Hobart to Northern Suburbs Light Rail Business Case

A report providing a summary of the findings of all three stages of the project

Prepared for the Department of Infrastructure Energy and Resources

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ACIL Tasman

Economics Policy Strategy

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Executive summary

ACIL Tasman, Hyder Consulting and SEMF were appointed by the Department of Infrastructure, Energy and Resources (DIER) to assess the business case for a light rail passenger system which makes use of the existing rail corridor between Hobart and Brighton; the Northern Suburbs Light Rail System (NSLRS). The study consisted of three distinct stages:

- An initial background stage which describes the context and setting for the project as a whole and sets broad parameters for the remainder of the project.
- A second stage which develops optimal operating service models (OOSMs) for the light rail system.
- A third stage which calculates the economic costs and benefits associated with the optimal operating service models.

This final report of the project summarises the findings of the previous three reports into a single document and presents the overall findings of the study.

The overall conclusions from the project were clear.

The first stage of the project established some suitable boundaries for further analysis, and suggested that the last three proposed stations on the line (Granton, Bridgewater and Brighton) were unlikely to deliver benefits commensurate with the costs required to upgrade the line to them, based on distance and likely patronage. For this reason, we recommended that the NSLRS terminate at Claremont.

The second stage concluded that either diesel or overhead electric traction would be suitable. Battery-powered vehicles were considered, but presented a higher development risk than the more mature technologies presented by diesel and overhead electrification. It also concluded that, in order to improve the track to the point where passenger trains could be operated safely (from Hobart to Claremont) an investment of $33-$45 million would be required, and this would only be sufficient to allow the trains to operate at speeds between 40 and 45 km/h on average.

The third and final stage of the study concluded that for a railway operated according to the parameters described in Stage Two, the value of the subsidy required would outweigh the value of any community benefits by a considerable margin.

It is worth noting, however, that we also suggested in the third stage of the project that feeder bus services to Brighton be improved with the money saved from not operating competing buses with the NSLRS from Glenorchy to

Hobart, and that these bus services produced substantial benefits relative to their costs.

However, we also acknowledged that rail systems may have an intrinsic attractiveness which is not possessed by other modes of public transport. Therefore, a model that considers only cost savings (chiefly, travel time saved) could underestimate potential demand. Higher levels of demand were therefore entered into the model to mimic different levels of the "sparks effect" as the intrinsic attractiveness of rail compared to other public transport modes is sometimes known.

It required a level of passenger demand approximately 250 per cent higher than the base level demand estimates to produce a benefit cost ratio slightly in excess of one, and hence positive net benefits. However, even small reductions from this level of demand lead to a benefit-cost ratio of less than one. Our overall conclusion, therefore, was that a positive net benefit was a possible outcome, but that the project represents a high risk investment.

1 Introduction

ACIL Tasman, Hyder Consulting and SEMF were appointed by the Department of Infrastructure, Energy and Resources (DIER) to assess the business case for a light rail passenger system which makes use of the existing rail corridor between Hobart and Brighton; the Northern Suburbs Light Rail System (NSLRS). The study consisted of three distinct stages:

- A background stage which describes the context and setting for the project as a whole and sets broad parameters for the remainder of the project.
- A stage which develops optimal operating service models (OOSMs) for the light rail system.
- A stage which calculates the economic costs and benefits associated with the optimal operating service models.

The final stage of the project summarises the findings of the study as detailed in the previous three reports into a single document; this report.

For each stage of the project, we have followed a consistent framework:

- Firstly, we describe the requirements under the original request for tender in relation to this stage of the project.
- Secondly, we outline the approach actually undertaken, and any deviations from the original tender specifications.
- Thirdly, we provide an overview of the key findings of each stage of the project, with a focus on those findings which underpinned future stages.

Chapter Two of this report outlines the findings from the first stage of the project. Chapter Three outlines the findings from the second stage and Chapter Four outlines the findings from the third stage. Chapter Five concludes with an overall synopsis of the project. Each of the reports from the three stages is included with the appendices.

2 Stage One Report

The basic requirement of the first stage of the process was to set the boundaries for the future stages of the analysis, to ensure that they were appropriately focussed, and the resources put towards them suitably directed. There was also a need to develop background information suitable for inclusion in any future Infrastructure Australia submission, and thus a large part of this stage involved undertaking this analysis. The first part of this chapter outlines the requirements of DIER, as expressed in its original tender. The second outlines the actual methodology followed, and the final part highlights results.

2.1 Requirements

The first stage of the project was informed by the dual aims of providing background suitable to the subsequent two stages, and to assembling relevant information in a suitable form that it could be later used by DIER, as necessary, to form part of a submission to Infrastructure Australia. This required the development of an understanding of key policy and other considerations from relevant documents and key stakeholders. DIER expressed its requirements in the tender documentation thus:

> The aim of this stage is to provide a succinct consideration of work previously undertaken by DIER and others to understand transport problems in Hobart. That understanding will provide the context of solving such problems in Hobart's Northern suburbs by utilising a Light Rail Service (LRS).
>
> The Contractor will need to identify the advantages of solving existing and future transport problems utilising a LRS in the Northern suburbs rail corridor. It is anticipated that the LRS will perform a critical transport role in Hobart acting as a backbone to the Hobart metropolitan public transport system and that there would be significant community and market support for a LRS.
>
> In the course of analysis and development of OOSM, broad consideration must be given to potential responses to transport problems including, additional roads, behaviour change measures, increased buses on existing grid and dedicated bus-ways and lanes. This is to be demonstrated in a comparative table.
>
> Notwithstanding these, the primary aim of this Business Case is to explore the case of light rail and the effectiveness of that solution for solving the transport problems of the Northern Suburbs and between the CBD.

2.2 Analytical methodology

Since this was a background stage, a major focus of our methodology was developing an understanding of the relevant background information which could inform the later, analytical stages of the project. This included consideration of planning, policy and other related documentation pertaining to transport and land use goals in Hobart, and consideration of the views of key stakeholders. Stakeholder consultation took place over the course of a week in March, and the stakeholders consulted are outlined in Table 1. The team would like to extend its thanks to all stakeholders who gave generously of their time, and provided important feedback for our study.

