Washington Airport Pavement Management Manual

PREPARED FOR

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February 2019

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

PREFACE

Washington's airport system represents a tremendous capital investment and plays a critical role in the economic health of the state. As this system has aged, the upkeep of the existing pavements has become increasingly important. Therefore, the Washington State Department of Transportation (WSDOT) Aviation maintains a statewide airport pavement management system (APMS) to provide the airports, the State, and the Federal Aviation Administration (FAA) with the pavement information and analytical tools that help them identify pavement-related needs, optimize the selection of projects and treatments over a multiyear period, and evaluate the long-term impacts of decisions made regarding the Washington airport pavement infrastructure.

The principal objective for the APMS is to assess the relative condition of pavements for selected Washington airports in the Washington Aviation System Plan (WASP) and the Federal Aviation Administration (FAA) National Plan of Integrated Airport Systems (NPIAS). The APMS can be used as a tool to identify system needs, make programming decisions for funding, provide information for legislative decision making, and assist local jurisdictions with planning decisions.

As part of the APMS, Applied Pavement Technology, Inc. (APTech) has prepared this manual for WSDOT Aviation and the individual airports to use in conjunction with their pavement management activities. This work is being funded with a grant from the FAA. This report is designed to be used in conjunction with the Interactive Data Exchange Application (IDEA) that can be accessed through the WSDOT Aviation website. It is divided into the following sections:

- Section 1 provides an overview of the pavement management process and the Pavement Condition Index (PCI) procedure.
- Section 2 provides guidance on what an airport needs to do to remain in compliance with Public Law 103-305. While this law only applies to NPIAS airports, it is highly recommended that Non-NPIAS airports also undertake the activities prescribed in it. Section 2 also contains information on distress types/severity combinations that warrant immediate action and/or notification of WSDOT and the FAA.
- Section 3 describes how an airport sponsor can use the IDEA to plan for pavement maintenance and rehabilitation (M&R) projects.

It is important to note that the role of WSDOT Aviation, as an advocate to airports, is not to supplant the role of the airport sponsor. Additionally, it is not the role of WSDOT Aviation to serve in an enforcement capacity or to bring an airport into compliance with state or federal requirements. The role of WSDOT Aviation is to identify the pavement needs and recommended process of preserving the pavements within the WASP and NPIAS. Airport sponsors provide the key policy and financial decisions necessary for preserving airport pavements in Washington.

SECTION 1

INTRODUCTION TO PAVEMENT MANAGEMENT

1. INTRODUCTION TO PAVEMENT MANAGEMENT

Airport sponsors and aviation agencies are responsible for the pavement infrastructure at airports, and this infrastructure represents a large capital investment. Careful management of the pavements has become increasingly important as pavements have aged, funding levels have become more restrictive, and the competition for pavement rehabilitation project funding has heightened. Monitoring the condition of airport pavements and using an APMS to plan for the needs of the pavement infrastructure provide airports, state aviation agencies, and the FAA with the ability to advise and assist airports on methods to effectively manage the pavement infrastructure. An APMS provides many benefits, including the ability to:

- Monitor the condition of a pavement system objectively.
- Select more cost-effective maintenance and rehabilitation (M&R) treatments.
- Extend pavement life through the application of preventive maintenance actions, such as crack sealing and surface treatments.
- Track the performance of selected treatments.
- Provide information needed to justify and secure funding.
- Show the impact of funding decisions.
- Evaluate best return on investment.
- Communicate pavement conditions and needs.
- Fulfill many of the NPIAS airport requirements of Public Law 103-305 and Grant Assurance 11 for maintaining a pavement maintenance management system.
- Fulfill WSDOT Grant Assurance 12, Chapter 468-260 WAC.

Pavement Management Overview

Pavement management is a systematic method of assessing current pavement conditions, determining M&R needs, and prioritizing these needs to make the best use of anticipated funding levels. An APMS is typically a computerized software program, such as PAVER, that facilitates the storage and analysis of airport pavement-related data.

Pavement Management Historical Perspective

The concept of pavement management has evolved significantly since its inception in the 1970s. The intent of original pavement management practitioners was to develop an objective approach to do the following: assess current pavement condition, predict future pavement condition, and prioritize pavement rehabilitation needs over a multiyear period in an effort to optimize the use of available funding.

As standardized condition survey techniques came into place, more information regarding the cause of pavement deterioration became available. This information was then used to assess available repair alternatives and select the best repair strategy. This approach greatly improved the effectiveness of selected rehabilitation treatments since they were now being chosen to address specific pavement deficiencies.

As computerized pavement management systems became available, an even more sophisticated level of analysis became possible. With today's systems, pavement condition data are not only used to assess current conditions but also to identify pavement deterioration trends. This capability allows the agency to forecast future pavement conditions. As a result, agencies are better able to assess the long-term impacts of decisions made today on future network conditions as well as identify the optimal time for repair so that funding can be scheduled in advance of the forecasted need.

Programmed into an APMS, PCI information is used to determine when preventive maintenance actions (such as crack sealing) are advisable and to identify the most cost-effective time to perform major rehabilitation (such as an overlay). The importance of identifying not only the best repair alternative 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 when the rate of deterioration increases. The financial impact of delaying repairs beyond this point can be severe.

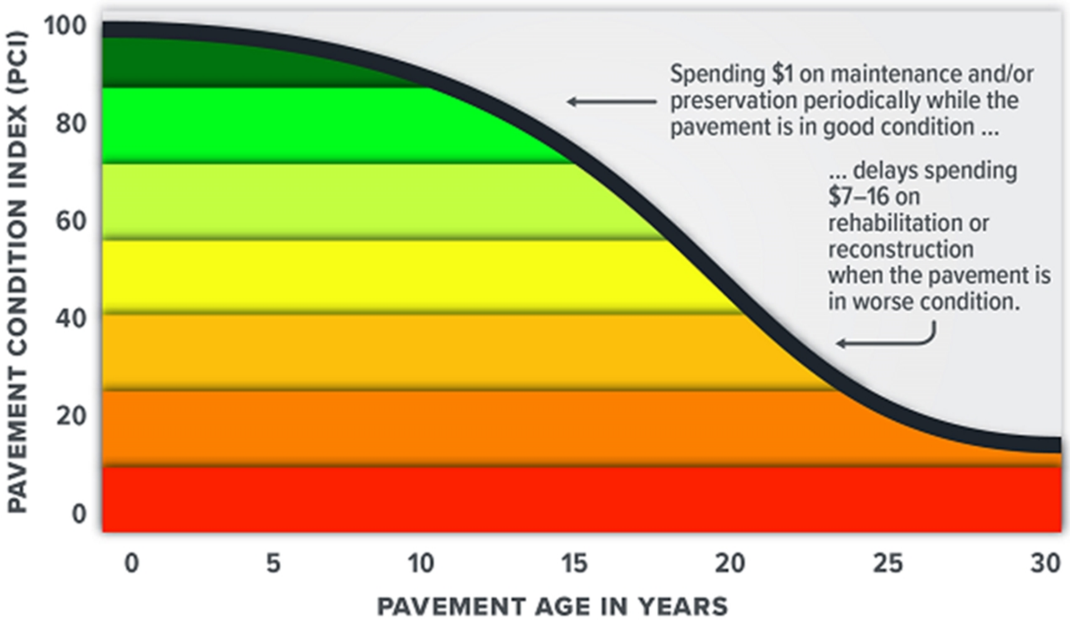

Figure 1. Typical pavement condition life cycle.

