Concord
NORTH CAROLINA
High Performance Living

PAVEMENT ASSESSMENT & MANAGEMENT PLAN

GoodRoads Consulting, PLLC

July 30, 2023

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Introduction

In January, the City of Concord contracted with GoodRoads Consulting, Inc. (“GoodRoads”) to perform a pavement evaluation, pavement marking inventory, and a multi-year paving plan. The summary of this project, the methodology used, results, and a multi year plan with recommendations are contained in this report.

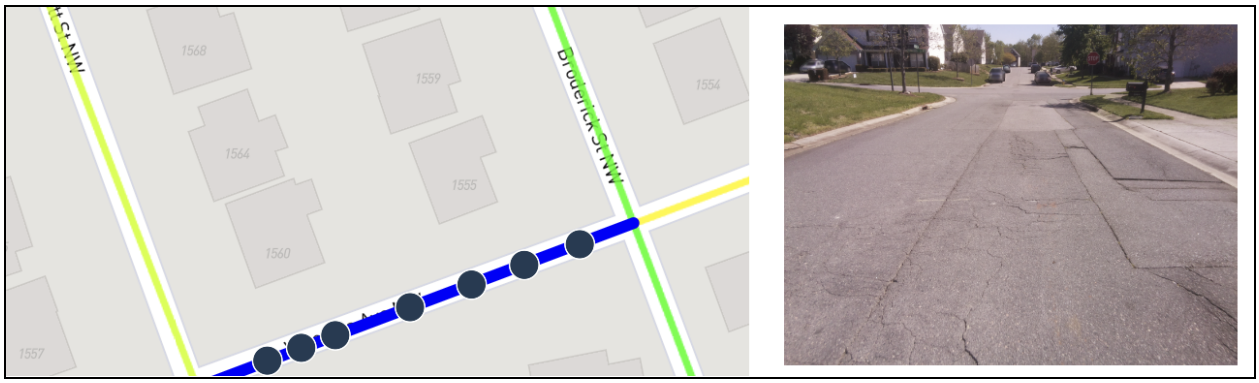
Inspection Methodology

A pavement assessment was completed according to the Pavement Condition Index (PCI) methodology (ASTM standard D6433). The assessment using the GoodRoads technology includes 4 steps: data collection, artificial intelligence assessment, quality assurance, PCI rating calculation. These steps are explained in further detail below.

Data Collection

GoodRoads affixes its data collection devices called “Roadies” to the hood of a vehicle, driving each road in the city and collecting images of the roads. After a few days of driving, photos of every street in the City are captured and stored in our system.

Battery-powered “Roadie” mounts magnetically to the hood of any vehicle

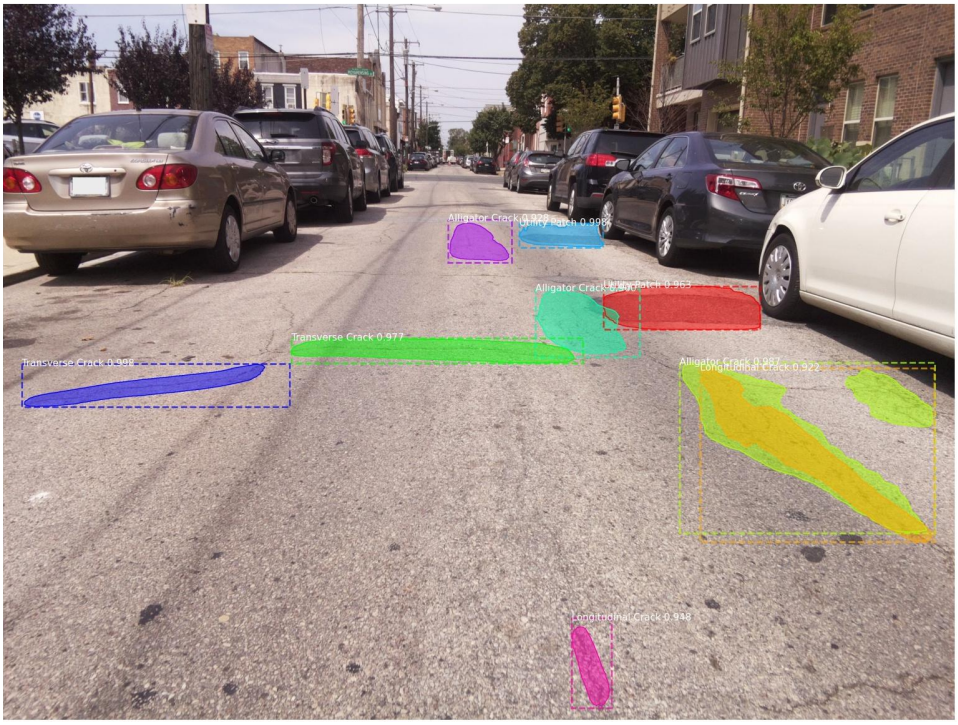


Images are collected every ~35 feet as the vehicle drives on City streets

After a day of data collection, Roadie is connected to WiFi and the process of uploading the thousands of images collected completes overnight.

