$ -	$ -	$ 0.00	$ -	$ -
Sub-total: Lifecycle costs	$ -	$ -	$ -	$ 0.36	$ -	$ -	$ -	$ -	$ 0.03	$ -	$ -
Total of estimate	$ 0.04	$ 0.04	$ 0.04	$ 0.40	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.07	$ -	$ -
Nominal - USED FOR FINANCIAL OUTPUTS											
1.03 Operations and Maintenance Costs	**2049**	**2050**	**2051**	**2052**	**2053**	**2054**	**2055**	**2056**	**2057**	**2058**	**2059**
Base CaseNominal - USED FO Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseNominal - USED FO Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseNominal - USED FO Building Works	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.05	$ 0.05	$ 0.05	$ -	$ -
Base CaseNominal - USED FO Infrastructure Works	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.05	$ -	$ -
Base CaseNominal - USED FO Other Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseNominal - USED FO Contingency	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ -	$ -
Sub-total: O&M costs	$ 0.08	$ 0.08	$ 0.09	$ 0.09	$ 0.09	$ 0.09	$ 0.10	$ 0.10	$ 0.10	$ -	$ -
1.04 Lifecycle Costs											
Base CaseNominal - USED FO Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseNominal - USED FO Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseNominal - USED FO Building Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.05	$ -	$ -
Base CaseNominal - USED FO Infrastructure Works	$ -	$ -	$ -	$ 0.77	$ -	$ -	$ -	$ -	$ 0.03	$ -	$ -
Base CaseNominal - USED FO Other Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base CaseNominal - USED FO Contingency	$ -	$ -	$ -	$ 0.08	$ -	$ -	$ -	$ -	$ 0.01	$ -	$ -
Sub-total: Lifecycle costs	$ -	$ -	$ -	$ 0.85	$ -	$ -	$ -	$ -	$ 0.08	$ -	$ -
Total of estimate	$ 0.08	$ 0.08	$ 0.09	$ 0.94	$ 0.09	$ 0.09	$ 0.10	$ 0.10	$ 0.19	$ -	$ -

Inland Rail - Transporting Hydrogen

Gate 2 - Options Assessment Rev 2

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2 Option 1

REAL - USED FOR ECONOMIC OUTPUTS

2.01 Operations and Maintenance Costs

	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059
Option 1REAL - USED FOR EC Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1REAL - USED FOR EC Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1REAL - USED FOR EC Building Works	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ -	$ -
Option 1REAL - USED FOR EC Infrastructure Works	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ -	$ -
Option 1REAL - USED FOR EC Other Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1REAL - USED FOR EC Contingency	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ -	$ -
Sub-total: O&M costs	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ -	$ -

2.02 Lifecycle Costs

Option 1REAL - USED FOR EC Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1REAL - USED FOR EC Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1REAL - USED FOR EC Building Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.02	$ -	$ -
Option 1REAL - USED FOR EC Infrastructure Works	$ -	$ -	$ -	$ 0.63	$ -	$ -	$ -	$ -	$ 0.02	$ -	$ -
Option 1REAL - USED FOR EC Other Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1REAL - USED FOR EC Contingency	$ -	$ -	$ -	$ 0.06	$ -	$ -	$ -	$ -	$ 0.00	$ -	$ -
Sub-total: Lifecycle costs	$ -	$ -	$ -	$ 0.69	$ -	$ -	$ -	$ -	$ 0.04	$ -	$ -
Total of estimate	$ 0.06	$ 0.06	$ 0.06	$ 0.75	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.10	$ -	$ -

Nominal - USED FOR FINANCIAL OUTPUTS

2.03 Operations and Maintenance Costs

	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059
Option 1Nominal - USED FOR . Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1Nominal - USED FOR . Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1Nominal - USED FOR . Building Works	$ 0.07	$ 0.07	$ 0.07	$ 0.07	$ 0.08	$ 0.08	$ 0.08	$ 0.08	$ 0.09	$ -	$ -
Option 1Nominal - USED FOR . Infrastructure Works	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.06	$ 0.06	$ 0.06	$ -	$ -
Option 1Nominal - USED FOR . Other Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1Nominal - USED FOR . Contingency	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ -	$ -
Sub-total: O&M costs	$ 0.13	$ 0.13	$ 0.13	$ 0.14	$ 0.14	$ 0.15	$ 0.15	$ 0.16	$ 0.16	$ -	$ -

2.04 Lifecycle Costs

Option 1Nominal - USED FOR . Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1Nominal - USED FOR . Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1Nominal - USED FOR . Building Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.05	$ -	$ -
Option 1Nominal - USED FOR . Infrastructure Works	$ -	$ -	$ -	$ 1.48	$ -	$ -	$ -	$ -	$ 0.05	$ -	$ -
Option 1Nominal - USED FOR . Other Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option 1Nominal - USED FOR . Contingency	$ -	$ -	$ -	$ 0.15	$ -	$ -	$ -	$ -	$ 0.01	$ -	$ -
Sub-total: Lifecycle costs	$ -	$ -	$ -	$ 1.62	$ -	$ -	$ -	$ -	$ 0.10	$ -	$ -
Total of estimate	$ 0.13	$ 0.13	$ 0.13	$ 1.76	$ 0.14	$ 0.15	$ 0.15	$ 0.16	$ 0.26	$ -	$ -

END

Inland Rail - Transporting Hydrogen

Gate 2 - Options Assessment Rev 0

Base Case

19/04/2022

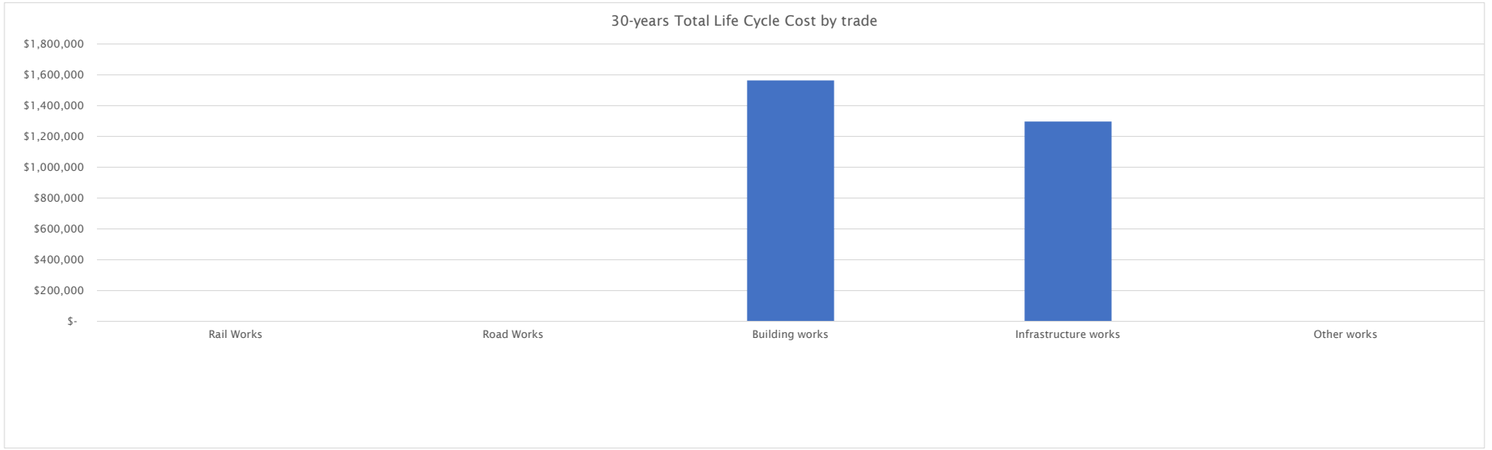
Includes maintenance contingency

ESTIMATED CASHFLOW

ESTIMATED CASHFLOW BY CATEGORY

Life Cycle Cost - Total Cost (includes all replacements, planned & preventative maintenance and reactive maintenance)

Base Case	Description	Total Cost (Capital) (Excl. GST)	Total Cost (Life Cycle Cost) (Excl. GST)	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
	Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Building works	$ 4,094,489	$ 1,563,563	$ 13,021	$ 15,879	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 37,900	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737
	Infrastructure works	$ 3,627,376	$ 1,297,116	$ 12,012	$ 14,821	$ 17,631	$ 17,631	$ 20,411	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 29,156	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 20,411
	Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total	$ 7,721,865	$ 2,860,679	$ 25,032	$ 30,700	$ 36,367	$ 36,367	$ 39,147	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 67,055	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 39,147



Replacement Cost

Base Case	Description	Total Cost (Capital) (Excl. GST)	Total Cost (Life Cycle Cost) (Excl. GST)	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
	Rail Works	$ -	$ -	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Road Works	$ -	$ -	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Building works	$ 4,094,489	$ 1,010,041	0	0	0	0	0	0	0	0	0	19,163	0	0	0	0	0
	Infrastructure works	$ 3,627,376	$ 776,619	0	0	0	0	2,780	0	0	0	0	11,525	0	0	0	0	2,780
	Other works	$ -	$ -	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	$ 7,721,865	$ 1,786,660	$ -	$ -	$ -	$ -	$ 2,780	$ -	$ -	$ -	$ -	$ 30,688	$ -	$ -	$ -	$ -	$ 2,780

Planned, Preventative and Reactive Maintenance

Base Case	Description	Total Cost (Capital) (Incl. GST)	Total Cost (Life Cycle Cost) (Incl. GST)	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
	Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Building works	$ 4,094,489	$ 553,522	$ 13,021	$ 15,879	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737
	Infrastructure works	$ 3,627,376	$ 520,497	$ 12,012	$ 14,821	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631
	Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total	$ 7,721,865	$ 1,074,019	$ 25,032	$ 30,700	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367

Inland Rail - Transporting Hydrogen

Gate 2 - Options Assessment Rev 0

Base Case

19/04/2022

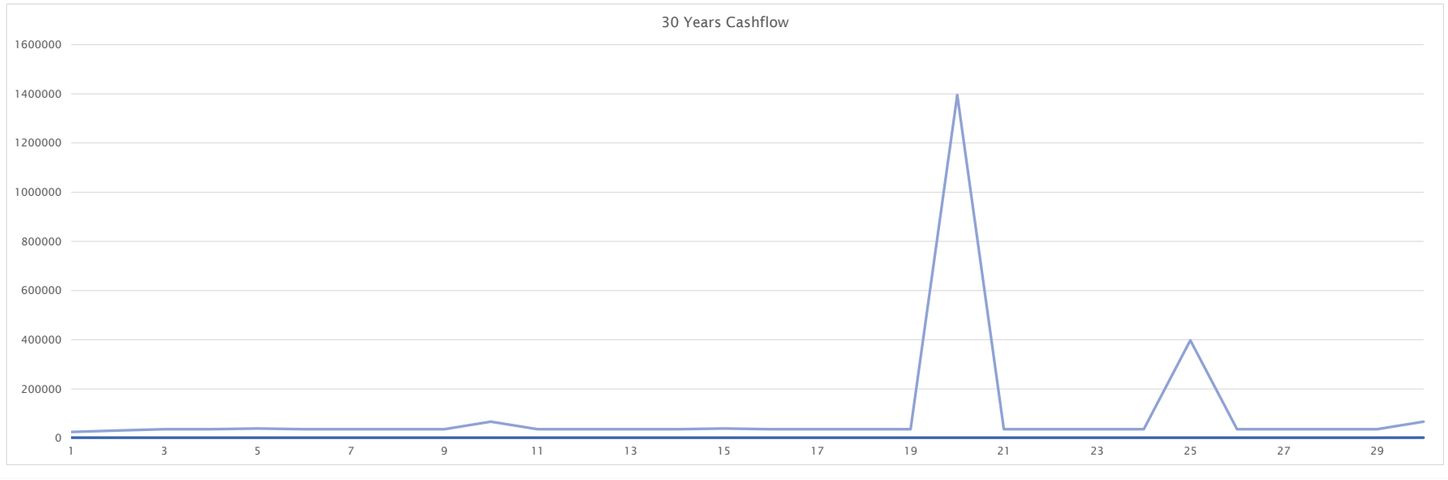
Includes maintenance contingency

ESTIMATED CASHFLOW

ESTIMATED CASHFLOW BY CATEGORY

Life Cycle Cost - Total Cost (includes all replacements, planned & preventativ

Base Case	Description	Total Cost (Capital) (Excl. GST)	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
	Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Building works	$ 4,094,489	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 990,451	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 37,900
	Infrastructure works	$ 3,627,376	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 404,461	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 378,810	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 29,156
	Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total	$ 7,721,865	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 1,394,913	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 397,547	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 67,055



Replacement Cost

Base Case	Description	Total Cost (Capital) (Excl. GST)	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
	Rail Works	$ -	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Road Works	$ -	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Building works	$ 4,094,489	0	0	0	0	971,715	0	0	0	0	0	0	0	0	0	19,163
	Infrastructure works	$ 3,627,376	0	0	0	0	386,831	0	0	0	0	361,179	0	0	0	0	11,525
	Other works	$ -	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	$ 7,721,865	$ -	$ -	$ -	$ -	$ 1,358,545	$ -	$ -	$ -	$ -	$ 361,179	$ -	$ -	$ -	$ -	$ 30,688

