

ARCHERFIELD AIRPORT MASTER PLAN

TECHNICAL PAPER

TP 02/10

(Revision 2)

**RUNWAY SYSTEM DESIGN
WIND USABILITY ANALYSIS**

**Accounting for the Unserviceability
of the
Current 04/22 Parallel Secondary Runways**

FEBRUARY 2010

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1. INTRODUCTION

TP01/10 estimated the usability factors of the existing and alternative runway systems. The objective of this Technical Paper is to examine the usability delivered in practice by the existing runways, taking account of periods when one or other of the 04/22 natural surfaced or grassed runways is unserviceable following rain.

Periods of unserviceability have been derived from past records of Notices to Airmen (NOTAM) issued to notify these occurrences.

The examination spans the same 16 years of meteorological data sourced from the Bureau of Meteorology (BOM) for the wind analysis considered in TP01/10.

2. BACKGROUND

The existing runway system has been shown to provide the ICAO 95% usability factor for all classes of aircraft, taking account of the crosswind limitations imposed for each class for the purpose of airport master planning. However, these estimates of usability have been derived on the basis that the secondary 04/22 grassed parallels will be available and serviceable whenever they are required to supplement the paved and asphalt surfaced 10/28 parallels.

During and following rain events the secondary 04/22 grass parallel runways may be assessed unserviceable, because the surface is too soft and wet for aircraft to land safely or for emergency vehicles to attend the scene of an accident which may occur on take-off or landing.

For practical purposes the original usability estimates need to be modified by allowing for periods when the secondary 04/22 grass parallels are required but are assessed unserviceable due to these soft wet surface conditions.

The assessment accounts for occasions when either one or both of runways are unserviceable as both must be available before air traffic control (ATC) will transfer traffic from the 10/28 parallels. Transitioning from a parallel to a single runway option introduces operational risks which are deemed unacceptable by ATC. Their preference, in such circumstances, is to continue operations on runways 10/28 even though crosswinds may exceed the accepted limits for "ab-initio" student pilots.

3. DATA ANALYSIS

Wind strength and direction data recorded by BOM in the 16 years 1992 - 2008 was analysed in estimating usability factors detailed in TP01/10. Runway 04/22 unavailability data for the same period was obtained from Airservices Australia NOTAM briefing reports filed in logbooks maintained by Archerfield Airport ground and operational staff. The summary data is presented in the following table. As there is evident variation the data is summarised on both an annual and seasonal basis. Summer being designated as December-February, Autumn as March-May, Winter as June-August and Spring as September-November.

Closures indicate part or full days where the runways have been advised unavailability by NOTAM due to rain events. Days where a NOTAM was cancelled following the first unavailability inspection have been excluded from this count. No data could be sourced for the period May 1994 – August 1995.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1992							8	2	3	--	6	16	35
1993	6	4	3	--	2	--	7	3	3	4	6	7	45
1994	6	17	23	3									49
1995									2	--	18	11	31
1996	10	5	1	5	17	--	4	3	7	6	6	13	77
1997	8	9	4	3	11	2	3	2	3	8	15	3	71
1998	4	13	1	18	21	1	6	8	15	--	9	5	101
1999	11	7	16	17	18	5	17	17	18	18	9	14	167
2000	15	3	10	3	2	6	3	5	--	9	11	7	74
2001	7	10	23	16	5	4	3	--	1	6	4	16	95
2002	4	4	3	5	12	8	--	12	1	--	2	14	65
2003	1	20	19	20	16	4	7	7	1	13	--	9	117
2004	10	14	11	4	4	--	--	4	6	5	9	10	77
2005	9	4	--	11	17	14	11	2	10	7	4	4	93
2006	14	9	14	5	4	15	4	6	13	--	3	6	93
2007	16	16	6	--	3	10	1	10	8	16	22	17	125
2008	28	29	15	--	3	17							92
Total	149	164	149	110	135	86	74	81	91	92	124	152	1407
	465			394			241			307			
	Summer			Autumn			Winter			Spring			
	34.3%			29.2%			18.7%			22.5%			26.3%

The 04/22 grassed runways have been deemed unavailability and closed to aircraft operations 26.3% of the time on average in the period 1992-2008. Seasonal variation has ranged from a high of 34.3% in Summer to a low of 18.7% in Winter.

4. IMPACT OF UNSERVICEABILITY ON RUNWAY USABILITY

TP01/10 established that the existing 10/28 paved and asphalt surfaced runways provide the 95% ICAO recommended usability factor for operations at night, but that additional runways are required to meet this usability criteria in daylight hours for aircraft with a 10 knots (kt) crosswind limitation. This analysis is therefore limited to day hours and to a 10kt crosswind.

For the purposes of this analysis the 04/22 grassed parallel runways are assumed to be unserviceable when the BOM data indicates rainfall greater than 0.1mm in any three hour observation period. In these conditions the runway surface is deemed wet and unserviceable. The runways are then assumed to remain unserviceable for the balance of the period advised by NOTAM, until dry to depth. In other words, the runways remain unserviceable for some time although no further rainfall is recorded and "dry" conditions prevail.

Graphs showing results of meteorological data analysis are included as Attachments 1-16 at the end of this Technical Paper.

The summary data presented in the following tables shows that, in Summer, the secondary runways are required to augment Day Hours – Wet Conditions usability by an average of 7.4% but will be unserviceable for all of that time. They are also required to augment Day Hours – Dry Conditions usability by an average of 14.76% but will only be serviceable for 68.43% of that time. On this basis the 04/22 grassed runways provide a practical increase in usability of only 10.1% when dry, and an overall day hours usability of 93.26%.

SUMMER		Observations	
Day Hours - Dry Conditions		5142	96.00%
Runway 10/28 Usability	83.26%		
Runway 10/28 + 04/22 Usability	98.02%		
Runway 04/22 is required	14.76%		
but is serviceable only	68.43% of the time in "dry" conditions		
so increases usability by only	10.10%		
Runway 10/28 + 04/22 Adjusted Usability	93.36%		
Day Hours - Wet Conditions		214	4.00%
Runway 10/28 Usability	90.88%		
Runway 10/28 + 04/22 Usability	98.28%		
Runway 04/22 is required	7.40%		
but is unserviceable all the time	"wet conditions" are experienced		
Runway 10/28 + 04/22 Adjusted Usability	90.88%		
Weighted Average Day Hours Serviceability			
Runway 10/28 + 04/22 Usability	93.26%		

In Autumn the secondary runways are required to augment Day Hours – Wet Conditions usability by an average of 3.23% but will be unserviceable for all of that time. They are required to

augment Day Hours – Dry Conditions usability by an average of 5.56% but will only be serviceable for 72.60% of that time. On this basis the 04/22 grassed runways provide a practical increase in usability of 4.04% when dry, and a weighted day hours usability of 97.13%.

AUTUMN		Observations	
Day Hours - Dry Conditions		5225	97.52%
Runway 10/28 Usability	93.19%		
Runway 10/28 + 04/22 Usability	98.75%		
Runway 04/22 is required	5.56%		
but is serviceable only	72.60%	of the time in "dry" conditions	
so increase usability by only	4.04%		
Runway 10/28 + 04/22 Adjusted Usability	97.23%		
Day Hours - Wet Conditions		133	2.48%
Runway 10/28 Usability	93.41%		
Runway 10/28 + 04/22 Usability	96.64%		
Runway 04/22 is required	3.23%		
but is unserviceable all the time		"wet conditions" are experienced	
Runway 10/28 + 04/22 Adjusted Usability	93.41%		
Weighted Average Day Hours Serviceability			
Runway 10/28 + 04/22 Average Usability	97.13%		

In Winter the secondary runways are required to augment Day Hours – Wet Conditions usability by an average of 4.77% but will be unserviceable for all of that time. They are required to augment Day Hours – Dry Conditions usability by an average of 4.21% but will only be serviceable for 82.52% of that time. On this basis the 04/22 grassed runways provide a practical increase in usability of 3.47% when dry, and a weighted day hours usability of 98.12%.

