

Pavement Data Collection and Pavement Management System Update

Carson City, Nevada

PREPARED FOR

Carson City Public Works
3505 Butti Way
Carson City, NV 89701
(775) 887-2000

PREPARED BY

Applied Pavement Technology, Inc.
1755 E Plumb Lane, Suite 264
Reno, NV 89502
(217) 398-3977
www.appliedpavement.com

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INTRODUCTION

Carson City Public Works (CCPW) contracted with Applied Pavement Technology, Inc. (APTech) to analyze Carson City's (City) roadway pavement assets and update its pavement management software.

This report provides a detailed description of the current condition of pavement assets in Carson City. This information will assist Carson City's elected officials in balancing City priorities.

Carson City is the capital of the State of Nevada. It was founded in 1864, covers about 157 square miles, and has a population of about 58,640 (U.S. Census Bureau 2020). CCPW is responsible for maintaining approximately 274 centerline miles of roads paved with asphalt concrete, which equates to 51,223,161 square feet, or 1.84 square miles of pavement (per PAVER database).

PROJECT BACKGROUND

In 2024, the Carson Area Metropolitan Planning Organization (CAMPO) hired APTech to collect pavement condition data for Carson City and Douglas County and update the associated PAVER databases. APTech worked closely with CAMPO to review the road networks in the corresponding pavement management software (PMS), collect pavement condition data, and update each PAVER PMS accordingly. This report summarizes the work completed and results of the efforts for Carson City.

Scope of Work

The four tasks identified to successfully complete this project are described below.

Task 1 – Project Management

APTech conducted a kickoff meeting on October 22, 2024. Discussions confirmed primary objectives of the effort, agency expectations, schedules, milestones, special circumstances, and data needs. Information provided by the City included a roadway network shape file and the latest PAVER database available. APTech identified project roles, responsibilities, and contact information for all key personnel to promote accountability and effective communication. Additionally, biweekly coordination meetings were held to provide periodic status reports.

Task 2 – Network Review

APTech reviewed the roadway network, and using information provided by the City, updated the network by adding missing roadway assets and removing roadway assets no longer under City jurisdiction. This updated network was used to guide the condition data collection survey. Any identified changes were coordinated directly with City staff and were modified in the PAVER database.

Task 3 – Pavement Condition Data Collection

Between October and November 2024, APTech used its Enhanced Data Gathering Equipment (EDGE – shown in Figure 1) for automated data collection. The EDGE collected downward imagery using a Laser Crack Measurement System (LCMS), road surface profile data (longitudinal and transverse), and four right-of-way (ROW) camera views (forward, forward-left, forward-right, and rearward). All collected information was georeferenced using an onboard GPS antenna. On two- or three-lane local roadways (including roads with one lane each direction and a center turning lane), data were collected on one lane in one direction. On four- and two-lane regional roadways, data were collected on one lane in each direction.

Information processing included conversion of LCMS data into images, automated identification of distresses, calculation of rutting, and measurement of faulting (for jointed concrete pavements). Once the processing was completed, image files were reviewed by APTech's trained staff to validate the type, severity, and extent of each distress. Additional sectioning changes were communicated to the City and were used to update the network accordingly in PAVER.

After completion of the data collection and validation tasks, APTech loaded distress data into PAVER, where a Pavement Condition Index (PCI) was calculated for every surveyed section within the network. Additionally, APTech provided a web-based image viewing tool that

provides the City access to the collected imagery to take virtual drives of each section within the roadway network.

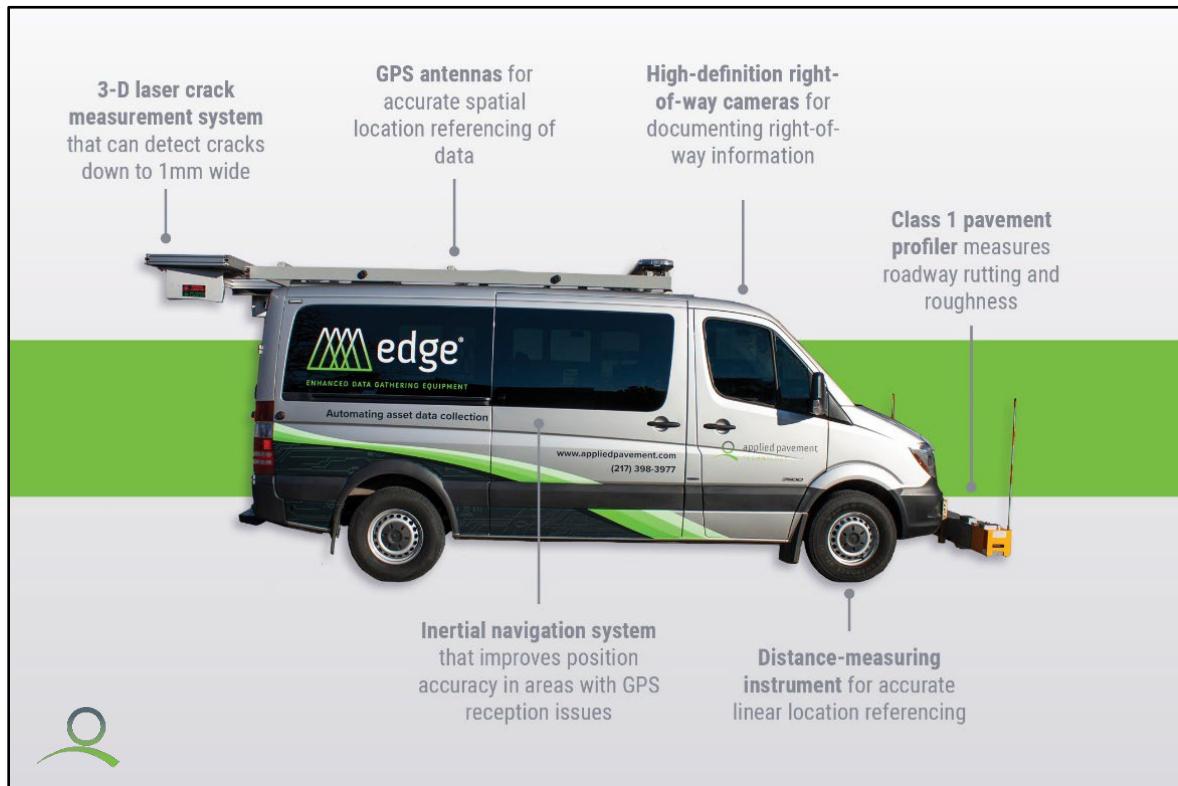


Figure 1. APTech's EDGE data collection vehicle.