Planned, Preventative and Reactive Maintenance

Base Case	Description	Total Cost (Capital) (Incl. GST)	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
	Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Building works	$ 4,094,489	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737
	Infrastructure works	$ 3,627,376	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631
	Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total	$ 7,721,865	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367

Inland Rail - Transporting Hydrogen

Gate 2 - Options Assessment Rev 0

Base Case

19/04/2022

Includes maintenance contingency

Escalated Cashflow - (3%)

ESCALATED CASHFLOW BY CATEGORY

Life Cycle Cost - Total Cost (includes all replacements, planned & preventative maintenance and reactive maintenance)

Base Case	Description	Total Cost (Capital) (Excl. GST)	Total Cost (Life Cycle Cost) (Excl. GST)	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
	Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Building works	$ 4,094,489	$ 3,079,969	$ 15,094	$ 18,960	$ 23,044	$ 23,735	$ 24,447	$ 25,180	$ 25,936	$ 26,714	$ 27,515	$ 57,326	$ 29,191	$ 30,067	$ 30,969	$ 31,898	$ 32,855
	Infrastructure works	$ 3,627,376	$ 2,657,432	$ 13,925	$ 17,697	$ 21,684	$ 22,334	$ 26,632	$ 23,694	$ 24,405	$ 25,137	$ 25,891	$ 44,100	$ 27,468	$ 28,292	$ 29,141	$ 30,015	$ 35,791
	Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	Total	$ 7,721,865	$ 5,737,401	$ 29,019	$ 36,657	$ 44,727	$ 46,069	$ 51,078	$ 48,875	$ 50,341	$ 51,851	$ 53,407	$ 101,427	$ 56,659	$ 58,359	$ 60,110	$ 61,913	$ 68,645

WoL Cost Summary - Real $

Option 1A Development	Total	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Expenses																
Capital Cost	$ 7,721,865															
Replacement Cost	$ 1,786,660	$ -	$ -	$ -	$ -	$ 2,780	$ -	$ -	$ -	$ -	$ 30,688	$ -	$ -	$ -	$ -	$ 2,780
Annual Maintenance	$ 1,074,019	$ 25,032	$ 30,700	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367
Operating Cost	$ 42,000	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400
Total Expenses	**$ 10,624,544**	$ 26,432	$ 32,100	$ 37,767	$ 37,767	$ 40,547	$ 37,767	$ 37,767	$ 37,767	$ 37,767	$ 68,455	$ 37,767	$ 37,767	$ 37,767	$ 37,767	$ 40,547

WoL Cost Summary - Escalated (3%)

Option 1A Development	Total	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Expenses																
Capital Cost	$ 7,721,865															
Replacement Cost	$ 3,751,541	$ -	$ -	$ -	$ -	$ 3,627	$ -	$ -	$ -	$ -	$ 46,418	$ -	$ -	$ -	$ -	$ 4,875
Annual Maintenance	$ 1,985,860	$ 29,019	$ 36,657	$ 44,727	$ 46,069	$ 47,451	$ 48,875	$ 50,341	$ 51,851	$ 53,407	$ 55,009	$ 56,659	$ 58,359	$ 60,110	$ 61,913	$ 63,770
Operating Cost	$ 77,214	$ 1,623	$ 1,672	$ 1,722	$ 1,773	$ 1,827	$ 1,881	$ 1,938	$ 1,996	$ 2,056	$ 2,118	$ 2,181	$ 2,247	$ 2,314	$ 2,383	$ 2,455
Total Expenses	**$ 13,536,481**	$ 30,642	$ 38,329	$ 46,449	$ 47,843	$ 52,905	$ 50,756	$ 52,279	$ 53,847	$ 55,463	$ 103,545	$ 58,840	$ 60,606	$ 62,424	$ 64,296	$ 71,100

Discounted Cashflow Forecast Summary - (7%)

Discounted Cashflow Summary - 4%

Base Case	Description	Discounting Rate	Total Cost (Life Cycle Cost) (Excl. GST)	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
	Expenses																	
	Capital Cost	4%	**$ 7,721,865**															
	Replacement Cost	4%	**$ 1,404,059**	$ -	$ -	$ -	$ -	$ 2,548	$ -	$ -	$ -	$ -	$ 26,805	$ -	$ -	$ -	$ -	$ 2,314
	Annual Maintenance	4%	**$ 887,406**	$ 20,575	$ 28,971	$ 33,989	$ 33,662	$ 33,339	$ 33,018	$ 32,701	$ 32,386	$ 32,075	$ 31,766	$ 31,461	$ 31,158	$ 30,859	$ 30,562	$ 30,268
	Operating Cost	4%	**$ 34,909**	$ 1,334	$ 1,321	$ 1,308	$ 1,296	$ 1,283	$ 1,271	$ 1,259	$ 1,247	$ 1,235	$ 1,223	$ 1,211	$ 1,199	$ 1,188	$ 1,177	$ 1,165
	Total Expenses		**$ 10,048,239**	$ 21,909	$ 30,292	$ 35,298	$ 34,958	$ 37,170	$ 34,289	$ 33,959	$ 33,633	$ 33,309	$ 59,794	$ 32,672	$ 32,358	$ 32,047	$ 31,739	$ 33,747

Discounted Cashflow Summary - 7%

Base Case	Description	Discounting Rate	Total Cost (Life Cycle Cost) (Excl. GST)	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
	Expenses		$ -															
	Capital Cost	7%	**$ 7,721,865**															
	Replacement Cost	7%	**$ 693,812**	$ -	$ -	$ -	$ -	$ 1,973	$ -	$ -	$ -	$ -	$ 18,002	$ -	$ -	$ -	$ -	$ 1,348
	Annual Maintenance	7%	**$ 530,973**	$ 17,848	$ 24,426	$ 27,854	$ 26,813	$ 25,810	$ 24,845	$ 23,917	$ 23,023	$ 22,162	$ 21,333	$ 20,536	$ 19,768	$ 19,029	$ 18,318	$ 17,633
	Operating Cost	7%	**$ 21,084**	$ 1,157	$ 1,114	$ 1,072	$ 1,032	$ 994	$ 956	$ 921	$ 886	$ 853	$ 821	$ 791	$ 761	$ 733	$ 705	$ 679
	Total Expenses		**$ 8,967,734**	$ 19,005	$ 25,540	$ 28,926	$ 27,845	$ 28,777	$ 25,802	$ 24,837	$ 23,909	$ 23,015	$ 40,156	$ 21,326	$ 20,529	$ 19,762	$ 19,023	$ 19,660

Discounted Cashflow Summary - 10%

Base Case	Description	Discounting Rate	Total Cost (Life Cycle Cost) (Excl. GST)	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
	Expenses		$ -															
	Capital Cost	10%	**$ 7,721,865**															
	Replacement Cost	10%	**$ 351,873**	$ -	$ -	$ -	$ -	$ 1,538	$ -	$ -	$ -	$ -	$ 12,223	$ -	$ -	$ -	$ -	$ 797
	Annual Maintenance	10%	**$ 339,690**	$ 15,543	$ 20,692	$ 22,952	$ 21,492	$ 20,124	$ 18,843	$ 17,644	$ 16,521	$ 15,470	$ 14,486	$ 13,564	$ 12,701	$ 11,892	$ 11,136	$ 10,427
	Operating Cost	10%	**$ 13,633**	$ 1,008	$ 944	$ 884	$ 827	$ 775	$ 725	$ 679	$ 636	$ 596	$ 558	$ 522	$ 489	$ 458	$ 429	$ 401
	Total Expenses		**$ 8,427,061**	$ 16,551	$ 21,636	$ 23,836	$ 22,319	$ 22,437	$ 19,569	$ 18,323	$ 17,157	$ 16,066	$ 27,267	$ 14,086	$ 13,190	$ 12,350	$ 11,564	$ 11,625

Inland Rail - Transporting Hydrogen

Gate 2 - Options Assessment Rev 0

Base Case

19/04/2022

Includes maintenance contingency

Escalated Cashflow - (3%)

ESCALATED CASHFLOW BY CATEGORY

Life Cycle Cost - Total Cost (includes all replacements, planned & preventativ

Base Case	Description	Total Cost (Capital) (Excl. GST)	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
	Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Building works	$ 4,094,489	$ 33,840	$ 34,855	$ 35,901	$ 36,978	$ 2,013,383	$ 39,230	$ 40,407	$ 41,619	$ 42,868	$ 44,154	$ 45,478	$ 46,843	$ 48,248	$ 49,696	$ 103,538
	Infrastructure works	$ 3,627,376	$ 31,843	$ 32,799	$ 33,783	$ 34,796	$ 822,187	$ 36,915	$ 38,023	$ 39,163	$ 40,338	$ 892,691	$ 42,795	$ 44,079	$ 45,401	$ 46,763	$ 79,650
	Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	Total	$ 7,721,865	$ 65,684	$ 67,654	$ 69,684	$ 71,774	$ 2,835,570	$ 76,145	$ 78,430	$ 80,782	$ 83,206	$ 936,845	$ 88,273	$ 90,921	$ 93,649	$ 96,458	$ 183,188

WoL Cost Summary - Real $

Option 1A Development	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
Expenses															
Capital Cost															
Replacement Cost	$ -	$ -	$ -	$ -	$ 1,358,545	$ -	$ -	$ -	$ -	$ 361,179	$ -	$ -	$ -	$ -	$ 30,688
Annual Maintenance	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367	$ 36,367
Operating Cost	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400
Total Expenses	$ 37,767	$ 37,767	$ 37,767	$ 37,767	$ 1,396,313	$ 37,767	$ 37,767	$ 37,767	$ 37,767	$ 398,947	$ 37,767	$ 37,767	$ 37,767	$ 37,767	$ 68,455

WoL Cost Summary - Escalated (3%)

Option 1A Development	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
Expenses															
Capital Cost															
Replacement Cost	$ -	$ -	$ -	$ -	$ 2,761,643	$ -	$ -	$ -	$ -	$ 851,142	$ -	$ -	$ -	$ -	$ 83,836
Annual Maintenance	$ 65,684	$ 67,654	$ 69,684	$ 71,774	$ 73,927	$ 76,145	$ 78,430	$ 80,782	$ 83,206	$ 85,702	$ 88,273	$ 90,921	$ 93,649	$ 96,458	$ 99,352
Operating Cost	$ 2,529	$ 2,604	$ 2,683	$ 2,763	$ 2,846	$ 2,931	$ 3,019	$ 3,110	$ 3,203	$ 3,299	$ 3,398	$ 3,500	$ 3,605	$ 3,713	$ 3,825
Total Expenses	$ 68,212	$ 70,258	$ 72,366	$ 74,537	$ 2,838,416	$ 79,077	$ 81,449	$ 83,892	$ 86,409	$ 940,144	$ 91,671	$ 94,421	$ 97,254	$ 100,172	$ 187,013

Discounted Cashflow Forecast Summary - (7%)

Discounted Cashflow Summary - 4%

Base Case	Description	Discounting Rate	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
	Expenses																
	Capital Cost	4%															
	Replacement Cost	4%	$ -	$ -	$ -	$ -	$ 1,077,376	$ -	$ -	$ -	$ -	$ 272,920	$ -	$ -	$ -	$ -	$ 22,095
	Annual Maintenance	4%	$ 29,977	$ 29,689	$ 29,403	$ 29,121	$ 28,841	$ 28,563	$ 28,289	$ 28,017	$ 27,747	$ 27,481	$ 27,216	$ 26,955	$ 26,695	$ 26,439	$ 26,184
	Operating Cost	4%	$ 1,154	$ 1,143	$ 1,132	$ 1,121	$ 1,110	$ 1,100	$ 1,089	$ 1,079	$ 1,068	$ 1,058	$ 1,048	$ 1,038	$ 1,028	$ 1,018	$ 1,008
	Total Expenses		$ 31,131	$ 30,832	$ 30,535	$ 30,242	$ 1,107,327	$ 29,663	$ 29,378	$ 29,095	$ 28,815	$ 301,458	$ 28,264	$ 27,992	$ 27,723	$ 27,456	$ 49,288