Levels of Pavement Management

Pavement management provides information for decision making at two distinct levels: **network-level** management and **project-level** management.

Network-Level Pavement Management

Network-level pavement management involves the evaluation of all pavements under an agency's jurisdiction to determine future M&R needs for the development of multiyear budget plans. The level of pavement evaluation required to perform this type of management involves visually inspecting representative samples of pavement. Based on the analysis of the network-level pavement condition data, candidate pavement areas are selected for potential M&R projects. General unit costs are used at the network level, and specific designs are not developed. The WSDOT Aviation APMS operates at the network level.

Project-Level Pavement Management

Once a pavement area has been identified as a candidate for repair (such as a runway rehabilitation project), it is then evaluated at the project level. This level of analysis requires higher inspection sampling rates. Additional testing, such as nondestructive testing and coring, is often used during project-level analysis to provide additional knowledge about pavement condition and distress mechanisms. Based on the results of project-level analysis, specific treatments (such as an overlay) can be selected for the candidate pavement areas and more accurate cost estimates can be developed.

APMS Components

An APMS is composed of six basic components, as shown in figure 2.

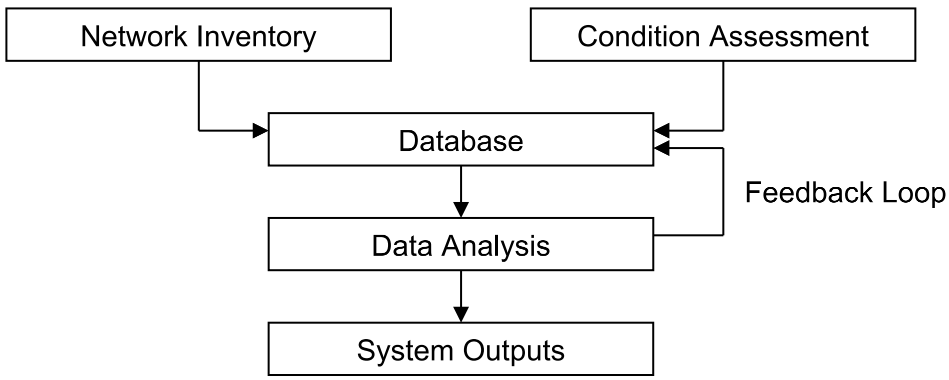

Figure 2. Basic components of APMS.

Network Inventory

Network inventory is used to define the physical characteristics of the pavements being managed. Typically, the collected information includes construction, maintenance, traffic, and condition data. It is important to keep two guidelines in mind when determining the extent of historical information to include in the inventory. First, the data should be accessible so that substantial time is not invested in a search of construction records. Secondly, the collected information should serve a purpose. Establishing a network inventory is the foundation for the APMS.

Condition Assessment

Pavement management decisions depend on some method of pavement evaluation. The method selected to evaluate pavement condition is extremely important because it serves as the basis of all recommendations. For that reason, it is critical to select an objective and repeatable procedure so that APMS recommendations are reliable.

Pavement managers must evaluate their needs when determining not only the type of condition data to collect but also how often to collect the data. For example, an agency experiencing rapid deterioration rates may elect to survey their pavements more frequently than it would under normal circumstances. Each agency must ensure that the data collection aspects of their APMS match both their needs and financial means.

Database

Once the network inventory and pavement condition assessment data have been collected, a database can be established to store and utilize the information. Although a manual filing system may be possible for a small network, the efficiency and cost-effectiveness of storing data on a computer makes an automated database the most practical alternative, especially when a comprehensive APMS is desired.

Data Analysis

Data analysis can occur at the network or project level. At the network level, potential rehabilitation needs of the entire network are evaluated and prioritized for planning and scheduling budget needs over a multiyear period. The objective of network-level analysis is to evaluate rehabilitation needs for a future time period and prioritize project lists so that the agency makes the best use of the limited funds available for M&R. After the planning and programming decisions have been made during the network-level analysis, the information in the database can be used to supplement a project-level analysis. At the project level, each individual project is investigated in detail to determine the appropriate rehabilitation treatment.

System Outputs

Results of planning analyses are useful only if the recommendations can be easily conveyed. There are a number of different methods for presenting the results of the analyses, including tables, reports, graphs, and maps.

Engineers may prefer seeing detailed information in the form of comprehensive reports. However, because of the volume of information contained in these types of reports, they might not be effective for quickly conveying information to managers or airport sponsors. Instead, graphical reports may be more useful for people who need to quickly evaluate large amounts of data.

Many airport agencies have found value in linking their APMS to computer-aided drafting (CAD) maps in order to display information through color-coded maps. This capability has greatly enhanced the usefulness of the APMS to managers and sponsors who need to convey a lot of information in a short period of time. Maps are very useful in identifying pavement M&R projects recommended during each year of the analysis or for displaying the results of a condition assessment. The PAVER pavement management software, used by WSDOT Aviation and the FAA, provides a direct GIS link between the CAD maps and the pavement management database to facilitate the development of this type of output.

Feedback Loop

An often-overlooked component of an APMS is the development of a feedback loop. The feedback loop establishes a process by which actual performance and cost data are input back into the models used in the pavement management analysis. For example, the APMS may use models that estimate the life of an asphalt overlay at 12 years. Actual performance data may show that the life of the agency's overlays is closer to 8 to 10 years. This type of information should be used to update the pavement management models so that the system recommendations remain reliable and become better with time.

WSDOT Aviation APMS Process

The following activities were completed during the WSDOT Aviation APMS implementation in 1999/2000 and the subsequent updates in 2005, 2012, and 2018:

- Records review.
- Pavement network definition and map generation.
- Pavement condition assessment.
- Database development.
- APMS customization.
- Data analysis.
- Report preparation.

Records Review

Before initiating fieldwork, a comprehensive review of existing records was undertaken to collect data needed to populate the inventory portion of the APMS database. Records pertaining to construction history, maintenance history, and as-built pavement layer thickness were gathered and reviewed. The record information was often supplemented by information obtained from the FAA, WSDOT, airport staff, airport consultants, and fixed based operators (FBOs). The collected information was used to divide the airport pavements into distinct pavement units. The inventory data was also used during the development of pavement deterioration models.

Pavement Network Definition and Map Generation

Using information from the records review, the pavement system at each airport was divided into units called branches, sections, and sample units.

A branch is a single entity that serves a distinct function. For example, a runway is considered a branch because it serves the single function of allowing aircraft to take off and land. For airfields, a branch typically represents an entire runway, taxiway, apron, helipad, or T-hangar (taxilane).

Because of the disparity of pavement-related characteristics that can occur within a branch, branches are further subdivided into sections. A section is an area of the pavement that has uniform construction history, pavement structure, traffic patterns, and condition throughout its entire area. For example, if a runway is extended at some point, the original portion of the runway and the extension are considered two different pavement sections. Even though the cross section and traffic patterns might be identical for both sections, the extension was constructed at a different time and possibly exhibits different pavement condition.

