UNIVERSITY OF SOUTHERN QUEENSLAND

Faculty of Health, Engineering and Sciences
School of Civil Engineering and Surveying

Progress towards sustainable road construction –
An investigation into the Roads and
Maritime Services of New South Wales and
Sustainability Rating Tools.

A dissertation submitted by:
Alexander Labrosse

Student Number:
61058927

In fulfilment of the requirements of:

Bachelor of Engineering Honours
Civil Engineering

October 2015

ABSTRACT

Sustainability is a concept that is becoming more significant within the roads and transportation industry and recently, the need to achieve more sustainable roads is becoming highly desired. The Roads and Maritime Services of New South Wales (RMS) is a state government agency, responsible for managing the road network, by providing sufficient capacity and maintenance solutions to improve efficiencies.

The aim of the first section of the research was to conduct an assessment on the RMS, in order to identify strengths and weaknesses with respect to working towards improving sustainability within road construction. Findings from this critical review were that the RMS has a long history of innovative processes, which includes specific sustainability strategies, as well as integration of sustainable concepts directly into work procedures, standards and specifications. One negative from the assessment was that there are no systems that allow benchmarking of how sustainable processes are within projects. This results in an inability to consistently measure progress and achievements as well as propose improvements. Sustainability Rating Tools (SRT) were investigated as a method that allows for quantified measurement of sustainability in projects, hence identified as a potential solution to these issues.

The aims of the second section of the research were to firstly develop a new SRT that would be self assessable and tailored for use within RMS, and then to assess the functionality of the system through implementation on a current case study. The *Sustainability Monitoring and Reporting Tool* or *"SMaRT"* was developed and implemented on a $4.7 million roundabout construction project. The *SMaRT* system was based off important features identified through the assessment on the RMS, as well as through evaluation of existing SRTs. As a result, the system resulted in the consolidation of "best practice" features and accounted for current values of the RMS. Implementation of the system showed that it functioned as envisaged, and was able to provide results that could be utilised positively for future projects in order to improve sustainability within construction. Overall, final recommendations are that SRTs provide great benefit and should be investigated further, however the use of *SMaRT* within RMS is likely unfeasible due to several deterring factors.

LIMITATIONS OF USE

The Council of the University of Southern Queensland, its Faculty of Health, Engineering & Sciences, and the staff of the University of Southern Queensland, do not accept any responsibility for the truth, accuracy or completeness of material contained within or associated with this dissertation.

Persons using all or any part of this material do so at their own risk, and not at the risk of the Council of the University of Southern Queensland, its Faculty of Health, Engineering & Sciences or the staff of the University of Southern Queensland.

This dissertation reports an educational exercise and has no purpose or validity beyond this exercise. The sole purpose of the course pair entitled "Research Project" is to contribute to the overall education within the student's chosen degree program. This document, the associated hardware, software, drawings, and other material set out in the associated appendices should not be used for any other purpose: if they are so used, it is entirely at the risk of the user.

DISCLAIMER

The comments and views expressed in this paper are those of the author and not of the Roads and Maritime Services of NSW.

These comments should be viewed in the context as defined under the "Limitations of Use" above, and to reiterate, form part of an educational exercise only.

CERTIFICATION OF DISSERTATION

I certify that the ideas, designs, results, analyses and conclusions set out in this dissertation are entirely my own effort, except where otherwise indicated and acknowledged.

I further certify that the work is original and has not been previously submitted for assessment in any other course or institution, except where specifically stated.

Alexander G. P. Labrosse

Student Identification Number: 0061058927

ACKNOWLEDGEMENTS

Firstly, I would like to express my sincere gratitude to my supervisor, Doctor David Thorpe for the continual support throughout this undergraduate research, and for his patience, dedication, and knowledge. His guidance helped me in all the time of research and writing of this thesis. I am especially grateful for the help during the initial planning and development stages as well as the preparation of the final document.

I would like to thanks my mother, Barbara for her unrelenting support throughout my degree as well the assistance she provided in proof reading assignments. Without you providing me food, water, and constant reminder that there is an outside world during long periods of study, I am sure I would not have made it through.

Last but not least, I would like to thank the rest of my family, and all my friends whom have worked through the undergraduate degree with myself, for the stimulating discussions, fun times, support and all assistance along the way. It has been a long and tiresome few years, but overall an enjoyable experience.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

GLOSSARY OF TERMS

ABS –   Australian Bureau of Statistics

ACE –   Association for Consultancy and Engineering (UK)

ACIF –   Australian Construction Industry Forum

AGIC –   Australian Green Infrastructure Council

AHP –   Analytic Hierarchy Process

ARRB –   Australian Road Research Board

BREEAM –   Building Research Establishment Environment Assessment
                  Methodology

CCA –   Compared Comparison Approach

CECA –   Civil Engineering Contractors Association (UK)

CEEQUAL –   Civil Engineering Environmental Quality Assessment and
                  Award Scheme

CIRIA –   Construction Industry Research and Information
                  Association (UK)

DECC –   Department of Environment & Climate Change

DJSI –   Dow Jones Sustainability Index

ENM –   Excavated Natural Material

EPA –   Environmental Protection Agency

EPRM –   Excavated Public Road Material

ESD –   Ecologically Sustainable Development

FHWA –   Federal Highway Administration (USA)

GDP –   Gross Domestic Profit

GHG –   Greenhouse Gases

GreenLITES –	Green Leadership in Transportation Environmental Sustainability
GRI –	Global Reporting Initiative
GVA –	Gross Value Added
ICE –	Institute of Civil Engineers
ILC –	Infrastructure Life Cycle Management
IDRC –	International Development Research Centre
INVEST (USA) –	Infrastructure Voluntary Evaluation Sustainability Tool
INVEST –	Integrated VicRoads Environmental Sustainability Tool
IOA Model –	Universalia Institutional and Organisational Assessment Model
ISCA –	Infrastructure Sustainability Council of Australia
IS Rating System –	Infrastructure Sustainability Rating System
ISI –	Institute for Sustainable Infrastructure
LEED –	Leadership in Energy and Environmental Design
MRWA –	Main Roads Western Australia
NYSDOT –	New York State Department of Transport
NSW –	New South Wales, Australia
NZ –	New Zealand
OA –	Organisational Assessment
PMHC –	Port Macquarie – Hastings Council
QLD –	Queensland, Australia
RMD –	Regional Maintenance Delivery
RMS –	Roads and Maritime Services of NSW
RTA –	Roads and Traffic Authority of NSW

SMaRT –   Sustainability Monitoring and Reporting Tool

SRT –   Sustainability Rating Tool

TAGG –   Transport Authorities Greenhouse Group

TBL –   Triple Bottom Line

TMR –   Department of Transport and Main Roads, Queensland

UK -   United Kingdom

USA –   United States of America

USQ –   University of Southern Queensland

VENM –   Virgin Excavated Natural Material

VicRoads –   State Government of Victoria's VicRoads

CHAPTER 1

INTRODUCTION

The following report presents the findings from the research project titled:

> *"Progress towards sustainable road construction - An investigation into the Roads and Maritime Services of New South Wales and Sustainability Rating Tools".*

This topic has stemmed from several motivating factors, including; experience from working in industry with the Roads and Maritime Services, exposure to large-scale infrastructure projects, and a long developed passion for innovation and creative solutions. The main research question behind the overall project idea is:

> *Can a roadway be considered truly sustainable, and if so what are the methods for assessing this sustainability?*

The aim of this introductory chapter is to introduce the main facets of the research topic and to provide background and context to the project that has been undertaken, as well as defining the projects objectives that are to be achieved.

1.1 WHAT IS SUSTAINABILITY?

There are many definitions used for sustainability, all focusing on a set of key points that are applicable in most areas and industries. The definition of sustainability that has been aligned with for the following report is perhaps the most prevalent and most distinguishable, being:

> *"the needs of the present generation should be met without compromising the needs of future generations"* (RMS 2010; Thorpe 2013; Siew, 2014).

Sustainable development is an evolving concept that emerged early in the 1980s due to the realisation that there was a need to balance economic and social progress with natural resources and consideration for the environment (Edwards, 2009). These three categories of economic, environmental and social form the basis of true sustainable practice, which have become known as "Triple Bottom Line" (TBL) considerations. Each facet should be considered equally as important when assessing for sustainability to ensure solutions are optimal and do not expose the project to unnecessary risk or damage (Klotz & Grant, 2009).

1.2   WHO ARE THE ROADS AND MARITIME SERVICES?

The Roads and Maritime Services (RMS) was formed on the first of November 2011, as the successor of the former Roads and Traffic Authority of New South Wales (RTA) and the former Maritime Authority of NSW (NSW Maritime) (RMS, 2014c). The RMS is a multimodal transport agency, dealing with road and waterway users within NSW, whose focus and purpose can be categorised into four main areas including; managing the road network to improve efficiency and reduce travel times, providing sufficient capacity and maintenance solutions for all users, educating and licensing drivers as well as registering vehicles and vessels and improving safety for all users of the road and waterways. The vision of the organisation is to be the leader in safe, efficient and high quality services and infrastructure to all areas of NSW, with focus especially on the customer. The RMS places the customer at the centre of everything they do; considers reputation and impact; as well as effectiveness and efficiency of any works carried out as main areas of importance (RMS, 2014c).

With respect to the roads network, the RMS has responsibility within NSW over:
- 18,036km of state roads, which include 4,317 belonging to the National Road Network and 147km of privately-funded roads,
- 2,970km of regional roads and local roads,
- funding for 18,257km of Council managed, regional roads,
- 5,287 bridges and major culverts,

- 22 tunnels,
- 3,945 traffic signal sites and around 12,000 other traffic facilities, systems and corridor assets.

These assets are spread over all of NSW, providing facilities for over 5 million road users, managed by over 6,500 staff across all departments (ABS, 2015c).

In the 2013/2014 financial year, the RMS delivered a total of $3 Billion worth of capital works and over $1.5 Billion worth of maintenance and repair works. Some of the more major construction projects carried out during this time included:

- opening of Hunter expressway linking Newcastle and Greater Hunter Region,
- completion of Hume highway duplication – a minimum four-lane, 800km highway from Melbourne to Sydney.
- ongoing Pacific Highway works, from Sydney to Brisbane,
- planning work for WestConnex and NorthConnex motorways, providing vital links in our metropolitan road network and improving freight access,
- ongoing delivery of the Princes Highway upgrade, with objectives of improving safety and access to the South Coast, and
- ongoing delivery of essential bridge upgrade projects to improve freight productivity in rural and regional areas.

It is clear that the RMS as an organisation manages a substantial amount of engineering construction projects each year and has a large responsibility to various stakeholders to do so responsibly (RMS, 2014c).

1.3   STATUS OF THE CONSTRUCTION INDUSTRY IN AUSTRALIA

The construction industry within Australia provides a substantial contribution to the nation's economy, with 8.5% of the total gross value added (GVA) coming from construction, and an associated annual average growth rate of 4.8%. This puts it in the top three for value adding industries, alongside "Financial and Insurance" and "Mining" (Australian Trade Commission, 2015). The world's total

economies have a combined Gross Domestic Profit (GDP) of US$81,274 Billion (AU$113,818Billion), and with Australia having a 1.9% share, this equates to the construction industry contributing a total value of approximately US$131Billion (AU$184Billion) to the annual GVA (Australian Trade Commission, 2015).

In 2011, there were a total of over 1 million people employed in the construction and construction related industry, with over 70,000 people employed in the engineering construction sector (ABS, 2012). The total number of employed persons in Australia is around 11.6 million, which means the construction industry employs around 9% of the total workforce.

The main driving factors for the demand we see towards the construction industry stem from economic factors such as population growth, consumer confidence, changes in interest rates and inflation. Resource availability including both labour and materials also drive change within the industry (ABS, 2010). Specifically within construction, the Australian Bureau of Statistics (ABS) categorises engineering construction (involving activities such as the building of roads, bridges, water, sewerage and electrical infrastructure for example) separately and defines that in terms of expenditure, the engineering construction industry accounts for around 50% of the total expenditure, with the other 50% going towards residential (houses and units) and non –residential (offices, hotels, shops) (ABS, 2015a; ABS, 2015b). Overall, these statistics clearly identify that the construction industry is a major influence within Australia, and there is substantial benefit from ensuring the systems and processes associated are efficient and optimised wherever possible.

1.4   RESEARCH OBJECTIVES

The aims of this research project can be divided into two stages. Firstly, there is a broad aim to investigate the current systems and processes utilised by the RMS and to identify how much focus the organisation has on improving sustainability in road construction. Comparisons will be made of the RMS and other road

construction agencies in order to gauge how the RMS performs in the broader picture. Secondly, it is proposed to develop a Sustainability Rating Tool (SRT) for the RMS, in order to identify if there is room for such application in real life construction projects. The outcomes of this research will aim to provide suggestions for improvements within the organisation, as well as benchmarking the current status to identify when progress is made in the future.

These aims cans be broken into specific objectives for the project, including:

- To research the background and history of sustainability in the road construction industry and identify the main reasons of how and why sustainability is becoming more prevalent in the roads sector.
- To conduct a comprehensive review on the sustainability processes, initiatives and measures that concern road construction within the RMS in recent history.
- To compare the RMS as an organisation with respect to the progress made by other construction agencies and road authorities.
- To adapt and develop an SRT that can be used to provide a quantitative measure of sustainability and aid in improving RMS construction projects.
- To implement the SRT to a current or recent RMS project to assess its performance and evaluate the benefit versus cost with regards to promoting sustainability.
- To correlate all findings from the research and discuss the implications of the results as well as defining a set of "lessons learnt" for the overall experience and recommending potential improvements to the RMS system that will promote sustainable choices and sustainable roads.

1.5   CONCLUSIONS AND REPORT AIMS

Overall this Chapter has broadly exposed the area of sustainability, the RMS and the associated construction industry within Australia. The context provided provides sufficient background to the overall topic area, which will be further investigated in the following chapters. The basic aim of the following report is to

present the research findings of the project, with information presented in line with the following structure. In Chapter 1, background information has been provided to the topic describing the context of the issues and explaining how they pertain to the RMS. Chapter 2 includes a comprehensive literature review on the topic, followed by Chapter 3, which defines the project methodology in detail. The results and all development work from the project are contained with Chapters 4 through 8, with Chapter 8 providing a case study including specific examples. The report will conclude with a comprehensive discussion on all findings in Chapter 9 and final conclusions and recommendations in Chapter 10.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The following chapter will review literature to establish the context, background and justification behind the project aims that have been identified in Chapter 1. This chapter will identify broadly how sustainability has developed in the roads and transportation industry over the years, aiming to provide a timeline of events that has led to the current situation within the industry. The Roads and Maritime Services (RMS) approach to sustainability will be identified as well as defining what trends are present in industry within Australia and globally. The overall aim of this literature review is to define what work has been completed in the topic area and where there are gaps that can benefit from further research. This Chapter will conclude by identifying the direction for the research based on the findings.

2.2 THE CHANGING DEFINITION OF SUSTAINABILITY

As identified in Chapter 1, there are many definitions for sustainability, which have developed over time. It has proven difficult to pinpoint a single definition that encapsulates all areas concerned with sustainability, rather a number of general statements of broad principles have been widely accepted that can then be more precisely defined to suit individual organisations circumstances (Edwards, 2009).

For example, Muench, Anderson & Bevan (2010) define sustainability as;

> *"a system characteristic which reflects the system's capacity to support natural laws and human values."*

Where natural laws relate to basic principles that must be upheld to maintain the ecosystem and human values are equitable and economical choices.

The Federal Highway Administration (FHWA) in North America define the goal of sustainability as;

> *"the satisfaction of basic social and economic needs, both present and future, and the responsible use of natural resources, all while maintaining or improving the well-being of the environment on which life depends"*

The FHWA also adds on that sustainability is typically described by using Triple Bottom Line (TBL) concepts, which include all of social, economical and environmental principles (Reid, 2015).

From the Infrastructure Sustainability Council of Australia (ISCA), Infrastructure Sustainability is specifically defined as:

> *"Infrastructure that is designed, constructed and operated to optimise environmental, social and economic outcomes of the long term"* (ISCA, 2014).

Lastly, the RMS, has defined sustainability as:

> *"ensuring that development, both now and in the future, conserves and maintains natural, social and economic resources without impacting negatively on future generations"* (RTA, 2002a).

Although these definitions vary, among many others that can be identified, sustainability in its broadest sense can be defined as the ability to maintain a certain process or state at a certain point in time or to a certain level (Edwards, 2009).

Perhaps the most cited definition relating to sustainable development is:

> *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"*

This definition is stated within such literature as; Edwards (2009); RMS (2010), Siew (2014) and Thorpe (2013). As identified in Chapter 1, this is the definition that this research project has aligned to.

2.3   TRIPLE BOTTOM LINE REPORTING

Historically, previous efforts to achieve sustainability have tended to be focused on environmental performance, with the least concern for the social dimension. When assessing sustainability, Klotz & Grant (2009) describe how it can be detrimental to focus on only one area without considering the others, as the determined solutions may be sub-optimal or even create unacceptable risk or damage to other areas. For example, a rapidly renewable material may be available and suitable for use, which can be hauled on a route that does not disrupt local communities, however the economic cost of transport and environmental damage from emissions and operations may be unacceptably high (Klotz & Grant, 2009).

Environmental performance of facilities during the operational phase is also a popular area for consideration, however it is now being realised that large results are achieved if such efforts are expanded into the design and construction phases. For example, among the environmental impacts from construction processes including waste generation, energy and resource use; emissions account for over 50% of total impact (Ahn, Rekpalli, Martinez and Pena-Mora, 2009). Willets, Burdon and Glass (2010), Lambous and Moss (2011) & Alam and Kumar (2013) among others make the TBL clear and identify that effective management and progress towards sustainability in construction will be achieved by considering these aspects together.

Environmental considerations are still important, with several initiatives regarding reduction, reuse and recycling of materials available in most areas of the world. This theme continues within the RMS, with recycled materials being utilised within the organisation for several years. For example, on the topic of reusing materials and reducing waste, Saride, Puppala & Williammee (2010) detail

research on road base construction methods in the United States of America (USA) and shows how recycled materials have been used effectively. Herrador et al. (2012) goes into detail of the successful application of different forms of construction and demolition waste in base pavement layers in a trafficked length of pavements and Behl, Sharma and Kumar (2014) identify how waste PVC plastic can be incorporated into bituminous binders for asphalt construction.

2.4   BACKGROUND TO SUSTAINABILITY AND ROADS

The literature makes clear that sustainability is a concept largely present in most industries today with the civil engineering, construction and specifically the roads and transportation sector no exception. The roads and transportation industry however, has begun to see a period of major change, where sustainability is becoming more prevalent. The fundamental reason for the change is stemming from the fact that there has been global realisation that the world has geophysical limits, to which the industry puts considerable pressure on (Toleman, 2008; Klotz & Grant, 2009).

Another influence for promoting sustainable practice has come as a consequence of the construction industry becoming more accountable for the waste, energy use and greenhouse gas (GHG) emissions, as well as social and environmental implications (Balwin, 2003). A better understanding and more information is partially responsible for this community engagement (Thorpe, 2013), as well as education of the public leading to more interest due to popular issues such as climate change and environmental pollution (Toleman, 2008). The literature states the importance of finding the balance between aspiring for sustainability, and other factors including economical considerations, asset management, constructability, safety, social and lifecycle considerations as well as environmental benefit (Lambous and Moss, 2011).

Camarena (2013) defines the main elements dealing with sustainability and roads as:

> *"environment and economic decision making; public engagement; decision for long-term environmental performance; construction planning; and planning for lifetime monitoring and maintenance."*

Muench, Anderson and Bevan (2010) identify that sustainability must be considered a system, which reflects human values. We see that the theme towards sustainable development presently is to consider a holistic approach, however this is only a recent theme with papers published in the past decade. Muench, Anderson and Bevan (2010), Toleman (2008) & Willets, Burdon and Glass (2010) for example identify that typically considerations were only with environmental factors, rather than an all-encompassing approach as identified in Section 2.3. Hasna (2010) also identifies that there is still no set or consistent definition of sustainability in the industry, which has led to varying approaches – due to there being a wide range of sustainability issues. To progress towards sustainable construction, from an engineering perspective, there is an obvious need for clarity on how the science of sustainability can be integrated into practice. For this to happen, there must be consensus on what exactly sustainability is defined as (Hasna, 2010).

2.5 PROGRESS TOWARDS SUSTAINABLE ROAD CONSTRUCTION

Toleman & Rose (2008) identify that historically; attitudes towards most things have been within the mindset that the earth has unlimited resources. In the past 30 years, this is starting to change into the perception that there are physical limitations.

There is no clear evidence presenting itself in the literature to show where efforts would be most effective in developing sustainable roads. There are however some obvious areas where research is targeted, including recycled materials, reusing

waste, refined management, and lifecycle considerations. Wathne (2011) delves into this issue specifically, by questioning; *"are we focusing on the right things?"* The article argues efforts spent trying to ensure sustainable design and construction may be better spent on the operational phase of roads. For example, the importance of specifying rigid and smooth pavement to aid in improved fuel efficiency and energy savings. Another article with this theme is Thorpe (2011), who questions the point of; *"can roads actually be sustainable?"* The paper specifically targets the idea of resilience, and that a road will struggle to be termed sustainable if it cannot maintain viability as a transport route after extreme events. The paper includes useful information regarding the main considerations that must be made when developing a road and why the issues are so prohibiting towards gaining true sustainability. As the proposed direction of the research is to focus on road construction; these papers will be critical to reflect on, to identify, and to validate why only the construction stage of road building was chosen to be the centre of the research.

Vorobieff (2010) presents the challenges that will face any road construction agency, especially those dealing with concrete pavements. The paper reports how pavement engineers have been accustomed to selecting only the highest quality products and identifies that this is not sustainable. The paper identifies the need for changing processes in order for these pavement constructions to continue. This theme of altering the thought process of decision makers appears several times in the literature including within the articles by Wathne (2011), and Balwin (2003). It is clear there needs to be a more efficient way to identify what is sustainable best practice, rather than focusing only on one aspect – such as economics or environmental aspects.

Thorpe (2013) identifies the difficulties in design and construction stages from a sustainability standpoint and that to achieve sustainability; a holistic approach including environmental management, water sensitive urban design, advanced materials and environmentally responsible project management is essential. Other aspects of the design and construction stages are examined.

2.6   HISTORY OF THE ROADS AND MARITIME SERVICES

Recent literature shows the RMS has implemented a sustainability strategy, which explains the overarching commitments of the organisation and the target dates for these sustainability related issues to be achieved (RMS, 2010). The document "Towards a Sustainable RTA", by the RMS details how there is a commitment in working towards a safe, sustainable and efficient transport system operating with minimal impact on the natural, cultural and built environments (RMS 2014, pers. comm., 15 Oct. 2014[1]). The report is more however directed for the organisation as a whole, with only minimal detail regarding sustainability in construction. This is consistent for other pieces of literature dealing with sustainability in the RMS, including the papers Monckton and Moss (2009) and Lambous and Moss (2011).

Sustainability in the RMS does not appear to be a new idea, with evidence showing that there have been initiatives of varying magnitude used for over 20 years (Moss, Monckton & Lambous 2010). It has not been until relatively recently however that any real assessment of progress towards sustainable roads has been brought forth, especially with regards to construction. There is definitely room for improvement with regards to being able to benchmark progress and identify areas to promote sustainable construction, as again as noted, the focus on sustainability is from an organisational standpoint, rather than specifically trying to improve the systems and management within construction.

In general, there is a common theme in the literature explaining why sustainable practice is becoming more prevalent and identified as important. In terms of the RMS, some reasons for moving forward to promote sustainability involve:

- the increasing costs of obtaining material,
- the increasing costs of disposing wastes,
- the reduction in security of supply of some materials,
- legislative changes among other influencing factors (Lambous and Moss 2011).

---

[1] Online training course on sustainability undertaken with the RMS

These are common themes identified in the literature throughout the industry, as discussed by Toleman (2008), Balwin (2003) & Muench and Anderson (2009) and as mentioned previously.

Recalling that the research area is looking at the progress around sustainable road construction; Moss, Monckton & Lambous (2010) include many relevant examples. This paper examines issues faced in the construction of roads in recent times (specifically from an RMS standpoint), but also draws on a broader comparison from the past 20 years. The paper deals with methods for measuring sustainability on construction projects as well as some Australian initiatives used to improve construction. It contains case studies from the RMS experience going back to the year 2000. The paper concludes saying how the construction industry has evolved significantly over 20 years and that the trend will continue. Although the paper makes known what the expected direction is with respect to construction sustainability, it fails to identify the methods that can be employed to assist with the change. Although this was not the intention of the paper, it is an important consideration to identify.

Through examining environmental considerations with respect to sustainability, it is clear that RMS materials and technical standards show a progressive increase in the tolerance for recycled materials used for construction. RMS (2014a) states that although the RMS has been using recycled products for over 50 years in construction, increasing diversity of recycled materials and development of more innovative solutions has allowed more recycled products to be reused. More investment into field trials and testing has also made this possible. Current standards utilised by the RMS incorporate materials such as reclaimed asphalt pavement, blast furnace slag, fly ash, brick and masonry and crushed concrete of which are used in various stages of construction (RMS, 2014a; Monckton & Moss 2009; RMS 2014, pers. comm., 15 October).

2.7 INDUSTRY TRENDS AND THEMES

Overall, there appears to be similar trends nationally and internationally regarding sustainable road construction. The reasons for sustainability gaining traction within the industry stem from the common concerns identified previously from Muench, Anderson and Bevan (2010), Toleman (2008) & Camarena (2013).

Vorobieff (2010) describes how asset maintenance agencies are finding more troubles in maintaining concrete pavements as they reach the later stages of design life and in turn, the pavement design and construction process needs to be furthered refined. Balwin (2003) provides a historical approach to monitoring changing construction practices and the consequential impact to sustainability. It is identified that material use and requirements over time have been largely governed by cost. He identifies that when material costs were low, natural materials were heavily exploited and the opposite when costs were high. The article explains how this methodology is not sustainable and describes ways to move forward; in particular, through waste reuse. These articles bring forth the idea of whole-of-life considerations being crucial to a sustainable system and how choices should not solely be made based on any single aspect.

Hutabarat, Harris and Black (1998) describe the main themes towards transport and sustainable development in the United Kingdom (UK) and the USA and describes the applicability within Australia. They describe the importance of a national approach to sustainability in construction to ensure geographic and sectoral integration and efficient use of economic, environmental and social resources. Again, the theme of a holistic approach is clear. The paper also identifies some useful areas for comparison between the RMS and international agencies, which will be useful for the project when evaluating the RMS systems.

Willets, Burdon and Glass (2010) describe that the construction industry is one of the largest sectors in the UK providing work for 2.1 million people and generating nearly 10% of the GDP. Throughout its construction, operation and maintenance, the built environment contributes nearly 50% of all carbon emissions, 33% of

landfill waste, and consumes 13% of raw materials and 50% of water. Willets, Burdon and Glass (2010) then go on to describe how the civil infrastructure industry appears to be lacking progress with regards to sustainability initiatives and that there appears to be great benefit in being able to quantify sustainability for achieving better efficiencies within any organisation (Wilson et al., 2010). This paper brings forth the importance of targeting the construction stage, which supports the direction of research.

2.8 NEED FOR MORE SUSTAINABLE PRACTICE

2.8.1 GROWTH WITHIN THE RMS

In 2002, what was then the Roads and Traffic Authority (RTA) instigated all organisational wide reporting to include consideration of TBL principles and clear definition of environmental, economic and social issues when reflecting on projects and progress (RTA, 2002b). Up until this point, sustainability reporting was scarce in the organisation and not present in most of the systems. Moss, Monckton and Lambous (2009) state that even though ecologically sustainable development was prevalent in the industry since the early 1990s, the widespread implementation of the principles was not until the early 2000s.

In terms of necessitating the importance of sustainability reporting and development, we can investigate previous RMS reporting to identify what trends there are in terms of organisational growth and increase in works. Specifically, the RTA (2002b) stated that the responsibilities of the organisation included:

- 17,670km of State Roads, including 3,106km of National Highways,
- 3,000km of Regional Roads and Local Roads in the unincorporated area of NSW,
- funding for 18,488km of Council managed, Regional Roads,
- 4,588 bridges, including major culverts and tunnels, and
- nine vehicular ferries.

During this same year, the RTA had a total written down asset value of $50Billion, including the value of the land under roads and a total property value of $3.8Billion (including plant, equipment, private sector provided infrastructure and other non-current assets). The annual funding allocated from state, commonwealth and other road user contributions was $2.5Billion, to complete the RMS works program (RTA, 2002b).

As a comparison, in 2008 the responsibilities of the RTA included:
- 17,932km of State roads, including 4,269km of AusLink network (national highways) and 161km of privately-funded toll roads,
- 2,946km of Regional and local roads in the unincorporated area of NSW,
- funding for 18,490km of Council managed, Regional Roads,
- 5,051 bridges, major culverts and tunnels,
- nine vehicular ferries, and
- 3,690 traffic signal sites, as well as other traffic facilities, systems and corridor assets.

The written down asset value in 2008 was $80Billion, with a total property value of $4Billion. The annual funding allocated for the RTA works program was $3.8Billion (RTA, 2008).

And most recently, the RMS (2014c) state that current responsibilities include:
- 18,036km of state roads, which include 4,317 belonging to the National Road Network and 147km of privately-funded roads,
- 2,970km of regional roads and local roads,
- funding for 18,257km of Council managed, Regional Roads,
- 5,287 bridges and major culverts,
- 22 tunnels, and
- 3,945 traffic signal sites and around 12,000 other traffic facilities, systems and corridor assets.

In 2014, the RMS had a total written down asset value of $94Billion and a total property value of $3.8Billion (the decrease can be attributed to change in organisational structure and increase of hired plant and equipment rather than principally owned assets). The annual funding allocated for works by the RMS in

2014 was $5.1Billion (RMS, 2014c). It is clear that the organisation as a whole is growing and hence efforts towards sustainability should be improving alongside.

2.8.2 GROWTH WITHIN THE CONSTRUCTION INDUSTRY

From 2001 to 2013, the engineering construction sector within Australia saw a dramatic growth trend with the value of work being completed increasing by more than seven times during this period. As of December 2001, the total value of work done in the engineering construction sector was an estimated $4,513.9Million ($4.5Billion) and in the corresponding time period in 2013, this value was an estimated $32,448.2Million ($32.4Billion) (ABS, 2001; ABS, 2013). This can be mainly attributed to a boom in the resources sector, but also due to population growth and demands for upgraded facilities (Kaspura, 2015). Refer to Figure 2.1 below.

The decrease of work done in the industry from 2013 to the present can be attributed to the disruption from the global financial crisis, which started to reduce the total engineering construction work since 2000 – 2010 (Kaspura, 2015). The Australian Construction Industry Forum (ACIF) is known for providing reasonably accurate forecasts for both regular construction as well as engineering construction. Recent forecasts show that growth will occur again in the industry, starting around 2017, after remaining relatively flat from the present time. The growth is not expected to rise again to such a high rate, however will increase more constantly in time (Kaspura, 2015).

The trend in growth for the wider construction sector was relatively similar to the RMS until 2013, with the RMS not experiencing a dramatic reduction in the quantity of work undertaken. In the past 10 years, the RMS has seen only rapid growth, with the most salient feature being the increase in the asset value – almost doubling from $50B to $94B (RMS, 2014c; RTA, 2002b)
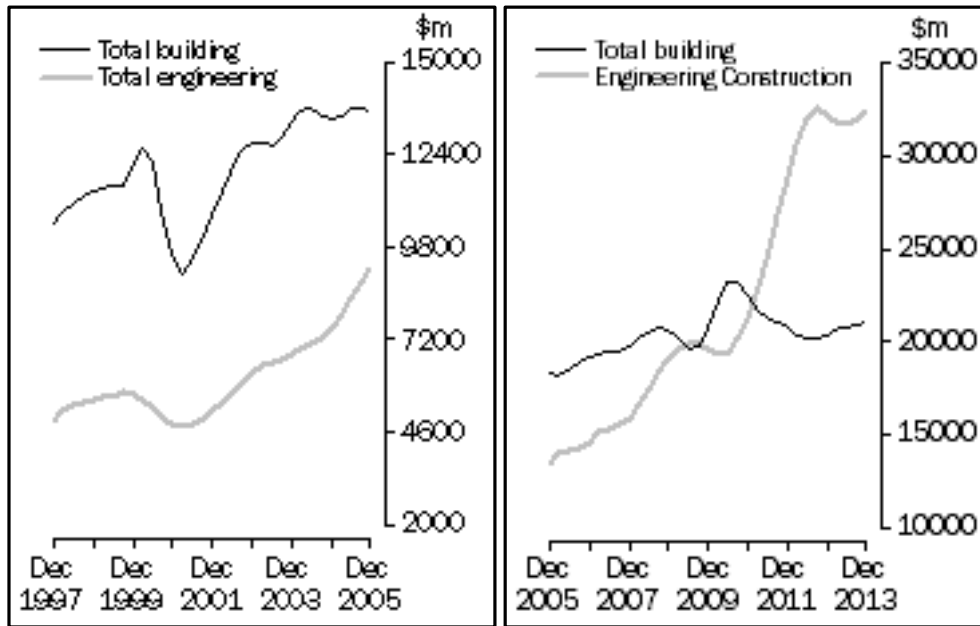
Figure 2.1: Value of engineering construction work completed in Australia between 1997 and 2013, (ABS, 2013).

From December 2013 till the present, as noted above there has been a decrease in total value of work completed, with the most recent data (March 2015) showing a total estimated value of $25,153.5Million ($25.1Billion) (ABS, 2015a; ABS, 2015b). Refer to Figure 2.2 below.
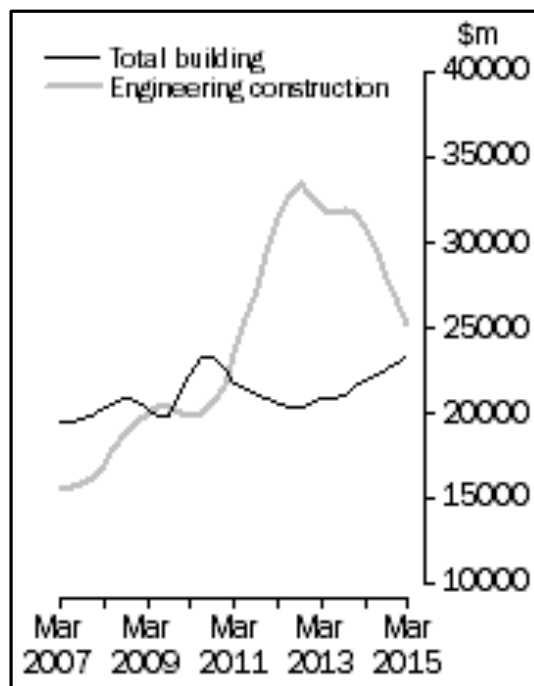
Figure 2.2: Reduction in engineering construction work between 2013 and 2015, (ABS, 2015a).

2.9   TECHNIQUES FOR MEASURING SUSTAINABILITY

As identified previously, there is strong evidence in the literature that suggests that being able to quantifiably rate how sustainable a project is has significant benefits in the long term. This is notably an area that lacks information, however there are some key areas that apply to road infrastructure in particular.

The assessment of the sustainability of a construction project has in the past generally tended to be a qualitative summation of project impacts against ecologically sustainable development (ESD) principles, drawing on some quantitative measures where available and where they can be directly compared with a useful benchmark. Similarly, assessment of the choice on construction materials has generally been undertaken by considering the likely performance of materials against desirable sustainability characteristics (Moss, Monckton & Lambous, 2009).

There are efforts being put towards quantifying sustainable practice, along with establishing a certain benchmark to allow constancy in the reporting techniques and outputs. One such method is by establishing and utilising Sustainability Rating Tools (SRTs), which will be discussed in the following section.

In terms of standardising reporting requirements, the Global Reporting Initiative (GRI) is a set of guidelines that assist organisations in assembling sustainability reports. The GRI is the world's most widely accepted and extensively utilised sustainability reporting framework, founded in 1997 (GRI, 2014; Klotz, 2009).

The system uses 49 core performance indicators, to convey the information from the organisation, exposing the most critical impacts on the environment, society and economy. By developing and communicating their understanding about the connections between sustainability and business, companies can enhance their value, measure and manage change and drive improvements and innovations. The overall aim of the GRI system is to make robust and purposeful sustainability reporting standard practice (GRI, 2014; Klotz, 2009).

2.10 INFRASTRUCTURE SUSTAINABILITY RATING TOOLS (SRTs)

SRTs have been making an impact within the roads and transportation industry since around 2003 where the Civil Engineering Environmental Quality Assessment and Award Scheme (CEEQUAL), developed by the Institute of Civil Engineers (ICE) was first introduced (Lees, 2010). Currently there are several systems available for a wide range of industry as well as some that are specifically tailored for road infrastructure projects.

