Norfolk Island Regional Council

Norfolk Island Airport

Airside Pavement Inspection

February 2017

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Executive Summary

GHD technical specialist James Palmer, under the direction of Norfolk Island Regional Council, was requested to visit Norfolk Island to undertake a detailed site inspection of Norfolk Island International Airport and report on maintenance and rehabilitation repairs necessary to address existing pavement surfacing issues. The following report documents the findings of that detailed site inspection.

Documented to ASTM D5340-12: Standard Test Method for Airport Pavement Condition Index Surveys, the report provides a Pavement Condition Index (PCI) rating for each of the airside pavement sections at the airport, and the landside car park.

The PCI is a numerical index between 0 and 100 which is used to indicate the general condition of an airside pavement.

Norfolk Island has the following PCI values for its numerous airside pavement locations:

- Runway 11/29 – PCI = 88 - GOOD
- Runway 11 end - PCI = 50 - POOR
- Runway 04/22 Ch0 to 950m – PCI = 90 - GOOD
- Runway 04/22 Ch950 to 1450m - PCI = 60 - FAIR
- Taxiway - PCI = 79 - SATISFACTORY
- Apron – PCI = 69 - FAIR

The runways are generally in a GOOD condition however there are localised areas that required attention in the short term (next 24 months) in the form of pavement maintenance to address potential future operational concerns associated with Foreign Object Debris (FOD) as they are currently VERY POOR deteriorating to SERIOUS.

GHD have packaged up a Short Term Maintenance/Preservation and a secondary Longer Term Rehabilitation preferred option.

The following works are considered to be included in this option required in the next 24 months at a cost of $8,905,800:

2017 30 000 000 x 7% =
2018 32,100 000 x 7% =
2019 34 347 000 x 7% =
2020 36,751,290 x 7% =
2021 39,323,880

1. Apron Rehabilitation;
2. Taxiway Overlay;
3. Runway 11 turning end maintenance;
4. Mill and Fill maintenance repairs to the Taxiway and Runway intersection;
5. Surface Enrichment Sprayed Treatment (SEST) to oxidised surfacings; and
6. Crack bandaging.

The following works would then be undertaken at approximately year 2023/2024 at a cost of $21,700,000;

1. Overlay of Runway 11/29; and
2. Overlay of Runway 04/22 – full length.

This recommended option has a total cost of $30,605,800 and would possibly extend the life of the airside pavements at Norfolk Island to 2039.

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GHD has prepared the preliminary cost estimate/prices set out in section 6 of this report ("Price") using information reasonably available to the GHD employee(s) who prepared this report; and based on assumptions and judgments made by GHD.

The Cost Estimate has been prepared for budgetary purposes and must not be used for any other purpose.

The Cost Estimate is a preliminary estimate only. Actual prices, costs and other variables may be different to those used to prepare the Cost Estimate and may change. Unless as otherwise specified in this report, no detailed quotation has been obtained for actions identified in this report. GHD does not represent, warrant or guarantee that the works can or will be undertaken at a cost which is the same or less than the Cost Estimate.

Where estimates of potential costs are provided with an indicated level of confidence, notwithstanding the conservatism of the level of confidence selected as the planning level, there remains a chance that the cost will be greater than the planning estimate, and any funding would not be adequate. The confidence level considered to be most appropriate for planning purposes will vary depending on the conservatism of the user and the nature of the project. The user should therefore select appropriate confidence levels to suit their particular risk profile.

1. Introduction

1.1 General

The following report documents the findings of a detailed site inspection of Norfolk Island International Airport.

GHD technical specialist James Palmer, under the direction of Norfolk Island Regional Council, was requested to visit Norfolk Island to undertake a detailed site inspection of Norfolk Island International Airport and report on maintenance and rehabilitation repairs necessary to address existing pavement surfacing issues.

Documented to ASTM D5340-12: Standard Test Method for Airport Pavement Condition Index Surveys, the report provides a Pavement Condition Index (PCI) rating for each of the airside pavement sections at the airport.

The GHD also provides a visual assessment of the airside access roads and the landside car park.

The report then goes on to review remedial solution options, required timeframes to implement and potential packaging options.

1.2 The Site

Figure 1 Aerial of Norfolk Island International Airport

The airport has two runways, a link taxiway and a passenger apron.

The main runway, orientation 11/29, is a flexible International Civil Aviation Organisation (ICAO) Code 4C runway pavement which has a Take-off Runway Available (TORA) length of 1,950m long and is 45m wide with no shoulders.

The cross wind runway, orientation 04/22, is a flexible ICAO Code 3C runway pavement which has a TORA length of 1,450m long and is 30m wide with no shoulders.

The taxiway is a 23m wide Code C taxiway with a downward longitudinal profile heading towards the passenger apron. The apron 120m by 60m has two gates both of which have in-ground fuel hydrants.

Norfolk Island International Airport is reported as originally being constructed by the United States(US) Army Air Force in 1942, most likely the Naval First Battalion, named the "Seabees", who constructed many flexible runways across the South Pacific during World War II[1].

Since this date the airport pavements have gone through numerous reconstructions and overlays. The most well reported suggests the main 11/29 runway was reconstructed in 1982 and consisted on 75mm of asphalt on 250mm of fine crushed rock basecourse and 150mm of sand/clay sub-base. Asphaltic overlays are reported have occurred in 1991 and 2007[2] after this construction in 1982.

The 2007 overlay works included the addition of approximately 55mm of asphalt concrete overlay placed on the Runway 11/29, the section of Runway 04/22 used as taxiway access to the apron, a 200m stretch of runway 04/22 extending to the 04 threshold, the link taxiway and the passenger apron.

At that time the apron was reported to have had a 15m widening extension to the north east.

1.3 Standards

The pavement inspection and remedial solutions have been documented whilst applying guidance from the documents in table 1.