Discounted Cashflow Summary - 7%

Base Case	Description	Discounting Rate	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
	Expenses																
	Capital Cost	7%															
	Replacement Cost	7%	$ -	$ -	$ -	$ -	$ 544,449	$ -	$ -	$ -	$ -	$ 119,639	$ -	$ -	$ -	$ -	$ 8,402
	Annual Maintenance	7%	$ 16,974	$ 16,339	$ 15,729	$ 15,141	$ 14,575	$ 14,030	$ 13,505	$ 13,000	$ 12,514	$ 12,047	$ 11,596	$ 11,163	$ 10,745	$ 10,344	$ 9,957
	Operating Cost	7%	$ 653	$ 629	$ 605	$ 583	$ 561	$ 540	$ 520	$ 500	$ 482	$ 464	$ 446	$ 430	$ 414	$ 398	$ 383
	Total Expenses		$ 17,627	$ 16,968	$ 16,334	$ 15,723	$ 559,584	$ 14,570	$ 14,025	$ 13,501	$ 12,996	$ 132,149	$ 12,043	$ 11,592	$ 11,159	$ 10,742	$ 18,742

Discounted Cashflow Summary - 10%

Base Case	Description	Discounting Rate	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
	Expenses																
	Capital Cost	10%															
	Replacement Cost	10%	$ -	$ -	$ -	$ -	$ 280,377	$ -	$ -	$ -	$ -	$ 53,656	$ -	$ -	$ -	$ -	$ 3,282
	Annual Maintenance	10%	$ 9,763	$ 9,142	$ 8,560	$ 8,016	$ 7,506	$ 7,028	$ 6,581	$ 6,162	$ 5,770	$ 5,403	$ 5,059	$ 4,737	$ 4,435	$ 4,153	$ 3,889
	Operating Cost	10%	$ 376	$ 352	$ 330	$ 309	$ 289	$ 271	$ 253	$ 237	$ 222	$ 208	$ 195	$ 182	$ 171	$ 160	$ 150
	Total Expenses		$ 10,139	$ 9,494	$ 8,890	$ 8,324	$ 288,172	$ 7,298	$ 6,834	$ 6,399	$ 5,992	$ 59,266	$ 5,254	$ 4,919	$ 4,606	$ 4,313	$ 7,320

Inland Rail - Transporting Hydrogen

Gate 2 - Options Assessment Rev 0

Base Case

19/04/2022

Includes maintenance contingency

CASHFLOW SUMMARY

Description	Total Opex Cost Over 30 years	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Annual Maintenance & Replacement																
Annual Planned and Reactive Maintenance																
Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Building works	$ 553,522	$ 13,021	$ 15,879	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737
Infrastructure works	$ 520,497	$ 12,012	$ 14,821	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631
Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Annual Maintenance	**$ 1,074,019**	**$ 25,032**	**$ 30,700**	**$ 36,367**	**$ 36,367**	**$ 36,367**	**$ 36,367**	**$ 36,367**	**$ 36,367**	**$ 36,367**	**$ 36,367**	**$ 36,367**	**$ 36,367**	**$ 36,367**	**$ 36,367**	**$ 36,367**	**$ 36,367**
Replacement/Major Periodic Maintenance (MPM)																
Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Building works	$ 1,010,041	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 19,163	$ -	$ -	$ -	$ -	$ -	$ -
Infrastructure works	$ 776,619	$ -	$ -	$ -	$ -	$ 2,780	$ -	$ -	$ -	$ -	$ 11,525	$ -	$ -	$ -	$ -	$ -	$ 2,780
Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Replacement/Major Periodic Maintenance (MPM)	**$ 1,786,660**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 2,780**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 30,688**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 2,780**
Operating Cost																	
Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Building works	$ 22,200	$ 740	$ 740	$ 740	$ 740	$ 740	$ 740	$ 740	$ 740	$ 740	$ 740	$ 740	$ 740	$ 740	$ 740	$ 740	$ 740
Infrastructure works	$ 19,800	$ 660	$ 660	$ 660	$ 660	$ 660	$ 660	$ 660	$ 660	$ 660	$ 660	$ 660	$ 660	$ 660	$ 660	$ 660	$ 660
Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Operating Cost	$ 42,000	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400
Total OPEX Cost - Base Estimate	**$ 2,902,679**	**$ 26,432**	**$ 32,100**	**$ 37,767**	**$ 37,767**	**$ 40,547**	**$ 37,767**	**$ 37,767**	**$ 37,767**	**$ 37,767**	**$ 68,455**	**$ 37,767**	**$ 37,767**	**$ 37,767**	**$ 37,767**	**$ 37,767**	**$ 40,547**

Inland Rail - Transporting Hydrogen

Gate 2 - Options Assessment Rev 0

Base Case

19/04/2022

Includes maintenance contingency

CASHFLOW SUMMARY

Description	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
Annual Maintenance & Replacement															
Annual Planned and Reactive Maintenance															
Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Building works	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737	$ 18,737
Infrastructure works	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631	$ 17,631
Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Annual Maintenance	**$ 36,367**	**$ 36,367**	**$ 36,367**	**$ 36,367**	**$ 36,367**	**$ 36,367**	**$ 36,367**	**$ 36,367**	**$ 36,367**	**$ 36,367**	**$ 36,367**	**$ 36,367**	**$ 36,367**	**$ 36,367**	**$ 36,367**
Replacement/Major Periodic Maintenance (MPM)															
Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Building works	$ -	$ -	$ -	$ -	$ 971,715	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 19,163
Infrastructure works	$ -	$ -	$ -	$ -	$ 386,831	$ -	$ -	$ -	$ -	$ 361,179	$ -	$ -	$ -	$ -	$ 11,525
Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Replacement/Major Periodic Maintenance (MPM)	**$ -**	**$ -**	**$ -**	**$ -**	**$ 1,358,545**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 361,179**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 30,688**
Operating Cost															
Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Building works	$ 740	$ 740	$ 740	$ 740	$ 740	$ 740	$ 740	$ 740	$ 740	$ 740	$ 740	$ 740	$ 740	$ 740	$ 740
Infrastructure works	$ 660	$ 660	$ 660	$ 660	$ 660	$ 660	$ 660	$ 660	$ 660	$ 660	$ 660	$ 660	$ 660	$ 660	$ 660
Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Operating Cost	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400	$ 1,400
Total OPEX Cost - Base Estimate	**$ 37,767**	**$ 37,767**	**$ 37,767**	**$ 37,767**	**$ 1,396,313**	**$ 37,767**	**$ 37,767**	**$ 37,767**	**$ 37,767**	**$ 398,947**	**$ 37,767**	**$ 37,767**	**$ 37,767**	**$ 37,767**	**$ 68,455**

Inland Rail - Transporting Hydrogen

Gate 2 - Options Assessment Rev 2

Option 1

19/04/2022

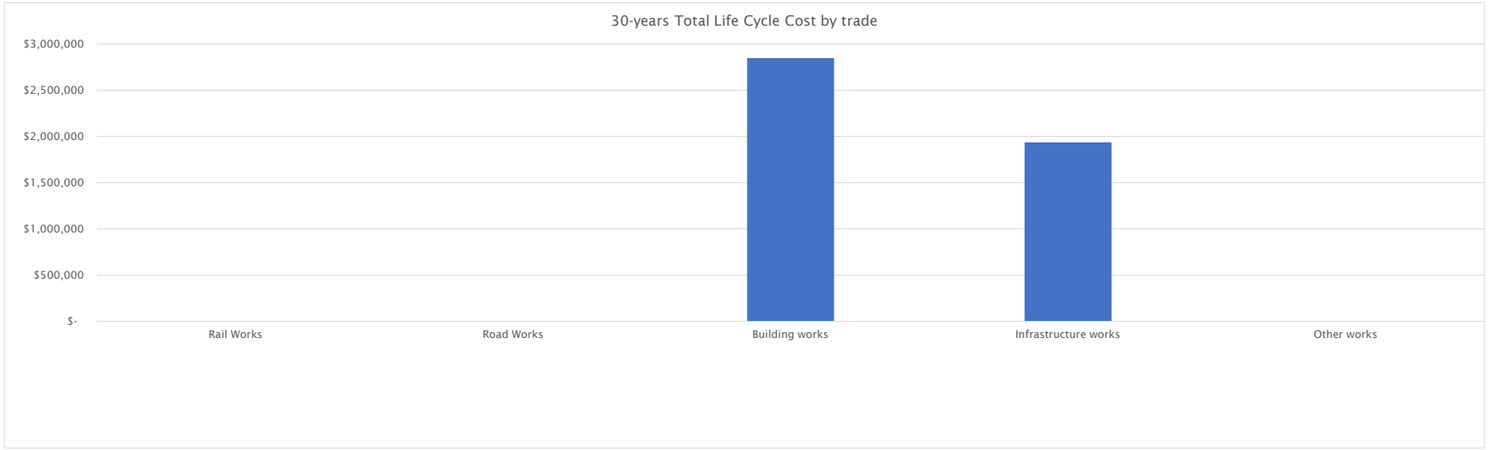
Includes maintenance contingency

ESTIMATED CASHFLOW

ESTIMATED CASHFLOW BY CATEGORY

Life Cycle Cost - Total Cost (includes all replacements, planned & preventative maintenance and reactive maintenance)

Option 1	Description	Total Cost (Capital) (Excl. GST)	Total Cost (Life Cycle Cost) (Excl. GST)	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
	Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Building works	$ 7,937,844	$ 2,846,667	$ 23,590	$ 28,562	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 52,696	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533
	Infrastructure works	$ 4,193,031	$ 1,935,632	$ 15,420	$ 19,282	$ 23,144	$ 23,144	$ 27,524	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 41,302	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 27,524
	Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total	$ 12,130,875	$ 4,782,298	$ 39,010	$ 47,844	$ 56,677	$ 56,677	$ 61,057	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 93,998	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 61,057



Replacement Cost

Option 1	Description	Total Cost (Capital) (Excl. GST)	Total Cost (Life Cycle Cost) (Excl. GST)	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
	Rail Works	$ -	$ -	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Road Works	$ -	$ -	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Building works	$ 7,937,844	$ 1,855,579	0	0	0	0	0	0	0	0	0	19,163	0	0	0	0	0
	Infrastructure works	$ 4,193,031	$ 1,252,904	0	0	0	0	4,380	0	0	0	0	18,158	0	0	0	0	4,380
	Other works	$ -	$ -	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	$ 12,130,875	$ 3,108,483	$ -	$ -	$ -	$ -	$ 4,380	$ -	$ -	$ -	$ -	$ 37,321	$ -	$ -	$ -	$ -	$ 4,380

Planned, Preventative and Reactive Maintenance

Option 1	Description	Total Cost (Capital) (Incl. GST)	Total Cost (Life Cycle Cost) (Incl. GST)	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
	Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Building works	$ 7,937,844	$ 991,088	$ 23,590	$ 28,562	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533
	Infrastructure works	$ 4,193,031	$ 682,727	$ 15,420	$ 19,282	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144
	Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total	$ 12,130,875	$ 1,673,816	$ 39,010	$ 47,844	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677

Inland Rail - Transporting Hydrogen

Gate 2 - Options Assessment Rev 2

Option 1

19/04/2022

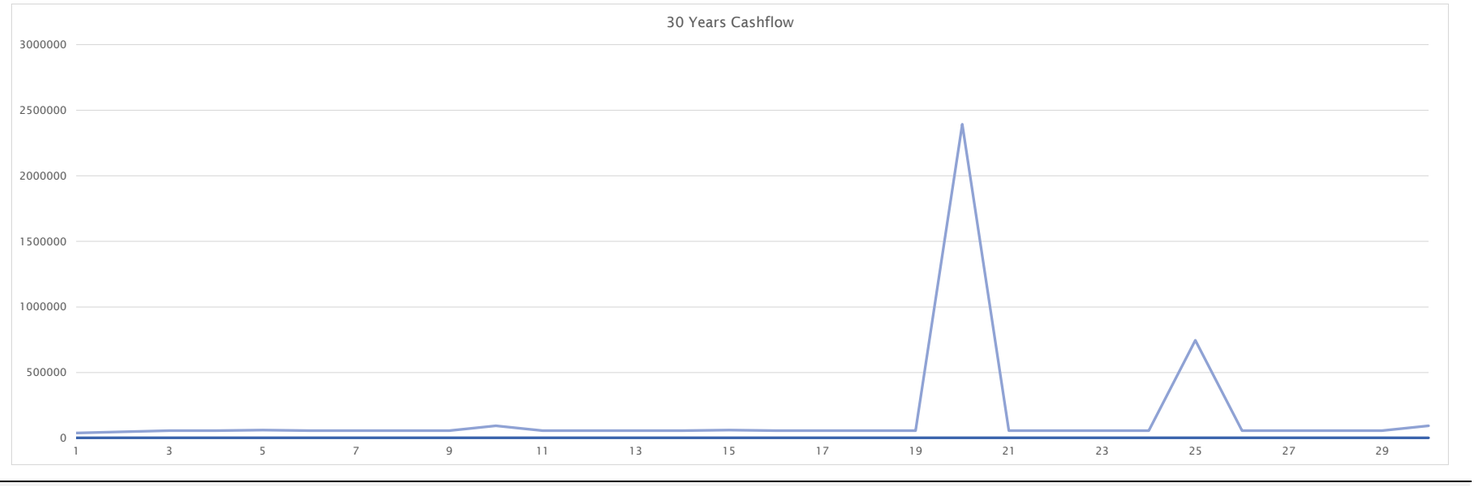
Includes maintenance contingency

ESTIMATED CASHFLOW

ESTIMATED CASHFLOW BY CATEGORY

Life Cycle Cost - Total Cost (includes all replacements, planned & preventativ

Option 1	Description	Total Cost (Capital) (Excl. GST)	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
	Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Building works	$ 7,937,844	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 1,850,786	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 52,696
	Infrastructure works	$ 4,193,031	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 542,090	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 712,027	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 41,302
	Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total	$ 12,130,875	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 2,392,876	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 745,560	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 93,998



