WorleyParsons

resources & energy

DEPARTMENT OF INFRASTRUCTURE AND REGIONAL DEVELOPMENT

Norfolk Island Roads Audit and Strategy Report

301015-03669 – REP-001

01 September 2015

Infrastructure
Level 12, 141 Walker Street,
North Sydney NSW 2060
Australia
Telephone: +61 2 8923-6866
Facsimile: +61 2 8923-6877
www.worleyparsons.com
ABN 61 001 279 812

WorleyParsons

resources & energy

DEPARTMENT OF INFRASTRUCTURE AND REGIONAL DEVELOPMENT
NORFOLK ISLAND ROADS AUDIT AND STRATEGY REPORT

SYNOPSIS

Disclaimer

This report has been prepared on behalf of and for the exclusive use of Department of Infrastructure and Regional Development, and is subject to and issued in accordance with the agreement between Department of Infrastructure and Regional Development and WorleyParsons. WorleyParsons accepts no liability or responsibility whatsoever for it in respect of any use of or reliance upon this report by any third party.

PROJECT 301015-03669 - NORFOLK ISLAND ROADS AUDIT AND STRATEGY REPORT

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
A	Issued for Client Review	H A Batt	W. Stalder/ R. Hogan	A. Gilham	29.06.2015	N/A	N/A
0	Issued for Use	G. Williams	A. Gilham	A. Gilham	01.09.2015		

CONTENTS

1 EXECUTIVE SUMMARY

In April 2015 the Department of Infrastructure and Regional Development (DoIRD) sought offers for a road infrastructure audit and development of a strategy to design and prioritise road infrastructure upgrades on Norfolk Island (NI).

Worley Parsons (WP) was awarded the work on 28th April 2015 and began work with a kick off meeting in Canberra on 30th April and the first of three visits to the island from 1st May. The Department's requirements are expressed in five objectives outlined in Section 4.

Findings at a glance:

- There are 78 km of paved roads on the island.
- Potholes are ubiquitous and a source of community and tourist frustration.
- 30 km of the roads are rated "Condition 2: Urgent attention needed".
- Cost to restore surface of all Condition 2 roads is in the order of $10-15m.
- Cost of initial roads upgrade program of 5 roads is $3.5-$5.5m.
- There are 12 bridges and major structures on the Island. Two are significantly deteriorated; the others are satisfactory with some ongoing maintenance.
- School precinct is recommended for study and then upgrade. Cost circa $500k.
- Footpath and associated works from Queen Elizabeth Avenue (QEA) to Burnt Pine is recommended for upgrade.
- Rock supply is adequate in the short term for roadworks, however there is a need for a new quarry to be opened in the medium term.
- Equipment is inadequate, with at least 3 critical items missing or unreliable.
- A roads experienced engineer is urgently required.

Condition reports for roads and structures can be found in Appendix A. The study has confirmed previous reports that indicate the Norfolk Island road infrastructure is in poor condition.

Regarding current hazardous situations, two issues are considered to be highest priority: the school precinct and the zone from the school to the town centre which includes the Taylors Road/ QEA intersection, a required all weather footpath/shared path from there into town, the QEA pavement and the Taylors Road pavement. Other less costly initiatives could include provision of more barriers or other devices in high drop-off locations, advisory signing, mirrors in areas of poor sight distance and raised reflective markers/line-marking.

Most **road foundations** have been built quite well, although a long time ago and, as a rule, do not show evidence of structural failure of the subgrade. Failures in the road surface are mainly caused by breakdown of the bitumen seal; however addressing the surface failures has been left so long it now requires reconstruction of the pavement layer immediately below.

Regarding structures, apart from (i) the Bay Street Bridge which was found to be in very poor condition and was closed by the Administration (ANI, Admin, the Administration of Norfolk Island) pending action and (ii) the heritage Bounty Bridge which should be closed to avoid the risk of further settlement due to traffic, other bridges and major culverts were found to be in reasonable condition.

Regarding strategy, a roads program is required: it would provide certainty thus allowing investment in essential equipment and would have a significant return on investment (value for money). The current crisis management approach costs many times the cost of arresting the decline.

Design standards and methods are required and must be appropriate for the Norfolk Island situation. This report recommends design standards and provides some comment on current methods however development of new or improved methods requires trials, testing and adaptation to local circumstances. The suggested design standards should only be applied to new works and then with considerable judgement. Design is always about balance and requires compromise. There is general agreement the country lanes aspect is a very important guiding principle and it will continue to be a significant influence on the application of design standards and methods.

Intervention criteria for maintenance are not defined so it is difficult to pre-determine what potholes, drainage, signposting, barriers and so on will be addressed first and why.

Regarding specifications, an Admin General Specification exists for use by contractors but it has no technical information for roadworks, simply referring to “in accordance with the drawings”; however there are no drawings for works currently being carried out by Admin. Experience and judgement are needed in deciding what specifications to use and how to interpret them for a given situation.

All materials for road infrastructure works are imported with the exception of crushed rock. If the potential sources of not-yet-quarried rock that are currently the subject of debate were to be quarried there would be more than enough rock to deal with all road condition problems on the island as well as Cascade Pier and the Airport resheeting works that must take place by about 2020.

There is perhaps a surprising amount of **road construction and maintenance equipment** on the island however much of it is old and unreliable.

Regarding **human resources** the most glaring gap is the absence of a roads-experienced engineer. A very small crew of Admin people is engaged in roadworks. They need specifications, guidance and training. It has been reported there is a significant number of people who have left the island, taking with them a reasonable skill level in roadworks who would be keen to return to the island if and when work was available. A number of on island contractors have quite good knowledge of some aspects of road engineering but would need strong independent client supervision.

An alternative course would be to bring in external contractors which could be expected to be of similar cost, would allow a faster start to significant works and could be scaled according to funding however it is not so obvious that it would leave a legacy of experience amongst the island people.

Note - since drafting this report the Commonwealth government has amended the Norfolk Island Act 1979. The report has not been modified to reflect any changes that have or will occur as a result of the amendment.

2 BACKGROUND TO THE STUDY

Norfolk Island is a small Australian external territory of 34.5 square kilometres located in the South Pacific. It is remote, being 1,471 kilometres from Brisbane, 1,673 kilometres from Sydney, 1,074 kilometres from Auckland and 934 kilometres from Noumea, in the French territory of New Caledonia. The Territory of Norfolk Island comprises three major islands: Norfolk Island, Philip Island, and Nepean Island. Only Norfolk Island is settled.

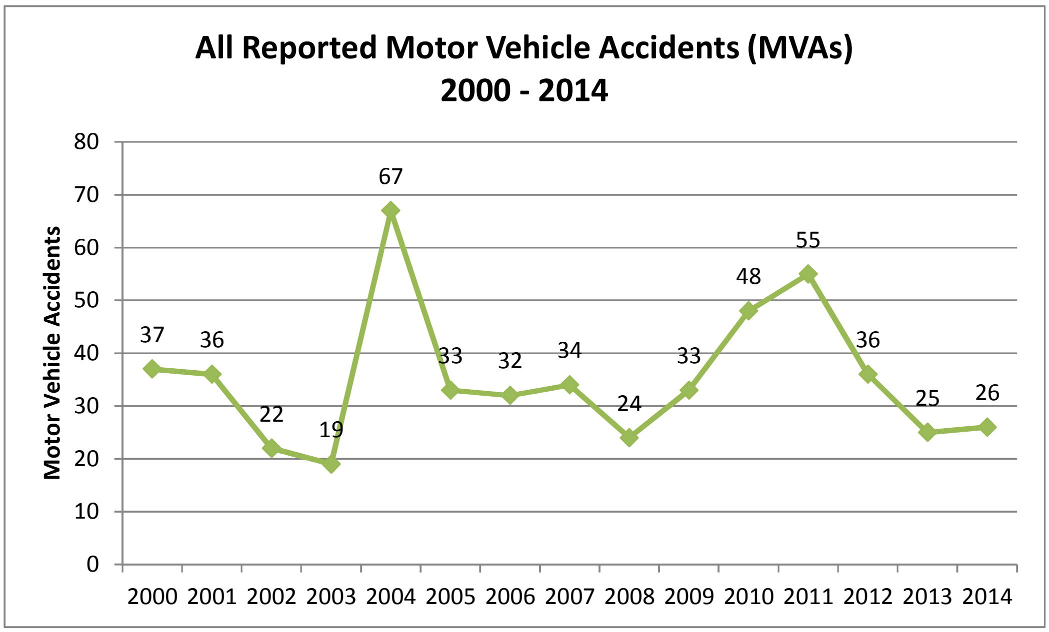
In 2014, Norfolk Island's residential population was estimated to be about 1,300. It continues to decline as family members leave for Australia and New Zealand for employment and education (Joint Standing Committee on the National Capital and External Territories, 2014). At any one time, there may be an additional 700 tourists visiting the island.

Norfolk Island has a unique history for Australian jurisdictions. In brief, there was discontinuous settlement of the island, by Pacific Islanders probably over the period 1,000-1,500 AD, and several British settlements in 1788-1814, 1825-1855, and from 1856. Of these, the Second Settlement, 1825-1855, left a lasting legacy of substantial infrastructure, such as public buildings, but also roads, jetties and bridges. Norfolk Island became a territory administered by Australia in 1913. Norfolk Island experienced major change and development during World War 2, when up to 2,000 New Zealand troops were garrisoned on the island, an airfield was constructed, and existing roads were widened and re-built.

The most recent GIS information provided by the Norfolk Island Administration indicates that there are 78 kilometres of paved roads. This figure excludes unformed roads, private roads and property accesses. Previous estimates were 67 kilometres of urban and rural roads (Asset Technologies Pacific, 2005), and 121 km of roads, comprising 90 kilometres of paved roads and 31 kilometres of unpaved roads (Faulkes, 2014). The study team did not try to reconcile these figures but did make sure they covered all roads except a few "very minor" roads (see Appendix A).

As at October 2013, there were 2,365 vehicles registered on Norfolk Island, and a further 564 unregistered motor vehicles. The minimum age for driver licensing on Norfolk Island is 15 years for a motorcycle rider licence (with a maximum engine capacity 185cc), and 15 years 9 months for a learner driver licence to drive a car. The permissible blood alcohol concentration for Norfolk Island drivers is 0.08% (0.08 grams per 100 millilitres of blood) for full licence holders and 0.00% (zero) for novice licence holders. The speed limits for roads on the island are low: a maximum speed of 50 km/h in the rural areas, 40 km/h in Burnt Pine, 30 km/h near the school at Middlegate and along the Kingston foreshore, 30 km/h in the Norfolk Island National Park, and 10 km/h within the carpark at the airport. All livestock roaming the roads have the right of way. As with the other Australian jurisdictions and in New Zealand, driving is on the left hand side of the road. There is a cultural tradition for drivers to wave to all approaching vehicles, and often to pedestrians at the roadside (the "Norfolk wave"). Currently, there is no formal public transport provision on the island. A taxi service is available, and a free shuttle bus is available to most accommodation providers on the island. Provision of a shuttle bus can be applied as a condition of approval for major community events. There are no railways, waterways, ports or harbours on the island. Jetties are located at Kingston and Cascade to support lighterage to ships offshore, usually transferring cargo. But on occasion, passengers are also transferred ashore for day trips from visiting cruise ships. This means that when ships are visiting the island there is an increase in heavy vehicle movements, either on Taylors Road and into Burnt Pine if the lighter service is operating from Kingston, or on Cascade Road through Middlegate and thence Queen Elizabeth Avenue into Burnt Pine.

Accident statistics for the island are of limited reliability, as many accidents are not reported to the police however in 2014 the total number of motor vehicle collisions reported numbered 26. Of this 5 were classified as serious (i.e. involving injury and/or death). As shown in the below graph there has been a reduction in the number of reported accidents in recent years and the NI Police Force have stated that they are confident that the implementation of a unified road safety strategy would see further significant reductions.



The development of a road safety strategy for Norfolk Island (Faulks, 2014) provided an opportunity for integrated re-appraisal of the island's road transport. The report found that the provision of safer roads was an important issue for Norfolk Island. A wide variety of issues relating to roads and roadside infrastructure were identified, including

- "The provision of signage, lane markings, and installation of roadside barriers at high drop situations and for the protection of vulnerable venue and historical sites;
- The presence of stock hazard on roads, including cattle using the commons for pasture as well as horse riders and horse-drawn vehicles used for tourism, as well as stock grazing or moving along paths on high roadside embankments;
- The widespread frequency of drivers encountering blind spots within the road transport system, resulting from the "country lanes" aspect of Norfolk Island roads;
- The location of a number of black spots associated with road crashes and near-miss incidents (typically locations associated with road segments where there have been enhancements to the road infrastructure such as improved pavements, wider road width, improved lines of sight, where drivers can achieve higher and often illegal speeds);

- The presence of hazardous roadside infrastructure, including power poles, transformers, etc., as well as Norfolk pines and other vegetation;
- Issues associated with road pavement quality and compliance with other road standards." (pp. 23-24)

The strategy also proposed that any future actions to ensure safer roads on Norfolk Island must consider preserving the "country lanes" aspect of Norfolk Island roads where the road itself is "self enforcing" for low vehicle speeds, while improving the roads to reflect Australian standards. It noted a danger is that improving road aspects such as lines of sight, removing roadside structures and vegetation and improving pavements can create an environment that is perceived by drivers as supportive of driving at higher speeds. Mission Road and Collins Head Road, both locations of fatal road crashes, present as higher speed roads. The "country lanes" aspect of Norfolk Island roads also provides a charming and positive tourist experience.

A concurrent inquiry into future economic development of Norfolk Island by the Joint Standing Committee on the National Capital and External Territories (JSCNCET) recognised that there was, in particular, a strong case for investment in the road transport infrastructure on Norfolk Island. The Committee recommended:

Recommendation 5

The JSCNCET recommends that the Commonwealth Government ensure that, as part of the new governance arrangements, the public road infrastructure on Norfolk Island is assessed against current Australia-wide design, building and engineering standards and, where needed, work is undertaken to remedy deficiencies. (pp. xv-xvi)

3 NORFOLK ISLAND ADMINISTRATIVE FRAMEWORK

Norfolk Island is an integral part of the Commonwealth of Australia, and has no international status independent of Australia (Faulks, 2014). The Norfolk Island administrative framework is undergoing a significant, if not seismic, change.

The island was established as a self-governing territory by the Norfolk Island Act 1979 (Commonwealth), and under the Act the Norfolk Island Legislative Assembly has wide-ranging powers to make laws, including road transport law and criminal law. In 2010, the Federal Parliament amended the Act to improve Norfolk Island's governance arrangements, reform its electoral system and implement a contemporary financial management framework. The amendments extended Commonwealth administrative law to Norfolk Island.

An inquiry by the Joint Standing Committee on the National Capital and External Territories in 2014 concluded that the current administrative arrangements were no longer tenable. The Committee recommended

“that, as soon as practicable, the Commonwealth Government repeal the Norfolk Island Act 1979 (Cth) and establish an interim administration, to assist the transition to a local government type body, determined in line with the community’s needs and aspirations. This will require the development of a new legislative framework.”

The Commonwealth Government is implementing a new policy to better integrate Norfolk Island with Australian institutions.

Norfolk Island Map (Source: Google Maps 2015)

4 ROAD STUDY OBJECTIVES AND METHODOLOGY

Early in the project the following study objectives were agreed with DoIRD:

1. Assess the condition of road infrastructure and requirements to maintain, improve and augment.
2. Identify hazards and risks and works required to address risks; prioritise.
3. Assess standards and methodologies used locally for road infrastructure design, construction and maintenance, suggesting areas for improvement.
4. Identify local resources including materials equipment and labour highlighting gaps now and in the future together with other potential sources of resources.
5. Develop a strategy with indicative costs targeting high-risk areas and maintenance.

Further to the five study objectives, guiding principles for the study methodology were developed as follows:

i. Leverage from existing knowledge,
ii. Audit and analyse and form our own views and do not rely on anecdotal evidence,
iii. Independently verify the reliability of data,
iv. Determine and address gaps by obtaining new information and
v. Develop a strategy for the short, medium and long-term maintenance and improvement of the road system.

A sixth guiding principle emerged and appears to have unanimous support:

vi. Attribute high importance to the “country lanes aspect” in contrast to a rigid application of designed road safety, aiming for a “harmonised” approach.

4.1 Generic Hazards and Risks Identification

Contract award for this study was on 28th of April 2015. To ensure a fast running start should WorleyParsons be successful, an internal team kick off meeting was planned for 29th of April and airline tickets and accommodation were tentatively booked from May 1st.

On 29th April, as part of the internal team kick off meeting a hazards, vulnerabilities and risk meeting was held. The outcomes helped to guide early days of the study and were refined throughout the time of the study. The developed table of hazards and associated risks appears below. Specific risks were tested and refined at the Risk Workshop (reported in Appendices B1 and B2) which was held on 27th May during the second site visit.

Table 4.1: Generic Hazards and Risks

Hazard	Description of risks.
Cows on road and adjacent in road reserve	Difficult to see at night - not a huge risk in daylight hours. Report of a cow landing on a car, after coming off a cutting adjacent to the road.
Pot holes	Vehicles can encounter large pot holes in the wheel path, causing drivers to swerve to miss the hazards, with potential risk of head-on collisions. Ambulance Superintendent made the point that potholes make journey times to the hospital very long when carrying passengers. Filled potholes using current methods create a very bumpy road however this can serve to reduce risk ("self enforcing") of drivers going too fast for general road alignment and conditions.
Improved roads considerably better than the general adjacent road network	Drivers take the (limited) opportunity to drive too fast, above the posted speed limit on roads with improved alignment and surface condition risking crashes. Risk of over estimating the safety of the road.
Overhanging tree branches. Tree branches on road not cleaned off.	Potential damage to vehicles, reduced sight distances. Drivers may swerve to avoid branches, thus risking a crash
Steep high drop offs, adjacent to roads	Potential for vehicles to go over embankments or cliffs – large consequences.
Lack of shoulders and table drains, adjacent to bitumen sealed roads. Embankments are often present.	Narrow roads with minimal shoulders make it difficult to pull off in safety. Roads without table drains have inadequate surface drainage and consequently a reduced life. Where the verge is above the pavement level the road acts as a drain risking drivers swerving to avoid water on road.
Limited sight distances, at intersections	Potential collisions.
Limited sight distances, on horizontal curves	Potential for collisions with oncoming vehicles or objects on road (e.g. cows).
Limited sight distances, on vertical curves	Potential for collisions with oncoming vehicles or objects in road (e.g. cows).
Unseen footpath hazards (unconstructed footpaths)	Potential for pedestrian falls; and vehicles running into pedestrians, because pedestrians choose to walk on the road where-ever footpaths are not constructed or are in poor condition.

Hazard	Description of risks.
Difficult to see road edge	Potential for vehicles to leave the road, and collide with street furniture or worse.
Bridges and other structures with low structural capacity	Potential collapse – could be catastrophic
Slippery roads, when wet	Drivers at risk of being unable to negotiate slippery incline on unsealed roads. Instances of vehicles being abandoned until conditions improve.
Bikes and loose stones on roads	Potential accidents due to loss of traction
Utility poles close to road edge	Potential impacts between vehicles and poles.
Steep grassed batters adjacent to roads – inadequate footpaths	Dangerous to walk on. If pedestrians choose not to use these cuttings, they invariably walk on the road.
Road Safety issues around the school (in general)	Interaction between cars and students in drop-off zones outside schools is always a risk unless all people are vigilant, educated and the areas are well signed and supervised.
Non frangible hazards near road edge.	Collision between errant vehicle that hasn't had time to recover and non-frangible objects (e.g. trees, power poles, sign posts, headwalls).

On 30^{h} April a project kick off meeting was held with Department of Infrastructure and Regional Development. DoIRD subsequently issued notes of the meeting. Soon after this meeting the wording of the five study objectives were agreed.

4.2 Methodology – Island Visits 1, 2 and 3

The study team visited the island on three occasions. The issues to be considered were all on-island and many of the solutions and strategies to be suggested would also come from island information (apart from research into methods, standards and the like for comparable situations in other places) so it was planned from the beginning that the methodology would centre on WP study team visits to the island.

Most activity by the WP study team involved research and analysis in preparation for the visits, activity on the visits themselves, analysing information gathered and other outcomes.

Therefore it is easiest to understand the study methodology by considering it in terms of the three site visits as explained below.

4.2.1 First Visit 1st to 8th May 2015 Relationships and Information

At the first visit the team began to build working relationships with key players in the Norfolk Island Government, Administration and with the police, Road Safety Committee and the Works Manager, amongst others. Appendix E shows the people and groups consulted throughout the study.