Table 1 **Stakeholders consulted**

Name	Organisation
Tony Foster*	Mayor of Brighton
Emma Riley*	Planning Institute of Tasmania
Toby Rowallan *	Future Transport Tasmania
Leyon Parker *	Hobart City Council
Adriana Taylor *	Mayor of Glenorchy
Heather Haselgrove *	CEO of Metro Tasmania
Ben Johnston *	Hobart Northern Suburbs Rail Action Group
Stewart Williams *	University of Tasmania (Community Advisory Panel Chair)
Kristy Johnston	Hobart Northern Suburbs Rail Action Group
Mark Painter	Hobart City Council
Owen Gervasoni	Hobart City Council
Stuart Baird	Hobart City Council
Ian Addison	Future Transport Tasmania
John Livermore	Future Transport Tasmania
Darren West	Future Transport Tasmania
Jeremy Kays	Future Transport Tasmania
Hadley Sides	Sullivans Cove Waterfront Authority
Angela Moore	Glenorchy City Council
Tony McMullen	Glenorchy City Council
David Pearce	Glenorchy City Council
Belinda Loxley	Glenorchy City Council
Russell Grierson	Glenorchy City Council
Frank Pearce	Glenorchy City Council
Christine Lucas	Glenorchy City Council
Anthony James	Metro Tasmania
Peter O'Driscoll	O'Driscoll Coaches
Matthew Clark	Planning Institute of Tasmania
Peter Shelton-Collins	Department of Economic Development
Robin Walpole	TasRail
Bob Cotgrove	Transport Economics Consultant

Note: * denotes original members of the Community Advisory Panel who reviewed each stage of the project, and brought important feedback into the project. Their contributions to the outcomes of the study are gratefully acknowledged.

Since this background information also forms an important part of any Infrastructure Australia submission (Infrastructure Australia requires an understanding of similar information to make its assessments), we documented our findings in a format consistent with the Infrastructure Australia framework, according to the following topics:

- An assessment of the overall policy and planning framework within which the proposal sits, including an assessment of how the project meets the policy goals of Infrastructure Australia.
- An identification of the problems for which solutions are being sought.
- An assessment of the scale of these problems.
- An analysis of how the problems might have arisen.
- An identification of options which might be used to solve the problems.
- An assessment of each of these options, to derive an optimal solution which will be subjected to a detailed benefit-cost analysis.

Box 1 **The Infrastructure Australia process**

The Infrastructure Australia process (see www.infrastructureaustralia.gov.au) requires those making a submission to consider the problem they seek to solve within an appropriate policy framework, and to provide evidence that all potential solutions to that problem have been considered. The submission is then expected to provide the results of a detailed benefit-cost analysis for the optimal solution. The aim is to ensure that submissions consider all options, rather than simply seeking Federal money for a favoured infrastructure solution.

In comparison to our Stage One report, a full Infrastructure Australia submission would require considerably more analysis of precisely what the problem is in the Northern suburbs of Hobart that a light rail system might solve, and of all the potential solutions which might be used to solve it. The brief for this project was to examine the business case for a light rail system, not to write a submission to Infrastructure Australia. For this reason, the analysis of the problem and of solutions other than the rail system is relatively brief, and would need to be expanded if a submission is made in the future.

Setting the scene for Stages Two and Three

The second major component of the first stage of the project was to provide background to underpin the remainder of the project, and to provide suitable boundaries for future analysis. This was to ensure that scarce resources were not wasted in detailed analysis of options that are not feasible, or not desirable from the perspective of stakeholders in Hobart. Establishment of suitable boundaries involved three key steps:

- Firstly, we examined the route and the requirements, and established the most suitable places for stations and other related infrastructure. In this, we were greatly assisted by the background work undertaken by the Hobart Northern Suburbs Rail Action Group. This provided useful background for Stage Two, as it reduced the amount of variation in parameters for the NSLRS, allowing for more in-depth analysis of its key aspects.

- Secondly, we examined whether there are any planning or other constraints which might restrict what is done in regards to the NSLRS. This provided Hyder, in Stage Two, with a good understanding of what they could propose in terms of infrastructure solutions.
- Thirdly, we conducted a high level analysis of the total costs of the NSLRS on a section-by-section basis and examined likely patronage at each station, based upon the number of people who lived within 800 metres of each station, current bus usage[1], and a 300 bay park 'n ride at a strategic location along the route.[2] The aim was to understand at a high level the likely costs associated with extending the service to each station in order to ensure that later stages of the analysis did not conclude that the NSLRS was unviable simply because certain sections of the line are very costly to operate. In other words, we sought to maximise the likelihood of a positive business case being developed.

These three steps provided a useful way in which to set boundaries to the rail system, which improved the efficiency of later stages of the project.

2.3 Key findings

The most important results of this first stage, from the perspective of a wider audience in Hobart, are those which set the boundaries for the latter stages of the project. We summarise these findings below.

In regards to problems, we found that the following problems are pertinent:

- Congestion, particularly on the Brooker Highway and Main Road during peak periods.
- Social exclusion caused by a lack of suitable public transport options, particularly on the periphery of the region.
- Emissions of pollutants from motor vehicles, which are an important class of polluters in Tasmania.
- The ageing of the population in the region, which has important effects on demand for transport.
- The interaction between transport and land-use planning, which has historically been poor in Hobart.
- The high cost (to the public purse) of public transport in Hobart, which is partially related to low patronage levels.

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[1] Current bus patronage considered passengers using current bus services close to proposed light rail stations as well as patronage from the X1 service from the suburb of Bridgewater. Passenger from Bridgewater were assumed to feed into the NSLRS.

[2] Most of the demand came from people "walking on" to the train from their houses within 800 metres of the station, not from substitution from buses.