WINTER		Observations	
Day Hours - Dry Conditions		5383	98.52%
Runway 10/28 Usability	94.71%		
Runway 10/28 + 04/22 Usability	98.92%		
Runway 04/22 is required	4.21%		
but is serviceable only	82.52%		
so increases usability by only	3.47%	of the time in "dry" conditions	
Runway 10/28 + 04/22 Adjusted Usability	98.18%		
Day Hours - Wet Conditions		81	1.48%
Runway 10/28 Usability	93.96%		
Runway 10/28 + 04/22 Usability	98.73%		
Runway 04/22 is required	4.77%		
but is unserviceable all the time		"wet conditions" are experienced	
Runway 10/28 + 04/22 Adjusted Usability	93.96%		
Weighted Average Day Hours Serviceability			
Runway 10/28 + 04/22 Average Usability	98.12%		

In Spring the secondary runways are required to augment Day Hours – Wet Conditions usability by an average of 8.35% but will be unserviceable for all of that time. They are required to augment Day Hours – Dry Conditions usability by an average of 19.91% but will only be serviceable for 79.55% of that time. On this basis the 04/22 grassed runways provide a practical increase in usability of 15.84% when dry, and a weighted day hours usability of 93.39%.

SPRING			
		Observations	
Day Hours - Dry Conditions		5261	97.43%
Runway 10/28 Usability	77.67%		
Runway 10/28 + 04/22 Usability	97.58%		
Runway 04/22 is required	19.91%		
but is serviceable only	79.55%	of the time in "dry" conditions	
so increases usability by only	15.84%		
Runway 10/28 + 04/22 Adjusted Usability	93.51%		
		Observations	
Day Hours - Wet Conditions		139	2.57%
Runway 10/28 Usability	88.97%		
Runway 10/28 + 04/22 Usability	97.32%		
Runway 04/22 is required	8.35%		
but is unserviceable all the time		"wet conditions" are experienced	
Runway 10/28 + 04/22 Adjusted Usability	88.97%		
Weighted Average Day Hours Serviceability			
Runway 10/28 + 04/22 Average Usability	93.39%		

The annualised data is summarised in the following table. This shows that the secondary runways are required to augment Day Hours – Wet Conditions usability by an average of 6.03% but will be unserviceable for all of that time. They are required to augment Day Hours – Dry Conditions usability by an average of 11.84% but will only be serviceable for 75.69% of that time. On this basis the 04/22 grassed runways provide a practical increase in usability of 8.96% when dry, and a weighted day hours usability of 96.33%.

ANNUAL SUMMARY	Year	Observations	
Day Hours - Dry Conditions		21011	97.37%
Runway 10/28 Usability	87.50%		
Runway 10/28 + 04/22 Usability	99.34%		
Runway 04/22 is required	11.84%		
but is serviceable only	75.69%	of the time in "dry" conditions	
so increases usability by only	8.96%		
Runway 10/28 + 04/22 Adjusted Usability	96.46%		
Day Hours - Wet Conditions		567	2.63%
Runway 10/28 Usability	91.58%		
Runway 10/28 + 04/22 Usability	97.61%		
Runway 04/22 is required	6.03%		
but is unserviceable all the time		"wet conditions" are experienced	
Runway 10/28 + 04/22 Adjusted Usability	91.58%		
Weighted Average Day Hours Serviceability			
Runway 10/28 + 04/22 Average Usability	96.33%		

OBSERVATIONS AND RECOMMENDATIONS

In practical terms, the estimated annual usability satisfies the recommended ICAO criteria for all classes of aircraft. On this basis there is no requirement, in airport planning terms, to improve the serviceability or usability of the 04/22 natural surface parallel runways.

On the other hand there is significant seasonal variation, with the secondary runways required primarily in Spring and Summer but also being unserviceable for a significant proportion of the time. This is unsurprising given the long term rainfall pattern evident in the BOM data.

Although the ICAO recommended annual usability criteria are satisfied the seasonal analysis suggests that it may be desirable to improve the serviceability of the 04/22 natural surface parallel runways. As alternative runway directions are possible, it may also be prudent to consider if an alternative runway alignment is likely to provide enhanced serviceability and availability in and immediately following wet conditions.

5. SECONDARY RUNWAY OPTIONS

TP01/10 found that secondary runways oriented between 180/360 and 040/220 degrees Magnetic (°M) would provide some improvement in overall usability. The estimated gains were found to be marginal, as TP01/10 considered only the relative usability estimated by reference to wind conditions experienced at the site.

This Technical Paper extends that analysis by considering the impact of runway unserviceability on these usability estimates.

Topography of the airport site favours the maximum anti-clockwise rotation in the grassed runway direction as this would allow secondary runways to be located on higher ground, and above the influence of the ground water table which causes the current 04/22 grassed parallels to be so slow in drying out. The grassed runways need to be dry to depth – not simply at the surface - before they will be assessed serviceable for aircraft operations and/or emergency vehicle access.

Natural surfaced, grassed runways on higher ground can be “constructed” to a design profile which improves surface water run-off. Subsoil drains can also be installed to provide positive drainage of ground water and to lower the ground water table. It would be impracticable to implement the same measures in relation to the existing 04/22 grassed parallel runways without major earthworks.

As a result of these design and construction features, it can be assumed that the alternative secondary grassed runways will be unserviceable only in those periods where more than 0.1mm of rain is recorded in the BOM data. This is a deliberately conservative assumption.

The analysis is conducted by reference to alternative 010/190°M or 01/19 grassed runways as these provide the optimal balance between these design objectives and the runway usability estimates provided in TP01/10. The revised usability estimates are presented in the following tables.

In summer the estimated day hours usability is 98.82%, an increase of 5.56% or 5.02 days, compared with the current situation.

SUMMER		Observations	
Day Hours - Dry Conditions		5142	96.00%
Runway 10/28 + 04/22 Adjusted Usability	93.36%		
Runway 10/28 + 01/19 Usability	99.15%		
	an increase of	5.79%	
	or	5.02 days	
Day Hours - Wet Conditions		214	4.00%
Runway 10/28 + 04/22 Adjusted Usability	90.88%		
Runway 10/28 + 01/19 Adjusted Usability	90.88%		
Weighted Average Day Hours Serviceability			
Runway 10/28 + 04/22 Usability	93.26%		
Runway 10/28 + 04/22 Average Usability	93.26%		
Runway 10/28 + 01/19 Average Usability	98.82%		
	an increase of	5.56%	
	or	5.02 days	

Modest increases of 2.22% and 0.80%, or 2.04 and 0.74 days, are estimated in Autumn and Winter.