The team was able to obtain a large amount of relevant and significant information during the first visit. Appendix F shows the reports and the references for the study.

A significant "find" during the first visit was the existence of the road conditions study undertaken in 2005 [Ref 4]. The 2005 report was an asset management approach, which was not the approach to be taken for this study however its findings were of great value to this study. The report contains tabulation of road condition including bridges and major drainage structures as they were in 2005.

4.2.2 Second Visit 21st to 29 May Site Assessment, Verification and Targeted Information

After the first island visit the team spent two weeks collating information, analysing, drawing some tentative conclusions (which would require on-site verification), identifying gaps in information and planning for a second visit to the island.

At the second site visit the team took the following approach:

Objectives 1 and 2, (road infrastructure condition, hazards and risks) were addressed by a sub-team consisting of a structural and civil engineer who visited all the bridges and significant major drainage structures and roads, assessing each using the condition classification system that was used in 2005. Appendix A contains a table showing the 2005 condition, 2015 condition and comments together with recommendations regarding the structures.

Objectives 3, 4 and 5 (standards, methods, resources and strategies) had been extensively researched and considered prior to the second island visit and were dealt with on-island by a senior civil engineer with extensive road experience and the WP Project Manager who also has extensive experience in road design, construction and maintenance.

To assist in addressing Objectives 2 and 5 a Risk Identification and Preliminary Rating Workshop (see Appendices B1 and B2) was held on-island during the second visit with 10 invited stakeholders including members of the Road Safety Committee. Prior to the second visit a list of 29 risk areas had been identified through interviews, on-site inspections, literature searches and analysis. A Briefing Paper was prepared and issued to all participants. The workshop was an important input (but not the only input) for addressing Objective 2.

The Briefing Paper and a Workshop Report can be found in Appendices B1 and B2 respectively and are summarized below:

- All participants confirmed they had received the Briefing Paper including the list of 29 pre-identified risk areas.
- The five study objectives were introduced.
- The “Country Lanes Aspect” was unanimously confirmed as “very important”. It was explained this is a key criterion in deciding how to address the standards and methods that would be applied to treat problems with road infrastructure condition and risk areas.
- Four suggested assessment criteria were considered and agreed to.
- The pre-identified 29 areas were agreed to and further 4 were added making a total of 33 risk areas to be considered
- The participants confirmed they felt they were able to rate the 33 risks areas using a simplified system assigning a number 1, 2or 3 as described in the Briefing Paper. It was pointed out the simplified approach is different to an approach involving separately considering likelihood and consequence and then combining these into a risk rating. The meeting was comfortable to proceed with the simplified approach in this case.
- A GIS database with photographs was used to illustrate and remind participants of the pre-identified risk areas.
- Participants wrote handwritten comments regarding the list of risk areas. It was explained that this was an opportunity to provide more information to the team in addition to the simple rating and allocation of assessment criteria. Participants handed in their hand written comments, which were examined later by the WP study team and taken into account.
- Risk areas were “voted on” according to the rating scheme by placing coloured stickers on a wall map. Two risk areas in particular stood out as rated highest by the stakeholder workshop namely:
    - The school precinct and
    - Intersection of Queen Elizabeth Avenue and Taylors Road.
- Nine sites for potential treatment with barriers were identified. It was explained that consistency of approach is particularly important for barrier treatments not only for aesthetic reasons but to avoid drivers having a false sense of safety in some situations. These sites and possibly others need a separate holistic strategic study.
- The following day the WP study team applied a weighting system and held its own workshop, finding they generally agreed with the outcomes of the workshop. They also met later that day as pre-arranged with the chair of the Road Safety Committee and the Works Manager to discuss possible solutions for identified risk areas.

4.2.3 Third Visit 15th to 19th June – Verification, Validation and Refining

The purposes of the third visit were to verify the accuracy of some of the information provided, fill any remaining information gaps, carry out a sanity check of conclusions drawn and validate the report on-site against the proposal submitted by WorleyParsons and the 5 objectives that had been agreed with DoIRD.

5 OUTCOMES INCLUDING RECOMMENDED STRATEGIES

5.1 Condition Assessment (Objective 1)

5.1.1 Roads

Appendix A contains Table A1.1, which shows the roads that were assessed by the WP study team. All roads except some minor locally owned, unformed roads and National Park roads were assessed.

Appendix A shows the road condition classification system and it reports that 29 roads were rated Condition 2 (the lowest possible rating without the road being virtually unusable). A further 38 roads were rated Condition 3.

The study team agreed with a large body of opinion that the road network is in poor condition. It is assessed that many roads are on the brink of accelerated deterioration and the situation will become worse in the not too distant future unless focus is shifted and funds are provided to address roads that are about to fail significantly. Section 5.5.1 of this report recommends a strategy for a program of roadworks to address the worst condition roads.

5.1.2 Bridges and Major Drainage Structures

Appendix A also contains a report on every bridge and major drainage structure. One bridge (Bay Street Bridge) was found to be in poor and indeterminate condition and has been closed by the Administration of Norfolk Island pending a decision on what action to take.

Apart from the Bay Street Bridge and the heritage Bounty Bridge (which is recommended should be closed to traffic to lessen the risk of further settlement), other bridges and major culverts were found to be in reasonable condition but requiring ongoing maintenance actions.

5.2 Hazards and risks (Objective 2)

5.2.1 Two Highest Priority Issues

5.2.1.1 THE SCHOOL PRECINCT

At the on-island stakeholder workshop held 27th May 2015 (see Appendices B1 and B2) concerns regarding the school precinct were rated higher than any other.

The 2010 Middlegate Intersection Traffic Study by South Pacific Planning and Projects [Ref 20] identified the school intersection as the third busiest on Norfolk Island. The study considered options and recommended a roundabout. The report states:

The key objectives and goals for improvements to the intersection are:

Safety;

- To slow vehicular traffic;
- To improve pedestrian and bike access; especially to the School;
- To consider parking and pedestrian access in immediate vicinity of the intersection;
- To better identify and define areas for parking and pedestrian areas;
- To consider heavy vehicles – lighterage vehicles accessing Cascade; Island Industries and Block Factory vehicles, tour buses, school buses.
- To consider the broad environment: vehicular

The community has reported to the WP study team that in addition to improvements to the intersection it has in mind provision of additional off street parking next to the preschool in Middlegate Road. This initiative would require some changes to pedestrian crossings.

The school's Youth Assembly has also provided details of a proposal that was first raised approximately 12 years ago and looks at re-directing Collins Head Road around the intersection.

This study recommends high-priority be given to resolving the issues in the school precinct. A roundabout and the suggested off street parking might well be the appropriate responses. However it is recommended these two initiatives and any others be revisited in a brief study that updates the 2010 report and includes all relevant factors including pedestrian/cycle/scooter movements and the role the intersection plays in the road network for commercial activity including freight movement. It is understood there may not necessarily be community ownership of the idea of providing parking on the other side of the intersection so the recommended study should explore the expectations of those using, visiting and passing through the school precinct.

School Precinct Intersection looking north from Middlegate Road

5.2.1.2 THE INTERSECTION TAYLORS ROAD/QEA (AND ASSOCIATED WORKS)

The 2010 report referenced above stated this intersection was first or second busiest on the island. There are problems with sight distance for motorists approaching the intersection along Queen Elizabeth Avenue (QEA) and although a stop sign is provided on the QEA leg, its presence is not obvious to motorists approaching from Taylors Road. This is mainly a problem for tourists however it creates frustrations for the locals who are tempted to drive dangerously around them. Motorists coming from Burnt Pine and turning left through the intersection are observed to drive well in excess of a safe speed. A driveway access to a business is located very close to the intersection and creates a risk of rear-end crashes as people queue to cross the line of traffic to enter the business. The footpath is unformed and narrow as it turns the corner from QEA and heads toward Burnt Pine. The footpath in this vicinity as well as a small part of the intersection is built on privately owned land.

The intersection, including the footpath was rated second only to the school precinct by the stakeholder workshop and the WP study team agrees it should be given high-priority.

The intersection should be redesigned and upgraded. It is preferable but not essential to acquire the small portion of land on the northern corner.

When determining a program of works for this intersection there is a strong case to be made for providing a paved footpath linking the existing footpath on QEA (which stops approximately 15m short of the intersection) to the town centre. This was rated 4th by the stakeholder workshop. The community strongly support the provision of the footpath and have already begun fund raising to pay for the construction.

In addition to the intersection and footpath the pavement condition between the school and along Taylors Road to The Village Place is in poor condition. Consideration should be given to reconstructing the pavement as part of the same project.

Intersection of Taylors Road and QEA looking east towards QEA

5.2.2 Other Situations of High Priority

Given the past lack of attention to road infrastructure it is not surprising there are issues all over the island of varying urgency and importance. This section of the report discusses those that are considered by the WP study team to be "the next level down" from the two risk situations discussed above or are considered high value for money (relatively low cost and not of grossly disproportionate cost). As noted above appendices B1 and B2 have information concerning a risk workshop held with stakeholders on-island on 27th of May where a list of 33 issues were considered.

5.2.2.1 PANORAMIC PARKING

At the Panorama Seaside Apartments on Middlegate Road vehicles park at 90° or 45° to the road centreline, sometimes with the rear facing uphill, having crossed the centreline to enter the parking area. The dangers and inconvenience created by these practices were rated as number 3 by the stakeholder workshop and the WP study team agrees this area should be given high priority.

Middlegate Road is used for freight and the WP study team was told trucks carrying lighters for unloading ships cannot safely negotiate that section of road when parked vehicles are partially blocking the road.

It is recommended vehicles only be permitted to park parallel and it be made illegal to enter the parking area by crossing the centre of the road when heading downhill to the south: a left in left out from the south should be required.

It is not recommended the road be widened or straightened in this area.

Angled parking outside Panorama Apartments on Middlegate Road

5.2.2.2 BARRIERS

Previous reports have mentioned the high drop off areas around the island and the need to consider increased use of barriers (or other means of deflecting or stopping errant vehicles). This issue was canvassed at the stakeholder risk workshop 27th May where 9 areas in particular were identified (see Appendix B2). The workshop report points out that there are hundreds of other areas that pose some degree of risk. A strategy needs to be developed to carefully identify locations that require barriers; it is possible to create a false sense of safety especially when barriers are not erected in certain locations but they are provided in apparently similar locations. The type of barrier also needs to be investigated to ensure appropriateness and consistency.

Safety Barriers in need of replacement on Prince Philip Drive Barriers

5.2.3 Some "Minor" Works With High Value for Money

Where funds permit there are a number of works that could be carried out that are consistent with the country lanes aspect and would increase safety without disproportionate cost. These include:

- Domed convex mirrors in places of limited sight distance.
- Provision of raised pavement markers in the centre of sealed sections of road (without "legally defining" these as a formal centreline because to do so introduces enforcement issues when for example it is necessary to move around a cow that prefers not to move).
- Greater use of line-marking (purchase of a walk-behind line marking machine is recommended).
- Greater use of advisory signage.
- Utility poles in future be required to be placed well clear of the roadway where cost is not grossly disproportionate.
- Relocating intersection stop lines closer to the edge of the through lane carriageway and removing 'silent cops'

5.2.4 Roads Programme – Suggestion to Reconstruct Base Layer and Reseal

Arresting the rapid decline of oxidised and cracking seals throughout the island's roads would prevent a number of areas from becoming of much higher maintenance burden, risk and inconvenience in the not too distant future. This is a significant and growing issue for the island's road infrastructure network and is developed further in Section 5.5.1 and the appendices.

5.2.5 Taylors Road "Downhill Curves"

The locals often refer to the curves on Taylors Road between Queen Elizabeth Avenue and Country Road as the Taylors Road downhill curves. Sight distance is as low as 15 metres in places. Notwithstanding this, and in light of the country lanes aspect guiding principle, the on-island workshop on 27th of May 2015 and the WP study team's own deliberations did not attribute the highest significance to this area. It was rated by the stakeholders only seventh in order of issues of concern. It received no number one priority "votes" at the workshop and it did not receive a large number of second priority votes. Discussions with the police indicate they believe the road is "self regulating" with regards to speed.

It is mentioned here because it has been suggested by some that the road in this area be widened and possibly straightened to some degree in the belief this would make it much safer for pedestrians and cyclists. The suggested improvements to alignment and road width could increase (illegal) traffic speed by 50% to perhaps 70 or 80 km/h in which case an unprotected struck pedestrian would be at a far higher risk of severe injuries and death than at present. That risk would in turn probably lead to the need for immovable concrete barriers to protect pedestrians which would require even greater widening and not be consistent with the country lane aspect.

Measures such as domed convex mirrors and greater use of raised pavement markers and line marking are recommended and if installed their success in reducing risk should be monitored. If the objective of the suggested widening and straightening is to significantly improve pedestrian and cycle access for substantially increased pedestrian and cyclists numbers from Burnt Pine to and from KAVHA, a separate study is suggested with this objective in mind. It should consider the age profile and mobility of potential users and investigate alternative possibilities such as the use of Middlegate Road and a footpath or shared path route that does not necessarily follow a road reserve all of the way.

Taylors Road "Downhill Curves"

5.3 Standards and Methodologies for Design, Construction and Maintenance (Objective 3)

5.3.1 A Road Classification System

All roads have their own specific requirements depending on the role they are expected to play in the network as follows:

- **Town roads (within Burnt Pine)** - these have a higher traffic usage. Issues include higher pedestrian traffic, greater screwing forces on pavements particularly around the roundabout, the prevalence of sometimes elderly tourists inexperienced in their hire vehicles and with infrequent recent driving experience, 40 km/h speed limit which anecdotal evidence suggests locals in particular seem to have less regard for as they approach the cattle grids and the greater inconvenience and safety risk caused by the prevalence of potholes.
- **Commercial roads** outside the town area that are used for hauling freight and other industrial activity usually from Kingston and Cascade piers toward Burnt Pine. These roads are narrow in places and need special consideration from the point of view of sight distance and uncontrolled, often irresponsible parking (particularly by tourists). The team was told there are no parking laws on the island that would make such parking practices illegal. Trucks can experience a need to brake suddenly and therefore lose momentum and at times they find they can't fit the width of their vehicle around indiscriminately parked/stopped cars without moving across the centre of the road and risking a crash.
- **Rural residential streets**, which are typically short and often dead-ended with very few users and low traffic speed.
- **Rural roads (which are also "rural tourist roads")** making up the remainder of the network. Drivers on these roads can be inattentive to hazards, tempted to drive faster because of the open countryside feel and the relatively few other road users. Risks can be amplified at or near dark particularly because of the dark night sky.

Deciding which roads fall into which categories requires local knowledge as to current usage and knowledge of future planning for the island. Categorisation of roads could be helpful in deciding funding strategies. In this regard it is noted that a suggestion has been made (and has merit) that a route from the tourist area of KAVHA to the Captain Cook Memorial tourist destination via Anson Bay Road could perhaps be given its own category.

5.3.2 Design Standards

Recommendations as to appropriate Norfolk Island road design standards together with a discussion regarding the sources that have been drawn on appear in Appendix C1. It should be noted all standards need to be appropriately applied by professional designers who understand the basis of the standard and implications for adapting it. This adaptation includes how and when to take into account the "country lane aspect". Road design is a specific design specialisation and needs to be applied intelligently and appropriately.

5.3.3 Construction Standards and Methods

A discussion regarding road construction specifications and methods appears in Appendix C2. See also Section 5.5.1 regarding a strategy and method for design of possible reconstruction works for the top 50 or 100 mm of existing roads.

In summary, there are no formalised specifications, drawings or methods currently used for construction purposes by the Admin workforce. The ANI's Development Control Plan (DCP) for subdivision construction has some information but this is not sufficient or appropriate for construction of public roads. Works involving external consultants (such as Mount Pitt Road constructed for National Parks in 2003) would use appropriate specifications but as a rule literal interpretation of mainland specifications to Norfolk Island would almost certainly be problematic. For example the study team was told the designer's specification for pavement compaction was changed for the Mt Pitt Road project during construction.

Specifications for all types of construction work are required. Where mainland specifications are to be used as a basis they need to be reviewed and modified to be appropriate and achievable on Norfolk Island.

By way of another example, the quality of the work observed at Hibiscus Drive had several deficiencies. The construction team has achieved what it can, considering the lack of funding, experience, and training, testing and experienced engineering guidance. However, observed deficiencies included: seal not bonding to the DGB pavement, wire baskets bulging and not level and base course not properly compacted. Some of these deficiencies mean the works will not prove as durable as they could have been. Similarly the recent emergency culvert replacement at Anson Bay Rd is already showing signs of settlement and pavement weakness.

Thus construction works could benefit from appropriate designs and specifications, but of equal (or perhaps greater) importance is engineering oversight and training for the works supervisor, leading hands and plant operators in road construction processes.

5.3.4 Maintenance Standards and Methods

Maintenance similarly suffers from a lack of specifications, defined intervention levels and treatment options. The only maintenance observed was emergency repair of potholes and the system used for repair of potholes does not always address the most urgent repair the soonest.

Appendix C2 has a discussion of current maintenance methods and suggestions for the future.

Patching Crew fixing potholes on Anson Bay Road

5.4 Resources (Objective 4)

Appendix D provides information and a discussion on rock, sand, water and the need for coldmix or a propriety material.

In summary all materials other than those mentioned above must come from off-island. There are adequate supplies of rock for road maintenance and for the suggested initial programme of pavement reconstruction/resealing. However, to ensure supplies beyond the next 3 to 6 years, decisions and approvals are needed regarding locations and methods of winning rock. Sand is in very short supply however an alternative of using very small sized particles from crushers for primer seals (primer seals are not currently done) appears feasible. Potable water is in limited supply however; it is expected there is enough water suitable for roadworks located in the dams. As discussed in Appendix D it is suggested that coldmix be imported in the short term and then manufactured on-island.

Equipment resources do exist on the island however some critical items for road building are not available at all and/or are not reliable. Appendix D has a list of existing ANI equipment. Section 5.5 has further discussion regarding the need for more equipment.

As far as human resources are concerned the most glaring gap is the absence of a roads-experienced engineer. It has been approximately 10 years since Admin last employed an engineer and a good deal of the road building knowledge including lessons learnt has been lost. The situation can be recovered. A small crew of Admin people is engaged in roadworks but they need specifications, guidance and training. It has been reported there is a significant number of people who have left the island, taking with them a reasonable skill level in roadworks who would be keen to return to the island if and when work was available. Again it is stressed that there is a need, at least for a time, for external experienced supervision and training and higher level oversight. A number of on island contractors have quite good knowledge of some aspects of road engineering but are limited to one or two road construction processes only.

5.5 Recommended Strategies (Objective 5)

5.5.1 Road Infrastructure Condition – A Strategy

The current road maintenance/construction program ($500,000 p.a.) attempts to strike a balance between crisis repair of potholes, crisis response to urgent problems such as collapsed embankments and (minimal) provision of barriers and other road furniture with very little if any money available to arrest the decline of the road surfaces.

It is recommended to carry out more base reconstruction and reseals before much more of the existing pavement deteriorates. This would enable a large reduction in the quantum of pothole repairs and enable the higher priority potholes to be repaired sooner. With the current amount of pothole repairs continually being required, it is almost impossible to get to all of the urgent ones early. Thus, providing budget for improvement maintenance would help protect the existing assets and enable the routine maintenance to target the urgent issues more quickly and systematically.

Breaks in the bitumen sealed surface need to be repaired because of the following:

- Prevents the motorists suffering from a poor ride
- Reduces the risk of motorists swerving to avoid defects
- Reduces the likelihood of the potholes developing
- Helps keep the underlying pavement layers waterproof

Given the demonstrated risk that drivers will be tempted to drive too fast on improved road surfaces, design effort is required not only to provide appropriate specifications but also to consider the use of signage, line marking, rumble strips and the like. Further, expert assistance in training and supervising the works is strongly recommended for at least the first 12 months. In limited locations shoulders might be widened and drainage improved although the funds might be better spent on improvement of the road surface until such time as a large number of the Condition 2 roads are significantly improved.

Table 5.5.1 nominates 5 out of the 29 Condition 2 roads (refer Appendix A1) that could be addressed as first priority. There may be factors that the local people understand better which would suggest a different priority/sequence. The suggested reconstruction methodology is detailed in section 5.5.1.1.

A direct cost of $60 per m2 has been used to calculate the indicative direct cost in Table 5.5.1. This value is adapted from the 2012 Review of Maintenance Costs Report by Tasmanian Grants Commission [Ref 22]. The value was verified by a cross check with historical costs provided by ANI Works Department.