Task 4 – Reporting

The results from the project are summarized in this project report. This report documenting the work effort was submitted to the City for review. Comments from the City were incorporated to produce and deliver a final report in electronic format.

PAVEMENT NETWORK INVENTORY

CCPW maintains a database of all roadways. This database was updated to include the new sectioning and pavement data condition collected during this project. A detailed summary of roadway pavement assets that CCPW maintains, preserves, and rehabilitates follows.

Per the PAVER database, the network consists of 274 centerline miles (paved with asphalt concrete) of streets sectioned into 3,035 sections that fall under one of three functional classifications and one of five Pavement Performance Districts (see figures 2 and 3). Tables 1 and 2 summarize surface area, centerline mileage, functional classification, Pavement Performance District, and number of sections for CCPW's roadway pavement network. The network is predominantly comprised of local roads.

Table 1. Pavement area, centerline miles, and number of sections by functional classification.

Functional Class.	City Class.	Number of Sections	Centerline Miles	Area (ft ²)	Percentage of Network
Arterial	Regional	241	28	7,820,954	15.3%
Collector		511	54	9,879,805	19.3%
Local	Local	2,283	191	33,522,402	65.4%
Total		3,035	274	51,223,161	100%

Table 2. Pavement area, centerline miles, and number of sections by performance district.

Perf. District	Functional Class.	City Class.	Number of Sections	Centerline Miles	Area (ft ²)	Percentage of District Area
1	Arterial	Regional	55	9	2,068,055	20.4%
	Collector		97	8	1,337,722	13.2%
	Local	Local	367	40	6,727,902	66.4%
Performance District 1 Total			519	56	10,133,679	100%
2	Arterial	Regional	102	8	2,421,132	23.2%
	Collector		58	6	1,186,034	11.4%
	Local	Local	539	36	6,830,207	65.4%
Performance District 2 Total			699	50	10,437,373	100%
3	Arterial	Regional	24	5	988,173	10.2%
	Collector		88	14	2,272,523	23.5%
	Local	Local	354	38	6,408,499	66.3%
Performance District 3 Total			466	57	9,669,195	100%
4	Arterial	Regional	34	4	1,341,213	12.5%
	Collector		136	12	2,439,696	22.8%
	Local	Local	516	39	6,926,692	64.7%
Performance District 4 Total			686	55	10,707,601	100%
5	Arterial	Regional	26	3	1,002,381	9.8%
	Collector		132	14	2,643,829	25.7%
	Local	Local	507	39	6,629,103	64.5%
Performance District 5 Total			665	56	10,275,313	100%

