2023 ODAV Pavement Evaluation Program
Cascade Locks State Airport

Cascade Locks, Oregon

December 29, 2023

Prepared for

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1 OVERVIEW

GRI assisted with updating the Oregon Department of Aviation (ODAV) airport pavement management system and developing a five-year plan comprised of maintenance, surface treatment, rehabilitation, and reconstruction projects for the Cascade Locks State Airport in Cascade Locks, Oregon. This project was implemented as part of the ODAV and Federal Aviation Administration (FAA) *Oregon Continuous Aviation System Plan*. The information provided in this report ensures compliance with FAA Grant Assurance Number 11, which outlines that an airport shall have an effective airport pavement maintenance-management program in place to receive federal financial assistance for the construction, reconstruction, or repair of airport pavements.

GRI conducted surveys of the airside pavement at Cascade Locks State Airport in 2023 in accordance with the procedures of Advisory Circular 150/5380-7B and ASTM International (ASTM) D5340. We uploaded the survey data into the PAVER database and used the software to provide a rapid calculation of the pavement condition index (PCI) rating. The PCI is a numerical indicator that defines the functional condition of the pavement based on visual inspection. The scale ranges from zero to 100, where zero represents a pavement in the worst possible condition with no remaining functional life and 100 represents a pavement in the best possible condition with no defects.

2 PAVEMENT INVENTORY

Cascade Locks State Airport is located in Cascade Locks, Oregon, and is owned and operated by the Oregon Department of Aviation (ODAV). The airport consists of a single runway that serves general aviation aircraft. The general location of the airport is shown below on the Cascade Locks State Airport Location Map, Figure 2.1.

Figure 2.1: CASCADE LOCKS STATE AIRPORT LOCATION MAP

The airside pavements at Cascade Locks State Airport are comprised of asphalt concrete (AC) overlaid with AC (AAC). The airport pavements, delineated by surface type and branch use, are shown on the Cascade Locks State Airport Percent of Pavement Area by Surface Type, Figure 2.2, and on the Cascade Locks State Airport Pavement Area by Branch Use, Figure 2.3. The pavement inventory, including work history for each pavement section, is displayed spatially on the Cascade Locks State Airport Pavement Inventory, Figure 2.4. The pavement facilities summarized by branch and section are listed in Tables 1A and 2A, respectively, in Appendix A. The sample unit layout for each section is shown on Figure 1A in Appendix A. We used the sampling rates outlined in Table 3A of Appendix A in our survey. The pavement inventory, including work history for individual airport pavement sections, is provided in the work history report, Table 1F.

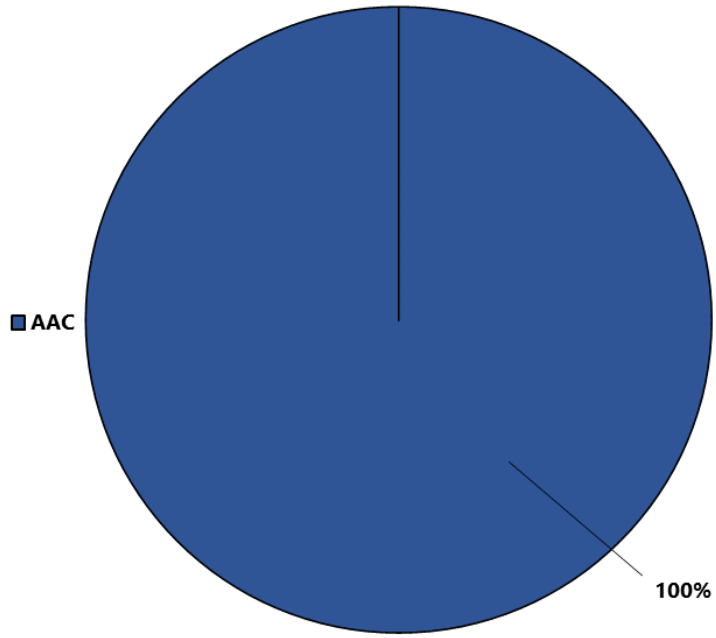


Figure 2.2: CASCADE LOCKS STATE AIRPORT PERCENT OF PAVEMENT AREA BY SURFACE TYPE

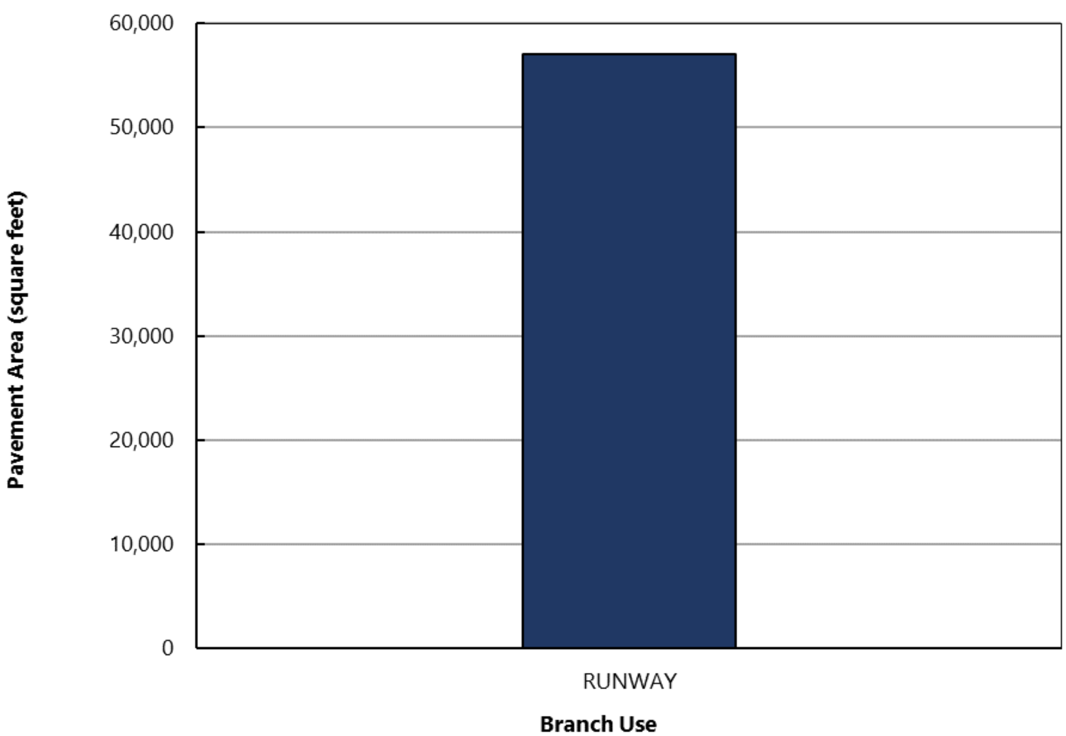
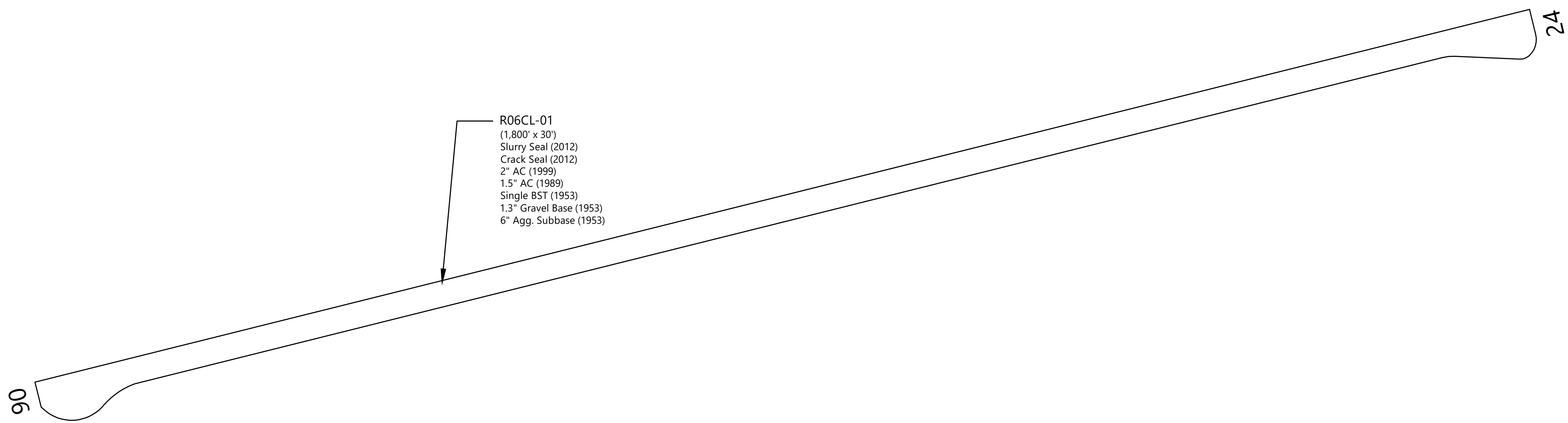
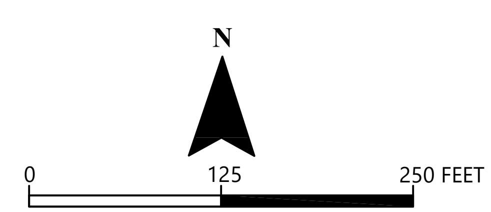


