Sierra Blanca Ruidoso Airport (SRR) Pavement Condition and Analysis

Submitted to:

Jane M. Lucero, AICP
Airport Development Administrator
New Mexico Aviation Division
P.O. Box 9830
Albuquerque, NM 87119
tel: 505-244-1788 ext. 111
e-mail: Jane.Lucero@state.nm.us

Prepared by:

Dr. Mark P. Cal, P.E.
Professor and Chair
Department of Civil & Environmental Engineering
801 Leroy Place, Jones Annex
Socorro, NM 87801
tel: (575) 835-5059
e-mail: mcal@nmt.edu

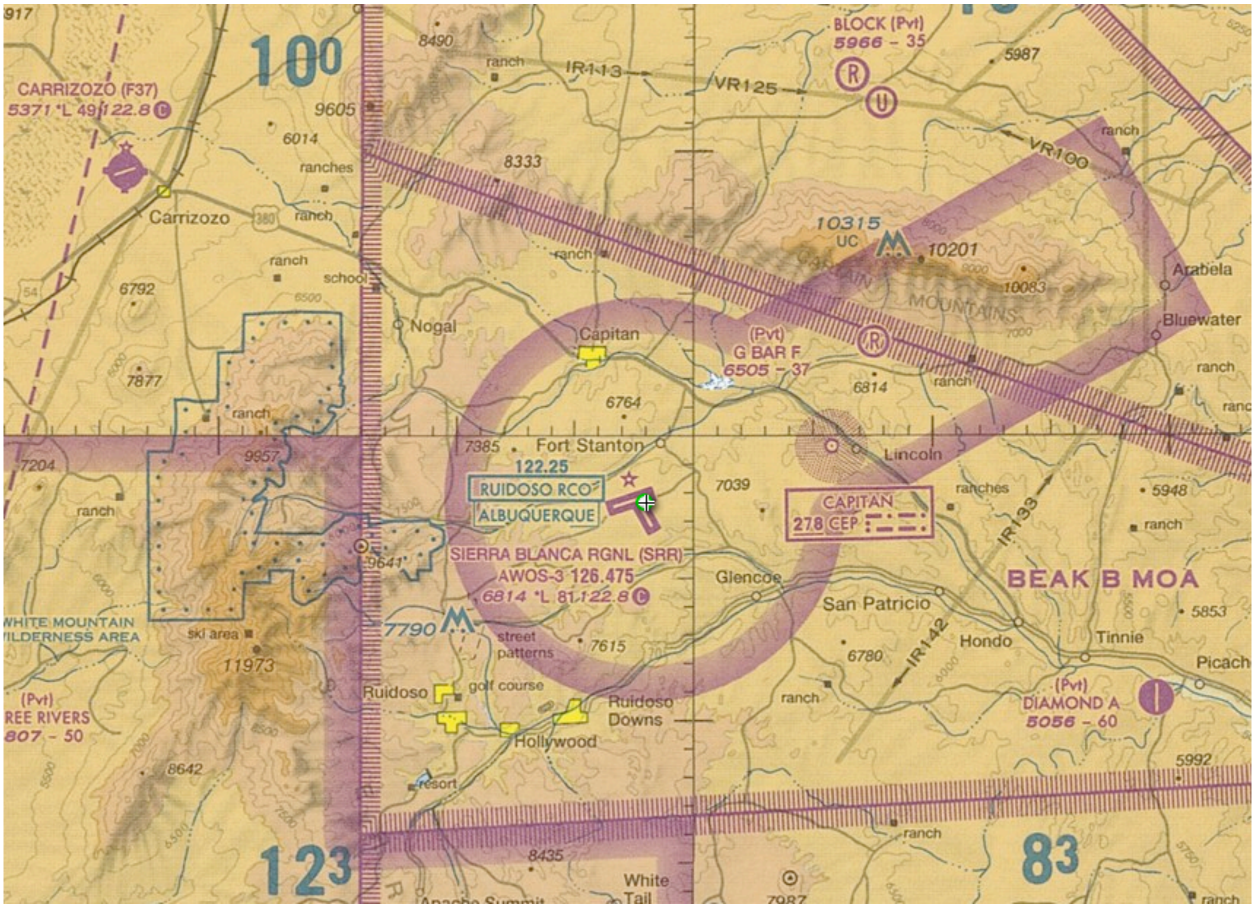
June 10, 2010 (FINAL)

Contents

1. Conditions at Sierra Blanca Ruidoso Airport (SRR)

Sierra Blanca Ruidoso Airport (SRR) is located about 180 miles southeast of Albuquerque, NM (Figure 1).

Figure 1. Geographic Location of Sierra Blanca Ruidoso Airport (SRR)



Source: www.skyvector.com

The estimated aircraft traffic at Sierra Blanca Ruidoso Airport, based on average reported flight data from 2007, is presented in Table 1 and predicted aircraft traffic is presented in Table 2. No growth is expected at this airport through 2027 based on the report by *Wilbur Smith Associates, Inc., New Mexico Airport Plan Update (2009)*. Traffic is mostly small general aviation aircraft, such as Cessna's. Air taxis account for about 11% of traffic and commercial traffic is about 5%. Less than 1% of the traffic is military helicopters.

Table 1. Sierra Blanca Ruidoso (SRR) Aircraft Operations (2007)

Aircraft Category	Yearly Traffic [no.]	Average Daily Traffic [no.]	Annual Aircraft [%]	Estimated Annual Departures [no.]
General Aviation Itinerant (Transient)	3610	9.9	57.0%	1805
General Aviation Local	1675	4.6	26.4%	837.5
Air Taxi	670	1.8	10.6%	335
Commercial	330	0.9	5.2%	165
Military (helicopters)	50	0.1	0.8%	25
Total	**6335**			
Estimated Departures	**3168**			

Source: Based on an average air traffic operations data from 2007.