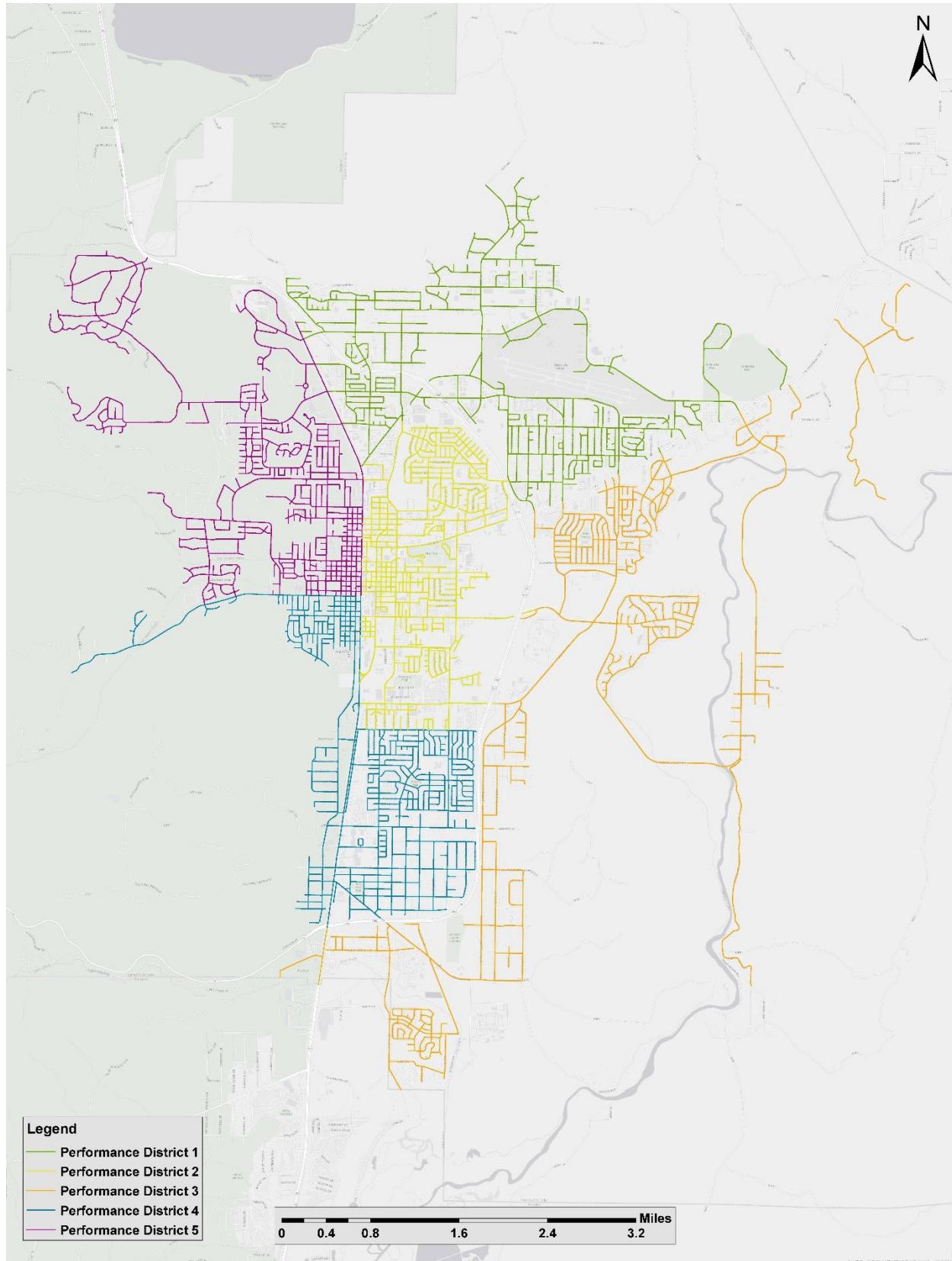


Figure 2. Carson City maintained roads by Performance District.

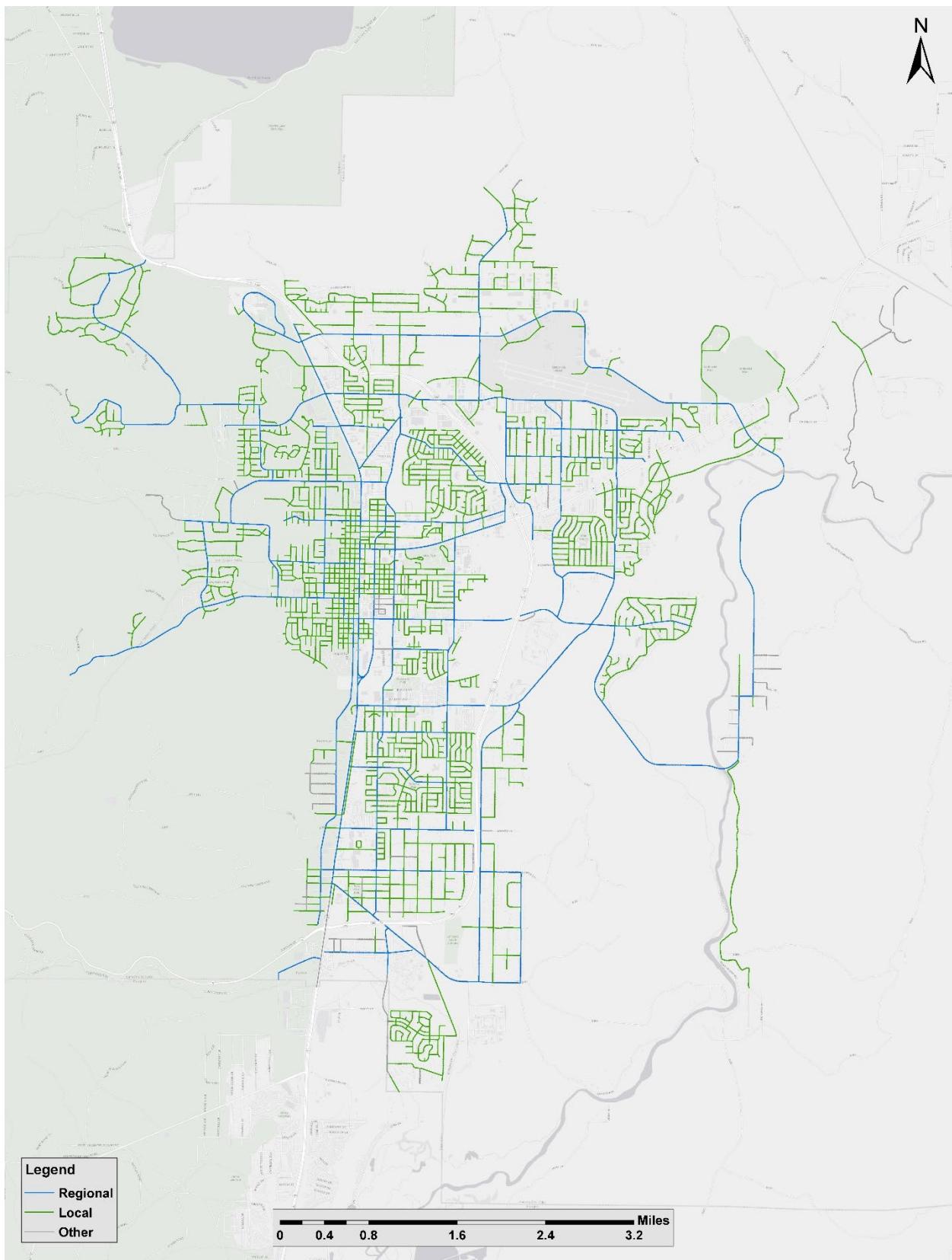


Figure 3. Carson City maintained roads by city classification.

PAVEMENT CONDITION ASSESSMENT

This section documents how condition data were collected and imported into the PMS and discusses the results. APTech collected condition data including rutting and surface distress. Surface distress and rutting are used to calculate a PCI in accordance with ASTM Standard D6433.

Data Collection

APTech used its EDGE automated data collection van to collect pavement condition data. As previously noted, the EDGE is equipped with ROW cameras, a Distance Measuring Instrument, GPS receivers, a five-laser road surface profiler bar, and a 3-D LCMS for comprehensive collection of georeferenced distress data. The EDGE collected condition data for roadway pavement sections in a single pass moving at posted roadway speeds without the need for traffic control.

The EDGE provides a permanent record of conditions through ROW and downward pavement surface images. These images are provided to the City through APTech's web viewer.