Figure 2.3: CASCADE LOCKS STATE AIRPORT PAVEMENT AREA BY BRANCH USE



ABBREVIATIONS: AC = ASPHALT CONCRETE; Agg. = AGGREGATE; BST = BITUMINOUS SURFACE TREATMENT



GRI OREGON DEPARTMENT OF AVIATION STATEWIDE PAVEMENT EVALUATION PROGRAM

CASCADE LOCKS STATE AIRPORT
PAVEMENT INVENTORY

DEC. 2023 JOB NO. 6593-E FIG. 2.4

3 PAVEMENT CONDITION INSPECTION RESULTS

3.1 Introduction

GRI conducted a visual PCI survey of the airside pavements at Cascade Locks State Airport in July 2023. The 2023 survey work was performed on sections last inspected in 2017 in order to update the Cascade Locks State Airport inspection data. GRI performed the 2023 PCI survey in accordance with the methods described in FAA Advisory Circular 150/5380-6C and ASTM D5340 and further discussed in Appendix B of this report.

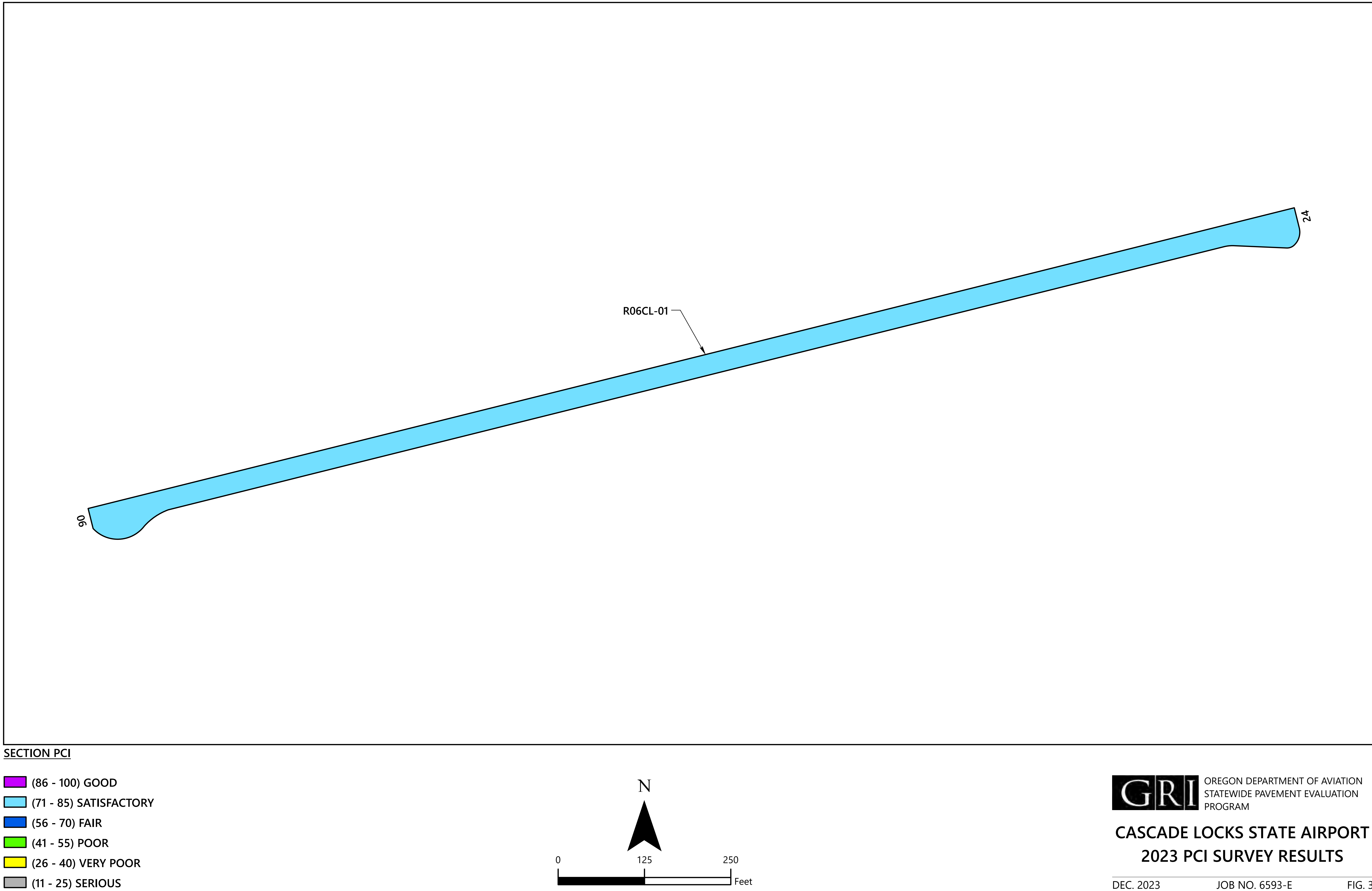
The PCI is based on the type, severity, and quantity of each distress found in an inspected sample unit. Further discussion of distress types for flexible pavement is provided in Appendix B and summarized in Table 1B in Appendix B. The results of the PCI survey are displayed using a seven-category rating scale in accordance with ASTM D5340. Details of the ASTM PCI rating scale are provided in Table 3-1 below.

Table 3-1: ASTM PCI RATING SCALE

PCI Color Legend	PCI Range	PCI Rating and Definition
	86 – 100	GOOD: Pavement has minor or no distresses and should require only routine maintenance.
	71 – 85	SATISFACTORY: Pavement has scattered low-severity distresses that should require only routine maintenance.
	56 – 70	FAIR: Pavement has a combination of generally low- and medium-severity distresses. Maintenance and repair needs may range from routine to major.
	41 – 55	POOR: Pavement has low-, medium-, and high-severity distresses that probably cause some operational problems. M&R needs will be major.
	26 – 40	VERY POOR: Pavement has predominantly medium- and high-severity distresses that cause considerable maintenance and operational problems. M&R needs will be major.
	11 – 25	SERIOUS: Pavement has mainly high-severity distresses that may affect operational safety; immediate repairs are needed.
	0 – 10	FAILED: Pavement deterioration has progressed to the point that safe aircraft operations are no longer possible; complete reconstruction is required.

3.2 Pavement Condition Index Survey Results

The area-weighted average PCI for all airport pavements at Cascade Locks State Airport is approximately 72. The primary distresses observed during the inspection were weathering and longitudinal and transverse cracking. Section PCI following our pavement survey is displayed below spatially on the Cascade Locks State Airport 2023 PCI Survey Results, Figure 3.1.



SECTION PCI

- (86 - 100) GOOD
- (71 - 85) SATISFACTORY
- (56 - 70) FAIR
- (41 - 55) POOR
- (26 - 40) VERY POOR
- (11 - 25) SERIOUS
- (0 - 10) FAILED

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CASCADE LOCKS STATE AIRPORT
2023 PCI SURVEY RESULTS

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The condition distribution of the network by percent of total pavement area is provided on the Cascade Locks State Airport Pavement Condition Rating by Percent of Area, Figure 3.2. A summary of the pavement condition results by branch and section are included in Tables 2B and 3B of Appendix B, respectively. A comparison between the previous inspection and the 2023 inspection is provided in Table 4B in Appendix B. The re-inspection report that includes inspection details for individual sample units is provided in Table 1E in Appendix E.