For inspection purposes, pavement sections were further subdivided into sample units. A sample unit for jointed portland cement concrete (PCC) airside pavement is 20 $\pm$ 8 slabs, and a sample unit for asphalt-surfaced airside pavement is an area of 5,000 $\pm$ 2,000 square feet.

Network definition maps were prepared for each airport.

Pavement Condition Assessment

APTech visually inspected the pavements at Washington airports using the PCI procedure. The PCI procedure is described in FAA Advisory Circular (AC) 150/5380-6C, *Guidelines and Procedures for Maintenance of Airport Pavements*, and ASTM D5340-12, *Standard Test Method for Airport Pavement Condition Index Surveys*.

The PCI is used to indicate the condition of the operational surface of the pavement and, to some extent, the structural integrity of the pavement. During a PCI survey, the distress type, distress severity, and distress quantity are recorded and analyzed. That information is used to calculate the PCI of the section. The final calculated PCI is a number from 0 to 100, with 100 representing a pavement in excellent condition, as illustrated in figure 3.

Representative AC Pavement Surface	**Representative PCC Pavement Surface**	**PCI**
		100
		60
		5

Figure 3. Visual representation of the PCI scale.

The types of distress identified during the PCI inspection provide insight into the cause of pavement deterioration, which is useful when selecting M&R strategies. Understanding the cause of distress helps in selecting a rehabilitation alternative that corrects the cause and thus eliminates or delays its recurrence. The distress types are broadly categorized as follows:

- Load-related distress, such as alligator cracking on asphalt concrete (AC)-surfaced pavements or corner breaks in portland cement concrete (PCC) pavements.
- Climate/durability distress, such as weathering on AC-surfaced pavements and durability cracking on PCC pavements.
- Other, a category that is assigned to distress types that cannot be attributed solely to load or climate/durability.

During the PCI survey, geospatially referenced photographs of each pavement section were taken. These photographs provide an overview of typical conditions and cover any unusual or severe distress identified in the field.

Database Development

As described in previous sections, the inventory and the pavement condition data provide the foundation of an APMS. All collected information was entered into WSDOT Aviation's PAVER database. This database contains information on the physical characteristics (such as pavement dimensions, surface types, ages, and so on) of each airport's pavement network as well as detailed work history and pavement distress information.

APMS Customization

For the APMS to be a useful tool, it must reflect the policies, practices, and procedures of WSDOT Aviation and the FAA. Therefore, APTech customized the PAVER software through such activities as the development of pavement performance models, the development of prioritization guidelines, and the identification of maintenance policies and M&R costs.

Data Analysis

Once PAVER was customized, the collected information was analyzed. Data analysis included an evaluation of visual distress data (e.g., current PCI, cause of deterioration, rate of deterioration); prediction of future pavement condition; development of a 1-year maintenance plan; and preparation of a 7-year M&R program that outlines the improvement needs for each pavement section.

Report Preparation

The final deliverables of the project included a statewide summary report, an executive summary, and this pavement management manual. An Interactive Data Exchange Application (IDEA) was also developed to provide the project results on WSDOT Aviation's website.

Summary

An APMS is a tool that is used to develop plans for the preservation of a pavement system within an environment of increased competition for available funds. When used appropriately, an APMS can provide the information necessary to make cost-effective decisions about the M&R of the pavement network while also providing the necessary information for the users to develop an understanding of the long-term impacts of the decisions being made. An APMS may also assist in conveying the resulting information to a variety of end-users.

SECTION 2

MONITORING PAVEMENT CONDITION

2. MONITORING PAVEMENT CONDITION

The pavements at an airport directly impact the safety of operations and represent a large capital investment that should be carefully preserved. Therefore, it is critical for each airport sponsor to actively monitor the condition of the pavement infrastructure and to track pavement maintenance needed and completed at an airport. This section of the manual provides information on what airports need to do to remain in compliance with Public Law 103-305. While this law only applies to NPIAS airports, it is highly recommended that non-NPIAS airports also undertake the activities prescribed in it. Monitoring pavement condition is a requirement of both FAA and WSDOT grant assurances. In addition, this section of the manual provides guidance on what pavement conditions require immediate attention and/or notification of WSDOT Aviation and the FAA.

Public Law 103-305

According to Public Law 103-305, any airport requesting federal funds for a project to replace or reconstruct a pavement under the airport grant assistance program must have implemented a pavement maintenance program. The law states that after January 1, 1995, NPIAS 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.

FAA AC 150/5380-7B provide detailed guidance pertaining to the requirements for an acceptable pavement management program (PMP). Appendix A of FAA AC 150/5380-7B outlines what needs to be included in a PMP to remain in compliance with this law and Grant Assurance #11. Following is a copy of this Appendix, along with instructions for supplementing this report so that all requirements are met. **Note that the italicized words are direct quotations from the FAA AC.** To remain in compliance with the law, individual airports will also need to undertake monthly drive-by inspections of pavement conditions and track pavement-related maintenance activities.

FAA AC 150/5830-7B, *Appendix A. Pavement Management Program (PMP)*

A-1.0 *An effective PMP specifies the procedures to follow to assure that proper preventative and remedial pavement maintenance is performed. The program should identify funding or anticipated funding and other resources available to provide remedial and preventive maintenance activities. An airport sponsor may use any format deemed appropriate, but the program needs to, as a minimum, include the following:*

A-1.1. Pavement Inventory. *The following must be depicted:*

a. Identification of all runways, taxiways, and aprons with pavement broken down into sections each having similar properties.

b. Dimensions of pavement sections.

c. Type of pavement surface.

d. Year of construction and/or most recent major rehabilitation.

e. *Whether AIP* [Airport Improvement Program] *or PFC* [Passenger Facility Charge] *funds were used to construct, reconstruct, or repair the pavement.*

A-1.2. PMP Pavement Inspection Schedule.

a. *Detailed Inspection. Airports must perform a detailed inspection of airfield pavements at least once a year for the PMP. If a Pavement Condition Index (PCI) survey is performed, as set forth in ASTM D 5340, Standard Test Method for Airport Pavement Condition Index Surveys, the frequency of the detailed inspection by PCI surveys may be extended to three years. Less comprehensive routine daily, weekly, and monthly maintenance inspections required for operations should be addressed.*

A-1.3. Record Keeping. *The airport must record and keep on file complete information about all detailed inspections and maintenance performed until the pavement system is replaced. The types of distress, their locations, and remedial action, scheduled or performed, must be documented. The minimum information recorded includes:*

a. *Inspection date.*

b. *Location.*

c. *Distress types.*

d. *Maintenance scheduled or performed.*

A-1.4. Information Retrieval. *An airport sponsor may use any form of record keeping it deems appropriate so long as the information and records from the pavement survey can generate required reports, as necessary.*

The WSDOT Aviation’s APMS provides airports with an excellent basis for meeting the requirements of this law. The airports now have a complete pavement inventory and a detailed inspection. To remain in compliance with the law, NPIAS airports will also need to undertake monthly drive-by inspections of pavement conditions and track pavement-related maintenance activities.

The form provided in table 1 can be used for the required monthly inspections. While only required for NPIAS airports, it is highly recommended that non-NPIAS airports perform these inspections as well and keep records of pavement conditions and M&R work completed at the airport.

Table 1. Pavement inspection form.