Source	Standard	Relevance
American Society of the International Association for Testing and Materials (ASTM)	ASTM D5340 – 12 Standard Test Method for Airport Pavement Condition Index Surveys	Standardised method of noting severity of airside pavement defects – (less subjective than other inspection methods)
Australian Government, Department of Defence	Airfield Pavement Maintenance Manual, November 2012	Standardised repair methodologies
Federation Aviation Administration (FAA)	Advisory Circulars AC 150/5380 – 6b – Guidelines and Procedures for Maintenance of Airport Pavements	Standardised repair methodologies

Table 1 Standard Guidance Documents

1.4 Methodology

Detailed pavement inspections were undertaken on the 23rd and 24th of January 2017. The inspection team included James Palmer of GHD Limited, Mandy Gardner and/or Dave Snell of the Norfolk Island Regional Council (NIRC).

[1] https://en.wikipedia.org/wiki/Norfolk_Island_Airport

[2] GHD Norfolk Island Airport Pavement Upgrade – Preliminary Design Report - May 2002 and GHD Norfolk Island Airport Upgrade Project Completion Report – July 2007

The weather was generally fine on all inspections days with cloud cover and ambient temperatures approximating 25ºC.

Inspections were undertaken utilising the categorisation and severity ratings documented in ASTM D5340 – 12.

The main runway was segmented in to 300m long 15m wide sections containing 10 samples units, each 15m wide and 30m long. Every third sample unit was inspected to provide a statistical representation of the pavement section.

Inspections began at the 11 end of the 11/29 runway. The threshold of Runway 11 is the starting chainage for all distances and sample units documented herein.

Inspections then took place on the 04/22 runway with sample units split in to 45m by 10m areas, the apron with sample units approximately 30m by 15m, and the taxiway in units 40m by 11.5m.

1.5 Airside pavement condition rating

The PCI is a numerical index between 0 and 100 which is used to indicate the general condition of an airside pavement.

The writer implemented a full PCI inspection at Norfolk Island to give the readers a quantitative assessment on the pavement condition. This involved segmenting the runways, taxiway and apron in to sections. Then dividing the sections in to sample units, with every third sample unit being inspected and full defect collection and severity assessment undertaken.

Using the ASTM for airport PCI surveys methodology, the deduction curves, and the algorithms documented therein the condition ratings for Norfolk Island pavement sections have been computed.

The range of condition ratings are summarised in Table 2

Rating	Condition	Description
	86-100 GOOD	Pavement has minor or no distresses
	71-85 SATISFACTORY	Pavement has scattered low-severity distresses
	56-70 FAIR	Pavement has generally low and medium severity distresses
	41-55 POOR	Pavement has low, medium and high severity distresses that probably cause operational problems
	26-40 VERY POOR	Pavement has predominantly medium and high severity distresses that cause considerable maintenance and operational problems
	11-25 SERIOUS	Pavement has mainly high severity distresses that cause operational restrictions
	0-10 FAILED	Pavement deterioration has progressed to the point that safe aircraft operations are no longer possible.

Table 2 PCI Ratings to ASTM D5340-12

2. Inspection Findings

2.1 Runway 11/29

2.1.1 General Observations

The asphalt surfacing throughout the airport appears as a dense graded asphalt surfacing with a maximum aggregate size of 19mm. The writer considers the mix to be AC14 to AS:2150 which is standard for hot rolled airport asphalt surfacings in Australasia.

The main runway is grooved with 6mm by 6mm grooves at 38mm centres to a width of 45m.

Overall the asphalt surface is oxidised and embrittlement of the surfacing has begun with notable environmental defects such as longitudinal cracking present throughout. This is as expected for an AC14 asphalt surfacing at an age of 9-10 years and is not a significant concern.

The surfacing of the Runway 11/29 is generally in a GOOD condition however mechanical defects in the form of slippage and alligator cracking are noted in a handful of locations. Mechanical defects present structural distress and where these are evident Foreign Object Debris (FOD) is an increasing concern.

The quantum of slippage cracking in the runway end would suggest that debonding of the asphalt layers is occurring at that location.

The full inspection notes and defects identification record is included in Appendix A, however the notable defects are discussed in detail in the following sections.

2.1.2 Characterisation of defects

Slippage Cracking

Slippage cracks are crescent or half-moon-shaped and always perpendicular to the direction of aircraft travel. They are produced by the turning and braking of aircraft wheels causing the asphalt surface to slide and deform.

The reason for the slippage cracks at Norfolk Island International Airport runway end is considered to include:

- Lack of bond between the two asphalt layers and possibly insufficient texture for the surfacing to adhere too;
- Inadequate shear strength of the asphalt mix (usually due to insufficient depth of the overlay <50mm);
- Moisture ingress to the asphalt interface layer exacerbating the debonding process; and
- Possibly a large non-standard wheel load - C130- Hercules, C17 – Globemaster or other.

Slippage cracking is evident throughout the Runway 11 strip end (used as a turning node starter). The majority of these cracks have received some form of rubberised crack sealant and or pavecoat treatment in an aid to hold them from deteriorating further.

These cracks, combined with the dry and brittle bitumen binder of the asphalt, increases the development of FOD. If areas with slippage cracks are not repaired, the cracks may link up and pieces of surfacing may be come dislodged, causing a FOD risk.

The only suitable repair methodology for slippage cracking is asphalt replacement to a depth where a suitable bond is created.

Figure 2 Photo example of slippage cracking at the 11 turning end

Alligator Cracking

Alligator cracking is a series of interconnected cracks caused by asphalt fatigue. Alligator cracking begins formation as a series of parallel cracks. As the defect worsens, under repeated traffic loading, interconnecting cracks are formed between the parallel cracks and the defect begins to resemble the look of alligator skin.

Alligator cracking is considered a major structural distress of asphalt surfacings. When supported by rutting defects it demonstrates a lack of pavement structural performance.

The severity of alligator cracking is categorised as follows:

- Low – Fine, longitudinal hairline cracks running parallel with minimal to no interconnecting cracks
- Medium – Well defined pattern of interconnecting cracks where all pieces of surfacing are held securely in place through good aggregate interlock.
- High – Pieces of surfacing are well defined and spalled at edges, some of the pieces rock under foot and may cause FOD potential.

Norfolk Island International Airport has evidence of medium severity alligator cracking. Located at the 11/29 and 04/22 runway intersection the alligator cracking is located in a critical zone.