Some of the more renowned, respected and proven SRTs include:
- CEEQUAL (UK, Institute of Civil Engineers),
- Greenroads (USA, Washington State Department of Transport),
- GreenLITES (USA, New York State Department of Transport),
- ENVISION (USA, Institute for Sustainable Infrastructure),
- INVEST (USA) (USA, Federal Highway Administration),
- Infrastructure Sustainability (IS) Rating Scheme (Infrastructure Sustainability Council of Australia) (Bockish, 2012; Wilson et al., 2010).

These SRTs among several other smaller, more localised or less developed systems have been introduced in different countries and regions, however the reasons behind development appear consistent. For example, Muench, Anderson and Bevan (2010) describe that the need for such systems can be described by four basic reasons:

1. Roadways can be more sustainable that what they currently are. This stems back to the concept that a holistic approach has not been historically implemented with regards to improving sustainability. For example, recycled materials may be used for a project however; the design and construction will not consider life cycle emissions and energy use.
2. To date, the implementation of sustainability efforts has not been to a consistent standard and hence it is difficult to assess improvements over time.

3. The science and engineering underlying road sustainability is complex and decision by non-experts, who are typically in charge of promoting direction or funding of these projects is problematic.

4. Various aspects of road sustainability are difficult to compare as they cannot be simply compared to a common value set.

As a consequence of these issues, currently it is difficult to gain an overarching view of the project's sustainability, hence why the rating system is beneficial. The ability to measure performance can help with these issues, so it is important that the SRT is simple, clear and adhere to all regulations and necessary requirements for it to be effective.

Alam and Kumar (2013) identify that a sustainability assessment framework can be an effective means to build sustainability aspects into the design, construction and operation of infrastructure assets and Lees (2010) identifies that rating systems provide a system for incentivising sustainable design and construction if the categories are well defined, understandable to the public and irrefutably beneficial in terms of sustainability. Abdul (2012) identifies that the primary objective of implementing a road rating system for the City of Vancouver Public Works was to identify the level of sustainable measures within specific projects and gauge success factors against other projects. It is also identified that currently there are no consistent standards or design frameworks for these systems; hence there is no direct way of comparing the performance. The application of such a system must be tailored specifically for its use – based on the area of application, the stage of a project it is to be used for (design and development, construction, operational, maintenance and end of life) plus other considerations (Abdul, 2012; Alam and Kumar, 2013).

There appears to be a global trend towards utilisation of SRTs and even though there is no specification for the development of such tools, they have a common objective to develop and encourage improvements in sustainability (Lees, 2010). The objectives of Greenroads defined by Muench, Anderson and Bevan (2010) address similar approaches as those identified by Lees (2010) for the IS rating system for example.

The USA appears to be paving the way in terms of implementation of SRTs, with several systems such as those mentioned above implemented around the country. Looking at one specifically, Muench, Anderson & Bevan (2010) describe that the purpose of Greenroads was to develop a proposed standard for quantifying sustainable practices associated with the design and construction of roadways. Greenroads:

- has potential to encourage more sustainable practice,
- provides a quantitative means of assessment,
- allows for informed decisions and trade offs regarding roadway sustainability,
- promotes establishment of an implementable baseline requirement to stimulate improvements, and
- is applicable to the design and construction of new or rehabilitated roadways including expansion or redesign. (Muench & Anderson 2009; Muench, Anderson & Bevan 2010).

The objectives of the Greenroads system would benefit the RMS system as well and hence we see there is potential for implementation and development in this area.

In terms of implementation, Clevenger, Ozbek and Simpson (2013) identify that over the last decade the building industry has seen many sustainability rating tools that address and reduce environmental impacts of vertical projects, for example buildings. The genesis of SRTs for buildings started in 1990 with the launch of the Building Research Establishment Environment Assessment Methodology or BREEAM system. Currently, the system has certified ratings to over 425,000 buildings and has had over 2 million registered buildings (BREEAM, 2015). During the same period, we see that civil infrastructure projects have not received the same attention. This relates back to previously when it was brought to attention how the roads and transportation industry has been somewhat left behind in terms of sustainable development and have recently commenced this period of substantial change.

2.11 DIRECTION OF RESEARCH

As identified in Section 2.6, the RMS sustainability strategy is directed more to the organisation as a whole. The lack of focus on construction of roads themselves shows that there is room for research and development. RMS (2010) also goes into more detail about the desire of the RMS to improve the sustainable practices already in place and directly states as one of the commitments as "promoting research and development into emerging road construction materials and processes. This is consistent with the information provided by Lambous and Moss (2011) who add "enhancing development and promote innovation".

Showing up as an industry wide trend, the roads and transportation sector has not seen the same concern to developing sustainability until recently as described in Willets, Burdon and Glass (2010) & Wilson et al. (2014). Historically, the main focus has also been on environmental protection, rather than an all-encompassing, holistic approach. Willets, Burdon and Glass (2010) state that sustainability in management is the only way to improve the overall concept and that even though construction is important, pre-construction and post construction are important as well.

It appears that there is a gap in the research regarding sustainability rating in Australia, with only the IS Rating Scheme being identified in Western Australia and a scheme used somewhat in Victoria called the; "Integrated VicRoads Environmental Sustainability Tool" or INVEST (Wilson et al., 2014). It is clear that SRTs could provide a way of effectively quantifying initiatives, assessing improvement within the industry and creating incentives for working toward sustainable roads. Muench, Anderson & Bevan (2010) state that SRTs would attract not only the organisation using them but also include road owners, funding agencies, designers, contractors, regulatory agencies such as the Environmental Protection Agency (EPA) and trade organisations such as Cement Concrete & Aggregates Australia. Quantifying sustainability may provide greater efficiencies for the organisation as well as providing information that will support change in the industry overall (Camarena, 2013; Muench, Anderson & Bevan, 2010).

Camarena (2013) identifies that although there are some good systems available, typically the data available is scarce and the gathering methods are underdeveloped. In order to be effective and beneficial, a system needs to be:

- self applied,
- self assessed,
- simple and minimally time consuming, and
- able to produce quantifiable, reliable information.

One key question that must be asked prior to deciding to use such a review tool is;

"Will the tool deliver enough value to justify the cost of implementing it?"

Economic consideration of implementing such systems will obviously remain a priority. Some questions that should be answered include:

- Does the tool assist in identifying areas for performance improvement?
- Will the tool require onerous activities and substantial work to collect data?
- Is the tool rigorous enough?
- Does the tool meet current performance assessment and reporting requirements? (Wilson et al., 2014)

To gain this level of specificity, a clear idea of sustainability and which areas are most important for the agency applying the system is essential. Hasna, 2010 outlines that there is still no set or consistent definition of sustainability and there are a wide range of sustainability issues (with regard to engineering and construction) in the literature, as it exists. For the RMS, it will be necessary to identify the current definition of sustainability, identify which areas have been defined as the most important and base the system around these core values.

Thorpe (2013) identifies a methodology for constructing a ranking system of sorts, which may prove beneficial in understanding how a system can be developed for the RMS for example. Other papers, that identify the process behind putting together a ranking system, include Eisenman and Meyer (2013) and Abdul (2012).

2.12 CONCLUSION

This chapter has identified that there is a high level of interest from the roads and transportation sector with regard to sustainability and how to improve the overall process of road construction. Overall it is clear that considering sustainability in road construction is a necessity and that for progress to be made, a holistic approach will have the greatest impact as well as considering a TBL approach rather than simply concentrating on environmental issues, as has been shown as a historical trend. The RMS system currently does not have sufficient focus on construction, rather taking an organisational approach, and there are no real tools available to benchmark progress and identify where improvements and progress can be made.

It has been identified that there are several SRTs, which are being used today, however as there is no standardised framework for development and it is difficult to compare individual system effectiveness. In order to develop a system appropriate for the RMS or any other agency, the more trusted and proven systems could be further analysed and adapted to form the basis of the model. It is important however to realise that all criteria and aspects of a system should be determined for the region of implementation to ensure sufficient specificity, maximum efficiency, and effectiveness.

The direction of the research has been clearly identified based on gaps in the available literature. The main ideas that have been drawn out from this literature review will be developed in the project methodology discussed in the following chapter, which will clearly define what is to be expected from the research and why such research is required.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

As identified, this project is mainly a research-based task that will focus on evaluating the RMS system, proposing improvements, and developing plus implementing a Sustainability Rating Tool (SRT) that can be applied to construction projects to progress towards sustainable roads. The introduction has given a broad overview of the chosen topic area as well as a brief insight to the reasons behind pursuing the research direction. This chapter will expand on the project objectives identified in Chapter 1, based on the knowledge and information that has been revealed from conducting the literature review. Overall, the aim of this chapter is to make clear the research process involved with each task, identifying the necessary techniques that will be employed for development and analysis and discuss the methods that will be used for evaluating the results.

3.2 PROJECT OBJECTIVES

On the basis that there can be greater understanding of how sustainability can be integrated and monitored in construction projects within the RMS, each of the project objectives identified in Section 1.5 will be described in more detail in order to define the process for achieving the desired outcomes. The project works were conducted in two stages; the first being a review and analysis of systems and processes, and the second stage involving development and implementation of an SRT as well as discussion of results.

3.3 STAGE 1 – REVIEW AND ANALYSIS

3.3.1 RESEARCHING BACKGROUND AND CONTEXT

This objective involved conducting a literature search and review, essential for any research project. The comprehensive literature review in Chapter 2 of this report was conducted, examining the background to the issues in detail, covering aspects of sustainability, roads and construction as well as identifying the trends towards developing sustainable roads. Secondary data for this review was obtained from a range of different sources including various journal databases, the University of Southern Queensland (USQ) library, Google Scholar, the RMS's technical library plus others. To aid in the literature searching and to categorise the information that had been found, a list of key terms was developed and each new piece of information cross referenced and correlated with these terms. Peer reviewed journals, conference papers, technical reports and specifications have formed the majority of literature in this review, with technical reports proving most available and beneficial for the information that was required. The direction of research identified in the literature review was developed from my own personal interpretation of where there is a gap in the field of study, based on personal knowledge and experience from working in industry. Common trends that have been exposed through conducting the review itself were also a factor in defining this gap in the literature.

3.3.2 RMS'S IMPLEMENTATION OF SUSTAINABLE PRACTICE

In order to conduct a comprehensive review on the processes, initiatives and measures related to sustainability within the RMS, a method of "Organisational Assessment" (OA) was defined. The Universalia "Institutional and Organisational Assessment" Model (IOA model) was utilised, as it provided a framework that allowed a defined structure to be incorporated for the assessment. In order to gauge the standard of sustainable practice within the RMS, the broad question to be addressed through the use of the OA was:

How does the RMS integrate sustainability into construction practices, what areas require further attention, and which areas show where the organisation excels?

The objectives of the OA, were to identify; areas of competency areas that could see improvements, areas exposing unnecessary risks, as well as identifying areas that would most benefit from revaluation (Lusthaus et al., 2002; Universalia, n.d.).

The IOA framework the RMS review was based on is shown in Figure 3.1 below. As "Sustainability", only a very specific aspect was to be assessed, it was not plausible or necessary to evaluate all listed components. Rather the salient features or themes constituting each of the four individual categories were analysed, with information being provided on how the RMS achieves the set targets and objectives. This allowed a more efficient viewing of the RMS in general, with a narrowed and concentrated focus on sustainable practice.
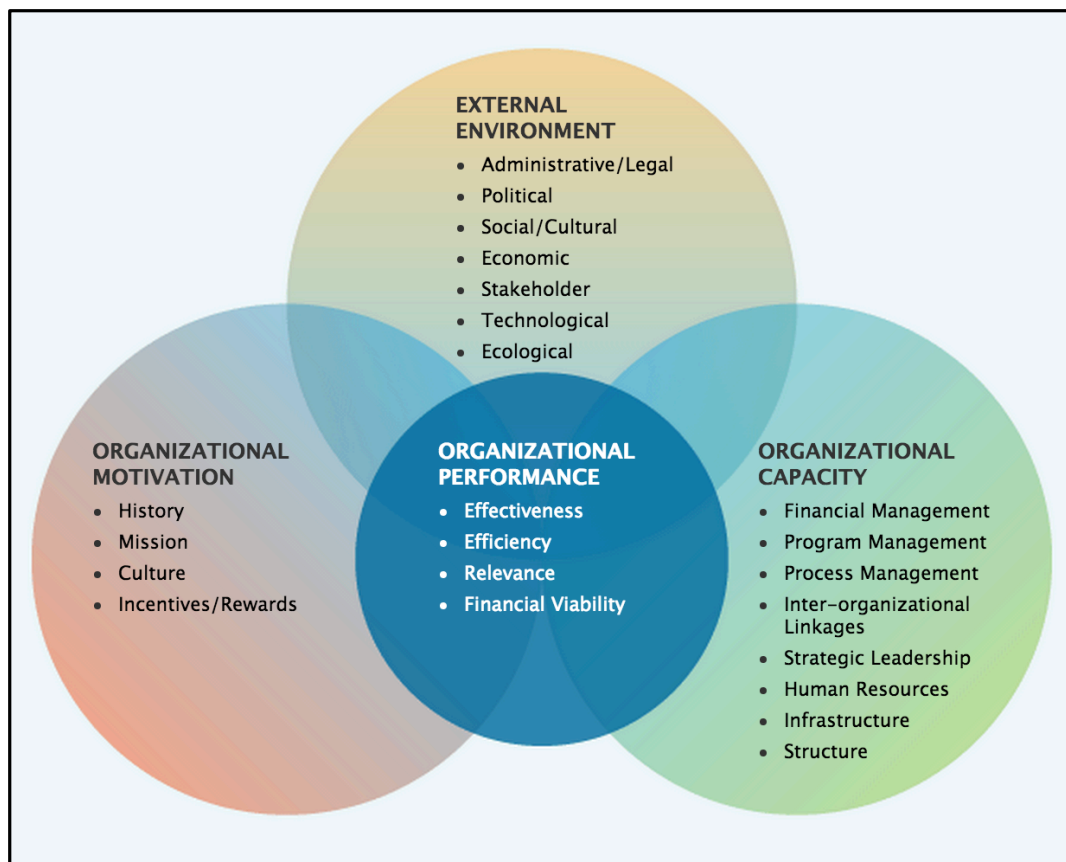
Figure 3.1: Universalia's Institutional and Organisational Assessment framework, (Universalia, n.d.).

The method for adapting the IOA model for use within this project involved representing each of the four categories with a centralised question, that covered the general idea each portion of the framework was responsible for achieving. The four categories were modified and tailored to specifically deal with only sustainability concerns, then each section was systematically assessed.

The methods for achieving this assessment involved critically reviewing the RMS systems, by examining documents such as technical procedures, specifications and standards as well as research reports, historical papers and other project documents. Pertinent features of the RMS systems were focused on including; the defined sustainability strategy, the mechanisms for delivering projects including "ProjectPack" and "MinorProject" systems, annual reports from the organisation as well as areas of particular importance to the organisation such as; materials and waste reuse, as well as emissions and climate change. To conclude this analysis, all information obtained and evaluated was produced into a succinct conspectus.

3.3.3   COMPARISON OF THE RMS TO INDUSTRY

To maintain research rigour and to minimise effect of any bias, qualitative data techniques such as those identified in Long and Johnson (2000) were considered and adhered to as closely as possible. These are to ensure there is validity and conviction in the results presented from the research, which when based substantially on qualitative data can exhibit some level of subjectivity. It is also noted that with qualitative data, there is some form of interpretation and understanding made during the collection of such data, which would suggest the analysis already commences to some extent during the collection stage. It must be noted that these techniques identified by Long and Johnson (2000) were not only utilised for the comparison of RMS to industry, but with all qualitative data analysis, including the activities described in Section 3.3.2 above and to be defined in Section 3.4 below.

The outcome of the critical review aimed to provide an objective, quantified comparison of the RMS systems to other road agencies. The crux of the activity involved a repeatable comparison of the RMS to other construction entities and departments in the industry. The majority of documents utilised for this critical review included technical reports and papers from the agencies themselves, which were individually analysed before being compared to the RMS. The aspects of comparison were kept consistent for each organisation, in an attempt to maintain consistency and equivalence in the results achieved.

The results from the RMS analysis formed the grounds for areas and features to be examined, as the essence of the project was to identify how the RMS can improve towards sustainable road construction. This was achieved by obtaining some ideas from other road agencies where they showed superiority over areas within the RMS that appeared less effective. In order to obtain a broad sample size, an attempt to compare both national and international agencies was firstly targeted, however throughout the research it was determined that this was unnecessary. The RMS operates along the east coast of Australia, under certain specific conditions, and governance, as well as the ideologies of people are all different from other locations around the world and around Australia. Due to the vast number of directions this comparison could have been directed, only a small selection of agencies for comparison were analysed in this final research report. This was justified as appropriate for the scope of the project, as it allowed for a broad overview of the industry to be obtained, as well as to identify some potential areas where other sectors of the industry are more successful than the RMS.

3.4 Stage 2 – Development and Implementation of a Sustainability Rating Tool (SRT)

3.4.1 Development

The final SRT that was developed in this research was called the "Sustainability Monitoring and Reporting Tool", or simply; *"SMaRT"*. The overall outcome from

this project objective was to develop a structured, simplistic, self-implementable (i.e. by the project manager/organisation) and "RMS specific" rating scheme that can be used for construction projects. Ideally the system would be applicable for RMS project managers as an assessment management tool for quantifying sustainability aspects of their projects once construction is completed, to propose ways forward for future works.

The process for developing this system involved three steps. The first step involved selecting current, available SRTs for analysis; to determine key features, certain components or inclusions that were necessary for any new SRT and that could be adapted in the new system to be developed.

Six of the more established systems were chosen, including:
1. Civil Engineering Environmental Quality Assessment and Award Scheme (CEEQUAL) – United Kingdom (UK).
2. ENVISION – United States of America (USA).
3. Green Leadership in Transportation Environmental Sustainability (GreenLITES) – USA.
4. Greenroads – USA.
5. Infrastructure Voluntary Evaluation Sustainability Tool (INVEST (USA)) – USA.
6. Infrastructure Sustainability Rating Scheme (IS) – Australia.

The choice of these systems came from evidence in the literature, with many papers making reference to, or analysing these systems themselves. Other SRTs could have been included for this analysis, however six was determined as a suitable starting point.

These systems were qualitatively compared, based on a pre-determined set of criterion, which were used for a thematic analysis. The comparisons were made based on contextual and methodological aspects, with contextual features encompassing; the type of decision maker, objective of the tool and object being analysed; whereas methodological features were dealing with system boundaries, parameters and presentation techniques.

The evaluation criteria included for the comparison included:

Contextual:

- Who, where and when was the system developed for, to gain context?

- What was the primary purpose for developing the system?

- What infrastructure type can the system be used for?

Methodological:

- How many categories does the system include?

- What is the number of individual criteria included in these categories?

- What is the total number of achievable points?

- How many award levels does each system utilise?

- What was the methodology to assigning weights?

The second step of developing the system involved defining the features and structure of the rating system. This process involved identifying features to be included in *SMaRT*, based on the analysis of the six systems above, as well as from the results of the RMS analysis, defined in Section 3.3.2. Common features identified in SRTs included the presence of different categories, with subcategories and individual credits defining one specific sustainability process. These credits are typically awarded a numerical score, which totals in the whole context of the system to give an overall rating for the entity undertaking the assessment. This general structure was followed for *SMaRT* as it has shown effective in the existing systems.

Through analysis of the RMS systems via the methods identified in Section 3.3, key sustainability concerns for the organisation were identified, which were used to define and name the categories which would form the basis of *SMaRT*. This process was essential as; through identifying the themes important to the organisation, it ensured that the final system had relevance to the current beliefs and values of the RMS as a whole. By reviewing the RMS systems first, writing individual criteria was also simpler and provided a strong context for themes to be built on. The development of the system has been described in more detail in Chapters 6 and 7 of this report.

The third step of developing the system involved assigning weightings and scores to each category and individual criterion. Methods for developing other rating systems were reviewed, including those mentioned in Thorpe (2013), Abdul (2012) & Eisenman and Meyer (2013). A "Compared Comparison Approach" (CCA) was used to assign the scores for each category, due to the relative simplistic nature of the technique as well as the nature of the task. This method has been discussed in more depth in Section 7.4.1 of this report, where the scoring process is exposed. More intricate methods were investigated such as the Analytic Hierarchy Process (AHP), however as the rating tool has been untried and tested, more sophisticated methods for assigning weights were deemed unnecessary. It was also noted that several of the existing SRTs also applied similar methodologies to awarding scores to criteria.

The basic process for assigning the scores using the CCA technique involved ranking each specific sustainability objective against all others in the system. Those criteria that have the most significant impact to sustainability are awarded higher scores, while those criteria with a less substantial impact, are awarded lower scores. This allowed each variable essentially to be ranked, reflecting its relative impact towards achieving sustainability. This process has been described in more detail in Section 7.4 of this report.

3.4.2 IMPLEMENTATION

In terms of applying the rating system, the objective to be achieved was an example output from the *SMaRT* system. Implementation of *SMaRT* firstly involved undertaking site work on a current RMS construction project, which was chosen as the Ocean Drive and Houston Mitchell Drive Roundabout (Ocean Drive Roundabout) project, located near Port Macquarie in NSW and investigated between March of 2015 and July of 2015. Data that was required for the analysis was obtained from visiting the site itself, through inspections of site operations, equipment, plant and overall set-up; as well as from project documents, and from

direct communications with those people with direct management responsibility over the project. The process of implementation involved sequentially working through each category of *SMaRT* and commenting on the achievements of the project.

The results from the implementation of *SMaRT* were reviewed in order to identify how; both the case study project has performed with regards to sustainability as well as how *SMaRT* has performed as a system. This analysis of the output involved reviewing a set of pre-determined questions, which were defined as key inclusions for *SMaRT*. These included:

- How much time was spent to rate the project?
- Who should be rating the projects?
- Does the system contribute to the evolution of more sustainable projects?
- How well has the project incorporated sustainability?
- Will the project be able to incorporate the results positively?
- Has the system been utilised efficiently as an assessment tool?

3.5   CONCLUSION

This chapter has described the procedure and techniques that have been used to complete the research, and achieve all the identified project objectives defined in Chapter 1. It has been identified that a critical review of the RMS and associated systems was undertaken in order to develop comments on the progress of the organisation, which have been compared to other construction agencies in a similar manner. A thematic, qualitative comparison of current SRTs was conducted and key features from these existing schemes were adapted for use in the developed *SMaRT* rating system. An important aspect that has been noted includes the attention to maintaining rigour in the research, which involved consideration of techniques identified in Long and Johnson (2000).

In terms of the rating system, it was identified that there is no set framework for development and hence the techniques utilised did not follow any set procedure.

Features of the system were chosen by defining requirements and identifying what was required to achieve these goals. The implementation stage of the research project involved partaking in site work for a current RMS construction project and obtaining sufficient site information to enable use of the rating system.

Overall, the methodology for the project has described the high application of qualitative data techniques and outlined the methods followed to ensure research rigour. The following chapters will provide the results obtained through the project work, of which has been collected and analysed via the methods outlined in this chapter.

CHAPTER 4

ROADS AND MARITIME SERVICES

4.1 INTRODUCTION

Conducting an assessment on the Roads and Maritime Services (RMS) is necessary in order to cast an overall judgment on the performance of the organisation. This will allow key features to be determined that can assist with the development of the Sustainability Rating Tool (SRT), *"SMaRT"*, to be presented in Chapter 7 of this report, which is a major component of the research project. The motifs that will be examined in this chapter include investigation into; the specific sustainability strategy, materials and waste reuse, past, present and future innovations and initiatives, and finally a general discussion on improvements over the years, with respect to the RMS. These areas will be examined in as much detail as possible, however due to the volume of information, the results provided will be a short, summation of the salient features to provide a holistic overview of the current status.

As identified in Section 3.3.2, the aims for this Chapter are to; identify areas of competency, areas that could see improvements, areas exposing unnecessary risk, as well as identifying areas that would most benefit from revaluation. Overall, an all encompassing view of the progress the RMS has made in recent times should be apparent and allow discussion of key areas to be conducted.

4.2 ORGANISATIONAL ASSESSMENT STRUCTURE

An organisational assessment (OA) can be defined as a systematic process that allows collection of valid data about how an organisation performs and the factors that affect this performance. There are several reasons why an OA would be conducted on an organisation, including; to identify the strengths and weaknesses at any time, provide stakeholders with information about performance, identify future needs of the organisation, and to present information that can aid strategic decisions. (Universalia, n.d.).

As identified in Section 3.3.2, the basis of the Universalia "Institutional and Organizational Assessment" Model (IOA model) was utilised for structuring the assessment conducted as part of this research. This particular framework was developed by the International Development Research Centre (IDRC) and Universalia with initial works starting in 1993 and published in 1995. The framework has been used in various countries around the world and on various types of organisations (Lusthaus et al., 2002; Universalia, n.d.). The system was chosen due to the simplicity of its interpretation of how an assessment process should be conducted, as well as the ability for the user to tailor the main facets of the framework to be appropriate for analysing selected components of the organisation only. It should be noted that alternative organisational assessment tools were also initially investigated including the Burke-Litwin model[2], the Seven-S model[3], and the Marvin Weisbord Six-Box model[4].

In order to simplify the IOA model for only assessment of sustainability concerns, the four main categories were assessed with the following centralised questions. The information obtained from this OA process is presented in Section 4.3 to 4.7 to follow.

---

[2] (Burke & Litwin, 1992)

[3] (Wilson & Beaton, 2003)

[4] (Weisbord, 1976)

Enabling Environment - *How does the organisation integrate the consideration of sustainability within operational procedures?*

This category within the IOA model can be interpreted as directly relating to the capacity of the organisation to implement sustainability initiatives. As a result, to evaluate this portion of the RMS, documentation was assessed to identify what extent sustainability has been included in the procedures and systems.

Organisational Capacity - *What are the strengths and weaknesses of the organisational structure that promote sustainability?*

This was evaluated by identifying the mechanisms for delivering information and results as well as making judgment on the hindrances or advantages these systems provide.

Organisational Performance - *How effectively and efficiently is the organisation in moving toward the fulfilment of its mission in achieving sustainable road construction?*

This was evaluated via critically evaluating how the organisation has performed overall, through previous annual reporting on achievements from the RMS.

Organisational Motivation - *What evidence is there to show how motivated the organisation is, with respect to achieving their set goals and mission? What achievements and struggles have been related to achieving these goals?*

This was evaluated by assessing past reporting on the topic area, to identify the methodology and history behind initiating change. Future plans of the organisation have also been identified (Lusthaus et al., 2002)

4.3 "TOWARDS A MORE SUSTAINABLE RMS"

As identified in Section 2.6, the current sustainability strategy for the RMS is titled; "*Towards a more Sustainable RTA",* developed and implemented since 2010. In terms of directly assessing the values RMS holds towards sustainability,

this document is the primary or most current point of reference for gauging the emphasis and efforts that are placed and the methods for implementation. It thus presents an opportunity to assess how the RMS "Enables the Environment", a key area of the organisational assessment.

The strategy was created in line with NSW state planning and values, which were developed with goals of long-term results in the area of delivering the best possible service to NSW and ensuring the government leads by example in the areas of water and energy use, reducing greenhouse gas (GHG) emissions, waste management and sustainable procurement. The overall aim of the RMS strategy is to; contribute to a more sustainable transport system in NSW, reduce the environmental footprint of the RMS's own activities, reduce the impact of climate change on road transport systems and infrastructure, and to reduce the environmental impacts associated with the goods and services the RMS purchases.

The main sustainability principles identified in the strategy as key tenants include:
- intergenerational equity: the quality of life of current generations does not reduce the capacity of future generations,
- sustainable communities: social, economic, environmental and cultural opportunities are all maximised,
- economic prosperity: resources are used to maximise productivity, minimise pollution and waste,
- Ecologically Sustainable Development (ESD): quality of life is improved through conserving and enhancing ecological processes,
- full pricing: prices of natural resources are set to at least recover full social and environmental costs associated with their extraction,
- bio-diversity: conserving biological diversity is a fundamental consideration in all economic and social decision making, and
- precautionary principle: all practicable measures should be imposed to ensure that cost-effective techniques are not postponed, which could be harmful to the environment or community.

In order to achieve these principles and commitments, individual management plans have been or are currently under development in the nine key areas as follows. These individual management plans were instigated as a means of assisting in development of environmental sustainability projects and initiatives.

- Climate change

- Air quality

- Energy management

- Water management

- Waste management

- Materials selection

- Biodiversity

- Heritage

- Liveable communities

Now, a direct excerpt from the strategy has been provided below:

> *"The strategy includes a series of environmental commitments. How these commitments are to be met are not prescribed in the document. Rather, individual actions are to be developed and implemented by each relevant area of the RTA so as to foster innovation and ongoing improvement. These actions will be collated and reported to the community in our Annual Report and on the RTA's website."* (RMS, 2010).

What can be deduced is that although the strategy identifies the areas that are to be targeted for improvements, the methods for doing so have no been identified for frontline delivery staff. These nine key areas are ideally translated into specific actions, which can be further incorporated into individual programs, and business unit plans, which is where the benefits and accomplishments are exposed. As a result, the strategy remains quite broad and would benefit from incorporating more defined objectives and goals for these nine key areas. While this is not decisively a disadvantage for the organisation, it does not promote individual assessment of projects or monitoring as projects in general. The conclusions that can be drawn are that the strategy is beneficial, however it could be expanded or progressed further to include more specific provisions for individual divisions within the organisation.

The newest sustainability strategy is currently in the later stages of approvals, with anticipated release for use by the end of 2015. This only information available for disclosure at this stage is that the strategy has amended some of the key categories as well as the addition of "Sustainable Procurement". The tentative categories for the new strategy include:

- Climate change resilience
- Air quality
- Energy and carbon management
- Pollution control (noise, land and water)
- Resource use and waste management
- Biodiversity
- Heritage
- Liveable Communities and
- Sustainable Procurement

No judgement can be made of the contents and information within this new strategy, however the inclusion of sustainable procurement is definitely a beneficial area due to the vast quantity of resources required to conduct works as well as the organisational shift towards more utilisation of external contractors and suppliers to carry out capital works (RMS, 2010; RMS 2014d).

4.4 PAST INITIATIVES

As identified in the sustainability strategy, each of the nine key areas were to have individual guidance manuals in order to assist with the achievement of each goal. At present, this has been achieved. The capacity of the organisation to achieve progress in the important areas presented in the sustainability strategy is quite possible due to these resources being created for management within projects. The RMS also has in place a defined environmental management system – *The RTA Environment Management System Manual*, which includes the typical process to follow for construction projects, which encapsulate the management plans defined

for sustainability as well as having the main objective to ensure the Environmental Policies are carried out.

With respect to the "Organisational Capacity", it has been identified that the RMS is on the forefront with utilisation of materials and the efforts towards climate change and GHG emissions. These two areas will be targeted in more detail. as they are relatively well presented within the organisation.

4.4.1 REUSE, RECYCLING AND WASTE RECOVERY

Expanding on the statement made in Section 2.6 regarding the improving trend for allowing higher tolerance of waste products in specifications, we can identify that the RMS are highly committed to reducing waste generation and consumption of natural and produced resources. The RMS employs the common waste hierarchy rubric, with the four levels of; Waste Avoidance, Reuse on Site, Reuse off Site (recycling or recovery) and Disposal.

The area of waste re-use is one where the RMS excels, with continual improvements from year to year as well as far exceeding the NSW Government's *Waste Avoidance and Resource Recovery Strategy* targets set for 2014. The RMS has also negotiated new resource recovery exemptions with the EPA, that helps facilitate beneficial re-use of road construction materials. These include factsheets on the reuse, recycling or disposal of Virgin Excavated Natural Material (VENM), Excavated Natural Material (ENM), Excavated Public Road Materials (EPRM), Recovered Aggregates and Asbestos (RMS, 2014c; RMS, 2014d).

Examination of past sustainability performance reporting, we can identify the improving trend over the past five years for recovery of the major types of construction waste, to a level at present where all construction related materials are close to 100% recovered. Refer to Table 4.1 below (RMS, 2014b; RMS, 2014c).

Table 4.1: Waste recovery rate for RMS between 2010 and 2014.

Waste Type	Waste Recovery Rates 2010-2011	Waste Recovery Rates 2012-2013	Waste Recovery Rates 2013-2014	NSW Govern. Waste Recovery Targets (by 2014)
Vegetation	85	86	94	76
Concrete	92	94	97	76
Steel	88	96	98	76
Asphalt	90	99	99	95
VENM	96	99	99	95

It is clear there are high improvements in this area, which have come from improved efficiencies, working with partners in industry to create new means of reusing materials, as well as being more aware of construction techniques and changing work methods. For example, the RMS has a history of working with the Department of Environment & Climate Change (DECC) in trialling the use of other alternative recycled construction materials such as crumbed rubber and crushed glass, both products of which are now incorporated into RMS materials and construction specifications (RTA, 2008).

The area surrounding resource management is important due to high quantities of materials used in the road construction process. As an example, in 2012-2013, the RMS purchased around:

- 1.1 million tonnes of aggregate for road maintenance and construction, and
- 275,000 tonnes of asphalt.

These figures are only for capital and maintenance works carried out by the RMS themselves, but does not account for contracted major works or other works carried out by councils for the RMS (RMS, 2014c).

The RMS is still constantly developing in this area of materials technology and as identified, have been leaders in this field for 50 years now. A summary list of the current specifications utilised by the RMS and the allowable recycled materials products is provided in Table 4.2 below (RMS, 2014a). This gives an idea of the vast breadth of waste products that are allowable, as well as the number of

specifications with provision for recovered products. It is clear that there are several specifications that allow use of recycled products. As identified in Chapter 2, population growth, demand for improved facilities, increasing costs of obtaining and disposing materials as well as overall changes to the process of obtaining resources are all reasons why efficient resource use is paramount in the changing industry today.

Table 4.2: List of waste products allowable in RMS specifications.

Recycled Material	Application and Benefits	Associated RMS Specification
Asphalt (i.e. Reclaimed Asphalt Pavement - RAP)	- used as base or sub base - blended for use in new asphalt	**Materials Specification** - 3051 Granular Base and Sub base Materials for Surfaced Road Pavements - 3153 Reclaimed Asphalt Pavement Material **Roadworks Specification** - R71 Unbound and Modified Pavement Course - R73 Construction of Plant Mixed Heavily Bound Pavement Course - R116 Heavy Duty Dense Graded Asphalt - R117 Light Duty Dense Graded Asphalt - R118 Crumb Rubber Asphalt - R121 Stone Mastic Asphalt
Blast Furnace Slag (BFS)	- used as base or sub base - aggregate for concrete - stabilising binder - supplementary cementitious material - partial replacement for cement in concrete	**Materials Specification** - 3211 Cements, Binders and Fillers **Roadworks Specification** - R73 Construction of Plant Mixed Heavily Bound Pavement Course - R75 In situ Pavement Stabilisation Using Slow Setting Binders - R90 Roller Compacted Concrete Sub base
Brick / Tile	- used for select formation material	**Materials Specification** - 3071 Selected Material in Formation **Roadworks Specification** - R44 Earthworks
Crushed Concrete	- used for pavement base or sub base when blended with other quarry materials	**Materials Specification** - 3051 Granular Base and Sub base Materials for Surfaced Road Pavements **Roadworks Specification** - R71 Unbound and Modified Pavement Course - R73 Construction of Plant Mixed Heavily Bound

Some other recycled materials available for use in RMS specifications include Fly Ash, Furnace Bottom Ash, Glass, Ground Granulated Blast Furnace Slag, Road Base Scrap Rubber and Steel Furnace Slag for example.

4.4.2 EFFORTS TOWARDS MEASUREMENT

In Section 2.9, a brief introduction to potential sustainability measuring techniques was provided as well as Section 2.11 stating the overall lack of measurement systems available within Australia. This has been identified in the past within the RMS organisation, and due to the absence of any tools that could be utilised for infrastructure projects, the RMS has partaken in developing their own tool – for assisting with the measurement and monitoring of GHG emissions to assist with monitoring of construction project performance (RMS, 2015a; Dilger et al., 201).

The GHG Assessment Workbook (GHG Workbook) was developed from co-operation between Australian state road authorities and the New Zealand (NZ) Transport Agency, whom combined to form the Transport Authorities Greenhouse Group (TAGG) in 2010. The TAGG was formed as a means of standardising a common approach to measurement of GHG emissions at different stages within construction, operations and maintenance life of a road project. The GHG Workbook outlines a process for approximating the GHG emissions for all major activities that are significant contributors to the overall emissions arising from a project but also provides a better understanding of how GHG emissions can be reduced. Benchmarking and comparisons of projects on an equivalent basis will be possible. The TAGG methodology has had multiple iterations since conception in 2010 and has been adapted more widely by organisations such as the Australian Road Research Board (ARRB), whom have proposed it be adapted as the nationwide GHG estimation standard for Australia (Dilger et al., 2011; Dilger, Bengtsson & Kneppers, 2011).

