Pavement Condition Survey Report – Year 2024

December 31, 2024

Prepared for:
City of Taylor, Texas
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Pavement Condition Survey Report – Year 2024

1. Introduction

The purpose of this survey is to determine the current condition for the road network currently maintained by the City of Taylor, Texas. This report documents the findings of the roadway pavements condition survey.

Applied Research Associates, Inc. (ARA) performed a pavement condition survey at City of Taylor, Texas between December 29, 2023 and March 11, 2024. We performed the survey in accordance with “ASTM D6433-20: Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys.”

For this project, we conducted a survey covering a total of 301 lane miles using ARA’s Multi-Function Vehicle (MFV). The survey involved capturing downward images of the city’s streets in both driving directions, which were utilized to identify and quantify existing surface distresses.

This survey was conducted using an automated system that collects pavement distress information. The use of an automated system for data collection is an integral component of the City’s ability to objectively compare conditions across the network. This collected data is converted to indices, allowing for comparisons among sections. In this report the Pavement Condition Index (PCI) is used to represent the current surface condition of the roadway sections included in the network. In addition, ARA provided information about the network condition based on the Overall Condition Index (OCI). OCI is that index that take into considerations the impact of surface distresses and irregularity (Roughness)

This report documents the pavement condition scores resulting from the field inspection survey. The overall network score at the time of the survey is a Pavement Condition Index (PCI) of 65.04, out of a perfect score of 100. The report provides a detailed analysis of the network's condition and includes summary statistics of the pavement condition scores. As an additional deliverable to the city, ARA has provided OCI score calculations at the block level, OCI scores at the super section level, and recommended treatments. Furthermore, ARA has conducted ranking of the network streets both at the block and super section levels. These rankings prioritize sections for receiving recommended treatments relative to the rest of the city’s network; lower numbers indicate higher priority for treatment.

2. Field Data Collection

2.1. Multi-Functional Vehicle (MFV)

ARA owns and operates six Multi-Functional Vehicles (MFVs), see Figure 1. Our MFVs include the Pavemetrics Laser Crack Measurement Systems (LCMS) for collecting continuous, high-resolution digital 3D line-scan pavement images with 2-mm crack resolution in any lighting condition as well as measure pavement rutting. The MFVs include a Road Surface Profiler (RSP) for measuring longitudinal and transverse profile, including International Roughness Index (IRI), Ride Number (RN), rutting measurements, and surface macro-texture. The MFV is a fully integrated, "geocentric" automated roadway data collection system. Combined with our analysis software, the MFV provides a complete data collection and analysis system.

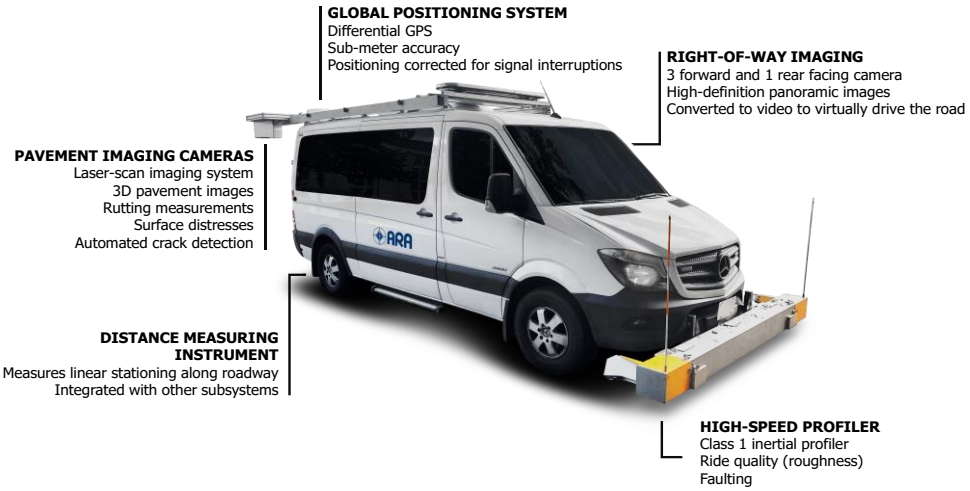

Figure 1. Multi-Function Vehicle (MFV)