Replacement Cost

Option 1	Description	Total Cost (Capital) (Excl. GST)	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
	Rail Works	$ -	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Road Works	$ -	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Building works	$ 7,937,844	0	0	0	0	1,817,253	0	0	0	0	0	0	0	0	0	19,163
	Infrastructure works	$ 4,193,031	0	0	0	0	518,946	0	0	0	0	688,883	0	0	0	0	18,158
	Other works	$ -	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	$ 12,130,875	$ -	$ -	$ -	$ -	$ 2,336,199	$ -	$ -	$ -	$ -	$ 688,883	$ -	$ -	$ -	$ -	$ 37,321

Planned, Preventative and Reactive Maintenance

Option 1	Description	Total Cost (Capital) (Incl. GST)	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
	Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Building works	$ 7,937,844	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533
	Infrastructure works	$ 4,193,031	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144
	Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total	$ 12,130,875	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677

Inland Rail - Transporting Hydrogen

Gate 2 - Options Assessment Rev 2

Option 1

19/04/2022

Includes maintenance contingency

Escalated Cashflow - (3%)

ESCALATED CASHFLOW BY CATEGORY

Life Cycle Cost - Total Cost (includes all replacements, planned & preventative maintenance and reactive maintenance)

Option 1	Description	Total Cost (Capital) (Excl. GST)	Total Cost (Life Cycle Cost) (Excl. GST)	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
	Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Building works	$ 7,937,844	$ 5,607,443	$ 27,347	$ 34,104	$ 41,242	$ 42,479	$ 43,754	$ 45,066	$ 46,418	$ 47,811	$ 49,245	$ 79,708	$ 52,244	$ 53,811	$ 55,426	$ 57,088	$ 58,801
	Infrastructure works	$ 4,193,031	$ 4,031,655	$ 17,876	$ 23,024	$ 28,464	$ 29,318	$ 35,912	$ 31,103	$ 32,036	$ 32,997	$ 33,987	$ 62,472	$ 36,057	$ 37,139	$ 38,253	$ 39,401	$ 48,263
	Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	Total	$ 12,130,875	$ 9,639,098	$ 45,223	$ 57,128	$ 69,706	$ 71,797	$ 79,666	$ 76,169	$ 78,455	$ 80,808	$ 83,232	$ 142,180	$ 88,301	$ 90,950	$ 93,679	$ 96,489	$ 107,064

WoL Cost Summary - Real $

Option 1A Development	Total	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Expenses																
Capital Cost	$ 12,130,875															
Replacement Cost	$ 3,108,483	$ -	$ -	$ -	$ -	$ 4,380	$ -	$ -	$ -	$ -	$ 37,321	$ -	$ -	$ -	$ -	$ 4,380
Annual Maintenance	$ 1,673,816	$ 39,010	$ 47,844	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677
Operating Cost	$ 60,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000
Total Expenses	**$ 16,973,174**	$ 41,010	$ 49,844	$ 58,677	$ 58,677	$ 63,057	$ 58,677	$ 58,677	$ 58,677	$ 58,677	$ 95,998	$ 58,677	$ 58,677	$ 58,677	$ 58,677	$ 63,057

WoL Cost Summary - Escalated (3%)

Option 1A Development	Total	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Expenses																
Capital Cost	$ 12,130,875															
Replacement Cost	$ 6,544,211	$ -	$ -	$ -	$ -	$ 5,715	$ -	$ -	$ -	$ -	$ 56,451	$ -	$ -	$ -	$ -	$ 7,680
Annual Maintenance	$ 3,094,886	$ 45,223	$ 57,128	$ 69,706	$ 71,797	$ 73,951	$ 76,169	$ 78,455	$ 80,808	$ 83,232	$ 85,729	$ 88,301	$ 90,950	$ 93,679	$ 96,489	$ 99,384
Operating Cost	$ 110,306	$ 2,319	$ 2,388	$ 2,460	$ 2,534	$ 2,610	$ 2,688	$ 2,768	$ 2,852	$ 2,937	$ 3,025	$ 3,116	$ 3,209	$ 3,306	$ 3,405	$ 3,507
Total Expenses	**$ 21,880,279**	$ 47,542	$ 59,516	$ 72,166	$ 74,331	$ 82,275	$ 78,857	$ 81,223	$ 83,660	$ 86,169	$ 145,206	$ 91,417	$ 94,160	$ 96,985	$ 99,894	$ 110,571

Discounted Cashflow Forecast Summary - (7%)

Discounted Cashflow Summary - 4%

Option 1	Description	Discounting Rate	Total Cost (Life Cycle Cost) (Excl. GST)	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
	Expenses																	
	Capital Cost	4%	**$ 12,130,875**															
	Replacement Cost	4%	**$ 2,440,366**	$ -	$ -	$ -	$ -	$ 4,015	$ -	$ -	$ -	$ -	$ 32,599	$ -	$ -	$ -	$ -	$ 3,645
	Annual Maintenance	4%	**$ 1,382,986**	$ 32,063	$ 45,149	$ 52,971	$ 52,461	$ 51,957	$ 51,457	$ 50,963	$ 50,473	$ 49,987	$ 49,507	$ 49,031	$ 48,559	$ 48,092	$ 47,630	$ 47,172
	Operating Cost	4%	**$ 49,871**	$ 1,906	$ 1,887	$ 1,869	$ 1,851	$ 1,833	$ 1,816	$ 1,798	$ 1,781	$ 1,764	$ 1,747	$ 1,730	$ 1,714	$ 1,697	$ 1,681	$ 1,665
	Total Expenses		**$ 16,004,099**	$ 33,969	$ 47,036	$ 54,840	$ 54,313	$ 57,806	$ 53,273	$ 52,761	$ 52,254	$ 51,751	$ 83,853	$ 50,761	$ 50,273	$ 49,789	$ 49,311	$ 52,482

Discounted Cashflow Summary - 7%

Option 1	Description	Discounting Rate	Total Cost (Life Cycle Cost) (Excl. GST)	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
	Expenses		$ -															
	Capital Cost	7%	**$ 12,130,875**															
	Replacement Cost	7%	**$ 1,201,784**	$ -	$ -	$ -	$ -	$ 3,109	$ -	$ -	$ -	$ -	$ 21,893	$ -	$ -	$ -	$ -	$ 2,124
	Annual Maintenance	7%	**$ 827,499**	$ 27,814	$ 38,067	$ 43,409	$ 41,787	$ 40,224	$ 38,721	$ 37,273	$ 35,880	$ 34,538	$ 33,247	$ 32,004	$ 30,808	$ 29,656	$ 28,548	$ 27,480
	Operating Cost	7%	**$ 30,120**	$ 1,653	$ 1,591	$ 1,532	$ 1,475	$ 1,419	$ 1,366	$ 1,315	$ 1,266	$ 1,219	$ 1,173	$ 1,129	$ 1,087	$ 1,046	$ 1,007	$ 970
	Total Expenses		**$ 14,190,278**	$ 29,467	$ 39,658	$ 44,941	$ 43,261	$ 44,752	$ 40,087	$ 38,588	$ 37,146	$ 35,757	$ 56,313	$ 33,134	$ 31,895	$ 30,703	$ 29,555	$ 30,574

Discounted Cashflow Summary - 10%

Option 1	Description	Discounting Rate	Total Cost (Life Cycle Cost) (Excl. GST)	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
	Expenses		$ -															
	Capital Cost	10%	**$ 12,130,875**															
	Replacement Cost	10%	**$ 607,020**	$ -	$ -	$ -	$ -	$ 2,424	$ -	$ -	$ -	$ -	$ 14,865	$ -	$ -	$ -	$ -	$ 1,256
	Annual Maintenance	10%	**$ 529,392**	$ 24,222	$ 32,247	$ 35,770	$ 33,494	$ 31,362	$ 29,367	$ 27,498	$ 25,748	$ 24,109	$ 22,575	$ 21,139	$ 19,793	$ 18,534	$ 17,354	$ 16,250
	Operating Cost	10%	**$ 19,476**	$ 1,440	$ 1,348	$ 1,262	$ 1,182	$ 1,107	$ 1,036	$ 970	$ 909	$ 851	$ 797	$ 746	$ 698	$ 654	$ 612	$ 573
	Total Expenses		**$ 13,286,763**	$ 25,662	$ 33,595	$ 37,032	$ 34,676	$ 34,893	$ 30,403	$ 28,468	$ 26,657	$ 24,960	$ 38,237	$ 21,885	$ 20,492	$ 19,188	$ 17,967	$ 18,079

Inland Rail - Transporting Hydrogen

Gate 2 - Options Assessment Rev 2

Option 1

19/04/2022

Includes maintenance contingency

Escalated Cashflow - (3%)

ESCALATED CASHFLOW BY CATEGORY

Life Cycle Cost - Total Cost (includes all replacements, planned & preventativ

Option 1	Description	Total Cost (Capital) (Excl. GST)	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
	Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Building works	$ 7,937,844	$ 60,565	$ 62,382	$ 64,254	$ 66,181	$ 3,762,267	$ 70,212	$ 72,318	$ 74,487	$ 76,722	$ 79,024	$ 81,394	$ 83,836	$ 86,351	$ 88,942	$ 143,962
	Infrastructure works	$ 4,193,031	$ 41,800	$ 43,054	$ 44,346	$ 45,676	$ 1,101,957	$ 48,458	$ 49,912	$ 51,409	$ 52,951	$ 1,677,937	$ 56,176	$ 57,861	$ 59,597	$ 61,385	$ 112,832
	Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	Total	$ 12,130,875	$ 102,365	$ 105,436	$ 108,599	$ 111,857	$ 4,864,224	$ 118,670	$ 122,230	$ 125,896	$ 129,673	$ 1,756,961	$ 137,570	$ 141,698	$ 145,949	$ 150,327	$ 256,794

WoL Cost Summary - Real $

Option 1A Development	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
Expenses															
Capital Cost															
Replacement Cost	$ -	$ -	$ -	$ -	$ 2,336,199	$ -	$ -	$ -	$ -	$ 688,883	$ -	$ -	$ -	$ -	$ 37,321
Annual Maintenance	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677	$ 56,677
Operating Cost	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000
Total Expenses	$ 58,677	$ 58,677	$ 58,677	$ 58,677	$ 2,394,876	$ 58,677	$ 58,677	$ 58,677	$ 58,677	$ 747,560	$ 58,677	$ 58,677	$ 58,677	$ 58,677	$ 95,998

WoL Cost Summary - Escalated (3%)

Option 1A Development	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
Expenses															
Capital Cost															
Replacement Cost	$ -	$ -	$ -	$ -	$ 4,749,011	$ -	$ -	$ -	$ -	$ 1,623,397	$ -	$ -	$ -	$ -	$ 101,957
Annual Maintenance	$ 102,365	$ 105,436	$ 108,599	$ 111,857	$ 115,213	$ 118,670	$ 122,230	$ 125,896	$ 129,673	$ 133,564	$ 137,570	$ 141,698	$ 145,949	$ 150,327	$ 154,837
Operating Cost	$ 3,612	$ 3,721	$ 3,832	$ 3,947	$ 4,066	$ 4,188	$ 4,313	$ 4,443	$ 4,576	$ 4,713	$ 4,855	$ 5,000	$ 5,150	$ 5,305	$ 5,464
Total Expenses	$ 105,978	$ 109,157	$ 112,432	$ 115,805	$ 4,868,290	$ 122,857	$ 126,543	$ 130,339	$ 134,249	$ 1,761,674	$ 142,425	$ 146,698	$ 151,099	$ 155,632	$ 262,257

Discounted Cashflow Forecast Summary - (7%)

Discounted Cashflow Summary - 4%

Option 1	Description	Discounting Rate	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
	Expenses																
	Capital Cost	4%															
	Replacement Cost	4%	$ -	$ -	$ -	$ -	$ 1,852,691	$ -	$ -	$ -	$ -	$ 520,545	$ -	$ -	$ -	$ -	$ 26,871
	Annual Maintenance	4%	$ 46,718	$ 46,269	$ 45,824	$ 45,383	$ 44,947	$ 44,515	$ 44,087	$ 43,663	$ 43,243	$ 42,827	$ 42,416	$ 42,008	$ 41,604	$ 41,204	$ 40,808
	Operating Cost	4%	$ 1,649	$ 1,633	$ 1,617	$ 1,601	$ 1,586	$ 1,571	$ 1,556	$ 1,541	$ 1,526	$ 1,511	$ 1,497	$ 1,482	$ 1,468	$ 1,454	$ 1,440
	Total Expenses		$ 48,367	$ 47,902	$ 47,441	$ 46,985	$ 1,899,224	$ 46,086	$ 45,643	$ 45,204	$ 44,769	$ 564,883	$ 43,912	$ 43,490	$ 43,072	$ 42,658	$ 69,118