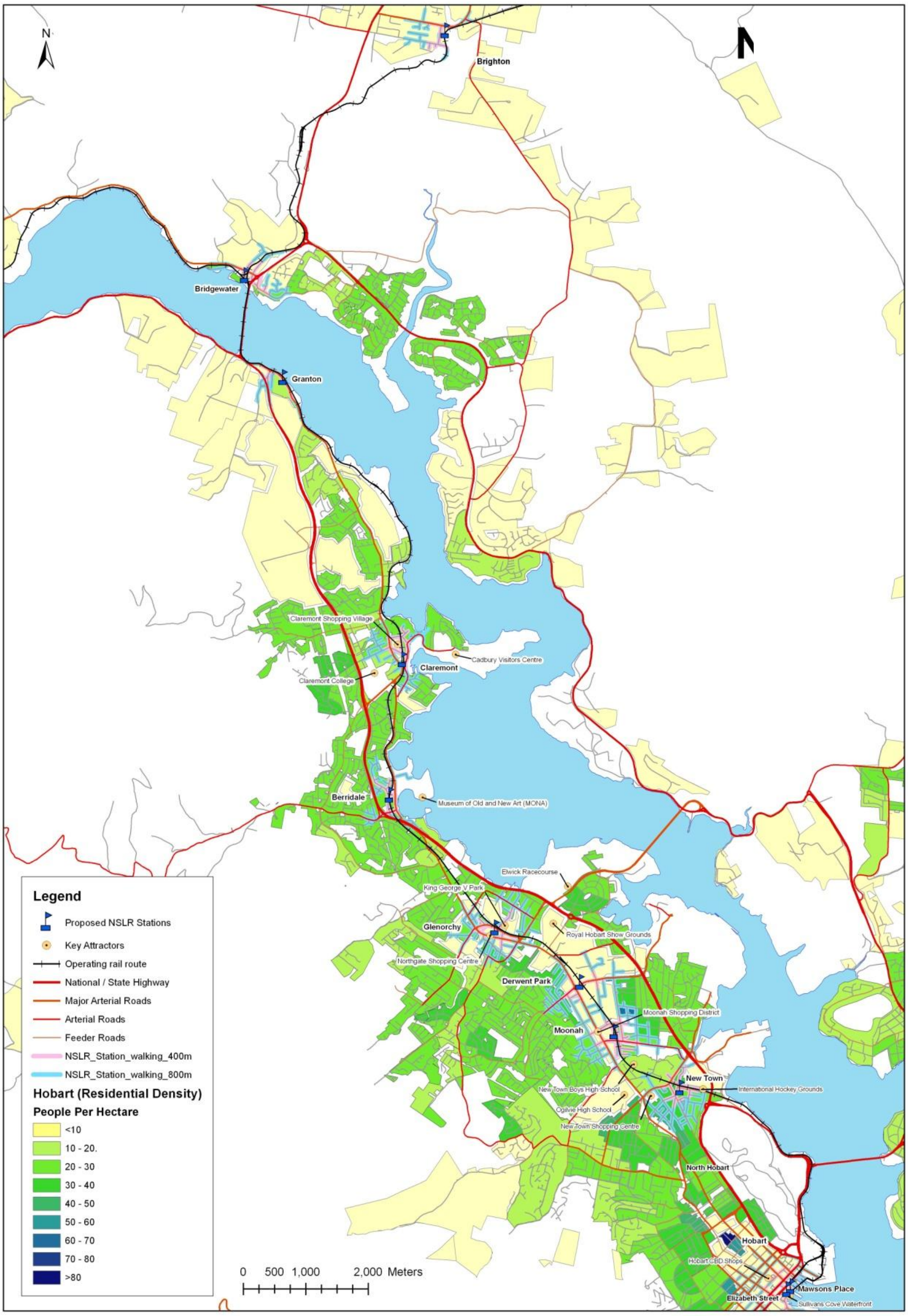
We examined a variety of solutions that did not necessarily involve the construction of "hard" infrastructure such as a railway service. These included:

- Legislative solutions, most particularly removing some of the barriers between taxis and buses in transport legislation, to allow smaller vehicles to operate bus-like services in areas of relatively low demand, and thus avoid the high cost of operating near-empty buses in areas of low demand.
- Making policy changes to change work starting times to spread the peak traffic demand into Hobart over several hours, avoiding needle-peaks. School starting times could also be changed for the same reason, but may cause problems where parents work and need to co-ordinate school and work starting times.
- Changing parking policies to reduce the availability of low-price parking in Hobart and thus reduce demand for car travel for commuting. This would reduce demand somewhat, but could have wider consequences, such as lower demand at shops in the city because of high parking. It would therefore need to be managed carefully.
- Developing tidal busways along the rail corridor, rather than the NSLRS.
- Increasing bus frequency to increase demand and reduce congestion. This can be effective because demand for buses is highly sensitive to the timing of services; more so than price.
- Road widening and de-bottlenecking along the Brooker Highway, with a particular focus on changing road infrastructure to improve priorities for buses.
- Developing emissions and congestion pricing. This can be effective in reducing demand, but it is difficult to establish accurate estimates of the actual costs imposed, and small charges will often have limited effects.

It is important to note that it is not necessary to adopt "hard" infrastructure solutions to solve problems such as congestion during peak periods, as the options above make clear. Each of the solutions was assessed against the problems above, but assessed also at a strategic level, with the intent of providing background to further work needed for an Infrastructure Australia submission that might be developed by DIER in the future. The main focus of the project was on the business case for the NSLRS.

In relation to the NSLRS, we found first of all that there do not appear to be any planning or heritage issues which might restrict what can be considered in Stage 2. We also found that the locations for stations proposed by the Hobart Northern Suburbs Rail Action Group in its various work, with the addition of a station at Derwent Park, are probably likely to be the best locations for stations, given loci of demand and space to build the relevant infrastructure. These are shown in Figure 1, together with information on trip attractors and population density along the route. All of this information was crucial in later stages, particularly when examining likely demand.

Figure 1 **Potential station locations**



[a]Data source: DIER analysis and Johnston, 2010.

In examining the costs of the service on a section-by-section basis, and the likely demand faced at each station, we found some rather stark differences between sections. The results of our analysis, presented in terms of a cost per boarding at each station (a section is the section of line up to each station named, from the Hobart terminus), are shown in Table 2 below. The various different cases in each column refer to different capital costs, and the best and worst cases refer to the highest and lowest (respectively) likely demand scenarios we examined.

Table 2 **Cost per boarding per station**

	Low Rolling Stock Costs				High Rolling Stock Costs			
	signalling only cost per km (track perfect)	Realistic most basic option (signal plus minor track upgrade)	New single track plus signalling*	new double track plus signalling	signalling only cost per km (track perfect)	Realistic most basic option (signal plus minor track upgrade)	New single track plus signalling*	new double track plus signalling
	Worst-Case Demand Scenario							
New Town	$46.31	$53.26	$62.96	$87.91	$50.62	$57.56	$67.26	$92.21
Moonah	$5.08	$5.37	$5.77	$6.93	$6.06	$6.35	$6.76	$7.92
Derwent Park	$4.33	$4.48	$4.70	$5.31	$5.27	$5.43	$5.64	$6.26
Glenorchy	$2.49	$2.54	$2.61	$2.74	$3.08	$3.13	$3.20	$3.33
Berridale	$5.46	$6.06	$6.88	$9.25	$6.21	$6.80	$7.63	$9.99
Claremont	$10.91	$12.10	$13.76	$17.47	$12.19	$13.38	$15.04	$18.74
Granton	$95.55	$115.35	$143.01	$215.12	$100.88	$120.68	$148.35	$220.45
Bridgewater	$8.01	$8.30	$8.70	$9.86	$12.05	$12.34	$12.74	$13.90
Brighton	$63.04	$73.96	$89.23	$132.92	$75.33	$86.26	$101.52	$145.22
	Best Case Demand Scenario							
New Town	$5.67	$6.53	$7.71	$10.77	$6.20	$7.05	$8.24	$11.30
Moonah	$2.72	$2.87	$3.09	$3.71	$3.25	$3.40	$3.62	$4.24
Derwent Park	$2.42	$2.50	$2.62	$2.97	$2.94	$3.03	$3.15	$3.49
Glenorchy	$2.22	$2.26	$2.32	$2.44	$2.74	$2.79	$2.85	$2.97
Berridale	$3.88	$4.30	$4.88	$6.56	$4.40	$4.82	$5.41	$7.09
Claremont	$4.50	$4.99	$5.67	$7.20	$5.02	$5.52	$6.20	$7.73
Granton	$60.48	$73.01	$90.52	$136.16	$63.85	$76.38	$93.90	$139.54
Bridgewater	$6.69	$6.93	$7.27	$8.23	$10.06	$10.30	$10.64	$11.61
Brighton	$17.31	$20.31	$24.50	$36.50	$20.69	$23.68	$27.88	$39.87