In order to assess the emissions, the TAGG Carbon Gauge Calculator for Road Projects (TAGG Calculator) is utilised. The TAGG calculator for road projects

comprises four steps to estimate road project GHG emissions. The first step is to select the major activities associated with the road project for which calculation of emissions is desired. This may be design, construction, operations or maintenance. The second step involves selecting the activities associated with the project that are likely significant to create substantial emissions. The third step involves entering the specific road project outputs, so the calculator can identify the associated emissions, which is completed by the TAGG calculator spreadsheet. The final step provides a method to review the assessment by generating the report with results (Energy Made Clean, 2011; RMS, 2015a).

Although this system is beneficial, there is still no tools currently available for implementing measurement or monitoring of sustainability concepts as a whole for road construction. The GHG Workbook and associated TAGG Calculator are also not mandatory inclusions for projects, hence it is at the discretion of the project team to implement or not. It was noted in Section 2.11 that this area of research is relatively immature within Australia, hence the reason why it has been considered in this research project, but also an important area for future works.

4.5   CONSTRUCTION DELIVERY MECHANISMS

With respect to "Organisational Capacity", it is important to identify how the RMS manages delivery of road construction projects. If the systems in place are unsuitable for the type of works conducted, then the organisation itself will struggle to further improve in specific areas, such as sustainability.

The RMS has in place an Infrastructure Lifecycle Management (ILC) system, which is a structured Quality Management system, conforming to the *ISO9001: Quality Management Systems* standard. The ILC system was developed to maintain a culture of continuous improvement through technical service areas of the RMS. Within the ILC system, the RMS utilises two main management systems for new construction projects. These are known as "ProjectPack" and "MinorProject", which have been specifically designed for use by those within

RMS, for RMS managed projects. These systems encapsulate all processes involved with the development and delivery of construction works (TKMS, 2005).

ProjectPack is the project management system used for major infrastructure projects. A major project is typically over $10 million in value, but could also be attributed to a project that is highly complex, technical or high in risk (PMO, 2005). Minor projects represent the majority of all construction projects delivered by the RMS, with typically the Regional Maintenance Delivery (RMD) division of RMS, local councils, or private contractors undertaking the work. Generally, a minor project consists of work that amounts up to $10 million, however depending on other factors again such as risk and complexity. The MinorProject set of tools were developed as a result of the ProjectPack documents being too complex and burdensome for smaller, simpler projects. They follow the same main values, and "best practice" approach and overall, can be used to facilitate effective management (RMS, 2008).

It is noted that environmental procedures; work, health and safety procedures; road safety procedures; and specific business unit procedures are not part of the overall ILC system. These procedures are however mandatory for use by project managers. It is important to recognise their role as the delivery mechanism for projects as it is envisaged with further development, evolution of these systems will occur, leading to more sustainability aspects integrated within the current forms and procedures. Although the ILC system does not directly involve assessing the capacity for which sustainable practice has been implemented currently, the systems do cover aspects of the triple bottom line (TBL) by identifying overall, the management and delivery process to follow (including the necessary system requirements) (TKMS, 2005; PMO, 2005).

Overall, the ILC system has shown its effectiveness in the past but is an area that is constantly reviewed to reflect changing procedures, perceptions and improvements of which is necessary to promote growth and development overall. As identified previously, to assist business units and project teams to achieve more sustainable practice in their projects, the nine key areas of the sustainability

strategy could be more effectively defined within these mechanisms for project delivery.

4.6   ANNUAL REPORTING

In order to assess "Organisational Performance", past annual reporting was consulted to gauge overall progress and achievements. As identified in Section 2.8, the RMS instigated sustainability reporting in 2002, with incorporation of TBL concepts when reflecting on projects. There was no statutory requirement to report on environmental issues at this time, hence shows the RMS's commitment to being at the forefront of environmental reporting and the response of the organisation in proving there was a commitment to achieving more sustainable practice. Throughout the assessment, this theme of the RMS "leading the way" with regards to initiating new processes and thinking is common, with several instances where new initiatives are introduced.

To gauge the progress since reporting commenced, three milestone dates will be analysed. Firstly, the "baseline conditions" will be defined, which in this instance includes data collected from 2002 (note; prior to 2002, no structured annual reporting was conducted within RMS). Reporting from 2008 and then the most recent 2014 data will then be evaluated, which will broadly allow deduction of any trends of efforts and progress with respect to sustainability. It is not possible to include all features for this timeframe, therefore the most noteworthy findings will be identified below and a brief judgment and discussion will be provided.

4.6.1 RMS STATUS IN 2002

Documentation from 2002 states that the organisation was moving towards a more overt recognition of sustainability, due to the concept being recognised as an overarching issue that related to the overall strategic direction of the RMS.

Individual areas of concern, including; water, air, greenhouse, noise, waste, biodiversity, heritage, research and development, and overall management were evaluated with regards to the impact towards sustainability and comments were provided on how well each area performed. This allowed diagnosis of specific issues that could be improved upon, in line with the newly developed mission towards becoming more sustainable.

The major conclusions within this report and the identified future objectives of the RMS were to include:

- further development of TBL reporting,
- improvements to the management of Aboriginal and non-Aboriginal heritage,
- integration of sustainability into RMS business plans and more sophisticated and comprehensive reporting on sustainability,
- development of a sustainability communication strategy that can be used to assist integration of sustainability principles across the RMS,
- improved biodiversity practice and management,
- introduction of additional sustainability initiatives
- improved waste management and reporting within environmental specifications, and
- improved contractor performance reporting.

Other changes at this point in the organisational timeline included the first dedicated sustainability strategy being endorsed, which was developed to compliment the redirected focus towards environmental reporting, and involvement with external stakeholders (RTA, 2002a; RTA, 2002b).

The documented evidence clearly shows an organisation introducing new and foreign concepts that did reflect a level of inexperience, however determined attitude with respect to sustainability. The future objectives were quite broad at this stage, as there were no clear areas which were valued more significantly at that point in time. We see that the main concerns from the future objectives involve appropriately setting up the systems required for continual sustainability

monitoring for future reporting. The future plans set by the RMS identified the mission to improve performance, which is necessary and commendable for organisational development and progress. This is a theme that continues throughout the years, with areas for improvements constantly being identified and addressed.

4.6.2 RMS STATUS IN 2008

In 2008, a corporate plan *The Blueprint* was developed, which included the *Green Plan*, with a strong focus on managing the environmental impacts of RMS's activities. This demonstrated leadership, developed green partnerships, and reduced the RMS's environmental footprint. To assist with the administration of this new Green Plan, a sustainability working party was developed in 2008, with representatives from across the organisation, to review and recommend environmental sustainability projects. Key projects for the sustainability working party included; promoting use and educating the benefits of recycled materials in construction and maintenance, reducing the environmental impact of properties and fleet (emissions, waste, energy, water), and examining opportunities for more sustainable procurement (RTA, 2008).

The RMS also became a part of the DECC's "Sustainability Advantage Program", which was designed to:

- accelerate environmental priority actions and the sustainability agenda,
- integrate environmental sustainability as a core business value,
- determine critical sustainability projects based on the RMS's business priorities, and
- identify sustainability projects and develop sustainability programs in areas such as resource efficiency, supply and employee awareness (RTA, 2008).

The major conclusions from the 2008 Annual Report include the following future objectives:

- provide training and tools to promote purchasing of recycled content and materials with lower environmental impact,
- develop improved data collection and reporting systems to allow better centralised reporting on construction and maintenance projects,
- continue to work with DECC and other government agencies and private industries to trial the use of alternative recycles construction materials,
- further reduce GHG emissions,
- develop improved reporting systems to track energy usage, and
- implement the newly developed Energy Management plan to achieve carbon neutral operation by 2020 (RTA, 2008).

We can see from this year, the concepts surrounding emissions and waste products were becoming more prevalent, due to changes in the organisation as well as previous objectives in other areas already being completed. The organisation at this stage has also started branching out more to other external stakeholder organisations to improve in specialist areas. There is also evidence showing more internal resources being assigned to improve sustainability implementation due to changing priorities. Although the interim years between 2002 and 2008 are not included in this report, the objectives stated in the 2002 report were completed by 2008.

4.6.3 RMS STATUS IN 2014

After introduction of the new sustainability strategy in 2010, the RMS introduced quarterly sustainability reporting to provide an overview of the RMS's GHG emissions and how they are changing over time. Resource use is also covered in this reporting, including materials, energy, water, office supplies, as well as waste and recycling from a combination of all RMS activities, including construction, maintenance, administration as well as now some influence from the maritime division. This form of reporting is highly beneficial, however from July of 2014,

the construction component was removed and now only building and corporate performance data is included. This could possibly be seen as detrimental, however as sustainability achievements are still included in annual reporting, the area is not being neglected but captured elsewhere (RMS, 2014c; RMS, 2010).

Substantial achievements identified in 2014 include development of several revised or new management plans including:

- revised and updated contaminated land management guidelines to meet current legislative requirements and industry practice,
- threatened species recovery plans,
- heritage and biodiversity plans,
- improved urban design excellence options, and
- waste reduction and energy consumption management plans (RMS, 2014c).

The major conclusions from the 2014 report have been identified in the following section as key challenges for the future.

4.7 FUTURE INITIATIVES

As a final assessment for "Organisational Motivation"; by including future plans and initiatives in each annual report as identified in Section 4.6 above, it already shows the RMS is highly motivated in improving and developing overall. While this report has only included sustainability concerns in this assessment, a wide range of areas are holistically included in annual reporting by the RMS, all of which have proposed measures for improvement. What can be deduced here is that the organisation as a whole entity is constantly developing and promoting improvements.

The RMS has produced a five-year plan, which outlines the future plans and works for the organisation. The plan identifies that there is an unprecedented wave of capital investment upcoming, however funding as a total percentage of total activity is reducing. The RMS has thus identified that efficiency and innovation is

necessary in order to perform competently and effectively in these future years. The plan identifies five key areas of challenges and improvement:

- safety as paramount concern,
- successful delivery of the infrastructure program,
- satisfy customer needs and satisfaction,
- operate more efficiently, and
- enhance economic and social outcomes.

Sustainability will obviously be integrated within all these topical areas as they all reflect areas of concern identified in the sustainability strategy (RMS, 2015b).

With respect to potential future works, there has been some interest in application of SRTs as well as more research and development into climate change and the issues posed to the road network. In terms of SRT implementation, Moss, Monckton & Lambous (2010) identified the potential for the Infrastructure Sustainability (IS) Rating System to be investigated further. Personal communication with the RMS environmental staff also confirmed this, with the IS system being trialled on selected projects currently being delivered, such as the NorthConnex and WestConnex motorway projects in Sydney. There is still trepidation with making more widespread use of these tools and as identified previously, this field and involvement is very new for the RMS, hence another reason why it has been investigated further within this research paper.

For climate change works, a key area being researched is network resilience, as new roads must be prepared and ready to handle changes created from the onset of climate change. For example, more intense rainfall events, frequent heat waves, droughts, floods or storm surges. If a road is not resilient, then it cannot be viewed as sustainable hence, RMS will prioritise its adaptation actions based on vulnerability and risk and will use the best available science and research to inform decisions (RMS, 2015a).

4.8 DISCUSSION

Overall, the IOA model appeared to provide the structure required to ensure the key points of the RMS systems with respect to sustainability were obtained. A comprehensive, yet succinct review has been provided, which ideally has exposed key areas of strength and weakness.

For assessment of the organisational performance over the years, although only three reporting years were included in this report, this provided suitable information to identify the main direction the organisation is heading as well as the motivation and success that has occurred. Additional research was conducted and it was identified that in each subsequent year/s, the commitments and future plans outlined in the documents were achieved in all cases. This is a sign of moving forward as there is evidence to show consistent progress in achieving set goals. This specifically is when talking about the organisation as a whole. Progress towards achieving more sustainable practice in construction is a bit more ambiguous, due to the lack of mechanisms available for benchmarking and continual monitoring.

The major result from the OA on sustainability is that the current RMS systems lack a defined method for monitoring the outcomes of projects with respect to sustainability. As a result, it is difficult to accurately assess the progress that has been made in the construction area. The TAGG calculator is a mechanism for allowing emissions monitoring however there should be a wider reach metric that can assist is project wide progress measurement, which can then be utilised as benchmarking data. One such method for this monitoring is the use of SRTs, which form an important part of this research. Preliminary works for this project identified this early on, and hence this full OA confirmed all premonitions, and further justifies the direction of the research.

From analysis of the sustainability strategy, it was stated in Section 4.3 that there could be developments in the area of including what actions or strategies would be necessary to achieve the set goals and commitments. This is an essential part of

any strategy as without a clear identification of what must be completed, success is difficult to determine. A potential improvement in this area (specifically to benefit sustainability progress in construction) would include identifying an action plan for construction delivery staff and a reporting period to reflect on any success. This is a key feature in improving the overall monitoring of sustainability as it allows key individuals within the organisation to facilitate change as well as identify specifically any progress.

Another area that appears to be essential in successfully monitoring sustainable performance in construction, is by maintaining a level of separation between the administrative and corporate success of the organisation and the physical nature of construction works. The types of works involved in these two divisions is very different. By combining all reporting into an organisational wide document the level of specificity that is necessary to pinpoint key issues and areas of achievement is not provided. This is specifically with reference to the previous quarterly sustainability reporting. As an example, reporting that energy consumption overall was reduced in one year does not benefit sustainability in construction if all energy savings came from changing light fittings and fixtures in RMS buildings. In this example, energy usage within construction may have increased and due to the integrated reporting, this trend is not as readily identifiable. This highlights the benefits for having separate reports and systems. The change to only include corporate reporting in quarterly reports as identified in Section 4.6.3, is a positive change for the organisation. There could be advantages gained from introducing a similar report for capital works however.

Although it has been identified that there are some issues with the RMS systems, what must not be ignored is that the RMS does in fact place considerable efforts into integrating sustainability into all their systems, even if not glaringly obvious. Through the examination of RMS standards and procedures in detail, it has become clear that considerations for sustainability are typically directly integrated into processes, rather than identified separately. There has been considerable achievement in incorporating heritage, biodiversity, community, pollutions and emissions, and materials in systems in a more integrated fashion. This Chapter identified achievements related to materials and waste reuse as well as climate

change and GHG emissions, however could really have also included more information on these other areas. Once again however, there would be difficulties in benchmarking against these specific areas due to this integration as there are no requirements to specifically report on them. This suggests another advantage of implementing a separate measurement framework such as an SRT, which divides key concerns into areas that are reported on.

In terms of improving the research overall, this chapter could have benefitted by involving key stakeholders from the organisation, or potentially conducting a survey in order to obtain the perceived views on how the organisation performs. This would have provided a subjective view of the organisation, however allowed for alternate perspectives on areas of strengths and weaknesses from individuals in varying positions. This would have not been too difficult to facilitate and could easily be incorporated in all sections of this chapter and cover all features of the OA depending on the questions chosen.

4.9   CONCLUSION

In conclusion, this chapter has identified several components of the RMS systems and processes that expose positives and negatives that are related to sustainability. The main positive features that have been exposed include;

- the organisation shows high motivation in improving efficiencies overall,
- there are several areas which show high success such as materials and waste reuse as well as potential impacts of climate change, and
- there are construction delivery mechanisms in place that are well equipped with integrated sustainability features already in operation, or that could be readily amended to include more specific descriptions of how sustainable considerations are promoted.

The main areas for improvement that have been identified include:

- the need for some formal system that enables benchmarking or more effective monitoring of sustainability in construction practice,

- an action plan or method for conveying specific requirements to achieve the goals set out in the sustainability strategy
- appropriate separation between corporate RMS and the construction delivery portion of the organisation

The following Chapter will introduce other related road construction organisations in order to identify similarities and differences between them and the RMS and to identify if there are any areas, which would allow improvements.

CHAPTER 5

INDUSTRY INITIATIVES

5.1 INTRODUCTION

Organisations that carry out road construction can include a variety of different agency types, varying according to size, capabilities or overall mission for example. For this research, two specific organisation types were included. Firstly, a comparison of other national roads and transportation agencies was included, as it was prudent to compare to the Roads and Maritime Services (RMS) to other organisations that have a similar role and overall similar concerns and values. Secondly, a brief examination into larger tier one civil contractors was conducted as these companies typically would tender for major infrastructure works engaged by the RMS.

The aim of this chapter is not to provide an organisational assessment on these agencies chosen for comparison, but rather to gain a broad understanding of the efforts they place on more sustainable practice, and to use this broad research to make general comparisons to the RMS. As a result, this chapter is more of a discussion chapter that identifies trends associated with the pertinent issues surrounding sustainability in construction, and exposes any innovative, or leading industry practices. It was deemed impractical and unnecessary to conduct a full assessment on all organisations identified as the main objective of this section is not to evaluate single organisations but to identify positive industry practice.

5.2 NATIONAL ROAD AGENCIES

5.2.1 OVERVIEW

For the purposes of this research, the general term "road agency" has been utilised to describe any governmental roads authority, service, or department whose primary focus is centred around building and maintaining the roads network. For this section, three road agencies; the Victorian Government's VicRoads (VicRoads), the Queensland Government's Department of Transport and Main Roads (TMR) and the Western Australian Government's Main Roads Western Australia (MRWA) were focused on for investigation.

Overall, the performance of these agencies appear to be quite similar to that of the RMS, with all having a relatively consistent approach to integrating sustainability into their respective corporate systems. All appear to have similar core values, as well as similar developmental timelines. For example, each organisation has some form of sustainability strategy that has been introduced to achieve the broader goal of achieving "more sustainable practice".

The MRWA developed a sustainability policy and strategy in 2003, to improve and strengthen the ways in which community needs were achieved and to help manage, operate and develop the business. A sustainability action plan was released in 2006, which aimed to define ways to achieve the objectives surrounding sustainable practice (MRWA, 2006a; MRWA, 2006b). The MRWA are currently developing a sustainability performance framework, which involves reporting against key performance indicators. This particular framework was developed as the result of internal stakeholder input from sustainability workshops that were intended to clarify long term priorities (MRWA, 2014b; MRWA, 2006b). For VicRoads, more specific direction towards sustainability came in 2010, with the company charter being amended to include the important consideration to: "make the transport system more sustainable", for which the sustainability and climate change strategy, as well as a sustainability action plan were developed (VicRoads, 2010; VicRoads, 2014). VicRoads presented their first dedicated sustainability reports in 2010/2011, which is around the same time the

RMS commenced their quarterly sustainability reporting, which is comparable, however the RMS did include triple bottom line (TBL) reporting as far back as 2002 (VicRoads, 2010; VicRoads, 2014). The TMR has appears to incorporate actions towards sustainability within their strategic development plan, with goals identified in their investment program for the next few years including to; improve the condition of the road reserve by improving nature conservation, fire risk management, road landscape, road traffic noise barriers, heritage management (TMR, 2013).

Other similarities to the RMS include the importance placed on climate change. VicRoads identifies that climate change will pose significant challenges in the future, with issues relating to the need to reduce emissions and the long term sustainability of the roads network itself being the two most prominent challenges. The organisation identifies that if there is not a strong culture of sustainability within VicRoads, then these desires cannot be achieved (VicRoads Environmental Sustainability, 2011). The TMR has identified that climate change planning is one of five key areas within the "Environment and Heritage Policy & Strategy". MRWA have conducted research, specifically the "Major Roads at Potential Risk due to Climate Change", which had the purpose of identifying what sections of the network would be at risk due to potential climate change impacts such as sea level rise and identifies ways to ameliorate impacts. These include continual review of standards and procedures, introducing climate change risk assessment in project planning and exploring innovative options to counter climate change impacts (MRWA, 2014a; TMR, 2008).

5.2.2 AREAS OF COMMENDABLE EFFORT

The organisational assessment in Chapter 4 identified that sustainability is engrained within the RMS systems, however, one area that has not yet been defined to the extent of others is sustainability within the procurement process. Although certain areas within the organisation already practice "green" purchasing of products and services, the practice needs to be integrated across the entire

organisation, which is what VicRoads has achieved through development of sustainable procurement guidelines (VicRoads, 2011). VicRoads place high emphasis on sustainable procurement, with these guidelines developed separately to the sustainability strategy and action plan. The plan was developed and released in August 2011, with the main purpose of introducing environmental considerations into a process that historically focused on cost and quality (VicRoads, 2011). As identified in Section 4.3 the new RMS sustainability strategy includes additional provision for procurement, however it is yet to be released. The TMR is incorporating the QLD Government's state procurement policy from 2008, to ensure that all purchasing provides value for money and is minimally damaging to the environment (TMR, 2010).

Although developing documentation and standards for more and more aspects results in a saturation and overly complex system of forms, introducing guideline and a strategy for procurement appears particularly useful and could be investigated by RMS. The VicRoads guidelines outline the entire process in a simple manner and allows wider thinking of alternate means to obtain the same result. The overall aim of sustainable procurement from VicRoads is that projects result in nothing being purchased, rather all materials are reused and recycled, borrowed or swapped (VicRoads, 2011).

Water management is another area where these agencies excel. VicRoads for example have identified set goals for non-potable water reuse including 80% of all water used for road construction by the end of 2015 to be non-potable (VicRoads, 2015). When this is compared with the RMS water management plans, this is substantially better. The RMS management plans simply state that various activities allow provisions for non-potable water, however there is no formal requirement that it is considered and as a result, water is typically obtained from the local supply (RTA, 2009).

5.2.3 INDUSTRY INVOLVEMENT WITH SUSTAINABILITY RATING TOOLS (SRTs)

As a main section of this research project is identifying the potential use and benefits of SRTs, investigation into the usage within Australia was conducted. VicRoads has taken a proactive approach in terms of establishing their own specific rating system, with the Integrated VicRoads Environmental Sustainability Tool (INVEST) being developed in 2010. The purpose behind developing this tool was centred around supporting the strategic, and organisational directions of the organisation. These were to ensure the overall transport system is more sustainable as well as reflecting the general theme from the government of Victoria to ensure there is more inclusion of sustainability in the transport sector. The system is self assessable and includes provision for all concepts involved with the TBL. The certification process involves an independent review panel, which comprises of internal and external leaders in sustainability. Verification is awarded if all the prerequisites are met, the scoring has appropriate supporting documentation, scores are allocated in relation to completion of an initiative, and the project meets the criteria for the assessment.

The main objectives of INVEST include:

- encouraging investigation and implementation of innovation to improve sustainability in road projects,
- recognising outstanding sustainability practice,
- improving the knowledge and attitude towards sustainable practice, and
- establishing benchmarks for sustainability and encourage improvement (VicRoads Environmental Sustainability, 2011).

These broad objectives show constancy with the information obtained from the literature search in Section 2.10. They are consistent in showing that different SRTs have the same end goal, even though there is limited definition in the means of structuring and developing the tools. INVEST however at this point in time has only been used minimally on a select number of projects and currently is not being utilised, due to ongoing development works (VicRoads Environmental Sustainability, 2011).

With regards to other road agencies, the only other organisation to show significant significant interest in SRTs from the investigation involved in this research, was the MRWA. The MRWA have been involved with the Infrastructure Sustainability Council of Australia's (ISCA) Infrastructure Sustainability (IS) rating system since early on in the development process, with certain pilot projects being provided for trial ratings during the development. MRWA also currently mandates the use of the system for all projects with a value of over $20 million in their network. The MRWA is the only state government road agency integrating constant use of the IS tool for a defined type of project (MRWA, 2014b).

The Queensland government was a founding member of the ISCA system, however the TMR doesn't currently implement usage of the IS system on any projects. From a quick search of other road agencies from other states and territories, there appears to be no further substantial usage outside MRWA. The reasons for having limited use were not investigated as part of this research. (LEES, 2010).

5.3   CONSTRUCTION CONTRACTORS

The major civil construction companies chosen for inclusion all revealed similar general themes surrounding the topic area, with each having a defined set of objectives that relate to sustainability overall. Three companies were examined, including Lend Lease Corporation Limited (Lend Lease), The CIMIC Group Limited (formerly known as Leighton Holdings) (Leighton) and SMEC Holdings Limited (SMEC). The Leighton group is one of the world's leading international contractors, operating in 22 countries in Asia, Middle East, Southern Africa, Australia and New Zealand. Their overall aim is to be renowned for excellence, delivering through operating brands and the empowerment of their people (Leighton Group, 2014). SMEC is an Australian based firm that operates internationally, mainly specialising in high quality consultancy services in a variety of different areas including water, mining, and energy, but most importantly for this research transportation and construction. With respect to road

construction, SMEC has been involved in various ways with 125,000km of roads, ranging from multi lane highways down to small village tracks (SMEC, 2013). Lend Lease is an internationally operating infrastructure and property group, with projects spanning from retail and commercial properties, to major infrastructure (LLC, 2011).

When investigating these organisations and their subsidiary branches, it was clear that there are similarities in their performance when compared against one another. The industry trends towards sustainability as identified in Section 2.7 are obvious and the information that was exposed during this research only further confirms this direction. The "strategic direction" plans or "future plans" of these companies all exposed the desire and commitment towards reducing material consumption, becoming more energy efficient, incorporating solutions that benefit the wider community for example.

The key aspects that were drawn from this investigation that are not present within the RMS systems, is the involvement these companies have with internationally recognised ranking metrics, for example, the Global Reporting Initiative (GRI), touched on in Section 2.9, and the Dow Jones Sustainability Index (DJSI). Participation for example includes Leighton whom were recognised by being included in the 2013 DJSI, with results showing the company performed well above the industry average and achieved the highest score across the construction and engineering sector for the Economic and Environmental dimensions of the index. The DJSI measures the leading global companies in terms of their sustainability performance against long-term economic, environmental and social criteria (Leighton Group, 2014).

With regards to SRTs, in Australia there has been involvement from these larger contractors with the ISCA's IS rating system on a variety of projects. This system will be defined further in Chapter 6 of this report.

5.3.1 GLOBAL REPORTING INITIATIVE

As a follow on from the brief introduction to the GRI in section Section 2.9, the GRI is a multi-stakeholder network that involves thousands of different individuals, organisations and academic institutes. From its inception in 1997 it has expanded to over 30 countries and pioneered the development of the world's most widely accepted sustainability reporting framework. The GRI framework was established to be relevant for all organisational types and sectors, which makes it directly available for use by the RMS (John Holland, 2010).

One key aspect of the GRI framework is the principle of materiality, which is:
> *"the threshold at which the sustainability subjects covered by the Guidelines – known as 'Aspects' – become sufficiently important that they should be report."*

This is important as each organisation will be different, and hence the GRI only applies to issues that are pertinent to the organisation that is using the framework, while the result overall is still comparable to others that use the framework (GRI, 2014).

As identified above, construction agencies have started incorporating GRI concepts into their systems. This is a way to ensure that reporting is accepted by other organisations as the GRI is an internationally accepted framework. For example, SMEC commenced reporting to the GRI guidelines in 2011, in order to ensure their reporting was in line with global best practice (SMEC, 2015). In 2010, the Leighton subsidiary company John Holland adapted the GRI framework in order to identify and measure the significant and material impacts of their operations (John Holland, 2010).

5.4 DISCUSSION

Key results from the above sections include the different emphasis different organisations place on certain areas of sustainability. While the analysis has been kept brief, the key features identified provide avenues for further investigation for improvements within the RMS systems. These main areas potentially include work related to sustainable procurement, improvements made to water resource management, potential investigation into aligning reporting of sustainability to widely accepted frameworks such as the GRI and finally, investigation into use of SRTs, for which was examined in this report.

With regards to the work conducted on national road agencies, the information available from VicRoads was more accessible and attainable, hence there has been more to compare and discuss from this organisation. For the objectives of this part of the research, the information available was adequate, however for further, more in depth comparison of the RMS to other road agencies, additional methods for obtaining information would be required. To improve the information collected, direct contact with key stakeholders within the organisations could have been conducted, which could have involved questionnaires or surveys. This is noted as a method for improving the research method as in Section 4.8 above. As the research to this point has been largely qualitative, subjective data from stakeholders would align itself quite well within the results.

Reflecting on Section 4.8 of this report, it was stated that although the RMS sustainability strategy was effective, there is no clear definition of the responsible parties or the necessary actions to achieve the set goals. VicRoads sustainability action plan is a more structured outline of the deliverables for the future as well as the responsible parties, the target dates, and what must be achieved. This is what RMS's sustainability strategy lacks, as it currently relies on individual (or individual business unit's) divisions to propose methods for achieving the goals.

With respect to the construction contractors, all those examined have a wider reach than the RMS, with both national and international stakeholders, more resourcing,

and typically a narrowed focus only on road construction itself. Due to this broad reach, there is a more important need to provide information that is understood and valid across the globe, which is why they have tended to incorporate internationally recognised metrics such as the DJSI and GRI. Such metrics as the GRI could benefit the RMS as with measurement and reporting on sustainability performance, it is important to provide transparent and relatable results that can be compared. The GRI provides a framework that is well established and well resourced and with the emphasis on materiality entrained in the system, it can be adapted quite readily to new organisations.

In terms of the research process and results presented in this chapter overall, a greater level of detail could have been provided, however for the purpose of the comparisons made, the methods used were appropriate. Improvements that could be made could be a more structured comparison methodology to compare organisations, potentially including different types of organisation other than the two here, and potentially investigating other international organisations, which may provide a whole new perspective. It is unclear what benefit these changes would provide to this research, however could be investigated as further works.

5.5 CONCLUSION

The main outcomes that have come from this section is that while organisations vary in their size, capabilities or overall mission, the trends towards more sustainable practice are relatively similar across the industry and all organisations appear to have grasped the importance of improving their ability to conduct works more sustainably. With regards to national road agencies, the TMR, MRWA and VicRoads were examined and key areas such as sustainable procurement and identification of water resource use were identified as high performing. These are areas that the RMS could benefit from more involvement. With regards to tier one construction companies, the tendency to align all company reporting with internationally recognised metrics is beneficial as it allows a broader understanding of progress as well as a wider acceptance of the facts provided.

While aligning the RMS with international frameworks may be excessive or unrealistic, the organisation or any organisation in general should aim towards achieving reporting and implement procedures that are recognised more widespread than just within the organisation.

Overall, this chapter has provided sufficient knowledge of the broader industry, in order to draw some conclusions between the current performance and potential areas for improvement of the RMS in the area of research. Chapter 5 completes the first stage of the research project – analysis and comparison of the RMS organisation. The following chapter commences the beginning of the SRT development, exposing and evaluating current SRTs for inclusions in the final system.

CHAPTER 6

ANALYSIS OF SUSTAINABILITY RATING TOOLS (SRTs)

6.1 INTRODUCTION

As identified in Section 2.10, it is documented that there are established SRTs currently being used by various road and government agencies, as well as other organisations globally. By examining a selection of the schemes more closely, it has become clear that the systems have been developed for a set of specific circumstances and typically not a generic tool that can be applied to any scenario. Those systems such as CEEQUAL and ENVISION, which have been developed for wider applications still require some intervention when applied, in order for them to be adapted to the region or scenario they are to be implemented.

This chapter aims to provide an analysis of six of the more well-known rating systems available today, as identified in Section 3.4.1, in order to gain knowledge on the advantages and disadvantages of each system, as well as the steps and methodology used in development. A thematic analysis has been conducted in order to identify whether patterns or certain characteristics are common to SRTs, in order to define a set of "mandatory" features or inclusions that should be included when developing *SMaRT* for the RMS. Note that the VicRoads INVEST system was not included in this analysis due to there being insufficient evidence of it being applied on real projects.

6.2 EXISTING RATING SYSTEMS

6.2.1 CIVIL ENGINEERING QUALITY ASSESSMENT AND AWARD SCHEME (CEEQUAL)

As identified in Chapter 2, CEEQUAL was developed between 1999 and 2003 by the Institute of Civil Engineers (ICE) in the United Kingdom (UK) (Lees, 2010; Shaw et al., 2012). The development of the system also had support and input from the Construction Industry Research and Information Association (CIRIA), the Civil Engineering Contractors Association (CECA) and the Association for consultancy and engineering (ACE) (CEEQUAL, 2015).

CEEQUAL was developed for all infrastructure types, not exclusively for road infrastructure and had the main purpose of encouraging and promoting best practice in all civil engineering areas through a broad range from environmental issues, through management, cultural heritage, socioeconomic issues and economic concerns (Thompson, 2010; CEEQUAL, 2015). The system can be used as an assessment tool for completed projects, however it is most effective when applied early as a planning and management aid for design and construction. The project is not applicable for operational or deconstruction phase for projects (Wilson et al., 2014; Shaw et al., 2012).

With respect to the features only considered for the construction stage within the system, the most recent version (Version 5; developed in 2012) involves nine individual categories that contain a total of 2340 points. These categories include: Project or Client Contract Strategy (161 points); Project or Contract Management (164 points); People and Communities (352 points); Land Use and Landscape (333 points); Historic Environment (128 points); Ecology and Biodiversity (197 points); Water Environment (138 points) Physical Resources Use and management (817 points); and Transport (50 points). These construction-related credits form approximately half of the total points of the system, with design credits bringing total to 4371 points.

The system was revised recently to include nine categories from the original 12 due to the two major changes in the civil engineering industry. These were; an increased important of community engagement and social impacts, as well as the more integrated approach to use and management of physical resources. We see that the system has evolved over time due to changes in the industry. This is essential in managing more sustainable practice as general conditions, requirements of humans and the environment, technology plus legislative measures are constantly changing (CEEQUAL, 2015).

Rewards are given to projects that go beyond any pre-defined social status-quo and are achieved through a points system, weighted to give a final score as a percentage. Those projects that achieve a higher percentage score are more highly regarded as sustainable. Points were assigned to the categories through the extensive industry experience between those stakeholders involved. The weights define the relative importance of the criteria within each section and reflect overall the contribution of the project to sustainability (CEEQUAL, 2015).

The system employs a five tiered certification ranking which is composed of the following tiers:

- 0 – 25%   = No Certification / Fail
- 25% – 40%   = Pass
- 40% – 60%   = Good
- 60% – 75%   = Very Good
- > 75%   = Excellent

These categories are spread between a "Pass", which indicates adherence to minimum legal compliance through to "Excellent", which defines a project as being at the pinnacle of best practice. The project can be self assessed by anyone who has sufficient knowledge and training with the system, however, the final rating of any type of project must be certified by an appointed, external representative (CEEQUAL, 2015).

6.2.2 ENVISION

The ENVISION system was developed in 2012 by the Institute for Sustainable Infrastructure (ISI) and in co-operation with the Zofnass Program for Sustainable Infrastructure based at the Harvard Graduate School of Design (Clevenger et al., 2013; ISI, 2015).

The system was specifically developed to fill the void that other more specific, sustainability rating schemes, such as Greenroads and INVEST (USA) were not accommodating for. The system provides industry wide sustainability metrics for all infrastructure types including water storage and treatment, energy generation, landscaping, information systems and most importantly transportation. ENVISION is effective at any stage throughout a project from planning, through design, construction and operations as well as the deconstruction phase of infrastructure, which sets it apart from other systems (ISI, 2015; Shivakumar et al., 2014).

The current version (version 2.0, developed in 2015) of the system involves assessing facets of a project against five separate categories, divided into 60 individual credits with a total achievable score of 809 points. The categories include: Quality of Life (181 points); Leadership (121 points); Resource Allocation (182 points); Natural World (203 points); and Climate and Risk (122 points) (ISI, 2015).

The scoring approach within the system awards varying levels of achievement, either being "Improved", "Enhanced", "Superior", "Conservative" or "Restorative". Each level awards a different score to the criteria being assessed, based on how effectively the criteria promotes the associated sustainable initiative. The assessor of the project determines the achievement level for each project credit by examining the ENVISION guidance manual, which explains each criterion in detail. The number of points awarded for the level of achievement gives a numerical measurement of sustainability (ISI, 2015).

The system employs a five tiered certification system similar to CEEQUAL, with:

- 0 – 20%   = No Certification
- 20% – 30%   = Bronze
- 30% – 40%   = Silver
- 40% – 50%   = Gold
- > 50%   = Platinum   (Clevenger et al., 2013)

The ENVISION system also requires third party certification; however, can also be self-assessed at no cost initially. The system is very complex and difficult to implement on short notice and for smaller projects, however very effective for larger, multi-faceted infrastructure projects where the time can be spent to fully investigate each individual credit. The inclusion of well defined, achievement levels is beneficial as it promotes incremental project improvement.