Table 5.5.1 Indicative Road Base Reconstruction Costs

Name	Length (m)	Area (m2)	Indicative direct cost
Anson Bay Road	5040	30,240	$1.8 m
QEA	1230	7380	$ 0.4m
Stockyard (condit 2)	690	4140	$ 0.3m
Taylors Road QEA to Village plus side areas	700	8000	$ 0.5 m
The Village Road	450	2700	$ 0.2 m
Total first priority works direct costs	**8110**	**52,460**	**$3.2m**
15% indirect costs say			*$0.5m*
15% furniture etc. say			*$0.5m*
Total with 30% as above			*$4.2m*
Contingency 30%			*$1.3m*
Total with contingency say			***$5.5m***

Economies of scale in a properly structured roads program might reduce some of these costs. One thing to be careful about in a strategy to reconstruct the base layer only would be the temptation to widen shoulders/verges and carry out corrective drainage works at the same time. Whilst the idea to carry out these other works is good and would improve road safety and the integrity of the pavement to some degree the task of addressing the pavement is now so urgent it is suggested priority be given to that.

The allowance of 15% in the table above recognises that some such work might be decided upon. The allowance of 15% indirect costs would include supervision and could also cover design and testing however such costs need to be looked at more closely depending on the procurement method decided upon.

Given the fact that many roads are on the brink of accelerated deterioration perhaps five years would be a reasonable time to bring many Condition 2 roads (not just the 5 roads nominated in the table) up to a much better standard. The total length of Condition 2 roads is in the order of 30 km with a combined area of 180,000 m2. The road base required at 50mm top up would be 15,000 tonnes and indicative direct cost at $60 per m2 would be approximately $11m direct cost at 2015 prices. Once the surface is reshaped and resealed it will be possible to carry out future resealing in say 15 years time at a far lower cost without the future need for reconstruction/ reshaping of the base prior to sealing.

Condition 3 roads should also be addressed as soon as funds allow because otherwise they will deteriorate into a Condition 2 and from there to crisis pothole fixing if they are left unattended (Condition 3: *The road or infrastructure asset is in fair condition with deterioration that requires attention.)*

5.5.1.1 A STRATEGY FOR BASE LAYER RECONSTRUCTION TO PREVENT NEW POTHOLES AND CORRECT SHAPE.

1. The problem

Few subgrade failures have been observed on the island road network, suggesting that most issues are in the top layer. Low traffic volumes and axle loads compared to say mainland roads would probably contribute to this. It appears the main reason for pavement failures (and potholes) are oxidation and cracking of the bitumen seal with subsequent water ingress and pumping action by car tyres.

2. Resources and Strategy

Any effective strategy will rely on developing and funding a roads program in the order of at least 3 to 5 years (not less). This would bring certainty to the forward works program thus allowing investment to be made in the necessary labour, materials and equipment.

There are four sources of reconstruction crews that could conceivably carry out the job:

1. Admin staff /contract workers utilising Admin owned equipment,
2. Admin staff /contract workers utilising equipment hired from on island contractors,
3. On Island contractors and
4. External contractors.

Regarding the first three, at least three critical items of equipment are not available reliably at the moment on the island for pavement layer reconstruction or for routine maintenance such as shoulder grading and unsealed road grading. They are: a reliable small grader, a rubber tyred roller (and an additional towed rubber tyred roller is preferable) and a bitumen decanter for melting imported drums of cold bitumen and heating it for hot application instead of the current cold emulsion method. A hot bitumen sprayer may also be required depending on the condition of the existing sprayer. There is some doubt as to whether it is serviceable or not.

It is suggested consideration be given to inviting tenders for reconstruction work and allowing a tender box to decide what procurement method is most appropriate. In tender comparison a hierarchy of percent local advantage could be given to the first three mentioned. External contractors might be given a percentage advantage for using local resources.

All of the abovementioned procurement methods would require a four-month or greater ramp up time after the appointment of a part time or full time roads experienced engineer. For procurement methods 1, 2 and 3 the engineer would need to address the issues of the lack of suitable on-island equipment and lack of trained local people. Specifications and methods would also need to be developed. Testing of existing roads and materials intended for use would be required and some design work would be required. If external contractors were to be brought in, the task of testing existing roads and crushed rock materials should be done with the information included in for-tender documentation. Some designs and specifications would also be required. These would need to be more rigorous than for options involving the use of local resources only.

3. Method

Given the pavement failure type it is suggested a value for money approach would be to restrict pavement improvement works to the top pavement layer. As construction proceeds careful monitoring by an experienced roads engineer/supervisor could confirm the depth of construction and adjust it according to conditions found. At this stage it would appear the process would involve ripping to approximately the depth of pothole repairs (about 50 to 100 mm), incorporating any bituminous material in the resultant ripped layer, probably adding perhaps 50 mm of crushed rock road base to provide a 100mm or 150mm road base layer (depth to be decided), reshaping, watering, compaction and a two coat flush seal. In some locations material might need to be taken off-site (or used on verges/ shoulders) to prevent the finished surface being higher than driveways, drainage structures and so on. It is envisaged the drainage would remain as at present without installation of a pit and pipe pavement drainage system. Limiting the depth of construction could also minimise the need to protect or move underground utilities.

Testing should be done beforehand to determine the likely thickness and nature of the base that can be “won” and the engineering characteristics of the reconstituted material as well optimum moisture content and potential for achieving adequate density and strength. Testing should be done also on the material below to determine its potential to support loads.

There is scant information available on what methods have been used in the past however the team has some confidence in unverified information suggesting that the above method has been used successfully on at least 12 roads some 20 years ago: roads where the base layer itself is still standing the test of time and is not the primary cause of current failures of the surface and the proliferation of potholes.

5.5.2 Structures

A strategy for dealing with the very poor condition of the Bay Street Bridge is discussed in Appendix A2.

It is recommended that the heritage Bounty Street Bridge be closed to vehicular traffic in order to eliminate the traffic’s effect on settlement.

Other strategies for ongoing maintenance are mentioned in Appendix A2 under headings for each structure.

6 RECOMMENDATIONS FOR FURTHER WORK

There is a need for a basic Maintenance Management System that records the assets and treatments carried out and that facilitates planned future maintenance treatment. This could be simply developed on an MS Access database or a purchased proprietary system.

There is also a need for ongoing technical development and professional road engineering input. The Works Supervisor would benefit from having a sister relationship with an Australian council to enable skills development and sharing ideas.

Other recommendations for further study work include:

- School Precinct Study
- Development of a Safety Barrier Strategy
- Detailed assessment of roadwork costs on the Island.

BLANK PAGE

7 APPENDICES

Norfolk Island Roads Audit and Strategy Report - Appendices

APPENDICES CONTENTS

APPENDIX A OBJECTIVE 1 DETAILS: CONDITION ASSESSMENT

A1. Road Surface Condition Assessment

A1.1 Introduction & Methodology

The study team undertook a condition assessment of the road system during the three Island visits. On the first island visit the team were provided with the 2005 Asset Management Plan prepared by Asset Technologies Pacific. The plan includes a table which summarises the roads and provides a condition rating as follows:

Condition 1. The road or infrastructure asset is in extremely poor condition due to severe deterioration or defects. Reconstruction is necessary and should be performed as soon as possible. The asset poses a danger to any potential user.

Condition 2. The road or infrastructure asset is in poor condition due to significant deterioration or defects. The deterioration or defect severely restricts the use of the asset. Urgent attention is necessary to restore the asset for safe and effective use.

Condition 3. The road or infrastructure asset is in fair condition with deterioration that requires attention.

Condition 4. The road or infrastructure asset is in good condition with superficial deterioration or defects.

Condition 5. The road or infrastructure asset is in very good condition with no deterioration or defects evident.

Condition 6. The road or infrastructure asset is under construction.

The condition rating from the 2005 audit was noted against each road using the roads list provided by the Administration's GIS department. During the island visits each road was inspected and a 2015 condition rating recorded using the same rating system as that used in 2005.

Table A1.1 shows the condition ratings. 29 roads are rated as Condition 2 and are candidates for first priority for a roads program involving reconstruction and sealing of the top layer in the near future. A further 38 roads are rated Condition 3 and they too are candidates for a roads program and in many cases might be able to be sealed or parts of them sealed without need for the far more expensive reconstruction of the top layer.

Of the Condition 2 roads the table shows 5 roads that are considered to be highest priority for reconstruction and sealing. The table also shows that about 4500 tonnes of rock would be needed if testing indicated the need to top up the existing road base by 50mm. The figures for rock are provided as an indication and do not include aggregate for sealing which currently uses about 200 tonnes per kilometre.

Table A1.1 Roads

Seq	Road Name	2005 Cond.	2015 Cond.	Prty 1	Rock (t) 50 mm	Owner	Comments
1	Allendale Dr		5			Admin	Sealed
2	Ama Ula Lane					Comm	Not a Formed Road
3	Anson Bay Road	2	2	1	2700	Comm	Access to National Park & Captain Cook Lookout. Very poor condition, severely affecting ride quality. Tourists use this road near sunset.
4	Bay Street	3	3			Comm	
5	Beefsteak Road	3	3			Comm	
6	Berrys Lane	4	3			Comm	Unsealed
7	Between Westpac / Ross's					Private	In Burnt Pine - included under Taylors Rd
8	Bishops Patterson Rd		2			Comm	Unsealed
9	Bligh Street		4			Comm	Driveway to Government House
10	Broak Road					Private	Sealed
11	Bounty Street	3	4			Comm	
12	Buffets Road		2			Comm	Unsealed
13	Buffetts Pole Road	2	2			Comm	(Christians Ln)
14	Bullocks Hut Road	3	3			Comm	
15	Bumbora Road	3	2			Comm	Access to reserve steep and rutted
16	Bun Pine Alley		2			Admin	Sealed

Seq	Road Name	2005 Cond.	2015 Cond.	Prty 1	Rock (t) 50 mm	Owner	Comments
17	Burglars Lane		3			Admin	Sealed
18	Calebs Lane		3			Comm	Sealed
19	Captain Cook Road					Comm	Included with Duncombe Bay Road
20	Captain Quintal Drive	4	4			Comm	
21	Cascade Road	3	3			Comm	
22	Cascade Road Section to Cascade Pier	3	3			Comm	Road related area at Cascade Pier unsealed and in poor condition.
23	Cats Lane		4			Admin	Sealed
24	Christians Lane		4			Admin	Sealed
25	Christine McCoy Lane					Comm	Less than 50 metres
26	Cobby Robinson		2			Comm	Unsealed
27	Collins Head Road	4	3				Near school is Cond. 2
28	Country Road Pier St to Taylors Rd	3	3			Comm	
29	Country Road Taylors Rd to Beefsteak Rd	3	4			Comm	
30	Crystal Pool		2			Comm	Unsealed
31	Cutters Corn Road		3			Admin	Sealed
32	David Buffett Road	3	3				Buffett Road
33	Davies Road		3			Admin	Unsealed
34	Dorcas Lane		4			Comm	Unsealed
35	Douglas Drive	3	3-4			Comm	
36	Driver Christian Road	3	3			Comm	
37	Duncombe Bay Road	3	4			Comm	(Captain Cook Road), 100m before National Park poor.
38	Edward Young Road	2	3			Comm	

Seq	Road Name	2005 Cond.	2015 Cond.	Prty 1	Rock (t) 50 mm	Owner	Comments
39	Edwin Ryland Evans Road		2/3			Comm	Unsealed/Concrete
40	Ephraim Christian Rd		3			Admin	Sealed + Unsealed
41	Fay Bataille Drive	3	2			Comm	Access to Scout Camp
42	Ferny Lane Douglas Dr to New Farm Rd	2	2			Comm	End near New Farm Rd Cond. 4
43	Ferny Lane Grassy Rd to Douglas Dr	4	4			Comm	Section near Douglas Drive Cond. 2
44	Fishermans Lane	3	4			Comm	
45	Fletcher Christian Road	2	4			Comm	
46	George Hunn Nobbs Rd		2			Admin	Sealed
47	Goldies Lane					Admin	130m
48	Grassy Road	4	4			Comm	
49	Greg Quintal Road		3			Comm	Unsealed
50	Harpers Road	4	4			Comm	
51	Headstone Road Anson Bay Rd to Headstone	4	4			Comm	
52	Headstone Road Headstone to Captain Quintal Dr	4	4			Comm	
53	Hemus Road		2			Admin	Unsealed
54	Hibiscus Drive	5	5			Admin	Recently sealed
55	Holman Christian Ln					Admin	Minor access track
56	Howards (off Mill)		3			Private	Unsealed
57	JE Road Red Rd to Selwyn Rd	4	4			Comm	
58	JE Road Selwyn Rd to New Cascade Rd	6	5			Comm	
59	John Adams Road	2	4			Comm	

Seq	Road Name	2005 Cond.	2015 Cond.	Prty 1	Rock (t) 50 mm	Owner	Comments
60	John Quintal Rd		2			Admin	Sealed + Unsealed
61	Jonathan Adams Road		3			Admin	Unsealed
62	Kilbourne Cresent					Private	Private driveway
63	Little Cutters Corn Lane		4			Admin	
64	Little Green Lane		2			Admin	Unsealed
65	Longridge Road		3			Comm	Sealed
66	Marshs Road	2	3			Comm	
67	Martins Road	2	3			Comm	
68	Matthew Quintal Road					Comm	Not a Formed Road
69	Matts Ground Rd		3			Comm	Unsealed
70	Middlegate Road	4	3			Comm	
71	Mill Road	2	3			Comm	
72	Mission Road	4	4			Comm	
73	Mitchells Lane	3	2			Admin	
74	Mount Pitt Road Cattle Grate to Grassy Rd	4	4			Comm	
75	Mulberry Lane	3	2-3			Comm	
76	New Cascade Road Harpers Rd to Cascade Rd	2	2			Comm	
77	New Cascade Road Taylors Rd to Harpers Rd	3	2-3			Comm	
78	New Farm Road	2	2			Comm	
79	Pacific Cable Track					Comm	Road Closed
80	Pier Street	3	4			Comm	
81	Pier Street Section to Kingston Pier	6	5			Comm	
82	Pitcairn Place		2			Admin	Sealed
83	Pitcairn Street					Comm	Not a Formed Road
84	Potts Farm Road		3			Admin	Unsealed
85	Poverty Row		3			Private	Sealed

Seq	Road Name	2005 Cond.	2015 Cond.	Prty 1	Rock (t) 50 mm	Owner	Comments
86	Prince Philip Drive Sealed	4	4			Comm	
87	Prince Philip Drive Unsealed	2	2			Comm	
88	Puppies Road		2				Unsealed
89	Quality Row	3	3			Comm	
90	Queen Elizabeth Avenue	2	2	1	700	Comm	
91	Red Road	2	2			Comm	Sealed to Prince Philip Drive
92	Rocky Point Road	2	2			Comm	(a) Unsealed section good. Rocky Point Rd (b)Unsealed section rutted Access to Crystal Pool unsealed and rutted
93	Rooty Hill Road	3	3			Comm	
94	Selwyn Pine Road	4	4			Comm	
95	Shortridge Road	2	3-4			Comm	
96	Snells Lane		4			Admin	Sealed
97	Stockyard Road	3	2-3	1	400	Comm	
98	Taries Lane		4			Admin	Sealed
99	Taylors Road Country Rd to Queen Elizabeth Ave	4	4			Comm	
100	Taylors Road Queen Elizabeth Av to The Village Place	2	2	1	400	Comm	Poor condition, severely effecting ride quality
101	Taylors Road The Village Place to Grassy Rd	4	4			Comm	
102	Tevarua Lane		3			Admin	Unsealed

Seq	Road Name	2005 Cond.	2015 Cond.	Prty 1	Rock (t) 50 mm	Owner	Comments
103	The Village Road	3	2	1	300	Admin	Poor condition, severely effecting ride quality
104	Two Chimneys Road	3	3			Comm	
105	Uncle Joes Rd		3			Admin	Unsealed
106	Webb Adams Road		3			Admin	Sealed
107	William McCoy Road		3			Comm	Unsealed
108	Works Depot Road	3	3				
109	Yorlor Lane	3	3			Admin	
110	Youngs Road	3	5			Comm	
	Totals: Priority 1 roads and approx. rock for base tonnage (50mm top up)			**5**	**4500**		

A2. Structures - Bridges and Major Culverts Condition Assessment

A2.1 Introduction

The 2005 Roads Report identified the 12 significant bridges and major culverts that formed part of the Norfolk Island roads network. Table A2.1a below shows the 12 culverts and their condition as reported in 2005. Table A2.1b shows the rating system used in the 2005 Roads Report.

The 12 bridges and culverts were inspected again during a visit to Norfolk Island 25th May to 29th May 2015. It was found that there were no additional bridges or culverts to be added to the list and that all bridges and culverts previously listed were still in use in the road network. The inspection in 2015 was visual with a photographic record of the current condition of each structure. As with the 2005 report no structural calculations were prepared.

Table A2.1a also shows the condition rating of each of the structures in 2015 in addition to the condition rating given in the 2005 report and provides recommendations for each structure.

During the assessment the bridge numbered 1 (Bay Street bridge) was considered to be unsafe unless propped and Administration was advised accordingly in writing. Since the advice the bridge has been closed to traffic and it is understood action will be taken to prop it, repair it, replace it or make it redundant by filling in the drainage channel.

Table A2.1a Norfolk Island bridges and major culverts

	Structure	2005 Condition	2015 Condition	2015 Recommendations. Refer also to Detailed comments
1	Bay St Bridge.	3	2	Bridge has been closed. Stabilise, remove or replace structure
2	Bay St culvert.	4	4	Good condition
3	Bounty St bridge.	2	1	Bridge has failed. Close bridge to vehicular traffic
4	Country road culvert.	4	4	Clear vegetation
5	Driver Christian Rd Bridge (Bloody Bridge).	4	4	Monitor for maintenance.
6	Harpers Road culvert.	4	3	Repair headwalls
7	Headstone Road culvert.	4	5	New structure
8	Marsh's road upstream culvert	3	3	Metal Corroded. Needs repair
9	Marsh's road downstream culvert	5	4	Minor concrete deterioration
10	New Cascade Rd culvert.	4	4	Some cracks in upstream and downstream headwalls
11	Pier St Bridge.	4	4	Superficial marks on headwall. Clear vegetation
12	Prince Phillip Drive bridge.	4	4	Some repair and maintenance

Table A2.1b Condition rating scheme for bridges and major culverts

Condition Rating	
Extremely poor	1
Poor	2
Fair	3
Good	4
Very good	5

A2.2 Overview of Results of Condition Assessment 2015

It can be seen from Table A2.1a that four bridges (numbered 1, 3, 6 & 9 in the table) have deteriorated since 2005 sufficient to lower their condition rating. One structure (Headstone Road Culvert, numbered 7 in the table) has a higher condition rating because a new structure has been provided to replace the previous one.

A2.3 Notes Regarding Each Bridge and Major Culvert

A2.3.1 Bay Street Bridge (New Bridge) Circa 1941

Bay Street Bridge is a skewed concrete deck bridge 3.6m wide x 8.2m long with a span of approximately 4 m onto a mass concrete bearing layer onto calcarenite rock. The insitu reinforced concrete deck is 400mm thick and has severely deteriorated along the seaward edge with concrete 'blown off' by expansion of corroded reinforcement. Cracks have also formed in the slab soffit indicating that saline moisture is reaching the reinforcement. This will lead to accelerated deterioration of the slab resulting in significant loss of strength. On the underside of the slab, there is also evidence of poorly compacted concrete and poorly graded aggregate.

Recommendation:

Plan to replace the bridge deck or either provide a new deck (with or without removing the existing deck) or introduce a new structural support beneath the centre of the bridge deck, (noting that such an approach would remain a temporary solution). Alternatively, if the Administration decide to fill in the drainage channel (for environmental reasons) the bridge can be entirely removed.

Corroded seaward slab edge.

Steel Reinforcement now ineffective

Poor quality concrete.

Cracks with calcification

A2.3.2 Bay Street Culvert (30m East of Bay St Bridge)

This structure appears to have not deteriorated significantly since 2005. It is in good condition. Drainage flow is currently restricted as the channel is blocked with beach sand.

Recommendation:

Should drainage flow into Emily Bay be required, then the channel could be dredged.

Bay Street Culvert From North

A2.3.3 Bounty Street Bridge (circa 1832)

Bounty Street Bridge is a heritage rock arch structure with rock headwalls upstream and downstream.

The arch is clearly visible on the upstream side - it has settled significantly and large cracks have formed above the arch and upward through the headwalls.

The downstream arch is currently submerged and obscured by vegetation. The headwall appears to have rotated to the east with signs of slumping of the grassed verge, which is retained by the headwall.

Recommendation:

The bridge is currently signposted with a load limit of 2 tonnes and the speed limit is posted as 30 km/h, however it is considered this does not guarantee the valuable heritage structure and it is recommended the bridge be closed to vehicular traffic until (if) a plan for restoration of the bridge is determined.