Inspected By: ___________________________

Date Inspected: ___________________________

Inspection Record: **Branch Location**	**Inspection Record:** **Section Location**	**Inspection Record:** **Distress Description/ Dimensions/Severity/ Recommended Action**	**Maintenance Action:** **Description of Repair**	**Maintenance Action:** **Date Performed**	**Maintenance Action:** **Cost**	**Maintenance Action:** **Funding Source**

Conditions Requiring Immediate Attention

Some pavement distress types at high severity levels warrant immediate remedial action and/or notification of the FAA and WSDOT Aviation due to their potential for posing a safety hazard. These are situations that can lead to tire damage, foreign object debris (FOD), loss of friction, or hydroplaning. Following are the descriptions of different distresses that occur on a pavement broken down by asphalt and portland cement concrete (PCC) pavement distress types. The occurrences of these distresses on runways or other areas where aircraft are maneuvering, especially at high speeds, are more critical.

Asphalt Distress Types

Following is a list of PCI distress type and severity combinations for asphalt-surfaced pavements that warrant immediate attention and/or notification of the FAA and WSDOT Aviation about the problem. Note that text taken directly from ASTM D5340-12 is italicized. There are many other PCI distress type/severity combinations that are not mentioned herein that may be found on Washington airfields. For a complete listing of airfield PCI distresses, please refer to ASTM D5340-12 or FAA AC 150/5380-6C.

Alligator Cracking

Alligator or fatigue cracking appears as a series of interconnecting cracks caused by fatigue failure of the AC surface. The fatigue failure is most often the result of repeated traffic loading. *After repeated traffic loading, the cracks connect, forming many-sided, sharp-angled pieces that develop a pattern resembling chicken wire or the skin of an alligator*.

At the high-severity level, *the pieces are well defined and spalled at the edges*; there is definite FOD potential. If extensive, the only recourse is to overlay or reconstruct the pavement. If localized, full-depth patching is an appropriate repair. Figure 4 illustrates what alligator cracking looks like at the high-severity level.

Figure 4. High-severity alligator cracking.

Bleeding

Bleeding is a film of bituminous material on the pavement surface that creates a shiny, glass-like, reflecting surface that usually becomes quite sticky. Bleeding is caused by excessive amounts of asphaltic cement or tars in the mix or low-air void content, or both. It occurs when asphalt fills the voids of the mix during hot weather and then expands out onto the surface of the pavement. Since the bleeding process is not reversible during cold weather, asphalt or tar will accumulate on the surface.

At its most severe, bleeding can result in a severe reduction in skid resistance. If bleeding is extensive and severe, as shown in figure 5, the asphalt layer should be removed and replaced.

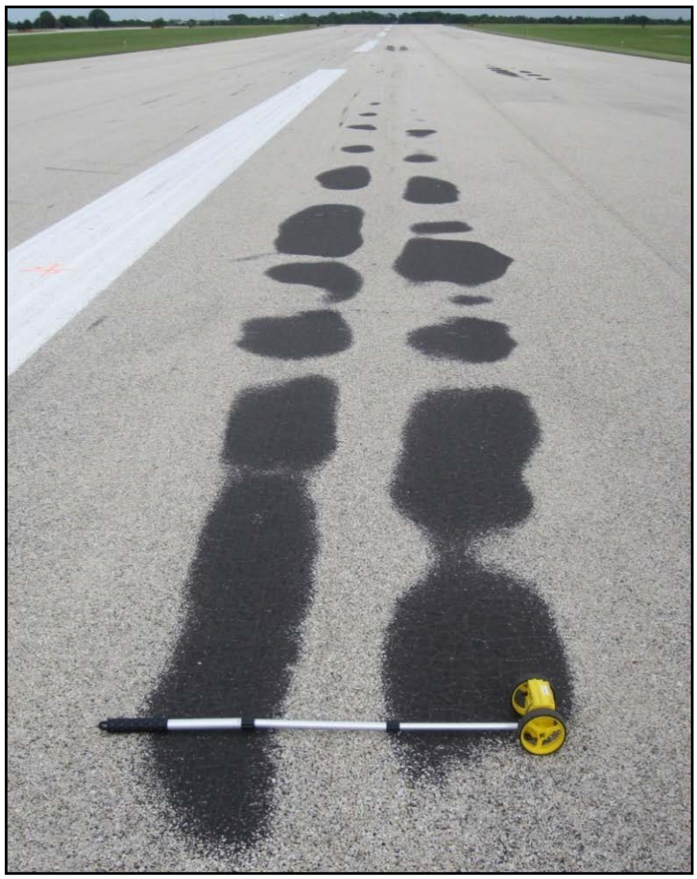

Figure 5. Extensive bleeding.

Depression

Depressions are localized pavement surface areas having elevations slightly lower than those of the surrounding pavement. Depressions can be caused by settlement of the foundation soil or can be built during construction. Depressions cause roughness and, when filled with water of sufficient depth, could cause hydroplaning of aircraft.

High-severity depressions in areas where an aircraft is trying to maneuver at high speeds should be patched. An example of a high-severity depression is shown in figure 6.

Figure 6. High-severity depression.

Joint Reflective Cracking and Longitudinal and Transverse (L&T) Cracking

Joint reflective cracking occurs on pavements that have an asphalt overlay over PCC pavement. This type of cracking is caused by the movement of the underlying PCC slabs.

Longitudinal cracks are parallel to the pavement's centerline. Transverse cracks are approximately perpendicular to the pavement's centerline, or direction of pavement laydown. This distress can be caused by the separation of the pavement at the paving lane joints, shrinkage of the asphalt pavement due to temperature differentials in older or brittle pavements, or reflective cracking from underlying existing cracks in overlaid pavements.

At the high-severity level, the *cracks are severely spalled and pieces are loose or missing causing definite FOD potential*. These cracks need to be sealed. If the crack width is extensive, consider patching the affected area. Figure 7 shows a crack that warrants immediate attention.

Figure 7. High-severity L&T cracking.

Patching

At high severity, a *patch is badly deteriorated and affects ride quality significantly or has high FOD potential*. High-severity patches need to be replaced to avoid FOD and/or tire damage potential. A photograph of a high-severity patch follows in figure 8.

Figure 8. High-severity patching.

Raveling

Raveling occurs as the coarse aggregate pieces begin to dislodge and produce loose pieces of material. Raveling may indicate that the asphalt binder has significantly hardened.

At high severity, the aggregate has worn away, which causes a high FOD potential and is a potential safety hazard since the loose aggregate could be ingested by aircraft engines. The surface texture is severely rough and pitted. If localized, high-severity raveling can be corrected with a patch; however, if extensive, an overlay will probably be needed. A photograph of high-severity raveling is shown figure 9.

Figure 9. High-severity raveling.

Rutting

Rutting is a surface depression in the pavement that is caused by repeated wheel loading in excess of the structural capacity of any or all of the pavement layers. Rutting is a load-related distress and is typically found in the wheel paths of aircraft.

At the high-severity level, the mean depth of the rutting is greater than 1 inch. If localized, this distress can be corrected with a patch. If it is an extensive problem, consider major rehabilitation. Figure 10 depicts rutting at the high-severity level.

Figure 10. High-severity rutting.