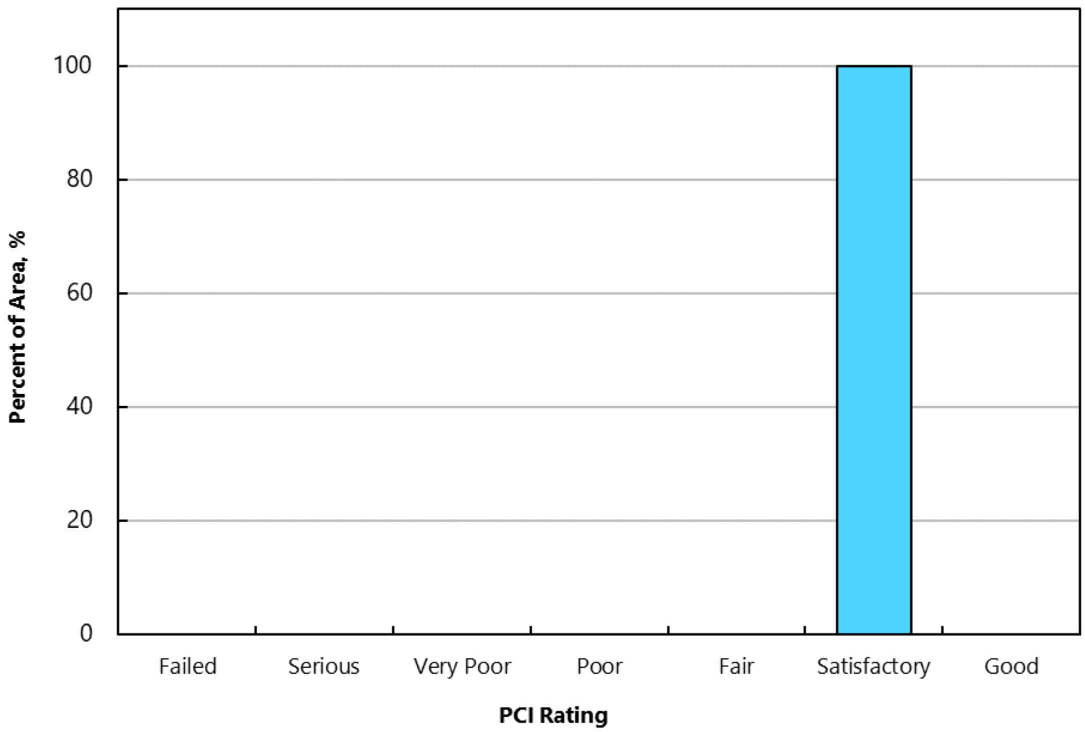


Figure 3.2: CASCADE LOCKS STATE AIRPORT PAVEMENT CONDITION RATING BY PERCENT OF AREA

4 FUTURE PAVEMENT CONDITION ANALYSIS

4.1 Introduction

In addition to assessing the current condition of a pavement, it is very important from a planning standpoint to be able to predict with reasonable accuracy the future condition. Additional details regarding our future pavement condition analysis, including pavement condition prediction models, are provided in Appendix C. The PCI performance curve developed for Cascade Locks State Airport is displayed on Figure 1C in Appendix C.

4.2 Future Condition Analysis

Using the condition prediction models discussed above, the projected condition of each pavement section was determined for 5- and 10-year periods. Based on this analysis, we project the PCI to decrease from a current value of 72 to a value of 67 in 2028 and 62 in 2033 if no maintenance or rehabilitation work is performed. The projected pavement condition in 5 years and 10 years for each pavement section at Cascade Locks State Airport is displayed spatially on the Cascade Locks State Airport Future Pavement Condition, Figure 4.1, and listed in Table 1C in Appendix C, along with the past and present PCI values for the pavement network.

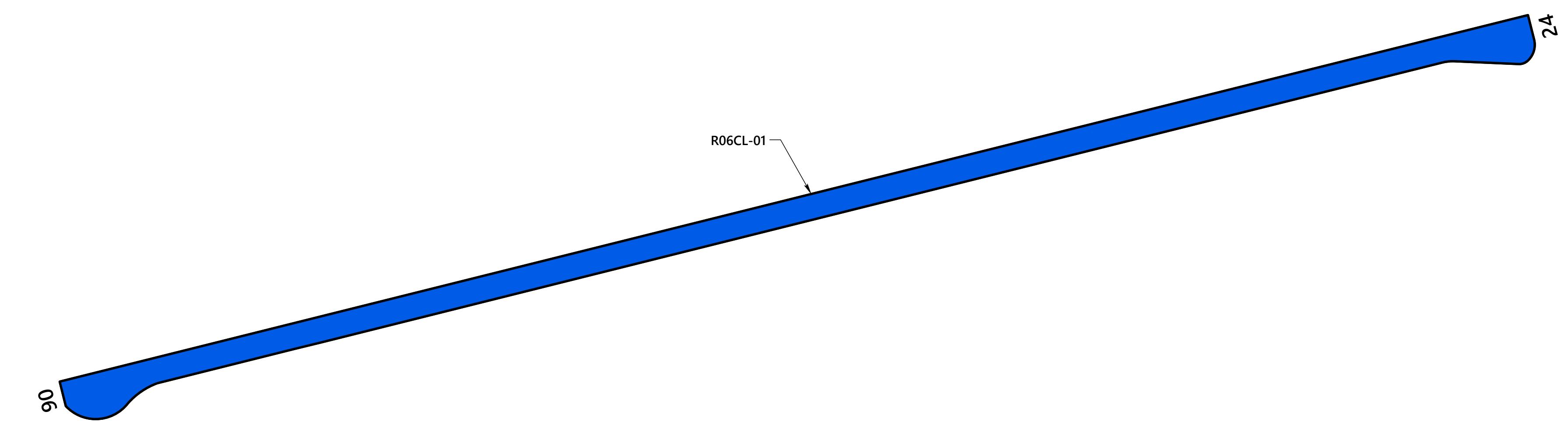
4.3 Functional Remaining Life

Functional remaining life is the practical amount of time a pavement is in service before requiring rehabilitation, as estimated solely based on visual condition. This is not to be confused with structural remaining life, which requires analysis of the structural capacity of a pavement and typically a field exploration and testing program that includes core explorations and falling weight deflectometer (FWD) deflection tests.

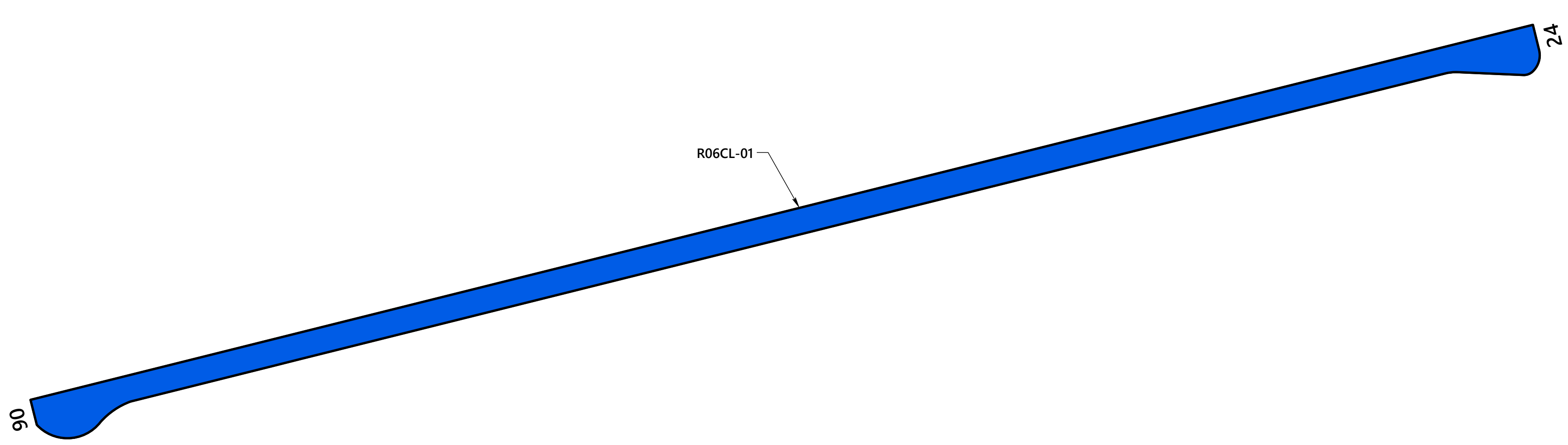
We calculated two forms of functional remaining life based on the current visual condition surveys of the pavement at Cascade Locks State Airport. The first type of functional remaining life is the time until rehabilitation, such as an overlay, is needed. The critical PCI, further discussed in Section C.3 of Appendix C, is the threshold used for this type of functional remaining-life analysis. The second type of functional remaining life is the time until the pavement is no longer operational due to high foreign object debris (FOD) potential and increased safety concerns for trafficking aircraft. A PCI of 40 was set as the trigger point for the end of the pavement's functional service life with regard to FOD potential.

