MONTANA

Aviation System Plan - 2009 Update

PAVEMENT CONDITION INDEXES

RPA

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Aviation System Plan - 2009 Update
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ABBREVIATIONS

AAC	Pavement surface type - structural asphalt overlays of asphalt
AC	Pavement surface type - asphalt / hot mix / plant mix bituminous surface course
ACAH	Pavement Family - Asphalt Aprons With Higher Than 30,000 lb. Load Rating
ACAM	Pavement Family - Asphalt Aprons With Load Rating From 12,500 to 30,000 lb.
ACPL	Pavement Family - Asphalt Pavements With Less Than 12,500 lb. Load Rating
ACRH	Pavement Family - Asphalt Runways & Taxiways With Higher Than 30,000 lb. Load Rating
ACRML	Pavement Family - Asphalt RWs & TWs, Load Rating 12,500 to 30,000 lb, 5000 or Fewer Ops.
ACRMU	Pavement Family - Asphalt RWs & TWs, Load Rating 12,500 to 30,000 lb, Over 5000 Ops.
Agg	Aggregate / gravel as a manufactured structural layer of a pavement section
AIP	Airport Improvement Program - FAA funding for airport maintenance and construction
APC	Pavement surface type - structural asphalt overlays of concrete
BST	Pavement surface type - bituminous surface treatments / single shot / double shot / triple shot
FAA	Federal Aviation Administration
FAA AC	Federal Aviation Administration, Advisory Circular
FOD	Foreign object debris. Loose material on a pavement surface that could cause aircraft damage
Form 5320-1	FAA-format for an airport pavement map with construction and maintenance history
GA	General Aviation
Global	Maintenance policy applied to the whole pavement (e.g. fog seals, overlays)
H	High - degree of severity for an asphalt defect
HLN/ADO	FAA's Helena Airports District Office
L	Low - degree of severity for an asphalt defect
L & T CR	Longitudinal and transverse cracking
LF	Linear foot (unit of length)
Local	Maintenance policy applied to small sections of a pavement (e.g. crack seal, patching)
M	Medium - degree of severity for an asphalt defect
M&R	Maintenance and rehabilitation
MAD	Montana Aeronautics Division
Major<Crit	Reconstruction of a pavement after its condition has dropped below the critical PCI
Major>Crit	Reconstruction of a pavement before its condition has dropped below the critical PCI
MDT	Montana Department of Transportaion
N	No degree of severity for an asphalt defect is defined, the defect is either present or not
NWM	FAA's Northwest Mountain Region
Ops	Aircraft operations (takeoff or landing)
P-152	FAA designation for compacting native soils
P-154	FAA designation for subbase gravel
P-208	FAA designation for basecourse gravel
P-209	FAA designation for crushed basecourse gravel
P-401	FAA designation for plant-mix bituminous pavement (asphalt)
P-403	FAA designation for small quantities of plant-mix bituminous pavement (asphalt) with less testing
P-501	FAA designation for Portland cement concrete surface course
P-609	FAA designation for an application of asphalt binder / emulsion to a pavement surface
PCAA	Pavement Family - Portland Concrete Cement - All Sections
PCC	Pavement surface type - Portland cement concrete
PCI	Pavement condition index
PFC	Porous Friction Course
PREV.	Preventative maintenance
RWY	Runway
SF	Square foot (unit of area)
ST	Pavement surface type - bituminous surface treatments / single shot / double shot / triple shot
STA	Station - formated distance with implied direction used by surveyors
STPA	Pavement Family - Bituminous Surface Treated Pavements of All Load Ratings
USACERL	U.S. Army Corps of Engineers Construction Engineering Research Laboratory
XX	Indicates an inspection and PCI rating were completed for a pavement previous to its reconstruction

CHAPTER 1
INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 PROJECT DESCRIPTION

This project, the 2009 Update to the Montana Aviation System Plan, continues development of a Pavement Management System for Montana's general aviation airports. This is an ongoing process begun in 1988 and updated on a three-year cycle since then. The Aeronautics Division of the Montana Department of Transportation, in coordination with the Federal Aviation Administration, Helena Airports District Office, contracted with Robert Peccia and Associates to provide the surveys and analysis required for the on-going development of the State's airport pavement management system.

The pavement management system is designed to be a systematic, and objective tool for determining maintenance and rehabilitation needs and priorities for paved surfaces on Montana's general aviation airports. As such, it is intended to provide better information to airport and aviation officials, so that Federal, State, and local resources can be more efficiently allocated toward maintaining and improving airport pavements. The Pavement Condition Index (PCI) provides a dependable scale for comparing the existing operational condition and structural integrity of airport pavements. The pavement management system's PCI provides a rational basis for justifying pavement replacement or rehabilitation projects. It can also provide feedback on pavement performance to validate or revise pavement design, construction, and maintenance procedures.

The project consists of airport pavement records updates, map updates (FAA Form 5320-1), pavement condition surveys, PCI calculations, PCI analyses, PCI predictions, maintenance suggestions, and maintenance budget projections. This final report documents work completed, assesses system-wide conditions and potential, and recommends work for future updates to the pavement management system. Inspection results, PCI values, predictions, maintenance suggestions, and brief interpretation of the results are provided directly to the sponsor for each airport. Results will be provided in electronic format to Montana Aeronautics Division for posting on the MDT web site.

Airport maps and pavement records (FAA Form 5320-1) were updated in digital format for fifty-three (53) airports. These airports also had intensive field inspections of pavement samples, collecting data to estimate current and future airport conditions. Pavement deterioration at all fifty-eight (58) general aviation airports in Montana's database were forecast at 1-, 5-, and 10-years using the Pavement Condition Index.

Field surveys were performed in accordance with the criteria specified in Federal Aviation Administration (FAA) Advisory Circular AC 150/5380-6 "Guidelines and Procedures for Maintenance of Airport Pavements". Calculations, analysis, and predictions were completed using the U.S. Army Corps of Engineers Construction Engineering Research Laboratory's (USACERL) "MicroPAVER" software system (versions 5.3.2 through 6.1.4).

Table 1.1 and Figure 1.1 show the airports surveyed and analyzed in this project.

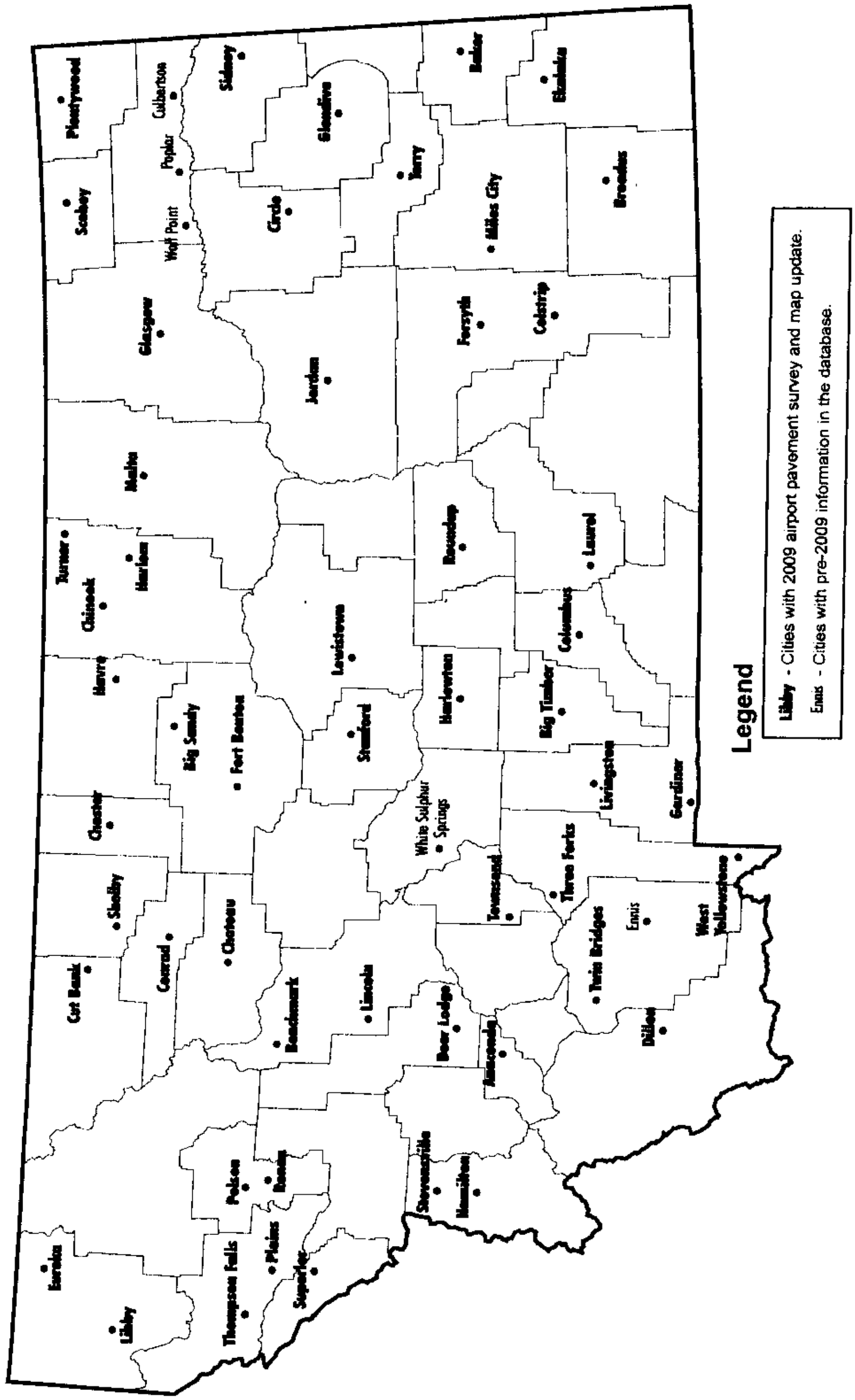
TABLE 1.1
MONTANA'S PAVEMENT MANAGEMENT SYSTEM - 2009 Update

Airport (Database Branch Number)	2009 Inspection Report	2009 Inspection Photos	FAA Form 5320-1 Update	PCI Predict.
Anaconda Airport (09)	X	X	X	X
Baker Airport (56)	X	X	X	X
Benchmark Airport (11)	X	X	X	X
Big Sandy Airport (18)	X	X	X	X
Big Timber Airport (25)	X	X	X	X
Broadus (62)	X	X	X	X
Chester, Liberty County Airport (15)	X	X	X	X
Chinook Airport (58)	X	X	X	X
Choteau Airport (19)	X	X	X	X
Circle, McCone County Airport (38)	X	X	X	X
Colstrip Airport (48)	X	X	X	X
Columbus (59)	X	X	X	X
Conrad Airport (46)	X	X	X	X
Culbertson Airport, Big Sky Field (34)				X
Cut Bank Airport (13)	X	X	X	X
Deer Lodge City-County Airport (08)	X	X	X	X
Dillon Airport (52)	X	X	X	X
Ekalaka Airport (57)	X	X	X	X
Ennis Big Sky Airport (50)				X
Eureka Airport (54)	X	X	X	X
Forsyth Airport, Tillit Field (43)	X	X	X	X
Fort Benton Airport (60)	X	X	X	X
Gardiner Airport (64)	X	X	X	X
Glasgow International Airport (31)	X	X	X	X
Glendive, Dawson Community Airport (40)	X	X	X	X
Hamilton, Ravalli County Airport (06)	X	X	X	X
Harlem Airport (17)	X	X	X	X
Harlowton, Wheatland County Airport (22)	X	X	X	X
Havre City-County Airport (16)	X	X	X	X

TABLE 1.1 (contd.)
MONTANA'S PAVEMENT MANAGEMENT SYSTEM - 2009 Update

Airport (Database Branch Number)	2009 Inspection Report	2009 Inspection Photos	FAA Form 5320-1 Update	PCI Predict.
Jordan Airport (37)	X	X	X	X
Laurel Municipal Airport (27)	X	X	X	X
Lewistown Airport (21)	X	X	X	X
Libby Airport (01)	X	X	X	X
Lincoln Airport (12)	X	X	X	X
Livingston Airport (24)	X	X	X	X
Malta Airport (61)	X	X	X	X
Miles City Airport, Frank Wiley Field (42)	X	X	X	X
Plains, Penn Stohr Field (63)	X	X	X	X
Plentywood, Sherwood Airport (36)	X	X	X	X
Polson Airport (03)	X	X	X	X
Poplar Airport (33)				X
Ronan Airport (53)	X	X	X	X
Roundup Airport (47)	X	X	X	X
Scobey Airport (35)	X	X	X	X
Shelby Airport (14)	X	X	X	X
Sidney-Richland Municipal Airport (39)	X	X	X	X
Stanford Airport (20)	X	X	X	X
Stevensville Airport (05)	X	X	X	X
Superior, Mineral County Airport (04)	X	X	X	X
Terry Airport (41)	X	X	X	X
Thompson Falls Airport (02)	X	X	X	X
Three Forks Airport (49)	X	X	X	X
Townsend Airport (55)	X	X	X	X
Turner Airport (29)	X	X	X	X
Twin Bridges Airport (51)	X	X	X	X
West Yellowstone Airport (10)	X	X	X	X
White Sulphur Springs Airport (23)				X
Wolf Point Airport (32)				X

FIGURE 1.1
MONTANA AIRPORTS' PAVEMENT DATABASE MAP



1.2 THE PAVEMENT MANAGEMENT SYSTEM

A pavement management system begins with an objective, repeatable method for determining present pavement condition. This project uses the Pavement Condition Index (PCI) developed at the US Army Corps of Engineers Research Lab (USACERL). The PCI is a numerical index from 0 to 100 that describes the pavement's overall structural integrity and operational condition, with 100 assigned to a new pavement with no flaws and zero to a highly degraded pavement. The PCI is based on the types, severities, and quantities of pavement distresses identified during on-site visual inspections.

A computerized database called MicroPAVER is used to store, manipulate, and present data that generates PCI values. This program was developed at USACERL specifically for use with the PCI. The MicroPAVER system is continually being improved and upgraded by Engineered Management Systems Software and is periodically reissued in a new version. Montana's pavement management system typically uses the most recent release of the software. The newer software has strived to enhance analysis and reporting tools, refine analysis routines, and improve the operator-computer interface. The current upgrade is a Windows-based program with reasonably easy data transfer and query routines. For this report MicroPAVER output was refined and supplemented using WordPerfect, Microsoft Excel, and Microsoft Access to improve readability and formatting.

As with any pavement management system, the following tasks are required to adequately document the process, obtain the required field data, and generate meaningful results.

- ✈ Assemble background data about the pavements to be studied.
- ✈ Prepare and update base maps, define the study areas.
- ✈ Conduct field inspections.
- ✈ Process the field inspection and background data.
- ✈ Analyze the data and generate appropriate reports.

The process begins with reviewing airport records to locate the pavements to be studied. Background information such as materials, thicknesses, construction dates, primary use (runway/taxiway/apron), surface area, and related data is assembled. This data is then used to divide pavements into a successively refined network by geographic location, functional use, consistency of characteristics, and manageable inspection size.

Each airport is considered a separate “zone” in Montana's airport database. Each zone (airport) is then divided by function or primary use into “branches.” All aprons are grouped into a single branch, all taxiways into another branch, and each runway is placed in a separate branch. Branches are further divided into “sections” with similar characteristics. Each section is defined as a pavement of consistent age, construction materials, and maintenance history. Finally, since sections are generally still large pavement areas, each is divided as evenly as possible into “sample units.” This last division of asphalt-surfaced areas into near 5000 square foot samples, and concrete-surfaced areas into near 20 slab samples is designated for convenient, manageable, and statistically valid pavement inspection.

After obtaining background information and dividing the pavements into zones, branches, sections, and sample units, the database network is created and base maps are drawn to document this network structure.

FAA Forms 5320-1, "Pavement Strength Survey" are revised and used as guides during field surveys. Base map layout is confirmed (or adjusted) on-site during visual pavement inspection.

As field inspections are completed, distress data is loaded into the MicroPAVER program. Pavement Condition Indexes are calculated providing a numerical rating of present condition by section. Sections are grouped by similar construction, strength, and primary use into "families" of pavements which should experience similar wear, deterioration, and useful lives. The PCI history of all pavements in a family are used to generate a pavement life cycle curve which can then be used to forecast PCI's for all member pavements in the family.

Finally, when the desired analyses have been completed, numerous reports can be generated to describe the pavement systems, their existing conditions, their approximate future conditions, and potential costs to improve performance and extend pavement life.

1.3 SCOPE OF SERVICES

The scope of services required for this phase of the pavement management system development consist of the following:

- ✈ Collecting and updating airport geometric and pavement condition information for fifty three (53) airports, excluding the following sections: Chester (A-2, A-3, A-4), Harlem (A-1), Laurel (R-2, R-3), and Lewistown (R-1);
- ✈ Updating base maps (FAA Form 5320-1) for the 53 airports whose pavement information has been reviewed. These maps are produced in AutoCAD and transferred to the more readily accessible Adobe PDF format. These maps are provided in hard copy and digital formats, for continued use in pavement management system updates;
- ✈ Define pavement zones, branches, sections, and sample units for any reconstruction, or new construction of airside pavements.
- ✈ Conduct visual condition surveys at 53 general aviation airports located throughout the State of Montana, load the survey data into MicroPAVER, and obtain current PCI values for each section;
- ✈ Develop "Family Analysis Curves" to model pavement performance by comparing similar pavements to one another. Predict future pavement conditions by using the Family Analysis Curves.
- ✈ Updating the State's MicroPAVER database, analyzing pavements, and producing summary reports for each airport studied;
- ✈ Delivering ten copies of a final report, organized and bound in a three-ring binder with cover graphics, table of contents, and appendices;
- ✈ Mailing pavement analysis results and recommendations for individual airports directly to airport managers.

CHAPTER 2
PROJECT APPROACH

CHAPTER 2 PROJECT APPROACH

Work on this project began with a review of the report produced for the Montana Aviation System Plan Update in 2006. That project provided the most recent update for the pavement management system. Since consistency is extremely important to periodic pavement condition surveys, the pavement definitions, naming conventions, and recommendations from previous studies were incorporated into this project to the extent possible.

2.1 HISTORICAL DATA COLLECTION

Airport construction information was collected for airports within the project scope that received FAA Airport Improvement Program (AIP) funds in fiscal years 2006-2009. Pavement information was reviewed and updated for construction since 2006 for each of the study airports. This information was obtained from airport layout plans (ALP), construction plans, FAA Form 5320-1, design reports, the 2009 Montana Airport Facility Directory, airport sponsors, and in some cases, directly from the engineer in charge of construction. When available records did not agree with completed construction, our inspection teams collected as-built dimensions in the field to update maps and sample sections.

All of the information obtained was used to prepare and/or update schematic maps for each airport, using FAA Form 5320-1 as a base. The maps show pavement locations, dimensions, compositions, and dates of construction.

2.2 NETWORK AND SAMPLE DEFINITION

Each airport's pavement network consists of the primary paved areas that the Owner is responsible for maintaining. In each case, the airport's pavement network was assigned to a zone. It was then divided into branches (facilities), sections (features), and sample units as defined by MicroPAVER procedures and those of the FAA Advisory Circular, AC 150/5380-6, "Guidelines and Procedures for Maintenance of Airport Pavements". It should be noted that MicroPAVER and this report use the terms "branch" and "section", while the FAA procedures refer to these as "facility" and "feature".

Once the updated base maps depicting the location of sections and sample units were prepared, the minimum number of sample units (n) that needed to be surveyed to obtain an adequate estimate of the section PCI was determined. The required number of sample units was estimated using the procedure defined in Attachment A of the Northwest Mountain Region (NWM) handout, entitled "Selection of Minimum Number of Sample Units". This is reproduced here in Table 2.1. The number of sample units selected provides for a 92% probability that the estimate of the mean section PCI is within +/- 5 points of the true mean PCI.

At least one sample more than the NWM recommendation was inspected on each runway section. This provided additional accuracy for the sections most likely to drive airport maintenance or improvement projects. The increased sampling density usually generated one sample overlapping the most recent previous survey to aide in verifying consistent inspection techniques.

TABLE 2.1
SELECTION OF MINIMUM NUMBER OF SAMPLE UNITS
92% Confidence Level

FLEXIBLE PAVEMENT		RIGID PAVEMENT	
N=1	n=1	N=1	n=1
N=2	n=2	N=2	n=2
N=3-6	n=3	N=3-4	n=3
N=7-13	n=4	N=5-6	n=4
N=14-38	n=5	N=7-8	n=5
N>38	n=6	N=9-11	n=6
		N=12-14	n=7
		N=15-19	n=8
		N=20-27	n=9
		N=28-38	n=10
		N=39-58	n=11
		N=59-104	n=12
		N=105-313	n=13
		N>313	n=14

N = Number of sample units in a pavement section or feature
(±5,000 square feet per sample unit for asphalt pavements, ±20 slabs for Portland Cement Concrete pavements)
n = Number of sample units to be surveyed

Reference: Northwest Mountain Region handout, "Pavement Condition Survey Program", (6/11/88 HLN/ADO)

After the number of sample units to inspect was determined, sample units to inspect were selected using "systematic random sampling". The method is described here, followed by an example in Table 2.2.

1) All the sample units within a section are numbered consecutively.

2) The sampling interval (I) is computed with the equation I=N/n, where N = total number of sample units in a section, n = the minimum number of sample units to be surveyed (from Table 2.1). The sampling interval (I) can be rounded up or down to a whole integer.

3) The first sample unit, is selected at random from numbers 1 through sampling interval (I).

4) Sample units to be inspected are identified as s, s+I, s+2I, s+3I, etc.. through the entire sample.

Sample units were selected before arriving at the site and inspections were conducted on the preselected sample units to avoid biasing the sample. In some cases systematic random sampling was not used either due to a decidedly “non-random” interaction of sample numbers and systematic survey points that concentrated sampling in a small area, or due to an effort to sample previously unsampled areas. The Anaconda example below illustrates the most common sample selection variations. Runway 16-34, designated “R-1", has few previously sampled areas, so the recommended systematic random sampling is used. Standard systematic random sampling is also used for T-1 in 2009. A variant “paired sample” systematic random sampling was used on taxiway T-1 in 2006 to pick-up several samples with no historical inspection. Section A-1 had samples selected entirely at random, for a good geometric distribution. Finally, on apron area A-2, samples were selected to include several previously uninspected samples, then completing the selection with geometrically disbursed samples. On aprons and other areas where some locations may see much more wear than others, it is more important to get a good geometric distribution of samples, than to get a numerically random sampling..

TABLE 2.2
EXAMPLE SAMPLE UNIT SELECTION

ANACONDA AIRPORT

Section Number	Total # of Sample Units (N)	Minimum # of Units to Inspect * (n)	Sample Spacing ** (I=N/n)	Random Start # (s)	Sample Units to Survey (s,s+i,s+2i,etc)	Actual Sample Units Surveyed
~~R-1~~	~~99~~	~~6 + 1 = 7[†]~~	~~14~~	~~6~~	~~6,20,34,48,62,76,90~~	~~6,20,34,48,62,76,90~~
			or		or	
			15		6,21,36,51,66,81,96	
T-1	20	5	3	2	2,5,8,11,14,17	2,5,8,11,14
			or			
			4	4	4,8,12,16,20	
			or			
		Paired sample variant used in 2006:			4,5,9,10,16,17	
A-1	9	4	2	1	1,3,5,7 (used in '97)	
				1	1,5,7,9 (variant used in '03)	
				2	2,4,6,8 (used in '94)	
			or			
			3	1	1,4,7,~~10~~ (along one edge - not used)	
		Selecting only for geometric distribution:				1,5,9,2
A-2	17	5	3	3	3,6,9,12, 15 (along one edge - not used)	
			or			
			4	2	2,6,10,14,~~18>~~17 (variant used in '03)	
		Selecting mostly un-inspected samples:				3,5,11,15,16

* Table 2.1, or engineer's judgement
** Rounded up or down to a whole number
[†]Robert Peccia & Associates' engineers chose to increase sampling frequency by 1 on all runways, to provide a higher probability of an accurate PCI assessment on this most critical airport pavement.

The airport base maps (FAA Form 5320-1) show the sections and sample units defined for each airport. Sample units selected for evaluation in the various project years are marked with different hatch patterns as shown in the map legend. Sample units selected for evaluation in the 2009 Update are marked with a heavy cross-hatch (////).

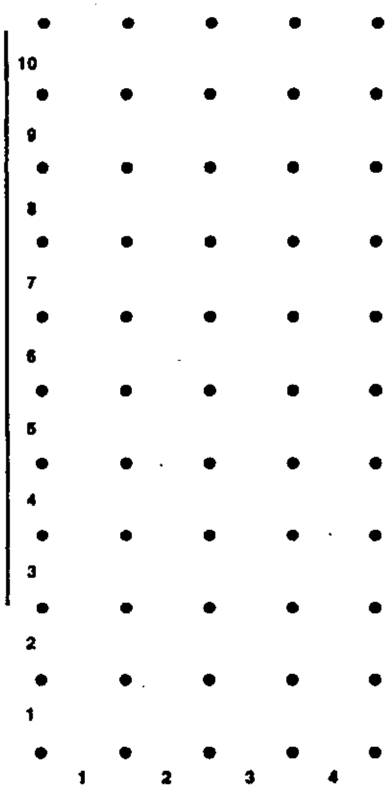
FIGURE 2.1

CONCRETE PAVEMENT INSPECTION SHEET

Branch ____________ Section ____________

Date ____________ Sample Unit ____________

Surveyed by ____________ Slab Size ____________



Distress Types

61. BLOW-UP
62. CORNER BREAK
63. LONG / TRANS / DIAGONAL CRACK
64. DURABILITY CRACK
65. JOINT SEAL DAMAGE
66. PATCHING, < 5 SF
67. PATCHING / UTILITY CUT
68. POPOUTS
69. PUMPING
70. SCALING / MAP CRACK / CRAZING
71. SETTLEMENT/FAULT
72. SHATTERED SLAB
73. SHRINKAGE CRACK
74. SPALLING - JOINTS
75. SPALLING - CORNER

Dist. Type	Sev.	No Slabs	% Slabs	Deduct Value
26#				
Deduct Total				
Corrected Deduct Value (CDV)				

PCI = 100 - CDV = ____________

Rating = ____________

ASPHALT PAVEMENT INSPECTION SHEET

Branch ____________ Section ____________

Date ____________ Sample Unit ____________

Surveyed by ____________ Area of Sample ____________

Distress Types

41. ALLIGATOR CRACKING
42. BLEEDING
43. BLOCK CRACKING
44. CORRUGATION
45. DEPRESSION
46. JET BLAST
47. JT. REFLECTION (PCC)
48. LONG. & TRANS. CRACKING
49. OIL SPILLAGE
50. PATCHING
51. POLISHED AGGREGATE
52. RAVELING / WEATHERING
53. RUTTING
54. SHOVING FROM PCC
55. SLIPPAGE CRACKING
56. SWELL

Sketch:

Existing Distress Types

Total Severity L						
M						
H						

PCI Calculation

Distress Type	Density	Severity	Deduct Value
Deduct Total			
Corrected Deduct Value (CDV)			

PCI = 100 - CDV = ____________

Rating = ____________

2.3 PAVEMENT CONDITION SURVEYS

Visual condition inspections were conducted in general accordance with the procedure outlined in Appendix A of the FAA Advisory Circular 150/5380-6, "Guidelines and Procedures for Maintenance of Airport Pavements". Modifications were made in accordance with the Northwest Mountain Region handout, "Pavement Condition Survey Program", (6/11/88 HLN/ADO). This handout proposes the following major changes to the procedure outlined in AC 150/5380-6.

1. The number of pavements to be surveyed was reduced by eliminating T-hangar taxiways and pavement sections smaller than 10,000 square feet.
2. The survey confidence level was reduced from 95% to 92%.

Detailed visual inspections were conducted on paved surfaces at each of the airports selected for this project during the period June 2009 through November 2009. The sections defined on base maps were verified, or revised if necessary. Sample units to be surveyed were temporarily marked on the pavement. Visual inspections were conducted measuring types, severities, and quantities of pavement distresses while walking over each selected sample unit. Distresses were recorded on inspection sheets like those shown in Figure 2.1. Individual pavement distress types and severities were identified using Appendix B of the FAA Advisory Circular 150/5380-6 and USACERL generated PCI Field Manuals for asphalt surfaced airfields and jointed concrete airfields. Photographs documenting overall condition and/or specific distresses were taken during the field surveys and are included in Chapter 4. Sample selection strives to select “representative” areas, but *photos were often selected to show extreme (and possibly atypical) distresses*.

After consulting with M. Y. Shahin, MicroPaver’s lead development engineer, two adjustments to previous field inspections were initiated beginning in 2000. Alligator cracking within one foot of the pavement edge was recorded as longitudinal cracks, and distresses recorded as “block cracking” in 1997 were reduced to longitudinal /transverse cracks. On larger airports, sections can be chosen to separate runway edge conditions from the center with separate PCI’s produced for heavily used center and seldom used edges. With smaller GA airports, it’s impractical to subdivide runway width, so edge failure can drive the PCI of a runway significantly below what its center section would warrant. Down-grading the type of distress recorded for edge failure better represents the quality of the commonly used portion of the pavement. Large, rectangular blocks seen on a few of Montana’s airports were judged to be just off the block cracking continuum, and recording them as such was excessively harsh on the section PCI. These two changes brought Montana’s pavement management system more in line with MicroPaver’s empirical research.

2.4 PAVEMENT CONDITION INDEX (PCI)

The pavement condition index (PCI) is an objective, repeatable numerical rating or “grade” that describes the overall condition of a pavement section on a scale of 0 (failed pavement) to 100 (perfect pavement). It is based on visual inspections of manageable sample pavement areas for types, severities, and quantities of a number of specific distresses. “Field verification of the PCI inspection method has shown that the index gives a good indication of a pavement’s structural integrity and operational condition. It has also been shown that, at the network level, the observation of existing distress in the pavement provides a useful index of both the current condition and an indication of future performance under existing traffic conditions.”[1]

FIGURE 2.2

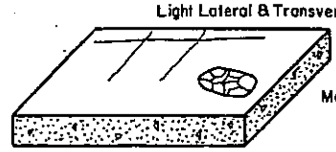
[1]USACERL Technical Report M-90/05, July 1990, Paver Update, “Pavement Maintenance Management for Roads and Streets Using the PAVER System,” by M. Y. Shahin & J. A. Walther, p40.

FIGURE 2.2

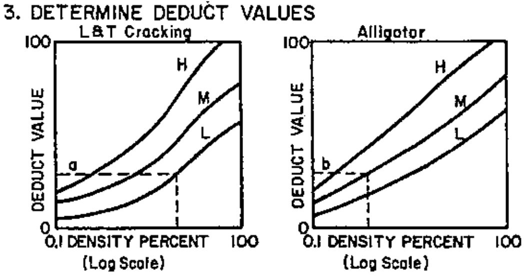
PCI CALCULATION STEPS

STEP I. DIVIDE PAVEMENT SECTION INTO SAMPLE UNITS.

STEP 2. INSPECT SAMPLE UNITS. DETERMINE DISTRESS TYPES AND SEVERITY LEVELS AND MEASURE DENSITY.