Pavement Condition Inspections

APTech performed pavement condition inspections following guidance provided in ASTM D6433, which is the acknowledged standard used by local agencies in the United States for pavement condition assessment. The standard defines asphalt concrete and portland cement concrete pavement surface distress types, severities, and quantities.

To accurately and efficiently identify all distresses on inspected CCPW pavement sections, APTech used a computer-based inspection system to process the imagery and data collected by the EDGE. This system uses algorithms to automatically identify different distresses. APTech pavement inspection analysts reviewed all data to verify that distresses were correctly classified and measured. The workstation survey process resulted in a database of distress information (type, severity, extent) for each roadway section. The distress database was uploaded into the PMS, where the PCI for each roadway section was calculated.

Figure 4 is a view of the computer system used for pavement distress rating. The two images on the left show cracking as noted on the range and intensity images from the LCMS. The yellow lines on the right side are the computer system identification of the pavement cracking.

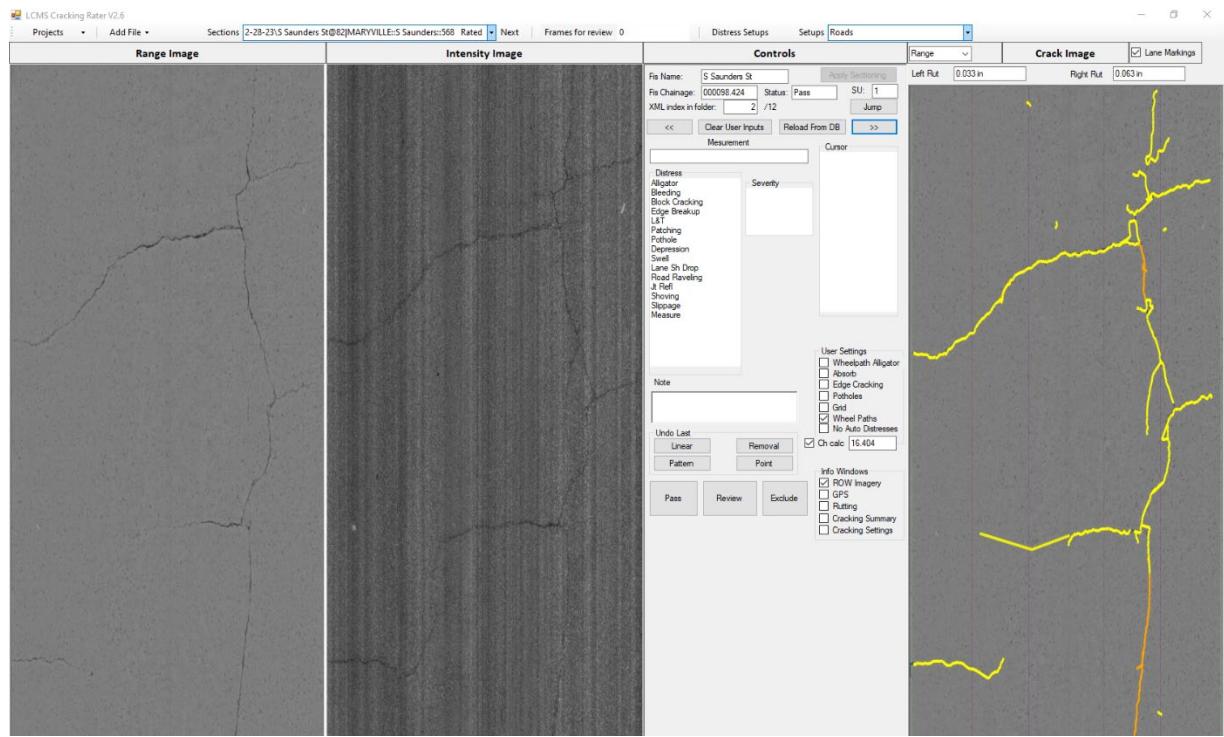


Figure 4. Digital images used for pavement distress rating.

Pavement Condition Index Calculations

PAVER used pavement distress data to calculate a PCI for each roadway section. The PCI scale ranges from a value of 0 (representing a pavement in a completely *Failed* condition) to a value of 100 (representing a pavement with no visible distress). In the PCI calculation, each distress type and severity combination has an associated deduct value. Structural distresses, like rutting and fatigue cracking, have much higher deduct values than other distresses. Small quantities of these distresses may reduce the PCI much faster than larger amounts of functional distresses. Table 3 summarizes PCI condition ranges, associated categories according to the ASTM definitions, and typical distresses present in each category.

Table 3. PCI ranges and condition categories.

PCI Range		Condition Category	Typical Distresses Present	
100	86	<i>Good</i>		Very little distress. Minor cracking.
85	71	<i>Satisfactory</i>		Mostly low-severity distress, with the possibility of some medium-severity distress. Little to no fatigue cracking. Minor rutting.
70	56	<i>Fair</i>		More medium-severity distress, including some fatigue cracking. Patching and rutting are typically present.
55	41	<i>Poor</i>		Medium- and high-severity cracking, including notable low- and/or medium-severity fatigue cracking, patching, and rutting.
40	26	<i>Very Poor</i>		Significant amounts of cracking, including notable medium- and high-severity fatigue cracking, raveling, and patching. Cracking is medium- to high-severity. Rutting may approach 0.5 inch.
25	11	<i>Serious</i>		Significant amounts of cracking, including considerable amounts of medium- and high-severity fatigue cracking, raveling, and patching. Majority of cracking is medium- to high severity. Rutting may approach 1 inch.
10	0	<i>Failed</i>		Significant amounts of cracking, including medium- and high-severity fatigue cracking, raveling, and patching. Cracking is generally high-severity. Possible high-severity rutting.

Figures 5 through 11 show representative images for each PCI condition category described in Table 3. There are multiple combinations of distress types, severities, and extent that may lead to the same PCI.

Figure 5 was taken on Airport Road. This road section has no visible distress (13 percent of the roads in Carson City are in the *Good* condition category).