The two types of functional remaining life for each section at Cascade Locks State Airport are summarized in Table 2C in Appendix C.

PREDICTED CONDITION IN 2028



PREDICTED CONDITION IN 2033



SECTION PCI

- (86 - 100) GOOD
- (71 - 85) SATISFACTORY
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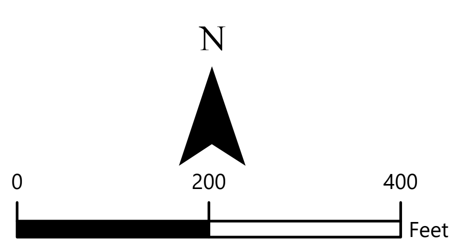
- (0 - 10) FAILED



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STATEWIDE PAVEMENT EVALUATION PROGRAM

CASCADE LOCKS STATE AIRPORT
FUTURE PAVEMENT CONDITION

DEC. 2023 JOB NO. 6593-E FIG. 4.1

5 MAINTENANCE AND REHABILITATION PROJECT RECOMMENDATIONS

5.1 Introduction

We evaluated M&R needs, as determined from the PAVER analysis results, in order to develop localized maintenance, surface treatment, rehabilitation, and reconstruction needs. Details of our M&R work priority and unit costs for work activities are provided in Tables 1D and 2D, respectively, in Appendix D.

5.2 Recommended Localized Maintenance

Localized maintenance refers to activities such as crack sealing and patching, which should be performed annually in order to properly maintain aging pavements. Using the PAVER Localized Distress Maintenance Analysis tool, we developed a list of recommended localized maintenance. This list is shown in Table 3D in Appendix D and is independent of the surface treatments, rehabilitation, and reconstruction projects associated with the five-year surface treatment and rehabilitation work plan. A summary of total localized maintenance quantities is provided in Table 5-1 below.

Table 5-1: LOCALIZED MAINTENANCE QUANTITIES

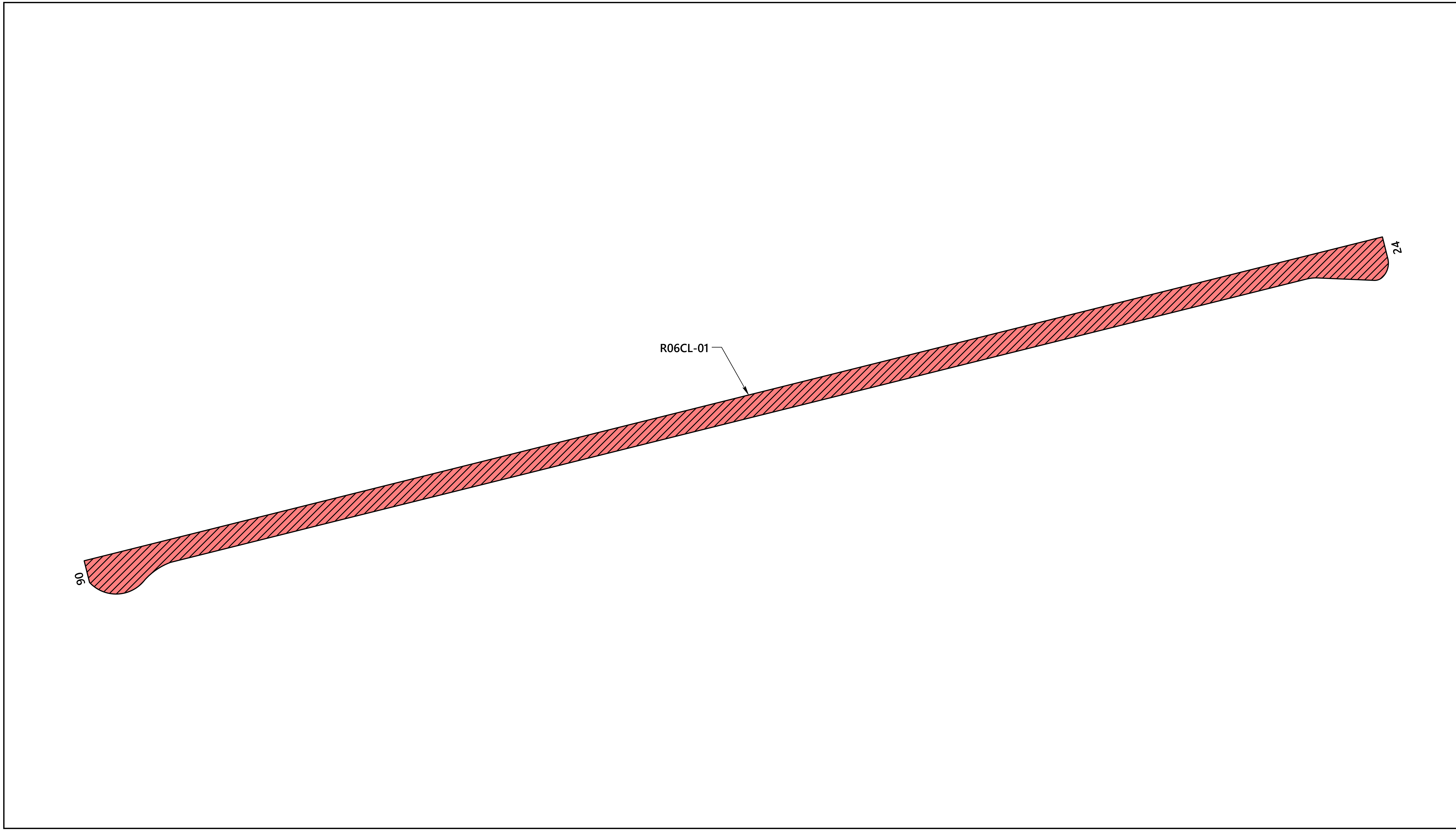
Localized Maintenance Operation	Quantity
Asphalt Concrete Crack Sealing	2,829 linear feet

5.3 Surface Treatment, Rehabilitation, and Reconstruction Plan

To develop the five-year work plan, we first ran the eliminate backlog scenario with the PAVER M&R Work Planning Module in order to generate a list, organized by year, of surface treatment, rehabilitation, and reconstruction projects. We then reviewed the project list and refined it into practical construction projects for each year. A summary of surface treatment, rehabilitation, and reconstruction quantities is provided in Table 5-2 below, and maps of the project locations by year are shown on the Cascade Locks State Airport 5-Year Pavement Management Plan, Figure 5.1. The complete list of recommended surface treatment, rehabilitation, and reconstruction projects is presented in Table 4D in Appendix D.

Table 5-2: SURFACE TREATMENT, REHABILITATION, AND RECONSTRUCTION QUANTITIES

Treatment Type	Quantity, square feet
Reconstruction	0
Overlay	0
Fog Seal	0
Slurry Seal	57,068

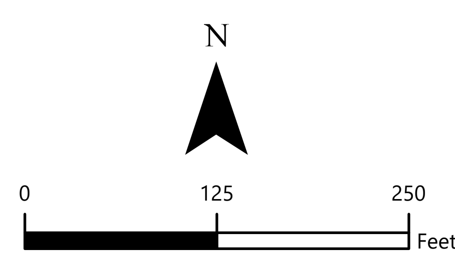


ACTION TIMING

- 2024
- 2025
- 2026
- 2027
- 2028

ACTION

- FOG SEAL
- SLURRY SEAL
- OVERLAY
- RECONSTRUCTION
- ROUTINE MAINTENANCE



GRI OREGON DEPARTMENT OF AVIATION STATEWIDE PAVEMENT EVALUATION PROGRAM

CASCADE LOCKS STATE AIRPORT

5-YEAR PAVEMENT MANAGEMENT PLAN

DEC. 2023 JOB NO. 6593-E FIG. 5.1

6 LIMITATIONS

This report has been prepared to assist the Oregon Department of Aviation (ODAV) with pavement-related project planning for the Cascade Locks State Airport. The scope is limited to the specific pavement areas described within this report. The conclusions and recommendations provided in this report are based on information provided by ODAV, estimated costs, and an understanding of the pavement conditions based solely on visual assessment. The surface treatment, rehabilitation, and reconstruction recommendations and project selections provided in this report, as well as their corresponding cost estimates, are based on a practical grouping of projects and an estimate of the structural requirements. It is possible that recommendations based on a structural evaluation would differ materially from the recommendations given within this report. Therefore, the information included in this report should be used solely for project planning purposes, and it should be understood that rehabilitation costs may vary from the cost estimates given within this report.