Note: * This scenario is closest to the costs projected in the more detailed cost modelling undertaken in Stage Two

Our analysis suggested that the last three stations on the proposed line (Granton, Bridgewater and Brighton) seem unlikely to be viable, even if the NSLRS provides significant time savings and other benefits to patrons using these stations. Bridgewater appears viable in Table 2 due to its being close to Granton (track costs are the highest component of costs, and are calculated on a per-km basis). We also undertook some sensitivity analysis looking at Bridgewater, Granton and Claremont as potential termini for the system, to see if this improves viability. Placing the terminus at Bridgewater does not change its situation markedly from that shown in Table 2. Placing it at Granton reduces the high cost per boarding of Granton shown in Table 2 (chiefly because the park 'n ride would move to Granton under this scenario), but it is still roughly twice as costly as the average for the other stations on the system. Placing the terminus at Claremont (and thus moving the park 'n ride) makes Claremont one of the lowest cost stations on the system, and was considered likely to improve the overall system benefit-cost ratio. By contrast, a terminus at Granton, Bridgewater or Brighton was considered likely to significantly reduce the overall system benefit cost ratio, and we concluded that the high costs associated with improving the line out to these stations and investing in extra rolling stock to maintain the 15-minute service may in fact render the system as a whole unviable if they are included. We thus recommended in Stage One that they not be considered further in Stage Two.

We did not conclude, however, that the relevant rail corridor should be removed. Brighton is the fastest-growing municipality in the region, and it may be that at some time in the future (more than a decade hence, based on the current growth rates and current costs of service) there is scope to extend the service further. Maintaining the corridor therefore provides an important option for the future flexibility of public transport provision in Hobart, and we suggested that it should remain an important policy priority.

3 Stage Two Report

The second stage of the project was essentially an engineering analysis; given the parameters set by the first stage of the project, Hyder developed a series of "Optimal Operating Service Models" (OOSMs) which aimed to show the least cost way of delivering the light rail service requirements for the Northern suburbs of Hobart.

As with the previous chapter, we show the original tender requirements for this stage first, before outlining briefly the methodology followed, and then turning to results.

3.1 Requirements

The second stage of the project was to build upon the first, and provide greater detail on the costs associated with developing the NSLRS; essentially the "cost" component of a benefit cost analysis. In its tender documentation, DIER expressed its requirements thus:

> This stage of the project should provide advice on OOSM. The Contractor must select the key LRS characteristics and associated assumptions which in turn allow the calculation of the most positive BCRs and NPVs.
>
> - A detailed discussion of LRS characteristics should be provided with respect to:
> - Below ground and rail structures;
> - Rolling stock utilised including motive power but at a minimum battery powered and overhead supplied electric vehicles must be considered;
> - Potential safe operating speeds of the rail vehicles;
> - Optimal distance of a route extension beyond the existing corridor from Macquarie Point towards or into Elizabeth Street. If penetration to Elizabeth Street is not feasible, analysis is required on the optimal termination point of LRS. At a minimum the route must extend as far as Mawson Place;
> - Optimal rail alignment through the Macquarie Point area with alignment of route extension beyond Macquarie Point to be assessed in consultation with the Department of Economic Development, the Sullivans Cove Waterfront Authority and TasPorts. In making this assessment planning feasibility must be considered;
> - Indicative timetables of LRS and associated bus and/or ferry services;
> - Track configuration and number of light rail stations, including extent and nature of passing loops, double track and sidings;
> - Optimal amount of rail-bus interchanges and park n rides (including kiss n ride) facilities mindful of land limitations and cost of construction against benefits. Such consideration must include input from local authorities; and

- Optimal staging of infrastructure and service roll-out along the corridor Hobart to Brighton Municipality.

Evidence must be provided in the evaluation of all options associated with the LRS when recommending OOSM. Evidence must include an assessment of risk for each option and the quantification of such risk when calculating costs of options.

Where evidence is inconclusive with respect to any of the characteristics above, analysis of such characteristics must be undertaken in Stage C. In other words, where it is not possible to exclude or include specific characteristics into OOSM, such characteristics must be fully evaluated in Stage C in the form of an Operating Service Model.

In the development of OOSM the Contractor must take into consideration the likelihood of future freight and heritage rail operations.

Infrastructure establishment and recurrent operational costs will be estimated, based on the best possible available unit cost rates relevant for local operating conditions associated with the LRS, specifically with the respect to, but not limited to:

- Capital purchases of rolling stock/vehicles;
- Rail and below rail development;
- Light rail stations and associated facilities, rail-bus interchanges and park n ride facilities;
- Depot(s);
- Communications and signaling;
- Service relocations;
- Project Management;
- Power substations;
- Integration with bus/ferry ticketing/financial systems; and
- Other costs.

All attributes of the LRS must be compliant with the accessibility requirements of the *Disability Discrimination Act 1992 (Cth)* (DDA).

The OOSM must utilise Key Scope Assumptions (see above) and include:

- Assessment of the rail corridor condition and advice on optimal amount of refurbishment required of the existing rail track, in particular level crossings. Trade-off analysis is required, comparing the cost of additional refurbishment against additional benefits generated by faster services;
- 1067mm gauge rolling stock utilised, including traction power, which at a **minimum** must consider the potential use of battery-powered and overhead supplied electric vehicles;
- Length of the route extension as defined in scope;
- Overall timetable frequency by temporal periods, which at a minimum must specify a high frequency of service of at least a 15 minute frequency Monday to Saturday, with higher frequencies (more frequent services) expected at

peak times. Lower frequencies are expected on Sundays and during later evening periods;

- Track and light rail station configuration with regard to the extent of passing loops, double tracking and location and number of stations;
- Continued access to the rail corridor for both Freight and Heritage vehicles and rolling stock;
- Optimal implementation staging of the LRS between Hobart and Brighton Municipality; and
- Indicative service timetables associated with the optimal staging above.