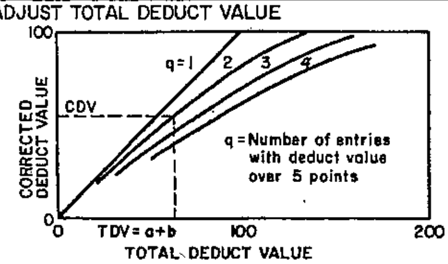


STEP 3. DETERMINE DEDUCT VALUES



STEP 4. COMPUTE TOTAL DEDUCT VALUE (TDV) a+b

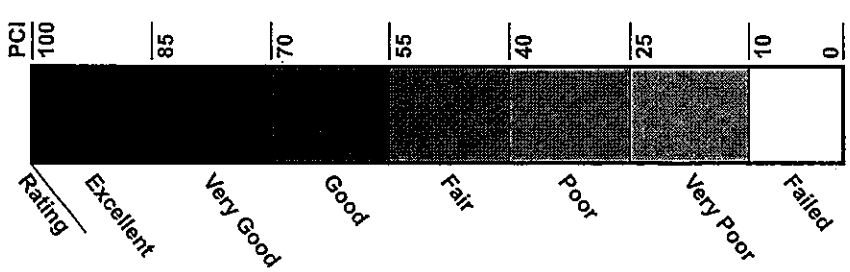
STEP 5. ADJUST TOTAL DEDUCT VALUE



STEP 6. COMPUTE PAVEMENT CONDITION INDEX (PCI) 100-CDV FOR EACH SAMPLE UNIT INSPECTED

STEP 7. COMPUTE PCI OF ENTIRE SECTION (AVERAGE PCI'S OF SAMPLE UNITS).

STEP 8. DETERMINE PAVEMENT CONDITION RATING OF SECTION



Source: USACERL Technical report M-90/05, July 1990, Paver Update, "Pavement Maintenance Management for Road & Streets Using the Paver System," by M.Y. Shahin & J.A. Walther, P41.

2.5 PCI CALCULATIONS

The PCI is produced for each surveyed sample unit with a series of calculations using the area of the sample and quantities of standard distress types as summarized in Figure 2.2. Pavements are divided into manageable sample areas and a random selection of these are intensively inspected (Figure 2.2, Step 1). Quantities of standardized distress types (descriptions and example photos in Appendix B) and severities are recorded during visual inspections by trained inspectors (Figure 2.2, Step 2). Quantities divided by the sample area give distress density for each type and severity of distress present. Distress densities are transferred to deduct values using composite curves generated from US Army Corps of Engineers pavement research (Figure 2.2, Step 3). The total deduct value is the sum of deducts due to individual distress types and severities (Figure 2.2, Step 4). To reflect the empirical fact that numerous minor defects are not as detrimental to a pavement's condition as a few major defects, this total deduct is scaled back when there are a large number of deducts recorded (Figure 2.2, Step 5). The Pavement Condition Index (PCI) is simply a perfect 100 pavement less the adjusted total deduct value (Figure 2.2, Step 6). The area-weighted average of the sample PCI's is taken as the section PCI (Figure 2.2, Step 7). There are seven discrete groupings of PCI values that describe the overall pavement quality with Pavement Condition Ratings (Figure 2.2, Step 8). The new version of MicroPAVER allows user-defined rating titles & ranges, and suggests that only PCI's above 55 are acceptable, with sub-55 PCI's rated as "poor" to "failed."

In addition to extrapolating PCI's from selected sample areas to larger sections of pavement, distress densities, distress quantities, and deducts are extrapolated for each section and included in the Inspection Report Summary. Extrapolated distress densities are the sum of distress quantities divided by the sum of the sampled areas. Distress densities are both scaled up by the section area to get extrapolated distress quantities, and also fed into the deduct curves to get extrapolated deducts for the section.

While these calculations can be completed by hand, the vast quantity of data collected for Montana's general aviation airports makes it much more feasible to use the MicroPAVER software package developed by USACERL expressly for PCI calculations. PCI's in this report were produced with MicroPAVER 5.3.2 - 6.1.4 for Windows.

2.6 PAVEMENT FAMILIES

In order to make sound management decisions, it is necessary to project the future condition of a pavement rather than just the present condition represented by the PCI. Comparing the eight airport pavement surveys spanning the last twenty-one years, it is apparent that a pavement's PCI degrades over time. By grouping pavements with similar properties, it is possible to distill an "average" behavior for the group. The MicroPAVER system calls groupings of like pavements "families." The intent is that grouped pavements will tend to perform similarly as they age. If this grouping is performed successfully, documented behavior of older pavements can be used to project probable behavior for younger pavements as they age. In other words, pavements within the same family should have PCIs that are roughly the same when their ages are the same. The choice of what properties, and ultimately which pavements are used to build a family are determined by the engineer. The number of families needs to be sufficiently large to cover different pavement types while preserving a statistically significant data set from the available survey data.

The database of Montana airports was configured in 1991 for sorting of families by parameters: surface type, primary use, pavement strength, rank, and asphalt thickness to total thickness ratio. In 1997 the medium strength asphalt runways were split into two families by approximate usage, or "operations count".

Surface types include: asphalt (AC), structural asphalt overlays of asphalt (AAC) or concrete (APC), bituminous surface treatments (ST), and Portland cement concrete (PCC). Concrete pads at the surface were designated "PCC," while those overlaid with asphalt were labeled "APC." When a pavement contained 1" or more of screed-applied asphalt cement coated aggregate it was called "AC," unless it was upgraded to an asphalt overlay of asphalt (AAC) by being overlaid with 1" or more of AC or with greater than 1" of porous friction course (PFC). Single-, double-, and triple-shot surfaces were designated as surface treatments (ST). These bituminous surface treatments (BST) were upgraded to structural strength similar to asphalt and called "AC" when overlaid with 1" or more of P-401, or with greater than 1" of porous friction course (PFC).

Primary uses for airport pavements are aprons, runways, and taxiways. Sections were assigned as "Apron", "Runway", or "Taxiway" based upon their use, and designated on FAA form 5230-1.

Pavement strengths are split into single axle loads of less than 12,500 pounds, 12,500 pounds up to and including 30,000 pounds, and over 30,000 pounds (light, medium, and heavy). Asphalt to total pavement section thickness ratio is set at less than 30%, between 30% and 70% inclusive, and over 70%. Design strength and asphalt thickness/total thickness ratio were encoded into a single character and stored into the database "Section Category" and updated for new construction. While asphalt thickness to total thickness ratio was not used in the final analysis of this report, it facilitated exploration of potential family groupings and could be used in future projects, so was not removed from the database. Pavement sections were assigned to one of ten section categories based on information shown on existing FAA Form 5320-1 for each airport. Unspecified P-609's (BST) were assumed to be double shots and assigned a nominal thickness of 1". Bituminous surface treatments (BST) and porous friction coats (PFC) were given credit for only half their nominal thickness in equivalent asphalt depth. Table 2.3 presents the section categories used and the requirements for each.

TABLE 2.3
SECTION CATEGORY CRITERIA

Section Category	AC/Total Depth Ratio	Design Strength (Single Wheel Load)
A	< 30%	< 12.5K
B	30% - 70%	< 12.5K
C	> 70%	< 12.5K
D	< 30%	12.5K - 30K
E	30% - 70%	12.5K - 30K
F	> 70%	12.5K - 30K
G	< 30%	> 30K
H	30% - 70%	> 30K
I	> 70%	> 30K
P	PCC, non-asphalt surface	

"Rank" is used to describe a pavement's status in the database and its use on the airfield. Current database members that remain in use on the airport are designated with an "O". Non-federally funded, abandoned, or demolished pavements are labeled with a rank of "N" or "A". Those sections excluded from inspections and the database by contractual agreement are ranked “E”. Only pavements with a rank of "O" were included in the 2009 update calculations and reports, dropping data for abandoned pavements from the era before preventative maintenance. Ranking could be used to prioritize funding allocation to heavy use airfields over lighter use fields, or to apply external budget priorities to maintenance and rehabilitation planning.

In 2000, medium strength runway/taxiways were subdivided by operations estimates into those having 5000 or fewer annual operations (L), and heavy use strips averaging over 5000 ops (U). This separation into “light use” versus “busy” was explored with other groupings, but each lacked sufficient samplings (mostly of older pavements) to produce reliable forecasting. Operations estimates were updated using 2009 FAA 5010-1 forms and rounded to the nearest thousand up to fifteen thousand, then to the nearest 5000 for annual estimates exceeding 15,000.

In 2006, the two families of surface treatment pavements were combined, as were the two primary usages associated with low strength pavement. There were no longer enough pavements in these dwindling families to produce statistically significant groups, nor to require separate estimations.

While a number of other parameters are currently available in the database, few if any would be reasonable sort criteria. There are user definable fields for refining or redefining families as the available data set grows and it becomes possible to use additional delimiters such as “Maintained” vs. “Unmaintained,” or “Harsh”, “Moderate”, “Minimal” to describe freeze-thaw cycle exposure at the site.

2.7 FAMILY ANALYSES

Families were assigned according to surface type, primary use, design strength (using section category values), and operations counts. These selection criteria made the most sense and produced results that fit well with common engineering judgement and measured data. Numerous grouping variations were explored with inferior results. Retaining the majority of the families used in earlier years allows meaningful comparisons with previous surveys. Family curves for all PCI system plans since 1991 are included in the appendix. The following eight families were defined, and are coded to indicate the combination of selection criteria used for each.

<u>FAMILY NAMES</u>:
ACPL, ACAM, ACRML, ACRMU, ACAH, ACRH, STPA, PCAA

<u>FAMILY NAME CODING:</u>
1st two letters = surface type
- AC = all asphalt cement pavements
- PC = all Portland cement pavements
- ST = surface treatment

3rd letter = primary use
- A = aprons
- R = runways and taxiways
- P = all primary uses (aprons, runways, and taxiways)

4th letter = design strength
- A = all strengths
- L = low strength (< 12.5K, single wheel)
- M = medium strength (12.5K - 30K, single wheel)
- H = high strength (> 30K, single wheel)

5th letter = operations count (where applicable)
L = light use ($\leq$ 5000 annual estimated operations)
U = busy (over 5000 annual estimated operations, or more than 1 op./daylight hour)

While there is scatter in the data that PCI families are based on, it is well within the limits expected from nearly sixty airports spread across a wide geographic region, with varying traffic loads and maintenance practices. While maintenance is great for airport pavements, the inspections that follow produce an upward spike in the pavements' "life cycle curve." These increases in PCI's over historical values create a certain amount of unavoidable "scatter" in the data. Likewise, a fog coat or crack sealant will likely age much more quickly than the original pavement; this steeper rate of decline also generates data scatter. There are a few pavement sections that exhibit an increase in successive PCI's, as well as a few with precipitous drops due to failed sealant or a transition from "cracking" to "alligator cracking". To compensate for the scatter we must realistically expect from the variations in the airport system, the database of accumulated PCI inspection results is statistically "screened." Six of the eight families used in this analysis are created from 90% of the available data, the remaining "outliers" are plotted but are not used to generate the family curve; the two most populous data sets ACRML and ACRMU screen only 1% of the outliers and allow for a maintenance "bump" in the data.

Pavement sections that are at the extremes of the pavement performance spectrum were removed from the data set used to construct the representative family curves. The engineer established a "boundary" of theoretical best and worst possible pavement life cycles to filter out abnormal pavement wear and maintenance spikes. Table 2.5 shows the typical boundary filter for asphalt pavements. A combination of factors may conspire to rapidly degrade a specific pavement -- excess moisture destabilizing the subgrade, poor construction practices, abuse, or overloading, Another branch could have all the luck (and care) - solid subgrade, conscientious construction, light usage, wintering the freeze-thaw cycles under an insulating blanket of snow. Uncommon PCI's are filtered out with best- and worst-case scenario boundaries. Occassionally, a section or two may be removed from the family construction due to the engineer's determination of irregular circumstances.

Table 2.4 on the following pages summarizes pavement section data from FAA 5320-1 forms, uses it to assign section categories and surface types, and then determines the family assignment for each section in the Montana airports database. This table has been updated to include approximate annual operations counts and documents the use of geotextiles in the pavement section. Table 2.4 includes all the information used to construct family groups, and additional data that was considered for new groupings.

TABLE 2.4 - SECTION PROPERTIES & FAMILY ASSIGNMENTS

BRANCH NAME (Airport City)	Section	Approx. Annual Operations	Geo-Grid / Fabric	Sub-base (Inches)	Base Course (Inches)		Surface Course (Inches)			Overlay (Inches)			Gravel Depth	Asphalt Depth	% Asphalt Depth	Pvmnt Strngth (1,000 lbs.)	Section Cate-gory	Branch Use	Surface Type	FAMILY
		(1000)	(g / f)	(Agg)	(Agg)	(AC)	(BST)	(AC)	(PCC)	(BST)	(AC)	(PFC)								
Anaconda	A-1	5			9			3					9	3	25%	12.5	D	Apron	AC	ACAM
Anaconda	A-2	5			9.7			4					9.7	4	29%	12.5	D	Apron	AC	ACAM
Anaconda	R-1	5			9			3			2.75		9	5.75	39%	16	E	Runway	AAC	ACRML
Anaconda	R-2	5			9.7			4					9.7	4	29%	12.5	D	Runway	AC	ACRML
Anaconda	T-1	5			9			3			2.8		9	5.8	39%	16	E	Taxiway	AAC	ACRML
Anaconda	T-1A	5			9			3					9	3	25%	12.5	D	Taxiway	AC	ACRML
Anaconda	T-2	5			9.7			4					9.7	4	29%	12.5	D	Taxiway	AC	ACRML
Anaconda	T-4	5			6			2		1			6	2.5	29%	30	D	Taxiway	AC	ACRML
Anaconda	T-5	5			9.7			4					9.7	4	29%	12.5	D	Taxiway	AC	ACRML
Baker	A-2A	7			11			2			5.25		11	7.25	40%	12.5	E	Apron	AAC	ACAM
Baker	A-3A	7	f		6		1	2		1	5.25		6	8.25	58%	4	B	Apron	AAC	ACPL
Baker	A-5	7	f	18	16			4					34	4	11%	12.5	D	Apron	AC	ACAM
Baker	A-6	7	f	22	8				8				PCC	PCC	PCC	PCC	P	Apron	PCC	PCAA
Baker	A-7	7	f	18	16			4					34	4	11%	12.5	D	Apron	AC	ACAM
Baker	R-1	7		35	22			5					57	5	8%	17.5	D	Runway	AC	ACRMU
Baker	T-1	7			11			2			3		11	5	31%	12.5	E	Taxiway	AAC	ACRMU
Baker	T-2	7			6		1	2			3		6	5.5	48%	12.5	E	Taxiway	AAC	ACRMU
Baker	T-3	7			11			2			4.5		11	6.5	37%	12.5	E	Taxiway	AAC	ACRMU
Baker	T-4	7	f	18	16			4					34	4	11%	12.5	D	Taxiway	AC	ACRMU
Benchmark	A-1A	0			6			3					6	3	33%	45	H	Apron	AC	ACAH
Benchmark	A-1B	0			6			3					6	3	33%	45	H	Apron	AC	ACAH
Benchmark	R-1	0			6			3					6	3	33%	45	H	Runway	AC	ACRH
Benchmark	R-2A	0			6			3					6	3	33%	45	H	Runway	AC	ACRH
Benchmark	R-2B	0			6			3					6	3	33%	45	H	Runway	AC	ACRH
Benchmark	T-1	0			6			3					6	3	33%	45	H	Taxiway	AC	ACRH
Big Sandy	A-1	5							6				PCC	PCC	PCC	PCC	P	Apron	PCC	PCAA
Big Sandy	R-1	5						2		0.25			0	2.125	100%	4	C	Runway	AC	ACPL
Big Sandy	R-2	5			8			4					8	4	33%	4	B	Runway	AC	ACPL
Big Sandy	T-1	5			8			4					8	4	33%	4	B	Taxiway	AC	ACPL
Big Sandy	T-2	5			6			3					6	3	33%	4	B	Taxiway	AC	ACPL
Big Timber	A-1	7			9.5			2.5					9.5	2.5	21%	12.5	D	Apron	AC	ACAM
Big Timber	A-2	7			4			2.5					4	2.5	38%	12.5	E	Apron	AC	ACAM
Big Timber	R-1	7			9.5			2.5					9.5	2.5	21%	12.5	D	Runway	AC	ACRMU
Big Timber	R-2	7			4			2.5					4	2.5	38%	12.5	E	Runway	AC	ACRMU
Big Timber	T-1	7			4			2.5					4	2.5	38%	12.5	E	Taxiway	AC	ACRMU
Big Timber	T-2	7			4		2				2		4	3	43%	12.5	E	Taxiway	AC	ACRMU
Big Timber	T-3	7			4			2.5					4	2.5	38%	12.5	E	Taxiway	AC	ACRMU
Big Timber	T-4	7		30	6			4					36	4	10%	12.5	D	Taxiway	AC	ACRMU
Big Timber	T-5	7		30	6			4					36	4	10%	12.5	D	Taxiway	AC	ACRMU
Broadus	A-1	5		6	4			3.5					10	3.5	26%	12.5	D	Apron	AC	ACAM
Broadus	R-1	5		6	4			3.5					10	3.5	26%	12.5	D	Runway	AC	ACRML
Broadus	T-1	5		6	4			3.5					10	3.5	26%	13.5	D	Taxiway	AC	ACRML
Chester	A-5	5			11			3					11	3	21%	12.5	D	Apron	AC	ACAM
Chester	R-3	5			13			3					13	3	19%	12.5	D	Runway	AC	ACRML
Chester	T-2	5			13			3					13	3	19%	12.5	D	Taxiway	AC	ACRML
Chester	T-3	5			12			3					12	3	20%	12.5	D	Taxiway	AC	ACRML

TABLE 2.4 - SECTION PROPERTIES & FAMILY ASSIGNMENTS

BRANCH NAME (Airport City)	Section	Approx. Annual Operations (1000)	Geo-Grid / Fabric (g / f)	Sub-base (Inches) (Agg)	Base Course (Inches) (Agg)	Base Course (Inches) (AC)	Surface Course (Inches) (BST)	Surface Course (Inches) (AC)	Surface Course (Inches) (PCC)	Overlay (Inches) (BST)	Overlay (Inches) (AC)	Overlay (Inches) (PFC)	Gravel Depth	Asphalt Depth	% Asphalt Depth	Pvmnt Strngth (1,000 lbs.)	Section Cate-gory	Branch Use	Surface Type	FAMILY
Chinook	A-1A	9			10			3					10	3	23%	12.5	D	Apron	AC	ACAM
Chinook	A-1B	9			10			3			2		10	5	33%	12.5	E	Apron	AAC	ACAM
Chinook	R-1	9			10			3			2		10	5	33%	12.5	E	Runway	AAC	ACRMU
Chinook	T-1	9			10			3			2		10	5	33%	12.5	E	Taxiway	AAC	ACRMU
Choteau	A-1	3			8		2				1		8	2	20%	24	D	Apron	AC	ACAM
Choteau	R-11	3		6	13			2					19	2	10%	24	D	Runway	AC	ACRML
Choteau	R-12	3	f	5.5	6.5			2					12	2	14%	24	D	Runway	AC	ACRML
Choteau	R-2	3	f	7.5	6.5			3					14	3	18%	24	D	Runway	AC	ACRML
Choteau	T-1	3			12			3					12	3	20%	24	D	Taxiway	AC	ACRML
Choteau	T-2	3	f	7.5	6.5			3					14	3	18%	24	D	Taxiway	AC	ACRML
Circle	A-1	4			8			3					8	3	27%	21	D	Apron	AC	ACAM
Circle	A-2	4		10	4			2					14	2	13%	16	D	Apron	AC	ACAM
Circle	R-11	4		8	8			3					16	3	16%	30	D	Runway	AC	ACRML
Circle	T-1	4		6	13			3					19	3	14%	21	D	Taxiway	AC	ACRML
Circle	T-2	4		12	13			3					25	3	11%	16	D	Taxiway	AC	ACRML
Colstrip	A-1	6			9			3			3.5		9	6.5	42%	12.5	E	Apron	AAC	ACAM
Colstrip	R-1	6			9			3			3.5		9	6.5	42%	12.5	E	Runway	AAC	ACRMU
Colstrip	T-1	6			9			3			3.5		9	6.5	42%	12.5	E	Taxiway	AAC	ACRMU
Colstrip	T-2	6			9			3			3.5		9	6.5	42%	12.5	E	Taxiway	AAC	ACRMU
Columbus	A-1	9	f		13			3					13	3	19%	12.5	D	Apron	AC	ACAM
Columbus	R-1	9	f		13			3					13	3	19%	12.5	D	Runway	AC	ACRMU
Columbus	T-1	9	f		13			3					13	3	19%	12.5	D	Taxiway	AC	ACRMU
Columbus	T-2	9	f		13			3					13	3	19%	12.5	D	Taxiway	AC	ACRMU
Columbus	T-3	9	f		13			3					13	3	19%	13.5	D	Taxiway	AC	ACRMU
Conrad	A-1	4			10			2			2.5		10	4.5	31%	12.5	E	Apron	AAC	ACAM
Conrad	R-3	4	f	8	3			3.5					11	3.5	24%	12.5	D	Runway	AC	ACRML
Conrad	T-4	4			10			2			2.5		10	4.5	31%	12.5	E	Taxiway	AAC	ACRML
Culbertson	*A-1*	*5*			*8*		*1*				*3*		*8*	*3.5*	*30%*	*12.5*	*E*	*Apron*	*AC*	*ACAM*
Culbertson	*R-1*	*5*			*8*		*1*				*3*		*8*	*3.5*	*30%*	*12.5*	*E*	*Runway*	*AC*	*ACRML*
Culbertson	*R-2*	*5*			*8*		*1*	*3*					*8*	*3.5*	*30%*	*12.5*	*E*	*Runway*	*AC*	*ACRML*
Culbertson	*T-1*	*5*			*8*		*1*				*3*		*8*	*3.5*	*30%*	*12.5*	*E*	*Taxiway*	*AC*	*ACRML*
Culbertson	*T-2*	*5*			*8*			*3*					*8*	*3*	*27%*	*12.5*	*D*	*Taxiway*	*AC*	*ACRML*
Cut Bank	A-1	6							7				PCC	PCC	PCC	PCC	P	Apron	PCC	PCAA
Cut Bank	R-1	6			12			5.5			3	1	12	9	43%	12.5	E	Runway	AAC	ACRMU
Cut Bank	R-21	6	f	8	12			3					20	3	13%	28	D	Runway	AC	ACRMU
Cut Bank	T-1	6			8			5					8	5	38%	12.5	E	Taxiway	AC	ACRMU
Cut Bank	T-2	6			6			2				1	6	2.5	29%	12.5	D	Taxiway	AC	ACRMU
Cut Bank	T-4	6			9			9.5				1	9	10	53%	12.5	E	Taxiway	AC	ACRMU
Cut Bank	T-5	6	f		11			3					11	3	21%	12.5	D	Taxiway	AC	ACRMU
Cut Bank	T-6	6	f		12			3					12	3	20%	20	D	Taxiway	AC	ACRMU
Deer Lodge	A-3	4			6			2.5			1.5		6	4	40%	30	E	Apron	AAC	ACAM
Deer Lodge	A-4	4			4			2.5			1.5		4	4	50%	30	E	Apron	AAC	ACAM
Deer Lodge	R-3	4			6			2.5			2		6	4.5	43%	30	E	Runway	AAC	ACRML
Deer Lodge	R-4	4			4			4					4	4	50%	30	E	Runway	AC	ACRML
Deer Lodge	T-1B	4			8			2.5					8	2.5	24%	12.5	D	Taxiway	AC	ACRML
Deer Lodge	T-2	4			10			2.5					10	2.5	20%	12.5	D	Taxiway	AC	ACRML

TABLE 2.4 - SECTION PROPERTIES & FAMILY ASSIGNMENTS

BRANCH NAME (Airport City)	Section	Approx. Annual Operations (1000)	Geo-Grid / Fabric (g / f)	Sub-base (Inches) (Agg)	Base Course (Inches) (Agg)	Base Course (Inches) (AC)	Surface Course (Inches) (BST)	Surface Course (Inches) (AC)	Surface Course (Inches) (PCC)	Overlay (Inches) (BST)	Overlay (Inches) (AC)	Overlay (Inches) (PFC)	Gravel Depth	Asphalt Depth	% Asphalt Depth	Pvmnt Strngth (1,000 lbs.)	Section Cate-gory	Branch Use	Surface Type	FAMILY
Dillon	A-3	11		10	4			1.5			1.5		14	3	18%	16	D	Apron	AAC	ACAM
Dillon	A-4	11	f	13	6			4					19	4	17%	33	G	Apron	AC	ACAH
Dillon	A-11	11			11.5			3					11.5	3	21%	22	D	Apron	AC	ACAM
Dillon	R-3	11			15			3					15	3	17%	30	D	Runway	AC	ACRMU
Dillon	R-4	11	f	24	15			3					39	3	7%	30	D	Runway	AC	ACRMU
Dillon	R-21	11			17			3					17	3	15%	30	D	Runway	AC	ACRMU
Dillon	T-2	11		10	4			1.5			1.5		14	3	18%	16	D	Taxiway	AAC	ACRMU
Dillon	T-3	11		7	4			3					11	3	21%	12.5	D	Taxiway	AC	ACRMU
Dillon	T-4	11	f	7	4			3					11	3	21%	12.5	D	Taxiway	AC	ACRMU
Dillon	T-5	11			15			3					15	3	17%	30	D	Taxiway	AC	ACRMU
Ekalaka	A-1	2		11.5	2		1				3.5		13.5	4	23%	12.5	D	Apron	AC	ACAM
Ekalaka	R-1	2		11.5	2		1				3.5		13.5	4	23%	12.5	D	Runway	AC	ACRML
Ekalaka	R-11	2	g,f		12			4					12	4	25%	12.5	D	Runway	AC	ACRML
Ekalaka	T-1	2		11.5	2		1				3.5		13.5	4	23%	12.5	D	Taxiway	AC	ACRML
Ekalaka	T-11	2	g,f		10			4					10	4	29%	12.5	D	Taxiway	AC	ACRML
Ennis	*A-1*	*11*			*8*			*3*					*8*	*3*	*27%*	*12.5*	*D*	*Apron*	*AC*	*ACAM*
Ennis	*A-2*	*11*			*8*			*3*					*8*	*3*	*27%*	*12.5*	*D*	*Apron*	*AC*	*ACAM*
Ennis	*R-1*	*11*			*8*			*3*					*8*	*3*	*27%*	*12.5*	*D*	*Runway*	*AC*	*ACRMU*
Ennis	*T-1*	*11*			*8*			*3*					*8*	*3*	*27%*	*12.5*	*D*	*Taxiway*	*AC*	*ACRMU*
Ennis	*T-2*	*11*			*8*			*3*					*8*	*3*	*27%*	*12.5*	*D*	*Taxiway*	*AC*	*ACRMU*
Eureka	A-1	2			4			3					4	3	43%	12.5	E	Apron	AC	ACAM
Eureka	R-1	2			4			3					4	3	43%	12.5	E	Runway	AC	ACRML
Eureka	T-1	2			4			3					4	3	43%	12.5	E	Taxiway	AC	ACRML
Eureka	T-2	2			4			3					4	3	43%	12.5	E	Taxiway	AC	ACRML
Eureka	T-3	2			6			3					6	3	33%	12.5	E	Taxiway	AC	ACRML
Eureka	T-4	2			6			3					6	3	33%	12.5	E	Taxiway	AC	ACRML
Forsyth	A-1	9			4			3			2.5		4	5.5	58%	18	E	Apron	AAC	ACAM
Forsyth	R-1	9			7			3					7	3	30%	12.5	E	Runway	AC	ACRMU
Forsyth	T-1	9			7			3					7	3	30%	12.5	E	Taxiway	AC	ACRMU
Forsyth	T-2	9			3			6			2.5		3	8.5	74%	12.5	F	Taxiway	AAC	ACRMU
Forsyth	T-3	9			7			3					7	3	30%	12.5	E	Taxiway	AC	ACRMU
Forsyth	T-4	9			7			3					7	3	30%	12.5	E	Taxiway	AC	ACRMU
Fort Benton	A-1	5	f		6			3					6	3	33%	12.5	E	Apron	AC	ACAM
Fort Benton	R-1	5	f		6			3					6	3	33%	12.5	E	Runway	AC	ACRML
Fort Benton	T-1	5	f		6			3					6	3	33%	12.5	E	Taxiway	AC	ACRML
Fort Benton	T-2	5	f		6			3					6	3	33%	12.5	E	Taxiway	AC	ACRML
Fort Benton	T-3	5			8			3					8	3	27%	12.5	D	Taxiway	AC	ACRML
Gardiner	R-1	9						4					0	4	100%	4	C	Runway	AC	ACPL
Gardiner	T-1	9						4					0	4	100%	4	C	Taxiway	AC	ACPL

TABLE 2.4 - SECTION PROPERTIES & FAMILY ASSIGNMENTS

BRANCH NAME (Airport City)	Section	Approx. Annual Operations (1000)	Geo-Grid / Fabric (g / f)	Sub-base (Inches) (Agg)	Base Course (Inches) (Agg)	Base Course (Inches) (AC)	Surface Course (Inches) (BST)	Surface Course (Inches) (AC)	Surface Course (Inches) (PCC)	Overlay (Inches) (BST)	Overlay (Inches) (AC)	Overlay (Inches) (PFC)	Gravel Depth	Asphalt Depth	% Asphalt Depth	Pvmnt Strngth (1,000 lbs.)	Section Cate-gory	Branch Use	Surface Type	FAMILY
Glasgow	A-3	30		6	3			3					9	3	25%	23	D	Apron	AC	ACAM
Glasgow	A-4	30							8				PCC	PCC	PCC	PCC	P	Apron	PCC	PCAA
Glasgow	A-6	30	f	12	14				9				PCC	PCC	PCC	PCC	P	Apron	PCC	PCAA
Glasgow	A-7	30	f	25	5			3					30	3	9%	12.5	D	Apron	AC	ACAM
Glasgow	R-2	30		8		5		4			5		8	14	64%	75	H	Runway	AAC	ACRH
Glasgow	R-3	30		17	6			2					23	2	8%	75	G	Runway	AC	ACRH
Glasgow	R-13	30		8		5		4					8	9	53%	25	E	Runway	AC	ACRMU
Glasgow	R-14	30	g,f	11	4			3					15	3	17%	25	D	Runway	AC	ACRMU
Glasgow	T-1	30		8		5		4			2	2.63	8	12.32	61%	75	H	Taxiway	AAC	ACRH
Glasgow	T-3	30		8		5		4			2	2.6	8	12.3	61%	75	H	Taxiway	AAC	ACRH
Glasgow	T-4	30											0	0		12.5	E	Taxiway	AC	ACRMU
Glasgow	T-5	30		6	6			4			5		12	9	43%	75	H	Taxiway	AAC	ACRH
Glasgow	T-7	30			10			3					10	3	23%	12.5	D	Taxiway	AC	ACRMU
Glasgow	T-8	30			6			2					6	2	25%	75	G	Taxiway	AC	ACRH
Glasgow	T-9	30											0	0		12.5	E	Taxiway	AC	ACRMU
Glasgow	T-10	30	f	12	13			5					25	5	17%	55	G	Taxiway	AC	ACRH
Glasgow	T-11	30	f	15	6			4					21	4	16%	25	D	Taxiway	AC	ACRMU
Glendive	A-1	6		6	6			4		1	2		12	6.5	35%	44	H	Apron	AAC	ACAH
Glendive	A-2	6						5			2.5		0	7.5	100%	12.5	F	Apron	AAC	ACAM
Glendive	R-1	6		6	6			4			2		12	6	33%	53	H	Runway	AAC	ACRH
Glendive	R-2	6		5	5			3			2		10	5	33%	38	H	Runway	AAC	ACRH
Glendive	R-3	6			6			3			2		6	5	45%	12.5	E	Runway	AAC	ACRMU
Glendive	T-1	6		6	6			4		1			12	4.5	27%	44	G	Taxiway	AC	ACRH
Glendive	T-2	6						5			2.5		0	7.5	100%	12.5	F	Taxiway	AAC	ACRMU
Glendive	T-5	6	f		12			5					12	5	29%	30	D	Taxiway	AC	ACRMU
Glendive	T-6	6	f		12			5					12	5	29%	30	D	Taxiway	AC	ACRMU
Hamilton	A-1	25		4	7		1						11	0.5	4%	17	D	Apron	ST	STPA
Hamilton	A-2	25			9		1						9	0.5	5%	17	A	Apron	ST	STPA
Hamilton	R-1A	25		4	7		1			1		1.5	11	1.75	14%	17	D	Runway	AC	ACRMU
Hamilton	R-2	25	f	40	4			2				1	44	2.5	5%	17	D	Runway	AC	ACRMU
Hamilton	T-2	25			9		1					1.5	9	1.25	12%	17	D	Taxiway	AC	ACRMU
Hamilton	T-3	25			9		1						9	0.5	5%	17	D	Taxiway	ST	STPA
Hamilton	T-5	25		12	8			4					20	4	17%	17	D	Taxiway	AC	ACRMU
Harlem	A-11	4		10.5	6			3					16.5	3	15%	12.5	D	Apron	AC	ACAM
Harlem	R-11	4		10.5	6			3					16.5	3	15%	12.5	D	Runway	AC	ACRML
Harlem	R-12	4		10.5	6			3					16.5	3	15%	12.5	D	Runway	AC	ACRML
Harlem	T-11	4		10.5	6			3					16.5	3	15%	12.5	D	Taxiway	AC	ACRML
Harlowton	A-11	2		4	7			2					11	2	15%	12.5	D	Apron	AC	ACAM
Harlowton	R-11	2			10			2					10	2	17%	12.5	D	Runway	AC	ACRML
Harlowton	T-11	2		4	7			2					11	2	15%	12.5	D	Taxiway	AC	ACRML