6.2.3 GREEN LEADERSHIP IN TRANSPORTATION ENVIRONMENTAL SUSTAINABILITY (GREENLITES)

The GreenLITES system was initiated as a project by the New York State Department of Transport (NYSDOT) in 2008. Initially, it was developed to modestly assess environmental issues, however, has since been updated to take a more holistic, triple bottom line (TBL) approach to project assessment, which supports a more sustainable society. The overarching aim of the NYSDOT was to better align sustainability efforts in planning, design, construction and maintenance, with long term needs in mind (Wilson et al., 2014; McVoy et al., 2011). The system was originally developed based off a sustainability rating scheme for buildings, known as the Leadership in Energy and Environmental Design (LEED) system[5], which is a proven SRT for buildings, successfully being used since 2000 (McVoy et al., 2011).

---

[5] LEED System: http://www.usgbc.org/about/history

The GreenLITES system was developed specifically for road infrastructure and specifically for projects within the NYSDOT jurisdiction. Due to this, it is highly specific and hence does not apply well in other scenarios or settings. The system was developed with a specific purpose in mind however, and within that context performs well and as envisaged.

Version 2.1.0 (2010) of GreenLITES utilises five individual rating categories, with 175 individual credits that add to a total of 280 points. The system also allows for users to create their own performance objectives and achieve scores for innovation and creative solutions. The major categories include: Sustainable sites (81 points); Water quality (20 points); Materials and resources (66 points); Energy and Atmosphere (104 points); and Innovation (9 points) (NYSDOT, 2012). The inclusion of a category for customised credits is beneficial as there is no guarantee that the base system encompasses all aspects that could potentially come about from various road or infrastructure projects, and hence ensures that no significant sustainable initiatives are missed.

The certification levels are again similar to CEEQUAL and ENVISION, with the following levels:

- 0 – 14 points   = No Certification
- 15 – 29 points = Bronze
- 30 – 44 points = Silver
- 45 – 59 points = Gold
- > 60 points   = Platinum

Technically, there is no limit to the maximum number of points a project can score (due to custom credits that can be created), however previous GreenLITES assessments show the highest rated projects achieving a 60 – 75-point score, with no project scoring over 80 points since its inception (McVoy et al., 2011).

The system is fully self implementable, however not accredited by NYSDOT if they are not involved with the process, and should not be implemented without their consent. The system is also specifically metrics based, with NYSDOT in mind hence would not apply effectively for external projects (NYSDOT, 2012).

6.2.4 GREENROADS

Greenroads was developed as a collaboration between the University of Washington and CH2M HILL, an American engineering company that provides various services for federal, state, and local government including consulting, design, construction and operational services. Development of the system started in 2007, and involved over 100 people, research support from industry, local and state-wide department of transport support, and 120 test projects (Muench & Anderson, 2009).

Greenroads is a specially formulated system for roadway design and construction, different to ENVISION and CEEQUAL, which strive to be applicable within any civil engineering industry. This makes the system more relevant to the task at hand of developing an industry/road construction specific rating tool (Muench & Anderson, 2009; Anderson, Weiland & Muench, 2011). The system again strives to award credits to projects that have successfully incorporated sustainable best practice and is applicable for new construction, reconstruction and rehabilitation, however not for operations or maintenance (Clevenger et al., 2013).

The Greenroads system has the unique requirement of 11 individual, mandatory credits, which must be achieved to allow certification of the facility. Regardless of how well the roadway performs in all other categories, if the mandatory requirements are not satisfied, the roadway cannot be certified. This appears to be quite prescriptive and hinders some high performing projects from gaining certification based on not achieving the mandatory criteria. The system is compiled of six main project categories, divided into the mandatory 11 project requirements plus 37 other voluntary credits, which total to 118 points (Muench & Anderson, 2009).

Within version 1.5, (2012-2015) of the Greenroads systems are the categories of; Environment & Water (21 points); Access & Equity (30 points); Construction Activities (14 points); Materials & Resources (23 points); Pavement Technologies (20 points); Custom Credits (10 points) plus the mandatory Project Requirements

(Muench & Anderson, 2009). The system was updated to Version 2 in July of 2015, with various amendments to category names, individual performance credits and total achievable points. No discernable change to the overall objectives of the system, have been made, hence for the purpose of the project work, version 1.5 was utilised.

The Greenroads system assigns weights in an attempt to make each assigned value "commensurate with its impact on sustainability". This cannot be done completely objectively for reasons including; that sustainability components are difficult to compare due to there being no accepted metric for comparison (e.g. aesthetic value of landscape view versus energy savings from altered pavement processes). Each criterion is given a score from 1 to 5, based on a compared comparison approach, from the project team. (Muench & Anderson, 2009; Anderson, Weiland & Muench, 2011).

For version 1.5 of the Greenroads system, there are four award levels – again, similar to the other systems assessed. The points stated do not include the mandatory credits, which must be achieved on top of any voluntary credit score.

- < 32 points   = No Award
- 32 – 42 points = Bronze (30 – 40% of total)
- 43 – 53 points = Silver (40 – 50% of total)
- 54 – 63 points = Gold (50 – 60% of total
- > 64 points   = Evergreen (> 60% of total)

Once all the project requirements are achieved and the voluntary credits are assessed, the scorecard can be sent to Greenroads for third party review and accreditation. This is quite an extensive process, which involves first registration, entering into an agreement with Greenroads, paying fees, obtaining feedback all before the project can be certified (Muench et al., 2009).

6.2.5 INFRASTRUCTURE VOLUNTARY EVALUATION SUSTAINABILITY TOOL (INVEST (USA))

INVEST (USA) was developed by the Federal Highway Administration (FHWA) in 2010, launched in 2012, to facilitate integration of sustainability into roads and transportation agencies programs and workbook (Reid, 2015). The system was intended to provide guidance for practitioners to implement sustainability best practices into projects, encouraging progress in the industry rather than be used as a framework for comparing the efficiency of various transport agencies. The system is road infrastructure specific, similar to Greenroads and GreenLITES, but different from ENVISION and CEEQUAL (Reid, 2015).

A main difference between INVEST (USA) and other systems that have been discussed is that this system is design to be carried through the construction stages, from the initial planning, through development and through to operations. The full lifecycle is considered, which has been identified as beneficial to the overarching goal of sustainability. The system has proven effective as a planning tool, a decision making tool or an evaluation tool (Reid, 2015).

The most recent version of the system is version 1.1 (January 2015), which includes the three categories, broken into 60 criteria. The three categories are: System planning (17 criteria); Project Development (29 criteria); and Operations and Management (14 criteria) (Abdul, 2012). These are incorporated specifically into separate scorecards for Paving, Basic Rural, Basic Urban, Extended Rural, Extended Urban and custom, which were created to remove all redundant criteria and hence allow the rating to only be on relevant features. This is beneficial, as any one system cannot be expected to cover all aspects of sustainability for every road project, and if there is an attempt to do so, there will be extraneous categories being assessed. When there is a criterion that is not applicable for a project, there should be a provision to remove it from the total rating of the project, as has been incorporated with the separate scorecards.

System planning is the first step and is where the agency's system-wide network is analysed and assessed to identify projects that will improve the safety, capacity, access, operations or other key features of the system. Project Development is the second step in the lifecycle and is where projects are conceptualised, planned, designed and constructed. Operations and Maintenance is the third step and is where the projects are evaluated and data is collected to identify new project needs, which are sent back to the system planning stage. (Reid, 2015).

The certification for INVEST (USA) again follows the basic structure exposed with the other systems:

- 0 – 30%   = No Award
- 30% – 40%   = Bronze
- 40% – 50%   = Silver
- 50% – 60%   = Gold
- > 60%   = Platinum   (Abdul, 2012)

The system is self implementable and easy to understand, involving scoring via an online service. However, the level of detail that is exhibited may prevent the system from being useful for smaller jobs. The complexity means that the time required to carry out assessments may be a prohibitive factor for project managers. Due to the system having no accreditation process for the ranking, it is not formally recognised by the FHWA as a management tool (Clevenger et al., 2013).

6.2.6 INFRASTRUCTURE SUSTAINABILITY RATING SCHEME (IS)

The IS rating system was developed by the Infrastructure Sustainability Council of Australia (ISCA), formally known as the Australian Green Infrastructure Council (AGIC) finished in 2011 (Lees, 2014). The AGIC at the time had a formal, technical collaboration with CEEQUAL, which allowed the development of the IS rating scheme to contain underlying concepts and methodology from the CEEQUAL system. The main difference between CEEQUAL and IS is that IS was

developed to be utilised for all phases of a project, from design through to operations (Daysh, 2013; Shaw et al., 2012).

The system was developed with the main purpose of driving improvements in the lifecycle sustainability of Australia's infrastructure. The developers have clearly identified areas of importance, which encapsulate broadly all industry types, not solely roads. The IS system is Australia's first and currently only national sustainability ratings schemes and contains quadruple bottom line considerations (environment, economics, society and governance). IS can also be utilised for all stages of building a road, from planning, through design and construction to operations (Lees, 2014).

For the pilot system (version 1.0, 2011) there are six individual "themes" within the system, which have a further 15 categories divided further into 51 credits. The themes are as follows: Management and Governance (20.5%); Using resources (24.5%); Emissions, Pollution and Waste (24.5%); Ecology (10.5%); People & Place (20%); Innovation (5%) (Lees, 2014).

As of August 2015, version 2.0 of the system was released, which has seen additional categories and performance credits added. As the system is still in early stages of development, there are constant updates being provided, which included seven revisions between 2014 and 2015 for example. For the purposes of the research project, version 1.0 was utilised for all comparisons.

This system follows the same structure as the others, with those projects that place high effort or emphasis on sustainability obtaining higher scores. The benchmarks for different sustainability levels are as follows:

- 0 – 24%   = No certification
- 25% – 49%   = Good
- 50% – 74%   = Excellent
- 75% – 105% = Leading   (Lees, 2014)

Note: the score goes to 105% due to the ability to add custom credits.

Similar to the ENVISION system, the IS system can be formally or informally implemented. A formal rating involves following a process identified by the ISCA, which involves registering the project and obtaining certification of the rating from the ISCA rating board. This is important as it ensures consistent scoring and rigour is maintained, as well as ensuring categories and credits are interpreted correctly. An informal rating is based on self implementation of the system, without accreditation, which still proves beneficial as it allows improvements to be identified internally for an organisation, or specifically for the project it has been used to rate (Lees, 2014).

6.3   DISCUSSION AND ANALYSIS

From the six predominant rating systems, we can see that there are clear similarities in terms of structure, format and functionality of the systems. These features common across the systems include:

- use of categories and subcategories to divide the general themes of TBL reporting into more specific areas,
- use of categories which in some capacity relate to TBL concepts,
- credits, which describe the individual areas of sustainability to be rated,
- a scoring system based on awarding points in order to give a numerical measurement of how effective sustainability initiatives perform, and
- certification levels to reward projects according to the level of sustainability they achieve.

Table 6.1 and 6.2 below summarises the results presented in Section 6.2 above, as well as listing some of the advantages and disadvantages of each system. This information analysis was conducted to provide additional information when developing *SMaRT,* in order to avoid features that hinder the systems and include features that improve efficiency.

Table 6.1: Summary of existing SRT analysis.

System / Feature	CEEQUAL	ENVISION	GreenLITES
Rating Method	Point System	Point System	Point System
Number of Major Categories	9	5	5
Number of Individual Credits	119	60	175
Maximum Points	2340 points (Construction Only)	809 points	271 points
Certification Levels	Excellent (>75%) Very Good (>60%) Good (>40%) Pass (>25%)	Platinum (>50%) Gold (>40%) Silver (>30%) Bronze (> 20%)	Platinum (>60 points) Gold (>45 points) Silver (>30 points) Bronze (>15 points)
Application Process	- Training required from CEEQUAL - Certified by third party	- Self assessable online - Certified by third party	- Self assessable but not accredited - GreenLITES authorisation
Advantages	- Longest reputation of success - Can be used outside of UK with modification - Comprehensive and all inclusive	- Simple structure showing varying levels of achievement - Can be self assessed initially or for internal applications	-Free and can be self evaluated - Can include custom credits - Simple compared to other systems - Specified for roads
Disadvantages	- Large number of criteria - Process is long and complex - Substantial cost for certification - Used for multiple infrastructure types - Limited to design and construct stages	- Criteria is very specific - Process is long and complex - Different scorecards may be confusing - Substantial cost for certification - Used for multiple infrastructure types - Limited to design and construct stages	- Specifically designed for only NYSDOT area - Criteria is highly specific for road projects - Reliability may be questioned due to self certification - Limited to design and construct stages

Table 6.2: Summary of existing SRT analysis (continued).

System / Feature	Greenroads	INVEST (USA)	IS Rating Tool
Rating Method	Point System	Point System	Point System
Number of Major Categories	6	3	6
Number of Individual Credits	118	60	51
Maximum Points	118 points	Up to 15 points each criteria Total points depends on chosen scorecard	105 points
Certification Levels	Evergreen (>60%) Gold (>50%) Silver (>40%) Bronze (>30%)	Platinum (>60%) Gold (>50%) Silver (>40%) Bronze (>30%)	Leading (>75%) Excellent (>50%) Good (>25%)
Application Process	- Registration with Greenroads - Assessor appointed to project	- Self assessable online - Certified by third party	- Self assessable but only recognised if registered and accredited with ISCA
Advantages	- Well established system - Specified for roads - Extensive proof of rated projects	- Free and self-evaluated - Different scorecards for different activities - Can be used for smaller projects - Can be used for all stages of a project	- Developed for use in Australia - Can be used effectively on smaller projects - Can be used for all stages of a project
Disadvantages	- Difficult for smaller projects - Complex - Difficult to obtain certification due to mandatory credits - Substantial cost for certification - Limited to design and construct stages	- Criteria is highly specific - No 3rd party certification may render result invalid - No ability to incorporate custom credits	- Broad criteria as for multiple infrastructure types - Substantial cost for certification

Table 6.2: Summary of existing SRT analysis (continued).

The main areas of differences between the systems include the number of categories and number of individual credits, the number of points awarded for each criteria and the emphasis each system stresses on certain areas of sustainable development. With regards to the division of credits and points awarded, a comparison has been made between the systems and provided below in Table 6.3. This has been conducted to identify the emphasis each system places on certain areas of sustainability, and to evaluate if all aspects of TBL reporting are suitably considered by each system.

Table 6.3: Division of credit points expressed as a percentage of total achievable score.

System / Category	CEEQUAL	ENVISION	GreenLITES	Greenroads	INVEST (USA)	IS Rating Tool
Project Management	15.43%	16.69%	9.16%	24.07%	25.40%	15.50%
People and Communities	16.62%	10.26%	17.22%	9.26%	6.35%	10.00%
Land Use and Landscape	13.12%	14.83%	8.42%	1.85%	4.76%	12.00%
Historic Environment	5.47%	3.71%	0.00%	1.85%	2.38%	5.00%
Ecology and Biodiversity	8.63%	5.32%	10.62%	8.33%	8.73%	10.50%
Water Environment	12.82%	15.95%	6.23%	10.19%	7.14%	7.00%
Physical Resource Use	22.78%	10.14%	24.18%	21.30%	15.08%	24.50%
Transport	2.14%	5.44%	16.12%	9.26%	21.43%	0.00%
Energy and Emissions	2.99%	17.68%	8.06%	13.89%	8.73%	15.50%

As each system contains different categories, it was necessary to first distribute each system's points into equivalent categories to produce Table 6.3. The nine categories of CEEQUAL were chosen as the baseline, simply as this system is the oldest and has the most evidence of being successfully utilised as an SRT over the years. There was however the addition of a category for "Energy and Emissions" and the categories "Project or Client Contract Strategy" and "Project or Contract Management" were combined into "Project Management". To obtain the percentages for this categorical comparison, the points from each system were divided into the new categories, and then the available points corresponding to that category were calculated as a percentage of the total available points. Figure 6.1 below represents the data from Table 6.3 by graphical means for a more relatable representation of the data.
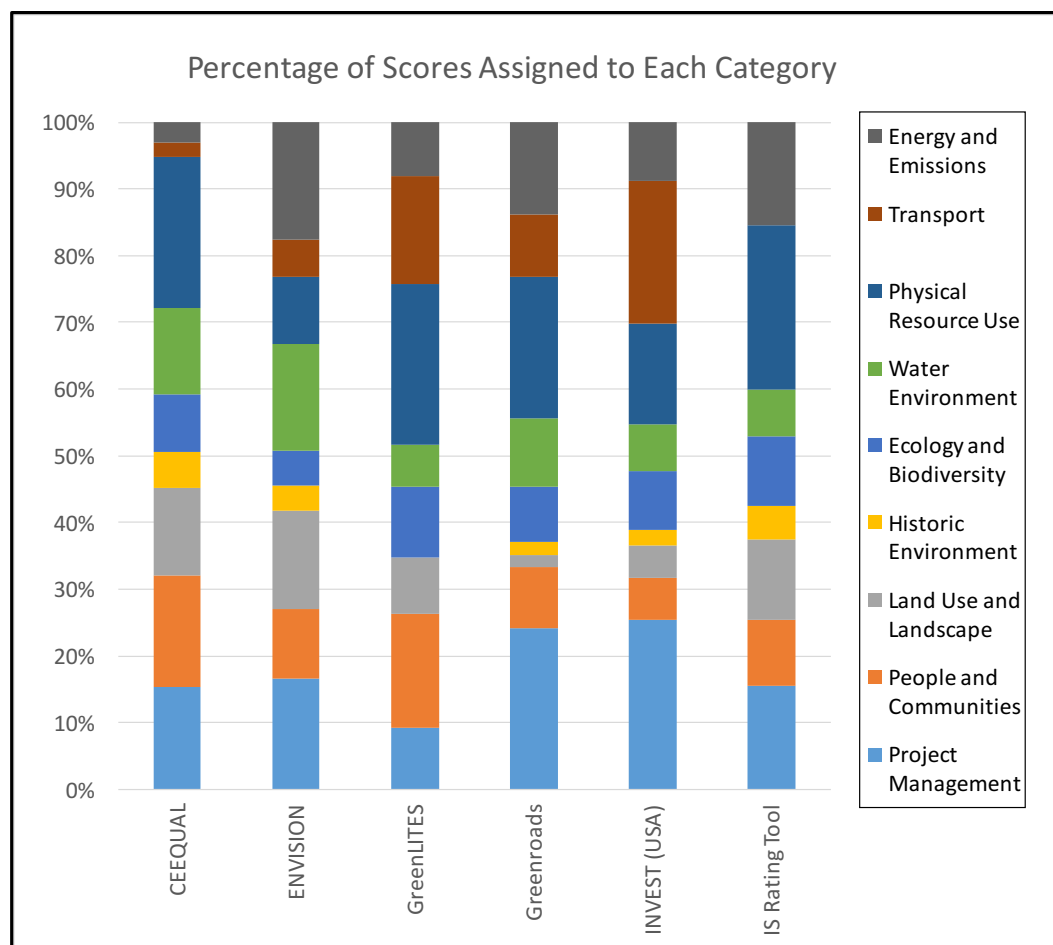
Figure 6.1: Division of credit points expressed as a percentage of total achievable score.

It is clear that not one of these systems equally distributes points across the categories and that all systems show large differences in the number of points applied in each area as alluded to earlier. This does not necessarily expose weakness in these systems, but it does show how each system has been developed differently, with different key values and based on different circumstances. This highlights how existing systems may not be appropriate for all scenarios, as they may unintentionally incorporate bias into the results. For example, a rating conducted using the GreenLITES system may give a higher score to a project that puts emphasis on reducing material and resource use, but fails to consider energy and emissions, however the same project rated using the ENVISION system may receive a poor score, due to the "Physical Resource Use" categories not being weighted as high. This should clearly define how there is no set rubric for development of these systems and the results should not be compared between systems for identical projects. Careful consideration of the division of points and the choice of the system are thus essential in obtaining results that accurately represent the progress of each project. The total score of each category is an important feature that will be discussed in the following chapter when the choices for the developed system – *SMaRT* are explained.

6.4   CONCLUSION

This chapter has provided a comparison of what have been identified as six of the more prominent SRTs currently being implemented. It is clear that while there are different systems available, the major structure and characteristics of each system is relatively similar. The major preventative measure for implementing one system in all situations is that they have typically been developed to work in a particular geographic region, and for an infrastructure type or types, which has resulted in the categories and credits used suitable in certain scenarios only. Due to this, any of the systems identified cannot simply be adapted as they stand to work for other construction agencies. It would however be feasible to adapt them with additional work and specification to ensure relevancy.

The aim of identifying common patterns between the systems was achieved, with almost necessary features for an SRT being defined, including; major categories, sub-categories and individual performance credits explaining specific criteria that must be met; points based scoring system to assign weight to each variable; and varying award levels to enable identification of how successfully a project has implemented sustainability. Overall, this information has been utilised, and discussed in the following chapter, where the process for development of the RMS specific SRT - *SMaRT* will be discussed.

CHAPTER 7

DEVELOPMENT OF THE SUSTAINABILITY MONITORING AND REPORTING TOOL (*SMaRT*)

7.1   INTRODUCTION

From the literature review, it was identified that the basic objectives of sustainability ratings tools (SRTs) include; potential to encourage more sustainable practice, ability to provide a quantitative means of assessment, capacity to allow for more informed decisions and trade offs regarding roadway sustainability, and functionality to establish an implementable baseline requirement to stimulate improvements. Along with these intentions, additional important features to be included in *SMaRT* were that it must be simplistic and to efficient implement, the overall assessment process should not be arduous and create any substantial delays to the project or additional time requirements, and the results should be beneficial for the entire project as well as the organisation. The system would be ineffective if the results provided no means of improvement, but rather acted solely as an additional administration tool.

This chapter aims to provide detailed information on the development of *SMaRT*, with appropriate justification behind the choice of features, structure, scoring approach and overall functionality. The *SMaRT* system can be divided into three components, which include:

1. Structure and Format
2. Categories and Assessment Criteria
3. Application of Scores and Certification Levels

The following chapter will discuss each of these components in more detail. The full, final revision of *SMaRT* (*SMaRT – v1.01)* has been provided as Appendix B

to this report and a sample of the scorecards that are proposed to be used alongside *SMaRT* have been provided as Appendix C to this report Appendix B is a substantial component of this research as it is the direct outcome of Stage 2 of the research project.

7.2 STRUCTURE AND FORMAT

The major features that were decided for inclusion in *SMaRT* included the following list, which has been put together based on the analysis included in Chapter 6. It was decided that *SMaRT* should; cover triple bottom line (TBL) concepts, it should be divided into categories, subcategories and individual achievement criteria when appropriate to enable easier use, scoring should be based on awarding points to define a varying level of achievement, and there should be different certification levels to summarise performance.

In terms of the format, the finalised system provided as Appendix B to this report has been copied from its original spreadsheet form. Ideally, the real tool in practice would remain as a spreadsheet, which is beneficial as the scorecard can be linked to the main sheet, which allows automatic calculation of scores and certification level, once the achievement level is specified and comments are populated. The scorecards are essential as they provide a clear summary of the project results, and allow the assessor to include their comments and evidence to justify why a particular score was awarded. The electronic form of the document also allows for more efficient data recording, saving of information, and ease of communicating results to stakeholders.

Table 7.1 is an excerpt from the final version of *SMaRT,* and shows the structure and presentation of the system. The "Categories" and "Subcategories" divide the whole project into areas that aim to cover all aspects of the TBL and aim to assess a range of issues. The "Performance Objectives" or "Credits" (used interchangeably from this point onwards) describe what process, area, or technology is being evaluated, the "Achievement Criteria" defines what must be

achieved in order to receive points as well as the points achievable, and the different levels of achievement, either "Achieving", "Improving" and "Exceeding" reflect how significant the contribution to sustainable practice is with respect to the credit being evaluated.

Table 7.1: Excerpt from SMaRT, showing a breakdown of the structure.

Category	Sub. Cat.	Ref.	Performance Objective / Credit	NON ACHIEVING (nil points)	Achieving	Improving	Exceeding
Sustainable Sites	ALIGNMENT	SIT-1	Is the project located in a previously developed OR brownfields site?	The project footprint is majorly considered a greenfields site **OR** the design has chosen an alternate alignment that increases negative environmental impact to favour another project consideration e.g. - cost	The project is approximately 50% green fields and 50% brownfield development. (5 Points)	The project is majorly a brownfields site (>75%), however additional greenfield land acquisition was required for some components. (10 Points)	The project is wholly within an existing road corridor and disturbed zone **OR** other brownfields site and no additional land acquisition was necessary. (15 points)
		SIT-2	Has an effort been made to reduce the footprint of the project?	Project has had no attempt to reduce footprint area.	Minimum corridor widths have been designed for, however no creative solutions or other measures have been proposed to reduce footprint. (3 points)	The design has incorporated some means of reducing the project footprint e.g. - retaining walls, - steeper batters, - barriers and reduced clear zones, - improved delineation and less wide travel lanes (6 points)	The project has introduced innovative ways to reduce the footprint area **AND** criteria from other levels is achieved. (10 points)

Roads and Maritime Services - Sustainability Monitoring and Reporting Tool — SMaRT

Criteria and Achievement Level

The structure of *SMaRT* has been majorly based of the structures of the ENVISION and IS systems combined. From the analysis in Chapter 6, the varying levels of achievement defining different efforts towards sustainability in a tabular form was deemed effective and simple to follow. It is more informative and flexible than a yes-no approach to awarding achievement, but also less complex than some of the other existing SRTs.

Issues with the existing systems mainly stemmed around the fact that typically the descriptions of what should be achieved to obtain a rating were long, verbose and in some instances repetitive in nature. For example, the Greenroads system involves awarding different points based on varying levels of input, however the means of delivering this information is generally a full page description – or longer, the same for CEEQUAL and INVEST. This is why the IS and ENVISION structure was preferred, as the individual achievement levels are clearly identifiable and the requirements to achieve each level are simply stated. This saves time, effort and minimises confusion for the project assessor. By dividing the credits into different performance levels and defining what must be achieved for each level, minimal training would also be required to implement the system, as it is straightforward – another reason why this structure and set up was chosen.

7.3   CATEGORIES AND PERFORMANCE CRITERIA

7.3.1 CATEGORIES

Following on from the theme that the system was meant to be simplistic and minimally time consuming, the development of the system started with a limited number of categories. The analysis of the six existing SRTs in Section 6.2 showed that although they contained different titled categories, many were interchangeable and could be treated as equivalent. The first step in defining what categories were to be included in *SMaRT* involved grouping all categories from these existing SRT systems in order to identify the common themes and reduce variables.

The initial grouping of the existing system categories was into five groups, namely:

- Management (including land use management),
- Environment,
- Climate and Pollution,
- Materials and Resources (including water, energy, and waste), and
- Community.

From the analysis conducted in Chapter 4 on the RMS, the sustainability strategy of the organisation exposed nine key areas, to cover all sustainability issues for the work they conduct. These categories are from the current sustainability strategy, which have been developed from multiple iterations since 2002. All RMS projects and systems have some association with this strategy, hence it is logical to ensure all these key areas are considered for *SMaRT*.

Examining these nine categories (refer to Section 4.3) from the RMS, it was possible to also condense them into the initial groupings used on the existing SRTs above, again to simplify the initial system. These five categories were hence determined as the starting point for *SMaRT*. It was expected that as the system developed, subsequent iterations of these categories would ensue based on the initial subcategories and credits chosen.

Therefore, the initial categories of *SMaRT* based off existing SRTs and the RMS sustainability strategy were the following;

- Management – incorporating sustainable procurement,
- Environment – incorporating biodiversity,
- Climate and Pollution – incorporating climate change, and air quality,
- Materials and Resources – incorporating energy, water, waste management, and materials selection, and
- Community – incorporating heritage, and liveable communities.

7.3.2 PERFORMANCE OBJECTIVES / CREDITS

The following stage in the process was defining the performance objectives for the system. Again this process commenced as a combination of review of the existing SRTs as well as development of new ideas that would better fit inline with the overall context of *SMaRT*.

As 50% of the existing systems analysed could be used for any infrastructure type, there were many sections and credits that were too general or did not apply for what was trying to be achieved with *SMaRT*, hence not appropriate. Conversely, the GreenLITES system is highly specific for the NYSDOT geographic area and activities, therefore although it befits road infrastructure, it was also not appropriate.

Due to these issues, although the ideas for the performance objectives stemmed from the existing systems, the majority were new and all were re-written from square one to fit inline with the objectives of *SMaRT*. It was important to only identify those credits, which would pertain to road construction and to the existing and future values of the RMS organisation, hence the outcomes from Chapter 4 was important when choosing these variables.

As the credits were being written, it was decided to divide the minimal number of categories up further, as it was identified that each category was incorporating too many individual credits. Although this does not impact the functionality of the system, to improve navigation of the credits and enhance the overall ease of use of the system, the broader five categories identify in Section 7.3.1 above were divided up into the final nine that form Version 1.01 of *SMaRT* (Appendix B). This saw the categories of "Materials and Resources" being divided into "Using Resources" and "Water and Energy", and "Management" divided into "Management and Governance" and "Design". It was important to separate water and energy from other resources, as they have been identified very specifically in the sustainability strategy of the RMS, and the management plans surrounding energy in particular are of a lesser quality than for other areas, and there was suggestion in Section

5.2.2 that the RMS could improve the management of water resources. By including water and energy as a separate category within *SMaRT,* the objective was to bring more attention and establish more emphasis around it, which in turn would improve the works conducted in the area. Design was added, as although it is technically not part of the construction phase, it indirectly impacts significant construction choices, so some provision was deemed necessary.

Sustainable procurement features were also included in *SMaRT*, due to the benefits identified from the information presented in Section 5.2.2 as well as the anticipated inclusions within the future sustainability strategy to be released by the RMS. It has become clear through this research that more sustainable sourcing of materials and services is one of the paramount issues when considering sustainability in road projects, hence why there has been an emphasis to include the theme, specifically in performance objectives MAN-1, MAN2, and MAN-3 for example (refer to Appendix B for the full version of *SMaRT*).

The inclusion for "Custom Credits" was also added to the system as it is unlikely that any SRTs are able to encapsulate all aspects of every road project, hence project representatives should be given the option to include project specific initiatives. Table 7.2 below shows the final categories, with the breakdown of subcategories and number of credits.

Table 7.2: Breakdown of Categories and Subcategories within SMaRT.

Category	Number of Subcategories	Number of Credits
Sustainable Sites	3	6
Management and Governance	2	7
Ecology	3	7
Using Resources	3	11
Water and Energy	2	6
Community and Quality of Life	5	10
Design	5	7
Pollution	3	8
Custom Credits	n/a	5
TOTAL	26	67

One important aspect of *SMaRT* is that; it is important to value each category relatively proportionately in order to propose equal significance on all aspects of the TBL. The number of subcategories and credits that constitute the final version of *SMaRT* were not restricted in any sense, however if an additional subcategory was added to a particular category, the total score would be assessed to identify how significant an impact it would have on the total weight of categories and the division of points. The final number of subcategories and credits as shown in Table 7.2 above reflects the attempt to have a relatively equal division between the categories and is the result of careful selection, iteration, combining themes and final revision of achievement criteria. Similar to Section 6.3 of this report, a percentage of credit points to total points comparison has been undertaken for all the existing systems analysed, as well as the newly created *SMaRT* system. The categories chosen for the comparison in Figure 7.1 below are the final categories chosen for *SMaRT*, shown in Table 7.2 above, however the "Design" category has been merged with "Management and Governance" as it is not technically part of the construction phase, rather indirectly influential, hence considered in this context as a management technique.

From Figure 7.1 below, it is clear that some of the existing SRT systems have tendency to favour certain components of sustainability, such as Greenroads clearly favouring the "Materials and Resources" category, whereas CEEQUAL has clearly put less emphasis on the "Energy and Atmosphere" category. This was identified in more detail in Section 6.3.

Again, as previously identified, this emphasis on certain components cannot be seen directly as showing one system more effective than the other, as each of the existing systems was developed for a different purpose and with varying concerns. Rather, the purpose of Figure 7.1 is to show graphically how *SMaRT* has relatively equally divided credit points between categories and given a general perception of how each of the categories is highlighted. In Section 7.4 to follow, the methodology and process for assigning the scores will be provided.
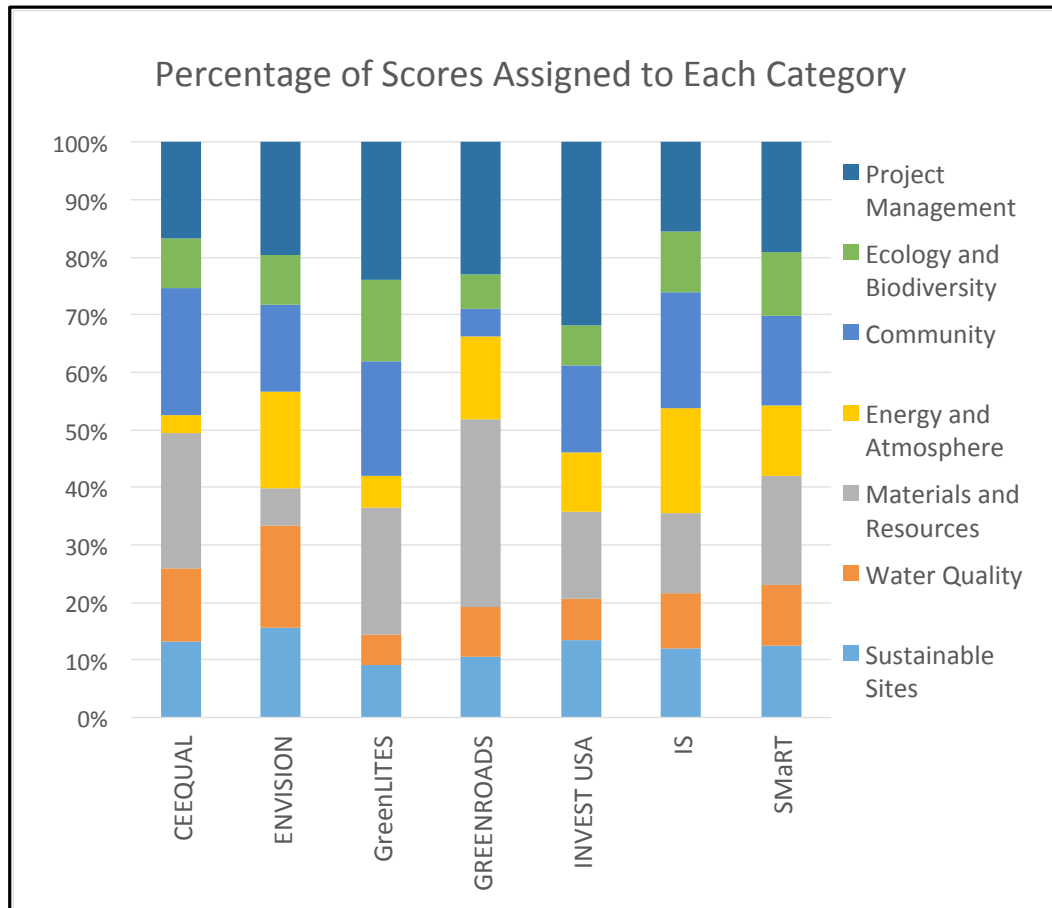
Figure 7.1: Division of points between each category within SMaRT and existing systems.

7.4   APPLICATION OF SCORES AND CERTIFICATION LEVELS

7.4.1   SCORING METHODOLOGY

As identified in Section 3.4.1 of this report, a Compared Comparison Approach (CCA) was utilised to assign scores to variables in the rating system, where each credit is scored relative to all others in the system. It was important to define a method of combining qualitative and quantitative data, which allows for analysis to be undertaken on different variables on an equivalent basis. The overall aim of assigning weights is to assign a numerical value to each performance objective, which reflects its relative impact on sustainability within the greater context of the entire project under assessment. The relative weight of each individual category in *SMaRT* have been represented in the chart shown in Figure 7.2 below.