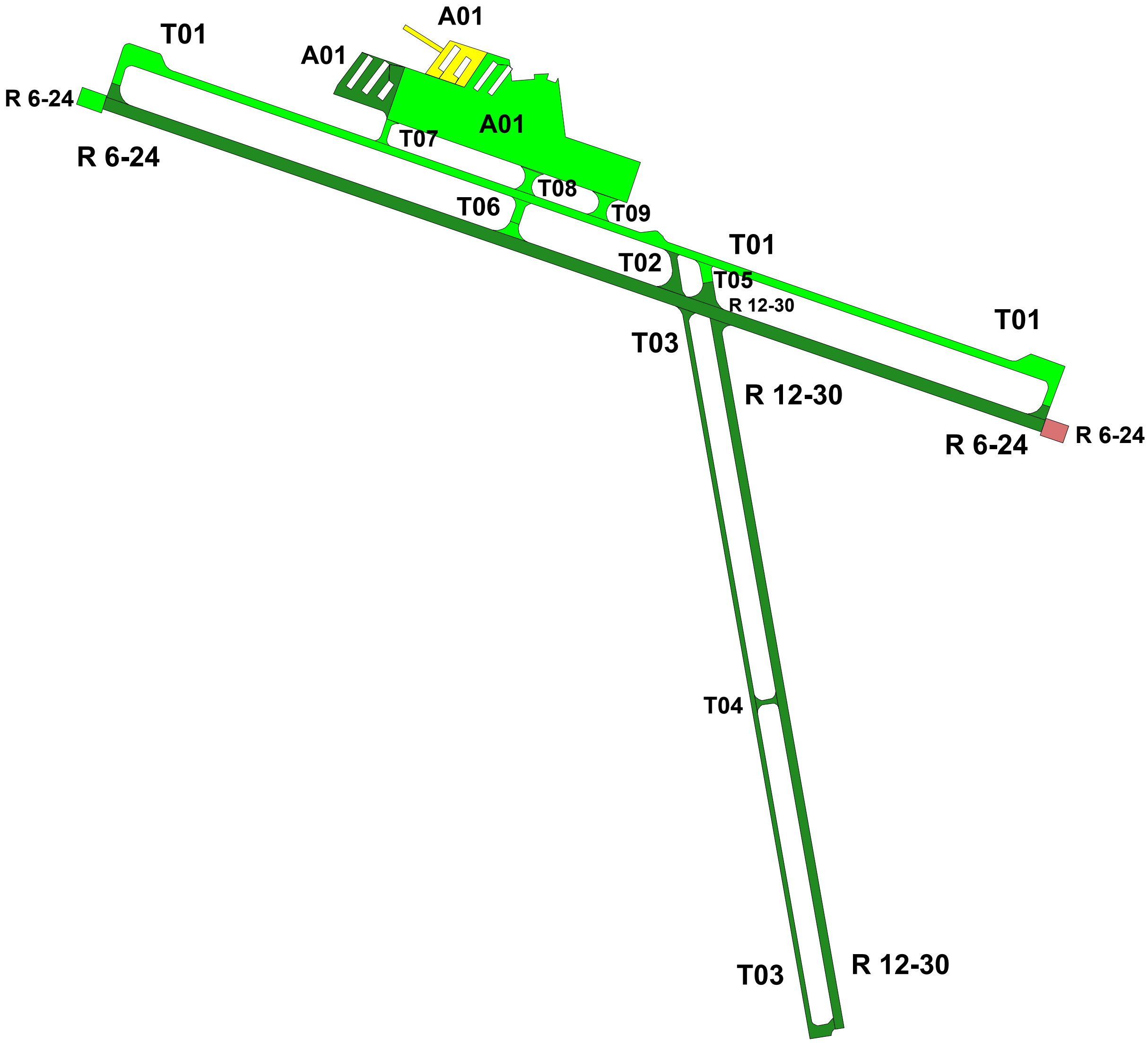
The asphalt concrete pavement on the runways, taxiways, and aprons was last inspected by New Mexico Tech (NMT) during March, 2007. Maps showing the pavement condition index (PCI) of these areas along with labels for the inspected areas are in presented in Figures 2 and 3.

Table 2. Sierra Blanca Ruidoso (SRR) Predicted Aircraft Operations 2007-2027

	2007	2012	2017	2027
General Aviation Itinerant (Transient)	3,610	3,610	3,610	3,610
General Aviation Local	1,675	1,675	1,675	1,675
Air Taxi	670	670	670	670
Air Carrier	330	330	330	330
Subtotal General Aviation	6,285	6,285	6,285	6,285
Military Itinerant	50	50	50	50
Subtotal Military	50	50	50	50
Total Itinerant	4,660	4,660	4,660	4,660
Total Local	1,675	1,675	1,675	1,675
Total Annual Operations	6,335	6,335	6,335	6,335
GA Itinerant Operations Percentage	57.0%	57.0%	57.0%	57.0%
GA Local Operations Percentage	26.4%	26.4%	26.4%	26.4%
Annual Operations Growth Rate (5 year periods, e.g. 2012-2017)		0%	0.0%	0.0%
Average Annual Operations Growth Rate (2007-2027)	0.0%			

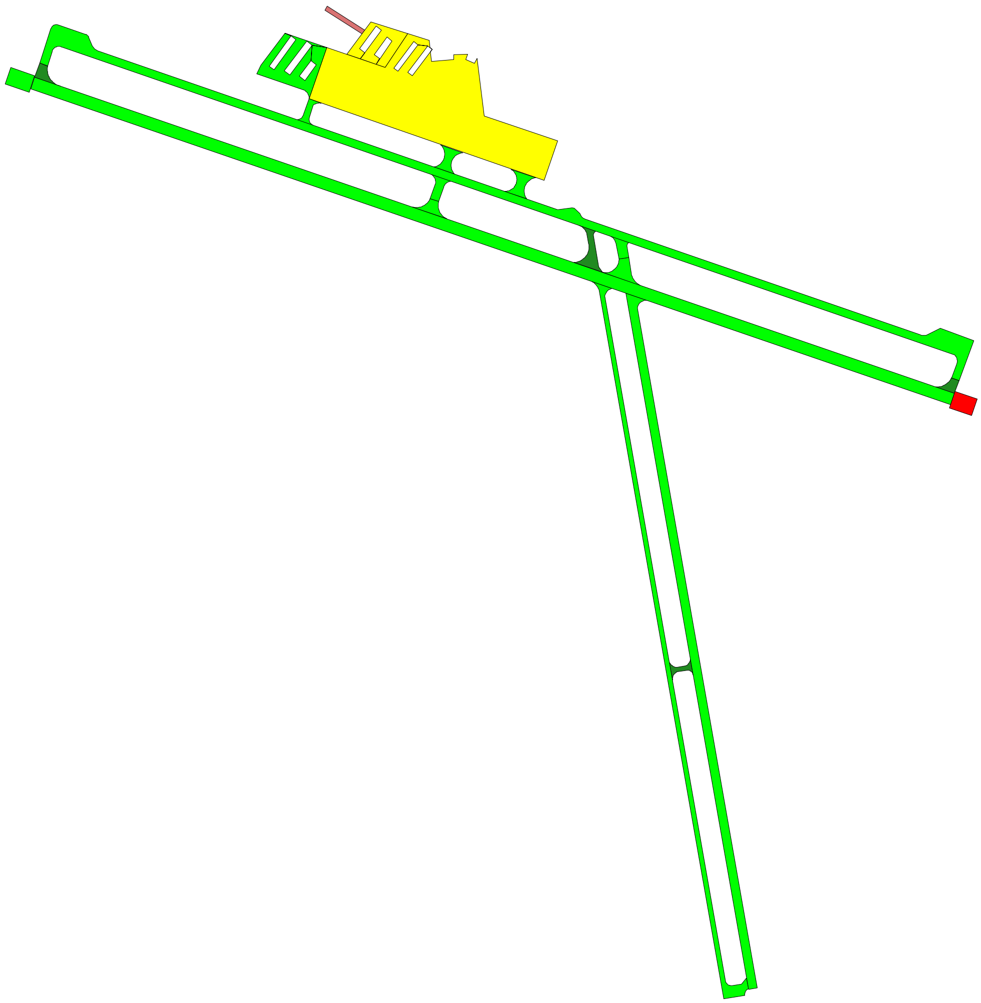
Note: Projections based on *New Mexico System Plan Update*, Wilbur Smith Associates, Inc. (2009).