Options include:

1. Accept gradual deterioration of the bridge structure.
2. Perform a thorough investigation to determine the cause of the failure of the bridge structure and provide methods for strengthening and repair.

Approach from South

Arch from upstream (West)

Cracked upstream headwall

Settled downstream arch and headwall

A2.3.4 Country Road Culvert (100m from Taylor Road)

Country Road Culvert is a 1500mm diameter reinforced concrete pipe in good condition. The culvert and headwalls are in good condition, as was stated in the 2005 report Cl 2.17.1.

Recommendation:

Vegetation growth should be removed to ensure adequate storm water flow through the culvert.

Upstream partly obscured by vegetation

Downstream culvert vegetation

A2.3.5 Driver Christian Road Bridge (Bloody Bridge) circa 1835

Driver Christian Road Bridge is a heritage rock arch bridge forming a storm water drainage culvert from Music Valley toward the sea. The bridge was built up using rubble filled buttressed rock walls to enable the road to traverse the valley. The downstream wall was rebuilt with a splay in 1914 following collapse of the original wall.

The bridge remains in good condition without significant defects.

Recommendation:

Periodic monitoring for maintenance requirements

Culvert from upstream side

Splayed downstream wall

Culvert and spillway from downstream side

A2.3.6 Harpers Road Culvert

Harpers Road Culvert is on one of two approach roads to Cascade Pier.

The 2005 report Cl 2.29.1 advises:

Harpers Road Culvert is a 2.1m x 2.1m concrete box culvert with rock headwalls. This is a narrow one-lane culvert crossing and upgrade of culvert is required for two-lane traffic. The culvert is in good condition with some damages to the downstream headwall need to be repaired.

The culvert concrete structure remains in good condition with a minimum concrete arch thickness of 300mm.

Recommendation:

The rock headwalls are still in need of repair.

Culvert from downstream side

Culvert wall

Damaged downstream headwall

Damaged upstream headwall

A2.3.7 Headstone Road Culvert

The original culvert has recently been replaced with a reinforced concrete structure. The structure is in very good condition with no visible signs of deterioration

Culvert from downstream side

Road gullies discharging to drainage channel

A2.3.8 Marsh's Road Upstream Culvert (Ball Bay)

The upstream culvert runs beneath the roadway at Ball Bay parking area. It is a 2000mm diameter steel pipe which is corroded and in need of repair, as advised in the 2005 report Cl 2.35.1. The concrete headwalls are cracked and there are no barriers along the top of the headwalls.

Recommendation:

Plan to replace the steel pipe culvert with a new RC pipe or box culvert.

Inlet to upstream culvert

Outlet to upstream culvert

A2.3.9 Marsh's Road Downstream Culvert (Ball Bay)

The downstream culvert runs beneath the roadway leading down to Ball Bay. It is a 1200mm diameter reinforced concrete pipe. The 2005 report advised that the pipe was in very good condition. In 2015 the pipe is in good condition with minor cracking on the internal top face close to the outlet.

Recommendation:

Repair cracked and spalling concrete to reinstate full protection to reinforcement within the RC pipe.

Inlet to downstream culvert

Damaged RC pipe culvert

A2.3.10 New Cascade Road Culvert

New Cascade Road culvert comprises a 900mm diameter reinforced concrete pipe 6m long. The pipe appears to be in good condition; however the inlet and outlet are not accessible for close visual inspection. The headwalls are in a similar condition to that reported in the 2005 Report (Cl.2.44.1), with cracks in both upstream and downstream walls.

Recommendation:

General maintenance - Repair the cracks in the headwalls.

Culvert crossing viewed from West

Inlet to culvert

A2.3.11 Pier Street Bridge (Heritage circa 1831)

Pier Street provides direct traffic access between Kingston Pier and Quality Row and to the township.

The 2005 report Cl 2.47.1 advises:

Pier Street Bridge is a heritage rock arch bridge 3m diameter and 9m span. The bridge is in good condition with some superficial marks on the surface of the rock headwalls.

The bridge remains in good condition with no additional signs of deterioration.

Arch from upstream side

Arch from downstream side

A2.3.12 Prince Philip Drive Bridge

Prince Philip Drive Bridge is a timber bridge total length 7.6m and 3.2m wide and is signposted for a 10 tonnes limit. The deck is supported on 3 longitudinal beams onto three main frames at 3.4 m centres. The outer frames are bolted to concrete abutments, which provide longitudinal and lateral stability to the structure.

Observed condition:

- The deck timbers and fixings are in good condition.
- The 3 longitudinal deck support beams are in good condition.
- The southern abutment header beam is in good condition
- The northern abutment header beam is deteriorated with signs of borers parallel stress lines and holes (pre-drilled) through the timber.
- The central header beam is in good condition.
- All nine timber support posts are in good condition.
- The concrete wing walls to the southern abutment and east side of the northern abutment are in good condition.
- There is no wing wall to the northwest edge of the abutment.
- All three footings are in good condition with no visible signs of settlement.

Recommendations:

1. General maintenance to include periodic removal of accumulated dirt on the deck to minimise moisture at interface of timber members.
2. Guardrail is in need of repainting.
3. The northern header beam should be replaced.

Bridge approach from north

Northern abutment and bridge support frame

Deteriorated northern header beam

Deteriorated northern header beam

Central and southern support frames

West edge of northern abutment

APPENDIX B. OBJECTIVE 2 DETAILS: HAZARDS AND RISKS.

Introduction: Hazards and Risks

On 29th April, as part of the team kick off meeting a hazards, vulnerabilities and risk meeting was held. The outcomes helped to guide early days of the study and were refined throughout the time of the study. The developed table of hazards and associated risks appears below.

Table B1: Generic Hazards and Risks

Hazard	Description of risks.
Cows on road and adjacent in road reserve	Difficult to see at night - not a huge risk in daylight hours. Report of a cow landing on a car, after coming off a cutting adjacent to the road.
Pot holes	Vehicles can encounter large potholes in the wheel path, causing drivers to swerve to miss the hazards, with potential risk of head-on collisions. Ambulance Superintendent made the point that potholes make journey times to the hospital very long when carrying passengers. Filled potholes using current methods create a very bumpy road however this can serve to reduce risk (“self enforcing”) of drivers going too fast for general road alignment and conditions.
Improved roads considerably better than the general adjacent road network	Drivers take the (limited) opportunity to drive too fast, above the posted speed limit on roads with improved alignment and surface condition risking crashes. Risk of over estimating the safety of the road.
Overhanging tree branches. Tree branches on road not cleaned off.	Potential damage to vehicles, reduced sight distances. Drivers may swerve to avoid branches thus risking a crash
Steep high drop offs, adjacent to roads	Potential for vehicles to go over embankments or cliffs – large consequences.
Lack of shoulders and table drains, adjacent to bitumen sealed roads. Embankments are often present.	Narrow roads with minimal shoulders make it difficult to pull off in safety. Roads without table drains have inadequate surface drainage and consequently a reduced life. Where the verge is above the pavement level the road acts as a drain risking drivers swerving to avoid water on road.
Limited sight distances, at intersections	Potential collisions.

Hazard	Description of risks.
Limited sight distances, on horizontal curves	Potential for collisions with oncoming vehicles or objects on road (eg cows).
Limited sight distances, on vertical curves	Potential for collisions with oncoming vehicles or objects in road (eg cows).
Unseen footpath hazards (unconstructed footpaths)	Potential for pedestrian falls; and vehicles running into pedestrians, because pedestrians choose to walk on the road where-ever footpaths are not constructed or are in poor condition.
Difficult to see road edge	Potential for vehicles to leave the road, and collide with street furniture or worse.
Bridges and other structures with low structural capacity	Potential collapse – could be catastrophic
Slippery roads, when wet	Drivers at risk of being unable to negotiate slippery incline on unsealed roads. Instances of vehicles being abandoned until conditions improve.
Bikes and loose stones on roads	Potential accidents
Utility poles close to road edge	Potential impacts between vehicles and poles.
Steep grassed batters adjacent to roads – inadequate footpaths	Dangerous to walk on. If pedestrians choose not to use these cuttings, they invariably walk on the road.
Road Safety issues around the school (in general)	Interaction between cars and students in drop-off zones outside schools is always a risk unless all people are vigilant, educated and the areas are well signed and supervised.
Non frangible hazards near road edge.	Collision between errant vehicle that hasn't had time to recover and non-frangible objects (eg trees, power poles, sign posts, headwalls).

Building on the above table of generic hazards and risks a list of 29 risk areas were identified through on site inspections, literature searches and analysis.

Specific risks were tested and refined at Risk Identification and Preliminary Rating Workshop held on 27th May during the second site visit (see appendices B1 and B2).

B1. Risk Workshop

A Risk Workshop was held with key stakeholders on the 27th May. The following briefing paper was issued to the participants prior to the workshop.

Briefing Paper (pre-workshop)

For the proposed Norfolk Island Road Infrastructure Strategy

Risk Identification and Preliminary Rating Workshop

27th May 2015.

Introduction (Risk Briefing Paper)

The state of road infrastructure on Norfolk Island is acknowledged as being generally very poor and needs no further introduction.

The subject study by Worley Parsons follows on from a number of key studies and reports in recent times notably:

- *The Joint Committee's visit to the island in April 2014 and their report October 2104. Recommendation 5 of their report pointed to the need for a study such as this.*
- *Ian Faulks' report September 2014 (which has been adopted except for the BAC issue). That report included a number of ideas regarding improvements to the road network and urged the retention of "the country lanes aspect" and promoted the concept of "self enforcing" roads.*

Work is proceeding on all five study objectives mentioned below. The objectives are inter-related for example Objective 1 (road infrastructure condition) feeds into Objective 2, however the condition of the pavement or roadside obstacles for example, is by no means the only contributor to hazardous circumstances.

A workshop will be held on-island in the week commencing 25th May (suggested timeslot day or night between Tuesday morning and Wednesday night) as outlined below. The workshop will be facilitated by Harry Batt (an experienced facilitator who is on the N.S.W. RMS Panel for Constructability Facilitators). It is envisaged the workshop would take 2 hours but desirably 3 hours. It needs to be understood that this is a focussed workshop and not a general meeting.

Study Objectives

1. *Assess the condition of road infrastructure and requirements to maintain, improve and augment.*
2. *Identify hazards and risks and works required to address risks; prioritise.*
3. *Assess standards and methodologies used locally for road infrastructure design, construction and maintenance, suggesting areas for improvement.*
4. *Identify local resources including materials equipment and labour highlighting gaps now and in the future together with other potential sources of resources.*
5. *Develop a strategy with indicative costs targeting high-risk areas and maintenance.*

Workshop Objectives

- *Achieve a common understanding of the Worley Parsons roads study and the issues found to date (those that are directly parts of Objectives 2 and 5).*

- *Briefly gauge the support for the "the country lanes aspect" and the concept of "self enforcing" roads.*
- *Target parts of Objectives 2 and 5: hazards and risks identification and preliminary rating, especially high-risk, high priority areas.*
- *Verification and adding to the list of risk areas identified to date (the main risks – not ALL risks)*
- *Preliminary rating of risks (1,2 or 3) but not prioritisation of works.*
- *Capture ideas from participants regarding risk treatments but not concentrate on this.*

Workshop Process and Agenda

1. *Personal introductions and housekeeping.*
2. *Very brief overview of the Worley Parsons study objectives, methodology and progress.*
3. *Gauge the support for the "the country lanes aspect" and the concept of "self enforcing" roads. Is this generally agreed?*
4. *Examine the current list of urgent/important risks and reach agreement, adding or changing as required.*
5. *Agree the criteria by which we will rate "risky' intersections and the like (see the suggested criteria below)*
6. *Apply the criteria as a whole to each "risky area" and rate each as 1, 2 or 3 (See Rating System below)*
7. *As we proceed make notes regarding possible risk treatments but don't concentrate on this (it can bog the meeting down).*
8. *Note that this is a risk identification and preliminary rating workshop. The outputs will be recommendations for the WP Team to consider further.*

Pre-Workshop Activities

The Worley Parsons team has compiled a table (attached as Appendix 1) of what appear to be the most urgent and important hazards and risks identified to date. The list was composed by:

- *Interviews / discussions with on-island individuals and groups – ideas were verified by cross checking with others. Notably this consultation included the Youth Assembly as well as the Road Safety Committee and its members.*
- *Literature search including many reports and other documents provided by the abovementioned people.*
- *On-site investigations including a process whereby wherever hazardous conditions were reported, the team looked for similar conditions that might also involve those hazards and risks.*

Assessment Criteria (subject to the workshop's agreement)

All criteria (see below) will be applied together and as a whole.

For each risk area (intersection etc.) we will ask which if any criteria stand out and we note the strength for each criterion as: strong, not strong and intermediate.

1. *Safety*
2. *Economic (freight, industrial and other commercial activity impacted)*
3. *Economic tourism adversely impacted*
4. *Heritage – risk to heritage items.*

Rating System (using the agreed criteria as a guide)

A common system for rating issues is to consider urgent and important. These can be represented as a table with two rows and two columns comprising four quadrants. The rows from the top down are urgent and less urgent and the columns are from left to right are important and less important. Issues that are both urgent and important are in Quadrant 1 at the top left hand corner of the table. Issues that are less- urgent and less important are at the bottom right hand corner.

It should be noted that we are using the term "less" rather than "non". In other words our list is only comprised of things that we recognise have a degree of urgency and also have a degree of importance. We are not including in this list perhaps dozens of other issues that do need attention but would not be rated highest.

Using the agreed criteria we will proceed one risk area at a time to apply the criteria and rate each risks area as 1, 2 or 3 as follows:

1. *Urgent and important (top left hand quadrant)*
2. *Urgent and less-important PLUS less-urgent and important*
3. *Less urgent, less important (but still deserving of being on the list).*

Next Steps: Treatments, Indicative Costings and Prioritisation

The Worley Parsons team will continue its investigations and will use the outcomes of this workshop as a guide. Participants should note that the outcomes of this workshop are not necessarily adopted but will be taken into account along with other inputs from the ongoing study.

An important principle that the team will apply (post-workshop) is to identify works that are relatively cheap and high value for money and which, although not perhaps the highest risks can be easily done and incorporated into an overall program of works. This could include works that are not on our list for rating in the workshop. Participants are invited to provide their thoughts on this however it is asked that they not be raised during this focussed workshop.

Post – Workshop Optional Discussion

If time permits and for any participants who are able to stay the Worley Parsons team would welcome discussion and information regarding the other objectives especially Objective 4: Resources.

Table of the Main Identified Risk Areas

Provided separately.

Suggested Invitees

Attendance at the workshop will be by invitation – it is not intended to be a public meeting and it is desirable to keep the meeting from being too large so as to be able to achieve focus. For those others who wish to have views put forward it is suggested they contact the participants beforehand and ask that those views be expressed. Final participants are yet to be confirmed but at this stage the following list is envisaged:

- *Members of the Road Safety Committee:*
    - *Allan Bataille (Chair)*
    - *OIC Police Sgt Catherine Tye*
    - *Michelle Nicholson (School Principal)*
    - *Brian James*
- *Matt Alexander (Heritage)*
- *Jodie Brown (Planning)*
- *Doug Creek (Squad Captain Volunteer Rescue Squad & Works Manager).*
- *Possibly a representative of the freight industry (to be confirmed).*
- *Possibly a representative from the Youth Assembly (to be confirmed).*
- *Bruce Taylor.*
- *Rob McKenzie.*

B2: Risk Workshop Report

Risk Identification and Preliminary Rating Workshop held on-island 27th May 2015

Introduction and Background (Study Objective 2)

The main body of this roads infrastructure report together with the briefing paper attached to this workshop report provide the context of the risk workshop held on-island 27th of May 2015.

Throughout May the WP study team identified 29 significant risk issues (risk areas). This had been done by a process of discussions with on island people with verification and further investigations by the team.

It was decided to hold a workshop with the objectives as indicated in the Briefing Paper attached. The Paper had been sent out beforehand to all invitees and included a list of the 29 risk issues. The idea was to test work done by the team to find whether or not people felt we had identified all of the significant issues and to get their point of view on what things they would rate both most urgent and most important. Risk rating was defined as a combination of what was most urgent and what was most important.

The core group of the participants was the Road Safety Committee who had been very helpful in assisting the team to understand the island and its road infrastructure issues. A list of the ten participants appears below.

Risk Workshop Participants

Name	Interest or position
Allen Bataille	Road Safety Committee Chair
Catherine Tye	Road Safety Committee and OIC Police
Kevin Coulter	Road Safety Committee
Brian James	Road Safety Committee
Bruce Taylor	Deputy CEO
Jody Quintal	Admin Planning Officer
Matt Alexander	Commonwealth Heritage Manager
Doug Creek	Works Manager and Captain Volunteer Rescue Squad
Duncan Evans	Freight representative
Mark Millett	School representative (also proxy for Youth Assembly)

Support for “The Country Lanes Aspect” Confirmed as Very Important

The “Country Lanes Aspect” was unanimously confirmed as “very important”. It was explained this is an absolutely key criterion to consider when proposing standards and methods that would be applied to treat problems with road infrastructure.

List of Significant Risks

The participants agreed to all of the 29 pre-identified risks that had been circulated with the Briefing Paper and added a further four making a total of 33 risk issues to be considered.

Locations and Photographs of Risk Areas

The WP study team had set up a GIS database that was used to show the location of each pre-identified risk area together with photographs to illustrate the hazards and the risks at those locations.

Locations of Significant Drop-Off Areas Potentially Requiring Barriers

As a separate exercise a discussion was held regarding the number of places where consideration might be given to providing barriers. The matter of potential barriers or other solutions was dealt with off-line from other hazards because the study team felt, and the workshop accepted that a whole-of-island strategic approach was needed to ensure a consistency in solutions. Inconsistent barriers or other solutions can send mixed messages to drivers, which can lead to a false sense of security in some situations. The workshop agreed there were possibly hundreds of situations but identified nine in particular:

	Road	Location
1	Rocky Point Rd	Drop off between the creek and Bumboras Rd
2	Prince Philip	Drop off at look out/bend
3	Ferny Lane	Adjacent runway 22, 57 Ferny Ln
4	Anson Bay Rd	Anson Bay Reserve & Puppys Point
5	Driver Christian Rd	Above bloody Bridge
6	Rooty Hill Rd	Below look out
7	Middlegate Rd	From Panorama Apartments to Quality Row
8	Anson Bay Rd	Near Bishop Patterson Rd
9	New Cascade Rd	Nr Creek Crossing

Risk Assessment Criteria

The workshop participants agreed to the four assessment criteria that had been suggested in the Briefing Paper. In traditional risk workshop jargon these could be described as a pre-definition of consequence categories.

B2.8 Rating System and recording

It was suggested to the group that having agreed that all of the 33 risks now identified were of sufficient likelihood and consequence to appear on our list then we could proceed to rate them using a simplified system in order to save time. Participants were asked if they were happy to proceed with the risk rating system as proposed in the Briefing Paper which involved rating risks with the number 1, 2 or 3. The commonly used system of determining likelihood and consequence was explained and the workshop felt they could rate risks with the simplified system as proposed.

Further, as explained in the Briefing Paper the workshop rating was a preliminary rating only and the study team would consider the workshop outcomes together with ongoing investigations before determining what risks would be reported as the highest risks.

Participants were each handed a hard copy table showing the 29 pre-identified risks with columns where they could note their comments regarding each risk and rate them. They were able to add the four additional risks to their hard copy table.

They were then asked to fill out coloured post-it stickers: red = risk rating 1 (the highest rating), blue (rating 2) and yellow (rating 3).

Participants were “allowed” up to 5 red stickers and as many blue or yellow as they required. They were asked to choose the coloured sticker corresponding to their rating and write: the number of the risk area together with the four letters S(Safety), C(commercial including freight), T(Tourism) and H(Heritage) corresponding to the four agreed assessment criteria. They were asked to write a number representing the percentage of the impact that they would attribute to each of the four criteria. For example a red sticker bearing the number 3 and S 80%, H 20% would mean that that person rated risk area number 3 a highest risk area and that in doing so they considered safety and heritage were the main things impacted according to the percentages they had written down.

Outcomes of the Risk Workshop

WEIGHTING

After the workshop the WP study team applied a weighting system to the preliminary risk ratings:

Prelim rating	Weighting
1 (red)	4 points
2 (blue)	2 points
3 (yellow)	1 points

OBSERVATIONS REGARDING WORKSHOP OUTCOMES

The workshop focussed on hazards and risks: the subject of Study Objective 2.