3.2 Analytical methodology

The approach followed in this stage of the report involved the following key elements:

- Hyder staff visited Hobart to ascertain the condition of the track visually, and to speak to stakeholders about track condition and other aspects of the rail system.
- Existing documentation, including engineering technical reports, on the current condition of the line were examined.
- Options for rolling stock were considered, including overhead electrical systems, "third rail" electrical systems, battery-powered systems and diesel-powered systems.
- Options were developed for potential rail models including assumptions about below-rail configuration and investment and above-rail rolling stock and operating parameters.
- The options were tested using software designed to optimise track configuration and timetables, to ensure each option was robust to changes in demand and usage.

The underlying ethos of the analysis was to identify cost-effective rail options which nevertheless provide a safe and comfortable service for patrons. To this end, options involving less high cost capital expenditure were favoured over "gold-plated" infrastructure solutions which provided similar outcomes. The aim of the analysis was to provide two OOSMs, but in order to do this, a wide variety of different options were considered for different elements of the above and below-rail infrastructure. These are summarised in Table 3.

Table 3 **Elements considered in developing options**

Elements considered		Options		Comments
1	Track Upgrade	1.1	Major Track Upgrade	In order to achieve 60kph speed limit the track would require major track upgrade. Same alignment will be maintained.
		1.2	Partial Track Upgrade	In order to achieve 45kph speed limit for passenger service partial upgrade of the track is required, estimated at approximately 50 to 60% of the track to be upgraded.
		1.3	Minor Track Upgrade	Sections with major defects to be rectified. Assessed as 10% of the track to be upgraded. This would include changes of all rotten timber sleepers, replacement of some rail fastenings and cess drain clearing. This would allow passenger service to run with a speed limit of 25 to 30kph.
2	Track Configuration	2.1	Single Track with Passing Loops	Use of the existing track.
		2.2	Double Track	Replace existing shared path with double track and relocation of the shared path.
3	Track Alignment, Hobart	3.1	From Rail Yard Directly on Davey Street	From Rail Yard at Macquarie Point directly onto Davey Street.
		3.2	Through Industrial Area, along Evans Street Davey Street	From Rail Yard through the industrial area to avoid future contaminated land remediation works.
4	Terminus Point in Hobart	4.1	Hobart Waterfront, Mawson Place	
		4.2	Elizabeth Street	Via Morrison Street to south of Davey Street.
		4.3	Elizabeth Street	Via Morrison Street to north of Davey Street.
		4.4	Elizabeth Street	On Davey Street up to Elizabeth Street.
5	Davey Street	5.1	Northern Side	
		5.2	Southern Side	
6	Rolling Stock	6.1	Diesel Powered Units	Diesel Multiple Units (DMU).
		6.2	Electrical Units	Overhead power supply.
		6.3	Mechanical Energy Storage	
		6.4	Electrical Energy Storage	Battery powered units.
7	Signalling	7.1	Electronic Interlocking Signalling System	
		7.2	Train Order System	
8	Electrification	8.1	Overhead Traction Power	
		8.2	Non Electrified System	
9	Maintenance Facility	9.1	Stabling Yard and Maintenance Facility	It is assumed stabling can be provided at an existing facility and a new maintenance depot will need to be constructed.

3.3 Key findings

The key findings of the report are as follows:

- The existing track, although currently used for freight, is deemed unsuitable for use as passenger rail in its current condition.
- The terminus in Hobart at this stage is recommended to be the Waterfront, Mawson Place or extended to Elizabeth Street south of Davey Street via Morrison Street.
- The most direct route should be adopted through the rail yards, with the possibility of amending the route in the future to accommodate the long term plan of the area.
- The preferred configuration is a single line with passing loops.
- Electronic interlocking signalling system is recommended.
- Overhead wire electrification and use of diesel powered units are the two recommended options to be considered. The final selection would be based on the attractiveness of the system and the cost associated with the alternatives. The overhead wire system provides a green energy solution whereas the diesel powered units could potentially provide a lower capital cost alternative if units are available at the time of purchase.
- Vehicles should preferably be substantially low floor.

The result of the analysis was the development of two OOSMs, which are substantially similar, except that one assumes overhead electric and one diesel rolling-stock. The major difference between these two options is the former has higher initial capital costs, but lower operating costs and the vehicles can accelerate faster producing lower travel times.

OOSM 1 uses diesel powered rolling-stock and OOSM 2 uses electrically-powered rolling stock (with overhead electrification). The common elements between the two scenarios are as follows:

- Use of the existing rail corridor.
- Track configuration is single track with passing loops.
- Major upgrade of the existing track in order to achieve 60kph speed limit and above. It is assessed that the system would require four operating units and three passing loops. It is recommended that an additional unit is purchased as a reserve vehicle.
- The track alignment within Hobart would run along the southern side of Davey Street and would connect directly into the rail yard from Davey Street.
- The terminus point in Hobart would be along the waterfront at Mawson Place.
- The recommended signalling system for use of the service is the Electronic Interlocking Signalling System.

- There would be bus interchanges containing provision for three bus stops at Claremont and six bus stops at Glenorchy.
- A park 'n ride facility with approximately 300 parking spaces would be provided at Claremont.
- A stabling facility for storage of the rolling stock when not in use would be at an existing facility. The rail yard at Macquarie Point could be considered as an option.
- Use of existing facilities for control room operations and staff offices.
- A new maintenance facility would need to be constructed with a maintenance pit that would accommodate maintenance operations.

Cost estimates were developed for the recommended OOSMs as well as indicative costs provided for the options considered. These costs, which form a direct input into the cost-benefit analysis in Stage Three of the project, are summarised in Table 4 below.

Table 4 **Cost parameters from Stage Two Report ($'000)**

Cost Item	OOSM 1 (Diesel)	OOSM 2 (Electric)
Track	$33,544	$45,044 (incl $11,500 for electrification)
Structure	$3,200	$3,200
Stations (incl terminus)	$3,990	$3,990
Urban design & landscaping	$204	$261
Project management	$2,047	$2,625
Design	$1,842	$2,362
Rolling stock (5 units)	$25,000	$25,000
Contingencies	$9,745	$9,745
Total capital expenditure	**$79,572**	**$92,227**
Maintenance – 1st five yrs	*$163 pa*	*$313 pa*
Maintenance – thereafter	*$2,400 pa*	*$2,400 pa*
Operating costs	*$2,750 pa*	*$2,500 pa*

4 Stage Three Report

The final stage of the report turned to an examination of the benefits associated with the project. The benefits are those that accrue to society at large from the presence of a rail system, rather than the revenues or profits of its operator; which often represent transfer payments from one part of society to another rather than benefits to society overall.