AUTUMN		Observations	
Day Hours - Dry Conditions		5225	97.52%
Runway 10/28 + 04/22 Adjusted Usability	97.23%		
Runway 10/28 + 01/19 Usability	99.50%		
	an increase of	2.27%	
	or	2.04 days	
Day Hours - Wet Conditions		133	2.48%
Runway 10/28 + 04/22 Adjusted Usability	93.41%		
Runway 10/28 + 01/19 Adjusted Usability	93.41%		
Weighted Average Day Hours Serviceability			
Runway 10/28 + 04/22 Average Usability	97.13%		
Runway 10/28 + 01/19 Average Usability	99.35%		
	an increase of	2.22%	
	or	2.04 days	

WINTER		
		Observations
Day Hours - Dry Conditions		5383 98.52%
Runway 10/28 + 04/22 Adjusted Usability	98.18%	
Runway 10/28 + 01/19 Usability	99.00%	
	an increase of 0.82%	
	or 0.74 days	
		Observations
Day Hours - Wet Conditions		81 1.48%
Runway 10/28 + 04/22 Adjusted Usability	93.96%	
Runway 10/28 + 01/19 Adjusted Usability	93.96%	
Weighted Average Day Hours Serviceability		
Runway 10/28 + 04/22 Average Usability	98.12%	
Runway 10/28 + 01/19 Average Usability	98.93%	
	an increase of 0.80%	
	or 0.74 days	

In Spring, the realigned runways are estimated to provide 98.49% usability, an increase of 5.10% or 4.64 days.

SPRING		
		Observations
Day Hours - Dry Conditions		5261 97.43%
Runway 10/28 + 04/22 Adjusted Usability	93.51%	
Runway 10/28 + 01/19 Usability	98.74%	
	an increase of 5.23%	
	or 4.64 days	
		Observations
Day Hours - Wet Conditions		139 2.57%
Runway 10/28 + 04/22 Adjusted Usability	88.97%	
Runway 10/28 + 01/19 Adjusted Usability	88.97%	
Weighted Average Day Hours Serviceability		
Runway 10/28 + 04/22 Average Usability	93.39%	
Runway 10/28 + 01/19 Average Usability	98.49%	
	an increase of 5.10%	
	or 4.64 days	

The annualised data is summarised in the following table. This shows overall usability is expected to increase to 99.43%, an increase of 3.10% or 11.32 days a year. As noted by reference to the seasonal data, the majority of these gains accrue in Spring and Summer when the secondary grass runways are most needed to augment the overall usability of the runway system.

ANNUAL SUMMARY		Year		
Day Hours - Dry Conditions			Observations	
			21011	97.37%
Runway 10/28 + 04/22 Adjusted Usability	96.46%			
Runway 10/28 + 01/19 Usability	99.64%			
	an increase of	3.18%		
	or	11.30 days		
Day Hours - Wet Conditions			Observations	
			567	2.63%
Runway 10/28 + 04/22 Adjusted Usability	91.58%			
Runway 10/28 + 01/19 Adjusted Usability	91.72%			
Weighted Average Day Hours Serviceability				
Runway 10/28 + 04/22 Average Usability	96.33%			
Runway 10/28 + 01/19 Average Usability	99.43%			
	an increase of	3.10%		
	or	11.32		

6. CONCLUSIONS

A detailed analysis of 16 years climate data has shown that the existing runway configuration satisfies the ICAO 95% usability factors for all aircraft operating, day or night. Although the overall usability criteria is met, a detailed seasonal analysis has shown that when most needed in Spring and Summer to augment overall usability, the 04/22 grassed parallels are often unserviceable and therefore unavailable for aircraft operations.

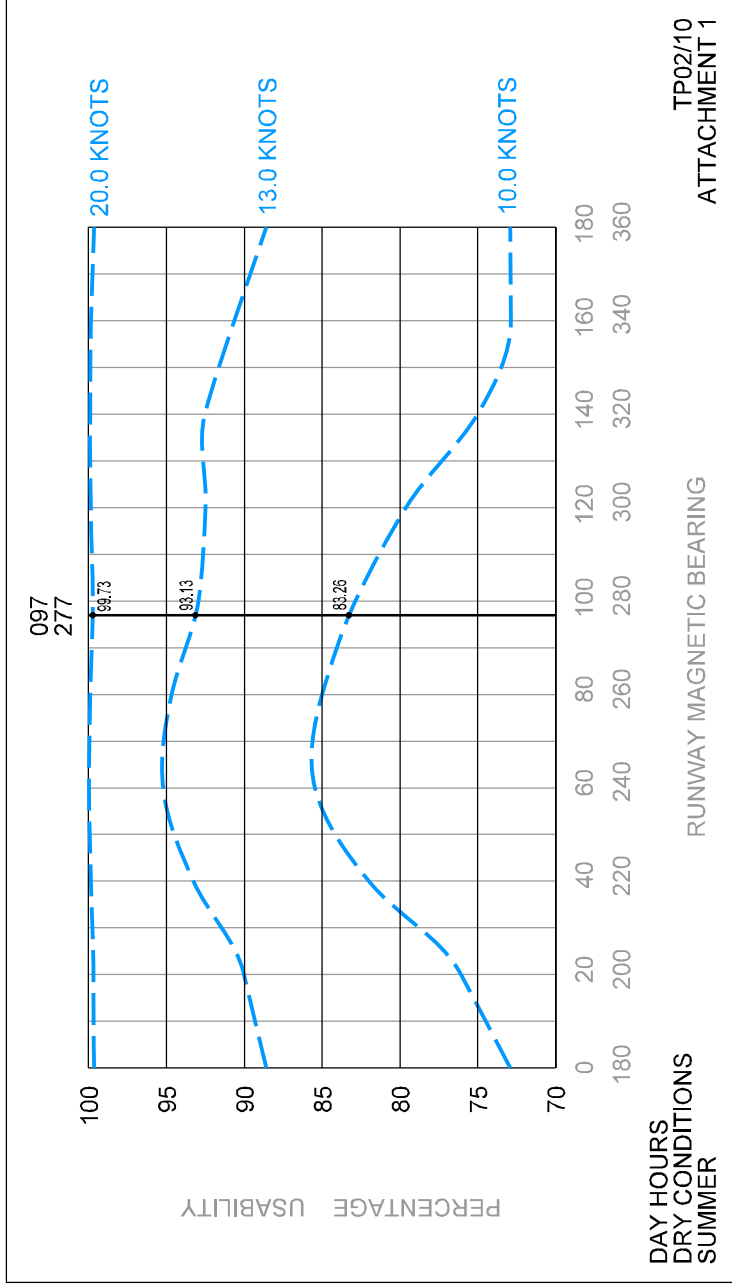
Although not justified by average annual serviceability considerations, this circumstance nevertheless suggests that it may be desirable to improve the serviceability of the secondary grass runways.