Artificial Intelligence Assessment

GoodRoads inspects both asphalt and concrete. Our artificial intelligence (“AI”) has been trained to inspect according to the ASTM D6433 “PCI” standard, which specifies the types of distresses and how to record them. Our AI identifies the distresses it sees in the photos and quantifies them in square feet.



Quality Assurance

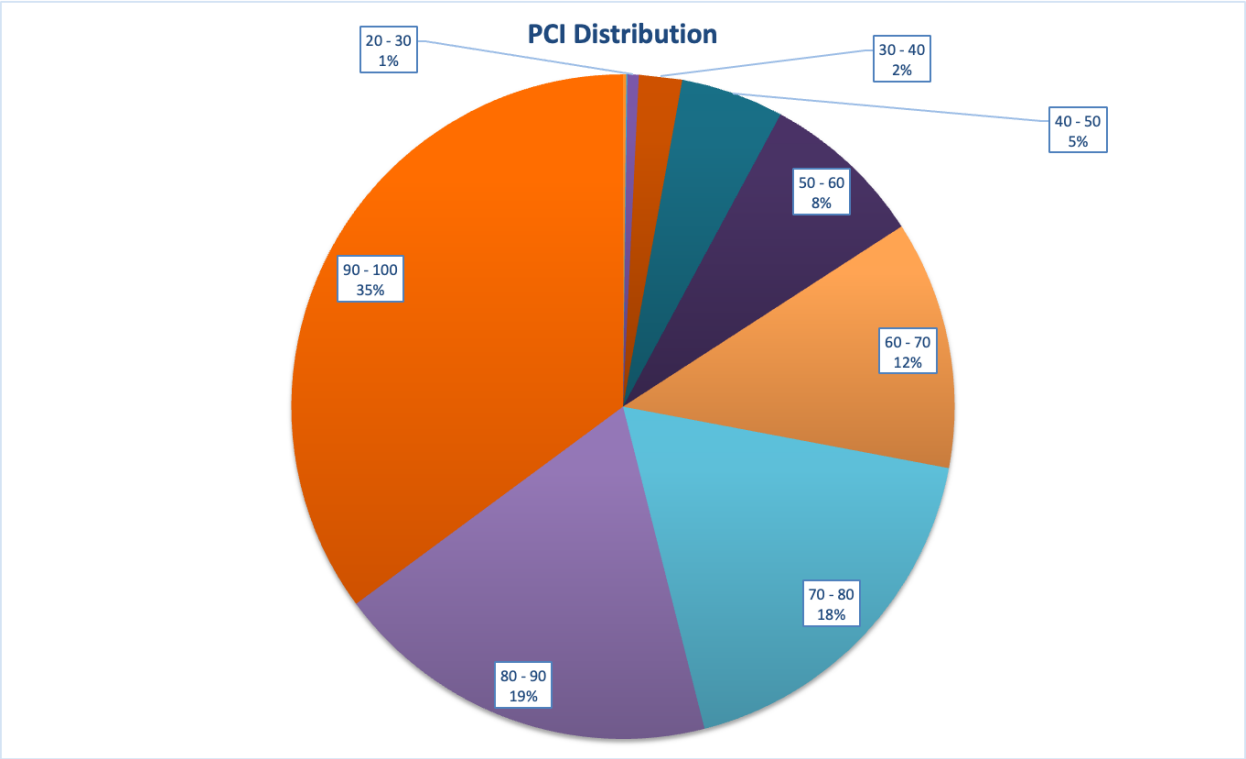
After our artificial intelligence completes its assessment, our Quality Assurance (“QA”) team members review the results in every photo to ensure accuracy and completeness. After our QA team reviews and corrects the AI results where necessary, the final step is calculation of a PCI rating according to the ASTM D6433 methodology.

