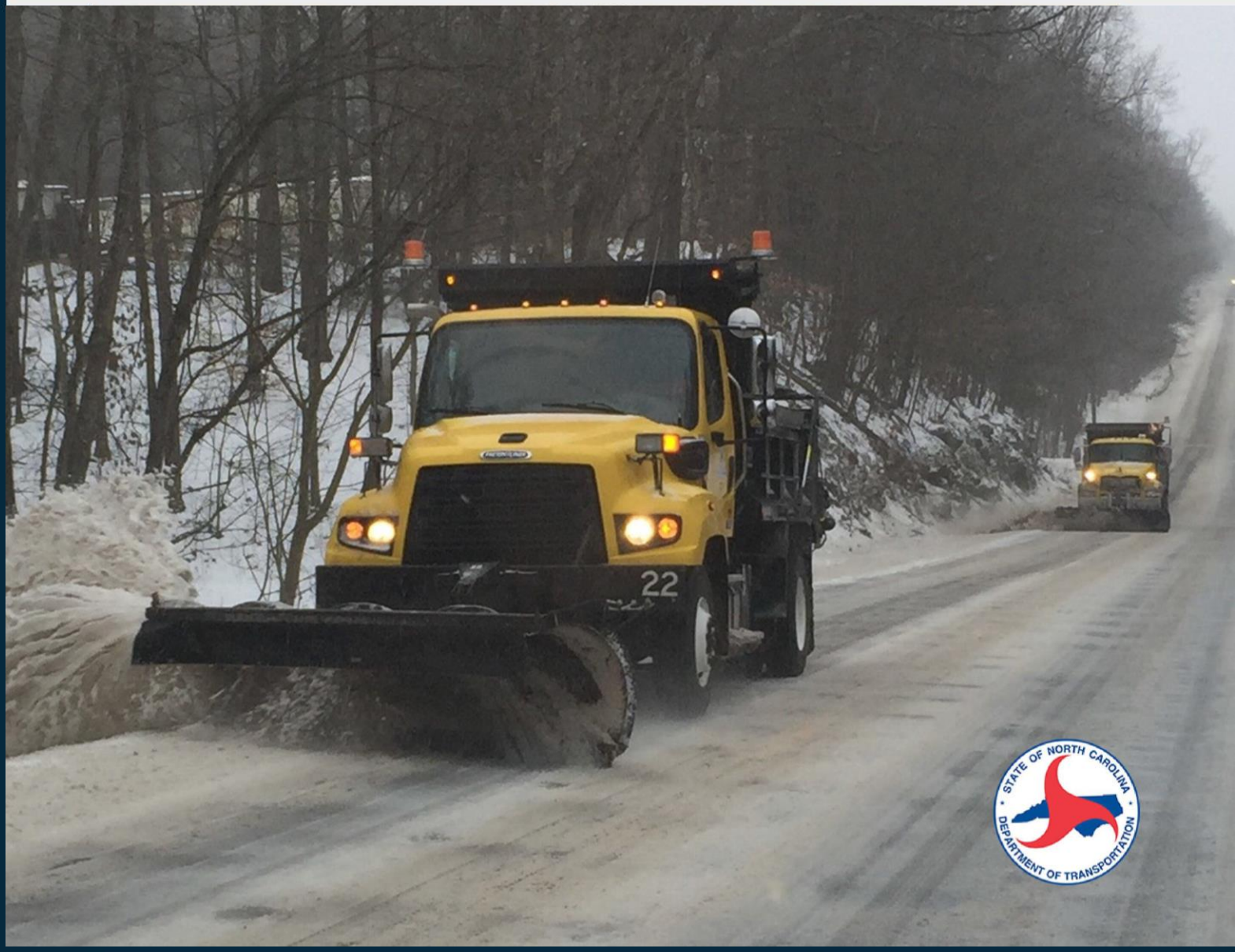
2024 Maintenance Operations and Performance Analysis Report (MOPAR)



2024

Required by G.S. 136-44.3

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DIVISION 1 INSIGHTS REPORT

This report uses data on inventory, condition, and costs to provide insights at the division, county, and route levels. It identifies long-term investment needs and opportunities across the system to optimize outcomes.[i]

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1 Division Funding Needs

1.1 Data Background

Launched in 2020, ArTEMIS initially tracked 30+ discrete maintenance functions on state-managed routes. Since then, it has expanded to capture a "fence-to-fence" view of assets, activity-based costs, and lifecycle investment forecasting, enabling more precise, data-driven maintenance planning.

The 2023 initiative leverages image recognition and AI/ML to assess conditions across 2+ million geo-located assets statewide. By aligning new inventory data with established sources like the Pavement Condition Survey, it enhances accuracy through "Route Scores" at route, county, division, and state levels, which help forecast investment needs. Similar to weather forecasting, aligning multiple datasets strengthens accuracy and reliability.

Statewide data collected and validated from January to September 2023 includes image collection, route walkthroughs, inspections, and quality reviews. These, alongside activity-based “should-cost” estimates—based on current market and industry standards—inform the Total Cost of Ownership model, supporting comprehensive maintenance planning.

1.2 Route Score Overview

1.2.1 Methodology

The table below shows the asset conditions contributing to Division 1's overall route score and how a route score is assembled at the route level (before being aggregated up by system counties, divisions, etc). The score uses point-in-time data collected January - September 2023.

Asset	State	Division 1
Pavement Index	83	79
Bridge Index	82	76
Shoulder	98%	99%
Pipes	82%	79%
Drop Inlets	89%	93%
Curb and Gutter	96%	95%
Pavement Striping	89%	87%
Signs	94%	95%
Guardrails and barriers	98%	99%
Words and Symbols[ii]	96%	94%
Traffic devices	100%	100%

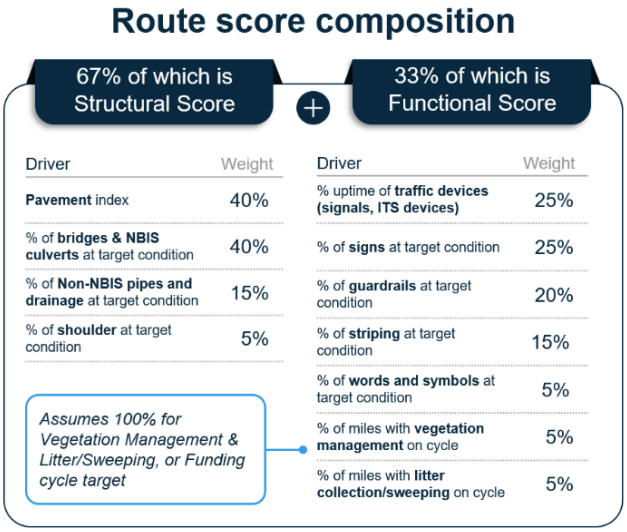
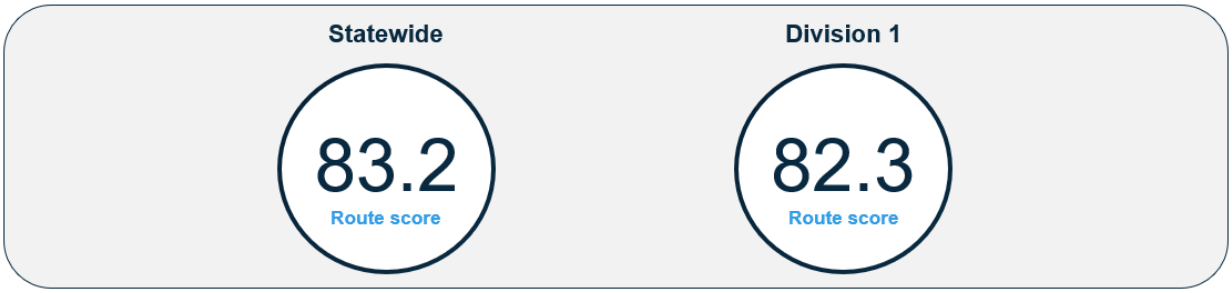


Table 1 – Asset scores (percentage of non-defective units or index score) across State and Division

1.2.2 Most Recent Outcomes

Using the scoring method shown above, the overall conditions of a division's roads can be shown with a single score that takes the weighted[iii] average of all its routes:



Route class	State	Division 1
Interstates	89	91
Primary	83	83
Secondary	82	82

Table 2 – Route scores by class

1.3 Route Score Distribution

The majority of the Division's network consists of routes in good condition, defined by a route score of 80 or higher. Over 6,500 lane miles (61% of network) are considered in good condition.

Conversely, less than 200 lane miles (2% of network) are considered in poor condition, defined by a route score lower than 60. Map 1 shows the condition of routes across the division.

Route score distribution, by lane miles

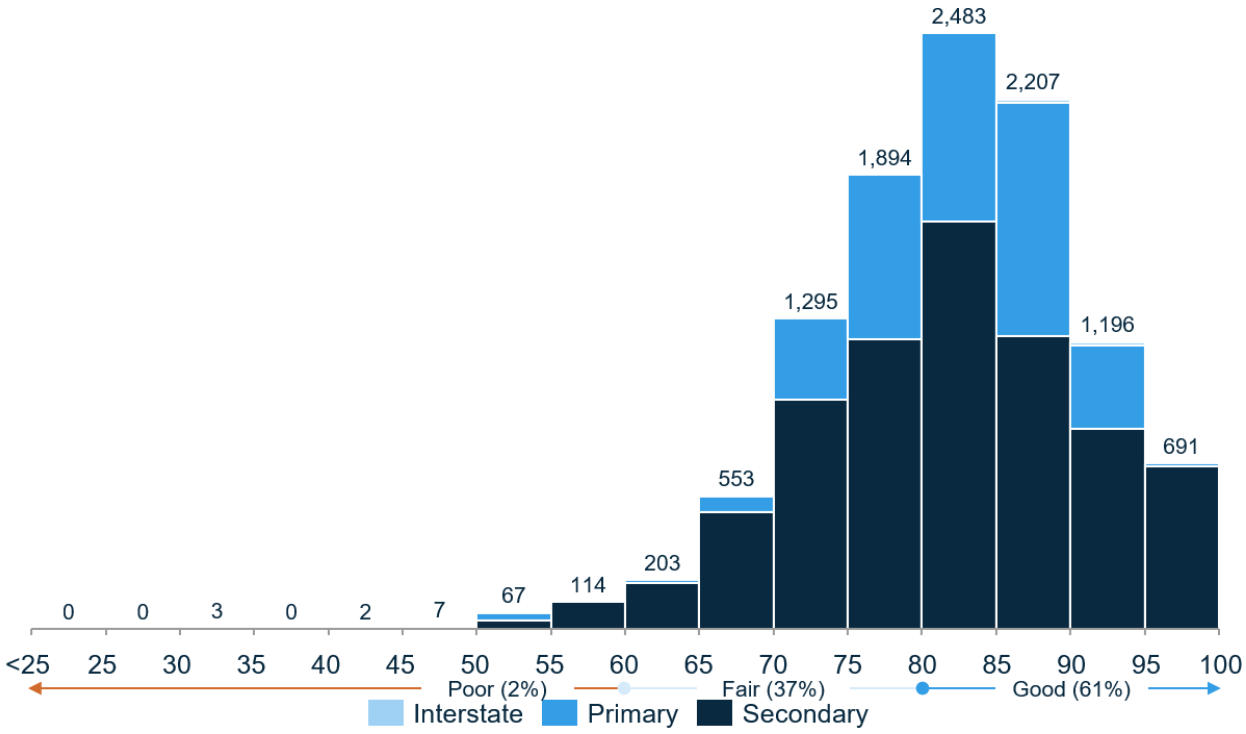
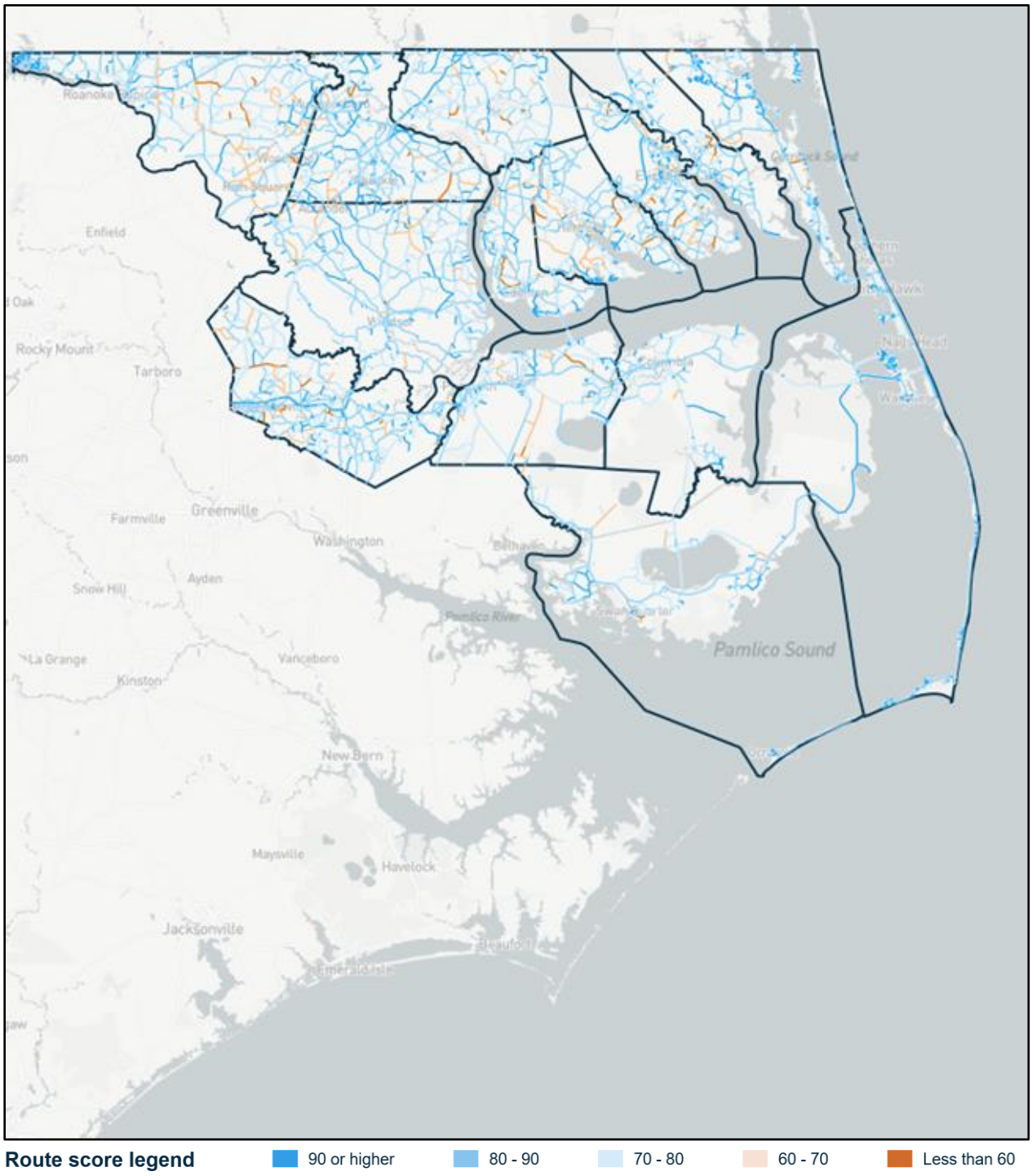


Figure 1 – Distribution of route score, measured in lane miles

Across the road network, the most common route score is between 80 and 85. Interstate and primary routes in Division 1 all have route scores of at least 50, while secondary routes exhibit route scores starting at 30.

These routes can be mapped spatially to evaluate the distribution by geography, as seen on the next page.

Route score distribution, by county



Map 1 – Spatial distribution of route score, grouped by county

1.4 Impact of static funding

Route Score is used to estimate the investment needed[iv] to maintain or achieve various condition levels over the next 10 years, assuming expected inflation[v] and asset deterioration.

Maintaining this division's current condition will require a year-over-year increase in funding, due to inflation and regular wear-and-tear. Static funding may be sufficient to maintain Division 1's route score in the next 3 years but will lead to a decline of **-1.7** points in 2028 and will potentially lower it by at least **-3.6** points over the next decade.

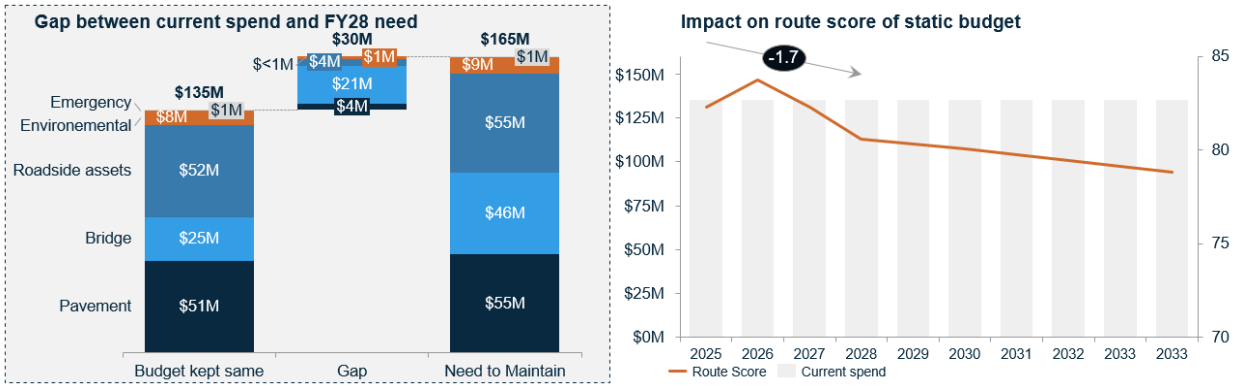


Figure 2 – Comparison of current spend and expected need; route score over time if no budget increase

1.5 Investment needs over the next 10 years

Using the Route Score, ArTEMIS can quantify investment needed to maintain or improve condition by raising the route score by zero points (maintain conditions), one point (slight improvement), five points (large improvement), and ten points (near-perfect conditions)[vi].

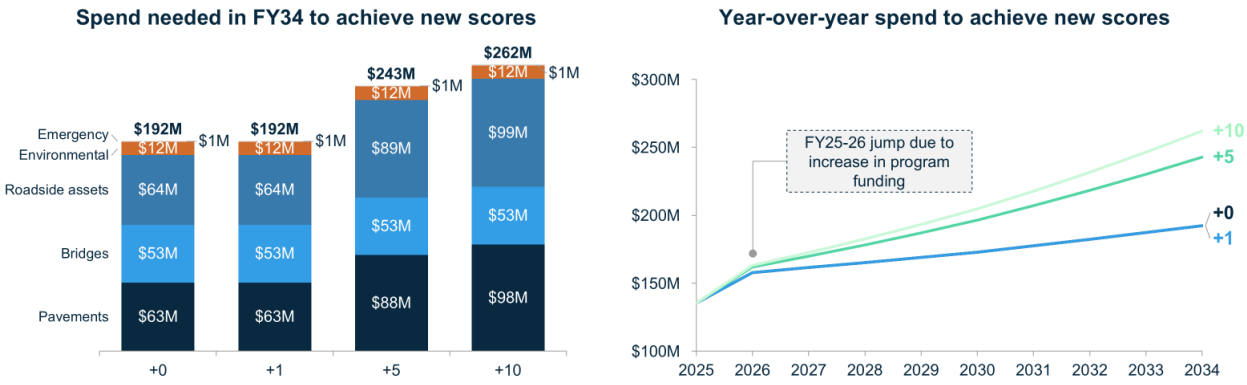


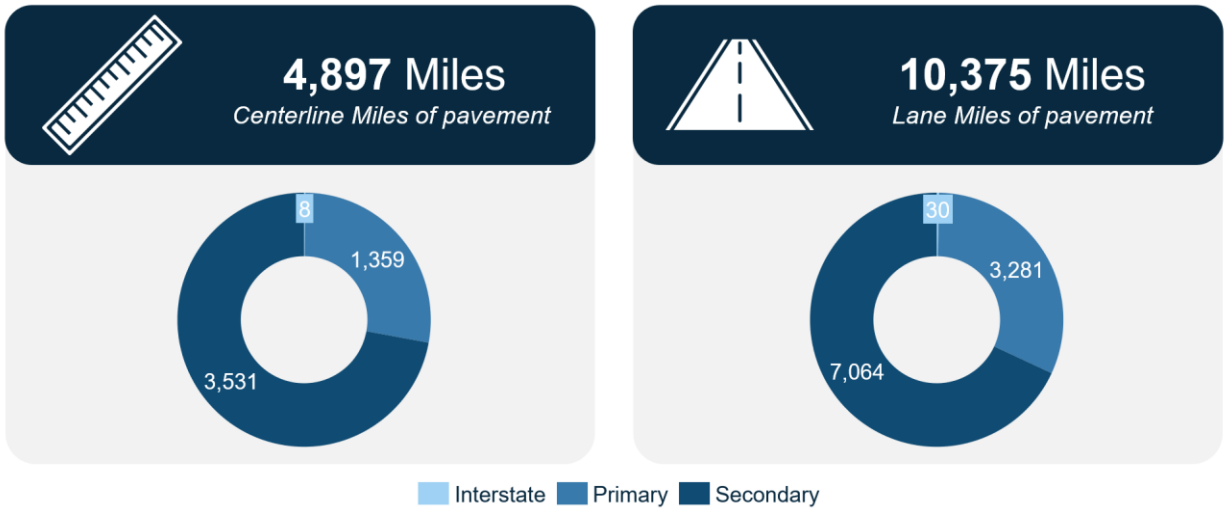
Figure 3 – Projected investment needed (YOE $) to improve route score over 10 years

As shown, maintaining and improving Division 1's Route Score requires greater investment:

- **+0** requires increasing spend to **$192M** by FY34; **$1,701M** in total investment
- **+1** requires increasing spend to **$192M** by FY34; **$1,701M** in total investment
- **+5** requires increasing spend to **$243M** by FY34; **$1,928M** in total investment
- **+10** requires increasing spend to **$262M** by FY34; **$2,009M** in total investment

2 Division Asset Inventory & Condition

2.1 Pavement & Asset Inventory



		Quantity			
Asset	**Unit**	**Interstate**	**Primary**	**Secondary**	**Overall**
Bike Lanes	LFT	0	19,707	211	19,918
Cablerail	MI	0	110	0	110
Concrete Barrier	MI	0	7	0	7
Crosswalk	EA	0	425	208	633
Curb and Gutter	MI	0	164	74	238
Drop Inlets	EA	1	3,333	1,117	4,451
Guardrail	MI	11	154	28	193
Impact Attenuator	EA	0	13	4	17
Induction Loop	EA	0	1,622	408	2,030
Mile marker	EA	20	386	21	427
Noise Wall*	LFT	0	0	0	0
Pavement Striping (defective only)	MI	0	613	1,440	2,054
Pipes[vii]	LFT	439	270,536	94,403	365,378
Retaining Wall*	LFT	0	5,511	5,264	10,776
Road Sign	EA	80	16,663	25,967	42,710
Rumble Strips*	MI	27	452	12	491
Sharrows	EA	0	20	3	23
Shoulder (defective only)	MI	0	22	53	75
Traffic Signal	EA	0	2,827	1,057	3,884
Variable Message Sign	EA	2	21	9	32
Word and Symbols	EA	11	11,800	1,330	13,141

Table 3 – Selection of roadside asset inventory; asterisk indicates no significance to route score

2.2 Pavement Conditions

Using Pavement Condition Survey (PCS) data, shown below is the breakdown of good, fair, and poor lane miles across the interstate, primary, and secondary systems.

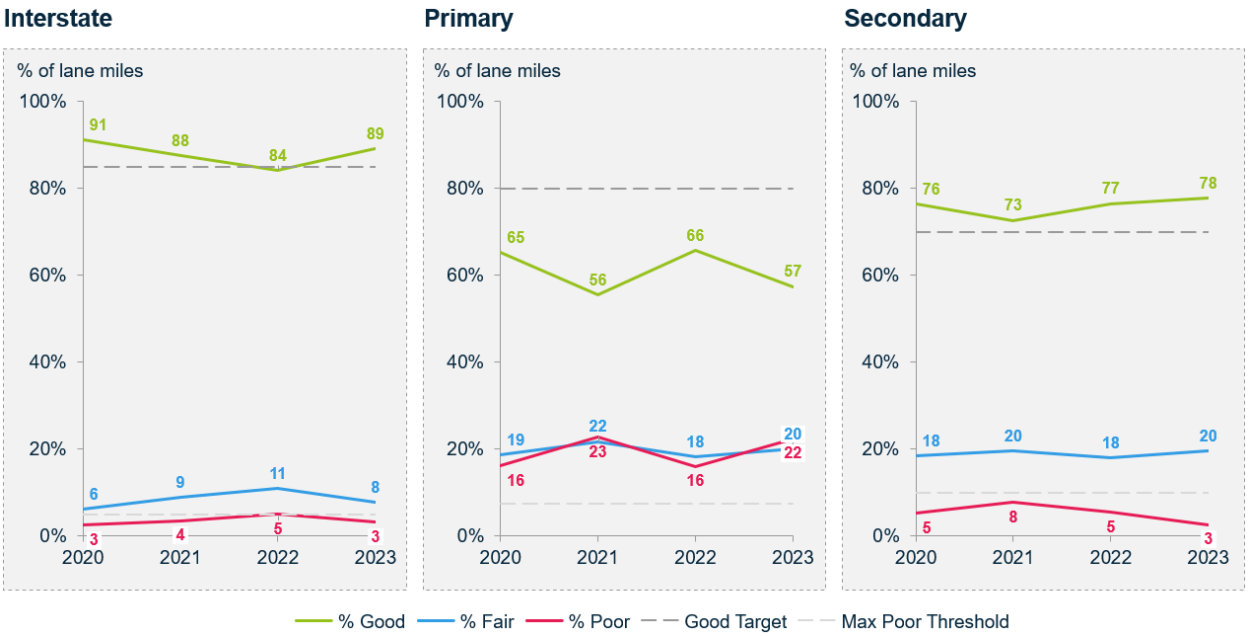


Figure 4 – Pavement conditions across interstate, primary, and secondary systems

Pavement conditions in Division 1 as evaluated via ArTEMIS analysis are below the state average, with a division-wide pavement index of **79**. Condition varies across the division by primary and secondary routes.

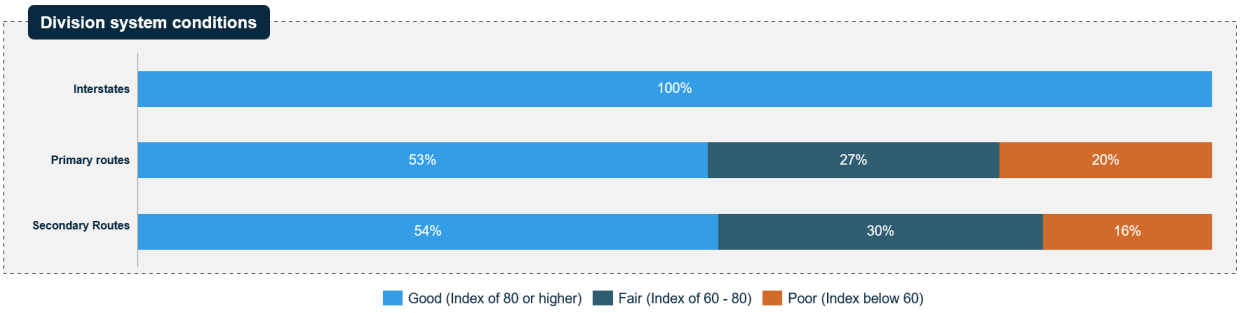


Figure 5.1 – Comparison of lane miles in good, fair, and poor conditions across Division 1

Figure 5.2 – Comparison of lane miles in good, fair, and poor conditions by primary and secondary systems

County pavement index (weighted by lane miles) range from 76 to 87. Deductions are primarily driven by two distresses: (1) alligator cracking and (2) transverse cracking, as seen in figure 6.

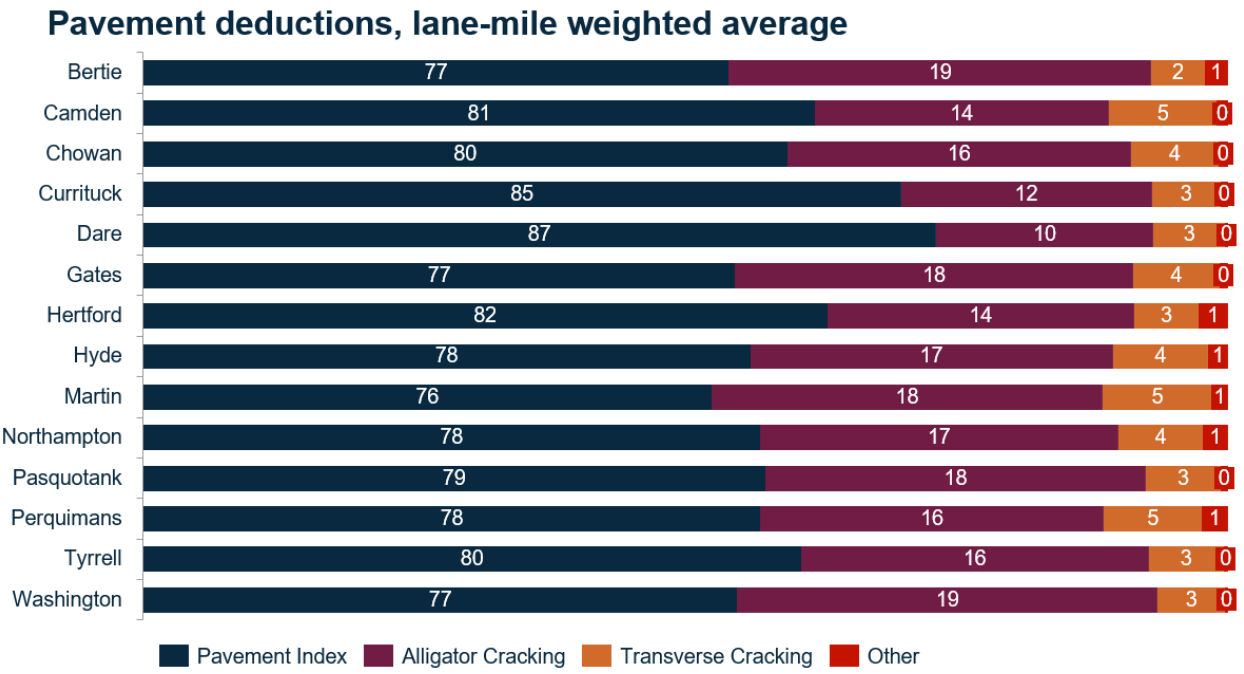


Figure 6 – Pavement index and deduction breakdown by county

Complementary models show similar assessments of pavement condition between the ArTEMIS model and the PCS model for Division 1. The pavement index utilizes the same scoring methodology as the PCS, the only differences being in how the data is collected/reviewed[viii].

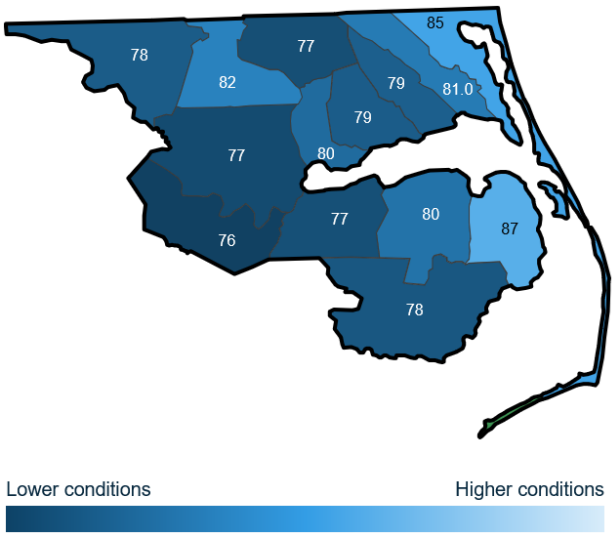


Figure 7 (shown on right) – Pavement index by county

	Condition			
Model	**Interstates**	**Primary**	**Secondary**	**Overall**
Pavement index (ArTEMIS)	99	79	79	79
Pavement condition score (PCS)	100	80	87	85

Table 4 – Condition comparison by pavement models for Division 1

2.3 Bridge Conditions

Bridge conditions are evaluated using a bridge index that translates general condition ratings (i.e., 1-9 scale) into a 100-point scale for easier comparison.

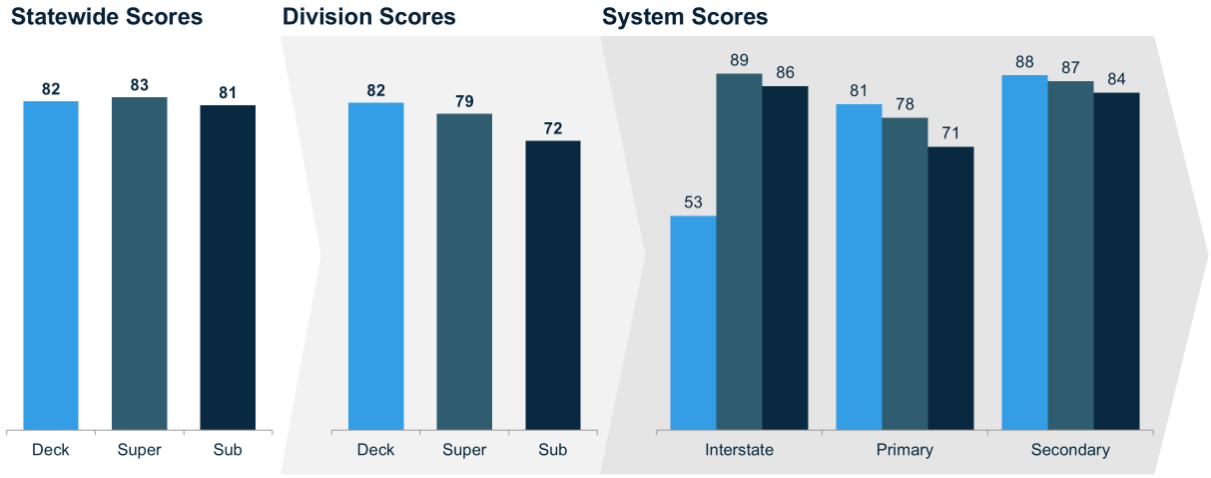


Figure 8.1 – Comparison of bridge deck, substructure, and superstructure conditions by system

Overall, the Division 1 bridge index (76) scores ~6 points lower than statewide bridge index (82).

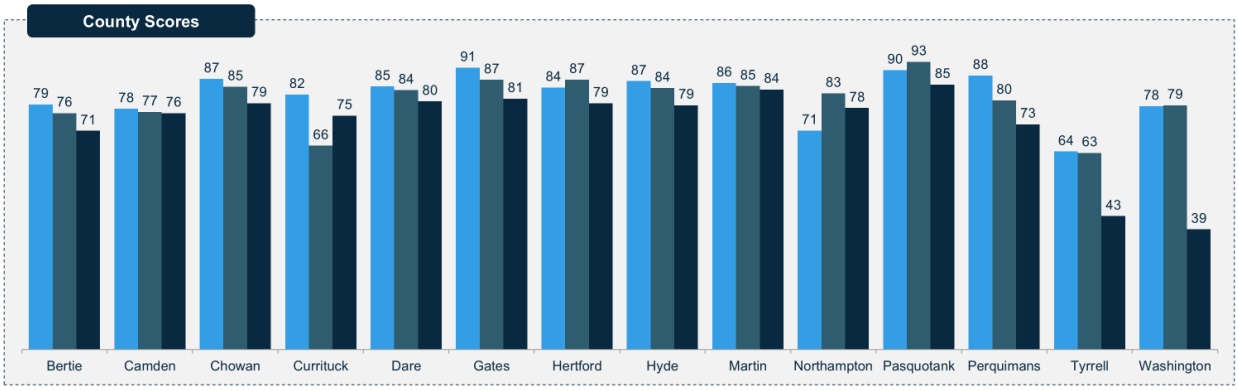


Figure 8.2 – Comparison of bridge deck, substructure, and superstructure conditions by county

The figure on the following page displays all bridges in poor condition (index below 60) or at-risk of becoming poor (index of 60 – 69). They are mostly on the secondary system. Each circle maps one bridge by latitude and longitude; circle size indicates deck area, with at-risk bridges sized uniformly.

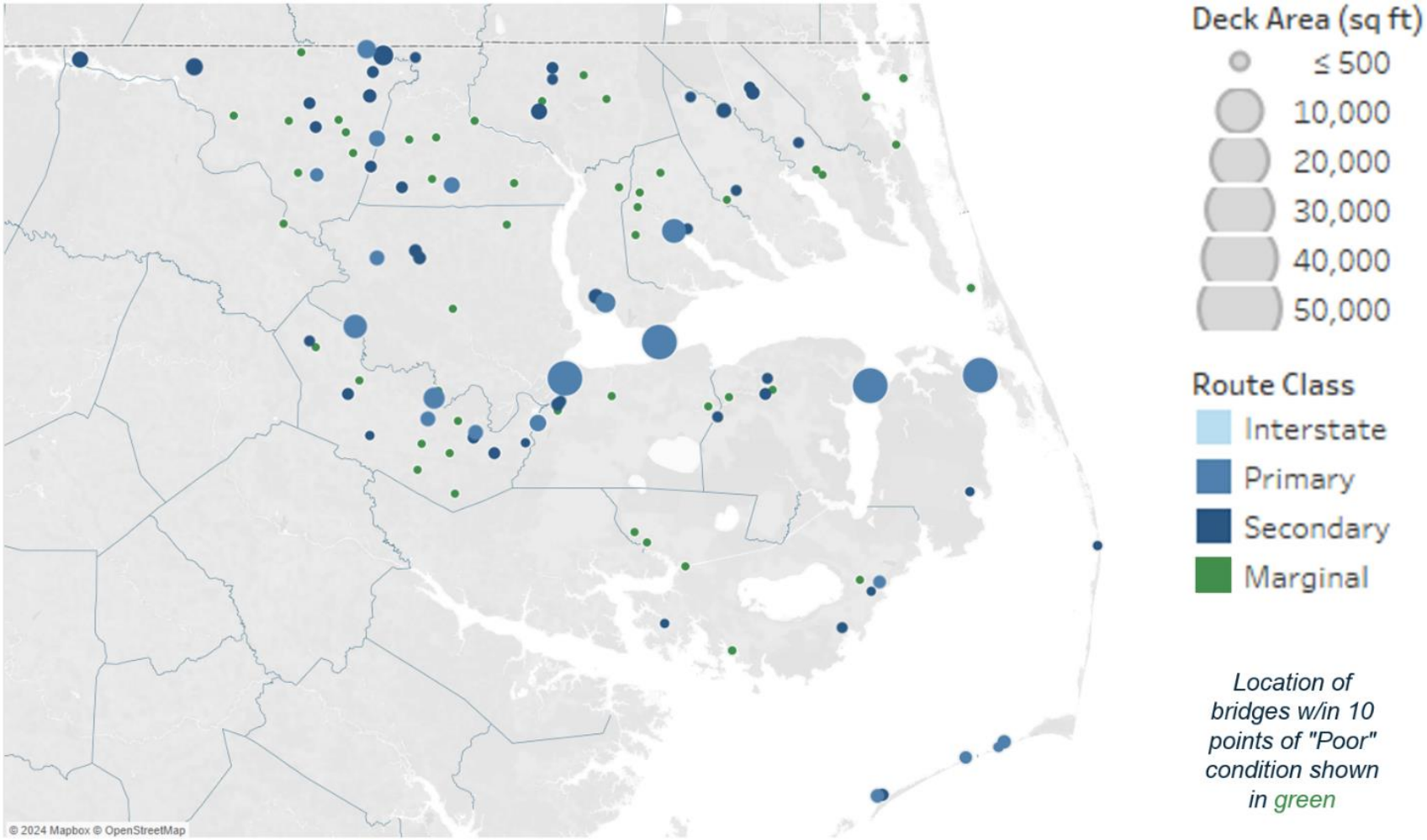


Figure 9 – Distribution of poor bridges and at-risk of becoming poor condition bridges in Division 1

2.4 Roadside Asset Conditions

Roadside asset condition is evaluated by measuring the proportion at which an asset is non-defective in a division, county, or route.

Asset	State	D1	Bertie	Camden	Chowan	Currituck	Dare	Gates	Hertford	Hyde	Martin	Northampton	Pasquotank	Perquimans	Tyrrell	Washington
Striping	89%	87%	89%	86%	88%	92%	93%	83%	84%	86%	87%	84%	90%	87%	85%	87%
Bike Lanes	78%	54%					65%			19%						
Word & Symbols	74%	81%	69%	84%	73%	93%	84%	78%	75%	60%	82%	69%	74%	61%	93%	91%
Sharrows	84%	87%	100%			0%	100%			75%						
Signs	94%	95%	96%	96%	94%	94%	94%	95%	97%	95%	95%	95%	94%	96%	96%	96%
Drop Inlets	89%	93%	97%	100%	97%	98%	89%	99%	87%	100%	85%	95%	97%	90%	91%	81%
Curb & Gutter	96%	95%	95%	99%	93%	97%	98%	93%	90%	75%	94%	94%	96%	96%	97%	96%
Guardrails	98%	99%	99%	99%	97%	99%	100%	100%	99%	99%	99%	98%	98%	99%	99%	99%
Shoulder	98%	99%	100%	99%	99%	99%	97%	99%	99%	100%	99%	99%	99%	99%	100%	100%

Most Defective — Least Defective

Figure 10 – Comparison of conditions between county functional assets [ix]

Below is roadside asset condition visualized with county boundaries, where colors are relative to the average condition across the state, for each respective asset.

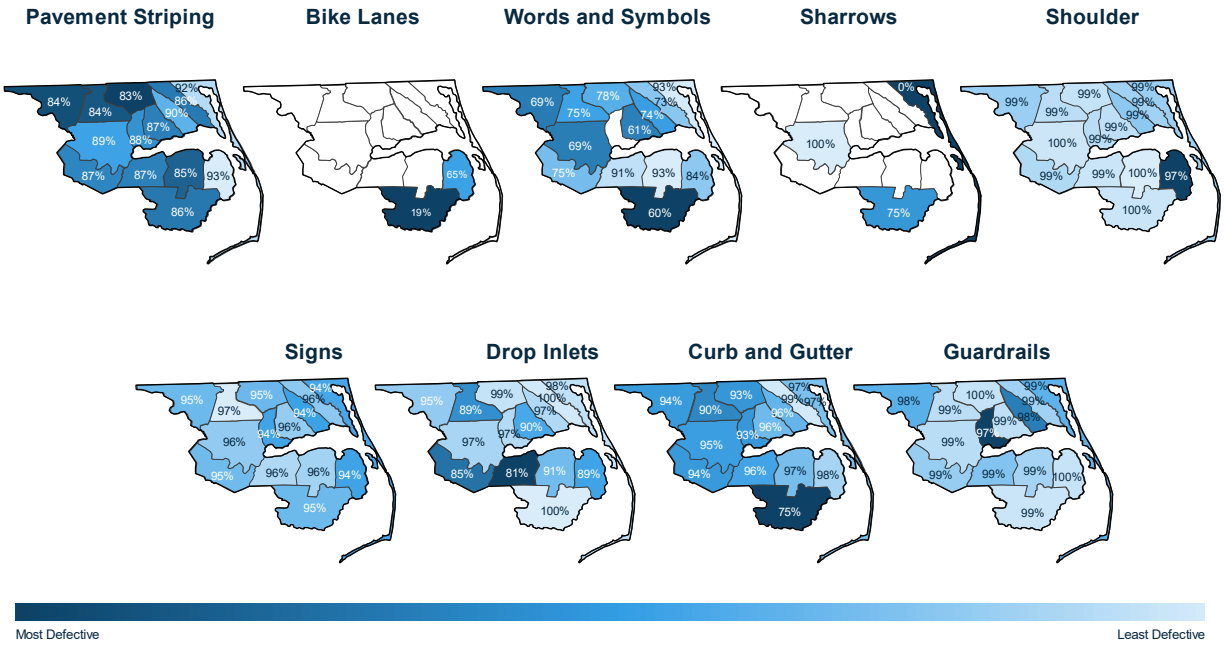


Figure 11 – Comparison of roadside asset conditions mapped to county boundaries

3 Rehabilitation / Rebuilding Needs

To develop a sense of what level of investment is required to ensure our state's ability to provide a safe and effective transportation network into the future, in the summer of 2024 the Director of Highway Operations reached out to all 14 Division Engineers and their teams, asking them to provide details on their highest priority ~35 miles of reconstruction/rehabilitation needs. The submitted sections for Division 1, along with estimated costs, are outlined below ranked in order of priority (as submitted).

Route	County	Comments	Miles	Est. Cost ($M)
US 13-17 NB	Bertie	Future I-87, poor pavement rating	2.18	$55M
US 17 BYP NB	Bertie	Future I-87, HI-0025 (2029), failing OGFC	6.6	$-
US 13-17 SB	Bertie	Future I-87, poor pavement rating	2.01	$-
US 17 BYP SB	Bertie	Future I-87, HI-0025 (2029), failing OGFC	6.79	$203M
US 17	Bertie	Future I-87, 5 lane undivided, poor pavements	4.81	$122M
US 17 NB	Bertie	Future I-87, poor pavement rating	3.14	$67M
US 17 SB	Bertie	Future I-87, poor pavement rating	3.14	$-
US 17 NB	Perquimans	Future I-87, HI-0026 (2029), JCP joint issues	11.95	$257M
US 17 SB	Perquimans	Future I-87, HI-0026 (2029), JCP joint issues	11.96	$-
US 17 NB	Camden	Future I-87, poor pavement rating	9.56	$-
US 17 SB	Camden	Future I-87, pavement issues adjacent to Intracoastal Waterway	9.56	$205M
Total	-	-	**71.7**	**$910M**

Table 5 – Submitted rehabilitation / rebuilding priorities and estimated costs

4 Cost Summary

To inform the model of how conditions translate into maintenance investment needs, should-cost was collected – what should various maintenance activities cost? This is used to estimate costs for the most common maintenance treatments down to the activity level.

Highlighted below are the unique unit costs for assets in Division 1, where activity costs of more common treatments are weighted more heavily than less common treatments for each asset[x].

Weighted average unit costs by Division

Asset	UOM	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14
Bike Lanes	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Cablerail*	LFT	$2	$1	$2	$5	$1	$1	$3	$2	$0	$5	$2	$0	$2	$1
Concrete Barrier*	LFT	$500	$8	$3	$1,350	$16	$15	$3	$182	$163	$182	$6	$42	$25	$50
Pipes	LFT	$267	$379	$315	$479	$273	$275	$327	$462	$296	$378	$395	$90	$256	$345
Crosswalk	EA	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Curb and Gutter*	LFT	$102	$132	$125	$83	$112	$144	$117	$109	$78	$112	$93	$39	$90	$88
Drop Inlets*	EA	$811	$809	$1,363	$460	$974	$714	$865	$788	$830	$1,041	$794	$744	$1,361	$1,297
Guardrail*	LFT	$16	$30	$36	$12	$1	$49	$30	$31	$12	$32	$6	$32	$50	$21
Impact Attenuator*	EA	$2,500	$12,500	$5,000	$8,840	$2,707	$1,925	$17,500	$750	$1,704	$9,250	$2,028	$2,613	$10,250	$3,000
Induction Loop	LFT	$1,381	$726	$2,777	$1,695	$825	$1,358	$748	$1,486	$573	$3,097	$1,322	$2,144	$1,167	$1,308
Mile marker	EA	$129	$171	$172	$135	$440	$268	$168	$276	$285	$164	$427	$137	$143	$192
Pavement Striping*	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Ramp Metering	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Road Sign	EA	$309	$365	$232	$288	$613	$378	$379	$366	$462	$249	$581	$249	$293	$338
Shoulder	SHM	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Timber Rail	LFT	$44	$6	$49	$313	$13	$8	$2	$49	$44	$49	$3	$23	$23	$63
Traffic Signal	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Word and Symbols	LFT	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Crack Seal	LM	$3,103	$4,000	$3,300	$3,409	$6,009	$2,100	$4,366	$4,000	$3,250	$6,000	$7,850	$4,366	$4,366	$5,000
Chip Seal	LM	$21,933	$18,625	$22,750	$17,014	$26,732	$53,875	$22,356	$49,000	$30,925	$17,500	$21,500	$22,902	$33,701	$32,500
Contract Resurfacing*	LM	$120,418	$140,000	$67,500	$96,025	$109,701	$92,500	$213,998	$97,500	$116,150	$185,000	$66,250	$87,184	$88,750	$151,250

Table 6 – Unit cost comparison between Divisions

[i] Condition and inventory data collected via ArTEMIS from January to September 2023; cost data collected from individual divisions and validated in February/March of 2024. Thus, funding scenarios outlined in this document were developed prior the impacts of Hurricane Helene & based on infrastructure condition data collected prior to the storm. As such, they do not account for the additional costs associated with the rehabilitation or reconstruction of infrastructure affected by the storm. Recognizing that rebuilding will entail significant expenses, the current scenarios focus on maintaining the regular operational budget and steady-state upkeep without reallocation of funds.

[ii] For purposes of calculating route score, "Words and Symbols" also includes bike lanes, crosswalks, sharrows.

[iii] When aggregated, route scores are weighted by lane miles and route class.

[iv] Maintenance costs are estimated solely by prioritizing the most efficient and cost-effective maintenance activities in terms of their impact on overall state/division route score, regardless of pre-existing plans, priorities, or ongoing projects.

[v] For these investment scenarios, we assume rates of inflation for labor, material, and equipment costs of 3%, 5%, and 8% respectively, per the 2023Q4 Engineering News-Record Cost Report. Costs for non-maintenance activities are assumed to increase at annual rate of 3%.

[vi] Spend to increase route score views pavement and roadside asset activities, only. Bridge activities that would increase score are currently not included. This may underestimate need when calculating need to improve by 10 pts.

[vii] Pipes are ingested into inventory counts via NCDOT survey

[viii] The pavement index assessment is consistent for every route and captures the entirety of the Division's inventory. At times, the asset detection algorithm powering the pavement index may miss light / moderate rutting.

[ix] Blank cells indicate that the asset type is not present in county and therefore excluded from analysis.

[x] Asterisk denotes predominately contracted activities. Concrete barriers, impact attenuators, guardrails, cable rails, road signs, and pavement markings are typically contracted out in D1. All cost data in this table were provided and validated by engineers from each division. Variations in costs may arise due to several factors, including the frequency of repairs, whether work is performed in-house or contracted out, and the defect severity at which interventions are initiated. For assets where specific cost data were unavailable, the average cost across all divisions was used. Data was collected and validated February - May 2024.

DIVISION 2 INSIGHTS REPORT

This report uses data on inventory, condition, and costs to provide insights at the division, county, and route levels. It identifies long-term investment needs and opportunities across the system to optimize outcomes.[i]

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1 Division Funding Needs

1.1 Data Background

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The 2023 initiative leverages image recognition and AI/ML to assess conditions across 2+ million geo-located assets statewide. By aligning new inventory data with established sources like the Pavement Condition Survey, it enhances accuracy through "Route Scores" at route, county, division, and state levels, which help forecast investment needs. Similar to weather forecasting, aligning multiple datasets strengthens accuracy and reliability.

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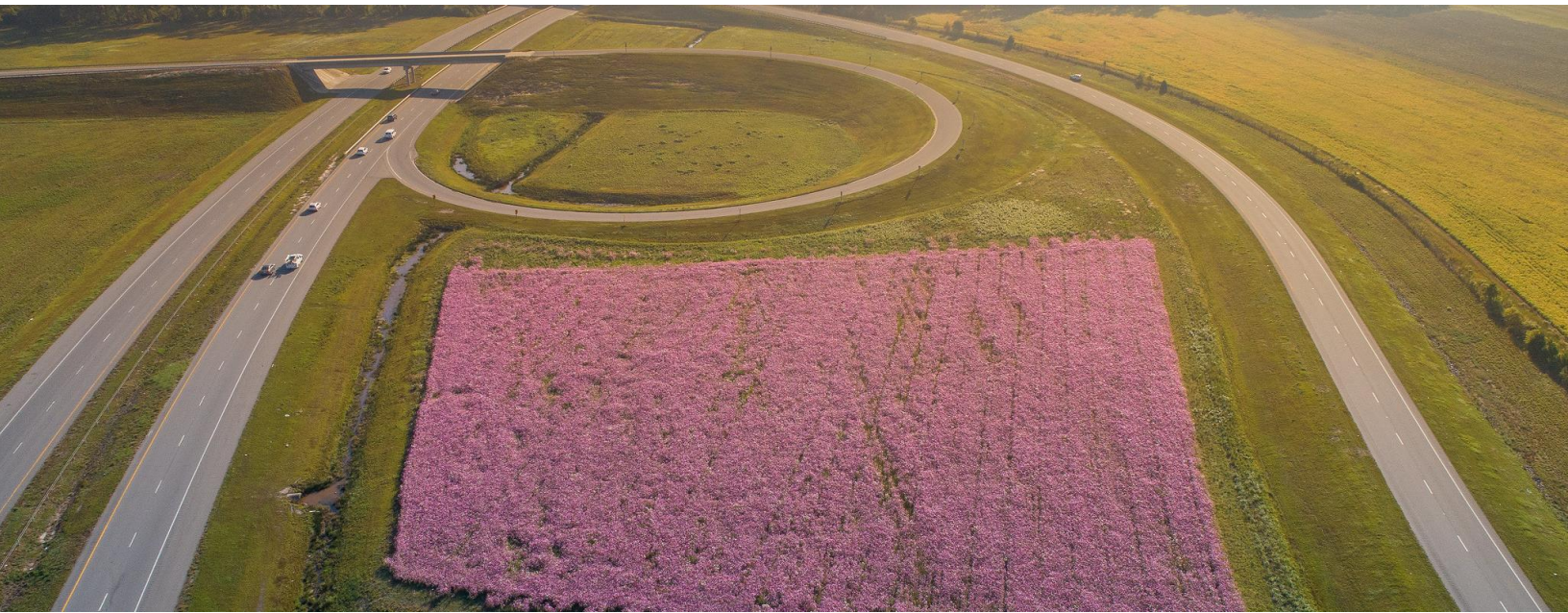

1.2 Route Score Overview

1.2.1 Methodology

The table below shows the asset conditions contributing to Division 2's overall route score and how a route score is assembled at the route level (before being aggregated up by system counties, divisions, etc). The score uses point-in-time data collected January - September 2023.