Discounted Cashflow Summary - 7%

Option 1	Description	Discounting Rate	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
	Expenses																
	Capital Cost	7%															
	Replacement Cost	7%	$ -	$ -	$ -	$ -	$ 936,251	$ -	$ -	$ -	$ -	$ 228,189	$ -	$ -	$ -	$ -	$ 10,218
	Annual Maintenance	7%	$ 26,453	$ 25,464	$ 24,512	$ 23,596	$ 22,714	$ 21,865	$ 21,047	$ 20,261	$ 19,503	$ 18,774	$ 18,072	$ 17,397	$ 16,746	$ 16,120	$ 15,518
	Operating Cost	7%	$ 933	$ 899	$ 865	$ 833	$ 802	$ 772	$ 743	$ 715	$ 688	$ 662	$ 638	$ 614	$ 591	$ 569	$ 548
	Total Expenses		$ 27,387	$ 26,363	$ 25,377	$ 24,429	$ 959,767	$ 22,636	$ 21,790	$ 20,976	$ 20,191	$ 247,626	$ 18,710	$ 18,011	$ 17,337	$ 16,689	$ 26,283

Discounted Cashflow Summary - 10%

Option 1	Description	Discounting Rate	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
	Expenses																
	Capital Cost	10%															
	Replacement Cost	10%	$ -	$ -	$ -	$ -	$ 482,146	$ -	$ -	$ -	$ -	$ 102,338	$ -	$ -	$ -	$ -	$ 3,991
	Annual Maintenance	10%	$ 15,216	$ 14,248	$ 13,341	$ 12,492	$ 11,697	$ 10,953	$ 10,256	$ 9,603	$ 8,992	$ 8,420	$ 7,884	$ 7,382	$ 6,912	$ 6,473	$ 6,061
	Operating Cost	10%	$ 537	$ 503	$ 471	$ 441	$ 413	$ 386	$ 362	$ 339	$ 317	$ 297	$ 278	$ 261	$ 244	$ 228	$ 214
	Total Expenses		$ 15,753	$ 14,750	$ 13,812	$ 12,933	$ 494,256	$ 11,339	$ 10,618	$ 9,942	$ 9,309	$ 111,055	$ 8,162	$ 7,643	$ 7,156	$ 6,701	$ 10,265

Inland Rail - Transporting Hydrogen

Gate 2 - Options Assessment Rev 2

Option 1

19/04/2022

Includes maintenance contingency

CASHFLOW SUMMARY

Description	Total Opex Cost Over 30 years	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Annual Maintenance & Replacement																
Annual Planned and Reactive Maintenance																
Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Building works	$ 991,088	$ 23,590	$ 28,562	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533
Infrastructure works	$ 682,727	$ 15,420	$ 19,282	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144
Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Annual Maintenance	**$ 1,673,816**	**$ 39,010**	**$ 47,844**	**$ 56,677**	**$ 56,677**	**$ 56,677**	**$ 56,677**	**$ 56,677**	**$ 56,677**	**$ 56,677**	**$ 56,677**	**$ 56,677**	**$ 56,677**	**$ 56,677**	**$ 56,677**	**$ 56,677**	**$ 56,677**
Replacement/Major Periodic Maintenance (MPM)																
Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Building works	$ 1,855,579	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 19,163	$ -	$ -	$ -	$ -	$ -	$ -
Infrastructure works	$ 1,252,904	$ -	$ -	$ -	$ -	$ 4,380	$ -	$ -	$ -	$ -	$ 18,158	$ -	$ -	$ -	$ -	$ -	$ 4,380
Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Replacement/Major Periodic Maintenance (MPM)	**$ 3,108,483**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 4,380**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 37,321**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 4,380**
Operating Cost																	
Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Building works	$ 39,300	$ 1,310	$ 1,310	$ 1,310	$ 1,310	$ 1,310	$ 1,310	$ 1,310	$ 1,310	$ 1,310	$ 1,310	$ 1,310	$ 1,310	$ 1,310	$ 1,310	$ 1,310	$ 1,310
Infrastructure works	$ 20,700	$ 690	$ 690	$ 690	$ 690	$ 690	$ 690	$ 690	$ 690	$ 690	$ 690	$ 690	$ 690	$ 690	$ 690	$ 690	$ 690
Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Operating Cost	$ 60,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000
Total OPEX Cost - Base Estimate	**$ 4,842,298**	**$ 41,010**	**$ 49,844**	**$ 58,677**	**$ 58,677**	**$ 63,057**	**$ 58,677**	**$ 58,677**	**$ 58,677**	**$ 58,677**	**$ 95,998**	**$ 58,677**	**$ 58,677**	**$ 58,677**	**$ 58,677**	**$ 58,677**	**$ 63,057**