TABLE 2.4 - SECTION PROPERTIES & FAMILY ASSIGNMENTS

BRANCH NAME (Airport City)	Section	Approx. Annual Operations (1000)	Geo-Grid / Fabric (g / f)	Sub-base (Inches) (Agg)	Base Course (Inches) (Agg)	Base Course (Inches) (AC)	Surface Course (Inches) (BST)	Surface Course (Inches) (AC)	Surface Course (Inches) (PCC)	Overlay (Inches) (BST)	Overlay (Inches) (AC)	Overlay (Inches) (PFC)	Gravel Depth	Asphalt Depth	% Asphalt Depth	Pvmnt Strngth (1,000 lbs.)	Section Cate-gory	Branch Use	Surface Type	FAMILY
Havre	A-3	8			5			6			4	1	5	10.5	68%	30	E	Apron	AAC	ACAM
Havre	A-4	8			8			3					8	3	27%	25	D	Apron	AC	ACAM
Havre	A-5	8		16	3			4				1	19	4.5	19%	45	G	Apron	AC	ACAH
Havre	R-5	8			14			3				1	14	3.5	20%	30	D	Runway	AC	ACRMU
Havre	R-11	8			8			2			2	1	8	4.5	36%	12.5	E	Runway	AAC	ACRMU
Havre	R-12	8		30	6			2		2		1	36	3.5	9%	12.5	D	Runway	AC	ACRMU
Havre	T-2	8		8	6			3				1	14	3.5	20%	30	D	Taxiway	AC	ACRMU
Havre	T-3	8		6	6			2				1	12	2.5	17%	12.5	D	Taxiway	AC	ACRMU
Havre	T-4	8		11.5	6			3				1	17.5	3.5	17%	30	D	Taxiway	AC	ACRMU
Havre	T-5	8		8	6			3				1	14	3.5	20%	30	D	Taxiway	AC	ACRMU
Jordan	A-11	2	g, f	11	4			3					15	3	17%	12.5	D	Apron	AC	ACAM
Jordan	R-1	2		7	5		1.5				3.5		12	4.25	26%	12.5	D	Runway	AC	ACRML
Jordan	T-1	2		7	5		1.5				3.5		12	4.25	26%	12.5	D	Taxiway	AC	ACRML
Jordan	T-12	2	g, f	11	4			3					15	3	17%	12.5	D	Taxiway	AC	ACRML
Laurel	A-3	45	f		12			4					12	4	25%	12.5	D	Apron	AC	ACAM
Laurel	R-4	45	f		12			4					12	4	25%	12.5	D	Runway	AC	ACRMU
Laurel	T-1	45			6		1				2		6	2.5	29%	14	D	Taxiway	AC	ACRMU
Laurel	T-2	45			6		1				2		6	2.5	29%	14	D	Taxiway	AC	ACRMU
Laurel	T-8	45	f		12			4					12	4	25%	12.5	D	Taxiway	AC	ACRMU
Laurel	T-9	45	f		12			4					12	4	25%	12.5	D	Taxiway	AC	ACRMU
Lewistown	A-1	15							7			2	APC	APC	APC	APC	P	Apron	APC	PCAA
Lewistown	A-2	15			6			2				1	6	2.5	29%	8	A	Apron	AC	ACPL
Lewistown	A-3A	15									3		0	3	100%	8	B	Apron	AC	ACPL
Lewistown	R-23	15			11			3					11	3	21%	12.5	D	Runway	AC	ACRMU
Lewistown	R-32	15			10.5			6		1		4	10.5	8.5	45%	40	H	Runway	AAC	ACRH
Lewistown	R-33	15			10			3				1	10	3.5	26%	40	G	Runway	AC	ACRH
Lewistown	R-34	15			10	7		2				1	10	9.5	49%	40	H	Runway	AC	ACRH
Lewistown	T-1	15			6.25			5.75				3	6.25	7.25	54%	45	H	Taxiway	AAC	ACRH
Lewistown	T-4	15									3		0	3	100%	12.5	E	Taxiway	AC	ACRMU
Lewistown	T-5	15			10			3				1	10	3.5	26%	40	G	Taxiway	AC	ACRH
Lewistown	T-7	15		6	4			3					10	3	23%	12.5	D	Taxiway	AC	ACRMU
Lewistown	T-8	15		6	4			3					10	3	23%	12.5	D	Taxiway	AC	ACRMU
Lewistown	T-9	15			11			3					11	3	21%	12.5	D	Taxiway	AC	ACRMU
Lewistown	T-10	15	f		9			3					9	3	25%	18	D	Taxiway	AC	ACRMU
Lewistown	T-11	15	f		9			3					9	3	25%	18	D	Taxiway	AC	ACRMU
Libby	A-1	5			8			4			2		8	6	43%	23	E	Apron	AAC	ACAM
Libby	A-2	5		6	2			4			2		8	6	43%	23	E	Apron	AAC	ACAM
Libby	A-3	5		6	6			3			2		12	5	29%	60	G	Apron	AAC	ACAH
Libby	A-4	5			8				6				PCC	PCC	PCC	PCC	P	Apron	PCC	PCAA
Libby	A-5	5		6	6				6				PCC	PCC	PCC	PCC	P	Apron	PCC	PCAA
Libby	R-1	5		8		2		2				1.2	8	4.6	37%	23	E	Runway	AAC	ACRML
Libby	R-2	5		6	2			4				1.2	8	4.6	37%	23	E	Runway	AAC	ACRML
Libby	T-2	5		6	6			3					12	3	20%	60	G	Taxiway	AC	ACRH
Libby	T-5	5	f		8			4					8	4	33%	23	E	Taxiway	AC	ACRML
Libby	T-6	5	f		8			4					8	4	33%	23	E	Taxiway	AC	ACRML

TABLE 2.4 - SECTION PROPERTIES & FAMILY ASSIGNMENTS

BRANCH NAME (Airport City)	Section	Approx. Annual Operations (1000)	Geo-Grid / Fabric (g / f)	Sub-base (Inches) (Agg)	Base Course (Inches) (Agg)	Base Course (Inches) (AC)	Surface Course (Inches) (BST)	Surface Course (Inches) (AC)	Surface Course (Inches) (PCC)	Overlay (Inches) (BST)	Overlay (Inches) (AC)	Overlay (Inches) (PFC)	Gravel Depth	Asphalt Depth	% Asphalt Depth	Pvmnt Strngth (1,000 lbs.)	Section Cate-gory	Branch Use	Surface Type	FAMILY
Lincoln	A-11	4		29	6.75			3					35.75	3	8%	12.5	D	Apron	AC	ACAM
Lincoln	A-2	4		29	6.75			3					35.75	3	8%	12.5	D	Apron	AC	ACAM
Lincoln	R-11	4		29	6.75			3					35.75	3	8%	12.5	D	Runway	AC	ACRML
Lincoln	T-11	4		29	6.75			3					35.75	3	8%	12.5	D	Taxiway	AC	ACRML
Livingston	A-1	6			7			2				1	7	2.5	26%	45	G	Apron	AC	ACAH
Livingston	A-2	6			4			3				1	4	3.5	47%	12.5	E	Apron	AC	ACAM
Livingston	R-1	6			7			1.5		1		1	7	2.5	26%	40	G	Runway	AC	ACRH
Livingston	R-2	6			7			2		1		1	7	3	30%	30	E	Runway	AC	ACRMU
Livingston	T-1	6			7			1.5		1			7	2	22%	40	G	Taxiway	AC	ACRH
Livingston	T-5	6		8	6			3					14	3	18%	40	G	Taxiway	AC	ACRH
Malta	A-1	3	g, f	14		2		2					14	4	22%	12.5	D	Apron	AC	ACAM
Malta	A-3	3	g, f	12	6				6				PCC	PCC	PCC	PCC	P	Apron	PCC	PCAA
Malta	A-4	3		14	4			4					18	4	18%	12.5	D	Apron	AC	ACAM
Malta	R-1	3	g, f	14				4					14	4	22%	12.5	D	Runway	AC	ACRML
Malta	T-1	3	g, f	14				4					14	4	22%	12.5	D	Taxiway	AC	ACRML
Malta	T-2	3	g, f	14				4					14	4	22%	12.5	D	Taxiway	AC	ACRML
Miles City	A-2	11	f	11	4			3					15	3	17%	12.5	D	Apron	AC	ACAM
Miles City	A-3	11						5		1			0	5.5	100%	12.5	F	Apron	AC	ACAM
Miles City	A-3A	11	f	11	4			3					15	3	17%	28	D	Apron	AC	ACAM
Miles City	A-4	11	f	11	4			3					15	3	17%	12.5	D	Apron	AC	ACAM
Miles City	A-5	11							10				PCC	PCC	PCC	PCC	P	Apron	PCC	PCAA
Miles City	R-12	11			19	9		4					19	13	41%	38	H	Runway	AC	ACRH
Miles City	R-21	11	f		8			2.5					8	2.5	24%	24	D	Runway	AC	ACRMU
Miles City	T-1B	11			6			2.5		1	3		6	6	50%	12.5	E	Taxiway	AAC	ACRMU
Miles City	T-2A	11			6			2.5		1	3		6	6	50%	20	E	Taxiway	AAC	ACRMU
Miles City	T-3	11	f	11	4			3					15	3	17%	38	G	Taxiway	AC	ACRH
Miles City	T-3B	11	f		13			2.5					13	2.5	16%	38	G	Taxiway	AC	ACRH
Miles City	T-6	11	f		8			2.5					8	2.5	24%	24	D	Taxiway	AC	ACRMU
Miles City	T-7	11	f		8			2.5					8	2.5	24%	24	D	Taxiway	AC	ACRMU
Plains	A-1	4	f	8	3			3					11	3	21%	12.5	D	Apron	AC	ACAM
Plains	R-1	4	f	8	3			3					11	3	21%	12.5	D	Runway	AC	ACRML
Plains	T-1	4	f	8	3			3					11	3	21%	12.5	D	Taxiway	AC	ACRML
Plains	T-2	4	f	8	3			3					11	3	21%	12.5	D	Taxiway	AC	ACRML
Plentywood	A-11	11			8			3			3		8	6	43%	12.5	E	Apron	AAC	ACAM
Plentywood	R-11	11	f		9			4					9	4	31%	12.5	E	Runway	AC	ACRMU
Plentywood	T-11	11	f		9			4					9	4	31%	12.5	E	Taxiway	AC	ACRMU
Polson	A-11	10			12			3					12	3	20%	12.5	D	Apron	AC	ACAM
Polson	R-11	10	f		13			3					13	3	19%	12.5	D	Runway	AC	ACRMU
Polson	T-11	10	f		13			3					13	3	19%	12.5	D	Taxiway	AC	ACRMU
Polson	T-12	10	f		13			3					13	3	19%	12.5	D	Taxiway	AC	ACRMU
Polson	T-14	10	f		12			3					12	3	20%	12.5	D	Taxiway	AC	ACRMU

TABLE 2.4 - SECTION PROPERTIES & FAMILY ASSIGNMENTS

BRANCH NAME (Airport City)	Section	Approx. Annual Operations (1000)	Geo-Grid / Fabric (g / f)	Sub-base (Inches) (Agg)	Base Course (Inches) (Agg)	(AC)	Surface Course (Inches) (BST)	(AC)	(PCC)	Overlay (Inches) (BST)	(AC)	(PFC)	Gravel Depth	Asphalt Depth	% Asphalt Depth	Pvmnt Strngth (1,000 lbs.)	Section Cate-gory	Branch Use	Surface Type	FAMILY
Poplar	A-1	5			6		2				1		6	2	25%	4	A	Apron	AC	ACPL
Poplar	R-1	5			6		2				1		6	2	25%	4	A	Runway	AC	ACPL
Poplar	T-1	5			6		2				1		6	2	25%	4	A	Taxiway	AC	ACPL
Poplar	T-2	5			6		2				1		6	2	25%	4	A	Taxiway	AC	ACPL
Ronan	A-11	4	f	8.5	6			2.5					14.5	2.5	15%	20	D	Apron	AC	ACAM
Ronan	A-12	4	f	8.5	6			2.5					14.5	2.5	15%	20	D	Apron	AC	ACAM
Ronan	R-11	4	f	8.5	6			2.5					14.5	2.5	15%	20	D	Runway	AC	ACRML
Ronan	T-5	4	f		14.5			3					14.5	3	17%	13	D	Taxiway	AC	ACRML
Ronan	T-11	4	f	8.5	6			2.5					14.5	2.5	15%	20	D	Taxiway	AC	ACRML
Roundup	A-1	5			10		1				2		10	2.5	20%	14	D	Apron	AC	ACAM
Roundup	A-2	5			10			2			2		10	4	29%	22	D	Apron	AAC	ACAM
Roundup	R-1	5			10			2			2		10	4	29%	22	D	Runway	AAC	ACRML
Roundup	T-1	5			10		1				2		10	2.5	20%	14	D	Taxiway	AC	ACRML
Roundup	T-3	5			8			3					8	3	27%	12.5	D	Taxiway	AC	ACRML
Scobey	A-11	4		8	6			4					14	4	22%	12.5	D	Apron	AC	ACAM
Scobey	A-12	4	g	6	6			4					12	4	25%	12.5	D	Apron	AC	ACAM
Scobey	R-11	4		6	6			4					12	4	25%	12.5	D	Runway	AC	ACRML
Scobey	R-12	4			14			4					14	4	22%	12.5	D	Runway	AC	ACRML
Scobey	T-11	4		6	6			4					12	4	25%	12.5	D	Taxiway	AC	ACRML
Scobey	T-12	4			14			4					14	4	22%	12.5	D	Taxiway	AC	ACRML
Scobey	T-13	4			10			4					10	4	29%	12.5	D	Taxiway	AC	ACRML
Shelby	A-21	8		18	6			3					24	3	11%	12.5	D	Apron	AC	ACAM
Shelby	A-22	8	g, f	18	4				6				PCC	PCC	PCC	PCC	P	Apron	PCC	PCAA
Shelby	R-21	8		18	14			3					32	3	9%	12.5	D	Runway	AC	ACRMU
Shelby	R-22	8		18	14			3					32	3	9%	12.5	D	Runway	AC	ACRMU
Shelby	T-6	8		8	4			3					12	3	20%	12.5	D	Taxiway	AC	ACRMU
Shelby	T-21	8	f	18	6			3					24	3	11%	12.5	D	Taxiway	AC	ACRMU
Shelby	T-22	8	f	18	6			3					24	3	11%	12.5	D	Taxiway	AC	ACRMU
Sidney	A-3A	25	f		10			4					10	4	29%	25	D	Apron	AC	ACAM
Sidney	A-11	25	f		8				8				PCC	PCC	PCC	PCC	P	Apron	PCC	PCAA
Sidney	A-12	25	f		10			4					10	4	29%	40	G	Apron	AC	ACAH
Sidney	A-13	25	f		10			4					10	4	29%	40	G	Apron	AC	ACAH
Sidney	A-14	25	f		8				8				PCC	PCC	PCC	PCC	P	Apron	PCC	PCAA
Sidney	A-15	25	f		6				6				PCC	PCC	PCC	PCC	P	Apron	PCC	PCAA
Sidney	R-11	25		6	3		2	4			4.5		9	9.5	51%	40	H	Runway	AAC	ACRH
Sidney	R-12	25		6	6		2	4			4.5		12	9.5	44%	40	H	Runway	AAC	ACRH
Sidney	T-2	25			6			4			4.5		6	8.5	59%	40	H	Taxiway	AAC	ACRH
Sidney	T-3	25		12			1	5					12	5.5	31%	12.5	E	Taxiway	AC	ACRMU
Sidney	T-4	25		16	6			4					22	4	15%	40	G	Taxiway	AC	ACRH

TABLE 2.4 - SECTION PROPERTIES & FAMILY ASSIGNMENTS

BRANCH NAME (Airport City)	Section	Approx. Annual Operations	Geo-Grid / Fabric	Sub-base (Inches)	Base Course (Inches)		Surface Course (Inches)			Overlay (Inches)			Gravel Depth	Asphalt Depth	% Asphalt Depth	Pvmnt Strngth (1,000	Section Cate-gory	Branch Use	Surface Type	FAMILY
		(1000)	(g / f)	(Agg)	(Agg)	(AC)	(BST)	(AC)	(PCC)	(BST)	(AC)	(PFC)				lbs.)				
Stanford	A-2	4			8			3					8	3	27%	12.5	D	Apron	AC	ACAM
Stanford	R-2	4			12		1				3		12	3.5	23%	12.5	D	Runway	AC	ACRML
Stanford	R-3	4			8			3					8	3	27%	12.5	D	Runway	AC	ACRML
Stanford	T-2	4			8			3					8	3	27%	12.5	D	Taxiway	AC	ACRML
Stevensville	A-1	13			5.5		1.8					1	5.5	1.4	20%	12.5	D	Apron	ST	STPA
Stevensville	A-2	13			6			2					6	2	25%	12.5	D	Apron	AC	ACAM
Stevensville	R-1	13			5.5		1.8					1	5.5	1.4	20%	12.5	D	Runway	ST	STPA
Stevensville	T-1	13			5.5		1.8					1	5.5	1.4	20%	12.5	D	Taxiway	ST	STPA
Stevensville	T-3	13			6			2					6	2	25%	12.5	D	Taxiway	AC	ACRMU
Stevensville	T-4	13		12	4			3					16	3	16%	12.5	D	Taxiway	AC	ACRMU
Superior	A-11	4		9	6			3					15	3	17%	30	D	Apron	AC	ACAM
Superior	R-11	4		9	6			3					15	3	17%	30	D	Runway	AC	ACRML
Superior	T-11	4		9	6			3					15	3	17%	30	D	Taxiway	AC	ACRML
Terry	A-11	1			11.5			2.5					11.5	2.5	18%	12.5	D	Apron	AC	ACAM
Terry	R-11	1			11.5			2.5					11.5	2.5	18%	12.5	D	Runway	AC	ACRML
Terry	T-11	1			11.5			2.5					11.5	2.5	18%	12.5	D	Taxiway	AC	ACRML
Thompson Falls	A-1	7			6		1.5				2		6	2.75	31%	12.5	E	Apron	AC	ACAM
Thompson Falls	A-2	7			4			2.5					4	2.5	38%	12.5	E	Apron	AC	ACAM
Thompson Falls	R-1	7			6		1.5				2		6	2.75	31%	12.5	E	Runway	AC	ACRMU
Thompson Falls	R-2	7			4		2.5				2		4	3.25	45%	12.5	E	Runway	AC	ACRMU
Thompson Falls	T-4	7			4			2.5					4	2.5	38%	12.5	E	Taxiway	AC	ACRMU
Thompson Falls	T-5	7			4			2.5					4	2.5	38%	12.5	E	Taxiway	AC	ACRMU
Thompson Falls	T-6	7			4			2.5					4	2.5	38%	12.5	E	Taxiway	AC	ACRMU
Three Forks	A-1	12			4			2.5			2		4	4.5	53%	12.5	E	Apron	AAC	ACAM
Three Forks	A-2	12							6				PCC	PCC	PCC	PCC	P	Apron	PCC	PCAA
Three Forks	R-1	12			4			2.5			2		4	4.5	53%	12.5	E	Runway	AAC	ACRMU
Three Forks	R-2	12			4			2.5			2		4	4.5	53%	12.5	E	Runway	AAC	ACRMU
Three Forks	T-1	12			4			2.5			2		4	4.5	53%	12.5	E	Taxiway	AAC	ACRMU
Three Forks	T-2	12			4			2.5			2		4	4.5	53%	12.5	E	Taxiway	AAC	ACRMU
Three Forks	T-3	12			4			2.5			2		4	4.5	53%	12.5	E	Taxiway	AAC	ACRMU
Three Forks	T-4	12			4			2.5					4	2.5	38%	12.5	E	Taxiway	AC	ACRMU
Townsend	A-1	5			4			3			2		4	5	56%	12.5	E	Apron	AAC	ACAM
Townsend	R-1	5			4			3			2		4	5	56%	12.5	E	Runway	AAC	ACRML
Townsend	T-1	5			4			3			2		4	5	56%	12.5	E	Taxiway	AAC	ACRML
Townsend	T-2	5			12			4					12	4	25%	12.5	D	Taxiway	AC	ACRML
Turner	A-1	4	f	22	6			3					28	3	10%	12.5	D	Apron	AC	ACAM
Turner	R-1	4	f	22	6			3					28	3	10%	12.5	D	Runway	AC	ACRML
Turner	T-2	4		22	6			3					28	3	10%	12.5	D	Taxiway	AC	ACRML
Turner	T-3	4	f	22	6			3					28	3	10%	12.5	D	Taxiway	AC	ACRML
Twin Bridges	A-1	3			11		1				1.8		11	2.3	17%	12.5	D	Apron	AC	ACAM
Twin Bridges	R-1	3			11		1				1.8		11	2.3	17%	12.5	D	Runway	AC	ACRML
Twin Bridges	T-1	3			11		1				1.8		11	2.3	17%	12.5	D	Taxiway	AC	ACRML

TABLE 2.4 - SECTION PROPERTIES & FAMILY ASSIGNMENTS

BRANCH NAME (Airport City)	Section	Approx. Annual Operations (1000)	Geo-Grid / Fabric (g / f)	Sub-base (Inches) (Agg)	Base Course (Inches) (Agg)	(AC)	Surface Course (Inches) (BST)	(AC)	(PCC)	Overlay (Inches) (BST)	(AC)	(PFC)	Gravel Depth	Asphalt Depth	% Asphalt Depth	Pvmnt Strngth (1,000 lbs.)	Section Cate-gory	Branch Use	Surface Type	FAMILY
West Yellowstone	A-1	7				8		3					0	11	100%	90	I	Apron	AC	ACAH
West Yellowstone	A-2	7						1.5					0	1.5	100%	30	F	Apron	AC	ACAM
West Yellowstone	A-3	7				7		4					0	11	100%	90	I	Apron	AC	ACAH
West Yellowstone	A-4	7			6		1					2	6	1.5	20%	30	D	Apron	AC	ACAM
West Yellowstone	A-5	7		32					16				PCC	PCC	PCC	PCC	P	Apron	PCC	PCAA
West Yellowstone	R-1	7				7		2.5			3		0	12.5	100%	105	I	Runway	AAC	ACRH
West Yellowstone	R-2	7				8		3			3		0	14	100%	90	I	Runway	AAC	ACRH
West Yellowstone	T-1	7				8		3					0	11	100%	90	I	Taxiway	AC	ACRH
West Yellowstone	T-2	7			4			3					4	3	43%	12.5	E	Taxiway	AC	ACRMU
White Sulphur Sprin	*A-1*	*6*			*4*		*3*					*1*	*4*	*2*	*33%*	*12.5*	*E*	*Apron*	*ST*	*STPA*
White Sulphur Sprin	*A-2*	*6*			*4*			*3*				*1*	*4*	*3.5*	*47%*	*12.5*	*E*	*Apron*	*AC*	*ACAM*
White Sulphur Sprin	*R-1*	*6*			*8*		*1*					*1*	*8*	*1*	*11%*	*12.5*	*D*	*Runway*	*ST*	*STPA*
White Sulphur Sprin	*R-2*	*6*			*4*			*3*				*1*	*4*	*3.5*	*47%*	*12.5*	*E*	*Runway*	*AC*	*ACRMU*
White Sulphur Sprin	*T-1*	*6*			*8*		*1*					*1*	*8*	*1*	*11%*	*12.5*	*D*	*Taxiway*	*ST*	*STPA*
White Sulphur Sprin	*T-2*	*6*			*4*			*3*				*1*	*4*	*3.5*	*47%*	*12.5*	*E*	*Taxiway*	*AC*	*ACRMU*
Wolf Point	*A-5*	*5*			*15*			*3*					*15*	*3*	*17%*	*18*	*D*	*Apron*	*AC*	*ACAM*
Wolf Point	*R-1*	*5*			*10*			*2*		*1.5*	*3*	*1*	*10*	*6.25*	*38%*	*47*	*H*	*Runway*	*AAC*	*ACRH*
Wolf Point	*R-2*	*5*			*12.5*			*2*		*1.5*	*4*	*1*	*12.5*	*7.25*	*37%*	*42*	*H*	*Runway*	*AAC*	*ACRH*
Wolf Point	*R-3*	*5*			*12.5*			*2*		*1.3*	*4.5*	*1*	*12.5*	*7.625*	*38%*	*57*	*H*	*Runway*	*AAC*	*ACRH*
Wolf Point	*R-4*	*5*			*12.5*			*2*		*1.5*	*4*	*1*	*12.5*	*7.25*	*37%*	*42*	*H*	*Runway*	*AAC*	*ACRH*
Wolf Point	*R-5*	*5*		*7*		*4*		*2*		*2.5*	*3*	*1*	*7*	*10.75*	*61%*	*43*	*H*	*Runway*	*AAC*	*ACRH*
Wolf Point	*R-6*	*5*		*9*		*4.5*		*2*		*2.8*	*3*	*1*	*9*	*11.38*	*56%*	*38*	*H*	*Runway*	*AAC*	*ACRH*
Wolf Point	*T-1*	*5*			*12.5*					*1.5*	*4*		*12.5*	*4.75*	*28%*	*38*	*G*	*Taxiway*	*AC*	*ACRH*
Wolf Point	*T-2*	*5*			*5*			*6*		*0.3*	*3*		*5*	*9.125*	*65%*	*12.5*	*E*	*Taxiway*	*AAC*	*ACRML*
Wolf Point	*T-3*	*5*		*8*	*2*			*2.5*					*10*	*2.5*	*20%*	*12.5*	*D*	*Taxiway*	*AC*	*ACRML*
Wolf Point	*T-4*	*5*			*15*			*3*					*15*	*3*	*17%*	*18*	*D*	*Taxiway*	*AC*	*ACRML*

NOTES:

Italic font indicates the airport was neither inspected nor mapped for this report, as such the included information is suspect. If construction has taken place it will not be reflected in this repor
Section properties & families are assumed from the most current pre-2006 pavements.

(Agg)=AGGREGATE (AC) = ASPHALT CEMENT CONCRETE (BST) = BITUMINOUS SURFACE TREATMENT (PCC) = PORTLAND CEMENT CONCRETE (PFC) = POROUS FRICTION COURSE

MicroPAVER gives the user great flexibility in defining families. The user is also free to redefine families at any time, since family definition plays a very important part in PCI predictions. As the pavement management system continues to develop, better family definitions may become apparent, and they should be revised accordingly.

After families have been defined and each pavement section is assigned to the appropriate family, MicroPAVER generates "Family Analysis Curves." These are PCI verses Age curves derived from a least-squares adjustment of all known observations within the family. Graphically speaking, each time a PCI evaluation of a section is completed, that section's PCI is plotted against its Age, forming a single data point (or observation) on that section's family analysis curve. The model is further constrained by insisting that a pavement cannot improve its condition over time (without outside intervention), so a family curve can never rise in PCI with age. The least squares adjustment then yields a single curve that is most representative of the data. In lieu of better information, the life cycle curve for pavement ages greater than any sampled in the family group is assumed to continue at the same rate of decay as at the last data point. In other words, the PCI predictions follow the straight-line tangent to the curve at the oldest pavement life.

Figures 2.3 through 2.10 illustrate the family analysis curves for the eight families defined in this project. These curves are based on actual data from pavement condition surveys spanning 1988-2009. In some cases, pavements were filtered out of the curve analyses when they fit poorly with the other data within the family, when there was a known atypical repair to specific pavements, or simply using good engineering judgement about the possible quality versus pavement age. Table 2.5 shows the assumed acceptable extreme PCI's used as boundary filters for most family data.

TABLE 2.5
PCI vs. AGE - ALLOWABLE EXTREMES/BOUNDARIES

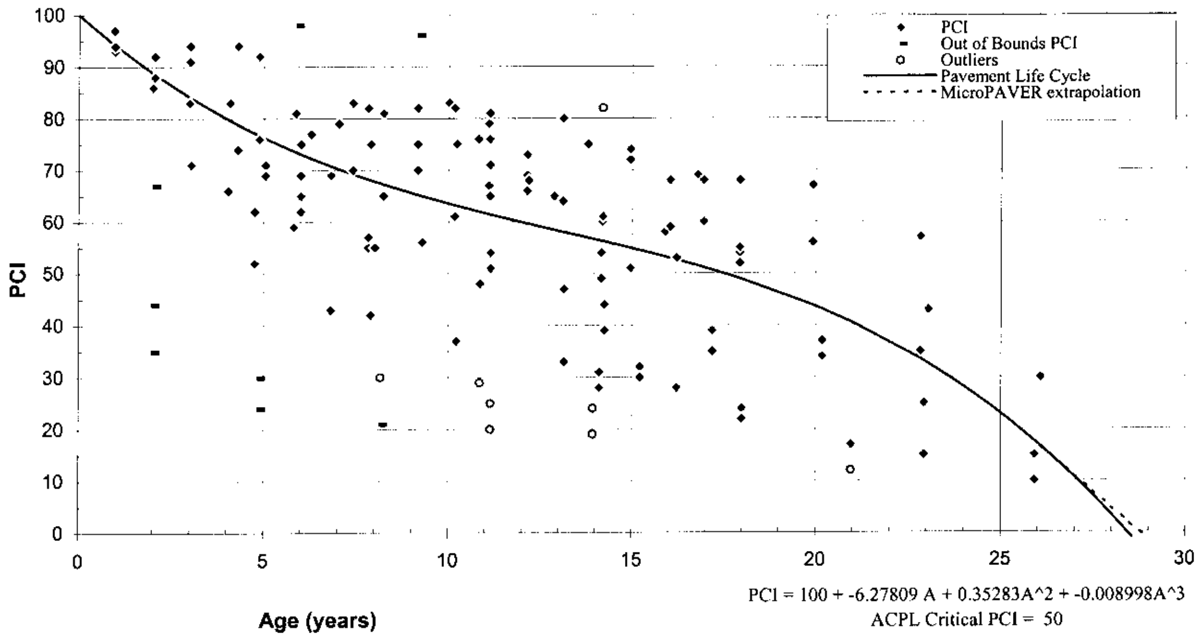
Age	Minimum PCI	Maximum PCI
0	90	100
3	58	100
5	36	95
15	0	90
20	0	86
25	0	70
30	0	54
40	0	20

Figures 2.3 through 2.10 show life cycle curves for each family as well as "valid" data points used to construct the curve, "out of bounds" data points, and "outliers" not used in the curve fit. Note that MicroPAVER uses the dashed linear projection rather than the curve for ages greater than sampled ages in the family. The lower right corner of each graph contains the family curve equation, as well as the "critical PCI" where the rate of deterioration increases markedly.