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Signs	94%	98%
Guardrails and barriers	98%	100%
Words and Symbols[ii]	96%	97%
Traffic devices	100%	100%

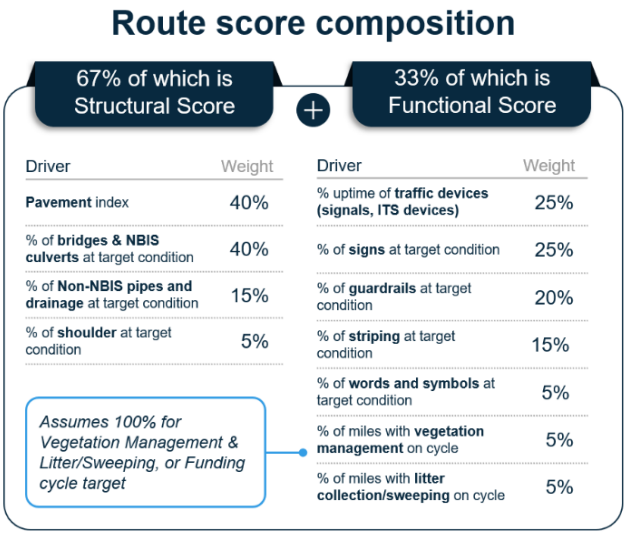
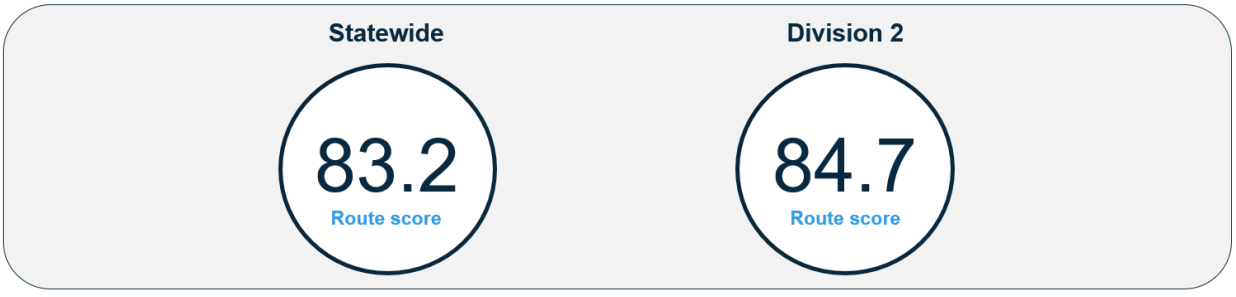


Table 1 – Asset scores (percentage of non-defective units or index score) across State and Division

1.2.2 Most Recent Outcomes

Using the scoring method shown above, the overall conditions of a division's roads can be shown with a single score that takes the weighted[iii] average of all its routes:



Route class	State	Division 2
Interstates	89	89
Primary	83	87
Secondary	82	73

Table 2 – Route scores by class

1.3 Route Score Distribution

The majority of the Division's network consists of routes in good condition, defined by a route score of 80 or higher. Over 7,800 lane miles (73% of network) are considered in good condition.

Conversely, less than 130 lane miles (1% of network) are considered in poor condition, defined by a route score lower than 60. Map 1 shows the condition of routes across the division.

Route score distribution, by lane miles

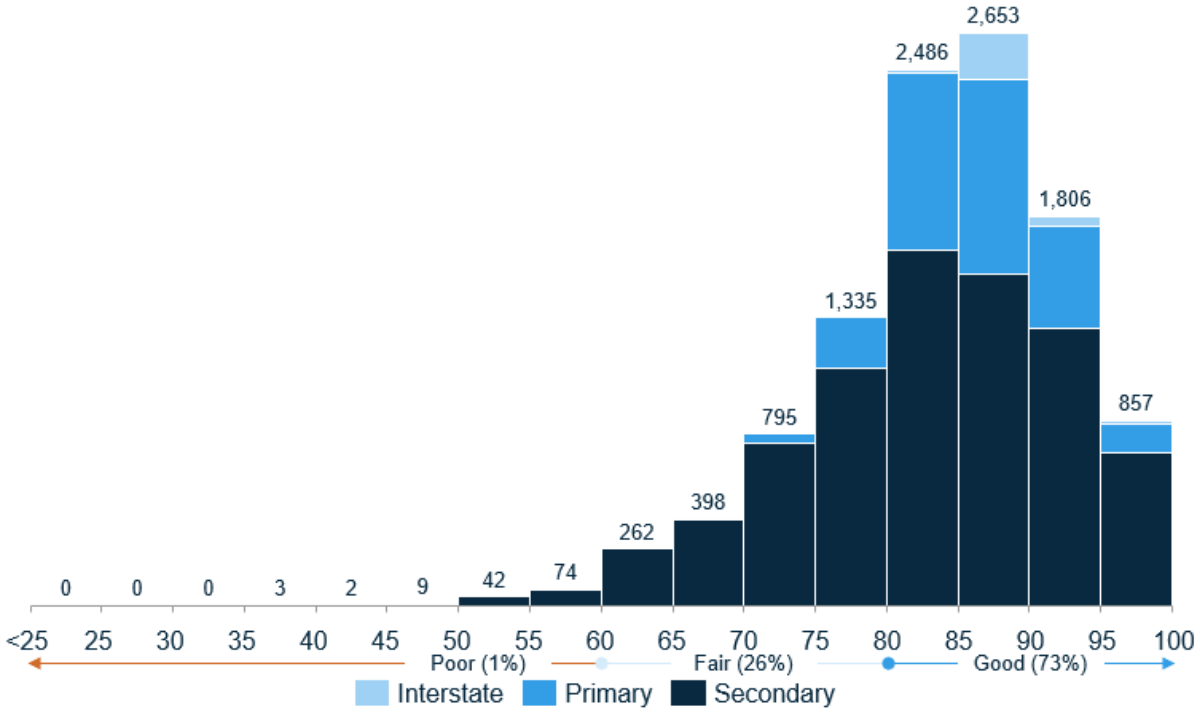
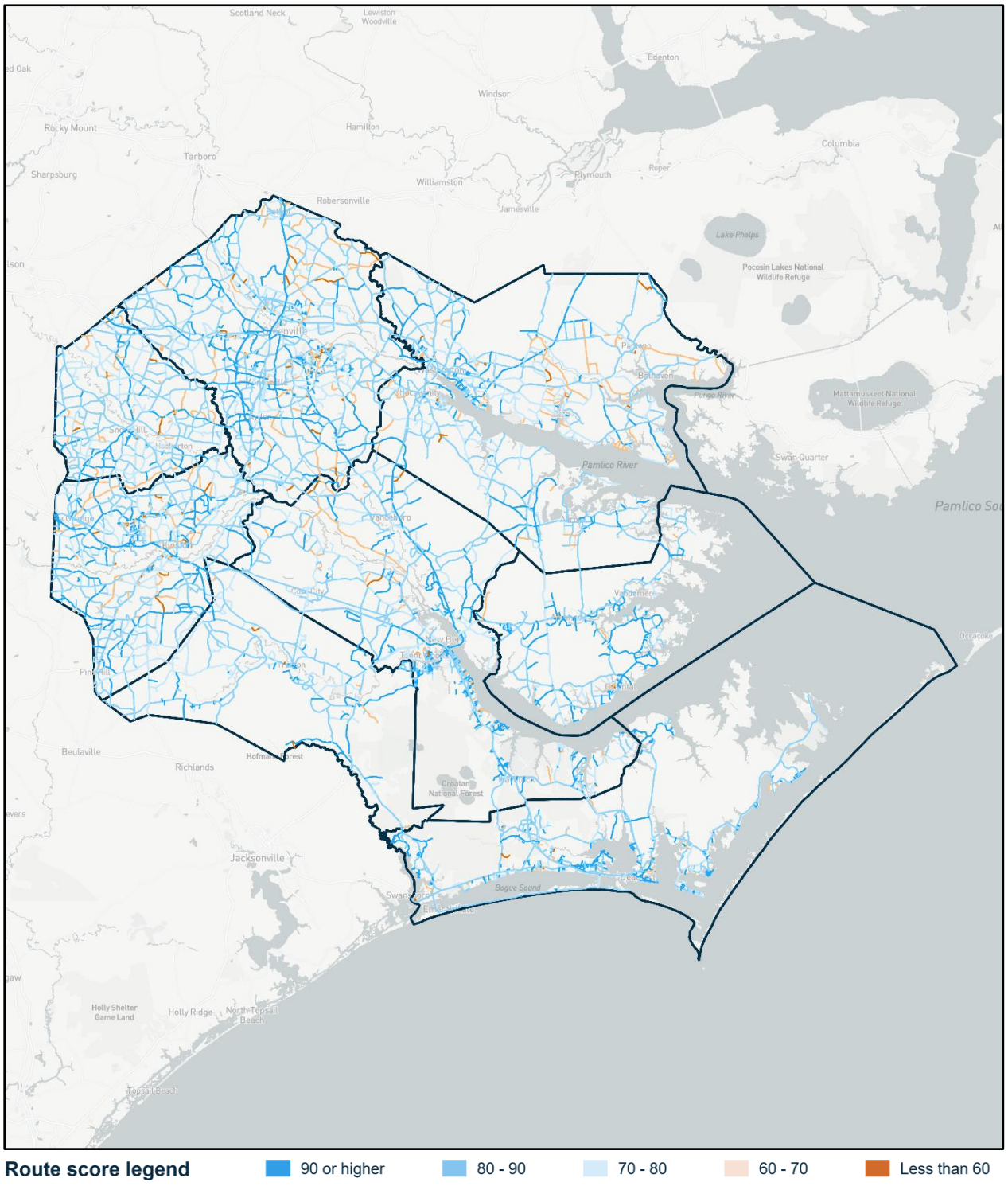


Figure 1 – Distribution of route score, measured in lane miles

Across the road network, the most common route score is between 85 and 90. Interstate and primary routes in Division 2 all have route scores of at least 70, while secondary routes exhibit route scores starting at 35.

These routes can be mapped spatially to evaluate the distribution by geography, as seen on the next page.

Route score distribution, by county



Map 1 – Spatial distribution of route score, grouped by county

1.4 Impact of static funding

Route Score is used to estimate the investment needed[iv] to maintain or achieve various condition levels over the next 10 years, assuming expected inflation[v] and asset deterioration.

Maintaining this division's current condition will require a year-over-year increase in funding, due to inflation and regular wear-and-tear. Static funding may be sufficient to maintain Division 2's route score in the next year but will lead to a decline of **-3.4** points in the following year and will potentially lower it by at least **-7.0** points over the next decade.

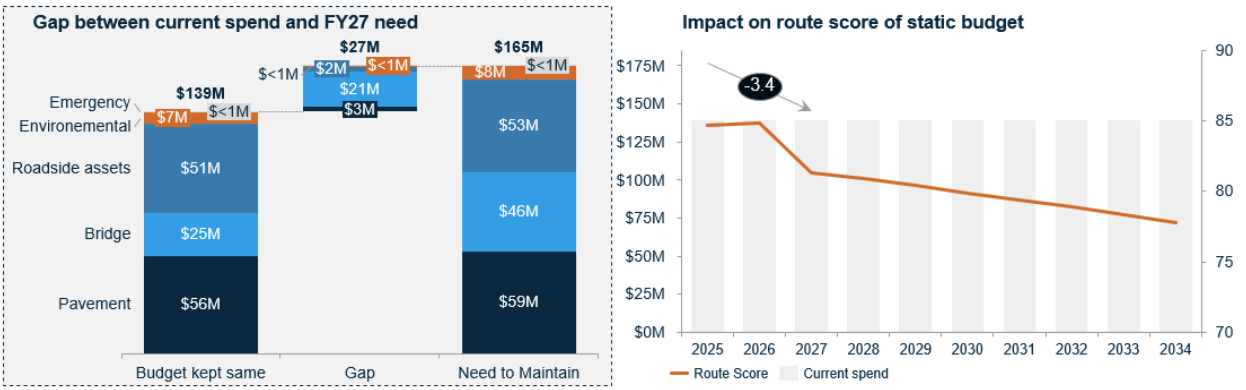


Figure 2 – Comparison of current spend and expected need; route score over time if no budget increase

1.5 Investment needs over the next 10 years

Using the Route Score, ArTEMIS can quantify investment needed to maintain or improve condition by raising the route score by zero points (maintain conditions), one point (slight improvement), five points (large improvement), and ten points (near-perfect conditions)[vi].

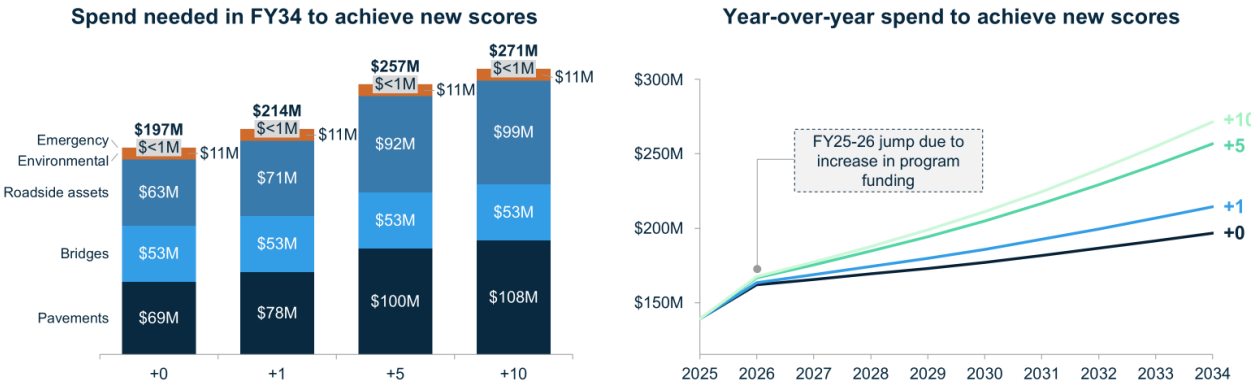


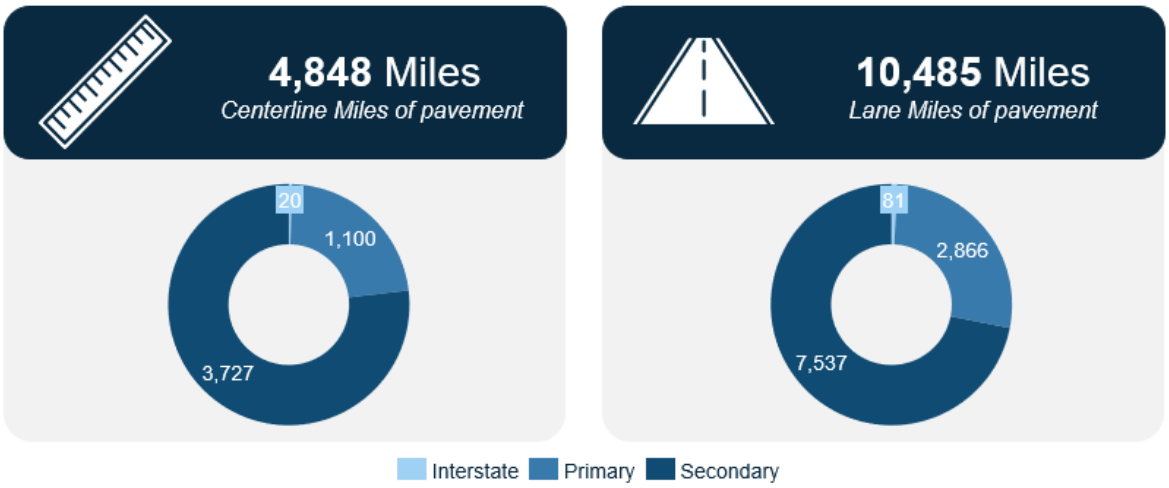
Figure 3 – Projected investment needed (YOE $) to improve route score over 10 years

As shown, maintaining and improving Division 2's Route Score requires greater investment:

- **+0** requires increasing spend to **$197M** by FY34; **$1,741M** in total investment
- **+1** requires increasing spend to **$214M** by FY34; **$1,823M** in total investment
- **+5** requires increasing spend to **$257M** by FY34; **$2,009M** in total investment
- **+10** requires increasing spend to **$271M** by FY34; **$2,071M** in total investment

2 Division Asset Inventory & Condition

2.1 Pavement & Asset Inventory



		Quantity			
Asset	**Unit**	**Interstate**	**Primary**	**Secondary**	**Overall**
Bike Lanes	LFT	0	33,970	19,121	53,091
Cablerail	MI	34	40	10	84
Concrete Barrier	MI	0.1	4.9	1	5
Crosswalk	EA	0	172	116	288
Curb and Gutter	MI	25	211	177	413
Drop Inlets	EA	451	3,164	2,962	6,577
Guardrail	MI	0	108	39	147
Impact Attenuator	EA	0	20	3	23
Induction Loop	EA	0	1,001	865	1,866
Mile marker	EA	83	221	15	319
Noise Wall*	LFT	0	6,917	796	7,712
Pavement Striping (defective only)	MI	24	269	1,580	1,873
Pipes[vii]	LFT	58,337	302,394	144,735	505,466
Retaining Wall*	LFT	0	2,148	0	2,148
Road Sign	EA	1,618	18,292	31,854	51,764
Rumble Strips*	MI	0	592	31	623
Sharrows	EA	0	77	59	136
Shoulder (defective only)	MI	1.3	13.7	43	58
Traffic Signal	EA	0	3,456	2,301	5,757
Variable Message Sign	EA	0	20	10	30
Word and Symbols	EA	1,952	11,500	5,354	18,806

Table 3 – Selection of roadside asset inventory; asterisk indicates no significance to route score

2.2 Pavement Conditions

Using Pavement Condition Survey (PCS) data, shown below is the breakdown of good, fair, and poor lane miles across the primary and secondary systems.

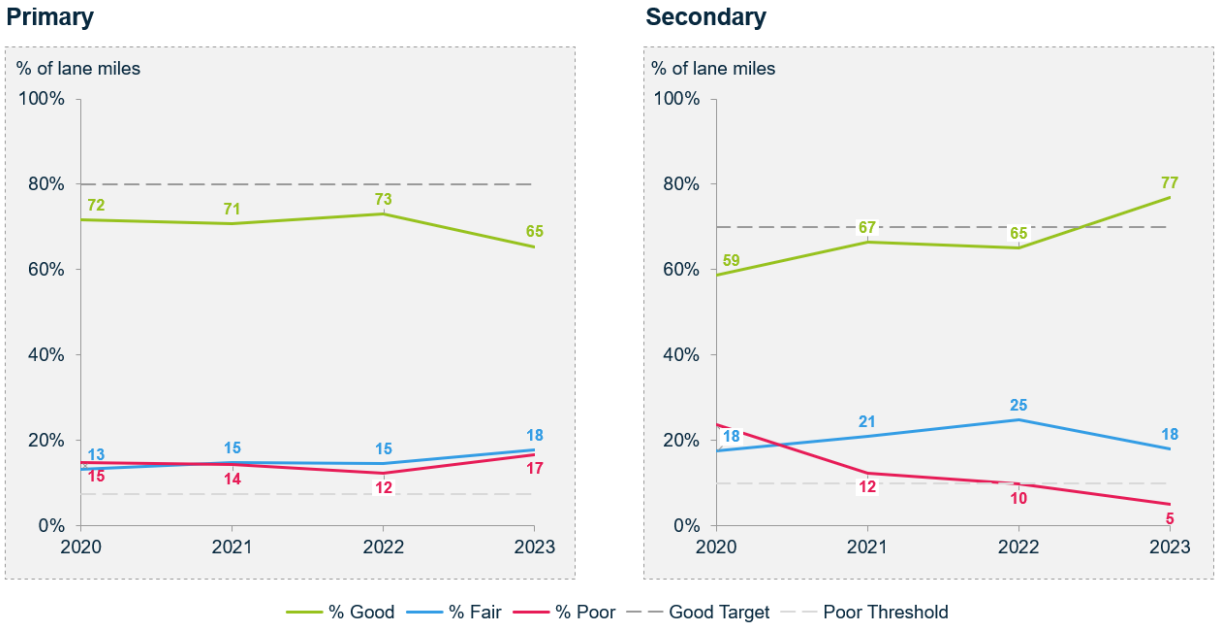


Figure 4 – Pavement conditions across primary, secondary systems

Pavement conditions in Division 2 as evaluated via ArTEMIS analysis are below the state average, with a division-wide pavement index of **81**. Condition varies across the division by primary and secondary routes.

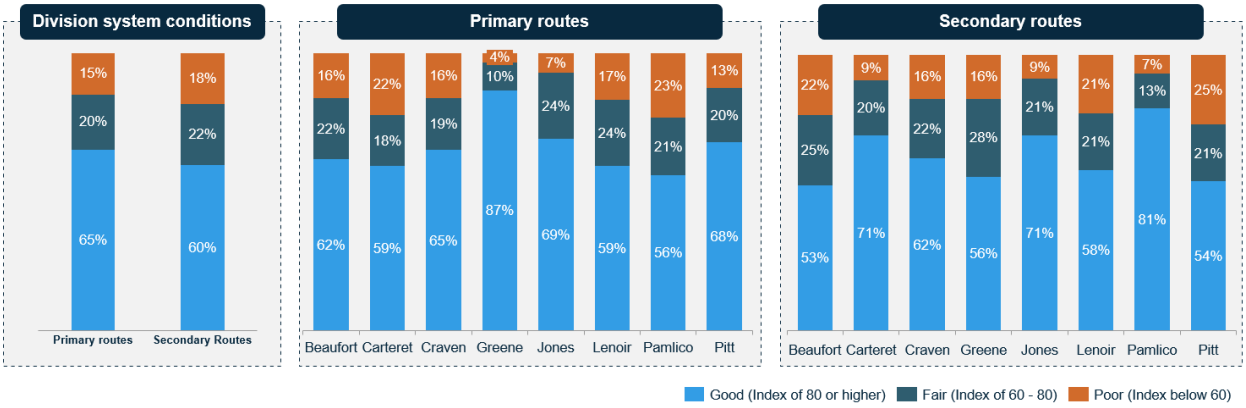


Figure 5 – Comparison of lane miles in good, fair, and poor conditions

County pavement index (weighted by lane miles) range **from 79 to 87**. Deductions are primarily driven by two distresses: (1) alligator cracking and (2) transverse cracking.

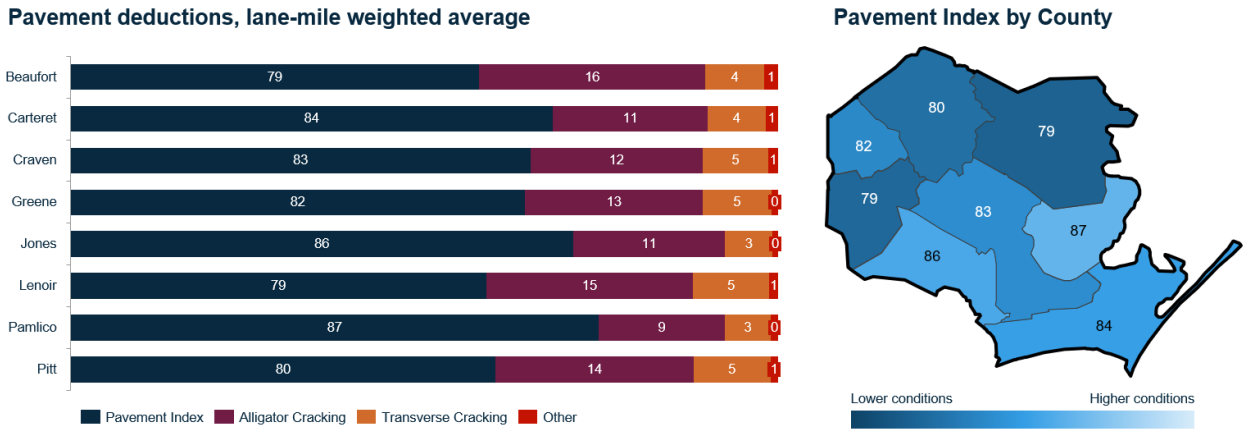


Figure 6 – Pavement index and deduction breakdown by county

Complementary models show similar assessments of pavement condition between the ArTEMIS model and the PCS model for Division 2. The pavement index utilizes the same scoring methodology as the PCS, the only differences being in how the data is collected/reviewed[viii].

	Condition			
Model	**Interstates**	**Primary**	**Secondary**	**Overall**
Pavement index (ArTEMIS)	87	84	80	81
Pavement condition score (PCS)	83	83	86	85

Table 4 – Condition comparison by pavement models for Division 2

2.3 Bridge Conditions

Bridge conditions are evaluated using a bridge index that translates general condition ratings (i.e., 1-9 scale) into a 100-point scale for easier comparison.

Overall, the Division 2 bridge index (82) scores on par with statewide bridge index (82).

Data is ingested from FHWA bridge portal.

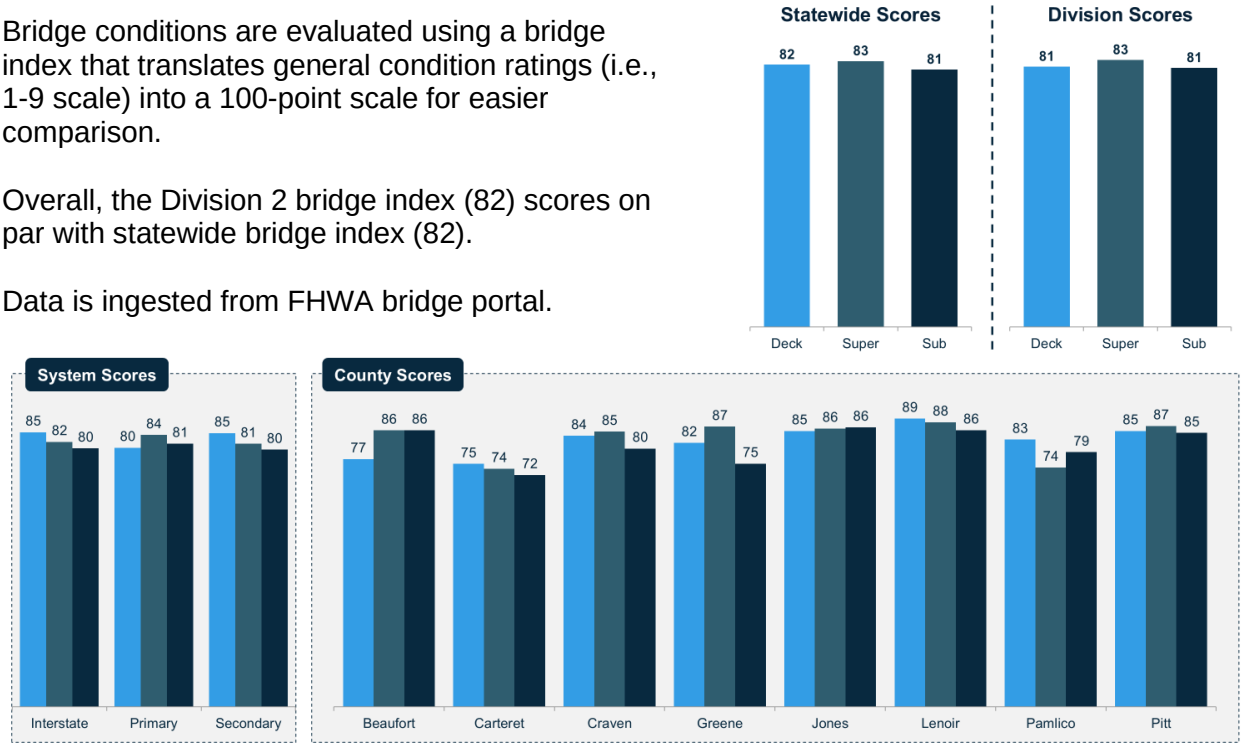


Figure 7 – Comparison of bridge conditions

The figure below displays all bridges in poor condition (index below 60) or at-risk of becoming poor (index of 60 – 69). They are mostly on the secondary system. Each circle maps one bridge by latitude and longitude; circle size indicates deck area, with at-risk bridges sized uniformly.

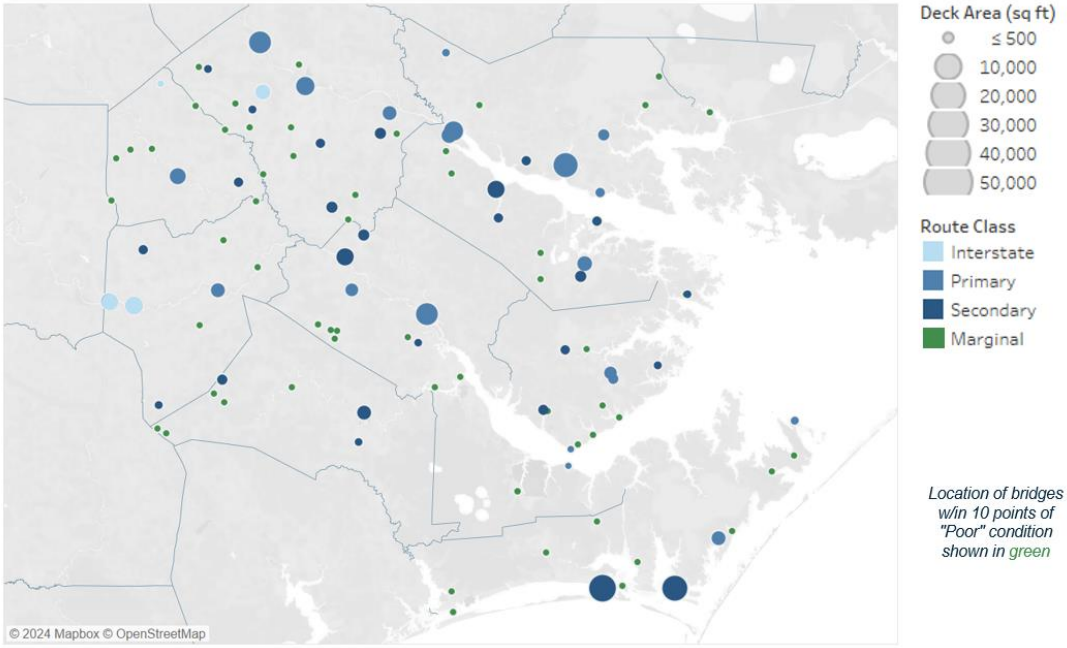


Figure 8 – Distribution of poor bridges and at-risk of becoming poor condition bridges in Division 2

2.4 Roadside Asset Conditions

Roadside asset condition is evaluated by measuring the proportion at which an asset is non-defective in a division, county, or route.

Asset	State	D2	Beaufort	Carteret	Craven	Greene	Jones	Lenoir	Pamlico	Pitt
Pavement Striping	89%	88%	86%	93%	86%	88%	87%	89%	92%	89%
Bike Lanes	78%	77%	98%		39%		100%			99%
Word and Symbols	74%	72%	81%	59%	64%	92%	84%	77%	41%	79%
Sharrows	84%	93%	100%	100%	100%		100%	100%		76%
Signs	94%	98%	99%	99%	99%	98%	99%	98%	98%	98%
Drop Inlets	89%	87%	88%	91%	82%	84%	93%	79%	88%	91%
Curb and Gutter	96%	98%	99%	99%	97%	98%	98%	96%	99%	98%
Guardrails	98%	100%	100%	99%	99%	100%	100%	99%	99%	100%
Shoulder	98%	99%	100%	99%	99%	100%	99%	99%	100%	99%

Most Defective — Least Defective

Figure 9 – Comparison of conditions between county functional assets [ix]

Below is roadside asset condition visualized with county boundaries, where colors are relative to the average condition across the state, for each respective asset.

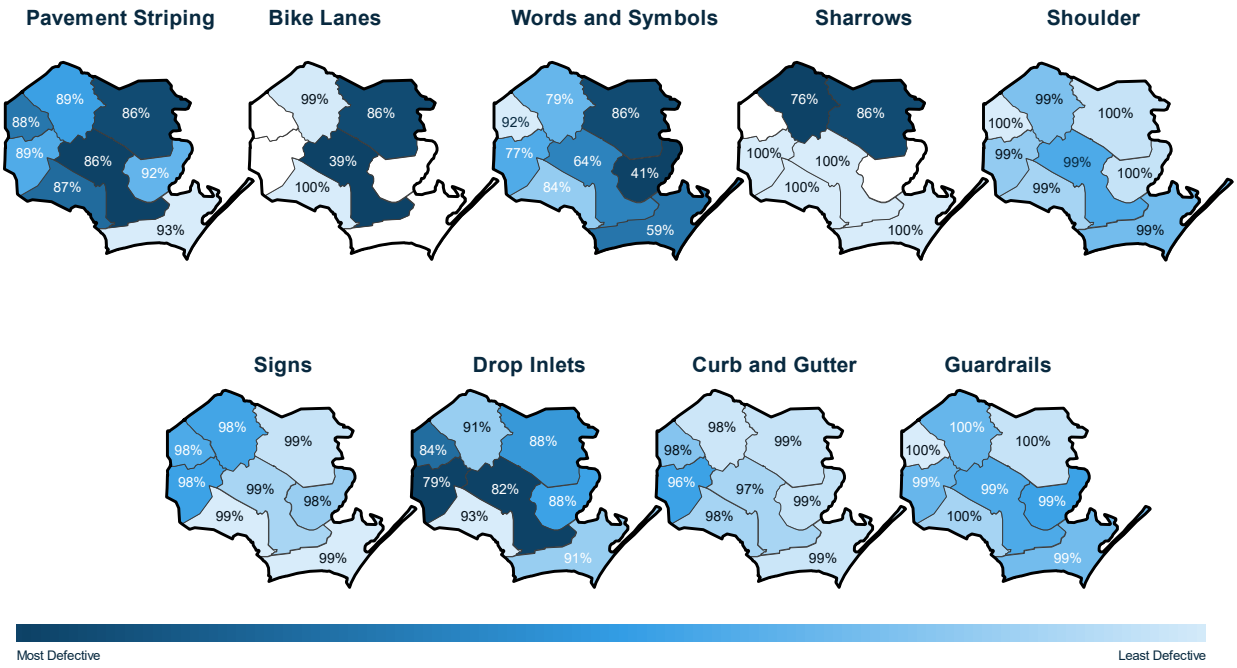


Figure 10 – Comparison of roadside asset conditions mapped to county boundaries

3 Rehabilitation / Rebuilding Needs

To develop a sense of what level of investment is required to ensure our state's ability to provide a safe and effective transportation network into the future, in the summer of 2024 the Director of Highway Operations reached out to all 14 Division Engineers and their teams, asking them to provide details on their highest priority ~35 miles of reconstruction/rehabilitation needs. The submitted sections for Division 2, along with estimated costs, are outlined below ranked in order of priority (as submitted).

Route	County	Comments	Miles	Est. Cost ($M)
US 70E	Lenoir	Upgrade to Interstate Standards	1.99	$100M
US 70W	Lenoir	Upgrade to Interstate Standards	1.99	$-
NC 903	Lenoir	Widen for additional lane width and paved shoulder with ditch relocation	9.95	$115M
US 70	Carteret	Widen for additional lane width and paved shoulder	20.82	$242M
US 70	Carteret	Widen for additional lane width and paved shoulder	2.40	$28M
NC 12	Carteret	Widen for additional lane width and paved shoulder	11.83	$-
Total	-	-	**49**	**$485M**

Table 5 – Submitted rehabilitation / rebuilding priorities and estimated costs

4 Cost Summary

To inform the model of how conditions translate into maintenance investment needs, should-cost was collected – what should various maintenance activities cost? This is used to estimate costs for the most common maintenance treatments down to the activity level.

Highlighted below are the unique unit costs for assets in Division 2, where activity costs of more common treatments are weighted more heavily than less common treatments for each asset[x].

Weighted average unit costs by Division

Asset	UOM	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14
Bike Lanes	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Cablerail*	LFT	$2	$1	$2	$5	$1	$1	$3	$2	$0	$5	$2	$0	$2	$1
Concrete Barrier*	LFT	$500	$8	$3	$1,350	$16	$15	$3	$182	$163	$182	$6	$42	$25	$50
Pipes	LFT	$267	$379	$315	$479	$273	$275	$327	$462	$296	$378	$395	$90	$256	$345
Crosswalk	EA	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Curb and Gutter*	LFT	$102	$132	$125	$83	$112	$144	$117	$109	$78	$112	$93	$39	$90	$88
Drop Inlets*	EA	$811	$809	$1,363	$460	$974	$714	$865	$788	$830	$1,041	$794	$744	$1,361	$1,297
Guardrail*	LFT	$16	$30	$36	$12	$1	$49	$30	$31	$12	$32	$6	$32	$50	$21
Impact Attenuator*	EA	$2,500	$12,500	$5,000	$8,840	$2,707	$1,925	$17,500	$750	$1,704	$9,250	$2,028	$2,613	$10,250	$3,000
Induction Loop	LFT	$1,381	$726	$2,777	$1,695	$825	$1,358	$748	$1,486	$573	$3,097	$1,322	$2,144	$1,167	$1,308
Mile marker	EA	$129	$171	$172	$135	$440	$268	$168	$276	$285	$164	$427	$137	$143	$192
Pavement Striping*	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Ramp Metering	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Road Sign	EA	$309	$365	$232	$288	$613	$378	$379	$366	$462	$249	$581	$249	$293	$338
Shoulder	SHM	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Timber Rail	LFT	$44	$6	$49	$313	$13	$8	$2	$49	$44	$49	$3	$23	$23	$63
Traffic Signal	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Word and Symbols	LFT	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Crack Seal	LM	$3,103	$4,000	$3,300	$3,409	$6,009	$2,100	$4,366	$4,000	$3,250	$6,000	$7,850	$4,366	$4,366	$5,000
Chip Seal	LM	$21,933	$18,625	$22,750	$17,014	$26,732	$53,875	$22,356	$49,000	$30,925	$17,500	$21,500	$22,902	$33,701	$32,500
Contract Resurfacing*	LM	$120,418	$140,000	$67,500	$96,025	$109,701	$92,500	$213,998	$97,500	$116,150	$185,000	$66,250	$87,184	$88,750	$151,250

Table 6 – Unit cost comparison between Divisions

[i] Condition and inventory data collected via ArTEMIS from January to September 2023; cost data collected from individual divisions and validated in February/March of 2024. Thus, funding scenarios outlined in this document were developed prior the impacts of Hurricane Helene & based on infrastructure condition data collected prior to the storm. As such, they do not account for the additional costs associated with the rehabilitation or reconstruction of infrastructure affected by the storm. Recognizing that rebuilding will entail significant expenses, the current scenarios focus on maintaining the regular operational budget and steady-state upkeep without reallocation of funds.

[ii] For purposes of calculating route score, "Words and Symbols" also includes bike lanes, crosswalks, sharrows.

[iii] When aggregated, route scores are weighted by lane miles and route class.

[iv] Maintenance costs are estimated solely by prioritizing the most efficient and cost-effective maintenance activities in terms of their impact on overall state/division route score, regardless of pre-existing plans, priorities, or ongoing projects.

[v] For these investment scenarios, we assume rates of inflation for labor, material, and equipment costs of 3%, 5%, and 8% respectively, per the 2023Q4 Engineering News-Record Cost Report. Costs for non-maintenance activities are assumed to increase at annual rate of 3%.

[vi] Spend to increase route score views pavement and roadside asset activities, only. Bridge activities that would increase score are currently not included. This may underestimate need when calculating need to improve by 10 pts.

[vii] Pipes are ingested into inventory counts via NCDOT survey

[viii] The pavement index assessment is consistent for every route and captures the entirety of the Division's inventory. At times, the asset detection algorithm powering the pavement index may miss light / moderate rutting.

[ix] Blank cells indicate that the asset type is not present in county and therefore excluded from analysis.

[x] Asterisk denotes predominately contracted activities. Cable rails, pavement markings, guardrails, impact attenuators, curb and gutter, variable message signs, and road signs are typically contracted out in D2. All cost data in this table were provided and validated by engineers from each division. Variations in costs may arise due to several factors, including the frequency of repairs, whether work is performed in-house or contracted out, and the defect severity at which interventions are initiated. For assets where specific cost data were unavailable, the average cost across all divisions was used. Data was collected and validated February - May 2024.

DIVISION 3 INSIGHTS REPORT

This report uses data on inventory, condition, and costs to provide insights at the division, county, and route levels. It identifies long-term investment needs and opportunities across the system to optimize outcomes.[i]

1 Division Funding Needs 29

2 Division Asset Inventory & Condition 34

3 Rehabilitation / Rebuilding Needs..... 39

4 Cost Summary 40

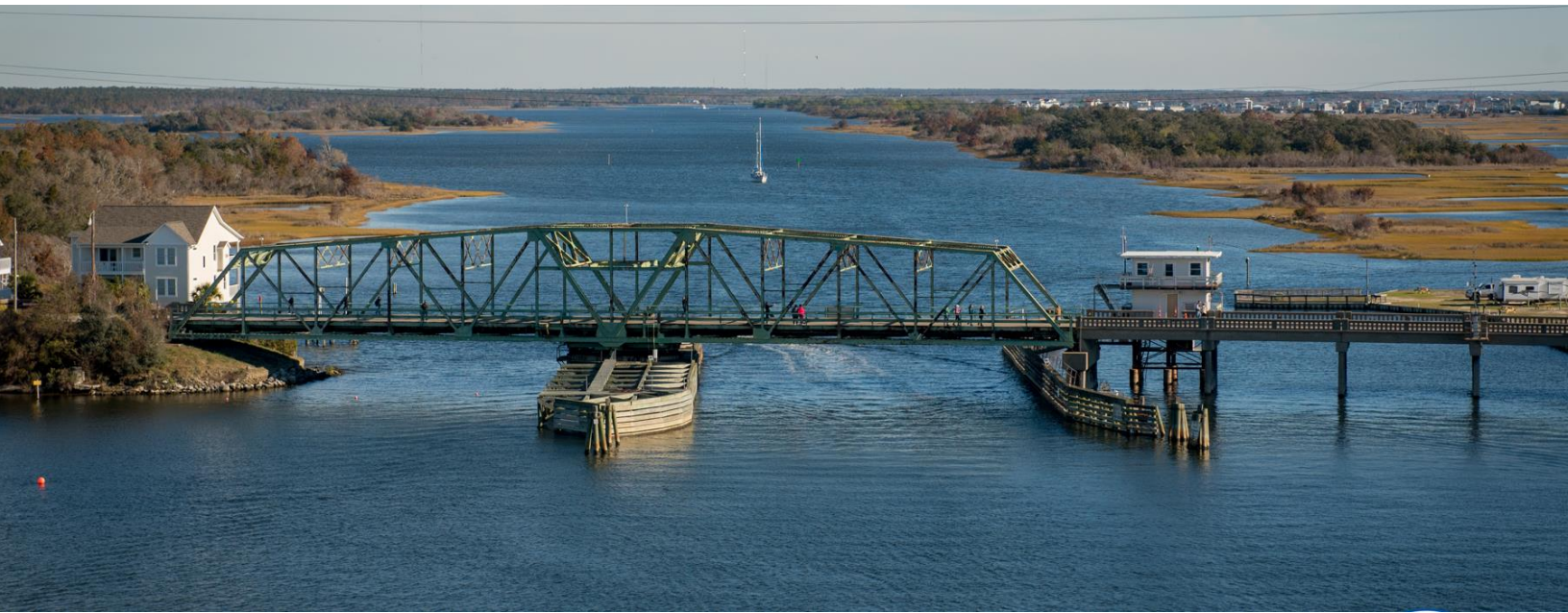
1 Division Funding Needs

1.1 Data Background

Launched in 2020, ArTEMIS initially tracked 30+ discrete maintenance functions on state-managed routes. Since then, it has expanded to capture a "fence-to-fence" view of assets, activity-based costs, and lifecycle investment forecasting, enabling more precise, data-driven maintenance planning.

The 2023 initiative leverages image recognition and AI/ML to assess conditions across 2+ million geo-located assets statewide. By aligning new inventory data with established sources like the Pavement Condition Survey, it enhances accuracy through "Route Scores" at route, county, division, and state levels, which help forecast investment needs. Similar to weather forecasting, aligning multiple datasets strengthens accuracy and reliability.

Statewide data collected and validated from January to September 2023 includes image collection, route walkthroughs, inspections, and quality reviews. These, alongside activity-based “should-cost” estimates—based on current market and industry standards—inform the Total Cost of Ownership model, supporting comprehensive maintenance planning.



1.2 Route Score Overview

1.2.1 Methodology

The table below shows the asset conditions contributing to Division 3's overall route score and how a route score is assembled at the route level (before being aggregated up by system counties, divisions, etc). The score uses point-in-time data collected January - September 2023.

Asset	State	Division 3
Pavement Index	83	80
Bridge Index	82	84
Shoulder	98%	99%
Pipes	82%	80%
Drop Inlets	89%	89%
Curb and Gutter	96%	98%
Pavement Striping	89%	88%
Signs	94%	93%
Guardrails and barriers	98%	99%
Words and Symbols[ii]	96%	96%
Traffic devices	100%	100%

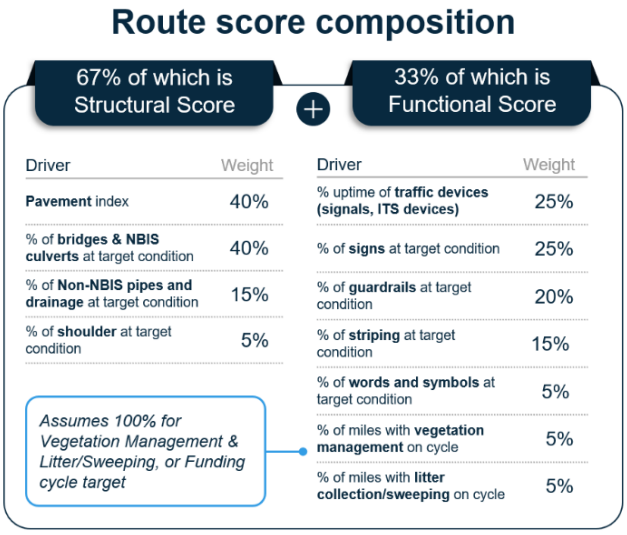
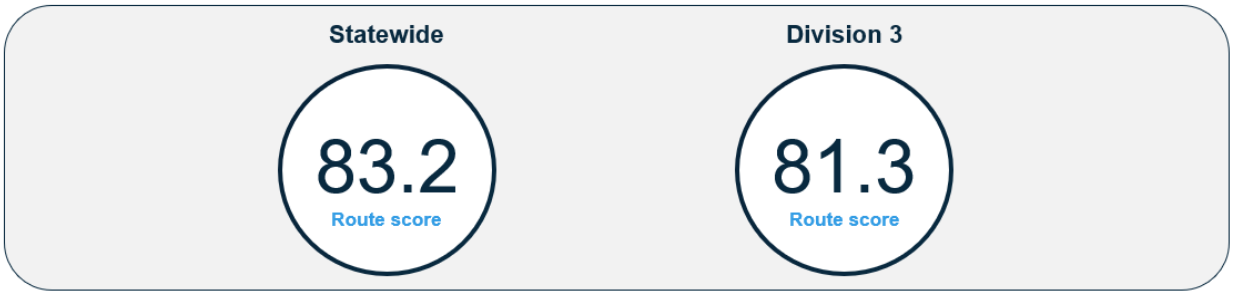


Table 1 – Asset scores (percentage of non-defective units or index score) across State and Division

1.2.2 Most Recent Outcomes

Using the scoring method shown above, the overall conditions of a division's roads can be shown with a single score that takes the weighted[iii] average of all its routes:



Route class	State	Division 3
Interstates	89	91
Primary	83	83
Secondary	82	79

Table 2 – Route scores by class

1.3 Route Score Distribution

The majority of the Division's network consists of routes in good condition, defined by a route score of 80 or higher. Over 6,700 lane miles (55% of network) are considered in good condition.

Conversely, less than 700 lane miles (5% of network) are considered in poor condition, defined by a route score lower than 60. Map 1 shows the condition of routes across the division.

Route score distribution, by lane miles

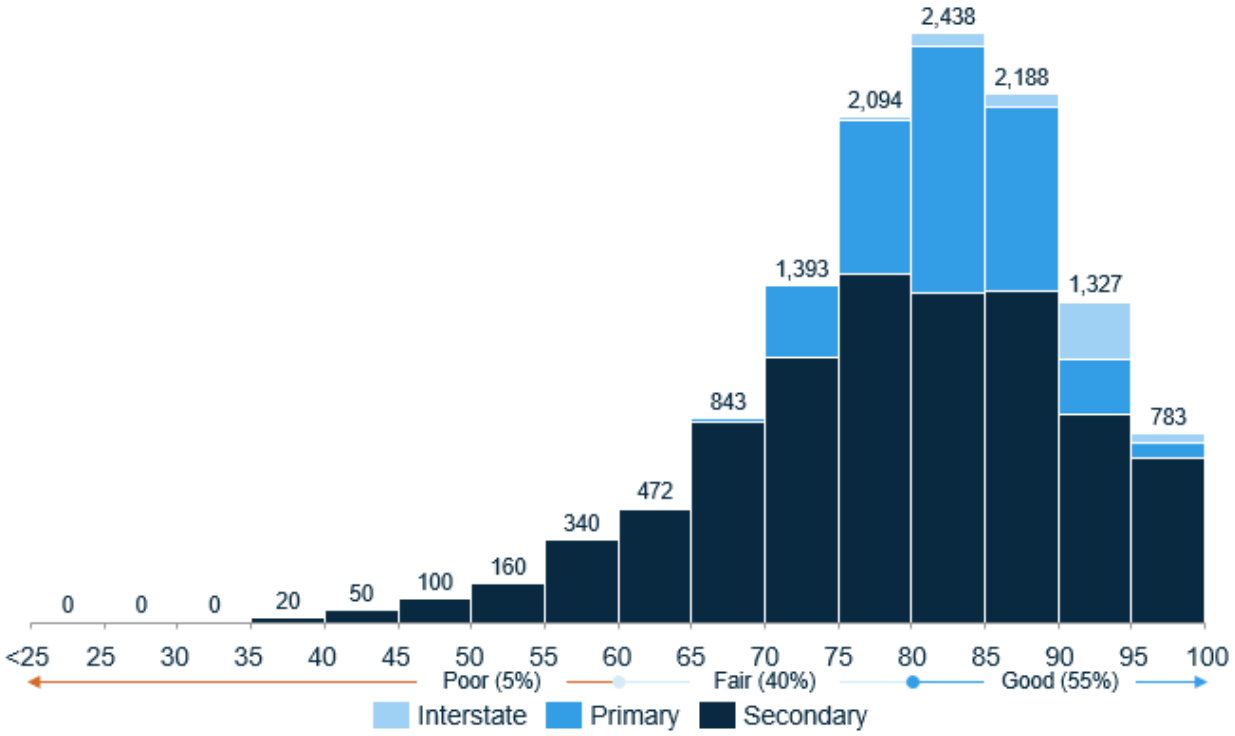
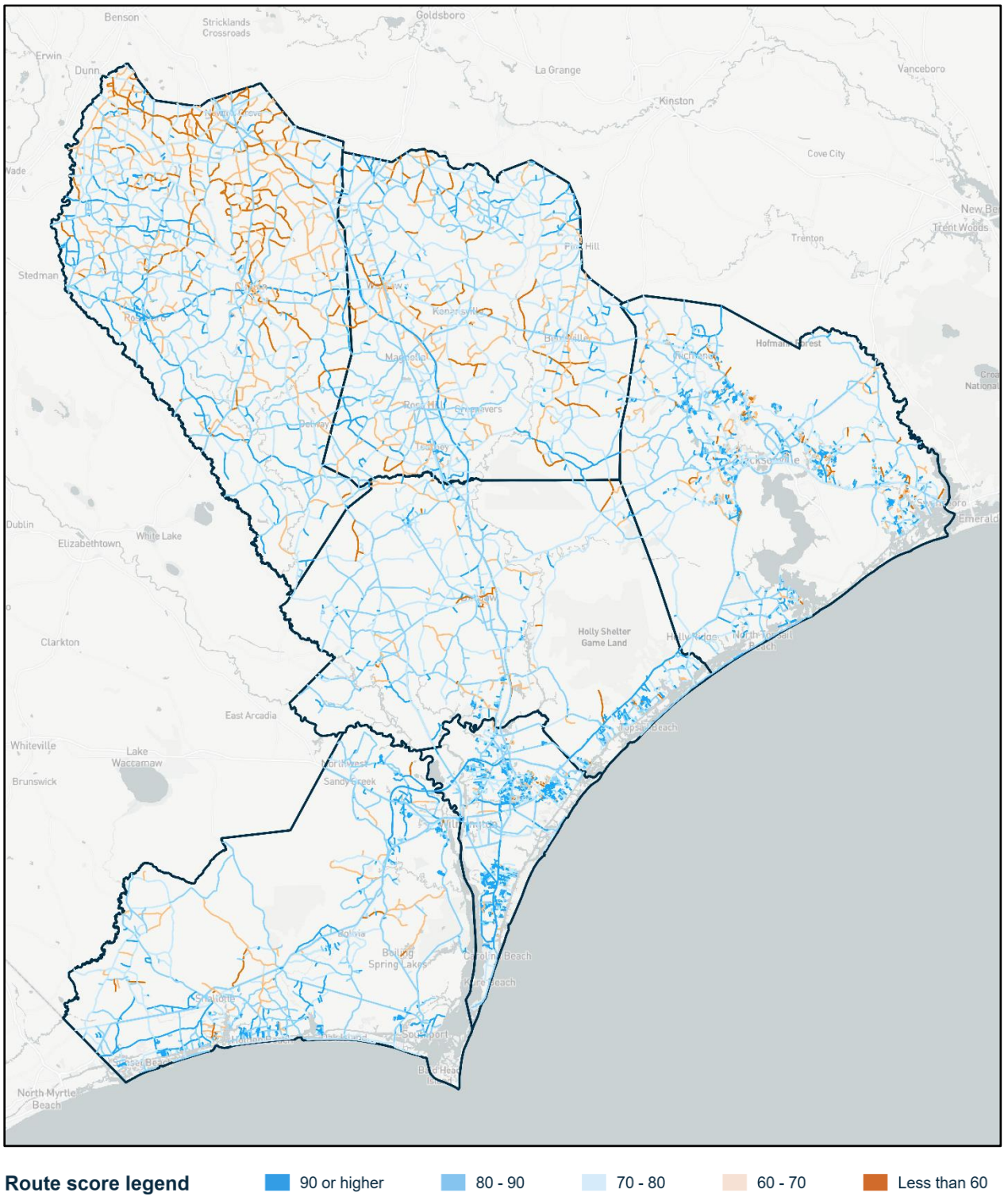


Figure 1 – Distribution of route score, measured in lane miles

Across the road network, the most common route score is between 80 and 85. Interstate and primary routes in Division 3 all have route scores of at least 70, while secondary routes exhibit route scores starting at 35.