Weighting of Categories in *SMaRT*

■ Sustainable Sites (9%) ■ Management and Governance (9%)
■ Ecology (13%) ■ Using Resources (13%)
■ Water and Energy (17%) ■ Community and Quality of Life (12%)
■ Design (16%) ■ Pollution Control (11%)
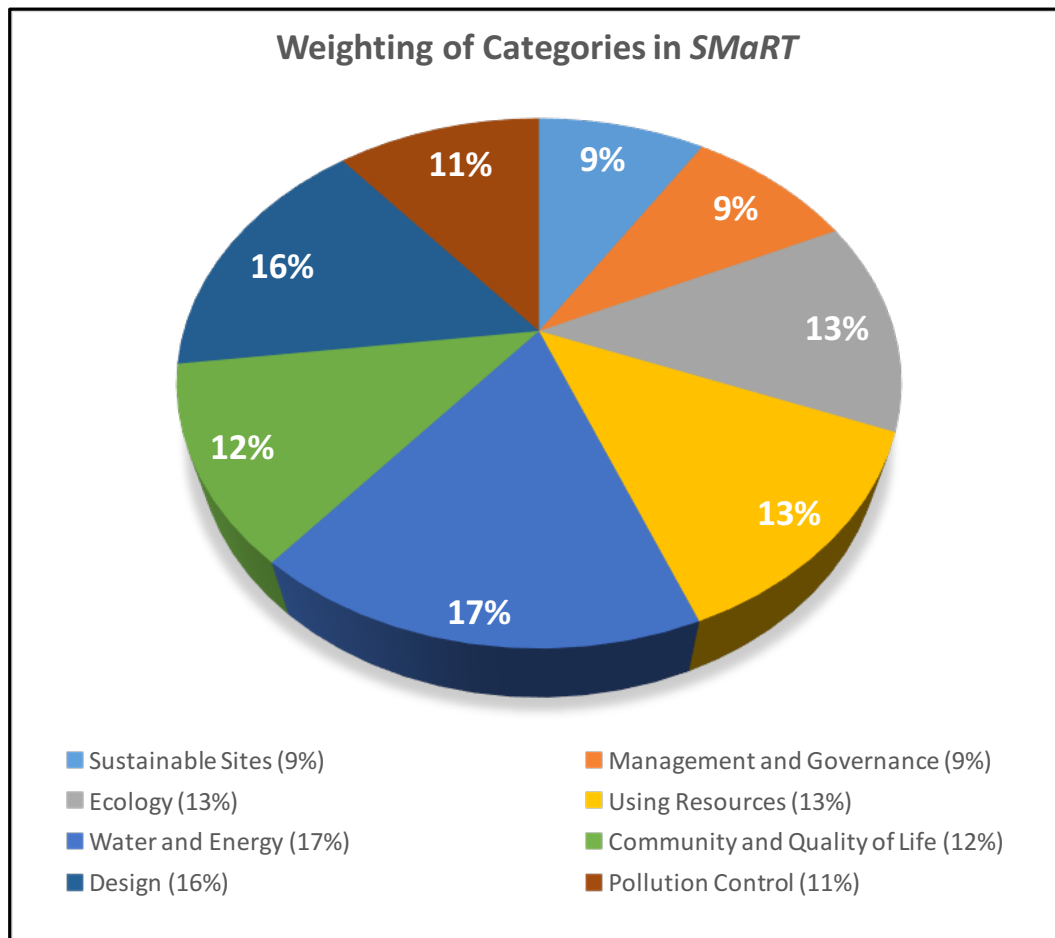
Figure 7.2: Relative weight of each category within SMaRT.

Anderson, Weiland & Muench, (2011) state that assigning weights to credits in an SRT cannot be conducted in a strictly empirical or objective manner as:

- some sustainability components are difficult to compare due to a lack of a suitable metric for comparison (e.g. preservation of scenic views versus managing stormwater treatment), and

- some actions may be impossible to measure their direct impact on sustainability; however, the execution may benefit future decisions or other aspects of the project.

This applies directly to *SMaRT*. For example, the performance objective POL-1 is *"Has the project implemented a waste and recycling plan?"* and POL-6 is *"Has the project reduced surface and groundwater contamination?"*. It does not make sense to award the top level of achievement to both of these credits, as clearly

preventing contamination of surface and groundwater systems would rank higher in terms of positive impacts with regards to sustainability than incorporating a management plan. Due to this, it was necessary to assign an overall weighting to the categories, in order to rank them with respect to one another within the context of the entire system.

The basic framework of assigning scores to each performance objective has been described below.

- The first step of the process involved firstly ranking individual performance objective relative to one another within each major category (i.e. Sustainable Sites, Pollution, Community etc.). This represented each performance objectives in an order with respect to their impact to sustainability.

- The second step of the process involved assigning a score to each achievement level for each performance objective. As a starting point, it was decided that each achievement level could receive between a minimum of 1-point and a maximum of 15-points. This range was chosen as it is large enough to allow for clear distinction between poor, adequate and excellent efforts and gives an improved range of results, but also not so large that if a misunderstanding of the criteria or incorrect scoring occurs then the final results have a high proportion of error.

- The third step involved reviewing all scores for each category, with respect to the other categories within *SMaRT*, as well as the total scores for each category.

To better show how this process of assigning scores was implemented, the methodology behind assigning scores to a selection of the credits from the "Sustainable Sites" category has been provided below as an example. This should provide insight to how the entire system was scored.

7.4.2 SCORING APPROACH FOR "SUSTAINABLE SITES"

The individual performance objectives were ranked 1 – 6, with 1 having the least impact and 6 having the most significant impact. With reference to the full system provided in Appendix B, the credits were ranked as follows: SIT-1 = 6th (i.e. most important), SIT-2 = 4th, SIT-3 = 5th, SIT-4 = 2nd, SIT-5 = 1st (i.e. least important) and SIT-6 = 3rd. Note, the performance objectives here are listed by their reference number, viz. SIT-1, SIT-2 etc., which can be identified in the complete system.

Starting at SIT-5, dealing with projects located in adverse locations – the "Achieving" level was awarded 1-point as the criteria only stipulates the requirement is identifying that the site is unfavourable, and some construction techniques have been identified that may reduce negative impacts. This does not have a significant contribution to obtaining a more sustainable project, hence the minimum score is award. The "Exceeding" level of improvement for SIT-5, is obviously higher achieving, however the impact of avoiding sites with unfavourable geology is still minimal, therefore the score awarded is only 6 points, less than half the maximum points. The "Improving" level was awarded points in the middle of this range, hence 4 points.

Furthermore, if we look at SIT-1, identifying whether a project is located in Brownfields sites –we identify that the achievement levels exhibit what can be considered a linear increase in the percentage of land that should be Brownfields to achieve higher levels i.e. 50% of project must be located in Brownfields to be "Achieving", 75% in Brownfields for "Improving" and 100% in Brownfields for "Exceeding". The "Exceeding" level of achievement is awarded 15-points, as this has been identified as having the maximum benefit towards a sustainable roadway. This is justified, as if 100% of a new construction project is in previously developed land, the chosen site has no additional impacts to the surrounding lands while meeting the project needs. Subsequently, the points decrease in a linear manner for the two lower levels, with 10 points awarded to the "Improving" level and 5 points to "Achieving" level.

With SIT-2, dealing with the effort from the project team to reduce the footprint of the project area, the "Exceeding" level of achievement was awarded 10-points as the impact of reducing the footprint area is ranked comparatively to the "Improving" level for SIT-1. Namely, the impact of introducing innovative ways to reduce the project footprint area is similar to if the project had >75% within Brownfield sites. The "Improving" level was awarded 6 points, as the result of implementing some measures to reduce the footprint area has been deemed slightly more effective than a project where 50% is Brownfields and 50% is Greenfields (i.e. "Achieving" level of SIT-1). The "Achieving" level for SIT-2 is awarded 3 points as the contribution is minimal but still relevant. A score of 1 point would be reserved for very minimal efforts, that only show early stages of improvement. The criterion is awarded 3 points as reducing the footprint area is an important consideration, and by comparison the impact is more substantial than the "Achieving" level from SIT-5 (i.e. 1 point).

The three examples provided above of how scores were assigned to SIT-5, SIT-1 and SIT-2 show that the process of assigning scores involved working sequentially through each credit and identifying how they relate to others that have previously been scored. The process is conceptually simple, however the result is suitable in defining each credit relative to one another, which is the essence of the rating system. More sophisticated techniques could have been used, however unnecessary at this stage of the system's development.

7.4.3 CERTIFICATION LEVELS

As was utilised in all of the systems compared in Chapter 6, a five-tiered system has been employed for the final structure in *SMaRT*. A tiered system is effective as it allows for clear distinction of improvements. The total points required to achieve each certification level were chosen with the aim that most current projects, under existing systems would fall under the "Certified" category if they implemented some measures to make systems more sustainable. A percentage based award system was also utilised as it is a framework that most people are

familiar with, and would automatically connect a higher percentage score relates to a higher level of achievement, which is true in this instance.

In order to obtain the certification level bounds, initially, the total score was divided into three – so the bottom one third of projects would represent non-certified projects, middle one third would represent certified projects and the top one third would represent high performing projects. High performing projects initially included Platinum, Gold and Silver Certifications, with Platinum being reserved for a very small percentage of projects assessed. This was determined as too demanding, as it was envisaged that minimal projects would be able to achieve even the Silver Rating. The ratings were hence adjusted, to be more appropriate for current projects, where sustainability has not been measured previously and is likely to result in lower rated projects. The requirements for a Platinum rating are still notably high as it is important to define significantly when a project goes above and beyond current expectations.

The final certification levels are thus shown in Table 7.3 below. These ratings still retain an adequate separation between levels, allowing clear distinction between those projects that just marginally implement sustainability into processes, to those more adept. It is noted that these certification levels will need to be reviewed in the future as ideally as more projects are assessed and the results are used to develop sustainability in road construction, projects will become more sustainable, and consistently achieve higher points.

One other important feature of *SMaRT* is that if any of the performance objectives are not applicable for the project, the system allows them to be scoped out and the total score achievable is reduced. In Section 6.2.5, non relevant or redundant credits were identified as a negative for the existing schemes, and that an improvement would be the provision to remove what is extraneous, such as what the INVEST (USA) system has conducted with specific scorecards for different activities.

Table 7.3: Certification levels within SMaRT.

	Platinum = 90% of total score ~90% of all Exceeding Level Criteria is met
	Gold = 75% of total score ~75% of all Exceeding Level Criteria is met
	Silver = 50% of total score ~100% of all Improving Level Criteria is met
	Certified = 35% of total score ~75% of all Achieving Level Criteria is met
NOTE: the fifth level in *SMaRT* represents a "Non Certified" rating.	

7.5 CONCLUSION

Overall this chapter has aimed to provide in suitable detail the process involved in developing the *SMaRT* system. The three major components of the system; Structure and Format, Categories and Assessment Criteria, and Application of Scores and Certification Levels, were all discussed and final comments on the current version of the system have been provided. It has been identified that *SMaRT* has adapted components and ideas from existing SRTs as well as improving and re-developing areas, which do not accommodate the values of the RMS. These include a structure adapted from the ENVISION and IS rating systems as well as incorporating features such as different categories and subcategories, performance objectives, achievement criteria and different certification levels. It is clear that the system is only in early stages of development, and that there will be necessary future works in order to prove its effectiveness. The following chapter will provide a case study, which involved applying *SMaRT* to a current RMS project, which will give further insight to how the system performs. Chapter 9 will further identify any issues and choices made with regards to the development of *SMaRT,* and will provide further discussion on how effective these choices are.

CHAPTER 8

CASE STUDY: OCEAN DRIVE AND HOUSTON MITCHELL DRIVE ROUNDABOUT

8.1 INTRODUCTION

In order to assess the functionality of *SMaRT,* and to identify any unforseen development issues, a case study project was chosen for a pilot test. The Ocean Drive and Houston Mitchell Drive Roundabout (Ocean Drive Roundabout) was the project chosen for analysis, which met the requirements that permitted the use of the rating system.

This chapter aims to present the results of applying *SMaRT* to an actual, and current Roads and Maritime Services' (RMS) construction project. These results should help to identify the simplicity or complexity of the system, as well as any challenges involved with implementing the ratings, the areas that require improvement, and to give an overall assessment of the applicability of such a tool to construction projects.

The information provided in this Chapter was obtained from personal involvement with the project; through direct communication with the project engineer, works supervisor and works manager; as well as from technical project documents.

8.2 PROJECT BACKGROUND AND CONTEXT

The Ocean Drive Roundabout project was delivered by the Regional Maintenance Delivery (RMD) division of RMS, utilising a main construction crew of 11 RMS staff plus various external contractors, skill hire and consultants.

The project was a combination of full width pavement reconstruction, targeted pavement rehabilitation works as well as new construction. The project was located at the intersection of an urban arterial road – Ocean Drive and a rural collector road – Houston Mitchell Drive, between the localities of Bonny Hills, NSW, 2445 and Lake Cathie, NSW, 2445, south of Port Macquarie on the mid-north coast of NSW. Refer to Figures 8.1 and 8.2 below.
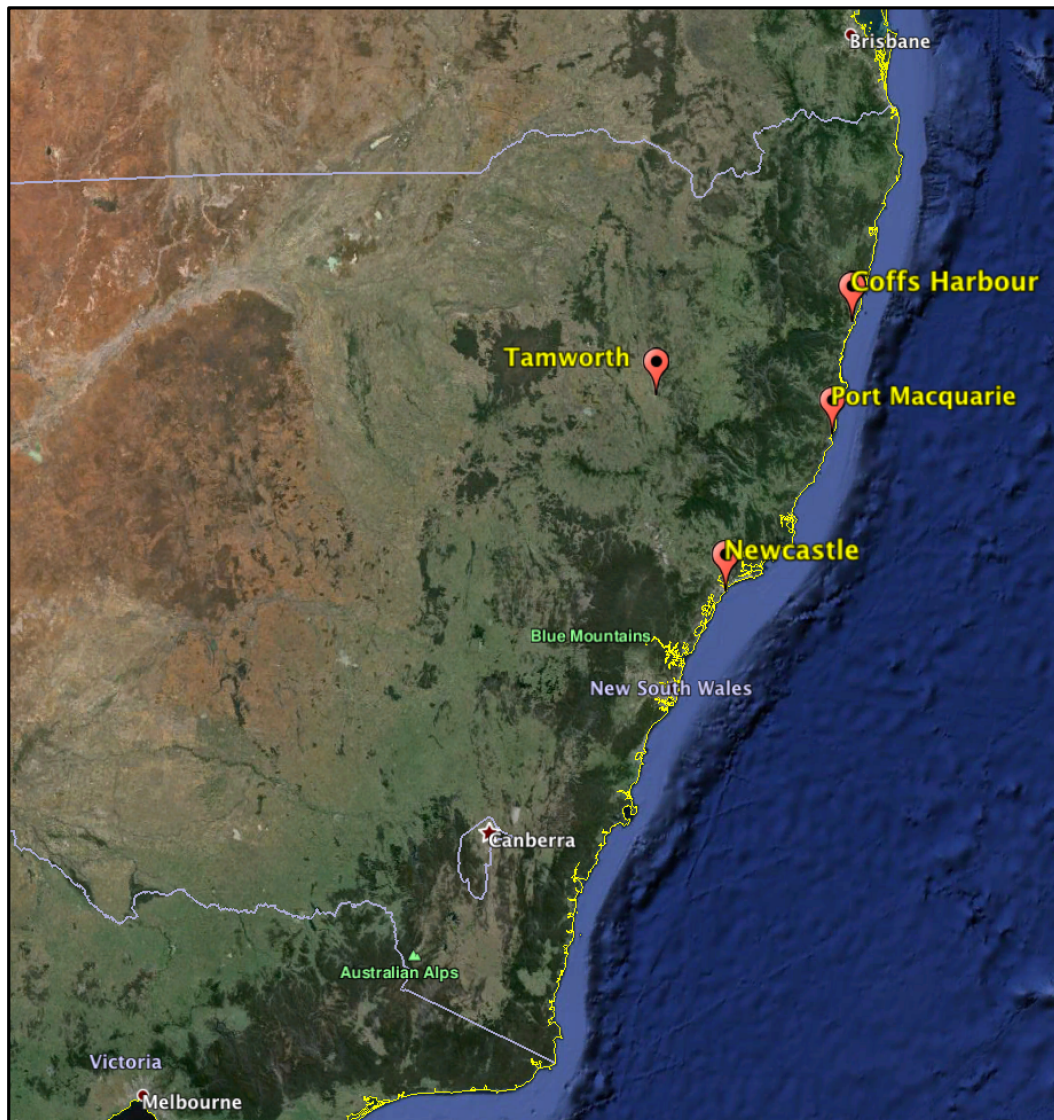
Figure 8.1: Location of case study with respect to NSW, (Google Earth).

Figure 8.2: Location of case study with respect to Port Macquarie, (Google Earth).

The Ocean Drive Roundabout was around a $4.7 million, construct only project, which was being provided by the RMS/RMD for the Port Macquarie – Hastings Council (PMHC). The formal agreement between RMD and PMHC was a memorandum of understanding, where the project was jointly funded by both

parties, and the RMS conducted all physical works. The project was initiated in 2011 by the PMHC, as it was identified that the future zoning and land use of the area would require upgraded traffic facilities for housing developments, a primary school and other residential facilities.

The project was put on hiatus for various reasons until November of 2014 when the RMS was engaged to deliver the works. Construction commenced 3rd March 2015, with an expected completion date of November 2015. Since 2011, the school has been completed, and subsequently opened February 2015 resulting in additional considerations for the construction team.

8.3 PROJECT SPECIFICS

The project design involved construction of a two lane, urban-standard roundabout on the main thoroughfare – Ocean Drive, with single lane approaches on the Houston Mitchell Drive approach. Refer to Appendix D for an overview showing the basic design.

The existing roadway required reconstruction and formed part of the proposed northbound lanes. The new southbound lanes were constructed from foundation level and the Houston Mitchell Drive section included widening and reconstruction of the pavement at the intersection approach, and rehabilitation of the pavement at the limit of construction works.

Features of the project included:
- 32,000 m^3 of bulk earthworks,
- 19,000 m^3 of foundation treatment,
- 11,200 m^2 of reconstructed pavement,
- 1,900 m^2 of rehabilitated pavement,
- 2,200 m^2 of in-situ stabilised earthworks,
- >10,000 m^3 of material provided by the project for local development work,

- 2,000 m of subsoil pavement drainage,
- 600 m of stormwater drainage,
- 25 precast concrete pits,
- 2,000 m of concrete kerbing,
- 550 m of erosion and sediment control structures,

- 900 m^3 of dense grade asphalt,
- 16,500 m^2 of bitumen spray seal,
- 500 m of concrete footpaths,
- 1,600 m of new cycle lane facilities,
- 2,100 m^2 of mass planting for landscaping.

The project also included significant utility relocations and installations for high voltage and low voltage power, potable water mains, recycled water mains, communications cables as well as future infrastructure for power and communications.

8.4 RESULTS

As described in Chapter 6, the output from *SMaRT* involves completion of individual scorecards for each category being assessed. The completed project scorecards have been included as Appendix E to this report. Due to the sensitivity of some documents with respect to the RMS, evidence has not been included as part of this report, however reference to the main project documents is included in the scorecards for the individual performance objectives.

The total score achieved by the Ocean Drive Roundabout was 41%, with an award level achievement of "Certified". The individual category scores are shown in Table 8.1 below.

Table 8.1: Scores achieved by the Ocean Drive Roundabout project.

Category	Points Received	Total Achievable	Percentage(%)
Sustainable Sites	44	69	63.8
Management and Governance	12	70	17.1
Ecology	36	71	50.7
Using Resources	62	122	50.8
Water and Energy	6	68	8.8
Community and Quality of Life	49	72*	68.1
Design	17	79	21.5
Pollution	34	78	43.6
Custom Credits	0	-	-
TOTAL	**260**	**629**	**41.3**
*COMM-9 scoped out due to not being applicable (10 points max)			

It is clear that from a percentage achieved perspective, the highest performing category was "Community and Quality of Life", closely followed by "Sustainable Sites", and the lowest scoring category by far was "Water and Energy". A discussion of why these results occurred is provided in the following section. The project did not create any additional "custom credits", or show any signs of cutting edge/ innovative processes.

8.5 DISCUSSION

As identified in Section 3.4.1 the objectives of the final rating system were to ensure that it was; self applicable and assessable (by the project manager or responsible representative), simplistic in nature, minimally time consuming and provided results that could be used to benefit overall sustainability benchmarking and progress.

With regards to general implementation ability of the system, overall the rating for the project took around four hours, which involved collecting evidence for each category. If this time is broken down, there are 62 categories in total (not including custom credits), which would equate to roughly four minutes per performance objective. The amount of time required to rate a project would vary according to the project scope, project magnitude, availability of information and the experience of the person conducting the assessment, hence this numerical value of time does not give a distinct or comparable assessment of how quickly or slowly the application of *SMaRT* is. However, considering time as an individual entity, four hours is relatively short period of time in the scheme of total project duration, hence would likely be acceptable. In order to gauge what duration could be expected from implementing the system, it would be necessary to engage further case studies in order to obtain more data to make

With regards to simplicity, the format and structure of *SMaRT* as defined in Section 7.2 was governed by ensuring the system was simple to use. This has translated through and was evident during the case study assessment. Although there may be bias involved as the developer of *SMaRT* conducted the assessment; the system categories, performance objectives and achievement criteria all associated well with corresponding aspects of the Ocean Drive Roundabout project and did not appear to contain ambiguity.

As identified in Section 3.4.1 ideally *SMaRT* would be used as an assessment tool however in this instance it was utilised mid project. The system still functions as intended when applied mid-project and functionality wise, there are no prohibiting factors preventing its use. Within Chapter 7, the process described for the development of the system does not expose any features, structure issues, or components that would prevent *SMaRT* being utilised pre-construction or mid-construction if applying to the construction process. This would need further investigation to clarify and define where it can and cannot be utilised. The reasons behind selecting the Ocean Drive Roundabout as the case study were based on; the availability of the project to accommodate the research needs, the availability of construction projects of a suitable scope and magnitude in the given timeframe, as well as the ability to procure sufficient information that could be used to address

all categories within the rating system. The Ocean Drive Roundabout suitably met all of these criteria. From the evaluation, the highest and lowest rated categories have been assessed, in order to identify how the results may be utilised to improve sustainable practice.

8.5.1 COMMUNITY AND QUALITY OF LIFE

As identified, this category performed the strongest; having out of the nine performance objectives assessed, three credits receiving "Exceeding" level awards, one receiving an "Improving" level award, four receiving "Achieving" level awards and only one receiving a "Non Achieving" awards (refer to Appendix E for full scorecard results).

The single performance objective that could see improvement relates to incorporating local materials and supplies into the design and construction of the project, to improve the aesthetic association with the surrounding area and community. With hindsight, although this credit was non achieving, there were minimal areas for the project team to incorporate local materials and hence, the result is warranted. This would be a different case if for example the project included intricate urban design features that may involve timber or rock work, which could be sourced locally. The points for achieving this performance objective are only a maximum of five, hence does not rank relatively high on the points scale.

By examining the "Exceeding" awards, it is clear that the project has excelled in; communication with the community in order to ensure the facility functions with their best interests in mind, as well as engaging local stakeholders for works where possible. It was identified that the project team quite easily obtained this level of achievement, hence the methods and processes used in these areas can be utilised for other projects in order to ensure future works aim to uphold the same success.

8.5.2 WATER AND ENERGY

As the weakest performing category; of the six credits assessed, two received "Achieving" level awards, while the remaining four were "Non Achieving" (refer to Appendix E for full scorecard results). The major hindrance within this category was the lack of management intervention and monitoring. The results identified that although the RMS had implemented some formal environmental management plan that considered water, the considerations were only minimal and appeared to be included in the plan only as they were system requirements of RMD. The water management plan only included provision for preventing pollution to receiving waters, in the form of erosion and sediment control methods, which are captured under the "Pollution" category in *SMaRT*. The project did not address the issues of water reuse and reduction, which form significant areas in the *SMaRT* system.

There can be two routes of actions from this result. If other projects are identified as poorly performing in this category (from other *SMaRT* assessment of projects), it would be conceivable that system or procedural changes would be the most appropriate action in order to improve projects. Although this may not be a simple process, the evidence shown by the system may be sufficient to prompt a review and assessment on methods to improve. Alternatively, if other projects are assessed with *SMaRT* and perform more favourably than the Ocean Drive Roundabout, it would suggest that the project team for this particular project have not implemented appropriate measures dealing with Water and Energy, which can be taken as "lessons learnt" when instigating future works. In both these instances, further trials and usage of *SMaRT* would be necessary to draw any valid conclusions.

8.6 CONCLUSION

The Ocean Drive Roundabout project was a suitable project for analysis based on the scope, magnitude and availability of information pertaining to the works. The scoring of the project resulted in a "Certified" rating, which supports the statement

made in Section 7.4.3 regarding that most projects should be awarded a rating if there is some formal attempt to manage sustainability. The project performed the strongest in the categories dealing with the overall location of the site and land use as well as the considerations for the community and stakeholders. The project performed the weakest in areas dealing with water and energy, which was clearly less considered than the other objectives. A discussion of how the results pertaining to these high and low performing categories was provided to identify how results from *SMaRT* could be used in a practical scenario in order to benefit future projects or identify lessons learnt.

Overall, this chapter has shown that *SMaRT* is at a stage where it can be implemented to "real life" projects. This case study however was conducted in a highly controlled environment as it was the first implementation of *SMaRT*. The development of the system is still in preliminary stages, where additional testing and trials would be beneficial, however this case study has allowed for targeted examination of the system and further works. It will be necessary to review these results if *SMaRT* is reviewed or developed further. The next chapter will discuss the project results overall and identify what implications and further works would be plausible to extend this research.

CHAPTER 9

DISCUSSION, LESSONS LEARNT AND FUTURE WORKS

This chapter aims to provide a summary of the findings from the research and analysis that has been described in the previous chapters of this report. Reflecting on the original objectives provided in Section 1.4, we can identify that there are three main facets to the research; analysis of the Roads and Maritime Services' (RMS) systems, development of *SMaRT*, and implementation of *SMaRT* of which all have been discussed below. The overall aim of this discussion chapter is to consolidate all research findings, identify the value provided by these results and to propose a set of key points that are the main lesson learnt from this project as well as proposing areas of further works that could be conducted as a follow on from this research.

9.1 RMS AND CONSTRUCTION AGENCIES

In terms of discussing the results obtained from the organisational assessment of the RMS and the comparison to industry, Section 4.8 and Section 5.4 of this report have already provided a substantial discussion on the benefits as well as areas for improvement within the existing RMS systems. The main points that can be derived from the research are summarised below.

It was stated in Section 2.11 within the literature review that the RMS has a lack of focus on construction of roads with regards to sustainability. This was a plausible deduction from the limited depth of investigation conducted during the initial literature searching stage, however the conclusions from the more detailed

assessment provided in Chapter 4 would dispute this claim. The major advantage identified through analysis of the RMS systems is that they do in fact place high emphasis on sustainability and that the majority of their systems have directly integrated sustainability into the considerations involved – including construction works. The purpose of this research was to identify progress within the RMS systems and it was clearly shown how there has been substantial and ongoing development in this area throughout the history of the organisation. The most effective period commenced in 2002, with a complete overhaul of the environmental direction. This resulted in several initiatives related to sustainability being encapsulated into the organisational systems.

Although the RMS does not explicitly pronounce how sustainability targets are being achieved and the methods for achieving set objectives – such as those in the sustainability strategy, there is vast, and ongoing development of project delivery systems, which are reviewed to incorporate more sustainability consideration when relevant. This is the reason why early investigation appeared to identify a lack of interest in sustainability as there is a lack of definition.

Conducting the assessment of the RMS was successful and identified key values for inclusion in *SMaRT*. As identified in Section 7.3.1, the base categories of the system came from the RMS sustainability strategy, which was a simple and straightforward decision within the project. More importantly however, was evaluating the breadth of; organisational documents, reports, specifications, project documents, and technical papers, which allowed a greater background of knowledge and insight, and assisted greatly in writing individual performance objectives and achievement criteria within *SMaRT*. Although it was not possible or necessary to comment on all investigation conducted within this report, the knowledge gained overall was a significant benefit.

Conversely, the major disadvantage in the RMS systems as initially identified in Section 2.6 of this report is that there is no mechanism for benchmarking sustainable projects. This research has identified several times the proven benefits of being able to quantify progress, and with the large amount of capital works being completed by the RMS each year, there is definite benefits from monitoring

performance. This is most important with long term ongoing works, for example with projects such as the Pacific Highway upgrades, or other large capital works, similar in scope and overall objectives.

As an overall comment on the results provided in Chapter 5, the end result was different as originally thought as identified in Section 3.3.3, and potentially did not provide as much benefit as envisaged during early project planning. Positive trends and ideas that could have potential to benefit the RMS were identified however, therefore there is a level of success. As the project developed, a heavier emphasis was placed on developing and trialling *SMaRT*, and hence conducting comprehensive organisational assessments on other road agencies became less in line with the scope of works for the research. The themes identified in the literature review in Section 2.7 were in fact confirmed, with each construction agency examined showing similar motives and actions to achieve more sustainable roads.

As is discussed in Section 9.4 below, accreditation of reporting and measurement is an important consideration within the RMS and may be a limiting factor to the successful use of an SRT. Continuing on from this realisation and as identified in Section 5.4, such frameworks as the Global Reporting Initiative appear to have great advantages. As identified, the RMS can improve on being more transparent with the actions and successes with regards to sustainability in construction and hence by incorporating an accredited framework for annual reporting, this would be more successful.

9.2   DEVELOPMENT OF SMART

This section includes comments on each component involved with the system development, and makes comments on the pros and cons of the final *SMaRT* system that was developed.

9.2.1 ENCAPSULATING THE TRIPLE BOTTOM LINE (TBL)

From the literature review, it was identified that previously, efforts to monitor sustainability tended to focus on the environmental aspects as opposed to a balanced view across the three pillars of economy, environment and social/community. The *SMaRT* system has taken this into consideration and a key deliverable during its development was equally considering aspects of the TBL. A feature of the final format of the system, is a column that identifies components of the TBL each credit relates to, which would benefit the assessor (refer to Appendix B). Another issue that was found during initial analysis of both existing literature and from the critical review in Chapter 6 was the existing breadth of SRTs tended to include social aspects, however typically in the capacity involving negative impacts to society, such as light, noise and air pollution. What has generally been excluded from the existing systems was provision for scoring of impact to community connectivity, community health and wellbeing. These were areas, which were important to ensure were covered within *SMaRT*, which has been achieved with credits such as COMM-5, COMM-6 & COMM-7 (refer to Appendix B).

With regards to the trend identified in Section 2.3 that typically economic criteria had less emphasis, it is noted that unfortunately within *SMaRT,* economics has not been incorporated as effectively as envisaged, with cost versus benefit not taken into account for all credits. There are credits that directly pertain to economic considerations; such as credits SIT-1 & 2; RES-2, 3, 5, & 9; W&E-1; DES-1; and POL-4 (refer to Appendix B) however, there is still a lack of direct evaluation of associated costs. This is a substantial area for future works, and would definitely be investigated if the system was to be progressed. Ideally, the cost versus benefit for applying each credit would be integrated into the individual scores, which would integrate weighting into the scores as well. This would be a method for streamlining the inclusion of any financial burden the system would impose.

The credits were written to try and broadly cover targets, rather than being too highly specific. For example, the credit RES-2 deals with the percentage of reused

"spoil" by the project. The term "spoil" was used, rather than specific examples such as "Building and Demolition waste" or "Unsuitable Excavated Natural Material" as the project may not have some of these more specific types of waste, hence they may receive non achieving rating. By utilising this broad term to cover several types of products, the system efficiently provides consideration for all types of waste material reuse on a project. This was the same approach taken to most credits, to be as specific as necessary, yet broad enough to encapsulate a large range of features that may be included in any road project. Issues with previous systems designed solely for roads came from being too specific, such as the GreenLITES system identified in Section 6.2.3.

9.2.2 ASSIGNING WEIGHTS

The Compared Comparison Assessment (CCA) approach used for *SMaRT* does work effectively, and if the scores are validated by those using the system, there should be minimal shortcomings from retaining this technique. *SMaRT* functions in isolation from other systems (i.e. results can not be compared directly to other systems due to no systems being equivalent) hence, the points system is a relative measure and the CCA method is valid based on the nature of the application. It would be safe to say that it is the simplest of the techniques investigated and was definitely beneficial for this early stage in *SMaRT* development.

It must be noted that the CCA does have disadvantages, mainly related to subjectivity involved in assigning each credit score. To improve the CCA approach utilised, additional stakeholders could be introduced, including other project engineers whom may be utilising the system, environmental representatives, senior managers plus other potential consultants. With the input of more professionals, with more experience, it can be expected that the relative scores become more appropriate and the system results will improve. Available resources and the available timeframe for this research project were the major hindrances in this area as it was not possible to obtain detailed input from other stakeholders and perform several iterations of the scoring process. As a comparison, as defined in

Section 6.2.4 and exposed in the literature, the Greenroads system was developed by a team of over 100 people, over three years. As a result, the level of detail in *SMaRT* can not be compared to the more established systems, however it can be deduced that for the scoring system to be better validated, additional perspectives and extensive consultation with stakeholders and experts in the field would be necessary.

An avenue for further investigation would be in utilising a separate method for assigning scores. Preliminary searching into rating techniques that can be employed for both qualitative and quantitative variables was conducted and several more sophisticated techniques were identified. One such article that identifies different methods for assigning weights is Thorpe (2013), who states other techniques such as the Analytic Hierarchy Process (AHP), assigning utility values to each variable or using a "rational management" approach. Others may include valuing each credit based on life-cycle analysis, or life-cycle cost analysis for example.

9.2.3 CERTIFICATION OF RESULTS

The details provided in Section 7.4.3 of this report clearly identify the objectives and thought process behind assigning varying certification levels to different levels of performance in projects. Awarding projects that have shown achievement is an essential component of an SRT and hence this component of the research was included for the sake of completeness in the development of a new system. It is noted however, that it is conceivably too early on in the development process to accurately assign certification levels.

For the system scoring and achievement levels to be validated, there should be a reasonable spread of results in each certification category, otherwise if there is a tendency for all projects to obtain similar scores, the credits chosen and the method for assigning values and weights is ineffective and essentially provides no value. In order to validate the certification levels, more test projects – similar to the case

study examined in Chapter 8 would need to be assessed and a statistical analysis conducted on the results. These pilot projects would be utilised as a learning experience for the RMS and those whom administer *SMaRT* itself. A possible scenario is that the certification levels follow a normal distribution, with the bounds for each certification level (i.e. Certified, Silver, Gold and Platinum) set varying standard deviations from the mean. For comparison sake, the pilot version of the IS system was trialled on 14 existing projects during the initial stages between 2010 and 2011, and the Greenroads system was trialled on over 120 projects during the initial three years of development from 2007 to 2010 as identified in Section 6.2.4 (Lees, 2014). This shows the level of development, time, effort, and reiteration these systems undergo prior to being optimally functional. As identified in Section 7.4.3 of this report, it is also envisaged that the certification levels will need periodic review as more projects are rated.

9.2.4 INCLUDED FEATURES

Potentially with more use, *SMaRT* may grow in size to cover more aspects of project work, which is seen within the RMS. Two key deliverables from *SMaRT* were that it was to remain simplistic and minimally time consuming, however it is clear that by increasing the number of variables that can be assessed, a greater understanding of the level of sustainability achieved and more detailed examination will be possible. There must be a balance between complexity of the system (and hence number of credits) and ease of application. This is the same for all existing systems. There is no benefit from continually expanding the system to include more features and to be more thorough, rather the base system should be revised and less valuable inclusions removed to ensure optimal effectiveness. Benefit versus cost analyses here would be required, to balance the size of the system, the time required to undertake the rating, and the number of assessors required based off the number of variables requiring scoring.

One of the key focuses of this research was concentrating on the construction stage of road development. It is clear that *SMaRT* has successfully achieved this by specifying credits based on how they apply in the construction context only. The applicability to exclusively construction however is somewhat prohibiting and could be seen as a disadvantage. The decision on the functionality of *SMaRT* came down to; the timeframe for the research project, available resources working on the system, and capacity and knowledge of those involved with the development to include adequate information that encapsulates other stages of road development.

It has become clear from the research that a system that encapsulates the entire life-cycle of a project is the most useful, and that there is argument to say that successful integration of sustainability is most influenced the earlier on in the development process (refer to Section 2.10). Due to this, further works for *SMaRT* may include integration of more pre-construction development works, as well as branching to the other areas such as; operations, maintenance stages, and decommissioning of projects. Any changes to *SMaRT* to allow other project stages to be assessed should be relatively simple, as the base structure and operation of the system has been developed in this project and has been shown to function. If the system was progressed further, applying it to these other stages of road development would be a high priority goal.

One other area for further works for the system is the consideration of existing laws, legislation and other previously established standards and processes. A system such as *SMaRT* should be straightforward in order for its appeal to be high. It is important however, to ensure it is viewed as reputable and reliable, for which integration of specifications would be beneficial.

9.3 IMPLEMENTATION OF SMART

9.3.1 OVERALL COMMENTS

As identified in Section 3.4.2, to reflect on how well the system was implemented, a set of questions were identified prior to conducting the case study, which would be used to evaluate the results. These questions have been repeated below for clarity.

- How much time was spent to rate the project?
- Who should be rating the projects?
- Does the system contribute to the evolution of more sustainable projects?
- How well has the project incorporated sustainability?
- Will the project be able to incorporate the results positively?
- Has the system been utilised efficiently as an assessment tool?