Inland Rail - Transporting Hydrogen

Gate 2 - Options Assessment Rev 2

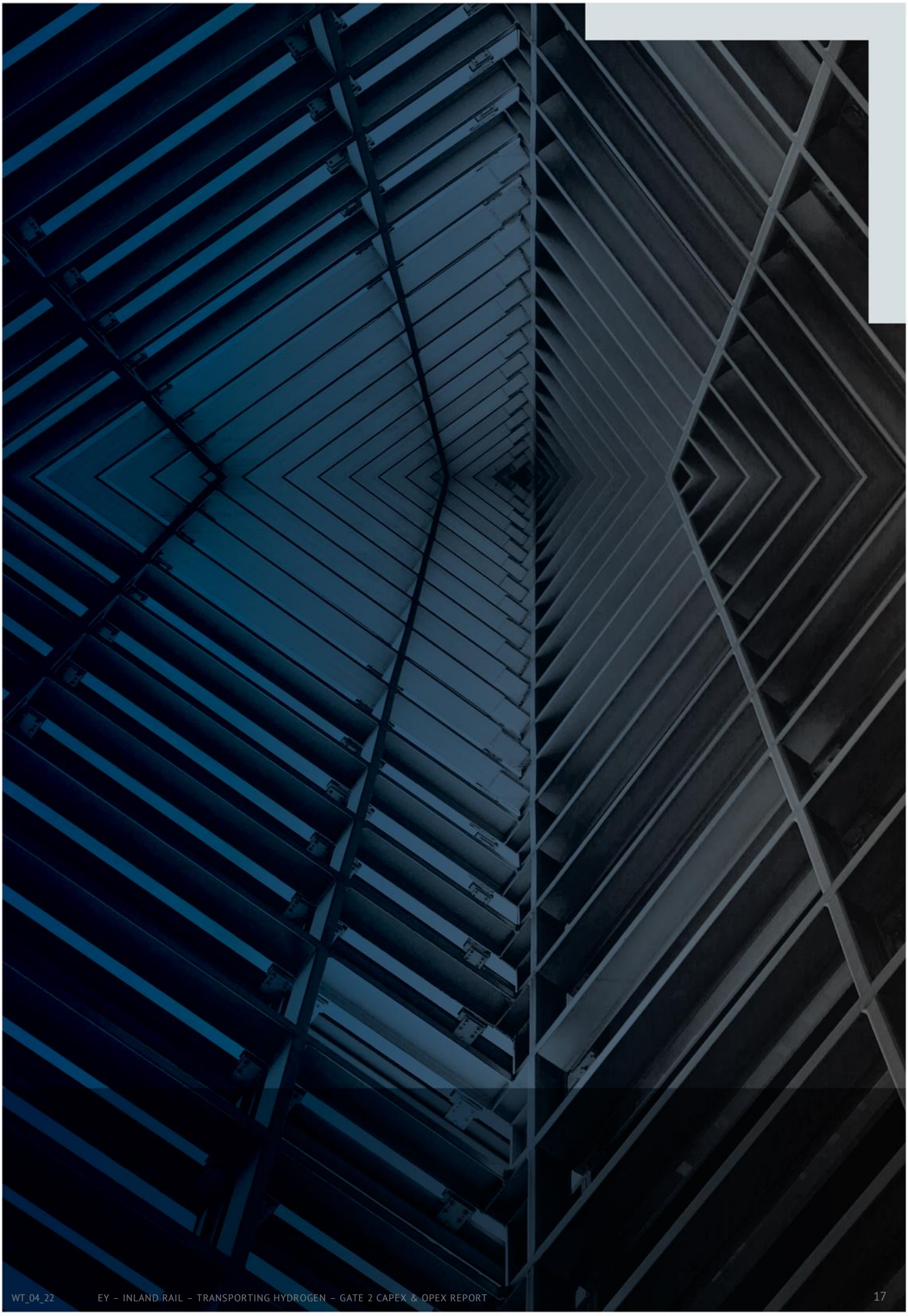
Option 1

19/04/2022

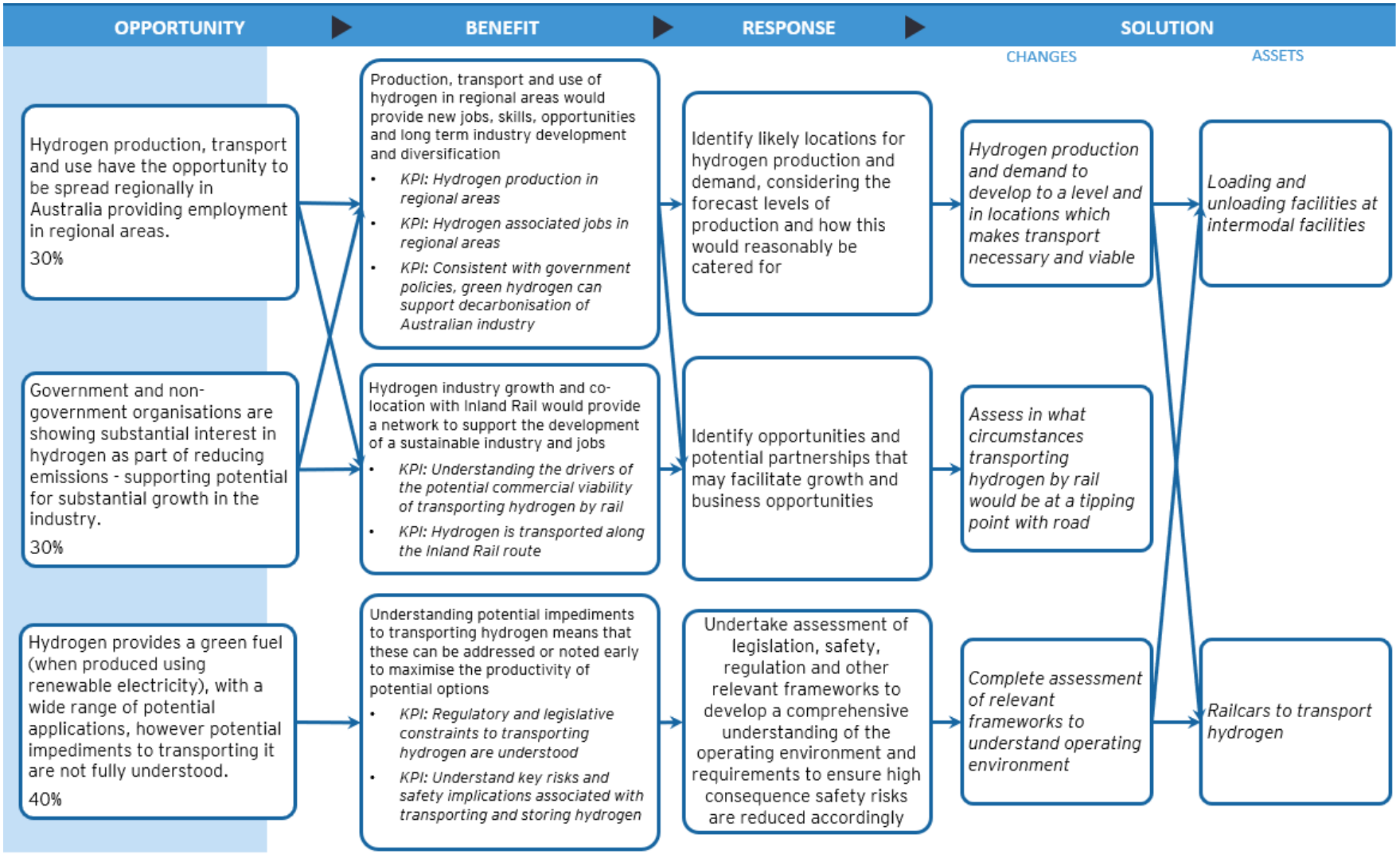
Includes maintenance contingency

CASHFLOW SUMMARY

Description	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
Annual Maintenance & Replacement															
Annual Planned and Reactive Maintenance															
Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Building works	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533	$ 33,533
Infrastructure works	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144	$ 23,144
Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Annual Maintenance	**$ 56,677**	**$ 56,677**	**$ 56,677**	**$ 56,677**	**$ 56,677**	**$ 56,677**	**$ 56,677**	**$ 56,677**	**$ 56,677**	**$ 56,677**	**$ 56,677**	**$ 56,677**	**$ 56,677**	**$ 56,677**	**$ 56,677**
Replacement/Major Periodic Maintenance (MPM)															
Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Building works	$ -	$ -	$ -	$ -	$ 1,817,253	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 19,163
Infrastructure works	$ -	$ -	$ -	$ -	$ 518,946	$ -	$ -	$ -	$ -	$ 688,883	$ -	$ -	$ -	$ -	$ 18,158
Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Replacement/Major Periodic Maintenance (MPM)	**$ -**	**$ -**	**$ -**	**$ -**	**$ 2,336,199**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 688,883**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 37,321**
Operating Cost															
Rail Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Road Works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Building works	$ 1,310	$ 1,310	$ 1,310	$ 1,310	$ 1,310	$ 1,310	$ 1,310	$ 1,310	$ 1,310	$ 1,310	$ 1,310	$ 1,310	$ 1,310	$ 1,310	$ 1,310
Infrastructure works	$ 690	$ 690	$ 690	$ 690	$ 690	$ 690	$ 690	$ 690	$ 690	$ 690	$ 690	$ 690	$ 690	$ 690	$ 690
Other works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Operating Cost	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000
Total OPEX Cost - Base Estimate	**$ 58,677**	**$ 58,677**	**$ 58,677**	**$ 58,677**	**$ 2,394,876**	**$ 58,677**	**$ 58,677**	**$ 58,677**	**$ 58,677**	**$ 747,560**	**$ 58,677**	**$ 58,677**	**$ 58,677**	**$ 58,677**	**$ 95,998**



Appendix E Investment Logic Map



Appendix F Key Activities at each Gate

Figure 18 Key activities at each Gate

Gate	1. Proposal details	2. Problem definition	3. Strategic fit	4. Stakeholders	5. Options	6. Demand	7. Costs	8. Benefits
2	Discuss and confirm the Proposal scope and Proposal details through discussions with the Department, the Proponent and other key stakeholders.	Facilitate a virtual ILM Workshop[63] with key stakeholders to clearly identify challenges, benefits, strategic responses and solutions based on available evidence and data.	Assess the alignment of the Proposal with CLIP principles and relevant strategies and plans. Assess the strategic fit from a demand, operational and technical perspective.	Assess the level of 3rd party support for the Proposal (financial and non-financial). Review the stakeholder landscape and identify the interest groups and the Proposal impacts.	Undertake an Options Assessment Workshop and explore the three identified options, identifying further Proposal or strategic options that should be assessed.	Initial assessment of low/medium/high demand (including road and rail split) and potential impacts of the Proposal on demand.	Prepare and assess high-level capital and whole of life cost estimates for each of the options under consideration.	Preliminarily assess the Proposal option's benefits, including the operating, land use, transport and non-traditional benefits. Examine the reliability of those estimates.
3	Not required.	Not required.	Not required.	Build on Gate 2 with further analysis required to assess deliverability of the Proposal.	Not required.	Analysis of current and future network demand including multiplier impacts and network enabling effects.	Build on the Gate 2 process to inform the economic and financial assessment. For costs, prepare P50 capital and whole of life cost estimates for each of the options under consideration.	
4	Not required.	Not required.	Not required.	Not required.	Not required.	Build on the Gate 3 submission to update the CBA for the preferred option.		

Gate	9. Cost Benefit Analysis	10. Funding and financing	11. Regional economic impact [64]	12. Regulatory requirements	13. Environmental, heritage / planning	14. Property strategy	15. Risk management	16. Governance, and other
2	Not required.	Identify sources of third-party funding or in-kind support.	Not required.	Identify the potential environmental, planning or other regulatory requirements that the Proposal may trigger.	Provide if available. Not required for evaluation.	Provide if available. Not required for evaluation.	Provide if available. Not required for evaluation.	Provide if available. Not required for evaluation.

[63] *This has been indicatively proposed but can be discussed and agreed with the Department before progressing to Gate 2*
[64] The requirements of Section 11.0 Regional Economic Impact will be considered following the Gate 2 stage including the level of quantitative or CGE analysis that may be required.

3	Undertake a rapid CBA to assess the economic merits of the Proposal.	Prepare a detailed financial viability analysis including sources of project financing and project funding options. Undertake sensitivity analysis of financial viability results.	Identify and qualitatively discuss the expected qualitative regional economic impacts to the region.	Build on the Gate 2 submission to evaluate the ease of delivery.	Identify the environmental, heritage, and planning issues that have been identified, and what assessments have been undertaken. Detail the Proposal's expected environmental, heritage and planning approval pathway, including timelines	Identify the property transactions expected to be required. Prepare a property strategy regarding transactions and tenure arrangements, including timeframes.	Identify and assess risks and document them in a risk register and Risk Management Plan.	Document governance arrangements and prepare a post implementation plan that supports ongoing monitoring and review.
4	Update the Rapid CBA of the preferred option and assess the wider economic benefits (if required).	Required for evaluation of the Proposal's financial viability. Consider co-funding opportunities and other potential revenue that could be generated.	Undertake detailed quantitative CGE modelling[10] to assess the Proposal's economic impact on Australia (if required).	No additional information required. Note amendments based on new information if applicable.	No additional information required. Note amendments based on new information if applicable.	Build on the Gate 3 submission to evaluate the ease of delivery.	Build on the Gate 3 submission to evaluate the ease of delivery.	Build on the Gate 3 submission to evaluate performance monitoring measures.

Appendix G Options Technical Report

SNC·LAVALIN

ATKINS
Member of the SNC-Lavalin Group

561 P2_037 - Transporting Hydrogen by Rail Gate 2 Options Report

Inland Rail Interface Improvement Program

EDPM-AU-5205578-561 001
Issue A

20 June 2022

AEC Transport for NSW Authorised Engineering Organisation

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Title	:	561 P2_037 - Transporting Hydrogen by Rail Gate 2 Options Report
Report No.	:	EDPM-AU-5205578-561 001
Issue	:	A
Date	:	20 June 2022

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1. Glossary of Terms

Abbreviation / Term	Description
ARTC	Australian Rail Track Corporation
ASME	American Society of Mechanical Engineers
CLIP	Country Lines Improvement Program
CSC	Container Safety Certificate
ILM	Investment Logic Mapping
ISO	International Organisation for Standardisation
IRIIP	Inland Rail Interface Improvement Program
PEP	Productivity Enhancement Program
RAIDOC	Risk, Assumptions, Issues, Dependencies, Opportunities and Constraints
TAL	Tonnes Axle Load
Tanktainer	An ISO 20’ or 40’ intermodal container used for transporting gas or liquid
TEU	Twenty foot Equivalent Unit (a 20’ ISO container size)

2. Introduction

The Inland Rail Interface Improvement Program (II Program) assists in the development of project ideas that could boost the benefits that flow from Inland Rail. The aim of the II Program is to support the development these ideas to ultimately increase the amount of freight on Inland Rail.

The Proposal focuses on understanding the potential to transport compressed gaseous hydrogen by rail between Toowoomba and Parkes. It is conceptual in nature as there is no existing production, transportation, or consumption of hydrogen in the region by rail.

The Proposal explores the potential to transport hydrogen via Inland Rail, however the scope of the Proposal was limited by the Department from the broader scope of the Proponent's original EOI submission to "investigating the opportunities associated with transporting liquid hydrogen and compressed gaseous hydrogen by rail".

The Proponent and working group subsequently advised that the project scope was to consider the transport of compressed gaseous hydrogen between Toowoomba and Parkes only.

Figure 1 – Geographical context for the Proposal

Inland Rail will connect Melbourne and Brisbane via regional Victoria, New South Wales, and Queensland by providing 1,700 km of rail alignment. The route alignment for Inland Rail passes through both Parkes and Toowoomba with these centres being approximately 850km apart.

In developing options for the Proposal, a number of inputs were considered.

- Pressure under which gaseous hydrogen is transported,
- Volume of product to be produced and transported,
- First and last mile considerations,
- Storage facilities for full and empty tanktainers.

This report considers the single option as follows:

- Transporting of gaseous hydrogen by rail in tanktainers.

3. Current transport options

Compressed hydrogen gas is currently transported by road through the use of tube trailers.

Tube trailers are semi-trailers that consist of clusters of high-pressure hydrogen tanks. These tanks can vary in length between 20' (6.10m) for small tubes and 53' (16.15m) for jumbo tube trailers are typically made from seamless steel tubes.

Figure 1: seamless steel (228 bar) tube trailer *Source: TiApm*

Figure 2: super max jumbo seamless steel (178bar) tube trailer *Source: Weldship*

New tube trailers designs are now investing in composite materials for the construction of the storage vessel with the new designs able to store the gaseous hydrogen under higher pressures and therefore a greater volume and mass able to be transported in a single trip.

Figure 3: Type IV composite (257bar) tube skid on trailer *Source: Lincoln Composites*

- Tube-trailers made of steel are less costly to build, but the wall thickness and hence the weight of the pressure vessels increases with the required working pressure. Steel tube trailers are also limited in capacity by on-road weight restrictions; they can transport a hydrogen payload of up to 300 kg in a single trip.
- Composite tube-trailers use Type III (Aluminium liner wrapped with carbon fibre composite) or Type IV (plastic polyethylene liner wrapped with carbon fibre composite) pressure vessels have the advantage over their steel counterparts due to being lighter in weight,

corrosion resistant, low maintenance, cost competitive and having high payload capacity (up to 1,000 kg in a single trip), also able withstand higher working pressures (currently up to 500 bar with development to between 700 bar 900 bar pressures underway by some manufacturers).

To transport compressed hydrogen gas by rail, approved containers for rail traffic will need to be produced and certified. Since the requirements are similar to road traffic and there are currently freight flows of compressed and liquid natural gas by rail in dedicated ISO tanktainers, it is expected that certification for tanktainers for use in transporting gaseous hydrogen by rail in Australia could be obtained in the near future.

The International Organisation for Standardisation (ISO) works towards ascertaining a fixed set of industrial and commercial standards for various products and services. This is done to ensure consistency in quality and reliability.

When a tank container (tanktainer) is manufactured, it must comply with the size, durability, and strength as per the ISO standards. Each tank goes through strict inspection and only then is it certified. A container safety certificate (CSC) is also issued by the manufacturer.

Figure 4: Example of 20' ISO tanktainer
Source: www.matts-place.com

Figure 5: 20' ISO tanktainer on rail skell wagon
Source: Wongm's Rail Gallery

4. Transporting Gaseous Hydrogen

4.1. Overview

This Proposal considers the transportation of gaseous hydrogen by road or rail.

This option makes the following assumptions:

- the technology used to transport gaseous hydrogen is the same as that used for transportation by road, i.e. intermodal tanktainers at 20' (6.10m) and 40' (12.15m) lengths.
- first and last mile considerations are the same for rail and road, i.e. transport is between intermodal terminal facilities where tanktainers can be unloaded.
- a 10MW Electrolyser can produce 4,250kg of Hydrogen per day.
- storage of full tanktainers awaiting delivery and empty tanktainers awaiting filling are stored in a dedicated storage facility.

4.2. Tanktainers

4.2.1. Capacity of tanktainers

For the purpose of this report a tanktainer has been defined as either a 20' or 40' intermodal container used for transporting gas or liquid as a bulk cargo that has been constructed to ISO standards.

The most common size of tanktainer used for transporting of other gaseous compounds by rail is 20' and it is to this size that considerations and estimates have been made.

There are number of suppliers internationally that are manufacturing tanktainers for the transport of gaseous hydrogen.

There currently isn't an international standard which standardises the working pressure of container vessels, with suppliers providing different solutions depending on both the material used to construct the pressure vessel and the sizes of the pressure vessels.

Examples of working pressures and the matching useable capacity in kg H_2 between different suppliers is show in the table below.

	Working Pressure	Useable capacity in kg H_2
Supplier A	380 bar	506
	500 bar	558
	640 bar	634
Supplier B	300 bar	365
	500 bar	500
Supplier C	300 bar	401
	318 bar	421
	381 bar	487

Table 1: Examples of working pressures and capacity of hydrogen tanktainers (20' ISO size

4.2.2. Manufacture of tanktainers

Currently the majority of tanktainers for the transport of hydrogen are manufactured overseas, however there are a number of companies starting to manufacture hydrogen storage vessels for use in transport, starting with road and offering rail opportunities if demand is present.