Two risk areas stood out as being of highest concern to the workshop participants:

- The school precinct (risk areas 3 and 6 combined) and
- Intersection of Queen Elizabeth Avenue (QEA) and Taylors Road including the footpath at the corner. (Risk Area 1)

THE STUDY TEAM'S RATING AND ONGOING INVESTIGATIONS

The study team considered all of the risk areas that had been discussed at the workshop and generally agreed that the preliminary ratings by stakeholders would be a useful guide to their ongoing investigations. Hand written comments made by the workshop on the hardcopy sheets (and handed in) were considered in this and subsequent assessments.

RANKING OF 33 IDENTIFIED RISK AREAS

Table B2

	Description (short)	Weighted rating	Comments
1	Int Taylors, QEA	36	Geometry, right of way, footpath
2	Footpath QEA to Burnt Pine	20	Unformed, peds walk on road
3	School corner	54	Total for school precinct ** (38+16)
4	Int Anson, Douglas, Headstone	4	Sight distance at intersection
5	Bay St broken seal	14	Loose surface
6	Panorama parking	22	Impinges on safe lane width
7	Taylors downhill curves	14	Tight horiz. alignment reduces sight distance
8	Int Stockyard, Martins, Marsh	9	Poor layout, sight distance
9	Bounty Street bridge	9	Bridge sinking and cracking
10	Int hospital corner	20	Speeding. Some confused right of way
11	Prince Philip Dr barrier	14	Barriers separate strategy **
12	Mission Road	5	Speeding. Rd appears safer than it is.
13	Country Rd straight	12	Speeding. Rd appears safer than it is.
14	Int Ferny, Douglas	3	Angle (geometry). **
15	School parking	Incl in 3	Considered part of the school corner issue)
16	Hibiscus Dr	1	Poor alignment

	Description (short)	Weighted rating	Comments
17	Int Young, Cascade	7	Right of way confusion **
18	Anson Bay Road	9	Bumpy at speed.
19	QEA bikeway near Fletcher	4	Step in level
20	John Quintal Road	1	trees
21	Hemus	2	Rough surface
22	Selwyn near Nat Park	7	Rough surface
23	Int Country, Longridge	8	Signing
24	Int Harpers,New Cascade	12	Angle (geometry), sight distance **
25	Int Taylors, Country	7	Pedestrians on road
26	Ferny near RESA	2	Vehicles run wide
27	Int Mission, Anson	10	Geometry, sight distance, speed **
28	Int Mission, Grassy, My Pitt	8	Geometry, sight distance, speed **
29	Loose gravel on roads generally	6	Loose gravel
30	Bumbora	4	Steep not sealed
31	Rocky Point, Crystal	4	Sealed section steep, potholed
32	Kingston Pier precinct traffic	6	Traffic management when unloading boats
33	Taylors- QEA to hospital	2	Cyclists at risk

** Notes:

1. The team identified a number of safety issues in the vicinity of the school in addition to those the workshop had identified. The team informed the workshop that they would suggest that all these issues be handled on a precinct basis and needed a separate study to address them.
2. Regarding barriers and high drop off points there are hundreds of such places around the island. Clearly it is not appropriate to put barriers up in every single location. Further, the type of barrier to be applied might vary according to the location and there is a need for consistency in the approach to this matter. In some places a wheel stop would be more appropriate than a steel concrete or barrier. The whole issue with these high drop risk areas needs to be addressed in a similar manner to the school precinct with a strategy and approach to be attended rather than ad hoc works carried out. However action should be taken on the Prince Phillip Road area as a matter of some high importance if not urgency.
3. A number of intersections have poor geometry resulting in reduced sight lines and confusion (mainly for tourists) over which movement has right of way. Also large turning radii encourage drivers to take left turns at excessive speeds.

High Priority Area 1: The School Precinct

A number of safety issues have been identified at the school precinct. The Norfolk Island community have at least two solutions in mind, namely a roundabout at the intersection and a separate parking area to be built on Middlegate Road next to the pre-school and away from the places where school traffic congestion occurs. The police report that the special 30 km/h speed limit during school hours is ignored by many and this creates safety risks and a significant enforcement issue. In addition to reported issues the team observed children walking on the road to avoid apparently “minor” hazards (but putting themselves at greater risk) and car drivers leaning forward to position their head hard up against the front windscreen in an attempt to look over the left shoulder (almost through the back windscreen) for oncoming traffic hazards.

Whilst there are clearly urgent and important needs to be addressed their resolution should be as part of an overall precinct strategic study and should not occur by way of ad hoc construction works.

It is suggested a school precinct traffic and road safety needs study be commenced as soon as possible. It is envisaged the study would include community consultation as well as stakeholder engagement. This study has identified the strategic need but it is beyond the scope to take it further to a full definition of all needs and practical affordable solutions that would meet with a degree of community acceptance.

High Priority Area 2: Intersection QEA and Taylors Road (incl. footpath)

INTERSECTION ISSUES

As with the school precinct there are a number of factors to be considered at this intersection. The intersection, including the footpath on the northern side needs to be redesigned and reconstructed to improve safety. The design should address the current apparent confusion for some drivers regarding who has right-of-way. The community perception seems to be that this changes throughout the day depending on whether it is school drop off and pick up time or not. The proximity of “The Building Centre” driveway in QEA close to the intersection currently creates a hazardous situation under the current arrangement. The footpath is inadequate for safe passage of the school children and tourists who negotiate this corner. An important constraint to resolving the footpath in this area is the fact that the existing narrow foot passage and buried services next to the corner fence post are in fact approximately 2 metres onto privately owned land. It is understood further that discussions have been held in the past regarding the purchase of land but have not reached a mutually acceptable resolution. A technical solution appears to be possible that does not require purchasing or leasing of land however it would be preferable to obtain additional land from the corner property.

RECOMMENDED ASSOCIATED WORKS

There is a strong safety case for extending the footpath towards the town (possibly all the way into the centre of town) to join with the current footpath as part of a package of work in this area. Safety of school children and elderly tourists are particularly at risk in wet weather.

Also as part of a package of work in this area consideration could be given to the poor condition of the road surface along QEA to the school and along Taylors Road up to and including The Village Place, joining with previous road improvement works in the town centre.

Depending on funding constraints these works might all be addressed as a single package or a logical sequence could be developed.

APPENDIX C. OBJECTIVE 3 DETAILS: STANDARDS AND METHODOLOGIES

C1 - Design

C1.1 Road Design Generally

Norfolk Island (NI) has an extensive roads network considering the population. In general, the roads have a “country lane” feel reminiscent of English country lanes. There is a standard for subdivision roads on NI but not specifically for the public roads. Other than for works designed by mainland consultants, it appears that designs are “rule of thumb” and experience based rather than to a specific road design standard.

The quality of the construction of the older assets (roads and bridges) is generally quite good. Convict bridges exist in their original condition with only minimal maintenance required. The main complication with the historic assets is complying with European Heritage requirements to ensure no impact on the heritage.

The quality of the road construction varies with the roads in undulating areas being fairly soundly built, albeit with numerous surfacing failures but only the occasional pavement failures. See also the comments in C1 .2 regarding pavement design and C2.1 regarding road construction methods. Cross and longitudinal drainage is, however, apparently an issue after sustained or heavy rain. There were few cross drains, table drains or longitudinal drains evident.

In the more mountainous areas, most of the roads are also structurally quite good with only an occasional sign of poor embankment construction or other construction deficiency. However the mountainous roads require a more strenuous approach to the management of the drainage water and there are similarly evidence of poor pavement and sealing practices. The mountainous roads are more difficult to build and more susceptible to issues. The quality of all of the roads is helped considerably by the quality of the road materials available on island.

There do not appear to be any records of maintenance except in the last six years. Similarly there are no apparent maintenance standards or maintenance management system that provides a record of construction and past maintenance treatments.

As in all new or upgrades of roads, compromises often need to be made to established road design standards in order to make the road viable or even constructible. Thus for example, maximum cut batter slopes of 1 to 1.5 may be achievable in flat rural areas but in mountainous terrain, would mean either expensive retaining walls or most of the mountain would need to be excavated to comply. Thus compromises to road design standards are common to accommodate the variety of different circumstances encountered in designing and constructing roads across a range of topographies. In fact the largest road authority in Australia, NSW RMS, has formalised this by issuing what is known as the Brownfields Guide, which gives designers opportunity to adopt lower road design standards for work on existing roads.

Recommendations as to appropriate Norfolk Island road design standards appear below. However, it should be clearly noted that all standards need to be appropriately applied by professional designers that understand the implications of varying the standard and the basis for the standard and this includes how and when to take account of the “country lane aspect”. Road design is a specific design specialisation and needs to be applied intelligently and appropriately.

In some cases where new roads have been built, the standards adopted have been to various levels of conformity with Australian roads standards (Austroads) and ARRB (Australian Roads Research Board). Thus the recently designed and built Mt Pitt access road is in a mountainous area and Type W barrier railing has been specified and installed along the sections with a steep road grade for the majority of outer road edge. This is in contrast to most other locations on the island where no barriers are used or timber railing only. Eventually it would be prudent to see the whole island have a consistent treatment in relation to traffic barriers and this report makes a strategic recommendation that this be looked into further.

C1.2 Pavement Design

The road condition audit showed few examples of failures in the pavement layer or the underlying subgrade: the failures mainly being in the bitumen seal. However, having been left untreated for so long these have now led to significant loss of shape, resulting in a poor (bumpy) ride which needs correction.

Before recommending a strategy for future pavement design and construction it was decided to investigate what designs and methods have been used in the last 20 or so years as far as could be obtained from local memories. It was possible to obtain (unverified) information that the following roads were reconstructed from the original pavements by treating or providing only the top 100 base layer: Ferny (part), Collins Head (Middlegate to Stockyard), Stockyard (Collins Head to Two Chimneys), Taylors Road (QEA to KAVHA), Middlegate, Mission, Selwyn Pine (part), road to Steels Point, Fishermans Lane, Allendale, Harpers (part) and Prince Phillip Drive (part).

More recent construction (Mt Pitt year 2003) specified 180 mm base in two equal layers. It appears it was agreed after testing to compact in a single layer. The greater layer thickness seems to be the exception and, as noted above, 100 mm base thickness was the rule in previous years.

Further, the pavement design recently adopted locally for maintenance or minor roadworks has been 150mm thick Dense Graded Subbase (DGS) and 50 to 100 mm Dense Graded Basecourse (DGB) on top. Presumably this would apply when the new finished level is to be 200 mm or more above existing finished level.

Regarding specification and quality of the base, Admin purchases DGB20 however there is no evidence of any certification as to quality and no testing is done by Admin to confirm quality. Visual inspections indicated some material appeared suitable but other material was of doubtful quality. The suitability should be certified by the supplier and checked by Admin. Full testing including plasticity index, maximum dry density and CBR testing might be problematic if done in Australia or New Zealand because it is possible there might be quarantine restrictions. However testing for organic matter and grading could easily be done locally if a simple laboratory were to be set up.

Empirically it is considered that the 150mm underlying DGS adopted is a suitable thickness but that the top 50 to 100 mm DGB adopted should be increased to a minimum 100mm (as per historical examples quoted above) or (if testing indicates) 150mm compacted thickness. Given the fact that rock supply, whilst adequate is not abundant and not to be overspecified, efforts should be made to continue the reuse of existing pavement/ seal materials with prior experimentation and testing to verify its suitability and on a road-by-road basis. Coupled with this is the uncertainty as to the thickness of existing re-usable base material which can vary from virtually nil to considerably more than 100 mm across the cross-section due to lack of control of layer thickness in the past.

An important concept in the design of any asset is Design Life, which relates to a period before significant maintenance or even replacement becomes the economic choice. For mainland highly trafficked roads for example the pavement design life might be 40 years with a commensurate large initial capital cost. Given the current state of Norfolk Island Road a lesser design life is more appropriate. Put simply it would be possible to adopt a standard with a very high design life (and improve very few roads) or apply the same amount of money to a lesser standard (but still adequate design) and improve a lot more roads. It is not possible to put a number on the design life of the suggestions made in this report but it is believed if resealing were to be done in under 15 years, after the suggested improvements, there would be much fewer significant failures.

The pavement design suggested in this report is based on the assumption that hot mix would not be available for some time (perhaps five years or so) until the airport runway is resheeted. If and when hot mix becomes available it could be used to waterproof the surface, seal the cracks and improve the shape and ride considerably in the existing pavement However it would also increase the level of the road surface by at least 30mm with the commensurate associated issues such as access levels, drainage, kerbs etc. This would need to be considered if and when the opportunity arose to asphalt some roads. The advantage of asphalt would be that it would eliminate the need to rip and reshape the existing road surface with all its commensurate problems. However, it is doubtful that the current roads would last another five years without some major intervention.

Standard pavement designs and pavement specifications need to be developed together with testing regimes and a testing facility. The designs should bear in mind the potential for re-use of existing base and seal either as acceptable base or subbase material. Pulverising and reuse together with topping up as required would not only use less rock but would avoid the requirement to take material off-site.

It is understood field compaction or material density is checked only by a simplified dropped hammer method (Clegg Impact Soil Tester) but that method is not consistently used. Compaction of the fill, sub base and base course is very important in achieving durability. Experienced road construction personnel understand the relationship between moisture content and compactive effort required to achieve the specified minimum compaction. Without a means to test moisture content and relative compaction of the various layers and a process of scientifically sampling each layer of each section of road, then the likelihood of achieving the required compaction is fairly low.

Basic equipment for a materials testing laboratory could be sourced and permanently set up but only staffed as and when required. The testing would require a trained operator.

The standard means now used in Australian road construction of verifying material density is by using a nuclear density meter to test the soil moisture content and the material relative density compared to a theoretical maximum density from a soil sample. Once the base density is determined and assuming consistent material, this enables instantaneous results and is a simpler and less labour intensive operation. There is a nuclear density meter available at the airport, which could be used for roadworks. However, it requires regular calibration, which could cause a problem insofar as transport, as it contains a nuclear element. For the same reason it also requires safe storage.

C1.3 Drainage Design

Hydrology is the science of determining the volume of overland water flow following a rainfall event. This enables the correct sized pipe culverts or bridge to be determined. It also ensures that the road embankment does not create afflux, which may cause flooding to private or heritage public properties. The hydrology of the culvert catchments on Norfolk Island is unknown. Some basic hydrology investigation and assessment is required in order to ascertain the minimum size of cross drainage. This does not need to be sophisticated but should conform to the “Australian Rainfall and Runoff” and Austroads Guide to Road Design: Part 5 Drainage Design.

Surface drainage is important so as to shed surface water quickly away from the road. Subsurface drainage is important so as to keep water away from the pavement.

Little evidence was observed of any longitudinal drainage and only a few examples of cross drainage. Whilst not observed, it was advised that water running or ponding on the road surface is an ongoing problem for safety and convenience. The typical road cross-section is a 6 m wide pavement with a grassed verge either side or varying width. This verge is usually higher than the adjacent road and causes water to pond or causes the road to act as a longitudinal drain. This is undesirable for road safety as vehicles try to avoid the ponding, for convenience as motorists can splash pedestrians and for the durability of the road pavement as it will weaken the pavement and cause early distress.

To correct this problem for the existing roads would, in many places, unfortunately destroy the country lane feel. A compromise in some locations may be to channel the water away from the pavement using flat V shaped table drains at regular intervals and at low points. In cuttings this solution will not work and a table drain could be graded at least at the outer edge of the shoulder and below the level of the pavement. It is not recommended that a pit and pipe drainage system be installed as this can be expensive and would create secondary problems associated with concentrating flows.

There are no records of subsoil drains being used. Despite this there is little evidence of sub-surface water damage. This may be explained if the underlining layers are permeable enough to quickly drain the water away and not weaken the pavement or the fill. However, it is considered prudent that in future all cuts have subsoil drains installed at the outer edge of the shoulder and marked with marker posts. Where springs are encountered in the cuttings, the herringbone subsoil drains should also be installed.

Standards for surface, longitudinal, cross drainage and subsoil drainage need to be developed, or adapted.

C1.4 Recommended Design Standards

Recommended standards for road infrastructure design are addressed below. Applicable standards/guidelines are reviewed and suggestions are made for geometric design criteria for application on Norfolk Island.

The following guidelines have been selected for review on the basis they would be appropriate for the rural and low volume nature of the Norfolk Island Roads System. Relevant extracts from these documents are provided.

- Austroads – Rural Road Design
- ARRB – Unsealed Roads Manual
- ARRB – Road Classification, Geometric Designs and Maintenance Standards for Low Volume Roads
- Norfolk Island DCP No 1 – New Subdivision Roads

The speed limits for roads on the island are low: a maximum speed of 50 km/h in the rural areas, 40 km/h in Burnt Pine, 30 km/h near the school at Middlegate and along the Kingston foreshore, 30 km/h in the Norfolk Island National Park, and 10 km/h within the carpark at the airport. All livestock roaming the roads have the right of way.

Annual Average Daily Traffic counts (AADT) for roads on the island are not known however they are expected to be in the order of 500 – 1000 for the most highly used roads and much less for others. The relatively straight and flat section through Burnt Pine Township might, however, be in the order of 3000 at times (highly variable due to tourism peaks and troughs).

Table C1 summarises the guidelines and puts forward proposed values for Norfolk Island (Column- 'This Study Proposal'). The island roads have been grouped into two categories:

1. Main Roads > 150AADT, generally sealed
2. Secondary Roads < 150 AADT, generally unsealed

It should be recognised that it is not proposed that the existing road infrastructure be assessed against the new criteria but that the criteria potentially be adopted for new roads (or significant upgrades) that are beyond the scope of the existing Norfolk Island Subdivision DCP.

Table C1 Summary of Existing Guidlines and Proposed Criteria for Norfolk Island

Road Classification	Sealed Main Road >150 ADT					Secondary Road < 150 ADT				
Operating Speed	50 km/hr					50 km/hr				
Reference Guideline	Austroads - RRD	ARRB - URM	ARRB - LVR	NI - DCP 1	This Study Proposal	Austroads - RRD	ARRB - URM	ARRB - LVR	NI - DCP 1	This Study Proposal
Geometric Characteristic										
Cross-Section Elements										
Number of Traffic Lanes	2[2]	2	2		2	1	2	1/2	1	1/2
Min. Lane Width	3.1[2]	3.0	3.0		3.0	3.5	3.0	3.5/3.0	3.0	3.0
Min. Shoulder Width	0.75	0.5	0.5		0.5	0.75	0.5	1.5/0.5	2.5	1.5/0.5
Min. C/W Width (lane + shoulder)	7.7	7.0	7.0		7.0		7.0	6.5/7.0	11.0	6/7
Min. Formation Width (inc. verges)	9.7	9.0	9.0		9.0		9.0	8.5/9.0	16.0	8/9
Min Cross Fall										
Sealed	3	-	3		3			3	4	3
Unsealed	4	5	5		5		5	5	-	5
Max. Super Elevation										
Sealed	10	-	7-10				-	6-10	-	6-10
Unsealed		-	8				-	8	-	8
Max. Cut Batter (OTR)	1v:1.5h	-			1v:1.5h	1v:1.5h	-	-	1v:1h	1v:1.5h
Max. Fill Batter	1v:2h	-			1v:2h	1v:2h	-	-	1v:1h	1v:2h
Horizontal Geometry										
Min. Horizontal Radius										
Sealed	44[1]	-	45		45	44[1]	-	45	20[3]	45
Unsealed	-	140	140		-		100	100	-	100
Min. Stopping Site Distance										
Sealed	47	-	50		50	47	-	50	60[3]	60 (3)
Unsealed	-	70	70		-	-	70	70	-	60 (3)
Min. Meeting Site Distance										
Sealed	-	-	100		100		-	100	-	100
Unsealed	-	130	130		-	-	130	130	-	130
Vertical Geometery										
Max. Vertical Grade [1]	10	12	12		10	10	12	12	16	10
Min. Crest VC K Values	5.0	10	5/9		10		10	5/9	-	10
Min. Sag VC K Values	2.0	4	4		4		4	4	-	4

(1) Values for mountainous terrain shown
(2) Value fro AADT 150-500 shown
(3) Value to be determined for each site taking into consideration the particular requirements of the development together with the toppography and geology of the site

C1.4.1 Reference: Austroads Rural Road Design

The following extracts from the Rural Road design guide are considered relevant for road design on Norfolk Island. The accompanying figures and tables have not been included.