These routes can be mapped spatially to evaluate the distribution by geography, as seen on the next page.

Route score distribution, by county

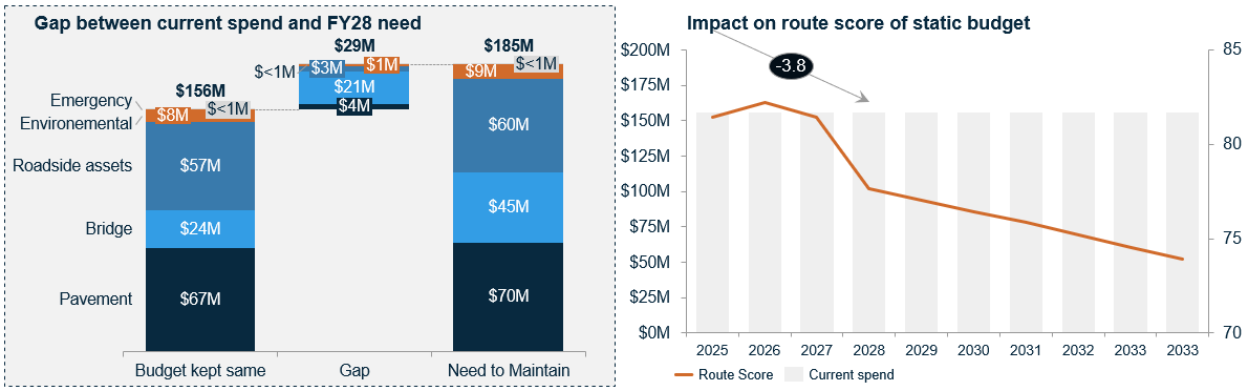


Map 1 – Spatial distribution of route score, grouped by county

1.4 Impact of static funding

Route Score is used to estimate the investment needed[iv] to maintain or achieve various condition levels over the next 10 years, assuming expected inflation[v] and asset deterioration.

Maintaining this division's current condition will require a year-over-year increase in funding, due to inflation and regular wear-and-tear. Static funding may be sufficient to maintain Division 3's route score in upcoming years but will lead to a decline of **-3.8** points by 2028 and will potentially lower it by at least **-7.6** points over the next decade.



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1.5 Investment needs over the next 10 years

Using the Route Score, ArTEMIS can quantify investment needed to maintain or improve condition by raising the route score by zero points (maintain conditions), one point (slight improvement), five points (large improvement), and ten points (near-perfect conditions)[vi].

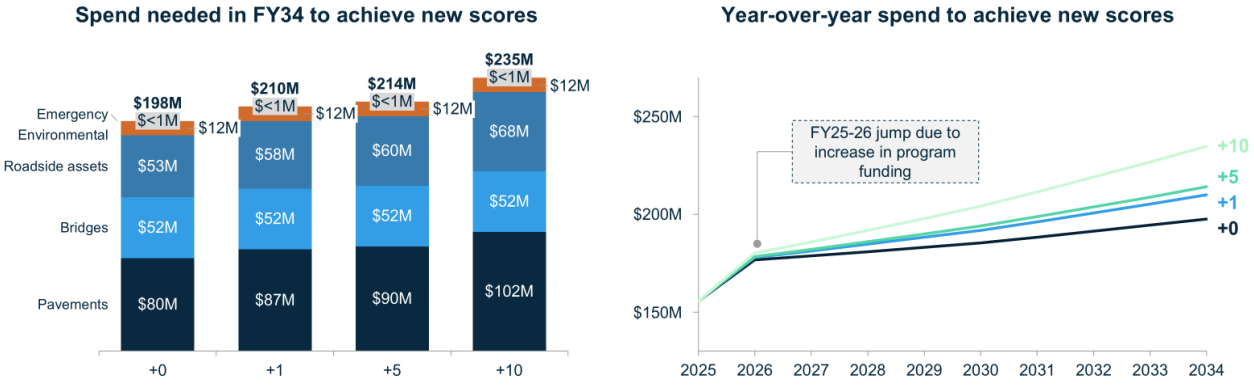


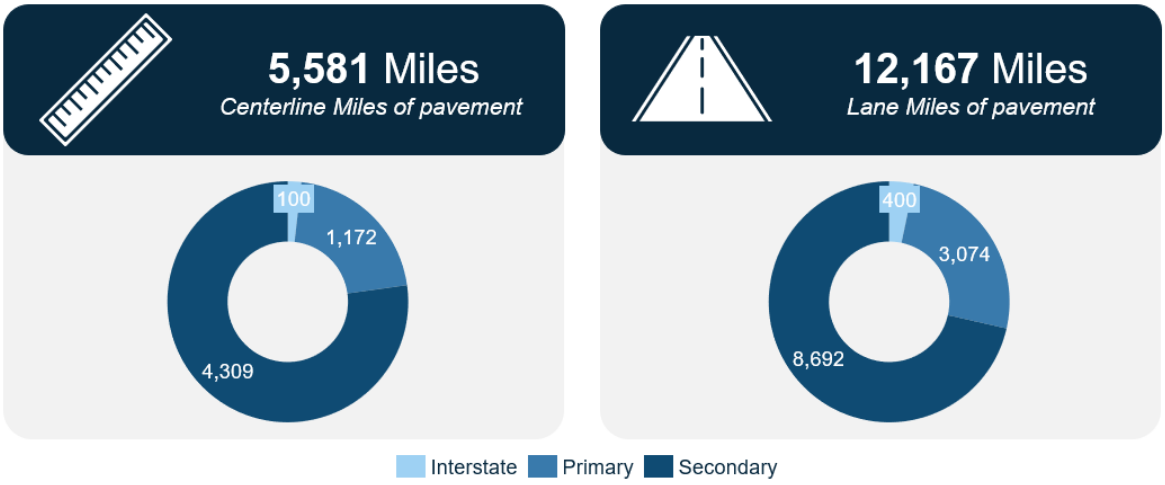
Figure 3 – Projected investment needed (YOE $) to improve route score over 10 years

As shown, maintaining and improving Division 3's Route Score requires greater investment:

- **+0** requires increasing spend to **$198M** by FY34; **$1,832M** in total investment
- **+1** requires increasing spend to **$210M** by FY34; **$1,891M** in total investment
- **+5** requires increasing spend to **$214M** by FY34; **$1,911M** in total investment
- **+10** requires increasing spend to **$235M** by FY34; **$2,007M** in total investment

2 Division Asset Inventory & Condition

2.1 Pavement & Asset Inventory



		Quantity			
Asset	**Unit**	**Interstate**	**Primary**	**Secondary**	**Overall**
Bike Lanes	LFT	0	132,340	284,104	416,444
Cablerail	MI	179	40	0	219
Concrete Barrier	MI	1	5	2	8
Crosswalk	EA	0	436	273	709
Curb and Gutter	MI	2	312	197	511
Drop Inlets	EA	179	5,336	7,985	13,500
Guardrail	MI	38	144	58	239
Impact Attenuator	EA	15	45	14	74
Induction Loop	EA	3	1,413	789	2,205
Mile marker	EA	275	170	21	466
Noise Wall*	LFT	0	0	3,923	3,923
Pavement Striping (defective only)	MI	19	563	1,562	2,144
Pipes[vii]	LFT	3,750	254,457	155,690	413,897
Retaining Wall*	LFT	0	963	1,122	2,085
Road Sign	EA	953	23,890	36,912	61,755
Rumble Strips*	MI	312	248	10	570
Sharrows	EA	6	117	134	257
Shoulder (defective only)	MI	2	32	103	138
Traffic Signal	EA	0	4,812	1,899	6,711
Variable Message Sign	EA	12	37	11	60
Word and Symbols	EA	233	23,255	6,224	29,712

Table 3 – Selection of roadside asset inventory; asterisk indicates no significance to route score

2.2 Pavement Conditions

Using Pavement Condition Survey (PCS) data, shown below is the breakdown of good, fair, and poor lane miles across the interstate, primary, and secondary systems.

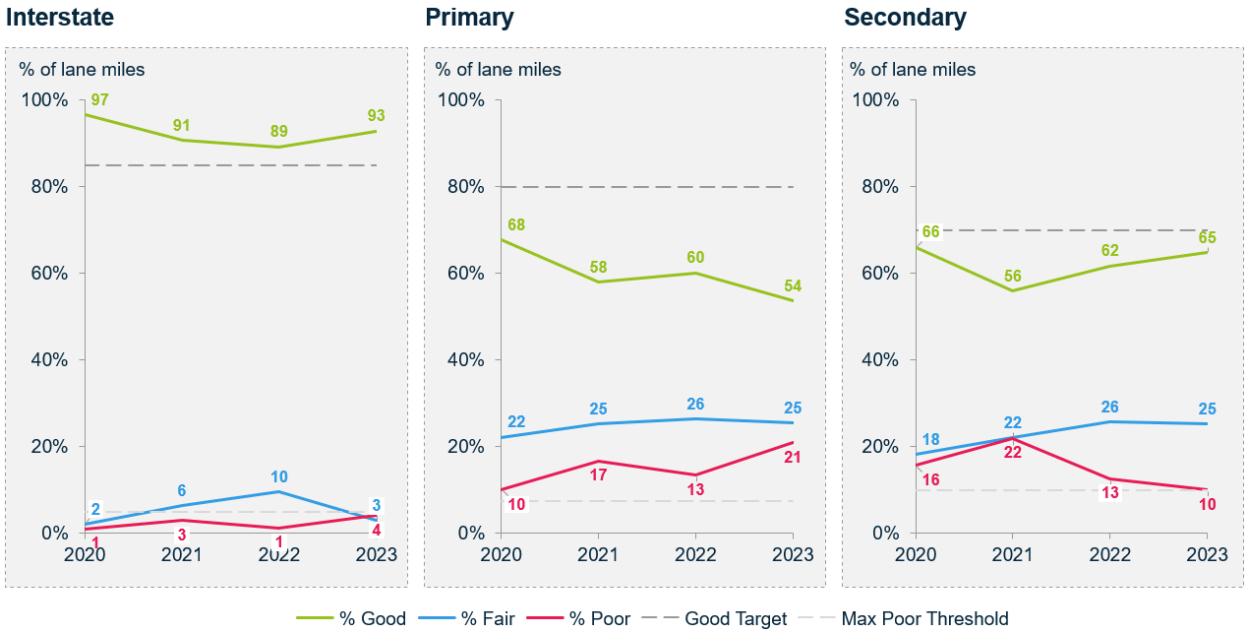


Figure 4 – Pavement conditions across interstate, primary, and secondary systems

Pavement conditions in Division 3 as evaluated via ArTEMIS analysis are below the state average, with a division-wide pavement index of **80**. Condition varies across the division by primary and secondary routes.

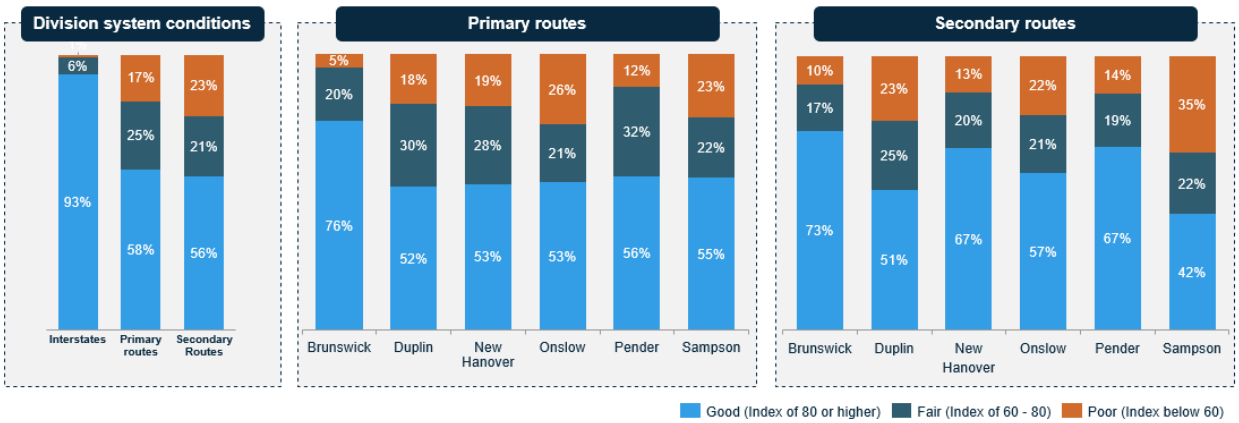


Figure 5 – Comparison of lane miles in good, fair, and poor conditions

County pavement index (weighted by lane miles) range **from 74 to 87**. Deductions are primarily driven by two distresses: (1) alligator cracking and (2) transverse cracking.

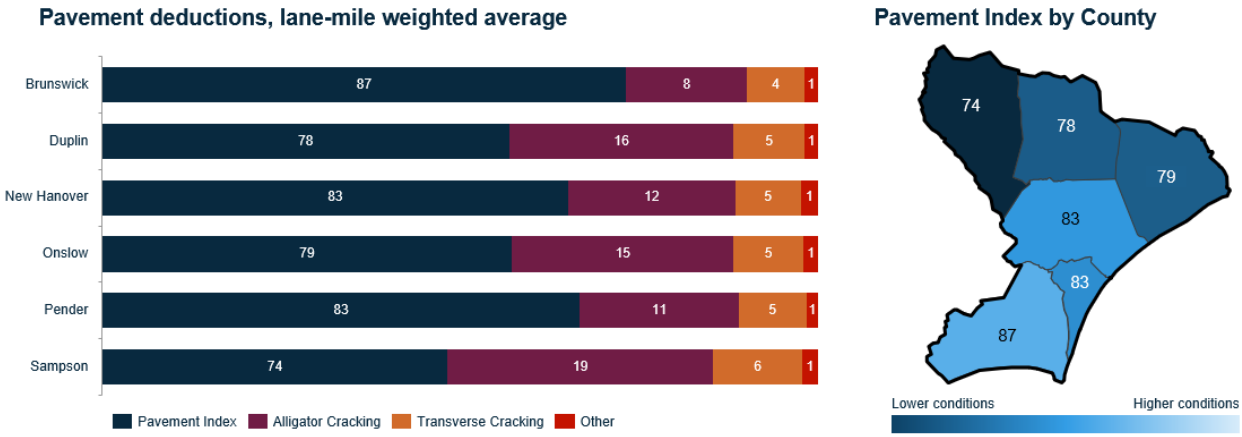


Figure 6 – Pavement index and deduction breakdown by county

Complementary models show similar assessments of pavement condition between the ArTEMIS model and the PCS model for Division 3. The pavement index utilizes the same scoring methodology as the PCS, the only differences being in how the data is collected/reviewed[viii].

	Condition			
Model	**Interstates**	**Primary**	**Secondary**	**Overall**
Pavement index (ArTEMIS)	96	81	79	80
Pavement condition score (PCS)	93	78	83	82

Table 4 – Condition comparison by pavement models for Division 3

2.3 Bridge Conditions

Bridge conditions are evaluated using a bridge index that translates general condition ratings (i.e., 1-9 scale) into a 100-point scale for easier comparison.

Overall, the Division 3 bridge index (84) scores ~2 points higher than statewide bridge index (82).

Data is ingested from FHWA bridge portal.

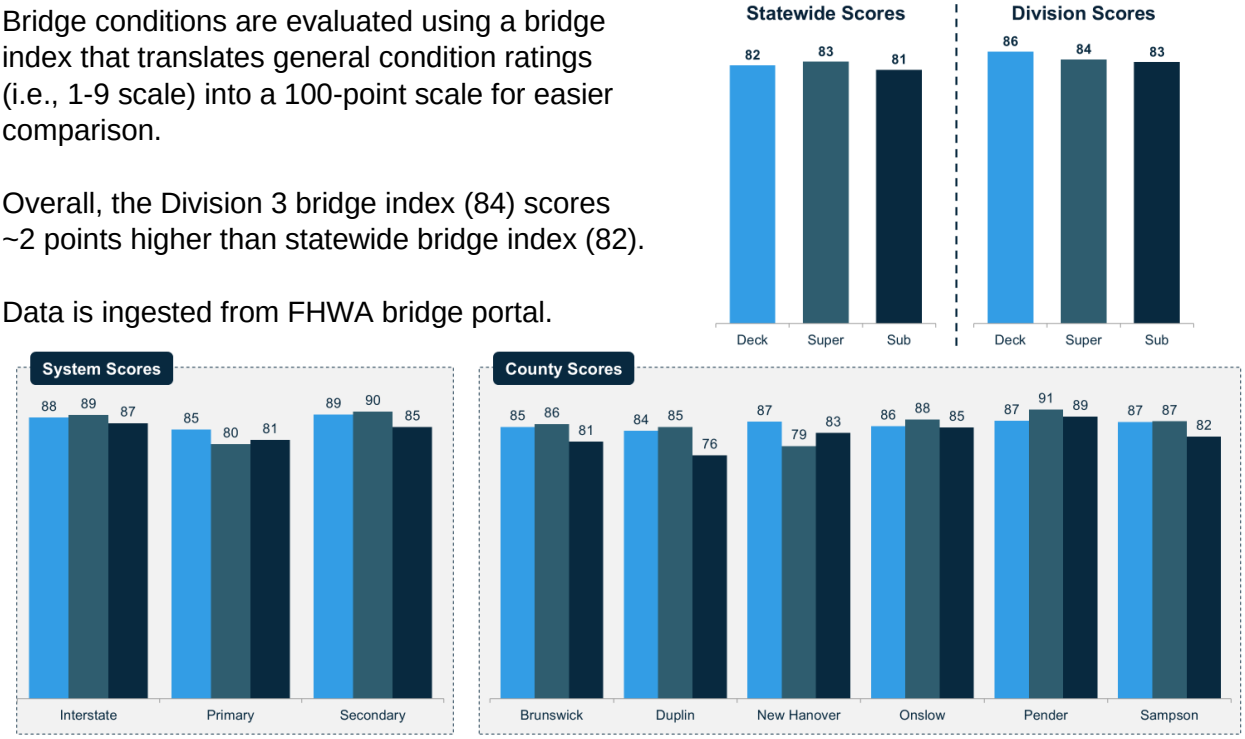


Figure 7 – Comparison of bridge conditions

The figure below displays all bridges in poor condition (index below 60) or at-risk of becoming poor (index of 60 – 69). They are mostly on the secondary system. Each circle maps one bridge by latitude and longitude; circle size indicates deck area, with at-risk bridges sized uniformly.

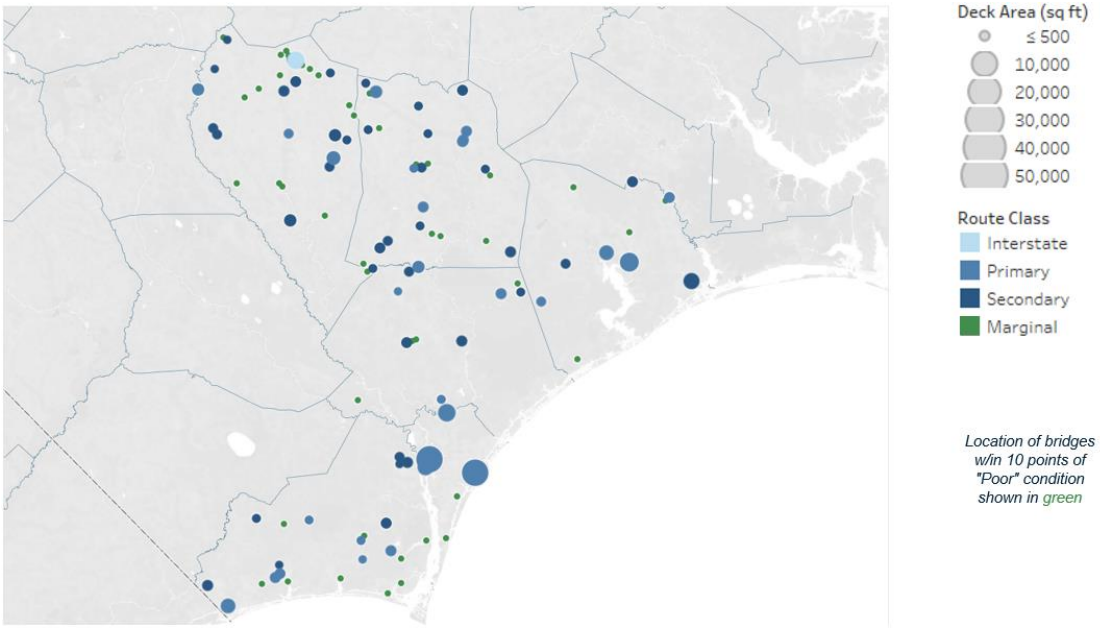


Figure 8 – Distribution of poor bridges and at-risk of becoming poor condition bridges in Division 3

2.4 Roadside Asset Conditions

Roadside asset condition is evaluated by measuring the proportion at which an asset is non-defective in a division, county, or route.

Asset	State	D3	Brunswick	Duplin	New Hanover	Onslow	Pender	Sampson
Pavement Striping	89%	88%	89%	87%	95%	90%	88%	85%
Bike Lanes	78%	84%	88%		82%	98%	66%	
Word and Symbols	74%	71%	76%	53%	70%	69%	81%	75%
Sharrows	84%	71%	96%	86%	62%	74%	60%	
Signs	94%	93%	93%	92%	95%	95%	90%	91%
Drop Inlets	89%	89%	90%	88%	89%	88%	93%	92%
Curb and Gutter	96%	98%	98%	97%	98%	98%	99%	98%
Guardrails	98%	99%	98%	99%	98%	99%	99%	99%
Shoulder	98%	99%	98%	99%	98%	98%	98%	99%

Most Defective — Least Defective

Figure 9 – Comparison of conditions between county functional assets [ix]

Below is roadside asset condition visualized with county boundaries, where colors are relative to the average condition across the state, for each respective asset.

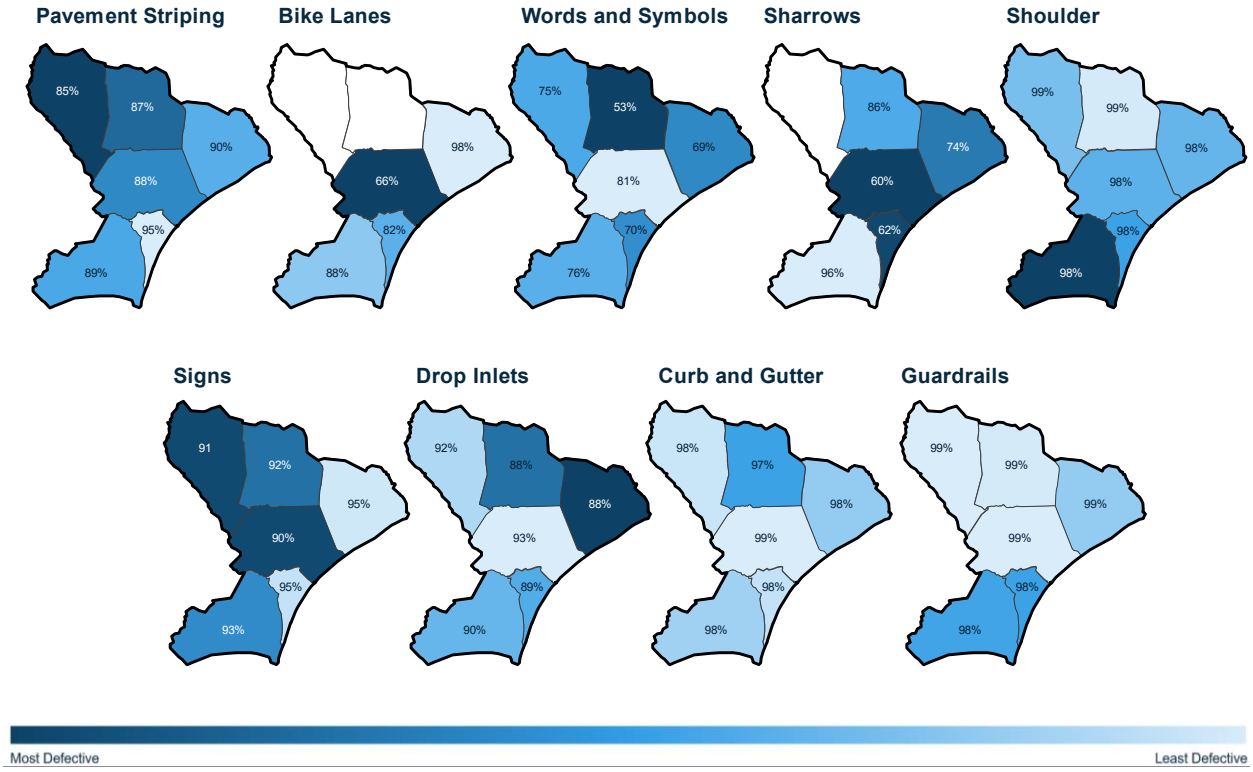


Figure 10 – Comparison of roadside asset conditions mapped to county boundaries

3 Rehabilitation / Rebuilding Needs

To develop a sense of what level of investment is required to ensure our state's ability to provide a safe and effective transportation network into the future, in the summer of 2024 the Director of Highway Operations reached out to all 14 Division Engineers and their teams, asking them to provide details on their highest priority ~35 miles of reconstruction/rehabilitation needs. The submitted sections for Division 3, along with estimated costs, are outlined below ranked in order of priority (as submitted).

Route	County	Comments	Miles	Est. Cost ($M)
SR 1002	Pender	Top priority - on the posted roads list. Connects two primary routes and increased traffic expected with Hampstead Bypass. Looking into designating as primary.	2.92	$45M
US 421	Pender	Failing micro surfacing.	4.45	$117M
US 17	Onslow	Accelerated surface deterioration.	7.43	$272M
I-140	Brunswick	Accelerated surface deterioration.	10.38	$259M
US 74 WB	New Hanover	Accelerated surface deterioration.	5.400	$206M
SR 1627 EB	New Hanover	Accelerated surface deterioration. US 74 turns into this SR.	0.431	$46M
SR 1627 WB	New Hanover	Accelerated surface deterioration. US 74 turns into this SR.	0.356	$-
SR 1308	Onslow	On the posted road list. AADT = 17500.	2.113	$79M
SR 1403	Onslow	On the posted road list. AADT = 14500.	3.843	$95M
Total	-	-	**37.3**	**$1,119M**

Table 5 – Submitted rehabilitation / rebuilding priorities and estimated costs

4 Cost Summary

To inform the model of how conditions translate into maintenance investment needs, should-cost was collected – what should various maintenance activities cost? This is used to estimate costs for the most common maintenance treatments down to the activity level.

Highlighted below are the unique unit costs for assets in Division 3, where activity costs of more common treatments are weighted more heavily than less common treatments for each asset[x].

Weighted average unit costs by Division

Asset	UOM	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14
Bike Lanes	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Cablerail*	LFT	$2	$1	$2	$5	$1	$1	$3	$2	$0	$5	$2	$0	$2	$1
Concrete Barrier*	LFT	$500	$8	$3	$1,350	$16	$15	$3	$182	$163	$182	$6	$42	$25	$50
Pipes	LFT	$267	$379	$315	$479	$273	$275	$327	$462	$296	$378	$395	$90	$256	$345
Crosswalk	EA	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Curb and Gutter*	LFT	$102	$132	$125	$83	$112	$144	$117	$109	$78	$112	$93	$39	$90	$88
Drop Inlets*	EA	$811	$809	$1,363	$460	$974	$714	$865	$788	$830	$1,041	$794	$744	$1,361	$1,297
Guardrail*	LFT	$16	$30	$36	$12	$1	$49	$30	$31	$12	$32	$6	$32	$50	$21
Impact Attenuator*	EA	$2,500	$12,500	$5,000	$8,840	$2,707	$1,925	$17,500	$750	$1,704	$9,250	$2,028	$2,613	$10,250	$3,000
Induction Loop	LFT	$1,381	$726	$2,777	$1,695	$825	$1,358	$748	$1,486	$573	$3,097	$1,322	$2,144	$1,167	$1,308
Mile marker	EA	$129	$171	$172	$135	$440	$268	$168	$276	$285	$164	$427	$137	$143	$192
Pavement Striping*	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Ramp Metering	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Road Sign	EA	$309	$365	$232	$288	$613	$378	$379	$366	$462	$249	$581	$249	$293	$338
Shoulder	SHM	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Timber Rail	LFT	$44	$6	$49	$313	$13	$8	$2	$49	$44	$49	$3	$23	$23	$63
Traffic Signal	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Word and Symbols	LFT	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Crack Seal	LM	$3,103	$4,000	$3,300	$3,409	$6,009	$2,100	$4,366	$4,000	$3,250	$6,000	$7,850	$4,366	$4,366	$5,000
Chip Seal	LM	$21,933	$18,625	$22,750	$17,014	$26,732	$53,875	$22,356	$49,000	$30,925	$17,500	$21,500	$22,902	$33,701	$32,500
Contract Resurfacing*	LM	$120,418	$140,000	$67,500	$96,025	$109,701	$92,500	$213,998	$97,500	$116,150	$185,000	$66,250	$87,184	$88,750	$151,250

Table 6 – Unit cost comparison between Divisions

[i] Condition and inventory data collected via ArTEMIS from January to September 2023; cost data collected from individual divisions and validated in February/March of 2024. Thus, funding scenarios outlined in this document were developed prior the impacts of Hurricane Helene & based on infrastructure condition data collected prior to the storm. As such, they do not account for the additional costs associated with the rehabilitation or reconstruction of infrastructure affected by the storm. Recognizing that rebuilding will entail significant expenses, the current scenarios focus on maintaining the regular operational budget and steady-state upkeep without reallocation of funds.

[ii] For purposes of calculating route score, “Words and Symbols” also includes bike lanes, crosswalks, sharrows.

[iii] When aggregated, route scores are weighted by lane miles and route class.

[iv] Maintenance costs are estimated solely by prioritizing the most efficient and cost-effective maintenance activities in terms of their impact on overall state/division route score, regardless of pre-existing plans, priorities, or ongoing projects.

[v] For these investment scenarios, we assume rates of inflation for labor, material, and equipment costs of 3%, 5%, and 8% respectively, per the 2023Q4 Engineering News-Record Cost Report. Costs for non-maintenance activities are assumed to increase at annual rate of 3%.

[vi] Spend to increase route score views pavement and roadside asset activities, only. Bridge activities that would increase score are currently not included. This may underestimate need when calculating need to improve by 10 pts.

[vii] Pipes are ingested into inventory counts via NCDOT survey

[viii] The pavement index assessment is consistent for every route and captures the entirety of the Division’s inventory. At times, the asset detection algorithm powering the pavement index may miss light / moderate rutting.

[ix] Blank cells indicate that the asset type is not present in county and therefore excluded from analysis.

[x] Asterisk denotes predominately contracted activities. Cable rails, shoulder, impact attenuators, guardrails, curb and gutter, and drop inlets are typically contracted out in D3. All cost data in this table were provided and validated by engineers from each division. Variations in costs may arise due to several factors, including the frequency of repairs, whether work is performed in-house or contracted out, and the defect severity at which interventions are initiated. For assets where specific cost data were unavailable, the average cost across all divisions was used. Data was collected and validated February - May 2024.

DIVISION 4 INSIGHTS REPORT

This report uses data on inventory, condition, and costs to provide insights at the division, county, and route levels. It identifies long-term investment needs and opportunities across the system to optimize outcomes.[i]

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3 Rehabilitation / Rebuilding Needs..... 51

4 Cost Summary 52

1 Division Funding Needs

1.1 Data Background

Launched in 2020, ArTEMIS initially tracked 30+ discrete maintenance functions on state-managed routes. Since then, it has expanded to capture a "fence-to-fence" view of assets, activity-based costs, and lifecycle investment forecasting, enabling more precise, data-driven maintenance planning.

The 2023 initiative leverages image recognition and AI/ML to assess conditions across 2+ million geo-located assets statewide. By aligning new inventory data with established sources like the Pavement Condition Survey, it enhances accuracy through "Route Scores" at route, county, division, and state levels, which help forecast investment needs. Similar to weather forecasting, aligning multiple datasets strengthens accuracy and reliability.

Statewide data collected and validated from January to September 2023 includes image collection, route walkthroughs, inspections, and quality reviews. These, alongside activity-based “should-cost” estimates—based on current market and industry standards—inform the Total Cost of Ownership model, supporting comprehensive maintenance planning.

1.2 Route Score Overview

1.2.1 Methodology

The table below shows the asset conditions contributing to Division 4's overall route score and how a route score is assembled at the route level (before being aggregated up by system counties, divisions, etc). The score uses point-in-time data collected January - September 2023.

Asset	State	Division 4
Pavement Index	83	85
Bridge Index	82	83
Shoulder	98%	98%
Pipes	82%	89%
Drop Inlets	89%	82%
Curb and Gutter	96%	93%
Pavement Striping	89%	92%
Signs	94%	92%
Guardrails and barriers	98%	98%
Words and Symbols[ii]	96%	96%
Traffic devices	100%	100%

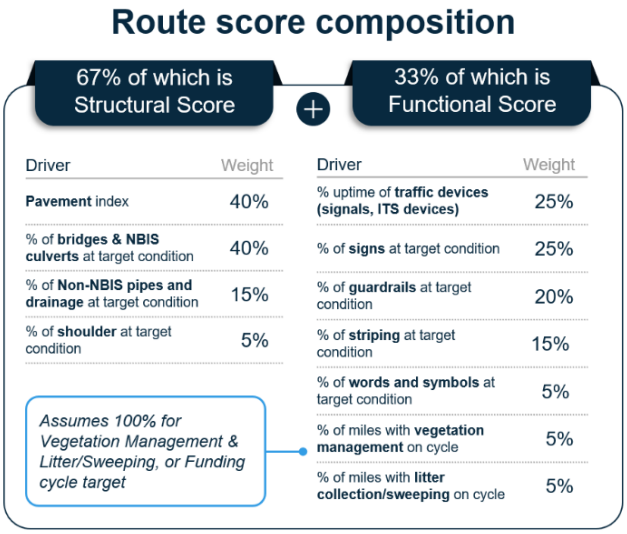
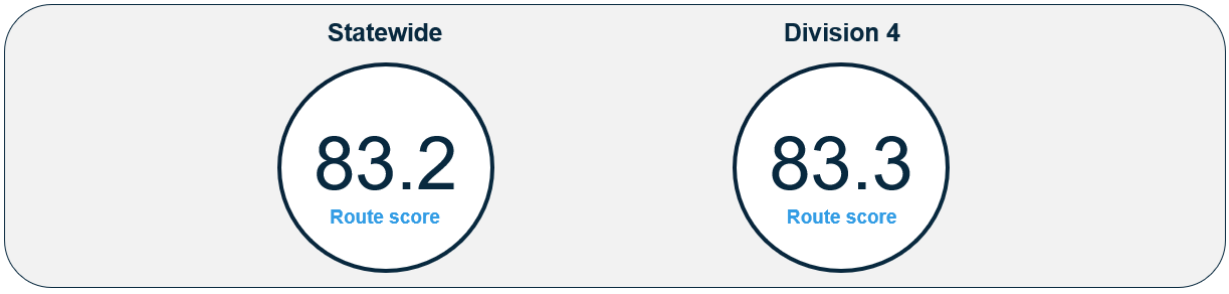


Table 1 – Asset scores (percentage of non-defective units or index score) across State and Division

1.2.2 Most Recent Outcomes

Using the scoring method shown above, the overall conditions of a division's roads can be shown with a single score that takes the weighted[iii] average of all its routes:



Route class	State	Division 4
Interstates	89	86
Primary	83	83
Secondary	82	82

Table 2 – Route scores by class

1.3 Route Score Distribution

The majority of the Division's network consists of routes in good condition, defined by a route score of 80 or higher. Over 8,000 lane miles (66% of network) are considered in good condition.

Conversely, less than 250 lane miles (2% of network) are considered in poor condition, defined by a route score lower than 60. Map 1 shows the condition of routes across the division.

Route score distribution, by lane miles

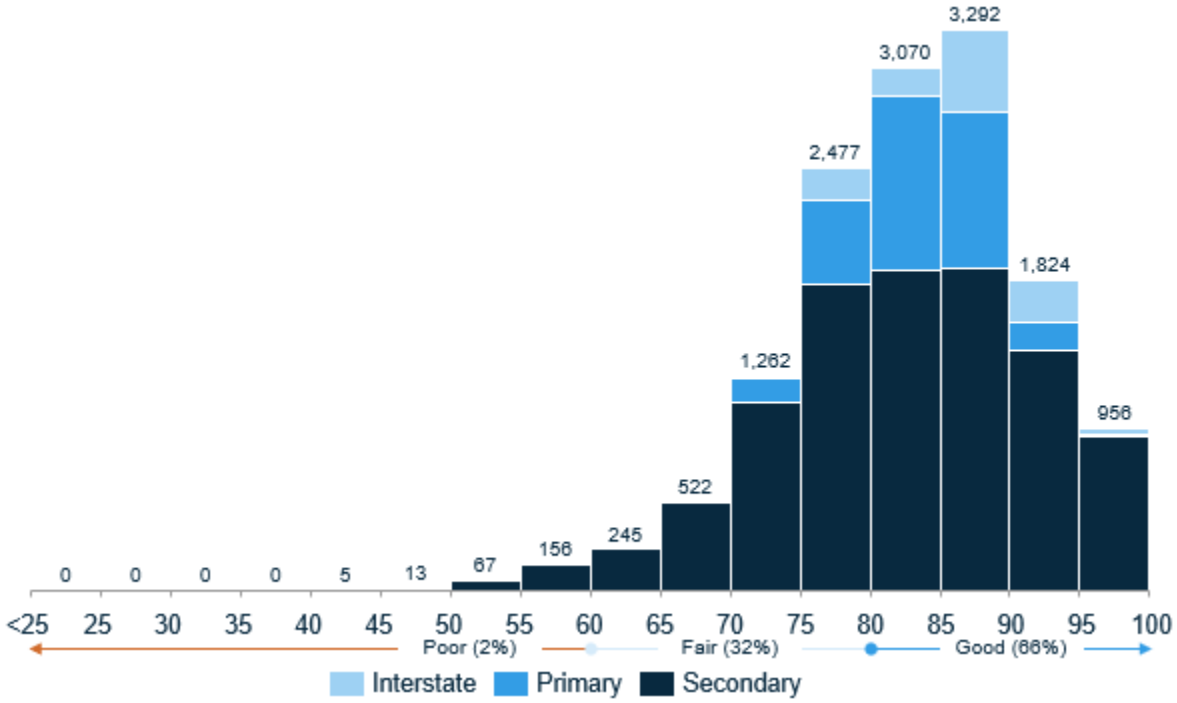
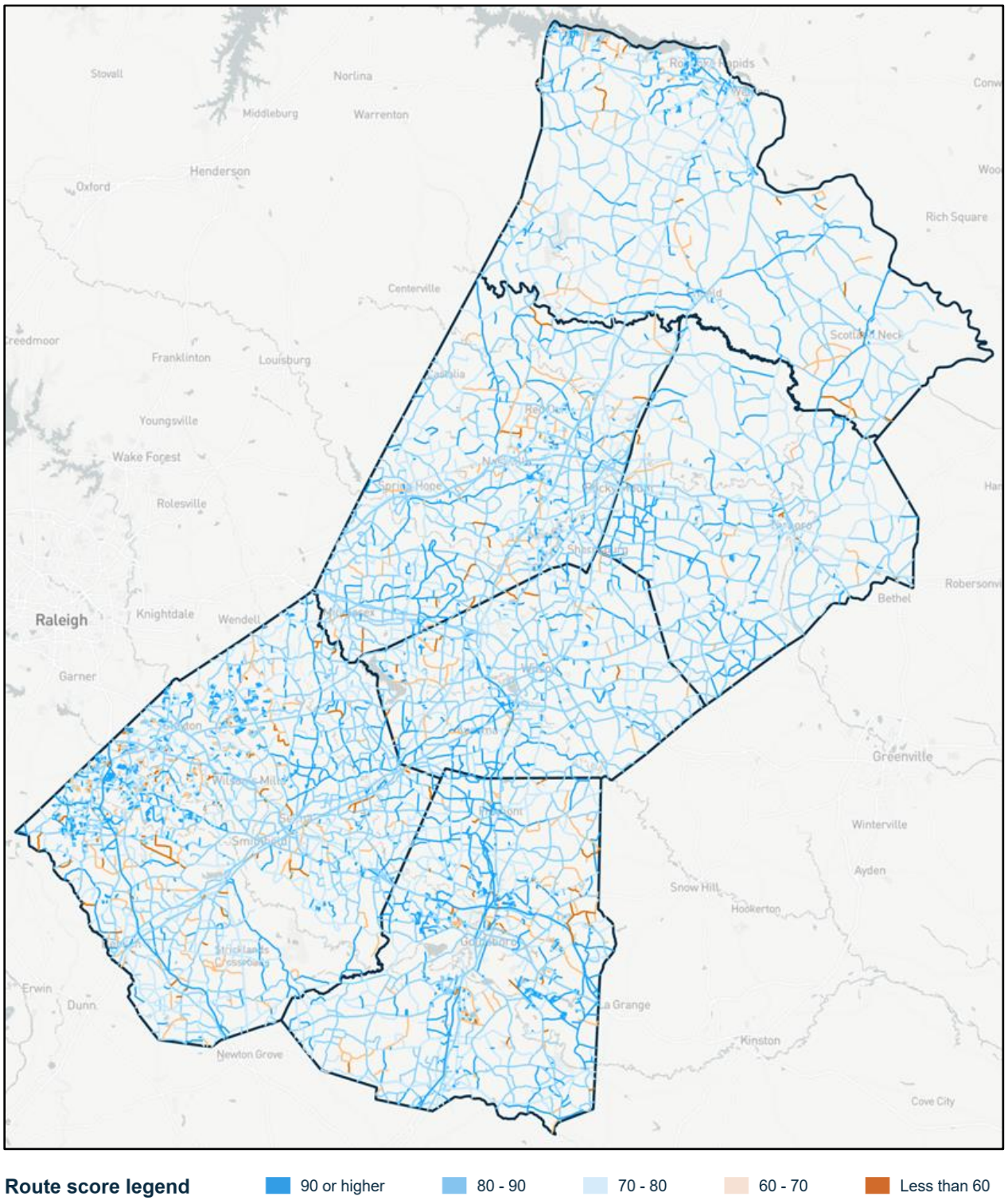


Figure 1 – Distribution of route score, measured in lane miles

Across the road network, the most common route score is between 85 and 90. Interstate and primary routes in Division 4 all have route scores of at least 70, while secondary routes exhibit route scores starting at 40.

These routes can be mapped spatially to evaluate the distribution by geography, as seen on the next page.

Route score distribution, by county



Map 1 – Spatial distribution of route score, grouped by county

1.4 Impact of static funding

Route Score is used to estimate the investment needed[iv] to maintain or achieve various condition levels over the next 10 years, assuming expected inflation[v] and asset deterioration.

Maintaining this division's current condition will require a year-over-year increase in funding, due to inflation and regular wear-and-tear. Static funding may be sufficient to maintain Division 4's route score in the next year but will lead to a decline of **-2.2** points in the following year and will potentially lower it by at least **-7.8** points over the next decade.

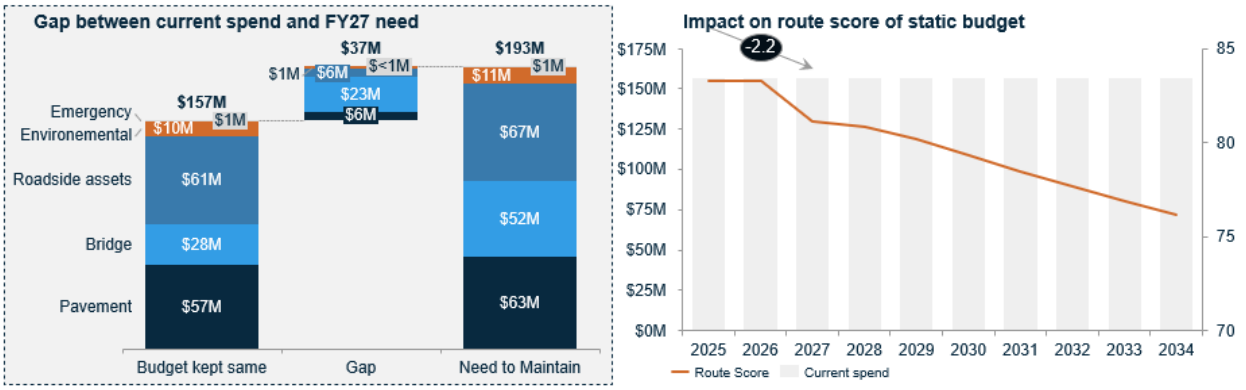


Figure 2 – Comparison of current spend and expected need; route score over time if no budget increase

1.5 Investment needs over the next 10 years

Using the Route Score, ArTEMIS can quantify investment needed to maintain or improve condition by raising the route score by zero points (maintain conditions), one point (slight improvement), five points (large improvement), and ten points (near-perfect conditions)[vi].

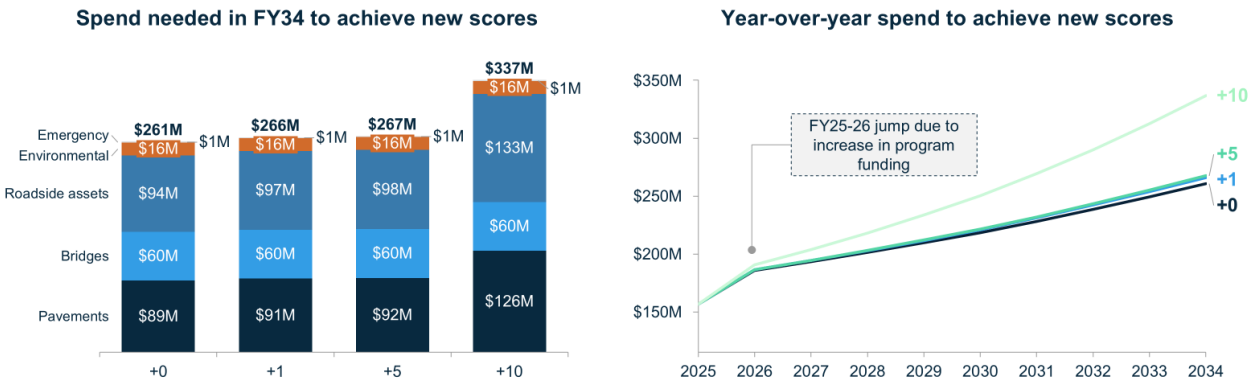


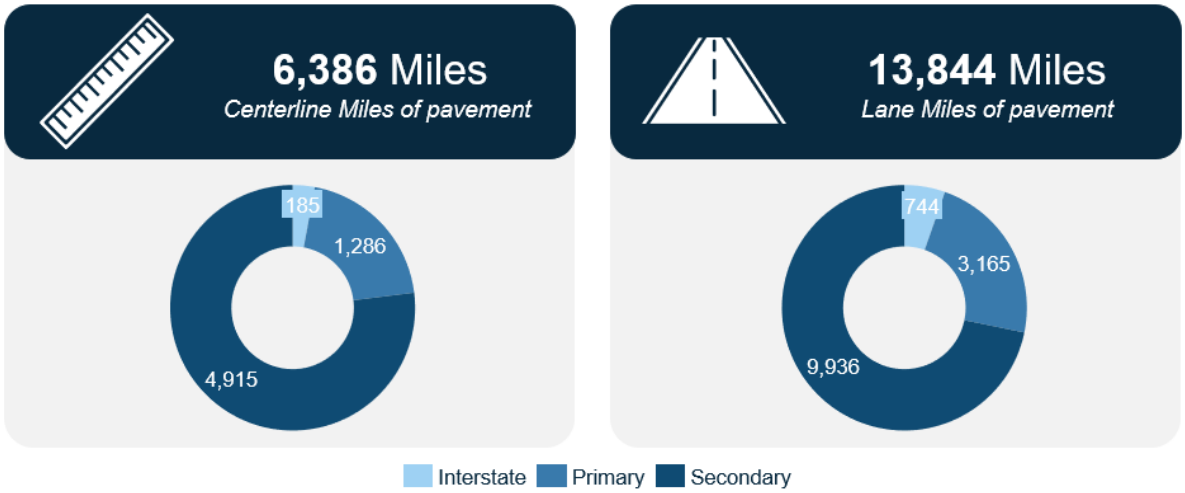
Figure 3 – Projected investment needed (YOE $) to improve route score over 10 years

As shown, maintaining and improving Division 4's Route Score requires greater investment:

- **+0** requires increasing spend to **$261M** by FY34; **$2,142M** in total investment
- **+1** requires increasing spend to **$266M** by FY34; **$2,172M** in total investment
- **+5** requires increasing spend to **$267M** by FY34; **$2,165M** in total investment
- **+10** requires increasing spend to **$337M** by FY34; **$2,461M** in total investment

2 Division Asset Inventory & Condition

2.1 Pavement & Asset Inventory



		Quantity			
Asset	**Unit**	**Interstate**	**Primary**	**Secondary**	**Overall**
Bike Lanes	LFT	0	11,784	2,608	**14,392**
Cablerail	MI	247	37	3	**287**
Concrete Barrier	MI	36	14	6	**56**
Crosswalk	EA	0	126	123	**249**
Curb and Gutter	MI	26	197	240	**463**
Drop Inlets	EA	595	2,689	4,516	**7,863**
Guardrail	MI	194	56	97	**347**
Impact Attenuator	EA	66	17	5	**90**
Induction Loop	EA	30	1,415	1,642	**3,087**
Mile marker	EA	648	102	64	**814**
Noise Wall*	LFT	0	749	0	**749**
Pavement Striping (defective only)	MI	110	319	1,264	**1,693**
Pipes[vii]	LFT	124,529	305,491	192,300	**622,320**
Retaining Wall*	LFT	0	1,908	3,843	**5,750**
Road Sign	EA	5,090	20,003	44,478	**69,571**
Rumble Strips*	MI	438	434	184	**1,056**
Sharrows	EA	0	0	22	**22**
Shoulder (defective only)	MI	31	29	133	**193**
Traffic Signal	EA	723	3,323	3,558	**7,604**
Variable Message Sign	EA	20	26	20	**76**
Word and Symbols	EA	2,586	8,691	7,892	**19,169**

Table 3 – Selection of roadside asset inventory; asterisk indicates no significance to route score

2.2 Pavement Conditions

Using Pavement Condition Survey (PCS) data, shown below is the breakdown of good, fair, and poor lane miles across the interstate, primary, and secondary systems.

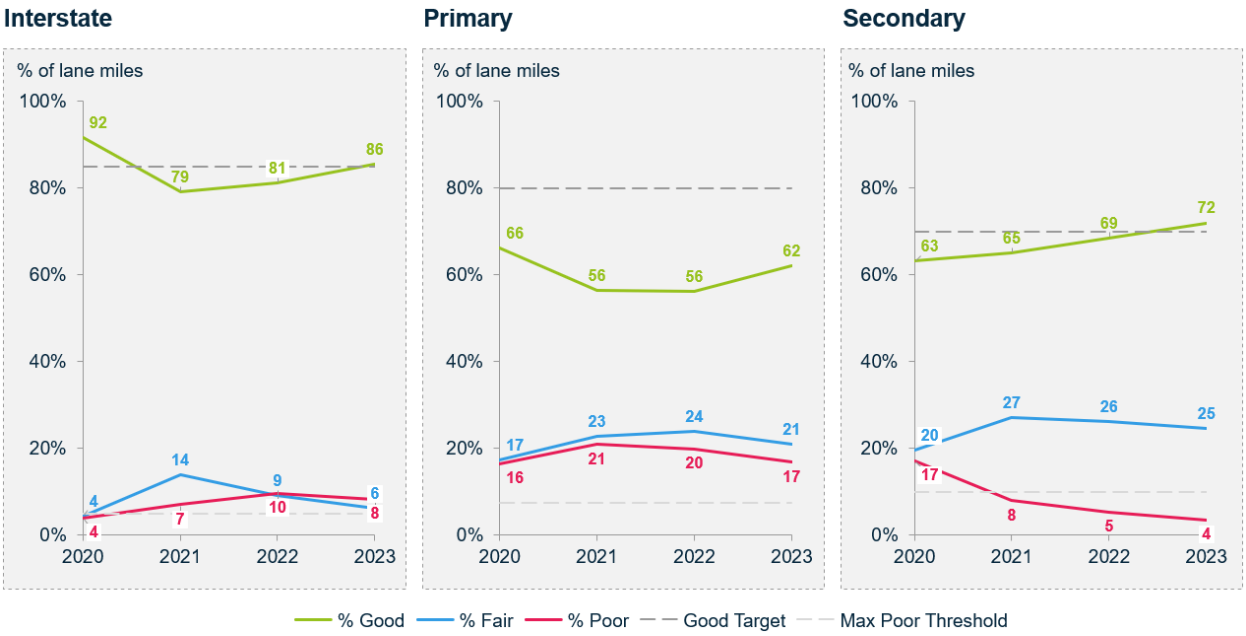


Figure 4 – Pavement conditions across interstate, primary, and secondary systems

Pavement conditions in Division 4 as evaluated via ArTEMIS analysis are above the state average, with a division-wide pavement index of **85**. Condition varies across the division by primary and secondary routes.