These manufacturers offer both full outright ownership purchasing or dry leases (typically 3 year minimum terms).

For certification, the design standards of Australian Dangerous Goods, Australian Standards, ASME and ISO will all need to be met. ASME compliance is required if the tanktainer is expected to travel internationally.

4.3. Road freight operation

4.3.1. Storage of tanktainers

Typical truck lengths can vary between 19m for a prime mover and semi-trailer (2TEU) and 54m for an A-triple (6TEU).

Sizing of a secure storage area for hydrogen therefore assumes that space needs to be allowed for 8No. A-triple sized trucks (approx. four days production) of hydrogen tanktainers plus room for empty tanktainers for reverse traffic flow and/or storage pending refilling for future distribution.

Due to the highly flammable nature of hydrogen, the secure storage facility has also been scoped to include the ability to fight fires using a locally installed hydrant system.

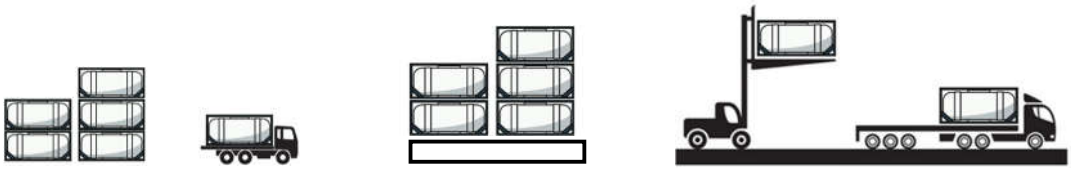
4.3.2. Scope summary for secure hydrogen storage for transport by road (refer to Appendix A for full scope breakdown)

Site component	Description
Toowoomba Secure Hydrogen Store	
Hard stand	4,480m^2 (56m x 80m)
Security fencing	278m
Gatehouse	1No.
Fire hydrant system	1No.
Parkes Secure Hydrogen Store	
Hard stand	4,480m^2 (56m x 80m)
Security fencing	278m
Gatehouse	1No.
Fire hydrant system	1No.

Storing, loading and transit operation

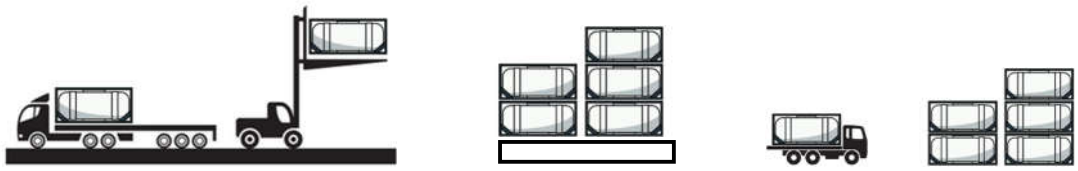
Full tanktainers will be transferred from the production plant to the Toowoomba storage facility pending sufficient volume to transit as part of a full, or part, consist road train.

Full tanktainers will be transferred from the Toowoomba storage facility to the Toowoomba intermodal terminal to transit as part of a full, or part, consist road train.

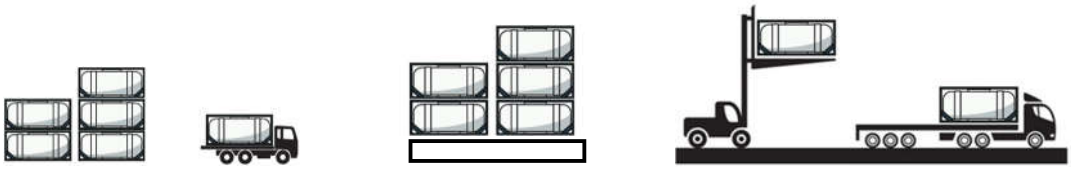


Trucks will transfer hydrogen by road between Toowoomba and Parkes.

The trucks will be unloaded of full tanktainers which will be transferred from the Parkes intermodal terminal to the Parkes storage facility pending transfer to customers.

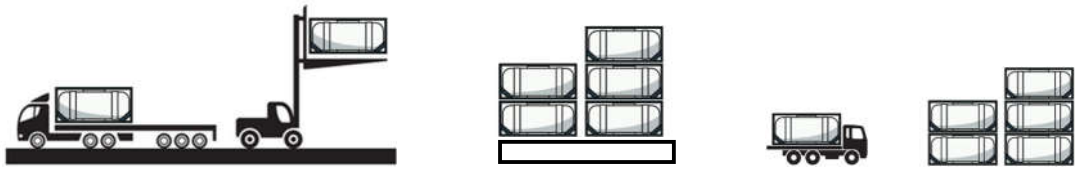


Empty tanktainers will be loaded onto trucks for transfer from the Parkes storage facility to the Parkes intermodal terminal to be loaded onto truck for the reverse (empty) flow of tanktainers to Toowoomba.



Trucks will transfer empty hydrogen tanktainers by road between Parkes and Toowoomba.

The trucks will be unloaded of empty tanktainers which will be transferred from the Toowoomba intermodal terminal to the Toowoomba storage facility pending transfer to the production plant for refilling.



Empty tanktainers are transferred to the production plant for refilling and the cycle starts again.

Based on the assumed daily output of a 10MW Electrolyser of 4,250kg of Hydrogen per day, and a nominal tanktainer storage capacity of 400kg at 300 bar working pressure, it will take less than 1 day to fill enough tanktainers to service a 54m A-triple (6TEU) road train. Smaller truck configurations can be used.

Roads must be gazetted for the type of truck configuration operating on them.

If tanktainers which are capable of operating at higher working pressures are used, the time taken to fill a sufficient number of containers will increase.

Depending on design, opportunities to load road trains at the storage facilities, skipping the requirement of transferring tanktainers to the intermodal terminal for loading there, may exist.

Local Roads

No changes have been assumed to take place to any roads as a tanktainer operationally will be treated no differently than normal container freight other than considerations for its contents and with the additional advantage that the tanktainer will be lighter than normal fully laden containers.

4.4. Rail freight operation

4.4.1. Storage of tanktainers

Typical intermodal train lengths start from 600m, which can accommodate 80TEU of container freight, although 300m part lengths are also common where trains are consolidated and deconsolidated at intermodal terminals to form part of larger trains.

Sizing of a secure storage area for hydrogen therefore assumes that space needs to be allowed for a full 600m train of hydrogen tanktainers plus two further sets of empty tanktainers for reverse traffic flow and/or storage pending refilling for future distribution.

Due to the highly flammable nature of hydrogen, the secure storage facility has also been scoped to include the ability to fight fires using a locally installed hydrant system.

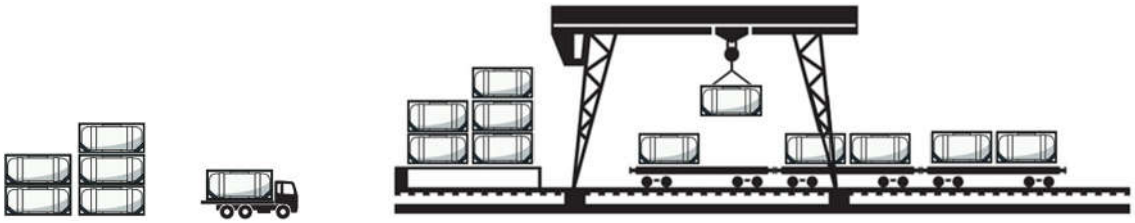
4.4.2. Scope summary for secure hydrogen storage for transport by rail (refer to Appendix A for full scope breakdown)

Site component	Description
Toowoomba Secure Hydrogen Store	
Hard stand	8,960m^2 (56m x 160m)
Security fencing	438m
Gatehouse	1No.
Fire hydrant system	1No.
Parkes Secure Hydrogen Store	
Hard stand	8,960m^2 (56m x 160m)
Security fencing	438m
Gatehouse	1No.
Fire hydrant system	1No.

Storing, loading and transit operation

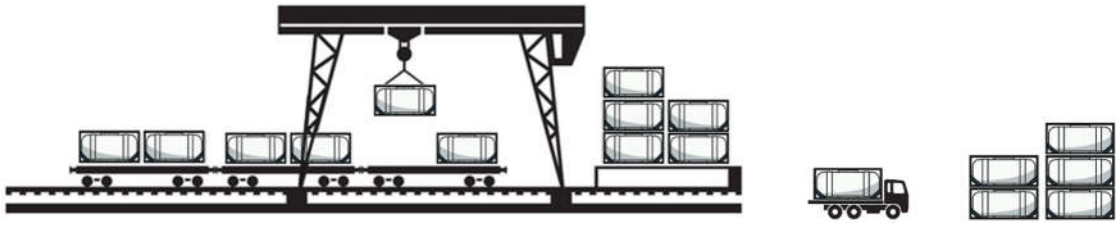
Full tanktainers will be transferred from the production plant to the storage facility, pending sufficient volume to transit as part of a full, or part, consist intermodal freight train.

Full tanktainers will be transferred from the Toowoomba storage facility to the Toowoomba intermodal terminal to transit as part of a full, or part, consist intermodal freight train.

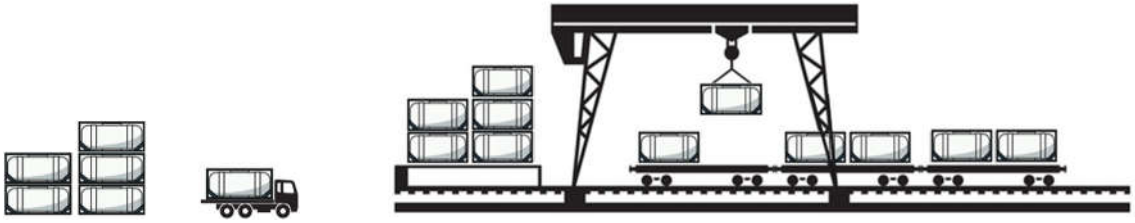


The train will transfer hydrogen by rail between Toowoomba and Parkes.

The train will be unloaded of full tanktainers which will be transferred from the Parkes intermodal terminal to the Parkes storage facility pending transfer to customers.

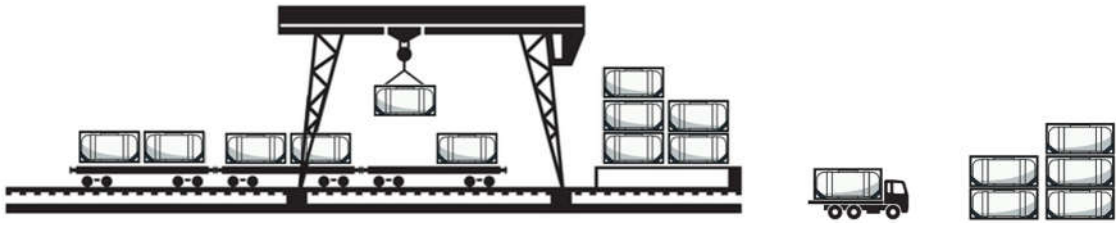


Empty tanktainers will be transferred from the storage facility to the Parkes intermodal terminal to be loaded on the freight train for the reverse (empty) flow of tanktainers to Toowoomba.



The train will transfer empty hydrogen tanktainers by rail between Parkes and Toowoomba.

The train will be unloaded of empty tanktainers which will be transferred from the Toowoomba intermodal terminal to the local storage facility pending transfer to the production plant for refilling.



Empty tanktainers are transferred to the production plant for refilling and the cycle starts again.

Based on the assumed daily output of a 10MW Electrolyser of 4,250kg of Hydrogen per day, and a nominal tanktainer storage capacity of 400kg at 300 bar working pressure, it will take approximately 5 days to fill enough tanktainers to service a 300m (40TEU) train consist and 8 days to produce a sufficient quantity to service a 600m (80TEU) train.

If tanktainers which are capable of operating at higher working pressures are used, the time taken to fill a sufficient number of containers will increase.

Local Roads

No changes have been assumed to take place to any roads as a tanktainer operationally will be treated no differently than normal container freight other than considerations for its contents and with the additional advantage that the tanktainer will be lighter than normal fully laden containers.

5. Systems Engineering Approach

A Systems Engineering approach has been applied to the design development for the Inland Rail Interface Improvement Program. This approach has the following goals:

- The appropriate strategic responses and benefit statements are identified and applied to each project,
- The Proponents' requirements and other requirements identified during design development are incorporated into this approach; and
- The relevant project Risks, Assumptions, Issues, Dependencies, Opportunities and Constraints (RAIDOC) are recorded in the RAIDOC register.