FAMILY LIFE CYCLE CURVES

FIGURE 2.3

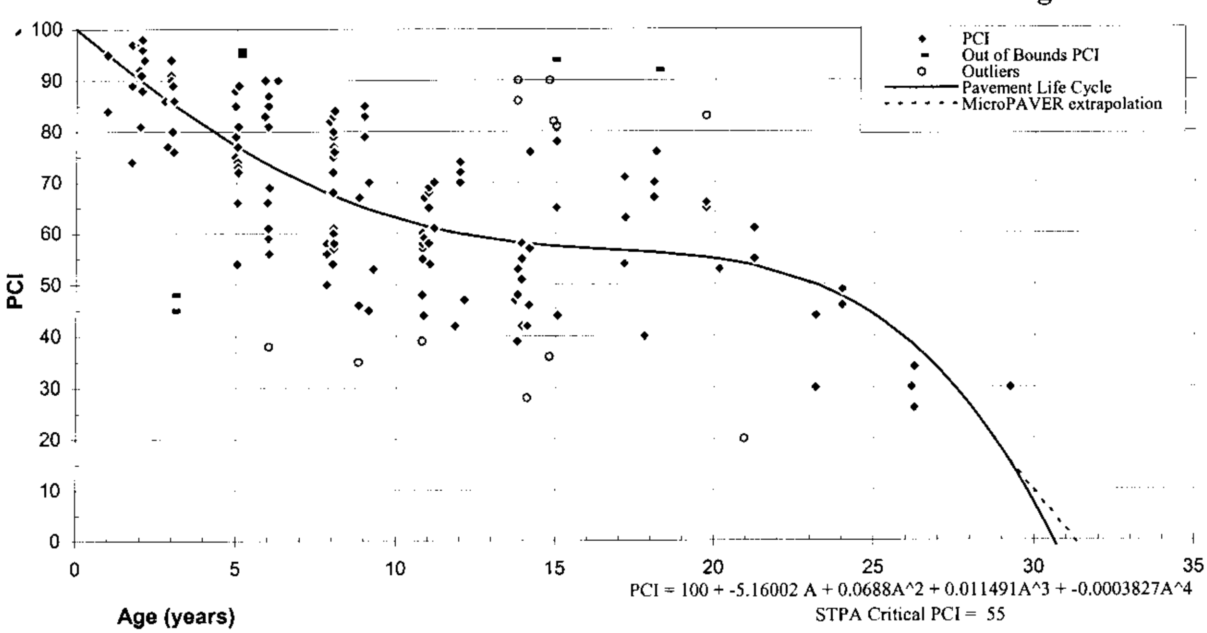
ACPL - Asphalt Pavements with less than 12,500 lb. Load Rating



PCI = 100 + -6.27809 A + 0.35283A^2 + -0.008998A^3
ACPL Critical PCI = 50

FIGURE 2.4

STPA - Bituminous Surface Treated Pavements of All Load Ratings



PCI = 100 + -5.16002 A + 0.0688A^2 + 0.011491A^3 + -0.0003827A^4
STPA Critical PCI = 55

FIGURE 2.5
ACAH - Asphalt Aprons With Higher Than 30,000 lb. Load Rating

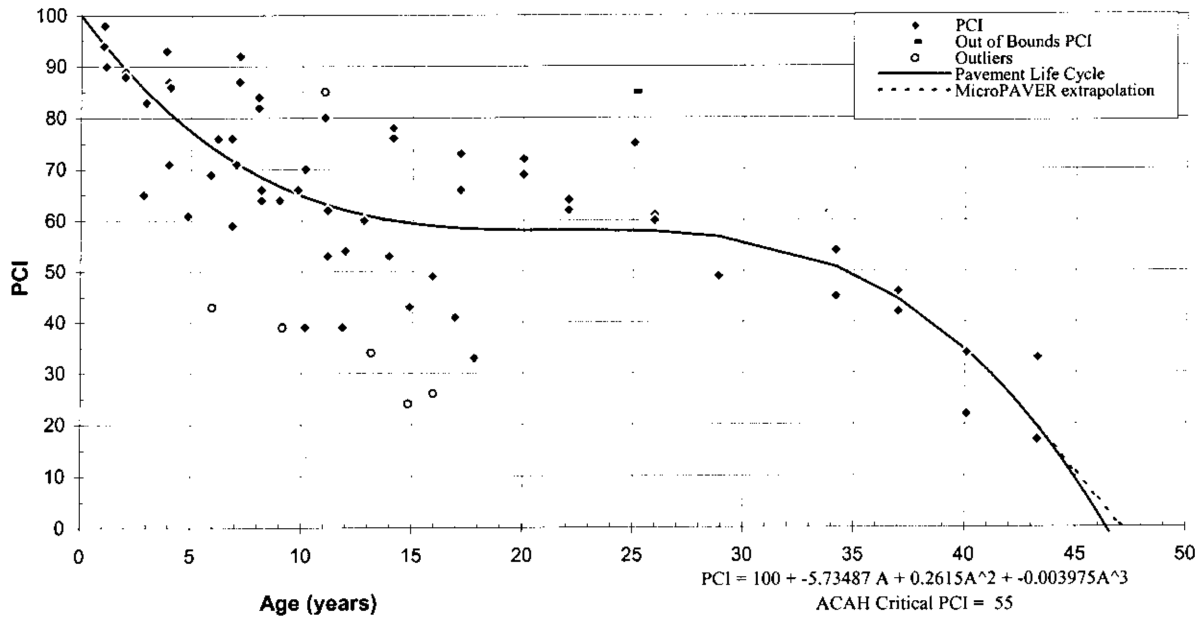


FIGURE 2.6
ACRH - Asphalt Runways And Taxiways With Higher Than 30,000 lb. Load Rating

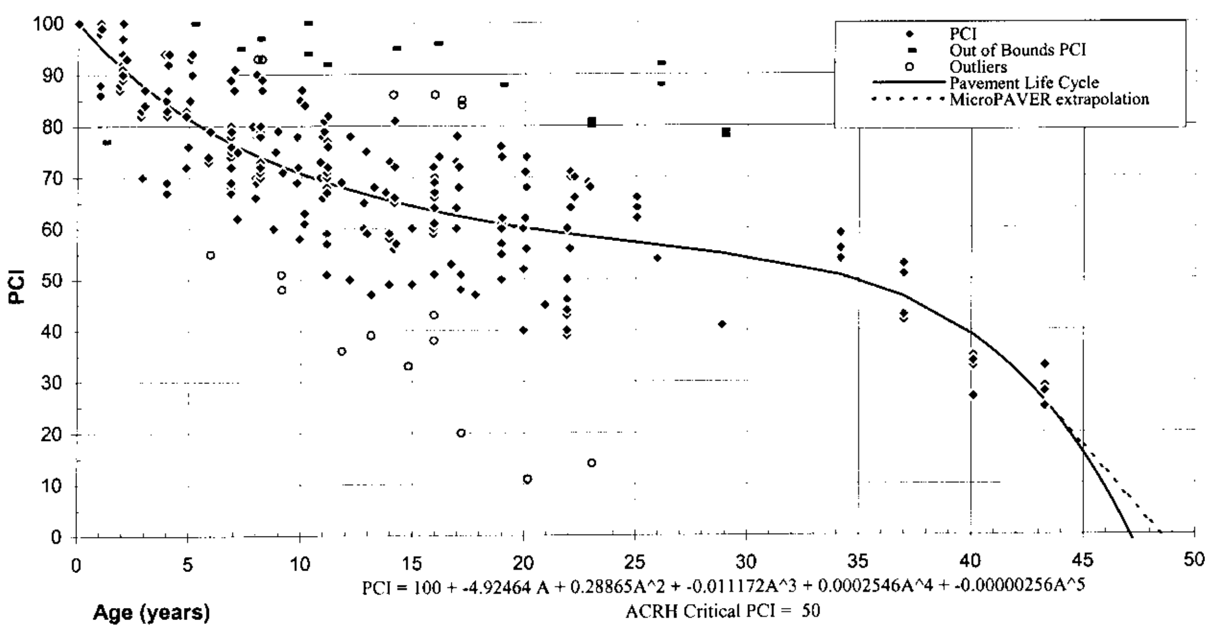


FIGURE 2.7
ACRML - Asphalt RWs And TWs, Load Rating 12,500 To 30,000 lb, 5000 or Fewer Ops.

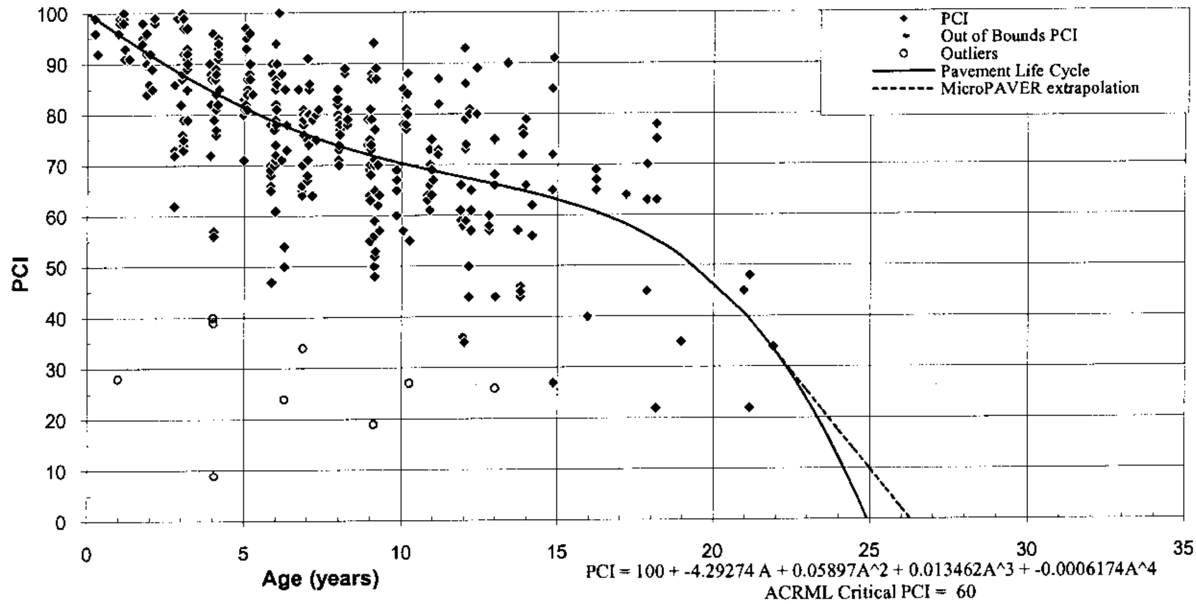


FIGURE 2.8
ACRMU -Asphalt RWs And TWs, Load Rating 12,500 To 30,000 lb, Over 5000 Ops.

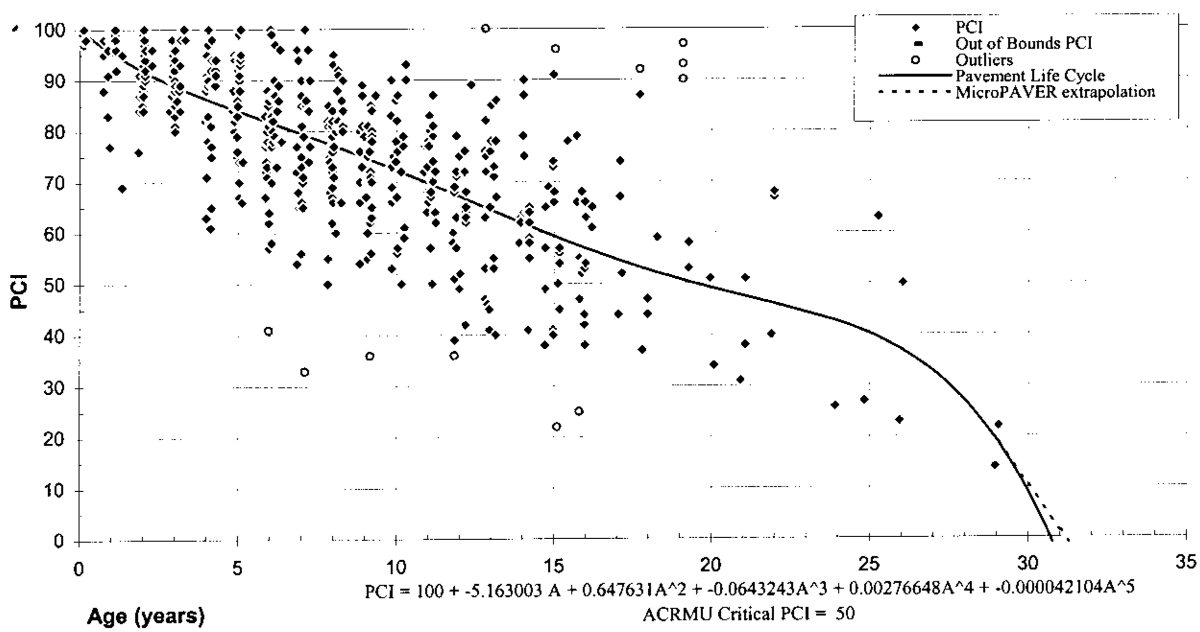


FIGURE 2.9
ACAM - Asphalt Aprons With Load Rating From 12,500 To 30,000 lb.

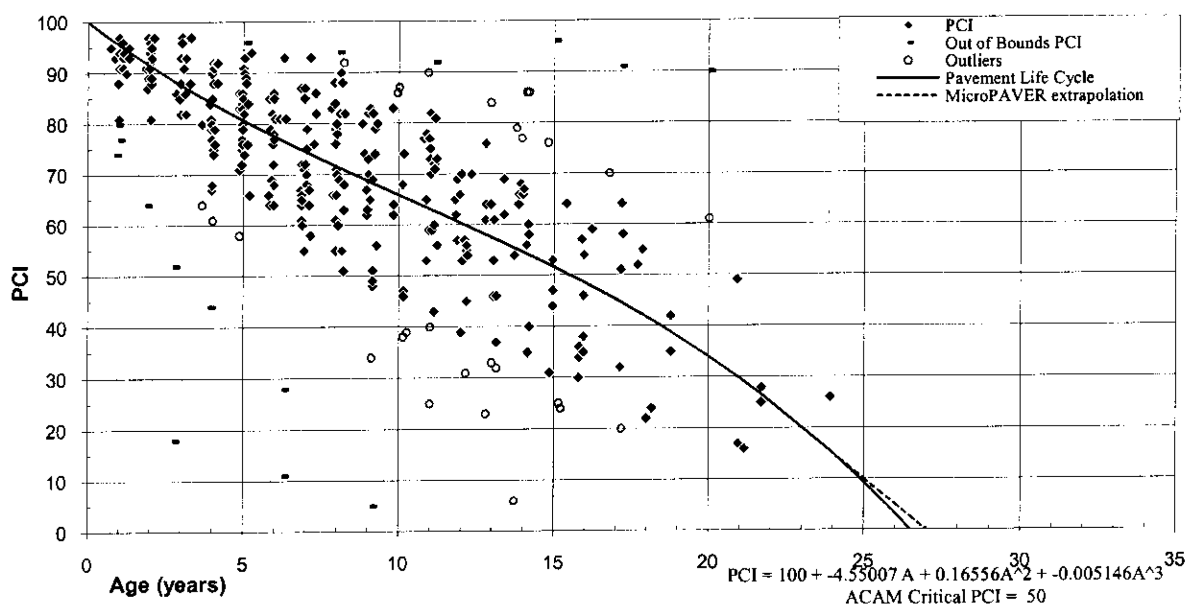


FIGURE 2.10
PCAA - Portland Concrete Cement - All Sections

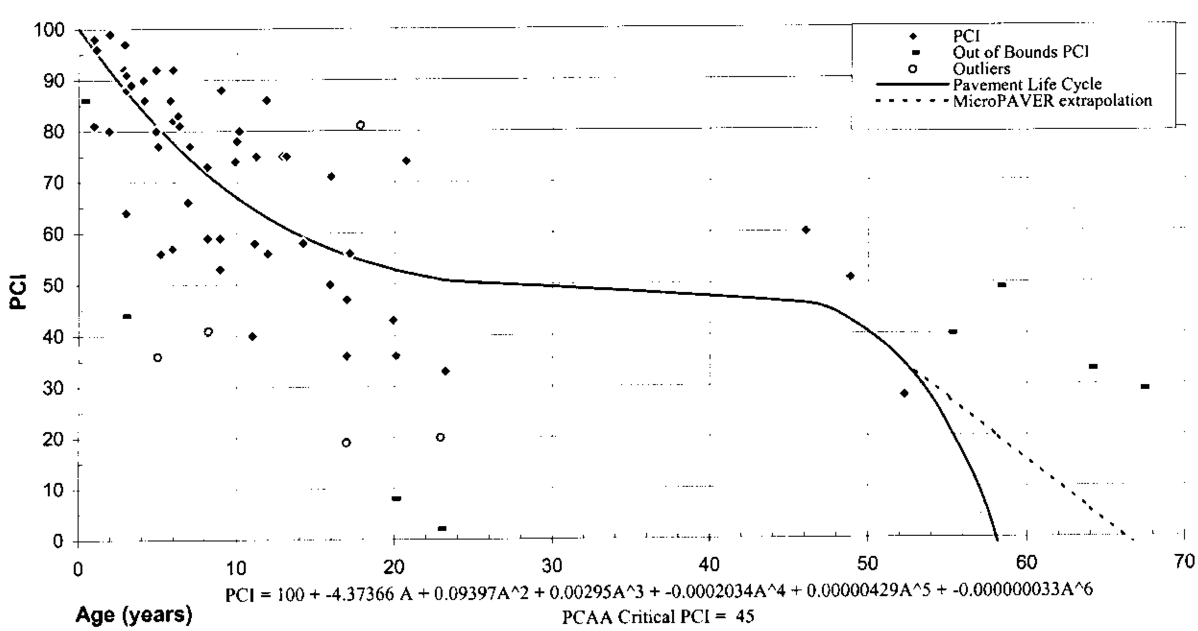
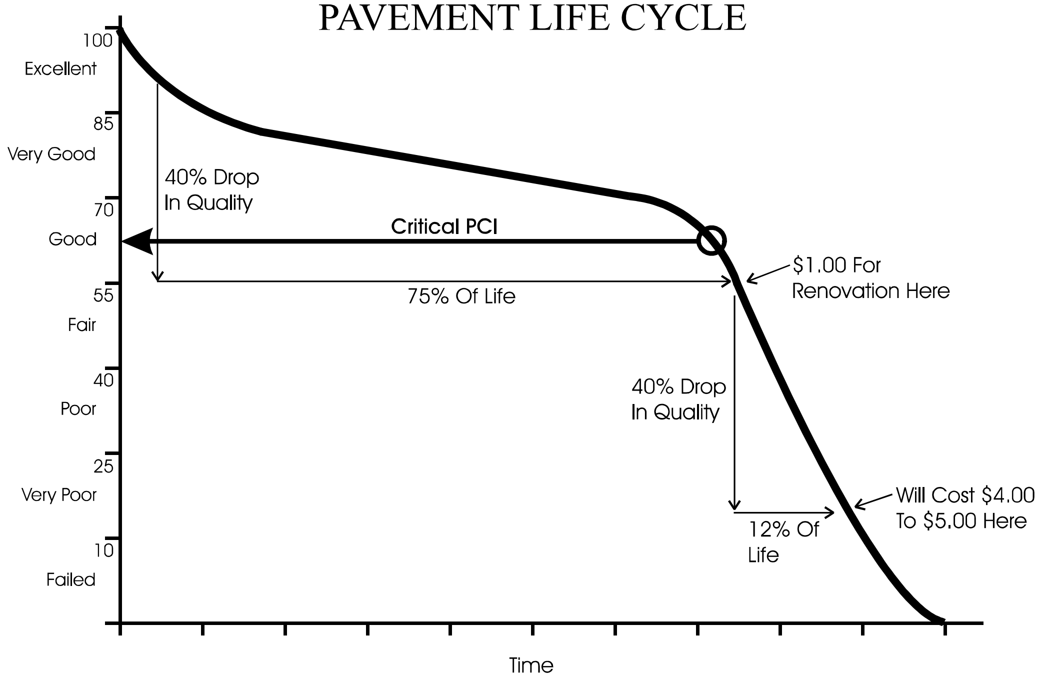


Figure 2.11 illustrates a theoretical pavement life cycle, and some very general observations about renovation costs throughout the pavement's life. The critical PCI is at the crest of the curve where continued maintenance begins to be less economical than reconstruction.

FIGURE 2.11

PAVEMENT LIFE CYCLE



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CHAPTER 3
RESULTS AND RECOMMENDATIONS

CHAPTER 3 RESULTS AND RECOMMENDATIONS

3.1 FAMILY ANALYSIS CURVES

Pavement families for this analysis are slowly evolving from the consistent 1988-1997 family groups. The families are designed to group similar pavements based on material type, primary use, design strength, and annual operations within the context of the current pavement design and maintenance norms. The core of the original family groupings have been retained since they are providing increasingly stable and accurate predictors of Montana airport pavement behavior. With pavement maintenance norms changing the database's oldest pavement's behavior is no longer an accurate predictor of future condition. So, inspection data from abandoned, demolished, and non-maintained sections are no longer included in the family curve determinations. These dropped inspections are no longer representative "typical" sections and there are sufficient inspections to provide statistical validity without these data points. The two original surface treatment families were combined into a single family in 2006, and remain so this year, since very few of these pavements remain. Likewise, pavements with design loads under 12,500 pounds are now rarely constructed, so the dwindling remnants of these "light" pavements have been grouped into a single family, regardless of their use. Comparison of the family curves from 1991 to the present provides some insight into the appropriateness of the family definition criteria, and the likely long-term usefulness of the curves. (See Figure A.1of the Appendix)

2009 family ACPL (Asphalt Concrete, All Pavements, Low Strength) combined former families ACAL and ACRL, light duty asphalt aprons and runway/taxiways, respectively. FAA policies no longer encourage constructing asphalt pavements with design loads less than 12,500 pounds, so the remaining members of this shrinking family are upgraded to medium strength whenever reconstruction or maintenance is required. The family exhibits about 7 years of rapid aging followed by 10 years of slower decline. After approximately 17 years of acceptable performance, the family curve passes through a critical PCI of 50 and begins a rapidly accelerating decline in pavement quality. A good deal of scatter in ACPL data indicate variations in construction quality, maintenance, use, and climate. Improving maintenance practices are documented by a raised graph in the 5-10 year range. Additional inspections of older pavements show slightly better performance than predicted in 2006.

2009 family STPA (Surface Treatment, All Pavements, All Strengths) has the same basic shape as the 2006 curve, but returns to the "55" critical PCI of 2003 and marginally extends the decaying performance. The bulk of the data for this family comes from pavements 15-years old or less, with only two airports continuing to contribute data for pavement over 20-years of age. These relatively low-strength pavements exhibit a fairly uniform rate of deterioration through their first 13 years, followed by an 8-year plateau, giving just over 20-years of usable life before rapidly declining to an unserviceable condition. Double- and triple-shot surfaces continue to be replaced by dense-grade mixes, decreasing the pool of family members.

2009 family ACAH (Asphalt Concrete, Aprons, High Strength) is a statistically small, scattered data set with most of its data in the first 15 years. High strength aprons exhibit the same rapid aging over the initial 12-years as other aprons, but are projected to have nearly 20 years of good quality performance, rather than the 5 to 10 years predicted for lower design strength pavements. Family ACAH predicts 30 years of good, usable pavement life before the accelerated aging after critical PCI of 55. However, all data for pavements in this family older than 20-years are from Benchmark and Yellowstone Airports, both of which are protected from much of our winter freeze-thaw cycling by a blanket of snow and sustained cold temperatures. The end-of-life behavior promised by this family curve will be representative of these "special case" airports, but is likely 5 to 10 years overly optimistic for the remaining family members.

2009 family ACRH (Asphalt Concrete, Runways/Taxiways, High Strength) shows very consistent curves from 2000 through 2009. A large number of sections (43) helps to stabilize this family curve for the first 20 years. All ACRH data beyond 26 years is from Benchmark Airport, where the transition past critical PCI into rapid deterioration has occured. The long usable life demonstrated at Benchmark is probably not realistic for the other airports of this family that are exposed to consistently greater use and are not generally protected by a wintertime blanket of snow. Rather than the approximate 30- to 35-years of usable life predicted by ACRH, most pavements in this family will probably expect about 25 years above their critical PCI of 50.

2009 family ACRML (Asphalt Concrete, Runways/Taxiways, Medium Strength, Light Use) show better than average performance over the first 10 years of life, the results of preventative maintenance programs in common application across the State. Most of the pavements in this family have been crack sealed and fog sealed, or overlaid since the previous inspection. This is one of the largest sets in the database, and the pavement behavior is quite uniform -- boundary limits are not used when establishing this family, and only 1% of the data is removed as “outliers.” ACRML has a very slow initial aging rate, plus more than typical time in the over-70 PCI range. These pavements can expect about 17-years of useable life above their critical PCI of 60.

2009 family ACRMU (Asphalt Concrete, Runways/Taxiways, Medium Strength, Busy Use) shows a pronounced preventative maintenance “bump” in the 5- to 10-year range of the life cycle curve. All boundary filters and most of the statistical filtering were removed from this data-rich family since the few irregularities have virtually no statistical significance. ACRMU pavements, as a group, are the busiest and best maintained pavements in the GA airport system. Changes in maintenance strategies and funding resulted in nearly every ACRMU pavement that was inspected showing signs of recent preventative maintenance. This maintenance appears to be producing a consistently better quality pavement, in addition to significantly extending the pavements’ usable life. This family projects over 20 years of good service before passing the critical PCI of 50 and beginning rapid aging.

2009 family ACAM (Asphalt Concrete, Aprons, Medium Strength) has good high-density data for 20-years of pavement behavior. This data has consistently shown a near-linear decline in quality with age, rather than the typical asphalt “plateau” separating two rapid drops. The pattern is clear, even though the graph is not what is usually expected. This family has a couple airports with PCIs rated below 30 at less than 10 years of age, and a couple pavements that were recently sealed resulting in temporarily elevated PCI’s that were filtered out of the data set. A wide dispersion of data points suggests that pavements within these families are following different aging patterns, possibly because of differences in construction quality, maintenance practices between airports, varied wear and traffic loads, or because of other design, or environmental conditions. A linear decline in quality typically indicated heavy wear and hard use.

2009 family PCAA (Portland Cement, Aprons, All Strengths) displays a 22-year decline to PCI 50 based on many concrete aprons across the State. Cut Bank Airport’s ramp provided expected PCI’s for 43- to 51-years, before they started replacing slabs and no longer represented “typical” aging. Further, the heavy design strength and relatively light usage of Cut Bank Airport’s main apron may not give an accurate projection for less “over-designed” slabs. Engineering judgement would indicate a PCAA life span for concrete regularly exposed to it’s design loads to be about 35 years.

3.2 PCI PREDICTIONS

Pavement Condition Index values were predicted for one, five, and ten years into the future for all pavements in the database, using the previously discussed pavement families: ACPL, ACAM, ACRML, ACRMU, ACAH, ACRH, STPA, and PCAA. The MicroPAVER software predicts PCI's by taking the last inspected PCI value, finding the corresponding PCI value on the family curve for that pavement, and assuming the particular pavement ages in the same way the family curve declines. Graphically, the family curve is moved *horizontally* until it lies on top of the last inspected PCI-verses-age point, then the family curve is followed forward.

FIGURE 3.1
MICROPAVER PCI PREDICTION PROCESS

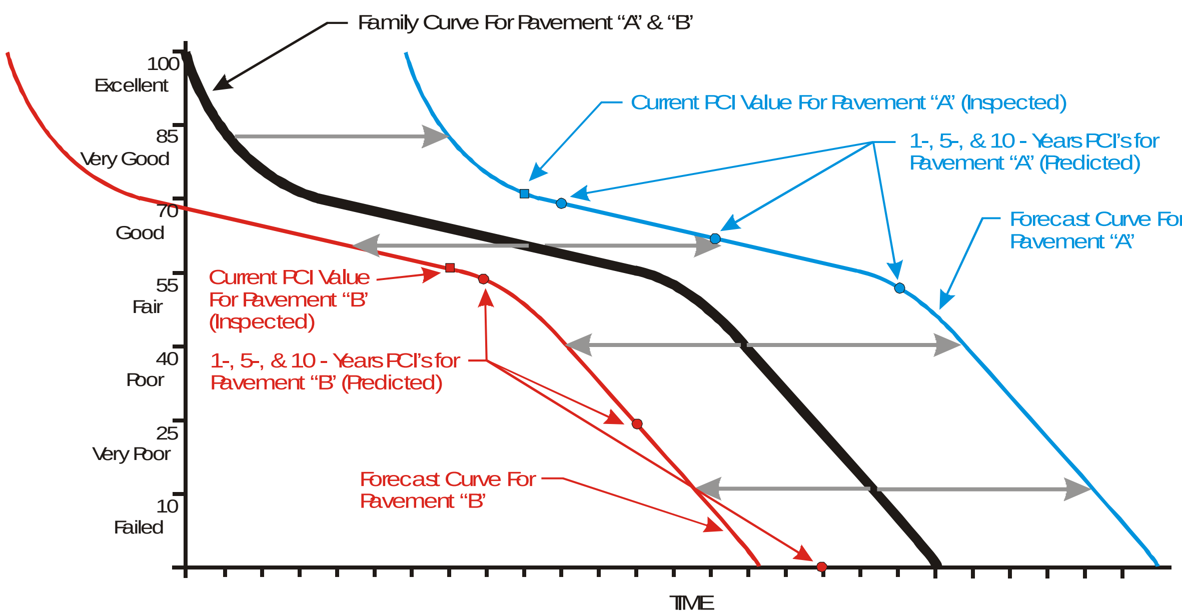

Table 3.1 shows inspected PCI values for all pavement sections included in the Montana airport pavement database. It also includes predicted PCI values for the years 2010, 2014, and 2019, based on the last inspected PCI-verses-age for each airport and the 2009 family curves. PCI's calculated from inspections are separated from projected estimates by a "critical PCI" unique to the pavement family. Pavements above their critical PCI can be economically maintained, while those "below critical" have begun rapid decay and are typically reconstructed. The "critical PCI" is the pavement condition rating (PCI value) shortly before the family curve predicts a dramatic decrease in pavement quality.