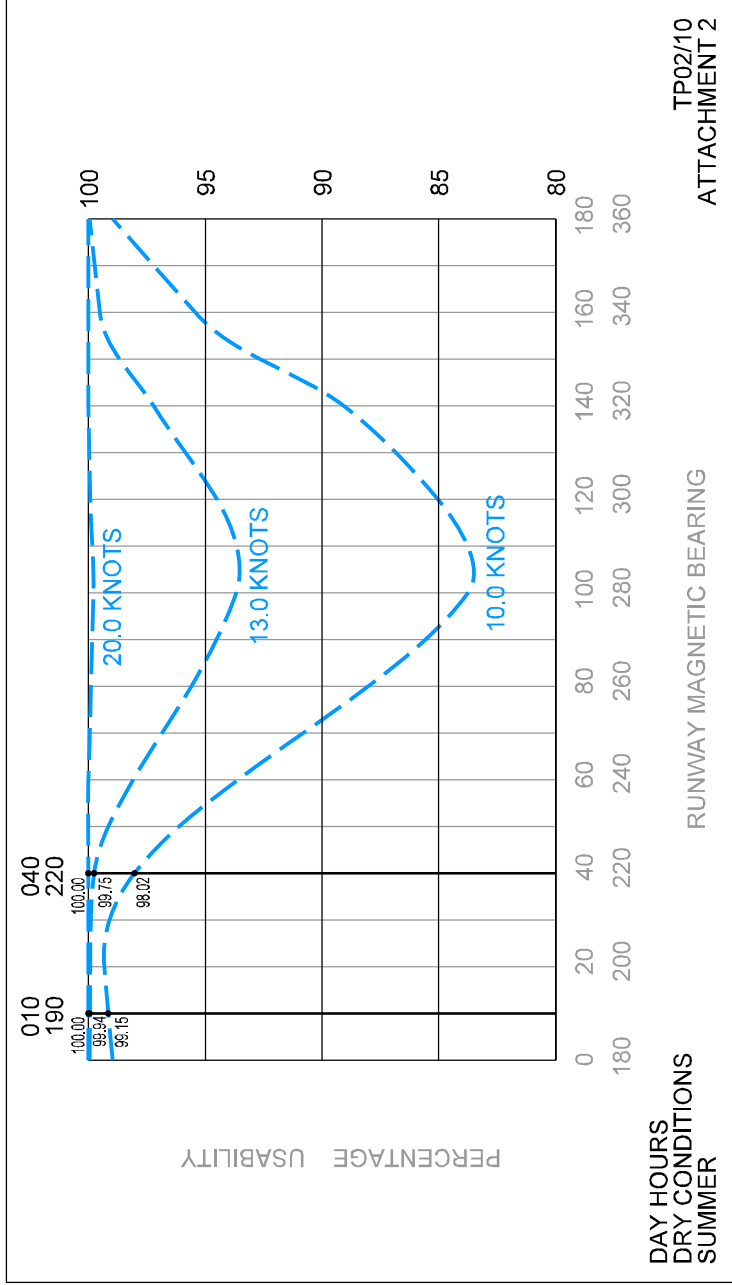
TP01/10 has shown that practical alternatives to the existing secondary runways are available which retain or increase the estimated usability factor of the runway system. This paper has postulated that natural surfaced, grassed runways on higher ground can be "constructed" to a design profile which improves surface water run-off and that subsoil drains can also be installed to provide positive drainage of ground water and to lower the ground water table.

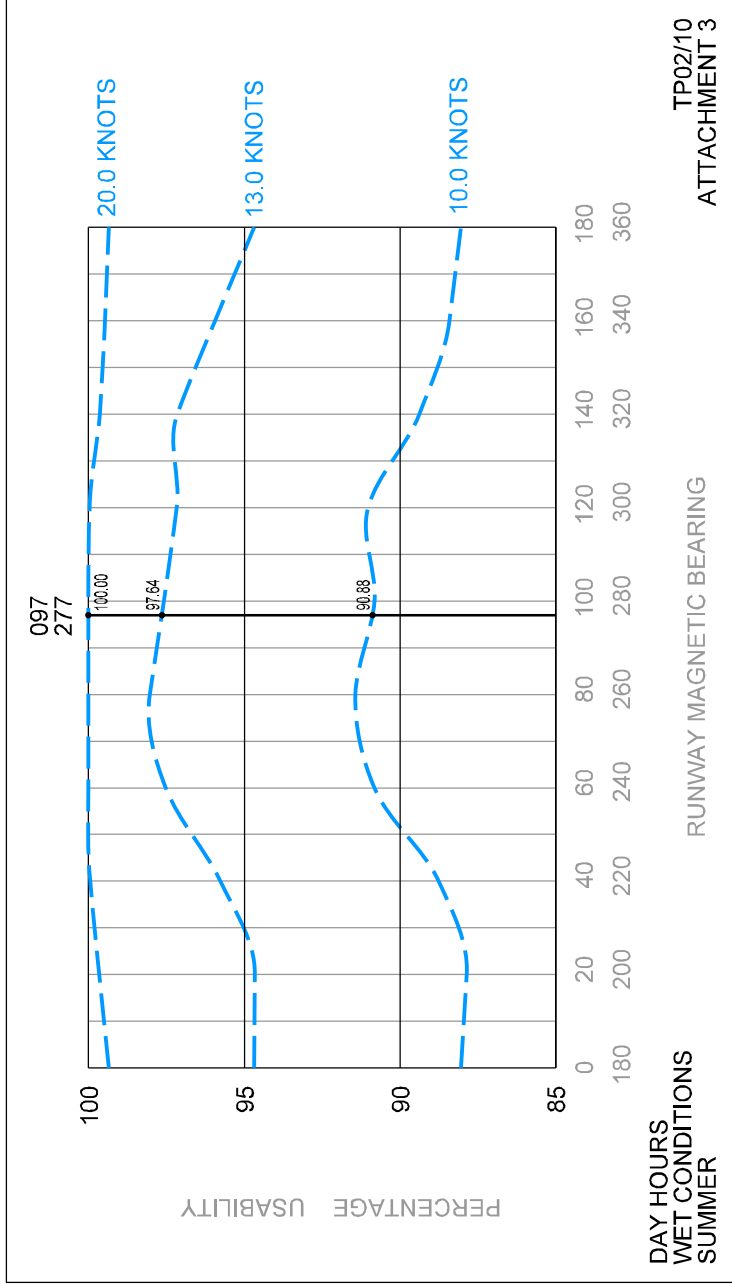
These design and construction features can be assumed to limit runway unserviceability to those periods where meteorological conditions are "wet" as the runways will remain dry at depth.

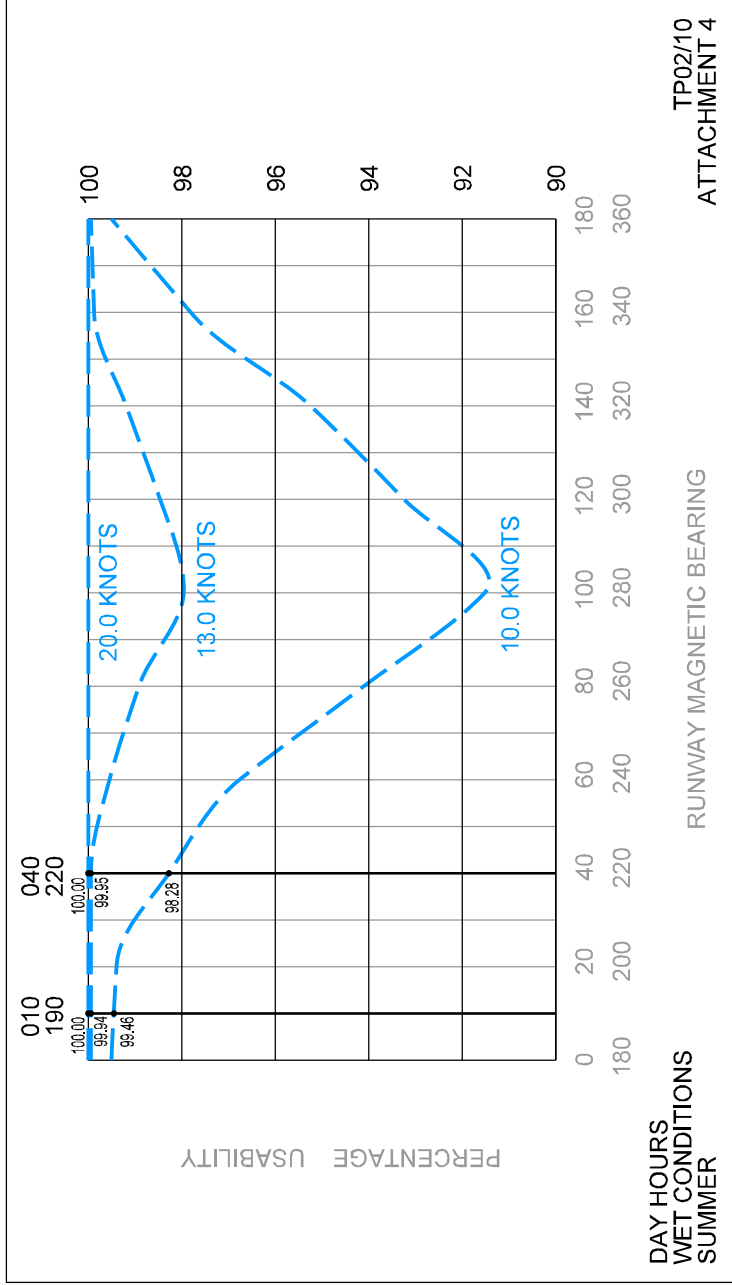
Alternative 01/19 grassed runways appear to provide the optimal balance between the drainage design objectives and the runway usability estimates provided in TP01/10.