Because the condition of the airport pavement network is dynamic, an effective maintenance and rehabilitation program should be reviewed and updated on a regular basis. In addition to regularly surveying and updating the pavement condition, completed construction activities should be tracked in the PAVER database. If Cascade Locks State Airport would like to know more about the results presented in this report, please contact the undersigned.

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This document has been submitted electronically.

APPENDIX A

Pavement Inventory Reports and Maps

APPENDIX A

PAVEMENT INVENTORY REPORTS AND MAPS

A.1 PAVEMENT NETWORK

Cascade Locks State Airport is located in Cascade Locks, Oregon, and is owned and operated by the Oregon Department of Aviation (ODAV). The pavement network/facilities at Cascade Locks State Airport serve a variety of general aviation aircraft. Cascade Locks State Airport consists of a single runway. Airside pavements consist of asphalt concrete (AC) overlaid with AC (AAC).

The current airport pavement management system (APMS) network at Cascade Locks State Airport has an approximate area of 57,068 square feet of paved airside facilities. The pavement network has previously been divided (by others) into a hierarchical order of branches, sections, and sample units that facilitate inspection and maintenance planning. The pavement facilities summarized by branch and section are listed in Tables 1A and 2A, respectively. Pavement sections and the sample unit layout for each section are shown on Figure 1A in this appendix.

A.2 BRANCHES

A branch, as defined in the PAVER system, is a facility that is a readily identifiable part of the pavement system and has a distinct function. For airports, branches typically consist of individual runways, taxiways, and aprons. The current pavement network for Cascade Locks State Airport contains 1 branch, tabulated in Table 1A and shown on Figure 1A.

A.3 SECTIONS AND SAMPLE UNITS

A pavement section is the smallest management unit used when considering the application and selection of maintenance and rehabilitation (M&R) repairs and treatments and is defined by Section 2.1.8 of ASTM International (ASTM) D5340 as *"a contiguous pavement area having uniform construction, maintenance, usage history, and condition."* All sections should also have the same traffic volume and load intensity. The current pavement network included in the PAVER database for Cascade Locks State Airport contains 1 section that is managed by the Oregon Department of Aviation (ODAV), which is tabulated in Table 2A and shown spatially on Figure 1A.

PAVER assigns a rank, which designates that pavement's prioritization in receiving maintenance and repair. The highest use or priority pavements, such as runways, taxiways, and terminal aprons, are ranked *Primary*, while the surrounding aprons and shoulders are ranked *Secondary* and low-use areas are ranked *Tertiary*. The ranks for all sections are shown on Table 2A.

To facilitate the visual survey of the airport pavement, each section is further subdivided into smaller areas called sample units. Similar sizing of these units is critical, and studies have found that maintaining the size of the sample units to within 40% of the established normal distribution reduces the standard error of the average pavement condition index (PCI) values. To meet this criterion, the ASTM method recommends sample units for flexible pavements be 5,000 ± 2,000 square feet. The delineation of sample units for each section is displayed on Figure 1A.

A.4 SAMPLE UNIT DELINEATION

For an APMS survey, a PCI confidence level of 92% and an allowable error (e) of eight PCI points are used for all airport pavements. To determine the number of sample units that need to be inspected to achieve the required confidence level and allowable error, the following equation is used:

$$n = \frac{N \times s^2}{\left(e^2/_4\right)(N-1)+s^2} \qquad \text{(Equation 1)}$$

where:

n = number of sample units to be inspected
N = total number of samples in the pavement sections
e = allowable error
s = section standard deviation

For the 2023 Cascade Locks State Airport PCI survey, Table 3A was used as a guideline in developing sampling rates for flexible pavement that reflect similar rates used for other large airport pavement networks. In general, this sampling rate distribution provides a 92% confidence level with a standard error of eight PCI points.

Sample unit locations at Cascade Locks State Airport were selected using a systematic random sampling model method. This technique is implemented by first determining the number of sample units needed based on the confidence interval calculated using Equation 1. The first sample unit is randomly placed in the section and then the remaining sample units are systematically spaced throughout the section at an equal distance apart.

Table 1A: CASCADE LOCKS STATE AIRPORT PAVEMENT BRANCHES

Facility Designation (Branch ID)	Branch Name	Number of Sections	Approximate Area, square feet
R06CL	Runway 06/24 Cascade	1	57,068

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Table 2A: CASCADE LOCKS STATE AIRPORT CURRENT PAVEMENT INVENTORY

BranchID	Branch Name	Branch Use	SectionID	From	To	Rank	Length, feet	Width, feet	Approximate Area, square feet	LCD	Surface Type
R06CL	Runway 06/24 Cascade	RUNWAY	01	R06 End	R06CL-2	P	1,800	30	57,068	9/1/1999	AAC

Abbreviations:
P = Primary pavement
LCD = Last Construction Date. The date of the last major rehabilitation (e.g. overlay)
AAC = AC overlaid AC

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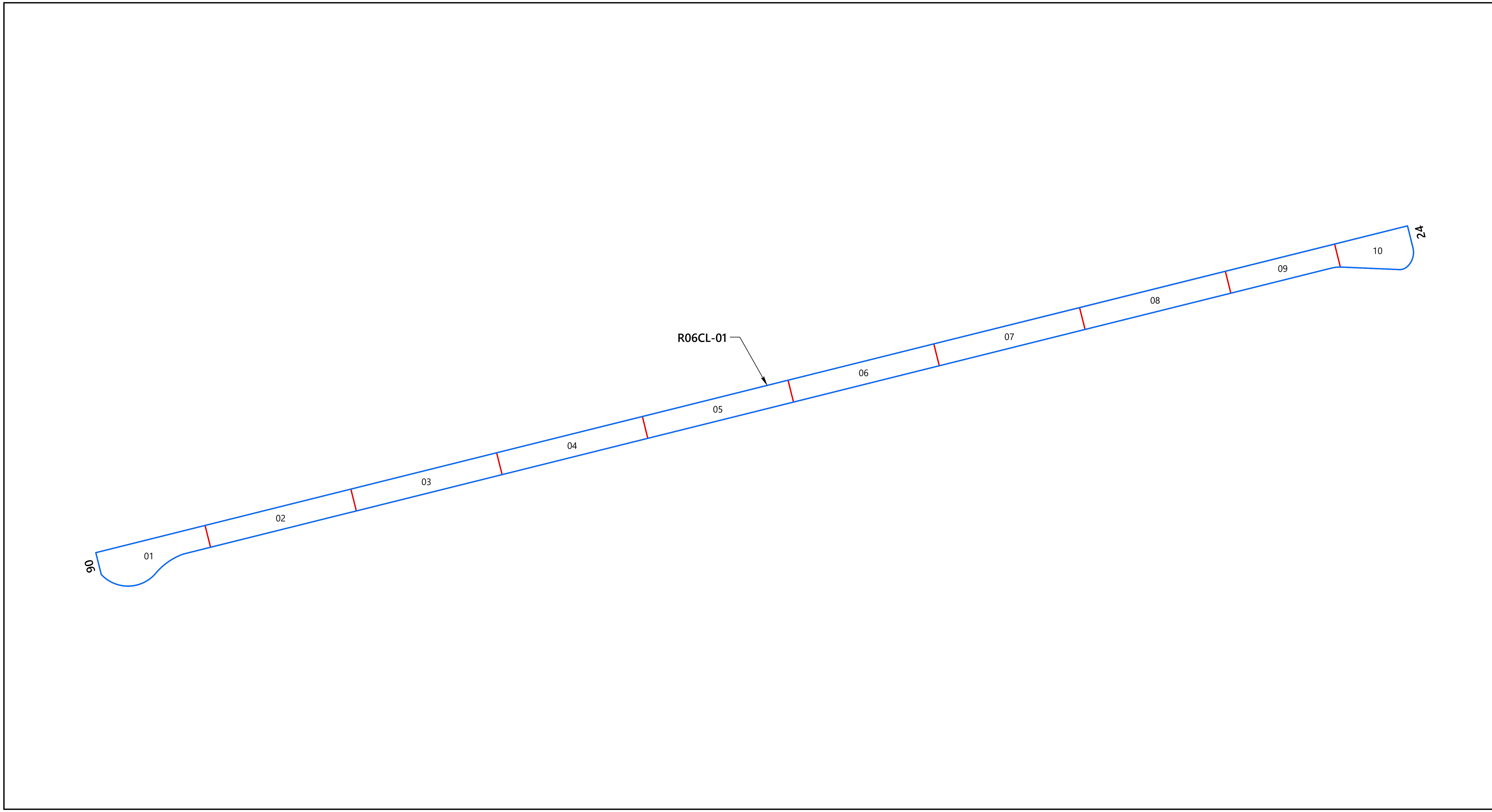
Table 3A: EXAMPLE SAMPLE RATES FOR AC PAVEMENTS