Alligator cracks allow ingress of moisture into the underlying asphalt and/or pavement layers with resulting moisture damage of underlying layers. In combination with the dry and brittle binder and ravelling, increases the development of FOD. If areas with alligator cracks are not repaired, the cracks may link up and pieces of surfacing may be come dislodged, causing a substantial FOD risk.

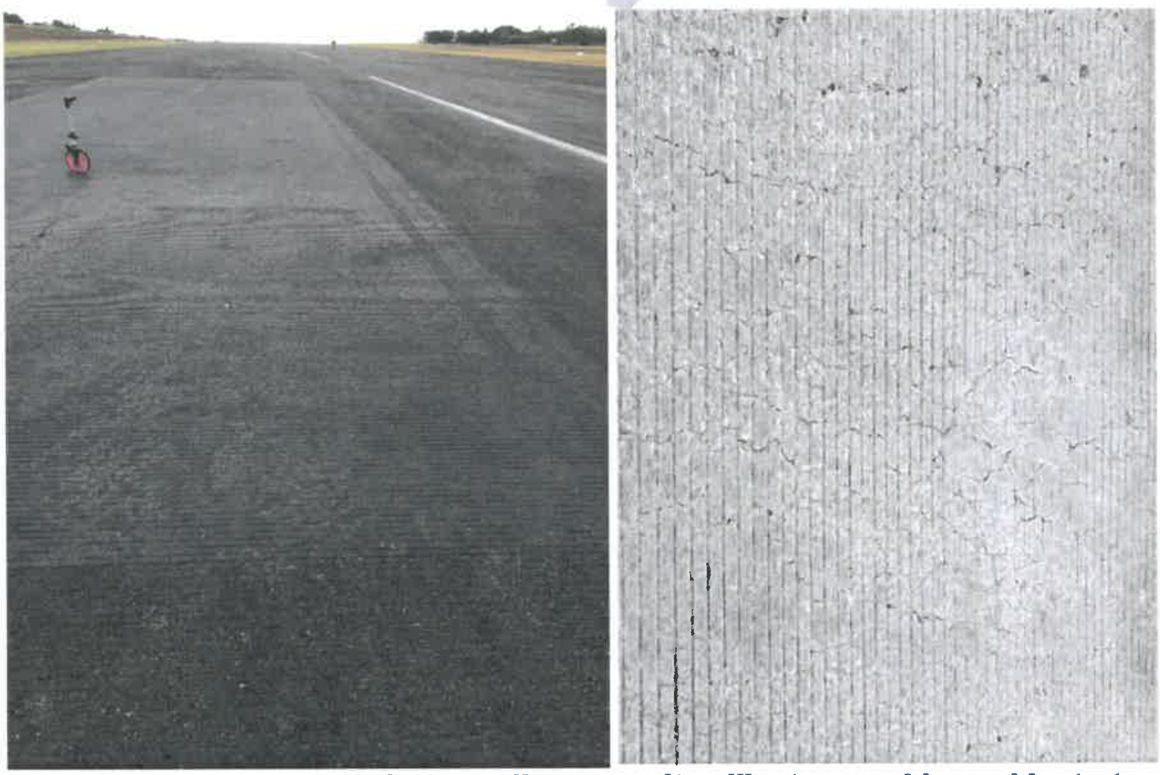

Figure 3 Photo examples of the medium severity alligator cracking evident at Norfolk Island runway intersection

2.1.3 Longitudinal and Transverse Cracking

Longitudinal cracks are almost always parallel to the runway centreline (unless a transverse construction joint) and form through poorly constructed paving lane joints or shrinkage of the surfacing due to embrittlement/hardening of the asphalt. The severity of longitudinal cracks can be categorised as follows:

- Low severity – Cracks are less that 6mm in width with light to no spalling
- Medium severity – Cracks are greater than 6mm in width and there is either light random cracking spurring off the main crack, or the crack is unfilled and lightly spalled with no loose material
- High severity – Cracks are severely spalled there are pieces missing and/or loose and pose FOD potential.

Norfolk Island International Airport has longitudinal cracking throughout the airside pavement site. Most are low in severity and cause limited FOD concern.

If left untreated longitudinal cracking allow water ingress and with repeated aircraft loading increases in severity to either a spalling crack or an alligator cracking defect. In areas of no aircraft traffic the untreated cracks progress to block cracking defects.

Figure 4 Photo example of an open and unsealed low severity longitudinal crack at Norfolk

White Staining

Throughout the airport site white staining exists on the asphalt surfacing. The staining is caused by a water/aggregate reaction as water penetrates voids in the asphalt surfacing.

Hot rolled asphalt provides its best durability when it is compacted to the point where air voids are in the optimal range of 3-5% of volume. Above 6-7% the voids in the dense graded asphalt the chance of interconnect voids becomes an issue.

Moisture penetration is a main contributing factor for asphalt and pavement deterioration and interconnect voids enable this to occur.

Figure 5 Photo example of white staining at Nelson Airport

Where possible, areas of high air voids should be surfaced with a sealing product to improve water proofing and to reduce the rate of deterioration.

The white staining present at Norfolk Island is high-volume which algae and detritus build-up occurring in outer runway edge locations where the staining and moisture collection is at its worst.

Ravelling

Ravelling is the dislodging of aggregates from the pavement surface. This occurs when the binder (in this case bitumen) deteriorates through oxidation/ageing (chemical transformation following application of ultraviolet light) and fails to perform its primary role of bringing adhesion between the aggregates.

Ravelling is exacerbated by braking/turning forces which when applied to the surface break the weak bonds of the binder allowing aggregate particles to be stripped and expelled.

Ravelling severity is characterised by the quantum of aggregate loss. A 300mm by 300mm representative sample of the asphalt surfacing is taken whilst counting the missing number of aggregate pieces;

- Low severity is between 5 to 20 missing aggregate pieces
- Medium severity is between 20 and 40 missing aggregate pieces
- High severity is greater than 40 missing aggregate pieces.

Ravelling is occurring across the main runway site in locations where there was segregation in the asphalt mix at the time of construction and in zones where limited fines were present in the asphalt matrix.

All ravelling witnessed at Norfolk Island was low severity and therefore minimal FOD risk.