Figure 2. Sierra Blanca Ruidoso (SRR) PCI Branch Map, March 10, 2007



Condition	Scale	Color
Good	100-86	
Satisfactory	85-71	
Fair	70-56	
Poor	55-41	
Very Poor	40-26	
Serious	25-11	
Failed	10-0	

Figure 3. Sierra Blanca Ruidoso (SRR) Estimated PCI Branch Map 2010



Condition	Scale	Color
Good	100-86	
Satisfactory	85-71	
Fair	70-56	
Poor	55-41	
Very Poor	40-26	
Serious	25-11	
Failed	10-0	

Table 3. Sierra Blanca Ruidoso (SRR) PCI Measurements for 2007 and 2010 Estimates

Branch ID	Area [ft^2]	PCI 2007	PCI 2010
ALL*	3,620,860	79	70
Apron 01	1,364,350	75	64
Runway 6-24	872,800	72	61
Runway 12-30	453,100	89	81
Taxiway 01	601,960	88	81
Taxiway 02	18,900	93	87
Taxiway 03	231,750	90	83
Taxiway 04	5,250	94	88
Taxiway 05	12,750	84	75
Taxiway 06	21,000	85	76
Taxiway 07	10,000	81	72
Taxiway 08	14,000	80	71
Taxiway 09	15,000	81	72

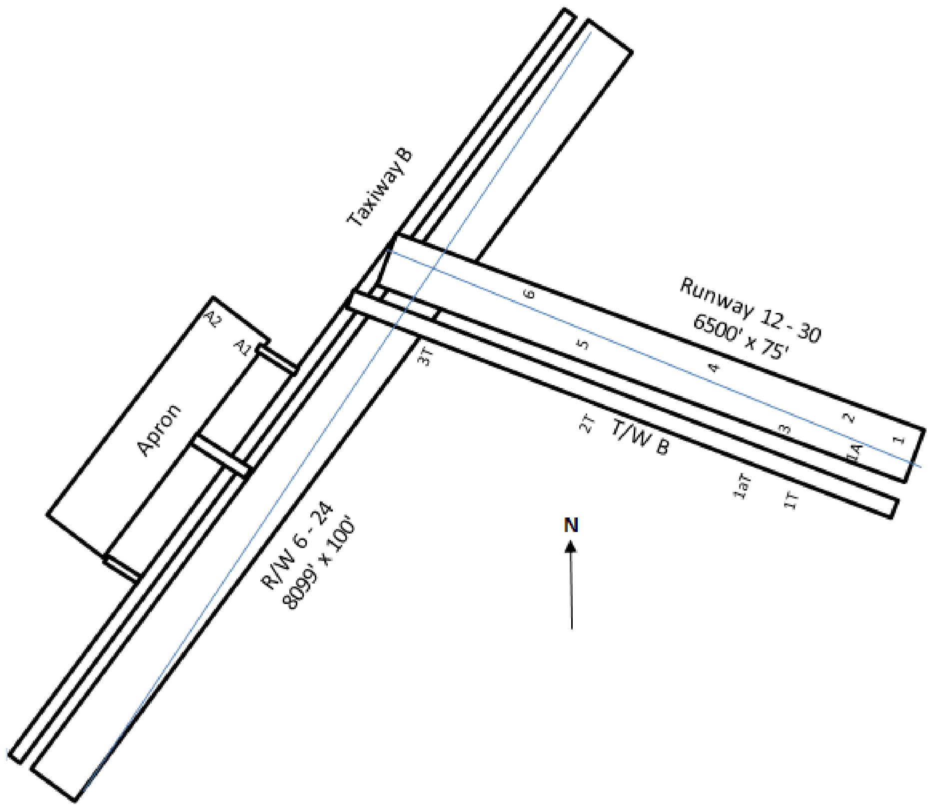
*weighted average PCI

Condition	Scale	Color
Good	100-86	
Satisfactory	85-71	
Fair	70-56	
Poor	55-41	
Very Poor	40-26	
Serious	25-11	
Failed	10-0	

2. Soil and Aggregate Analysis

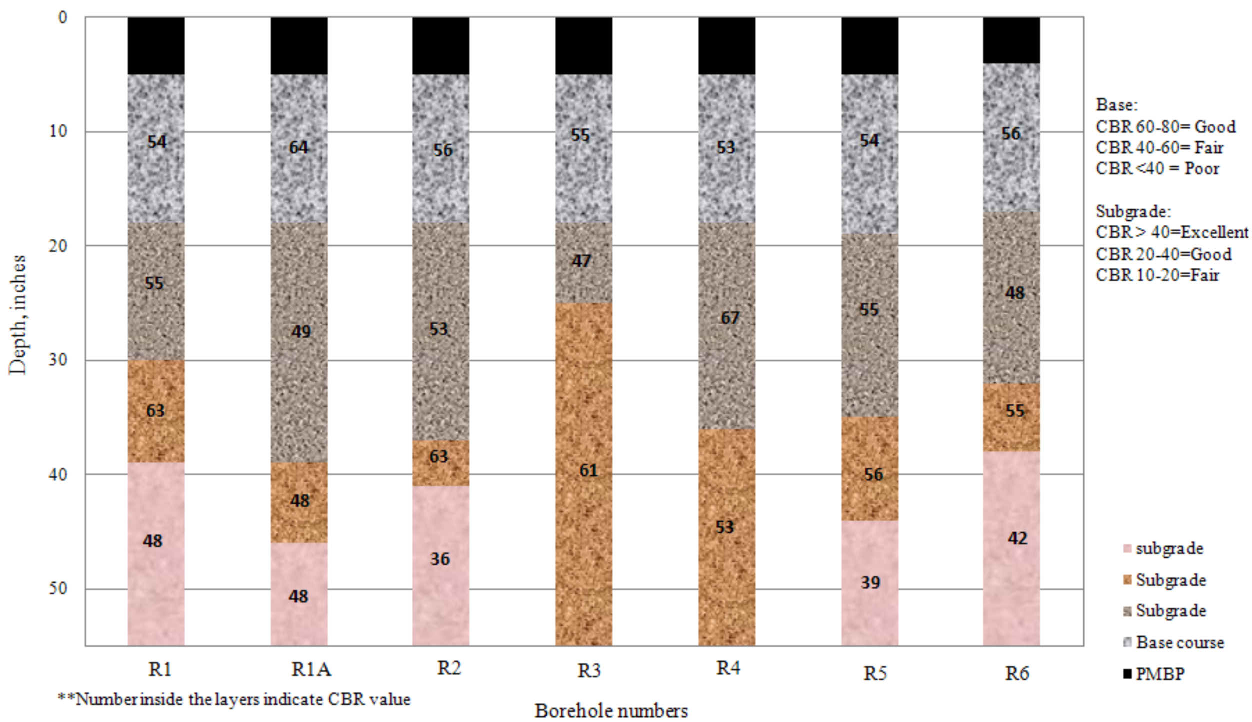
In November, 2008, the University of New Mexico (UNM) produced a report for the New Mexico Department of Transportation (NMDOT) – Aviation Division on the analysis of boreholes taken from the runways, taxiways and aprons at Sierra Blanca Ruidoso (SRR). The data consisted of asphalt concrete, base and subgrade thicknesses, generalized material compositions and California Bearing Ratio (CBR) for the materials underlying the pavement. In their analysis, samples from 13 boreholes were taken, and their locations are shown in Figure 4.