AC Sampling Rate	
Total Number of Sample Units, N	**Sample Units to Survey, n**
1	1
2-3	2
4-6	3
7-13	4
14-38	5
39+	6

Note: AC = Asphalt Concrete



LEGEND

SECTION

SAMPLE UNIT

N

0 125 250 Feet

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CASCADE LOCKS STATE AIRPORT
SAMPLE UNIT LAYOUT

DEC. 2023 JOB NO. 6593-E FIG. 1A

APPENDIX B

Pavement Condition Index Survey Results

APPENDIX B

PAVEMENT CONDITION INDEX SURVEY RESULTS

B.1 METHODOLOGY

As previously discussed, the PCI is a measure of the pavement's functional surface condition and provides a methodology for assessing the causes of distress and whether the distress is related to a load or climatic conditions. Although the PCI is not a direct measure of structural capacity, it provides a suggestion of the structural needs of the pavement.

The PCI is based on the type, severity, and quantity of each distress found in an inspected sample unit. The results are displayed using a seven-category rating scale in accordance with ASTM D5340. Flexible pavement (e.g., AC and AAC) distress types are presented in Table 1B. A summary of the pavement condition results by branch and section is included in Tables 2B and 3B of Appendix B, respectively.

Table 1B: PAVER DISTRESS CODES FOR FLEXIBLE PAVEMENT

Flexible Pavement		
PAVER Code	Pavement Distress	Related Cause
41	Alligator Cracking	Load
42	Bleeding	Other
43	Block Cracking	Climate/ Durability
44	Corrugation	Other
45	Depression	Other
46	Jet Blast	Other
47	Joint Reflection Cracking	Climate/ Durability
48	Longitudinal & Transverse Cracking	Climate/ Durability
49	Oil Spillage	Other
50	Patching	Climate/ Durability
51	Polished Aggregate	Other
52	Raveling	Climate/ Durability
53	Rutting	Load
54	Shoving	Other
55	Slippage Cracking	Other
56	Swelling	Other
57	Weathering	Climate/ Durability

To obtain the section PCI, we extrapolated the PCI of each selected sample unit over the entire section area. Distresses found in sample units classified as "additional"– defined as nonrepresentative instead of random- are not extrapolated over the entire section but merely added to the extrapolated quantity. The PCI rating scale presented previously in Table 3-1 of Section 3.1 is based on ASTM D5340.

Section 4.1 of ASTM D5340, governing PCI surveys, offers this caution:

"The PCI is a numerical indicator that rates the surface condition of the pavement. The PCI provides a measure of the **present condition** of the pavement based on the distress observed on the surface of the pavement, which also indicates the structural integrity and surface operational condition (localized roughness and safety). The PCI **cannot** measure structural capacity, nor does it provide a direct measurement of skid resistance or roughness. It provides an objective and rational basis for determining maintenance and repair needs and priorities. Continuous monitoring of the PCI is used to establish the rate of pavement deterioration, which permits the early identification of major rehabilitation needs. The PCI provides feedback on pavement performance for validation or improvement of current pavement design and maintenance procedures."

Based on the limitations of the PCI method, it is imperative that engineers and planners treat the PCI as a tool that will assist them during the M&R planning process. Any major project should always be preceded by an up-to-date, detailed, 100% project-level inspection of the pavement in order to reevaluate maintenance needs prior to the project design process.

B.2 DISTRESS TYPES

Distress tends to fall into one of the following four cause categories:

- **Load-related:** Flexible pavement distresses include alligator/fatigue cracking, corrugation, depression, polished aggregate, rutting, and slippage cracking.

- **Climate- and durability-related:** Flexible pavement distresses include bleeding, block cracking, joint reflection cracking, longitudinal and transverse (L&T) cracking, swelling, and raveling/weathering.

- **Moisture- and drainage-related:** Flexible pavement distresses include alligator/fatigue cracking, depressions, potholes, and swelling.

- **Other factors:** Include oil spillage, jet blast erosion, bleeding, and patching.

As described above, distress may be the result of more than one cause. For example, depressions may be caused by incorrect compaction during construction or by subgrade softening due to environmental factors. In addition, distress may be initiated by one cause but may progress to a distress of higher severity by another cause. Therefore, engineering judgment is critical in analyzing the actual cause or causes of the distress.

B.3 PAVEMENT CONDITION INDEX SURVEY RESULTS

The evaluated Cascade Locks State Airport pavement network consists of 1 branch and 1 section. A total of 4 sample units were visually inspected in the field. Data from the inspected sample units was input into the PAVER database, and a resultant PCI for each section was computed. Additional details regarding the PCI and distress types observed for each surveyed sample unit are provided in the re-inspection report, Table 1E, in Appendix E. Based on the 2023 PCI survey, the area-weighted average PCI for the entire pavement network at Cascade Locks State Airport is approximately 72, which corresponds to a PCI rating of Satisfactory.

To investigate the rate of deterioration of each pavement section, we compared the PCI results from the 2023 survey to the PCI results from the previous inspection. The variation in PCI between inspections for Cascade Locks State Airport pavement sections is outlined in Table 4B in this appendix.

Table 2B: CASCADE LOCKS STATE AIRPORT CURRENT BRANCH CONDITION REPORT

Branch ID	Number of Sections	Approximate Area, square feet	Use	Area Weighted Average Branch PCI	PCI Category
R06CL	1	57,068	RUNWAY	72	Satisfactory

Use Category	Number of Sections	Total Area, square feet	Area Weighted Average PCI
RUNWAY	1	57,068	72
ALL	**1**	**57,068**	**72**

Abbreviation: PCI = Pavement Condition Index

Table 3B: CASCADE LOCKS STATE AIRPORT 2023 PAVEMENT CONDITION INDEX SURVEY RESULTS

BranchID	SectionID	Last Construction Date	Surface Type	Use	Last Inspection Date	Age at Inspection	PCI	PCI Category	PCI % Climate	PCI % Load	PCI % Other
R06CL	01	9/1/1999	AAC	RUNWAY	7/1/2023	24	72	Satisfactory	99	0	1

Abbreviations:

PCI = Pavement Condition Index, AAC = AC overlaid AC

Table 4B: CASCADE LOCKS STATE AIRPORT COMPARISON OF PREVIOUS INSPECTION AND 2023 RESULTS

					2017 Survey			2023 Survey				
Branch ID	Section ID	Surface Type[1]	Approximate Area, square feet	LCD[2]	PCI	PCI Category	Inspection Date	PCI	PCI Category	Age[3]	Δ PCI/yr[4]	Rate of Deterioration
R06CL	01	AAC	57,068	9/1/1999	78	Satisfactory	6/8/2017	72	Satisfactory	18	-0.99	NORMAL

Abbreviations:

[1] AC = Asphalt Concrete, AAC = Asphalt Overlay AC, PCI = Pavement Condition Index

[2] LCD = Last construction date. The date of the last major pavement rehabilitation (e.g. AC overlay)

[3] Age = Pavement age in years at the time of the PCI survey in 2017

[4] Δ PCI/yr = Change in PCI points per year between 2017 survey and 2023 survey

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APPENDIX C

Future Pavement Condition Analysis

APPENDIX C

PAVEMENT CONDITION ANALYSIS

C.1 METHODOLOGY

In addition to assessing the current condition of a pavement, it is very important from a planning standpoint to be able to predict with reasonable accuracy its future condition. In a pavement management plan (PMP), this is done with the aid of a prediction model. When an APMS is initially implemented, the default models are typically used to predict the future condition of a pavement. However, after PCI surveys are completed, the historical data are then used to refine the models, so they better represent the deterioration of a particular class of pavement based on local climatic conditions, loading, material sources, construction procedures, etc. The importance of accurate prediction models is part of the reason it is essential to conduct periodic, routine surveys in order to track the rate of deterioration.