2.2 Runway 04/22

2.2.1 General Observations

The asphalt surfacing throughout a 950m length of the 02/22 runway from Runway 22 end appears as a dense graded asphalt surfacing with a maximum aggregate size of 19mm. The writer considers the mix to be AC14 to AS:2150 which is presented elsewhere on the airport from the 2007 overlay works.

Overall throughout this length, the defects and condition is similar to that on the main runway. With the majority of the defects being environmental in nature with the asphalt surface being oxidised and with longitudinal cracking present throughout.

From CH950m to CH1450m the surfacing of the runway is older and likely the 1991 surfacing type. The asphalt surfacing in this location appears as a finer asphalt, likely a 10mm asphalt concrete mix.

The environmental effects on the older surfacing type are more sustained than the new surfacing, with extensive low severity block cracking evident throughout. The surfacing in this location is in a FAIR condition.

The full inspection notes and defects identification record is included in Appendix A, however the notable defects are discussed in detail in the following sections.

2.2.2 Characterisation of Defects

Block Cracking

Block cracks are interconnecting cracks that divide the pavement into rectangular pieces. The blocks range in size. Block cracking is caused mainly by cyclic temperature related shrinkage of an oxidised and hardened asphalt surfacing.

Block cracking is not caused by trafficking. The severity of block cracking can be categorised as follows:

- Low severity – Blocks are defined by cracks that are non-spalled or lightly spalled causing no FOD potential.
- Medium severity – Blocks are defined by cracks that are moderately spalled. Cracks are greater than 6mm in width and there is either light random cracking spurring off the main crack or there is moderate spalling potential.
- High severity – Blocks are well defined and cracks are severely spalled, there are pieces missing and/or loose and pose definite FOD potential.

The full extent of the 500m of 04/22 runway has low severity block cracking throughout. Weed control is a constant maintenance item for the airport personnel with the block cracks harbouring detritus upon which weeds grow from.

With only light General Aviation aircraft using the crosswind runway the block cracking defect causes minimal to no FOD threat to passenger services.

Figure 6 Photo example of block cracking at Norfolk Island

2.3 Taxiway

2.3.1 General Observations

The link taxiway is surfaced with an AC14 from the 2007 overlay works. The surfacing is generally in a SATISFACTORY condition with minor environmental issues present from the oxidation of the surfacing. However, there are notable locations where mechanical defects are present and these cause an increased alarm.

Structural distresses in the form of alligator cracking are present in numerous locations along the length of the taxiway. The majority are present at the Runway 04/22 end of the taxiway.

In all locations the alligator cracking has progressed to medium severity and remedial treatment is necessary in the short term prior to the defect becoming an operational FOD related concern.

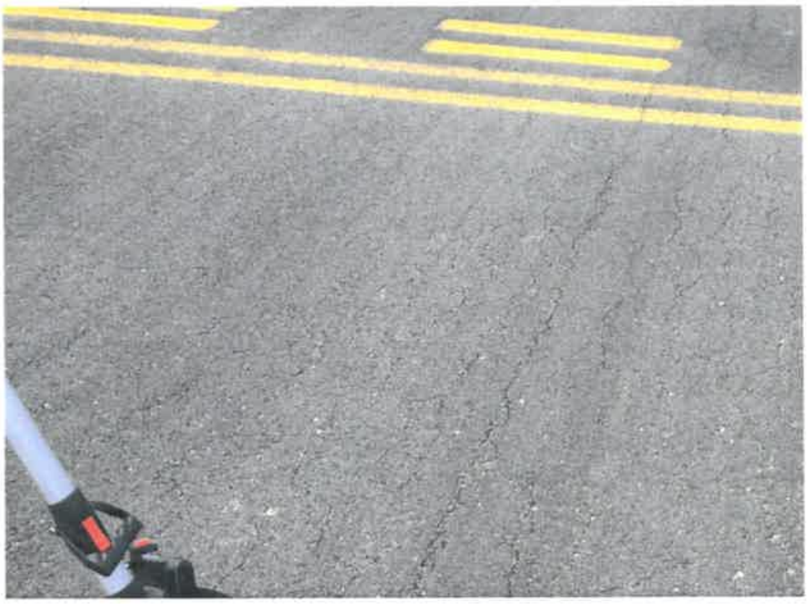

Figure 7 Photo example of alligator cracking on the taxiway at Norfolk Island

2.4 Apron

2.4.1 General Observations

The passenger apron is currently presenting the worst of the asphalt surface defects present at Norfolk Island Airport. These include depressions, rutting, slippage cracking, ravelling cold tar surfacing and longitudinal environmental cracking.

Overall the apron is in a FAIR condition but there are zones where the surfacing is VERY POOR heading towards SERIOUS. At these levels of condition operability becomes a challenge and this is confirmed by the current parking of the A320 aircraft on gate 1 being relocated regularly to minimise the impacts on failing sections of the surfacing.

Major distresses in the form of depression and rutting are presented in the parked positions on Gate 1 and these are discussed further herein.

The apron current falls towards the terminal without a cut off slot drain. This is against the recommended practice of National Fire Protection Association (NFPA) 415 guidance *"Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways"* nominating apron ramps used for fuelling have a fall away from buildings housing passengers to prevent safety hazard in the event of a fuel spill. This item should be considered to be addressed with any potential considered rehabilitation of the parking apron.

Depressions/Rutting

Depressions are localised pavement surface areas having elevations lower than those in the surrounding pavement. Depressions are best observed after rain events where water ponding occurs.

Rutting stems from deformation in any of the pavement layers through consolidation or lateral movement of materials due to traffic loads and is usually evident in the wheel tracking zones of an airport pavement.

The severity of depressions/rutting on an apron can be categorised as follows:

- Low severity – Maximum depth of the depression is 13 to 25mm
- Medium severity – Maximum depth of the depression is 26 to 51mm
- High severity – Maximum depth of the depression is >51mm

The depressions evident on the passenger apron are considered to be in excess of 60mm in depth thus are high severity.

Asphalt generally lacks the shear capacity to cater for the high point loads of Code C aircraft tyre pressures and vertical pavement deformation under repeated or long duration traffic loading is a common occurrence.