Figure 4. Borehole Locations at Sierra Blanca Ruidoso (SRR)



As part of the November, 2008 pavement and base analysis report, UNM examined Runways 12-30 (Figure 5).

Figure 5. Base and Subgrade Analysis for Runway 12-30

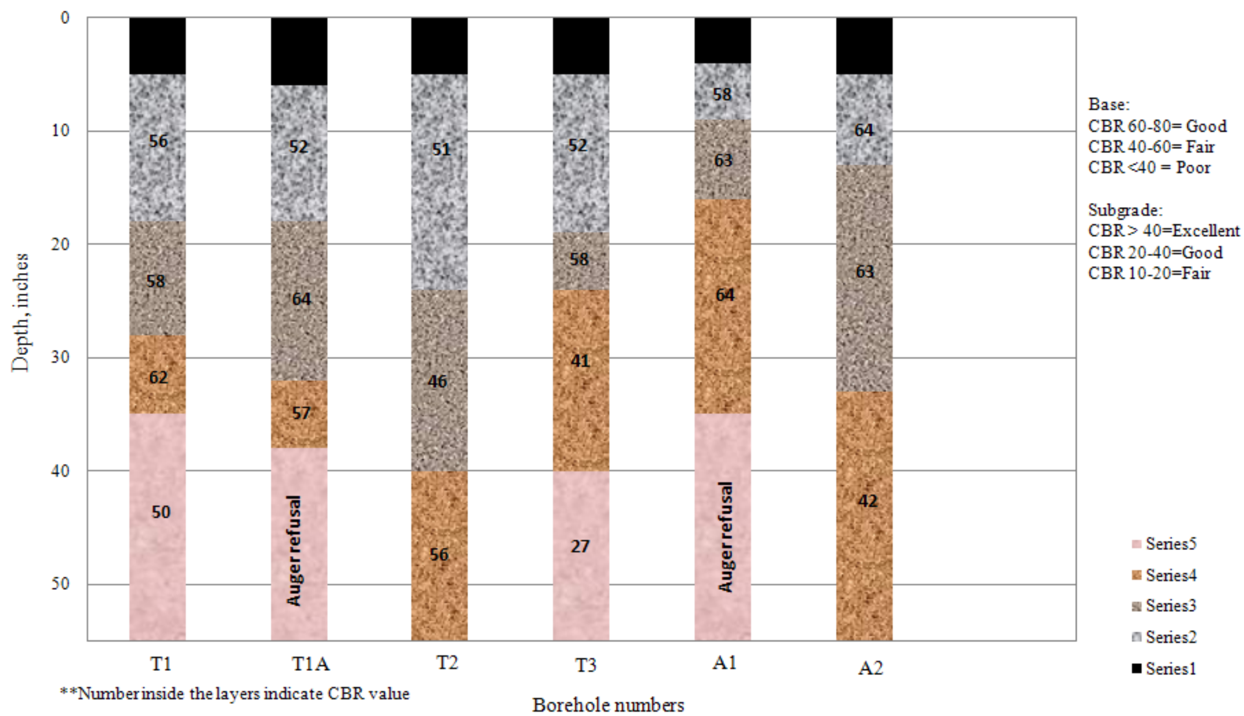


Runway 12-30

Seven borehole samples were taken on Runway 12-30. The average asphalt concrete depth was 4.9-inches. The average base depth was about 13-inches, which is acceptable as a support for asphalt concrete pavement and the design aircraft traffic (see the design section of this report). The CBR for the subgrade material was very good to excellent (range of 36-67 and an average of 52).

During November, 2008, the University of New Mexico (UNM) also produced an analysis of the base and subgrade materials underlying areas of Taxiway B and the Apron 1 (Figure 6).

Figure 6. Base and Subgrade Analysis for Taxiways and Aprons



Taxiway B

Four borehole samples were taken on Taxiway B. The average asphalt depth on Taxiway 1 was 5.3-inches. The average base depth was about 14.5-inches. The CBR for the base material is generally fair (average of 53). The subgrade material is good to excellent (average of 52).

Apron 1

Two borehole samples were taken on Apron 1. The average asphalt depth on the aprons was 4.5-inches. The average base depth was about 30-inches, which is more than acceptable as a support for asphalt concrete pavement and the design aircraft (see the design section of this report). The CBR for the base material is in the range of fair to good (average of 61). The subgrade material is excellent (average of 42).

FWD Analysis

In a November, 2008 report, the University of New Mexico (UNM) and the New Mexico Department of Transportation (NMDOT) presented data from the use of the falling weight deflectometer (*FWD*) method to analyze the structural capacity of the pavement wearing surface, base course, and the subgrade for Runways 6-24 and 12-30. As noted in the report, the modulus value for the asphalt concrete was below 200,000 psi (normal for a runway) in many areas tested, and that the standard deviation of results was sometimes greater than the mean, which means means that a weak section of pavement could been considered to be structurally sound in the data analysis. It was also noted from the *FWD* analysis that the base course provided sufficient bearing capacity.

Skid Resistance

No skid resistance tests were performed at this airport.

3. Predicted Pavement Conditions Assuming No Maintenance

MicroPAVER 6 was used to predict the PCI values of the various pavement sections present at the Sierra Blanca Ruidoso (SRR) airport, assuming that no future maintenance occurs (Tables 4 and 9 and Figures 7-10). The pavement prediction relies on initial construction dates, when known, and the 2007 on-site pavement inspection. Additional inspection or construction data would increase the reliability of the predictive capabilities of the model.