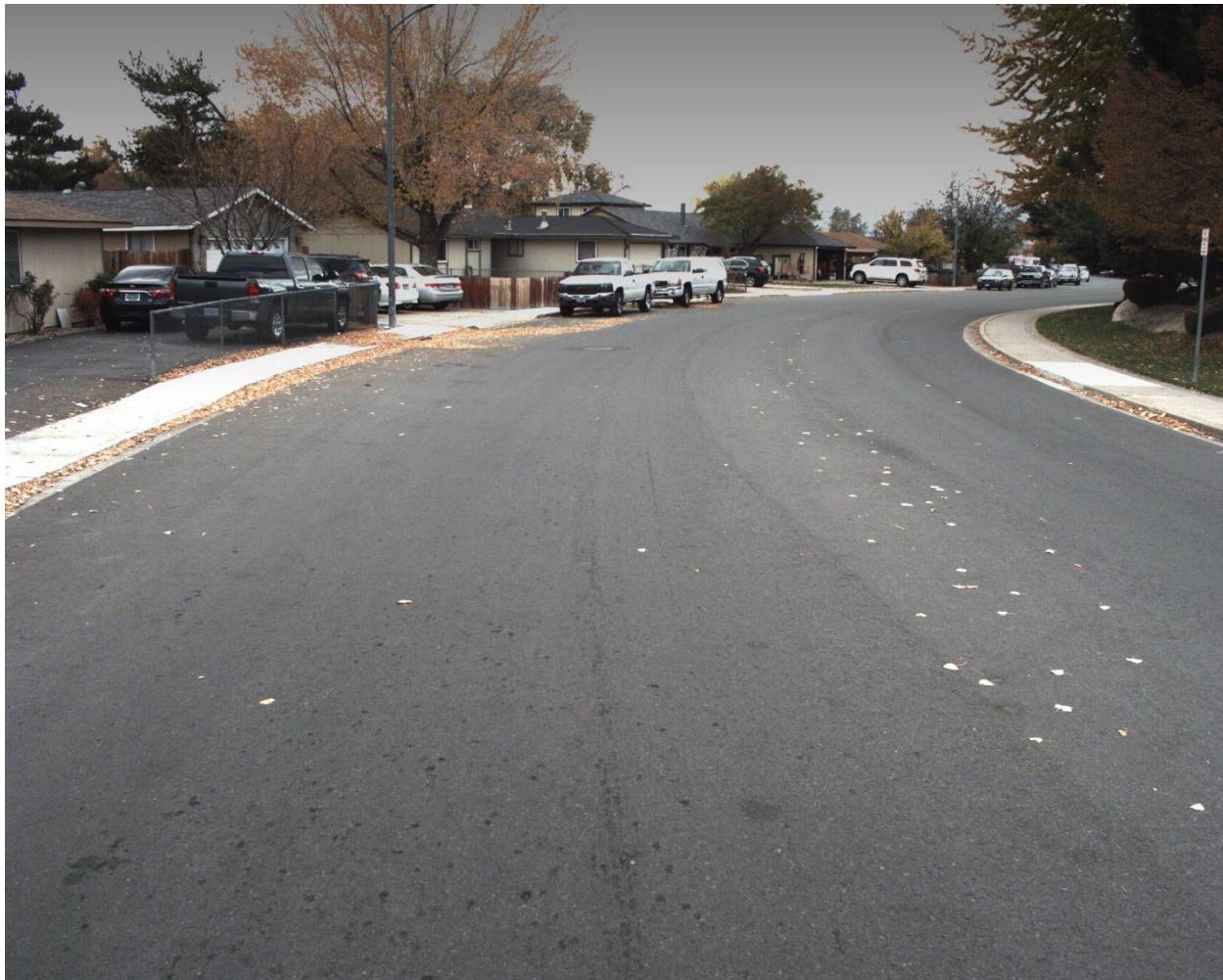


Figure 5. Pavement in *Good* condition category (PCI 100–86).

Figure 6 is a photograph taken on Ballarat Drive. This road shows low- and medium-severity longitudinal and transverse cracking (20 percent of the roads in Carson City are in the *Satisfactory* condition category).



Figure 6. Pavement in *Satisfactory* condition category (PCI 85–71).

Figure 7 was taken on Bedford Way. This pavement shows a combination of medium-severity transverse cracking and low-severity alligator cracking (24 percent of the roads in Carson City fall in the *Fair* condition category).



Figure 7. Pavement in *Fair* condition category (PCI 70–56).

Figure 8 shows a photo on Alfred Way. This section shows a combination of low- and medium-severity longitudinal cracking and medium-severity alligator cracking (19 percent of the roads in Carson City are in the *Poor* condition category).



Figure 8. Pavement in *Poor* condition category (PCI 55–41).

Figure 9 shows the condition of Crain Street. This section shows a combination of low- and medium-severity longitudinal and transverse cracking and a considerable amount of medium-severity alligator cracking with low-severity rutting (18 percent of the roads in Carson City fall in the *Very Poor* condition category).



Figure 9. Pavement in *Very Poor* condition category (PCI 40–26).

Figure 10 shows an overview photo on Stanton Drive. This section shows a combination of low- and medium-severity longitudinal and transverse cracking along with considerable amounts of medium- and high-severity alligator cracking with low- and medium-severity rutting (5 percent of the roads in Carson City are in the *Serious* condition category).



Figure 10. Pavement in *Serious* condition category (PCI 25–11).

Figure 11 presents a photograph on Asphalt Drive and shows a combination of medium- and high-severity alligator cracking and potholes (less than 1% of the roads in Carson City fall in the *Failed* condition category).



Figure 11. Pavement in *Failed* condition category (PCI 10–0).