Shoving of Asphalt Pavements by PCC Pavements

Pavement expands as its temperature increases. Due to its greater strength, when PCC pavement expands adjacent to an asphalt pavement, it can sometimes cause a permanent vertical deformation in the asphalt pavement. Additionally, PCC pavement has a tendency to grow as gradual openings at the joint widen and are filled with incompressible material or when distresses such as alkali-silica reactivity (ASR) cause the pavement to expand. This is referred to as pavement growth, which can produce vertical deformation in adjacent asphalt pavements. This deformation is called shoving.

At high-severity, *a large amount of shoving has occurred, causing severe roughness or break-up of the asphalt pavement*. This situation can be corrected by milling the asphalt surface to restore smoothness and patching as needed. Installing an expansion joint may minimize the potential for recurrence of the distress. Figure 11 is a photograph of high-severity shoving.

Figure 11. High-severity shoving at AC/PCC interface.

Swelling

Swell is characterized by an upward bulge in the pavement's surface. A swell may occur sharply over a small area or as a longer, gradual wave. Either type of swell can be accompanied by surface cracking. A swell is usually caused by frost action in the subgrade or by swelling soil, but a small swell can also occur on the surface of an asphalt overlay (over PCC) as a result of a blowup in the PCC slab.

At the high-severity level, the height differential is greater than 1 ½ inches. This distress can be corrected with a patch, or, if it is an extensive problem, the pavement can be reconstructed. Consideration should be made to stabilizing and draining the subgrade and adding a frost protection layer if that is a factor. High-severity swelling is shown in figure 12.

Figure 12. High-severity swelling.

Weathering

Weathering is the wearing away of the asphalt binder and/or fine aggregate that occurs in an asphalt-surfaced pavement as the pavement ages and hardens. Weathering is an indication that the pavement is becoming more brittle.

At high severity, a significant amount of fine aggregate has worn away. If localized, high-severity weathering can be corrected with a patch; however, if extensive, a surface treatment may be needed. Figure 13 shows a photograph of high-severity weathering.

Figure 13. High-severity weathering.

PCC Distress Types

The following is a list of the PCI distress type and severity combinations for PCC pavements that warrant immediate attention and/or notification of WSDOT Aviation and the FAA about the problem. Note that text taken directly from the ASTM D5340-12 is presented in italics. There are many other PCI distress type and severity combinations that are not mentioned herein that may be found on Washington airfields. For a complete listing of airfield PCI distresses, please refer to ASTM D5340-12 or FAA AC 150/5380-6C.

Alkali Silica Reaction (ASR)

ASR is caused by a chemical reaction between the alkalis in the cement and certain reactive silica minerals that forms a gel. The gel absorbs water, causing expansion in the concrete that can lead to crack formation. These cracks often appear in a mapping pattern.

At high severity, ASR causes the slab's surface integrity and functionality to degrade significantly, which poses a high potential for FOD. Repair of a slab containing ASR requires complete removal and replacement of the affected area. High-severity ASR is shown in figure 14.

Figure 14. High-severity ASR.

Blowup

Blowups occur in hot weather, usually at a transverse crack or joint that is not wide enough to permit expansion of the concrete slabs. The insufficient width may be caused by infiltration of incompressible materials into the joint space. When expansion cannot relieve enough pressure, a localized upward movement of the slab edges (buckling) or shattering will occur in the vicinity of the joint. Blowups can also occur at utility cuts and drainage inlets. This type of distress is almost always repaired immediately because of severe damage potential to aircraft.

Depending on the situation, a full-depth patch or slab replacement will be required. An expansion joint must be provided during the repair. Figure 15 is a photograph of this distress type at high-severity level.

Figure 15. High-severity blowup.

Corner Break

A corner break is 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. Load repetition combined with loss of support and curling stresses usually cause corner breaks.

At high severity, *one of the following conditions exists: (1) filled or nonfilled crack is severely spalled, causing definite FOD potential; (2) a nonfilled crack has a mean width greater than approximately 1 inch, creating tire damage potential; or (3) the area between the corner break and the joints is severely cracked*. This distress needs to be repaired with a full-depth patch or in some cases with a slab replacement. A high-severity corner break is shown in figure 16.

Figure 16. High-severity corner break.

Durability ("D") Cracking

Durability cracking is usually caused by a pavement's inability to withstand the forces created by freeze-thaw cycles in concrete pavements that are susceptible to moisture penetration. Durability cracking can lead to the disintegration of a pavement along joints and cracks.

At high-severity levels, significant FOD potential can exist, and the slab will often require replacement or full-depth patch. High-severity durability cracking is shown in figure 17.

Figure 17. High-severity durability cracking.

Longitudinal, Transverse, and Diagonal [LTD] *Cracks*

LTD cracks *divide a slab into two or three pieces*. These types of cracks are usually caused by a combination of repeated loading, curling stresses, and/or shrinkage stresses. In general, low-severity cracks are usually caused by curling and/or warping stresses and are not considered serious structural problems. *Medium- and high-severity cracks are usually working cracks and are considered major structural distresses*.

At the high-severity level, the slab will often require replacement or large, full-depth patches. Figure 18 is a photograph of a high-severity LTD crack.

Figure 18. High-severity LTD crack.

Patching (Small or *Large)*

A patch is an area where the original pavement has been removed and replaced by a filler material. Patching is divided into two types: small (less than 5 ft^2) and large (over 5 ft^2).

High-severity patches must be replaced. An example of high-severity patching is shown in figure 19.

Figure 19. High-severity patching.

Scaling

Scaling is the breakdown of the slab surface to a depth of approximately ¼ to ½ in. Scaling appears as a flaking away of the pavement's surface and presents FOD potential. The overfinishing of the concrete surface during construction can cause this distress. Other potential causes of scaling include *addition of water to the pavement surface during finishing, lack of curing, and attempted surface repairs of fresh concrete with mortar*.

At the high-severity level, there is substantial FOD potential, and slab replacement is usually the only viable alternative. Figure 20 is a photograph of high-severity scaling.

Figure 20. High-severity scaling.

Settlement or Faulting

ASTM D5340-12 defines settlement or faulting as *a difference of elevation at a joint or crack caused by upheaval or consolidation*. Instability in load transfer mechanisms, softening or loss of underlying support, and expanding materials in the subgrade are common causes of this type of distress.

At the high-severity level, as shown in figure 21, settlement or faulting can cause tire damage potential. Grinding may be considered, if extensive, to restore a smooth ride quality.

Figure 21. High-severity faulting.

Shattered Slab

A shattered slab is defined as intersecting cracks *that break a slab into four or more pieces due to overloading or inadequate support or both*.

The only option at the high-severity level is to replace the slab. High-severity shattered slabs are shown in figure 22.

Figure 22. High-severity shattered slab.

Spalling (Joint)

Joint spalling is the breakdown of the slab edges within 2 ft of the side of the joint. A joint spall usually does not extend vertically through the slab but intersects the joint at an angle. Spalling is typically caused by the introduction of incompressible material in the joint, weaker pavement at the joint caused by overworking of the pavement during construction, traffic loading, or a combination of these.

In order for a joint spall to be recorded at high severity, it must be greater than 2 feet long. The joint spall: *(1) is broken into more than three pieces defined by one or more high-severity cracks with high FOD potential and high possibility of the pieces becoming dislodged or (2) joint is severely frayed with high FOD potential.* This distress should be repaired with a partial-depth patch. A photograph of this distress type at the high-severity level is shown in figure 23.

