SPIRIT LAKE MUNICIPAL AIRPORT
PAVEMENT MANAGEMENT REPORT

Prepared For:
Iowa Department of Transportation
Office of Aviation

Prepared By:
Applied Pavement Technology, Inc.

November 2003

Office of Aviation
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INTRODUCTION

Applied Pavement Technology, Inc. (APTech), through a subcontract with Kirkham Michael & Associates, updated the Airport Pavement Management System (APMS) for the Iowa Department of Transportation (Iowa DOT). As part of this project, pavement conditions at Spirit Lake Municipal Airport were assessed in November 2003 using the Pavement Condition Index (PCI) procedure.

During a PCI inspection, the types, severities, and amounts of distress present in a pavement are quantified. This information is then used to develop a composite index that represents the overall condition of the pavement in numerical terms, ranging from 0 (failed) to 100 (excellent). The PCI number provides an overall measure of condition and an indication of the level of work that will be required to maintain or repair a pavement. Further, the distress information provides insight into what is causing the pavement to deteriorate, which is the first step in selecting the appropriate repair action to correct the problem.

Programmed into an APMS, PCI information is used to determine when preventive maintenance actions (such as crack sealing) are advisable and also to identify the most cost-effective time to perform major rehabilitation (such as an overlay). The importance of identifying not only the type of repair but also the optimal time of repair is illustrated in figure 1. This figure shows that there is a point in a pavement's life cycle where the rate of deterioration increases. The financial impact of delaying repairs beyond this point can be severe.

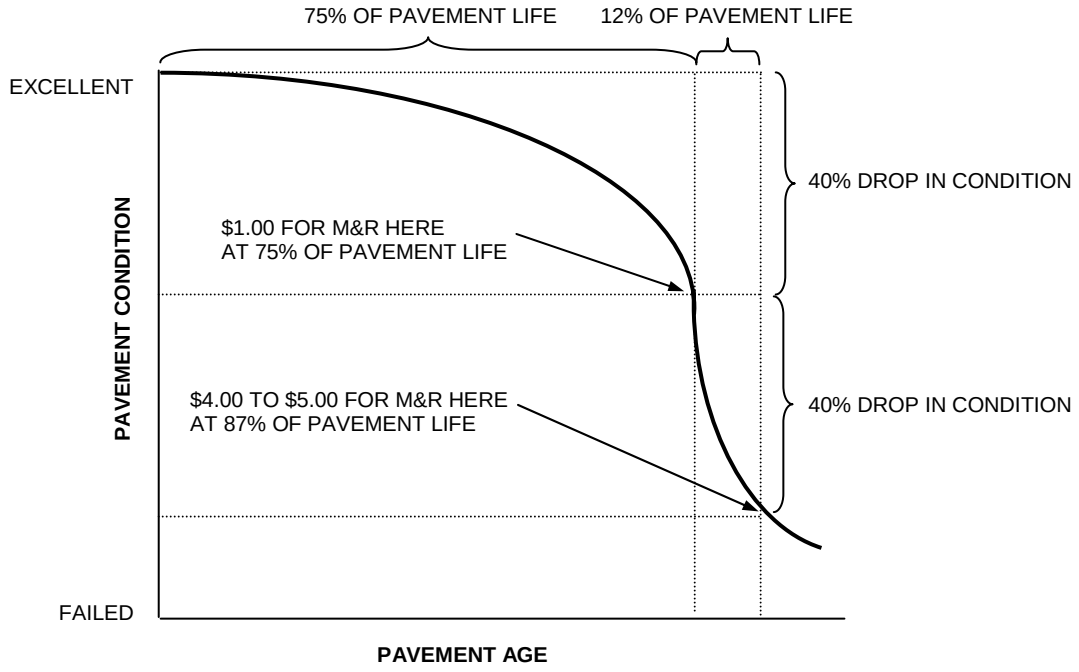


Figure 1. Pavement condition versus cost of repair.