Information on benefits was combined with information on costs from Stage Two of the project to provide a benefit-cost analysis. This analysis was conducted according to the procedures established by Infrastructure Australia, such that it could easily feed into any future submission by DIER to Infrastructure Australia.

As with previous chapters, we outline the requirements in the tender documentation first, before describing the methodology followed, and finally outlining results.

4.1 Requirements

The final stage of the project required a detailed examination of the benefits associated with the NSLRS; the "benefits" component of a benefit cost analysis. It also required that these benefits be combined with the costs derived as part of Stage Two to provide an overall benefit cost ratio and net benefit. This undertaking, in essence, completed the seventh stage of the IA process. In its tender documentation, DIER described its requirements thus:

> OOSM and any associated variation in characteristics of the LRS should be analysed using an economic appraisal framework. This will allow appraisal of the economic viability of the LRS. The analysis must include calculation of BCRs and NPVs for each OOSM and any variation in characteristics.
>
> The Contractor will consider material from the section, *Future Market Demand for Light Rail Services* (see page 3) and will develop future scenarios as a basis for calculating demand.
>
> The contractor must undertake the economic evaluation so that it aligns with the requirements of an Infrastructure Australia submission. Consequently, the Contractor must utilise consistent:
>
> - Demand Modelling Approaches;
> - Discount Rates;
> - Project life;
> - Sensitivity testing with respect to risk assessment, oil prices, carbon prices, population growth/decline; and
> - Approach to assessing wider economic benefits including Agglomeration Impacts, Imperfect Competition and Labour Market Impacts.

Whenever possible, benefits will be quantified to include the future demand for the LRS. Benefits will be quantified over a thirty year period from construction, considering not only anticipated increases in population and urban development, but other measures influencing demand including, but not limited to:

- Any time savings associated with individual travel;
- Government polices to encourage the increased use of public transport as defined in the *Tasmanian Urban Passenger Transport Framework*;
- Existing and development of all attractors within access of the LRS. Attractors considered will include all shopping, commercial activity, educational, health and aged care facilities, recreational as well as tourism associated attractors, such as the Museum of Old & New Art (MONA);
- Possible reduction in demand for private cars in consideration of the impacts of increased oil prices, emission targets/taxes, marketing campaigns to encourage public transport use and other social impacts;
- Integrated feeder bus and/or ferry services (from the Hobart waterfront);
- Impact of potential car parking availability at light rail stations and consideration of potential future parking restrictions in nearby shopping precincts; and
- Land use changes near the rail corridor, for example recognition of the potential impact of urban renewal and redevelopment along and near the corridor. To include Transit Orientated Developments (TODs) along the rail corridor based on advice provided by local authorities and with reference to the draft Southern Tasmanian Regional Land Use Strategy.

It should be noted that 'Medium Case' population projections as defined by the Tasmanian Department of Treasury and Finance, must be utilised in the Business Case.

Economic benefits/cost savings must be captured; including those normally associated with benefits assessment as stated below and, as far as practicable, the quantification of wider economic benefits. When quantification is not possible qualitative benefits must be captured. Qualitative benefits must be carefully illustrated by clear qualitative information including provision of case studies in the associated reports.

- Specific valuation of net cost savings include, but are not limited to:
- Individual Travel time savings;
- Vehicle operating cost savings;
- Improved patronage and revenue on all public transport services;
- Road Traffic Decongestion cost savings;
- Reduced pollution;
- Road maintenance cost savings and deferred expansion cost savings;
- Environmental cost savings;

- Economic development and urban renewals associated with TODs to include changes in property valuations;
- Social cost savings, including improving access for the transport disadvantaged, fostering social inclusion and community cohesiveness;
- Tourism benefits including improved mobility for visitors and facilitating heritage/tourist rail access;
- Road crash costs savings;
- Direct and indirect job creation during/after construction; and
- Residual (infrastructure and rolling stock) values.

4.2 Analytical methodology

Stage Three of the study required us to examine the net benefits associated with the development of the NSLRS, and to compare them with the costs derived in Stage Two.

The estimation of the benefits in a cost-benefit analysis is grounded in the economic notions of consumer and producer surplus.

Technically, the consumer surplus is the area between the demand curve and a horizontal line at the prevailing market price. Put simply, the consumer surplus reflects the difference between what people pay for a good or service and how much they would have been prepared to pay. The 'bonus' they receive is called a 'consumer surplus'.

Producers who can produce for less than the prevailing market price also receive a benefit. The net benefit to society from a policy decision (such as to establish a LRS) can be determined from the resultant change in producer and consumer surpluses. This is discussed in Box 2 (overleaf).

Calculation of the subsidy is relatively simple; it is simply revenues minus costs (including the costs of raising taxes to pay the subsidy).

Calculation of the consumer surplus is more challenging. Since it is the area under the demand curve (see Box 2), we first need to construct a demand curve for each mode of transport, before and after the construction of the NSLRS.

To construct this curve, we used a simple model of consumer choice. We identified the different modes of transport available, for a representative consumer in each of over 200 Statistical Collection Districts (as defined by the ABS) in the Northern suburbs of Hobart. We calculated the cost to the consumer of using each of those transport modes for a specific trip. These costs included cash costs, the value of the time taken to make the trip, risks of accidents, pollution costs and benefits associated with removing social exclusion. The costs were calculated in a functional form, which allows for variation in the components, such as the value of travel time.

We choose a set of values for each of the elements of the cost function (a travel time cost, a fare etc.) for each mode and then compare the costs of making a trip based upon this set of values. We then assume each consumer minimises the total resource cost of a trip, by taking the lowest cost option available to them.

We record the choice of mode and the resource cost/quantity combination on the relevant scatter plot for the mode chosen. We then choose another set of inputs, and repeat the process; in total around 500,000 times. This results in a scatter plot of choices for each mode.

We then fit a demand curve to each of these scatter plots via regression analysis, and calculate the area under each demand curve at the region-wide average resource cost. The sum of the surpluses after the construction of the NSLRS is subtracted from the sum of the surpluses prior to its construction, and any necessary subsidies are subtracted from this result.

We account for the fact that the urban form is likely to change in response to the development of the NSLRS by assuming that "transit oriented development" zones will be established around four stations, and people will move to these zones, creating an urban density equal to that of Subiaco in Perth (one of the more successful of these zones in Australia) and using the NSLRS for a majority of trips. We also consider an extension to the model, being an extension of the track from Mawson Place to Elizabeth Street, with costs provided by Hyder.[3]

[3] The extension does not alter our overall conclusions; if the NSLRS were built, extending it to Elizabeth Street does not change the overall cost-benefit analysis results.