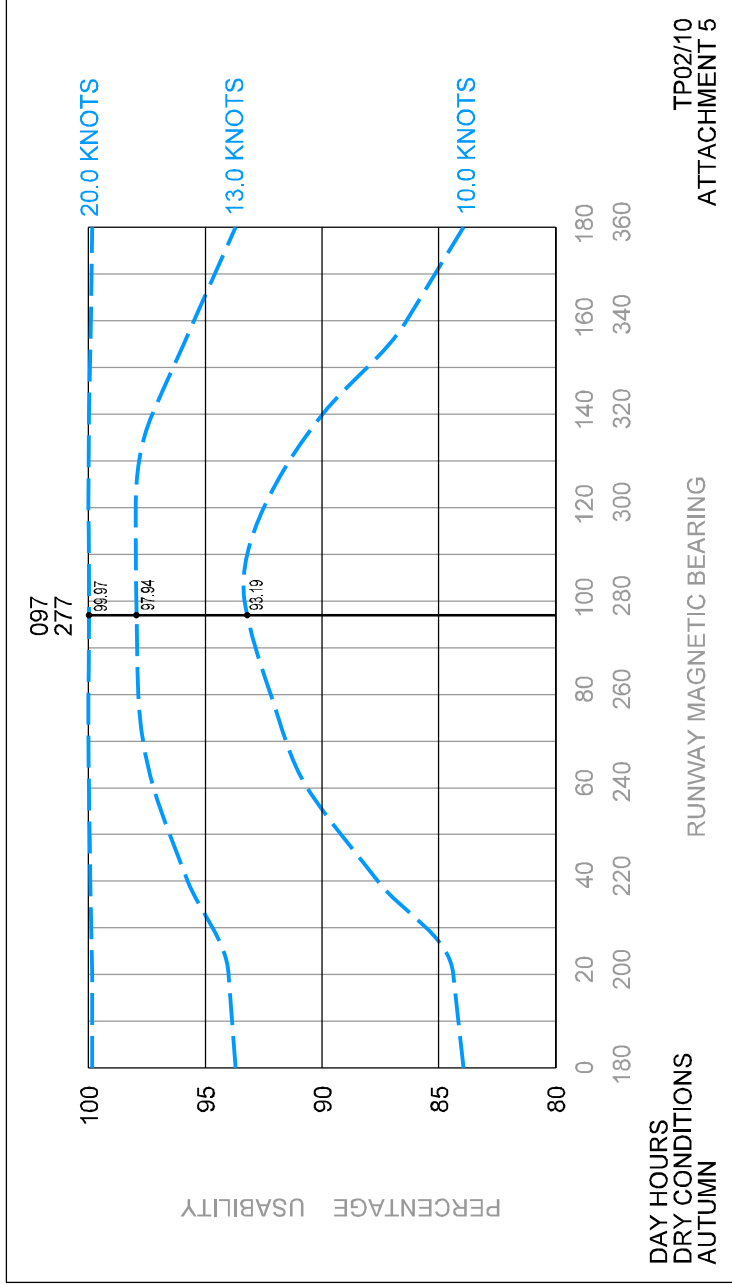
Compared with the current situation overall usability is expected to increase to 99.43%, an increase of 3.1% or 11.32 days a year. The majority of these gains accrue in Spring in Summer when the secondary grass runways are most needed to augment the overall usability of the runway system.