2.2. Challenges during Data Collection

In narrow roads like alleys, multi-functional vehicles encounter substantial constraints when collecting images of pavement surfaces. These limitations arise primarily from the restricted space available for maneuvering. The narrow width of these alleys poses a significant challenge for the vehicle to efficiently capture pavement surface images in both driving directions. This scenario is exemplified in Figure 2.

Figure 2. Data Collections in Narrow Routes (Alleys)

Additionally, the presence of parked vehicles along both sides of the road hinders the vehicle's movement, further impeding its ability to navigate freely. Consequently, the data collection process becomes one-directional, concentrating solely on one travel direction due to these spatial limitations. Figure 3 depicts a situation where surface images were collected in both directions despite the presence of parked cars on both sides of the road. However, due to the necessity to navigate around the parked vehicles, a substantial portion (more than 50% of intersections) of the captured images ended up duplicating the same location along both pathways.

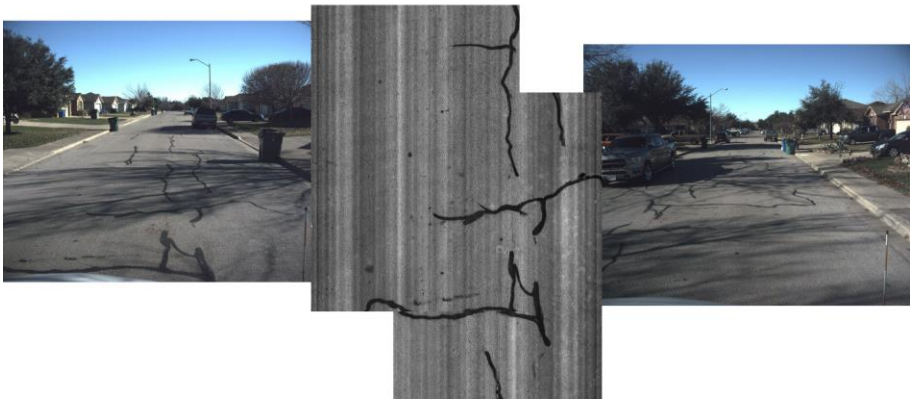

Figure 3. Impacts of Parked Vehicles on both Sides of the Roads on Data Collection

2.3. Data Processing and Distress Rating

Data acquired with the Laser Imaging system allows the automated detection/identification of various types of distresses including all types of cracking, rutting, raveling, potholes, edge drop-off, sealed cracks, lane markings, and macrotexture.

We followed a two-step approach for distress rating, where a combination of fully automated computer-based crack type determination and a semi-automated rating process performed by an experienced pavement inspector.

All acquired data were then analyzed through distress rating software, Dynatest Explorer/Dynatest Rating Module (DE/DRM); shown in Figure 4. Distresses were then categorized by type, severity, and quantity the results including location and extent. International Roughness Index (IRI) values were extract, as well.

After conducting rigorous QC on the rated distresses, an XML file containing all the distresses associated with each pavement section were exported for the calculation of the PCI score using Paver.

Figure 4. ARA Distress Rating Procedure

3. Description of Pavement Condition Index (PCI)

The Pavement Condition Index (PCI) was calculated for each pavement section. The PCI procedure adopted by the City of Taylor uses a scale from 0 for a failed pavement to 100 for a pavement in perfect condition. PCI is based on the type, severity, and extent of surface distress as illustrated in Figure 5.