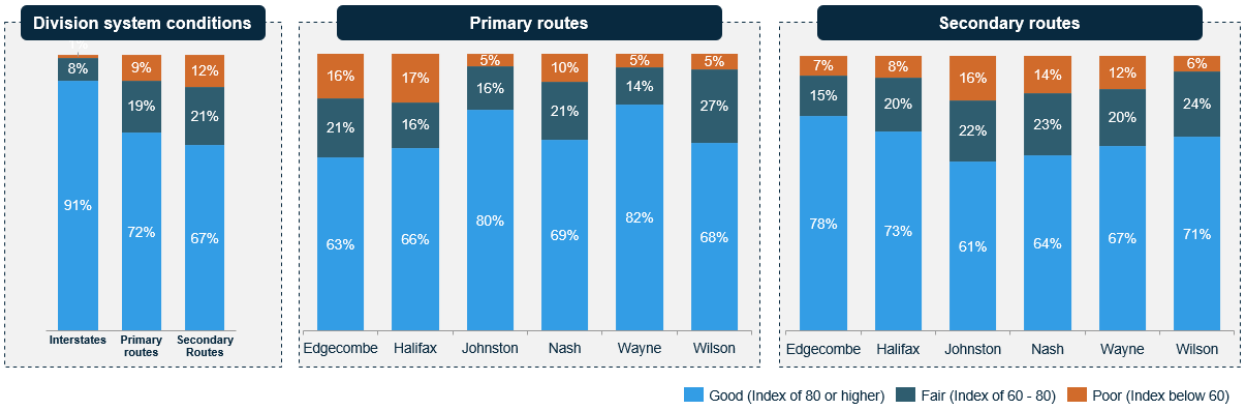


Figure 5 – Comparison of lane miles in good, fair, and poor conditions

County pavement index (weighted by lane miles) range **from 84 to 86**. Deductions are primarily driven by two distresses: (1) alligator cracking and (2) transverse cracking.

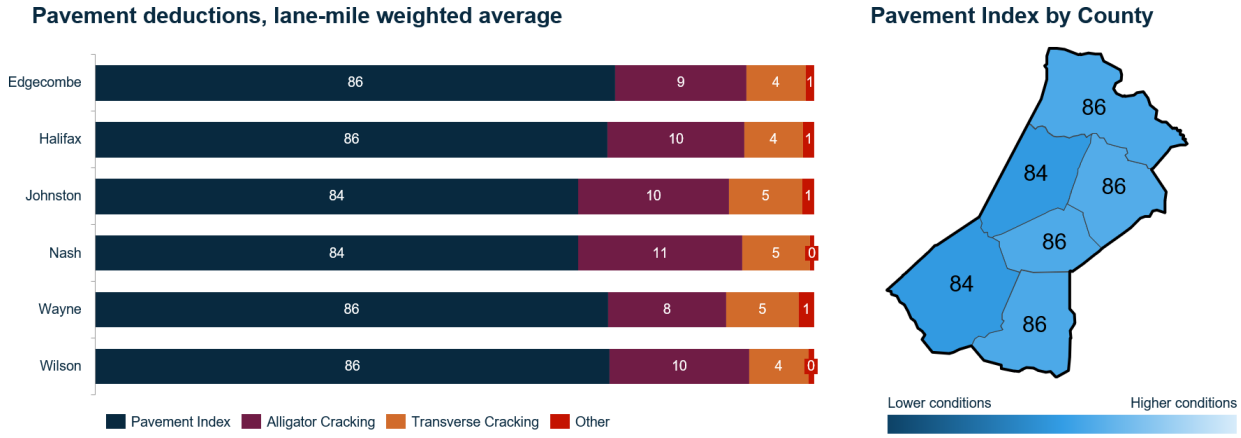


Figure 6 – Pavement index and deduction breakdown by county

Complementary models show similar assessments of pavement condition between the ArTEMIS model and the PCS model for Division 4. The pavement index utilizes the same scoring methodology as the PCS, the only differences being in how the data is collected/reviewed[viii].

	Condition			
Model	**Interstates**	**Primary**	**Secondary**	**Overall**
Pavement index (ArTEMIS)	89	86	84	85
Pavement condition score (PCS)	88	82	86	85

Table 4 – Condition comparison by pavement models for Division 4

2.3 Bridge Conditions

Bridge conditions are evaluated using a bridge index that translates general condition ratings (i.e., 1-9 scale) into a 100-point scale for easier comparison.

Overall, the Division 4 bridge index (83) scores ~1 point higher than statewide bridge index (82).

Data is ingested from FHWA bridge portal.

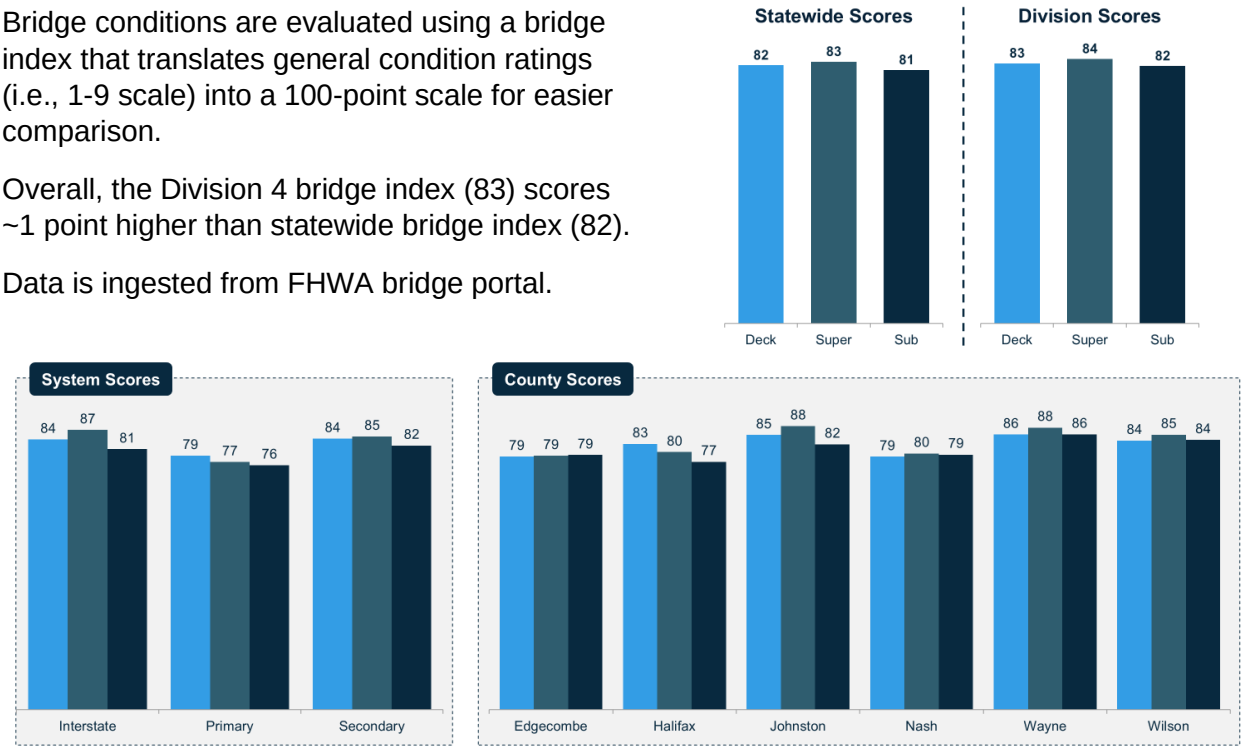


Figure 7 – Comparison of bridge conditions

The figure below displays all bridges in poor condition (index below 60) or at-risk of becoming poor (index of 60 – 69). They are mostly on the secondary system. Each circle maps one bridge by latitude and longitude; circle size indicates deck area, with at-risk bridges sized uniformly.

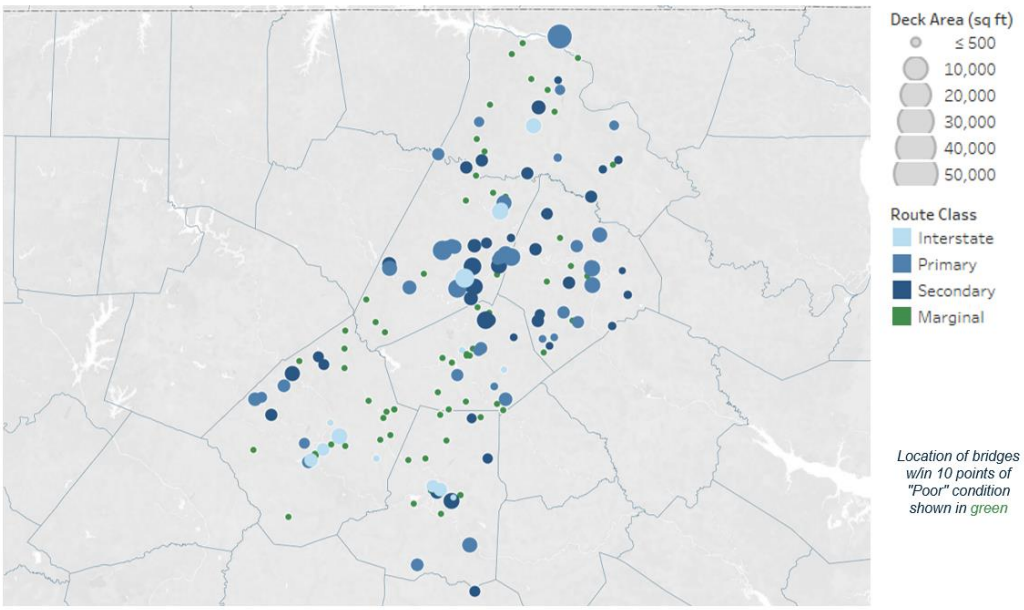


Figure 8 – Distribution of poor bridges and at-risk of becoming poor condition bridges in Division 4

2.4 Roadside Asset Conditions

Roadside asset condition is evaluated by measuring the proportion at which an asset is non-defective in a division, county, or route.

Asset	State	D4	Edgecombe	Halifax	Johnston	Nash	Wayne	Wilson
Pavement Striping	89%	92%	92%	90%	93%	89%	94%	93%
Bike Lanes	78%	91%	39%			100%		
Word and Symbols	74%	76%	62%	81%	73%	79%	77%	78%
Sharrows	84%	55%	52%		100%			
Signs	94%	92%	93%	92%	91%	94%	91%	94%
Drop Inlets	89%	82%	88%	73%	91%	82%	81%	75%
Curb and Gutter	96%	93%	92%	95%	95%	96%	93%	85%
Guardrails	98%	98%	99%	98%	98%	98%	99%	98%
Shoulder	98%	98%	99%	99%	98%	99%	99%	95%

Most Defective — Least Defective

Figure 9 – Comparison of conditions between county functional assets [ix]

Below is roadside asset condition visualized with county boundaries, where colors are relative to the average condition across the state, for each respective asset.

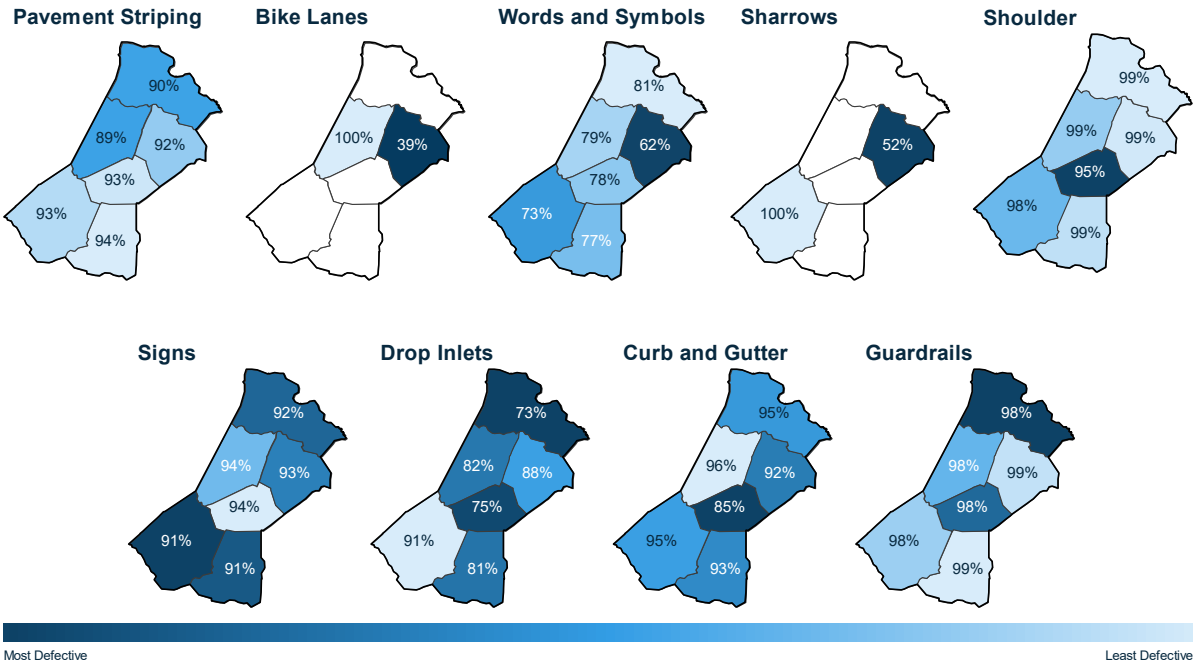


Figure 10 – Comparison of roadside asset conditions mapped to county boundaries

3 Rehabilitation / Rebuilding Needs

To develop a sense of what level of investment is required to ensure our state's ability to provide a safe and effective transportation network into the future, in the summer of 2024 the Director of Highway Operations reached out to all 14 Division Engineers and their teams, asking them to provide details on their highest priority ~35 miles of reconstruction/rehabilitation needs. The submitted sections for Division 4, along with estimated costs, are outlined below ranked in order of priority (as submitted).

Route	County	Comments	Miles	Est. Cost ($M)
US70	Johnston	Widened Shoulders and Bridges to Convert to Interstate Standard.	2.00	$-
US Hwy 70	Wayne	Lenoir County to Wood Peck	7.00	$237M
I-95	Halifax	Potholes, rutting, recently resurfaced on each side.	6.60	$227M
I-95	Nash	Patching, Slab Jacking, Joint Repair, friction course raveling. Currently a Future IM project	19.00	$575M
Total	-	-	**34.6**	**$1,039M**

Table 5 – Submitted rehabilitation / rebuilding priorities and estimated costs

4 Cost Summary

To inform the model of how conditions translate into maintenance investment needs, should-cost was collected – what should various maintenance activities cost? This is used to estimate costs for the most common maintenance treatments down to the activity level.

Highlighted below are the unique unit costs for assets in Division 4, where activity costs of more common treatments are weighted more heavily than less common treatments for each asset[x].

Weighted average unit costs by Division

Asset	UOM	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14
Bike Lanes	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Cablerail*	LFT	$2	$1	$2	$5	$1	$1	$3	$2	$0	$5	$2	$0	$2	$1
Concrete Barrier*	LFT	$500	$8	$3	$1,350	$16	$15	$3	$182	$163	$182	$6	$42	$25	$50
Pipes	LFT	$267	$379	$315	$479	$273	$275	$327	$462	$296	$378	$395	$90	$256	$345
Crosswalk	EA	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Curb and Gutter*	LFT	$102	$132	$125	$83	$112	$144	$117	$109	$78	$112	$93	$39	$90	$88
Drop Inlets*	EA	$811	$809	$1,363	$460	$974	$714	$865	$788	$830	$1,041	$794	$744	$1,361	$1,297
Guardrail*	LFT	$16	$30	$36	$12	$1	$49	$30	$31	$12	$32	$6	$32	$50	$21
Impact Attenuator*	EA	$2,500	$12,500	$5,000	$8,840	$2,707	$1,925	$17,500	$750	$1,704	$9,250	$2,028	$2,613	$10,250	$3,000
Induction Loop	LFT	$1,381	$726	$2,777	$1,695	$825	$1,358	$748	$1,486	$573	$3,097	$1,322	$2,144	$1,167	$1,308
Mile marker	EA	$129	$171	$172	$135	$440	$268	$168	$276	$285	$164	$427	$137	$143	$192
Pavement Striping*	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Ramp Metering	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Road Sign	EA	$309	$365	$232	$288	$613	$378	$379	$366	$462	$249	$581	$249	$293	$338
Shoulder	SHM	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Timber Rail	LFT	$44	$6	$49	$313	$13	$8	$2	$49	$44	$49	$3	$23	$23	$63
Traffic Signal	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Word and Symbols	LFT	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Crack Seal	LM	$3,103	$4,000	$3,300	$3,409	$6,009	$2,100	$4,366	$4,000	$3,250	$6,000	$7,850	$4,366	$4,366	$5,000
Chip Seal	LM	$21,933	$18,625	$22,750	$17,014	$26,732	$53,875	$22,356	$49,000	$30,925	$17,500	$21,500	$22,902	$33,701	$32,500
Contract Resurfacing*	LM	$120,418	$140,000	$67,500	$96,025	$109,701	$92,500	$213,998	$97,500	$116,150	$185,000	$66,250	$87,184	$88,750	$151,250

Table 6 – Unit cost comparison between Divisions

[i] Condition and inventory data collected via ArTEMIS from January to September 2023; cost data collected from individual divisions and validated in February/March of 2024. Thus, funding scenarios outlined in this document were developed prior the impacts of Hurricane Helene & based on infrastructure condition data collected prior to the storm. As such, they do not account for the additional costs associated with the rehabilitation or reconstruction of infrastructure affected by the storm. Recognizing that rebuilding will entail significant expenses, the current scenarios focus on maintaining the regular operational budget and steady-state upkeep without reallocation of funds.

[ii] For purposes of calculating route score, "Words and Symbols" also includes bike lanes, crosswalks, sharrows.

[iii] When aggregated, route scores are weighted by lane miles and route class.

[iv] Maintenance costs are estimated solely by prioritizing the most efficient and cost-effective maintenance activities in terms of their impact on overall state/division route score, regardless of pre-existing plans, priorities, or ongoing projects.

[v] For these investment scenarios, we assume rates of inflation for labor, material, and equipment costs of 3%, 5%, and 8% respectively, per the 2023Q4 Engineering News-Record Cost Report. Costs for non-maintenance activities are assumed to increase at annual rate of 3%.

[vi] Spend to increase route score views pavement and roadside asset activities, only. Bridge activities that would increase score are currently not included. This may underestimate need when calculating need to improve by 10 pts.

[vii] Pipes are ingested into inventory counts via NCDOT survey

[viii] The pavement index assessment is consistent for every route and captures the entirety of the Division's inventory. At times, the asset detection algorithm powering the pavement index may miss light / moderate rutting.

[ix] Blank cells indicate that the asset type is not present in county and therefore excluded from analysis.

[x] Asterisk denotes predominately contracted activities. Cable rails, impact attenuators, guardrails, timber rail, concrete barriers, curb and gutter, drop inlets, and pavement markings are typically contracted out in D4. All cost data in this table were provided and validated by engineers from each division. Variations in costs may arise due to several factors, including the frequency of repairs, whether work is performed in-house or contracted out, and the defect severity at which interventions are initiated. For assets where specific cost data were unavailable, the average cost across all divisions was used. Data was collected and validated February - May 2024.

DIVISION 5 INSIGHTS REPORT

This report uses data on inventory, condition, and costs to provide insights at the division, county, and route levels. It identifies long-term investment needs and opportunities across the system to optimize outcomes.[i]

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2 Division Asset Inventory & Condition 58

3 Rehabilitation / Rebuilding Needs..... 63

4 Cost Summary 64

1 Division Funding Needs

1.1 Data Background

Launched in 2020, ArTEMIS initially tracked 30+ discrete maintenance functions on state-managed routes. Since then, it has expanded to capture a "fence-to-fence" view of assets, activity-based costs, and lifecycle investment forecasting, enabling more precise, data-driven maintenance planning.

The 2023 initiative leverages image recognition and AI/ML to assess conditions across 2+ million geo-located assets statewide. By aligning new inventory data with established sources like the Pavement Condition Survey, it enhances accuracy through "Route Scores" at route, county, division, and state levels, which help forecast investment needs. Similar to weather forecasting, aligning multiple datasets strengthens accuracy and reliability.

Statewide data collected and validated from January to September 2023 includes image collection, route walkthroughs, inspections, and quality reviews. These, alongside activity-based “should-cost” estimates—based on current market and industry standards—inform the Total Cost of Ownership model, supporting comprehensive maintenance planning.

1.2 Route Score Overview

1.2.1 Methodology

The table below shows the asset conditions contributing to Division 5's overall route score and how a route score is assembled at the route level (before being aggregated up by system counties, divisions, etc). The score uses point-in-time data collected January - September 2023.

Asset	State	Division 5
Pavement Index	83	83
Bridge Index	82	84
Shoulder	98%	99%
Pipes	82%	85%
Drop Inlets	89%	86%
Curb and Gutter	96%	98%
Pavement Striping	89%	90%
Signs	94%	95%
Guardrails and barriers	98%	97%
Words and Symbols[ii]	96%	97%
Traffic devices	100%	100%

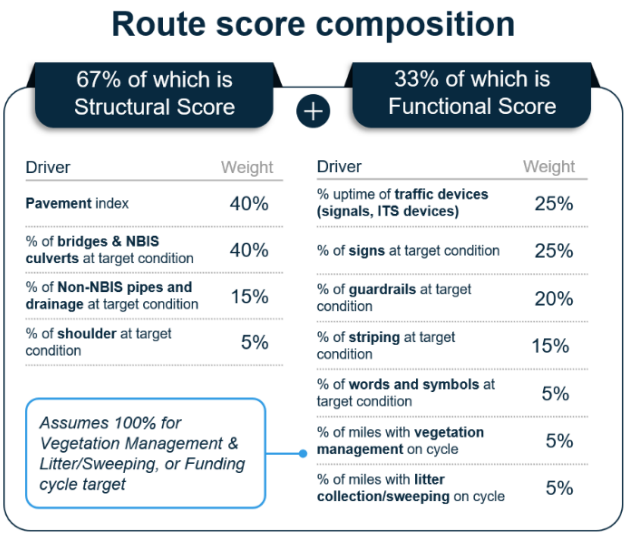
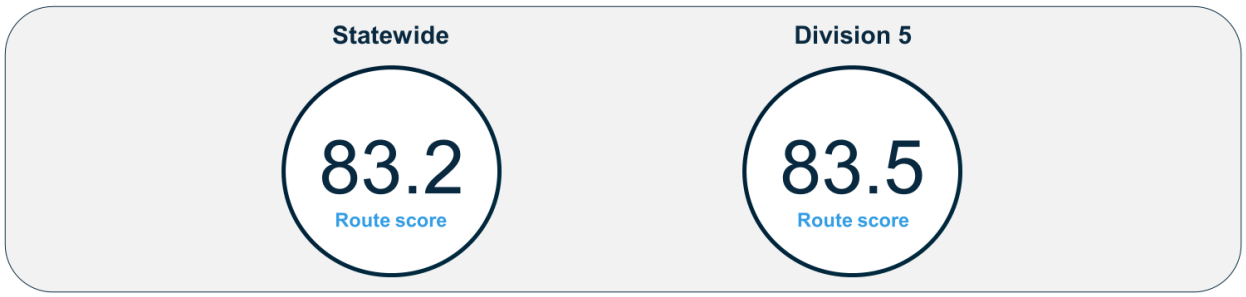


Table 1 – Asset scores (percentage of non defective units or index score) across State and Division

1.2.2 Most Recent Outcomes

Using the scoring method shown above, the overall conditions of a division's roads can be shown with a single score that takes the weighted[iii] average of all its routes:



Route class	State	Division 5
Interstates	89	87
Primary	83	82
Secondary	82	83

Table 2 – Route scores by class

1.3 Route Score Distribution

The majority of the Division's network consists of routes in good condition, defined by a route score of 80 or higher. Over 9,900 lane miles (66% of network) are considered in good condition.

Conversely, less than 180 lane miles (1% of network) are considered in poor condition, defined by a route score lower than 60. Map 1 shows the condition of routes across the division.

Route score distribution, by lane miles

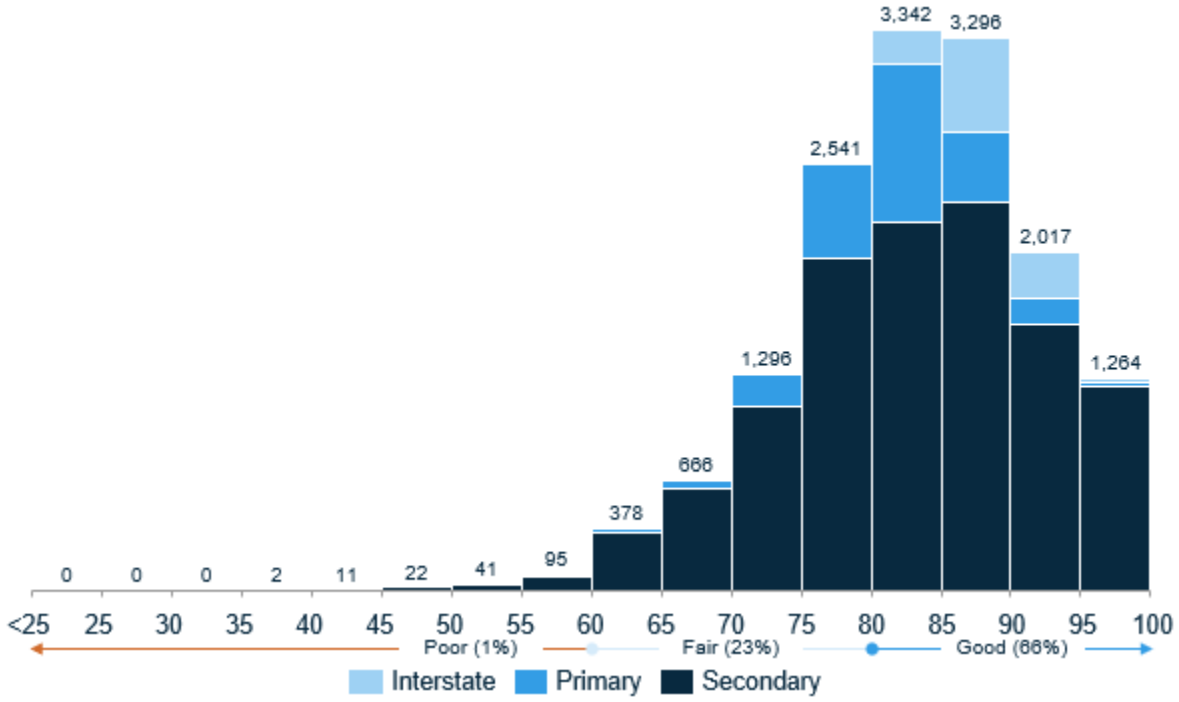
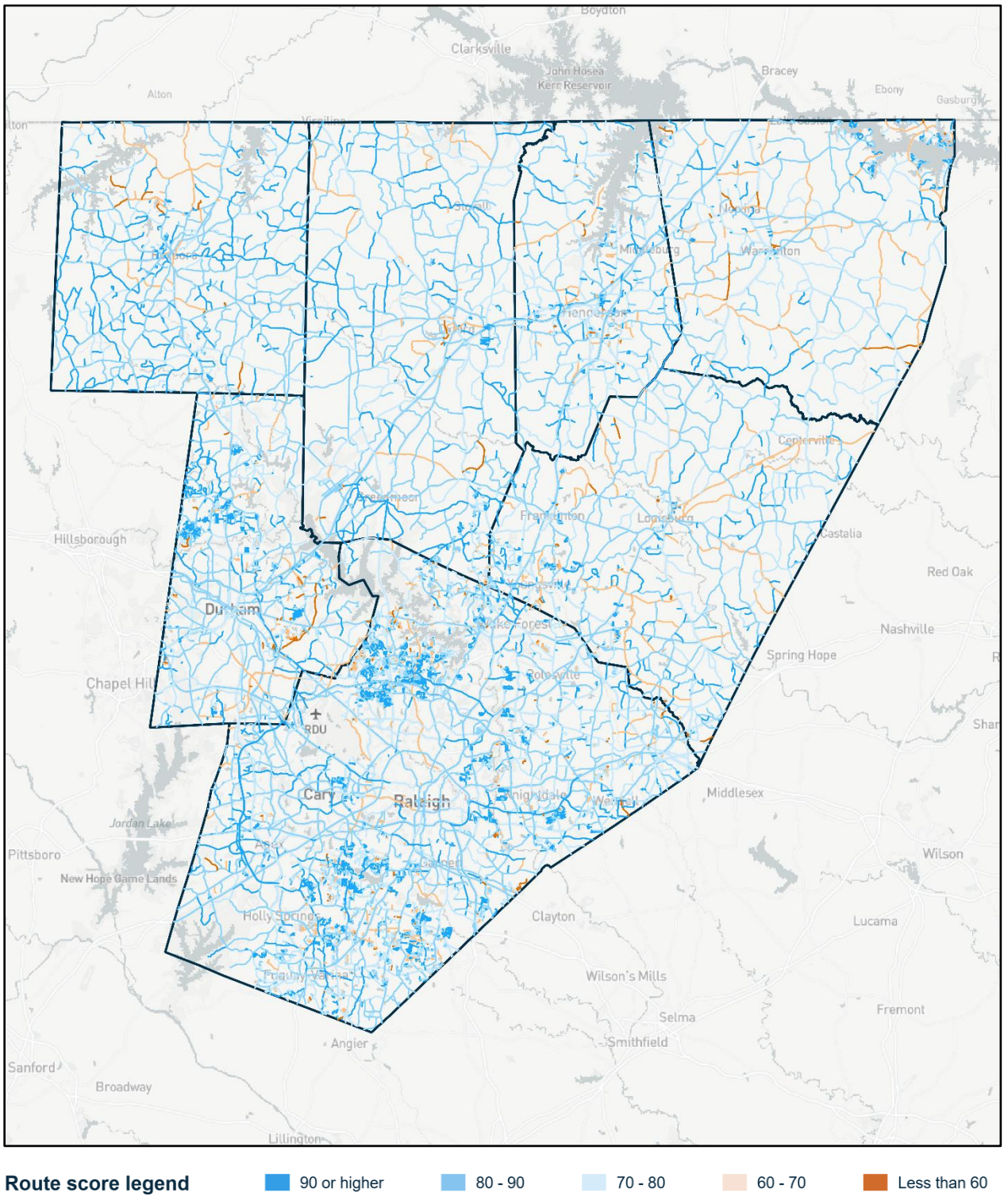


Figure 1 – Distribution of route score, measured in lane miles

Across the road network, the most common route score is between 85 and 90. Interstate and primary routes in Division 5 all have route scores of at least 60, while secondary routes exhibit route scores starting at 35.

These routes can be mapped spatially to evaluate the distribution by geography, as seen on the next page.

Route score distribution, by county



Map 1 – Spatial distribution of route score, grouped by county

1.4 Impact of static funding

Route Score is used to estimate the investment needed[iv] to maintain or achieve various condition levels over the next 10 years, assuming expected inflation[v] and asset deterioration.

Maintaining this division's current condition will require a year-over-year increase in funding, due to inflation and regular wear-and-tear. Static funding will lead to a decline of **-1.6** points in the next year and will potentially lower it by at least **-8.5** points over the next decade.

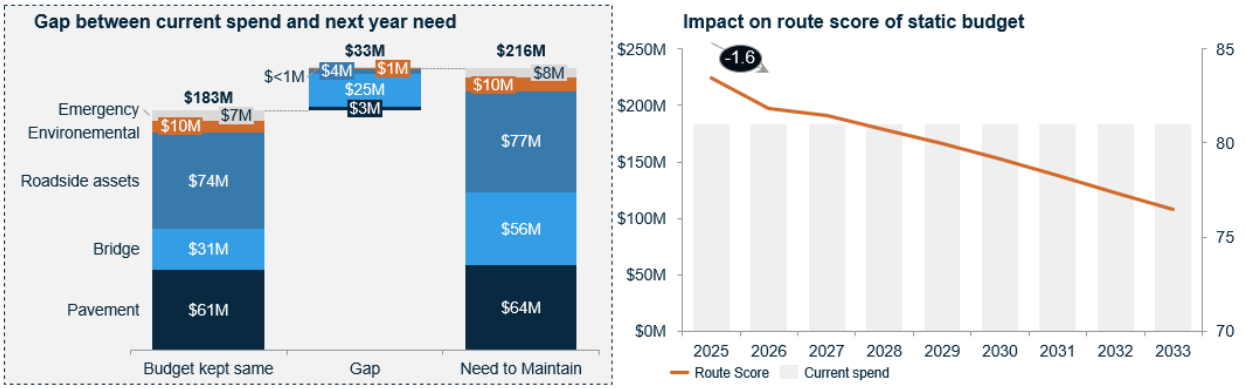


Figure 2 – Comparison of current spend and expected need; route score over time if no budget increase

1.5 Investment needs over the next 10 years

Using the Route Score, ArTEMIS can quantify investment needed to maintain or improve condition by raising the route score by zero points (maintain conditions), one point (slight improvement), five points (large improvement), and ten points (near-perfect conditions)[vi].

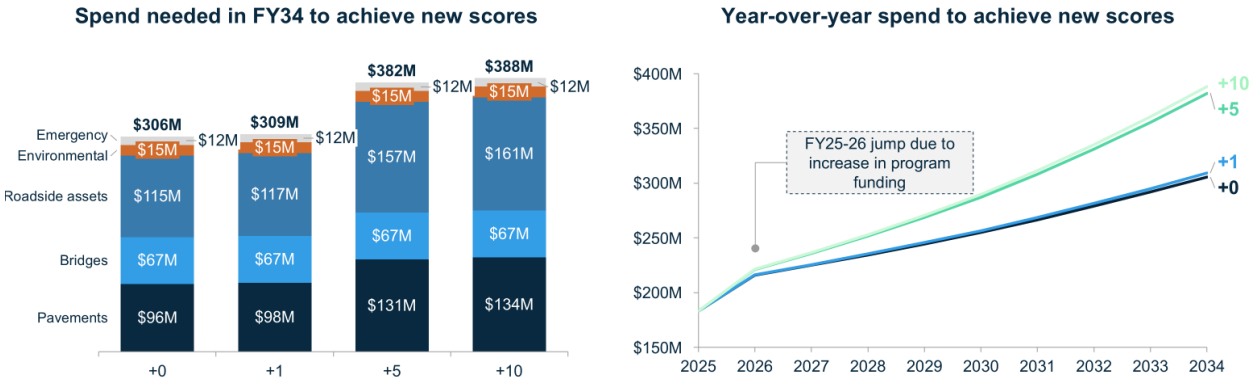


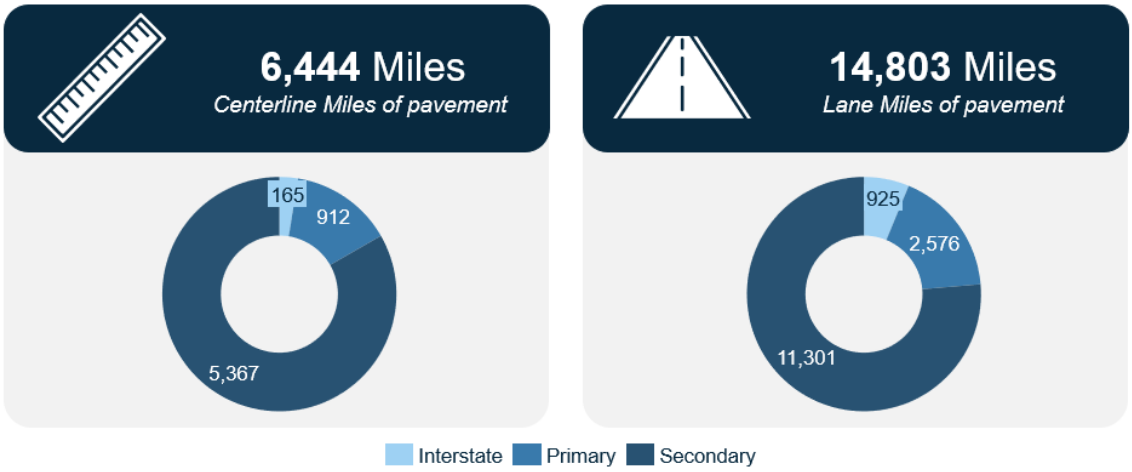
Figure 3 – Projected investment needed (YOE $) to improve route score over 10 years

As shown, maintaining and improving Division 5's Route Score requires greater investment:

- **+0** requires increasing spending to **$306M** by FY34; **$2,501M** in total investment
- **+1** requires increasing spending to **$309M** by FY34; **$2,517M** in total investment
- **+5** requires increasing spending to **$382M** by FY34; **$2,824M** in total investment
- **+10** requires increasing spending to **$388M** by FY34; **$2,850M** in total investment

2 Division Asset Inventory & Condition

2.1 Pavement & Asset Inventory



		Quantity			
Asset	**Unit**	**Interstate**	**Primary**	**Secondary**	**Overall**
Bike Lanes	MI	0	13	68	**81**
Cablerail	MI	116	52	6	**174**
Concrete Barrier	MI	157	14	15	**185**
Crosswalk	EA	0	587	1,929	**2,516**
Curb and Gutter	MI	46	355	1,039	**1,440**
Drop Inlets	EA	843	4,577	14,046	**19,466**
Guardrail	MI	286	169	183	**639**
Impact Attenuator	EA	92	45	37	**174**
Induction Loop	EA	43	2,652	4,654	**7,349**
Mile marker	EA	478	346	81	**905**
Noise Wall*	MI	5	3	1	**9**
Pavement Striping (defective only)	MI	420	338	1,567	**2,326**
Pipes[vii]	LFT	46,858	214,602	259,577	**521,037**
Retaining Wall*	MI	1	1	2	**4**
Road Sign	EA	4,535	19,512	68,749	**92,796**
Rumble Strips*	MI	653	296	64	**1,013**
Sharrows	EA	0	65	752	**817**
Shoulder (defective only)	MI	4	22	126	**151**
Traffic Signal	EA	707	7,203	13,572	**21,482**
Variable Message Sign	EA	38	48	120	**206**
Word and Symbols	EA	1,926	16,651	31,621	**50,198**

Table 3 – Selection of roadside asset inventory; asterisk indicates no significance to route score

2.2 Pavement Conditions

Using Pavement Condition Survey (PCS) data, shown below is the breakdown of good, fair, and poor lane miles across the interstate, primary, and secondary systems.

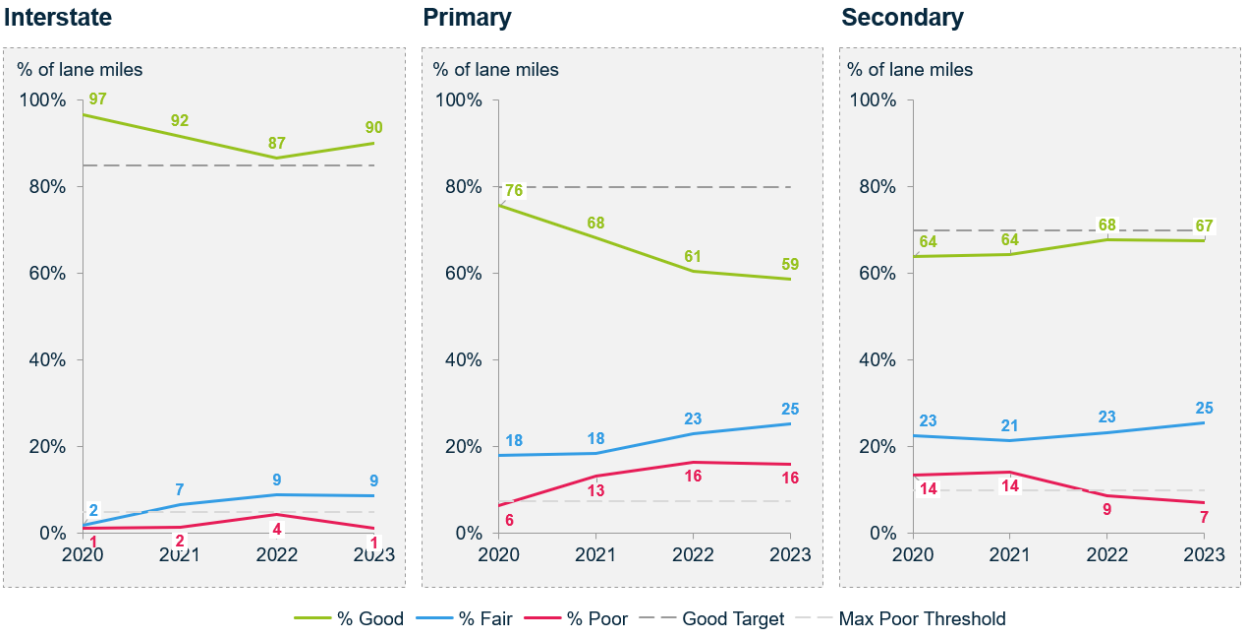


Figure 4 – Pavement conditions across interstate, primary, and secondary systems

Pavement conditions in Division 5 as evaluated via ArTEMIS analysis are similar to statewide condition, with a division-wide pavement index of **83**. Condition varies across the division by primary and secondary routes.

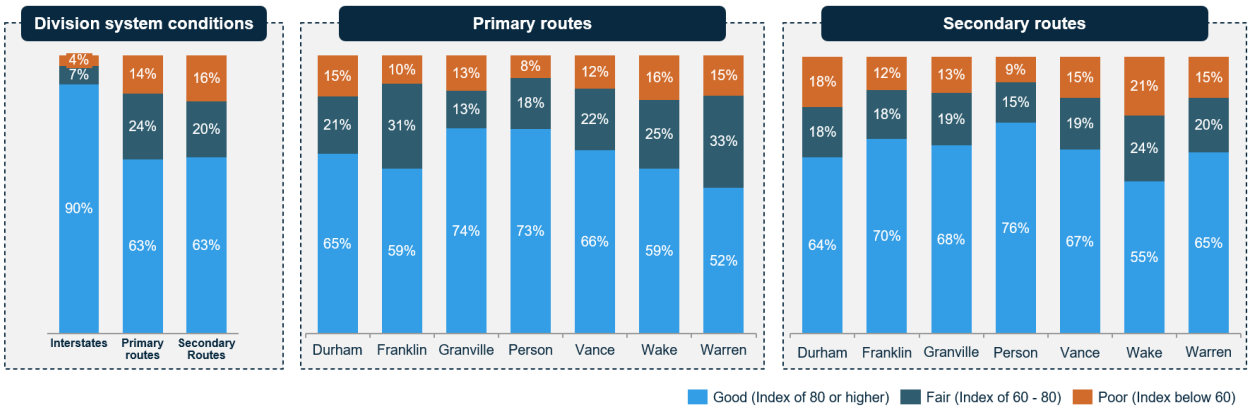


Figure 5 – Comparison of lane miles in good, fair, and poor conditions

County pavement index (weighted by lane miles) range **from 81 to 88**. Deductions are primarily driven by two distresses: (1) alligator cracking and (2) transverse cracking.

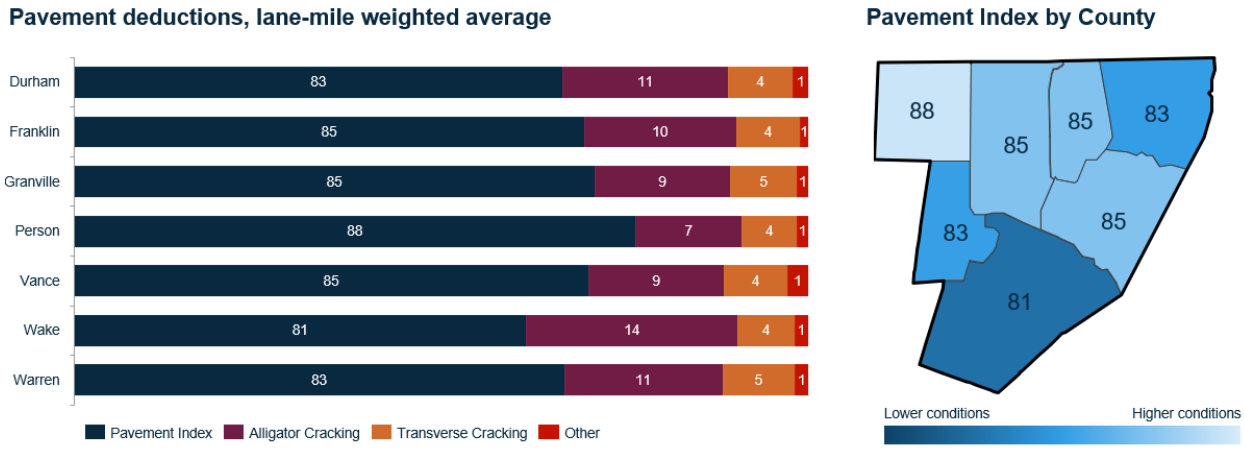


Figure 6 – Pavement index and deduction breakdown by county

Complementary models show similar assessments of pavement condition between the ArTEMIS model and the PCS model for Division 5. The pavement index utilizes the same scoring methodology as the PCS, the only differences being in how the data is collected/reviewed[viii].

	Condition			
Model	**Interstates**	**Primary**	**Secondary**	**Overall**
Pavement index (ArTEMIS)	93	82	83	83
Pavement condition score (PCS)	89	80	84	84

Table 4 – Condition comparison by pavement models for Division 5

2.3 Bridge Conditions

Bridge conditions are evaluated using a bridge index that translates general condition ratings (i.e., 1-9 scale) into a 100-point scale for easier comparison.

Overall, the Division 5 bridge index (84) scores ~2 point higher than statewide bridge index (82).

Data is ingested from FHWA bridge portal.

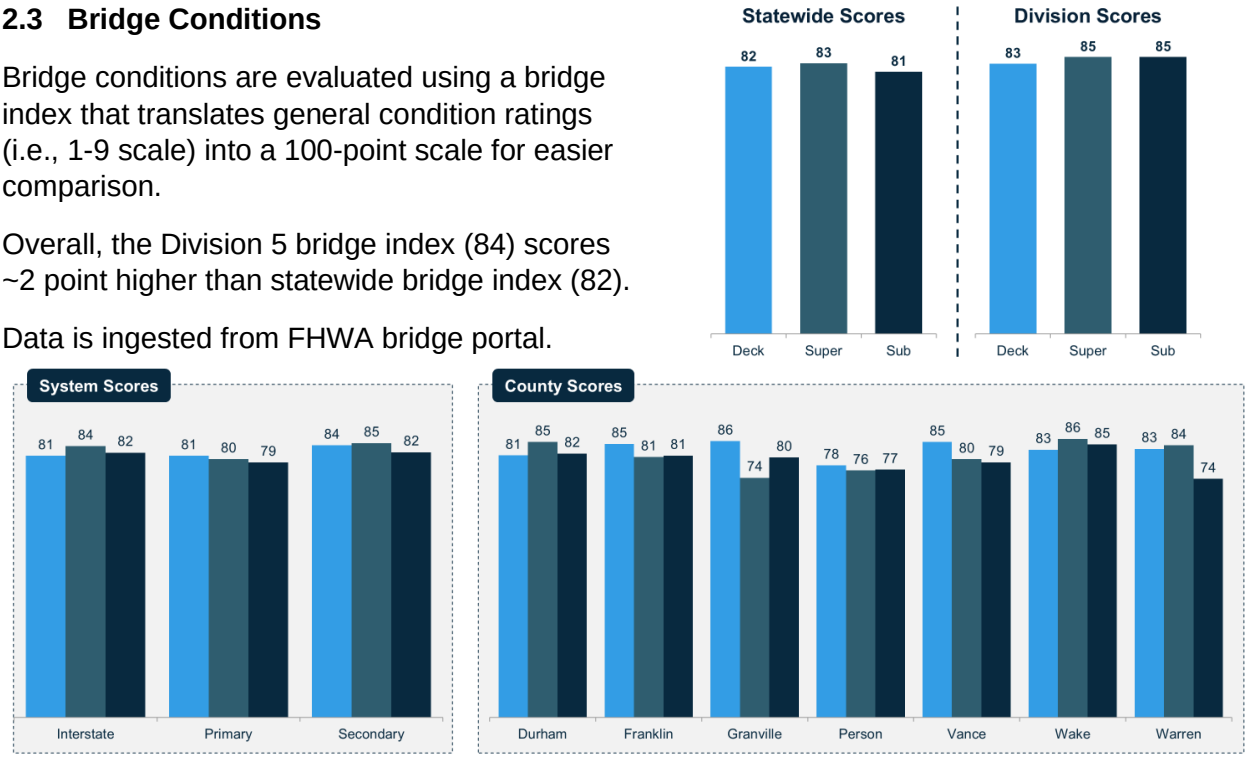


Figure 7 – Comparison of bridge conditions

The figure below displays all poor-condition bridges (bridge index below 60) and bridges at-risk of becoming poor (bridge index of 60 – 69). They are mostly on the secondary road system. Each circle indicates one bridge mapped using its exact location (latitude, longitude); circle size indicates deck area, with at-risk bridges mapped as uniformly sized dots.

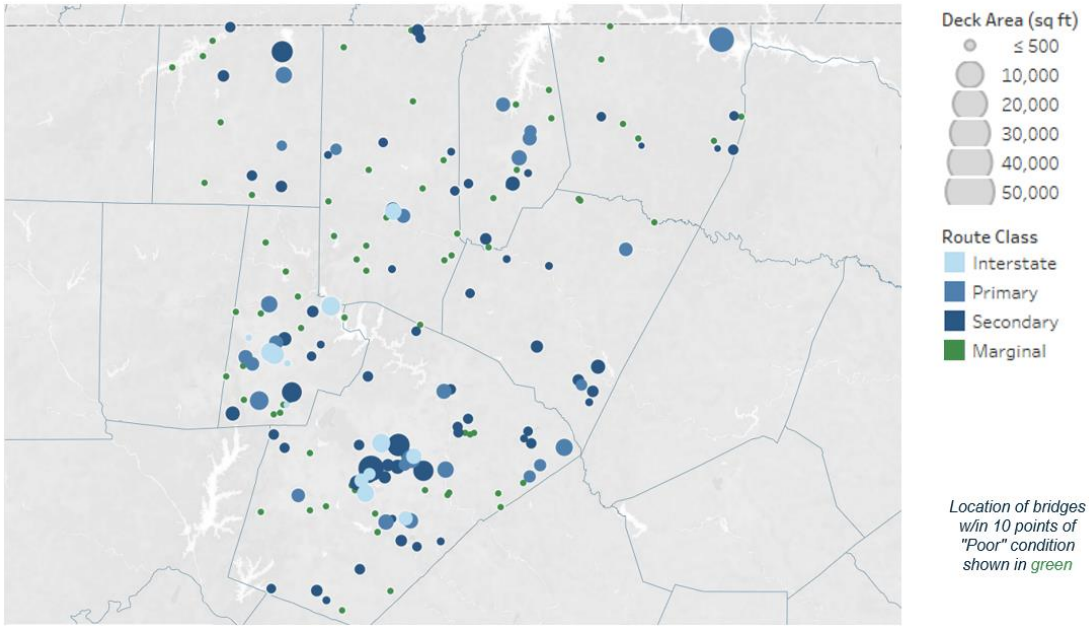


Figure 8 – Distribution of poor and at-risk of becoming poor condition bridges in Division 5

2.4 Roadside Asset Conditions

Roadside asset condition is evaluated by measuring the proportion at which an asset is non-defective in a division, county, or route.

Asset	State	D5	Durham	Franklin	Granville	Person	Vance	Wake	Warren
Pavement Striping	89%	90%	90%	90%	88%	90%	90%	90%	85%
Bike Lanes	78%	83%	78%		100%			86%	
Word and Symbols	74%	74%	75%	79%	83%	85%	78%	73%	72%
Sharrows	84%	86%	90%					86%	
Signs	94%	95%	93%	90%	96%	93%	94%	96%	90%
Drop Inlets	89%	86%	85%	90%	84%	73%	76%	86%	84%
Curb and Gutter	96%	98%	96%	96%	96%	95%	89%	99%	85%
Guardrails	98%	97%	97%	99%	96%	99%	99%	97%	99%
Shoulder	98%	99%	98%	99%	99%	99%	99%	98%	99%

Most Defective — Least Defective

Figure 9 – Comparison of conditions between county functional assets [ix]

Below is roadside asset condition visualized with county boundaries, where colors are relative to the average condition across the state, for each respective asset.