Current Network Conditions

The 2024 area-weighted PCI for the CCPW network is 60. This value indicates the network is in *Fair* condition overall. A map of the City network showing the PCI for each segment is shown in Figure 12. Tables 4 and 5 provide a breakdown of the area-weighted PCIs by functional classification and jurisdiction. These findings show that regional roads have the highest area-weighted PCI of 69 (*Fair*), while local roads are in worse condition with an area-weighted PCI of 55 (*Poor*). Note that these are average values, and there is a distribution of condition levels within the network.

Table 4. Area-weighted PCI by City classification.

City Class.	Area (ft ²)	Percentage of Network	Area Weighted PCI
Regional	17,700,759	34.6%	69
Local	33,522,402	65.4%	55
Total	51,223,161	100%	60

Table 5. Area-weighted PCI by performance district.

Perf. District	City Classification	Area (ft ²)	Percentage of District Area	Area Weighted PCI
1	Regional	3,405,777	33.6%	59
	Local	6,727,902	66.4%	54
Performance District 1 Total		10,133,679	100%	56
2	Regional	3,607,166	34.5%	73
	Local	6,830,207	65.5%	54
Performance District 2 Total		10,442,425	100%	60
3	Regional	3,260,696	33.7%	74
	Local	6,408,499	66.3%	55
Performance District 3 Total		9,669,195	100%	61
4	Regional	3,780,909	35.3%	79
	Local	6,926,692	64.7%	52
Performance District 4 Total		10,707,601	100%	61
5	Regional	3,646,210	35.5%	62
	Local	6,629,103	64.5%	60
Performance District 5 Total		10,275,313	100%	60

A summary of 2024 PCI results for each pavement section is provided as a separate spreadsheet and includes the following information:

- Branch ID.
- Section ID.
- From and To (indicating beginning and ending locations).
- City Classification.
- Length.
- Width.
- Area.
- Previous PCI Date.
- Previous PCI.
- 2024 PCI.
- 2024 PCI Category.

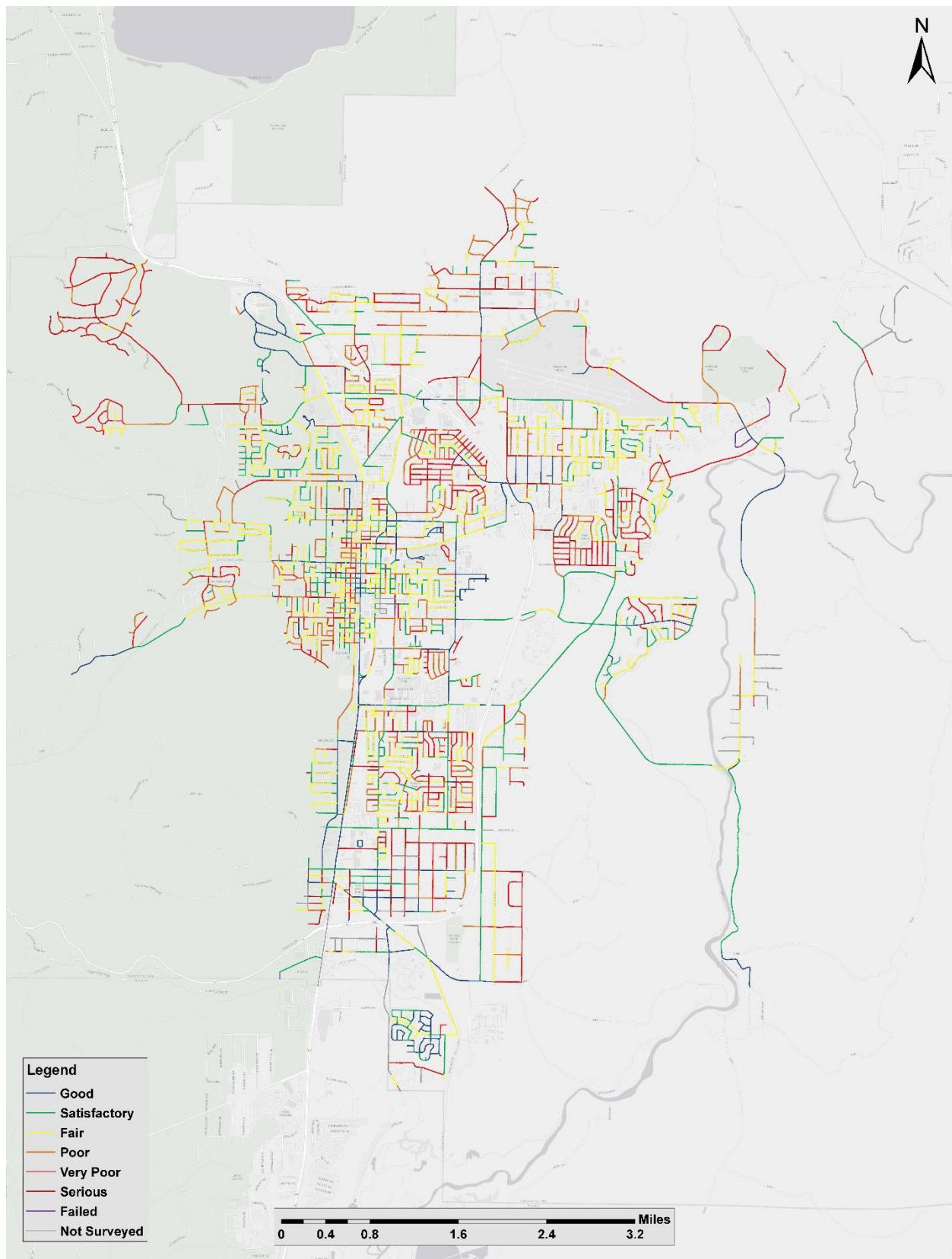


Figure 12. Carson City map showing color-coded PCIs.

Figure 13 displays the distribution of pavement area by condition category. Approximately 33 percent of the roadway network area is in *Good* to *Satisfactory* condition with PCIs greater than 70. Roadways in *Good* or *Satisfactory* condition are typically excellent candidates for pavement preservation treatments. Strategically timed pavement preservation treatments may extend the life of these roadways in a cost-effective manner, delaying the need for more costly treatments.