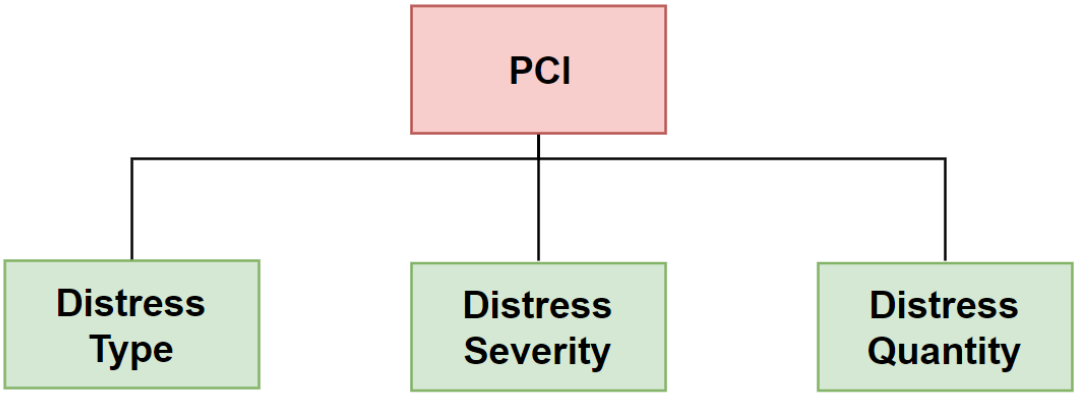

Figure 5. Pavement Condition Index (PCI)

Deduct values are defined for each distress type because some distress types have a greater impact on pavement performance than others. High severity distresses or high extent ("area") distress types have a greater influence in reducing a pavement's PCI score. Distress types caused by traffic loads (such as Fatigue Cracking) also have higher deduct values than distress types caused by climate (such as Transverse Cracking).

The deduct values used in this analysis are based on the Army Corps of Engineers distress rating system in accordance with the ASTM D6433-20 standard. Modifying default deduct values is not recommended without a thorough understanding of the effects that this modification will generate and how it will impact construction trigger levels, deterioration models, and maintenance selection. All sections were surveyed for distresses using ARA's Multi-Functional Vehicle (MFV).

4. Examples from the PCI Survey

The section below presents some examples from the pavement condition survey. The examples include roadway segments at various PCI values and with different distresses. On every example, the Right of Way (ROW) images are presented. The PCI value of each section is included in the figure captions.

Figure 6. 4TH Street East, PCI = 95

Figure 7. Boyer Drive, PCI = 80

Figure 8. 10TH Street West, PCI = 69

Figure 9. Lexington Street, PCI = 63

Figure 10. Marshall Street, PCI = 51

Figure 11. Burkett Street, PCI = 45

Figure 12. Hosack Street, PCI = 34

Figure 13. Lark Lane, PCI = 22

Figure 14. 6TH Street West, PCI = 8

Figure 15. 2ND Street East, PCI = -1 (Gravel Roads)

5. Network Condition

5.1. Distribution of Pavement Condition for the City of Taylor

Table 1 and Figure 16 summarize the PCI for the City of Taylor, Texas, based on an ARA semi-automated distress survey. The results reveal the distribution of pavement conditions across various PCI ranges. The data indicates that 6.43% of the surveyed area, covering 188,407 SY, is categorized as "Not Collected". Only 0.08% of the area, equating to 2,340 SY, falls within the "Failed" category. A slightly larger portion, 4.78%, or 140,009 SY, is classified as "Serious" (PCI range of 10 to 25). The "Very Poor" and "Poor" categories account for 14.90% (436,962 SY) and 15.46% (453,307 SY) of the surveyed area. The "Fair" category (PCI range of 55 to 70) constitutes 15.50%. The "Satisfactory" category (PCI range of 71 to 85) covers 21.70% (636,233 SY), the second-largest proportion. Finally, the "Good" category (PCI range of 85 to 100) represents 21.15% of the surveyed area. The PCI score along with a PCI-based rank of all streets of City of Taylor is provided in Appendix A.