PCI Rating Calculation

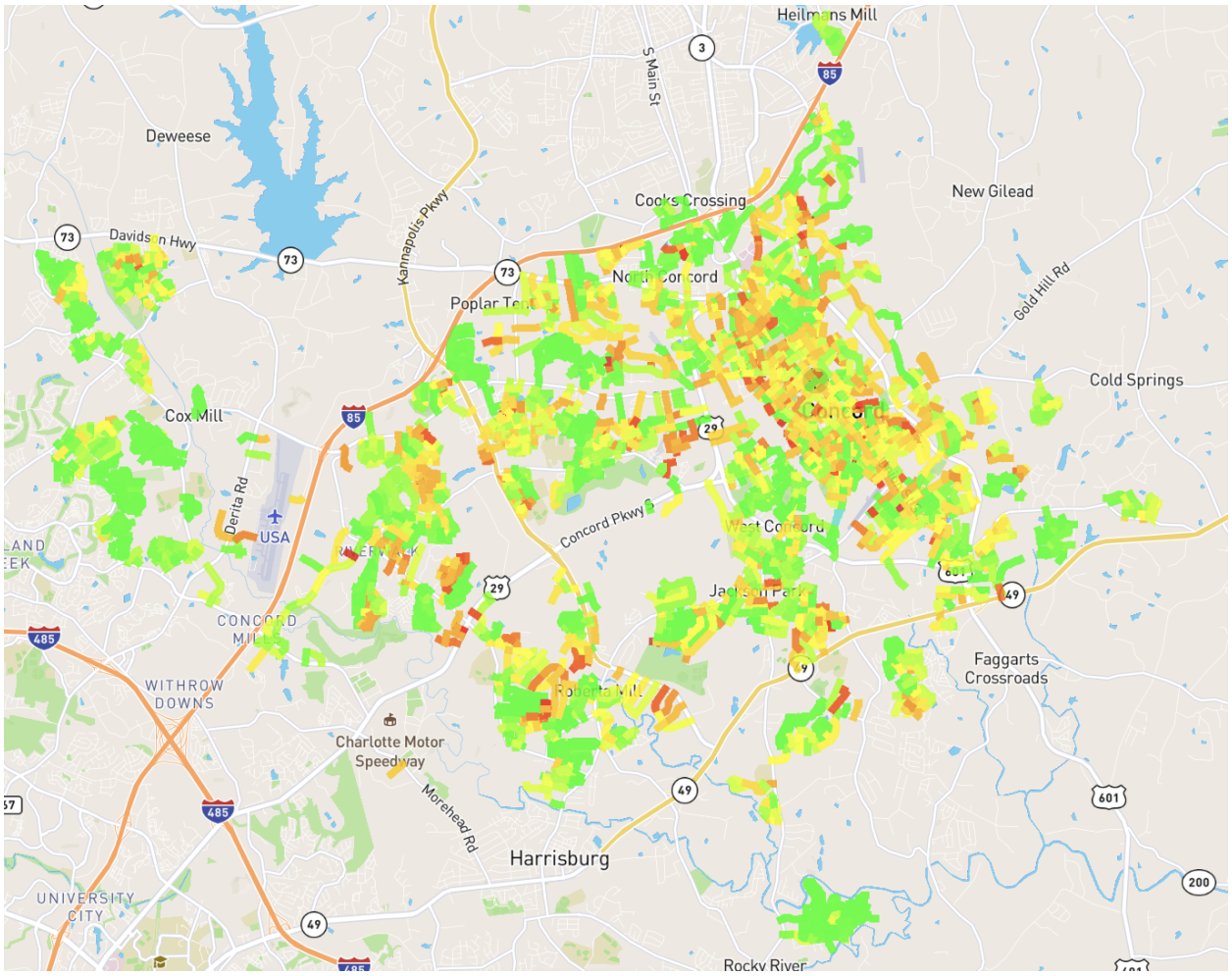
The PCI methodology includes a detailed rating calculation. Ratings are assigned to each road segment (typically a city block in length). In general, very bad roads are assigned a 0 and very good, new roads are assigned a 100, with a spectrum in between depending on the distress types and quantities present. For Concord, GoodRoads provided an additional severity to each photo to more precisely match the PCI rating methodology. Distresses are aggregated from each of the photos of a street segment and the calculation yields a PCI rating for that road segment.