Older PCI values for a pavement section are replaced with "XX" whenever the pavement is demolished and reconstructed. 2009 PCI inspections were not conducted on a number of airports that were reconstructed or rehabilitated since the 2006 survey, nor were inspections completed on a few airports with an extended period of maintenance inactivity. Airports not inspected in 2009 are shown in italics - please realize that predictions for these airports may not reflect their current conditions.

TABLE 3.1 - SUMMARY OF PCI RATINGS

Airport City (Branch Name)	Section	Section Area (sq. feet)	Constr. Year	Family Group	Surveyed PCIs 1994	1997	2000	2003	2006	2009	Critical PCI	Predicted PCIs 2010	2014	2019
Anaconda	A-1	49,140	1992	ACAM	96	84		81	77	58	**50**	57	45	25
Anaconda	A-2	84,000	1993	ACAM	94	92		74	64	61	**50**	60	49	30
Anaconda	R-1	450,000	2009	ACRML	97	88		82	66	99	**60**	98	83	71
Anaconda	R-2	271,200	1993	ACRML	99	95		80	75	69	**60**	69	63	46
Anaconda	T-1	108,800	2009	ACRML	XX	XX		XX	XX	96	**60**	95	81	70
Anaconda	T-1A	15,450	1992	ACRML	99	96		87	79	77	**60**	77	69	62
Anaconda	T-2	21,000	1993	ACRML	100	92		84	66	65	**60**	65	56	27
Anaconda	T-4	8,925	1985	ACRML	71	50		63	45	44	**60**	43	17	0
Anaconda	T-5	12,075	1993	ACRML	97	94		88	68	67	**60**	67	60	37
Baker	A-2A	120,000	1992	ACAM	XX	93	83	77	79	70	**50**	69	58	42
Baker	A-3A	14,700	1992	ACPL		100	82	76	75	69	**50**	68	60	51
Baker	A-5	40,000	1997	ACAM		100	88	86	62	66	**50**	65	53	36
Baker	A-6	14,994	1997	PCAA		100	88	81	59	56	**45**	55	52	49
Baker	A-7	12,885	2001	ACAM				90	80	79	**50**	78	66	52
Baker	R-1	367,500	2001	ACRMU	96	70	50	85	79	67	**50**	66	56	47
Baker	T-1	33,750	2001	ACRMU	98	66	69	88	74	69	**50**	68	58	48
Baker	T-2	137,200	2001	ACRMU	97	74	55	85	75	73	**50**	72	61	50
Baker	T-3	53,620	2001	ACRMU	94	66	50	94	76	79	**50**	78	68	55
Baker	T-4	45,415	1997	ACRMU		100	88	87	79	75	**50**	74	63	52
Benchmark	A-1A	22,500	1966	ACAH			54	46	34	33	**55**	32	13	0
Benchmark	A-1B	45,000	1966	ACAH			45	42	22	17	**55**	16	0	0
Benchmark	R-1	465,000	1966	ACRH			59	51	35	29	**50**	28	11	0
Benchmark	R-2A	75,000	1966	ACRH			56	53	33	28	**50**	27	11	0
Benchmark	R-2B	60,000	1966	ACRH			54	42	27	25	**50**	24	8	0
Benchmark	T-1	13,500	1966	ACRH			56	42	34	33	**50**	32	15	0
Big Sandy	A-1	5,760	1986	PCAA			64	36	8	2	**45**	1	0	0
Big Sandy	R-1	192,000	1986	ACPL		67	60	60	67	35	**50**	33	12	0
Big Sandy	R-2	36,000	1993	ACPL	100	94	83	82	80	68	**50**	67	59	50
Big Sandy	T-1	26,720	1986	ACPL		79	82	68	56	57	**50**	56	48	31
Big Sandy	T-2	14,400	1993	ACPL	100	72	69	61	64	59	**50**	58	51	36
Big Timber	A-1	40,000	1996	ACAM	XX		90	87	86	61	**50**	60	48	29
Big Timber	A-2	23,750	1996	ACAM			90	85	86	61	**50**	60	48	29
Big Timber	R-1	348,750	1996	ACRMU	XX		91	87	78	67	**50**	66	56	47
Big Timber	R-2	47,625	1996	ACRMU			95	90	86	71	**50**	70	60	49
Big Timber	T-1	4,650	1996	ACRMU	XX		89	75	74	53	**50**	52	46	32
Big Timber	T-2	39,600	1996	ACRMU	XX		83	73	67	55	**50**	54	47	36
Big Timber	T-3	13,750	1996	ACRMU			90	85	78	73	**50**	72	62	51
Big Timber	T-4	85,365	2003	ACRMU					93	83	**50**	82	73	60
Big Timber	T-5	35,020	2003	ACRMU					89	76	**50**	75	65	53
Broadus	A-1	99,855	2005	ACAM						86	**50**	84	72	58
Broadus	R-1	330,000	2005	ACRML						85	**60**	83	73	66
Broadus	T-1	45,500	2005	ACRML						89	**60**	87	76	67
Chester	A-5	96,824	1997	ACAM			82	76	74	54	**50**	54	40	18
Chester	R-3	345,000	1997	ACRML			91	81	79	65	**60**	65	56	27
Chester	T-2	10,850	1997	ACRML			89	77	74	57	**60**	57	35	4
Chester	T-3	16,825	1997	ACRML			85	79	79	61	**60**	61	46	13
Chinook	A-1A	92,627	1991	ACAM		64	65	62		52	**50**	50	36	13
Chinook	A-1B	39,000	2006	ACAM						82	**50**	80	68	54
Chinook	R-1	300,000	2006	ACRMU		57	60	51		87	**50**	86	77	64
Chinook	T-1	103,075	2006	ACRMU		39	55	36		92	**50**	90	81	68
Choteau	A-1	46,336	2001	ACAM	XX			91	88	82	**50**	81	69	55
Choteau	R-11	198,000	2001	ACRML	XX			92	85	78	**60**	78	70	62
Choteau	R-12	24,000	2001	ACRML	XX			88	88	79	**60**	79	70	63
Choteau	R-2	375,000	2001	ACRML				83	81	78	**60**	78	70	62
Choteau	T-1	38,760	2001	ACRML	XX			81	84	81	**60**	81	71	64
Choteau	T-2	35,560	2001	ACRML				89	87	79	**60**	79	70	63

TABLE 3.1 - SUMMARY OF PCI RATINGS

Airport City (Branch Name)	Section	Section Area (sq. feet)	Constr. Year	Family Group	Surveyed PCIs 1994	1997	2000	2003	2006	2009	Critical PCI	Predicted PCIs 2010	2014	2019
Circle	A-1	27,000	2007	ACAM	76	61	60	48		65	**50**	64	52	35
Circle	A-2	34,860	2007	ACAM	87	56	57	53		66	**50**	65	53	36
Circle	R-11	307,500	2007	ACRML						90	**60**	88	76	67
Circle	T-1	2,900	2007	ACRML	82	76	63	45		84	**60**	82	72	65
Circle	T-2	2,900	2007	ACRML	74	60	58	39		83	**60**	81	72	65
Colstrip	A-1	66,000	2008	ACAM	87	68	64	64	30	90	**50**	89	76	62
Colstrip	R-1	382,500	2008	ACRMU	88	65	66	72	47	97	**50**	96	84	73
Colstrip	T-1	27,300	2008	ACRMU	77	70	53	53	25	93	**50**	92	82	70
Colstrip	T-2	19,600	2008	ACRMU	96	71	69	75	55	90	**50**	89	80	68
Columbus	A-1	77,012	1998	ACAM				79	80	59	**50**	58	46	26
Columbus	R-1	285,000	1998	ACRMU				85	81	67	**50**	66	56	47
Columbus	T-1	76,575	1998	ACRMU				92	84	57	**50**	56	49	39
Columbus	T-2	14,640	1998	ACRMU				90	82	68	**50**	67	57	48
Columbus	T-3	45,275	2001	ACRMU				88	83	60	**50**	59	51	42
Conrad	A-1	95,000	2002	ACAM	XX	XX		77	76	76	**50**	76	64	50
Conrad	R-3	345,000	2002	ACRML	XX	XX		95	76	76	**60**	76	69	61
Conrad	T-4	23,040	2002	ACRML	XX	XX		86	88	80	**60**	80	71	64
Culbertson	*A-1*	*47,000*	*1993*	*ACAM*	*100*	*61*	*65*	*62*	*61*		***50***	*51*	*37*	*14*
Culbertson	*R-1*	*180,000*	*1993*	*ACRML*	*100*	*57*	*70*	*65*	*58*		***60***	*42*	*16*	*0*
Culbertson	*R-2*	*48,000*	*1993*	*ACRML*	*100*	*79*	*65*	*69*	*57*		***60***	*40*	*14*	*0*
Culbertson	*T-1*	*25,000*	*1993*	*ACRML*	*100*	*39*	*64*	*60*	*58*		***60***	*43*	*17*	*0*
Culbertson	*T-2*	*25,000*	*1993*	*ACRML*	*100*	*56*	*66*	*67*	*60*		***60***	*47*	*21*	*0*
Cut Bank	A-1	102,000	1942	PCAA	28	40	49		33	29	**45**	29	18	6
Cut Bank	R-1	397,500	1984	ACRMU	89	78	61		67	63	**50**	63	53	45
Cut Bank	R-21	437,850	2007	ACRMU	XX	XX	XX		XX	93	**50**	92	82	70
Cut Bank	T-1	34,125	1990	ACRMU	93	85	77		54	53	**50**	53	46	33
Cut Bank	T-2	92,000	1990	ACRMU	90	86	79		63	58	**50**	58	50	41
Cut Bank	T-4	156,800	1991	ACRMU	99	90	84		68	59	**50**	59	50	42
Cut Bank	T-5	104,013	2000	ACRMU			100		67	72	**50**	72	61	50
Cut Bank	T-6	19,600	2007	ACRMU						96	**50**	95	84	72
Deer Lodge	A-3	55,310	1996	ACAM		95	88	82		62	**50**	61	50	32
Deer Lodge	A-4	15,904	1996	ACAM		93	92	86		69	**50**	68	57	41
Deer Lodge	R-3	330,000	1996	ACRML		91	85	80		90	**60**	89	77	68
Deer Lodge	R-4	59,987	2006	ACRML						92	**60**	91	78	69
Deer Lodge	T-1B	5,392	1997	ACRML			90	78		89	**60**	88	76	68
Deer Lodge	T-2	31,000	1997	ACRML		91	81	74		80	**60**	79	71	64
Dillon	A-3	92,250	1994	ACAM	100	86	84	79	65	96	**50**	95	80	66
Dillon	A-4	78,200	2002	ACAH				95	87	92	**55**	91	75	64
Dillon	A-11	193,569	2008	ACAM						94	**50**	93	79	64
Dillon	R-3	467,400	1998	ACRMU			91	90	81	81	**50**	80	71	58
Dillon	R-4	58,500	1998	ACRMU			76	84	82	83	**50**	82	73	60
Dillon	R-21	178,680	2009	ACRMU						98	**50**	97	85	73
Dillon	T-2	16,510	1994	ACRMU	100	88	82	76	68	96	**50**	95	84	72
Dillon	T-3	212,275	1998	ACRMU			84	88	85	80	**50**	79	70	57
Dillon	T-4	26,575	2002	ACRMU				95	88	96	**50**	95	84	72
Dillon	T-5	33,288	2009	ACRMU						97	**50**	96	84	73
Ekalaka	A-1	100,000	2004	ACAM	95	66	58	55	89	86	**50**	84	72	58
Ekalaka	R-1	249,150	2004	ACRML	97	73	50	48	92	83	**60**	82	72	65
Ekalaka	R-11	35,850	2004	ACRML	88	56	55	39	84	79	**60**	78	70	63
Ekalaka	T-1	73,500	2004	ACRML	88	56	55	39	92	85	**60**	83	73	66
Ekalaka	T-11	29,556	2004	ACRML	88	56	55	39	86	80	**60**	79	70	63

TABLE 3.1 - SUMMARY OF PCI RATINGS

Airport City (Branch Name)	Section	Section Area (sq. feet)	Constr. Year	Family Group	Surveyed PCIs 1994	1997	2000	2003	2006	2009	Critical PCI	Predicted PCIs 2010	2014	2019
Ennis	A-1	112,350	1990	ACAM	92	93	87	84	54		50	43	27	2
Ennis	A-2	88,128	1992	ACAM	92	89	88	78	66		50	56	44	23
Ennis	R-1	370,100	1990	ACRMU	97	84	56	78	38		50	18	0	0
Ennis	T-1	96,425	1990	ACRMU	94	96	87	85	66		50	57	49	41
Ennis	T-2	117,775	1992	ACRMU	95	95	77	77	58		50	51	44	27
Eureka	A-1	76,125	1991	ACAM	92	77	73		76	55	50	54	41	19
Eureka	R-1	315,000	1991	ACRML	96	94	73		72	63	60	62	50	18
Eureka	T-1	56,700	1991	ACRML	87	85	74		85	70	60	69	64	49
Eureka	T-2	42,000	1991	ACRML	100	87	68		65	45	60	43	17	0
Eureka	T-3	60,000	2002	ACRML					96	74	60	73	67	58
Eureka	T-4	17,500	2002	ACRML					94	78	60	77	69	62
Forsyth	A-1	89,640	1994	ACAM			69	74	69	25	50	24	4	0
Forsyth	R-1	360,000	1994	ACRMU			71	81	71	56	50	56	48	38
Forsyth	T-1	53,120	1994	ACRMU			78	81	63	45	50	45	34	2
Forsyth	T-2	95,550	1994	ACRMU			73	73	57	45	50	45	34	2
Forsyth	T-3	19,600	1994	ACRMU			80	89	72	57	50	57	49	40
Forsyth	T-4	12,600	1994	ACRMU			88	87	79	54	50	54	47	35
Fort Benton	A-1	98,784	1999	ACAM				79	79	68	50	67	56	39
Fort Benton	R-1	322,500	1999	ACRML				84	85	77	60	76	69	61
Fort Benton	T-1	45,640	1999	ACRML				81	86	81	60	80	71	64
Fort Benton	T-2	31,745	1999	ACRML				77	80	78	60	77	69	62
Fort Benton	T-3	181,300	1959	ACRML				46	26	21	60	19	0	0
Gardiner	R-1	165,015	1996	ACPL						42	50	40	23	0
Gardiner	T-1	3,823	1996	ACPL						41	50	39	21	0
Glasgow	A-3	47,400	2002	ACAM	XX	XX		81	68	55	50	54	40	19
Glasgow	A-4	5,250	1986	PCAA	59	58		47	43	20	45	19	9	0
Glasgow	A-6	12,800	2000	PCAA				64	57	53	45	53	50	49
Glasgow	A-7	68,675	2002	ACAM				83	79	71	50	70	58	43
Glasgow	R-2	410,000	1987	ACRH	62	94		86	76	66	50	66	62	58
Glasgow	R-3	90,000	1987	ACRH	74	84		96	88	70	50	70	65	60
Glasgow	R-13	101,250	2003	ACRMU	XX	XX		100	93	86	50	86	77	64
Glasgow	R-14	298,125	2003	ACRMU				100	92	86	50	86	77	64
Glasgow	T-1	58,500	1986	ACRH	69	77		78	71	68	50	67	63	59
Glasgow	T-3	70,900	1996	ACRH				71	58	59	50	59	57	54
Glasgow	T-4	29,000	1980	ACRMU				47	23	14	50	11	0	0
Glasgow	T-5	74,250	1996	ACRH	XX	77		87	85	68	50	68	63	59
Glasgow	T-7	36,750	1993	ACRMU				57	41	53	50	52	46	31
Glasgow	T-8	20,000	1995	ACRH		93		90	78	73	50	72	66	61
Glasgow	T-9	12,400	1993	ACRMU				56	45	42	50	41	22	0
Glasgow	T-10	11,200	2000	ACRH				88	79	79	50	78	70	64
Glasgow	T-11	16,000	2003	ACRMU				100	92	89	50	89	79	67
Glendive	A-1	145,700	2003	ACAH	XX	XX	XX	XX	83	69	55	68	61	58
Glendive	A-2	50,000	2002	ACAM	XX	XX	XX	93	81	60	50	58	46	27
Glendive	R-1	465,000	2007	ACRH	77	59	59	64		81	50	80	71	65
Glendive	R-2	105,400	2007	ACRH	79	57	59	73		80	50	79	71	64
Glendive	R-3	174,000	2003	ACRMU	XX	XX	XX	XX	88	74	50	73	62	51
Glendive	T-1	31,000	2007	ACRH	72	51	49	60	60	69	50	68	64	60
Glendive	T-2	38,000	2002	ACRMU	XX	XX	XX	94	82	68	50	67	56	47
Glendive	T-5	59,220	2007	ACRMU						94	50	92	82	70
Glendive	T-6	20,545	2007	ACRMU						91	50	89	80	68
Hamilton	A-1	57,000	1980	STPA	46	64	53		30	30	55	29	0	0
Hamilton	A-2	145,800	1983	STPA	69	76	71		44	34	55	33	1	0
Hamilton	R-1A	165,000	1992	ACRMU	99	95	95		87	67	50	67	56	47
Hamilton	R-2	150,000	1992	ACRMU	98	99	93		90	74	50	74	63	52
Hamilton	T-2	56,550	1994	ACRMU	93	88	64		52	22	50	21	0	0
Hamilton	T-3	82,050	1983	STPA	60	57	55		30	26	55	25	0	0
Hamilton	T-5	53,912	2002	ACRMU					89	90	50	90	80	68

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Airport City (Branch Name)	Section	Section Area (sq. feet)	Constr. Year	Family Group	Surveyed PCIs 1994	1997	2000	2003	2006	2009	Critical PCI	Predicted PCIs 2010	2014	2019
Harlem	A-11	65,320	2003	ACAM					92	84	**50**	82	70	56
Harlem	R-11	288,750	2003	ACRML					90	84	**60**	82	72	65
Harlem	R-12	18,750	2003	ACRML					88	84	**60**	82	72	65
Harlem	T-11	28,174	2003	ACRML					87	77	**60**	76	69	61
Harlowton	A-11	50,600	1997	ACAM	XX		91	81	83	53	**50**	52	38	15
Harlowton	R-11	273,600	1997	ACRML	XX		76	71	77	59	**60**	58	39	7
Harlowton	T-11	17,045	1997	ACRML	XX		88	88	94	74	**60**	73	67	58
Havre	A-3	25,000	1987	ACAM			53	34	42	25	**50**	22	2	0
Havre	A-4	25,000	1987	ACAM	64		46	36	35	28	**50**	25	6	0
Havre	A-5	109,350	1994	ACAH			76	64	54	43	**55**	41	26	2
Havre	R-5	530,000	1993	ACRMU	100		84	82	76	68	**50**	67	56	47
Havre	R-11	21,400	1994	ACRMU	96		77	66	60	49	**50**	48	41	15
Havre	R-12	171,600	1994	ACRMU	100		83	80	68	65	**50**	64	54	46
Havre	T-2	28,000	1994	ACRMU	97		58	54	58	38	**50**	36	12	0
Havre	T-3	17,500	1994	ACRMU	97		70	70	63	57	**50**	56	48	39
Havre	T-4	31,500	1993	ACRMU	97		79	73	76	66	**50**	65	55	46
Havre	T-5	127,750	1993	ACRMU	100		74	67	65	52	**50**	51	45	28
Jordan	A-11	50,000	2003	ACAM					90	88	**50**	86	73	59
Jordan	R-1	322,500	2003	ACRML	76	69	67		91	83	**60**	81	72	65
Jordan	T-1	24,538	2003	ACRML	40	50	41		94	90	**60**	88	76	67
Jordan	T-12	14,425	2003	ACRML					90	84	**60**	82	73	65
Laurel	A-3	171,360	2001	ACAM				93	84	69	**50**	68	57	41
Laurel	R-4	390,000	2000	ACRMU				93	81	70	**50**	69	59	49
Laurel	T-1	85,680	1988	ACRMU	78			66	44	51	**50**	50	44	25
Laurel	T-2	51,566	1988	ACRMU	86			66	47	38	**50**	37	13	0
Laurel	T-8	98,550	2000	ACRMU				91	81	75	**50**	74	64	52
Laurel	T-9	67,060	2001	ACRMU				95	86	80	**50**	79	69	57
Lewistown	A-1	100,800	1993	PCAA	98	90	77	78	75	50	**45**	50	49	48
Lewistown	A-2	30,744	1993	ACPL	97	83	79	83	65	58	**50**	57	50	35
Lewistown	A-3A	15,000	1983	ACPL	76	43	39	34	43	30	**50**	28	7	0
Lewistown	R-23	246,000	1996	ACRMU		95	89	77	72	67	**50**	66	56	47
Lewistown	R-32	327,000	1989	ACRH	93	87	72	66	68	56	**50**	56	53	47
Lewistown	R-33	205,000	1989	ACRH	89	89	76	72	72	68	**50**	68	63	59
Lewistown	R-34	78,000	1999	ACRH			98	85	89	73	**50**	72	66	62
Lewistown	T-1	299,000	1993	ACRH	100	94	91	87	75	72	**50**	71	66	61
Lewistown	T-4	21,250	1989	ACRMU	65	66	62	40	44	34	**50**	32	6	0
Lewistown	T-5	88,200	1989	ACRH	99	93	82	81	72	74	**50**	73	67	62
Lewistown	T-7	183,706	1999	ACRMU			96	94	81	76	**50**	75	65	53
Lewistown	T-8	68,272	1999	ACRMU			92	92	66	57	**50**	56	49	39
Lewistown	T-9	70,000	1980	ACRMU				72	50	22	**50**	19	0	0
Lewistown	T-10	15,540	2005	ACRMU					96	82	**50**	81	72	59
Lewistown	T-11	36,781	2006	ACRMU						82	**50**	81	72	59
Libby	A-1	18,600	2002	ACAM	XX	XX		93	79	70	**50**	69	58	42
Libby	A-2	110,700	2002	ACAM	XX	XX		91	80	75	**50**	74	63	48
Libby	A-3	107,040	2002	ACAH	XX	XX		90	87	71	**55**	70	63	59
Libby	A-4	1,050	2004	PCAA						36	**45**	35	15	0
Libby	A-5	2,700	2004	PCAA						77	**45**	76	66	57
Libby	R-1	285,000	1999	ACRML	XX	XX		82	67	57	**60**	56	33	3
Libby	R-2	90,000	1999	ACRML	XX	XX		82	68	57	**60**	56	33	3
Libby	T-2	82,600	1987	ACRH	94	100		74	62	56	**50**	56	53	47
Libby	T-5	68,501	1999	ACRML				91	80	78	**60**	77	69	62
Libby	T-6	17,400	1999	ACRML				93	91	85	**60**	84	73	66

TABLE 3.1 - SUMMARY OF PCI RATINGS

Airport City (Branch Name)	Section	Section Area (sq. feet)	Constr. Year	Family Group	Surveyed PCIs 1994	1997	2000	2003	2006	2009	Critical PCI	Predicted PCIs 2010	2014	2019
Lincoln	A-11	54,954	2005	ACAM						80	**50**	79	67	53
Lincoln	A-2	18,040	2005	ACAM						80	**50**	79	67	53
Lincoln	R-11	318,000	2005	ACRML						85	**60**	84	73	66
Lincoln	T-11	62,575	2005	ACRML						84	**60**	83	73	65
Livingston	A-1	69,993	1993	ACAH	93	86	76	66	60	49	**55**	48	37	14
Livingston	A-2	55,550	1993	ACAM	96	92	87	83	76	57	**50**	56	43	23
Livingston	R-1	318,750	1993	ACRH	99	92	78	78	60	59	**50**	59	57	54
Livingston	R-2	108,750	1993	ACRMU	99	90	77	83	63	54	**50**	53	47	34
Livingston	T-1	20,000	1993	ACRH	100	87	75	69	65	60	**50**	60	57	55
Livingston	T-5	89,775	2005	ACRH					85	85	**50**	84	74	66
Malta	A-1	95,800	1997	ACAM				81	67	57	**50**	55	43	22
Malta	A-3	13,824	2003	PCAA					92	86	**45**	84	72	61
Malta	A-4	4,500	2007	ACAM						64	**50**	62	51	33
Malta	R-1	337,500	1997	ACRML				81	75	59	**60**	57	38	6
Malta	T-1	37,100	1997	ACRML				78	64	61	**60**	60	43	11
Malta	T-2	28,200	1997	ACRML				73	69	66	**60**	65	57	29
Miles City	A-2	38,750	2001	ACAM	48	55	48		77	55	**50**	54	41	19
Miles City	A-3	60,000	1985	ACAM	49	56	53		49	26	**50**	24	4	0
Miles City	A-3A	63,950	2001	ACAM	66	50	40		83	71	**50**	70	59	43
Miles City	A-4	53,500	2001	ACAM	48	45	44		76	61	**50**	60	48	29
Miles City	A-5	2,500	1989	PCAA	56	41	40		19	8	**45**	7	0	0
Miles City	R-12	560,100	2008	ACRH	XX	XX	XX		XX	98	**50**	96	82	71
Miles City	R-21	426,000	1998	ACRMU			93		76	67	**50**	66	56	47
Miles City	T-1B	38,000	1985	ACRMU	62	63	41		31	26	**50**	23	0	0
Miles City	T-2A	63,000	1998	ACRMU	XX	XX	84		72	73	**50**	72	61	50
Miles City	T-3	43,750	2001	ACRH	48	50	47		76	66	**50**	65	62	58
Miles City	T-3B	28,000	1998	ACRH	XX	XX	90		70	66	**50**	65	62	58
Miles City	T-6	50,400	1998	ACRMU			89		80	73	**50**	72	61	50
Miles City	T-7	33,250	1998	ACRMU			87		76	68	**50**	67	57	47
Plains	A-1	141,750	2006	ACAM						86	**50**	85	72	58
Plains	R-1	348,750	2006	ACRML						89	**60**	88	76	67
Plains	T-1	47,775	2006	ACRML						88	**60**	87	75	67
Plains	T-2	27,540	2006	ACRML						84	**60**	83	73	65
Plentywood	A-11	73,348	2001	ACAM	XX	XX	XX	81	72	66	**50**	64	53	36
Plentywood	R-11	292,500	2001	ACRMU	XX	XX	XX	89	83	75	**50**	74	63	52
Plentywood	T-11	141,080	2001	ACRMU				88	85	74	**50**	73	62	51
Polson	A-11	199,475	1998	ACAM	XX	XX		76	66	56	**50**	55	43	22
Polson	R-11	315,000	1998	ACRMU	XX	XX		74	66	62	**50**	61	52	44
Polson	T-11	170,450	1999	ACRMU	XX	XX		75	73	64	**50**	63	54	45
Polson	T-12	32,925	1999	ACRMU	XX	XX		65	56	59	**50**	59	50	42
Polson	T-14	23,875	2003	ACRMU					92	84	**50**	84	74	61
Poplar	*A-1*	*75,000*	*1982*	*ACPL*			*54*				***50***	*23*	*2*	*0*
Poplar	*R-1*	*180,000*	*1982*	*ACPL*			*52*				***50***	*17*	*0*	*0*
Poplar	*T-1*	*29,160*	*1982*	*ACPL*			*68*				***50***	*50*	*39*	*15*
Poplar	*T-2*	*23,400*	*1982*	*ACPL*			*55*				***50***	*26*	*5*	*0*
Ronan	A-11	162,800	2000	ACAM				87	85	79	**50**	78	67	52
Ronan	A-12	41,600	2000	ACAM				89	78	74	**50**	73	62	47
Ronan	R-11	360,000	2000	ACRML				86	71	62	**60**	62	48	16
Ronan	T-5	23,500	2008	ACRML						87	**60**	86	75	67
Ronan	T-11	192,675	2000	ACRML				92	74	70	**60**	70	64	50

TABLE 3.1 - SUMMARY OF PCI RATINGS

Airport City (Branch Name)	Section	Section Area (sq. feet)	Constr. Year	Family Group	Surveyed PCIs 1994	1997	2000	2003	2006	2009	Critical PCI	Predicted PCIs 2010	2014	2019
Roundup	A-1	36,400	2002	ACAM	XX	XX	XX	83	75	66	**50**	64	53	36
Roundup	A-2	15,390	2002	ACAM	XX	XX	XX	88	74	65	**50**	63	52	35
Roundup	R-1	382,500	2002	ACRML	XX	XX	XX	96	84	76	**60**	75	68	60
Roundup	T-1	36,720	2002	ACRML	XX	XX	XX	95	84	79	**60**	78	70	62
Roundup	T-3	15,800	2002	ACRML				97	90	85	**60**	83	73	66
Scobey	A-11	46,500	1998	ACAM	XX				88	53	**50**	51	38	15
Scobey	A-12	9,728	1998	ACAM	XX				84	65	**50**	63	52	35
Scobey	R-11	255,000	1998	ACRML	XX				80	70	**60**	69	64	48
Scobey	R-12	46,500	1998	ACRML	XX				82	73	**60**	72	66	56
Scobey	T-11	40,640	1998	ACRML	XX				83	61	**60**	60	43	11
Scobey	T-12	5,750	1998	ACRML	XX				85	66	**60**	65	57	29
Scobey	T-13	12,577	2003	ACRML					92	86	**60**	84	74	66
Shelby	A-21	97,273	2003	ACAM					83	77	**50**	77	65	51
Shelby	A-22	22,193	2003	PCAA					91	83	**45**	82	71	60
Shelby	R-21	375,000	2004	ACRMU					83	80	**50**	80	70	57
Shelby	R-22	222,000	2003	ACRMU					81	78	**50**	78	68	55
Shelby	T-6	115,000	1994	ACRMU	100	86	83		63	50	**50**	50	43	23
Shelby	T-21	89,250	2003	ACRMU					86	78	**50**	78	68	55
Shelby	T-22	64,400	2004	ACRMU					78	69	**50**	69	58	48
Sidney	A-3A	55,000	2007	ACAM	XX	XX	XX		XX	84	**50**	82	70	56
Sidney	A-11	80,156	2004	PCAA					99	92	**45**	90	76	64
Sidney	A-12	21,000	2004	ACAH					97	71	**55**	70	62	59
Sidney	A-13	114,774	2006	ACAH						77	**55**	75	65	60
Sidney	A-14	30,000	2006	PCAA						97	**45**	95	80	66
Sidney	A-15	9,375	2006	PCAA						88	**45**	86	73	62
Sidney	R-11	402,000	2003	ACRH					91	73	**50**	72	66	61
Sidney	R-12	570,500	2003	ACRH					95	72	**50**	71	66	61
Sidney	T-2	30,000	1997	ACRH	XX	100	70		75	69	**50**	68	64	60
Sidney	T-3	30,000	1984	ACRMU	50	35	44		40	27	**50**	23	0	0
Sidney	T-4	338,250	1992	ACRH	100	85	80		67	53	**50**	53	48	34
Stanford	A-2	60,000	1997	ACAM	XX		93	81	82	70	**50**	69	58	42
Stanford	R-2	70,000	1997	ACRML	XX		93	86	88	79	**60**	78	70	63
Stanford	R-3	262,500	1997	ACRML	XX		92	81	79	73	**60**	72	66	56
Stanford	T-2	13,100	1997	ACRML			97	90	87	86	**60**	85	74	66
Stevensville	A-1	70,000	1991	STPA	79	81	79	70	65	70	**55**	69	61	57
Stevensville	A-2	90,425	1994	ACAM	100	97	93	80	70	64	**50**	64	52	35
Stevensville	R-1	228,000	1991	STPA	89	85	83	72	78	67	**55**	67	60	57
Stevensville	T-1	29,225	1991	STPA	85	86	85	75	81	67	**55**	67	60	57
Stevensville	T-3	161,448	1994	ACRMU	100	98	96	87	89	78	**50**	78	68	55
Stevensville	T-4	12,600	2003	ACRMU					97	94	**50**	93	83	71
Superior	A-11	37,284	2004	ACAM	XX	XX	XX		92	74	**50**	73	62	47
Superior	R-11	270,979	2004	ACRML	XX	XX	XX		92	84	**60**	83	73	65
Superior	T-11	72,413	2004	ACRML	XX	XX	XX		89	80	**60**	79	71	63
Terry	A-11	52,234	2001	ACAM	XX	XX		94	75	76	**50**	75	63	49
Terry	R-11	322,500	2001	ACRML	XX	XX		95	83	79	**60**	78	70	63
Terry	T-11	23,463	2001	ACRML	XX	XX		92	71	73	**60**	72	66	56
Thompson Falls	A-1	26,790	1995	ACAM			91	82	90	66	**50**	65	54	37
Thompson Falls	A-2	52,490	1995	ACAM			93	88	77	67	**50**	66	55	38
Thompson Falls	R-1	252,000	1995	ACRMU			93	88	83	79	**50**	78	68	56
Thompson Falls	R-2	63,000	1995	ACRMU			88	82	67	64	**50**	63	54	45
Thompson Falls	T-4	66,300	1995	ACRMU			93	91	78	75	**50**	74	64	52
Thompson Falls	T-5	50,090	2000	ACRMU			99	97	90	81	**50**	80	70	58
Thompson Falls	T-6	15,175	2003	ACRMU				97	98	85	**50**	84	75	62