Table 1. PCI Pavement Condition Distribution

PCI Condition	PCI Range	Area SY	Area %	Length mile	Length %
Not Collected	-1	188,407.00	6.43%	10.70	0.40%
Failed	0 - 10	2,340.00	0.08%	0.13	0.40%
Serious	25-Oct	140,009.00	4.78%	7.96	5.30%
Very Poor	25 - 40	436,962.00	14.90%	24.83	17.40%
Poor	40 - 55	453,307.00	15.46%	25.76	13.90%
Fair	55 - 70	454,580.00	15.50%	25.83	17.10%
Satisfactory	71 - 85	636,233.00	21.70%	36.15	22.70%
Good	85 - 100	620,125.00	21.15%	35.23	23.20%

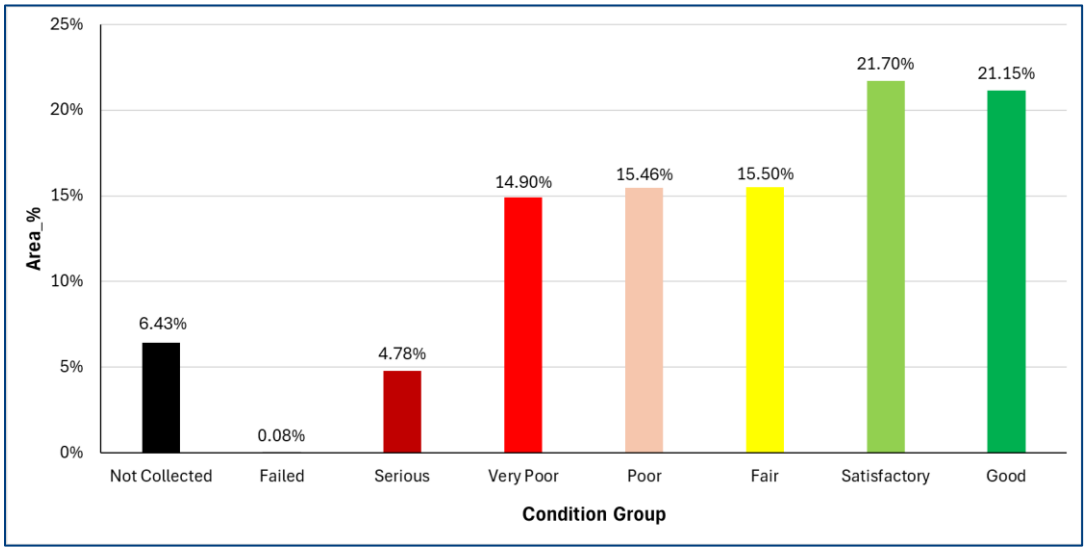

Figure 16. PCI Pavement Condition Distribution by Area

5.2. 2020 & 2024 Surveys

The comparison of pavement conditions between 2020 and 2024, based on PCI ranges and area percentages, highlights notable changes in distribution. The "Failed" category (PCI range 0 - 10) experienced a significant reduction, dropping from 3.89% in 2020 to 0.08% in 2024. Similarly, roads in "Serious" condition (PCI range 10 - 25) decreased from 10.36% (291,672 SY) to 4.78% (140,009 SY), reflecting substantial improvement.

Conversely, there was a slight increase in the "Very Poor" and "Poor" condition categories, rising from 13.43% to 14.90% and from 13.86% to 15.46%, respectively. The "Fair" category declined from 18.65% (525,146 SY) in 2020 to 15.50% (454,580 SY) in 2024. However, improvements were observed in the "Satisfactory" and "Good" condition categories. The "Satisfactory" category increased from 18.72% to 21.70%, while the "Good" category grew slightly from 21.10% to 21.15% . These shifts indicate an overall improvement in pavement conditions, with a focus on addressing the most critical areas.