Figure 8 Photo example of depressions at Norfolk

2.5 Other visual inspections items to note

2.5.1 ARFF and Aircraft Hangar link taxiways

There are two minor link taxiways/access points on to the Taxiway and the 11/29 runway. These include an aircraft hangar access and an aircraft rescue fire fighting (ARFF) linkage, respectively.

Both are formed in concrete as a rigid pavement and present themselves in a GOOD condition without any immediate maintenance needs.

Minor defects in the form of spalling and structural cracking were evident in numerous concrete slabs but neither quantum nor the width of the cracks presented a concern.

Given the location, low operational risk and the low use, considerable residual life is likely to reside within these pavements.

2.5.2 Airside roads and Maintenance yard

All airside roads and the maintenance yard parking area have a myriad of surfacing types and conditions.

Some areas have very old asphalt surfacings, others have a two coat bituminous spray seal. All surfacing types are in a dilapidated state and have oxidised to an extent were ravelling is excessive.

Potholes, exposed aggregate basecourse layers and poor ride quality are evident throughout. In areas where the airside road joins the taxiway the ravelling is a considerable FOD concern with stones and aggregates migrating on to the taxiway with vehicle traffic. This is demanding increased maintenance vigilance and clearance by airport personnel.

2.5.3 Landside Car Park

The landside carpark also has a myriad of surfacing types, ages and conditions.

The area in GOOD condition appears to be the asphalt trial for the runway works in 2007. Other areas include a two coat bituminous spray seal of varying performance.

The area to the east of the car park is at a higher geometric topography to the rest of the car park and as such minimal distressed from moisture ingress but is suffering from aggregate ravelling and chip loss.

In the western end of the car park, the lower topographic end of the car park, which has numerous drainage infrastructure items present, the surfacing is suffering from excessive ravelling, exposed basecourse aggregates, potholes and poor ride quality evident throughout.

The car park surfacing is generally in a POOR condition and some form of resurfacing should be sought with any works package that may assembled by NIRC.

Figure 9 Photo example of landside car park surfacing quality

3. PCI Condition rating

The following figure presents the PCI condition ratings for the airside paved surfacings at Norfolk Island Interr
Appendix A.

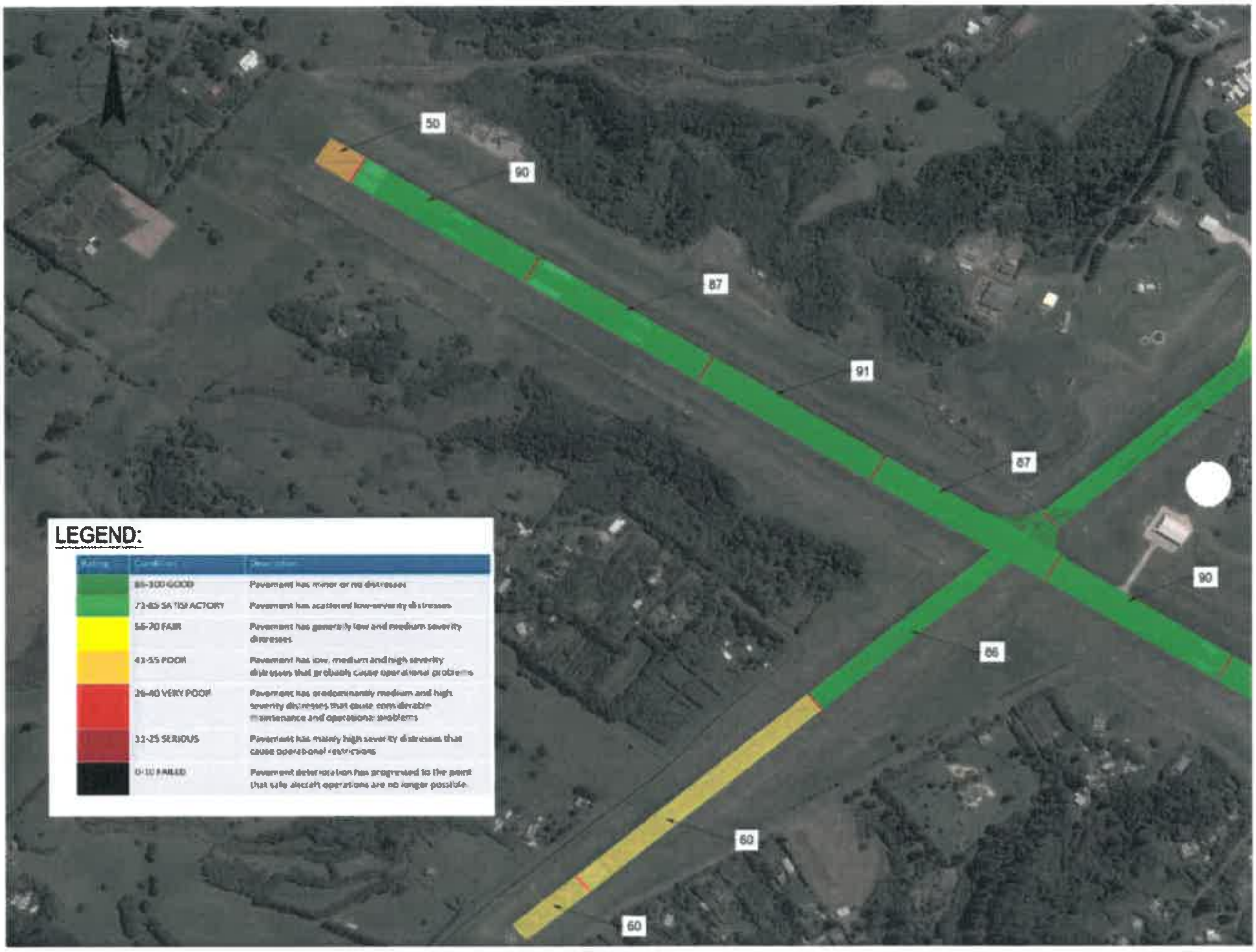

Figure 10 PCI Layout for Norfolk Island Airport

The PCI layout in Figure 10 demonstrates the PCI numerical value for the following locations:

- Runway 11/29 – PCI = 88 - GOOD
- Runway 11 end - PCI = 50 - POOR
- Runway 04/22 Ch0 to 950m – PCI = 90 - GOOD
- Runway 04/22 Ch950 to 1450m - PCI = 60 - FAIR
- Taxiway - PCI = 79 - SATISFACTORY
- Apron – PCI = 69 - FAIR

It is international standard practice to set a cut off of PCI values upon which maintenance works are undertaken giving due to consideration to operational location of the pavement surface and the priority to the airport network.