To fully evaluate these questions, the original restrictions on the *SMaRT* system must also be considered. These included the system to be:

- self applied and self assessed
- simple and minimally time consuming, and
- able to produce quantifiable, reliable information.

Through the case study provided in Chapter 8 of this report as well as through explanation of the system development in Chapter 7, it is possible to reflect on these earlier commitments and set criteria for evaluation, to identify how successful the implementation of *SMaRT* has been. The points that can be easily answered, are that; the system has been proven to be self applicable and assessed, the system is not too time consuming or onerous, and that by including certification levels, the achievement of any project is quantified. These were discussed in earlier sections.

Other achievements from the implementation are the inclusions of promoting more sustainable projects and identifying how a project can use the results in a positive manner. The ways in which *SMaRT* can be used to fulfil these points are described particularly well from the descriptions provided in Section 8.5.1 and 8.5.2. When

describing how and why the case study project scored lowest and highest in certain categories, methods for moving forward are identified in terms of utilising the benefits exposed from using *SMaRT* as well as learning from the downfalls. This is an important component of the project and has provided strong evidence on the benefits from the system.

Section 8.5 also answers the question that *SMaRT* does not in fact need to be restricted to being used as an assessment tool. Although this was the initial objective for the system, throughout this research it has become clear that there are substantial benefits from implementing an assessment prior to construction or during, as was done with the case study. As identified in Section 9.2.4 above, assessment and identifying changes earlier on in a project lifecycle is the most effective means in provoking beneficial change. As the structure and features of *SMaRT* do not prohibit its use at different time periods for a construction project, it would not make sense after these discoveries to restrict it to be solely used for assessment. In fact, with additional case study trials, it is envisaged that *SMaRT* would be viewed as equally effective when applied pre, mid or post construction.

In terms of whom should be implementing the system, when conducting the case study, the assessment was conducted individually. Other considerations have developed over time and the following questions would be important to consider for future works:

- Is a single assessor suitable? What biases would exist? Should the number of assessors per project be determined from a cost, risk or complexity analysis of the project?
- Who would monitor the total scores given to a project – should a third party certification be incorporated?
- What type of training would be required for project assessors?
- Could a scale be introduced, which stipulates the assessment requirements? For example, for projects of value between $0 and $5 million, assessment is by the trained Project Engineer only. For projects between $5 million and $10 million, the Project Engineer is accompanied by a third party, which could be any other trained employee, and for projects >$10 million,

an external audit from someone directly outside business unit is carried out. This would still be an employee of the RMS.

These new questions bring up pertinent issues relating to the facilitation of the scheme for any further projects. They also relate to the issue of self assessment versus external assessment which is discussed further in Section 9.4 below.

9.3.2 REFLECTION ON CASE STUDY

The Ocean Drive Roundabout project utilised for the case study would be considered as a minor project under the RMS systems and subsequently was managed under the "MinorProject" set of tools as identified in Section 4.5. Overall, the assessment was simple and conducted particularly effectively with *SMaRT* working well. The major realisation from implementing *SMaRT* to a real life project was that although there are no specific restrictions on the type or size of a project, it is likely only useful or feasible to implement it to certain minor projects. With increasing project size, the system may not be able to successfully function as there will be an increasing number of features that may represent a single credit and/or the complexity of addressing each component would become overly complicated. The *SMaRT* system would thus become over saturated with information, which would likely result in much of it being discounted. There is also a possibility that with excessive information, credits may be incorrectly interpreted, resulting in higher or lower than actual scores being awarded.

As a result, it is likely that *SMaRT* in its current format would not be effective for overly large or overly complex projects, which in the RMS would represent any project utilising the "ProjectPack" set of tools. This consideration relates back to the necessity of trialling additional test projects, as it is only with additional trials and with the assistance of additional stakeholders will more information present itself regarding what type and size of projects are suitable. Relating to this, if the system is only available for use on minor projects, does this provide the magnitude of benefits the system was originally intended for? It is generally found that major projects have the most widespread impacts and hence it may be identified that these are the projects that rating would be more beneficial. As identified in Section

4.7, the RMS is currently incorporating trials for using the IS rating system on major projects as these also have more capacity and resources to implement these types of new systems. This is an important area that will need further clarification as well as identifying what types of projects *SMaRT* can be used for. Once this is determined, the application of *SMaRT* can be better defined, which in theory will allow it to be effectively integrated into systems.

9.4 SMART UTILISATION AND THE RMS

The final thoughts on the likelihood of the RMS to incorporate *SMaRT* is that it is unlikely due to several uncertainties associated with travelling down the route of developing and maintaining a newly designed, and stand alone system. Although there are several benefits from *SMaRT*, the main factors that detract from the appeal of *SMaRT* include the following.

In terms of resources required to maintain a system that works optimally, the components (categories, credits, scores etc.) all must be periodically reviewed as the organisation and industry are subject to changing conditions. These may include social pressures, politics, or restructuring within the organisation. To utilise a stand alone system would likely require a new department to facilitate its operation. As well as this, from the frontline staff perspective, there is historically a hesitation to introduce more and more reporting systems, as they create additional work, require additional time, and may impose additional restrictions.

Related to resourcing, there is further development works to finalise *SMaRT*, which still involves a large amount of works to get it to a level that is truly effective. The system provided in this report is essentially the first iteration, which as discussed would need input and a review on all its features from other stakeholders. This is a time consuming exercise, which may take years. An alternative, is spending the time and resources on optimising an existing system such as the IS rating system, which is already available and has proven effectiveness.

Finally, with regards to acceptance of results, by having *SMaRT* self assessable, it eases access to the tool, promotes its use as no external consultants are required, simplifies the overall process, and allows it to be more readily integrated into management systems. What must be considered however is; does the nature of being self assessable detract from the tendency of other stakeholders to view results as valid or accurate? In this research, it was identified that a main objective for *SMaRT* was to ensure it was self assessable. It is still believed that this is a major benefit for any SRT used by a single organisation, however consideration should be made on how such a system would compare to others that are more recognised across industry. Further discussions with the RMS environmental staff identified that this is likely one of the more influential factors as widespread accreditation assists in maintaining a level of rigour in results provided and withholds a positive reputation, which are key deliverables for the RMS.

9.5 CONCLUSION

This chapter has identified several areas where the project has excelled, however also identified several areas where the project would benefit from further works. The discussion between the RMS and other construction agencies has synthesised the main findings as well as made the comments that there can be changes made to improve overall. There is a comprehensive and thorough examination on the development, implementation and ability of *SMaRT* to be utilised by the RMS. Final conclusions were drawn that the system does show potential, however is unlikely to be further progressed for a variety of reasons.

Overall this chapter has provided a summary of the main thoughts that have come as a result from the research project and included comments on the impact these main areas have had overall. The following chapter will provide the final conclusions drawn from this research project.

CHAPTER 10

CONCLUSION

It is clear that this report has comprehensively presented the two key areas of the research project – assessment of the Roads and Maritime Services (RMS), as well as the use of sustainability rating tools (SRTs). The original objectives presented in Section 1.4 of this report have been achieved and as a result, the research project has been successful. Key findings that should be taken away from this research are provided below, including comments on the overall implications of the findings and additional works for the future. These future works are in addition to those identified in Chapter 9 above.

10.1 CONCLUSIONS AND CONTRIBUTIONS

The engineering construction industry, and more specifically the roads and transportation sector can expect to see a positive trend in the quantity of required works in coming years. It was identified that this is particularly true for the RMS, which have shown in the past 10 years or so an increasing capital works program as well as a huge rise in total asset value that requires ongoing maintenance. These facts have identified that it will be necessary for organisations to optimise their systems, improve overall efficiencies, and strive for more sustainable practice.

The organisational assessment conducted on the RMS revealed key areas of their systems including their total capacity to conduct works, their motivation in improving systems, as well as their overall performance in recent years. Analysis of previous reporting has clearly shown the RMS is highly motivated in being an industry leader achieving more sustainable practice. Specifically, since 2002,

several changes have been made to systems, organisation structure, and reporting that promotes improved integration of triple bottom line (TBL) considerations.

With respect to sustainability in construction, although the RMS has proven to be particularly effective at integrating more sustainable processes, the initiatives aimed at achieving more sustainable roads are not well exposed or monitored, and there are currently no methods for measuring and benchmarking progress for construction projects. This inability to measure how well a project has performed sustainability wise, has been identified as a major downfall for both the RMS, and the entire construction industry. The benefits of SRTs were identified in this report and promoted as one potential method for improvements in this area.

The Sustainability Monitoring and Reporting Tool (*SMaRT)* was created based off a selection of the best practice features, identified through examination of existing SRTs as well as identifying key values and beliefs of the RMS organisation through the assessment. The aim; to develop an SRT that was specific for the RMS, was achieved and its functionality was verified through implementation on a case study project. The results of the case study identified key areas of high and low performance within the assessed project, and these results provided recognition on how the system can be utilised in a positive manner to benefit the organisation.

Overall, it can be said that the RMS performs well above average and are continually striving for ways to improve. With this mindset in the organisation and the clear determination shown from the assessment, there are no immediate improvements the RMS needs to make in order to achieve more sustainable practice or to improve performance to the level of other construction organisations. The *SMaRT* system has shown potential in this project, however even if it was not to be progressed further, the project works have identified several of the main considerations that should be made when using any SRT, which is beneficial. A comprehensive critical review was provided on various existing SRTs; including their benefits and disadvantages, comments on where such tools are most effective, and overall an in-depth analysis on the effectiveness of each tool. This information can be useful in the future for any further investigation into their use or implementation.

10.2 FINAL THOUGHTS

The RMS should continue to develop options for better measurement and benchmarking of sustainability within construction projects as it has been clearly identified that there are benefits, which promote the overall goal of achieving "truly sustainable roads". With the current construction practices, technology, and overall approach to construction (especially major construction works) it is believed at this stage in time that it is not possible to develop a truly sustainable roadway as there are still a multitude of contributing factors that still need a substantial amount of research works of which only a small portion has been considered in this project. These may include further investigation into resilience of roads, total cradle-to-grave analysis, sustainable operation of roads, and consideration of the decommissioning of facilities for example.

With respect to the use of the *SMaRT* system, it is believed that the RMS is more likely to pursue alternate options for measuring sustainability, such as the already established and recognised Infrastructure Sustainability (IS) rating system. As identified in Section 4.7, there is sporadic use of the IS system currently on major projects within the RMS, however there needs to be more emphasis from those in positions of power to trial the system on more projects in order to accurately identify the benefits it can provide.

Although the *SMaRT* system has been identified as plausible and functional within the RMS, it is the lack of accreditation of the system and high amount of required resources that are the main detracting factors. If the organisation were to continue the use of the IS system, it is absolutely paramount to introduce some level of specification to the tool as it has been clearly identified that these type of industry wide SRTs tend to have irrelevant criteria when applied exclusively in a roads context. It would be beneficial for the RMS to work with the Infrastructure Sustainability Council of Australia in order to tailor their system to better suit the organisational needs and values of the RMS, in order to ensure that the maximum benefit can be obtained from the use of the SRT.

Within the broader area of SRTs in general, future works towards developing a set framework for their development would assist in allowing comparisons between different systems. It was identified that there is currently no set methodology for development of SRTs and as a result, each new system has no equivalence or point of reference to existing systems. There would be industry-wide benefits if these systems followed a defined metric, as ideally it would allow for comparisons on the level of sustainability between projects, allowing for more effective lessons learnt and improvements.

Overall, the final recommendations related to the RMS and the use of SRTs is that there should be further investigation, as it is clear these tools provide very distinct advantages. With increasing importance on obtaining sustainable infrastructure, there must be ways to measure efforts and monitor progress, which SRTs definitely provide the means to achieve.

REFERENCES

Abdul, K, 2012, 'Applicability of a Road Rating System to the City of Vancouver', Technical Report, City of Vancouver Public Works, Vancouver, BC, Canada.

Ahn, C, Rekpalli, P V, Martinez, J C, Pena-Mora, F A, 2009, 'Sustainability Analysis of Earthmoving Operations', *Proceedings of the 2009 Winter Simulation Conference*, held 13-16 December 2009, Austin, TX, pp. 2605-2611.

Alam, S, Kumar, A, 2013, 'Sustainability Outcomes of Infrastructure Sustainability Rating Schemes for Road Projects', *Proceedings of the Australasian Transport Research Forum 2013,* held 2-4 October 2013, Brisbane, QLD, Australia.

Australian Trade Commission, 2015, 'Why Australia – Benchmark Report 2015', Technical Report, Australian Government, Sydney, NSW, Australia.

Anderson, J, Weiland, C, & Muench, S, 2011, 'Greenroads Manual: v1.5', Technical Report, University of Washington, Seattle, WA, USA.

Australian Bureau of Statistics (ABS), 2010, *Australian Economic Indicators, Oct 2010, Australia,* cat. no. 1350.0, ABS, Canberra, viewed 13 July 2015.

Australian Bureau of Statistics (ABS), 2012, *Year Book Australia, 2012,* Australia*,* cat. no. 1301.0, ABS, Canberra, viewed 13 July 2015, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/1301.0>

Australian Bureau of Statistics (ABS), 2001, *Construction Work Done, Australia, Preliminary, Dec 2001*, Australia, cat. no. 8755.0, ABS, Canberra, viewed 14 July 2015, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/allprimarymain features/F127A6061141B3C4CA2570990081E248?opendocument>

Australian Bureau of Statistics (ABS), 2013, *Construction Work Done, Australia, Preliminary, Dec 2013*, Australia, cat. no. 8755.0, ABS, Canberra, viewed 14 July 2015, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/allprimarymain features/ACA1EC39996CDF2ECA257CE50012F0ED?opendocument>

Australian Bureau of Statistics (ABS), 2015a, *Construction Work Done, Australia, Preliminary, Mar 2015*, Australia, cat. no. 8755.0, ABS, Canberra, viewed 14 July 2015, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8755.0>

Australian Bureau of Statistics (ABS), 2015b, *Engineering Construction Activity, Australia, Mar 2015*, Australia*,* cat. no. 8762.0, ABS, Canberra, viewed 14 July 2015, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8762.0>

Australian Bureau of Statistics (ABS), 2015c, *Motor Vehicle Census, Australia, 31 Jan 2015, Australia,* cat. no. 9309.0, ABS, Canberra, viewed 11 July 2015, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/9309.0>

Balwin, B, 2003, 'Renewing, Initiating and Promoting Sustainable Practices in Road Construction Waste Management', *In the National Environment Conference 2003, Environmental Engineering Society, Queensland,* held 2003, Brisbane, QLD, Australia.

Behl, A, Sharma, G, Kumar, G, 2014, 'A Sustainable Approach: Utilization of Waste PVC in Asphalting of Roads', *Construction and Building Materials,* vol. 54, no. 14, pp. 113-117, Science Direct, Elsevier.

Bockish, J, 2012, 'Comparison of Transportation Sustainability Rating Systems', Research Paper, Gresham Smith and Partners, Alpharetta, GA, USA.

BREEAM, 2015, What is BREEAM?, Watford, UK, viewed 21 August 2015, <http://www.breeam.org/about.jsp?id=66>

Burke, WW, Litwin, GH, 1992, 'A Casual Model of Organizational Performance and Change', *Journal of Management,* vol.18, no. 3, pp. 523-545.

Camarena, S, 2013, "Sustainable Road Maintenance and Construction Utilising New Technologies", *Proceedings of the Institute of Public Works Engineering Australasia Biennial Conference 2013,* held 11-15 August 2013, Darwin, NT, Australia.

CEEQUAL, 2015, 'An Introduction to CEEQUAL', Technical Report, CEEQUAL, London, UK.

Clevenger, C M, Ozbek, M E, Simpson, S, 2013, 'Review of Sustainability Rating Systems used for Infrastructure Projects', *Proceedings of the 49th Annual ASC International Conference,* held 10-13 April 2013, San Luis Obispo, CA, USA.

Daysh, K, 2013, 'An Investigation into the Application of International Environmental Greenroads Certification Standards to Road Construction in New Zealand', Masters thesis, University of Waikato, Hamilton, New Zealand.

Department of Transport and Main Roads (TMR), 2010, 'Queensland Transport and Roads Investment Program: 2010-11 to 2013-14', Technical Report, TMR, Brisbane, Queensland, Australia.

Department of Transport and Main Roads (TMR), 2013, 'Queensland Transport and Roads Investment Program: 2013/14 to 2016/17', Technical Report, TMR, Brisbane, Queensland, Australia.

Dilger, A, Riley, C, Young, S, Bengtsson, J, Kneppers, B, 2011, *Greenhouse Gas Assessment Workbook for Road Projects*, Technical Guidance Manual, TAGG, Sydney, NSW, Australia.

Dilger, A, Riley, C, Bengtsson, J, 2011, *Supporting Document for Greenhouse Gas Assessment Workbook for Road Projects*, Technical Guidance Manual, TAGG, Sydney, NSW, Australia.

Edwards, T, 2009, *Sustainable Development*, Parliamentary paper, NSW Parliamentary Library Research Service, Sydney, Australia.

Energy Made Clean, 2011, *Greenhouse Gas Assessment Calculator for Road Projects*, Version 01, Spreadsheet Program, Sydney, NSW, Australia

Eisenman, A, Meyer, M, 2013, 'Sustainable Streets and Highways: An Analysis of Green Roads Rating Systems', Technical Report, Georgia Department of Transportation, Forest Park, GA, USA.

Every, G, 2014, 'Review of Environmental Factors', PMHC, Port Macquarie, NSW, Australia.

Every, G, Shaw, R, 2014a, 'Proposed Roundabout Ocean Dr & Houston Mitchell Dr Bonny Hills – RR-196-021', Engineering Construction Drawings, PMHC, Port Macquarie, NSW, Australia.

Every, G, Shaw, R, 2014b, 'Technical Design Report – Final: Ocean Drive & Houston Mitchell Dr Roundabout – Design Plan (RR-196-021)', Technical Report, PMHC, Port Macquarie, NSW, Australia.

Global Reporting Initiative (GRI), 2014, 'An Introduction to G4: The Next Generation of Sustainability Reporting', Technical Report, GRI, Amsterdam, Netherlands.

Hasna, A M, 2010, 'Sustainability Classification in Engineering Discipline and Approach', *International Journal of Sustainable Engineering,* vol. 3, no. 4, pp. 258-276.

Herrador, R, Perez, P, Garach, L, Ordonez, J, 2012, 'Use of Recycled Construction and Demolition Waste Aggregate for Road Course Surfacing', *Journal of Transport Engineering,* vol. 138, no. 2, pp. 182-190, American Society of Civil Engineers.

Hutabarat, R, Harris, D, Black, J, 1998, 'Transport and Sustainable Development: Considerations for Australia and Approaches in the USA and the UK', *Proceedings of the 22nd Australasian Transport Research Forum*, held September 1998, Sydney, NSW, Australia.

Institute for Sustainable Infrastructure (ISI), 2015, 'ENVISION: Rating System for Sustainable Infrastructure', Washington, DC, USA.

Infrastructure Sustainability Council of Australia (ISCA), 2014, *What is Infrastructure Sustainability,* Sydney, NSW, Australia, viewed 16th July 2015, <http://www.isca.org.au/about/what-is-isca-2/item/60-what-is-isca>

John Holland, 2010, 'Sustainability 2010', Technical Report, Leighton Holdings Limited, St Leonards, NSW, Australia.

Kaspura, A, 2015, 'Engineering Construction and Infrastructure in NSW', Technical Report, Institute of Engineers Australia, Barton, ACT, Australia.

King & Campbell Surveying, 2014, 'Statement of Environmental Effects for Temporary Stockpiling of Virgin Excavated Natural Material for the Filling of the Rainbow Beach District Sporting Fields. Lot 1 DP1193553, 1350 Ocean Drive, Bonny Hills', King & Campbell Surveying, Port Macquarie, NSW, Australia.

Klotz, L & Grant, D, 2009, 'A Balanced View of Sustainability in Civil Engineering and Construction', *Proceedings of the 2009 Construction Research Congress: Building a Sustainable Future,* held 5-7 April 2009, Seattle, WA, USA.

Lambous, C, Moss, J, 2011, 'Sustainability and Use of Recycled Materials for Pavements', Technical Report, Roads and Maritime Services, Parramatta, NSW, Australia.

Lees, S, 2014, 'Pilot Application of the Infrastructure Sustainability Rating Tool to Local Council Road Management – Stage 1', Technical Report, Australian Centre of Excellence for Local Government, University of Technology, Sydney, NSW, Australia.

Leighton Group, 2014, 'Sustainability Report 2013', Technical Report, Leighton Holdings Limited, St Leonards, NSW, Australia.

Lend Lease Corporation Limited (LLC) 2011, 'Sustainability Report 2011', Technical Report, LLC, Sydney, NSW, Australia.

Long, T, Johnson, M, 2000, 'Rigour, Reliability and Validity in Qualitative Research', *Clinical Effectiveness in Nursing,* vol. 4, no. 1, pp. 30-37.

Lusthaus, C, Adrien, MH, Anderson, G, Carden, F, Montalvan, GP, 2002, *Organizational Assessment,* Inter-American Development Bank, Washington DC, USA.

Main Roads Western Australia (MRWA) 2006a, 'Sustainability Policy', Technical Report, MRWA, Perth, WA, Australia.

Main Roads Western Australia (MRWA) 2006b, 'Main Roads Sustainability Strategy', Technical Report, MRWA, Perth, WA, Australia.

Main Roads Western Australia (MRWA), 2014a, *Climate Change,* MRWA, Perth, WA, Australia, viewed 14th September 2015, <https://www.mainroads.wa.gov .au/AboutMainRoads/AboutUs/Sustainability/Pages/ClimateChange.aspx>

Main Roads Western Australia (MRWA) 2014b, 'Main Roads Western Australia –
Annual Report 2014', Technical Report, MRWA, Perth, WA, Australia.

McVoy, GR, Nelson, DA, Krekeler, P, Kolb, E, & Gritsavage, JS, 2011, 'Moving
Towards Sustainability: New York State Department of Transportation's
GreenLITES Story', *Proceedings of the American Society of Civil Engineers'
Green Streets and Highways Conference,* held 14-17 November 2010, Denver,
CO, USA.

Monckton, R, Moss, J, 2009, 'Towards Sustainable Construction', Technical Report,
Roads and Maritime Services, Parramatta, NSW, Australia.

Moss, J, Monckton, R, Lambous, C, 2010, 'Australia's Progress Towards Sustainable
Construction Practices – Examples from a Road Agency', *Proceedings of the
Second International Conference on Sustainable Construction Materials and
technologies,* held 28-30 June 2010, Ancona, Italy.

Muench, ST, Anderson, JL, 2009, 'Greenroads: A Sustainability Performance Metric
for Roadway Design and Construction', Research Report, Washington State
Department of Transportation, Office of Research and Library Services,
Olympia, WA, USA.

Muench, ST, Anderson, J, Bevan TA, 2010, 'Greenroads: A Sustainability Rating
System for Roadways', *International Journal of Pavement Research and
Technology,* vol. 3, no. 5, pp. 270-279.

New York State Department of Transport (NYSDOT), 2012, *Operations Certification
Program,* Technical Manual, NYSDOT, Albany, NY, USA.

Project Management Office (PMO), 2005, *ProjectPack Operating Manual,*
Organisation Standard, RMS, Sydney, NSW, Australia.

Queensland Government Department of Main Roads (TMR), 2008, 'Environment and
Heritage Policy & Strategy', Technical Report, TMR, Brisbane, Queensland,
Australia.

Regional Maintenance Delivery (RMD), 2010a, 'Communications Register – 113'
Project Document, RMD, Sydney, NSW, Australia.

Regional Maintenance Delivery (RMD), 2010b, 'Environment Plan', Technical
Procedure, RMD, Sydney, NSW, Australia.

Regional Maintenance Delivery (RMD), 2010c, 'Quality Plan', Technical Procedure,
RMD, Sydney, NSW, Australia.

Regional Maintenance Delivery (RMD), 2010d, 'Register of Waste and Recyclable
Materials and their Disposal Details – 407' Project Document, RMD, Sydney,
NSW, Australia.

Regional Maintenance Delivery (RMD), 2010e, 'Safety Plan', Technical Procedure, RMD, Sydney, NSW, Australia.

Regional Geotechnical Solutions (RGS), 2014, 'Geotechnical Investigation and Pavement Design – Final Report', RGS, Port Macquarie, NSW, Australia.

RMD – see Regional Maintenance Delivery

Regional Maintenance Delivery (RMD), 2014a, 'Procurement Plan – 950', Project Document, RMD, Sydney, NSW, Australia.

Regional Maintenance Delivery (RMD), 2014b, 'Procurement: Procedures for Strategic Procurement of Goods and Services for Project Delivery – CF-07', Technical Procedure, RMD, Sydney, NSW, Australia.

Regional Maintenance Delivery (RMD), 2014c, 'Procurement Strategy Template – CF-08', Technical Procedure, RMD, Sydney, NSW, Australia.

Regional Maintenance Delivery (RMD), 2015a, 'Construction Environmental Management Plan, Technical Procedure, RMD, Sydney, NSW, Australia.

Regional Maintenance Delivery (RMD), 2015b, 'Contractor Management Procedure – OCP-04', Technical Procedure, RMD, Sydney, NSW, Australia.

Regional Maintenance Delivery (RMD), 2015c, 'Contractor Pre-Engagement Questionnaire – 901', Project Document, RMD, Sydney, NSW, Australia.

Regional Maintenance Delivery (RMD), 2015d, 'Waste Minimisation and Management Plan – 421', Technical Procedure, RMD, Sydney, NSW, Australia.

Reid, L, 2015, "INVEST – Sustainable Highways Self-Evaluation Tool", Technical Report, FHWA, Washington, DC, USA.

RMS – see Roads and Maritime Services

Roads and Maritime Services (RMS), 2010, 'Towards a More Sustainable RTA', Technical Report, Roads and Maritime Services, Parramatta, NSW, Australia.

Roads and Maritime Services (RMS), 2014a, 'Applications for Recycled Materials in Road Construction', Technical Procedures, Roads and Maritime Services, Parramatta, NSW, Australia.

Roads and Maritime Services (RMS), 2014b, 'Environmental Sustainability Performance Report', Technical Report, RMS, Sydney, NSW, Australia.

Roads and Maritime Services (RMS) 2014c, 'Roads and Maritime Services - 2013/14 Annual Report', Technical Report, RMS, Sydney, NSW, Australia.

Roads and Maritime Services (RMS), 2014d, *Sustainability,* RMS, Sydney, NSW, Australia, viewed 4th September 2015, <http://www.rms.nsw.gov.au/about/environment/sustainability/index.html>

Roads and Maritime Services (RMS), 2015a, *Energy and Greenhouse,* RMS, Sydney, NSW, Australia, viewed 4th September 2015, <http://www.rms.nsw.gov.au/about/environment/sustainability/energy-greenhouse.html>

Roads and Maritime Services (RMS), 2015b, 'Roads and Maritime Services 2020 Strategy', Technical Report, RMS, Sydney, NSW, Australia.

Roads and Traffic Authority (RTA), 2002a, 'Environment Report – 2002'*,* Technical Report, RTA, Sydney, NSW, Australia.

Roads and Traffic Authority (RTA), 2002b, 'Roads and Traffic Authority – Annual Report 2002', Technical Report, RTA, Sydney, NSW, Australia.

Roads and Maritime Services (RMS), 2008, *Operating Manual – Minor Project,* Organisation Standard, RMS, Sydney, NSW, Australia.

Roads and Traffic Authority (RTA), 2008, 'Roads and Traffic Authority – Annual Report 2008', Technical Report, RMS, Sydney, NSW, Australia.

Roads and Traffic Authority (RTA), 2009, 'RTA Water Management Plan – Part B: Construction', Technical Report, RTA, Sydney, NSW, Australia.

Saride, S, Puppala, AJ, Williammee, R, 2010, 'Assessing Recycled/Secondary Materials as Pavement Bases', *Institution of Civil Engineers: Ground Improvement,* vol. 163, no. 1, pp. 3-12 ICE Publishing, Institute of Civil Engineers.

Shaw, G, Kenny, J, Kumar, A, Hood, D, 2012, 'Sustainable Infrastructure Operations: A Review of Assessment Schemes and Decision Support', *Proceedings of the 25th ARRB Conference – Shaping the future: Linking Policy, Research and Outcomes,* held 23-26 September 2010, Perth, Australia.

Shivakumar, S, Pedersen, T, Wilkins, S 2014, 'ENVISION[TM] – A Measure of Infrastructure Sustainability', *Proceedings of Pipelines 2014: From Underground to the Forefront of Innovation and Sustainability,* held 3-6 August 2014, Portland, OR, USA.

Siew, RYJ, 2014, 'A Review of Sustainability Reporting Tools (SRTs) for Communities', *International Journal of Sustainable Construction Engineering & Technology,* vol. 5, no. 2, pp. 39-52.

SMEC, 2013, 'Roads and Highways', Technical Report, SMEC, Melbourne, VIC, Australia.

SMEC, 2015, 'Sustainability Report 2014-2015', Technical Report, SMEC, Melbourne, VIC, Australia.

Technical Knowledge and Management Systems (TKMS), 2005, *Infrastructure Life Cycle Management System Manual,* Organisation Standard, RMS, Sydney, NSW, Australia.

Thompson, P, 2010, 'Teaching Sustainability in Civil Engineering Using CEEQUAL', *Institution of Civil Engineers: Engineering Sustainability,* vol. 163, no. 4, pp. 209-217.

Thorpe, D, 2013, 'Evaluating Factors in Sustainable Road Construction and Management', Australian Centre for Sustainable Business and Development Working Paper, University of Southern Queensland.

Thorpe, D, 2011, 'Sustainable Roads – An Achievable Goal?', *Proceedings of the 2011 Society for Sustainability and Environmental Engineering International Conference: Escaping Silos*, held 24-26 October 2011, Brisbane, QLD, Australia.

Toleman, R, Rose, G 2008, 'Partnerships for Progress – Toward Sustainable Road Systems', *Journal of the Transportation Research Board,* vol. 2067, no.18, pp. 155-163.

Universalia, n.d., *Your Introductory Guide to OA,* Montreal, Quebec, Canada, viewed 1st October 2015, <http://www.reflectlearn.org/discover/your-introductory-guide-to-oa#_Why_Conduct_an>

VicRoads, 2010, 'Sustainability and Climate Change Strategy: 2010 – 2015', Technical Report, VicRoads, Kew, Victoria, Australia.

VicRoads, 2014, 'Sustainability and Climate Change Action Plan: Status Report 30 June 2014', Technical Report, VicRoads, Kew, Victoria, Australia.

VicRoads Environmental Sustainability, 2011, 'Integrated VicRoads Environmental Sustainability Tool (INVEST)', Technical Report, VicRoads, Kew, Victoria, Australia.

VicRoads, 2011, 'Sustainable Procurement Guidelines', Technical Report, VicRoads, Kew, Victoria, Australia.

VicRoads, 2015, 'VicRoads Annual Report 2014/15', Technical Report, VicRoads, Kew, Victoria, Australia.

Vorobieff, G, 2010, 'Challenges Confronting Sustainable Practices for Concrete Pavement Design and Construction in Australia', *International Journal of Pavement Research and Technology,* vol. 3, no. 5, pp. 259-269.

Wathne, L, 2011, 'Sustainability Opportunities with Pavement: Are we Focusing on the Right Things?', *Proceedings of the 2010 Australian Society for Concrete Pavements,* held 2 August 2011, West Ryde, NSW, Australia.

Weisbord, MR, 1976, *Organizational Diagnosis: Six Places to Look for Trouble with or Without a Theory,* Group & Organization Studies, Block Petrella Associates Inc., Wynnewood, PA, USA, pp. 430-447.

Willets, R, Burdon, J, Glass, J, 2010, 'Fostering Sustainability in Infrastructure Development Schemes', *Proceedings of Engineering Sustainability 163,* Institution of Civil Engineers, London, UK, pp. 159-166.

Wilson, D, Beaton, L, 2003, *Promoting Institutional & Organisational Development. A Source Book of Tools and Techniques,* Department for International Development, London, England.

Wilson, K, Farr, A, Whistler, L, Matan, A, 2014, 'Sustainability Performance Assessment by Road Agencies', a literature review undertaken as a collaborative project between Curtin University and Queensland University of Technology.

APPENDIX A

PROJECT SPECIFICATION

University of Southern Queensland

FACULTY OF HEALTH, ENGINEERING AND SCIENCES

ENG4111 / 4112 Research Project
PROJECT SPECIFICATION

FOR: Alexander Labrosse

TOPIC: AN INVESTIGATION INTO THE SUSTAINABILITY SYSTEMS AND PROCESSES USED WITHIN ROAD CONSTRUCTION BY THE ROADS AND MARITIME SERVICES OF NSW

SUPERVISOR: Dr. David Thorpe (University of Southern Queensland)

ENROLMENT: ENG4111 – Semester 1, 2015
                  ENG4112 – Semester 2, 2015

PROJECT AIM: This project seeks to investigate, analyse and compare the sustainability processes and initiatives implemented by the Roads and Maritime Services (RMS) in New South Wales, Australia.

PROGRAMME: **Issue 2.0, 14th March 2015**

1. Research the background and history of sustainability in the construction industry and identify how and why sustainability is becoming more prevalent
2. Identify how and where the RMS implements sustainability in road construction and analyse the effectiveness of their systems.
3. Review and compare the RMS systems with those of other construction agencies within Australia and globally
4. Undertake a critical review of the comparisons made between these construction agencies in order to propose improvements to the RMS system that will promote sustainable choices
5. Develop a weighted rating scheme that can be used to provide a quantitative measure of sustainability and aid in reviewing the various systems
6. Write and submit dissertation in the required format for assessment

As time permits;

7. Implement the rating scheme to a current, past or future construction project to review its usefulness and effectiveness as a tool
8. Discussion and evaluation of specific case studies of recent RMS construction projects
9. Administer a questionnaire to key individuals within the organisation to gauge the general feelings towards sustainable practice. This may benefit the research by identifying further areas for improvements as well as gain additional industry knowledge
10. Develop the rating scheme further into a suitable computer based modelling tool that will improve its ability for use, especially for larger projects.