Approximately 45 percent of the roadways in the City are in *Fair* or *Poor* condition with PCIs between 40 and 70. Based on the City's standard practice, roadways in these condition categories will likely require some form of rehabilitation work or pavement preservation work to restore or prolong performance. The remaining 22 percent of the City's roadways are in *Very Poor*, *Serious*, or *Failed* condition. Roadways in these conditions are generally candidates for more costly reconstruction or major rehabilitation.

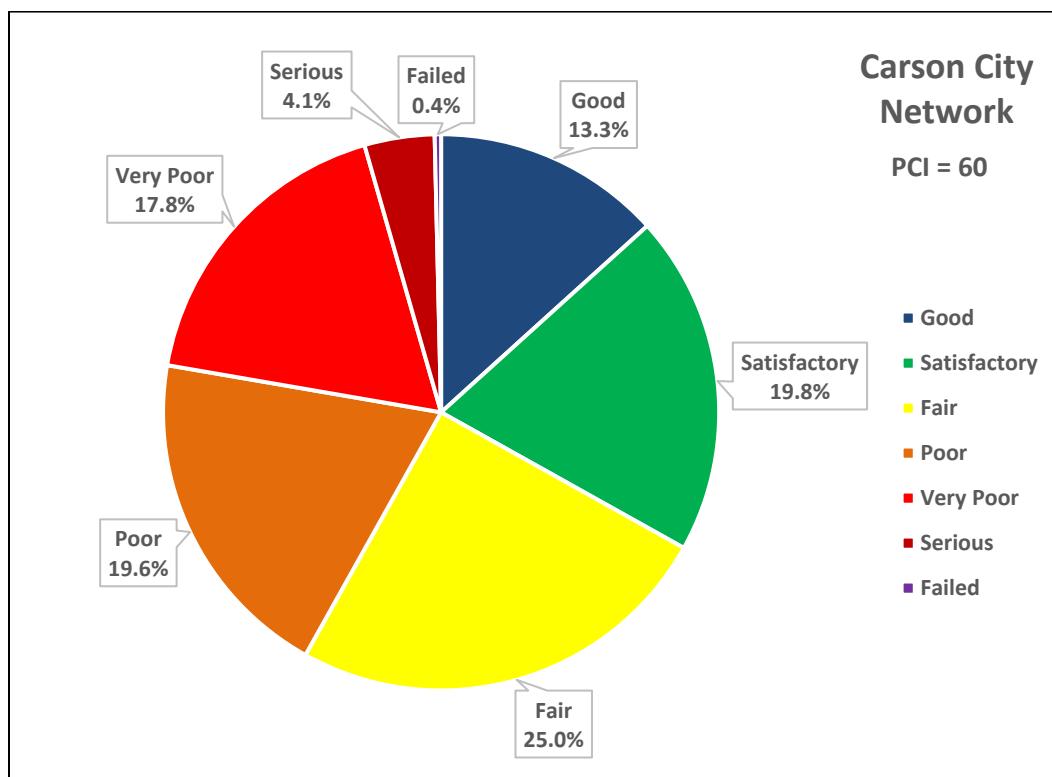


Figure 13. Distribution of network pavement area by condition category.

Figures 14 and 15 display the distribution of pavement area by condition category for each City classification. Approximately 53 percent of the regional roads are in *Good* or *Satisfactory* condition, while only 22 percent of the local roads are in *Good* or *Satisfactory* condition.

Table 6 shows the annual report card used by CCPW, which summarizes the average area-weighted PCI for all facility types since 2015. These tables show the percentage change between the first and latest data collection efforts (2015 and 2024), as well as the difference between the previous and latest data collection efforts (2021 and 2024).

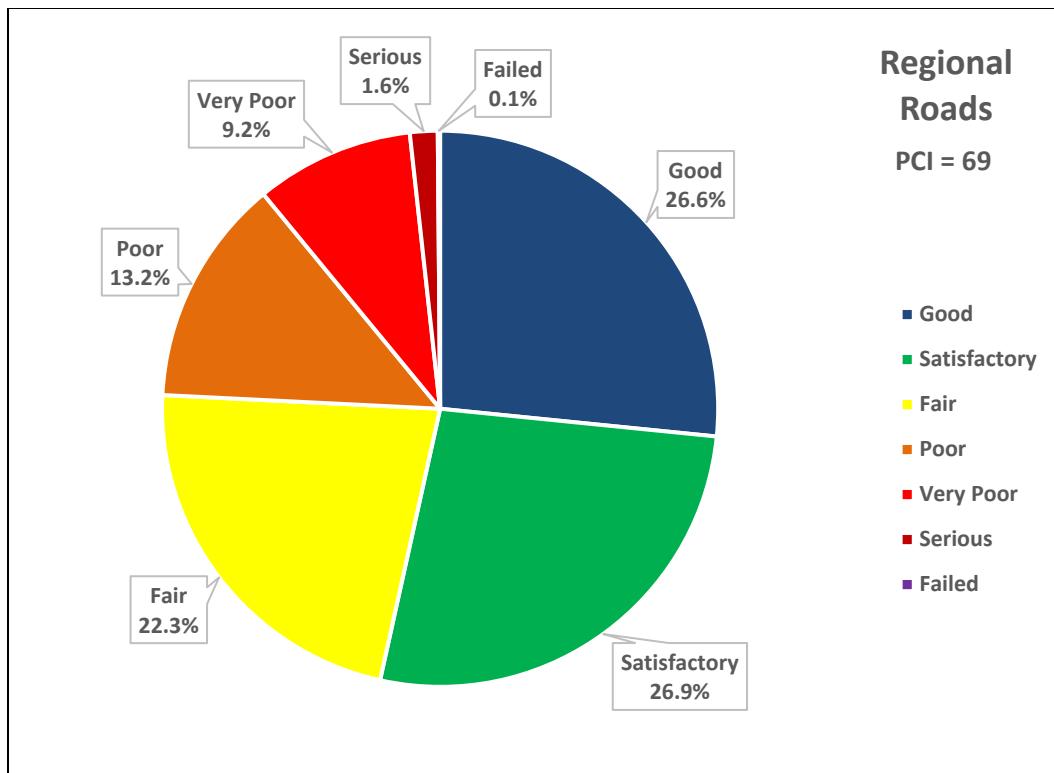


Figure 14. Distribution of pavement area by condition category for regional roadways.