The pavement evaluation results for Spirit Lake Municipal Airport are presented within this report and can be used by Iowa DOT, the Federal Aviation Administration (FAA), and Spirit Lake Municipal Airport to prioritize and schedule pavement maintenance and rehabilitation actions at the airport.

PAVEMENT INVENTORY

Approximately 150,000 square feet of runway, taxiway, and apron pavements were evaluated at Spirit Lake Municipal Airport, as shown in figure 2. This figure also shows the average age of the pavements.

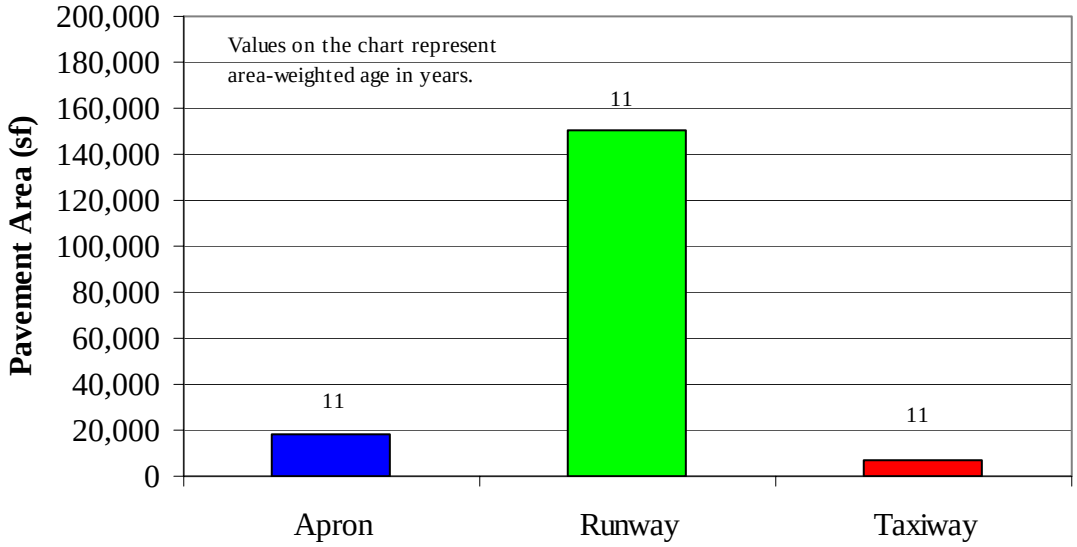


Figure 2. Pavement inventory.

Figure 3 is a network definition map that identifies the pavements at Spirit Lake Municipal Airport evaluated during this project. This map shows how the pavement network was divided into branches, sections, and sample units for pavement management purposes. It also shows the nomenclature used in the Micro PAVER pavement management database to identify the different pavement areas. Finally, the map summarizes the construction history information compiled during the records review and identifies the areas inspected during the visual survey.

Figure 3. Network definition map.

PAVEMENT EVALUATION

Pavement Evaluation Procedure

APTech inspected the pavements at Spirit Lake Municipal Airport using the PCI procedure. This procedure is described in FAA Advisory Circular (AC) 150/5380-6A, which is located in Appendix A, and ASTM Standard D5340. The PCI provides a numerical indication of overall pavement condition, as illustrated in figure 4. The types and amounts of deterioration are used to calculate the PCI value of the section. The PCI ranges from 0 to 100, with 100 representing a pavement in excellent condition.

Typical Pavement Surface[1]	PCI
	100
	60
	5

[1]Photographs shown are not specific to the project.

Figure 4. Visual representation of PCI scale.

It should be noted that a PCI value is based on visual signs of pavement deterioration and does not provide a measure of structural capacity.