Results

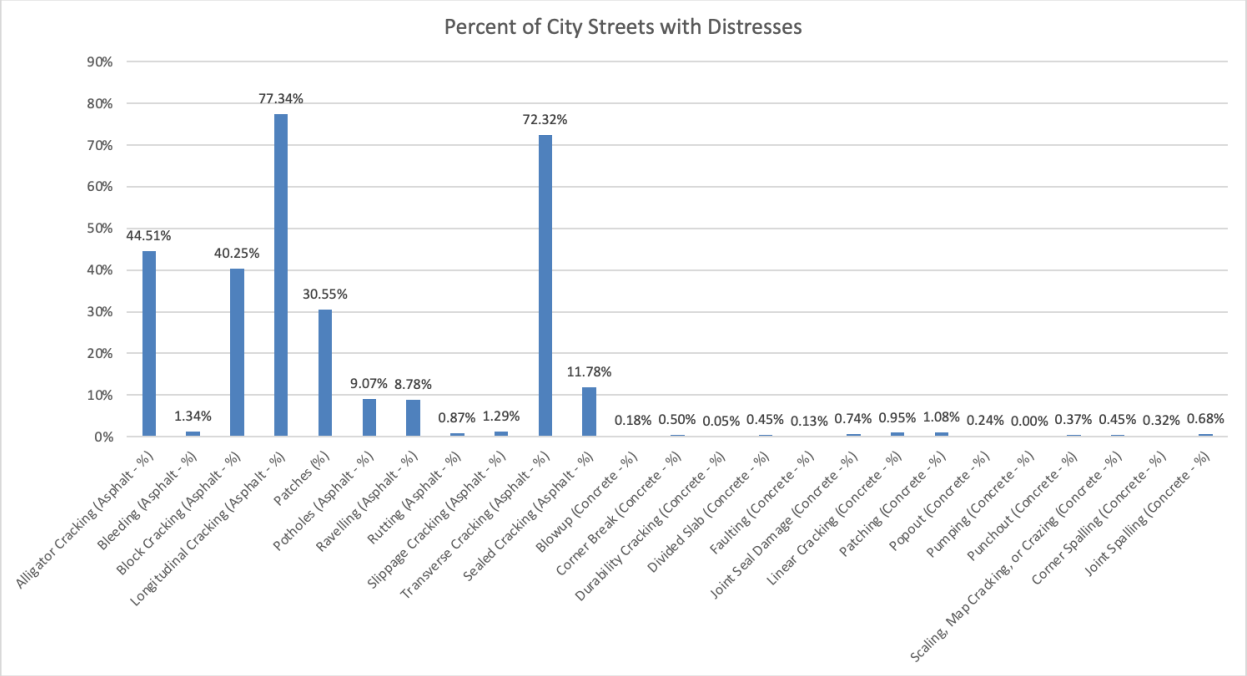
GoodRoads inspected 390 miles of paved City roads. The average PCI rating of the City’s roads is 79.6 (weighted average by length) with 44% of the City’s road miles above an 85 PCI rating. The distribution of PCI ratings is shown in the pie chart below.



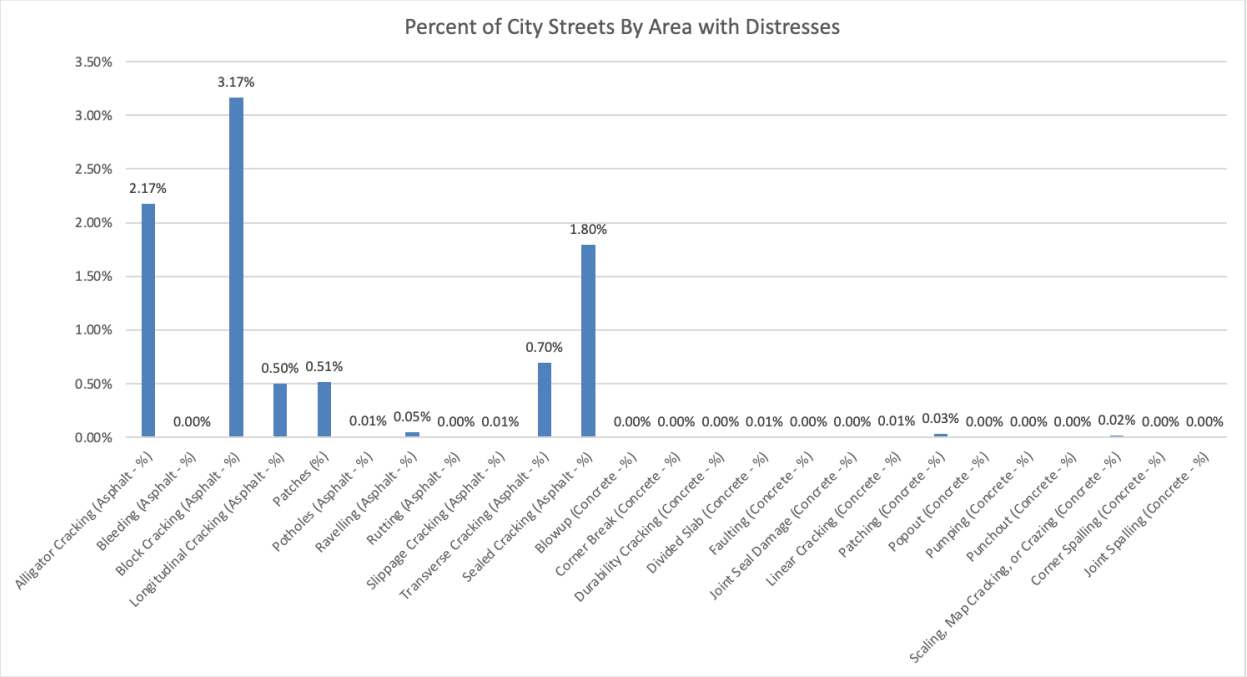
Results of the pavement assessment are accessible to City Transportation staff through the GoodRoads software web platform. The following is a map of the results color-coded according to the following scale: red is a low rating (close to 0) and green is a high rating (close to 100).