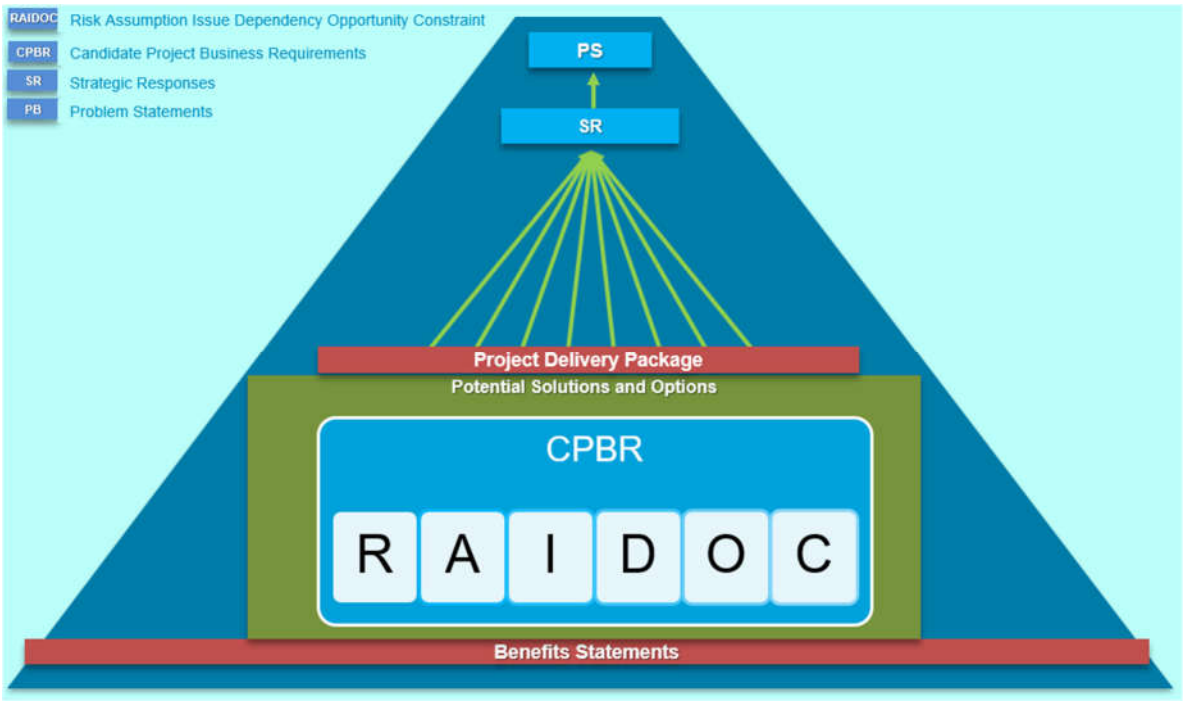


Figure 2 RAIDOC Mapping

The aim of the RAIDOC register is to create a common repository of RAIDOC items that are identified throughout the project development.

The RAIDOC entries were initially captured through internal workshops.

The RAIDOC register is in the form of an MS Excel spreadsheet and can be used by SMEs on a day to day basis while they perform technical design work.

The RAIDOCs are instantiated for each option within a project. The systems engineering approach for each project employs the strategic responses and benefit statements provided from the ILM workshop facilitated by EY.

If strategic responses have not been outlined for a project then the RAIDOC is linked to either the CLIP or PEP principles.

Appendices

Appendix A Cost scope summary

Road transport option

Location	Assets	Requirements	More information
Toowoomba	Hard stand	4,480m2 (56m x 80m)	Sufficient to store 8No. A-triple trucks worth (48TEU) of full containers plus allowance for empty containers. Assume full containers are single stacked but empty containers are double stacked
Hydrogen	Security fencing	278m (assumes gap for gatehouse)	Perimeter fencing around hydrogen compound hardstand
Secure	Gatehouse	1No.	Controlled access and exit from stored hydrogen compound
Store Area	Fire hydrant system	1No. (9 hydrants)	Fire hydrant system for fire fighting purposes compliant to AS2419

Location	Assets	Requirements	More information
Parkes	Hard stand	4,480m2 (56m x 80m)	Sufficient to store 8No. A-triple trucks worth (48TEU) of full containers plus allowance for empty containers. Assume full containers are single stacked but empty containers are double stacked
Hydrogen	Security fencing	278m (assumes gap for gatehouse)	Perimeter fencing around hydrogen compound hardstand
Secure	Gatehouse	1No.	Controlled access and exit from stored hydrogen compound
Store Area	Fire hydrant system	1No. (9 hydrants)	Fire hydrant system for fire fighting purposes compliant to AS2419

Rail transport option

Location	Assets	Requirements	More information
Toowoomba	Hard stand	8,960m2 (56m x 160m)	Sufficient to store 1 full trains worth (80TEU) of full containers plus 2 trains worth of empty containers. Assume full containers are single stacked but empty containers are double stacked
Hydrogen	Security fencing	438m (assumes gap for gatehouse)	Perimeter fencing around hydrogen compound hardstand
Secure	Gatehouse	1No.	Controlled access and exit from stored hydrogen compound
Store Area	Fire hydrant system	1No. (18 hydrants)	Fire hydrant system for fire fighting purposes compliant to AS2419

Location	Assets	Requirements	More information
Parkes	Hard stand	8,960m2 (56m x 160m)	Sufficient to store 1 full trains worth (80TEU) of full containers plus 2 trains worth of empty containers. Assume full containers are single stacked but empty containers are double stacked
Hydrogen	Security fencing	438m (assumes gap for gatehouse)	Perimeter fencing around hydrogen compound hardstand
Secure	Gatehouse	1No.	Controlled access and exit from stored hydrogen compound
Store Area	Fire hydrant system	1No. (18 hydrants)	Fire hydrant system for fire fighting purposes compliant to AS2419

Appendix B RAIDOC Register

A unique MASTER ID in a standardised format.	*The date on which the RAIDOC item's status was updated*	*A unique Discipline ID indicating the originator of the RAIDOC item.*	*The (user)name of the person who created the RAIDOC item*	*The date when the RAIDOC item was created*	*The current status of the RAIDOC item* *Open* *Closed*			*A title for ease of reference.*	*A short description that should accurately and succinctly describe the RAIDOC item.*	*Risk* *Assumption* *Issue* *Dependency* *Opportunity* *Constraint*	*Where the RAIDOC item comes from e.g. requirement ID, document reference, Optioneering list etc.*	*Of Risk occurring /Assumption not holding / Opportunity not taken / Constraint being removed*	*Candidate Project Business Requirements*	*Investment Logic Mapping*			*Additional information. that assists in better understanding the RAIDOC item.*
Unique ID	**STATUS DATE**	**Responsible**	**Created By**	**Created On**	**STATUS**	**Option 1**	**Option 2**	**Title**	**Description**	**RAIDOC Type**	**Source**	**Impact**	**Candidate Project Business Requirements**	**Strategic responses**	**Linked Benefits**	**Benefit Indicator**	**Comments**
THR-1	20/05/2022	Rail Systems	Alan Braithwaite	20/05/2022	Open	Option 1	Option 2	Rail transport	The technology used to transport gaseous hydrogen is the same as that used for transportation by road, i.e. intermodal tanktainers at 20' (6.10m) and 40' (12.15m) lengths.	Assumption	Transporting Hydrogen by Rail Gate 2 Options Report	The route alignment for Inland Rail passes through both Parkes and Toowoomba with these centres being approximately 850km apart		Identify likely locations for hydrogen production and demand, considering the forecast levels of production and how this would reasonably be catered for	Benefit 1: Production, transport and use of hydrogen in regional areas would provide new jobs, skills opportunities and long term industry development and diversification Benefit 2: Hydrogen industry growth and co-location with Inland Rail would provide a network to support the development of a sustainable industry and jobs	Effective	
THR-2	20/05/2022	Rail Systems	Alan Braithwaite	20/05/2022	Open	Option 1	Option 2	Rail transport Location: Toowoomba/Parks	First and last mile considerations are the same for rail and road, i.e. transport is between intermodal terminal facilities where tanktainers can be unloaded.	Assumption	Transporting Hydrogen by Rail Gate 2 Options Report	Tube-trailers made of steel are less costly to build, but the wall thickness and hence the weight of the pressure vessels increases with the required working pressure		Identify likely locations for hydrogen production and demand, considering the forecast levels of production and how this would reasonably be catered for	Benefit 1: Production, transport and use of hydrogen in regional areas would provide new jobs, skills opportunities and long term industry development and diversification Benefit 2: Hydrogen industry growth and co-location with Inland Rail would provide a network to support the development of a sustainable industry and jobs Benefit 3: Understanding potential impediments to transporting hydrogen mean that these can be addressed or noted early to maximise the productivity of potential options	Effective	
THR-4	20/05/2022	Rail Systems	Alan Braithwaite	20/05/2022	Open	Option 1	Option 2	Rail transport	A 10MW Electrolyser can produce 4,250kg of Hydrogen per day	Assumption	Transporting Hydrogen by Rail Gate 2 Options Report	The route alignment for Inland Rail passes through both Parkes and Toowoomba with these centres being approximately 850km apart		Identify opportunities and potential partnerships that may facilitate growth and business opportunities	Benefit 1: Production, transport and use of hydrogen in regional areas would provide new jobs, skills opportunities and long term industry development and diversification Benefit 2: Hydrogen industry growth and co-location with Inland Rail would provide a network to support the development of a sustainable industry and jobs	Effective	
THR-5	20/05/2022	Rail Systems	Alan Braithwaite	20/05/2022	Open	Option 1	Option 2	Rail transport	Storage of full tanktainers awaiting delivery and empty tanktainers awaiting filling are stored in a dedicated storage facility	Assumption	Transporting Hydrogen by Rail Gate 2 Options Report	The route alignment for Inland Rail passes through both Parkes and Toowoomba with these centres being approximately 850km apart		Identify opportunities and potential partnerships that may facilitate growth and business opportunities	Benefit 1: Production, transport and use of hydrogen in regional areas would provide new jobs, skills opportunities and long term industry development and diversification Benefit 2: Hydrogen industry growth and co-location with Inland Rail would provide a network to support the development of a sustainable industry and jobs	Effective	
THR-6	20/05/2022	Rail Systems	Alan Braithwaite	20/05/2022	Open	Option 1	Option 2	Certified	To transport compressed hydrogen gas by rail, approved containers for rail traffic will need to be produced and certified.	Assumption	Transporting Hydrogen by Rail Gate 2 Options Report	Since the requirements are similar to road traffic and there are currently freight flows of compressed and liquid natural gas by rail in dedicated ISO tanktainers, it is expected that certification for tanktainers for use in transporting gaseous hydrogen by rail in Australia could be obtained in the near future		Identify opportunities and potential partnerships that may facilitate growth and business opportunities	Benefit 3: Understanding potential impediments to transporting hydrogen mean that these can be addressed or noted early to maximise the productivity of potential options	Effective	
THR-7	20/05/2022	Rail Systems	Alan Braithwaite	20/05/2022	Open	Option 1	Option 2	Hard Stand	Sufficient to store 1 full trains worth (80TEU) of full containers plus 2 trains worth of empty containers. Assume full containers are single stacked but empty containers are double stacked	Opportunity	Transporting Hydrogen by Rail Gate 2 Options Report	The route alignment for Inland Rail passes through both Parkes and Toowoomba with these centres being approximately 850km apart		Identify opportunities and potential partnerships that may facilitate growth and business opportunities	Benefit 1: Production, transport and use of hydrogen in regional areas would provide new jobs, skills opportunities and long term industry development and diversification Benefit 2: Hydrogen industry growth and co-location with Inland Rail would provide a network to support the development of a sustainable industry and jobs Benefit 3: Understanding potential impediments to transporting hydrogen mean that these can be addressed or noted early to maximise the productivity of potential options	Effective	
THR-8	20/05/2022	Rail Systems	Alan Braithwaite	20/05/2022	Open	Option 1	Option 2	Road Interface	No changes have been assumed to take place to any roads as a tanktainer operationally will be treated no differently than normal container freight other than considerations for its contents and with the additional advantage that the tanktainer will be lighter than normal fully laden containers.	Opportunity	Transporting Hydrogen by Rail Gate 2 Options Report	Road and rail interface and operation in section 4.3 and 4.4 of Source report.		Identify opportunities and potential partnerships that may facilitate growth and business opportunities	Benefit 1: Production, transport and use of hydrogen in regional areas would provide new jobs, skills opportunities and long term industry development and diversification Benefit 2: Hydrogen industry growth and co-location with Inland Rail would provide a network to support the development of a sustainable industry and jobs Benefit 3: Understanding potential impediments to transporting hydrogen mean that these can be addressed or noted early to maximise the productivity of potential options	Effective	

Amendment Record

Issue	Description	Distribution	Date
Draft 1	First draft for internal review	SNC-Lavalin	13.05.2022
Draft 2	Second draft for external review	Elizabeth Renteria	13.05.2022
Draft 3	Third draft for external review	Elizabeth Renteria	20.05.2022
Draft 4	Fourth draft for external review	Elizabeth Renteria & Matthew Scott	20.05.2022
A	First Issue	Elizabeth Renteria	20.06.2022