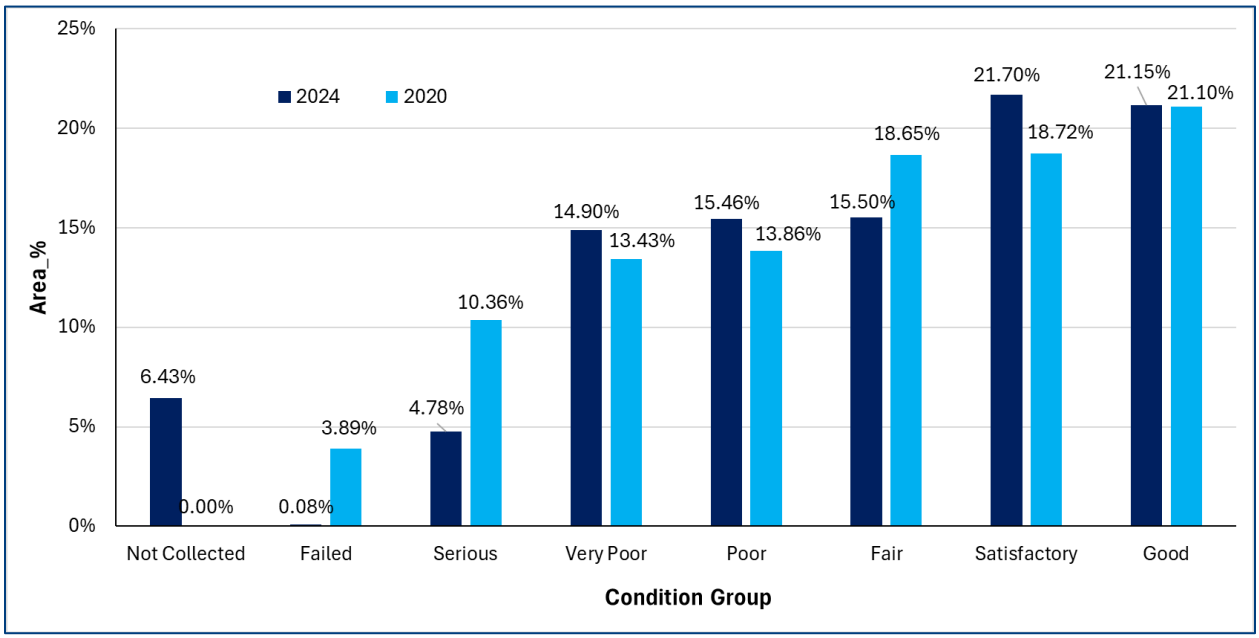

Figure 17. 2020 & 2024 Condition Surveys

6. Overall Condition Index

The Overall Condition Index (OCI) stands as a pivotal metric within Pavement Management Systems (PMS), offering a comprehensive assessment of the health and integrity of road sections. In essence, OCI serves as a holistic indicator that may encapsulates various pavement distresses, structural deficiencies, and performance factors into a single numerical value. In the current project, we calculated OCI taking into consideration both the PCI and Ride Index (RI). The weights of PCI and RI in the final OCI value are 75 and 25 percent respectively.

OCI provides transportation agencies and decision-makers with invaluable insights into the overall condition of road networks, facilitating informed asset management strategies and investment prioritization. As a cornerstone of modern infrastructure management, OCI plays a crucial role in optimizing resource allocation, enhancing roadway safety, and prolonging pavement lifespan.

In comparison to traditional Pavement Condition Index (PCI) methodologies, the OCI offers a distinct array of advantages that transcend mere surface-level evaluations. While PCI primarily focuses on surficial distresses such as cracking and rutting, OCI extends its purview to encompass a broader spectrum of factors influencing pavement performance. By integrating information about pavement irregularity as expressed by the ride index, OCI provides a more nuanced understanding of pavement surface condition.

Table 2 illustrates the distribution of OCI condition categories based on the percentage area and length they cover in the city of Taylor. The majority of the area falls under conditions ranging from "Good" to "Fair," with "Satisfactory" being the most prevalent at 22.16% of the area, followed closely by "Good" at 20.41%. The "Fair" condition category covers 15.34% of the area, while "Poor" and "Very Poor" conditions collectively account for 29.81% of the area. Specifically, "Poor" covers 17.05%, and "Very Poor" covers 12.76%. The remaining categories, including "Serious," "Failed," and "Not Collected," represent smaller proportions of the total area, with "Serious" covering 5.57%, "Failed" at 0.29%, and "Not Collected" at 6.43%. The OCI scores of all city-maintained streets are presented in Appendix B. The rank of each pavement section based on the OCI value relative to the remaining pavement sections is presented in Appendix B.