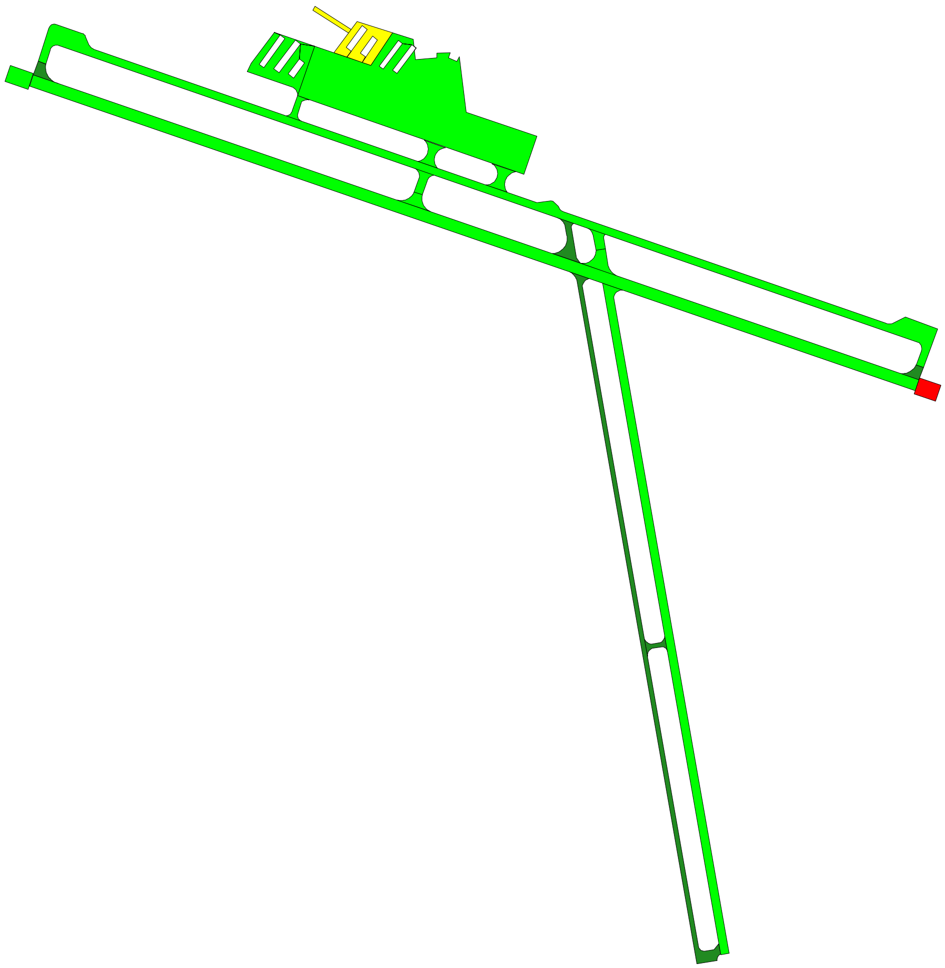
Table 4. Predicted Pavement Conditions (PCI) Assuming no Maintenance

Branch ID	2007	2009	2010	2013	2018
ALL*	79	73	70	59	38
Apron 01	75	68	64	52	29
Runway 6-24	72	65	61	49	29
Runway 12-30	89	84	81	72	52
Taxiway 01	88	83	81	72	53
Taxiway 02	93	89	87	78	61
Taxiway 03	90	85	83	74	55
Taxiway 04	94	90	88	80	63
Taxiway 05	84	78	75	65	44
Taxiway 06	85	79	76	66	45
Taxiway 07	81	75	72	61	39
Taxiway 08	80	74	71	60	37
Taxiway 09	81	75	72	61	39

*weighted average PCI

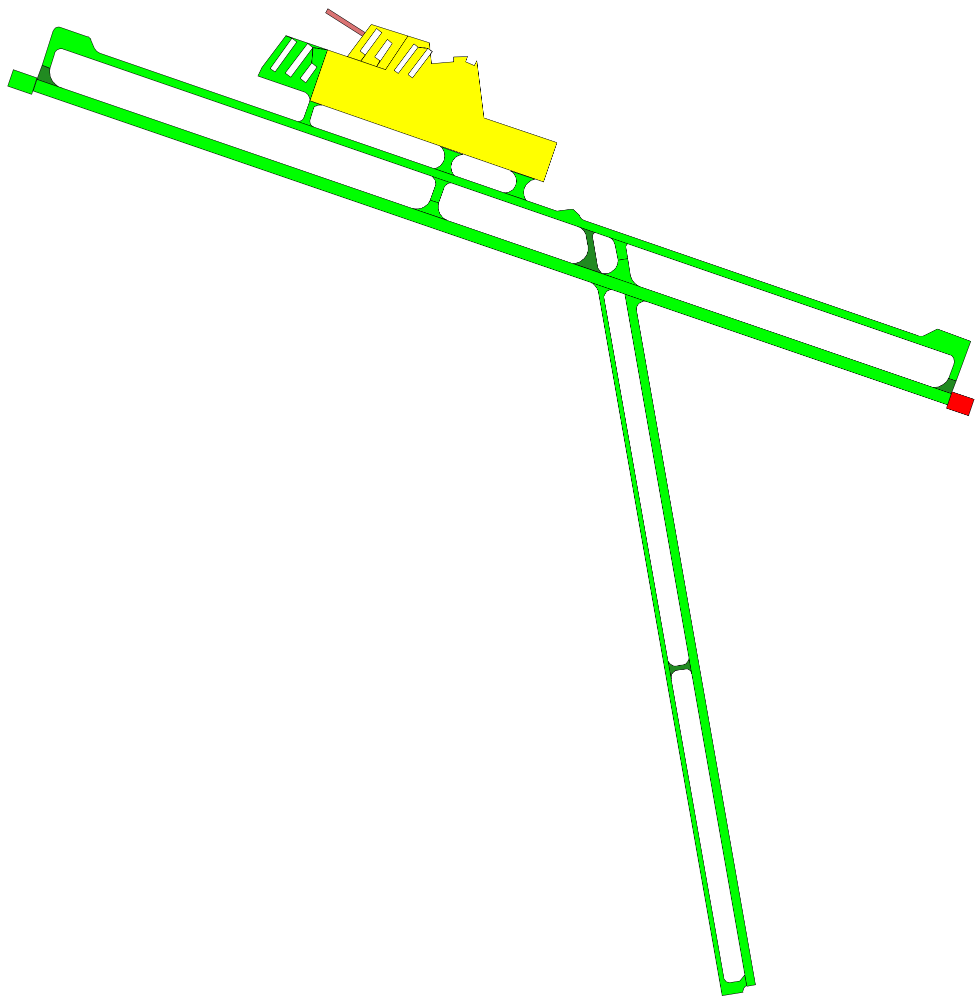
Condition	Scale	Color
Good	100-86	
Satisfactory	85-71	
Fair	70-56	
Poor	55-41	
Very Poor	40-26	
Serious	25-11	
Failed	10-0	