When managing a City's road quality, it is important to pay attention to the types and quantities of distresses found. In Concord, the most common distresses are individual (longitudinal and transverse) cracks, block cracking and fatigue or "alligator" cracking. The following chart quantifies the distresses found on City streets by the number of streets with that distress.



While these results seem to indicate a large portion of streets with distresses, considering the actual size and quantity of the distresses compared to the overall area of the City's roads helps put this into perspective. The following chart quantifies the percentage of distresses by area.



Pavement Maintenance Plan

GoodRoads has prepared a 3-year annual road maintenance plan for the City Transportation department. The primary goal of the Transportation department is to achieve safety and efficiency for the traveling public. According to the North Carolina Benchmarking Project (https://benchmarking.sog.unc.edu/), which polls 9 cities in North Carolina (including Concord) on an annual basis, the North Carolina average percentage of road miles above an 85 rating was 40% in 2022. This serves as a logical benchmark for Concord's street maintenance program. Concord's average percentage of road miles above an 85 rating was 31% in 2019, with a 14 percentage point increase in 2023 to 44%.

The goal of the current pavement management plan is to exceed the average of the cities participating in the NC Benchmarking project. The following recommendations are aimed at achieving this goal. Full Projections are included in the Appendix.

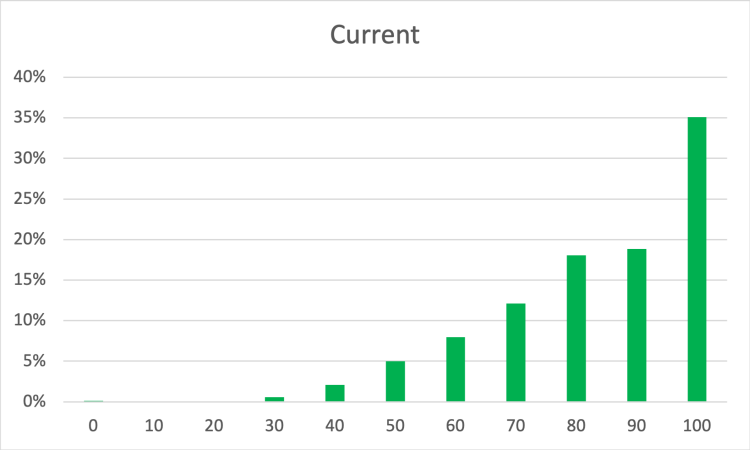
Criteria

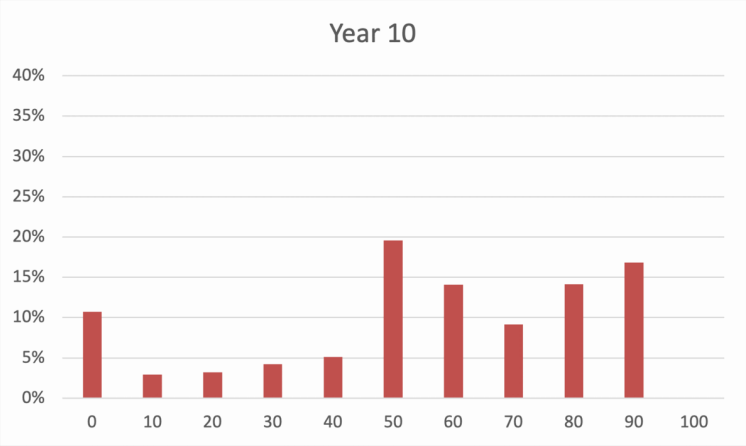
The City has historically used the following general criteria for planning pavement maintenance:

- Localized patching of alligator cracking on roads with less than 25% alligator cracking ($250k budget)
- Roads with a PCI less than 65 receive mill and overlay. Typically the City will do all roads in the neighborhood of a prioritized road for mill and overlay ($2M budget)
- Crack seal on roads that have cracking but do not meet the above criteria, typically roads with a PCI above an 80. Often the crack seal team will do all neighborhood roads surrounding a planned crack seal road. ($80k budget)
- Concrete roads are demolished and replaced with asphalt. The process involves concrete removal, stabilizing the soil and then replacing with ABC Base, intermediate and surface asphalt. (With caution: old utilities are often embedded in the concrete pavement) (separate ad hoc budget)
- The time horizon considered for this maintenance plan is 3 years.