It is the experience of the writer that cut off values, as follows, are that usually established for an airport of similar significance and importance to Norfolk;

- Main Runway – PCI = 75
- Main Taxiway – PCI = 70
- Main Apron – PCI – 65

It is also the experience of the writer that airport clients can anticipate a deterioration rate of 1.5 to 2 PCI points per year in an asphalt surfacing in Australasia that is 9-10 years old.

Giving due consideration these deterioration rates and the recommended cut offs for asset maintenance NIRC, should consider that the passenger apron and the Runway 11 end should receive rehabilitation in the short term (2 years). With the taxiway and runways receiving rehabilitation in the medium term (5-6 years).

Without these maintenance works NIRC should anticipate operational challenges by commercial airline operators in the near future.

4. Airside Operational Risk and Works Planning

4.1 High Priority Areas

Continued safe aircraft operations have the potential to be impacted by the following high priority zones which will require remediation in the near future (within the next 24 months);

- Alligator cracking on the Taxiway in three locations. Sizes 16m by 4m, 40 by 3m, and 12.5m by 2m all located at the runway 04/22 interface end of the taxiway;
- Alligator cracking on the 11/29 runway at the interface with the 04/22 runway. Size 30m by 10m;
- Rutting and depressions in the Gate 1 park position of the apron; and
- Slippage cracking in the Runway 11 strip end and on the passenger apron, evident throughout.

Without the remediation of the above, the Norfolk Island Regional Council should anticipate operational challenges by commercial airline operators in the near future.

4.2 Planning for replacement/rehabilitation

An asphalt overlay is currently not considered necessary for the runways at Norfolk Island. With the addition of a preventative maintenance treatment strategy GHD consider that there is a residual life of 5 -7 years in the surfacing prior to the need for replacement or overlay.

Given the defects and distresses present in the apron and taxiway, these pavement structures are considered to be of differing performance to the runways and thus investigation and rehabilitation should be anticipated in the next 2 years.

4.3 Maintenance Strategies

4.3.1 FAA Guidance documentation

Federal Aviation Authority (FAA) Advisory Circular (AC) No: 150/5380 -7B provides very useful detail on Airport Pavement Management Programs (PMP).

The document outlines the benefits of preventative maintenance strategies which go towards reducing overall costs associated with pavement maintenance.

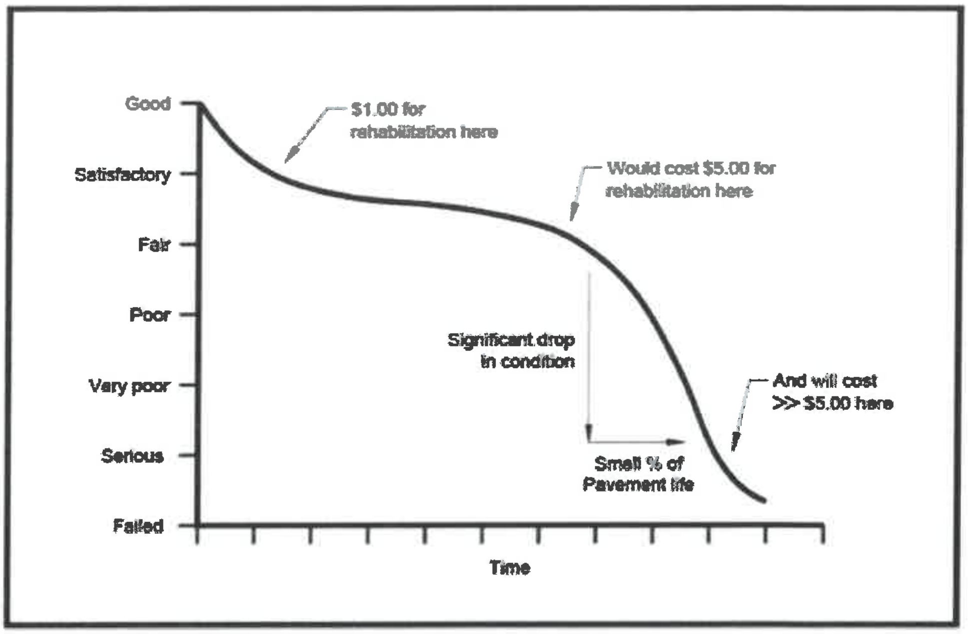

Figure 1. Typical Pavement Condition Life Cycle.

Figure 1 of AC 150/5380 – 7B brings a very clear picture of rehabilitation costs based on pavement condition with time.

It demonstrates that the effort to improve the condition of the pavement after it has past the FAIR condition is far greater that if it were a simple overlay or mill and fill operation.

Through their stock of many airports and vast research in to this area the FAA have identified that undertaking preventative pavement preservation techniques, such as Sprayed Enrichment Surface Treatments (SEST), regular crack bandaging, and well planned mill and fill patch repairs, they were able to extend the life of surfacings considerably.