APPENDIX B

SUSTAINABILITY MONITORING AND REPORTING TOOL *(SMART) – v1.01*

Roads and Maritime Services - Sustainability Monitoring and Reporting Tool

Category	Sub. Category	Ref.	Performance Objective / Credit	TBL Impacts? Env, Econ, Soc	Criteria and Achievement Level				Related Credits
					NON ACHIEVING (nil points)	**Achieving**	**Improving**	**Exceeding**	
Sustainable Sites	ALIGNMENT	SIT-1	Is the project located in a previously developed **OR** brownfields site?	Env, Soc	The project footprint is majorly considered a Greenfields site **OR** the design has chosen an alternate alignment that increases negative environmental impact to favour another project consideration e.g. - cost	The project is approximately 50% greenfields and 50% brownfield development. **(5 Points)**	The project is majorly a brownfields site (>75%), however additional greenfield land acquisition was required for some components. **(10 Points)**	The project is wholly within an existing road corridor and disturbed zone **OR** other brownfields site and no additional land acquisition was necessary. **(15 points)**	SIT-5 SIT-5
		SIT-2	Has an effort been made to reduce the footprint of the project?	Env, Econ	Project has had no attempt to reduce footprint area.	Minimum corridor widths have been designed for, however no creative solutions or other measures have been proposed to reduce footprint. **(3 points)**	The design has incorporated some means of reducing the project footprint e.g. - retaining walls, - steeper batters, - barriers and reduced clear zones, - improved delineation and less wide travel lanes **(6 points)**	The project has introduced innovative ways to reduce the footprint area **AND** criteria from other levels is achieved. **(10 points)**	SIT-1
		SIT-3	Has the alignment or design accounted for future expansion and/or development such as additional lanes or potential bike/pedestrian facilities.	Env, Soc	The project had focus on reducing costs, which has resulted in no future planning that would provision for simple expansion of the current road or facilities.	The project has identified the predicted design life of the facility and potential planned solutions to resolve traffic and pedestrian issues and requirements when that time is reached. **(2 Points)**		The project has integrated into the design future plans for expansion **AND** have made additional provisions during construction to facilitate future development e.g. - wide medians for additional lanes - additional width acquisition to allow future footpaths - pavement constructed beyond edge of existing travel lanes to allow for easy install of additional or auxiliary lanes **(15 points)**	SIT-4 RES-10 COMM-6 DES-2 DES-3
	LANDUSE & LANDSCAPE	SIT-4	Does the design of the road promote transportation efficiencies for all road users?	Soc	The roadway constructed does not benefit any single group of road users and appears inadequately designed.	The roadway has been constructed in a way that favours only a certain type of user without disadvantaging other users to a lower level of service than the original conditions. e.g. - suitable for cars but unfavourable for rigid trucks (where the facility is intended for both types of users) **(4 points)**	The roadway has been constructed in a way that promotes efficient journeys by more than a single group of users without compromising safety of others. **(8 points)**	The project shows a significant improvement in the efficiency of travel by all road users at all times, while maintaining safe and efficient functioning of the facility. **(12 points)**	SIT-3 COMM-6 DES-2 DES-3 DES-7

			Question		Level 0	Level 1	Level 2	Level 3	Ref
Sustainable Sites	**LANDUSE & LANDSCAPE**	SIT-5	Does the project design avoid adverse geology?	Econ	The project alignment has resulted in the roadway being positioned in an area with unfavourable geology resulting in additional resources, time, money plus additional impacts in terms of waste, energy usage and emissions.	The project has been located in an area of unfavourable geology due to other restraints (such as a project rehabilitating and widening an existing roadway), however construction techniques have been employed to reduce negative effect of the site geology **AND** before establishment, the project team have identified any faults or areas of concern including groundwater hydrogeology. **(1 point)**	The project has been located in an area of unfavourable geology due to other restraints, however construction techniques have been employed to reduce negative effect of the site geology **AND** hazard areas are avoided through implementation of buffer areas and other management techniques to reduce potential for impacts. **(4 points)**	The project has been designed to be located in an area that has no adverse geologic features and no negative impacts on aquifers **AND** criteria from other levels is achieved. **(6 points)**	SIT-1
	ACCESS	SIT-6	Does the project require any temporary construction features that must be removed or rehabilitated once the project is completed? e.g. - access tracks, - hardstand areas, - sediment basins - stockpile sites	Env, Econ	The project requires several additional construction features that has absorbed a substantial amount of time and resources prior to the actual construction work **AND** will require significant time after project completion to effectively remediate to an acceptable level.	The project has required some temporary construction features that can be remediated once project is completed. **(3 points)**	The project has required some temporary construction features that majorly become part of the final design **OR** can be easily and efficiently remediated during or shortly after construction works are complete. **(8 points)**	The project has been carefully planned to ensure all additional construction features that are required can be integrated into the final design. **(11 points)**	W&E-3
Management and Governance	**PLANNING & PROCUREMENT**	MAN-1	Has the project provided a commitment to sustainable procurement?	Env	No formal commitments to sustainability have been defined.	The project has defined and documented some level of commitment to sustainability in procurement of all services. **(3 points)**	The project has defined and documented a commitment to sustainable procurement that involves at least two of the three areas for triple bottom line considerations. **(7 points)**	The project team have publicly stated their commitments to sustainability and specific targets have been identified that consider all aspects of the triple bottom line. **(10 points)**	MAN-5 MAN-6
		MAN-2	Have sustainability issues been considered in the tender assessments of different suppliers for inclusion in construction activities?	Env, Econ	Procurement strategy has not actively involved consideration of sustainability	There has been minor consideration of sustainability with regard to sustainability in systems, however this area has not played a significant role in awarding of contracts. **(1 point)**	All systems from suppliers have been assessed with regard to sustainability, during the tender process and have played a role in awarding contracts. **(4 points)**	All major suppliers have provided a sustainability management plan to the principal, which is assessed prior to engaging **AND** the contribution to sustainable practice is considered when awarding contracts. **(5 points)**	MAN-3 MAN-4 RES-9
		MAN-3	Do the suppliers and manufacturers chosen for the project implement sustainable practices?	Env, Econ, Soc	Performance Objective Man-2 has been given a 'NON ACHIEVING' rating.	Some (>25%) suppliers for the project meet sustainable procurement policies. **(4 points)**	The majority (>50%) of suppliers for the project meet sustainable procurement policies. **(8 points)**	All suppliers and manufacturers for the project meet some level of sustainable procurement policies. **(12 points)**	MAN-2 RES-7 RES-9
		MAN-4	Have there been management plans developed for the project in the areas of: - Quality Management - Environmental Management - Noise Management - Water Management - Site Management - Waste and Pollution Management	Env, Econ, Soc	The suppliers used do not meet the minimum management requirements of RMS however are still utilised for the project.	The suppliers have in place some system which involves certain management plans and shows an effort to integrate sustainability considerations into their processes. **(2 points)**	The suppliers that are engaged have met all RMS' systems requirements by achieving the same level or exceeding those implemented by the RMS, showing a strong focus on the importance of sustainable management. **(5 points)**	All management plans implemented by the suppliers are ISO accredited AND criteria from lower levels is achieved. **(6 points)**	MAN-2 MAN-5

Category	Sub-category	ID	Question	Aspects	Level 0	Level 1	Level 2	Level 3	Cross-ref
Management and Governance	MANAGEMENT	MAN-5	Has the project team shown an effective contribution / commitment to sustainability and taken a positive leadership role?	Env, Econ, Soc	There is no intervention or promotion of achieving sustainable practice from those in management positions. The project documents do not include any sustainable targets other than broad organisational commitments.	The project team has identified commitments to sustainability that are defined as key deliverables for the project. The commitment includes specific statements identified in project documents. **(4 points)**	The project team shows a significant commitment to sustainability, with the exception of some areas. Commitments are clearly identified in project documents and there are numerous examples of activities undertaken to show sustainability performance objectives are being achieved. **(10 points)**	Sustainability is one of the course values of the project team and all policies, processes and management reflects this attitude. Commitments defined go beyond restoring and involved enhancing actions with respect to sustainability **AND** all criteria from lower levels are achieved. **(14 points)**	MAN-4 MAN-6
		MAN-6	Has the project team identified an individual/s to manage and report on sustainability for the project during construction works?	Env, Econ, Soc	The project team relies on the established organisation systems **AND** no team member has been assigned responsibility to monitor sustainability targets.	The management structure for the project specifically outlines key deliverables that those in management positions must delegate responsibility for and which must be reported on throughout the construction stage. **(3 point)**	The management structure specifically outlines a position that has direct responsibility for sustainability reporting on a regular basis **AND** Level 1 criteria is achieved. **(5 points)**	An external auditor is engaged to independently examine and report on progress with regards to sustainability **AND** all criteria from lower levels are achieved. **(8 points)**	MAN-5
		MAN-7	Have sustainability considerations been a key aspect of focus when making decisions?	Env, Econ, Soc	Budget and program are the major driving factors behind decision making only.	Sustainability considerations are brought into the decision making process, however budget and program still dominate. **(6 points)**	Budget, Program and Sustainability are considered equally important when making decisions during construction. **(12 points)**	Sustainability is the major factor when making decisions during the construction stage. **(15 points)**	MAN-1
Ecology	ECOLOGY	ECOL-1	Are revegetation efforts suitable and effective as well as promoting sustainable practice?	Env, Soc	Site vegetation only includes minimal, necessary works such as grassing for bank stabilisation **OR** vegetation chosen is inappropriate and ineffective in the area and will not flourish e.g. tropical plants in arid locations	The project has resulted in a net gain of vegetation and potential habitat areas as well as providing sufficient cover and stabilisation for all earthworks and construction areas. Some introduced species are non-natives and will require above average maintenance in the future. **(4 points)**	The project has resulted in a net gain of vegetation and potential habitat areas as well as providing sufficient cover and stabilisation for all earthworks and construction areas. Introduced species are predominantly natives that are known to thrive in the project area as well as being lower maintenance for future years. **(6 points)**	Site vegetation used is native and has been introduced via a 'reforestation' technique of seeding over a longer period of time to provide higher survival rates and higher durability, rather than introducing larger nursery trees. Revegetation has been a continuous effort throughout the project duration to introduce species back into the environment as soon as permissible. Vegetation chosen will require little amounts of maintenance in coming years and has a long lifetime. **(9 points)**	ECOL-2 ECOL-3 RES-1
		ECOL-2	Has there been an effort to retain mature vegetation or where not possible replace with suitable species?	Env	Mature vegetation is removed from the project area **AND** is not replaced or substituted for as part of the works.	The project has contributed a minimum 1:1 replacement of removed trees. No ultimate net loss of tree canopy will result once trees are mature. **(2 points)**		Design requires no mature trees to be removed **AND** planting efforts have exceeded those required. Landscape design has allowed for additional mature cover and habitat trees in areas that do not pose additional issues to the function of the road facility and are likely to remain permanently i.e. not in areas that require heavy maintenance and/or removal once the vegetation reaches a certain size. **(6 points)**	ECOL-1 ECOL3 ECOL-5
		ECOL-3	Does the site vegetation chosen complement the aesthetic value of the surroundings?	Env, Soc	Revegetation of the site has been completed with plantings that have no significance to the area **OR** are non native species that will struggle with development **OR** are species that require high levels of maintenance.	The majority of species chosen meet the three criteria of being native, low maintenance and complimentary to the appearance of the surrounding, with the remaining vegetation not likely to create any future issues with maintenance or issues with the functioning of the road facility. **(3 points)**		All species chosen have relevance to the area **AND** are similar species to those that surround the project **AND** are low/no water species that require minimal maintenance. **(5 points)**	ECOL-2 COMM-8

Ecology	ECOLOGY	ECOL-4	Has there been identification of any ecological sensitive sites within the project boundary and are they being protected? e.g. - Endangered Ecological Communities, - historic or heritage areas, - habitat areas, - threatened or endemic species, - conservation areas, - areas of national or international significance	Env, Soc	Ecologically sensitive sites have been identified within the construction area, however no effort has been made for preservation.	The project team have engaged experts in the field to map any areas that may be a sensitive site **AND** procedures have been implemented to protect these during construction activities. **(7 points)**	The project team have engaged experts in the field to map any areas that may be a sensitive site and procedures have been implemented to protect these during construction activities **AND** restore any sites that are subject to impact. **(8 points)**	All identified sensitive sites have been protected during construction works and measures have been implemented to enhance and develop these sites **AND** all criteria from lower levels is met. e.g. - delineating and introducing signage for conservation areas - introducing additional plantings to improve habitat - consulting with the community to identify ways to improve heritage sites **(15 points)**	COMM-7 POL-6
	BIODIVERSITY	ECOL-5	Has the project aimed to protect species biodiversity?	Env	The project team has dismissed the importance of enhancing biodiversity in the area or and minimal requirements are the only controls put in place to manage biodiversity.	The project team has involved professionals to identify existing habitats surrounding or are part of the project site **AND** efforts made by the project team are to reduce negative impacts and protect habitats in the area **OR** offset any damage caused by construction works e.g. - potential purchasing of biodiversity offsets **(7 points)**	The project team has involved professionals to identify existing habitats surrounding or are part of the project site **AND** efforts made by the project team are to preserve, protect and **restore** habitats in the area. **(8 points)**	The project team has involved professionals to identify existing habitats surrounding or are part of the project site **AND** efforts made by the project team are to **connect and enhance** habitats in the area. The project should aim to reinstate appropriate environmental features as well as improving the link between existing habitats. e.g. - vegetative connections - connectivity in streams (structures in culverts) **(14 points)**	ECOL-2
	ECOLOGICAL CONNECTIVITY	ECOL-6	Has the project been planned or staged in a way that prevents disruption to large areas of vegetation, habitat and migration routes for fauna?	Env	The construction staging involves several areas under concurrent works, which has resulted in a widespread and sudden impact to surrounding local ecology and landscape.	Construction works are staged in a way that minimises the area of impacted vegetation and habitat in an attempt to gradually implement change for better acceptance by local fauna, allowing them to vacate naturally **AND** remediation of impacted areas is conducted progressively during construction. **(7 points)**			ECOL-7
		ECOL-7	Has the project employed a design that mitigates against habitat fragmentation and promotes ecological connectivity?	Env, Soc	Constructed works will involve isolating or dividing several potential habitat areas, with no safe means of passage for local fauna.	Construction works do not encroach on any habitat areas and the project results in a condition same as before the works **OR** the works are conducted in an areas which causes minimal impact to habitat (e.g. through a plantation rather than a state forest). **(5 points)**	Partial mitigation of habitat fragmentation has been accounted for by such construction options as oversizing culverts for safe passage, overhead bridge or such structures as fish ladders etc. **(10 points)**	Design and construction goes above and beyond requirements by implementing such measures as raised roadways to allow safe passage of fauna, altered alignment or specialist means of passage. **(15 points)**	ECOL-6
Using Resources	REUSE & RECYCLING	RES-1	Has the project made use of all topsoil stripped from site?	Env, Econ	>50% of topsoil is not reused on the project and is required to be disposed of elsewhere off the project	> 60% of topsoil stripped from the project area is reused on site for revegetation or other works. **(5 points)**	> 80% of topsoil stripped from the project area is reused on site for revegetation or other works. **(7 points)**	100% of topsoil has been reused on the project for revegetation and other works and may have been screened and blended to provide a product of higher quality than was removed, which will assist with revegetation. **(9 points)**	RES-4 RES-5 POL-2

			Question	Themes	Level 1	Level 2	Level 3	Level 4	Ref
Using Resources	**REUSE & RECYCLING**	RES-2	Has the project made use of all spoil material that has been excavated from the project area?	Env, Econ	>50% of spoil is not reused on the project and must be disposed of offsite.	>60% of spoil has been reused on the project or for associated activities, resulting in a reduction in material requirements and costs associated with treatment and disposal. **(6 points)**	>80% of spoil has been reused on the project or for associated activities, resulting in a reduction in material requirements and costs associated with treatment and disposal. **(8 points)**	100% of spoil has been reused on the project or for associated activities, resulting in a reduction in material requirements and costs associated with treatment and disposal. **(10 points)**	RES-4 RES-5 POL-2
		RES-3	Has the project incorporated reuse of other substantial materials on the project? e.g. - repurposing large trees for timber - large concrete members from decommissioned structures - concrete kerbing crushed for verge material - salvaged plants for revegetation	Env, Econ	Waste or unneeded materials are typically sent to landfill or to be disposed of without effort to repurpose and reuse them onsite or for other construction activities.	The majority of all waste streams are managed to allow purposeful reuse of most materials on the project **OR** the majority of all waste streams are reused, either for the project or taken offsite for further processing and use elsewhere. **(8 points)**		All waste generated or removed from the project is reused on the project and has resulted in a significant reduction in the import quantities of materials and overall cost attributed to the project. **(11 points)**	RES-5 POL-2
		RES-4	Have REUSE and RECYCLE initiatives throughout the project resulted in a reduction in the quantity of significant waste streams going to landfill? Diversion methods may be a combination of techniques that include: - sending material to alternate processing facilities to be recycled - reusing materials onsite - disposal to other sites with development approval - donation to other development authorities or community organisations Significant waste streams include those associated with physical works towards project construction and not general municipal waste.	Env, Econ	The majority of wastes have been sent to landfill as a result of the minimal effort and planning placed on an effective waste management plan **OR** the Level 1 criteria for RES-1,2,3 at minimum are not achieved.	A waste management plan has been developed, which mandates a minimum of 90% of spoil and 80% of inert and non-hazardous waste is diverted from landfill, of which the project has achieved. **(6 points)**	A waste management plan has been developed, which mandates a minimum of 95% of spoil and 90% of inert and non-hazardous waste is diverted from landfill, of which the project has achieved. **(9 points)**	The criteria for Level 2 is achieved **AND** the project has achieved the highest level of re-use under performance objective RES-3. **(12 points)**	RES-5 POL-1 POL-2
		RES-5	Has there been an attempt to REDUCE construction materials throughout the project?	Econ, Env	No effort in the form of changes to design, materials, processes, etc. have been made in an attempt to reduce material use.	The project has made some effort to reduce construction materials, however incentives for reducing material requirements have been more influenced by methods of reducing costs rather than improving sustainability. **(3 points)**	All opportunities to reduce materials use are investigated and the project has employed several feasible and cost justifiable techniques to reduce construction materials. e.g. - utilising specialised geotextiles to reduce extent of foundation treatments and thickness of earthworks layers - utilising stabilised materials to reduce thickness of pavement layers - utilising clever roadway designs to minimise stormwater drainage - utilising old pavement and other retained infrastructure to reduce construction volumes - using site won materials **(12 points)**	Innovative new methods have been employed into the construction process that have had a significant impact on material reduction and may provide options for future projects **AND** criteria for all other levels is met **(15 points)**	RES-1 RES-2 RES-6 POL-2

Category	Subcategory	Code	Question	Disciplines	Description (Level 1)	(Level 2)	(Level 3)	(Level 4)	Cross-ref
	MATERIAL PROCUREMENT	RES-6	Does the project include a balanced earthworks design?	Econ, Env	For any reason, earthworks for the project rely heavily on imported materials. e.g. - rehabilitation of a roadway completely in fill areas, - adverse geology resulting in high amounts of unsuitable - natural material won from site is contaminated or non-viable for use	The project wins more than 50% of the earthworks requirements. **(7 points)**	The project wins more than 75% of the earthworks requirements **(10 points)**	The general earthworks design is balanced (+/- 10% of bulk volume) **AND** construction works and earthworks volumes have been accurately represented in the design **AND** project utilises all site won material prior to importing. **(13 points)**	RES-5
Using Resources	MATERIAL PROCUREMENT	RES-7	Is there evidence that the project team has considered responsible and sustainable sourcing of materials for all construction activities?	Env	The Level 1 criteria has not been achieved for Man-3 and Man-4	The project has evidence to show that >25% of total materials have been sourced responsibly from suppliers. **(4 points)**	The project has evidence to show that >50% of total materials have been sourced responsibly from suppliers. **(8 points)**	The project has evidence to show that >80% of total materials have been sourced responsibly from suppliers. **(10 points)**	MAN-3
		RES-8	Has the project team made an effort to implement less energy intensive materials? - warm mix vs. hot mix asphalt - flyash concrete - recycled glass footpaths	Econ, Env	No investigation or research has been conducted into less energy intensive materials and the project design and construction processes are based on typical processes used for past projects the team are accustomed to.	The project team have introduced some alternate materials to the project that reduce the overall energy consumption **AND** the implementation of these measures is documented as a benefit to the project. **(8 points)**		Innovative new methods have been employed into the construction process that have had a significant impact on energy reduction **AND** will prove beneficial for future projects. **(13 points)**	W&E-4
		RES-9	Has the project team utilised local / regional materials suppliers in an attempt to reduce transportation costs and impacts and to retain local benefits?	Env, Econ, Soc	< 50 % of materials are locally sourced. i.e. within the distances specified: soils (80 km), aggregate (80 km), concrete (160 km), plants (400 km), and all other materials (800 km).	>50 % of materials are locally sourced. i.e. within the distances specified: soils (80 km), aggregate (80 km), concrete (160 km), plants (400 km), and all other materials (800 km). **(5 points)**	>75 % of materials are locally sourced i.e. within the distances specified: soils (80 km), aggregate (80 km), concrete (160 km), plants (400 km), and all other materials (800 km). **(7 points)**	>95 % of materials are locally sourced i.e. within the distances specified: soils (80 km), aggregate (80 km), concrete (160 km), plants (400 km), and all other materials (800 km). **(9 points)**	MAN-2 MAN-3 COMM-4 COMM-10
		RES-10	Has the project team considered whole-of-life considerations / lifecycle impacts of construction activities?	Econ	The project team has put in no effort to predict or consider future impacts of the roadway and no lifecycle analysis has been conducted.	Lifecycle analysis has been conducted for construction decisions, however these have not played a significant role in promoting changes to design or processes. **(4 points)**		A comprehensive lifecycle analysis of all construction activities is conducted and the project design reflects changes made to positively impact future works associated with maintaining and prolonging the life of the facility. **(15 points)**	SIT-3 DES-4 DES-5
	HAZARDOUS SUBSTANCES	RES-11	Has the project introduced measures to minimise the use of hazardous substances within the construction process?	Env	Project has made no attempt to reduce the use of hazardous substances or processes that result in the production of contaminated wastes.	The project has made an assessment on project materials and identified potential substitute options for hazardous substances with those less hazardous AND these substitutions have been made **(5 points)**			
Water and Energy	WATER	W&E-1	Does the project include a water management plan?	Env	No water management plan is developed for the project and there is little effort to reduce potable water usage.	Opportunities to reduce potable water usage are investigated and all feasible and cost effective measures are identified. **(2 points)**	A water tracking management plan has been developed and feasible measures to reduce potable water usage are implemented. **(6 points)**	The water management plan introduced involves implementation of feasible options for reducing potable water use as well as monitoring of water usage throughout the project. **(7 points)**	W&E-2 W&E-3 POL-6

Category	Sub-category	Code	Question	Disc.				Ref
Water and Energy	WATER	W&E-2	Has the project team implemented a water tracking plan?	Econ, Env	The project has made no effort to monitor water usage for construction activities **OR** the Level 1 criteria for W&E-1 is not achieved.	A water tracking plan exists, as part of the water management plan that monitors the usage of water, however there are no restrictions on usage. **(3 points)**		The project team have implemented a water tracking plan that involves reporting on usage for all site activities and ensuring that construction practices do not exceed those set in the plan. **(8 points)**	W&E-1
		W&E-3	Does the project make use of water collected on site from runoff or from other sources?	Econ, Env	All water that enters site is not collected and freely discharges through controls.	Runoff and other water is collected on site by structures that have been constructed for the final facility and is reused for various construction activities. **(4 points)**	Provisions have been made to install additional devices that collect ideally all runoff and stormwater and a plan is introduced on how to effectively utilise these sources. e.g. - rainwater tank , - sediment basins **(7 points)**	The water management plan identifies a potential use for any water that enters the construction site **AND** the criteria from other levels is achieved **(9 points)**	W&E-1 POL-6
	ENERGY AND CARBON	W&E-4	Have the project team made an effort to reduce the net embodied energy of project materials?	Env	The project team have not assessed the embodied energy of materials used during construction and hence excluded consideration for embodied energy in the procurement process.	The embodied energy of materials used in significant quantities has been obtained and validated or calculated from a life-cycle assessment. The embodied energy involves energy used in initial extraction, refinement and manufacture. **(9 points)**	The project team has achieved a reduction of the embodied energy usage for the project by more than 25% through methods such as: - reducing the quantity of materials - selecting alternate materials with lower embodied energy **AND** the criteria of Level 1 has been achieved. **(12 points)**	The project team has achieved a reduction of the embodied energy usage for the project by more than 50% through methods such as: - reducing the quantity of materials - selecting alternate materials with lower embodied energy **AND** the criteria of Level 1 has been achieved. **(15 points)**	RES-8 W&E-5
		W&E-5	Does the project utilise an energy and carbon monitoring management plan or have measures to track energy usage?	Env	The project does not include any formal process for monitoring or recording energy use or GHG emissions.	An energy usage and GHG emissions plan has been developed for the project, which is used to collect data for future projects. **(3 points)**	An energy usage and GHG emission plan has been developed for the project and is being used to make adjustments during the construction to areas which are the largest negative contributors, improving the projects energy footprint **AND** the criteria for Level 1 is achieved. **(8 points)**	An energy usage and GHG emission plan has been developed for the project and has formed the basis for making changes to the construction process and design prior to commencement of construction **AND** the criteria for the other levels is achieved. **(15 points)**	W&E-4 W&E-6 POL-5 POL-7 POL-8
		W&E-6	Has the project utilised materials and processes that have resulted in a lower than typical energy consumption	Env	The project team have not implemented construction practices that utilise lower energy rates than other similar sized projects **OR** the Level 1 criteria for W&E-5 is not achieved.	The project team have started implementing construction techniques that have resulted in energy consumption lower than typical construction projects of a similar size. **(4 points)**	The project team have implemented construction techniques that have resulted in energy consumption substantially lower than typical construction projects of a similar size. **(10 points)**	The project team have significantly altered typical construction processes or utilised innovative techniques in order to reduce energy consumption for all construction activities. **(14 points)**	W&E-5
Community and Quality of Life	HEALTH & WELLBEING	COMM-1	Does the project take into account the health and safety implications of all construction practices on public health and safety?	Soc	Majority of community has view that project has negative impacts to the community.	An appropriate, risk based assessment of safety to the community is undertaken, along with community engagement. **(3 points)**	Surveys of the community are undertaken to identify concerns and issues, which are addressed appropriately **AND** level 1 criteria is achieved. **(4 points)**		COMM-2

Community and Quality of Life		ID	Question	Type	Level 0	Level 1	Level 2	Level 3	Ref
Community and Quality of Life	STAKEHOLDER PARTICIPATION	COMM-2	Have the project team made a sufficient effort in addressing all concerns raised by the community and other stakeholders?	Soc	Majority of community has view that project did not suitably address their concerns or enquiries.	The project involves formal community policies and procedures, which include a representative that deals with all issues. **(5 points)**	The construction of the project results in > 60% of community satisfied with how they have been engaged **AND** the Level 1 criteria is achieved. **(7 points)**	The construction of the project results in > 80% of community satisfied with how they have been engaged **AND** the Level 1 criteria is achieved **AND** all construction related complaints are responded to and resolved promptly **(8 points)**	COMM-1 COMM-3
Community and Quality of Life	STAKEHOLDER PARTICIPATION	COMM-3	Has the project team included a dedicated member responsible for ongoing community consultation?	Soc	The project has no defined personnel for community consultation and it is difficult for the community to contact representatives from the project.	One member of the project team has taken responsibility for all communications with the community to ensure information conveyed is consistent. e.g. project manager or works supervisor **(4 points)**	The management structure specifically outlines a position that has direct responsibility for community engagement and reporting on a regular basis **AND** this person regularly engages with the community to provide updates and to maintain an informative relationship. **(6 points)**	The project team maintains ongoing community consultation services after the construction works are completed for any further issues the community may face (more applicable for larger projects) **AND** criteria from other levels are achieved. **(7 points)**	COMM-2
Community and Quality of Life	STAKEHOLDER PARTICIPATION	COMM-4	Has the project actively seeked engaging local firms to quote for work?	Econ, Soc	Local firms have not been targeted and engaging contractors has been through a centralised process.	The project team have actively contacted potential contractors to identify expressions of interest and have included these firms when advertising for tenders and quotes. **(5 points)**		The project team have actively contacted potential contractors to identify expressions of interest and have run a local tender process separately to identify whether works can remain local prior to advertising on a broader scale. **(6 points)**	RES-9
Community and Quality of Life	LIVEABLE COMMUNITIES	COMM-5	Do the construction activities and final facility impact negatively on the way the local community conduct day to day activities?	Soc	The roadway facility has resulted in the majority of the community having the perception that conditions are less favourable after construction than previously.	Initial discussions with the community and concerned stakeholders were completed in order to ensure design would have a positive impact on most residents nearby to the roadway facility as well as those community members that use it **AND** these concerns were considered when finalising design plans and during construction. **(3 points)**	Community consultation has been conducted to identify in detail community concerns with the performance of the final facility during project works **AND** concerns are dealt with appropriately to maintain community knowledge and engagement **AND** the final facility provides an improved level of service to the majority of residents nearby and community users **AND** criteria from Level 1 is achieved. **(6 points)**	The project team has worked closely and regularly with the community to ensure no negative outcomes exist once project construction is completed **AND** the final facility provides an improved level of service to all residents **AND** criteria from other levels is achieved. **(8 points)**	COMM-6
Community and Quality of Life	LIVEABLE COMMUNITIES	COMM-6	Has the project improved community access and mobility e.g. - local roads adjacent to main motorways to improve local traffic needs - grade separated interchanges to suburbs to improve safety - increased number of pedestrian and cyclist facilities - improved public transport facilities such as additional bus shelters etc.	Soc	Community access to and through the roadway facility is to the same level of as previously and does not enable more efficient, safer or easier access to surrounding areas of the community.	The project team has worked in conjunction with their owners and operators of facilities nearby in order to identify design gaps, future needs and feasible options that can be made during construction to provide easier, improved access and mobility for the current community **OR** to plan for future development needs in order to identify what further works are required. **(3 points)**		The project team and roadway design has gone above and beyond current requirements by planning for future community needs and has included in construction several features that improve mobility and access from such measures as reducing congestion, improving walkability, transportation strategy etc. **AND** criteria for other levels is achieved. **(8 points)**	COMM-5 DES-1 DES-2 DES-3

Category	Sub	Code	Question	Disc	Level description				Ref
Community and Quality of Life	IMPORTANT SITES	COMM-7	Has the project aimed to preserve sites of historical and cultural importance? - Heritage sites - Memorial sites - Aboriginal significance - Archaeological significance - Sites with community importance	Env, Soc	Minimal effort has been made to preserve sites if identified **OR** lack of in depth investigation into the significance of potential sites	Where sites are identified, the project team works closely with any related stakeholders to mitigate against any possible impacts to the resource. **(9 points)**	Where sites are identified, potential stakeholders are contacted early on and worked with to identify feasible preservation methods or a sensitive design approach where full protection is not practicable. **(10 points)**	The project and construction has been designed to fully preserve and/or enhance the character-defining features of that resource. - restoration of lost features such as historic landscape - expansion of recreational facilities - improves accessibility to cultural or historical sites **(15 points)**	ECOL-4
Community and Quality of Life	AESTHETICS	COMM-8	Has the project team included community in decisions regarding the final aesthetics of the project?	Env, Soc	The project design and construction have not taken into account the opinion of the local community.	The community has been involved during the pre-construction works to ensure decisions made reflect a community view. **(5 points)**		The project team have involved the community in decisions **AND** have gone above and beyond the minimum requirements for all aesthetic qualities of the project to improve the overall community. **(8 points)**	ECOL-3
Community and Quality of Life	AESTHETICS	COMM-9	Are any noise mitigation or light spill mitigation measures implemented well suited and designed for the area?	Env, Soc	The mitigation measures are disjunct from the surrounding environment and do not aesthetically meet community needs. e.g. - highly modern styled noise wall in a rural setting	The mitigation measures include techniques that are complementary to the surroundings e.g. - Appropriately design noise walls and headlight screens where a physical structure is required - Vegetation barriers and natural means where possible **(6 points)**		Innovative measures for noise and light spill mitigation have been employed **AND** the level 1 criteria is achieved. **(10 points)**	POL-3 POL-4 MAN-4
Community and Quality of Life	AESTHETICS	COMM-10	Has the project incorporated local products and materials into the design and construction to improve the area visually? e.g. - local plants - local timbers - local stone	Env, Soc	The project has chosen materials that do not represent the local area, which provide the project with an appearance that detracts from the surroundings.	The project has incorporated some local materials into the design and construction of the roadway **AND** the visual aesthetics of the surroundings have improved. **(5 points)**		The project team have gone above and beyond to improve the visual aesthetics of the area **AND** criteria from the lower level is achieved. **(8 points)**	RES-9
Design	TRAFFIC FLOW	DES-1	Does the project design improve public transit facilities, freight movements and ease of access?	Soc	The project results in a roadway with no additional capacity or ability to handle increased heavy vehicle demands or vehicles in general.	The project has provided at minimum the same level of traffic flow capacity as previously, however the roadway has the ability for upgrades with minimal costs (e.g. change of linemarking only) **OR** additional safety features have been introduced that maintain the previous level of service, however traffic movements are now more structured and safer (e.g. separation medians, auxiliary turning lanes, improving signage, sight distance etc.) **(1 point)**	The roadway design has multiple individual provisions that aid in traffic flow. e.g. - additional travel lanes - auxiliary turning lanes - grade separated interchanges - separated cyclist and motorist facilities **(4 points)**	The roadway design has gone above and beyond the current required level of service in an attempt to plan for future traffic demands. **(8 points)**	COMM-6
Design	ROADWAY & TRAFFIC	DES-2	Does the project design improve community access facilities and safety; including pedestrian walkways, cyclist lanes and safer crossings?	Soc	The project has provided pedestrian facilities worse than previously **OR** the level of restoration of altered facilities has not been sufficient.	Pedestrian facilities have been provided to a level greater than previously, however there are areas for improvement (e.g. crossings across live lanes) **(3 points)**	Facilities provided are substantially improved over previously. **(5 points)**	Level 2 criteria is achieved **AND** the project has introduced an innovative solution for pedestrian and cyclist facilities **OR** the facilities provided go above and beyond the current requirements **(9 points)**	DES-3 COMM-6 SIT-4

			Question		Level 1	Level 2	Level 3	Level 4	Ref
Design	ROADWAY & TRAFFIC	DES-3	Does the project design improve the safety of the roadway?	Soc	The project has provided a roadway that has the same level of safety for motorists as previously **OR** the constructed roadway provides safe means of passage for only one particular group of user e.g. safe passage for cars but not for cyclists	Safety has been dramatically improved for all motorists from improvements to aspects including: - improvements to wearing course and surface quality - improved signage and delineation - improved visibility - improved separation and division between motorists, cyclist and pedestrians. **(4 points)**	Community consultation has been included in order to identify specific community concerns with safety of which have been considered for the final design **AND** the Level 1 criteria is achieved. **(6 points)**	The project team has constructed a roadway that goes above and beyond the requirements for safety in an attempt to plan for the future use **AND** the criteria for other levels is achieved. **(10 points)**	DES-2 SIT-4 COMM-6
	PAVEMENT	DES-4	Has the project included a long life pavement design that minimises the time required before intervention and maintenance is required?	Econ, Env	The project involves a pavement design to a standard that predicts necessary intervention and maintenance within 10 years.	The project has implemented a pavement design that predicts a design life of 20 years or greater before significant maintenance is required. **(4 points)**	The project has implemented a pavement design that predicts a design life of 40 years or greater before significant maintenance is required. **(8 points)**	The project has utilised innovative pavement technologies that have resulted in a long life pavement while using other sustainable processes or technology **AND** criteria from lower levels is achieved. e.g. - warm mix asphalt in lieu of hot mix asphalt **(12 points)**	RES-10
		DES-5	Has the design included whole-of-life considerations and planned for reduced maintenance requirements?	Econ, Soc	The design appears to involve features that have been made in isolation from maintenance planners and there are several obvious issues that will create more maintenance issues in the future.	The project has included some design features and considerations that have been chosen to assist with long term maintenance e.g. - reduced areas requiring mowing - long life pavements - concrete vs. timber bridges **(10 points)**		There is clear evidence that the project team have adopted a whole-life approach in the design and construction of the majority of project elements **AND** several design features and considerations have been chosen to assist with long term maintenance. **(15 points)**	RES-10
	RESILIENCE	DES-6	Is there evidence that the project team have considered flooding risk and resilience in the design and actively designed the project for greater flood resilience if warranted?	Econ, Env, Soc	The project has not been designed to cater for any heightened flood risk or a higher probability interval.	The project team have identified benefits from improving the resilience and flooding design due to particular site conditions and have implemented measures to improve the design. e.g. - sites sensitive to intense rainfall - sites prone to large, intense volumes of runoff **(10 points)**			
	INTELLIGENT TRANSPORT	DES-7	Does the project include any intelligent transport systems or has there been any discussion on potential beneficial systems? e.g. -Traffic surveillance systems - Dynamic / Variable Message Signs	Econ, Env, Soc	Intelligent Transport Systems have not been included in project design, construction or implementation.	Intelligent Transport Systems of some form are implemented within the project in an attempt to improve the constructed facility and overall sustainability. **(7 points)**		Innovative ITS solutions have been implemented in the project **AND** criteria from lower level is achieved. **(15 points)**	SIT-4 COMM-6

			Question	Theme		Level 1	Level 2	Level 3	Ref
Pollution Control	**WASTE**	POL-1	Has the project identified a waste and recycling plan?	Env, Econ	The project does not include any form of waste and recycling plan and hence no formal means of tracking waste generation and disposal methods.	A waste management plan is developed and implemented that contains requirements for reusing, recycling and reducing materials. **(3 points)**	A waste management plan is developed and implemented that contains requirements for reusing, recycling and reducing materials **AND** the waste management plan involves reporting requirements and targets for the project team. **(4 points)**	The project involves an in depth waste management plan for the site, which involves construction waste and general waste **AND** the project implements waste separation **AND** criteria for other levels is achieved. **(5 points)**	RES-4
		POL-2	Diversion from landfill	Env, Econ	Large quantities of waste that could have potential reuse are disposed of at landfill sites.	> 50% of waste is diverted from landfill **(5 points)**	>80% of waste is diverted from landfill **(8 points)**	>95% waste diverted from landfill **(10 points)**	RES-1 RES-2 RES-3 RES-4
	EMISSIONS TO LAND, WATER & AIR	POL-3	Have the impact of *noise* and *vibration* been considered for the project works?	Env, Soc	The project has resulted in a roadway that has increased the ambient noise in the area **OR** for greenfields sites, inadequate studies and consultation of sensitive receptors has been undertaken.	The project can provide evidence that the resultant noise levels for the final project are less than the existing situation or are acceptably low. **(5 points)**	Baseline studies of existing noise and vibration levels are conducted for comparison **AND** Noise and vibration monitoring is conducted at set intervals and the project is shown to have a positive impact on noise levels for the area **BUT** the resultant noise levels for the final project are less than the existing situation or are acceptably low. **(7 points)**	The project has been designed to reduce ambient noise in the area and have included several features that are specifically included to reduce noise **AND** criteria for other levels is achieved. e.g. - noise walls - buffer zones - noise reducing pavements **(9 points)**	COMM-9
		POL-4	Has the impact of light pollution been considered for the project works?	Env, Soc	The design has resulted in nearby receptors having negative impacts from light sources associated with the project.	Best practice measures are implemented to prevent light spill from the project during construction works **AND** the project team has identified and implemented through careful assessment the minimum lighting requirements for the roadway AND the design of the project results in no additional light impacts once project is completed. **(6 points)**		The project team has engaged experts to assess minimum lighting requirements that satisfy safety and way finding and reduces impacts to receptors **AND** qualitatively, there are no impacts to the night sky **AND** lighting is on a "time-of-day" schedule, which reduces unnecessary illumination and saves energy costs **AND** the Level 1 criteria is achieved. **(9 points)**	COMM-9
		POL-5	Have the construction works impacted negatively to air quality in the area **AND** will the final project result in net positive impacts to air quality?	Env, Soc	The construction process has resulted in several instances of air quality issues **OR** the project results in negative impacts to air quality directly or indirectly e.g. - poor design resulting in longer queue times and hence greater emissions	The project team has included in the systems an air quality management plan, which includes regular monitoring of plant and equipment and other activities likely to release significant airborne pollutants **AND** the project team regularly implements controls to ensure pollutants are not dispersed. e.g. - watering down of dusty haul roads - regular maintenance on engines - ceasing certain works during windy weather (lime stabilisation) **(4 points)**	Level 1 criteria is achieved **AND** The air quality management plan includes monitoring and targets for six categories of pollutants: - particulate matter, carbon monoxide, sulfur compounds, nitrogen compounds, lead, noxious odours and ozone. **AND** baseline levels have been identified from prior to commencement of construction works, which have not been exceeded. **(7 points)**	Criteria from other levels is achieved **AND** air quality of facility after construction works shows that an improvement has been made by the construction team. **(10 points)**	POL-7 W&E-5