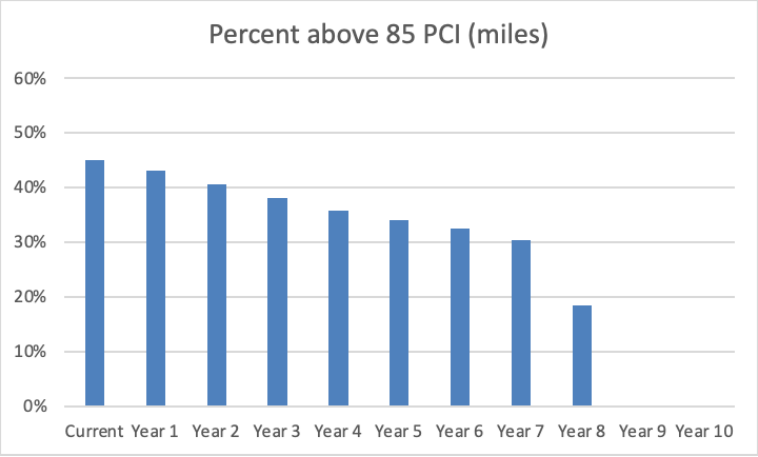
Baseline

Before considering different maintenance strategies, it is helpful to set a baseline. In other words, what would Concord's roads look like if no maintenance was done and they were allowed to age unabated? The graphs below give more detail into how this aging occurs. These graphs show the % of roads at each 10-PCI interval shown on the x-axis and how those percentages change over the next 10 years:





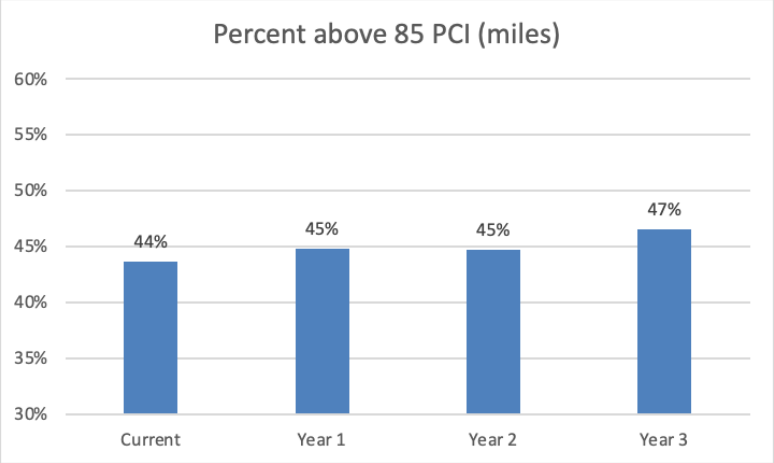
The graphs below depict this aging with respect to “% of roads above an 85”:

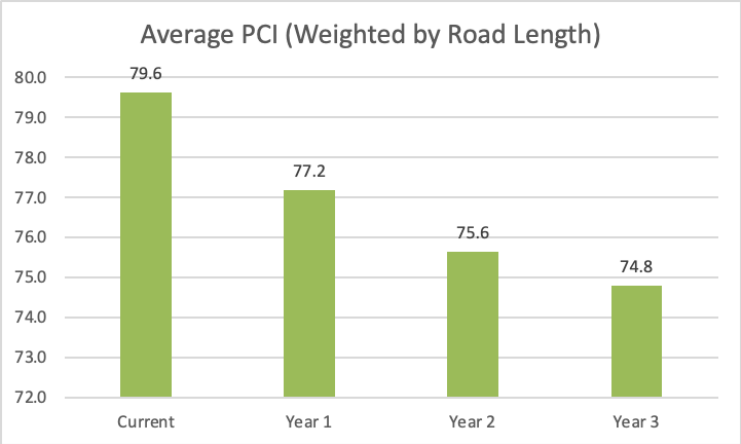


Alternative 1: Meeting Existing Criteria

The City's current strategy will increase the % of roads above 85, however the average rating trends downward. Below are the results of applying Concord's current pavement management strategy as outlined above:

Year	Maintenance	Roads	Cost	Miles
1	Mill and overlay	84	$ 1,805,431	5.81
	Patch	17	$ 188,963	1.42
	Crack seal	205	$ 28,658	19.73
	SUBTOTAL	**306**	**$ 2,023,051**	**26.95**
2	Mill and overlay	57	$ 1,800,388	5.69
	Patch	13	$ 196,709	1.22
	Crack seal	167	$ 27,017	18.47
	SUBTOTAL	**237**	**$ 2,024,114**	**25.39**
3	Mill and overlay	44	$ 1,795,187	5.57
	Patch	10	$ 195,677	1.11
	Crack seal	423	$ 74,135	44.73
	SUBTOTAL	**477**	**$ 2,065,000**	**51.41**