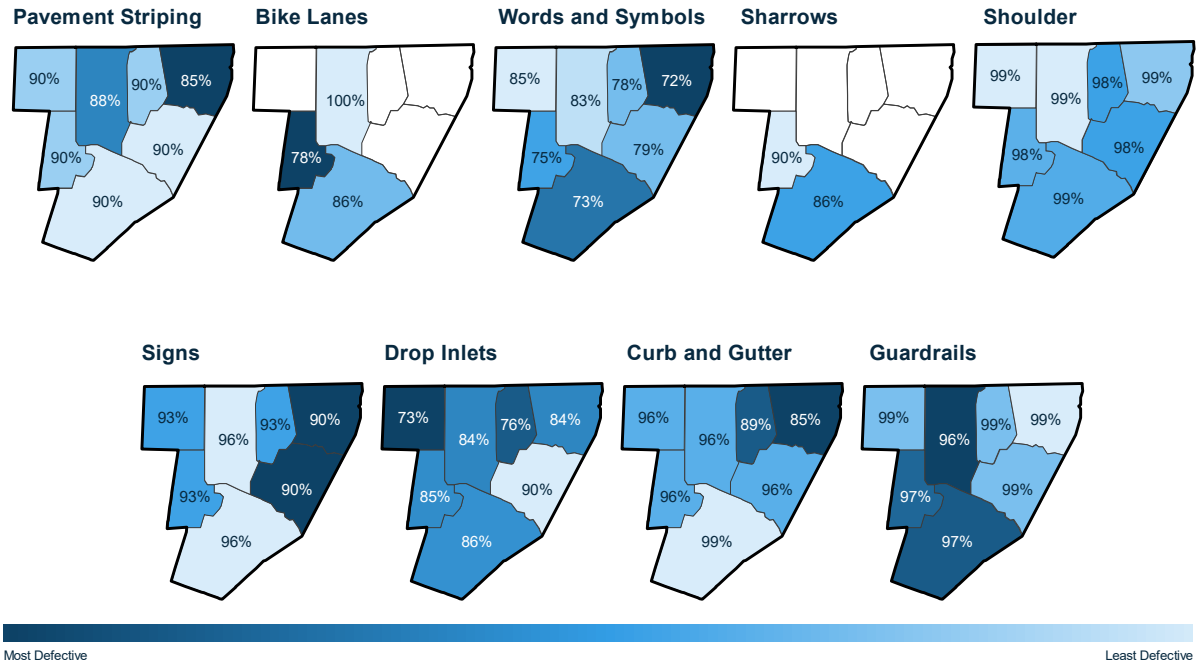


Figure 10 – Comparison of roadside asset conditions mapped to county boundaries

3 Rehabilitation / Rebuilding Needs

To develop a sense of what level of investment is required to ensure our state's ability to provide a safe and effective transportation network into the future, in the summer of 2024 the Director of Highway Operations reached out to all 14 Division Engineers and their teams, asking them to provide details on their highest priority ~35 miles of reconstruction/rehabilitation needs. The submitted sections for Division 5, along with estimated costs, are outlined below ranked in order of priority (as submitted).

Route	County	Comments	Miles	Est. Cost ($M)
I-40	Wake	Concrete structure rapidly deteriorating due to end of lifespan and ASR presence. 2 lanes are old JCP and 1 lane and collector lanes are a mix of asphalt and concrete.	3.72	$421M
US 1	Wake	ASR in cement stabilized subgrade and increased truck traffic is resulting in rapid pavement deterioration. Project continues in D8.	3.40	$102M
I-85	Durham/ Granville	Concrete structure deteriorating due to high truck traffic and end of pavement lifespan.	1.79	$131M
NC 147	Durham	Concrete structure deteriorating due to high truck traffic and end of pavement lifespan.	3.94	$353M
US 70, Glennwood Ave	Wake	Underlying concrete pavement structure is very old resulting in frequent repairs and occasional closures.	7.50	$462M
US 1, Capital Blvd.	Wake	Concrete structure deteriorating due to high truck traffic and end of pavement lifespan.	2.05	$155M
I-40	Durham	Concrete structure deteriorating due to high truck traffic and end of pavement lifespan.	10.01	$790M
US 501	Person	Concrete structure under asphalt is deteriorating	19.00	$84M
Total	-	-	**35.03**	**$2,499M**

Table 5 – Submitted rehabilitation / rebuilding priorities and estimated costs

4 Cost Summary

To inform the model of how conditions translate into maintenance investment needs, should-cost was collected – what should various maintenance activities cost? This is used to estimate costs for the most common maintenance treatments down to the activity level.

Highlighted below are the unique unit costs for assets in Division 5, where activity costs of more common treatments are weighted more heavily than less common treatments for each asset[x].

Weighted average unit costs by Division

Asset	UOM	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14
Bike Lanes	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Cablerail*	LFT	$2	$1	$2	$5	$1	$1	$3	$2	$0	$5	$2	$0	$2	$1
Concrete Barrier*	LFT	$500	$8	$3	$1,350	$16	$15	$3	$182	$163	$182	$6	$42	$25	$50
Pipes	LFT	$267	$379	$315	$479	$273	$275	$327	$462	$296	$378	$395	$90	$256	$345
Crosswalk	EA	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Curb and Gutter*	LFT	$102	$132	$125	$83	$112	$144	$117	$109	$78	$112	$93	$39	$90	$88
Drop Inlets*	EA	$811	$809	$1,363	$460	$974	$714	$865	$788	$830	$1,041	$794	$744	$1,361	$1,297
Guardrail*	LFT	$16	$30	$36	$12	$1	$49	$30	$31	$12	$32	$6	$32	$50	$21
Impact Attenuator*	EA	$2,500	$12,500	$5,000	$8,840	$2,707	$1,925	$17,500	$750	$1,704	$9,250	$2,028	$2,613	$10,250	$3,000
Induction Loop	LFT	$1,381	$726	$2,777	$1,695	$825	$1,358	$748	$1,486	$573	$3,097	$1,322	$2,144	$1,167	$1,308
Mile marker	EA	$129	$171	$172	$135	$440	$268	$168	$276	$285	$164	$427	$137	$143	$192
Pavement Striping*	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Ramp Metering	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Road Sign	EA	$309	$365	$232	$288	$613	$378	$379	$366	$462	$249	$581	$249	$293	$338
Shoulder	SHM	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Timber Rail	LFT	$44	$6	$49	$313	$13	$8	$2	$49	$44	$49	$3	$23	$23	$63
Traffic Signal	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Word and Symbols	LFT	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Crack Seal	LM	$3,103	$4,000	$3,300	$3,409	$6,009	$2,100	$4,366	$4,000	$3,250	$6,000	$7,850	$4,366	$4,366	$5,000
Chip Seal	LM	$21,933	$18,625	$22,750	$17,014	$26,732	$53,875	$22,356	$49,000	$30,925	$17,500	$21,500	$22,902	$33,701	$32,500
Contract Resurfacing*	LM	$120,418	$140,000	$67,500	$96,025	$109,701	$92,500	$213,998	$97,500	$116,150	$185,000	$66,250	$87,184	$88,750	$151,250

Table 6 – Unit cost comparison between Divisions

[i] Condition and inventory data collected via ArTEMIS from January to September 2023; cost data collected from individual divisions and validated in February/March of 2024. Thus, funding scenarios outlined in this document were developed prior the impacts of Hurricane Helene & based on infrastructure condition data collected prior to the storm. As such, they do not account for the additional costs associated with the rehabilitation or reconstruction of infrastructure affected by the storm. Recognizing that rebuilding will entail significant expenses, the current scenarios focus on maintaining the regular operational budget and steady-state upkeep without reallocation of funds.

[ii] For purposes of calculating route score, "Words and Symbols" also includes bike lanes, crosswalks, sharrows.

[iii] When aggregated, route scores are weighted by lane miles and route class.

[iv] Maintenance costs are estimated solely by prioritizing the most efficient and cost-effective maintenance activities in terms of their impact on overall state/division route score, regardless of pre-existing plans, priorities, or ongoing projects.

[v] For these investment scenarios, we assume rates of inflation for labor, material, and equipment costs of 3%, 5%, and 8% respectively, per the 2023Q4 Engineering News-Record Cost Report. Costs for non-maintenance activities are assumed to increase at annual rate of 3%.

[vi] Spend to increase route score views pavement and roadside asset activities, only. Bridge activities that would increase score are currently not included. This may underestimate need when calculating need to improve by 10 pts.

[vii] Pipes are ingested into inventory counts via NCDOT survey

[viii] The pavement index assessment is consistent for every route and captures the entirety of the Division's inventory. At times, the asset detection algorithm powering the pavement index may miss light / moderate rutting.

[ix] Blank cells indicate that the asset type is not present in county and therefore excluded from analysis.

[x] Asterisk denotes predominately contracted activities. Cable rails, impact attenuators, pavement markings, guardrails, and drop inlets are typically contracted out in D5. All cost data in this table were provided and validated by engineers from each division. Variations in costs may arise due to several factors, including the frequency of repairs, whether work is performed in-house or contracted out, and the defect severity at which interventions are initiated. For assets where specific cost data were unavailable, the average cost across all divisions was used. Data was collected and validated February - May 2024.

DIVISION 6 INSIGHTS REPORT

This report uses data on inventory, condition, and costs to provide insights at the division, county, and route levels. It identifies long-term investment needs and opportunities across the system to optimize outcomes.[i]

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2 Division Asset Inventory & Condition 70

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4 Cost Summary 76

1 Division Funding Needs

1.1 Data Background

Launched in 2020, ArTEMIS initially tracked 30+ discrete maintenance functions on state-managed routes. Since then, it has expanded to capture a "fence-to-fence" view of assets, activity-based costs, and lifecycle investment forecasting, enabling more precise, data-driven maintenance planning.

The 2023 initiative leverages image recognition and AI/ML to assess conditions across 2+ million geo-located assets statewide. By aligning new inventory data with established sources like the Pavement Condition Survey, it enhances accuracy through "Route Scores" at route, county, division, and state levels, which help forecast investment needs. Similar to weather forecasting, aligning multiple datasets strengthens accuracy and reliability.

Statewide data collected and validated from January to September 2023 includes image collection, route walkthroughs, inspections, and quality reviews. These, alongside activity-based “should-cost” estimates—based on current market and industry standards—inform the Total Cost of Ownership model, supporting comprehensive maintenance planning.

1.2 Route Score Overview

1.2.1 Methodology

The table below shows the asset conditions contributing to Division 6's overall route score and how a route score is assembled at the route level (before being aggregated up by system counties, divisions, etc). The score uses point-in-time data collected January - September 2023.

Asset	State	Division 6
Pavement Index	83	84
Bridge Index	82	88
Shoulder	98%	98%
Pipes	82%	81%
Drop Inlets	89%	88%
Curb and Gutter	96%	98%
Pavement Striping	89%	92%
Signs	94%	92%
Guardrails and barriers	98%	98%
Words and Symbols[ii]	96%	97%
Traffic devices	100%	100%

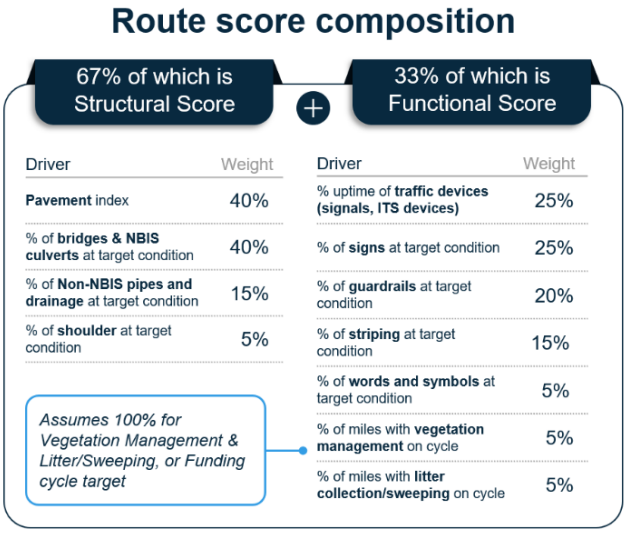
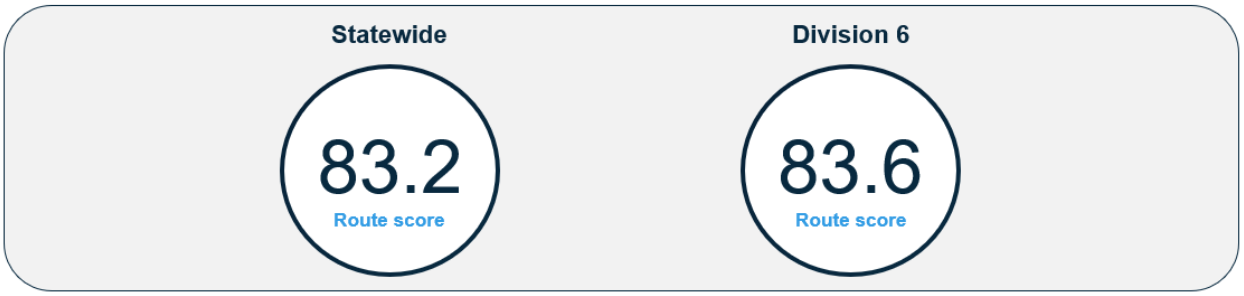


Table 1 – Asset scores (percentage of non-defective units or index score) across State and Division

1.2.2 Most Recent Outcomes

Using the scoring method shown above, the overall conditions of a division's roads can be shown with a single score that takes the weighted[iii] average of all its routes:



Route class	State	Division 6
Interstates	89	88
Primary	83	84
Secondary	82	83

Table 2 – Route scores by class

1.3 Route Score Distribution

The majority of the Division's network consists of routes in good condition, defined by a route score of 80 or higher. Over 8,900 lane miles (67% of network) are considered in good condition.

Conversely, less than 270 lane miles (8% of network) are considered in poor condition, defined by a route score lower than 60. Map 1 shows the condition of routes across the division.

Route score distribution, by lane miles

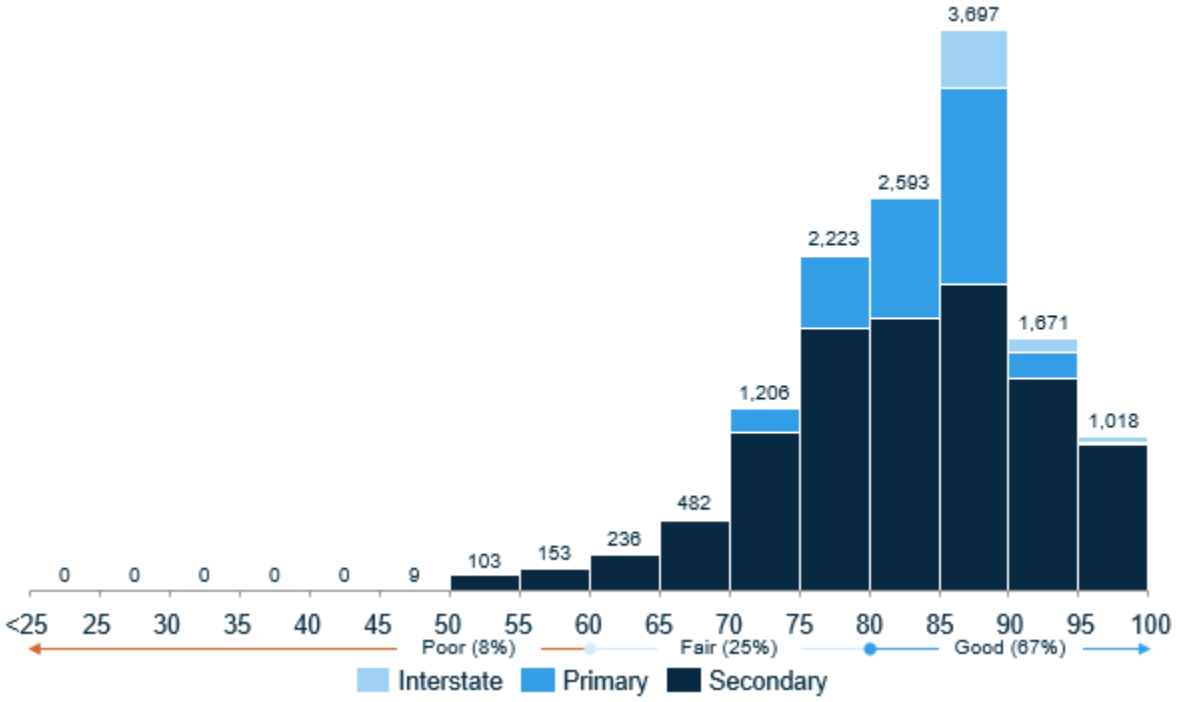
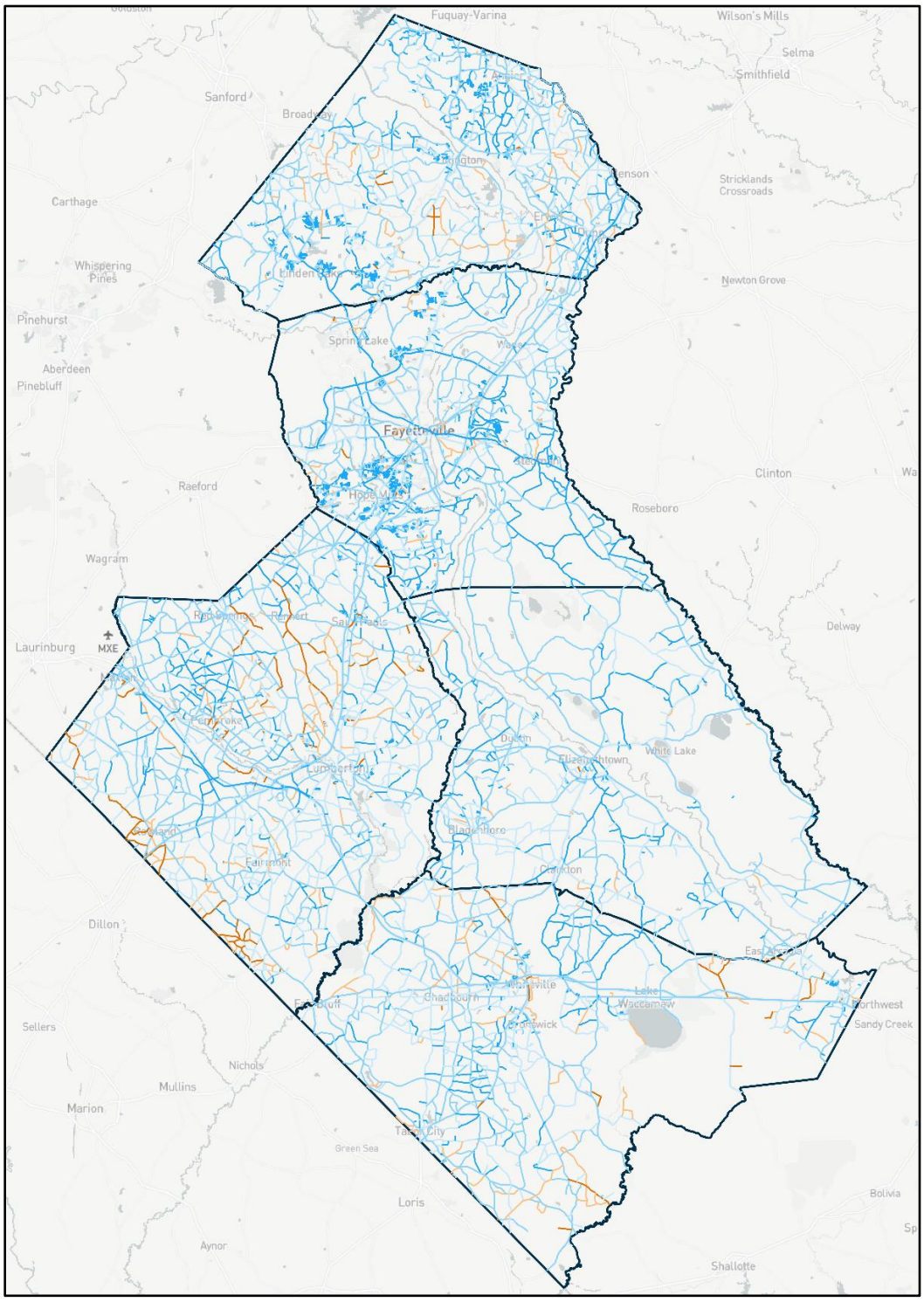


Figure 1 – Distribution of route score, measured in lane miles

Across the road network, the most common route score is between 85 and 90. Interstate and primary routes in Division 6 all have route scores of at least 70, while secondary routes exhibit route scores starting at 45.

These routes can be mapped spatially to evaluate the distribution by geography, as seen on the next page.

Route score distribution, by county



Route score legend 90 or higher | 80 - 90 | 70 - 80 | 60 - 70 | Less than 60

Map 1 – Spatial distribution of route score, grouped by county

1.4 Impact of static funding

Route Score is used to estimate the investment needed[iv] to maintain or achieve various condition levels over the next 10 years, assuming expected inflation[v] and asset deterioration.

Maintaining this division's current condition will require a year-over-year increase in funding, due to inflation and regular wear-and-tear. Static funding may lead to a decline of **-1.8** points in the next year and will potentially lower it by at least **-8.9** points over the next decade.

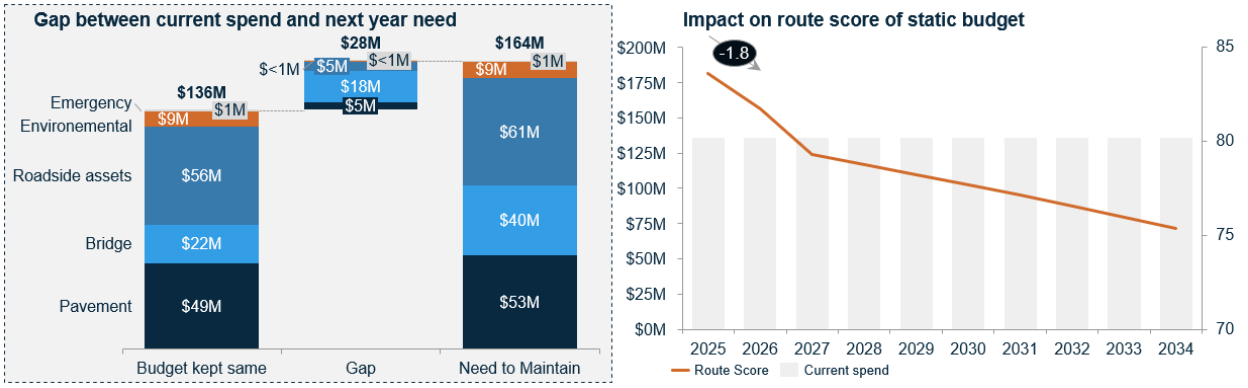


Figure 2 – Comparison of current spend and expected need; route score over time if no budget increase

1.5 Investment needs over the next 10 years

Using the Route Score, ArTEMIS can quantify investment needed to maintain or improve condition by raising the route score by zero points (maintain conditions), one point (slight improvement), five points (large improvement), and ten points (near-perfect conditions)[vi].

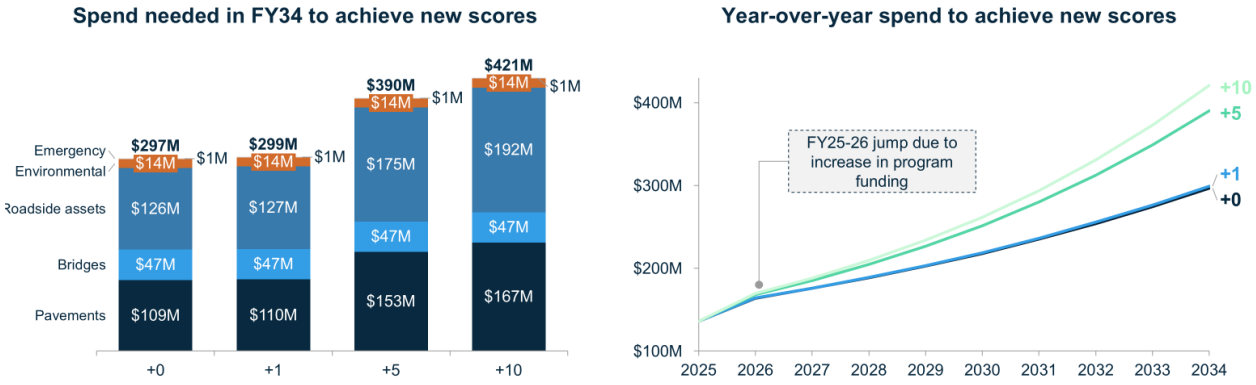


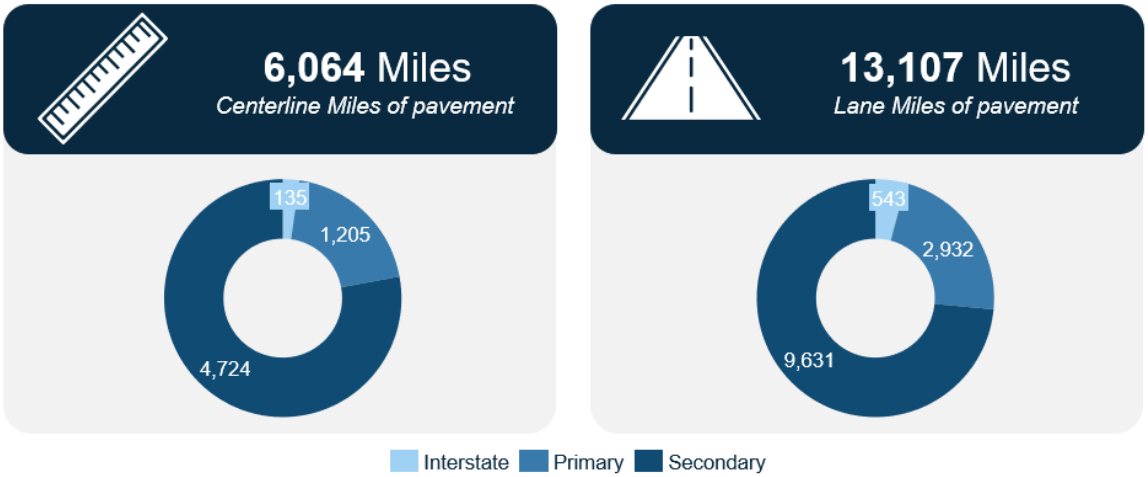
Figure 3 – Projected investment needed (YOE $) to improve route score over 10 years

As shown, maintaining and improving Division 6's Route Score requires greater investment:

- **+0** requires increasing spend to **$297M** by FY34; **$2,146M** in total investment
- **+1** requires increasing spend to **$299M** by FY34; **$2,155M** in total investment
- **+5** requires increasing spend to **$390M** by FY34; **$2,504M** in total investment
- **+10** requires increasing spend to **$421M** by FY34; **$2,616M** in total investment

2 Division Asset Inventory & Condition

2.1 Pavement & Asset Inventory



		Quantity			
Asset	**Unit**	**Interstate**	**Primary**	**Secondary**	**Overall**
Bike Lanes	LFT	0	0	6,753	6,753
Cablerail	MI	89	83	9	181
Concrete Barrier	MI	73	8	5	86
Crosswalk	EA	0	85	230	315
Curb and Gutter	MI	5	246	216	467
Drop Inlets	EA	269	3,834	8,741	12,844
Guardrail	MI	79	93	76	248
Impact Attenuator	EA	77	32	15	124
Induction Loop	EA	22	462	519	1,003
Mile marker	EA	135	111	17	263
Noise Wall*	LFT	17,113	3,825	0	20,938
Pavement Striping (defective only)	MI	49	439	1,109	1,597
Pipes[vii]	LFT	48,481	339,266	252,449	640,196
Retaining Wall*	LFT	1,398	5,294	4,745	11,437
Road Sign	EA	1,535	16,356	32,617	50,508
Rumble Strips*	MI	364	516	75	955
Sharrows	EA	0	0	0	0
Shoulder (defective only)	MI	3	43	149	195
Traffic Signal	EA	132	3,792	3,254	7,178
Variable Message Sign	EA	18	17	9	44
Word and Symbols	EA	822	12,900	9,091	22,813

Table 3 – Selection of roadside asset inventory; asterisk indicates no significance to route score

2.2 Pavement Conditions

Using Pavement Condition Survey (PCS) data, shown below is the breakdown of good, fair, and poor lane miles across the interstate, primary, and secondary systems.

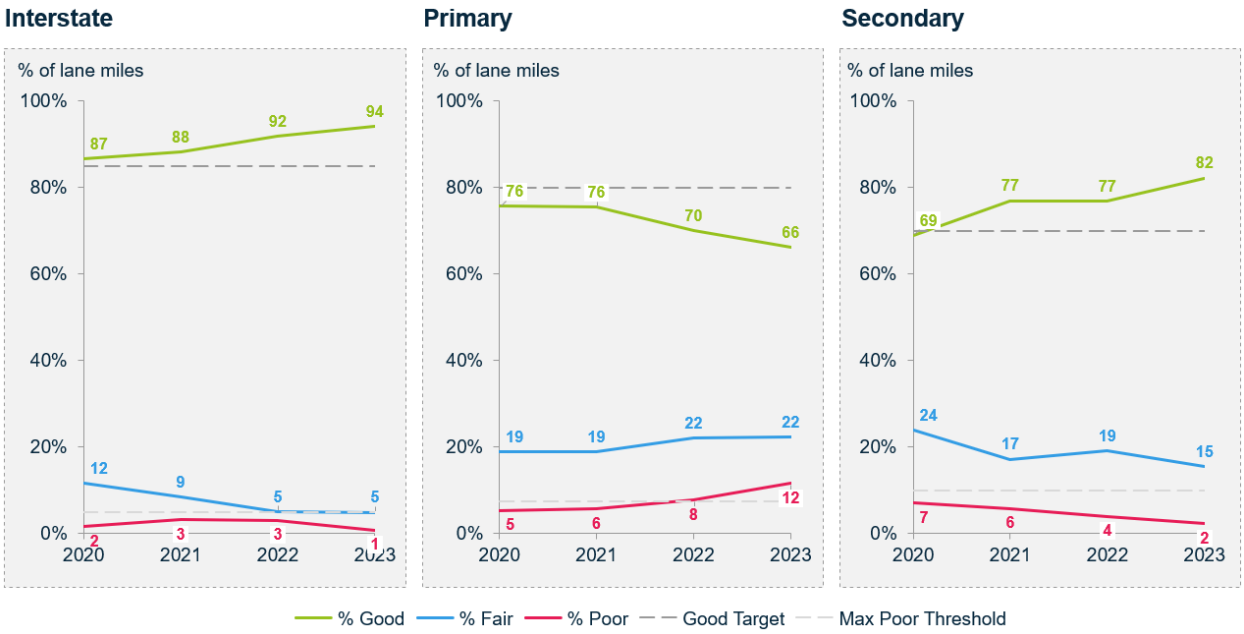


Figure 4 – Pavement conditions across interstate, primary, and secondary systems

Pavement conditions in Division 6 as evaluated via ArTEMIS analysis are above the state average, with a division-wide pavement index of **84**. Condition varies across the division by primary and secondary routes.

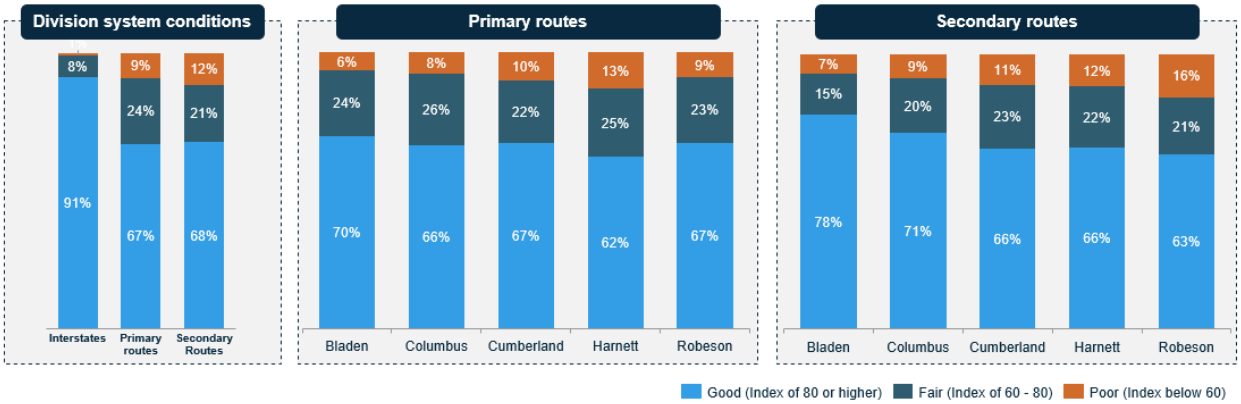


Figure 5 – Comparison of lane miles in good, fair, and poor conditions

County pavement index (weighted by lane miles) range **from 83 to 87**. Deductions are primarily driven by two distresses: (1) alligator cracking and (2) transverse cracking.

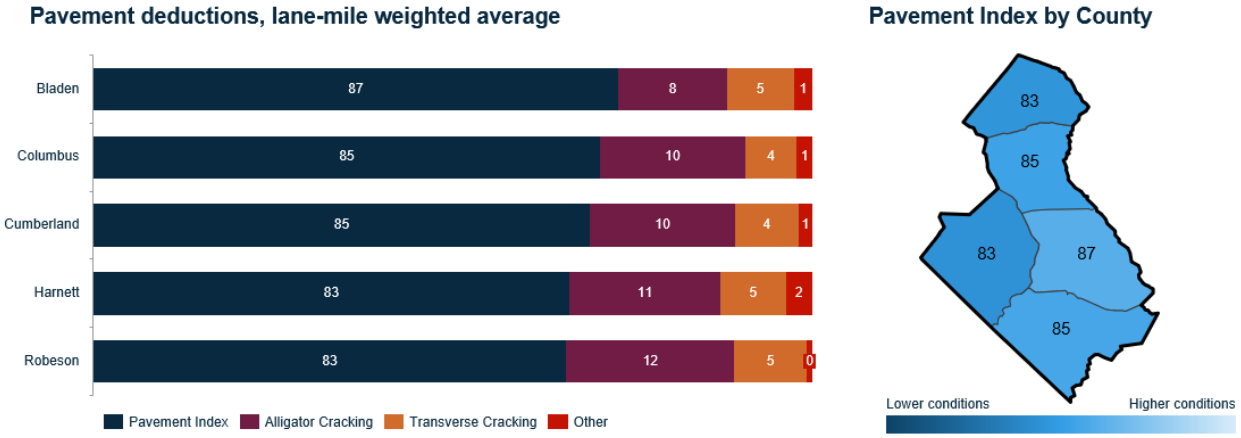


Figure 6 – Pavement index and deduction breakdown by county

Complementary models show similar assessments of pavement condition between the ArTEMIS model and the PCS model for Division 6. The pavement index utilizes the same scoring methodology as the PCS, the only differences being in how the data is collected/reviewed[viii].

	Condition			
Model	**Interstates**	**Primary**	**Secondary**	**Overall**
Pavement index (ArTEMIS)	95	84	84	84
Pavement condition score (PCS)	95	83	88	87

Table 4 – Condition comparison by pavement models for Division 6

2.3 Bridge Conditions

Bridge conditions are evaluated using a bridge index that translates general condition ratings (i.e., 1-9 scale) into a 100-point scale for easier comparison.

Overall, the Division 6 bridge index (88) scores ~6 points higher than statewide bridge index (82).

Data is ingested from FHWA bridge portal.

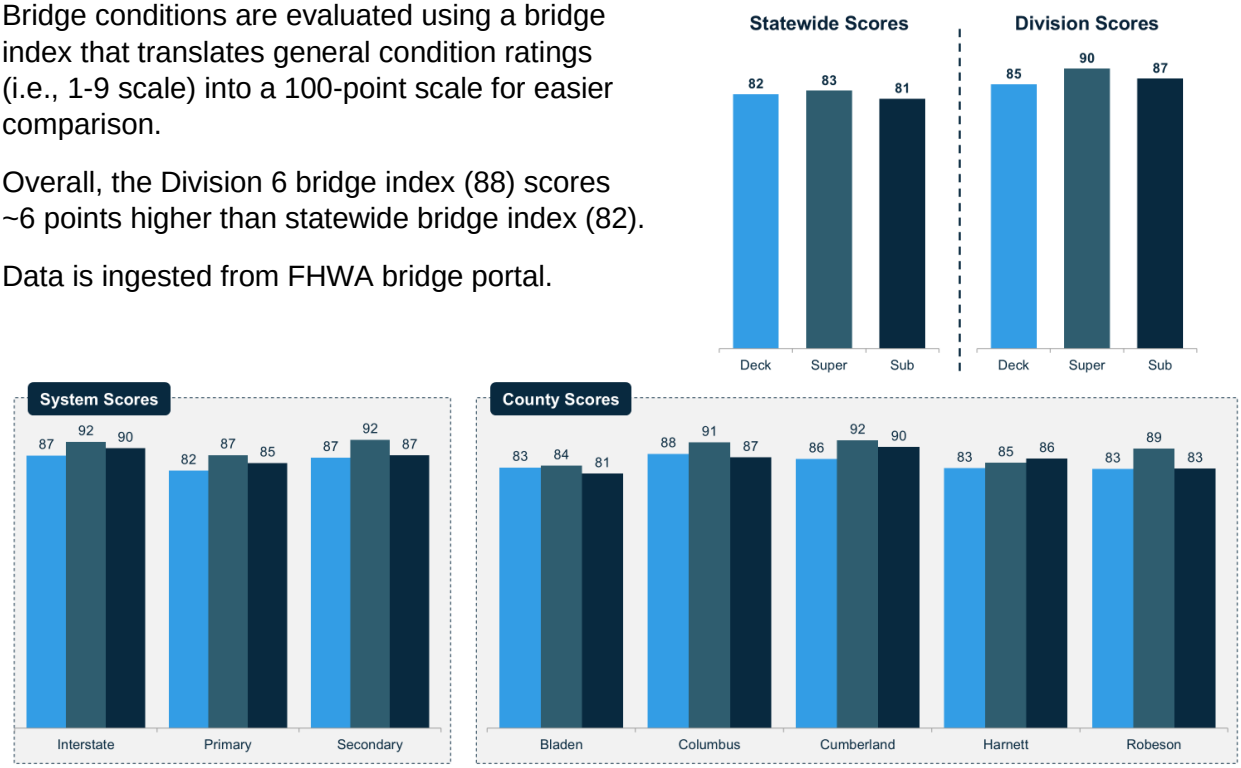


Figure 7 – Comparison of bridge conditions

The figure below displays all bridges in poor condition (index below 60) or at-risk of becoming poor (index of 60 – 69). They are mostly on the secondary system. Each circle maps one bridge by latitude and longitude; circle size indicates deck area, with at-risk bridges sized uniformly.

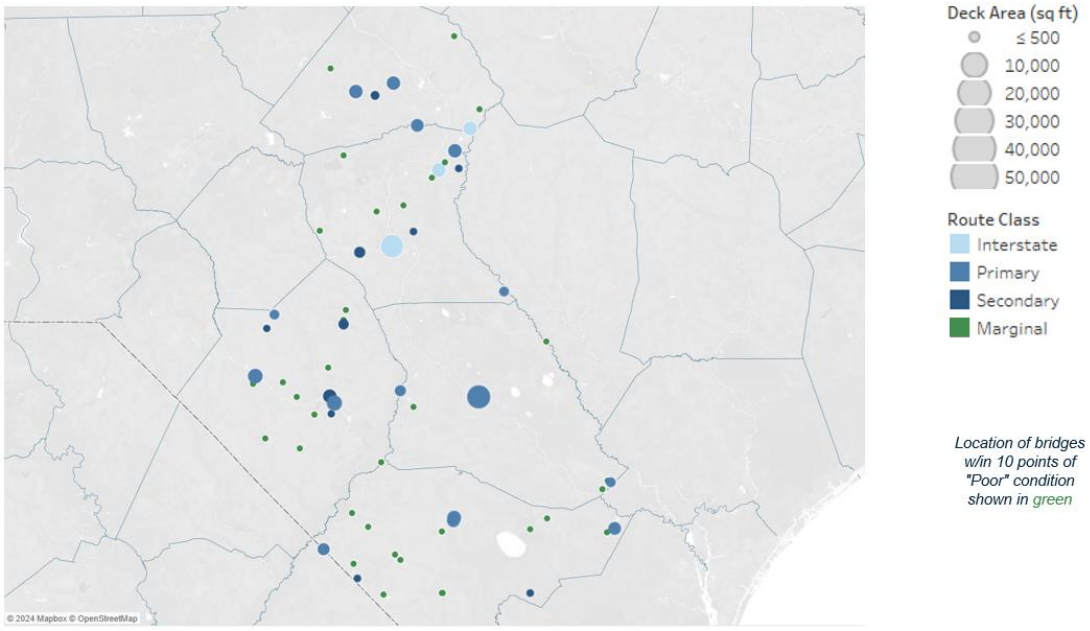


Figure 8 – Distribution of poor bridges and at-risk of becoming poor condition bridges in Division 6

2.4 Roadside Asset Conditions

Roadside asset condition is evaluated by measuring the proportion at which an asset is non-defective in a division, county, or route.

Asset	State	D6	Bladen	Columbus	Cumberland	Harnett	Robeson
Pavement Striping	89%	92%	91%	91%	93%	93%	92%
Bike Lanes	78%	100%					100%
Word and Symbols	74%	75%	68%	81%	75%	72%	77%
Sharrows	84%						
Signs	94%	92%	90%	87%	96%	97%	88%
Drop Inlets	89%	88%	78%	94%	89%	86%	88%
Curb and Gutter	96%	98%	97%	98%	98%	97%	95%
Guardrails	98%	98%	99%	98%	98%	98%	97%
Shoulder	98%	98%	98%	99%	98%	98%	99%

Most Defective — Least Defective

Figure 9 – Comparison of conditions between county functional assets [ix]

Below is roadside asset condition visualized with county boundaries, where colors are relative to the average condition across the state, for each respective asset.

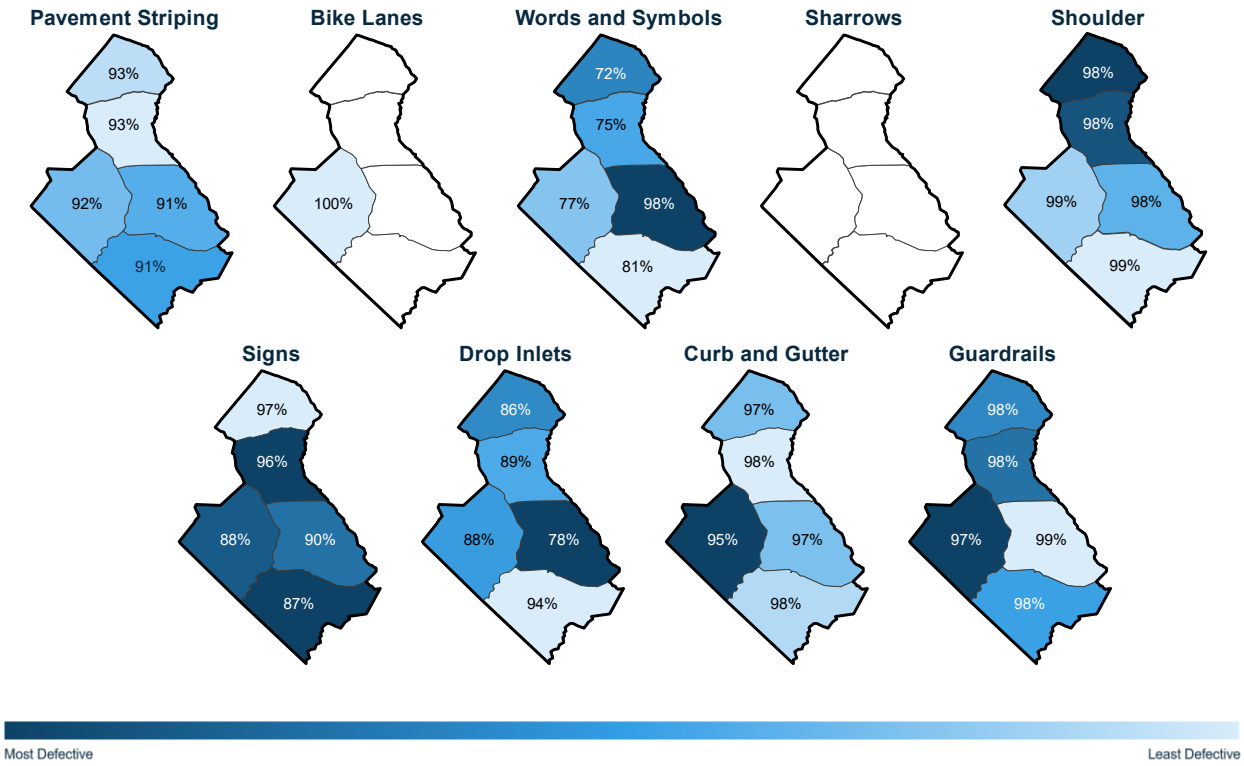


Figure 10 – Comparison of roadside asset conditions mapped to county boundaries

3 Rehabilitation / Rebuilding Needs

To develop a sense of what level of investment is required to ensure our state's ability to provide a safe and effective transportation network into the future, in the summer of 2024 the Director of Highway Operations reached out to all 14 Division Engineers and their teams, asking them to provide details on their highest priority ~35 miles of reconstruction/rehabilitation needs. The submitted sections for Division 6, along with estimated costs, are outlined below ranked in order of priority (as submitted).

Route	County	Comments	Miles	Est. Cost ($M)
US 401 BYP	Cumberland	Rutting, wheel path failures. In HMIP 2026 & 2027	4.39	$118M
NC 87	Bladen	Pavement 25+ Years Old with PCS <60 Would benefit from mill w/ multiple lifts	4.18	$90M
US 421	Harnett	Shoving, rutting. In HMIP 2028	7.64	$89M
US 421	Harnett	Rutting. In HMIP 2028	1.59	$18M
US 421	Harnett	Rutting. In HMIP 2028	1.26	$32M
US 421	Harnett	Rutting. In HMIP 2028	3.44	$74M
NC 41	Bladen	Pavement 16 Years Old with PCS 67-72 Would benefit from mill with multiple lifts	1.76	$38M
NC 72	Robeson	Asphalt deteriorates exponentially following a resurfacing operation due to the presence of concrete and aging utilities.	2.05	$26M
NC 72	Robeson	Asphalt deteriorates exponentially following a resurfacing operation due to the presence of concrete and aging utilities.	2.20	$28M
US 301	Robeson	Concrete spalding is a hinderance to the rideability of the route.	5.90	$76M
NC 41	Robeson	Asphalt deteriorates exponentially following a resurfacing operation due to the presence of subgrade issues and aging utilities.	1.80	$21M
Total	-	-	**36.21**	**$610M**

Table 5 – Submitted rehabilitation / rebuilding priorities and estimated costs

4 Cost Summary

To inform the model of how conditions translate into maintenance investment needs, should-cost was collected – what should various maintenance activities cost? This is used to estimate costs for the most common maintenance treatments down to the activity level.

Highlighted below are the unique unit costs for assets in Division 6, where activity costs of more common treatments are weighted more heavily than less common treatments for each asset[x].

Weighted average unit costs by Division

Asset	UOM	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14
Bike Lanes	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Cablerail*	LFT	$2	$1	$2	$5	$1	$1	$3	$2	$0	$5	$2	$0	$2	$1
Concrete Barrier*	LFT	$500	$8	$3	$1,350	$16	$15	$3	$182	$163	$182	$6	$42	$25	$50
Pipes	LFT	$267	$379	$315	$479	$273	$275	$327	$462	$296	$378	$395	$90	$256	$345
Crosswalk	EA	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Curb and Gutter*	LFT	$102	$132	$125	$83	$112	$144	$117	$109	$78	$112	$93	$39	$90	$88
Drop Inlets*	EA	$811	$809	$1,363	$460	$974	$714	$865	$788	$830	$1,041	$794	$744	$1,361	$1,297
Guardrail*	LFT	$16	$30	$36	$12	$1	$49	$30	$31	$12	$32	$6	$32	$50	$21
Impact Attenuator*	EA	$2,500	$12,500	$5,000	$8,840	$2,707	$1,925	$17,500	$750	$1,704	$9,250	$2,028	$2,613	$10,250	$3,000
Induction Loop	LFT	$1,381	$726	$2,777	$1,695	$825	$1,358	$748	$1,486	$573	$3,097	$1,322	$2,144	$1,167	$1,308
Mile marker	EA	$129	$171	$172	$135	$440	$268	$168	$276	$285	$164	$427	$137	$143	$192
Pavement Striping*	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Ramp Metering	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Road Sign	EA	$309	$365	$232	$288	$613	$378	$379	$366	$462	$249	$581	$249	$293	$338
Shoulder	SHM	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Timber Rail	LFT	$44	$6	$49	$313	$13	$8	$2	$49	$44	$49	$3	$23	$23	$63
Traffic Signal	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Word and Symbols	LFT	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Crack Seal	LM	$3,103	$4,000	$3,300	$3,409	$6,009	$2,100	$4,366	$4,000	$3,250	$6,000	$7,850	$4,366	$4,366	$5,000
Chip Seal	LM	$21,933	$18,625	$22,750	$17,014	$26,732	$53,875	$22,356	$49,000	$30,925	$17,500	$21,500	$22,902	$33,701	$32,500
Contract Resurfacing*	LM	$120,418	$140,000	$67,500	$96,025	$109,701	$92,500	$213,998	$97,500	$116,150	$185,000	$66,250	$87,184	$88,750	$151,250

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[iii] When aggregated, route scores are weighted by lane miles and route class.

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[v] For these investment scenarios, we assume rates of inflation for labor, material, and equipment costs of 3%, 5%, and 8% respectively, per the 2023Q4 Engineering News-Record Cost Report. Costs for non-maintenance activities are assumed to increase at annual rate of 3%.

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[vii] Pipes are ingested into inventory counts via NCDOT survey

[viii] The pavement index assessment is consistent for every route and captures the entirety of the Division's inventory. At times, the asset detection algorithm powering the pavement index may miss light / moderate rutting.

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[x] Asterisk denotes predominately contracted activities. Shoulder, impact attenuators, cable rails, guardrails, curb and gutter, drop inlets and pavement markings are typically contracted out in D6. All cost data in this table were provided and validated by engineers from each division. Variations in costs may arise due to several factors, including the frequency of repairs, whether work is performed in-house or contracted out, and the defect severity at which interventions are initiated. For assets where specific cost data were unavailable, the average cost across all divisions was used. Data was collected and validated February - May 2024.

DIVISION 7 INSIGHTS REPORT

This report uses data on inventory, condition, and costs to provide insights at the division, county, and route levels. It identifies long-term investment needs and opportunities across the system to optimize outcomes.[i]

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1 Division Funding Needs

1.1 Data Background

Launched in 2020, ArTEMIS initially tracked 30+ discrete maintenance functions on state-managed routes. Since then, it has expanded to capture a "fence-to-fence" view of assets, activity-based costs, and lifecycle investment forecasting, enabling more precise, data-driven maintenance planning.

The 2023 initiative leverages image recognition and AI/ML to assess conditions across 2+ million geo-located assets statewide. By aligning new inventory data with established sources like the Pavement Condition Survey, it enhances accuracy through "Route Scores" at route, county, division, and state levels, which help forecast investment needs. Similar to weather forecasting, aligning multiple datasets strengthens accuracy and reliability.

Statewide data collected and validated from January to September 2023 includes image collection, route walkthroughs, inspections, and quality reviews. These, alongside activity-based “should-cost” estimates—based on current market and industry standards—inform the Total Cost of Ownership model, supporting comprehensive maintenance planning.

1.2 Route Score Overview

1.2.1 Methodology

The table below shows the asset conditions contributing to Division 7's overall route score and how a route score is assembled at the route level (before being aggregated up by system counties, divisions, etc). The score uses point-in-time data collected January - September 2023.

Asset	State	Division 7
Pavement Index	83	81
Bridge Index	82	84
Shoulder	98%	99%
Pipes	82%	84%
Drop Inlets	89%	95%
Curb and Gutter	96%	97%
Pavement Striping	89%	94%
Signs	94%	96%
Guardrails and barriers	98%	98%
Words and Symbols[ii]	96%	92%
Traffic devices	100%	100%

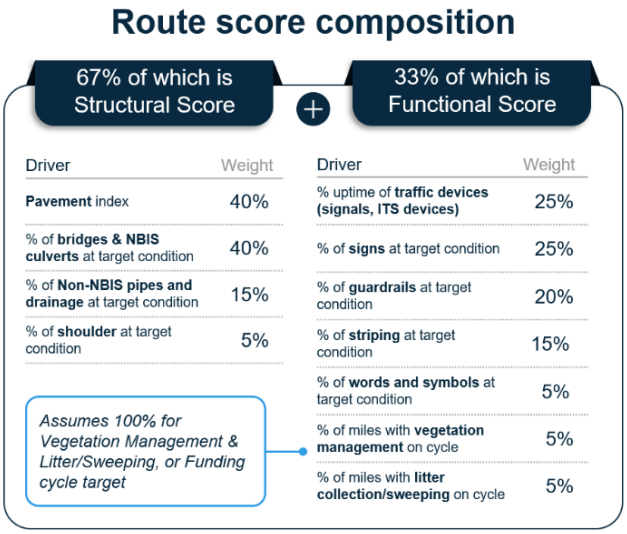
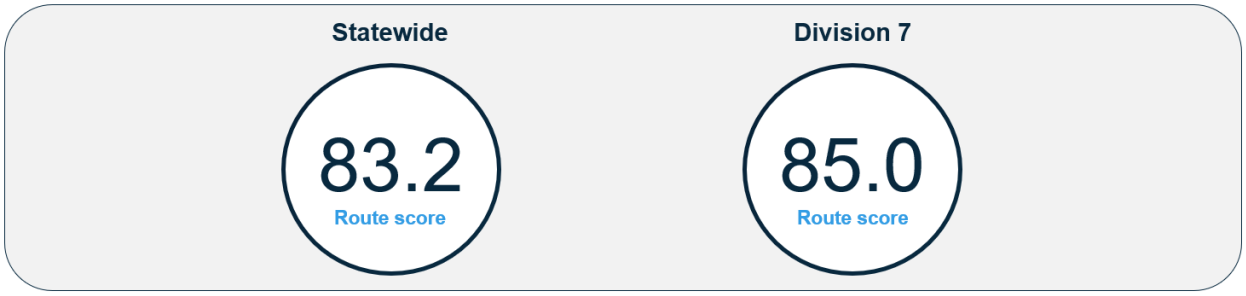


Table 1 – Asset scores (percentage of non-defective units or index score) across State and Division

1.2.2 Most Recent Outcomes

Using the scoring method shown above, the overall conditions of a division's roads can be shown with a single score that takes the weighted[iii] average of all its routes:



Route class	State	Division 7
Interstates	89	91
Primary	83	82
Secondary	82	84

Table 2 – Route scores by class

1.3 Route Score Distribution

The majority of the Division's network consists of routes in good condition, defined by a route score of 80 or higher. Over 8,400 lane miles (69% of network) are considered in good condition.