In PAVER, the pavement deterioration curves are developed based on the "family" model procedure. A pavement "family" is defined as a group of pavements with similar deterioration characteristics. The procedure for developing the prediction models is:

1) Define the pavement families.
2) Review the data.
3) Conduct a data-outlier analysis.
4) Model the data.

C.2 PREDICTION MODELS

We developed separate condition prediction models for each pavement "family" at Cascade Locks State Airport. The delineation is based on branch use, surface type, section rank, and structural design life. We use one distinct model for the following "family" of pavements at Cascade Locks State Airport. For each model, we reviewed the data in order to filter out any inconsistent or inaccurate data or any data that fell outside the boundary values set by PAVER. After outliers are removed and the data are checked for accuracy and reasonableness, the PAVER program calculates a best-fit curve using a polynomial-constrained, least-squares analysis procedure. This best-fit curve for each family is used in the analysis to predict the average behavior of all sections within each "family." Our condition prediction model is provided on Figure 1C below.

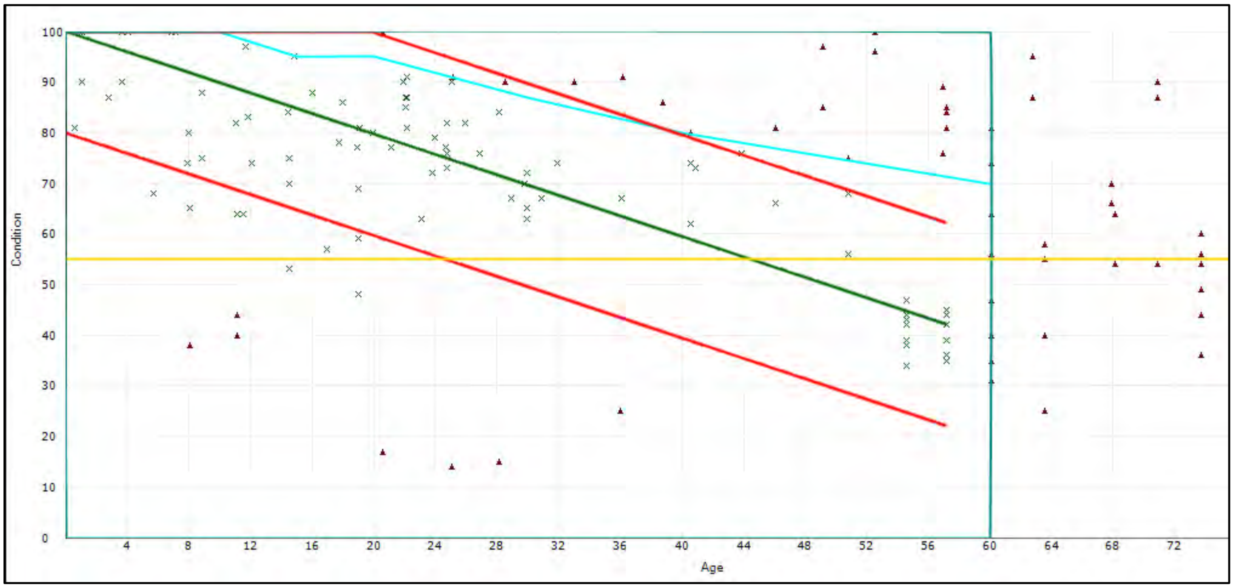

Figure 1C - CONDITION PREDICTION MODEL FOR NORTHWESTERN CATEGORY 5 AC AND AAC RUNWAYS

C.3 CRITICAL PCI

Each of the condition-prediction models has an assigned critical PCI. The critical PCI is the point at which the pavement condition begins to deteriorate more quickly over time. As the condition deteriorates to a worse state, major M&R (rehabilitation/reconstruction) is triggered because the cost to apply localized M&R increases significantly. Pavement sections with PCI above the critical value are given a higher priority for funding during budget analysis in order to prevent them from deteriorating to the point where more costly rehabilitation is necessary. We used the following critical PCI values at Cascade Locks State Airport:

- Runways – 55
- Taxiways/Taxilanes – 50
- Aprons – 45

C.4 FUTURE CONDITION ANALYSIS

As previously discussed, the projected condition of each pavement section was determined for 5- and 10-year periods. The projected pavement conditions in 5 years and 10 years for each pavement section at Cascade Locks State Airport, along with the conditions at the previous inspection, are listed in Table 1C.

C.5 FUNCTIONAL REMAINING LIFE

As mentioned above, functional remaining life is the practical amount of time a pavement is in service before requiring rehabilitation, as estimated based solely on visual condition. This is not to be confused with structural remaining life, which requires analysis of the structural capacity of a pavement.

We calculated two forms of functional remaining life based on the current visual condition surveys of the pavement at Cascade Locks State Airport, the time until rehabilitation, and the time until the pavement is no longer operational due to high foreign object debris potential and increased safety concerns for trafficking aircraft (PCI less than 40). The results of the functional life analysis are provided in Table 2C.

Table 1C: PAST, PRESENT AND FUTURE PCI

BranchID	SectionID	Past Inspection PCI 2017	Current PCI 2023	Predicted Future PCI 2028	2033
R06CL	01	78	72	67	62

Abbreviation: PCI = Pavement Condition Index

GRI

Table 2C: CASCADE LOCKS STATE AIRPORT FUNCTIONAL REMAINING LIFE ANALYSIS

Branch ID	Section ID	Surface Type	Current PCI	Years to Major M&R	Major M&R Trigger PCI[1]	Years to End of Functional Service Life
R06CL	01	AAC	72	16 - 20	55	> 20

GRI

APPENDIX D

Unit Cost Data and Maintenance and Rehabilitation Plan

APPENDIX D

UNIT COST DATA AND MAINTENANCE AND REHABILITATION PLAN

D.1 ANALYSIS METHODOLOGY

We evaluated the M&R needs, as determined from the PAVER analysis results, in order to develop project recommendations for the next five years. The purpose of this analysis is to determine the M&R needs of the Cascade Locks State Airport pavement network condition over time. We used PAVER v7.1.1 software to develop network-level project recommendations for the next five years.

The PAVER M&R Work Planning Module identifies when and where M&R is required and how much it will cost. M&R plans can be developed either by assuming an annual budget or by identifying specific constraints, such as a condition goal, to determine the budget required to meet the goal. The M&R work planning analysis was based on a five-year period beginning on August 1, 2024. A backlog elimination analysis scenario was selected to generate a list of surface treatment, rehabilitation, and reconstruction projects in order to optimize the allocation of capital and establish preservation-based project recommendations. The repair strategies considered for pavement sections in our analysis are as follows:

- Reconstruction – Considered for pavements with a PCI less than 40.
- Rehabilitation (AC Overlay) – Considered for pavements between 40 PCI and the critical PCI, and for pavements exhibiting significant load-related distresses.
- Surface Treatment – Treatments (fog seal, slurry seal, thin AC overlay) applied to an entire pavement section with the intent of slowing the rate of deterioration.
- Localized Maintenance – Maintenance performed on a routine basis such as crack sealing, wide crack repair, and patching.

It should be noted that the five-year list of recommended projects only includes the highest-cost maintenance items and does not include routine localized maintenance (e.g., crack sealing) work that should also be conducted in addition to and concurrently with the five-year work plan.

D.1.1 Pavement Rank and Use Prioritization

Pavement sections are assigned a rank to establish their relative importance in the overall pavement network, which is most commonly defined by their use (e.g., Taxiway, Apron, Runway). The PAVER analysis uses the combination of the section rank and the branch use to define the priority of each section during the M&R analysis. Table 1D displays the branch use and section rank prioritization schema we used for analysis.

Table 1D: M&R WORK PRIORITY BY BRANCH USE AND SECTION RANK

Branch Use	Section Rank		
	Primary	Secondary	Tertiary
RUNWAY	1	3	6
TAXIWAY	2	5	8
APRON	4	7	9

D.2 MAINTENANCE POLICIES AND UNIT COSTS

Distress-maintenance policies are policies that determine what type of work should be applied to a specific distress type and severity. For example, on an AC pavement, a medium-severity longitudinal/transverse crack would be repaired by crack sealing. Policies for all the distress types and severities are established by ASTM D5340.