Speed Concept - Low Speed Roads

These are roads having many curves with radii less than 150m. Operating speeds on the curves vary from 50 km/h to 70km/h. These roads are only used when difficult terrain and costs preclude the adoption of higher speeds. The alignments provided in these circumstances could be expected to produce a high degree of driver alertness, so those lower standards are both expected and acceptable. The most pragmatic approach to the design of individual elements in such constrained situations is to provide the best that appears practicable, and to check that it is within the absolute minimum standards for the predicted 85^{th} percentile speed. Innovative, non-standard treatments will often be required when these standards cannot be met. On roads with speed limits less than 100 km/h, the operating speed of vehicles will be determined by the geometric constraints of the road on the imposed speed limits and the corresponding operating speeds refer Section 7.2 and Figure 7.1.1.3.5 85th Percentile Speed

The term "eighty fifth percentile speed" indicates that 85 percent of car drivers will travel at or below this speed and 15 percent will travel faster. In effect, this means that designs based on the 85th percentile speed will cater for the majority of drivers. For design purposes, the 15% of drivers who exceed this speed are considered to be aware of the increased risk they are taking and are expected to maintain a higher level of alertness, effectively reducing their reaction times.

Stopping Site Distances

The concept of car stopping sight distance is illustrated in Figure 8.2. It is measured between the driver's eye and a small object on the road.

*SSD values for cars are calculated using the adopted longitudinal friction factor values, are shown in Table 8.3(a)***.**

Horizontal Curves

The minimum radii of horizontal curves for given operating speeds are as shown in Table 9.2.

Site Distances on Horizontal Curves

Horizontal curves with minimum radii shown in Table 9.2 do not necessarily meet the sight distance requirements described in Section 8. Where a lateral obstruction off the pavement such as a bridge pier, cut slope or natural growth restricts sight distance, the stopping sight distance appropriate to the design speed of the curve determines the minimum desirable radius of curvature.

Figure 9.5shows the relationship between horizontal sight distance, curve radius and lateral clearance to the obstruction and is valid when the sight distance at the appropriate design speed is not greater than the length of curve. This relationship assumes that the driver's eye *and the sighted object are above the centre of the inside lane, 1.75m in from the outer edge of lane based on a standard 3.5 m lane width. When the design sight distance is greater than the length of curve, a graphical solution is appropriate.*

For alignments on lower speed roads, particularly in difficult terrain, it may not be feasible to achieve the 2.5 seconds reaction time stopping sight distances shown in Section 8. Increasing curve radius to improve the sight distance may increase the operating speed so that longer, and still unavailable, design stopping sight distances are required. In these situations, the designer should provide the maximum sight distance practicable, and ensure that it is not less than the stopping sight distance corresponding to a 2.0 second reaction time.

Where sight benches in side cuttings are required on horizontal curves or a combination of horizontal and vertical curves, the horizontal and vertical limits of the benching are determined graphically or by modelling.

Benching for Visibility on Horizontal Curves

Benching is the widening of the inside of a cutting on a curve to obtain the specified sight distance. It usually takes the form of a flat table or bench over which a driver can see an approaching vehicle or an object on the road. In plan view, the envelope formed by the lines of sight fixes the benching. The driver and the object he is approaching are assumed to be in the centre of the inner lane and the sight distance is measured around the centre line of the lane, the path the vehicle would follow in braking. Benching adequate for inner lane traffic more than meets requirements for the outer lane.

Where a horizontal and crest vertical curve overlap, the line of sight between approaching vehicles may not be over the top of the crest but to one side and may be partly off the formation. Cutting down the crest on the pavement will not increase visibility if the line of sight is clear of the pavement, and the bottom of the bench may be lower than the shoulder level. In these cases, as well as in the case of sharp horizontal curves, a better solution may be to use a larger radius curve so that the line of sight remains within the formation. However, this will tend to increase the operating speed, which in turn will increase the sight distance required.

Maximum Grades

Grades used in design are, therefore, only controlled at the upper end by vehicle performance. In most designs, the general maximum grade to be sought will be based on level of service and quality of service considerations, modified as appropriate by the severity of the terrain and the relative importance of the road. Table 10.2 shows maximum grades over long lengths of road in various terrain types.

The adoption of grades steeper than the general maximum may be justified in the following situations:

- *Comparatively short sections of steeper grade which can lead to significant cost savings;*
- *Difficult terrain in which general maximum grades are not practical;*
- *Where absolute numbers of heavy vehicles are generally low; and*
- *Less important local roads where the costs or impact of achieving higher standards are difficult to justify.*

In any case, design options for the road include, on one hand, flattening the grade, and on the other, the provision of auxiliary lanes and/or special facilities for safely controlling runaway vehicles on downgrades (refer Section 13.7).

"When adopting maximum grades, side drains need to be considered in respect to the maximum velocity of flow for scour protection. Special lining of the drains may be required to limit damage to the drain and the environment."

Crest Vertical Curves

Minimum crest vertical curve K values are shown in Table 10.4 for various operating speeds, reaction times, and vertical height constraints.

Sag Vertical Curves

Appearance is important when considering small and larger changes in grade (the same as for crest curves).

Sag vertical curves are generally designed to achieve the comfort criterion as a minimum.

Values of minimum K for sag curves are shown in the Table 10.5.

Road Widths :

(not included in this extract)

Verge

The main functions of the verge are to provide:

- *Traversable transition between the shoulder and the batter slope;*
- *A firm surface for stopped vehicles at a safe distance from traffic lanes;*
- *Support for the boxing edge and shoulder material;*
- *Space for installation of guide posts and road safety barriers; and*
- *Provide rounding between the formation cross slope and embankment batter slope to assist controllability of vehicles, which encroach the formation and to reduce scouring due to road storm water run off.*

The minimum widths for these functions are shown in Table 11.6.

Crossfalls

Shoulders generally should be steeper than the adjacent traffic lanes to assist surface drainage (marginal increase of 1%). However, where the shoulder consists of full depth pavement and is sealed, its slope may be the same as the adjacent pavement in order to facilitate construction.

*On straights the shoulder cross fall is shown in Table 11.5**.** On superelevated sections of roads, the shoulder on the high side and low side must have the same crossfall as the traffic lanes. A cross fall of 5% or more extended across the verge may lead to more frequent maintenance and should be monitored.*

Superelevation

Use of maximum superelevation will need to be applied in steep terrain or where there are constraints on increasing the radius of an individual curve in a group. The current design practice shows that superelevation exceeding 7% is rarely used. In mountainous terrain there is normally insufficient distance to fully develop steep (more than 7%) superelevation and in less rugged terrain the use of steep superelevations is questionable considering the potential adverse effect on high centre of gravity vehicles. Therefore, the absolute maximum superelevation should be 7% with 6% being the normal maximum superelevation for high-speed rural roads. The maximum superelevation (low speed <90 km/h) in mountainous terrain should be 10%. Other factors that must be considered for 10% maximum super are:

Batters

Batters are surfaces, commonly but not always of uniform slope, which connect carriageways or other elements of cross sections to the natural surface. Batters may:

- *Provide a recovery area for errant vehicles;*
- *Be used as part of the landscaped area; and*
- *Be used for access by maintenance vehicles.*

Batter slopes are usually defined as the ratio of one vertical on "x" horizontal and are shown as, for example, 1 on 4.

The following factors should be considered when selecting batter slopes:

- *The results and recommendations of geotechnical investigation;*
- *Batter stability;*
- *Batter safety (economics of eliminating safety barriers);*
- *Future costs of maintaining the adopted slope;*
- *Appearance and environmental effects;*
- *Earthworks balance;*
- *Available width of road reserve; and*
- *Landscaping requirements.*

Slopes flatter than the desirable maximum (see Table 11.7) should be used where possible.

Clear Zones

It is not feasible to provide width adjacent to the carriageway that will allow all errant vehicles to recover. Therefore it is necessary to reach a compromise or level of risk management. The most widely accepted form of risk management for roadside hazards is the 'clear zone concept'. The clear zone is the horizontal width measured from the edge of the traffic lane that is kept free from hazards to allow an errant vehicle to recover. The clear zone is a compromise between the recovery area for every errant vehicle, the cost of providing that area and the probability of an errant vehicle encountering a hazard. The clear zone should be kept free of non-frangible hazards where economically possible; alternatively, hazards within the clear zone should be shielded. The clear zone width is dependent on:

- *Speed;*
- *Traffic volumes;*
- *Batter slopes; and*
- *Horizontal geometry.*

It should be noted that the clear zone width is not a magical number and where possible hazards beyond the desirable clear zone should be minimised.

Clear zone widths vary throughout the world depending on land availability and design policy. The concept originated in the United States in the early 60's and has progressively been refined and updated. For a typical high-speed road the clear zone width varies between 4.0m (France, South Africa) to 10.0m (Canada,

USA). More recent studies have found that the first 4.0-5.0m provides most of the potential benefit from clear zones.

Figure 17.2 provides an indication of appropriate clear zone widths for a straight section of road with trafficable batters The clear zone width increases where there is sub-standard horizontal geometry, especially on the outside of a curve or where non-trafficable batter slopes are present. Non-trafficable batter slopes refers to batter slopes of steeper than 1 on 4.

The clear zone width on the outside of curves increases by a factor Fc, which depends on the operating speed and the radius of the curve. Fc ranges between 1.0 to 1.9. Figure 17.3 provides guidance on adjustment factors for clear zones on the outside of curves.

Where batter slopes are steeper than 1 on 4 (that is non trafficable) designers should give consideration to the provision of a road barrier (refer to Section 17.4).

A guide for the installation of roadside safety barriers on embankment is shown on Figure 17.4.

Figure 17.5 indicates the variation of clear zone widths on batters steeper than 1 on 6 to give an effective clear zone width to be used in design.

Existing Hazards within a Clear Zone

Common existing roadside hazards in a rural environment include:

- *Poles – power poles or sign posts;*
- *Trees;*
- *Batters;*
- *Dams and water courses;*
- *Drainage and associated infrastructure like culverts and endwalls;*
- *Fences; and*
- *Bridge piers.*

The most desirable action is to remove or relocate hazards although this is not always possible due to road reservation or economic and environmental constraints. Where hazards cannot be relocated then they should either be shielded or made 'more forgiving'.

It is becoming increasingly common for light poles and signposts to be provided with frangible bases. This is an attempt to provide a forgiving roadside while still providing the necessary roadside infrastructure. Common types of frangible poles include:

- *Slip base poles;*
- *Impact absorbent poles;*
- *Steel frangible posts;*
- *Aluminium frangible assemblies; and*
- *Wooden frangible posts.*

The support connection of a slip base pole is intended to shear on impact with the pole landing close to the point of impact. Impact absorbent poles crumple and bend around the vehicle. Slip base poles can usually be re-used after an impact and for this reason tend to be more common. However, they can only be used where there will not be a conflict with overhead services in the event of an impact, and where the risk to other road users, particularly pedestrians, is minimised.

Steel frangible posts fail on impact as a result of shear failure planes. Aluminium assemblies collapse due to shear pin action. Frangible wooden signposts have holes drilled at the base creating a plane of weakness that permits the posts to collapse on impact.

Other measures to make roadside hazards more forgiving include:

- *Considering the mature trunk size of trees prior to planting;*
- *Installing driveable culvert end walls; and*
- *Extending culvert walls to beyond the clear zone width.*

C1.4.2 REFERENCE ARRB UNSEALED ROADS MANUAL

THE FOLLOWING EXTRACTS FROM THE UNSEALED ROADS MANUAL ARE CONSIDERED RELEVANT FOR ROAD DESIGN ON NORFOLK ISLAND.

UNSEALED ROAD CLASSIFICATION ARRB UNSEALED ROADS

Table 4.1 Unsealed roads classification system

Road class	Class type	Service function description	Road type description
4A	Main road > 150 ADT	This type of road is used for major movements between population centres and connection to adjacent areas. High traffic volumes occur and the road can carry large vehicles.	• All weather road predominantly two-lane and unsealed. Can be sealed if economically justified • Operating speed standard of 50–80 km/h according to terrain • Minimum carriageway width is 7 m
4B	Minor road 150–50 ADT	This type of road is used for connection between local centres of population and links to the primary network. Roads may or may not be sealed depending on the importance and function of the road.	• All weather two-lane road formed and gravelled or single-lane sealed road with gravel shoulders • Operating speed standard of 30–70 km/h according to terrain • Minimum carriageway width is 5.5 m.
4C	Access road 50–10 ADT	Provides access to low use areas or individual rural property sites and forest areas. Caters for low travel speed and a range of vehicles and may be seasonally closed.	• Substantially a single lane two-way generally dry-weather, formed (natural materials) track/road • Operating speeds standard of < 20–40 km/h according to terrain • Minimum carriageway width is 4 m • May be restricted to four-wheel drive vehicles
4D	Tracks < 10 ADT	Provides primarily for four-wheel drive vehicles. Mainly used for fire protection purposes, management access and limited recreational activities.	• Predominantly a single-lane two-way earth track (unformed) at or near the natural surface level • Predominantly not conforming to any geometric design standards • Minimum cleared width is 3 m

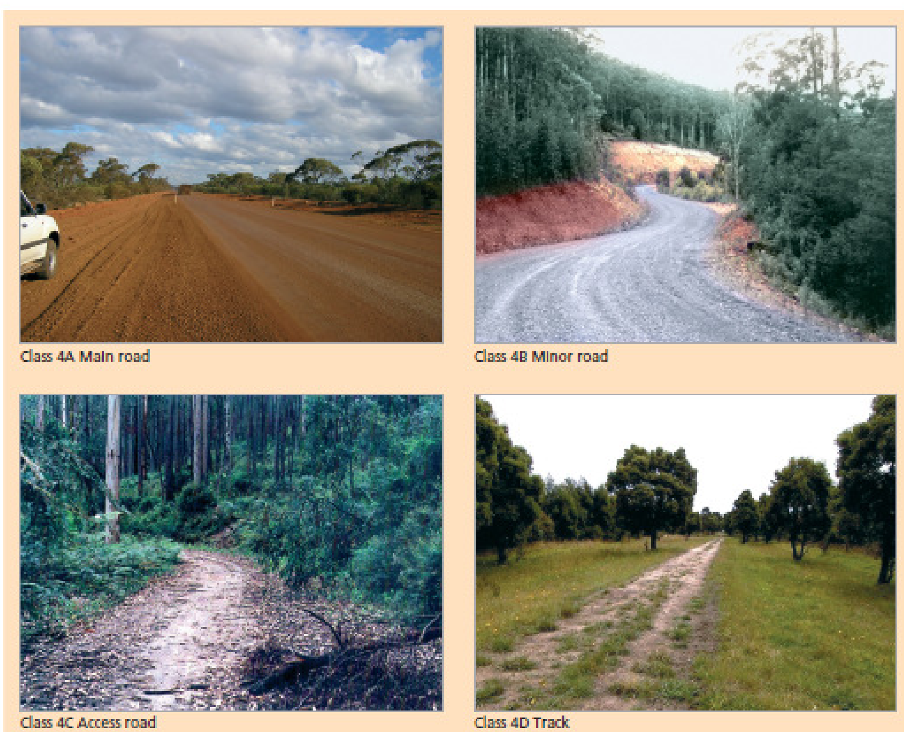

Class 4A Main road
Class 4B Minor road
Class 4C Access road
Class 4D Track

Figure 4.2 Typical examples for each road classification

GEOMETRIC DESIGN STANDARDS ARRB UNSEALED ROADS

Table 4.2 Guidelines for the main geometric design standards for unsealed roads

Road classification	4A Main			4B Minor			4C Access			4D Tracks			Comments
Terrain type[1]	Flat	Rolling	M'tain	Flat	Rolling	M'tain	Flat	Rolling	M'tain	Flat	Rolling	M'tain	
Main geometric characteristic *based on safety, costs and environmental considerations*													
Operating speed value km/h	80	70	50	70	50	30	60	40	20	N/A	N/A	N/A	based on 85th percentile speed
Cross-section elements													
number of traffic lanes	2	2	2	2	2	2	1	1	1	1	1	1	unsealed lanes
minimum cross fall unsealed road	5	5	5	5	5	5	5	5	5	4	4	4	min of 4% to drain rainfall off tracks
maximum superelevation %[2]	6	7	8	6	8	10	6	8	10	N/A	N/A	N/A	
minimum traffic lane width m[3]	3.5	3	3	3	3	3	3	3	3	3	3	3	
minimum shoulder width m	1	1	0.5	0.5	0.5	0.5	1.5	1	0.5	0	0	0	
minimum carriageway width (lanes + shoulder) m	9	8	7	7	7	7	6	5	4	3	3	3	
minimum formation width (including verges)[4]	11	10	9	9	9	9	8	7	6	3	3	3	
Horizontal geometry													
minimum radius curve m[5]	320	250	140	250	100	35	170	60	15	N/A	N/A	N/A	
minimum stopping sight distance m[6]	150	120	70	120	70	30	90	50	30	N/A	N/A	N/A	
minimum meeting sight distance m[7]	290	230	130	230	130	60	180	100	60	N/A	N/A	N/A	
Vertical geometry													
maximum vertical grade %[8]	6	8	12	6	8	12	6	8	12	N/A	N/A	N/A	for tracks avoid steep grades to reduce soil erosion
minimum crest vertical curve K values[9]	50	30	10	30	10	5	19	8	2	N/A	N/A	N/A	
minimum sag vertical curve K values[10]	11	8	4	8	4	3	6	3	2	N/A	N/A	N/A	

1 Flat, rolling or mountainous terrain.

2 The maximum superelevation value will need to take into account the use of the road by high loaded heavy vehicles, speed and curve radii.

3 In cases where there are a high percentage of heavy vehicles (> 20%) minimum lane widths can be increased by 0.5 m.

4 Allows for 1m verge/table drain width. This must be reviewed based on actual locations where for drainage reasons greater widths may be required.

5 Values rounded up. For minimum radius curves widening on the inside of a curve may be necessary to accommodate longer vehicles.

6 Based on a reaction time of 2 seconds and surface coefficients relating to unsealed surfaces and values rounded up. Values based on flat grades and allowances will need to be made for up and down grades.

7 This is mainly a requirement for single lane two-way roads. Values rounded up.

8 In some cases higher grades of up to 20% can be allowed for short sections (about 150 m). Keep grades on unsealed roads lower due to ravelling and scouring of surface.

9 Calculation of these values is to be based on information contained in Austroads (2003). The length of the vertical curve (L) is based on the product of K multiplied by the algebraic difference in grades percentage A (i.e. L = K × A).

10 Sag values are based on comfort control criteria.

C1.4.3 REFERENCE ARRB – LOW VOLUME ROADS

THE FOLLOWING EXTRACTS FROM THE LOW VOLUME ROADS GUIDELINE ARE CONSIDERED RELEVANT FOR ROAD DESIGN ON NORFOLK ISLAND.