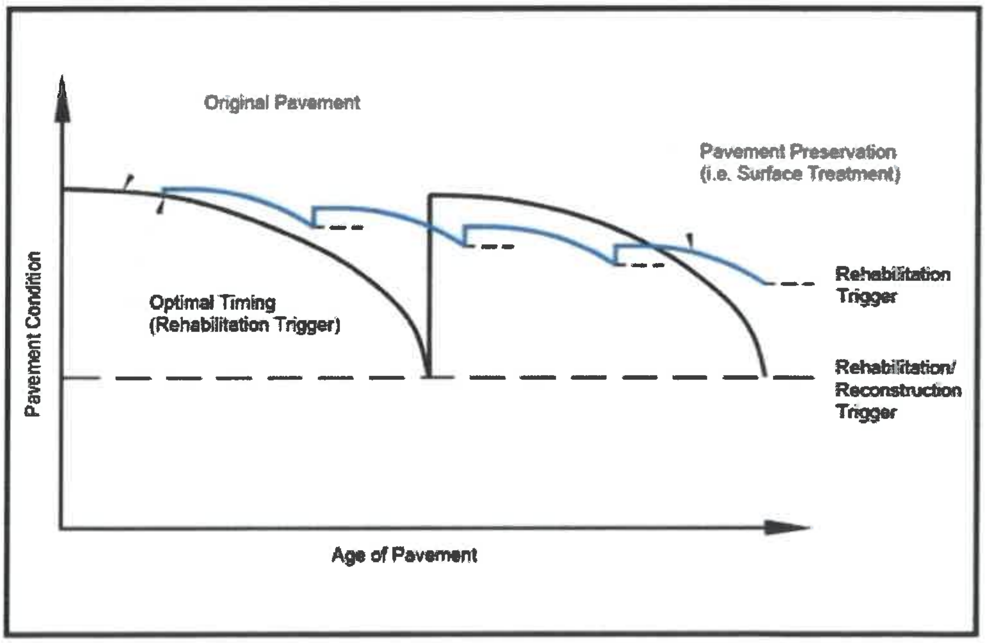

Figure 2. Pavement Preservation Concept.

For the writer this will always be the recommended maintenance strategy as it improves pavement performance disproportionally to the cost bringing savings.

At this time it is advisable that Norfolk Island give consideration to this approach in conjunction with any short term maintenance works that may be required by NIRC.

In to the future, NIRC should consider utilising existing maintenance teams and equipment to implement these preservation treatment types.

4.4 Logistical Challenges of Norfolk Island

Norfolk Island lacks any deep sea port/wharf structures, nor is there any hot rolled asphalt producing plant and machinery on island.

During the 2007 overlay works a large groyne was installed at Ball bay necessary to take the barge full of asphalt equipment.

Any maintenance repairs will require the mobilisation of barged equipment similar to that of 2007 and thus a significant mobilisation costs exists regardless of the quantum of work undertaken.

In packaging a maintenance strategy NIRC needs to give careful consideration to this large mobilisation cost.

5. Remedial Considerations of the main defect

The following table summarises the remedial considerations for repairs to medium to high severity defects of

Defect Type 1: Environmental Longitudinal Cracking		
Item	**Standard Repair Method**	**Alternative Repair Method**
Repair Method	Routed to remove loose spalls and to provide a "reservoir" detail. Then applied with hot rubberised bitumen	Applied with hot rubberised bitumen
Purpose	Prevent propagation or widening of crack, to hold or prevent spalling FOD, anc performance)	
Cost to Implement	Highest	Moderate
Construction period	Routing slows the repair methodology. Relatively instantaneous cure once RBB applied. Programme 2-300m per day.	Cure Relatively instantaneous. Programme 1-2km per day.
Availability to Norfolk	No routing machine. No crack bandaging machine	No crack bandaging machine
Repair duration	3-5 years	1-3 years
Pros	The best performance at holding/preventing FOD. Easy to apply Best longevity	Good performance at holding/preventing FOD. Easy to apply
Cons	High cost	Moderate longevity Moderate cost
Operational Risk	Lowest	Low
Recommendation	**Recommended**	Not Recommended

Defect 2: Slippage and Alligator cracking		
Item	**Standard Repair Method**	**Alternative Repair Method**
Repair Method	Replacement of defected asphalt with a hot rolled asphalt (HRA) patch repair to a depth which improves bond performance (usually deeper than asphalt interfacing layers) by a reputable contractor	Applied with hot rubberised bitum
Purpose	To remove defected asphalt materials, improve bond performance and mitigat	
Cost to Implement	High. Low normally, but with no specialist contractor or asphalt plant on island this costed option is therefore considerable for the quantum of patch repairs identified.	Low
Construction period/ impact to operations	Requires mobilisation of asphalt plant. 3-6 months. Approximately 500 sqm of patches can be completed in 8hr shift. No cure time. Minimal impact to operations.	Cure Relatively instantaneous. P 2km per day.
Availability to Norfolk Island	No contractor with specialist airport asphalt knowledge available on site. Would require months to mobilise to site. No milling machine.	No crack bandaging machine
Repair Duration	3-5 years	1-2 years – holding repair only
Pros	Speed of construction. Minimal operational impact	Good performance at holding/pre Easy to apply
Cons	Cost to mobile an asphalt plant to site	Poor longevity, only holds the iss proper repair is required. Moderate cost
Operational Risk	Lowest	Low
Recommendation	**Preferred recommended option**	Not Recommended

Defect 3: Apron rutting and depressions		
Item	**Standard Rehabilitation Method**	**Alternative Repair Method**
Repair Method	Replacement of defected asphalt with a hot rolled asphalt (HRA) patch repair to a depth which improves bond performance (usually deeper than asphalt interfacing layers) by a reputable contractor	Rehabilitation of the apron under wide treatment addressing the ge refuelling concerns. Pavement re with imported aggregates and ne surfacing.
Purpose	To remove defected asphalt materials, improve bond performance and mitigat	
Cost to Implement	High. Low normally, but with no specialist contractor or asphalt plant on island this costed option is therefore considerable for the quantum of patch repairs identified.	Highest
Construction period/ impact to operations	Requires mobilisation of asphalt plant. 3-6 months. Approximately 500 sqm of patches can be completed in 8hr shift. No cure time. Minimal impact to operations.	Requires mobilisation of asphalt construction team. 3-6 months. Apron works would need to be st
Availability to Norfolk Island	No contractor with specialist airport asphalt knowledge available on site. Would require months to mobilise to site. No milling machine.	No contractor with specialist airp knowledge available on site. Wou months to mobilise to site. No milling machine.
Repair Duration	3-5 years	15 years
Pros	Speed of construction. Minimal operational impact	Rehabilitation option bring the ap required standard
Cons	Cost to mobile an asphalt plant to site	Cost to mobile an asphalt plant to
Operational Risk	Low	Lowest
Recommendation	Not recommended	**Recommended**

Notes:-

1. All assumptions are indicative and for comparison purposes only to assist in the selection of preferred treatments
2. Mobilisation periods are based on availability of shipping lines to Apia and feedback following questioning of available C
3. Construction periods are heavily reliant on Civil Works Contractors productivities. These are indicative only and have be

6. Packaging of Airside Works

6.1 General

Given the need for short term repairs and the otherwise relatively GOOD condition of the pavements, a challenge exists on the decision to mobilise an asphalt plant once or twice within the next 5-6 years, GHD have therefore considered numerous works packaging scenarios for NIRC consideration.