Box 2 Consumer and producer surplus

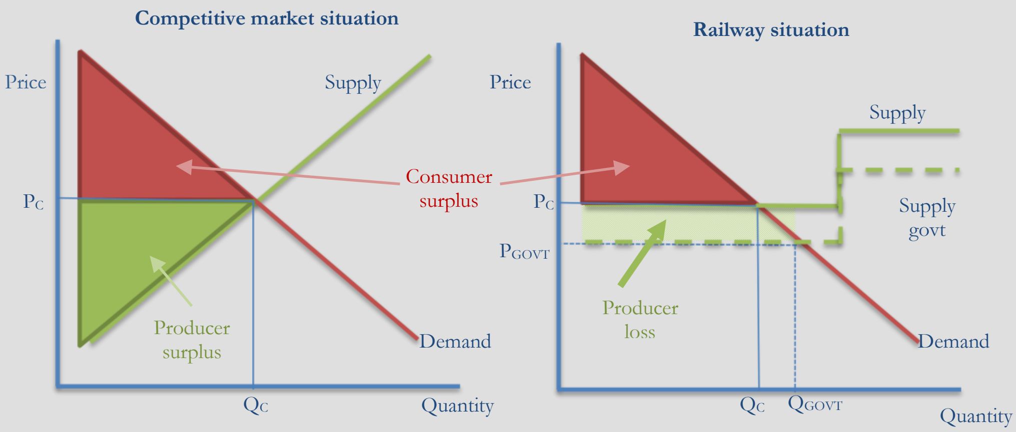
In a competitive market, a firm produces the quantity Q_C, which it sells for the price P_C, generating the red consumer and green producer surplus shown in the left-hand side of Figure 2.

For a railway, the situation is different. Not only is it usually the only provider of rail services in its jurisdiction but, more importantly, its supply curve has a different shape. Most of the costs of a railway are fixed, and thus the supply curve (here of the single railway firm) is flat (or close to it) over a wide range of output. This means that it does not earn a consumer surplus per se, as some firms in a competitive market do.

However, if government determines that the price of passenger railways should be less that the price the railway would like to charge to cover its costs, say a price of P_{GOVT}, which increases supply to Q_{GOVT}, the railway operator will suffer losses (the hashed rectangle below). These must be covered or the railway will not function. Usually, this occurs through the provision of grants from government; a subsidy for the railway.

Just as in the left-hand side of Figure 2, the total benefit to society of the good being produced is the sum of the consumer and producer surpluses, in the right hand side it is the sum of the positive consumer surplus and the negative producer loss which comprises the relevant social benefit of the railway being proposed.

Figure 2 Graphical representation of consumer surplus



Note that the consumer surplus in the right-hand diagram extends down as far as P_{GOVT} and across as far as Q_{GOVT}, but is obscured by the losses shown for the producer.

Our model is grounded in the resource costs of travel, and is heavily dominated by travel time costs. As such, it does not account for some of the intrinsic attraction of rail compared to other public transport modes, which has been observed in many cities and has been called a "sparks effect". It is difficult to specify exactly what causes a sparks effect, and thus predict its likely size in Hobart. We therefore took two extreme examples; no sparks effect at all (ie. modelling the railway exactly according to its parameters established in Stage Two of the project), and a second case whereby we engineered the model to produce a strong sparks effect which gives a modal share as large as the best-performing public transport systems in Australia. We then looked at a number of intermediate cases.

There are a number of benefits which a railway can bring which are less easily quantified, and we thus explored these in a discursive fashion.[4] The reason for doing so is not that such benefits are unimportant, but rather because they are difficult to quantify robustly, and including them with other numbers in the cost-benefit analysis can skew results unduly. The benefits we examined include:

- The social costs of congestion, rather than the costs directly borne by motorists (which we cover in the methodology outlined above), such as the costs to business from workers being late. Based on work undertaken by the Bureau of Transport and Regional Economics, we estimated that the NSLRS could reduce these costs in the strong sparks effect case (and only in that case) by between $206,000 and $1 million per annum. However, we note that a lack of data on actual contributions to congestion on a road-by-road basis make these estimates insufficiently robust to be included in the calculation of benefit-cost ratios.
- The wider benefits associated with the development of transit oriented development, such as a reduction in urban sprawl, an ability to capitalise on public investments in infrastructure by concentrating use, urban revitalisation and the expansion of housing and lifestyle choices. We note, however, the need to plan carefully to ensure a transit oriented development successfully delivers these benefits, and meshes appropriately with the transport infrastructure.
- Tourism benefits associated with the railway, such as improved access to key tourism sites (MONA, the Claremont Golf Club Redevelopment, the Royal Hobart Showgrounds and others) as well as opportunities for enhanced tourism experiences such as heritage trams and "train-cycle" tours.

4.3 Key findings

The benefits and costs of the extreme cases of the strong sparks effect and no sparks effect are shown in Table 5.

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[4] We also supply more detail around some of the benefits that are quantified, such as improvements to social inclusion.

Table 5 **Benefit cost analysis results**

	Strong Sparks Effect		No Sparks Effect	
	Benefit cost ratio	Net benefit ($ mil)	Benefit cost ratio	Net benefit ($ mil)
OOSM 1 (diesel rolling stock)				
4 % disc rate	1.11	22.7	0.0	-268.8
7 % disc rate	1.10	14.5	0.0	-191.5
10 % disc rate	1.09	9.9	0.0	-144.2
OOSM 2 (electric rolling stock)				
4 % disc rate	0.97	-7.3	0.0	-299.6
7 % disc rate	0.95	-7.4	0.0	-213.8
10 % disc rate	0.94	-6.9	0.0	-161.4