In general terms, pavements with a PCI of 60 to 100 that are not exhibiting significant load-related distress will benefit from preventive maintenance actions, such as crack sealing and surface treatments. Pavements with a PCI of 40 to 60 may require major rehabilitation, such as an overlay. Often, when the PCI is less than 40, reconstruction is the only viable alternative due to the substantial damage to the pavement structure. Figure 5 illustrates how the appropriate repair type varies with the PCI of a pavement section.

PCI	Repair Type
81 – 100	Preventive Maintenance
66 – 80	
51 – 65	Major Rehabilitation
41 – 50	
0 – 40	Reconstruction

Figure 5. PCI versus repair type.

The types of distress identified during the PCI inspection provide insight into the cause of pavement deterioration. PCI distress types are characterized as load-related (such as alligator cracking on hot-mix asphalt [HMA] pavements or corner breaks on portland cement concrete [PCC] pavements), climate/durability-related (such as weathering [climate-related on HMA pavements) and D-cracking [durability-related on PCC pavements]), and other (distress types that cannot be attributed solely to load or climate/durability). Understanding the cause of distress helps in selecting a rehabilitation alternative that corrects the cause and thus eliminates its recurrence.

Appendix B identifies the distress types considered during a PCI inspection and the likely cause of each distress type.

Pavement Evaluation Results

The pavements at Spirit Lake Municipal Airport were inspected on November 21, 2003. The 2003 area-weighted condition of Spirit Lake Municipal Airport is 61, with conditions ranging from 47 to 62 (on a scale of 0 [failed] to 100 [excellent]).

Figures 6 and 7 provide graphs summarizing the overall condition of the pavements at the Spirit Lake Municipal Airport. Figure 8 is a map that displays the condition of the pavements evaluated. Table 1 summarizes the results of the pavement evaluation. Appendix C presents photographs taken during the PCI inspection, and Appendix D contains detailed information on the distresses observed during the visual survey. Appendix E includes detailed work history

information that was collected during the record review process. A disk with a copy of the Micro PAVER database is attached to the inside of the back cover of this report.

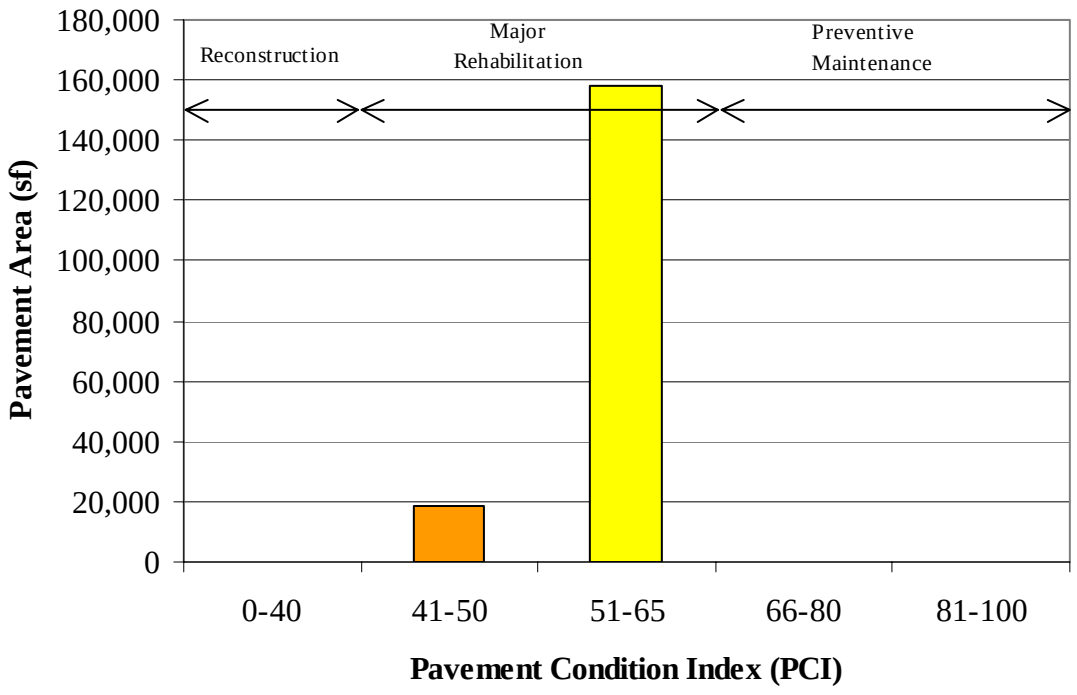


Figure 6. Overall condition.