TABLE 3.1 - SUMMARY OF PCI RATINGS

Airport City (Branch Name)	Section	Section Area (sq. feet)	Constr. Year	Family Group	Surveyed PCIs 1994	1997	2000	2003	2006	2009	Critical PCI	Predicted PCIs 2010	2014	2019
Three Forks	A-1	63,800	2000	ACAM	XX	XX		91	82	70	**50**	69	58	43
Three Forks	A-2	5,400	1986	PCAA	73	75		56	36	33	**45**	32	22	9
Three Forks	R-1	246,000	2000	ACRMU	XX	XX		89	78	70	**50**	69	59	49
Three Forks	R-2	60,000	2000	ACRMU	XX	XX		93	87	80	**50**	80	70	57
Three Forks	T-1	12,975	2000	ACRMU	XX	XX		83	82	63	**50**	62	53	45
Three Forks	T-2	74,150	2000	ACRMU	XX	XX		93	87	79	**50**	78	69	56
Three Forks	T-3	33,300	2000	ACRMU				90	80	65	**50**	64	55	46
Three Forks	T-4	70,344	2000	ACRMU				97	87	78	**50**	77	67	55
Townsend	A-1	105,000	2002	ACAM	XX	XX	XX	94	84	72	**50**	70	59	44
Townsend	R-1	240,000	2002	ACRML	XX	XX	XX	91	87	81	**60**	79	71	64
Townsend	T-1	34,700	2002	ACRML	XX	XX	XX	93	87	80	**60**	78	70	63
Townsend	T-2	7,750	2002	ACRML				92	82	78	**60**	77	69	62
Turner	A-1	33,800	1995	ACAM			94	70	59	64	**50**	62	51	33
Turner	R-1	216,000	1995	ACRML			84	79	75	72	**60**	71	65	54
Turner	T-2	6,360	1995	ACRML			90	70	64	81	**60**	79	71	64
Turner	T-3	20,000	1995	ACRML			87	74	69	76	**60**	75	68	60
Twin Bridges	A-1	90,000	2000	ACAM	XX	XX		85	72	48	**50**	47	32	8
Twin Bridges	R-1	258,000	2000	ACRML	XX	XX		82	70	48	**60**	47	21	0
Twin Bridges	T-1	67,500	2000	ACRML	XX	XX		87	72	52	**60**	51	26	0
West Yellowstone	A-1	195,680	1980	ACAH	75	66	72		61	49	**55**	48	36	13
West Yellowstone	A-2	125,000	1980	ACAM	56	51	61		47	37	**50**	35	16	0
West Yellowstone	A-3	125,000	1980	ACAH	77	73	69		60	49	**55**	48	36	13
West Yellowstone	A-4	75,000	1980	ACAM	86	91	90		79	58	**50**	56	44	23
West Yellowstone	A-5	4,320	1988	PCAA	91	88	86		81	74	**45**	72	63	56
West Yellowstone	R-1	1,012,500	2003	ACRH	86	85	71		92	78	**50**	77	69	63
West Yellowstone	R-2	247,500	2003	ACRH	80	84	71		88	79	**50**	78	70	64
West Yellowstone	T-1	750,000	1980	ACRH	94	84	63		54	41	**50**	39	23	3
West Yellowstone	T-2	7,000	1993	ACRMU	98	100	94		82	79	**50**	78	68	55
White Sulphur Springs	*A-1*	*18,960*	*1992*	*STPA*	*96*	*96*	*79*	*69*	*58*		***55***	*56*	*53*	*37*
White Sulphur Springs	*A-2*	*57,870*	*1992*	*ACAM*	*96*	*96*	*78*	*73*	*68*		***50***	*59*	*47*	*27*
White Sulphur Springs	*R-1*	*276,000*	*1992*	*STPA*	*95*	*95*	*72*	*65*	*55*		***55***	*50*	*31*	*0*
White Sulphur Springs	*R-2*	*102,000*	*1992*	*ACRMU*	*100*	*100*	*77*	*77*	*63*		***50***	*55*	*48*	*37*
White Sulphur Springs	*T-1*	*23,364*	*1992*	*STPA*	*91*	*91*	*69*	*56*	*51*		***55***	*39*	*9*	*0*
White Sulphur Springs	*T-2*	*38,495*	*1992*	*ACRMU*	*99*	*100*	*70*	*66*	*62*		***50***	*54*	*47*	*36*
Wolf Point	*A-5*	*106,363*	*1994*	*ACAM*			*68*	*69*	*57*		***50***	*47*	*32*	*8*
Wolf Point	*R-1*	*285,000*	*1984*	*ACRH*			*66*	*55*	*39*		***50***	*25*	*8*	*0*
Wolf Point	*R-2*	*43,900*	*1984*	*ACRH*			*61*	*57*	*43*		***50***	*32*	*14*	*0*
Wolf Point	*R-3*	*42,500*	*1984*	*ACRH*			*64*	*61*	*50*		***50***	*44*	*31*	*10*
Wolf Point	*R-4*	*20,000*	*1984*	*ACRH*			*70*	*50*	*40*		***50***	*26*	*10*	*0*
Wolf Point	*R-5*	*65,000*	*1984*	*ACRH*			*67*	*74*	*60*		***50***	*58*	*56*	*52*
Wolf Point	*R-6*	*52,500*	*1984*	*ACRH*			*69*	*60*	*46*		***50***	*37*	*20*	*0*
Wolf Point	*T-1*	*9,750*	*1984*	*ACRH*			*51*	*55*	*44*		***50***	*33*	*16*	*0*
Wolf Point	*T-2*	*11,920*	*1984*	*ACRML*			*40*	*35*	*34*		***60***	*13*	*0*	*0*
Wolf Point	*T-3*	*21,875*	*1994*	*ACRML*			*61*	*55*	*36*		***60***	*14*	*0*	*0*
Wolf Point	*T-4*	*28,200*	*1994*	*ACRML*			*79*	*63*	*58*		***60***	*42*	*16*	*0*

TOTAL SURFACED AREA: 40,422,723 (sq. feet)

2009 SURVEY AREA: 37,801,688 (sq. feet) = 94%

NOTES:

"XX" in PCI columns indicates previous PCI values have been voided to account for new construction.

No entry in PCI columns indicates no inspection of the pavement section for the given year.

Italics indicates the airport was not inspected for this report, as such the included information is suspect. If construction has taken place it will not be reflected in this report. Families and PCI predictions are assumed from pre-2006 pavements.

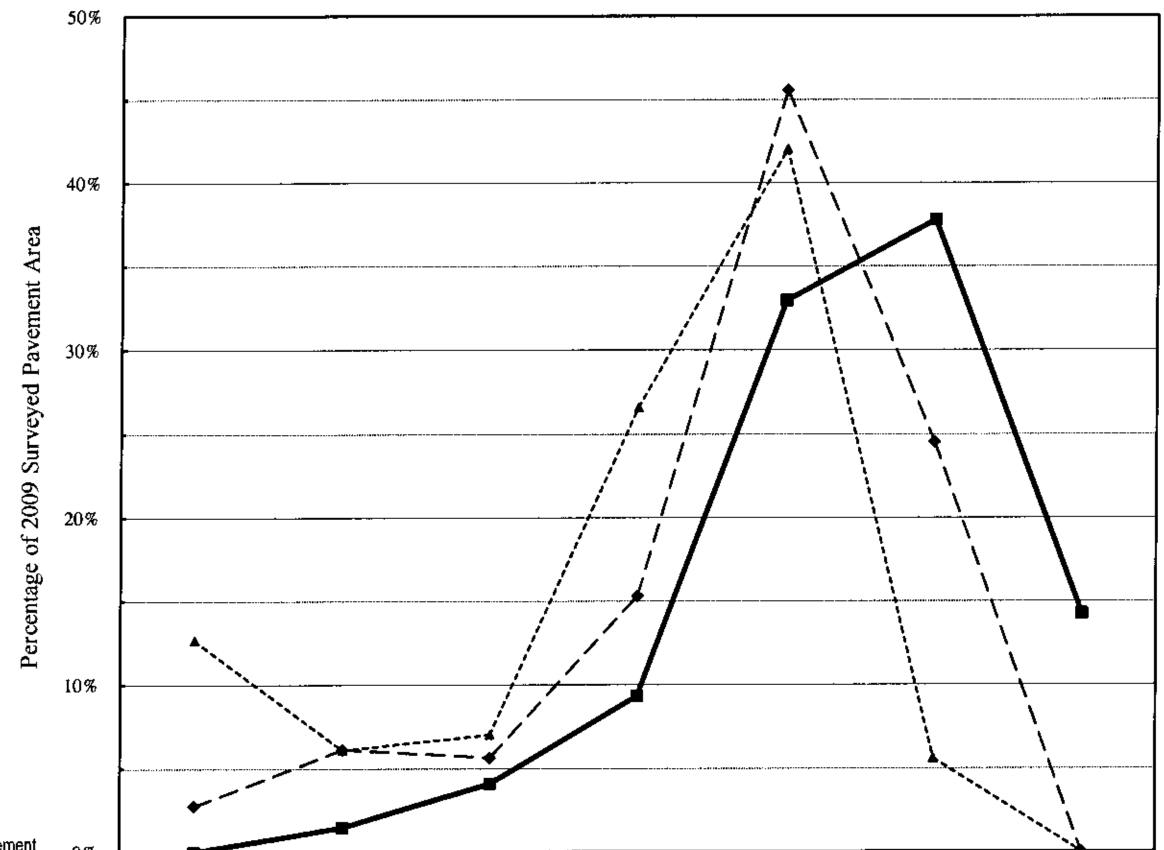
3.3 SYSTEM-WIDE PAVEMENT CONDITIONS

MicroPAVER uses current PCI values as a starting point on the pavement section's family curve, then continues down the family curve to project PCI's in the future. The constrained "best-fit" life cycle curves generated for each family are valid only to the age for which there is survey data, after which they assume a straight-line projection of the curve's slope (shown with dashed lines on the family curves). An Excel spreadsheet was used to summarize, organize, and enhance the presentation of MicroPAVER-processed information into system-wide pavement condition ratings (Figure 3.2). The Pavement Condition Ratings shown are area-weighted to portray the percentage of 2009-surveyed Montana airport pavement area falling into each rating class. Square footages for each pavement section were accumulated into one of seven Pavement Condition Ratings, based on their inspected or predicted PCI values, and the rating scale shown in Figure 2.2, Step 8. The pavement area in each condition rating was then converted to percentages by dividing by the total 2009-surveyed area. The resulting distribution of Pavement Condition Ratings shown in Figure 3.2 projects a representative aging of all inspected airport pavements given continued maintenance practices, but no major rehabilitation or reconstruction.

FIGURE 3.2

SYSTEM-WIDE PAVEMENT CONDITION RATINGS

"No Action" Alternative For Pavements Surveyed in 2009



Pavement Condition Ratings:	Failed	Very Poor	Poor	Fair	Good	Very Good	Excellent
2009	0.0%	1.5%	4.1%	9.3%	33.0%	37.8%	14.3%
2014	2.8%	6.1%	5.7%	15.3%	45.6%	24.5%	0.0%
2019	12.6%	6.1%	7.0%	26.6%	42.0%	5.6%	0.0%

The data in Table 3.1 and Figure 3.2 both show unequivocally that if reconstruction programs on Montana airports were suspended or discontinued, airport pavements would degrade to marginal serviceability within about 10 years. While there are many finer points to be gleaned from the graph of system-wide pavement condition ratings (Figure 3.2), splitting the pavement ratings into three groups (below fair, fair, and above fair) will help translate the extensive data set to more comprehensible insights.

Pavements rated as "Fair" are generally in a state of transition on two fronts: surface defects are beginning to be noticeable in both type and frequency, and the expense of reconstruction is becoming more economical than continued preventative maintenance. While surface distresses indicating deterioration of the pavement/base course system are visible, they are subtle enough to not have major effects on ride quality nor are they generating significant foreign object debris (FOD). Studies continue to indicate that reconstruction of "good" to "fair" quality asphalt surfacing is more economical than waiting until major distresses appear. While it may seem counterintuitive to reconstruct good-looking pavement, reconstruction before the gravel base deteriorates is much less expensive. The area of transitional pavements in the absence of reconstruction is projected to escalate from 9% to 15% to 27% in the years 2009, 2014, and 2019, respectively.

Those pavements rated above "Fair" are high-quality surfaces providing trouble-free use and relatively low maintenance costs. Currently, lower-cost preventative maintenance is the recommended course of action for 85% of the pavement area in the PCI database. Without investments in (re)construction, the area of pavement in this high service/low cost maintenance class drops to 70% in five years and 48% in 10 years.

Pavements assessed as below "Fair" condition provide increasing maintenance headaches, growing probabilities of damaging aircraft, decreasing ride quality, and escalating repair and reconstruction costs. "Below fair" pavements range from showing noticeable defects, all the way to near gravel surfaces. These serviceable, but low quality pavements grow from 6% (by area) of the database pavement area to 15% and 26% of the State-wide system pavements in 2014 and 2019, respectively.

This prediction is based on the assumption that current maintenance practices, aircraft activity, and loadings will continue, and that no new construction or major reconstruction will occur. In other words, they show what would happen if Montana airports discontinued pavement construction / reconstruction programs.

3.4 MAINTENANCE PRIORITIES

As an aid to pavement maintenance project prioritization three summary tables have been constructed using PCI projections from Table 3.1. These tables consider project prioritization from a system-wide approach, a community-based vantage, and a "maintain vs. reconstruct" option. These summary tables are meant only as an "early warning indicator" and should not be misconstrued as being an absolute authority. Where a rehabilitation or reconstruction project has been completed since the most recent PCI inspection, projections are shown with a ~~strike out~~.

Preserving the current investment in Montana's general aviation (GA) airport pavements may include prioritizing maintenance projects as in Table 3.2. Fog seals, crack sealing, and thin-lift overlays *applied before the pavement crosses its critical PCI* are the most economical way of extending pavement life. By prioritizing projects by their square footage, it's possible to allocate State and Federal dollars to best extend the life of the greatest pavement area. Table 3.2 can be used to guide a *system-wide approach to economical pavement maintenance.*

TABLE 3.2
PAVEMENT PROJECTED TO GO SUBCRITICAL
BY PAVEMENT AREA

2009-2014

City	(sq. ft.)
Chester	458,649
Forsyth	392,200
Eureka	391,125
Ronan	360,000
Sidney	338,250
Ennis	302,328
~~White Sulphur Springs~~	~~217,325~~
Polson	199,475
Livingston	164,300
Malta	161,100
Anaconda	154,140
Columbus	153,587
Havre	145,250
Shelby	115,000
Big Timber	108,000
Scobey	92,890
Chinook	92,627
Miles City	92,250
Laurel	85,680
Glasgow	84,150
West Yellowstone	75,000
Lewistown	68,272
Harlowton	50,600
Glendive	50,000
Culbertson	47,000
Cut Bank	34,125
~~Poplar~~	~~29,160~~
Big Sandy	26,720

2014-2019

City	(sq. ft.)
Havre	733,100
Cut Bank	646,300
Lewistown	603,744
Laurel	561,360
Baker	561,250
Miles City	523,200
Polson	518,375
Big Timber	396,375
Three Forks	356,075
Columbus	344,915
Stanford	322,500
Scobey	311,228
Anaconda	283,275
Turner	249,800
Ronan	234,275
Libby	211,900
Hamilton	165,000
Thompson Falls	142,280
Eureka	116,700
Townsend	105,000
Fort Benton	98,784
Stevensville	90,425
Terry	75,697
Plentywood	73,348
Deer Lodge	71,214
Glasgow	68,675
Shelby	64,400
Circle	61,860
Roundup	51,790
Glendive	38,000
Superior	37,284
Harlowton	17,045
Big Sandy	14,400

2009-2019

City	(sq. ft.)
Havre	878,350
Polson	717,850
Cut Bank	680,425
Lewistown	672,016
Laurel	647,040
Miles City	615,450
Ronan	594,275
Baker	561,250
Eureka	507,825
Big Timber	504,375
Columbus	498,502
Chester	458,649
Anaconda	437,415
Scobey	404,118
Forsyth	392,200
Three Forks	356,075
Sidney	338,250
Stanford	322,500
Ennis	302,328
Turner	249,800
~~White Sulphur Springs~~	~~217,325~~
Libby	211,900
Shelby	179,400
Hamilton	165,000
Livingston	164,300
Malta	161,100
Glasgow	152,825
Thompson Falls	142,280
Townsend	105,000
Fort Benton	98,784
Chinook	92,627
Stevensville	90,425
Glendive	88,000
Terry	75,697
West Yellowstone	75,000
Plentywood	73,348
Deer Lodge	71,214
Harlowton	67,645
Circle	61,860
Roundup	51,790
Culbertson	47,000
Big Sandy	41,120
Superior	37,284
~~Poplar~~	~~29,160~~

~~strike out~~ indicates a pavement rehabilitation/replacement project has taken place since the previous PCI inspection.

When inconvenience and/or the future rehabilitation burden on local communities is of prime importance, maintenance can be prioritized by the percent of each airport's pavement forecasted to drop below the critical PCI. Table 3.3 is a ranking of airport communities that could be investing most economically in pavement maintenance. These communities can get their biggest "bang for the buck" if available maintenance dollars are spent before the critical PCI transition. Table 3.3 can help establish a *community-based emphasis to economical pavement maintenance*.

Tables 3.2 and 3.3 each provide three different time frames to consider in the project prioritization scenario, the first and second five-year period following inspection, and a ten-year overview. Please note that critical PCI transition tables do not give an indication of the type of maintenance that would be most beneficial, only the timing of the application. Inspection Summary Reports and Maintenance Reports are better indicators of the need for thin lift overlays, fog seals, crack sealing, localized patching, or other remediation.

Airports listed in Table 3.4 are candidates for reconstruction or repairs. Continued investments in maintaining these pavements produce diminishing returns, and are not the best investment of funds. The airports with greater than 75% of their pavements subcritical should be targeted for complete reconstruction, while those in the 25% range just need a section or two of pavement reconstructed.

The break-out of pavement ratings ("fair", "poor", etc.) can be used to determine the need for action. For example, since 100% of Benchmark's pavements have subcritical PCI's, and all are rated "poor" to "very poor", Benchmark Airport should be encouraged to reconstruct as soon as possible to avoid accelerating degradation, continued loss of base course structural strength, and rising reconstruction costs. Wolf Point is showing 87% subcritical pavements. While Wolf Point's airport will remain serviceable with only localized "safety" repairs for quite a number of years, the monies invested would be better directed toward acquiring an AIP local match for a reconstruction project. White Sulphur Springs shows up in the partial reconstruct list, but a quick consideration of their remaining sections show they are near-critical, bumping this airport into a recommended complete reconstruction (currently in progress). Havre, Laurel, Cut Bank, Miles City, and Sidney each has an overall high quality pavement with an isolated "historical" section in need of repairs. A significant number of airport operations combined with "poor", or "very poor" pavement conditions should boost an airport to the top of the reconstruction list.

These tables are provided only as an aid in the larger framework of GA airport funding allocation. Used judiciously, they can simplify and improve the airport improvement prioritization process.

TABLE 3.3
PAVEMENT PROJECTED TO GO SUBCRITICAL
BY % OF EACH AIRPORT'S PAVEMENT AREA

2009-2014

City	
Chester	98%
Eureka	69%
Forsyth	62%
Ronan	46%
~~White Sulphur Springs~~	~~42%~~
Ennis	39%
Malta	31%
Columbus	31%
Polson	27%
Livingston	25%
Scobey	22%
Sidney	20%
Chinook	17%
Big Timber	17%
Anaconda	15%
Harlowton	15%
Culbertson	14%
Havre	13%
Shelby	12%
Laurel	10%
Big Sandy	10%
~~Poplar~~	~~9%~~
Miles City	6%
Glasgow	6%
Glendive	5%
Lewistown	4%
West Yellowstone	3%
Cut Bank	3%

2014-2019

City	
Turner	90%
Stanford	80%
Scobey	75%
Polson	70%
Columbus	69%
Havre	67%
Baker	67%
Laurel	65%
Three Forks	63%
Big Timber	62%
Cut Bank	48%
Miles City	36%
Lewistown	34%
Ronan	30%
Anaconda	28%
Townsend	27%
Thompson Falls	27%
Libby	27%
Hamilton	23%
Eureka	21%
Terry	19%
Circle	16%
Stevensville	15%
Fort Benton	15%
Plentywood	14%
Deer Lodge	14%
Roundup	11%
Superior	10%
Shelby	7%
Big Sandy	5%
Glasgow	5%
Harlowton	5%
Glendive	3%

2009-2019

City	
Columbus	100%
Chester	98%
Scobey	97%
Polson	97%
Turner	90%
Eureka	90%
Havre	81%
Stanford	80%
Big Timber	79%
Ronan	76%
Laurel	75%
Baker	67%
Three Forks	63%
Forsyth	62%
Cut Bank	51%
Anaconda	43%
Miles City	42%
~~White Sulphur Springs~~	~~42%~~
Ennis	39%
Lewistown	38%
Malta	31%
Townsend	27%
Thompson Falls	27%
Libby	27%
Livingston	25%
Hamilton	23%
Sidney	20%
Harlowton	20%
Terry	19%
Shelby	18%
Chinook	17%
Circle	16%
Stevensville	15%
Big Sandy	15%
Fort Benton	15%
Plentywood	14%
Culbertson	14%
Deer Lodge	14%
Glasgow	11%
Roundup	11%
Superior	10%
~~Poplar~~	~~9%~~
Glendive	8%
West Yellowstone	3%

~~strike-out~~ indicates a pavement rehabilitation/replacement project has taken place since the previous PCI inspection.

PCI_PROJ XLS %PCI

TABLE 3.4
% OF EACH AIRPORT'S PAVEMENT WITH 2010 SUBCRITICAL PCI

Category	Airport City	SubCritical 0-55	Failed 0-10	Very Poor 11-25	Poor 26-40	Fair 41-critical PCI
Complete Reconstruct when Appropriate	Poplar	100%		83%	8%	9%
	Benchmark	100%		15%	85%	
	Gardiner	100%			2%	98%
	Twin Bridges	100%				100%
	Wolf Point	87%		45%	18%	25%
	Culbertson	86%			15%	71%
	Harlowton	80%				80%
	Big Sandy	72%	2%		70%	
	Malta	72%				72%
Partial Reconstruct when Appropriate	~~Ennis~~	~~61%~~		~~47%~~		~~14%~~
	~~White Sulphur Spring~~	~~58%~~			~~5%~~	~~53%~~
	Hamilton	48%		20%	29%	
	West Yellowstone	47%			34%	13%
	Libby	48%			0%	48%
	Forsyth	38%		14%		24%
	~~Fort Benton~~	~~27%~~		~~27%~~		
Localized Repair / Reconstruct	Havre	19%		5%	3%	12%
	Laurel	16%			6%	10%
	Shelby	12%				12%
	Livingston	11%				11%
	Scobey	10%				10%
	Cut Bank	8%			8%	
	Miles City	7%	0%	7%		
	Eureka	7%				7%
	Lewistown	6%		4%	2%	
	Glasgow	3%		3%		1%
	Chester	2%				2%
	Sidney	2%		2%		
	Three Forks	1%			1%	
	Anaconda	1%				1%

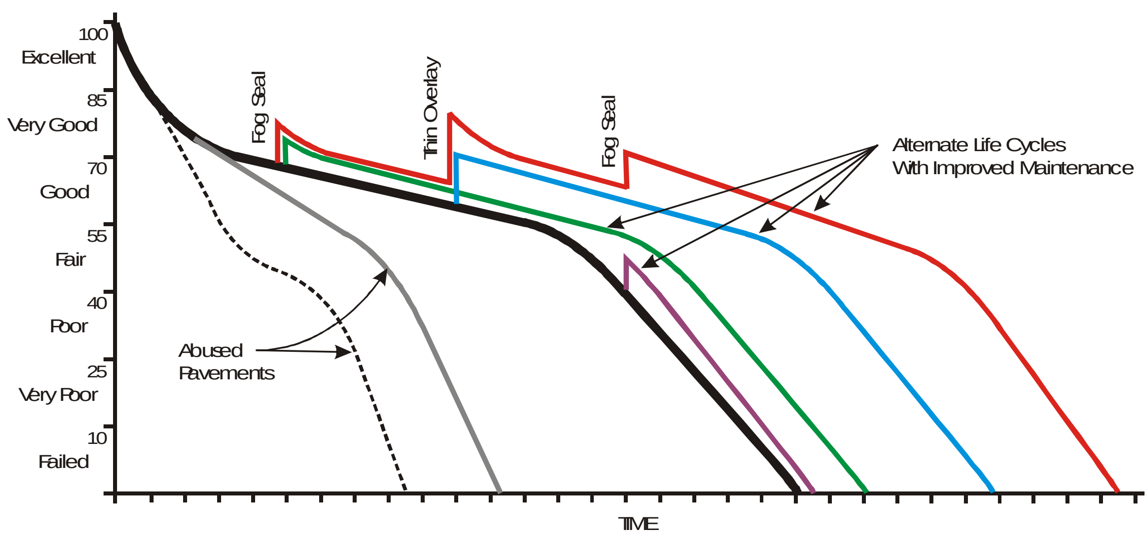
~~strike-out~~ indicates a pavement rehabilitation/replacement project has taken place since the previous PCI inspection.

PCI_PROJ 10SubCrit

3.5 MAINTENANCE PRACTICES

All of the results obtained from this analysis are affected by maintenance practices. In general, improved maintenance raises all points of the curve, produces a "bump up" in quality, and/or extends the "flat" portion of the pavement life cycle, providing a longer usable pavement life before dropping off at the critical condition. Figure 3.3 revisits the pavement life cycle curve from Figure 2.12 showing the benefits of improved maintenance practices. While occasional maintenance extends pavement life, regular preventative maintenance clearly extends the usable life of pavement well beyond it's non-maintained expected usable life. Most pavements around the State are already benefitting from recent increases in federal airport funding and improved maintenance policies. Families have more data scatter than previous years, due in large part to new maintenance policies mixed with the old data. Future analyses may be able to quantify these effects by studying maintenance practices more closely along with the PCI evaluations, and redefining pavement families to account for maintenance practices.

FIGURE 3.3
EXTENDED PAVEMENT LIFE CYCLE



3.6 MAINTENANCE AND REHABILITATION PLANNING

MicroPAVER for windows consolidates the Maintenance & Rehabilitation (M&R) planning into a single work plan with a number of application, modeling, and reporting options. The scope of policy application is set by a sort routine, just like that used to set families. The sort can be structured to report on all database members, currently maintained pavements, one airport, or even a single section of an airport pavement. Once the scope of the M&R plan has been defined a choice of three modeling routines is available: Minimum Condition Report, Consequence Model Report, and Limit to Budget Report. These three reports take dramatically different approaches to modeling pavement aging and its effect on budgeting for optimum pavement quality. The final option of establishing an M&R routine is to set-up the table(s) specific to each model. These range from target minimum PCI's for future years, simple cost by condition tables, to elaborate webs of costs and consequences of specific remedies to be applied to specific grades of distress.

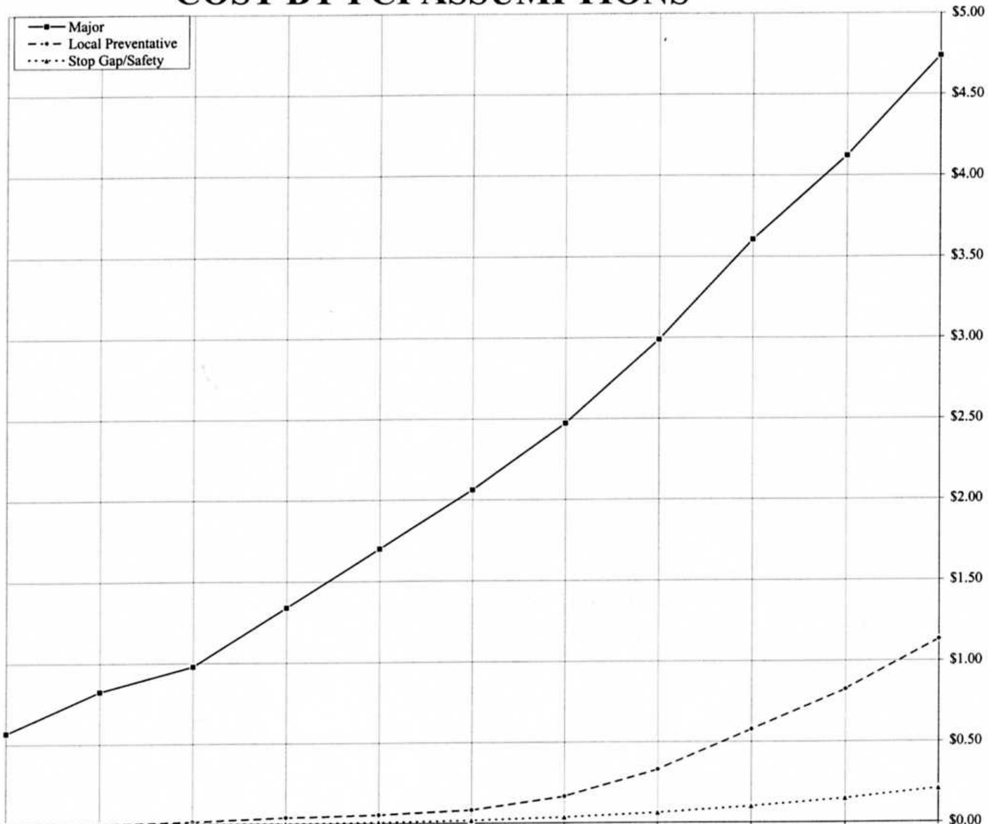
The first step in establishing a work plan is to determine the scope of application. This scope may be restricted for such reasons as reducing computing time, or exploring optimum repair strategy at a single airport. Within the Selection Criteria option of the work plan, the user may select "All Items" to get past and present pavement sections stored in the database, or choose "Build Selection" to construct a smaller group. To choose currently maintained pavements filter using "Rank = O," i. e. select all pavements that have been classified as "current" (This is the same as previous MicroPAVER versions' "Network Report"). Airports can be addressed individually by setting "Zone" equal to the airport's four-character code **and** setting "Rank = O." Smaller selections are filtered out using "BranchID" or "SectionID."