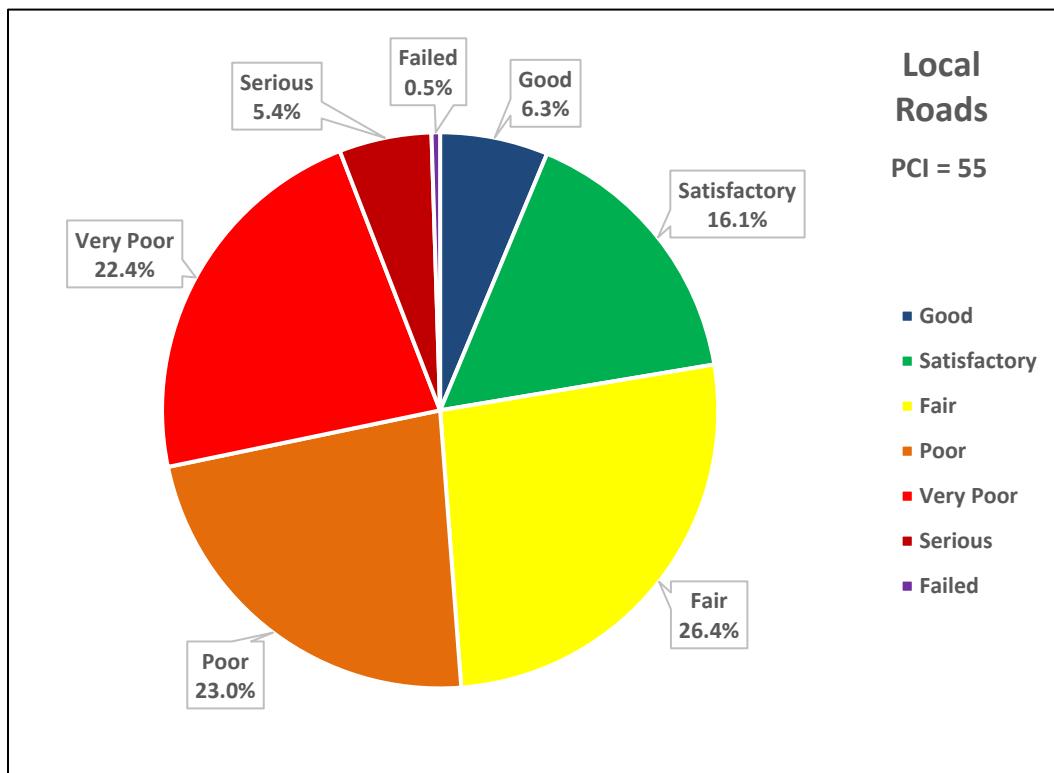


Figure 15. Distribution of pavement area by condition category for local roadways.

Table 6: 2015 to 2024 condition report card.

Pavement Condition Index (PCI) - Annual Report Card													
Facility Type		Insp. PCI	Est. PCI	Insp. PCI	Est. PCI				Insp. PCI	Est. PCI	Insp. PCI	Percent Change 2022 to 2024	Percent Change 2015 to 2024
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024		
City-wide	Regional Roads	68	68	67	68	67	67	63	74	67	69	-6%	2%
	Local Roads	63	62	61	59	57	53	49	56	49	55	-2%	-13%
	All Roads	65	64	63	62	60	58	54	62	55	60	-4%	-8%
Performance District 1	Regional Roads	68	67	67	66	66	62	56	69	60	59	-14%	-13%
	Local Roads	62	62	62	60	56	52	48	57	50	54	-5%	-14%
	All Roads	64	64	64	62	59	55	51	61	53	56	-9%	-14%
Performance District 2	Regional Roads	74	74	73	72	70	71	68	80	73	73	-9%	-1%
	Local Roads	70	67	64	60	58	54	49	53	46	54	1%	-24%
	All Roads	71	70	67	65	62	60	56	63	55	60	-5%	-16%
Performance District 3	Regional Roads	75	74	72	74	74	71	68	77	68	74	-4%	-2%
	Local Roads	53	53	57	57	57	54	51	58	53	55	-5%	4%
	All Roads	60	60	62	62	62	59	56	64	57	61	-4%	3%
Performance District 4	Regional Roads	58	59	61	64	62	75	69	79	74	79	-1%	36%
	Local Roads	60	59	58	56	52	49	45	51	45	52	1%	-15%
	All Roads	59	59	59	59	56	58	53	61	55	61	0%	3%
Performance District 5	Regional Roads	68	67	64	63	62	58	53	65	58	62	-5%	-8%
	Local Roads	70	68	66	64	61	57	52	60	52	60	0%	-15%
	All Roads	69	68	65	64	61	57	52	62	54	60	-2%	-12%

SUMMARY

CAMPO contracted with APTech to document the condition of Carson City's pavement network and update its PAVER database. The goal was to provide the City with an up-to-date pavement condition evaluation to use for annual pavement maintenance planning and to help prioritize pavement maintenance and rehabilitation needs for future years.

Between October and November 2024, APTech inspected approximately 274 centerline-miles of roadway pavement maintained by the City. The 2024 area-weighted network PCI is 60, placing the network in *Fair* condition.

Additionally, roads were analyzed by City classification. Regional roads represent 35 percent of the network and have an area-weighted PCI of 69, placing this group in the *Fair* condition category. Local roads represent the remaining 65 percent of the network and have an area-weighted PCI of 55, placing this group in the *Poor* condition category.

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