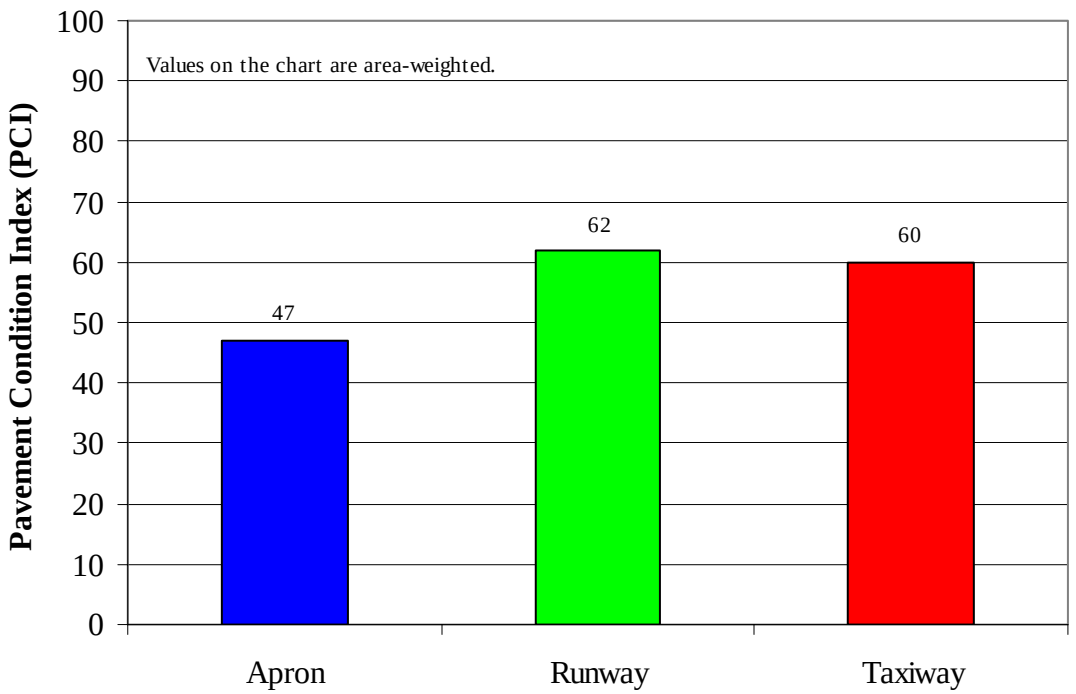
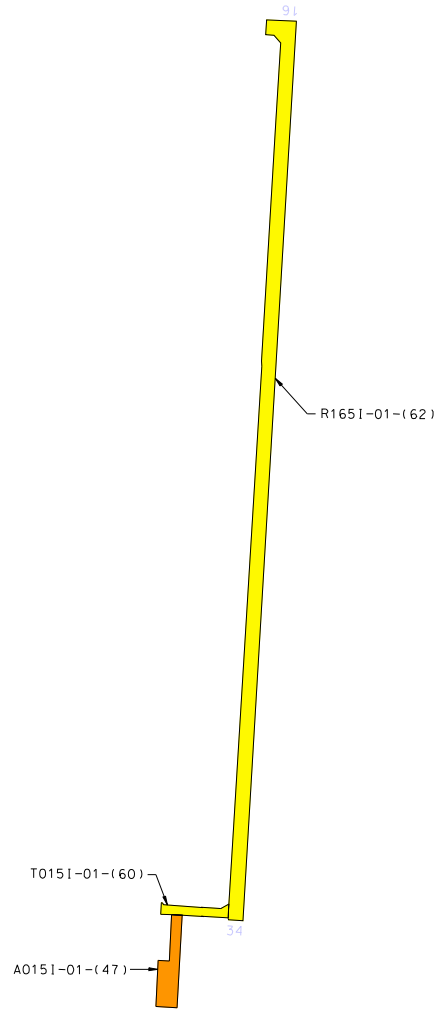


Figure 7. Condition by use.