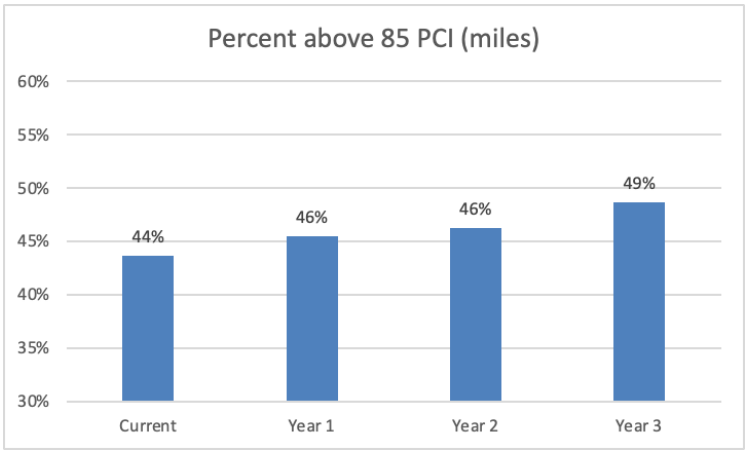


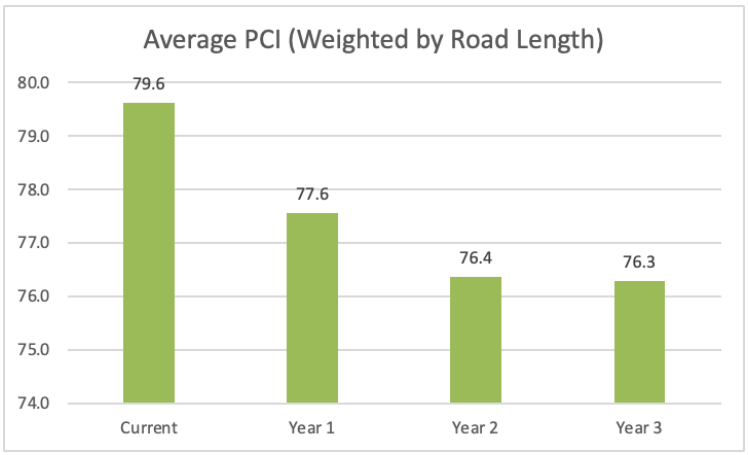


Alternative 2: Increase Budget

Increasing the budget does help but the added benefit is directly proportional to the added cost. Assuming a budget increase of $1M, the following projections result:

Year	Maintenance	Roads	Cost	Miles
1	Mill and overlay	117	$ 2,718,135	8.82
	Patch	23	$ 278,504	1.93
	Crack seal	211	$ 29,425	20.07
	SUBTOTAL	**351**	**$ 3,026,064**	**30.81**
2	Mill and overlay	73	$ 2,697,625	8.14
	Patch	20	$ 293,241	1.85
	Crack seal	177	$ 27,648	19.94
	SUBTOTAL	**270**	**$ 3,018,514**	**29.93**
3	Mill and overlay	84	$ 2,697,336	8.39
	Patch	17	$ 293,846	1.49
	Crack seal	723	$ 127,573	80.13
	SUBTOTAL	**824**	**$ 3,118,756**	**90.02**





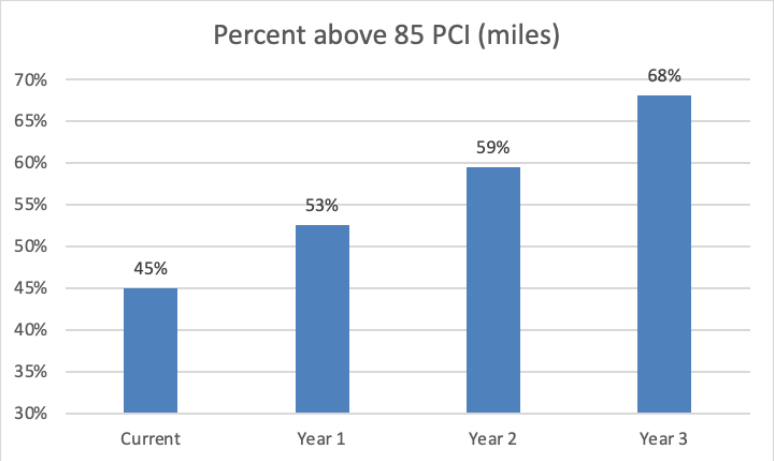
Alternative 3: Fill the Gap

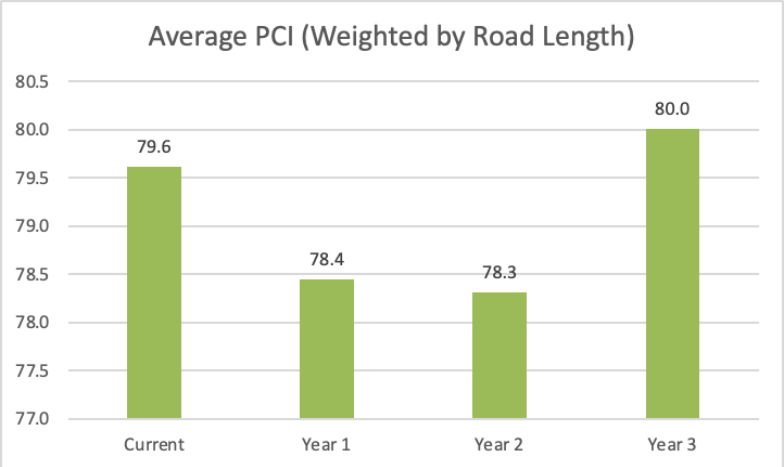
Concord has a high percentage of roads in the 70's, 80's and 90's (72% of centerline miles). In order to maintain all of these roads, the City should implement maintenance techniques that keep these roads at their current high quality. These would be techniques like rejuvenators, crack seal, and High Density Mineral Bond. These techniques are also a fraction of the cost of mill and overlay.