Table 2. OCI Pavement Condition Distribution

PCI Condition	OCI Range	Area SY	Area %	Length mile	Length %
Not Collected	-1	188,407.00	6.43%	10.70	0.40%
Failed	0 - 10	8,549.00	0.29%	0.49	0.40%
Serious	25-Oct	163,300.00	5.57%	9.28	5.30%
Very Poor	25 - 40	374,017.00	12.76%	21.25	17.40%
Poor	40 - 55	499,921.00	17.05%	28.40	13.90%
Fair	55 - 70	449,724.00	15.34%	25.55	17.10%
Satisfactory	71 - 85	649,655.00	22.16%	36.91	22.70%
Good	85 - 100	598,390.00	20.41%	34.00	23.20%

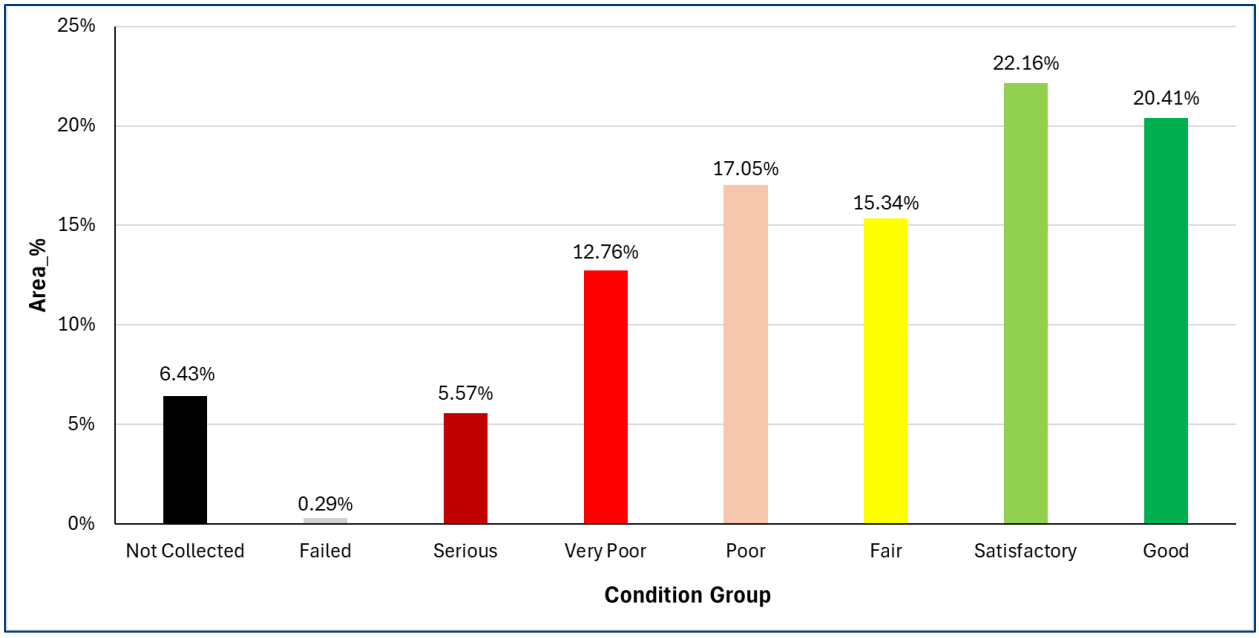

Figure 18. OCI Pavement Condition Distribution by Area

7. Comparison between PCI and OCI

Figure 19 compares the percentages of areas classified into different condition groups based on the Pavement Condition Index (PCI) and the Overall Condition Index (OCI). The condition groups range from Failed to Good, with OCI percentages generally higher in poorer condition categories and lower in better condition categories compared to PCI. In the Failed and Serious groups, the area percentage increased significantly, indicating the impact of including pavement surface roughness in the condition score.