PAVEMENT CONDITION INDEX (PCI) RATING	
PCI	REPAIR TYPE
81-100	PREVENTIVE MAINTENANCE
66-80	
51-65	MAJOR REHABILITATION
41-50	
0-40	RECONSTRUCTION

LEGEND

BRANCH NUMBER
SECTION NUMBER
PCI VALUE
R12AT-01-(94)



N

0 200
SCALE IN FEET

PLAN VIEW

SPIRT LAKE MUNICIPAL AIRPORT

PAVEMENT CONDITION INDEX MAP

CREATION DATE: JULY, 1996 LAST MODIFIED: JAN. 2004

IOWA DEPARTMENT OF TRANSPORTATION - OFFICE OF AVIATION

DESIGN SHEET NO. 2 OF 2 FILE NO. _____ DESIGN NO. _____

DESIGNED BY _____ CHECKED BY _____ DETAILED BY RAL CADD FILE OF3.pci	KIRKHAM MICHAEL CONSULTING ENGINEERS	Applied Pavement Technology, Inc.		DICKINSON COUNTY	PROJECT NUMBER	SHEET NUMBER 2

XXXXXXXXXXSYSTEMTIME XXXXXXXUSERNAME XXXXXXXXXX

Table 1. Pavement evaluation results.

Spirit Lake Municipal Airport								
Branch[1]	**Section**	**Surface Type [2]**	**Section Area, sf**	**LCD [3]**	**2003 PCI**	**% Distress Due To:**		**Distress Types**
						Load [4]	**Climate or Durability [5]**	
A015I	01	AC	18,600	6/30/1992	47	61	39	Longitudinal and transverse cracking, Alligator cracking
R165I	01	AC	150,750	6/30/1992	62	38	62	Alligator cracking, Longitudinal and transverse cracking, Depression
T015I	01	AC	7,118	6/30/1992	60	24	76	Longitudinal and transverse cracking, Alligator cracking

[1] See Figure 3 for the location of the branch and section.

[2] AC = asphalt cement concrete; AAC = asphalt overlay on AC; PCC = portland cement concrete; APC = asphalt overlay on PCC.

[3] LCD = last construction date.

[4] Distress due to load includes those distresses attributed to a structural deficiency in the pavement, such as alligator (fatigue) cracking, rutting, or shattered concrete slabs.

[5] Distress due to climate or durability includes those distresses attributed to either the aging of the pavement and the effects of the environment (such as weathering and raveling or block cracking in asphalt pavements) or to a materials-related problem (such as durability cracking in a concrete pavement).

PAVEMENT MAINTENANCE AND REHABILITATION PROGRAM

Using the information collected during the pavement inspection, a 5-year rehabilitation program was developed for Spirit Lake Municipal Airport. In addition, a 1-year plan for localized preventive maintenance (such as crack sealing and patching) was prepared. The Micro PAVER pavement management software was used to perform this analysis.

Analysis Parameters

Localized Maintenance Policies and Unit Costs

Localized maintenance policies were developed for AC and PCC pavements. These policies, shown in Appendix F, identify the localized maintenance actions that Iowa DOT considered appropriate to correct different distress types. Kirkham Michael & Associates estimated unit costs for each of the localized maintenance actions in the maintenance policies and these costs are provided in Appendix F. Please note that this information was developed in conjunction with Iowa DOT and is of a general nature for the entire state. The maintenance policies and unit costs may require adjustment to reflect specific conditions at Spirit Lake Municipal Airport.