Figure 23. High-severity joint spalling.

Spalling (Corner)

Corner spalling is defined as *the raveling or breakdown of the slab within approximately 2 feet of the corner.* Corner spalling has the same causes as joint spalling and must be greater than 3 inches wide to be considered a spall.

In order for a corner spall to be recorded at high-severity, *one of the following conditions exists: (1) spall is broken into two or more pieces defined by high-severity fragmented crack(s) with loose or absent fragments; (2) pieces of the spall have been displaced to the extent that a tire damage hazard exists; or (3) spall has deteriorated to the point where loose material is causing high FOD potential.* Due to the high FOD potential, this distress should be repaired with a partial-depth patch. Figure 24 shows high-severity corner spalling.

Figure 24. High-severity corner spalling.

SECTION 3

DEVELOPING AND IMPLEMENTING AN M&R PLAN FOR YOUR AIRPORT

3. DEVELOPING AND IMPLEMENTING AN M&R PLAN FOR YOUR AIRPORT

In addition to this manual, IDEA available on the WSDOT Aviation website was developed. This section of the manual provides information on how you can use the information contained in the IDEA to prepare an M&R plan for your airport.

Developing an M&R Plan

Using a sample airport, following is an approach for using the IDEA to develop your M&R plan. The first step is to access the IDEA though the WSDOT Aviation website, which contains the following sections:

- Statewide summary.
- Airport details.
- Maintenance guidelines.
- Pavement inspection.
- Miscellaneous.

Using this manual, in conjunction with the IDEA, you will complete the following steps described in detail below:

- Determine current pavement inventory and pavement conditions.
- Identify cause of deterioration and determine appropriate repair action.
- Develop short-term localized maintenance plan.
- Develop long-term rehabilitation plan.
- Develop plan for tracking condition and maintenance.
- Work closely with the FAA and WSDOT Aviation to obtain funding for M&R, if needed.
- Implement plan.

Determine Current Pavement Inventory and Pavement Conditions

Using the *Airport Details* tab of the IDEA and by selecting *Data View=Section* in the upper left corner, review the pavement infrastructure that you are responsible for managing—such as the physical location of the pavements, the cross-section and age of the pavements, and 2018 pavements' condition. Your individual *Airport Details* page contains a map that shows the locations of the pavement sections at the airport and each section is hatched representing the condition observed during the 2018 inspection. Selecting a section on the map will display details from the 2018 pavement inspection on the right-hand side of the screen along with inspection photographs, work history information, condition, and overview of recommended work (available on separate subtabs). An example of this map for a sample airport is provided in figure 25.

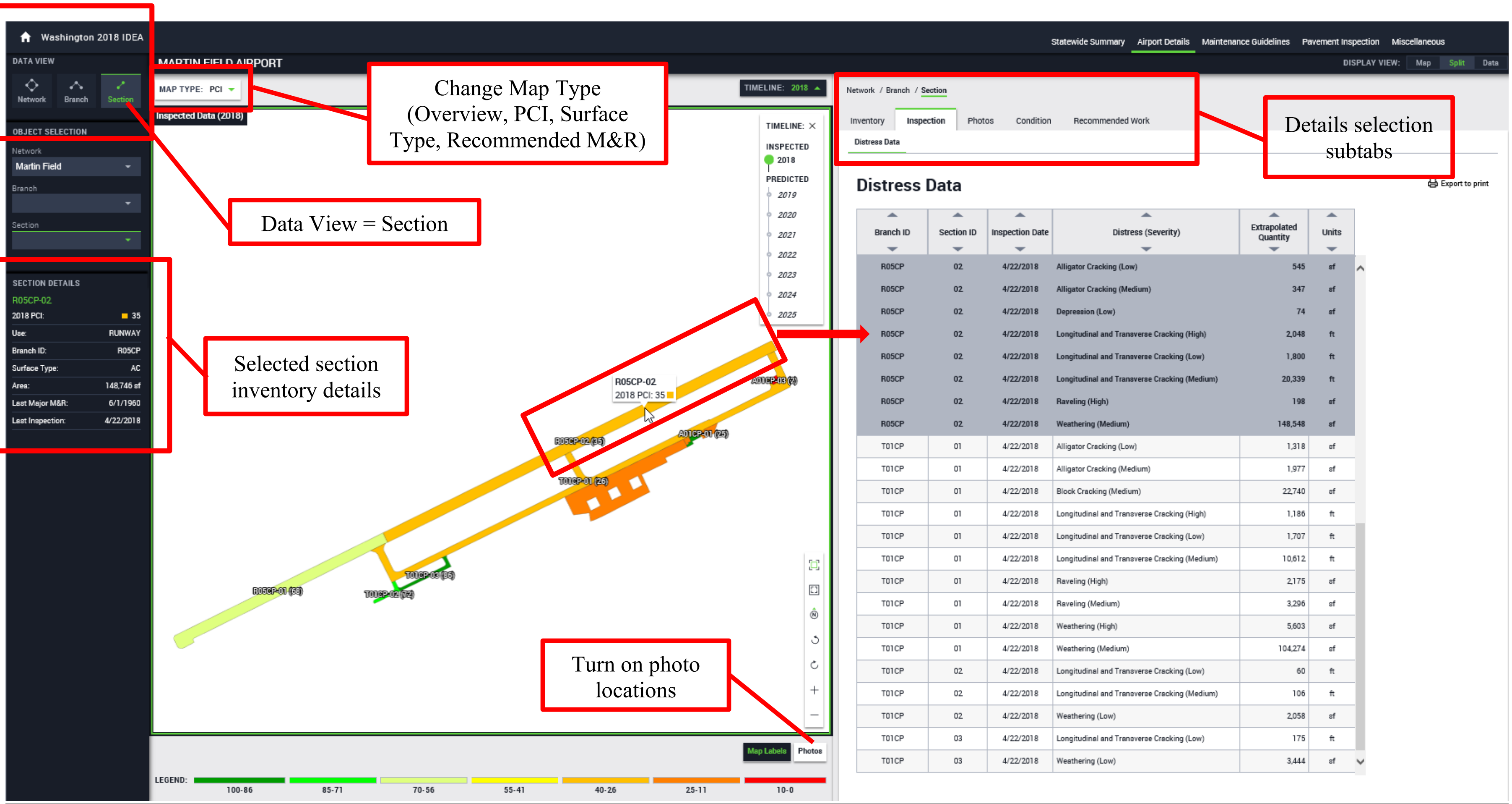

Figure 25. Sample pavement condition map.

Identify Cause of Deterioration and Appropriate Repair Action

Selecting a section on the interactive map in the IDEA will provide detailed information on the 2018 pavement inspection results. It not only provides you with an overall PCI but also describes the type, severity, and quantity of distresses observed. For more information on specific pavement distress types, you can refer to the *Pavement Inspection* tab of the IDEA. This tab provides information on the PCI procedure and detailed information on the different distress types, including criteria for inspection, probable causes of the distress types, and feasible maintenance strategies.

Using this information, you can determine the cause of deterioration and identify appropriate feasible repair actions. A link to FAA AC 150/5380-6C and FAA AC 150/5380-7B, which provide further guidance on what repairs are appropriate for different distress types as well as specific guidance on how to conduct the repair, can be found under the *Maintenance Guidelines* tab of the IDEA.