ARRB ROAD CLASSIFICATION SYSTEM FOR LOW VOLUME ROADS

Road Class	Class Type	Service Function Description	Road Type Description	Parks Victoria Equiv.	NRE Equiv.	NRE Royalty Classes
5A	Primary Road > 100 ADT #	Provides primarily for the main traffic movements into and through a region. This includes access to high use visitor sites and forest areas. Caters generally for higher travel speed, all vehicle types including large vehicles (ie buses and trucks).	All weather road predominantly two-lane and mainly sealed. A high quality* of service road Design speed standard of 80 - 50 km/h according to terrain Minimum carriageway width is 7 m	Class S1 Class U1		Class A

Road Class	Class Type	Service Function Description	Road Type Description	Parks Victoria Equiv.	NRE Equiv.	NRE Royalty Classes
5B	*Secondary Road* *100 - 30 ADT*	*Provides access to moderate use visitor sites and forest areas.* *Serves the purpose of collecting and distributing traffic from local areas, moderate use visitor sites and forest areas to or from primary or minor roads.* *Caters for moderate travel speed a full range of vehicles including large vehicles*	*All weather two lane road formed and gravelled or single lane sealed road with gravel shoulders* *A good quality of service road* *Design speed standards of at 70 30 km/h according to terrain* *Minimum carriageway width is 5.5m*	*Class S2* *Class U2*	*Class 1 & 2*	*Class B (i)*
Road Class	***Class Type***	***Service Function Description***	***Road Type Description***	***Parks Victoria Equiv.***	***NRE Equiv.***	***NRE Royalty Classes***
5C	*Minor Road* *50 – 20 ADT*	*Provides a link to low and moderate use visitor sites and forest areas, and forms a feeder link to a logging coupe* *Access track/road or fire track.* *Purpose is to link areas, which are traffic generators to secondary or primary roads.* *Caters for lower travel speed and full range of vehicles*	*Generally all-weather single lane two-way unsealed formed road usually lightly gravelled* *A fair quality of service road* *Design speed standards of 60 - 20 km/h according to terrain* *Minimum carriageway width is 4m*	*Class U3*	*Class 3*	*Class B (ii)* *Class C (i)*

5D	*Access Track/ Road* *< 20 ADT*	*Provides access to low use visitor sites and forest areas Can be short term, temporary or feeder roads to access individual timber harvesting coupes.* *Provides for fire protection and management access (sometimes exclusively for management vehicles only)* *Caters for low travel speed and a range of vehicles in dry weather* *May be seasonally closed*	*Substantially a single lane two-way generally dry-weather, formed (natural materials) track/road* *A low quality of service track/road* *Design speeds of 40 - <20 km/h according to terrain* *Minimum carriageway width is 4m* *May be restricted to four wheel-drive vehicles*	*Class U4*	*Class 4*	*Class C (ii) & D (ii)*

Road Class	Class Type	Service Function Description	Road Type Description	Parks Victoria Equiv.	NRE Equiv.	NRE Royalty Classes
5E	*Rough Tracks* *< 10 ADT*	*Provides primarily for four wheel-drive vehicles* *Mainly used for fire protection purposes, management access and limited recreational activities.* *Caters for very low travel speed* *May be seasonally closed.* *May be restricted to management vehicles only*	*Predominantly a single lane two-way earth tracks (unformed) at or near the natural surface level* *A very low quality of service track* *Predominantly not conforming to any geometric design standards* *Minimum cleared width is 3m*	*Class U5*	*Class 5*	*Class D (i) & (ii)*

GUIDELINES TO THE MAIN ARRB GEOMETRIC DESIGN STANDARDS FOR LOW VOLUME ROADS

Guidelines to the Main Geometric Design Standards

Road Classification	**5A Primary**			**5B Secondary**			**5C Minor**			**5D Access**			**5E Tracks**			**Comments**
Terrain Type (1)	Flat	Rolling	M'tain	Flat	Rolling	M'tain	Flat	Rolling	M'tain	Flat	Rolling	M'tain	Flat	Rolling	M'tain	
Main Geometric Characteristic																based on safety, costs and environmental considerations
Speed value km/hr	80	70	50	70	50	30	60	40	20	40	30	< 20	N/A	N/A	N/A	based on 85th percentile speed
Cross section elements																
number of traffic lanes	2	2	2	1 / 2	1 / 2	1 / 2	1	1	1	1	1	1	1	1	1	single lane sealed / two lane unsealed
minimum cross fall/camber %																
sealed road	3	3	3	3	3	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
unsealed road	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	min of 4 % to drain rain fall off tracks
maximum superelevation % (2)																
sealed road	7 – 10	7 – 10	7 – 10	6 – 8	6 – 10	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	actual value based on curve
unsealed road	6	7	8	6	8	10	6	8	10	6	8	10	N/A	N/A	N/A	radius adopted
minimum traffic lane width m (3)	3.5	3	3	3.5 / 3	3.5 / 3	3.5 / 3	3	3	3	3	3	3	3	3	3	sealed / unsealed values
minimum shoulder widths m	1	1	0.5	2 / 0.5	1.5 / 0.5	1 / 0.5	1.5	1	0.5	1	0.5	0.5	0	0	0	sealed / unsealed values
minimum carriageway width (lanes + shoulder) m	9	8	7	7.5 / 7	6.5 / 7	5.5 / 7	6	5	4	5	4	4	3	3	3	sealed / unsealed values
minimum formation width (including verges) (4)	11	10	9	9.5 / 9	8.5 / 9	7.5 / 9	8	7	7	7	6	5	3	3	3	sealed / unsealed values
Horizontal Geometry																
minimum radius curve m (5)																
sealed road	160	100	45	110	45	15	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
unsealed road	320	220	140	250	100	35	170	60	15	70	35	15	N/A	N/A	N/A	
minimum stopping sight distance m (6)																
sealed road	110	90	50	90	50	25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	at tight curves check for lateral obstructions to provide the stopping sight distance required
unsealed road	150	120	70	120	70	30	90	50	30	50	30	20	N/A	N/A	N/A	
minimum meeting sight distance m (7)																
sealed road	210	170	100	170	100	45	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	for high volume roads may need to check for overtaking provisions
unsealed road	290	230	130	230	130	60	180	100	60	100	60	40	N/A	N/A	N/A	
Vertical Geometry																
maximum vertical grade % (8)	6	8	12	6	8	12	6	8	12	6	8	15	N/A	N/A	N/A	for tracks avoid steep grades to reduce soil erosion
minimum crest vertical curve K values (9)	23 / 46	14 / 28	5 / 9	14 / 28	5 / 9	2 / 5	9	4	2	4	2	1	N/A	N/A	N/A	sealed / unsealed values
minimum sag vertical curve K values (10)	10	8	4	8	4	3	6	3	2	3	2	1	N/A	N/A	N/A	sealed / unsealed values

NOTES ARRB LOW VOLUME ROADS

1. *Flat, rolling or mountainous terrain.*
2. *The maximum superelevation value will need to take into account the use of the road by high loaded heavy vehicles, speed and curve radii.*
3. *(In cases where there is a high percentage of heavy vehicles (> 20 %) minimum lane widths can be increased by 0.5 m.*
4. *Allows for 1m verge/table drain width. This must be reviewed based on actual locations where for drainage reasons greater widths may be required.*
5. *This is based on Austroads (1989) and Giummarra G. (2001). Lower values of surface coefficients on unsealed roads result in radii being greater. Values*
6. *Rounded up. For minimum radius curves widening on the inside of a curve may be necessary to accommodate longer vehicles.*
7. *Based on a reaction time of 2 seconds and surface coefficients relating to sealed and unsealed surfaces and values round up. Values based on flat grades and allowances will need to be made for up and down grades.*
8. *This is a requirement for single lane two-way roads. Values rounded up.*
9. *In some cases higher grades of up to 20 % can be allowed for short sections (about 150 m).*
10. *Keep grades on unsealed roads lower due to ravelling and scouring of surface.*
11. *Calculations of these values are to be based on information contained in Austroads (1989) for sealed roads and Giummarra G. (2000) for unsealed roads. The length of the vertical curve (L) is based on the product of K multiplied by the algebraic difference in grades percentage A. (ie L + K x A).*
12. *Sag values are based on comfort control criteria.*

C1.4.4 REFERENCE NI DCP FOR SUB-DIVISIONS

THE FOLLOWING EXTRACTS FROM THE NI DCP ARE CONSIDERED RELEVANT FOR ROAD DESIGN ON NORFOLK ISLAND.

GEOMETRIC ROAD DESIGN STANDARDS NI - DCP

This section sets out the geometric design standards for new subdivision roads. The application of appropriate road design standards is aimed at ensuring that new road alignments adequately provide for safe access to and from properties.

Road alignments and design must be appropriate for the topography and geology of the land. Appropriate provision should be made for public utilities, drainage and where necessary, traffic control devices and pedestrian access.

Speed restriction signs shall be placed at the ends of and main entrances into roads with a design speed less than 50km/h.

The maximum longitudinal gradient on a road in an area of varying topography might result in the need for cut and fill earthworks. The width of the road reserve may need to be increased to provide for batters and cuttings and the required clearance to the boundary between the road reserve and adjoining properties. Attention should be given to ensuring that potentially hazardous features are visible to the driver and adopting traffic engineering measures that will help a driver avoid errors of judgement.

The road reserve shall accommodate curves that meet the specified Minimum Curve Radii. Designers should ensure that, for a given design speed, the minimum radius of curvature is such that drivers can safely negotiate the curve. Curves that progressively tighten produce an uncomfortable sense of disorientation and alarm, as can sudden reverse curves that drivers cannot anticipate. Where curves in the road alignment restrict vehicle speed the relationship between the radius of the curve and the desired vehicle speed is given in Table 1.

Table 1 **Speed/Radius Relationship.**

Desired Vehicle Speed (km/hr)	Curve Radii (m) on Road Centreline	
	Curvilinear Alignment (no tangents)	Isolated Curve Alignment (with tangent sections)
20	15	10
25	20	15
30	30	20
35	50	30
40	90	40

Benching of the batter on the inside curve could be employed as a means of avoiding widening of the road reserve width. The driver can see oncoming traffic or obstructions over the bench, maintaining minimum sight distance. The height of any such bench should be at least 300mm lower than the line of sight, to allow for growth of grass.

Roads that are designed for speeds of 40km/hr or less and with curves of 60m radius or less generally have the pavement crowned on a curve instead of superelevation.

- *The three dimensional coordination of the horizontal and vertical alignment of a road should be aimed at improved traffic safety and aesthetics. The following principles should be applied:*
- *The design speed of the road in both horizontal and vertical planes should be of the same order.*
- *Combined horizontal and vertical stopping sight distance and minimum sight distance should be considered three dimensionally.*
- *Sharp horizontal curves should not be introduced at or near the crest of a vertical curve. A horizontal curve should leave the vertical curve and be longer than the vertical curve.*
- *A short vertical curve on a long horizontal curve or a short tangent in the gradeline between sag curves may adversely affect the road's symmetry and appearance.*

Roads having both horizontal and vertical curvature should be designed to conform with the terrain to achieve desirable aesthetic quality and harmony with the landform.

Sustained crossfalls should not exceed 4%, although up to 6% may be used where unavoidable. The rate of change of crossfall should not exceed: 6% per 30m for through traffic; 8% per 30m for free flowing turning movements; or 12% per 30m for turning movements for which all vehicles are required to stop. The crossfall on a distributor road should take precedence over the grade in side roads.

The design of intersections or junctions should allow all movements to occur safely without undue delay. Where an intersection with an existing public road is required to serve a development complete reconstruction of the intersection will be necessary where the speed environment and irregularity of the existing road pavement may endanger the safety of traffic in the locality.

Intersections should be generally located in such a way that:

- *The roads intersect preferably at 90° and not less than 70°.*
- *The landform allows clear sight distance on each of the approaches to the intersection.*
- *The minor road intersects the convex side of the major road.*
- *The vertical grade lines at the intersection do not impose undue driving difficulties.*
- *The vertical grade lines at the intersection allow for direct surface drainage.*
- *Adequate stopping and sight distances are provided for horizontal and vertical curves.*

Adequate provision should be made for vehicles to turn around at the end (termination) of the road. The minimum cul-de-sac radius shall be 6m seal.

Table 2

Minimum Design Standards for new roads serving:

(a) No more than 10 existing and potential portions (i.e. the maximum potential number of portions served by the new road based on the subdivision standards for the relevant zone(s); or

(b) Residence – Accommodation Unit(s) or Residence – Multiple Dwelling(s) or Residence – Dual Occupancy/ies that comprise, or have the potential to comprise, a number of units, which combined with the total in (a) above, would result in a number no more than 10; or

(c) Minor commercial, light industrial or other types of development which, when combined with the portions and/or residences served by the new road (i.e. (a) and (b) above), would not result in a volume of traffic greater than that generated solely by the limits imposed under (a) or (b).

Design Element	Standard Required	Rationale
Single lane: carriageway width	4m sealed	Must be sealed for dust abatement.
Shoulder width	3m unsealed	To provide for passing vehicles. May also be used as a corridor for public utilities.
Minimum Total Road Reserve	10m	Minimum to allow for installation of public utilities, drainage and traffic control devices and for pedestrian movement.
Clearance between boundary of road reserve and tops of cuttings and toes of batters	3m	Cuttings and batters shall be accommodated within the road reserve. Adequate clearance between the tops of cuttings and the toes of batters and the boundary between the road reserve and adjoining properties.
Maximum Longitudinal Gradient	16%	Safe sight distances, traction and property access. Approval of steeper grades up to 20% over a maximum distance of 30m may be given in extreme cases, subject to specific design requirements.
Crossfall	4%	To facilitate drainage run-off, while being of a gradient not affecting safety and property access. Up to 6% if unavoidable.
Maximum slope of batters and cuttings	1:1	To maintain slope stability, prevent erosion and facilitate re-grassing.
Design Speed	40km/h	Maximum safe speed.
Safe Stopping Sight Distance*	60m	Minimum line of sight distance measured from the driver's eye, 1m above the road to an object 150mm above the road in the centre of the same traffic lane.
Minimum horizontal curve radius*	20m	Visibility may be restricted on horizontal curves due to an obstruction on the inner side of the curve.
Minimum vertical curve radius*	25m	Visibility may be restricted on vertical curves due to an obstruction beyond a curve crest, or as with a sag curve, beyond the headlight illumination on the ascending side of the road.
Kerb Type		Layback or grass swale

Sources: Road Planning and Design Manual, Qld Main Roads; AUSPEC Geometric Road Design (Urban and Rural) D1: Northern Rivers – Local Government, February 1997.

* The applicability of these standards shall be determined for each development application, taking into consideration the particular requirements of that proposed development together with the topography and geology of the site.

Table 3
Minimum Design Standards for new roads serving land and developments beyond the limits applicable for Table 2.

Design Element	Standard Required	Rationale
Single lane: carriageway width	6m sealed	Must be sealed for dust abatement.
Shoulder width	5m unsealed	To provide for passing vehicles. May also be used as a corridor for public utilities.
Minimum Total Road Reserve	16m	Minimum to allow for installation of public utilities, drainage and traffic control devices and for pedestrian movement.
Clearance between boundary of road reserve and tops of cuttings and toes of batters	3m	Cuttings and batters shall be accommodated within the road reserve. Adequate clearance between the tops of cuttings and the toes of batters and the boundary between the road reserve and adjoining properties.
Maximum Longitudinal Gradient	16%	Safe sight distances for design speed. and property access issues. Approval of steeper grades up to 20% over a maximum distance of 30m may be given in extreme cases, subject to specific design requirements.
Crossfall	4%	To facilitate drainage run-off, while being of a gradient not affecting safety and property access. Up to 6% if unavoidable.
Maximum slope of batters and cuttings	1:1	To maintain slope stability, prevent erosion and facilitate re-grassing.
Design Speed	40km/h	Maximum safe speed.
Safe Stopping Sight Distance*	60m	Minimum line of sight distance measured from the driver's eye, 1m above the road to an object 150mm above the road in the centre of the same traffic lane.
Minimum horizontal curve radius*	20m	Visibility may be restricted on horizontal curves due to an obstruction on the inner side of the curve.
Minimum vertical curve radius*	25m	Visibility may be restricted on vertical curves due to an obstruction beyond a curve crest, or as with a sag curve, beyond the headlight illumination on the ascending side of the road.
Kerb Type		Layback or grass swale

Sources: Road Planning and Design Manual, Qld Main Roads; AUSPEC Geometric Road Design (Urban and Rural) D1: Northern Rivers – Local Government, February 1997.
* The applicability of these standards shall be determined for each development application, taking into consideration the particular requirements of that proposed development together with the topography and geology of the site.

9. Road Standards

The applicability of a particular standard shall be determined for each development application, taking into consideration the particular requirements of that proposed development together with the topography and geology of the site.

Australian Standards reference numbers to be used in conjunction with other road work specifications.

Road Engineering Element	Australian Standards Reference	Norfolk Island Requirement (if different from AS)
ROAD CONSTRUCTION **Earthworks** Specification for earthworks and formation (including surface design) General Earthworks **Bituminous Surfacing** Specification for supply and delivery of residual bitumen Specification for supply and delivery of bitumen emulsion (cationic and anionic)	 Refer to AS2187 Parts 1 & 2, 1152 Refer to AS2868 – 1986 Refers to AS2008 – 1980 AS2341 - 1992 Refer to AS1160 AS2341	
DRAINAGE Drainage, Retaining Structures and protective treatments		Talbot's formula shall be applied: see Tables below.
FENCING General	AS2423 — 1991	
TRAFFIC MANAGEMENT Specification for control of traffic at road and bridge works Specification for road marking paint Specification for plastic guide posts Specification for raised pavement markers Specification for reflective post delineators **Road Furniture** Road furniture Grid construction	 Refer to AS1742.3 AS1342.3 AS1650 AS1627 AS1143 Refer to AS1433 AS1580 Refer to AS1906 Refer to AS1906 AS1743 - 2001 AS1111 – 1980 AS1906 – 1981 Refer to AS1348.1 – 1986	
DRIVEWAYS		
PARKING		
UTILITIES		
Roadside and Public Reserves Vegetation control Litter bins and stands	 Refer to AS1348.1 ASK126 – 1984	
Concrete Procedure for design of Portland cement concrete construction	 Refer to AS1012 AS1129 AS1130 AS1315 AS1317	

DRAINAGE DESIGN STANDARDS NI - DCP

DRAINAGE TABLE FOR SIZING CULVERTS
TALBOT'S FORMULA
(2.5 inches/hour rainfall)

AREA (sq feet) REQUIRED FOR WATERWAY

No. of Acres	Steep Slopes Heavy Soils Moderate Cover	Moderate Slopes Heavy to Light Soils Dense Cover	Gentle Slopes Agricultural Soils & Cover
2	0.8	0.6	
4	1.4	1.0	
6	1.9	1.4	0.9
8	2.3	1.7	1.2
10	2.7	2.0	1.4
20	4.6	2.5	2.3
30	6.3	4.8	3.2
40	7.8	5.9	3.9
50	9.3	7.0	4.6
60	10.7	8.0	5.3
70	12.0	9.0	6.0
80	13.3	10.0	6.6
90	14.5	11.0	7.2
100	15.8	11.8	7.8
150	21.2	16.0	10.7

CULVERT SIZES FOR WATERWAYS LISTED ABOVE

Area of Waterway (sq ft)	Diameter of Round Pipe (inches)
1.25	15
1.80	18
3.10	24
4.90	30
7.10	36
9.60	42
12.60	48
15.90	54
19.60	60
23.80	66
28.30	72

C2. Construction and Maintenance Standards and Methods

C2.1 Road Construction Specifications and Methods

To the untrained eye, road construction may appear as a simple process of putting some dirt down and then spraying it with bitumen to get a “tar” road. Actually constructing a durable and fit for purpose road involves developing a design and specification package and translating that into a road using carefully selected methodologies, materials and equipment. This involves a lot of skill, appropriate resources and client supervision to ensure that the work has been carried out in accordance with the design and specifications.

Normal road construction requires a range of specialised professionals from road design engineers or road designers, geotechnical engineers, surveyors, laboratory managers, construction engineers, and skilled construction supervisors. All of these specialists must understand and then interpret the drawings and specifications for the road crew to build. Then the skill of the road crew, as a team and individually, as well as the skill and experience of the supervisor is essential in achieving a durable result. This all assumes an appropriate and complete design to work from but also relies on the skill of working with imperfect materials and conditions.

In Australia or New Zealand, if you run out of pre-coat for the aggregate, you order it from the supplier and it’s there the next day. In Norfolk Island this takes more like a week if it can be air freighted or longer if sea freighted. Similarly plant breakdowns on NI may mean the part or item has to be shipped to Australia or New Zealand making the plant inoperable until returned and installed. All of these issues complicate the construction process and make local knowledge that much more important. An added complication may be that natural imported materials may need to be heat treated to kill possible unwanted pests. This would add considerable delays and cost. It is understood that heat treatment was required for sand imported for the airport asphalt project in 2006.

No formal technical specifications are used for construction work by Admin forces. The DCP for subdivision has some information but this is hardly sufficient for public road construction. It appears Admin has not had an engineer on staff for perhaps 8 to 10 years. In some cases, without the benefit of engineering guidance, information is obtained from the Internet or from supplier’s pamphlets. This practice results in seemingly logical construction processes, however it was observed a number of important errors had been made due to a lack of theoretical understanding. Road building knowledge has largely been lost however it is suggested the situation can be recovered with appropriate training. Works involving external consultants would use appropriate specifications but literal interpretation of mainland specifications to NI would be almost certainly, problematic.

Specifications for all types of construction work are required. Each required specification should be reviewed and modified to be appropriate and achievable on NI. [1]No formal specifications were used for the minor construction work at Hibiscus Drive being built at the time of the second visit.

[1] If specifications were suitable from the recent Mt Pitt works, then this would be a good start.

The quality of the work observed at Hibiscus Drive had some observed deficiencies, such as seal not bonding to the DGB pavement, wire baskets not level and bulging and base course not properly compacted. Unfortunately this work will not prove to be durable. Similarly the recent emergency culvert replacement at Anson Bay Rd is already showing signs of settlement and pavement weakness. Thus the work could have benefitted from appropriate designs and specifications, but of equal importance, training for the works supervisor and leading hands and plant operators in road construction processes.

It is also noted that the Hibiscus Drive works have been carried out on a road that was originally privately built and transferred to the Administration and the original design and construction is substandard in a number of ways.

C2.2 Road Pavement Maintenance Specifications and Methods

Maintenance similarly appears to suffer from a lack of specifications, intervention levels and treatment options.

The only maintenance observed was routine or emergency maintenance. It is not clear that there is sufficient budget or resources for any improvement maintenance.

The system used for repair of potholes is systematic and logical however, the major drawback is that it does not always address the most urgent repair the soonest.