Major Rehabilitation Unit Costs

Micro PAVER estimates the cost of major rehabilitation based upon the PCI of the pavement. Kirkham Michael & Associates developed these costs for this project and they are presented in Appendix F. If major rehabilitation is recommended in the 5-year program, further engineering investigation will be needed to identify the most appropriate rehabilitation action and to more accurately estimate the cost of such work.

Budget and Inflation Rate

An unlimited budget and an inflation rate of 4.5 percent were used during the analysis.

Analysis Approach

The 5-year program was prepared with the goal of maintaining the pavements above established critical PCI values. Iowa DOT set the critical PCI at 65 for runways, 60 for taxiways, and 55 for aprons.

During this analysis, major rehabilitation was recommended for pavements in the year they dropped below their critical PCI value.

For the first year of the analysis only, a localized preventive maintenance plan was developed for those pavement sections that were above their critical PCI value. If major rehabilitation was triggered for a section in 2005 or 2006, then localized maintenance was not recommended for 2004. While localized preventive maintenance should be an annual undertaking at Spirit Lake Municipal Airport, it is not possible to accurately predict the propagation of cracking and so on. The airport should budget for maintenance every year and can use the 2004 maintenance plan as a baseline for that work. As the pavements age, it can be assumed that the amount of localized maintenance required will increase.

Analysis Results

A summary of the pavement repair program for Spirit Lake Municipal Airport is presented in table 2.

Table 2. 5-year program under an unlimited funding analysis scenario.

Year	Branch[1]	Section	Type of Repair[2]	Estimated Cost[3]
2004	A015I	01	Major Rehabilitation	$51,150
	R165I	01	Major Rehabilitation	$462,048
	T015I	01	Major Rehabilitation	$22,066

[1]See Figure 3 for the location of the branch and section.

[2]Major Rehabilitation: such as pavement reconstruction or an overlay.
Localized Maintenance: such as crack sealing or patching.

[3]Cost estimates are based on broad statewide numbers and should be adjusted to reflect local costs.

The recommendations made in this report are based upon a broad network level analysis and are meant to provide Spirit Lake Municipal Airport with an indication of the type of pavement-related work required during the next 5 years. Further engineering investigation may be needed to identify which repair action is most appropriate. In addition, the cost estimates provided are based on a statewide policy and Spirit Lake Municipal Airport should adjust the plan to reflect local costs.

Because an unlimited budget was used in the analysis, it is possible that the pavement repair program will need to be adjusted to take into account economic and/or operational constraints. It is important to remember that regardless of the recommendations presented within this report, Spirit Lake Municipal Airport is responsible for repairing pavements where existing conditions pose a hazard to safe operations.

General Maintenance Recommendations

It is recommended that the following strategies be considered for prolonging pavement life:

1. Conduct an aggressive campaign against weed growth through timely herbicide applications. Vegetation growing in pavement cracks is very destructive and significantly increases the rate of pavement deterioration.

2. Implement a periodic crack sealing program. Keeping water and debris out of the pavement system through sealing cracks is a proven method for cost-effectively extending the life of the pavement system.

3. Ensure that dirt does not build up along the edges of the pavements. This can create a “bathtub” effect – reducing the ability of water to drain away from the pavement system.

4. Closely monitor heavy equipment movement, such as construction equipment, emergency equipment, and fueling equipment, to make sure that it is only operating on pavement designed to accommodate the heavy loads this type of equipment often applies.

Failure to restrict heavy equipment to appropriate areas may result in the premature failure of airport pavements.

PUBLIC LAW 103-305

Public Law 103-305 states that after January 1, 1995 airport sponsors must provide assurances or certifications that an airport has implemented an effective airport pavement maintenance management system (PMMS) before the airport will be considered for funding of pavement replacement or reconstruction projects. To be in full compliance with the Federal law, the PMMS must include the following components at a minimum: pavement inventory, pavement inspections, record keeping, information retrieval, and program funding.