Develop Short-Term Localized Preventive Maintenance Plan

The Year 1 *Maintenance* subtab of the *Recommenced Work* tab [*Data View=Network*] contains a recommended 2019 localized preventive maintenance plan for each airport. This was prepared using the maintenance policies and unit costs shown on the *Unit Cost* and *Maintenances Policies* subtabs, respectively. **These were developed for the entire state; therefore, they will need to be adjusted as necessary for a specific airport.** Figure 26 shows a sample localized preventive maintenance plan table that includes the distress to be corrected, its quantity, corrective action, and the estimated costs.

The short-term localized maintenance plan will need to be revisited each year, since it is not possible to predict the exact needs that an airport will face year to year with respect to crack sealing, patching, and so on.

Develop Long-Term Rehabilitation Plan

The *Work Plan* subtab of the *Recommended Work* tab [*Data View=Network*] contains details of the M&R plan under unlimited funding scenario as shown in figure 27. In addition, a map showing this information is also available once *Data View=Section* is selected and *Map Type* is changed to *Recommended M&R*. **This plan was prepared using costs developed for airports of a similar size and geographic region to your airport but are not specific to any airport. Therefore, costs may need to be adjusted.**

Since the plan was developed using an unlimited budget analysis, no adjustments were made to take into account economic or operational constraints. **Therefore, it is possible that the work plan presented in IDEA should be adjusted to phase/combine the work so that it can be funded in the same year.** Figure 28 shows a sample airport rehabilitation plan and an example of how it can be adjusted by combining work to fall in the same fiscal year.

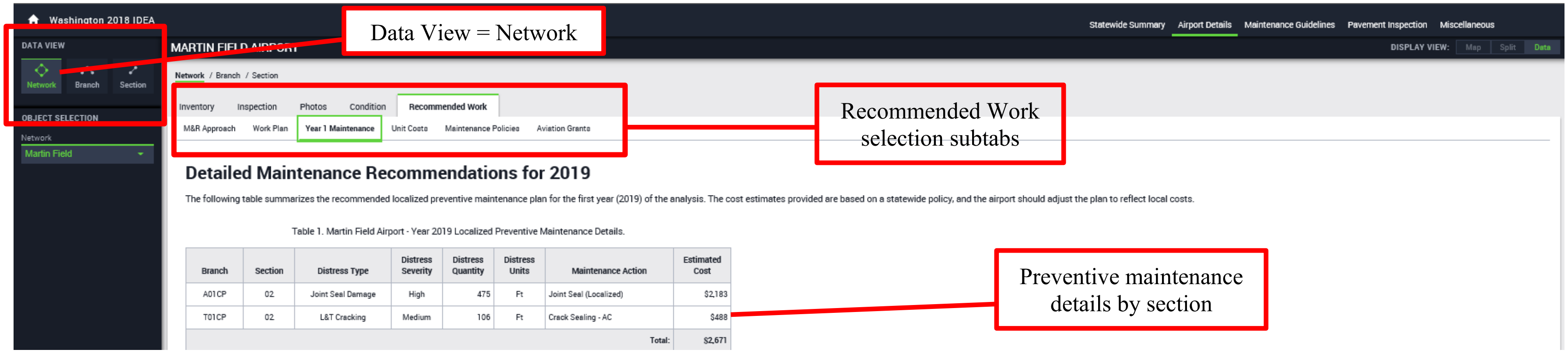

Figure 26. Sample localized preventive maintenance plan table.

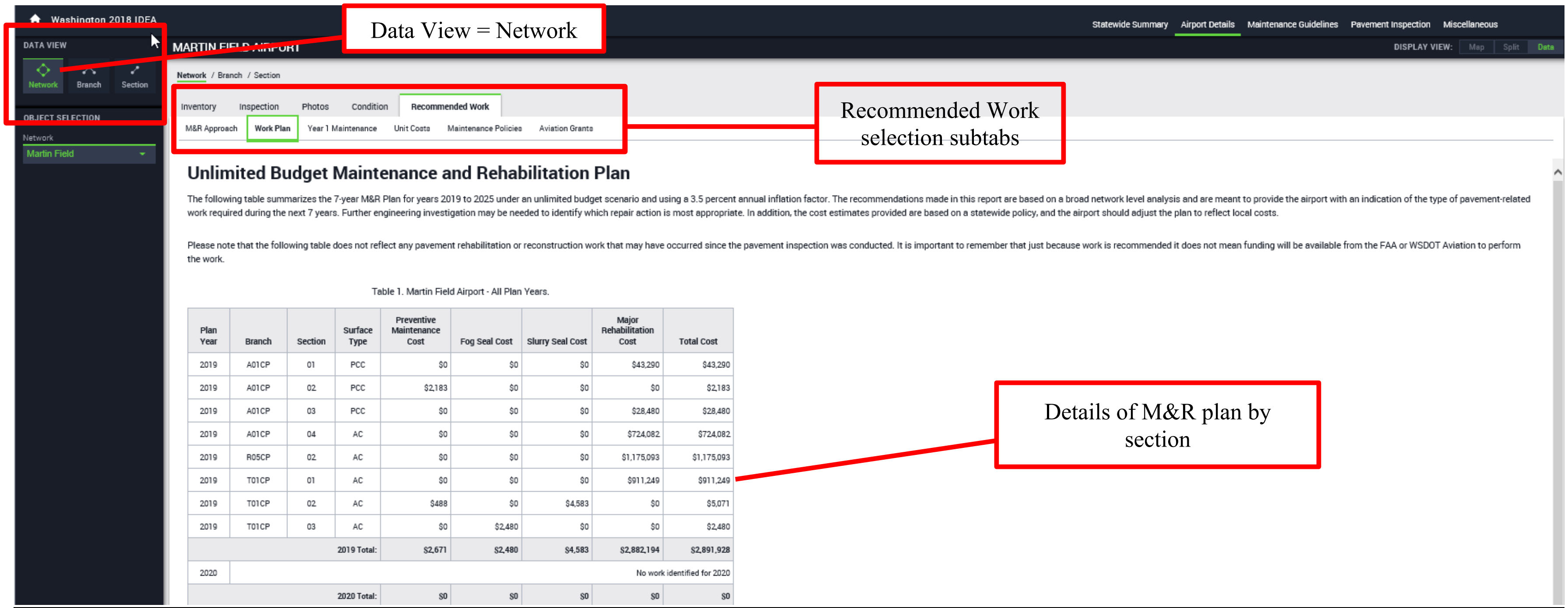

Figure 27. Sample work plan table.