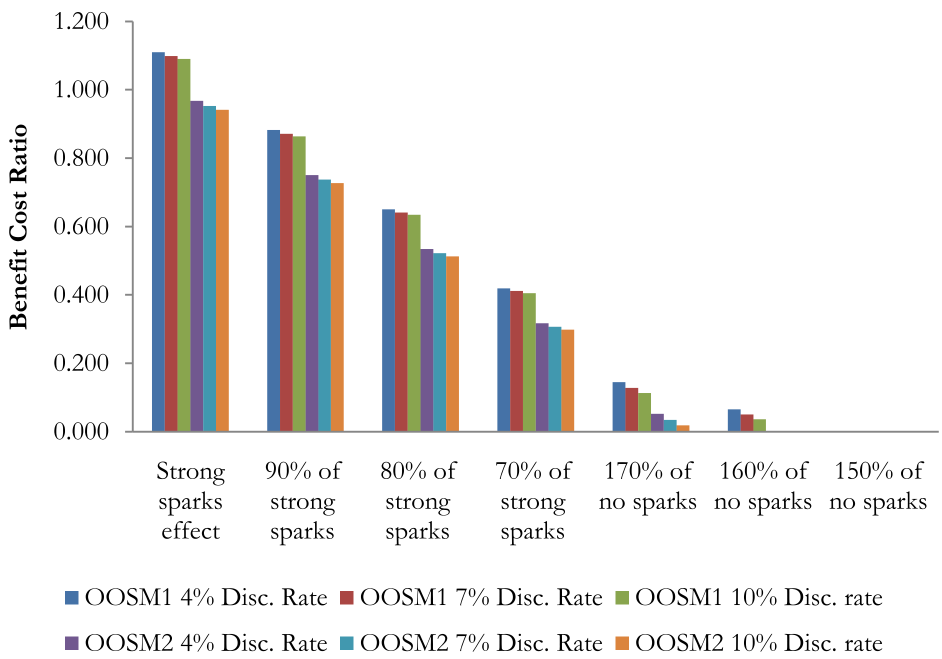
The difference between the strong sparks effect and no sparks effect cases is stark; the consumer surplus in the latter case is only roughly a fifth of that prevailing in the former case, and is insufficient to overcome the subsidy required to operate the NSLRS. The result is a negative stream of benefits and a benefit-cost ratio of zero; the minimum possible. The reason for this is that, while people do use the NSLRS in the no sparks effect case, their numbers are not large, and the benefits they obtain (mostly in terms of travel time savings) are small.

To explore the robustness of each of these extreme cases, we looked at a number of intermediate cases by decreasing (or increasing) patronage and consumer surplus from the levels found for the strong and no sparks effects cases (respectively). The patronage and consumer surplus assumptions in these various cases are shown in Table 6, and the resultant benefit-cost ratios in Figure 3. Note in Figure 3 that the benefit-cost ratio for all levels of demand lower than 150 percent of the no sparks case is zero, and hence we do not show levels of demand below this level.

Table 6 **Patronage and consumer surplus**

	Patronage (weekly)					Consumer surplus ($ mil per annum)				
	Year 1	Year 5	Year 10	Year 20	Year 30	Year 1	Year 5	Year 10	Year 20	Year 30
Strong sparks effect	90,188	92,588	110,607	117,408	123,832	$11.123	$12.724	$13.468	$14.296	$15.078
90% of strong sparks	81,169	83,330	99,546	105,667	111,448	$10.011	$11.452	$12.121	$12.866	$13.570
80% of strong sparks	72,150	74,071	88,486	93,926	99,065	$8.898	$10.179	$10.774	$11.436	$12.062
70% of strong sparks	63,132	64,812	77,425	82,185	86,682	$7.786	$8.907	$9.427	$10.007	$10.554
170% of no sparks	42,950	44,094	66,750	70,854	74,731	$3.639	$4.736	$5.141	$5.457	$5.756
160% of no sparks	40,424	41,500	62,823	66,686	70,335	$3.425	$4.457	$4.839	$5.136	$5.417
150% of no sparks	37,897	38,906	58,897	62,518	65,939	$3.211	$4.179	$4.536	$4.815	$5.078
140% of no sparks	35,371	36,312	54,971	58,350	61,543	$2.997	$3.900	$4.234	$4.494	$4.740
130% of no sparks	32,844	33,719	51,044	54,182	57,147	$2.783	$3.621	$3.931	$4.173	$4.401
120% of no sparks	30,318	31,125	47,118	50,015	52,751	$2.569	$3.343	$3.629	$3.852	$4.063
110% of no sparks	27,791	28,531	43,191	45,847	48,355	$2.355	$3.064	$3.326	$3.531	$3.724
No sparks case	25,265	25,937	39,265	41,679	43,959	$2.140	$2.786	$3.024	$3.210	$3.386

Figure 3 **Benefit cost ratios with increases and decreases in patronage**



When we examine sparks effects larger than the no sparks effect case but smaller than the strong sparks effect case by increasing patronage (and consumer surplus) from the no sparks effect base, and decreasing them from the strong sparks effects maximum demand end-point, we find an asymmetry.

The benefit cost ratio in the strong sparks effect case diminishes sharply with even small reductions in patronage, whilst we require an increase in patronage of sixty percent above the no sparks effect case level to achieve benefit cost ratios greater than zero.

The authors are agnostic about the existence or otherwise of a sparks effect associated with the NSLRS. We note that empirical cases exist where the replacement of a bus route with a rail route have resulted in large increases in patronage, but also note that clear reasons as to why this might occur (absent of the train being faster than the bus) have not been forthcoming, or seem relatively small compared to the size of the effect.

For this reason, we did not make predictions about the likely size of any sparks effect. Rather, we suggested that a benefit cost ratio slightly in excess of one requires a strong sparks effect, but that even a slightly smaller sparks effects will produce much less favourable results. Our overall conclusion, therefore, was that a positive net benefit was a possible outcome, but also a very high risk investment.

5 Conclusions

The conclusions for the First Stage were as follows:

- There do not appear to be any planning or other issues preventing the development of the NSLRS.
- The last three stations on the proposed line (Granton, Bridgewater and Brighton) do not appear to be viable as part of the NSLRS

The Second stage concluded that:

- Considerable work would need to be done on the track to make it suitable and safe for passenger use; costing between $33 and $45 million.
- Either diesel or overhead electric traction would be suitable, but battery power is likely to involve higher risks. With five vehicles, the cost of rolling stock would be roughly $25 million.
- Maintenance and operating costs would be roughly $5 million per annum, after an initial period of five years where the upgraded track would require little maintenance.

The Third stage of the report concluded that:

- On the basis of the operating parameters and costs developed in Stage Two, the project would represent a significant net cost to the community. This conclusion is robust; even if demand levels are 50 percent above the base case, the net societal benefits are smaller than the costs of the subsidy required to operate the NSLRS.
- Some aspects of rail demand are difficult to predict using models based on the total resource costs of travel (that is cash costs, time costs and externalities such as accident risk and pollution), and that rail appears inherently more attractive than other modes of transport.
- If the NSLRS transpires to be sufficiently attractive that its patronage matches the best in Australia, its benefits will just exceed its costs. This conclusion is not robust to changes in demand, as benefit cost ratios fall below one with only small decreases in forecast patronage.
- Overall, a positive net benefit was a possible outcome, but represents a very high risk investment for Tasmania.

A Previous Reports

The three reports summarised in this final report can be found by following the web-links below.

http://www.transport.tas.gov.au/miscellaneous/northern_suburbs_to_hobart_cbd_light_rail_business_case/what_is_stage_1

http://www.transport.tas.gov.au/miscellaneous/northern_suburbs_to_hobart_cbd_light_rail_business_case/what_is_stage_2

http://www.transport.tas.gov.au/miscellaneous/northern_suburbs_to_hobart_cbd_light_rail_business_case/stage_3_economic_evaluation