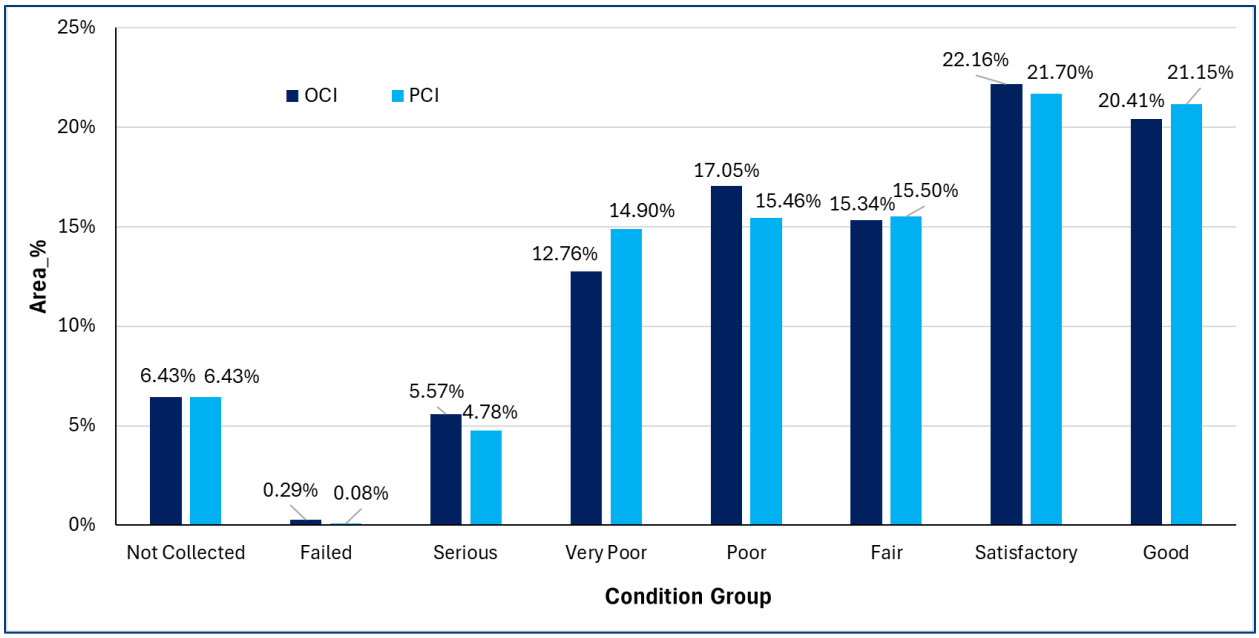

Figure 19. PCI and OCI Comparison

8. Pavement Super Sections

Typically, pavement condition assessments and treatment recommendations are based on individual pavement blocks. However, at the City's request, we present scores using "super sections," which consist of adjacent pavement segments with distinct Pavement Identification Numbers (PIDs) but statistically similar surface conditions. We merged adjacent sections under two constraints: the total length does not exceed 2000 feet, and only sections with statistically similar OCI scores are combined. For example, sections with OCI scores of 16 and 60 were not merged, as this would average to 38 and necessitate costly reconstruction for both blocks. By keeping them separate, only the block with an OCI of 16 requires reconstruction, while the block with an OCI of 60 needs only preservation, which is significantly less expensive. For detailed information regarding the Overall Condition Index (OCI) scores of each super section, please refer to Appendix B.

9. Treatment selection

This section outlines the recommended treatments for all city-maintained streets based on their pavement condition at the time of the survey. Recommendations are made assuming an unlimited budget, allowing for immediate application of the suggested treatments. No budget or optimization analysis for treatment recommendations was conducted.