The City is currently implementing crack seal on roads with cracking but still generally above an 80 PCI. This leaves a treatment gap between the 65 PCI threshold for Mill and Overlay and 80 PCI for crack seal. Because 25% of Concord's roads are between a 65 and 80, Concord should consider implementing a treatment strategy to keep these roads from lapsing into the mill and overlay threshold. Patching, crack seal, High Density Mineral Bond and similar techniques would be good options.

The third alternative fills this gap with High Density Mineral bond. The following projections result:

Year	Maintenance	Roads	Cost	Miles
1	Mill and overlay	2	$ 6,616	0.02
	Crack seal	126	$ 18,174	11.37
	HDMB	287	$ 2,042,042	30.78
	SUBTOTAL	**415**	**$ 2,066,832**	**42.17**
2	Mill and overlay	3	$ 37,033	0.14
	Crack seal	265	$ 69,760	30.66
	HDMB	295	$ 1,960,100	29.11
	SUBTOTAL	**563**	**$ 2,066,893**	**59.9**
3	Mill and overlay	7	$ 144,458	0.47
	Crack seal	1766	$ 318,197	185.33
	HDMB	217	$ 1,603,980	22.59
	SUBTOTAL	**1990**	**$ 2,066,634**	**208.38**





Conclusion

While Alternative 3 yields the most positive results, it would be an abrupt change from the City's current strategy. Because of this it is recommended that the City of Concord maintain its current plan (Alternative 2) for the next year and evaluate preventive maintenance techniques to "fill the gap" starting in the next 1-2 years. A transition to including these new techniques could be done swiftly or a phased approach could be used to gradually introduce them into the City's strategy.

Other Recommendations

A few general recommendations did not fit into a specific alternative but are worth considering. These recommendations are included below:

Keeping Up With the Benchmark

The City Transportation Department has set the goal of meeting the average "Lane Miles rated 85 or better" of the cities that participate in the NC Benchmarking 2.0 program. Concord, with 44% of roads above 85 PCI, already exceeds the average of 40%. However, that average increased from 2021 to 2022 by 7 percentage points. And since Concord participates in the Benchmarking program, an increase in the City's overall PCI score will necessarily bring up the average. It is important to consider that this goal may be a moving target from year to year.

The Worst Roads

Mill and overlay is effective at treating aged roads with some environmental cracking like block cracking. However, if fatigue or alligator cracking, reflective cracking, slippage cracking and unstable patches are present, mill and overlay can fail rapidly when the underlying distresses reflect through the new asphalt. For this reason, the City should monitor any roads below a 40 PCI that receive mill and overlay to determine if a minimum PCI threshold should be set for implementing mill and overlay. It may be worth the extra cost to remove and replace roads that drop below a 40 PCI.

Neighborhoods

Concord will typically mill and overlay an entire neighborhood at once. This strategy reduces mobilization cost and avoids spreading the burden of road construction over several years in a neighborhood. The City may want to consider which neighborhoods are the best candidates for this strategy. Some neighborhoods with a wider range of road quality, or larger neighborhoods with only a few roads that meet mill and overlay criteria may yield more value if the neighborhood is "phased" over a number of years in these cases. The Appendix includes a list of neighborhoods, their average ratings, range of ratings (distance between maximum and minimum PCI's), and number of roads. This list can be referenced to target neighborhoods with the appropriate average rating and smaller PCI ranges. The GoodRoads software can also use average rating in selecting entire neighborhoods for maintenance.

Communication with the Public

Any road maintenance strategy is best implemented with good public communication. Examples of effective communication we have see in other cities include:

- Requiring the contractor to hand out flyers before, during and after construction explaining the work remaining and how it will affect residents.
- Posting a map and detailed description of the planned maintenance on the City's website.
- Communicating the City's maintenance strategy at council meetings at least once a year (or more frequently). Explaining the techniques to be used and the reasoning behind them can help educate citizens and public leaders about the City's maintenance strategy and goals.

Regular Inspections

The best way to implement a pavement maintenance plan is to frequently measure progress. This could be through annual inspections. This allows a strategy to be adjusted based on new observations.

Field Verify

As with any plan, tweaks to accommodate situations "in the field" are always necessary. It is important to verify by physically visiting all roads planned for maintenance prior to implementing the planned work.