Although our work scope does not include budget analysis, we did assign construction costs to the maintenance work so that PAVER would allocate M&R projects that were approximately equal in costs for each year of the five-year period. The anticipated cost of performing M&R is based on cost tables that relate M&R work type costs to PCI. We reviewed the unit costs from the 2017 report and updated them by reviewing the bid tabulations for recent projects within the vicinity of Cascade Locks State Airport and information provided by the ODAV Pavement Maintenance Program (PMP) project team. The costs for reconstruction are based on the existing pavement sections present within each branch use at Cascade Locks State Airport. The costs represent the fully-loaded costs and include aspects of the project such as administration, contingencies, mobilization, and striping. The cost tables used in the analysis are presented in Table 2D below.

Table 2D: REGION 1 UNIT COST DATA

Type of M&R	Work Type	Unit Cost	Work Unit
Major M&R	Complete Reconstruction with AC	$17.32	Sq Ft
	Cold Mill and Overlay – 2 Inches Thick	$7.64	Sq Ft
Surface Treatment (Global) M&R	Surface Treatment - Slurry Seal	$0.52	Sq Ft
	Surface Treatment - Fog Seal	$0.31	Sq Ft
Localized Preventive M&R	Crack Sealing - AC	$3.12	Ft
	Crack Sealing - PCC	$23.4	Ft
	Crack Sealing – Wide Cracks	$51.48	Ft
	Joint Sealing – PCC	$7.80	Ft
	AC Patching – Full Depth	$78.00	Sq Ft
	PCC Patching – Full Depth	$156.00	Sq Ft

D.3 RECOMMENDED LOCALIZED MAINTENANCE

In order to properly maintain aging pavements, localized M&R activities such as crack sealing and patching should be performed on a routine basis. A list of recommended localized maintenance activities is provided in Table 3D of this appendix.

D.4 RECOMMENDED SURFACE TREATMENT, REHABILITATION, AND RECONSTRUCTION PROJECTS

Surface treatment, rehabilitation, and reconstruction projects refer to activities such as slurry seal/fog seals, AC overlays, and reconstruction. A list of recommended projects is provided in Table 4D of this appendix.

Table 3D: CASCADE LOCKS STATE AIRPORT NETWORK MAINTENANCE REPORT

Branch ID	Section ID	Distress	Severity	Action	Work Quantity	Unit	Unit Cost	Work Cost	Section Total
R06CL	01	Long. & Transv. Cracking	Medium	Crack Sealing - AC	88	Ft	$3.12	$273	
R06CL	01	Long. & Transv. Cracking	Medium	Crack Sealing - AC	1,159	Ft	$3.12	$3,616	$8,826
R06CL	01	Long. & Transv. Cracking	Low	Crack Sealing - AC	1,582	Ft	$3.12	$4,937	

Abbreviations:

Long. = Longitudinal; Transv. = Transverse; AC = Asphalt Concrete; Ft = Feet

Table 4D: FIVE-YEAR GLOBAL MAINTENANCE AND REHABILITATION PLAN

Action Year	Branch ID	Section ID	Branch Use	Surface Type	Current PCI	Action	Area, square feet	Unit Cost per square foot	Total Cost
2024	R06CL	01	RUNWAY	AAC	72	Slurry Seal	57,068	$0.52	$29,675

Abbreviations:
PCI = Pavement Condition Index, AAC = AC overlaid AC

Cost Summary	
2024 Total Project Cost	$29,675
2025 Total Project Cost	$0
2026 Total Project Cost	$0
2027 Total Project Cost	$0
2028 Total Project Cost	$0
Total 5-Year Project Cost	**$29,675**

APPENDIX E

Reinspection Report

Re-Inspection Report

ODA_2023Survey_11-21-23
Generated Date 12/5/2023

Network: Cascade **Name:** Cascade Locks State

Branch: R06CL **Name:** Runway 06/24 Cascade **Use:** RUNWAY **Area:** 57,068 SqFt

Section: 01 of 1 **From:** R06 End **To:** R06CL-2 **Last Const.:** 9/1/1999
Surface: AAC **Family:** 2023_Region1_Cat5_Runway_AC **Zone:** KCZK **Category:** E **Rank:** P
Area: 57,068 SqFt **Length:** 1,800 Ft **Width:** 30 Ft
Slabs: **Slab Length:** Ft **Slab Width:** Ft **Joint Length:** Ft
Shoulder: **Street Type:** **Grade:** 0 **Lanes:** 0
Section Comments:

Work Date	Work Type	Code	Is Major M&R
9/1/1953	Subbase - Aggregate	SB-AG	True
9/2/1953	Base Course - Aggregate	BA-AG	True
9/3/1953	Surface Course - BST	SU-SB	True
9/1/1989	Overlay - AC Thin	OL-AT	True
9/1/1999	Overlay - AC Thin	OL-AT	True
9/1/2012	Crack Sealing - AC	CS-AC	False
9/2/2012	Surface Treatment - Slurry Seal	ST-SS	False

Last Insp. Date: 7/1/2023 **TotalSamples:** 10 **Surveyed:** 4
Conditions: **PCI:** 72
Inspection Comments:

Sample Number: 01 **Type:** R **Area:** 6128.00 SqFt **PCI:** 68
Sample Comments:

48	L & T CR	L	163.00	Ft
48	L & T CR	M	83.00	Ft
48	L & T CR	M	147.00	Ft
57	WEATHERING	L	6128.00	SqFt

Sample Number: 04 **Type:** R **Area:** 6000.00 SqFt **PCI:** 77
Sample Comments:

48	L & T CR	L	51.00	Ft
48	L & T CR	M	37.00	Ft
48	L & T CR	M	70.00	Ft
57	WEATHERING	L	6000.00	SqFt

Sample Number: 06 **Type:** R **Area:** 6000.00 SqFt **PCI:** 75
Sample Comments:

48	L & T CR	L	109.00	Ft
48	L & T CR	L	60.00	Ft
48	L & T CR	M	44.00	Ft
48	L & T CR	M	70.00	Ft
57	WEATHERING	L	6000.00	SqFt

Sample Number: 08 **Type:** R **Area:** 6000.00 SqFt **PCI:** 68
Sample Comments:

45	DEPRESSION	L	6.00	SqFt
47	JT REF. CR	M	37.00	Ft
48	L & T CR	L	98.00	Ft
48	L & T CR	L	188.00	Ft
48	L & T CR	M	39.00	Ft
50	PATCHING	L	10.00	SqFt
57	WEATHERING	L	6000.00	SqFt

APPENDIX F

Work History Report

Work History Report

Pavement Database: ODA_2023Survey_MASTER DB-12-5-2023_3pm

Network: Cascade Locks State **Branch:** R06CL Runway 06/24 Cas **Section:** 01 **Surface:**AAC

L.C.D. 9/1/1999 **Use:** RUNWAY **Rank:** P **Length:** 1,800.00 (Ft) **Width:** 30.00 (Ft) **True Area:** 57068 (SqFt)

Work Date	Work Code	Work Description	Cost	Thickness (in)	Major M&R	Comments
9/2/2012	ST-SS	Surface Treatment - Slurry Seal	0.00	0.00	☐	PMP 2012
9/1/2012	CS-AC	Crack Sealing - AC	0.00	0.00	☐	PMP 2012
9/1/1999	OL-AT	Overlay - AC Thin	0.00	2.00	☑	
9/1/1989	OL-AT	Overlay - AC Thin	0.00	1.50	☑	
9/3/1953	SU-SB	Surface Course - BST	0.00	0.00	☑	
9/2/1953	BA-AG	Base Course - Aggregate	0.00	1.30	☑	
9/1/1953	SB-AG	Subbase - Aggregate	0.00	6.00	☑	

Work History Report

Pavement Database: ODA_2023Survey_MASTER DB-12-5-2023_3pm

Summary:

Work Description	Section Count	Area Total (SqFt)	Thickness Avg (in)	Thickness STD (in)
Base Course - Aggregate	1	57,068.00	1.30	0.00
Crack Sealing - AC	1	57,068.00	0.00	0.00
Overlay - AC Thin	2	114,136.00	1.75	0.25
Subbase - Aggregate	1	57,068.00	6.00	0.00
Surface Course - BST	1	57,068.00	0.00	0.00
Surface Treatment - Slurry Seal	1	57,068.00	0.00	0.00