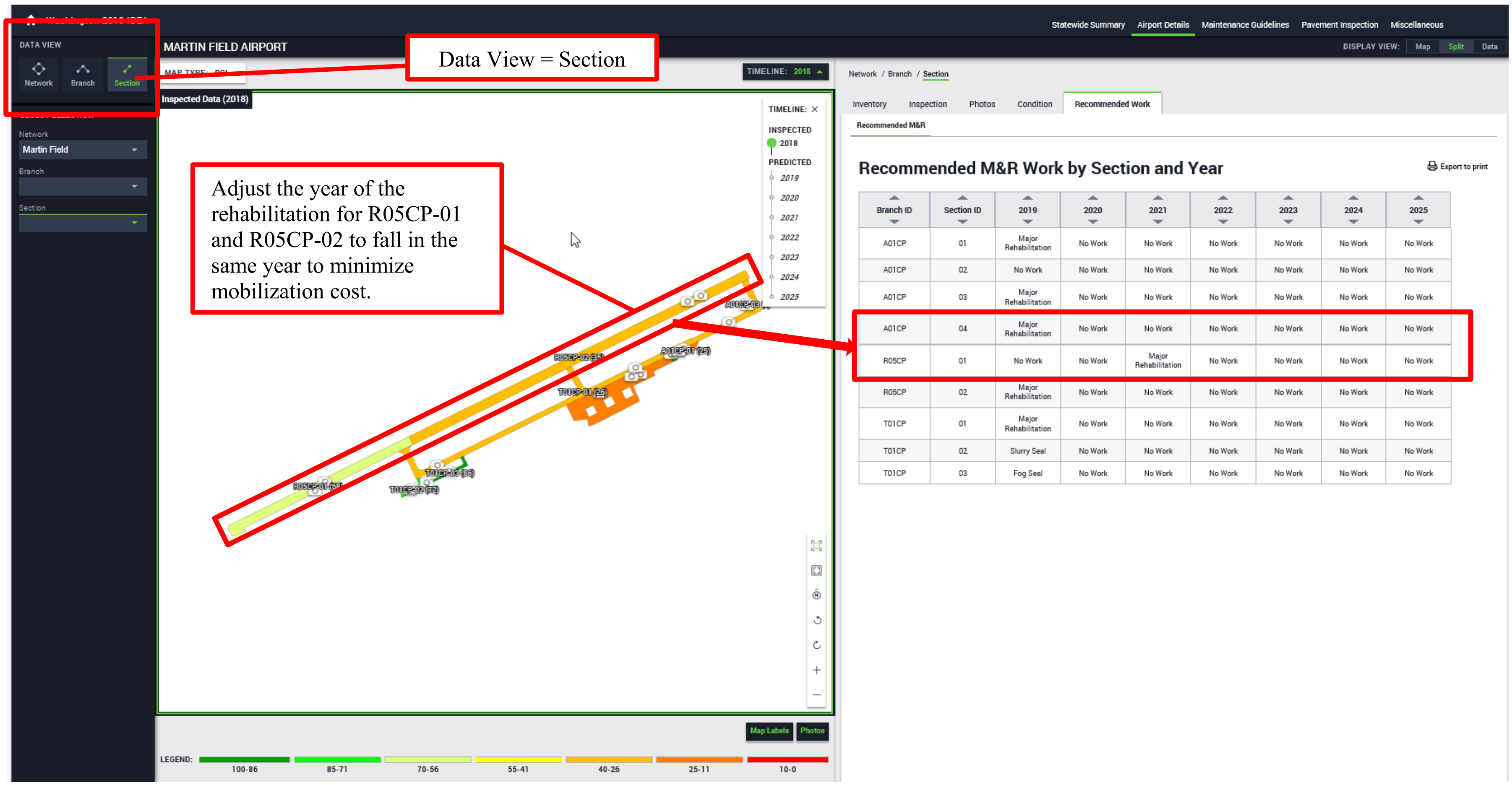

Figure 28. Sample adjusted work plan map.

Develop Procedure for Monitoring Pavement Condition and Tracking Maintenance

For NPIAS airports it is required, and for non-NPIAS it is highly recommended, that you monitor pavement condition and track pavement-related maintenance needed and performed at your airport. You should perform a drive-by inspection of your airport pavements at least monthly. During this inspection, note the distresses observed, maintenance needed, and any maintenance that has been performed since the last inspection. A sample inspection sheet that you can use is provided in table 1 in Section 2 of this report. It is recommended that you retain each month's inspection sheet and provide to WSDOT Aviation and FAA if needed.

Request Funding for Pavement Maintenance and Rehabilitation

If you do not have adequate local funding for the work needed, you will need to put together a strategy for obtaining funding. Depending on your airport, you may have federal or state funding available to you.

Federal Funding

To be eligible for federal funding, your airport must be a part of the NPIAS. If it is in the NPIAS, you are eligible for federal funding as described below.

General Aviation Non-Primary Entitlement Program (NPE)

General aviation non-primary airports in the NPIAS with funding requests on record are currently eligible to receive NPE funds. Except for a few minor exceptions, an airport is currently limited to 20 percent of their 5-year cost of their current NPIAS value or $150,000, whichever is less. However, these amounts may change in the future as available funding fluctuates. It is permissible for airports to delay using their entitlement and bank up to 3 years of this money to have a maximum of $600,000 in the fourth year to fund larger projects. Unused funds will expire after 4 years unless the sponsor obligates the funds under a grant or transfers the funds to another NPIAS airport. It is critical if you want to pursue this source of money that you keep your 5-year CIP with the FAA up to date in WSDOT's Statewide Capital Improvement Plan CIP web application.

NPE funds can be used for projects that are eligible under the Airport Improvement Program (AIP) Grant program such as most airfield capital improvement projects as well as limited airfield pavement maintenance work.

The following types of maintenance work may be eligible for NPE money:

- Crack cleaning, filling, and/or sealing of longitudinal and transverse cracks.
- Grading pavement edges.
- Maintaining drainage systems.
- Pavement patching.
- Remarking paved areas.

The following types of maintenance work are not eligible for NPE money:

- Snow removal equipment.
- Herbicide application.
- Sweeping.
- Snow and ice removal.
- Rubber removal.
- Mowing turf runways.
- Any other operational cost.

Airport Improvement Program (AIP) Grant

NPIAS airports are eligible to receive AIP grants for pavement-related work. Under Vision 100, for most airports, 90 percent of these AIP grants are paid by the FAA with exception of large and medium hub airports at 75 percent. The airport sponsor is responsible for the remaining portion of the project cost. AIP funds are eligible for many activities, including pavement construction, reconstruction, and rehabilitation.

To be eligible to use AIP grant money for maintenance, the airport must be able to show that it is unable to fund maintenance under its Grant Assurances using its own resources. The airport must also agree to undertake and keep current at least the minimum pavement maintenance management program as required by the FAA. And, if the sponsor of a pavement maintenance management program is a State aviation agency, PCI shall be a current part of the State's airport system planning. Maintenance projects are not funded where the FAA determines a rehabilitation or reconstruction project is required because pavement condition has deteriorated to such a point that a maintenance project would not be considered cost effective.

State Funding

WSDOT Aviation targets 65 to 75 percent of its investments through the Airport Aid Grant Program to be used for pavement projects. The maximum grant amount per airport is $750,000. To be eligible, your airport must have an approved airport layout plan (ALP) and be included in the WASP. All projects must be included in WSDOT Aviation's 5-year Statewide Capital Improvement Program (SCIP). If you are a NPIAS airport, you must apply first to the FAA for funding, and then WSDOT Aviation will consider providing up to half the matching funds to that amount. Non-NPIAS airports are required to provide a minimum 5 percent match. As funding becomes more competitive, the maximum grant amount and the percent of the state match may change. In prioritizing projects, runways receive the highest priority. Pavement preservation projects are considered a higher priority than new construction.

Implement the Plan

Now you have a plan for preserving and rehabilitating your airport pavements—both in the short and the long term. It is up to you to implement the plan!