Figure 7. Sierra Blanca Ruidoso (SRR) Predicted PCI Map for 2009



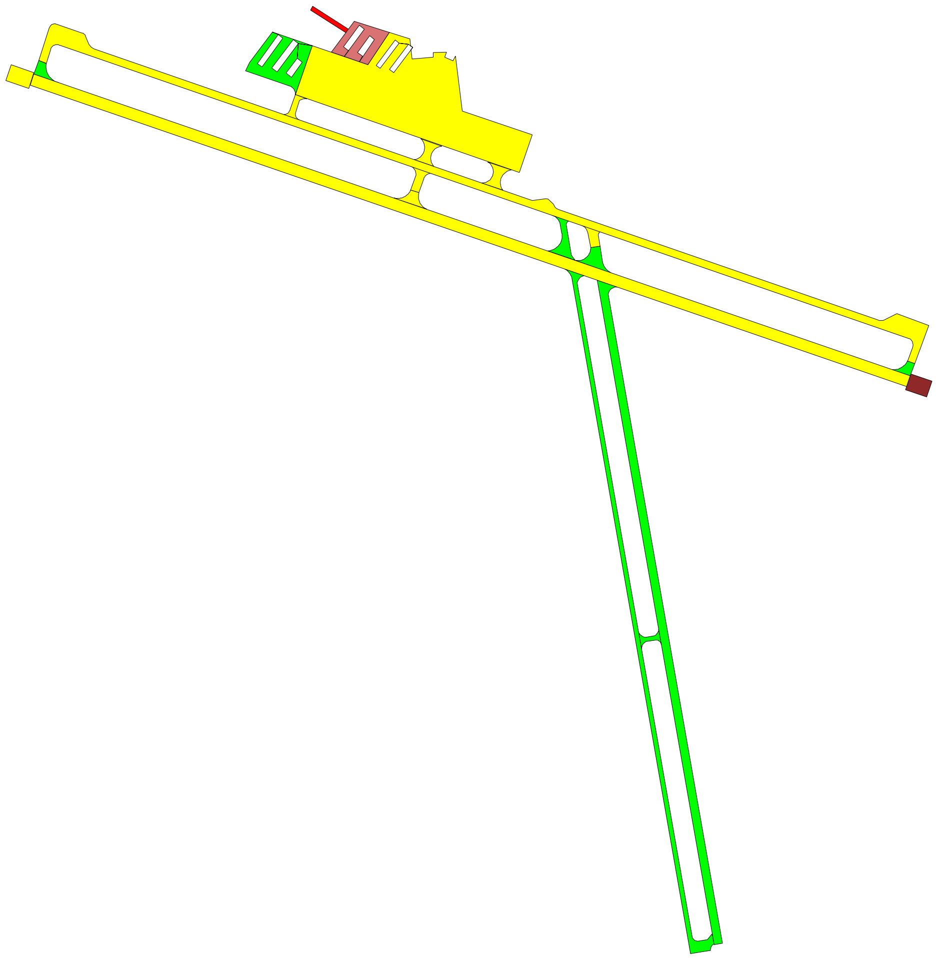
Condition	Scale	Color
Good	100-86	
Satisfactory	85-71	
Fair	70-56	
Poor	55-41	
Very Poor	40-26	
Serious	25-11	
Failed	10-0	

Figure 8. Sierra Blanca Ruidoso (SRR) Predicted PCI Map for 2010



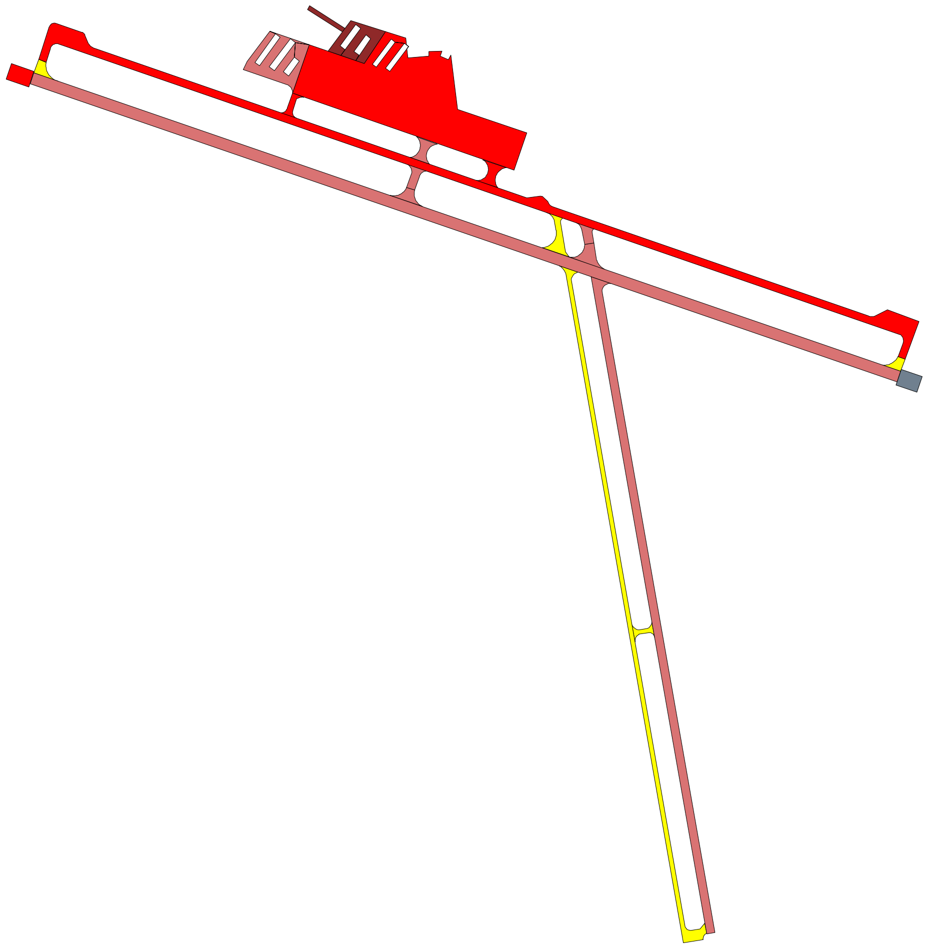
Condition	Scale	Color
Good	100-86	
Satisfactory	85-71	
Fair	70-56	
Poor	55-41	
Very Poor	40-26	
Serious	25-11	
Failed	10-0	

Figure 9. Sierra Blanca Ruidoso (SRR) Predicted PCI Map for 2013



Condition	Scale	Color
Good	100-86	
Satisfactory	85-71	
Fair	70-56	
Poor	55-41	
Very Poor	40-26	
Serious	25-11	
Failed	10-0	

Figure 10. Sierra Blanca Ruidoso (SRR) Predicted PCI Map for 2018



Condition	Scale	Color
Good	100-86	
Satisfactory	85-71	
Fair	70-56	
Poor	55-41	
Very Poor	40-26	
Serious	25-11	
Failed	10-0	

4. Recommend Pavement Design

The recommend asphalt concrete pavement construction was determined using FAA design procedures for the design aircraft detailed in Table 5. FAA designs were completed using the *FAARFIELD version 1.302* airfield pavement design software. A normal FAA asphalt concrete design life of 20 years was assumed for the case listed below. The *CBR* of the subgrade was modeled at values of 15 and 25, which are much below the measured values. The design pavement and aggregate thicknesses were rounded up to the nearest 1/2-inch.