Conversely, less than 110 lane miles (1% of network) are considered in poor condition, defined by a route score lower than 60. Map 1 shows the condition of routes across the division.

Route score distribution, by lane miles

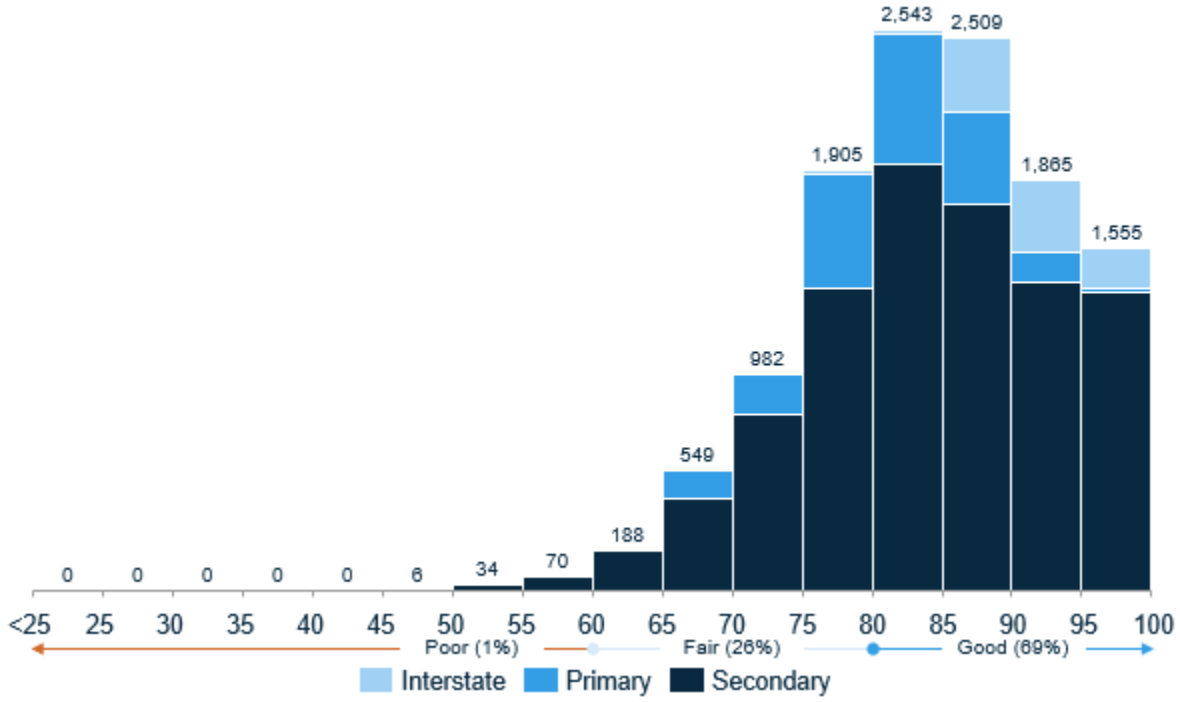
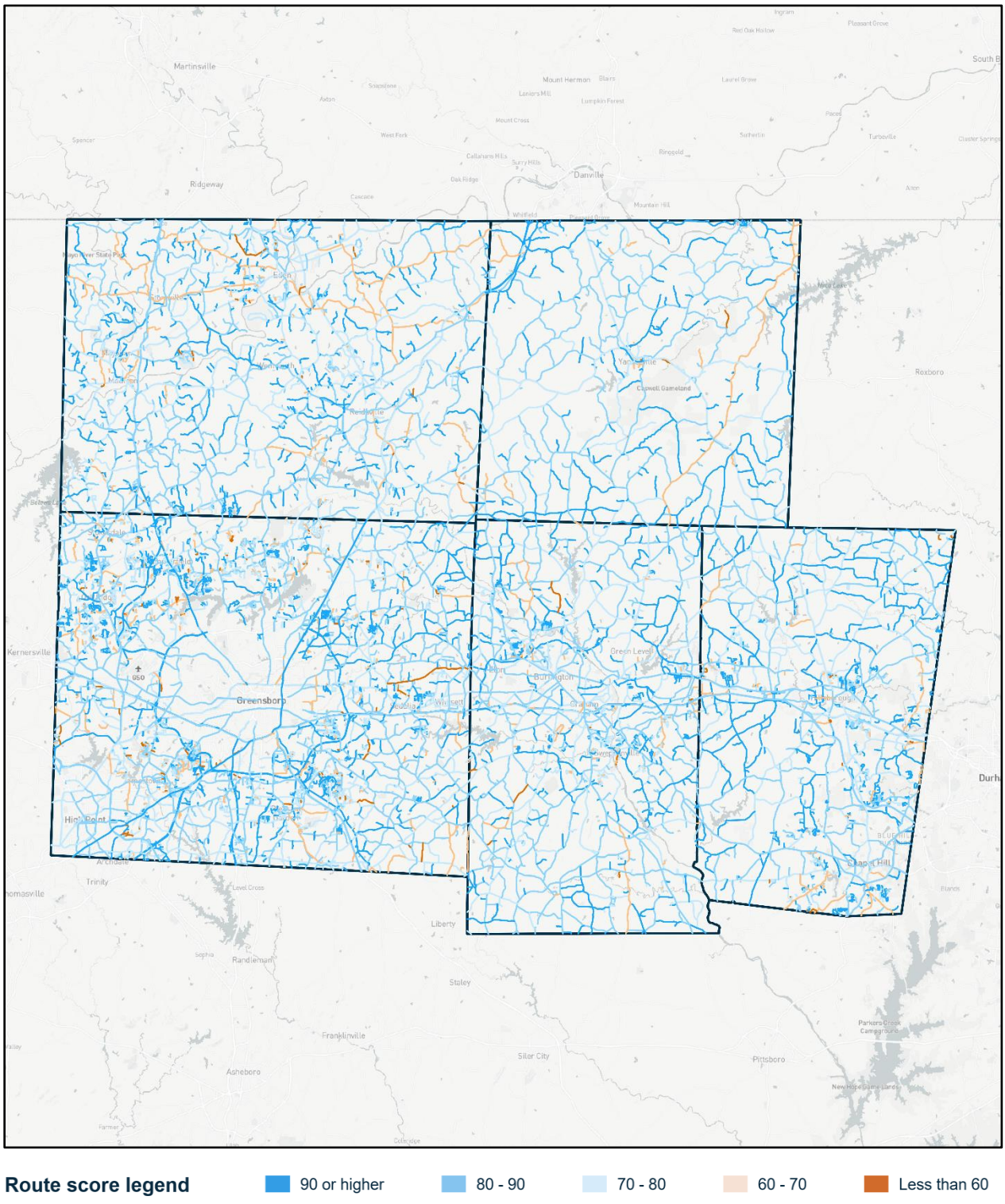


Figure 1 – Distribution of route score, measured in lane miles

Across the road network, the most common route score is between 80 and 85. Interstate and primary routes in Division 7 all have route scores of at least 65, while secondary routes exhibit route scores starting at 45.

These routes can be mapped spatially to evaluate the distribution by geography, as seen on the next page.

Route score distribution, by county



Map 1 – Spatial distribution of route score, grouped by county

1.4 Impact of static funding

Route Score is used to estimate the investment needed[iv] to maintain or achieve various condition levels over the next 10 years, assuming expected inflation[v] and asset deterioration.

Maintaining this division's current condition will require a year-over-year increase in funding, due to inflation and regular wear-and-tear. Static funding may be sufficient to maintain Division 7's route score in the next year but will lead to a decline of **-2** points in the following year and will potentially lower it by at least **-11.8** points over the next decade.

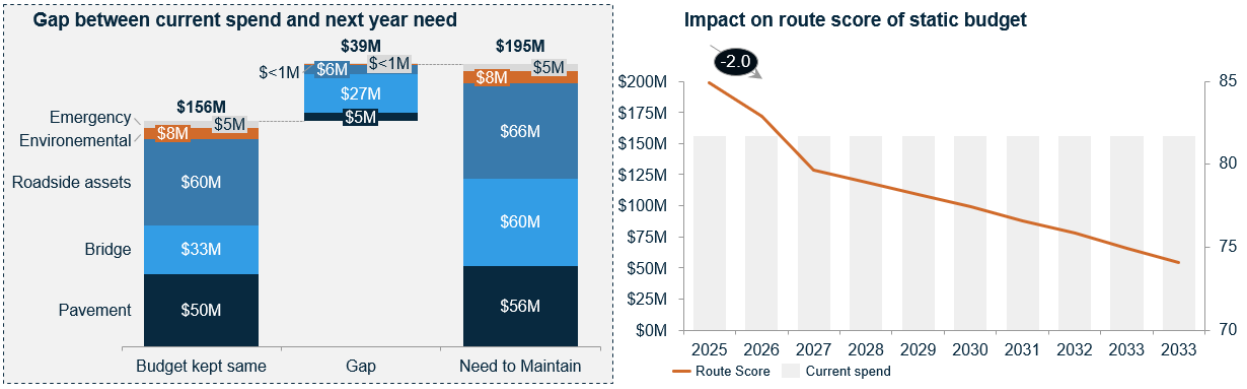


Figure 2 – Comparison of current spend and expected need; route score over time if no budget increase

1.5 Investment needs over the next 10 years

Using the Route Score, ArTEMIS can quantify investment needed to maintain or improve condition by raising the route score by zero points (maintain conditions), one point (slight improvement), five points (large improvement), and ten points (near-perfect conditions)[vi].

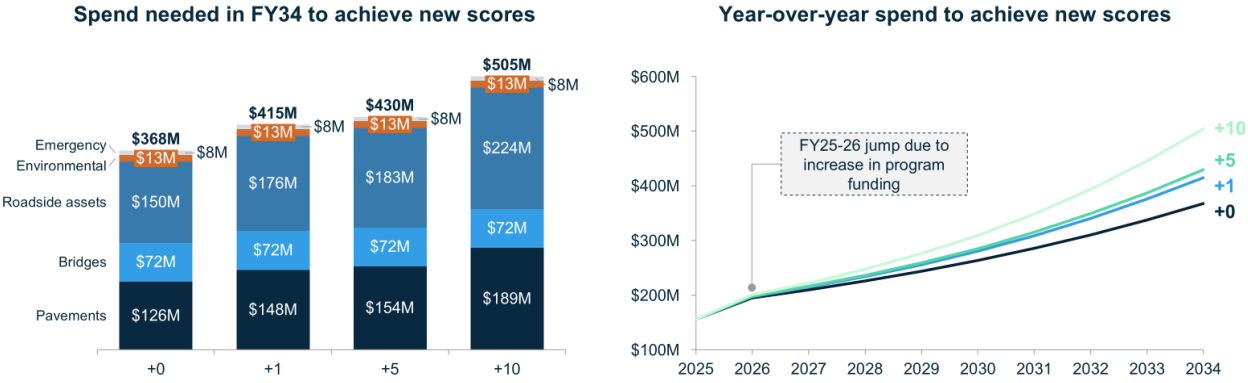


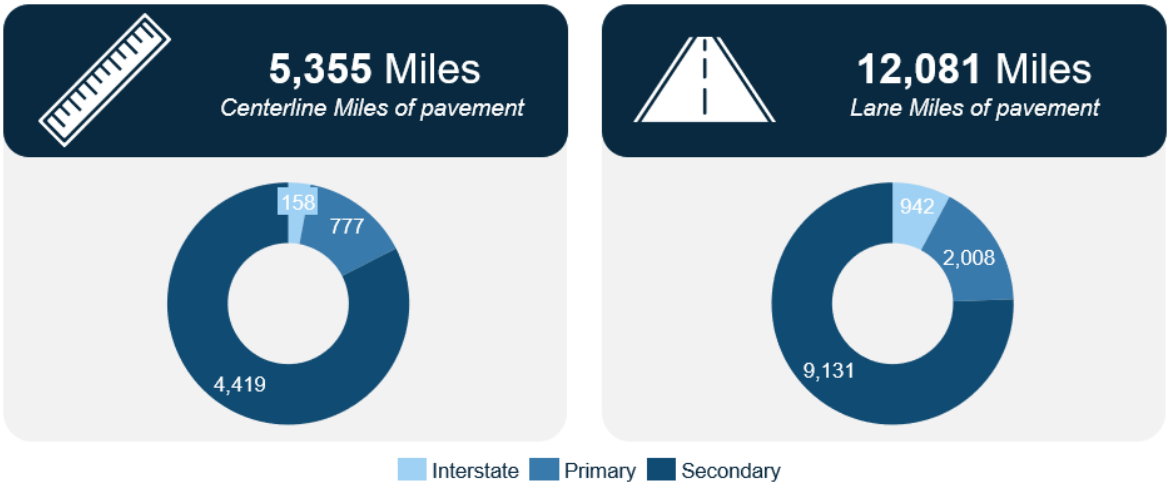
Figure 3 – Projected investment needed (YOE $) to improve route score over 10 years

As shown, maintaining and improving Division 7's Route Score requires greater investment:

- **+0** requires increasing spend to **$368M** by FY34; **$2,597M** in total investment
- **+1** requires increasing spend to **$415M** by FY34; **$2,779M** in total investment
- **+5** requires increasing spend to **$430M** by FY34; **$2,833M** in total investment
- **+10** requires increasing spend to **$505M** by FY34; **$3,104M** in total investment

2 Division Asset Inventory & Condition

2.1 Pavement & Asset Inventory



		Quantity			
Asset	**Unit**	**Interstate**	**Primary**	**Secondary**	**Overall**
Bike Lanes	LFT	0	65,652	150,658	216,310
Cablerail	MI	42	25	2	69
Concrete Barrier	MI	100	14	18	132
Crosswalk	EA	0	295	789	1,084
Curb and Gutter	MI	13	141	328	482
Drop Inlets	EA	648	3,053	9,344	13,045
Guardrail	MI	132	123	85	340
Impact Attenuator	EA	38	56	14	108
Induction Loop	EA	28	1,022	2,062	3,112
Mile marker	EA	270	102	21	393
Noise Wall*	LFT	17,097	0	3,266	20,363
Pavement Striping (defective only)	MI	53	289	750	1,091
Pipes[vii]	LFT	23,659	236,564	184,010	444,233
Retaining Wall*	LFT	5,868	14,267	33,051	53,186
Road Sign	EA	2,384	18,928	60,744	82,056
Rumble Strips*	MI	447	257	56	760
Sharrows	EA	0	140	203	343
Shoulder (defective only)	MI	1	12	83	96
Traffic Signal	EA	47	4,959	8,390	13,396
Variable Message Sign	EA	36	34	35	105
Word and Symbols	EA	984	12,389	15,733	29,106

Table 3 – Selection of roadside asset inventory; asterisk indicates no significance to route score

2.2 Pavement Conditions

Using Pavement Condition Survey (PCS) data, shown below is the breakdown of good, fair, and poor lane miles across the interstate, primary, and secondary systems.

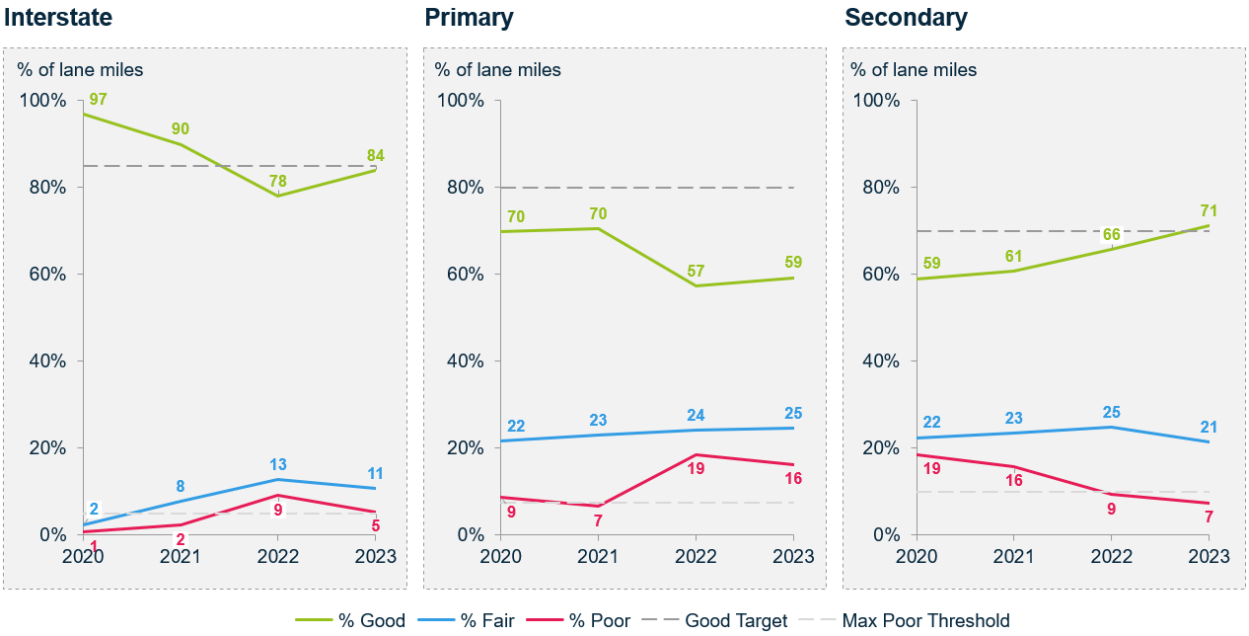


Figure 4 – Pavement conditions across interstate, primary, and secondary systems

Pavement conditions in Division 7 as evaluated via ArTEMIS analysis are below the state average, with a division-wide pavement index of **81**. Condition varies across the division by primary and secondary routes.

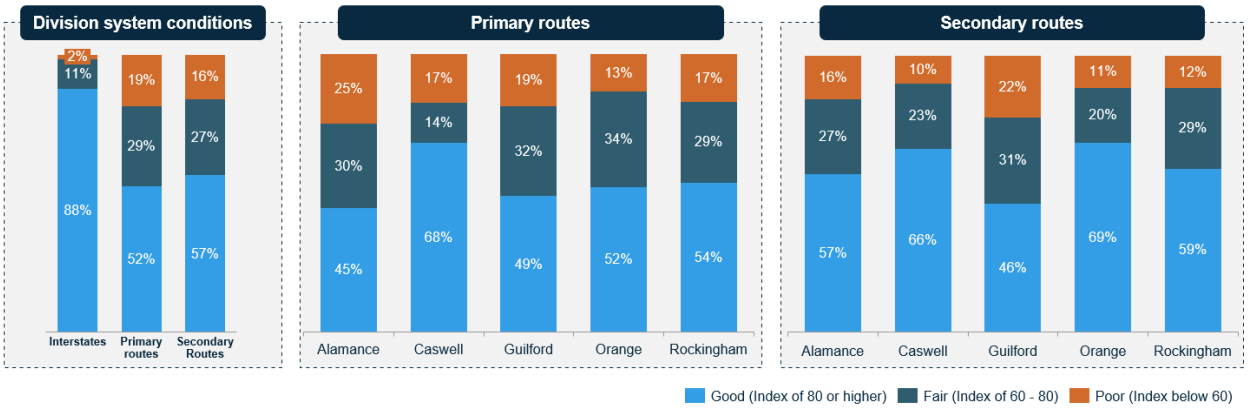


Figure 5 – Comparison of lane miles in good, fair, and poor conditions

County pavement index (weighted by lane miles) range **from 79 to 85**. Deductions are primarily driven by two distresses: (1) alligator cracking and (2) transverse cracking.

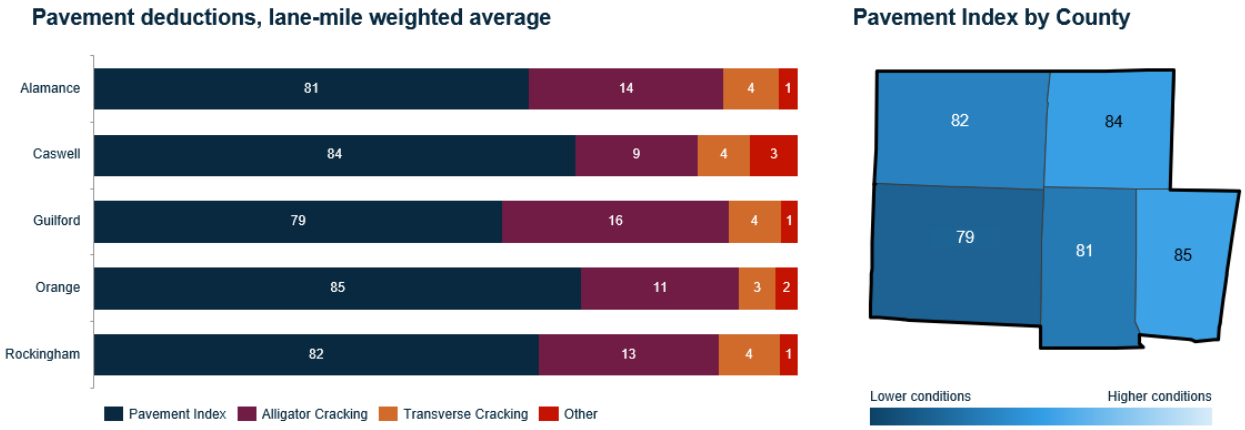


Figure 6 – Pavement index and deduction breakdown by county

Complementary models show similar assessments of pavement condition between the ArTEMIS model and the PCS model for Division 7. The pavement index utilizes the same scoring methodology as the PCS, the only differences being in how the data is collected/reviewed[viii].

	Condition			
Model	**Interstates**	**Primary**	**Secondary**	**Overall**
Pavement index (ArTEMIS)	93	79	81	81
Pavement condition score (PCS)	84	81	85	84

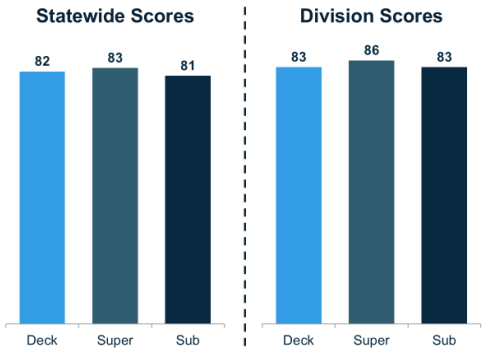
Table 4 – Condition comparison by pavement models for Division 7

2.3 Bridge Conditions

Bridge conditions are evaluated using a bridge index that translates general condition ratings (i.e., 1-9 scale) into a 100-point scale for easier comparison.

Overall, the Division 7 bridge index (84) scores ~2 points higher than statewide bridge index (82).

Data is ingested from FHWA bridge portal.



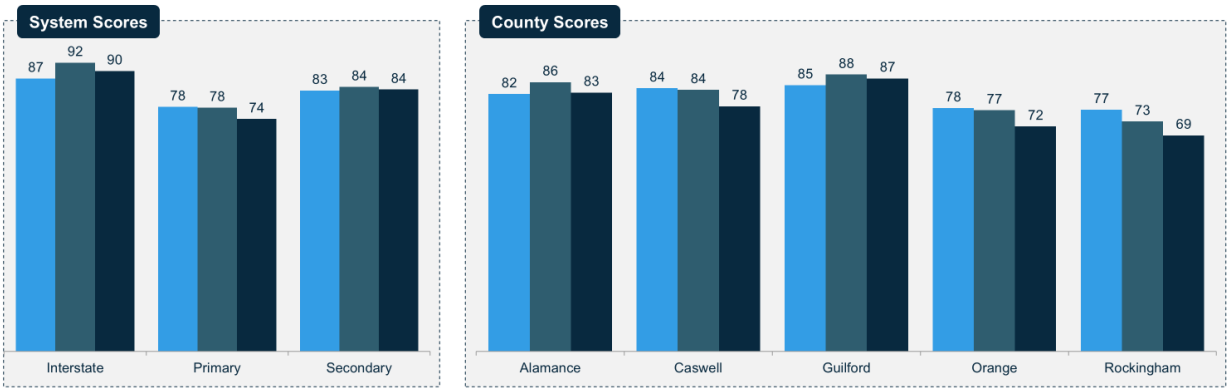


Figure 7 – Comparison of bridge conditions

The figure below displays all bridges in poor condition (index below 60) or at-risk of becoming poor (index of 60 – 69). They are mostly on the secondary system. Each circle maps one bridge by latitude and longitude; circle size indicates deck area, with at-risk bridges sized uniformly.

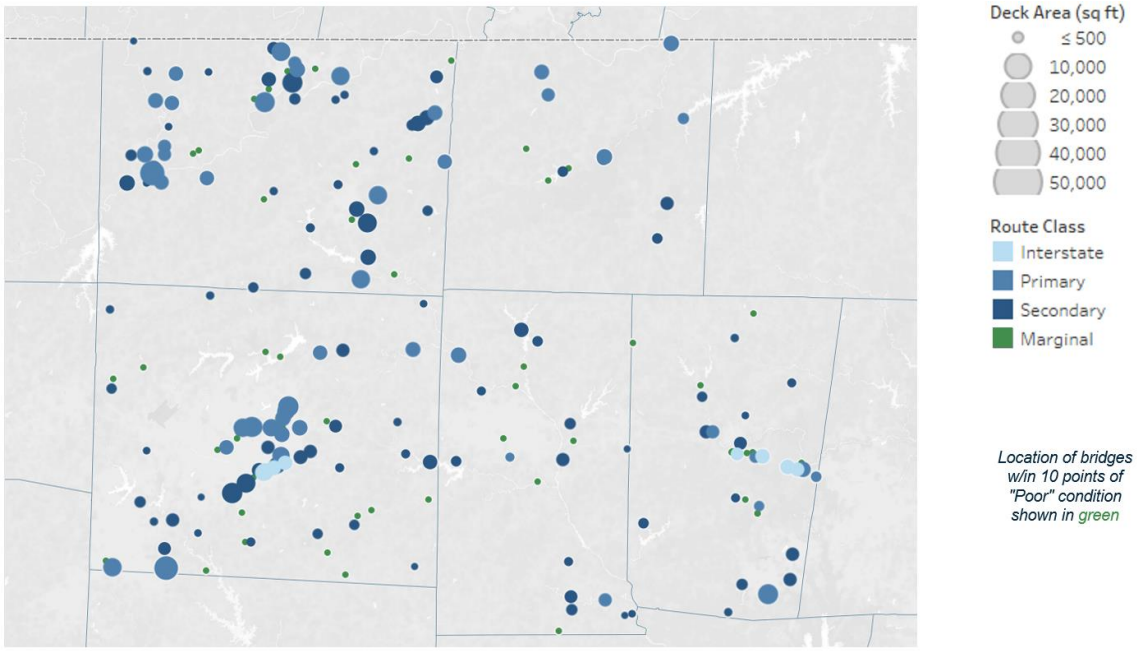


Figure 8 – Distribution of poor bridges and at-risk of becoming poor condition bridges in Division 7

2.4 Roadside Asset Conditions

Roadside asset condition is evaluated by measuring the proportion at which an asset is non-defective in a division, county, or route.

Asset	State	D7	Alamance	Caswell	Guilford	Orange	Rockingham
Pavement Striping	89%	94%	95%	91%	95%	91%	96%
Bike Lanes	78%	67%		0%	93%	65%	
Word and Symbols	74%	76%	82%	88%	72%	77%	78%
Sharrows	84%	84%	100%		81%	84%	
Signs	94%	96%	96%	96%	95%	96%	95%
Drop Inlets	89%	95%	95%	89%	96%	93%	92%
Curb and Gutter	96%	97%	97%	92%	98%	98%	94%
Guardrails	98%	98%	99%	98%	98%	97%	98%
Shoulder	98%	99%	98%	98%	99%	99%	99%

Most Defective — Least Defective

Figure 9 – Comparison of conditions between county functional assets [ix]

Below is roadside asset condition visualized with county boundaries, where colors are relative to the average condition across the state, for each respective asset.

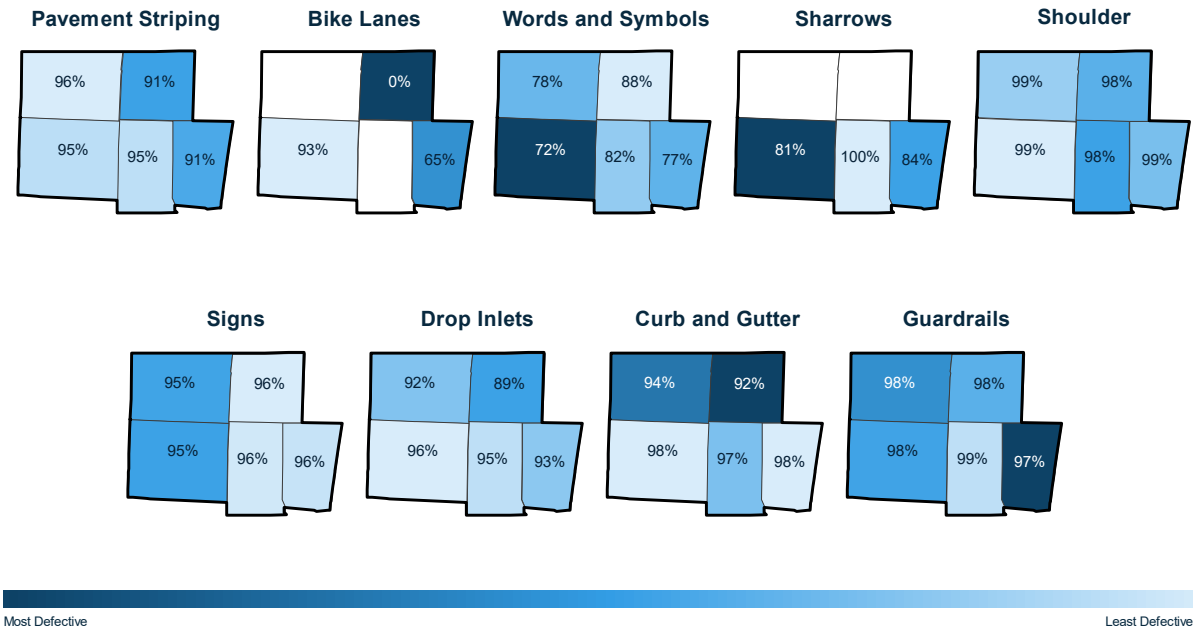


Figure 10 – Comparison of roadside asset conditions mapped to county boundaries

3 Rehabilitation / Rebuilding Needs

To develop a sense of what level of investment is required to ensure our state's ability to provide a safe and effective transportation network into the future, in the summer of 2024 the Director of Highway Operations reached out to all 14 Division Engineers and their teams, asking them to provide details on their highest priority ~35 miles of reconstruction/rehabilitation needs. The submitted sections for Division 7, along with estimated costs, are outlined below ranked in order of priority (as submitted).

Route	County	Comments	Miles	Est. Cost ($M)
SR 2670	Rockingham	South Scales Street in Reidsville-ADT 9300. Curb & Gutter has deteriorated over time. Concrete base under pavement is failing in areas. FDR project.	1.20	$24M
US 421	Guilford	Concrete base under pavement is failing in areas	2.00	$80M
I - 85	Orange	Concrete base under pavement is failing in areas. This is programmed to be upgraded in the future (2032) but still is a good candidate for reconstruction	8.00	$415M
Gate City Blvd	Guilford	Gate City Blvd from E Florida St to Coliseum Blvd. ADT for section ranges from to 13,500 to 22,000. Needs underlying structure, curb and gutter, and sidewalks rebuilt.	4.45	$174M
US 29	Guilford	Underlying structure has voids underneath, Large (7") drop-offs to curb and gutter, concrete center wall needs replacement, fence needs replacement, reduce number of interchanges for congestion.	4.20	$576M
SR 3762	Guilford	Martin Luther King from I-40 to south of Alamance Church Road. Heavy traffic(AADT 28000), MLK/Alamance Ch. Rd. Intersection is concrete that is in poor condition.	0.24	$37M
SR 1163/NC 62	Caswell	E. Main St/NC 62 in Yanceyville from 1st Street to NC 86. Pavement is in poor condition with poor ride quality. AADT is 3700.	0.76	$10M
Total	-	-	**20.85**	**$1,316M**

Table 5 – Submitted rehabilitation / rebuilding priorities and estimated costs

4 Cost Summary

To inform the model of how conditions translate into maintenance investment needs, should-cost was collected – what should various maintenance activities cost? This is used to estimate costs for the most common maintenance treatments down to the activity level.

Highlighted below are the unique unit costs for assets in Division 7, where activity costs of more common treatments are weighted more heavily than less common treatments for each asset[x].

Weighted average unit costs by Division

Asset	UOM	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14
Bike Lanes	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Cablerail*	LFT	$2	$1	$2	$5	$1	$1	$3	$2	$0	$5	$2	$0	$2	$1
Concrete Barrier*	LFT	$500	$8	$3	$1,350	$16	$15	$3	$182	$163	$182	$6	$42	$25	$50
Pipes	LFT	$267	$379	$315	$479	$273	$275	$327	$462	$296	$378	$395	$90	$256	$345
Crosswalk	EA	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Curb and Gutter*	LFT	$102	$132	$125	$83	$112	$144	$117	$109	$78	$112	$93	$39	$90	$88
Drop Inlets*	EA	$811	$809	$1,363	$460	$974	$714	$865	$788	$830	$1,041	$794	$744	$1,361	$1,297
Guardrail*	LFT	$16	$30	$36	$12	$1	$49	$30	$31	$12	$32	$6	$32	$50	$21
Impact Attenuator*	EA	$2,500	$12,500	$5,000	$8,840	$2,707	$1,925	$17,500	$750	$1,704	$9,250	$2,028	$2,613	$10,250	$3,000
Induction Loop	LFT	$1,381	$726	$2,777	$1,695	$825	$1,358	$748	$1,486	$573	$3,097	$1,322	$2,144	$1,167	$1,308
Mile marker	EA	$129	$171	$172	$135	$440	$268	$168	$276	$285	$164	$427	$137	$143	$192
Pavement Striping*	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Ramp Metering	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Road Sign	EA	$309	$365	$232	$288	$613	$378	$379	$366	$462	$249	$581	$249	$293	$338
Shoulder	SHM	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Timber Rail	LFT	$44	$6	$49	$313	$13	$8	$2	$49	$44	$49	$3	$23	$23	$63
Traffic Signal	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Word and Symbols	LFT	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Crack Seal	LM	$3,103	$4,000	$3,300	$3,409	$6,009	$2,100	$4,366	$4,000	$3,250	$6,000	$7,850	$4,366	$4,366	$5,000
Chip Seal	LM	$21,933	$18,625	$22,750	$17,014	$26,732	$53,875	$22,356	$49,000	$30,925	$17,500	$21,500	$22,902	$33,701	$32,500
Contract Resurfacing*	LM	$120,418	$140,000	$67,500	$96,025	$109,701	$92,500	$213,998	$97,500	$116,150	$185,000	$66,250	$87,184	$88,750	$151,250

Table 6 – Unit cost comparison between Divisions

[i] Condition and inventory data collected via ArTEMIS from January to September 2023; cost data collected from individual divisions and validated in February/March of 2024. Thus, funding scenarios outlined in this document were developed prior the impacts of Hurricane Helene & based on infrastructure condition data collected prior to the storm. As such, they do not account for the additional costs associated with the rehabilitation or reconstruction of infrastructure affected by the storm. Recognizing that rebuilding will entail significant expenses, the current scenarios focus on maintaining the regular operational budget and steady-state upkeep without reallocation of funds.

[ii] For purposes of calculating route score, "Words and Symbols" also includes bike lanes, crosswalks, sharrows.

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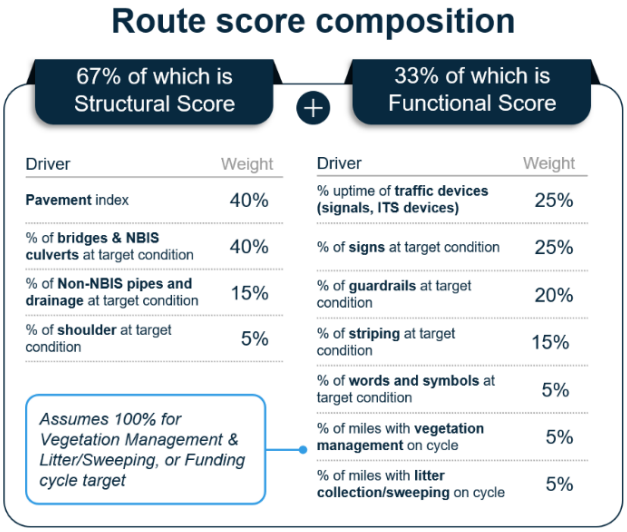

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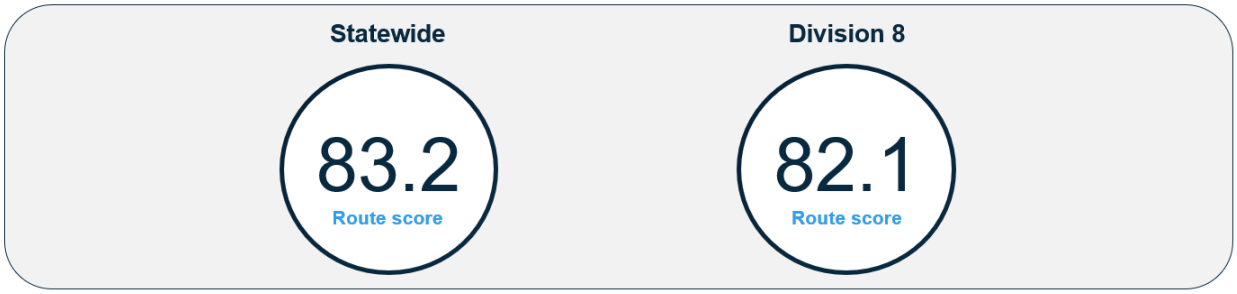

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1.3 Route Score Distribution

The majority of the Division's network consists of routes in good condition, defined by a route score of 80 or higher. Over 8,700 lane miles (60% of network) are considered in good condition.

Conversely, less than 330 lane miles (2% of network) are considered in poor condition, defined by a route score lower than 60. Map 1 shows the condition of routes across the division.

Route score distribution, by lane miles

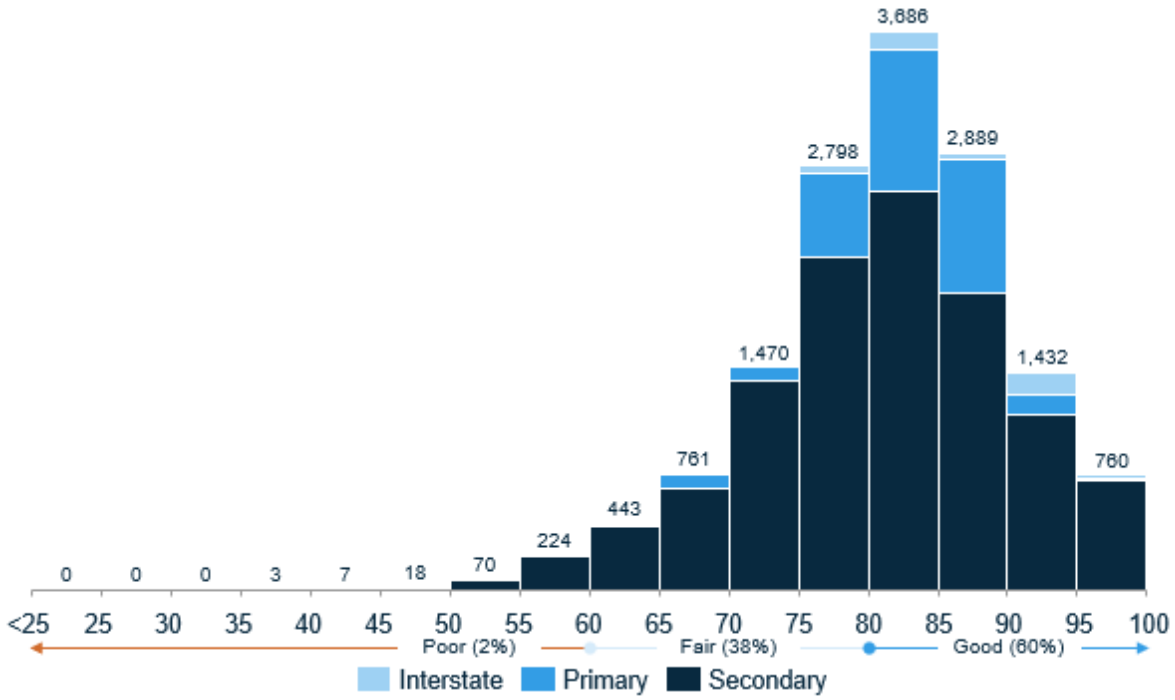
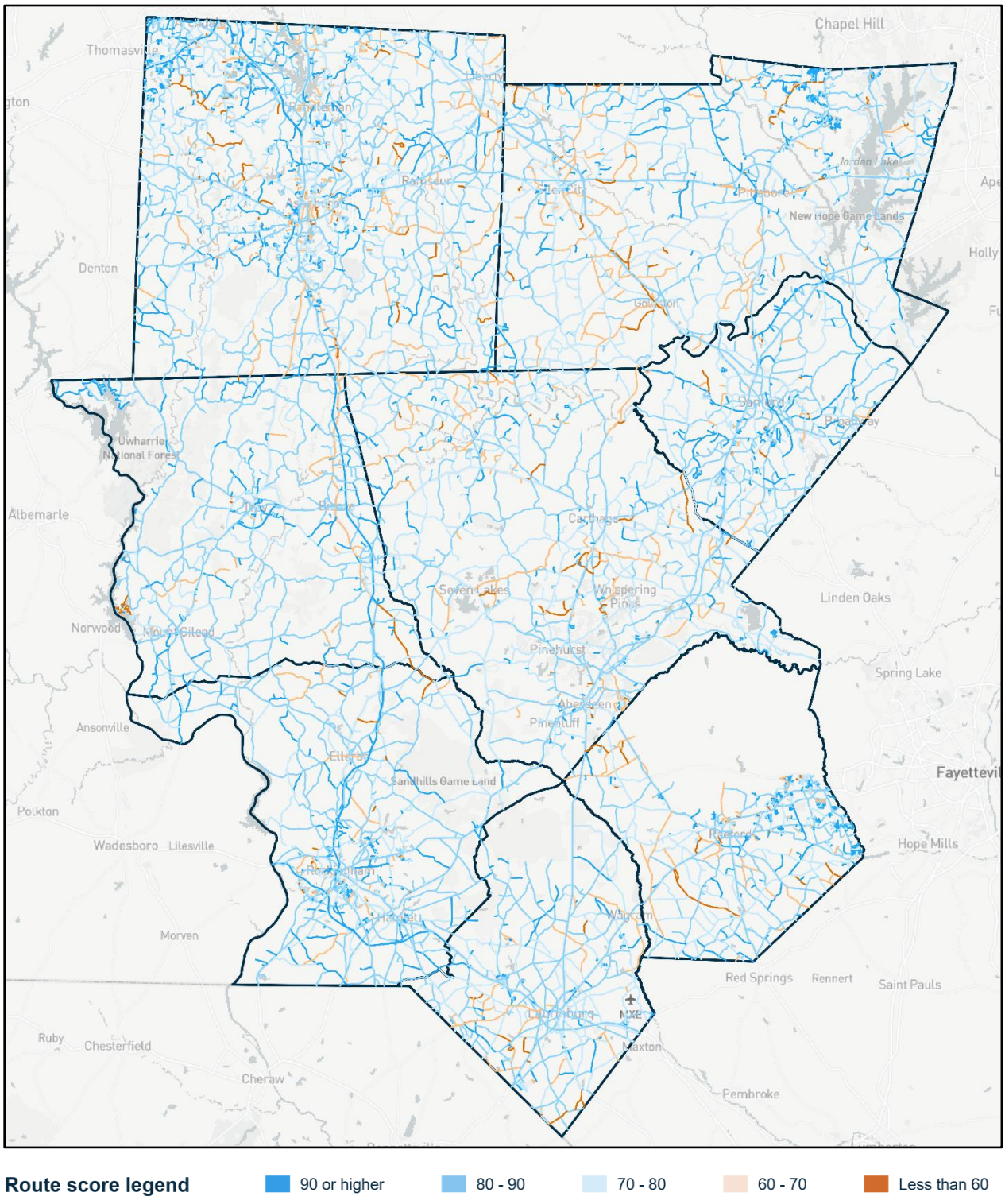


Figure 1 – Distribution of route score, measured in lane miles

Across the road network, the most common route score is between 80 and 85. Interstate and primary routes in Division 8 all have route scores of at least 60, while secondary routes exhibit route scores starting at 35.

These routes can be mapped spatially to evaluate the distribution by geography, as seen on the next page.

Route score distribution, by county



Map 1 – Spatial distribution of route score, grouped by county

1.4 Impact of static funding

Route Score is used to estimate the investment needed[iv] to maintain or achieve various condition levels over the next 10 years, assuming expected inflation[v] and asset deterioration.

Maintaining this division's current condition will require a year-over-year increase in funding, due to inflation and regular wear-and-tear. Static funding may lead to a decline of **-2.4** points in the following year and will potentially lower it by at least **-11.6** points over the next decade.

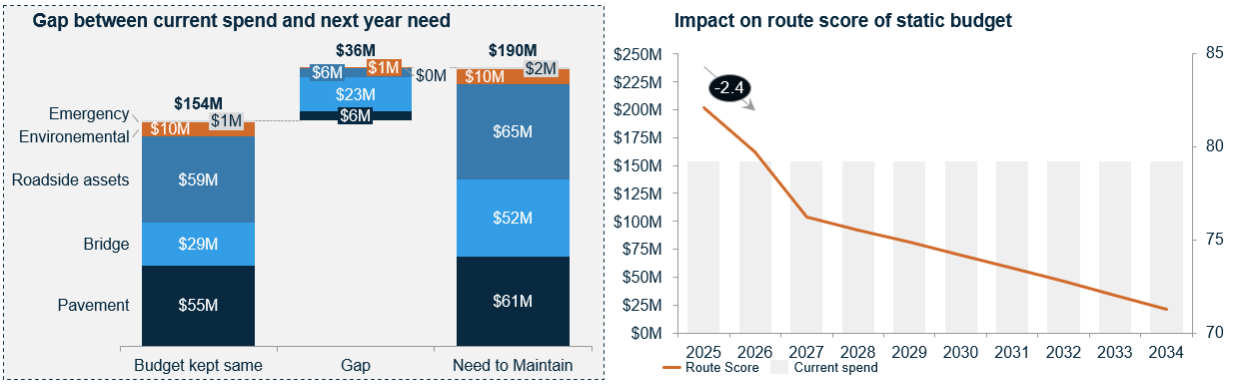


Figure 2 – Comparison of current spend and expected need; route score over time if no budget increase

1.5 Investment needs over the next 10 years

Using the Route Score, ArTEMIS can quantify investment needed to maintain or improve condition by raising the route score by zero points (maintain conditions), one point (slight improvement), five points (large improvement), and ten points (near-perfect conditions)[vi].

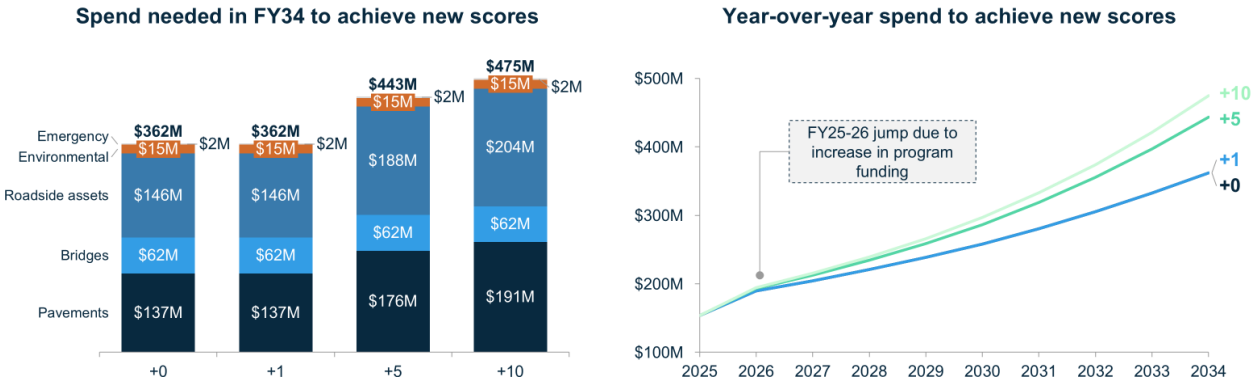


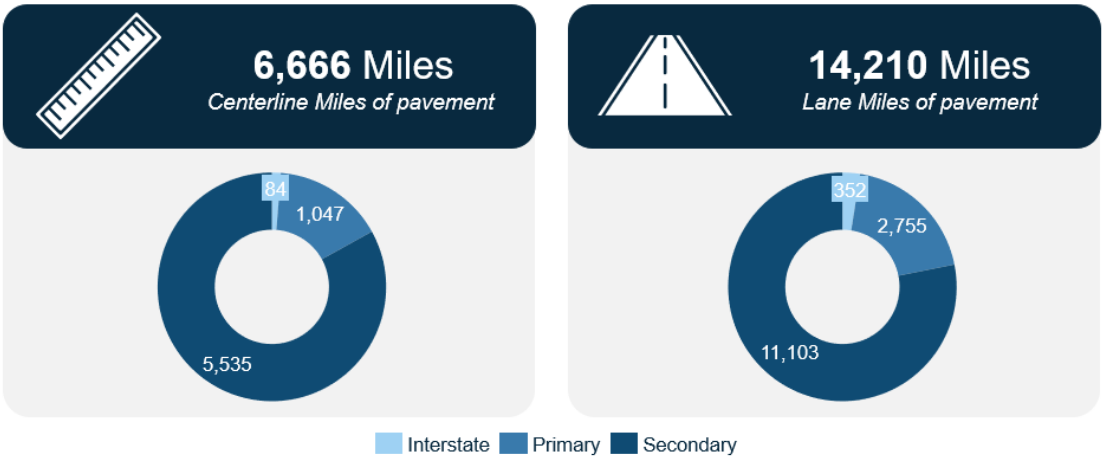
Figure 3 – Projected investment needed (YOE $) to improve route score over 10 years

As shown, maintaining and improving Division 8's Route Score requires greater investment:

- **+0** requires increasing spend to **$362M** by FY34; **$2,547M** in total investment
- **+1** requires increasing spend to **$362M** by FY34; **$2,547M** in total investment
- **+5** requires increasing spend to **$443M** by FY34; **$2,855M** in total investment
- **+10** requires increasing spend to **$475M** by FY34; **$2,969M** in total investment

2 Division Asset Inventory & Condition

2.1 Pavement & Asset Inventory



		Quantity			
Asset	**Unit**	**Interstate**	**Primary**	**Secondary**	**Overall**
Bike Lanes	LFT	0	618	53,086	53,704
Cablerail	MI	110	122	8	240
Concrete Barrier	MI	6	3	2	10
Crosswalk	EA	0	74	194	268
Curb and Gutter	MI	1	191	211	404
Drop Inlets	EA	177	3,060	6,298	9,535
Guardrail	MI	64	233	131	428
Impact Attenuator	EA	5	66	3	74
Induction Loop	EA	9	1,035	908	1,952
Mile marker	EA	183	191	41	415
Noise Wall*	LFT	1,376	762	0	2,139
Pavement Striping (defective only)	MI	74	592	2,192	2,858
Pipes[vii]	LFT	16,395	271,289	247,259	534,943
Retaining Wall*	LFT	0	8,286	25,456	33,742
Road Sign	EA	903	19,027	48,409	68,339
Rumble Strips*	MI	336	656	72	1,064
Sharrows	EA	0	1	164	165
Shoulder (defective only)	MI	2	41	203	246
Traffic Signal	EA	0	3,572	3,002	6,574
Variable Message Sign	EA	1	29	26	56
Word and Symbols	EA	263	13,360	5,759	19,382

Table 3 – Selection of roadside asset inventory; asterisk indicates no significance to route score

2.2 Pavement Conditions

Using Pavement Condition Survey (PCS) data, shown below is the breakdown of good, fair, and poor lane miles across the interstate, primary, and secondary systems.