The **Minimum Condition Report** is the simplest of the modeling routines. This report allows the user to set a single PCI minimum for each future year, then calculates the cost to repair any pavement that falls below these predetermined minimums. Costs of improvements increase with decreasing PCI and are calculated from a 1997 composite of nation-wide Department of Defense airfield maintenance costs adjusted for inflation of construction costs (see Figure 3.4). These PCI-based repair cost estimates are a systematic reflection of increasing repair costs for decreasing pavement quality. The minimum allowable PCI can be set for each year in the future to phase in repairs acceptable to available funding. For example, budget constraints might only allow raising the system-wide minimum PCI to 35 the first year, but this could then be raised to 41, 46, and 50 in successive years. Major M&R budgeting is predicted reasonably well for any number of years with little change in the validity of the results.

The **Consequence Model Report** treats extrapolated distress quantities with specific remedies (see Table 3.5) to remediate pavement distresses and increase the overall section PCI. For a preset cost (see Table 3.6) the pavement distress associated with the treatment replaces the original more severe distress in PCI calculations (see Table 3.7). For example, crack sealing AC pavements costs about one dollar and fifty cents per linear foot and fills medium- and high-severity cracks, reducing them to low-severity cracks. If an airport owner paid for recommended repairs to each pavement distress on their pavement and had their airport inspected immediately after completion of the repairs, the airport's new PCI and the bill for improvements would be approximately that predicted by the Consequence Model Report. The Consequence Model Report uses only localized repair options and makes no attempt to increase quantity or severity of distresses to account for the natural aging process nor to project distresses that have not already been recorded during an inspection. This report is designed to provide projections of the localized repair costs and consequences *only when repairs are applied within a year of the airport inspection.*

The **Limit to Budget Report** optimizes pavement quality using a set budget cap and four targeted maintenance policies: Localized Safety, Localized Preventative, Global, and Major Reconstruction. Localized Safety treatments attempt to keep an airport pavement safe for operation using only local treatments while waiting for funds to replace the entire pavement section. For example, a high severity depression could be patched to eliminate hydroplaning potential, but underlying subgrade problems could still necessitate eventual reconstruction. Local Preventative treatments are applied to above-critical-PCI pavements to prolong the pavement life and reduce the effect of nonstructural and minor structural local defects. Crack sealing is a common Local Preventative repair that will stop moisture penetration into the subgrade and preserve subgrade integrity and extend pavement life. Global Preventative measures are applied to above-critical-PCI pavements when defects affect the whole surface. For example, raveling can be slowed significantly by applying a surface seal, rebinding the aggregate into a high quality surface at a fraction of the cost of a new surface. Major M&R is a total reconstruction of a pavement section applied when that section is below the critical PCI for its family curve, or if alligator cracking, rutting, and the like, indicate structural failure even above the critical PCI. The "Major Under-Critical" case of Major M&R assumes that the critical PCI was chosen such that reconstruction is a more economical option than continued maintenance once a section has passed below its critical PCI. While it is very rare, structural failure of parts of a section indicate structural failure even above the critical PCI. The "Major Under-Critical" case of Major M&R assumes that the critical PCI was chosen such that reconstruction is a more economical option than continued maintenance once a section has passed below its critical PCI. While it is very rare, structural failure of parts of a section (like a culvert crossing of a runway settling) may produce an unusable pavement with a PCI rating above critical. This "Major Above-Critical" special case can only be treated effectively by reestablishing a sound foundation for the surface layer, hence its inclusion in the Major M&R policy.

FIGURE 3.4
COST BY PCI ASSUMPTIONS



CATEGORY \ PCI	100	90	80	70	60	50	40	30	20	10	0
Major	$0.5669	$0.8240	$0.9790	$1.3399	$1.6992	$2.0601	$2.4721	$2.9880	$3.6043	$4.1202	$4.7382
Local Preventative	$0.0000	$0.0000	$0.0165	$0.0412	$0.0544	$0.0824	$0.1648	$0.3296	$0.5768	$0.8240	$1.1339
Stop Gap/Safety	$0.0000	$0.0000	$0.0017	$0.0033	$0.0082	$0.0181	$0.0363	$0.0626	$0.1005	$0.1483	$0.2093

The Limited to Budget Report is an hybrid report which makes the best use of detailed inspection data for short-range predictions then switches to a more general, empirically verified long-range scheme. The first year predictions are based on a Consequence Model Report plus Global and Major repair options, while successive years use the same costs (see Figure 3.6) as the Minimum Condition Report. First year predictions of costs for local maintenance and conditions are determined from Localized Safety and Localized Preventative Maintenance Policies (Table 3.5) and their associated cost and consequence tables (Tables 3.6 and 3.7). In succeeding years, both Localized Safety and Preventative Maintenance costs are determined from the Cost by PCI table illustrated in Figure 3.4. Global M&R always takes its costs and consequences from user-defined values irrespective of pavement PCI's (see Table 3.8). In other words fog seals will have the same cost and useful life regardless of the quality of pavement they're applied to. Major Rehabilitation costs for all projection years are used from the Cost by PCI table in Figure 3.4.

TABLE 3.5
FIRST YEAR LOCALIZED MAINTENANCE POLICIES

LOCALIZED SAFETY OR "STOP-GAP"

Description	Severity	Treatment
Alligator Cracking	H	Patching - AC Deep
Block Cracking	H	Crack Sealing - AC
Depression	H	Patching - AC Deep
Jt. Ref. Cracking	H	Crack Sealing - AC
L & T Cracking	H	Crack Sealing - AC
Patching	H	Patching - AC Deep
Weath/Ravel	H	Patching - AC Shallow
Rutting	H	Patching - AC Deep
Shoving	H	Patching - AC Shallow
Slippage Cracking		Patching - AC Shallow
Swelling	H	Patching - AC Deep
Blow-Up	M	Patching - PCC Full Depth
Blow-Up	H	Patching - PCC Full Depth
Corner Break	H	Patching - PCC Full Depth
Linear Cracking	H	Crack Sealing - PCC
Durability Cracking	H	Slab Replacement - PCC
Small Patch	H	Patching - PCC Partial Depth
Large Patch/Utility	H	Patching - PCC Full Depth
Scaling/Crazing	H	Slab Replacement - PCC
Shattered Slab	H	Slab Replacement - PCC
Joint Spalling	H	Patching - PCC Partial Depth
Corner Spalling	H	Patching - PCC Partial Depth

LOCALIZED PREVENTATIVE

Description	Severity	Treatment
Alligator Cracking	H	Patching - AC Deep
Alligator Cracking	M	Patching - AC Deep
Block Cracking	H	Crack Sealing - AC
Block Cracking	M	Crack Sealing - AC
Depression	M	Patching - AC Deep
Depression	H	Patching - AC Deep
Jt. Ref. Cracking	H	Crack Sealing - AC
Jt. Ref. Cracking	M	Crack Sealing - AC
L & T Cracking	M	Crack Sealing - AC
L & T Cracking	H	Crack Sealing - AC
Oil Spillage		Patching - AC Shallow
Patching	M	Patching - AC Deep
Patching	H	Patching - AC Deep
Rutting	H	Patching - AC Deep
Rutting	M	Patching - AC Deep
Shoving	H	Patching - AC Shallow
Shoving	M	Patching - AC Shallow
Slippage Cracking		Patching - AC Shallow
Swelling	H	Patching - AC Deep
Swelling	M	Patching - AC Deep
Blow-Up	L	Patching - PCC Full Depth
Blow-Up	M	Slab Replacement - PCC
Blow-Up	H	Slab Replacement - PCC
Corner Break	H	Slab Replacement - PCC
Corner Break	M	Patching - PCC Full Depth
Linear Cracking	H	Crack Sealing - PCC
Linear Cracking	M	Crack Sealing - PCC
Durability Cracking	H	Slab Replacement - PCC
Durability Cracking	M	Patching - PCC Full Depth
Small Patch	M	Patching - PCC Full Depth
Small Patch	H	Patching - PCC Full Depth
Large Patch/Utility	H	Slab Replacement - PCC
Large Patch/Utility	M	Patching - PCC Full Depth
Scaling/Crazing	H	Slab Replacement - PCC
Scaling/Crazing	M	Slab Replacement - PCC
Faulting	H	Slab Replacement - PCC
Shattered Slab	M	Slab Replacement - PCC
Shattered Slab	H	Slab Replacement - PCC
Joint Spalling	H	Patching - PCC Partial Depth
Joint Spalling	M	Patching - PCC Partial Depth
Corner Spalling	M	Patching - PCC Partial Depth
Corner Spalling	H	Patching - PCC Partial Depth

TABLE 3.6
FIRST YEAR LOCALIZED MAINTENANCE COSTS

Repair Description	Cost
Crack Sealing - AC	$1.50/ft
Patching - AC Deep	$37.00/sf
Patching - AC Shallow	$15.00/sf
Crack Sealing - PCC	$1.50/ft
Patching - PCC Full Depth	$67.00/sf
Patching - PCC Partial Depth	$82.00/sf
Slab Replacement - PCC	$67.00/sf

TABLE 3.7
EXAMPLE FIRST YEAR REPAIR CONSEQUENCES

Crack Sealing - AC

Distress Description	Severity	New Distress Description	New Severity
Block Cracking	M	Block Cracking	L
Block Cracking	H	Block Cracking	L
Jt. Ref. Cracking	M	Jt. Ref. Cracking	L
Jt. Ref. Cracking	H	Jt. Ref. Cracking	L
L & T Cracking	M	L & T Cracking	L
L & T Cracking	H	L & T Cracking	L

TABLE 3.8
GLOBAL MAINTENANCE COSTS AND CONSEQUENCES

Repair Description	Cost	Application Interval	Years for PCI to Return to Preapplication Value
Overlay - AC Thin (Global)	$1.60/sf	10	5
Surface Seal - Fog Seal	$0.20/sf	5	2

Money is first allocated to sub-critical PCI sections for “stop gap” Localized Safety treatments. If it’s determined later that funding is available for major reconstruction of a section, then its stop-gap funds are redistributed. The second fiscal priority is to prolong the life of above-critical-PCI pavements with Local, then Global Preventative treatments. Local and Global Preventative funds are the example $1 invested near the critical PCI as shown in Figure 2.12 to avoid the necessity of spending $4 to $5 later. This investment in pavements before rapid deterioration produces an extended pavement life cycle as shown in Figure 3.2 and optimizes pavement quality per dollar spent. Major Under Critical and Major Above Critical repair treatments are prioritized for replacement by PCI and primary use as shown in Table 3.9.

TABLE 3.9
EFFECTIVE MAJOR M&R PRIORITIES

M&R Policy	PCI Range	Runways	Taxiways	Aprons
Major Above-Critical	100 - 70	2	4	6
	70 - Critical	1	3	5
Major Under-Critical	Critical - 40	1	3	5
	40 - 0	2	4	6

3.7 OTHER MICRO PAVER REPORTS (Available, but not included in this System Plan Update)

MicroPAVER provides several reporting options that are not included in this report since they do not directly address the intent of this project. They are briefly discussed here to provide insight on the potential advantages of implementing the pavement management system.

The **Inspection Schedule Report** allows the user to plan which pavements need to be inspected based on their current and expected conditions. This allows the user to time inspections for maximum effectiveness in identifying pavements in critical need of maintenance and/or reconstruction.

The **Condition History Report** allows the user to plot a specific pavement's history of PCI values through all of its existing PCI inspections. This option gives the user an at-a-glance assessment of an individual airport pavement's performance over time. This is available in graphical and tabular form under the heading "Condition Table" as part of the M&R Report, but was not included in this text. A 1-, 5-, and 10-year sampling are included in Table 3.1.

The MS Excel spreadsheets included in this report as Tables 2.4 and 3.1 can also be manipulated to perform many of the tasks possible in the MicroPAVER database. Depending on the computer equipment available and the expertise of the user, this spreadsheet format may be more convenient for some types of analysis.

MicroPAVER provides several other analysis routines to help the user decide among various maintenance and repair alternatives. These analysis and reporting options provide decision making information that may be useful for evaluating system-wide programs or for individual airport planning.

3.8 CONTINUED MICROPAVER IMPLEMENTATION

In addition to this report, the product for this 2009 Update to the Montana Aviation System Plan includes an up-to-date copy of the pavement database, and a current licensed copy of the MicroPAVER software. This will allow the Montana Aeronautics staff to use the software and database in their planning and budgeting efforts. Inspection reports and airport maps will be provided to Montana Aeronautics in a pdf-format for inclusion on their web site where they will be available to the public. Excerpts of the information contained in the reports are provided directly to airport managers, so they have a current indication of their pavement conditions and needs.

The continued success of this pavement management system is dependent on ongoing efforts to keep the database up to date. PCI surveys, conducted on a regular three-year cycle beginning in 1988, have collected pavement condition information for 64 of Montana's airports. Continued implementation of the current family models need not include surveys of each airport each time an update is completed. Instead, the frequency of inspections at each airport should be based on the likelihood of significant change since the last inspection. If previous survey results indicate an approaching PCI plateau, an airport could be skipped for a phase or two, allowing additional airports to be surveyed on available funds. Conversely, survey frequency should increase as conditions approach the critical PCI. The frequency of inspections at any given airport may also be based on the importance of that airport to the system, or the sponsor's needs for information to assess their maintenance and construction programs.

The PCI survey program depends on consistent inspection information to provide accurate and reliable estimates of condition and predictions of future condition. This is best achieved through strict compliance with the requirements of FAA Advisory Circular 150/5380-6 with the modifications from the Northwest Mountain Region handout "Pavement Condition Survey Program", since MicroPAVER is designed to work with these procedures. Personnel selected to conduct the PCI visual inspections should be well-trained, and experienced in the procedures outlined in these documents, to ensure the needed quality and consistency of data.

The program also benefits from close attention to detail in documenting the inspection and analysis processes. The MicroPAVER database, if properly maintained, preserves much of this data. FAA Forms 5320-1 also provide much of the needed information about pavement design criteria, and the definitions of sections and sample units. It is very important that these forms and the information they contain for Montana airports continue to be updated as changes occur, and that the information is updated in the MicroPAVER database. Coordination with the FAA, airport sponsors, and engineers working on airport improvement projects is essential in maintaining up-to-date records of the pavement systems in the database. Additional information, such as the spreadsheet summaries provided in this report should be carefully updated or noted as obsolete when database updates occur. Additionally, the MicroPAVER database may be compatible with other airport information management systems, providing a powerful combination of information in convenient formats. Because of the architecture of the database, it can be coordinated with other programs. Such efforts may require direct coordination with the developers of the program at the United States Army Corps of Engineers Research Labs.

Predictions developed for this update use a slowly evolving set of families. As noted earlier in this chapter, family analysis curves can be re-defined in any way the user desires. Results obtained in this update suggest that maintenance practices actually occurring on Montana's airports may play an increasingly important role in slowing pavement aging. As a result, future updates to the plan may be improved by increased attention to actual maintenance on each pavement section, and revised family analysis curves that account for differences in maintenance. Changes to the family analysis curves should not be undertaken without careful analysis however, since consistency of results is of great importance to the success of the program. Three rounds of inspections under a new maintenance regimen and increased federal investment in Montana's airport infrastructure does not yet provide enough data to split families into "well-maintained" and "poorly-maintained" groups. Most of the current families do not have enough survey points to divide without compromising the statistical validity of the data, especially on the aged end of the graph. In fact, should excellent maintenance continue, the database will not add any "below critical PCI" information; and while this will be good news to airport users, it adds more uncertainty to end-of-cycle PCI predictions.

Even with Montana's current wealth of data (using all inspections from 1988-2009; roughly 2760 PCI determinations from 39,000 recorded distresses) we are probably limited to 5-15 families. It is a very fine line between having enough types of families to fairly accurately model the different pavements in the State, and having too many families to be accurately defined by the existing data. To be "well-defined" a family must have inspections of representative pavements at a good range of ages. If pavements are less representative of the group, or data is lacking for a cluster of ages (especially the downward curve after critical PCI) a family can only be constructed with a good deal of engineering judgement, and as such, it may represent that judgement, more than the empirical reality. The challenge becomes choosing which few of the numerous common-sense delimiters create families with good statistical properties.

As this pavement management system evolves, it may be appropriate to slowly phase in one or more new criteria (maintenance practices, freeze-thaw cycling, insolation, etc.) in place of, or in addition to the current four criteria (pavement type, functional use, design strength, operations counts) while trying to maintain approximately 10 families. For example, operations counts were phased into the most data-rich family in 2003 as a way to split an overly large set (ACRM became ACRML and ACRMU). Functional usage was dropped from the light-duty design load pavements in 2006 creating two families where formerly there were four. There were not nearly enough "under 12,500 lb design load" or "surface treatments" remaining in the

State to warrant four families, so ACAL and ACRL were combined into ACPL, while STAA and STRA were lumped into STPA. There are no families with an excess of data, ripe for dividing into meaningful subsets. The families STPA and ACPL represent very few active pavements, but enough to keep around for a few more iterations. In short, the set of families from 2006 are currently functioning very well with no indications of a need for change at this time.

Appendix Figure A.1 is included to illustrate that the current set of families is fairly robust, although it also hints at how the high-age end of the graphs (with the least data) can show significant variation from year to year. Note how slight raising of the 0-5 year portions of each graph reflect a number of reconstructed airports and improving early preventative maintenance.

Finally, the Montana airport pavement database and associated software systems can only provide benefits if they are actively used to help manage Montana's airport pavements. The entire purpose of the program is to provide information to decision makers. Whether it is used by the Montana Aeronautics Division, the Federal Aviation Administration, airport sponsors, planners, or engineers, the system can be used to provide meaningful information about pavement conditions, performance, policies, and budget allocations.

CHAPTER 4
AIRPORT REPORT SUMMARIES

CHAPTER 4 AIRPORT REPORT SUMMARIES

4.1 INTRODUCTION

This chapter contains the airport inspection report summaries, maintenance reports, inspection photos, and updated FAA forms 5320-1 (Airport Layout Maps with Pavement Strength Survey / Pavement Condition Survey) for each airport surveyed in the 2009 Update to the Montana Aviation System Plan.

Airports are arranged alphabetically by the name of the city in which they are located and maps are folded so that the city name sticks out to provide a convenient locating tab. The city name also appears in large, bold print at the top left corner of each inspection report and maintenance report page. Inspection and summary data is grouped by section and samples which are called out on the included map. The first character of a section name is coded to its primary use, so **A-3** will be an apron, **R-1** a runway, and **T-5A** a taxiway. These section designations are in large, bold print at the top right corner of each inspection report page.

4.2 INSPECTION REPORT SUMMARIES

The Airport Inspection Report Summaries are presented for each airport using MicroPAVER's "Inspection Report" to compile the 2009 PCI survey project data and perform calculations, then refined and reformatted using MS Access. A variety of descriptive information about the section is listed immediately below the header on the left three quarters of the page, while the database classification codes for the section are on the right margin. The Inspections section presents first and foremost the section PCI in a medium-sized, bold print, followed by the sampling rate and date of inspection. The specific, recorded distresses for a number of samples completes the documentation of the field surveys. The Extrapolated Distress Quantities section approximates the distresses present in the entire section from those measured in the sampled areas, and shows values for intermediate steps in the PCI calculation routine. The Distresses are listed in order of decreasing "deducts," so the distresses listed first are those causing most damage to the pavement. Maintenance concerns should be prioritized to address these distresses in the order they appear. The classification by distress mechanism may point to the most significant force in pavement deterioration. Finally, no entry in a given section of an inspection report simply means there were no measurable distresses in the sample inspected.

4.3 MAINTENANCE REPORT SUMMARIES

The Maintenance Report Summaries are presented for each airport using MicroPAVER's Budget Constrained M&R Report with Unlimited Budget to project the 2009 survey data into a local repair recommendation and a fifteen year budgeting projection. The results are refined and reformatted using MS Access. The First Year Local Report lists a number of distresses that could be repaired locally to promote safety and pavement life and suggests types of repairs and probable costs. Fifteen Year Projections estimate an annual budget necessary to keep all airport pavements above their critical PCI's, as well as detailing a time line of suggested repairs. The section designation requiring work and an abbreviated treatment suggestion are located along the left edge of the page, with total cost and resulting change in PCI along the right page edge. The detailed breakdown of cost by treatment is listed in the center. A section is not called out in parts of the maintenance report if it is in satisfactory condition and needs no repairs.

4.4 INSPECTION PHOTOS

One or more pages of inspection photos are provided for each airport to illustrate specific pavement distresses identified in the 2009 survey, or to show the overall appearance of pavement sections. We have increased the number and size of the photos, typically providing both an overview and close-up detail of each pavement section. This “virtual tour” of Montana’s airports will provide the report reader with a clearer understanding of the conditions that contributed to our evaluations.

While inspections are completed for typical representative sample areas, photos often strive to document the worst pavement distresses of a section - *they often show the exception, not the rule*. These photos document the extremes of our evaluation and instruct airport managers and others charged with maintaining Montana’s pavements what to look for on an airport pavement. Copies of these photos will be provided for inclusion on Montana Aeronautics Division’s web site.

4.5 FAA FORM 5320-1

The FAA form 5320-1 for each airport is a standard form that describes the components of each pavement section, and identifies pavement improvement dates. The form has been adapted to also show sample units defined for each pavement section. This allows the field-inspected sample units to be precisely located on the airport, and allows consistent sampling from PCI project to project.

4.6 REPORTS

The information presented in this chapter for individual airports is also provided directly to each airport's manager, for their use in planning improvements to their airport pavements.

Some pavement sections were not included in the current survey, either because they were brand new and assumed to be in "perfect" condition, or because they are abandoned, not maintained, not part of the federally financed system, T-hangar taxiways, or too small to significantly affect the program. A few sections were left out of the 2009 scope of work since they have deteriorated well below the critical PCI, so no significant information could be gained from their inspection. These omitted pavement sections are listed in Table A.3 in the appendix along with reasons for omission.

Individual airport reports for 2009 surveyed airports follow:

TABLE A.1
PAVEMENT DISTRESSES

ASPHALT PAVEMENTS

Distress Name	Description
Alligator Cracking	Load related - a major distress
Bleeding	Excess asphalt cement on surface reduces traction - design or construction defect
Block Cracking	Rectangular, interconnected cracks - related to climate, age, durability
Corrugation	Closely spaced ridges & valleys, perpendicular to traffic, caused by braking action & unstable pavement base.
Depression	Low spots by settlement or load, cause roughness and future deterioration
Jet Blast	Asphalt has been burned by jet engines
Joint Reflection	Caused by movement of Portland cement under an asphalt overlay - will cause future problems
Longitudinal & Transverse Cracking (L & T Crack)	Random cracks, usually not load related, but due to poor construction joints or climate/age/durability
Oil Spillage	Usually on aprons - softens asphalt and speeds aging process
Patching	A defect no matter how well-done
Polished Aggregate	Aggregate is worn smooth - poor traction
Ravelling/Weathering	Pavement is disintegrating - asphalt cement has hardened with age, or extreme load damage
Rutting	Surface depression in wheel path - almost always from snowplows and sand trucks
Shoving from PCC	Asphalt is crushed from adjacent PCC movement
Slippage Cracking	Minor cracks - caused by braking or turning wheels
Swell	Upward bulge - usually from frost heave or expansive clays below pavement.

TABLE A.1 (continued)
PAVEMENT DISTRESSES

PORTLAND CEMENT PAVEMENTS

Distress Name	Description
Blow-Up	Slabs expand in hot weather and crush each other
Corner Break	Poor support at corner of slab, combined with loading
Longitudinal / Transverse / Diagonal Cracks	Cracks extend clear across a slab dividing it into two or three pieces
“D” Crack	Durability Cracks - climate related
Joint Seal Damage	Poor or missing crack sealant - lets water and incompressible materials between slabs - can cause blow-up, pumping, spalling
Patching < 5 ft^2	A defect no matter how well-done
Patching / Utility Cuts	A defect no matter how well-done
Popouts	Small piece of pavement dislodged from surface - freeze / thaw or poor aggregate
Pumping	Subgrade materials are liquefied and then “pumped” up through cracks when loaded
Scaling/Map Cracking/Crazing	Hairline cracks in surface - usually caused by over-finishing the surface, or by climate factors
Settlement Fault	Slabs move up/down at joint with respect to each other
Shattered Slab	Cracked into four or more pieces
Shrinkage Crack	Short, fine surface cracks, usually a construction defect
Spalling - Joints	Edges broken along slab joints, usually near surface only - due to incompressible materials in joints
Spalling - corners	Breaks in slab at joint corners, usually near surface only - due to incompressible materials in joints

TABLE A.2
SECTIONS OMITTED FROM 2009 PCI SURVEY

AIRPORT	OMITTED SECTION	REASON FOR OMISSION
Anaconda	A-3, T-3	Private Apron & Taxiway
Baker	Adjacent to Hangars	Private Taxiways
	A-8	Area < 10,000 sf
Big Sandy	North Apron	Private Apron
Chester Old Runway Turnaround	Not Maintained	
	A-2, A-3, A-4	Not Maint. / Scope Agreement
Choteau Southeast Apron	Private Apron	
	A-2	Not Maintained
Circle	T-4	Private Taxiways
Colstrip Hangar Taxiways	Area < 10,000 sf	
Conrad	A-2, T-3	Private / Not Maintained
	Turnaround	Area < 10,000 sf
Cut Bank	Adjacent to Hangars	Private Taxiways
Deer Lodge	T-1C	Not Maintained
Dillon	R-4A, Apron Remnants	Area < 10,000 sf
Forsyth A-2	Area < 10,000 sf	
	Various	Private Hangar Taxiways
Glasgow	North Apron	Improved Gravel- Not Pavement
Glendive	T-4	Hangar Taxiways
Hamilton	T-1	Area < 10,000 sf
	T-4, T-6	Private Hangar Taxiways
Harlem	T-3	Area < 10,000 sf
	A-1	Not Maintained / Scope Agreement
Havre	Various	Private Aprons & Hangar Taxiways
Laurel	T-5, T-6, T-7, T-10	Private Hangar Taxiways
	R-2, R-3	Not Maintained / Scope Agreement
Lewistown	R-1A, R-31, T-6	Not Maintained
	R-1	Not Maintained / Scope Agreement
Libby	T-3	Hangar Taxiways

TABLE A.2 (continued)
SECTIONS OMITTED FROM 2009 PCI SURVEY

AIRPORT	OMITTED SECTION	REASON FOR OMISSION
Livingston	Midfield Turnaround	Not Maintained
	A-3, T-2, T-3, T-4	Area < 10,000 sf
Malta	A-2	Area < 10,000 sf
Miles City	A-1, Various	Private Hangar Taxiways
	R-11A, R-21A, T-5A	Not Maintained
Plentywood	A-2	Private Apron
	T-3	Hangar Taxiway
Polson	A-3	Area < 10,000 sf
	T-13	Hangar Taxiway
Ronan	T-2, T-3, T-4	Hangar Taxiways
Roundup	T-2	Hangar Taxiway, Area < 10,000 sf
Shelby	Turnarounds	Area < 10,000 sf
Sidney	Various	Private Hangar Taxiways
	A-1A, A-5A, T-5	Area < 10,000 sf
Stanford	Chemical Washpad	Private Apron
	Runway Transition	Area < 10,000 sf
Stevensville	Adjacent to Hangars	Private Taxiway
Superior	Adjacent to Hangars	Private Taxiway
Terry	Turnaround & Access Taxiway	Area < 10,000 sf
Thompson Falls	T-3	Area < 10,000 sf
	North Side Hangar Access	Private Taxiway
Three Forks	Various	Private Access / Taxiway
Turner	T-1	Area < 10,000 sf / Private
Twin Bridges	Turnarounds	Area < 10,000 sf
	A-2, Various	Private Hangar Access
West Yellowstone	USFS facilities	Private Taxiway & Apron

TABLE A.3
FIRST YEAR REPAIR CONSEQUENCES

Crack Sealing - AC Consequences

Distress / Description	Severity	New Distress / Desc	New Severity
Block Cracking	H	Block Cracking	L
Block Cracking	M	Block Cracking	L
Jt. Ref. Cracking	H	Jt. Ref. Cracking	L
Jt. Ref. Cracking	M	Jt. Ref. Cracking	L
L & T Cracking	H	L & T Cracking	L
L & T Cracking	M	L & T Cracking	L

Patching - AC Deep Consequences

Distress / Description	Severity	New Distress / Desc	New Severity
Alligator Cracking	H	Patching	L
Alligator Cracking	M	Patching	L
Depression	H	Patching	L
Depression	M	Patching	L
Patching	H	Patching	L
Patching	M	Patching	L
Rutting	H	Patching	L
Rutting	M	Patching	L
Swelling	H	Patching	L
Swelling	M	Patching	L

Patching - AC Shallow Consequences

Distress	Severity	New Distress	New Severity
Oil Spillage	X	Patching	L
Weathering/Raveling	H	Patching	L
Shoving	H	Patching	L
Shoving	M	Patching	L
Slippage Cracking	X	Patching	L

TABLE A.3 (continued)
FIRST YEAR REPAIR CONSEQUENCES

Crack Sealing - PCC Consequences

Distress	Severity	New Distress	New Severity
Linear Cracking	H	Linear Cracking	L
Linear Cracking	M	Linear Cracking	L

Slab Replacement - PCC Consequences

Distress	Severity	New Distress	New Severity
Blow-Up	H		
Blow-Up	M		
Corner Break	H		
Durability Cracking	H		
Large Patch/Utility	H		
Scaling/Crazing	H		
Scaling/Crazing	M		
Faulting	H		
Shattered Slab	H		
Shattered Slab	M		