Table 5. Design Aircraft Used for Runway Pavement Design

Aircraft Category	Gross Weight [lb]	Estimated Annual Departures [number]	Annual Aircraft [%]	Annual Growth [%]
Cessna Skyhawk 172	2,558	3,000	83.3%	0%
Super King Air 350	15,100	400	11.1%	0%
Gulfstream-V	90,900	200	5.6%	0%
Total		3,600		

Table 6. Recommended Runway Pavement Designs

Layer Material	Thickness [in]	Modulus [psi]
HMA Asphalt Concrete Surface (P-401/P-403)[1]	4	200,000
Crushed Aggregate (P-209)[2]	5	62,000
Subgrade[3]	CBR = 25	37,500
HMA Asphalt Concrete Surface (P-401/P-403)[1]	4	200,000
Crushed Aggregate (P-209)[2]	9	52,000
Subgrade[3]	CBR = 15	22,500

1. The asphalt concrete modulus is assumed to have a constant value of 200,000 psi.
2. The crushed aggregate modulus depends upon thickness, and it is estimated by the *FAARFIELD* program.
3. The subgrade modulus (E) is estimated from the CBR-value, where $E = 1500 \times CBR$ [psi].

5. Current Pavement Design for Runways 2-20 and 12-30

Runway 12-30 is currently constructed as follows (Table 7):

Table 7. Actual Design Conditions for Runway 12-30 (2008)

Layer Material	Thickness [in]
Asphalt Concrete (AC)	4.9
Base Course	13
Subgrade (avg. CBR = 52)	> 35

Using the design aircraft traffic specified in Table 5, and the data obtained from borehole analysis of the runways, Runway 12-30 was adequately designed for a lifetime of 20 years, assuming that the design load capacity is not greatly exceeded. Since there are two runways present at Sierra Blanca Ruidoso (SRR) Airport, both runways should have aircraft traffic less than the design values presented in Table 5.

6. Maintenance and Rehabilitation (M&R) Schedule

The FAA recommends a 20-year lifespan for asphalt concrete airport pavements. As shown in Figure 11, it is much more expensive to perform maintenance on pavements that have deteriorated below a Pavement Condition Index (PCI) of about 60. At this PCI, a major rehabilitation or reconstruction (mill and overlay) is required to substantially increase the PCI-value. This type of treatment would incur a much greater expense compared to rehabilitating pavements with PCI values greater than 60. Rehabilitation of pavements with PCI values below 60 can cost 4 to 5 times as much compared to the rehabilitation of pavements with PCI values greater than 60. It is generally accepted that the maintenance and rehabilitation of taxiways and aprons is of a lower priority than runways, so a lower PCI threshold of around 40 could be used. Therefore, funding priorities typically favor runways.

A combination of data from *MicroPAVER* 6 and engineering judgment was used to generate the data for the estimated M&R schedule presented in Table 8. PCI-values where recommended maintenance should be performed are listed in the table legend. The M&R schedule relies greatly on the pavement inspection performed by NMT during June, 2007, but this inspection only represents a single set of pavement inspection data. Additional inspection data would increase the reliability of the predictive capabilities of the M&R model.

Figure 11. Typical Pavement Condition as a Function of Time

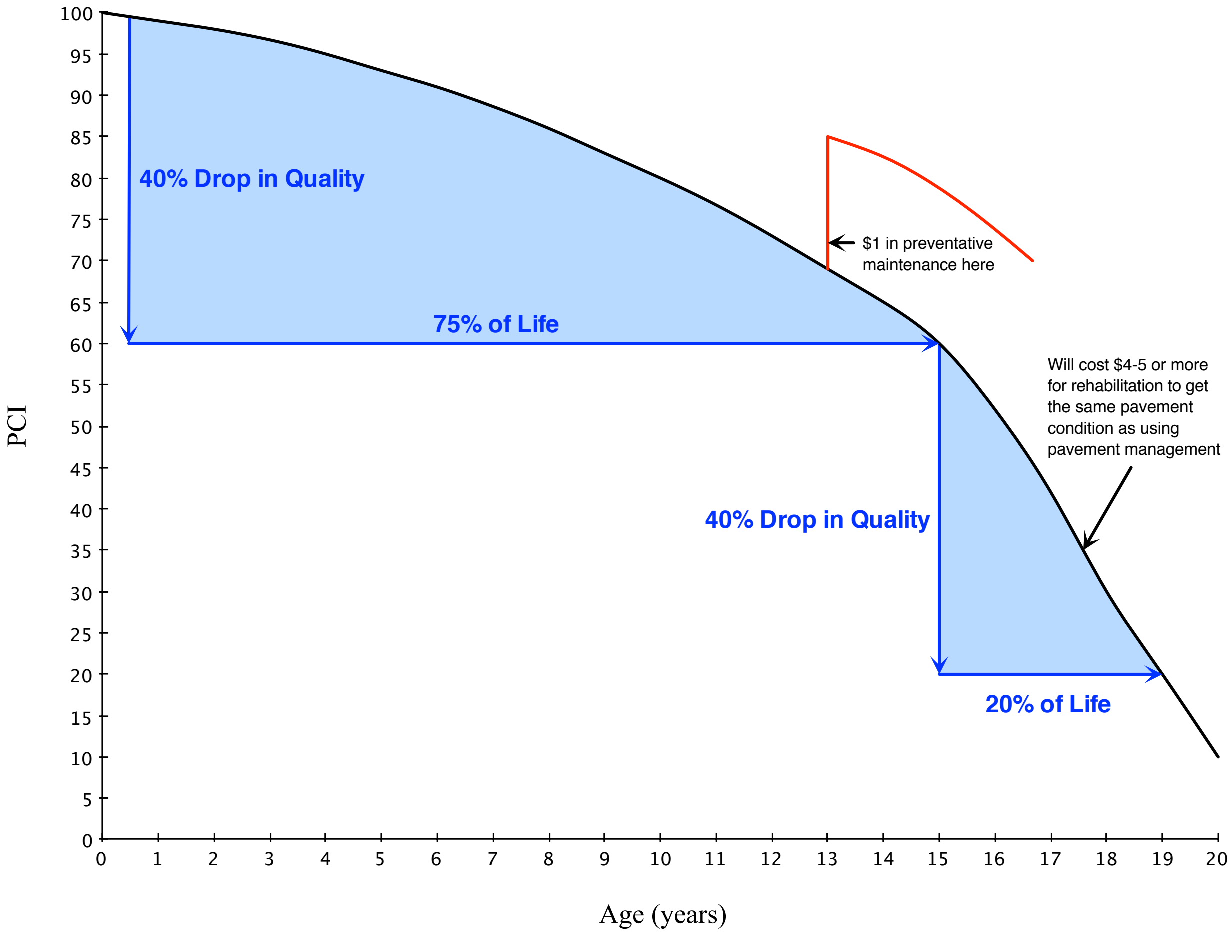


Table 8. Estimated Maintenance and Rehabilitation (M&R) Actions by Year

Branch ID	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
ALL*	73	70	66	63	59	55	51	46	42	38
Apron 01	68	64	60	56	52	48	43	39	34	29
Runway 6-24	65	61	58	54	49	45	40	36	32	29
Runway 12-30	84	81	78	75	72	68	64	61	57	52
Taxiway 01	83	81	78	75	72	68	64	61	57	53
Taxiway 02	89	87	84	81	78	75	72	69	65	61
Taxiway 03	85	83	80	77	74	70	67	63	59	55
Taxiway 04	90	88	85	83	80	77	74	71	67	63
Taxiway 05	78	75	72	69	65	61	57	53	49	44
Taxiway 06	79	76	73	69	66	62	58	54	50	45
Taxiway 07	75	72	68	65	61	57	53	48	44	39
Taxiway 08	74	71	67	63	60	55	51	47	42	37
Taxiway 09	75	72	68	65	61	57	53	48	44	39