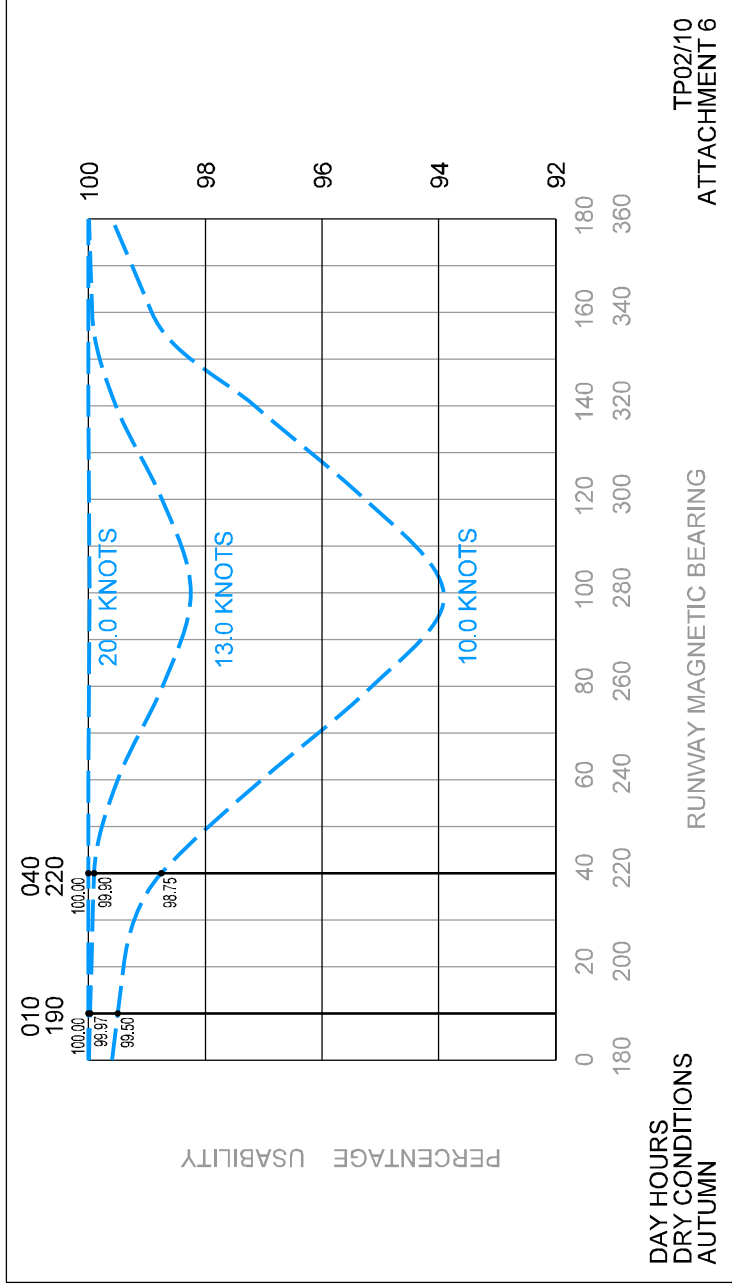


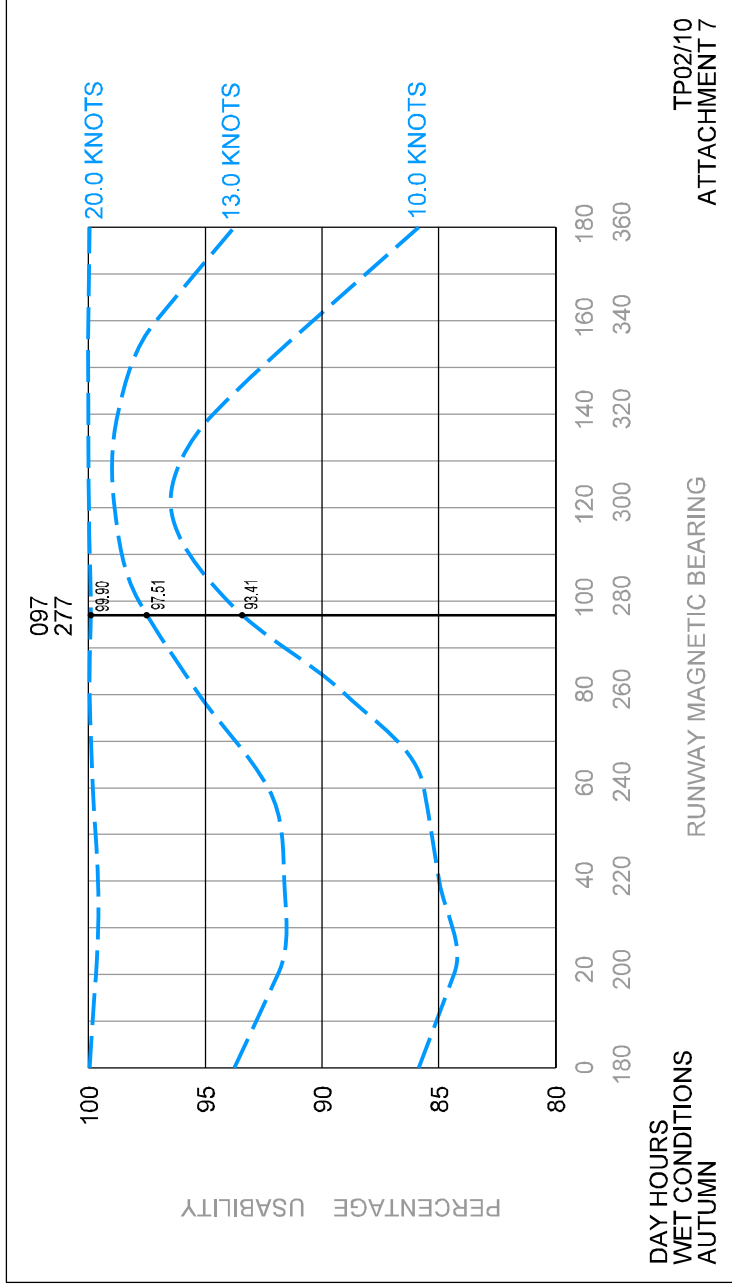






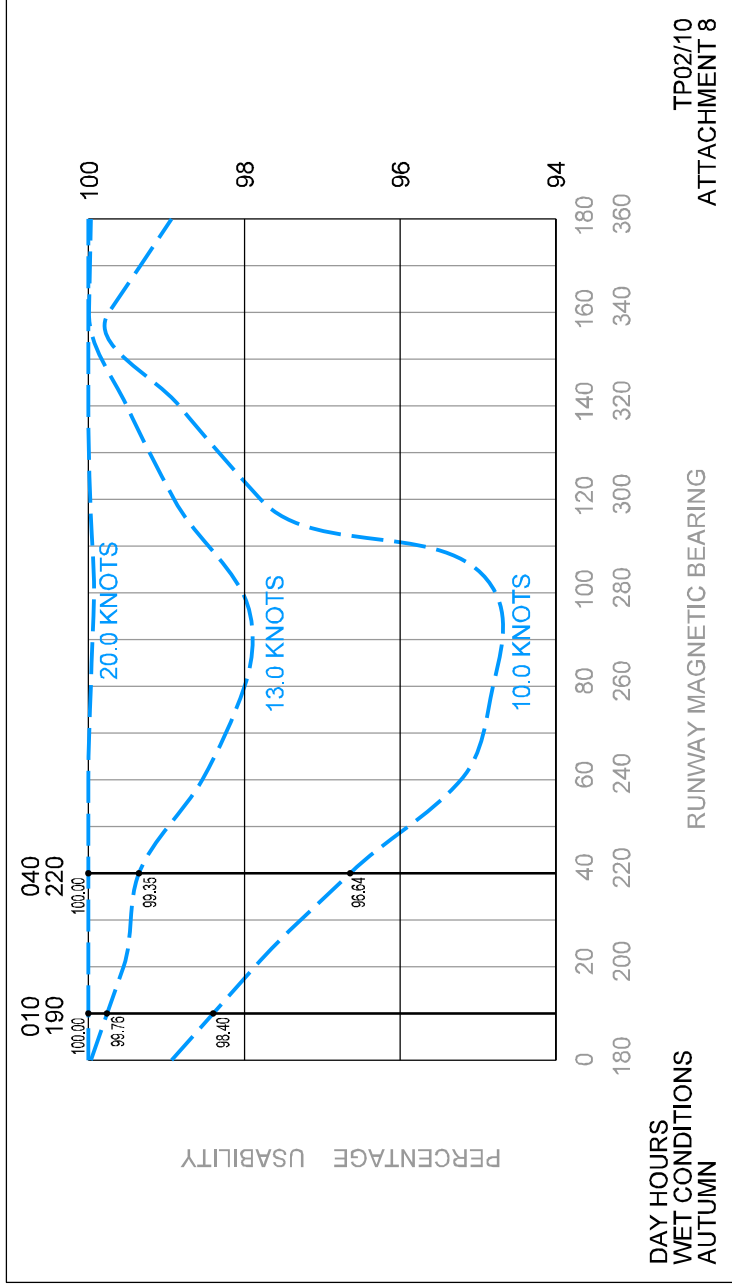


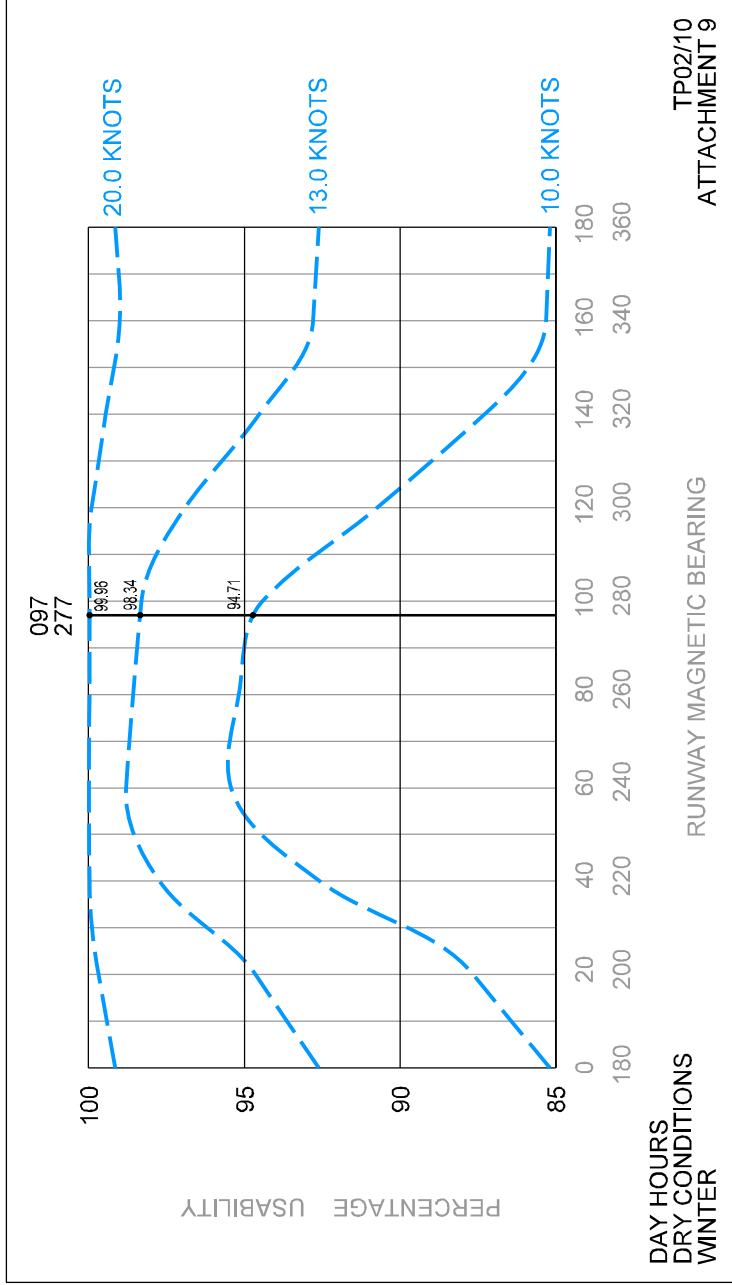


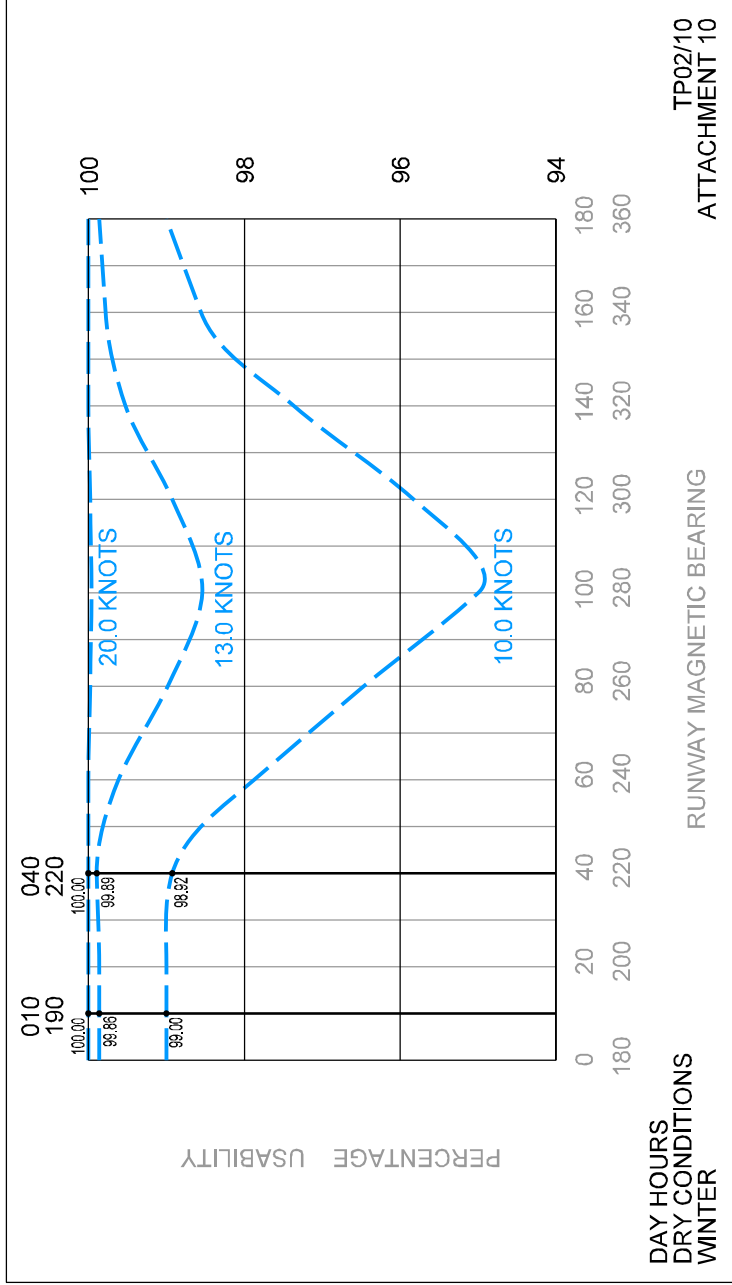