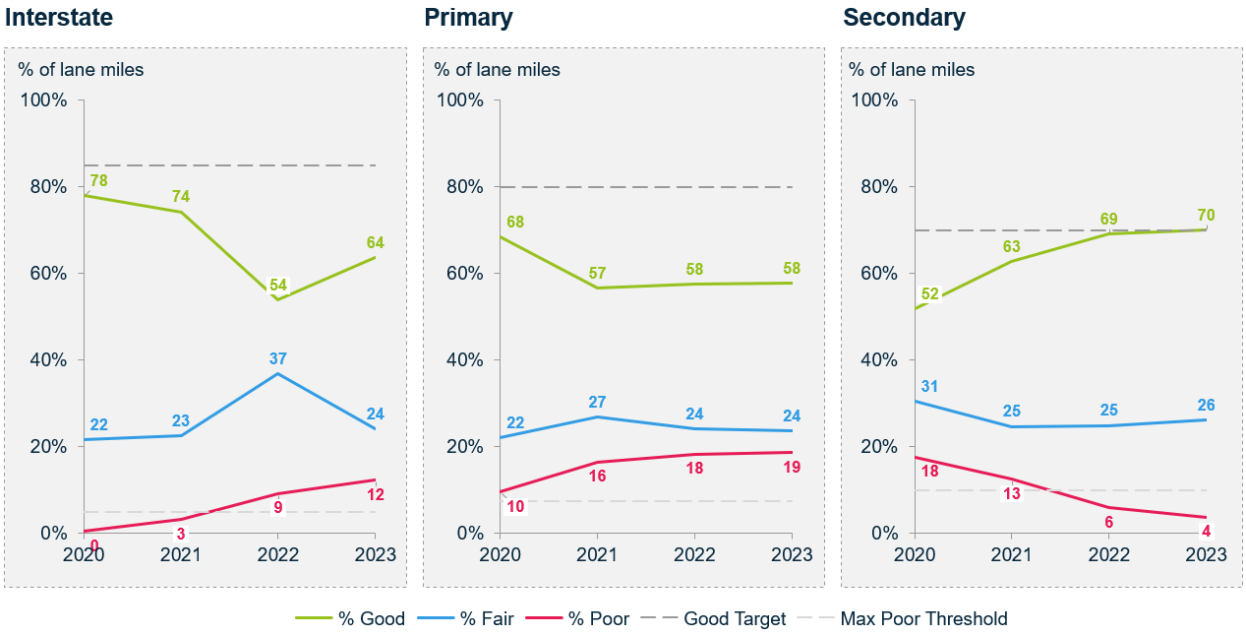


Figure 4 – Pavement conditions across interstate, primary, and secondary systems

Pavement conditions in Division 8 as evaluated via ArTEMIS analysis are below the state average, with a division-wide pavement index of **82**. Condition varies across the division by primary and secondary routes.

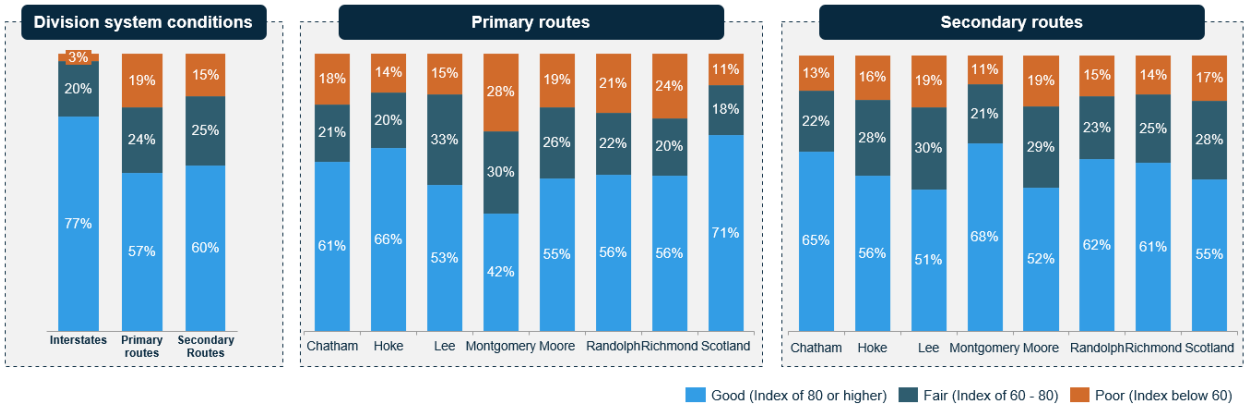


Figure 5 – Comparison of lane miles in good, fair, and poor conditions

County pavement index (weighted by lane miles) range **from 78 to 84**. Deductions are primarily driven by two distresses: (1) alligator cracking and (2) transverse cracking.

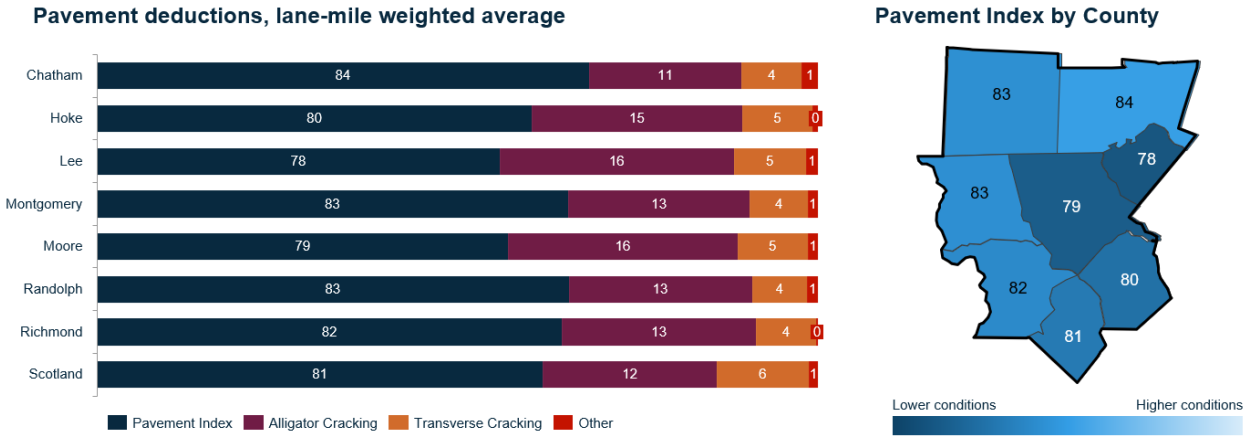


Figure 6 – Pavement index and deduction breakdown by county

Complementary models show similar assessments of pavement condition between the ArTEMIS model and the PCS model for Division 8. The pavement index utilizes the same scoring methodology as the PCS, the only differences being in how the data is collected/reviewed[viii].

	Condition			
Model	**Interstates**	**Primary**	**Secondary**	**Overall**
Pavement index (ArTEMIS)	89	80	82	82
Pavement condition score (PCS)	83	81	85	84

Table 4 – Condition comparison by pavement models for Division 8

2.3 Bridge Conditions

Bridge conditions are evaluated using a bridge index that translates general condition ratings (i.e., 1-9 scale) into a 100-point scale for easier comparison.

Overall, the Division 8 bridge index (85) scores ~3 points higher than statewide bridge index (82).

Data is ingested from FHWA bridge portal.

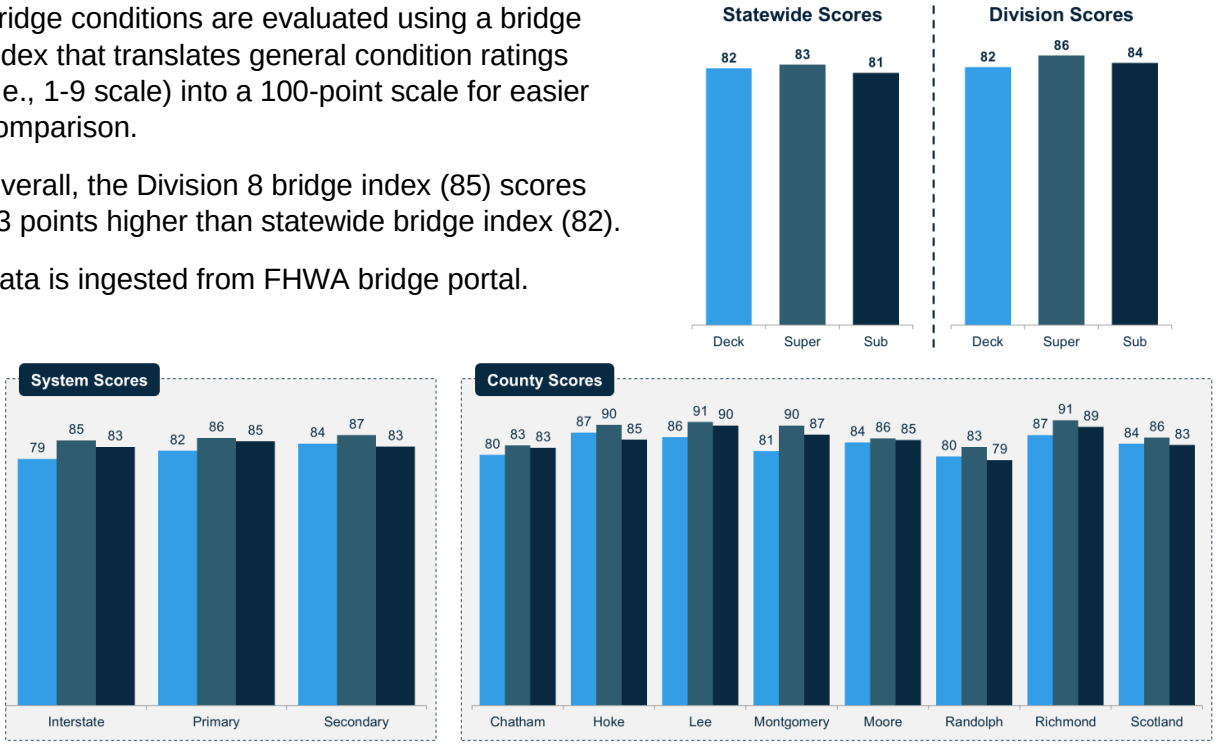


Figure 7 – Comparison of bridge conditions

The figure below displays all bridges in poor condition (index below 60) or at-risk of becoming poor (index of 60 – 69). They are mostly on the secondary system. Each circle maps one bridge by latitude and longitude; circle size indicates deck area, with at-risk bridges sized uniformly.

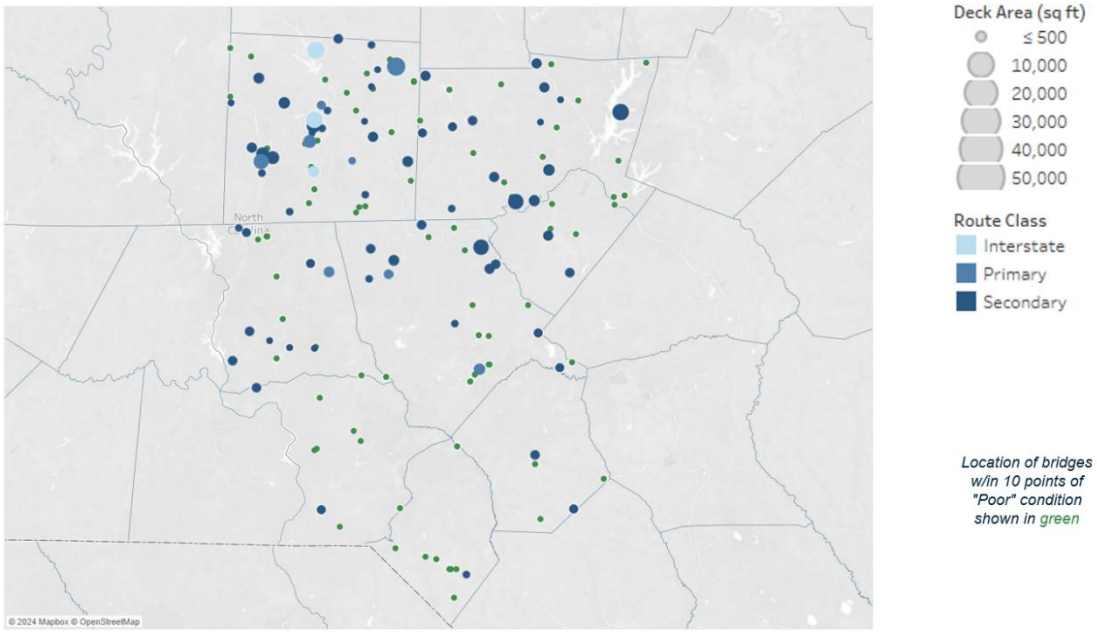


Figure 8 – Distribution of poor bridges and at-risk of becoming poor condition bridges in Division 8

2.4 Roadside Asset Conditions

Roadside asset condition is evaluated by measuring the proportion at which an asset is non-defective in a division, county, or route.

Asset	State	D8	Chatham	Hoke	Lee	Montgomery	Moore	Randolph	Richmond	Scotland
Pavement Striping	89%	87%	88%	90%	87%	84%	87%	87%	86%	89%
Bike Lanes	78%	97%	91%		97%		100%			
Word and Symbols	74%	76%	78%	73%	80%	73%	81%	69%	74%	85%
Sharrows	84%	90%	100%		100%		85%	79%		
Signs	94%	93%	92%	91%	96%	95%	92%	92%	95%	92%
Drop Inlets	89%	90%	95%	88%	86%	90%	95%	90%	84%	82%
Curb and Gutter	96%	91%	96%	89%	90%	90%	92%	94%	85%	85%
Guardrails	98%	99%	99%	99%	99%	99%	98%	99%	98%	97%
Shoulder	98%	98%	99%	97%	98%	98%	98%	98%	98%	98%

Most Defective — Least Defective

Figure 9 – Comparison of conditions between county functional assets [ix]

Below is roadside asset condition visualized with county boundaries, where colors are relative to the average condition across the state, for each respective asset.

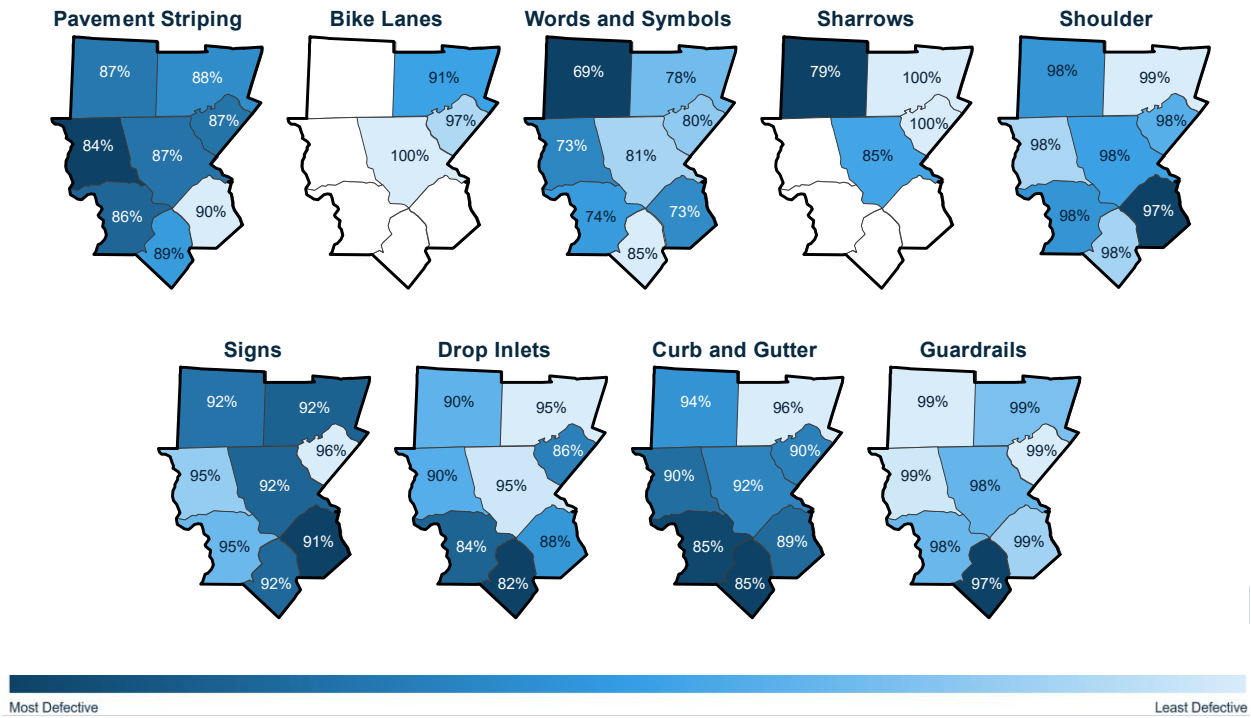


Figure 10 – Comparison of roadside asset conditions mapped to county boundaries

3 Rehabilitation / Rebuilding Needs

To develop a sense of what level of investment is required to ensure our state's ability to provide a safe and effective transportation network into the future, in the summer of 2024 the Director of Highway Operations reached out to all 14 Division Engineers and their teams, asking them to provide details on their highest priority ~35 miles of reconstruction/rehabilitation needs. The submitted sections for Division 8, along with estimated costs, are outlined below ranked in order of priority (as submitted).

Route	County	Comments	Miles	Est. Cost ($M)
US 401 Business	Hoke	This section of roadway needs joint repair	4.68	$54M
NC-24	Montgomery	Severe rutting and alligator cracking. C&G settled in multiple areas. Multiple areas patched. This section has a history of underlaying issue in the outside lanes.	2.00	$60M
NC-109	Montgomery	Severe rutting and alligator cracking. Multiple areas patched.	0.80	$16M
NC-109	Montgomery	Severe rutting. Multiple areas the ridge of rutting has been milled down and leveled; additional areas need rut repair.	7.20	$84M
I-73 NBL	Randolph	Mill and fill, interior lane deformation	8.10	$299M
US 220 BUS	Randolph	Concrete Base Buckles during higher temps causing roadway to rise, creating bump and cracking surface	1.10	$14M
Total	-	-	**23.88**	**$527M**

Table 5 – Submitted rehabilitation / rebuilding priorities and estimated costs

4 Cost Summary

To inform the model of how conditions translate into maintenance investment needs, should-cost was collected – what should various maintenance activities cost? This is used to estimate costs for the most common maintenance treatments down to the activity level.

Highlighted below are the unique unit costs for assets in Division 8, where activity costs of more common treatments are weighted more heavily than less common treatments for each asset[x].

Weighted average unit costs by Division

Asset	UOM	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14
Bike Lanes	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Cablerail*	LFT	$2	$1	$2	$5	$1	$1	$3	$2	$0	$5	$2	$0	$2	$1
Concrete Barrier*	LFT	$500	$8	$3	$1,350	$16	$15	$3	$182	$163	$182	$6	$42	$25	$50
Pipes	LFT	$267	$379	$315	$479	$273	$275	$327	$462	$296	$378	$395	$90	$256	$345
Crosswalk	EA	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Curb and Gutter*	LFT	$102	$132	$125	$83	$112	$144	$117	$109	$78	$112	$93	$39	$90	$88
Drop Inlets*	EA	$811	$809	$1,363	$460	$974	$714	$865	$788	$830	$1,041	$794	$744	$1,361	$1,297
Guardrail*	LFT	$16	$30	$36	$12	$1	$49	$30	$31	$12	$32	$6	$32	$50	$21
Impact Attenuator*	EA	$2,500	$12,500	$5,000	$8,840	$2,707	$1,925	$17,500	$750	$1,704	$9,250	$2,028	$2,613	$10,250	$3,000
Induction Loop	LFT	$1,381	$726	$2,777	$1,695	$825	$1,358	$748	$1,486	$573	$3,097	$1,322	$2,144	$1,167	$1,308
Mile marker	EA	$129	$171	$172	$135	$440	$268	$168	$276	$285	$164	$427	$137	$143	$192
Pavement Striping*	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Ramp Metering	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Road Sign	EA	$309	$365	$232	$288	$613	$378	$379	$366	$462	$249	$581	$249	$293	$338
Shoulder	SHM	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Timber Rail	LFT	$44	$6	$49	$313	$13	$8	$2	$49	$44	$49	$3	$23	$23	$63
Traffic Signal	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Word and Symbols	LFT	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Crack Seal	LM	$3,103	$4,000	$3,300	$3,409	$6,009	$2,100	$4,366	$4,000	$3,250	$6,000	$7,850	$4,366	$4,366	$5,000
Chip Seal	LM	$21,933	$18,625	$22,750	$17,014	$26,732	$53,875	$22,356	$49,000	$30,925	$17,500	$21,500	$22,902	$33,701	$32,500
Contract Resurfacing*	LM	$120,418	$140,000	$67,500	$96,025	$109,701	$92,500	$213,998	$97,500	$116,150	$185,000	$66,250	$87,184	$88,750	$151,250

Table 6 – Unit cost comparison between Divisions

[i] Condition and inventory data collected via ArTEMIS from January to September 2023; cost data collected from individual divisions and validated in February/March of 2024. Thus, funding scenarios outlined in this document were developed prior the impacts of Hurricane Helene & based on infrastructure condition data collected prior to the storm. As such, they do not account for the additional costs associated with the rehabilitation or reconstruction of infrastructure affected by the storm. Recognizing that rebuilding will entail significant expenses, the current scenarios focus on maintaining the regular operational budget and steady-state upkeep without reallocation of funds.

[ii] For purposes of calculating route score, "Words and Symbols" also includes bike lanes, crosswalks, sharrows.

[iii] When aggregated, route scores are weighted by lane miles and route class.

[iv] Maintenance costs are estimated solely by prioritizing the most efficient and cost-effective maintenance activities in terms of their impact on overall state/division route score, regardless of pre-existing plans, priorities, or ongoing projects.

[v] For these investment scenarios, we assume rates of inflation for labor, material, and equipment costs of 3%, 5%, and 8% respectively, per the 2023Q4 Engineering News-Record Cost Report. Costs for non-maintenance activities are assumed to increase at annual rate of 3%.

[vi] Spend to increase route score views pavement and roadside asset activities, only. Bridge activities that would increase score are currently not included. This may underestimate need when calculating need to improve by 10 pts.

[vii] Pipes are ingested into inventory counts via NCDOT survey

[viii] The pavement index assessment is consistent for every route and captures the entirety of the Division's inventory. At times, the asset detection algorithm powering the pavement index may miss light / moderate rutting.

[ix] Blank cells indicate that the asset type is not present in county and therefore excluded from analysis.

[x] Asterisk denotes predominately contracted activities. Cablerails, concrete barriers, timber rail, guardrails, curb and gutter, impact attenuators, and induction loops are typically contracted out in D8. All cost data in this table were provided and validated by engineers from each division. Variations in costs may arise due to several factors, including the frequency of repairs, whether work is performed in-house or contracted out, and the defect severity at which interventions are initiated. For assets where specific cost data were unavailable, the average cost across all divisions was used. Data was collected and validated February - May 2024.

DIVISION 9 INSIGHTS REPORT

This report uses data on inventory, condition, and costs to provide insights at the division, county, and route levels. It identifies long-term investment needs and opportunities across the system to optimize outcomes.[i]

1 Division Funding Needs 101

2 Division Asset Inventory & Condition 106

3 Rehabilitation / Rebuilding needs 111

4 Cost Summary 112

1 Division Funding Needs

1.1 Data Background

Launched in 2020, ArTEMIS initially tracked 30+ discrete maintenance functions on state-managed routes. Since then, it has expanded to capture a "fence-to-fence" view of assets, activity-based costs, and lifecycle investment forecasting, enabling more precise, data-driven maintenance planning.

The 2023 initiative leverages image recognition and AI/ML to assess conditions across 2+ million geo-located assets statewide. By aligning new inventory data with established sources like the Pavement Condition Survey, it enhances accuracy through "Route Scores" at route, county, division, and state levels, which help forecast investment needs. Similar to weather forecasting, aligning multiple datasets strengthens accuracy and reliability.

Statewide data collected and validated from January to September 2023 includes image collection, route walkthroughs, inspections, and quality reviews. These, alongside activity-based “should-cost” estimates—based on current market and industry standards—inform the Total Cost of Ownership model, supporting comprehensive maintenance planning.

1.2 Route Score Overview

1.2.1 Methodology

The table below shows the asset conditions contributing to Division 9's overall route score and how a route score is assembled at the route level (before being aggregated up by system counties, divisions, etc). The score uses point-in-time data collected January - September 2023.

Asset	State	Division 9
Pavement Index	83	84
Bridge Index	82	83
Shoulder	98%	98%
Pipes	82%	83%
Drop Inlets	89%	92%
Curb and Gutter	96%	95%
Pavement Striping	89%	88%
Signs	94%	96%
Guardrails and barriers	98%	97%
Words and Symbols[ii]	96%	94%
Traffic devices	100%	100%

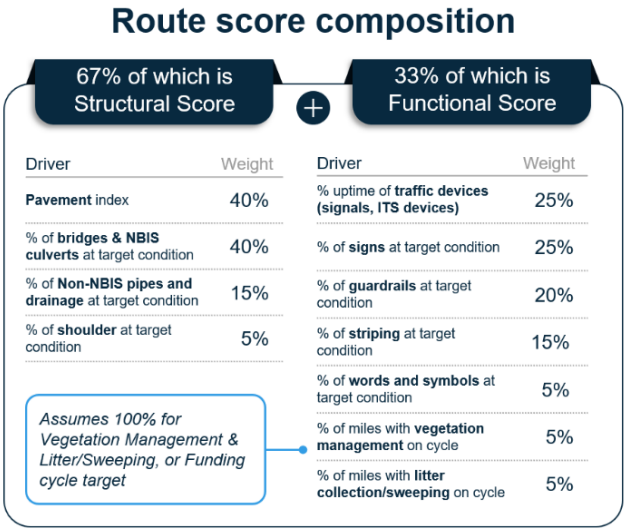
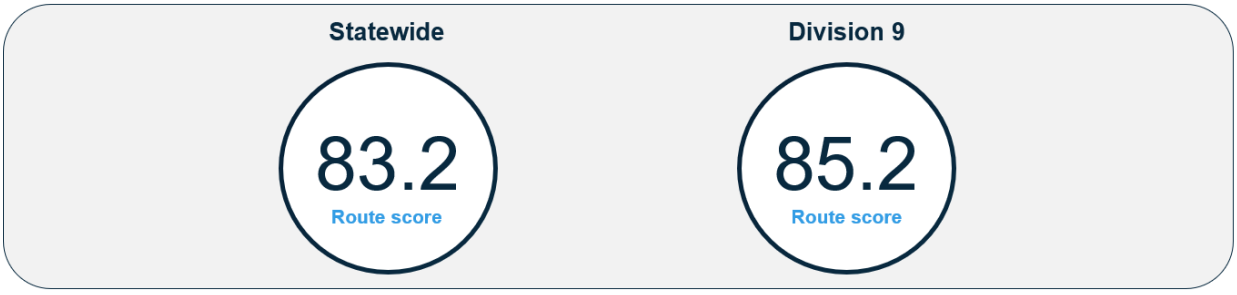


Table 1 – Asset scores (percentage of non-defective units or index score) across State and Division

1.2.2 Most Recent Outcomes

Using the scoring method shown above, the overall conditions of a division's roads can be shown with a single score that takes the weighted[iii] average of all its routes:



Route class	State	Division 9
Interstates	89	91
Primary	83	84
Secondary	82	84

Table 2 – Route scores by class

1.3 Route Score Distribution

The majority of the Division's network consists of routes in good condition, defined by a route score of 80 or higher. Over 7,800 lane miles (72% of network) are considered in good condition.

Conversely, less than 100 lane miles (1% of network) are considered in poor condition, defined by a route score lower than 60. Map 1 shows the condition of routes across the division.

Route score distribution, by lane miles

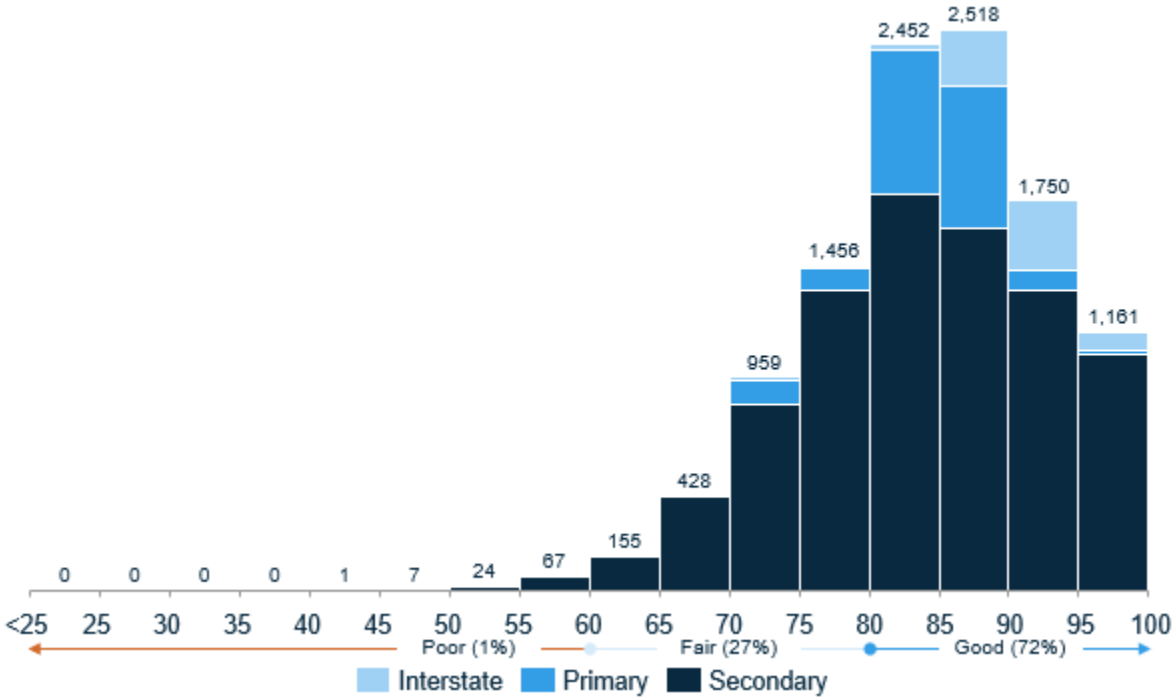
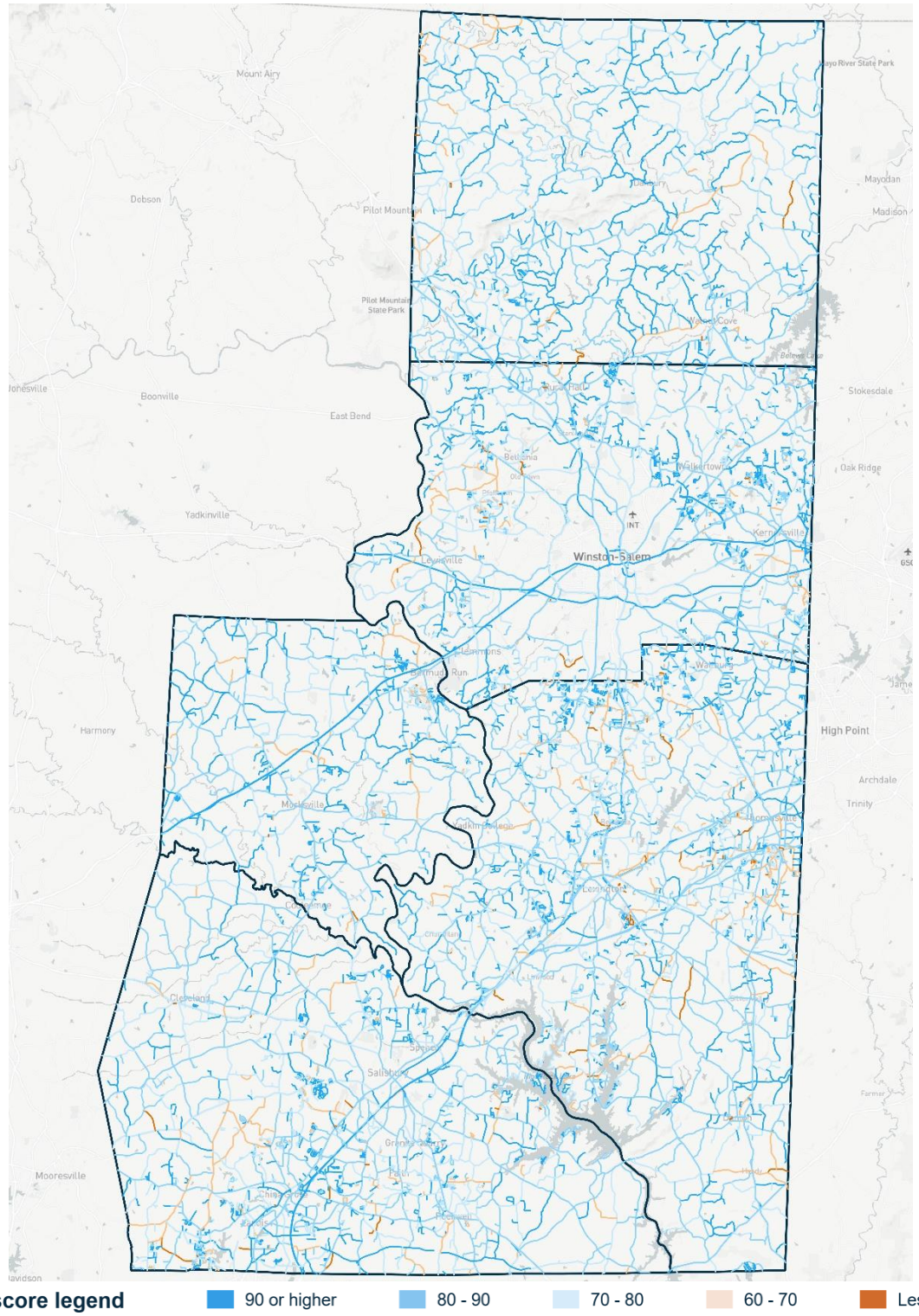


Figure 1 – Distribution of route score, measured in lane miles

Across the road network, the most common route score is between 85 and 90. Interstate and primary routes in Division 9 all have route scores of at least 70, while secondary routes exhibit route scores starting at 40.

These routes can be mapped spatially to evaluate the distribution by geography, as seen on the next page.

Route score distribution, by county



Map 1 – Spatial distribution of route score, grouped by county

1.4 Impact of static funding

Route Score is used to estimate the investment needed[iv] to maintain or achieve various condition levels over the next 10 years, assuming expected inflation[v] and asset deterioration.

Maintaining this division's current condition will require a year-over-year increase in funding, due to inflation and regular wear-and-tear. Static funding leads to a decline of **-1.7** points in the following year and will potentially lower it by at least **-9.5** points over the next decade.

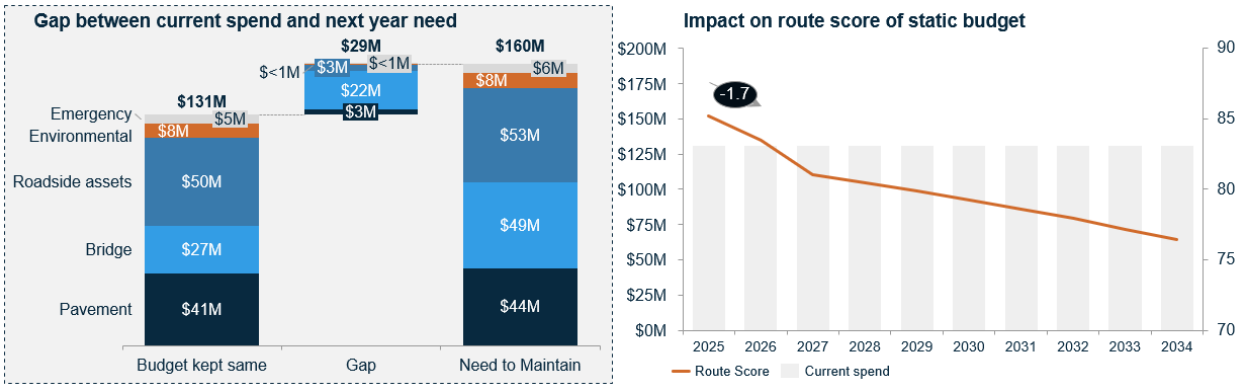


Figure 2 – Comparison of current spend and expected need; route score over time if no budget increase

1.5 Investment needs over the next 10 years

Using the Route Score, ArTEMIS can quantify investment needed to maintain or improve condition by raising the route score by zero points (maintain conditions), one point (slight improvement), five points (large improvement), and ten points (near-perfect conditions)[vi].

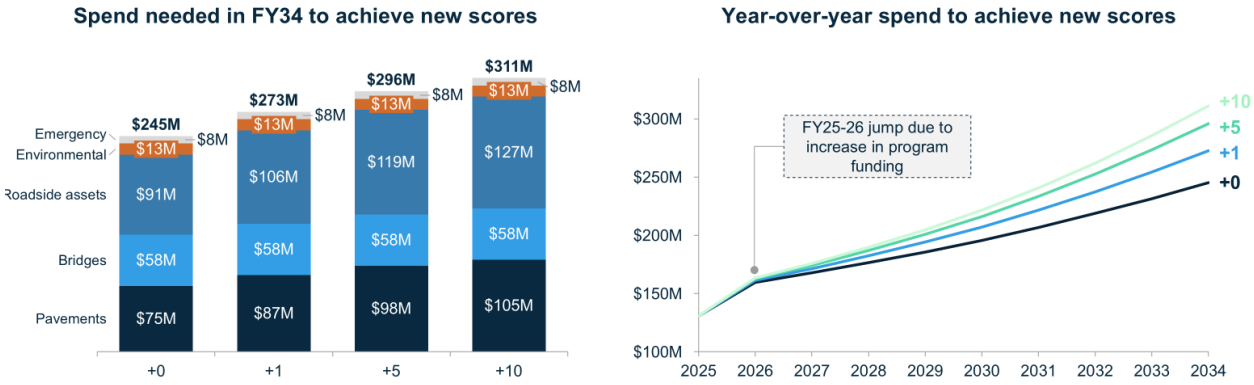


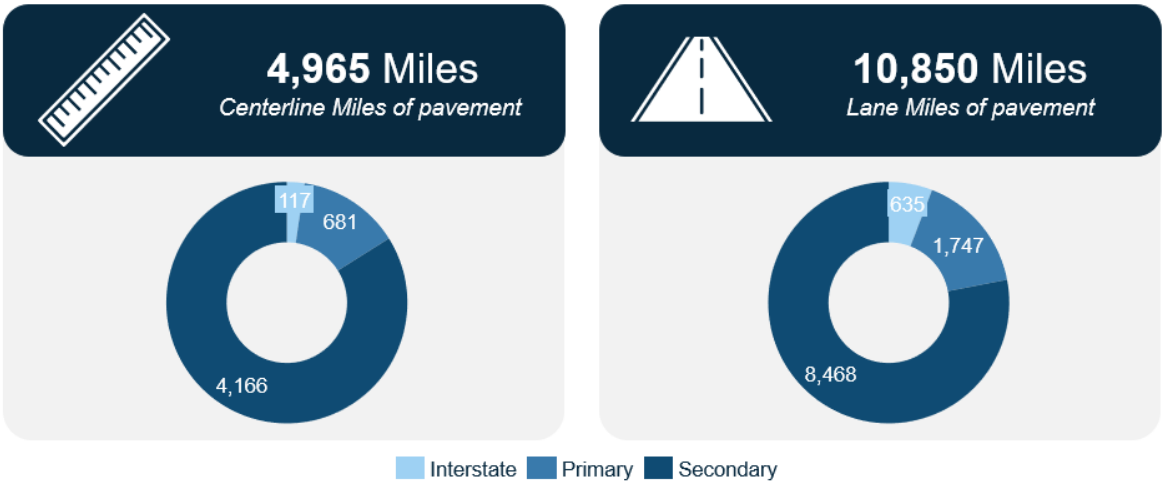
Figure 3 – Projected investment needed (YOE $) to improve route score over 10 years

As shown, maintaining and improving Division 9's Route Score requires greater investment:

- **+0** requires increasing spend to **$245M** by FY34; **$1,919M** in total investment
- **+1** requires increasing spend to **$273M** by FY34; **$2,033M** in total investment
- **+5** requires increasing spend to **$296M** by FY34; **$2,126M** in total investment
- **+10** requires increasing spend to **$311M** by FY34; **$2,186M** in total investment

2 Division Asset Inventory & Condition

2.1 Pavement & Asset Inventory



		Quantity			
Asset	**Unit**	**Interstate**	**Primary**	**Secondary**	**Overall**
Bike Lanes	LFT	0	28,382	45,590	73,971
Cablerail	MI	71	0	0	72
Concrete Barrier	MI	48	24	12	84
Crosswalk	EA	0	113	301	414
Curb and Gutter	MI	8	176	316	500
Drop Inlets	EA	636	2,408	6,235	9,279
Guardrail	MI	141	151	121	412
Impact Attenuator	EA	5	42	9	56
Induction Loop	EA	22	1,658	2,180	3,860
Mile marker	EA	254	54	35	343
Noise Wall*	LFT	16,023	10,869	25,530	52,422
Pavement Striping (defective only)	MI	65	312	1,637	2,015
Pipes[vii]	LFT	19,722	293,888	257,824	571,434
Retaining Wall*	LFT	1,980	17,972	43,727	63,679
Road Sign	EA	1,746	12,329	38,859	52,934
Rumble Strips*	MI	394	192	50	636
Sharrows	EA	0	107	193	300
Shoulder (defective only)	MI	0	29	180	209
Traffic Signal	EA	14	2,915	4,463	7,392
Variable Message Sign	EA	33	19	33	85
Word and Symbols	EA	479	8,427	8,811	17,717

Table 3 – Selection of roadside asset inventory; asterisk indicates no significance to route score

2.2 Pavement Conditions

Using Pavement Condition Survey (PCS) data, shown below is the breakdown of good, fair, and poor lane miles across the interstate, primary, and secondary systems.

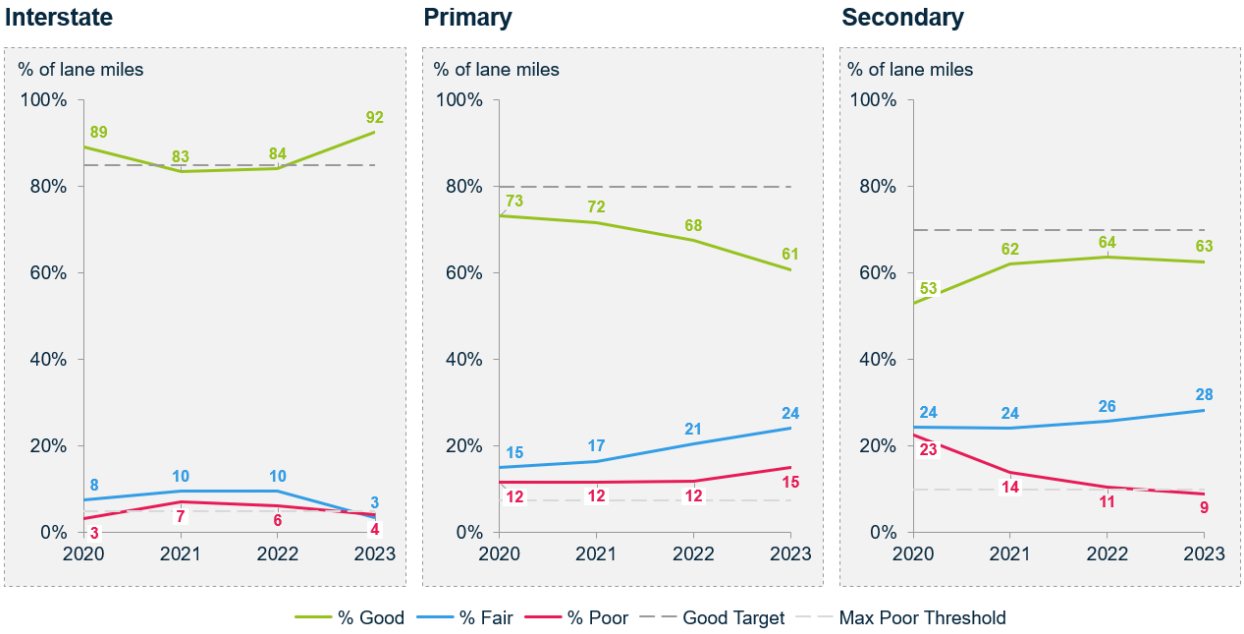


Figure 4 – Pavement conditions across interstate, primary, and secondary systems

Pavement conditions in Division 9 as evaluated via ArTEMIS are above the state average, with a division-wide pavement index of **84**. Condition varies across the division by primary and secondary routes.

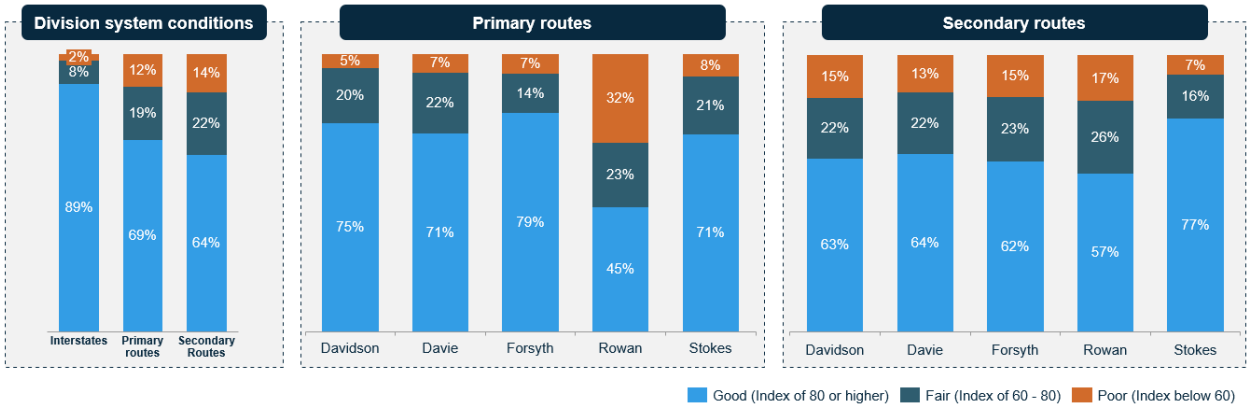


Figure 5 – Comparison of lane miles in good, fair, and poor conditions

County pavement index (weighted by lane miles) range **from 81 to 89**. Deductions are primarily driven by two distresses: (1) alligator cracking and (2) transverse cracking.

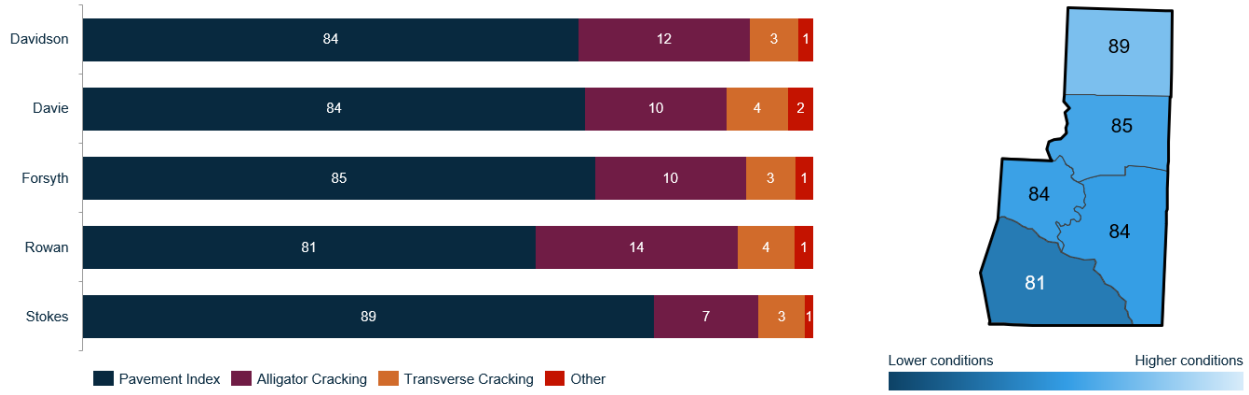


Figure 6 – Pavement index and deduction breakdown by county

Complementary models show similar assessments of pavement condition between the ArTEMIS model and the PCS model for Division 9. The pavement index utilizes the same scoring methodology as the PCS, the only differences being in how the data is collected/reviewed[viii].

	Condition			
Model	**Interstates**	**Primary**	**Secondary**	**Overall**
Pavement index (ArTEMIS)	95	85	83	84
Pavement condition score (PCS)	87	81	83	83

Table 4 – Condition comparison by pavement models for Division 9

2.3 Bridge Conditions

Bridge conditions are evaluated using a bridge index that translates general condition ratings (i.e., 1-9 scale) into a 100-point scale for easier comparison.

Overall, the Division 9 bridge index (83) scores ~1 point higher than statewide bridge index (82).

Data is ingested from FHWA bridge portal.

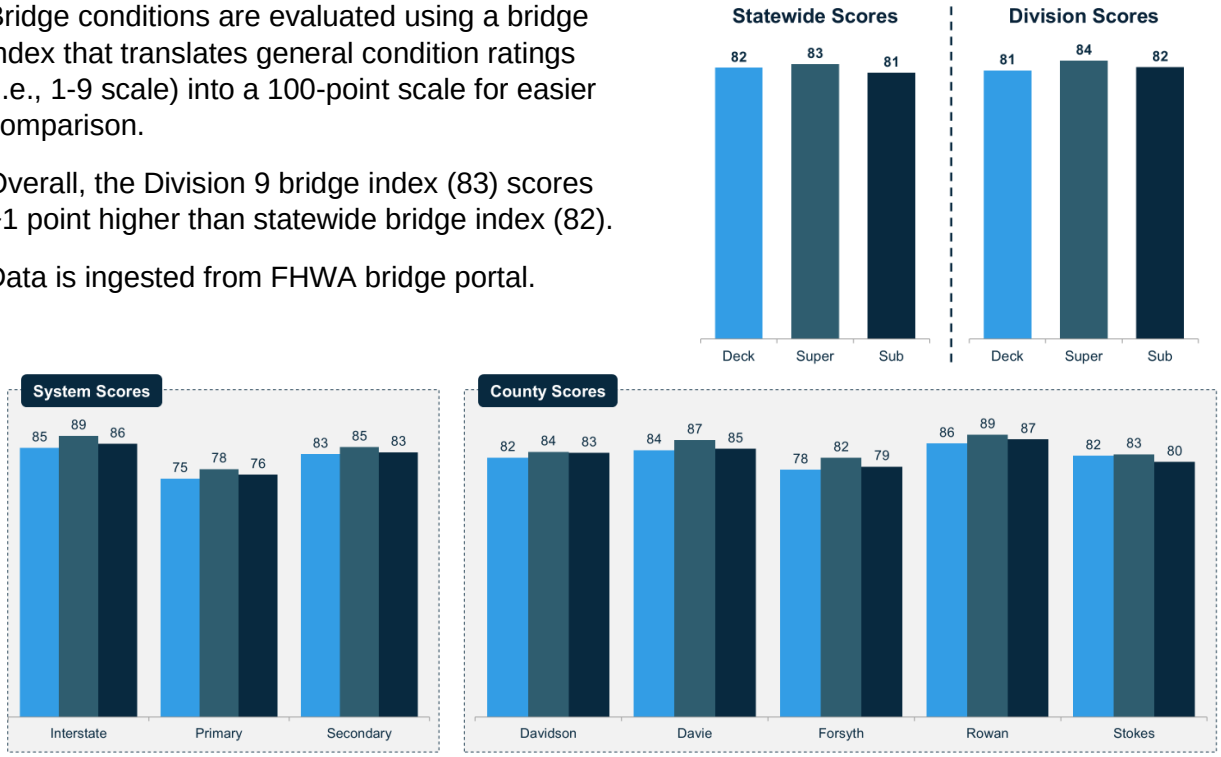


Figure 7 – Comparison of bridge conditions

The figure below displays all bridges in poor condition (index below 60) or at-risk of becoming poor (index of 60 – 69). They are mostly on the secondary system. Each circle maps one bridge by latitude and longitude; circle size indicates deck area, with at-risk bridges sized uniformly.

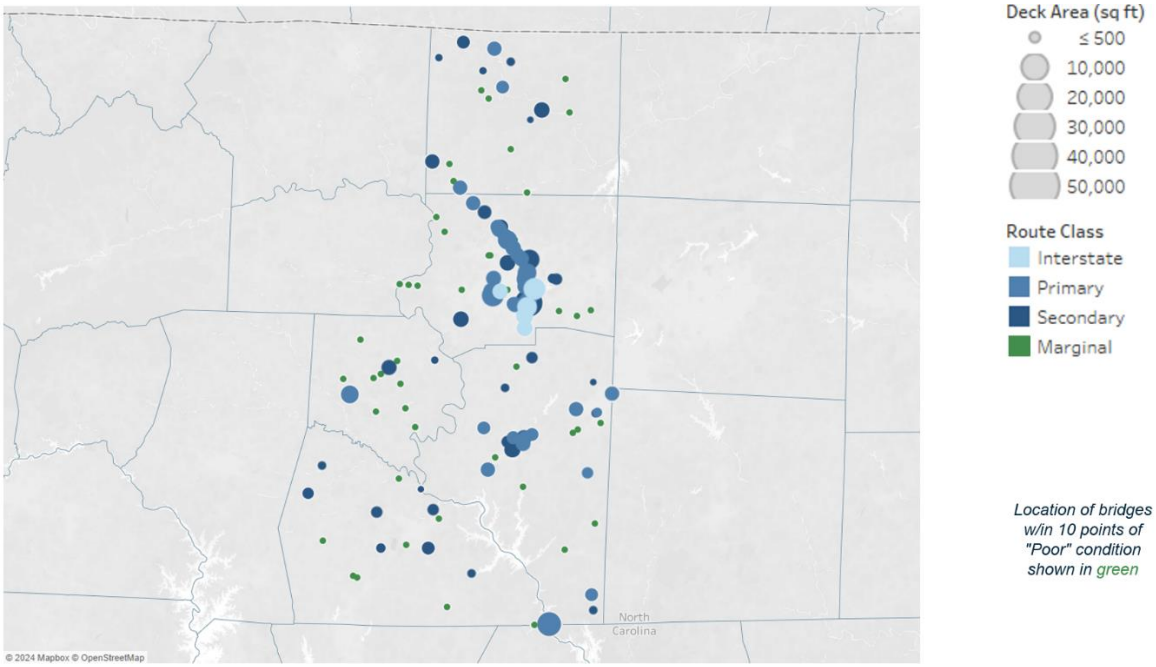


Figure 8 – Distribution of poor bridges and at-risk of becoming poor condition bridges in Division 9

2.4 Roadside Asset Conditions

Roadside asset condition is evaluated by measuring the proportion at which an asset is non-defective in a division, county, or route.