			Question		Level 0	Level 1	Level 2	Level 3	Ref
Pollution Control	**EMISSIONS TO LAND, WATER & AIR**	POL-6	Has the project reduced surface water and groundwater contamination?	Env	The project includes no surface water controls for runoff and members of the project team are not trained in environmental incidents including spill response and contamination incidents.	Sensitive environments and watercourses are identified prior to commencement of construction activities **AND** the project team has defined spill response and contamination procedures that are presented to all staff working on the project. **(3 points)**	The project team has installed controls including measures such as erosion and sediment structures, detention pools for contaminant runoff, bunded areas and diversion from sensitive areas **AND** Level 1 criteria is achieved. **(6 points)**	The project has gone above and beyond what is required by rehabilitating the surface water courses and surrounding ground as well as installing permanent controls to ensure no future contamination can occur **AND** criteria from lower levels is achieved. **(12 points)**	MAN-4 W&E-1 W&E-3
		POL-7	Has the selection of construction plant and equipment been influenced by the energy efficiency and emissions rating?	Env, Soc	Energy efficiency of plant has not contributed to selection criteria for any construction activities.	Energy use and emissions levels have been a key deciding factor for the choice of plant and equipment **AND** there is evidence that the selected plant is well maintained to ensure maximum operational efficiency. **(5 points)**		Typical construction plant and equipment have been substituted or augmented for more environmentally conscious processes **OR** additional management techniques and processes have been implemented to monitor energy use and emissions to ensure negative effects are minimised **AND** criteria from lower level is achieved. **(11 points)**	POL-5 POL-8 W&E-5
	CLIMATE CHANGE & RISK	POL-8	Have the project team utilised renewable energy where possible or implemented measures that reduce the overall consumption of fossil fuels and GHG emissions?	Env, Soc, Econ	All plant and equipment utilise fossil fuels for operations and no effort has been made to reduce fossil fuel consumption.	Alternatives to fossil fuel powered plant and equipment has been investigated **BUT** are non-feasible. An energy usage and GHG emissions plan is developed as per Level 1 of RES-15 and usage is monitored. **(2 points)**		All aspects of the construction process have been assessed for alternate fuel feasibility **AND** the project team has identified and implemented processes that can have renewable energy sources or offset credits can be purchased **AND** the Level 1 criteria is achieved. **(12 points)**	POL-7 W&E-5
Custom Credits / Innovation	**CUSTOM**		Has the project implemented any innovative processes, materials, strategies or technologies that have had a positive outlook on construction sustainability?		No innovative measures have been implemented by the project team.	*Describe the custom credit or innovative measure that the project team has implemented, not included in the above categories.* * - For each custom credit, a Level 1 achievement level is awarded with 5 points.* * - Maximum 5 custom credits can contribute towards the final score.*	*To constitute a custom credit, the project team must justify:* *- Why the initiative / process / technology promotes sustainable practice* *To constitute an innovation, the project team must show evidence that:* *- the initiative / process / technology is considered a first in either Australia or the world* *- the initiative / process / technology substantially contributes to the broader market transformation towards sustainable development in Australia or the world.*		
		CUST-1		Env, Econ, Soc					
		CUST-2		Env, Econ, Soc					
		CUST-3		Env, Econ, Soc					
		CUST-4		Env, Econ, Soc					
		CUST-5		Env, Econ, Soc					

APPENDIX C

SAMPLE OF *SMART* SCORECARDS

SMaRT Scorecards		
TOTAL SCORE ACHIEVABLE	639	
TOTAL SCORE RECEIVED	0	
PERCENTAGE OF TOTAL	0	
CERTIFICATION LEVEL		
Award Levels		
Platinum	>90% total	
Gold	>75% total	
Silver	>50% total	
Certified	>35% total	

Sustainable Sites Scorecard

Subcategory	Reference	Max. Points	Achievement Level	Points Awarded	Comments
Alignment - Greenfields vs. Brownfields	SIT-1	15			
Alignment - Project Footprint	SIT-2	10			
Alignment - Future Expansion Opportunity	SIT-3	15			
Land Use and Landscape - Transportation Efficiencies	SIT-4	12			
Land Use and Landscape - Adverse Geology	SIT-5	6			
Access - Temporary Construction Facilities	SIT-6	11			
			TOTAL	0	

Management and Governance Scorecard

Subcategory	Reference	Max. Points	Achievement Level	Points Awarded	Comments
Planning and Procurement - *Commitment*	MAN-1	10			
Panning and Procurement - *Tender Assessment*	MAN-2	5			
Planning and Procurement - *Suppliers and Manufacturers*	MAN-3	12			
Planning and Procurement - *Management Plans*	MAN-4	6			
Management - *Commitment*	MAN-5	14			
Management - *Responsibility*	MAN-6	8			
Management - *Decision Making*	MAN-7	15			
			TOTAL	0	

APPENDIX D

<u>CASE STUDY</u>: OCEAN DRIVE ROUNDABOUT DESIGN DRAWINGS

LEGEND

EXSITING

OPTIC FIBRE OPTUS
OPTIC FIBRE TELSTRA
OPTIC FIBRE COUNCIL
OPTIC FIBRE PRIVATE
OVERHEAD POWER
UNDERGROUND POWER
WATERMAIN
RECLAIMED WATERMAIN
SEWER MAIN
TELSTRA LOCAL CABLE
BOTTOM OF BANK
EDGE OF BITUMEN
STORMWATER PIPE

EXISTING TREE TO BE REMOVED

EXISTING TREE TO REMAIN

PROPOSED

STORMWATER PIPE
SUBSOIL DRAINAGE
CUT / FILL BATTER
DESIGN CENTRELINE
PROPOSED WATERMAIN
PROP. RECLAIMED WATERMAIN
PROP. LV U.G. ELEC (CONDUIT)
PROP. OVERHEAD POWER
PROP. ESS. ENERGY CONDUITS
PROPOSED ELEC POLE
PROPOSED STREETLIGHT
PROPOSED ELEC LINK

FAUX BRICK STENCILCRETE

NOTE: FOR 33KV OVERHEAD POWER RELOCATIONS SEE PLAN SET
DRAWING REFERENCE NUMBER 106960 BY APD POWER.
FOR 11KV OVERHEAD POWER RELOCATIONS AND LIGHTING
REQUIREMENTS SEE PLAN DRAWING REFERENCE 106725 BY APD POWER.

OCEAN DRIVE

LIMIT OF CONSTRUCTION CH41

159

Amended school entrance design to allow safer entrance and exit

LEGEND

EXSITING
- OPTIC FIBRE OPTUS
- OPTIC FIBRE TELSTRA
- OPTIC FIBRE COUNCIL
- OPTIC FIBRE PRIVATE
- OVERHEAD POWER
- UNDERGROUND POWER
- WATERMAIN
- RECLAIMED WATERMAIN
- SEWER MAIN
- TELSTRA LOCAL CABLE
- BOTTOM OF BANK
- EDGE OF BITUMEN
- STORMWATER PIPE
- EXISTING TREE TO BE REMOVED
- EXISTING TREE TO REMAIN

PROPOSED
- STORMWATER PIPE
- SUBSOIL DRAINAGE
- CUT / FILL BATTER
- DESIGN CENTRELINE
- PROPOSED WATERMAIN
- PROP. RECLAIMED WATERMAIN
- PROP. L.V U.G. ELEC (CONDUIT)
- PROP. OVERHEAD POWER
- PROP. ESS. ENERGY CONDUITS
- PROPOSED ELEC POLE
- PROPOSED STREETLIGHT
- PROPOSED ELEC LINK
- FAUX BRICK STENCILCRETE

NOTE: FOR 33KV OVERHEAD POWER RELOCATIONS SEE PLAN SET DRAWING REFERENCE NUMBER 106960 BY APD POWER.
FOR 11KV OVERHEAD POWER RELOCATIONS AND LIGHTING REQUIREMENTS SEE PLAN DRAWING REFERENCE 106725 BY APD POWER.

OCEAN DRIVE

160

APPENDIX E

CASE STUDY: OCEAN DRIVE ROUNDABOUT *SMART* SCORECARDS

SMaRT Scorecards		
TOTAL SCORE ACHIEVABLE	629	
TOTAL SCORE RECEIVED	260	COMM-9 has been scoped out as it is not applicable.
PERCENTAGE OF TOTAL	41.34	
CERTIFICATION LEVEL	"Certified"	
Award Levels		
Platinum	>90% total	
Gold	>75% total	
Silver	>50% total	
Certified	>35% total	

Sustainable Sites Scorecard

Subcategory	Reference	Max. Points	Achievement Level	Points Awarded	Comments
Alignment - *Greenfields vs. Brownfields*	SIT-1	15	Improving	10	The project involved widening of the existing Ocean Drive carriageway for 300m south of the roundabout and 330m north, a total length of 630m. The existing pavement was reconstructed to form the northbound lanes of the new pavement. The Houston Mitchell Drive portion of the project involved 225m of full pavement reconstruction, followed by 135m of pavement rehabilitation. There was only minimal widening at the approach to the roundabout. Total project area is calculated as 30,450m^2, with a total acquisition of Greenfield land of less than 6,125m^2 (hence 80% brownfields development). The Greenfields areas were all open fields grassland, with no trees or remnant vegetation removed. Refer to Appendix D for construction drawing - (Every & Shaw, 2014a)
Alignment - *Project Footprint*	SIT-2	10	Achieving	3	The project was designed with minimum corridor widths, however have included certain features that increase the footprint. For example, the 4m divided median is a design choice solely for landscaping purposes. Although this brings its own benefits, it has come at the cost of additional land acquisition. Geographic bounds are somewhat responsible for the reduced footprint in some areas, for example, on the eastern and western sides of the project at the southern end, there is a haulage company and the recent completed school, hence limited room for widening of the road reserve. The project aimed to reduce encroachment into these properties where possible. As per construction drawings - (Every & Shaw, 2014a)
Alignment - *Future Expansion Opportunity*	SIT-3	15	Exceeding	15	The project has planned for potential future expansion in multiple ways. These include designing the roundabout with four-legs to allow the future subdivision to have a permanent access; aligning the project at the tie-ins to allow simple continuation of the upgraded pavement works in the future and constructing the pavement past the design edge-lines to allow extension of cycle ways and pedestrian paths. Information from PMHC states that there is planned future works in the form of duplication of Ocean Drive, hence further works in the area is highly likely. As per construction drawings - (Every & Shaw, 2014a)

Land Use and Landscape - *Transportation Efficiencies*	SIT-4	12	Exceeding	The existing Ocean Drive portion of the project had a traffic volume of over 7000 AADT (Average Annual Daily Traffic), with 5% heavy vehicles and the Houston Mitchell Drive portion a volume of over 2200 AADT, with 5% heavy vehicles. As per Geotechnical Report - (Regional Geotechnical Solutions, 2014) The existing intersection provided very poor service for the amount of users, as it did not have a suitable radius for turning movements on all three approaches, especially negative for the heavy vehicle movements. The new roundabout caters for improved sight distance, improved turning radius, improved capacity (2 lanes in and out) and auxiliary lanes for turning movements. Prior, there were no pedestrian facilities, of which now there are dedicated paths on all sides running for the length of the project to assist with pedestrians travelling to the school and a cyclist lane has been installed, which is an improvement from the narrow shoulders used previously. Car lanes are same width, but now there are two lanes through the intersection, easing movements and benefitting peak hour flow.
Land Use and Landscape - *Adverse Geology*	SIT-5	6	Non Achieving / Achieving	The location of the project was set as it is majorly a reconstruction and upgrade project for the existing road. Due to this, construction did run into issues that required consideration in the methodology. The site area was located in essentially a low lying area, which substantial issues with holding water in the past due to lack of drainage. It was also identified that there was a natural spring located to the south west of the project. This natural depression provided highly unsuitable foundation conditions, which required excessive amounts of material to be removed. The geotechnical report provided information that the subgrade materials were typically highly plastic clays or highly fractured, degraded rock. Techniques such as specialised geotextiles and large bridging layers were employed to combat against the unfavourable existing soil and prevent issues from water. As per Geotechnical Report - (Regional Geotechnical Solutions, 2014) Additional comments in the Review of Environmental Factors - (Every, 2014)

| Access - *Temporary Construction Facilities* | SIT-6 | 11 | Achieving / Improving | 3 | The project required access to the adjacent private property to set up the site compound, including hardstands for the site office and other buildings, amenities block, light vehicle and heavy vehicle parking and access track from the road. The project also required a temporary stockpile area, constructed in the same vicinity, with an approximate area of 5000m^2.

The access constructed from the existing road to the compound area is to remain after construction, for the owners of the land, and the stockpile area is also remaining with the excess project material, as the developer proposes to utilise it within his facilities. The hardstand area for the buildings requires remediation, which will be done progressively towards the end of the project. No other temporary features are to be installed for the project.

As per pre-construction site concept plan. Stockpiling provisions as per King and Campbell Temporary Stockpiling Report - (King and Campbell, 2014) |
| | | | TOTAL | 44 | |

Management and Governance Scorecard

Subcategory	Reference	Max. Points	Achievement Level	Points Awarded	Comments
Planning and Procurement - *Commitment*	MAN-1	10	Non Achieving	0	The project procurement plan and other project documents do not include defined sustainability targets. As per RMD Procurement Procedure - Procedure CF-07 - (RMD, 2014b) As per RMD Procurement Strategy - Procedure CF-08 - (RMD, 2014c) As per RMD Procurement Plan - RMD Form-950 - (RMD, 2014a)
Panning and Procurement - *Tender Assessment*	MAN-2	5	Achieving	1	The RMD system involves a pre-engagement process for all suppliers and subcontractors, which requires evidence of all management systems. This includes environmental, quality, safety as well as note that contractors must adhere to RMS policy with regard to noise, chain of responsibility for deliveries and using public roads plus more. The tender process does not specifically call for contractors to define if they have a sustainability strategy or management plan of any kind, which is an area for improvement. As per RMD Contractor Pre-Engagement Process - RMD Form-901 - (RMD, 2015c) As per RMD Contractor Management Procedure - OCP-04 - (RMD, 2015b)
Planning and Procurement - *Suppliers and Manufacturers*	MAN-3	12	Non Achieving	0	No assessment of the suppliers and manufacturers was conducted; hence no rating could be implemented for this performance objective.

165

Category	Code	Score	Description	Status	Value
Planning and Procurement - *Management Plans*	MAN-4	5	The major suppliers tend to implement more refined management plans and concern, whereas the smaller subcontractors rarely had sufficient systems in place. This would result in the less equipped contractors being inducted to RMS systems in order to ensure the processes and work methods are to a suitable standard. For the RMS side of things, all management plans are approved prior to commencement of construction work. Refer to RMD Business Plans for Safety, Quality and Environment - (RMD, 2010b; RMD, 2010c; RMD, 2010e)	Improving	6
Management - *Commitment*	MAN-5	0	The project team has not identified any sustainability targets for the construction works.	Non Achieving	14
Management - *Responsibility*	MAN-6	0	The project structure does not identify any individuals responsible for sustainability monitoring and reporting. This lack of reporting is identified in the RMD systems, hence why not included in the project documents.	Non Achieving	8
Management - *Decision Making*	MAN-7	6	The project team has placed emphasis on ensuring the constructed facility is appropriate for the local users, especially for the school. Certain design changes were implemented to ensure the facility was safe and improved on the previous roadway. For example, the provision for safer movements into the school entrance was enabled by changing a 'left in', 'left out' movement, which would require U-turns by school buses; into an entrance that incorporated all turning movements that could be made in separate auxiliary lanes – a safer option in the long term. Most decisions, however were based around program due to significant weather delays early on. As per construction drawings - (Every & Shaw, 2014a)	Achieving	15
		12		TOTAL	

Ecology Scorecard

Subcategory	Reference	Max. Points	Achievement Level	Points Awarded	Comments
Ecology - *Revegetation*	ECOL-1	9	Achieving	4	The project design had minimal areas for landscape design, and hence had minimal revegetation works, which include grassed batters and shoulders and landscaped medians. Median plantings include three varieties of "Lomandra", a hardy, native plant as well as larger "Brachychiton Populneus" trees, also native, hardy and require low amounts of water. Refer to Appendix D for landscaping drawing.
Ecology - *Retaining Vegetation*	ECOL-2	6	Achieving	2	The land acquisition for the project was minimal and was primarily only grassed. There were no substantial or remnant vegetation areas within the project area, and where there were trees, they were not touched. As identified in ECOL-1, the project does include additional plantings in the final product, hence an improvement overall. For limit of construction works, refer to construction drawings - (Every & Shaw, 2014a) For land acquisition details, refer to Technical Design Report - (Every & Shaw, 2014b)
Ecology - *Aesthetic Value*	ECOL-3	5	Achieving	3	The chosen species do complement or improve the surrounding aesthetic value as well as being species that can grow in highly unfavourable soils and with little to no water, hence requiring little maintenance and ensuring durability. One potential issue in the future comes from the Brachychiton tree chosen, which is a semi deciduous tree that produces flowers and hence seeds. This may result in excessive leaf litter resulting in blocked drainage among other issues, which will require maintenance. As per construction drawings - (Every & Shaw, 2014a)
Ecology - *Ecologically Sensitive Sites*	ECOL-4	15	Improving	8	The project identified three sensitive sites, all outside of the project boundaries however nearby. The EEC to the south was the most likely to be impacted from construction activities as it is located downstream of the site and is where the majority of construction water flowed. Controls were implemented with this area in mind, to ensure no negative impacts. Site identified included: - White Stringybark - Tallowood Dry Sclerophyll Forest (Koala Habitat) - Swamp Oak Floodplain Forest (Endangered Ecological Community) - SEPP71 Coastal Land

Biodiversity - *Protection*	ECOL-5	14	Achieving	7	During the REF process, consultants were utilised to map the extent of the sensitive areas. Efforts made by the project team were to ensure no associated activities from the construction process would negatively impact the habitat or otherwise sensitive areas. Due to the scope of clearing works for the project, an achievement level higher than "Achieving" would not be possible as there are insufficient areas to conserve and enhance habitat.
Ecological Connectivity - *Disruption to Fauna and Flora*	ECOL-6	7	Achieving	7	Construction and clearing works were staged for the project. The broad project program involved clearing and construction of the eastern side of Ocean Drive as Stage 1, followed by some small areas of widening around the north west and south west sides of the intersection as Stage 2, widening along the entire length of the western side of Ocean Drive as Stage 3 and finally reconstruction of Houston Mitchell Drive as Stage 4. Due to the scope of clearing works for the project, an achievement level higher than "Achieving" would not be possible as there were only small areas of clearing that impacted minimal habitat.
Ecological Connectivity - *Habitat Fragmentation*	ECOL-7	15	Achieving	5	The road structure did not change from the existing to the current and hence no further discontinuity between the surrounding areas was imposed. Some design and construction choices were made to prevent issues with fauna passage, such as including plain wires for the bottom and top wire of boundary fencing to prevent animals becoming injured when either crossing under or jumping over the fencing. Due to the scope of clearing works for the project, an achievement level higher than "Achieving" would not be possible as there were only small areas of clearing that impacted minimal habitat.
			TOTAL	36	

Using Resources Scorecard

Subcategory	Reference	Max. Points	Achievement Level	Points Awarded	Comments
Resue and Recycling - *Topsoil*	RES-1	9	Exceeding	9	All topsoil stripped from the project was stockpiled for the duration, and progressively reused for revegetation works. Any remaining topsoil is to remain within the stockpile area for the land developers use. As the topsoil is not being transported offsite, there is a low net embodied energy in obtaining the material, which is sustainable and benefits the developer when the project's topsoil requirements are satisfied.
Reuse and Recycling - *Spoil*	RES-2	10	Exceeding	10	All Virgin Excavated Natural Material (VENM) or spoil excavated from the project was reused where possible within the construction activities such as for footpath construction, for the vegetated median and for batters. The remainder of the material is to remain onsite for the developer, who is to use the material for sporting fields for the school and planned subdivision. As the material is VENM and is not moving far from its origin, the disposal of the material in this way is the best possible outcome for the project – in terms of costs of disposal, energy used for transport and working with stakeholders. The final use of the material also has wider benefits for the community.

Other spoil material for the project that were 100% reused include; excavated road pavement materials (including spray seals and base gravels) and material won from the cutting. Excavated Road pavement materials were reused as select fill wherever required and the cutting material was either used as bridging rock, general fill or for batters etc. depending on the quality.

Refer to King and Campbell Temporary Stockpiling Report - (King and Campbell, 2014) |
| Reuse and Recycling - *General* | RES-3 | 11 | Achieving | 8 | Some examples of how the project has reused materials include: reusing rural fencing removed for construction activities on site for delineation and temporary fencing; reusing removed power poles for new installations by electrical contractor; and recycling crushed concrete components – such as existing kerb and guttering for use in general fills.

A level of "Achieving" is the recycled waste streams were only minor and hence did not significantly reduce or impact on imported materials for the project. |

Reuse and Recyling - *Initiatives*	RES-4	12	Improving	9	The project has a defined waste management plan, which outlines the predicted wastes and the required levels of tracking, the disposal requirements and the relevant procedures to follow when dealing with each type of waste. The plan does not however stipulate the targeted proportions of waste that must be recycled, reused or diverted from landfill. The plan does require quantities of waste to be tracked however. The waste tracking provides sufficient evidence that the targets of 95% of spoil and 90% of inert materials have been diverted from landfill. As per RMD Waste Minimisation and Management Plan - Form-421 (RMD, 2015d) As per RMD Waste Register - RMD Form-407 - (RMD, 2010d)
Reuse and Recycling - *Reducing*	RES-5	15	Improving	12	The project has implemented the use of a Polyfabrics Australia Geogrid, which is a specific geotextile used for subgrade treatment. As the adverse subgrade conditions were expected to create issues, the project has implemented this product to allow total earthworks thickness to be reduced. Rock bridging layers and stabilised select material zone layers were also implemented to mitigate against unsuitable foundation conditions and reduce layer thickness. The project made use of retaining the existing pavement in some areas, which would form the effective subgrade surface level. This meant that substantial excavation and disposal of waste materials was required, as well as minimising the quantity of material required to treat unsuitable foundations. The project implemented reuse of spoil and topsoil. As per Geotechnical Report - (Regional Geotechnical Solutions, 2014)
Material Procurement - *Balanced Design*	RES-6	13	Non Achieving	0	This criterion is non achieving due to the project location. As a reconstruction project, the project area only included a single cut to win material. Due to this, along with greater quantities of unsuitable material than expected, the project relied heavily on imported quarry materials.
Material Procurement - *Sustainable Sourcing*	RES-7	10	Non Achieving	0	The level 1 criteria for MAN-4 was not achieved, hence no achievement level can be awarded.

Category	Credit	Score	Status	Points	Notes
Material Procurement - *Energy Intensive Materials*	RES-8	13	Non Achieving	0	The project design utilises conventional materials, techniques and processes commonly available in the industry at the time of design and construction. The roundabout construction itself was a deep lift asphalt design, and the approach pavement included an asphalt wearing course, which could be an example of where the benefits of Warm Mix Asphalt of Hot Mix Asphalt could have been explored; concrete footpaths could have utilised alternatives; drainage design could have been revised to allow for polypropylene pipes to be used in lieu of concrete to save on energy used during installation.
Material Procurement - *Local Suppliers*	RES-9	9	Exceeding	9	Quarry materials for the project came from two local quarries. Heavily bound base gravel was from Pacific Blue Metals in Possum Brush – 83km away and all other gravels were obtained from Hanson Quarry at Sancrox – 17km away. Concrete was obtained from Hanson Concrete in Port Macquarie – 18km away. Most other materials and products were delivered from the Newcastle area, with precast pits and pipes the furthest a field, coming from Durham Drainage Products in Mulgrave – 400km. These all fall within the top category for local use. NOTE: These distances were taken from the ENVISION guidance manual – Section: RA1.4
Material Procurement - *Lifecycle Considerations*	RES-10	15	Non Achieving	0	No lifecycle analysis for the project has been considered.
Hazardous Materials - *Minimising*	RES-11	5	Achieving	5	The project utilised very minimal hazardous substances. Key construction choices such as utilising plant-mixed heavily bound gravels as opposed to mixing in-situ or onsite were made in order to reduce risk to workers and nearby receptors.
			TOTAL	62	

Water and Energy Scorecard

Subcategory	Reference	Max. Points	Achievement Level	Points Awarded	Comments
Water - *Management Plan*	W&E-1	7	Achieving	2	The Construction Environment Management Plan contains provisions for water and associated activities with potential for impacts. There is no identification of measures to reduce consumption or prevent wastage however. As per RMD Construction Environment Management Plan - Form-420 (RMD, 2015a) Refer to Review of Environmental Factors - (Every, 2014)
Water - *Tracking*	W&E-2	8	Non Achieving	0	The project has not implemented a water tracking plan on site. The largest use of water is for earthworks, both in dust suppression and maintaining adequate moisture content in materials during compaction, for which potable water was used during the project. Potable water was btained from town water supply, with abstraction point at the works depot, around 15km away.
Water - Reuse	W&E-3	9	Non Achieving	0	The project has not facilitated for collection of runoff or water from other sources (such as site building rooves) and hence, all water entering site is left to discharge freely through the implemented controls.
Energy and Carbon - *Embodied Energy*	W&E-4	15	Non Achieving	0	The project has made no requirement for the embodied energy of materials to be provided for significant suppliers. This would have been particularly beneficial for quarry material supply on this project.

Energy and Carbon - *Carbon Monitoring*	W&E-5	15	Non Achieving	0	The project has not implemented any plan to record and monitor energy use and emissions.
Energy and Carbon - *Consumption*	W&E-6	14	Achieving	4	A pugmill was utilised at the supplying quarry to produce the heavily bound base material. This was chosen for several reasons, including safety for workers and the public but with regards to this performance objective – energy and efficiency. By using the pugmill, a set quantity of moisture, additive and raw material is incorporated, brought to site and placed. The alternative was in-situ stabilisation, which requires additional plant – requiring additional power. The process would involve several passes for spreading the additive, several passes for mixing the additive, additional passes with the water tanker to ensure moisture is correct, potentially further mixing once again, all before compaction can commence resulting in a less energy efficient process.
			TOTAL	6	

Community and Quality of Life Scorecard

Subcategory	Reference	Max. Points	Achievement Level	Points Awarded	Comments
Stakeholder Participation - *Implications to Public*	COMM-1	4	Achieving	3	The public health and well-being have been considered in both design and construction. For example, twice a year there is an international ironman event in the local area, involving a triathlon style event for hundreds of athletes. The event makes use of the roadway, which was part of the project. The construction team required a risk analysis of the program and certain activities to ensure the road was in a suitable condition for the event. This required contingency planning, altered staging and community consultation to ensure the organisers of the event were aware of the conditions of the roadway prior to commencing the event.
Stakeholder Participation - *Community Concerns*	COMM-2	8	Exceeding	8	All sensitive receptors in the nearby community provided no complaints for the project work to date. The project has an identified communications plan and a communications register to manage any queries, complaints or ongoing concerns from any stakeholders. Project policies stipulate that all activities likely to raise negative impacts for nearby residents and community members must be taken through the RMS communications division, whom are responsible for ensuring the appropriate level of involvement is provided by the project team. The project has not identified a single member of the team to deal with all issues, rather the communications plan defines which team member is responsible for dealing with certain stakeholders. Refer to project communications plan Refer to project communications register - Form-113 (RMD, 2010a)
Stakeholder Participation - *Project Representative*	COMM-3	7	Achieving	4	The Project Engineer for the project was in charge of managing all community consultation. This was conducted when required, for example when changing work activities may impact resident, such as night works. The project documents do not identify specific community requirements.
Stakeholder Participation - *Local Firms*	COMM-4	6	Exceeding	6	RMD has in place different local panel contracts for services such as; surveying, arboriculture, utility locations, etc., which are in place specifically to engage local contractors in an attempt to reduce costs and improve efficiencies. For all other tender requirements, local suppliers were approached to identify any expression of interest in the works. This included quarry materials, concrete supply, electrical works, kerbing and footpath works etc. Materials and services were only procured non-locally when they were unavailable – such as precast concrete components and geotextiles.

Category	Code	Points	Rating	Score	Description
Liveable Communities - *Improved Amenity*	COMM-5	8	Improving	6	Community groups such as the members of the school were consulted to identify any concerns with how the roadway would affect there facility, which resulted in some changes during construction (such as revised design at the school entrance and staging of works to minimise disturbances during school terms by waiting until holiday periods. The level of service that the final roadway will provide is significantly improved for all users. Refer to Appendix D for updated construction drawing.
Liveable Communities - *Access and Mobility*	COMM-6	8	Exceeding	8	The project design and construction has included features such as pedestrian and cyclist facilities for the entire length, which provide a link between a lifestyle village and subdivision to the north, as well as access from planned, future subdivisions to the east and west of the project. The project has improved access for public transport services as well as including provision for a safe, permanent access for the future subdivision to be built on the adjacent land. As per construction drawings - (Every & Shaw, 2014a)
Important Sites - *Preservation*	COMM-7	15	Achieving	9	The project has been awarded a rating of "Achieving" as it was a project objective to preserve the visual amenity of the area, which is considered important by the local residents. A single memorial site was discovered to the south west of the project, within project boundaries but outside the limit of construction works. All efforts were employed to retain the memorial. No other significant sites were identified within the project boundaries.
Aesthetics - *Community Decisions*	COMM-8	8	Achieving	5	The community were engaged to some small extent prior to and during construction to ensure design choices were appropriate. The final choices could have included more community input.
Aesthetics - *Noise and Light Spill Mitigation*	COMM-9	10	N/A	-	This credit is not applicable as there were no required additional measures installed to combat the impacts of noise and light spill. The maximum score achievable is removed from the total score. The points are scoped out of the final total.
Aesthetics - *Local Products*	COMM-10	8	Non Achieving	0	The landscape and aesthetic design components of the project are minor and have not incorporated the local area into the choices.
			TOTAL	49	

175

Design Scorecard

Subcategory	Reference	Max. Points	Achievement Level	Points Awarded	Comments
Traffic Flow - *Improvements*	DES-1	8	Improving	4	The project design includes all of; additional travel lanes, auxiliary turning, acceleration and deceleration lanes as well as separated cyclist facilities. There has been planning for future population demands, however the project has only constructed facilities that are relevant to the current and design period demands. As per construction drawings - (Every & Shaw, 2014a)
Roadway and Traffic - *Access*	DES-2	9	Improving	5	The constructed facilities are substantially improved over the existing, no innovative solutions were employed or as identified in DES-1, the constructed facilities are only for the present demand.
Roadway and Traffic - *Safety*	DES-3	10	Achieving	4	The constructed roadway was completed to a higher class standard than what was existing, including improved wearing course, travel lane widths, signage, sight distance, separation and speed. As per pre-construction site concept plan.
Pavement - *Long Life*	DES-4	12	Achieving	4	The project design has incorporated a pavement structure that has a design life of 40 years, however the use of spray seals will result in several resprays in this timeframe along with probable regrading work. Asphalt wearing courses are a more durable solution, which will require at least one overlay or rehab but this would be considered non-major if there was no associated granular remediation. As per Geotechnical Report - (Regional Geotechnical Solutions, 2014)
Pavement - *Lifecycle*	DES-5	15	Non Achieving	0	The project design has had no direct initiatives to improve maintenance actions in the future.
Resilience - *Flooding Risk*	DES-6	10	Non Achieving	0	Additional resilience for the project was not considered for two reasons, being; that procedures do not call for additional provision or design changes to combat against an increase probability of occurrence, and that the area is not an area that is exposed to significant flooding risk.
Intelligent Transport Systems - *Implementation*	DES-7	15	Non Achieving	0	No provision for installation of any ITS features have been included.
			TOTAL	17	

Pollution Control Scorecard

Subcategory	Reference	Max. Points	Achievement Level	Points Awarded	Comments
Waste - *Pollution Plan*	POL-1	5	Achieving	3	The RMD waste management plan includes provision for all different types of wastes and the potential options for their disposal, reuse or recycling. The plan used for the project did not venture from the standard framework, hence no additional provisions for creative reuse, reporting on waste generated or waste separation was implemented. As per RMD Waste Minimisation and Management Plan - Form-421 (RMD, 2015d) As per RMD Waste Register - RMD Form-407 - (RMD, 2010d)
Waste - *Diversion from Landfill*	POL-2	10	Exceeding	10	Only minor amounts of municipal solid waste from mainly associated activities were sent to landfill, plus some amounts of mixed, unseparated other waste. The waste management plan and waste register identify the wastes transported to facilities for processing or landfill.
Emissions to Land, Water and Air - *Noise and Vibration*	POL-3	9	Achieving	5	Based on the provisions to promote efficient traffic flow through the intersection, as well as the use of Asphalt wearing courses, which are much quieter than coarse spray seals; the project has been awarded an "Achieving" level. No baseline monitoring was conducted for the project and there are no plans to carry out follow up noise measurement post construction completion.
Emissions to Land, Water and Air - Light Pollution	POL-4	9	Achieving	6	Additional street lighting has been provided along Ocean Drive as well as including street lighting along Houston Mitchell Drive, which was not present on the existing road. The nearest sensitive receptor is around 300m from the nearest streetlights and on another road itself. These are not expected to create any issues for residents. In terms of headlight spill, the project has not significantly changed the structure of the road geometry and hence, there is expected to be no negative impacts.

177

Category	Code		Status		Description
Emissions to Land, Water and Air - *Air Quality*	POL-5	10	Achieving	4	As the project team did not implement an air monitoring procedure for the construction works, a higher level than achieving cannot be awarded. The project team did implement air pollution preventative measures such as; wetting down haul roads and stockpiles to prevent dust; implementing a slag/lime blend for stabilisation works, which is denser than lime and hence less prone to becoming airborne; and regular plant servicing.
Emissions to Land, Water and Air - *Water Contamination*	POL-6	12	Improving	6	The project has identified sensitive sites and installed several water control devices at all discharge points for the project. These included measures such as topsoil bunds to direct water into localised collection points, sediment control fences, geofabric filter bunds, and velocity checks. All team members have been trained in spill response and emergency procedures during project inductions and there are several emergency kits for dealing with contamination released
Emissions to Land, Water and Air - *Emissions from Plant*	POL-7	11	Non Achieving	0	The project does not include any monitoring procedures for plant, and the choice of plant was based on already owning the assets required to conduct the works. Equipment is well maintained, however there was no influence from emissions in procuring alternate plant and equipment. The major plant utilised for construction works were principal owned items and hence no assessment was conducted on there efficiencies. Consideration for some minor items such as replacing diesel generators with solar powered was considered, however not regarded as feasible for the project.
Climate Change and Risk - *Renewable Energy*	POL-8	12	Non Achieving	0	The project has made no consideration for renewable energy or alternatively powered plant and equipment.
			TOTAL	34	

178

Custom Credit Scorecard

Subcategory	Reference	Max. Points	Achievement Level	Points Awarded	Comments
	CUST-1	5			
	CUST-2	5			
	CUST-3	5			
	CUST-4	5			
	CUST-5	5			
			TOTAL	0	