By undertaking this project, Iowa DOT has provided Spirit Lake Municipal Airport with an excellent basis for meeting the requirements of this law. The airport now has a complete pavement inventory and a detailed inspection. To remain in compliance with the law, the airport will also need to undertake monthly drive-by inspections of pavement conditions and track pavement-related maintenance activities.

Appendix A, which contains a copy of FAA AC 150/5380-6A, provides further information on Public Law 103-305. Specifically, Appendix 1 of this AC outlines what needs to be included in a PMMS.

SUMMARY

This report documents the results of the pavement evaluation conducted at Spirit Lake Municipal Airport. During a visual inspection of the pavements in 2003, it was found that the overall condition of the pavement network is a PCI of 61. A 5-year pavement repair program was generated for Spirit Lake Municipal Airport, which revealed that approximately $536,000 needs to be expended on the pavement system in order to maintain the pavements above their critical PCI levels.

APPENDIX A

FAA AC 150/5380-6A

APPENDIX B

CAUSE OF DISTRESS TABLES

Table B-1. Cause of pavement distress, asphalt-surfaced pavements.

Distress Type	Probable Cause of Distress
Alligator Cracking	Fatigue failure of the asphalt concrete surface under repeated traffic loading
Bleeding	Excessive amounts of asphalt cement or tars in the mix and/or low air void content
Block Cracking	Shrinkage of the asphalt concrete and daily temperature cycling; it is not load associated
Corrugation	Traffic action combined with an unstable pavement layer
Depression	Settlement of the foundation soil or can be "built up" during construction
Jet Blast	Bituminous binder has been burned or carbonized
Joint Reflection	Movement of the concrete slab beneath the asphalt concrete surface because of thermal and moisture changes
Longitudinal and Transverse Cracking	Cracks may be caused by 1) poorly constructed paving lane joint, 2) shrinkage of the AC surface due to low temperatures or hardening of the asphalt, or 3) reflective crack caused by cracks in an underlying PCC[1] slab
Oil Spillage	Deterioration or softening of the pavement surface caused by the spilling of oil, fuel, or other solvents
Patching	N/A
Polished Aggregate	Repeated traffic applications
Raveling and Weathering	Asphalt binder may have hardened significantly
Rutting	Usually caused by consolidation or lateral movement of the materials due to traffic loads
Shoving	Where PCC pavements adjoin flexible pavements, PCC "growth" may shove the asphalt pavement
Slippage Cracking	Low strength surface mix or poor bond between the surface and next layer of pavement structure
Swelling	Usually caused by frost action or by swelling soil

[1]PCC: portland cement concrete

Table B-2. Cause of pavement distress, portland cement concrete pavements.

Distress Type	Probable Cause of Distress
Blow-Up	Incompressibles in joints
Corner Break	Load repetition combined with loss of support and curling stresses
Cracks	Combination of load repetition, curling stresses, and shrinkage stresses
Durability Cracking	Concrete's inability to withstand environmental factors such as freeze-thaw cycles
Joint Seal Damage	Stripping of joint sealant, extrusion of joint sealant, weed growth, hardening of the filler (oxidation, loss of bond to the slab edges, or absence of sealant in joint
Patching (Small and Large)	N/A
Popouts	Freeze-thaw action in combination with expansive aggregates
Pumping	Poor drainage, poor joint sealant
Scaling	Over finishing of concrete, deicing salts, improper construction, freeze-thaw cycles, poor aggregate, and alkali-silica reactivity
Settlement	Upheaval or consolidation
Shattered Slab	Load repetition
Shrinkage	Setting and curing of the concrete
Spalling (Joint and Corner)	Excessive stresses at the joint caused by infiltration of incompressible materials or traffic loads; weak concrete at joint combined with traffic loads

APPENDIX C

INSPECTION PHOTOGRAPHS

R165I-01. Overview.