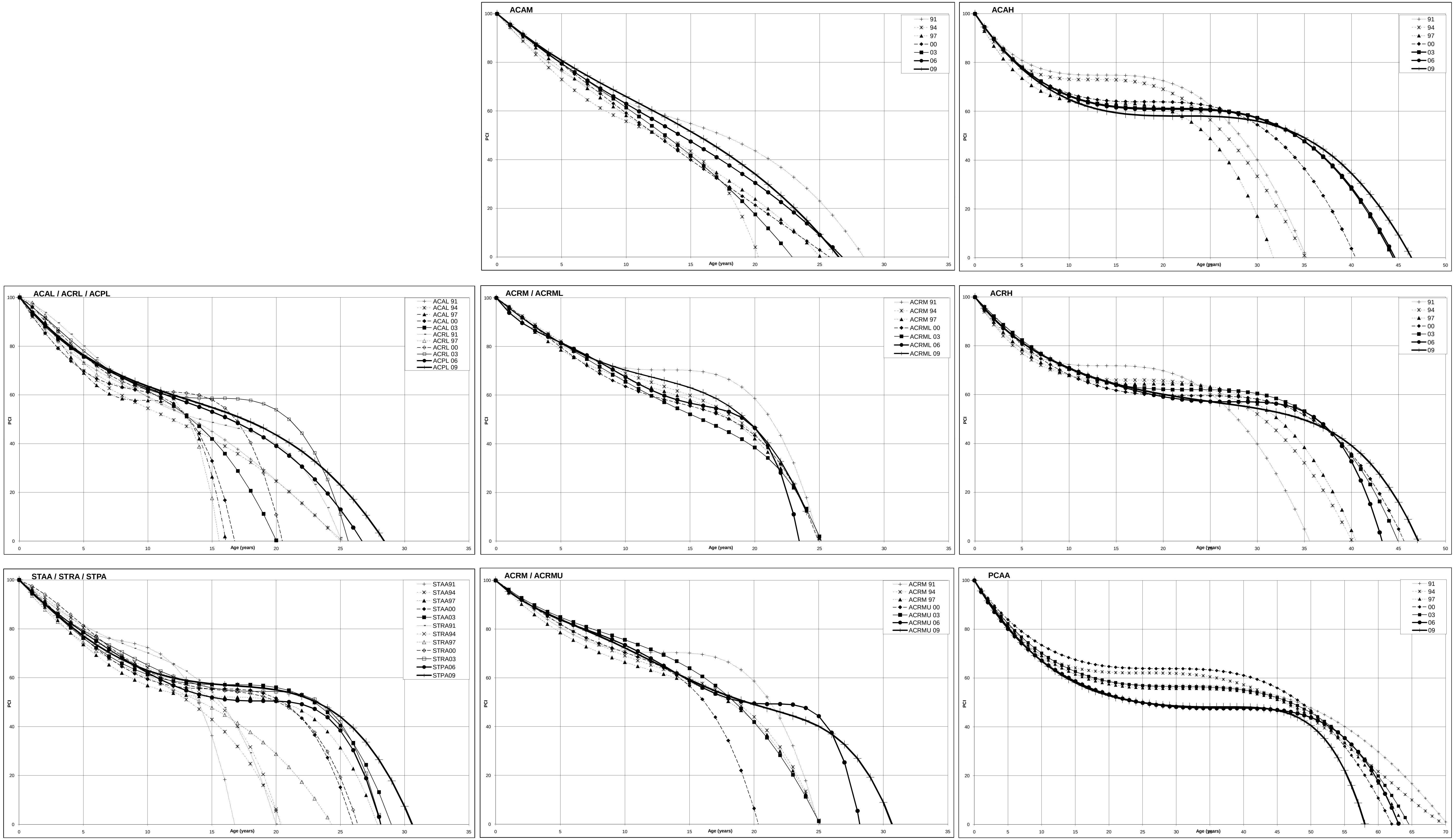
Patching - PCC Full Depth Consequences

Distress	Severity	New Distress	New Severity
Blow-Up	H	Large Patch/Utility	L
Blow-Up	L	Large Patch/Utility	L
Blow-Up	M	Large Patch/Utility	L
Corner Break	H	Large Patch/Utility	L
Corner Break	M	Large Patch/Utility	L
Durability Cracking	M	Large Patch/Utility	L
Small Patch	H	Small Patch	L
Small Patch	M	Small Patch	L
Large Patch/Utility	H	Large Patch/Utility	L
Large Patch/Utility	M	Large Patch/Utility	L

Patching - PCC Partial Depth Consequences

Distress	Severity	New Distress	New Severity
Small Patch	H	Small Patch	L
Joint Spalling	H	Large Patch/Utility	L
Joint Spalling	M	Large Patch/Utility	L
Corner Spalling	H	Large Patch/Utility	L
Corner Spalling	M	Small Patch	L

FIGURE A.1
FAMILY COMPARISONS



coefficients	ACAL					ACRL				ACPL	
constant	100	100	100	100	100	100	100	100	100	100	100
linear	-7.783	-8.537	-2.068	-7.764	-6.997	-6.663	-3E-07	-3.217	-3.721	-6.487	-6.278
quadratic	0.64	0.62	-2.02	0.0854	0.533	0.1575	-2.468	-0.745	-0.314	0.3793	0.3528
cubic	-0.032	-0.025	0.2971	0.0725	-0.022	0.0107	0.3478	0.1037	0.0405	-0.01	-0.009
quartic	5E-04	3E-04	-0.012	-0.004		-5E-04	-0.014	-0.003	-9E-04		
quintic									-9E-06		
critical PCI				55	55			55	55	50	50
outlier				90%	90%			90%	80%	90%	90%
corr coeff				0.78	0.85			0.71	0.90	0.77	0.75
Std of err				13.60	12.50			14.44	7.90	13.80	13.85
year	A 91	A 94	A 97	A 00	A 03	R 94	R 97	R 00	R 03	P 06	P 09

coefficients	ACAM							ACAH						
constant	100	100	100	100	100	100	100	100	100	100	100	100	100	100
linear	-4.891	-5.402	-4.85	-4.198	-4.493	-4.672	-4.55	-5.81	-6.907	-7.627	-5.918	-5.664	-5.686	-5.735
quadratic	-0.056	-0.192	0.0567	0.0057	0.109	0.1333	0.1656	0.4614	0.6204	0.5293	0.3233	0.2759	0.2749	0.2615
cubic	0.0238	0.0469	0.0024	0.0008	-0.005	-0.004	-0.005	-0.014	-0.022	-0.012	-0.006	-0.004	-0.004	-0.004
quartic	-8E-04	-0.002	-1E-04	-2E-05				8E-05	0.0002					
quintic														
critical PCI				50	55	50	50				60	60	60	55
outlier				90%	90%	90%	90%				90%	90%	90%	90%
corr coeff				0.85	0.88	0.84	0.83				0.63	0.68	0.78	0.81
Std of err				11.11	9.60	9.97	9.83				12.44	12.91	11.82	11.69
year	91	94	97	00	03	06	09	91	94	97	00	03	06	09

coefficients	ACRM			ACRML				ACRMU			
constant	100	100	100	100	100	100	100	100	100	100	100
linear	-4.1	-3.648	-5.259	-3.428	-4.497	-7.368	-4.293	-3.528	-4.137	-4.434	-5.163
quadratic	-0.093	-0.058	0.1823	-0.287	0.2764	1.4345	0.059	-0.178	0.2775	0.1423	0.6476
cubic	0.0332	0.0177	0.0048	0.0373	-0.033	-0.188	0.0135	0.0409	-0.011	0.0489	-0.064
quartic	-0.001	-6E-04	-4E-04	-0.001	0.002	0.0107	-6E-04	-0.002		-0.008	0.0028
quintic					-4E-05	-2E-04				0.0004	-4E-05
										-6E-06	
critical PCI				50	50	55	60	55	60	50	50
outlier				90%	90%	99%	99%	90%	90%	99%	99%
corr coeff				0.83	0.83	0.70	0.67	0.73	0.76	0.73	0.78
Std of err				9.07	8.48	11.40	11.10	9.55	7.52	10.49	10.22
year	M 91	M 94	M 97	L 00	L 03	L 06	L 09	U 00	U 03	U 06	U 09

coefficients	ACRH							STAA				
constant	100	100	100	100	100	100	100	100	100	100	100	100
linear	-6.4	-6.481	-5.625	-4.643	-4.109	-5.257	-4.925	-5.967	-3.011	-5.504	-3.962	-5.052
quadratic	0.5039	0.4276	0.2865	0.1501	0.1076	0.3976	0.2887	0.2342	-0.341	-0.069	-0.359	-0.035
cubic	-0.015	-0.011	-0.004	-1E-05	0.0015	-0.022	-0.011	0.0416	0.0385	0.0264	0.048	0.0217
quartic	0.0001	6E-05	-2E-05	-5E-05	-7E-05	0.0007	0.0003	-0.003	-0.001	-8E-04	-0.001	-6E-04
quintic						-8E-06	-3E-06					
critical PCI				55	60	55	50				50	55
outlier				90%	90%	90%	90%				90%	(90%)
corr coeff				0.74	0.81	0.82	0.85				0.76	0.76
Std of err				9.74	8.49	8.92	8.59				12.78	10.60
year	91	94	97	00	03	06	09	AA91	AA94	AA97	AA00	AA03

coefficients	STRA					STPA		PCAA						
constant	100	100	100	100	100	100	100	100	100	100	100	100	100	100
linear	-4.184	-3.445	-6.815	-1.946	-6.204	-5.534	-5.16	-4.674	-4.948	-4.34	-3.864	-4.182	-4.864	-4.374
quadratic	-0.004	-0.382	0.4	-0.602	0.691	0.42702	0.0688	0.1791	0.2296	0.1417	0.1376	0.1346	0.2038	0.094
cubic	0.0266	0.0576	-0.012	0.0558	-0.073	-0.04841	0.0115	-0.003	-0.004	-0.002	-0.002	-0.001	-0.005	0.0029
quartic	-0.001	-0.002		-0.001	0.0038	0.00288	-4E-04	1E-05	3E-05				9E-05	-2E-04
quintic					-7E-05	-5.7E-05							-7E-07	4E-06
critical PCI				50	55	50	55				60	55	50	45
outlier				95%	90%	90%	90%				90%	80%	90%	90%
corr coeff				0.82	0.76	0.80	0.79				0.86	0.86	0.77	0.76
Std of err				10.26	10.25	10.31	10.78				9.58	9.83	12.78	13.05
year	RA91	RA94	RA97	RA00	RA03	PA06	PA09	91	94	97	00	03	06	09

YEARCMPR.XLS Families

FIGURE A.2

ASPHALT PAVEMENT DISTRESSES BY CAUSES

Load	Climate/Durability	Other
Alligator Cracking	Block Cracking	Bleeding
Rutting	Joint Reflection Cracking	Corrugation
	Longitudinal/Transverse Cracking	Depression
	Patching	Jet Blast
	Weathering/Raveling	Oil Spillage
		Polished Aggregate
		Shoving
		Slippage Cracking
		Swelling

CONCRETE PAVEMENT DISTRESSES BY CAUSES

Load	Climate/Durability	Other
Corner Break	Blow-Up	Small Patch
Linear Cracking	Durability Cracking	Large Patch/Utility
Shattered Slab	Joint Seal Damage	Popouts
		Pumping
		Scaling/Crazing
		Faulting
		Shrinkage Cracking
		Joint Spalling
		Corner Spalling

PRIMER

PRIMER

Pavement Distresses – Descriptions, Causes, Classification, & Repair

The following pavement distresses commonly found on Montana's airport pavements are included in this "primer":

Asphalt (AC) Pavement Distresses:
Alligator Cracking
Bleeding
Block Cracking
Depression
Joint Reflection Cracking from PCC
Longitudinal & Transverse Cracking (Filled)
Longitudinal & Transverse Cracking (Non-Filled)
"Oil" Spillage
Patching
Raveling and Weathering (Mechanical)
Raveling and Weathering (Wear)
Rutting
Shoving from PCC
Swell

Concrete (PCC) Pavement Distresses:
Corner Break
Cracks: Longitudinal, Transverse, & Diagonal
Joint Seal Damage
Scaling, Map Cracking, and Crazing
Settlement or Fault
Shattered Slab
Spalling (Corner)
Spalling (Joints)

Technical material in this section is based on the following sources:

Pavement Maintenance Management for Roads and Streets Using The PAVER System, US Army Construction Engineering Research Laboratory, Technical Report M-90/05, July 1990, M.Y. Shahin and J.A. Walther.

Pavement Management for Airports, Roads and Parking Lots, M.Y. Shahin, 1994, Chapman and Hall.

Guidelines and Procedures for Maintenance of Airport Pavements
FAA AC 150/5380-6, 1982.

All photos are taken by employees of Robert Peccia & Associates.

Development of the pavement condition index (PCI) and the "PAVER" system is conducted by the US Army Construction Engineering Research Laboratory with support from: American Public Works Association, Federal Aviation Administration, Federal Highway Administration, US Air Force Engineering and Services Center, US Army Corps of Engineers, and US Navy.

Pavement Maintenance Management Systems like MicroPAVER® have been developed to:

- ❖ Assess overall pavement condition based on accumulated pavement distress.
- ❖ Set standard repair practices for common pavement distresses.
- ❖ Determine maintenance and rehabilitation needs and priorities.
    - Project life-cycle costs of repair and replacement options.
    - Decide when replacement is more economical than continued repair.
    - Optimize timing of repairs to preserve the infrastructure investment.
- ❖ Optimize pavement performance with available funds.
- ❖ Project future pavement conditions and maintenance requirements.

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Alligator Cracking

AC

Description: A series of interconnecting cracks caused by fatigue failure on the asphalt concrete surface under repeated traffic loading.

Causes: Loads in excess of the current pavement strength. Heavy aircraft, snow plows, fuel trucks, delivery trucks. Substandard installation or degradation of subgrade, subbase, and / or base course.

Light

Fine parallel hairline cracks with few or no interconnecting cracks. No spalling.
Repair: Do nothing / SurfaceSeal / Overlay

Medium

Pattern or network of cracks that may be lightly spalled.
Repair: Partial or full depth patch / Overlay / Reconstruct

High

Pattern or network of cracks with well-defined pieces and spalled edges
Repair: Partial or full depth patch / Overlay / Reconstruct

Bleeding

AC

Description: A film of bituminous material on the pavement surface that usually becomes sticky when hot and can cause hydroplaning when wet.

Causes: Excessive amounts of asphalt cement or tars in the mix and/or low air void content.

Yes/No

Extensive enough to cause reduced skid resistance.
Repair: Do Nothing / Heat, Sand & Sweep

Block Cracking

AC

Description: 1x1 foot to 10x10 feet interconnected cracks that divide the pavement into approximately rectangular pieces.

Causes: Shrinkage of the asphalt concrete and daily temperature cycling coupled with significant asphalt hardening.

Light Non- or only lightly-spalled Blocks with no foreign object damage/debris (FOD) potential. Nonfilled cracks have ¼ inch or less mean width and filled cracks have filler in satisfactory condition. Repair: Do nothing / Apply rejuvenator

Medium
* filled or nonfilled cracks that are moderately spalled
* nonfilled cracks with mean width greater than approximately ¼ inch
* filled medium cracks with failed sealant

Repair: :Seal cracks / Apply rejuvenator / Recycle surface / Heater scarify & overlay

High Severely spalled cracks with a definite FOD potential
Repair: Seal cracks / Recycle surface / Heater scarify and overlay

Depression

AC

Description: Localized pavement surface areas having elevations slightly lower than those of the surrounding pavement; "birdbath" areas; could cause hydroplaning & accelerate pavement decay.

Causes: Settlement of the foundation soil or improper construction.

Light

Mean Depth: Runways/Taxiways:1/8-½ inch Apron: ½-1 inch
Repair: Do nothing

Medium

Mean Depth: Runways/Taxiways: >1/2-1 inch
Apron: >1-2 inches
Repair: Partial or full depth patch.

High

Mean Depth: Runways/Taxiways: >1 inch
Apron: >2 inches
Repair: Partial or full depth patch

Joint Reflection Cracking From PCC

AC

Description: Cracks translated upward through an asphalt or tar surface over a portland cement concrete (PCC) Slab at the slab joints.

Causes: Movement of the PCC slab beneath the asphalt concrete (AC) surface due to thermal and moisture changes.

Light

- Filled or nonfilled cracks have light or no spalling.
- Nonfilled cracks have a mean width of ¼ inch or less.
- Filled cracks are of any width, but with filler material in satisfactory condition.

Repair: Do nothing / Seal cracks over 1/8 inch

Medium

- Filled or nonfilled cracks are moderately spalled.
- Filled cracks are not spalled or are only lightly spalled but with failed filler.
- Nonfilled cracks have mean crack width greater than ¼ inch with light/no spalling.

Repair: Seal cracks / Partial depth patch

High

Cracks are severly spalled (definate FOD potential).

Repair: Seal cracks / Partial depth patch / Reconstruct Joint

Longitudinal & Transverse Cracking (Filled)

AC

Description: Asphalt pavement cracking along or across the laydown direction.

Causes: Poorly constructed paving lane joint, shrinkage of the AC surface due to low temperatures or hardening of the asphalt, or a reflective crack caused by cracks beneath the surface course.

Light

- Nonfilled cracks have a mean width of ¼ inch or less
- Filled cracks are of any width, but their filler material is in satisfactory condition
- Cracks have no or minor spalling (little or no FOD potential).

Repair: Do nothing seal cracks over 1/8 inch / Surface seal

Medium

- Nonfilled cracks have mean crack width greater than ¼ inch possibly with light spalling.
- Filled or non filled cracks are moderately spalled (some FOD potential).
- Filled cracks have failed sealant with possible light spalling.

Repair: Seal cracks

High

Cracks are severly spalled, causing definite FOD potential. They're usually greater than 1 inch wide.

Repair: Seal cracks; Partial depth patch

Longitudinal & Transverse Cracking (Non-Filled)

AC

Description: Asphalt pavement cracking along or across the laydown direction.

Causes: Poorly constructed paving lane joint, shrinkage of the AC surface due to low temperatures or hardening of the asphalt, or a reflective crack caused by cracks beneath the surface course.

Light

- Nonfilled cracks have a mean width of ¼ inch or less
- Filled cracks are of any width, but their filler material is in satisfactory condition
- Cracks have no or minor spalling (little or no FOD potential).

Repair: Do nothing seal cracks over 1/8 inch / Surface seal

Medium

- Nonfilled cracks have mean crack width greater than ¼ inch possibly with light spalling.
- Filled or non filled cracks are moderately spalled (some FOD potential).
- Filled cracks have failed sealant with possible light spalling.

Repair: Seal cracks

High

Cracks are severly spalled, causing definite FOD potential. They're usually greater than 1 inch wide.

Repair: Seal cracks; Partial depth patch

"Oil" Spillage

AC

Description: Deterioration or softening of the pavement surface caused by the spilling of oil, fuel, or other solvents.

Causes: Spills, leaks, accidents, etc.

Yes/No spillage exists
Repair: Do nothing / Partial or full depth patch

AC

Patching

Description: An interruption in the continuous pavement mat. which reduces mat strength and may provide a path for moisture intrusion or adversely affect ride quality. A patch is considered a defect, no matter how well it is performing.

Causes: Tiedown anchors, pavement cores, utility cuts, and other pavement removal and replacement.

Light

Patch is in good condition and is performing satisfactorily.
Repair: Do nothing

Medium

Patch and /or patch joint has deteriorated and/or affects riding quality.
Repair: Seal cracks/Repair distress in patch/Replace patch

High

Patch and/or patch joint has badly deteriorated resulting in high FOD potential and poor ride quality.
Repair: Replace patch

AC

Raveling and Weathering (Mechanical)

Description: Wearing away of the pavement surface including dislodging of aggregate particles and loss of asphalt or tar binder.

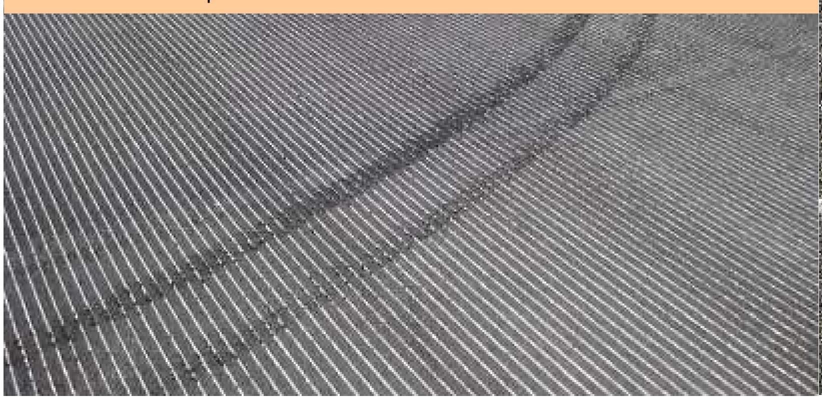
Causes: Plow scrapes, tracking of mud and gravel onto airport pavements by automobiles and sweeping.

Light

Aggregate or binder has started to wear away, causing little or no FOD potential.
Repair: Do nothing

Medium

FOD potential develops - surface becomes moderately rough and pitted with some loose chips.
Repair: Surface seal



High

High FOD potential - surface is severely rough and pitted with numerous loose chips.
Repair: Overlay / Recycle / Reconstruct

Raveling and Weathering (Wear)

AC

Description: Wearing away of the pavement surface including dislodging of aggregate particles and loss of asphalt or tar binder.

Causes: Use (including especially plow scrapes, touchdowns, braking and turning) and/or ultraviolet exposure that oxidizes & hardens the asphalt binder.

Light

Aggregate or binder has started to wear away, causing little or no FOD potential.
Repair: Do nothing / Surface seal

Medium

FOD potential develops - surface becomes moderately rough and pitted with some loose chips.
Repair: Surface seal

High

High FOD potential - surface is severely rough and pitted with numerous loose chips
Repair: Overlay /Recycle / Reconstruct

Rutting

AC

Description: A surface depression in the wheel path indicating structural failure of the pavement. Pavement uplift may occur along the sides of the rut.

Causes: Traffic loads exceeding the pavement section's strength, resulting in a permanent consolidation or lateral movement of the pavement layers or subgrade. A heavily loaded plow on wet spring subgrades may be the most common cause of rutting.

Light ≤ ¼ - ½ inch mean depth
Repair: Do nothing

Medium > ½ inch ≤ 1 inch mean depth
Repair: Partial or full depth patch / Patch and overlay

High > 1 inch mean depth
Repair: Partial or full depth patch / Patch and overlay

AC

Shoving From PCC

Description: A swelling and cracking of asphalt pavements where they adjoin concrete slabs.

Causes: Concrete pavements grow in size as the joints between slabs fill with debris. The increasing size of the slabs shoves and deforms adjacent asphalt pavements.

Light A slight amount of shoving has occurred, with little effect on ride quality and no asphalt break-up.
Repair: Do nothing

Medium A significant amount of shoving has occurred, causing moderate roughness and little or no asphalt break-up.
Repair: Partial depth patch / full depth patch

High A large amount of shoving has occurred, causing severe roughness or break-up of the asphalt pavement.
Repair: Partial depth patch / full depth patch

Swell

AC

Description: An upward bulge in the pavement's surface, sharply over a small area, or as a longer, gradual "wave" possibly accompanied by surface cracking.

Cause: Frost action in the subgrade or construction errors.

Light < ¾ inch height differential
Repair: Do nothing

Medium ¾ - 1 ½ inches height differential
Repair: Reconstruct / Patch

High > 1 ½ inch height differential
Repair: Reconstruct / Patch

Corner Break

PCC

Description: A crack that intersects the joints at a distance less than or equal to one-half the slab length on both sides, measured from the corner of the slab. The crack extends vertically through the entire slab thickness.

Causes: Load repetition combined with loss of support and curling stresses.

Light

Crack has either no spalling or minor spalling (no FOD potential) with a mean width less than approximately 1/8 inch.
Repair: Do nothing / Seal cracks / Undersealing project

Medium

* A nonfilled crack has a mean width between 1/8 inch and 1 inch.
* Moderately spalled.
* Failed filler.

Repair: Seal cracks / Full depth patch / Slab replacement / Undersealing project

High

* A nonfilled crack has a mean width greater than approximately 1 inch.
* Severely spalled.

Repair: Seal cracks / Full depth patch / Slab replacement / Undersealing project

Cracks: Longitudinal, Transverse, & Diagonal

PCC

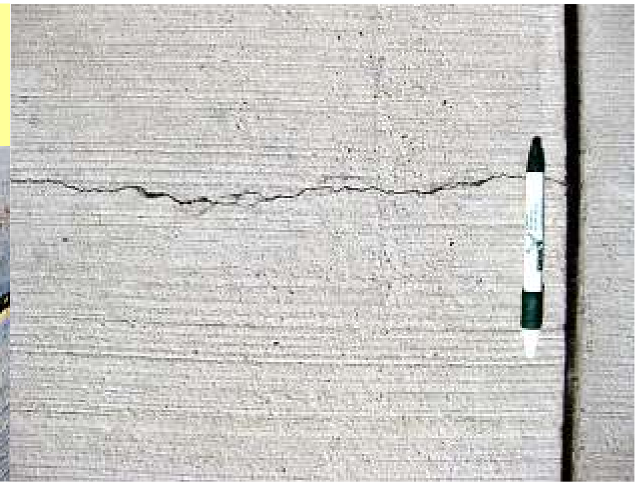
Description: Cracks that divide the slab into two or three pieces.

Causes: Load repetition, curling stresses and shrinkage stresses.

Light

* No spalling or minor spalling.
* Nonfilled cracks less than 1/8 inch wide.
* Filled crack with satisfactory filler.
* The slab is divided into three pieces by low severity cracks.

Repair: Do nothing / Seal cracks



Medium

* Moderately spalled.
* A nonfilled crack has a mean width between 1/8 inch and 1 inch.
* Filler in unsatisfactory condition.
* The slab is divided into three pieces by two or more cracks, one of which is at least medium severity.

Repair: Seal cracks

High

* Severely spalled.
* A nonfilled crack has a mean width approximately greater than 1 inch.

Repair: Seal cracks / Full depth patch / Slab replacement

Joint Seal Damage

PCC

Description: Any condition that allows significant infiltration of water or enables soil or rocks to accumulate in the joints preventing the slabs from expanding (may result in slab buckling, shattering, or spalling). Sealant hardens and cracks, loses edge bond, doesn't fill the joint, or has weed penetration.

Causes: Reduced pliability from weathering, or poor construction practices.

Light

Sealant is performing well with minor, if any, damage.
Repair: Do nothing

Medium

Joint sealer is in generally fair condition with some moderate damage.
Repair: Sealant needs replacement within 2 years

High

Joint sealer is in generally poor condition, or lacking over the entire surveyed section.
Repair: Sealant needs immediate replacement or application

Scaling, Map Cracking & Crazing

PCC

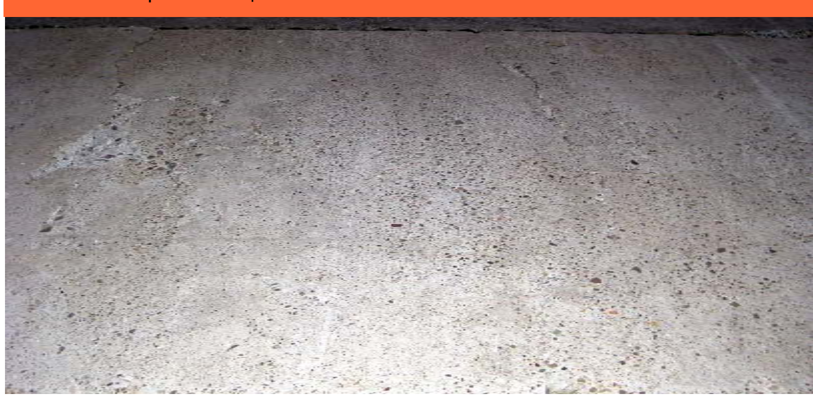
Description: A network of shallow, fine, or hairline cracks tending to intersect at angles of 120 degrees, which extend only through the upper surface of the concrete. May lead to "scaling" of the surface (the breakdown of the slab's top approx. ¼" - ½").

Causes: Over-finishing the concrete, use of deicing salts, freeze-thaw cycles, and poor aggregate.

Light Crazing or map cracking exists over most of the slab area; the surface is in good condition with no scaling.
Repair: Do nothing

Medium Slab is scaled over approximately 5 percent or less of the surface, causing some FOD potential.
Repair: Partial depth patch / Slab replacement

High Slab is severely scaled, causing a high FOD potential. Usually more than 5 percent of the surface is affected.
Repair: Slab replacement



Settlement or Faulting

PCC

Description: A difference of elevation at a joint or crack.

Causes: Water intrusion into expansive subgrades, base course leach-out and consolidation or contamination, and/or poor construction practices.

Light

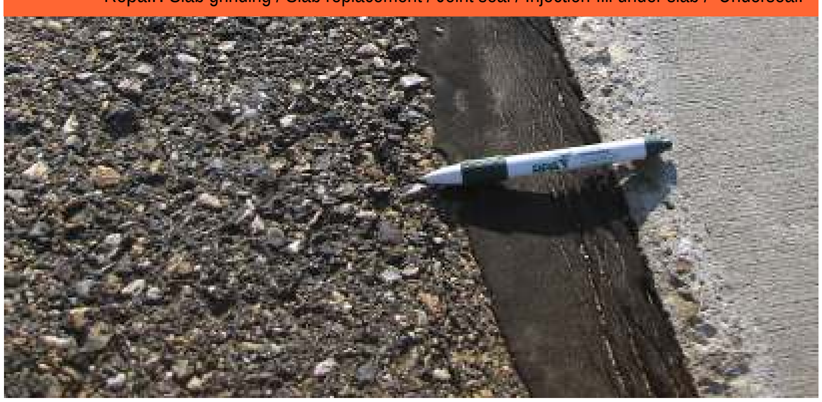
Edge Elevation Difference: Runways/Taxiways: < 1/4 inch
Aprons: 1/8 - ½ inch
Repair: Do nothing / Joint seal / Injection-fill under slab / Underseal.

Medium

Edge Elevation Difference: Runways/Taxiways: ¼ - ½ inch
Aprons: ½ - 1 inch
Repair: Slab grinding / Joint seal / Injection-fill under slab / Underseal.

High

Edge Elevation Difference: Runways/Taxiways: > ½ inch
Aprons: > 1 inch
Repair: Slab grinding / Slab replacement / Joint seal / Injection-fill under slab / Underseal.



Shattered Slab

PCC

Description: The slab is broken into four or more pieces, not all contained in a corner break.

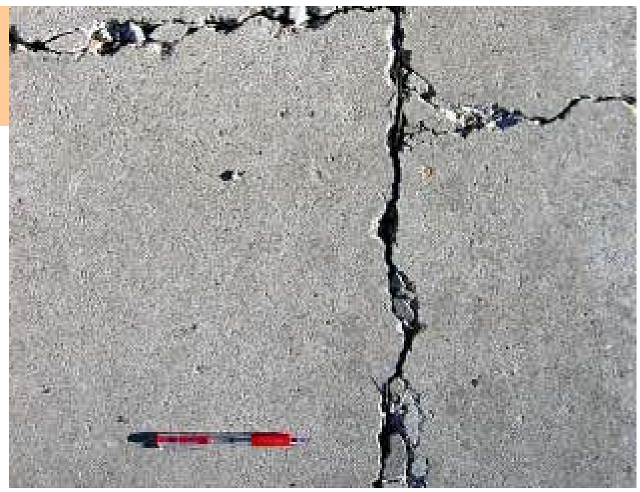
Cause: Overloading or inadequate support of the slab.

Light

The slab is broken into 4 or 5 pieces with over 85% of the cracks of low severity
Repair: Seal cracks

Medium

The slab is broken into 4 or 5 pieces with over 15% of the cracks of medium severity or the slab is broken into 6 or more pieces with over 85% of the cracks of low severity.
Repair: Seal cracks / full depth patch / slab replacement



High

The slab is broken into 4 or 5 pieces with some or all of the cracks of high severity or the slab is broken into 6 or more pieces with over 15% of the cracks of medium or high severity.
Repair: Full depth patch / slab replacement

Spalling (Corner)

PCC

Description: The raveling or breakdown of the slab within approximately 2 feet of the corner. Spalls angle downward to intersect the joint, not vertically through the slab.

Causes: Infiltration of incompressible materials, excessive traffic loads, or weak (overworked) concrete at the joint.

Light Corner edges are lightly frayed with few pieces (little or no FOD potential).
Repair: Do nothing

Medium Moderately frayed edge, fractured pieces may be loose or absent (some FOD or tire damage potential).
Repair: Partial depth patch

High Severely frayed, high severity cracks, fractured pieces absent (high FOD or tire damage potential).
Repair: Partial depth patch

Spalling (Joint)

PCC

Description: The breakdown of the slab within 2 feet of the edge. A joint spall usually does not extend vertically through the slab, but intersects the joint at an angle.

Causes: Infiltration of incompressible materials, excessive traffic loads, or weak (overworked) concrete at the joint.

Light

Joint is lightly frayed with few pieces (little or no FOD potential).

Repair: Do nothing

Medium

Moderately frayed edge, fractured pieces may be loose or absent (some FOD or tire damage potential).

Repair: Partial depth patch

High

Severely frayed, high severity cracks, fractured pieces absent (high FOD or tire damage potential).

Repair: Partial depth patch