6.2 Works Requirements

6.2.1 Apron Rehabilitation

The aircraft parking apron is in need of rehabilitation. Having gone through numerous overlays and extensions in its history the apron geometry is non-standard. Through an apron resurfacing contract, NIRC should look to address the unsuitable fall towards the terminal and the address and refuelling challenges that exist.

This would likely include the reconstruction of the apron pavement suitable to address levels. Within the pricing packages we have allowed to reconstruct the apron for a 20 design year life.

6.2.2 Short Term Repairs

Items referred to as short repairs here in include a total of 1,000sqm of 75mm deep mill and fill asphalt repairs to the runway, taxiway and apron areas, and a total of 10km of crack sealing to areas environmental cracking across the airport site.

6.2.3 Pavement Preservation

Items referred to as pavement preservation here in include a total of 150,000sqm of surface enrichment sprayed treatment (bitumen emulsion sprayed at 0.4 litres/sqm) to the runway, taxiway and apron areas.

6.3 Option 1 Do Minimum

This option looks to address the high priority repair works only in the short term. This option comes with operational risk as there is increased uncertainty of premature pavement failure in further apron/taxiway areas in mid term years (years to 2-5 from the inspection).

The following works are considered to be included in this option in the next 24 months:

1. Mill and Fill maintenance repairs to the Apron, Taxiway, Runway intersection and Runway 11 end
2. Crack Sealing of medium severity areas

The following works would then be undertaken at approximately year 2022;

1. Overlay of Runway 11/29;
2. Overlay of Runway 04/22 – full length;
3. Apron Rehabilitation; and
4. Taxiway resurfacing.

This option has a total cost of **$29,775,200** and would extend the life of the airside pavements at Norfolk Island to **2037**.

The initial package of works would cost **$3,455,200** with the secondary package costing **$26,320,000.**

6.4 Option 2 Short Term Maintenance/Preservation with Longer Term Rehabilitation

This option involves packaging the high priority repair works with a preventive maintenance package which looks to prolong the need for the full runway overlay.

The following works are considered to be included in this option in the next 24 months:

1. Apron Rehabilitation;
2. Taxiway Overlay;
3. Runway 11 turning end maintenance;
4. Mill and Fill maintenance repairs to the Taxiway and Runway intersection;
5. Surface Enrichment Sprayed Treatment (SEST) to oxidised surfacings; and
6. Crack bandaging.

The following works would then be undertaken at approximately year 2023/2024;

1. Overlay of Runway 11/29; and
2. Overlay of Runway 04/22 – full length.

This option has a total cost of **$30,605,800** and would possibly extend the life of the airside pavements at Norfolk Island to **2039**.

The initial package of works would cost **$8,905,800** with the secondary package costing **$21,700,000.**

6.5 Option 3 Full Works implemented

This option involves undertaking all the following works in the next 24 months:

1. Apron Rehabilitation;
2. Taxiway Overlay;
3. Overlay of Runway 11/29; and
4. Overlay of Runway 04/22 – full length.

This option has a total cost of **$26,320,000** and would extend the life of the airside pavements at Norfolk Island to **2033**.

Given the cost of the overlay in 2007 was $11,920,611.00 and there is a third of residual life remaining, NIRC can anticipate an additional loss of $3,973,537.00 in existing pavement life with this option. This takes the option total to **$30,293,537**.

6.6 Recommendation

Given the significant extension of pavement life for the minor increase in option cost, it would be our recommendation to proceed with Option 2 which includes two establishments.

The first establishment for an apron rehabilitation and pavement preservation contract, the second as a future runway overlay contract when the PCI of the runway pavements reach 75.

The NIRC should careful consideration to the secondary mobilisation cost and the opportunity to purchase any asphalt equipment mobilised during the initial short term repairs. The costs associated with equipment would not be considerably more than the secondary remobilisation cost and therefore a viable option to increase the islands asset base.

6.7 Additional Items

NIRC should consider a cost allowance of $250,000 for the optional addition of addressing the surfacing of landside car park and high use airside ancillary asphaltic surfacings with a spray seal. Alternatively, these areas could receive an asphalt surfacing, for this NIRC should allow $750,000.

6.8 Assumptions

All prices are in Australian Dollars and exclude GST & local duties or taxes.

Aggregates are considered to be needed to be imported due to lack of availability on island (as advised by Mike Johnston of NIRC). Where local aggregates are available and can be sourced a 25% saving on theabove costs can be achieved.

A mobilisation of an asphalt plant will require a significant cost associated with the installation of a groyne at Ball bay suitable to receive a landing barge. GHD have allowed a $2M set figure for the establishment of an asphalt plant in the calculations.

A minimum asphalt thickness of 65mm has been used for all overlay considerations.

Professional fees have been set at 5% of the Contract values.

Contingency has been set at 15% of the Contract values.

Preliminary & general overheads have been set at 20% of the Contract values.

It should be highlighted that indicative costs for works in Pacific region can be highly volatile as there are numerous factors at play (availability of equipment for long stand down periods, shipping logistics, local market influences, etc) and that accurate pricing can only be gained through quotation or tendering processes.

The timing of future works is based on our knowledge of sites across Australiasia and standard deterioration timelines and based on a single visit to Norfolk Island. GHD remove themselves for any responsibility for changes in these timelines due to specific conditions only found in Norfolk that could not be known at the time of the visit, also any increase in frequency or aircraft loadings to that currently implemented, and any unforeseen ground conditions.

Appendices

Appendix A Inspection Notes & PCI Rating Map

Appendix B Costs Estimates

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