T015I-01. Overview.

A015I-01. Overview.

APPENDIX D

INSPECTION REPORT

APPENDIX E

WORK HISTORY

APPENDIX F

MAINTENANCE POLICIES AND UNIT COST TABLES

Table F-1. Localized preventive maintenance policy, asphalt-surfaced pavements.

Distress Type	Severity Level	Maintenance Action
Alligator Cracking	Low	Monitor
	Medium	AC Patch
	High	AC Patch
Bleeding	N/A	Monitor
Block Cracking	Low	Monitor
	Medium	Crack Seal
	High	Crack Seal
Corrugation	Low	Monitor
	Medium	AC Patch
	High	AC Patch
Depression	Low	Monitor
	Medium	Monitor
	High	AC Patch
Jet Blast	N/A	AC Patch
Joint Reflection Cracking	Low	Monitor
	Medium	Crack Seal
	High	Crack Seal
Longitudinal and Transverse Cracking	Low	Monitor
	Medium	Crack Seal
	High	Crack Seal
Oil Spillage	N/A	AC Patch
Patching	Low	Monitor
	Medium	AC Patch
	High	AC Patch
Polished Aggregate	N/A	Monitor
Raveling and Weathering	Low	Monitor
	Medium	AC Patch
	High	AC Patch
Rutting	Low	Monitor
	Medium	Monitor
	High	AC Patch
Shoving	Low	Monitor
	Medium	AC Patch
	High	AC Patch
Slippage Cracking	N/A	AC Patch
Swelling	Low	Monitor
	Medium	Monitor
	High	AC Patch

Table F-2. Localized preventive maintenance policy, portland cement concrete pavements.

Distress Type	Severity Level	Maintenance Action
Blow-Up	Low	Slab Replacement
	Medium	Slab Replacement
	High	Slab Replacement
Corner Break	Low	Crack Seal
	Medium	Full Depth PCC Patch
	High	Full Depth PCC Patch
Cracks	Low	Monitor
	Medium	Crack Seal
	High	Slab Replacement
Durability Cracking	Low	Monitor
	Medium	Full Depth Patch
	High	Slab Replacement
Joint Seal Damage	Low	Monitor
	Medium	Joint Seal
	High	Joint Seal
Patching	Low	Monitor
	Medium	Full Depth PCC Patch
	High	Full Depth PCC Patch
Popouts	N/A	Monitor
Pumping	N/A	Monitor
Scaling	Low	Monitor
	Medium	Partial Depth PCC Patch
	High	Slab Replacement
Settlement	Low	Monitor
	Medium	Grinding
	High	Slab Replacement
Shattered Slab	Low	Crack Seal
	Medium	Slab Replacement
	High	Slab Replacement
Shrinkage	N/A	Monitor
Spalling (Joint and Corner)	Low	Monitor
	Medium	Partial Depth PCC Patch
	High	Partial Depth PCC Patch

Table F-3. Unit costs for preventive maintenance actions.

Maintenance Action	Unit Cost
AC Patch – AC Pavement	$4.45/sf
Crack Sealing – AC Pavement	$1.25/lf
PCC Patch – Spall Repair (partial depth)	$7.50/sf
PCC Patch – Full Depth	$5.55/sf
Crack Sealing – PCC Pavement	$1.50/lf
Joint Resealing – PCC Pavement	$1.50/lf
Grinding – PCC Pavement	$4.50/sf
Slab Replacement – PCC Pavement	$5.00/sf

Table F-4. Unit costs based on PCI values.

Pavement Type	PCI Values										
	0	10	20	30	40	50	60	70	80	90	100
Asphalt	$6.00	$6.00	$6.00	$6.00	$3.10	$3.10	$3.10	$2.75	$0.00	$0.00	$0.00
PCC	$8.30	$8.30	$8.30	$8.30	$2.75	$2.75	$2.75	$2.75	$0.00	$0.00	$0.00