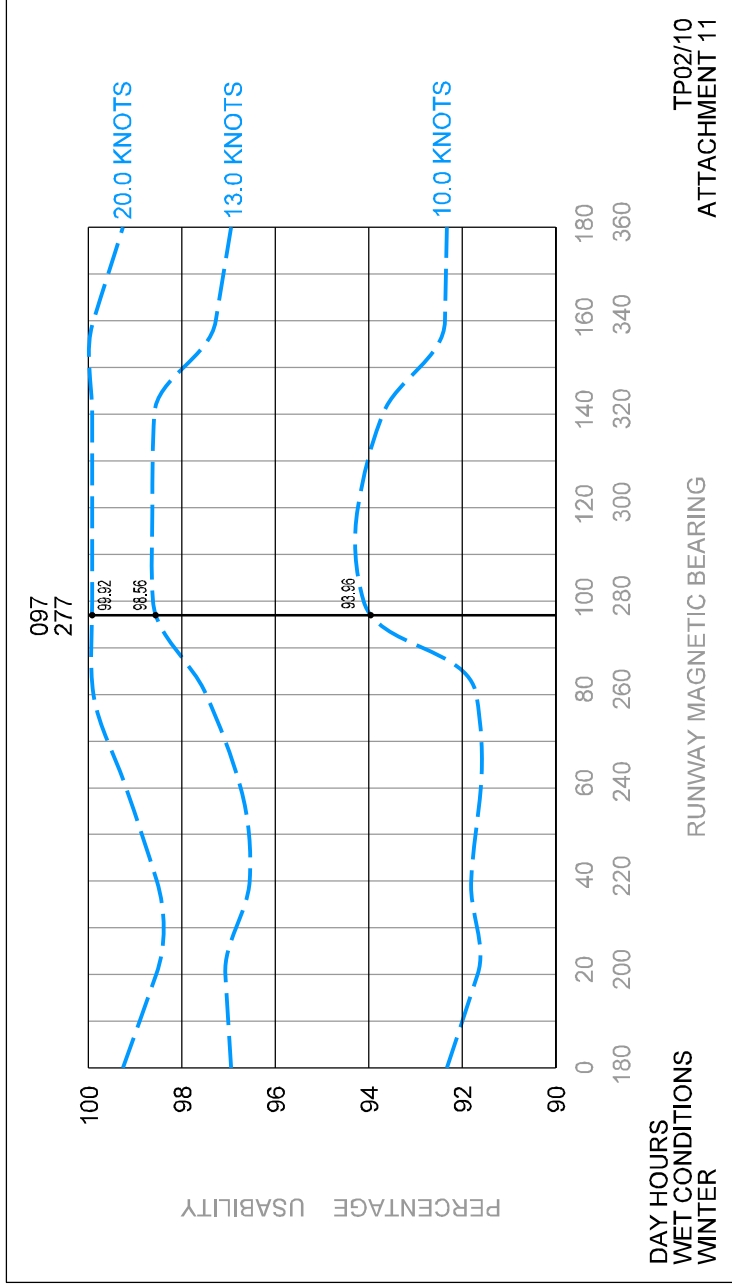
TP02/10
ATTACHMENT 7

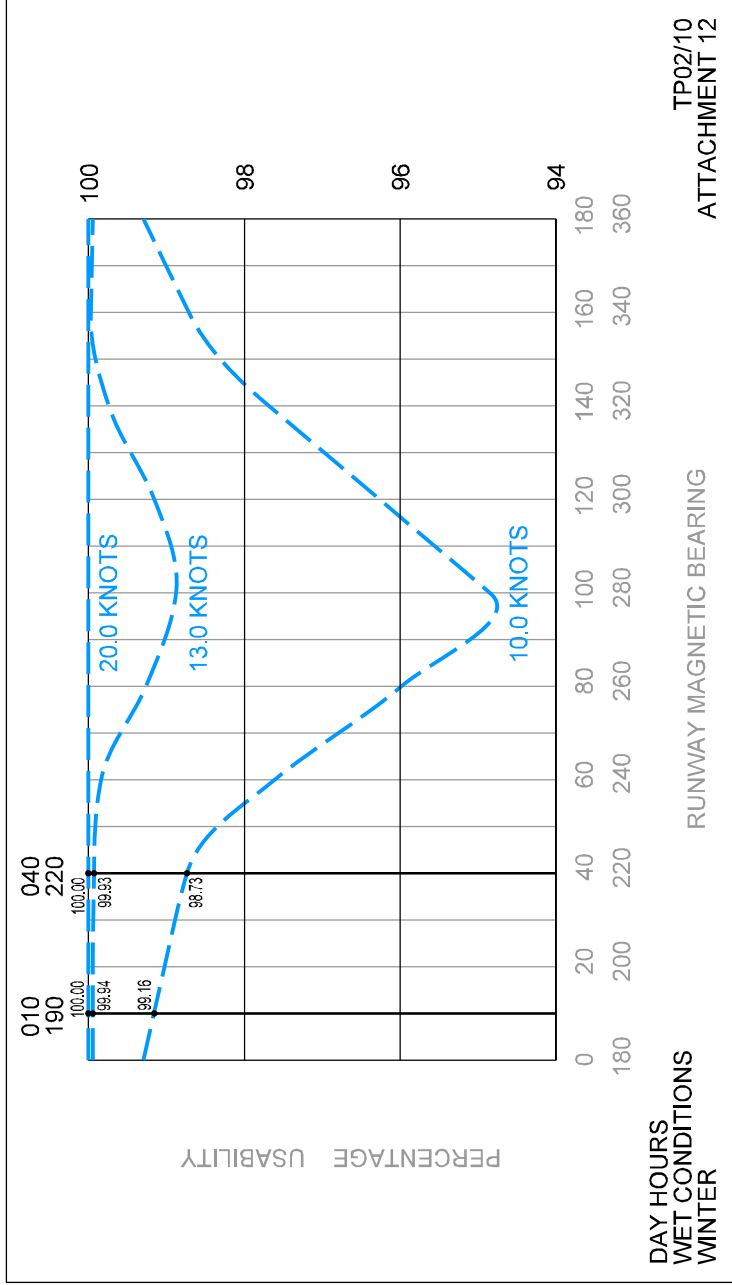
DAY HOURS
WET CONDITIONS
AUTUMN











TP02/10
ATTACHMENT 12

DAY HOURS
WET CONDITIONS
WINTER

PERCENTAGE USABILITY

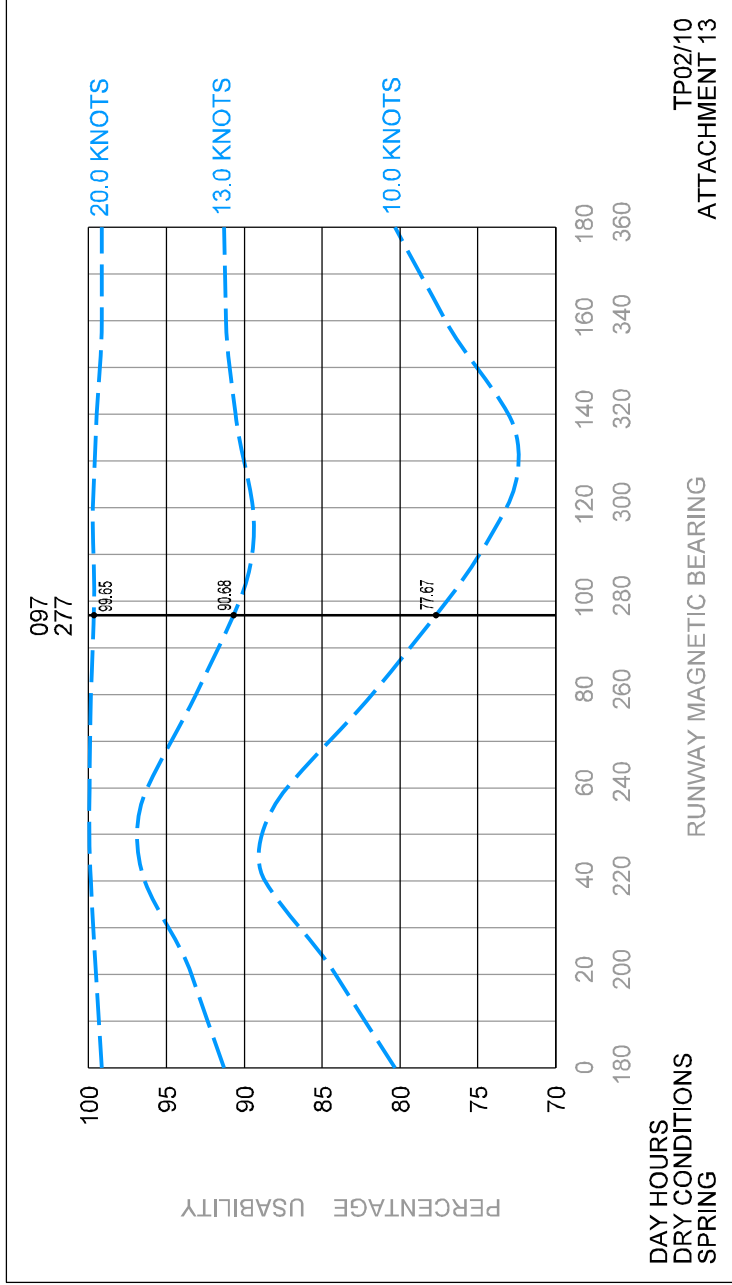
RUNWAY MAGNETIC BEARING

100
98
96
94

010
190
040
220

180 160 140 120 100 80 60 40 20 0 200 240 260 280 300 320 340 360

20.0 KNOTS
13.0 KNOTS
10.0 KNOTS



TP02/10
ATTACHMENT 13

DAY HOURS
DRY CONDITIONS
SPRING