The ultimate solution to this problem would be to complete more reseals before too much more of the existing pavement becomes more oxidised and loses all of its elasticity. This would enable a large reduction in the quantum of pothole repairs and enable the higher priority potholes to be repaired sooner. With the current amount of pothole repairs constantly being required, it is almost impossible to get to all of the urgent ones early. Thus providing budget for improvement maintenance such as heavy patching and re-seals would help protect the existing assets and enable the routine maintenance to target the urgent issues more quickly and systematically.

Breaks in the bitumen sealed surface need to be repaired because of the following:

- Prevents the motorists from suffering from a poor ride
- Reduces the risk of motorists swerving to avoid potholes
- Reduces the likelihood of the potholes expanding
- Keeps the pavement waterproof

In the past the standards for pothole maintenance appear to be “home grown” and a one size fits all but generally not durable or logical as well as an expensive use of materials. The current standards adopted for pothole repair are less expensive but do not suit every type of pothole or pavement deficiency encountered and thus needs to be applied with some degree of discernment and skill.

The repair method currently being used for pothole patching is to place road base in the hole, compact and level the road base and then spray an emulsion seal over the patch and surrounding road area, spread some 7 or 10mm aggregate and then compact. This method is basically a reasonable compromise at the moment for the deeper holes. In the medium to long-term the use of road base for filling shallow potholes is not considered to be good practice and coldmix or a proprietary product should be used instead. The best solution is to reconstruct the top layer so that there would be far less potholes to deal with and it would be rare for them to be as much as 100 mm deep. Also the use of the steel drum roller is possibly aiding the failure of adjacent sections of sealed road in some cases and an alternative such as the plate wacker would be better, desirably using a compactor plate smaller than the surface to be compacted so it “fits in the hole”. In the Norfolk Island context it is not possible to be definitive about what is meant by a shallow pothole however 50 mm deep might be a reasonable starting point for a roads experienced engineer to design some trials and determine appropriate solutions.

Some improvements to the method would be to square up the sides of the hole, then clean and prime the sides of the hole with emulsion, adjust the road base water content to be closer to optimum before compacting, leaving the road base about 10mm low and spraying a coat of emulsion followed by 10mm aggregate and then another coat of emulsion followed by 7mm aggregate and rolling the patch. This method is slower but a more thorough repair. However given the large task of pothole repairs required and the limited resources available, such an improvement may only serve to slow the process and the patches would then outlast the adjoining road which then fails.

For shallow potholes, the use of roadbase cannot be supported and another method is required.

A better (but more expensive) option for shallow holes is to use coldmix or a proprietary product. If bulk coldmix was sourced (see discussion in Appendix D) then the hole would be squared up as before, cleaned out and primed and then the coldmix placed and compacted (in layers for deeper holes). This method also works for wide cracks and deeper holes up to possibly maximum around 100mm depth. For narrow cracks, the crack should be sealed with emulsion and sand or 7mm aggregate.

Currently the bitumen storage and decanting unit is not used. Bitumen emulsion is heated to 70 degree C in the bitumen sprayer and used for the sprayed sealing. Bitumen emulsion seals have the advantage that the crew are not working with hot bitumen and that the emulsion is less susceptible to cooler climatic conditions. However the seals are more difficult to design the correct application rate, it is more expensive and also are only able to be used with smaller sized aggregate. A more extensive discussion on Bitumen Emulsion seals is available from “Bitumen Emulsions” Austroads August 2008. The use of bitumen emulsion for seals is considered acceptable on NI if correctly designed and applied and for the current scale of work. However if a program of road reconstruction works were to be developed, it would be preferable, cheaper and more durable to move to the use of hot bitumen with appropriate training and safety procedures.

C2.3 Other Maintenance Tasks That Are Required

Additional maintenance works that should be programmed include; drain and culvert clearing, shoulder grading, table drain clearing, tree trimming, batter stabilising with wire baskets or other, timber rail replacement and other tasks as required.

All of the maintenance tasks should have a maintenance specification and the workers need to be trained in the specifications. There should also be intervention criteria (ie a set of criteria that gives guidance to the maintenance supervisor as and when to intervene and undertake treatment) so that the maintenance personnel are working to a quantitative system of intervention.

APPENDIX D. OBJECTIVE 4 DETAILS: RESOURCES

D1 Materials

In so far as materials are concerned, the island has good sources of rock for manufacture of road making materials. The 2010 report for ANI [Ref 15] is a good source of information regarding previous reports, current arrangements, anticipated needs on the island, and options for future supply of rock. It is not the intention of this report to go over the same territory but suffice it to say:

- 17,000 tonnes of rock can be obtained from stockpiles near the school. It is understood the ANI policy or preference is to continue using this rock and not open up more quarry sites until it is used. The rock is not exclusively for roadworks use but is used for other purposes as well.
- 10,800 tonnes can be won from an easily accessible seam at the Cascade Quarry site. There is some suggestion this could be used for Cascade Pier works (which will require approximately 3000 tons or 9500 tons depending on which option is selected). If this is the case Cascade Pier would not draw on the 17,000 tonnes mentioned above.
- About 50,000 tonnes or 72,000 tonnes (depending on how close quarrying might go to the house at the top) is also reasonably accessible after the 10,800 tonnes mentioned above were removed. Apparently the airport will need about 30,000 tons for resheeting by approximately 2020. The WP study team is not aware of any quarry site that has been identified for the airport works but clearly the 50,000/72,000 source could be a candidate.
- There is a possibility of a future privately run quarry site at Puppy's Point Jacob's Rock on the western side of the island.
- A feasibility report was prepared in 2009 looking at the viability of quarrying material at Headstone in association with constructing a landing place

Current usage for pothole repairs is about 1000 tons per year (500 tonnes DGB20 and 500 tonnes of chip for sealing). If funds permit there is value in doubling the size of road maintenance effort to a full-time operation instead of two or three days per week and therefore increasing rock usage to about 2000 tonnes per year. If the recommended works program of reconstruction were to take place there should be a corresponding decrease in requirements for road maintenance in time as potholes become less common. When a period of sustained weather inevitably occurs the usage would increase.

From the 17,000 tonnes stockpile the entire future road and private building materials will be sourced which could exhaust the available supply from that source after 3 to 6 years. The issue of rock supply is a major issue but its resolution is outside the scope of this report. It is a looming issue and potential constraint on future development and maintenance of the existing assets.

If the decision were to be not to quarry any more rock from the island or any adjoining islands then the only alternative would be to import rock products from New Zealand or Australia at great cost.

Apparently the two private crushers can produce up to 500 tonnes each of total product per month. Their production is dependent on available staff and suitable climatic conditions, as they are not permitted to operate during certain wind conditions. The road materials produced and used are DGS, DGB, and 7mm, 10mm 14mm aggregates all of which can be obtained from both local quarries. The local quarries purchase large rocks from Admin and then process them to produce the road making materials.

The only road making material that is not easily available on the island is sand. Sand is required for asphalt and also for concrete. Crusher fines are able to be used but generally need supplementing with sand.

Coral sand is found on the beach at Emily Bay but it is considered inappropriate to be sourcing sand from that location.

It is understood that there may be off shore deposits of sand available. These may be suitable for road construction but would need to be dredged and stockpiled in a suitable area. The sand would also be required to be washed, and processed, to achieve the required grading.

An alternative to local sand is to import it from New Zealand or Australia. This sand would need processing to ensure it could pass NI quarantine and naturally would be very expensive. Another possibility is to import crushed glass. This is a waste product and is pure so would not need heat treatment but transport will remain expensive and it remains a new product in many applications.

A further alternative to using sand for primer sealing is to use the crushers to produce a 1 or 2 mm chip or similar. Initial discussions indicated this could be done.

The main source of water for roadworks is dam water. This is generally not potable but at present is plentiful. There are limited bores from the island's aquifer but these are restricted, expensive and limited to ensure that the aquifer is not over drawn down and then contaminated by sea water. The water is also of poor quality, although the quality is probably sufficient for use in roads construction.

There is a need for coldmix or other proprietary similar product for maintenance patching. Coldmix can be used for patching potholes, however it is best used for shallower depths. It is a mixture of bitumen emulsion, sand, aggregate, kerosene cutter and chemical agents. In Australia, road agencies purchase coldmix direct from asphalt companies and store it for their use. In the past it was imported to NI in 20 kg bags but this is a very expensive way of buying coldmix and in any case it has been reported that the coldmix was potentially not usable after spending a long time being transported to the island. In the short term it may be possible to buy in 1000 kg bags which might overcome the quality-on-arrival issue and could be a good way to begin a learning curve in how to best use it and gain confidence as a new method.

If trials are successful the suggestion is to move to locally manufacture weekly batches of coldmix. One alternative is to buy a small pug mill and manufacture the mix from that. The business case for this would need to be developed and may not prove viable.

Currently bitumen emulsion (ie a suspension of water and bitumen with emulsifiers) is imported from New Zealand in 1000 litre containers. This is used for seals, reseals and pothole patching.

D2 Existing ANI Equipment

There exists considerable road building equipment on the island however it has been 15 to 20 years since substantial roadbuilding was done on the island (except for Mt Pitt constructed by contractors) and some critical items of equipment need to be replaced. The Galion grader is so old (1965) that parts are difficult or impossible to obtain so when it is out of action for perhaps months at a time all pavement construction works must cease.

The application of the seal, which involves applying crushed stone on top of the sprayed bitumen and then rolling it into place, requires the use of a rubber tyred roller. The rubber tyres are meant to move and reorient the aggregate particles (“chips”) to align correctly and be gently pressed into the thin bitumen layer. However Admin no longer has a workable rubber tyred roller so they use a steel roller instead. This will crack or even crush the stone, it will not correctly orient the particles, it will bridge across and miss some particles and where it does make contact it will press the stone down into the underlying base material and possibly puncture what is meant to be a waterproof seal.

In order to continue road maintenance and some road construction, the existing plant needs to be kept operational and replaced at the end of their economic life. Individual assessments are:

- As described above it is considered that there is a defined need for a rubber tyred roller. This can be either a separate piece of equipment, a unit that is towed behind a tractor or grader or preferably both.
- There is a need for a replacement front-end loader although this could be replaced with a rubber tyred excavator with a 4in1 bucket and crane jib.
- If hot bitumen is to be used for reseals, then there is a need for a bitumen storage facility as the existing decanter is unsuitable and not operational.
- The bitumen sprayer currently used for spraying emulsion should also be capable of spraying hot bitumen but it is unclear whether this is the case.
- The large grader is seen as too big for use on many of the roads although such a machine could be useful for heavy patching and rehabilitation work. Whether the existing grader is repaired or replaced is a decision based on its remaining economic life. The small Galion grader is now 50 years old and requiring replacement
- If it was desired to manufacture coldmix, a small stationary pug mill is desirable, although a grader might conceivably be used in the interim (it is known that this has been done successfully elsewhere). Existing concrete storage bays are available for the storage of the coldmix but one of these would need to be covered for the storage.
- A small walk-behind line-marking machine (with paint and glass beads) is recommended.

In order to better control the quality of the roadworks, it is considered that a testing laboratory be established at the Works Office. This laboratory does not need to be a large facility but needs to be able test moisture content, maximum dry density and field density. This equipment would enable a standard range of field tests to be undertaken to better control the quality of the construction. If more sophisticated tests such as CBR and Plasticity Index were required then these will need to be carried out in Australia at an established NATA laboratory.

The NI laboratory could also be set up to test the compressive strength of concrete cylinders if needed for any major concrete works. The airport has a nuclear gauge and possibly other laboratory test equipment but no experienced operator. Prior to purchase of the laboratory equipment, an assessment should be made of the road testing capability at the airport.

In order to more effectively establish appropriate design codes and bitumen seal application rates, traffic counts are desirable. Basic counters comprise a simple tube and counter and are moved after a set time to another location. This can be supplemented by manual counts at intersections for peak periods. The school precinct is one such area that would benefit from traffic counts prior to carrying out a design. Admin has an old traffic counter but it is unserviceable and needs to be replaced.

Table D1 details the plant currently available for Admin use.

Table D1

Plant Item	Age	Condition	Utilisation
Galion grader (small)	50	Fair. Difficult to now source parts. Replace with small grader up to 10 years old.	Shoulders, road grading, road rehabilitation
Cat 12 Grader (large)	23	U/s- limited use due to the size of the unit only can be utilised in flatter areas.	Road construction, heavy grading and such as tyning existing roads or building new fills.
Rubber tyred roller	45	U/s – unable to be used. Replace with used roller up to 10 years old.	Final pavement rolling, sprayed seals, shoulder grading
Smooth drum roller	24	Good	Fill and pavement compaction, spray seals (not recommended)
Sheepsfoot roller	24	Good	Sheepsfeet added to the smooth drum roller as rings for deep compaction of fills and pavement
3000 l bitumen sprayer	24	Good	Sprayed seals. Can be heated electrically or by diesel heater on board. Can spray bitumen or bitumen emulsion
Bobcat with profiler head	13	Good	Excavate pavement in small strips.

Plant Item	Age	Condition	Utilisation
10 T truck with aggregate spreader	23	Fair-needs work and platform built for operator before further use to address WHS concerns.	Spreading aggregate for reseals.
5 T truck with aggregate spreader	30	Fair.	Sealing
Truck mounted water tanks	7	Good	Watering new works, washing pavements, clearing drains
Bobcat with road broom	8	Good	Clean road before sealing
Bobcat with 4in1 bucket	13	Good	Pickup debris, soil and spread soil.
Volvo FE Loader with 4in1 bucket	12	Poor – consider replacement either with another loader with pulvi mixer attachment or with a rubber tyred excavator.	Mix pavement during rehabilitation, load trucks, maintain stockpiles
10T Excavator (and various 6 T,8 T and smaller excavators)		Hired units	Excavate batters, load trucks, excavate drainage
20T Excavator with hammer		Hired unit	Remove rock from cuttings, break up large rocks
20T Excavator		Hired Unit $120/hr	Excavate batters, load trucks, excavate drainage
D6 dozer	30	Forestry unit with ripper tynes.	Ripping harder material
931 Drott Tracked Loader	27	Forestry unit with tynes	Loading and ripping
Various trucks		Fair	Transporting men and small equipment, carrying soil and aggregate, and other materials.
1 T twin drum Sakai roller	30	Good	Compacting around pipes, pothole patches

Plant Item	Age	Condition	Utilisation
Plate wacker		Good	Isolated pothole patches, adjacent to concrete wingwalls, along side pipes
25T crane		Good	Loading and unloading trucks and boats
16T Kato Crane	13	Good	Loading and unloading trucks and boats
Various 8T and 12T tip trucks		Hired units	Transporting soil and rock for road construction
Cutoff road saw		Hired from airport	Cutting pavement edge adjacent to new work. Ensures even edge
Diamond Core Drill		Hired from airport	Cores from pavement to determine pavement depth and layers
Maintenance crew			3 staff who are also required to do other works such as unloading ships

In addition to the above mentioned equipment ANI has a term contract which is current to 2017 for the supply of road building equipment by private contractors on the island. The contract includes trucks and other items but does not include the non-available critical road building equipment mentioned above.

APPENDIX E. PEOPLE AND GROUPS CONSULTED

	Author	Title
1	Allen Bataille (Ikey)	Administration of Norfolk Island, Registrar of Titles Chair Road Safety Committee
2	Brian James	Road Safety Committee
3	Bruce Taylor	Administration of Norfolk Island, Deputy CEO
4	Cheryl LeCren (Sarlu)	Administration of Norfolk Island, Lands & GIS Officer
5	Denise Quintal	EcoNorfolk Foundation, Events Coordinator
6	Doug Creek	Administration of Norfolk Island, Works Manager, Squad Captain Volunteer Rescue Squad
7	Gary Hardgrave	Administrator of Norfolk Island
8	George Smith	Norfolk Island Central School Youth Assembly, Mentor
9	Gerry Connell	Administration of Norfolk Island, Asset Manager
10	Hon. Ron Ward	Minister for Roads NI Parliament
11	Ian Faulks	Road Safety Consultant
12	Ian McLeod (Macka)	Norfolk Island National Parks, Ranger
13	Jap Menghetti	Cattle Farmer, Former Administration Workshop Manager
14	Jimbo Tavener	Norfolk Industries (Concrete and Quarry Products), Owner, Plant Hirer, Accommodation owner, car hirer
15	Jodie Quintal (Brown)	Administration of Norfolk Island, Planning Officer
16	Jon Gibbons	CEO ANI
17	Judith Davidson	KAVHA Research and Information Centre, Research and Interpretation Officer
18	Lisa Richards	ex Norfolk Island Museum
19	Matt Alexander	Commonwealth Heritage Manager
20	Matt Lee	Norfolk Island Police Force, Detective Senior Constable
21	Melissa Ward	Chair, Advisory Council
22	Michelle Nicholson	Norfolk Island Central School, Principal Road Safety Committee
23	Miriam Streulens	Freelance Planner, Former Administration of NI Planner
24	Neville Christian	Past Minister of NI Parliamant, Roadworks Contractor

	Author	Title
25	Peter Davidson (Feathers)	Conservator of Public Reserves, Acting Manager Land Use and Environment, Superintendent of St. Johns Ambulance and former Executive Director Infrastructure (Administration of Norfolk Island)
26	Richard Cottle	The Block Factory (Concrete and Quarry Products), Owner, Plant Hirer
27	Rob McKenzie AOM	Office of the Administrator, Official Secretary
28	Robyn Menghetti	Cattle Farmer, Restaurant & Café Owner, Former Administration of Norfolk Island CEO
29	Rowan Peterson	Norfolk Island Central School, Teacher
30	Selected Year 7 - 10 Students	Norfolk Island Central School, Youth Assembly
31	Sgt Catherine Tye	Norfolk Island Police Force, Officer in Charge Road Safety Committee
32	Sgt Dan Pyle	A/OIC NI Police
33	Trish Magri	Norfolk Island Central School Youth Assembly, Mentor

APPENDIX F. REFERENCES

	Author	Title
1	Administration of Norfolk Island (1997)	Burnt Pine Strategic Plan and Planning Report, Norfolk Island, Australia
2	Administration of Norfolk Island (2011)	Norfolk Island, Development Control Plan No.1, New Subdivision Roads, Norfolk Island, Australia
3	Administration of Norfolk Island ? (2009)	Preliminary Report on Provision of a 3rd Landing Facility at Headstone Point, Administration of Norfolk Island, Australia
4	Asset Technologies, Pacific (2005)	Administration of Norfolk Island, Urban & Rural Public Road System, Sydney, Australia *[A roads and structures conditions study sometimes referred to as "the 2005 Report"]*
5	Austroads (2002	Road Safety Audit, Austroads, Sydney, Australia.
6	Austroads (2003)	Rural Road Design: A Guide to the Geometric Design of Rural Roads, Austroads, Sydney, Australia
7	Baskerville, B	The Seven Bridges of Kingston, Internet Post, https://historymatrix.wordpress.com/2013/07/09/the-seven-bridges-of-kingston/
8	Beca International Consultants (2002)	Bridge Inspection, Prince Philip Drive, Norfolk Island,
9	Faulks, Ian J.	Safer Road Travel on Norfolk Island, Developing a Road Safety Strategy for 2014-2016, Norfolk Island Road Safety Committee
10	GHD (2007)	Norfolk Island Administration, Report on Norfolk Island Airport Upgrade Project
11	Giummarra, George (2001)	Road classifications, geometric designs and maintenance standards for low volume road, ARRB Transport Research, VIC, Australia
12	Giummarra, George (2009)	Unsealed Roads Manual, Guidelines to Good Practice, ARRB Transport Research, VIC, Australia
13	Hughes Trueman (2010)	Structural Report, Bounty Street Bridge, Kingston and Arthurs Vale Historic Area, Norfolk Island, Sydney, Australia
14	Lyell, Andrew (2009)	Cascade Cliff, Feasibility of Extending the Original Cascade Cliff Safety Project, Preliminary Proposal, Central West Drilling and Blasting Pty Ltd

	Author	Title
15	McNeil, Alan (2010)	Report on Options for Future Supply of Crushed Rock on Norfolk Island, Administration of Norfolk Island, Australia
16	O'Conner, Colin	Roads and Bridges of Norfolk Island
17	Porter, David (2014)	Initial Report on Development of New Rock and Gravel Supply for Norfolk Island,
18	RTA (2006)	Brownfield Design Guide, NSW Roads and Traffic Authority, Australia
19	SMEC Australia (2003)	Norfolk Island National Park Road Repairs, Mt Pitt Road Reconstruction Final Construction Report, ACT, Australia
20	South Pacific Planning and Projects (2007)	Middlegate Intersection Traffic Study: Analysis of Options to Improve Safety, Norfolk Island, Australia
21	Ward, Ron (2014)	Norfolk Island Pedestrian Access Concept
22	Tasmanian Grants Commission	Review of Maintenance Costs report 2012