Pavement treatment categories can be categorized into five groups; namely pavement reconstruction, pavement reclamation, pavement rehabilitation, pavement preservation, and pavement routine maintenance.

Pavement reconstruction involves the complete removal and replacement of an existing pavement structure with new or recycled materials, essentially building a new pavement from scratch. It's a comprehensive process aimed at creating a durable and functional road surface.

Pavement reclamation is a sustainable method used in road construction and rehabilitation that involves recycling the existing pavement material to create a new road surface. Rather than removing the old pavement entirely, it is pulverized or milled in place, mixed with additives if needed, and compacted to form a stable base for the new pavement layer. This approach offers cost savings, reduces environmental impact by minimizing waste, and speeds up construction. It also enhances road strength and durability by utilizing existing materials efficiently.

Pavement rehabilitation encompasses Mill and Overlay treatment. A Mill and overlay treatment is a common road maintenance technique used to improve the condition of existing pavement surfaces. The process involves milling off a certain thickness of the existing pavement surface, typically around 2 to 4 inches, to remove imperfections such as cracks, potholes, and rutting. After milling, a new layer of asphalt or other pavement material is applied over the milled surface to restore the road's smoothness and functionality. This overlay serves to seal the surface, enhance skid resistance, and extend the pavement's service life. Mill and overlay treatments are often employed as a cost-effective solution to rejuvenate deteriorating roads without the need for complete reconstruction.

Pavement preservation focuses on extending the service life of highways by selecting the most cost-effective actions to address specific conditions and performance needs. This approach aims to provide smoother, safer, and more reliable roads by preventing deterioration and minimizing the need for more extensive repairs or reconstruction in the future.

Pavement routine maintenance, like crack sealing, is a proactive strategy aimed at preserving roads. Crack sealing involves filling or sealing cracks and joints in the pavement to prevent water infiltration, which can lead to further damage. This preventive measure helps prevent cracks from expanding due to weather and traffic, reducing the need for costly repairs later. Overall, crack sealing contributes to safer, smoother, and longer-lasting road surfaces.

For this project, we utilized the decision matrix outlined in Table 3 to propose treatment strategies. Our recommendations encompass treatments for both individual blocks and broader super sections. These recommendations are founded on typical treatments aligned with the corresponding Overall Condition Index (OCI) values. However, it's crucial to emphasize that the actual implementation of these treatments requires validation in the field. Appendix C offers a comprehensive presentation of the recommended treatments for both block and super section levels, categorized according to OCI scores.

Table 3. Typical Treatment Recommendations by OCI

Treatment	OCI Range
Reconstruction/Level up	0-40 or Gravel-Surfaced Sections
Mill and Overlay	40-60
Preservation	60-80
Crack Sealing	80-95
Do Nothing (DN)	95-100

10. Closing

All the statistics in this report were based on certified ratings and calibrated/certified measurements made in the field, along with other inputs and assumptions described in the report. ARA has made every effort to base our procedures on sound methodology used by reputable pavement engineers.

If you should have any questions, concerns, or comments regarding this report, please do not hesitate to contact us.

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Appendix A.

PCI condition category for all city-maintained streets based on 2024 is presented in the Spreadsheet and the pdf map below:

1. City Street Names
2. PCI Score Block Level.xlsx
3. PCI Score Block Level.pdf

Appendix B.

OCI condition category for all city-maintained streets based on 2024 is presented in the Spreadsheets and pdf maps below:

1. OCI Score Block Level.xlsx
2. OCI Score Block Level.pdf
3. OCI Score Super Section Level.xlsx
4. OCI Score Super Section Level.pdf

Appendix C.

Treatment recommendations based on the OCI score for the block and super section level are provided in the spreadsheets and pdf maps below:

1. Recommended Treatments _ Block Level .xlsx
2. Recommended Treatments_Super Section Level.xlsx
3. Recommended Treatments _ Block Level .pdf
4. Recommended Treatments_Super Section Level.pdf