Legend (maintenance required – general condition)

None - Excellent	(dark green)	PCI ≥ 90 – maintenance is probably not necessary.
Light - Very Good	(light green)	80 ≤ PCI ≤ 90 – light maintenance, such as crack sealing may be necessary.
Medium - Good	(yellow)	65 ≤ PCI ≤ 80 – medium maintenance, such as crack sealing and surface coating.
Medium to Major - Fair	(pink)	40 ≤ PCI ≤ 65 – thin mill (half-depth) and overlay.
Major to complete - Poor or worse	(red)	PCI ≤ 40 – full-depth mill and overlay, or entire rebuild, if not structurally sound.

7. Maintenance and Rehabilitation (M&R) Options

NMDOT-Aviation Division currently uses the following pavement maintenance options:

- **Seal coat** – an asphalt seal placed on the top surface of the asphalt concrete pavement. It is used to seal small cracks, reduce pavement binder oxidation at the surface, and improve friction. Typical lifetime is 3-6 years.
- **Crack sealing** – typically, compressed air is used to clean cracks in the pavement, and then the cracks are filled with a sealant. This method reduces water infiltration, and it can prevent cracks from developing into more serious distresses, such as larger pavement pieces breaking loose. Typical lifetime is 3 years.
- **Crack filling (Mastic)** – this method is similar to crack sealing, but the preparation may vary, since more material has to be removed from the cracked area. This method is used for wide cracks. Typical lifetime is 2-3 years.
- **Thermoplastic coal tar emulsion slurry seal** – a proprietary thermoplastic compound derived from coal tar that is also resistant to surface fuel spillage. The thermoplastic coal tar emulsion slurry seal is mixed with aggregate material, and placed on the pavement wearing surface. It can be used for new pavement construction and also for rehabilitation. Typical lifetime is 5-7 years for rehabilitated pavements, and 15 years for new pavements.
- **Emulsified pavement sealer and rejuvenator** – an emulsified sealer and binder that is placed on the pavement wearing surface. The seal provides an anti-oxidative seal for the asphalt pavement surface. Typical lifetime is 3-5 years.
- **Fog seal** – a diluted emulsion, typically 1 part emulsion and 1 part dilutant (e.g. water), is added to the pavement surface. This treatment is used to delay raveling and oxidation. Typical lifetime is 1-2 years.
- **Slurry seal** – a mixture of fine aggregate, asphalt emulsion, water and mineral filler added to the pavement surface. This treatment is used, when excessive oxidation and hardening of the surface is a problem. Slurry seals retard surface raveling, seal small cracks, and improve surface friction. Typical lifetime is 3-5 years.

Estimated and relative costs for typical maintenance options are presented in Table 9. Table 10 contains the cost estimates for seal coating of the various airport branches (apron, runway, taxiway), assuming that the entire surface is coated. Since crack treatments depend upon the number and severity of cracks, any cost estimate would have to be based upon visual inspection of the affected areas.

Table 9. Current NMDOT-Aviation Division Pavement Maintenance Options

Crack Treatments	Estimated Cost (Applied) [linear ft]	Relative Cost	Estimated Additional Lifetime [years]
Crack sealing	$0.20	0.80	3
Crack filling	$0.25	1.00	2-3
Surface Treatments	[yd^2]		
Fog seal	$0.15	0.03	1-2
Coal tar sealer (seal coat)	$0.55	0.10	3-6
Emulsified pavement sealer and rejuvenator	$1.00	0.18	3-5
Slurry seal	$1.50	0.28	3-5
Thermoplastic coal tar emulsion slurry seal	$5.42	1.00	5-7

Note: relative cost is compared to the most expensive treatment. Estimated costs are based on 2008 average treatment cost.

Table 10. Estimated Costs of Seal Coatings at Sierra Blanca Ruidoso Airport Locations

Branch ID	Area [ft^2]	Fog Seal [$]	Seal Coat [$]	Emulsified Pavement Sealer [$]	Slurry Seal [$]	Thermoplastic Coal Tar Emulsion Slurry Seal [$]
Apron 01	1,364,350	$ 22,739	$ 83,377	$ 151,594	$ 227,392	$ 821,642
Runway 6-24	872,800	$ 14,547	$ 53,338	$ 96,978	$ 145,467	$ 525,620
Runway 12-30	453,100	$ 7,552	$ 27,689	$ 50,344	$ 75,517	$ 272,867
Taxiway 01	601,960	$ 10,033	$ 36,786	$ 66,884	$ 100,327	$ 362,514
Taxiway 02	18,900	$ 315	$ 1,155	$ 2,100	$ 3,150	$ 11,382
Taxiway 03	231,750	$ 3,863	$ 14,163	$ 25,750	$ 38,625	$ 139,565
Taxiway 04	5,250	$ 88	$ 321	$ 583	$ 875	$ 3,162
Taxiway 05	12,750	$ 213	$ 779	$ 1,417	$ 2,125	$ 7,678
Taxiway 06	21,000	$ 350	$ 1,283	$ 2,333	$ 3,500	$ 12,647
Taxiway 07	10,000	$ 167	$ 611	$ 1,111	$ 1,667	$ 6,022
Taxiway 08	14,000	$ 233	$ 856	$ 1,556	$ 2,333	$ 8,431
Taxiway 09	15,000	$ 250	$ 917	$ 1,667	$ 2,500	$ 9,033

8. Bibliography

Cal, M.P., *Sierra Blanca Ruidoso (SRR) Inspection and MicroPAVER Database,* New Mexico Tech, Socorro, NM (2007).

Ahmed, M. and Tarefder, R.A., *Analysis of FWD Data of the Airfield Pavements at Sierra Blanca Airport*, University of New Mexico, Albuquerque, NM, November (2008).

Bisht, R. and Tarefder, R.A., *Laboratory Evaluation of the Airfield Pavements at Sierra Blanca Airport*, University of New Mexico, Albuquerque, NM, November (2008).

Wilbur Smith Associates, Inc., *New Mexico Airport Plan Update* (2009).

Federal Aviation Administration (FAA), *FAARFIELD version 1.302*, Pavement Design Software (3/11/2009).