Asset	State	D9	Davidson	Davie	Forsyth	Rowan	Stokes
Pavement Striping	89%	88%	88%	92%	89%	84%	88%
Bike Lanes	78%	85%	99%		60%	99%	
Word and Symbols	74%	75%	77%	79%	74%	74%	70%
Sharrows	84%	94%	83%	100%	92%	98%	
Signs	94%	96%	96%	96%	96%	96%	96%
Drop Inlets	89%	92%	95%	92%	91%	90%	93%
Curb and Gutter	96%	95%	91%	94%	96%	95%	92%
Guardrails	98%	97%	98%	99%	97%	98%	96%
Shoulder	98%	98%	98%	99%	98%	97%	98%

Most Defective — Least Defective

Figure 9 – Comparison of conditions between county functional assets [ix]

Below is roadside asset condition visualized with county boundaries, where colors are relative to the average condition across the state, for each respective asset.

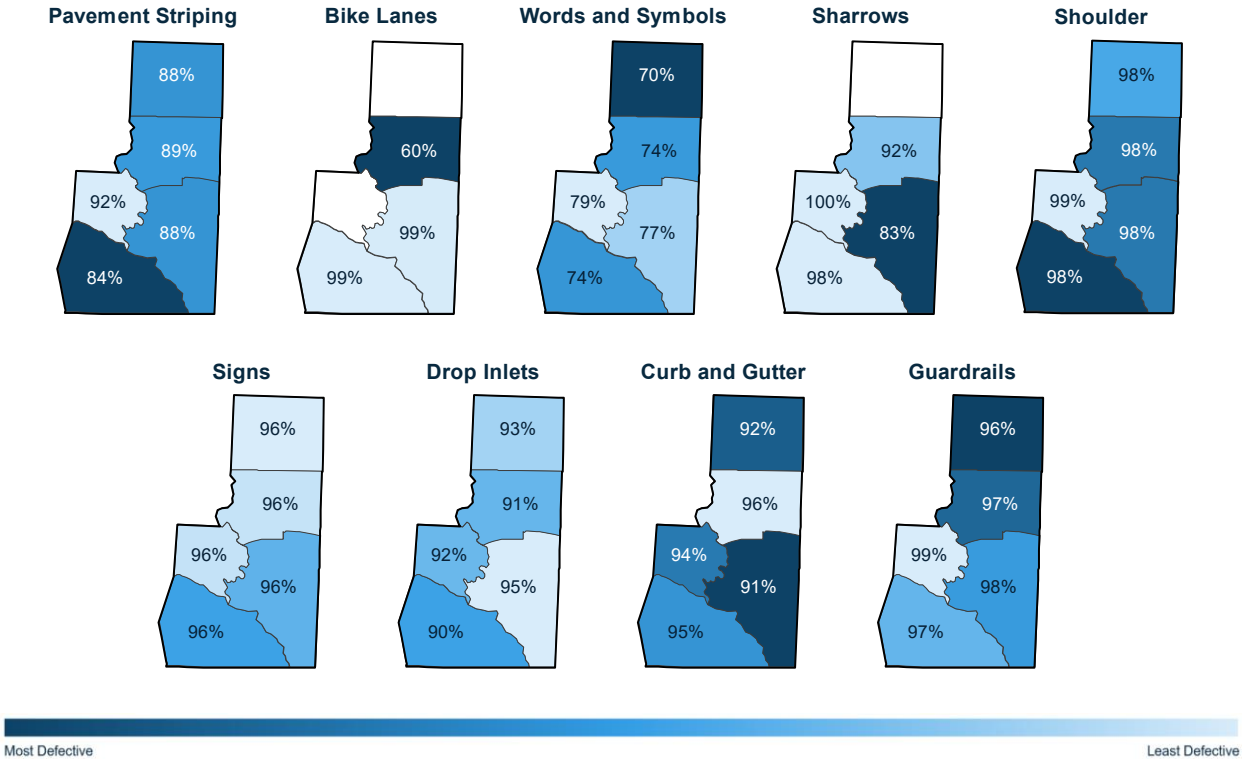


Figure 10 – Comparison of roadside asset conditions mapped to county boundaries

3 Rehabilitation / Rebuilding Needs

To develop a sense of what level of investment is required to ensure our state's ability to provide a safe and effective transportation network into the future, in the summer of 2024 the Director of Highway Operations reached out to all 14 Division Engineers and their teams, asking them to provide details on their highest priority ~35 miles of reconstruction/rehabilitation needs. The submitted sections for Division 9, along with estimated costs, are outlined below ranked in order of priority (as submitted).

Route	County	Comments	Miles	Est. Cost ($M)
US 52	Forsyth	--	11.40	$610M
I-285	Forsyth	IM Project TIP # HI-0005	4.70	$280M
US 52	Forsyth	Exact mile posting of US 52 / NC 74 interchange not available.	5.05	$245M
I-285	Davidson	--	9.33	$326M
US 421	Forsyth	--	7.25	$330M
Total	-	-	**38.83**	**$1,791M**

Table 5 – Submitted rehabilitation / rebuilding priorities and estimated costs

4 Cost Summary

To inform the model of how conditions translate into maintenance investment needs, should-cost was collected – what should various maintenance activities cost? This is used to estimate costs for the most common maintenance treatments down to the activity level.

Highlighted below are the unique unit costs for assets in Division 9, where activity costs of more common treatments are weighted more heavily than less common treatments for each asset[x].

Weighted average unit costs by Division

Asset	UOM	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14
Bike Lanes	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Cablerail*	LFT	$2	$1	$2	$5	$1	$1	$3	$2	$0	$5	$2	$0	$2	$1
Concrete Barrier*	LFT	$500	$8	$3	$1,350	$16	$15	$3	$182	$163	$182	$6	$42	$25	$50
Pipes	LFT	$267	$379	$315	$479	$273	$275	$327	$462	$296	$378	$395	$90	$256	$345
Crosswalk	EA	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Curb and Gutter*	LFT	$102	$132	$125	$83	$112	$144	$117	$109	$78	$112	$93	$39	$90	$88
Drop Inlets*	EA	$811	$809	$1,363	$460	$974	$714	$865	$788	$830	$1,041	$794	$744	$1,361	$1,297
Guardrail*	LFT	$16	$30	$36	$12	$1	$49	$30	$31	$12	$32	$6	$32	$50	$21
Impact Attenuator*	EA	$2,500	$12,500	$5,000	$8,840	$2,707	$1,925	$17,500	$750	$1,704	$9,250	$2,028	$2,613	$10,250	$3,000
Induction Loop	LFT	$1,381	$726	$2,777	$1,695	$825	$1,358	$748	$1,486	$573	$3,097	$1,322	$2,144	$1,167	$1,308
Mile marker	EA	$129	$171	$172	$135	$440	$268	$168	$276	$285	$164	$427	$137	$143	$192
Pavement Striping*	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Ramp Metering	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Road Sign	EA	$309	$365	$232	$288	$613	$378	$379	$366	$462	$249	$581	$249	$293	$338
Shoulder	SHM	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Timber Rail	LFT	$44	$6	$49	$313	$13	$8	$2	$49	$44	$49	$3	$23	$23	$63
Traffic Signal	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Word and Symbols	LFT	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Crack Seal	LM	$3,103	$4,000	$3,300	$3,409	$6,009	$2,100	$4,366	$4,000	$3,250	$6,000	$7,850	$4,366	$4,366	$5,000
Chip Seal	LM	$21,933	$18,625	$22,750	$17,014	$26,732	$53,875	$22,356	$49,000	$30,925	$17,500	$21,500	$22,902	$33,701	$32,500
Contract Resurfacing*	LM	$120,418	$140,000	$67,500	$96,025	$109,701	$92,500	$213,998	$97,500	$116,150	$185,000	$66,250	$87,184	$88,750	$151,250

Table 6 – Unit cost comparison between Divisions

[i] Condition and inventory data collected via ArTEMIS from January to September 2023; cost data collected from individual divisions and validated in February/March of 2024. Thus, funding scenarios outlined in this document were developed prior the impacts of Hurricane Helene & based on infrastructure condition data collected prior to the storm. As such, they do not account for the additional costs associated with the rehabilitation or reconstruction of infrastructure affected by the storm. Recognizing that rebuilding will entail significant expenses, the current scenarios focus on maintaining the regular operational budget and steady-state upkeep without reallocation of funds.

[ii] For purposes of calculating route score, "Words and Symbols" also includes bike lanes, crosswalks, sharrows.

[iii] When aggregated, route scores are weighted by lane miles and route class.

[iv] Maintenance costs are estimated solely by prioritizing the most efficient and cost-effective maintenance activities in terms of their impact on overall state/division route score, regardless of pre-existing plans, priorities, or ongoing projects.

[v] For these investment scenarios, we assume rates of inflation for labor, material, and equipment costs of 3%, 5%, and 8% respectively, per the 2023Q4 Engineering News-Record Cost Report. Costs for non-maintenance activities are assumed to increase at annual rate of 3%.

[vi] Spend to increase route score views pavement and roadside asset activities, only. Bridge activities that would increase score are currently not included. This may underestimate need when calculating need to improve by 10 pts.

[vii] Pipes are ingested into inventory counts via NCDOT survey

[viii] The pavement index assessment is consistent for every route and captures the entirety of the Division's inventory. At times, the asset detection algorithm powering the pavement index may miss light / moderate rutting.

[ix] Blank cells indicate that the asset type is not present in county and therefore excluded from analysis.

[x] Asterisk denotes predominately contracted activities. Variable message signs, impact attenuators, guardrails, shoulders, cable rails, and pavement markings are typically contracted out in D9. All cost data in this table were provided and validated by engineers from each division. Variations in costs may arise due to several factors, including the frequency of repairs, whether work is performed in-house or contracted out, and the defect severity at which interventions are initiated. For assets where specific cost data were unavailable, the average cost across all divisions was used. Data was collected and validated February - May 2024.

DIVISION 10 INSIGHTS REPORT

This report uses data on inventory, condition, and costs to provide insights at the division, county, and route levels. It identifies long-term investment needs and opportunities across the system to optimize outcomes.[i]

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2 Division Asset Inventory & Condition 118

3 Rehabilitation / Rebuilding needs 123

4 Cost Summary 125

1 Division Funding Needs

1.1 Data Background

Launched in 2020, ArTEMIS initially tracked 30+ discrete maintenance functions on state-managed routes. Since then, it has expanded to capture a "fence-to-fence" view of assets, activity-based costs, and lifecycle investment forecasting, enabling more precise, data-driven maintenance planning.

The 2023 initiative leverages image recognition and AI/ML to assess conditions across 2+ million geo-located assets statewide. By aligning new inventory data with established sources like the Pavement Condition Survey, it enhances accuracy through "Route Scores" at route, county, division, and state levels, which help forecast investment needs. Similar to weather forecasting, aligning multiple datasets strengthens accuracy and reliability.

Statewide data collected and validated from January to September 2023 includes image collection, route walkthroughs, inspections, and quality reviews. These, alongside activity-based “should-cost” estimates—based on current market and industry standards—inform the Total Cost of Ownership model, supporting comprehensive maintenance planning.

1.2 Route Score Overview

1.2.1 Methodology

The table below shows the asset conditions contributing to Division 10's overall route score and how a route score is assembled at the route level (before being aggregated up by system counties, divisions, etc). The score uses point-in-time data collected January - September 2023.

Asset	State	Division 10
Pavement Index	83	84
Bridge Index	82	85
Shoulder	98%	97%
Pipes	82%	80%
Drop Inlets	89%	88%
Curb and Gutter	96%	96%
Pavement Striping	89%	89%
Signs	94%	95%
Guardrails and barriers	98%	98%
Words and Symbols[ii]	96%	96%
Traffic devices	100%	100%

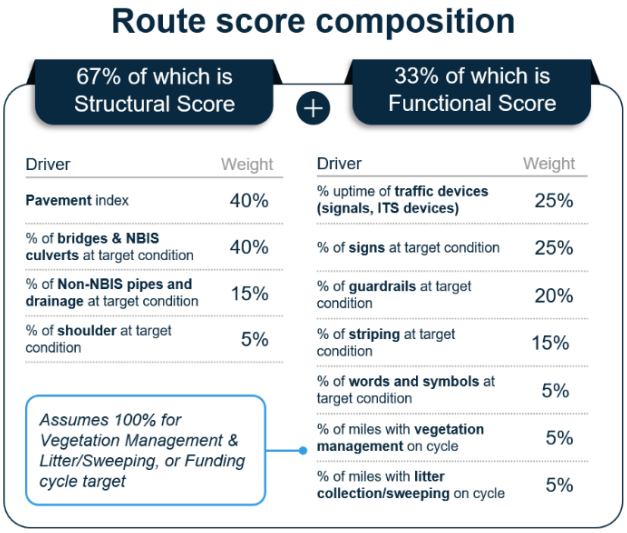
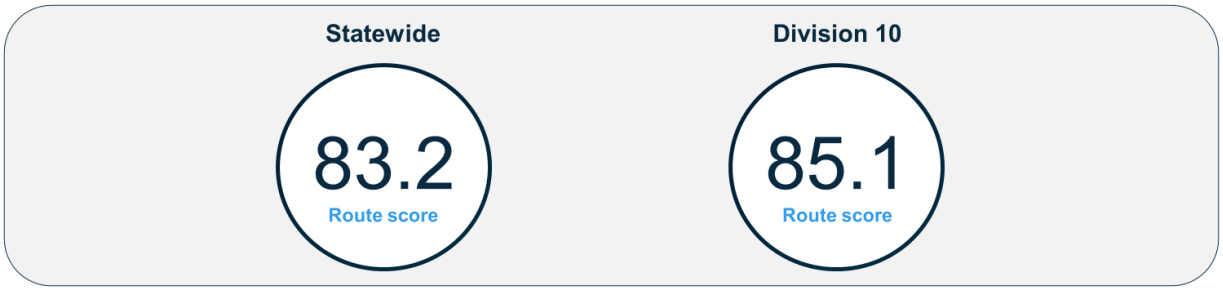


Table 1 – Asset scores (percentage of non-defective units or index score) across State and Division

1.2.2 Most Recent Outcomes

Using the scoring method shown above, the overall conditions of a division's roads can be shown with a single score that takes the weighted[iii] average of all its routes:



Route class	State	Division 10
Interstates	89	93
Primary	83	84
Secondary	82	83

Table 2 – Route scores by class

1.3 Route Score Distribution

The majority of the Division's network consists of routes in good condition, defined by a route score of 80 or higher. Over 7,800 lane miles (69% of network) are considered in good condition.

Conversely, less than 70 lane miles (1% of network) are considered in poor condition, defined by a route score lower than 60. Map 1 shows the condition of routes across the division.

Route score distribution, by lane miles

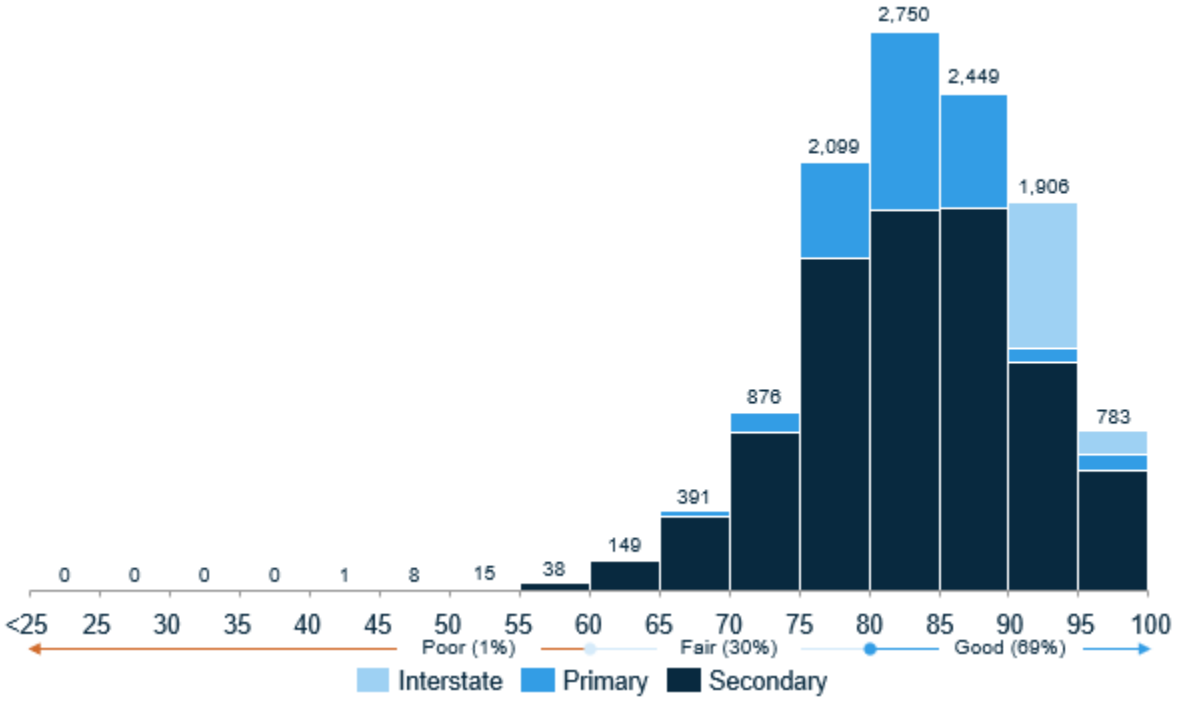
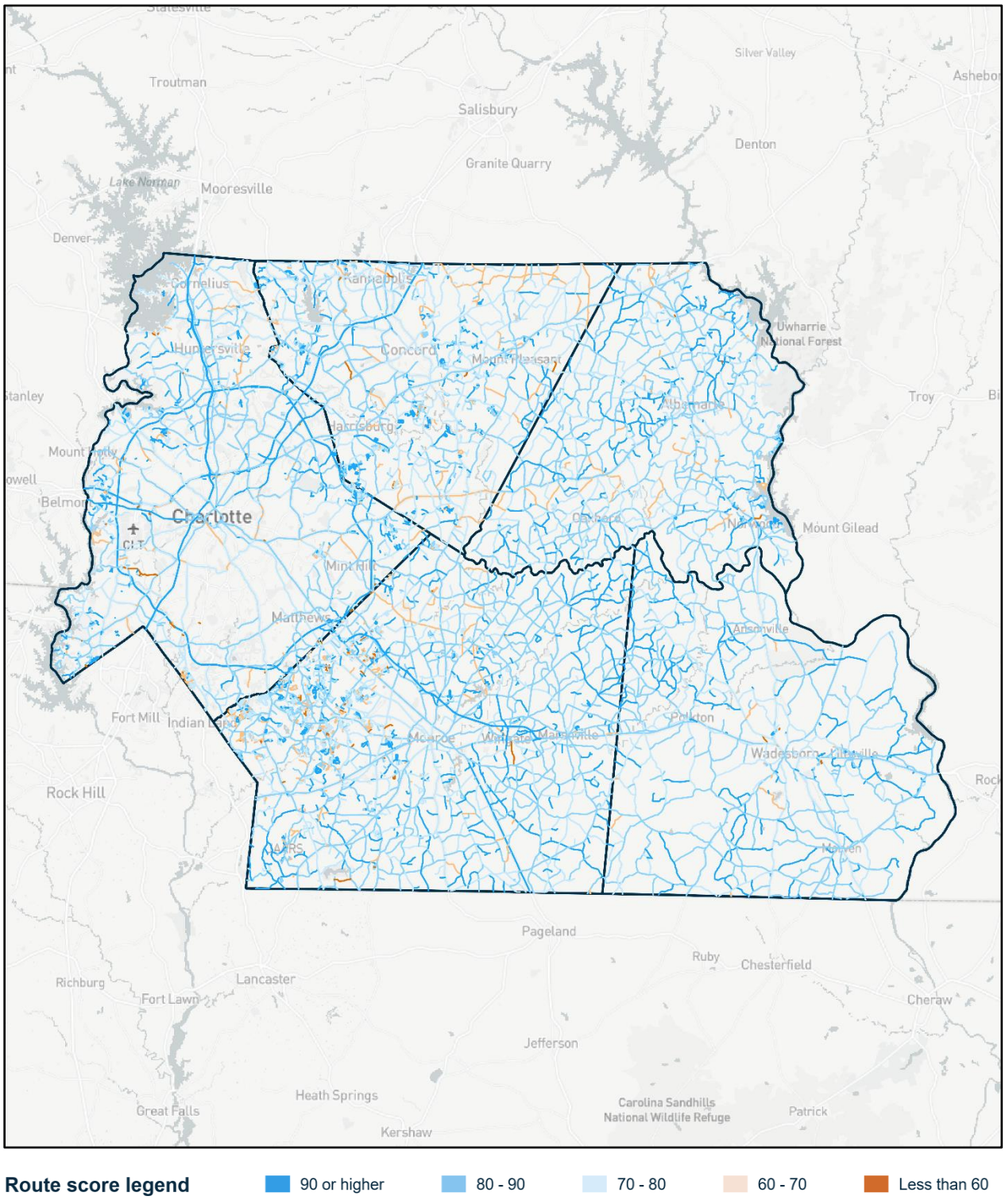


Figure 1 – Distribution of route score, measured in lane miles

Across the road network, the most common route score is between 85 and 90. Interstate and primary routes in Division 10 all have route scores of at least 65, while secondary routes exhibit route scores starting at 40.

These routes can be mapped spatially to evaluate the distribution by geography, as seen on the next page.

Route score distribution, by county



Map 1 – Spatial distribution of route score, grouped by county

1.4 Impact of static funding

Route Score is used to estimate the investment needed[iv] to maintain or achieve various condition levels over the next 10 years, assuming expected inflation[v] and asset deterioration.

Maintaining this division's current condition will require a year-over-year increase in funding, due to inflation and regular wear-and-tear. Static funding may lead to a decline of **-3.6** points in the following year and will potentially lower it by at least **-12.9** points over the next decade.

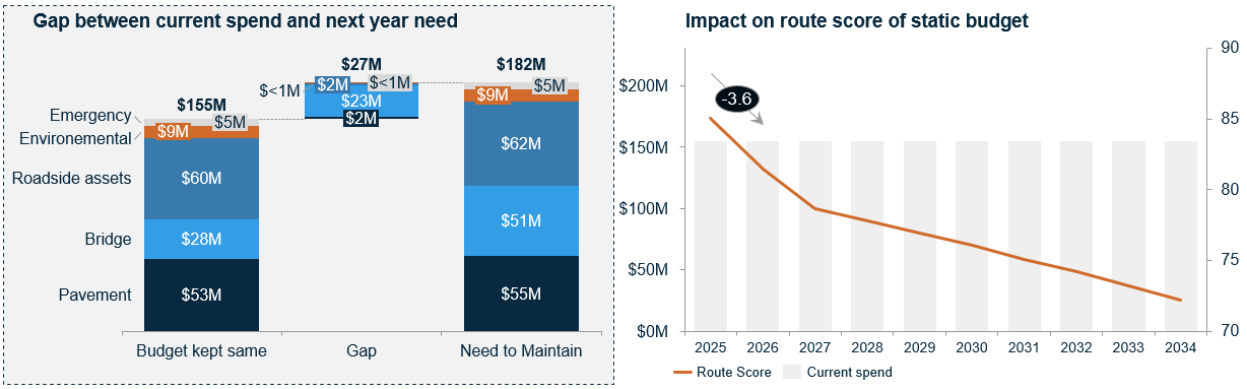


Figure 2 – Comparison of current spend and expected need; route score over time if no budget increase

1.5 Investment needs over the next 10 years

Using the Route Score, ArTEMIS can quantify investment needed to maintain or improve condition by raising the route score by zero points (maintain conditions), one point (slight improvement), five points (large improvement), and ten points (near-perfect conditions)[vi].

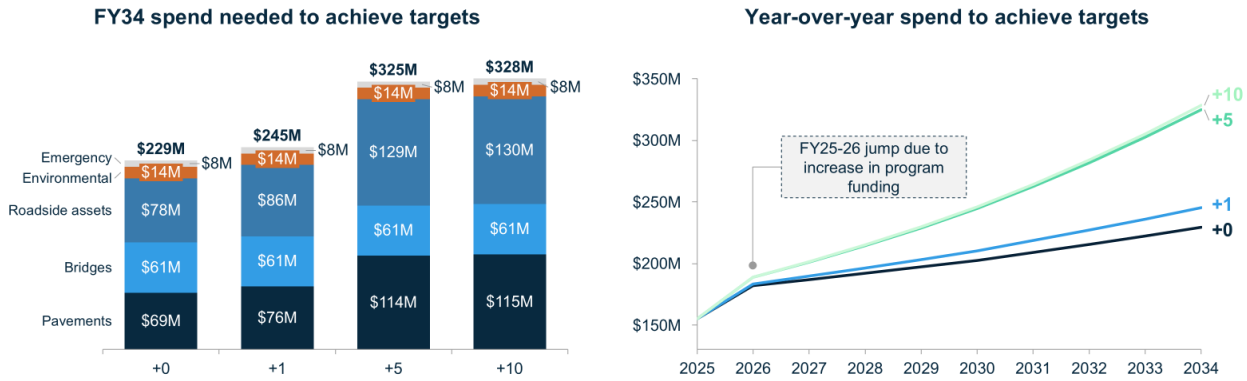


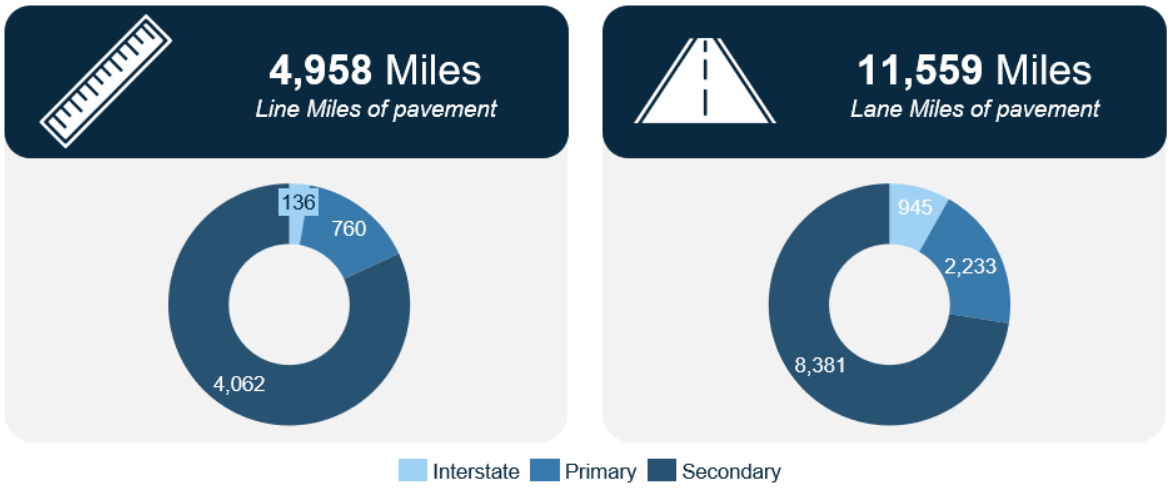
Figure 3 – Projected investment needed (YOE $) to improve route score over 10 years

As shown, maintaining and improving Division 10's Route Score requires greater investment:

- **+0** requires increasing spending to **$229M** by FY34; **$1,991M** in total investment
- **+1** requires increasing spending to **$245M** by FY34; **$2,064M** in total investment
- **+5** requires increasing spending to **$325M** by FY34; **$2,403M** in total investment
- **+10** requires increasing spending to **$328M** by FY34; **$2,417M** in total investment

2 Division Asset Inventory & Condition

2.1 Pavement & Asset Inventory



		Quantity			
Asset	**Unit**	**Interstate**	**Primary**	**Secondary**	**Overall**
Bike Lanes	MI	0	24	74	**98**
Cablerail	MI	63	37	0	**101**
Concrete Barrier	MI	183	28	26	**238**
Crosswalk	EA	0	844	1,196	**2,040**
Curb and Gutter	MI	12	521	599	**1,132**
Drop Inlets	EA	1,564	7,200	15,837	**24,601**
Guardrail	MI	113	148	130	**391**
Impact Attenuator	EA	99	129	18	**246**
Induction Loop	EA	31	2,857	3,304	**6,192**
Mile marker	EA	1,314	382	16	**1,712**
Noise Wall*	MI	19	2	2	**23**
Pavement Striping (defective only)	MI	68	465	1,270	**1,803**
Pipes[vii]	LFT	20,125	193,173	189,328	**402,626**
Retaining Wall*	MI	0	4	7	**11**
Road Sign	EA	3,060	20,778	47,122	**70,960**
Rumble Strips*	MI	373	309	25	**707**
Sharrows	EA	0	361	617	**978**
Shoulder (defective only)	MI	1	37	262	**300**
Traffic Signal	EA	104	8,243	8,478	**16,825**
Variable Message Sign	EA	38	56	124	**218**
Word and Symbols	EA	1,406	16,876	17,596	**35,878**

Table 3 – Selection of roadside asset inventory; asterisk indicates no significance to route score

2.2 Pavement Conditions

Using Pavement Condition Survey (PCS) data, shown below is the breakdown of good, fair, and poor lane miles across the interstate, primary, and secondary systems.

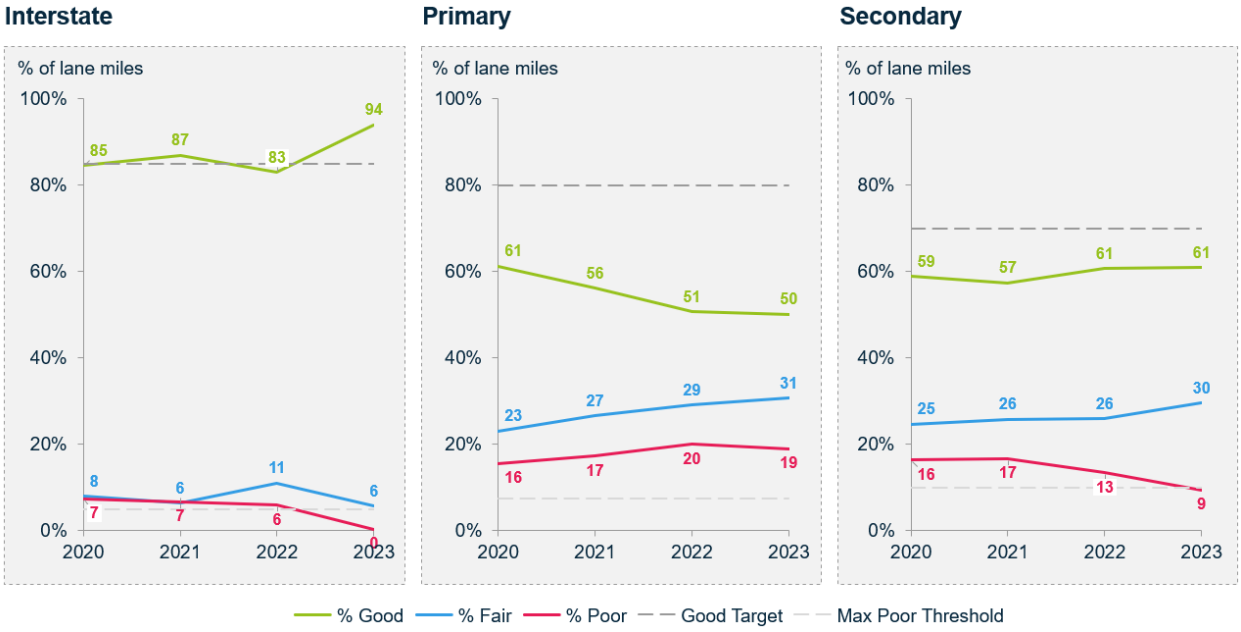


Figure 4 – Pavement conditions across interstate, primary, and secondary systems

Pavement conditions in Division 10 as evaluated via ArTEMIS are similar to statewide conditions, with a division-wide pavement index of **84**. Condition varies across the division by primary and secondary routes.

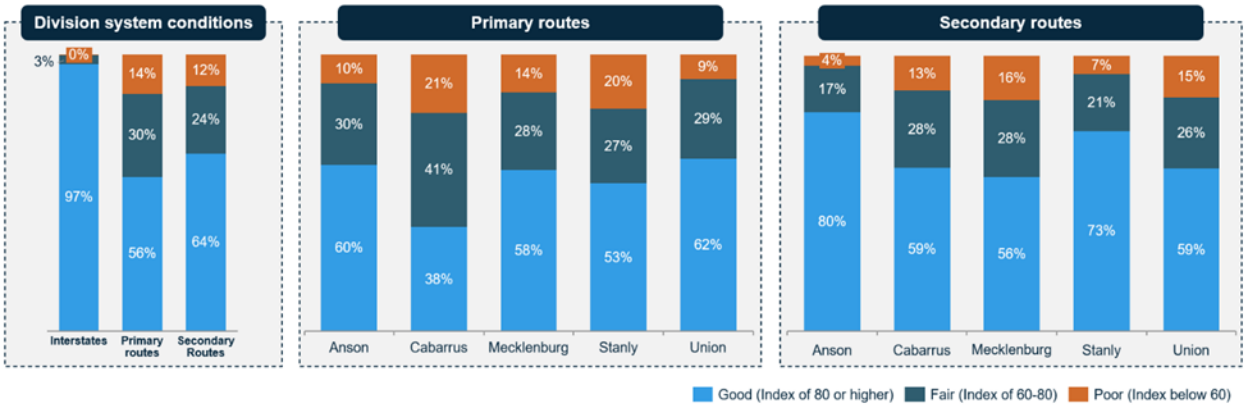


Figure 5 – Comparison of lane miles in good, fair, and poor conditions

County pavement index (weighted by lane miles) range **from 81 to 88**. Deductions are primarily driven by two distresses: (1) alligator cracking and (2) transverse cracking.

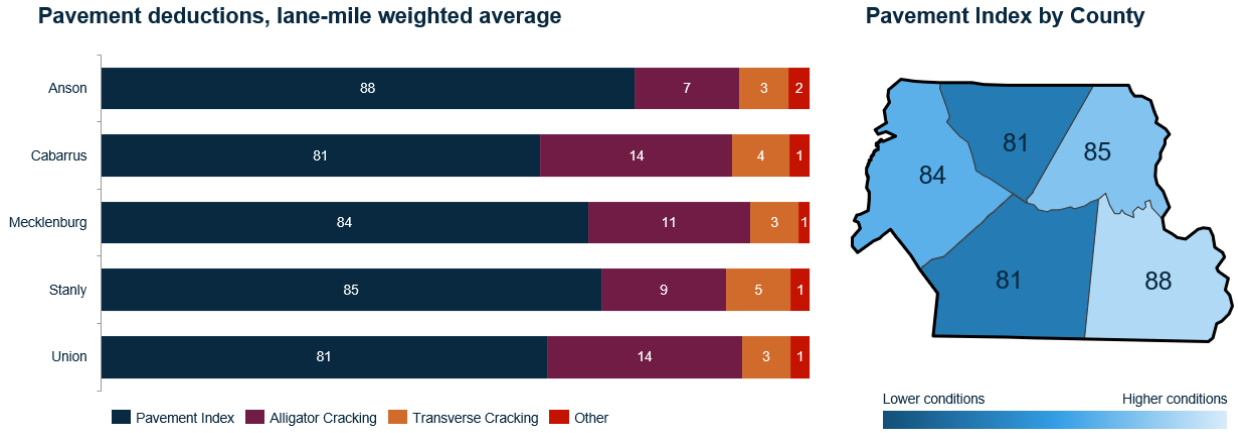


Figure 6 – Pavement index and deduction breakdown by county

Complementary models show similar assessments of pavement condition between the ArTEMIS model and the PCS model for Division 10. The pavement index utilizes the same scoring methodology as the PCS, the only differences being in how the data is collected/reviewed[viii].

	Condition			
Model	**Interstates**	**Primary**	**Secondary**	**Overall**
Pavement index (ArTEMIS)	97	80	83	84
Pavement condition score (PCS)	92	78	82	82

Table 4 – Condition comparison by pavement models for Division 10

2.3 Bridge Conditions

Bridge conditions are evaluated using a bridge index that translates general condition ratings (i.e., 1-9 scale) into a 100-point scale for easier comparison.

Overall, the Division 10 bridge index (85) scores ~3 point higher than statewide bridge index (82).

Data is ingested from FHWA bridge portal.

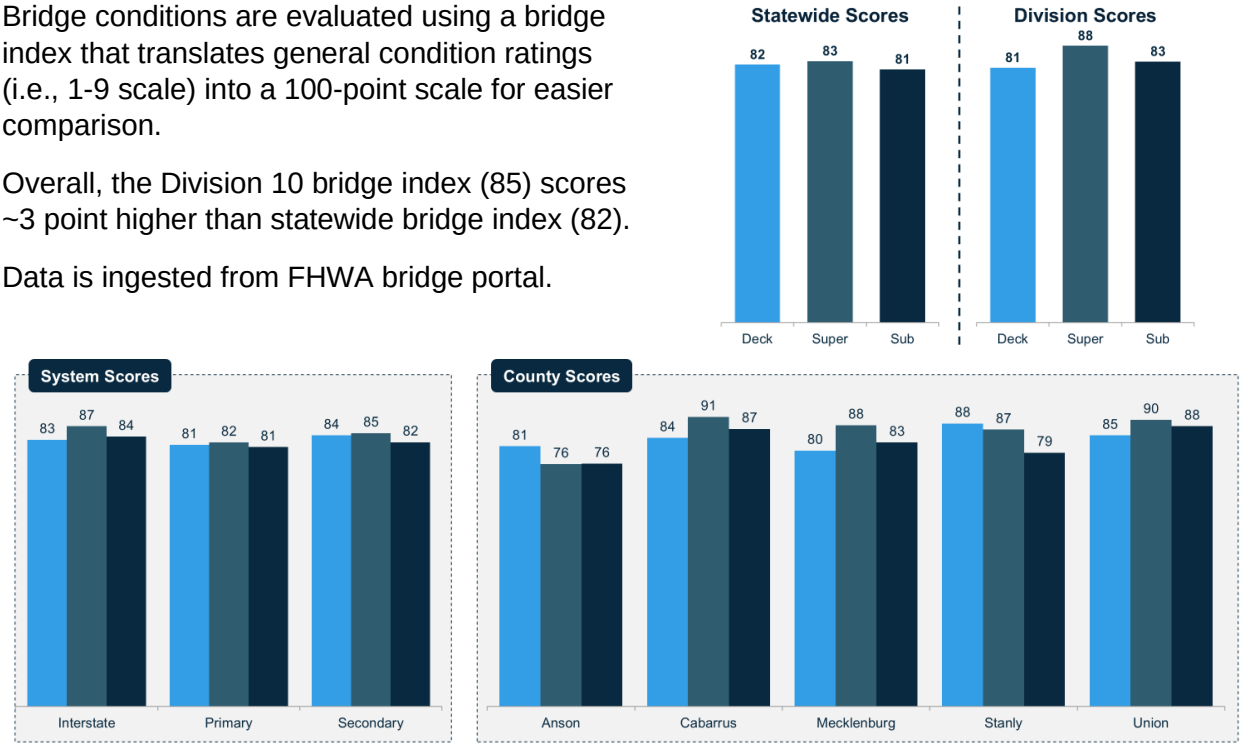


Figure 7 – Comparison of bridge conditions

The figure below displays all bridges in poor condition (index below 60) or at-risk of becoming poor (index of 60 – 69). They are mostly on the secondary system. Each circle maps one bridge by latitude and longitude; circle size indicates deck area, with at-risk bridges sized uniformly.

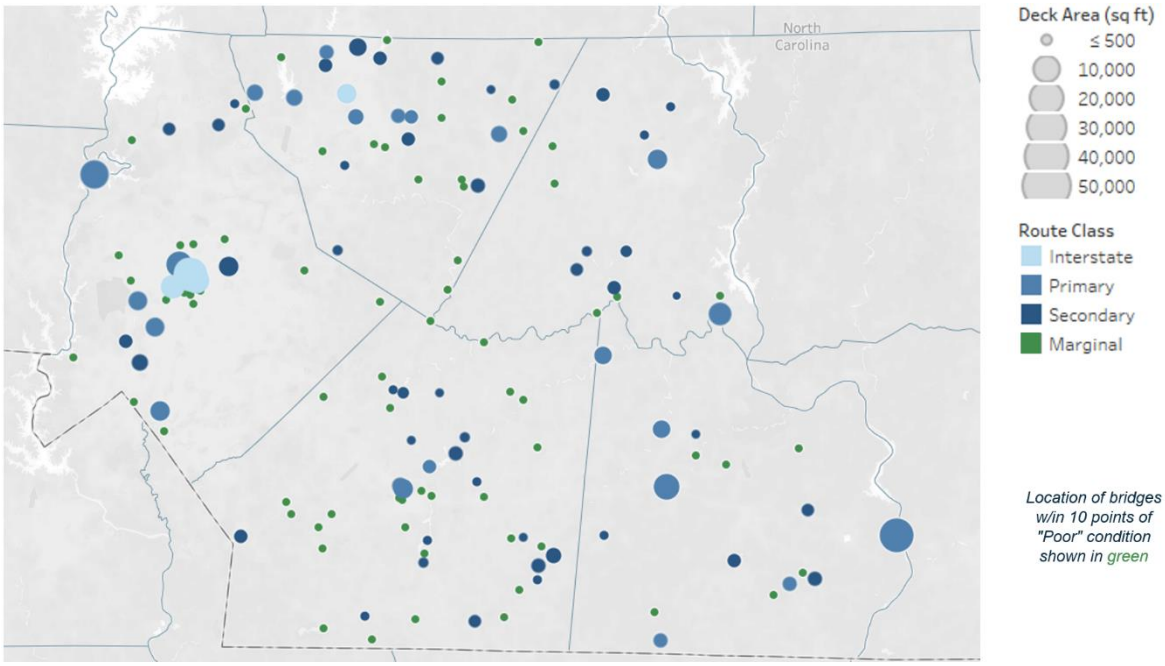


Figure 8 – Distribution of poor and at-risk of becoming poor condition bridges in Division 10

2.4 Roadside Asset Conditions

Roadside asset condition is evaluated by measuring the proportion at which an asset is non-defective in a division, county, or route.

Asset	State	D10	Anson	Cabarrus	Mecklenburg	Stanly	Union
Pavement Striping	89%	89%	89%	86%	90%	90%	91%
Bike Lanes	78%	81%		91%	78%		0%
Word and Symbols	74%	77%	72%	76%	80%	68%	77%
Sharrows	84%	88%	100%	91%	88%		80%
Signs	94%	95%	95%	95%	94%	94%	97%
Drop Inlets	89%	88%	73%	93%	83%	94%	94%
Curb and Gutter	96%	96%	75%	95%	97%	93%	96%
Guardrails	98%	98%	97%	99%	98%	98%	99%
Shoulder	98%	97%	97%	96%	98%	98%	96%

Most Defective — Least Defective

Figure 9 – Comparison of conditions between county functional assets [ix]

Below is roadside asset condition visualized with county boundaries, where colors are relative to the average condition across the state, for each respective asset.

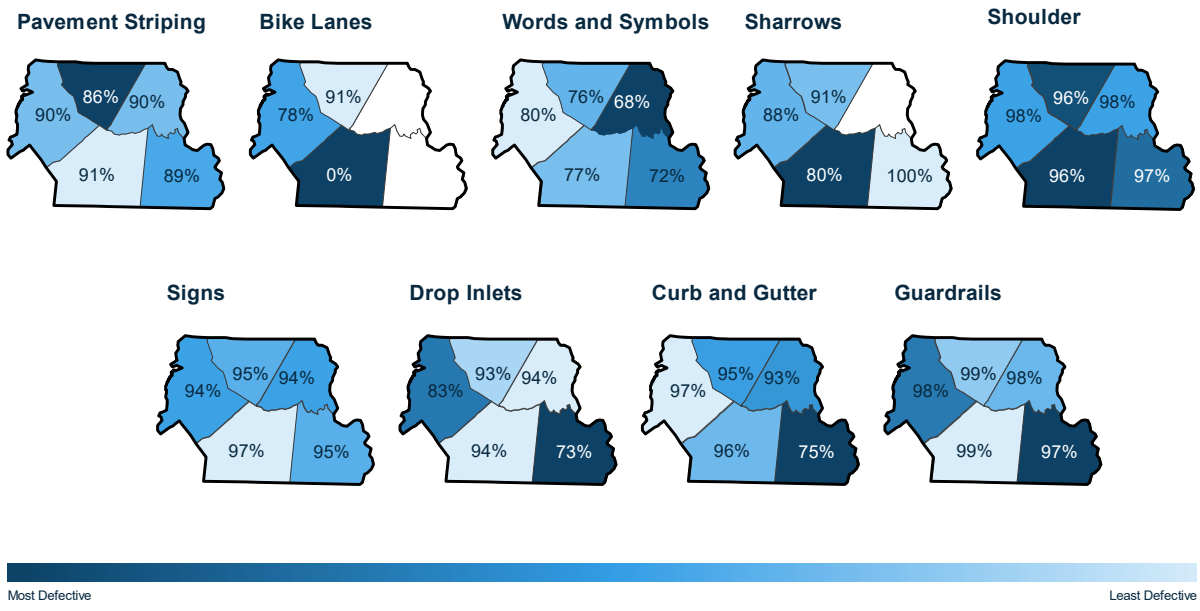


Figure 10 – Comparison of roadside asset conditions mapped to county boundaries

3 Rehabilitation / Rebuilding Needs

To develop a sense of what level of investment is required to ensure our state's ability to provide a safe and effective transportation network into the future, in the summer of 2024 the Director of Highway Operations reached out to all 14 Division Engineers and their teams, asking them to provide details on their highest priority ~35 miles of reconstruction/rehabilitation needs. The submitted sections for Division 10, along with estimated costs, are outlined below ranked in order of priority (as submitted).

Route	County	Comments	Miles	Est. Cost ($M)
80004404060 I-77 NB Ramp Exit 16 Sunset Rd	Mecklenburg	Entire concrete ramp riding surface replacement along with asphalt shoulders.	0.29	$29M
80004401060 I-77 Exit 16	Mecklenburg	Entire concrete ramp riding surface replacement along with asphalt shoulders.	0.31	--
80004631060 I-77 Exit 3	Mecklenburg	Replacement of several concrete slabs.	0.04	$29M
20000029060 US 29 N Tryon St	Mecklenburg	Recommend removing existing concrete substructure and reconstructing roadway with asphalt from the base coarse the full width of roadway.	1.02	$39M
20400029060 US 29 N Tryon St	Mecklenburg	Recommend removing existing concrete substructure and reconstructing roadway with asphalt from the base coarse the full width of roadway.	0.12	$2.3M
20400029060 US 29 N Tryon St	Mecklenburg	Recommend removing existing concrete substructure and reconstructing roadway with asphalt from the base coarse the full width of roadway.	0.06	$1.5M
20000029060 US 29 N Tryon St	Mecklenburg	Recommend removing existing concrete substructure and reconstructing roadway with asphalt from the base coarse the full width of roadway.	0.51	$13M
20600074060 Wilkinson Blvd	Mecklenburg	Recommend removing existing concrete substructure and reconstructing roadway with new concrete roadway slabs	0.03	$29M
20000074060 Wilkinson Boulevard	Mecklenburg	Recommend removing existing concrete substructure and reconstructing roadway with new concrete roadway slabs	0.04	--
10800485060 I85	Mecklenburg	Road has longitudinal cracking along the lane which has been determined to extend to the base coarse, this was verified by core samples.	1.05	$24M
NC 16	Mecklenburg	Concrete slabs are failing, large potholes	2.00	$26M
I-277	Mecklenburg	Area has been resurfaced, however the overall structure is failing. Multiple water issues in subgrade.	5.00	$206M
I-77	Mecklenburg	Area has been resurfaced, however the overall structure is failing. Multiple water issues in subgrade.	10.90	$416M
US 74 Eastbound	Mecklenburg	Poor pipes, drainage, subgrade issues	5.60	$241M
US 74 Westbound	Mecklenburg	Poor pipes, drainage, subgrade issues	5.60	--
US 74 Eastbound	Mecklenburg	Poor pipes, drainage, subgrade issues	0.39	--
US 74 Westbound	Mecklenburg	Poor pipes, drainage, subgrade issues	0.48	$18.5M

US 27 Southbound	Mecklenburg	Poor subgrade	0.45	$18.5M
US 27 Northbound	Mecklenburg	Poor subgrade	0.24	--
US 74 W Off Ramp to NC 51	Mecklenburg	Poor pipes, drainage, subgrade issues	0.43	$29M
NC 51 N On Ramp to US 74 E	Mecklenburg	Poor pipes, drainage, subgrade issues	0.33	--
US 74 E Off Ramp to NC 51 N	Mecklenburg	Poor pipes, drainage, subgrade issues	0.19	--
US 74 E Off Ramp to NC 51 S	Mecklenburg	Poor pipes, drainage, subgrade issues	0.25	--
NC 51 On Ramp to US 74 E	Mecklenburg	Poor pipes, drainage, subgrade issues	0.40	--
NC 51 S On Ramp to US 74 W	Mecklenburg	Poor pipes, drainage, subgrade issues	0.36	--
Total	-	-	**36.9**	**$1,791M**

Table 5 – Submitted rehabilitation / rebuilding priorities and estimated costs

4 Cost Summary

To inform the model of how conditions translate into maintenance investment needs, should-cost was collected – what should various maintenance activities cost? This is used to estimate costs for the most common maintenance treatments down to the activity level.

Highlighted below are the unique unit costs for assets in Division 10, with activity costs of more common treatments weighted more heavily than less common treatments for each asset[x].

Weighted average unit costs by Division

Asset	UOM	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14
Bike Lanes	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Cablerail*	LFT	$2	$1	$2	$5	$1	$1	$3	$2	$0	$5	$2	$0	$2	$1
Concrete Barrier*	LFT	$500	$8	$3	$1,350	$16	$15	$3	$182	$163	$182	$6	$42	$25	$50
Pipes	LFT	$267	$379	$315	$479	$273	$275	$327	$462	$296	$378	$395	$90	$256	$345
Crosswalk	EA	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Curb and Gutter*	LFT	$102	$132	$125	$83	$112	$144	$117	$109	$78	$112	$93	$39	$90	$88
Drop Inlets*	EA	$811	$809	$1,363	$460	$974	$714	$865	$788	$830	$1,041	$794	$744	$1,361	$1,297
Guardrail*	LFT	$16	$30	$36	$12	$1	$49	$30	$31	$12	$32	$6	$32	$50	$21
Impact Attenuator*	EA	$2,500	$12,500	$5,000	$8,840	$2,707	$1,925	$17,500	$750	$1,704	$9,250	$2,028	$2,613	$10,250	$3,000
Induction Loop	LFT	$1,381	$726	$2,777	$1,695	$825	$1,358	$748	$1,486	$573	$3,097	$1,322	$2,144	$1,167	$1,308
Mile marker	EA	$129	$171	$172	$135	$440	$268	$168	$276	$285	$164	$427	$137	$143	$192
Pavement Striping*	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Ramp Metering	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Road Sign	EA	$309	$365	$232	$288	$613	$378	$379	$366	$462	$249	$581	$249	$293	$338
Shoulder	SHM	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Timber Rail	LFT	$44	$6	$49	$313	$13	$8	$2	$49	$44	$49	$3	$23	$23	$63
Traffic Signal	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Word and Symbols	LFT	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Crack Seal	LM	$3,103	$4,000	$3,300	$3,409	$6,009	$2,100	$4,366	$4,000	$3,250	$6,000	$7,850	$4,366	$4,366	$5,000
Chip Seal	LM	$21,933	$18,625	$22,750	$17,014	$26,732	$53,875	$22,356	$49,000	$30,925	$17,500	$21,500	$22,902	$33,701	$32,500
Contract Resurfacing*	LM	$120,418	$140,000	$67,500	$96,025	$109,701	$92,500	$213,998	$97,500	$116,150	$185,000	$66,250	$87,184	$88,750	$151,250

Table 6 – Unit cost comparison between Divisions

[i] Condition and inventory data collected via ArTEMIS from January to September 2023; cost data collected from individual divisions and validated in February/March of 2024. Thus, funding scenarios outlined in this document were developed prior the impacts of Hurricane Helene & based on infrastructure condition data collected prior to the storm. As such, they do not account for the additional costs associated with the rehabilitation or reconstruction of infrastructure affected by the storm. Recognizing that rebuilding will entail significant expenses, the current scenarios focus on maintaining the regular operational budget and steady-state upkeep without reallocation of funds.

[ii] For purposes of calculating route score, “Words and Symbols” also includes bike lanes, crosswalks, sharrows.

[iii] When aggregated, route scores are weighted by lane miles and route class.

[iv] Maintenance costs are estimated solely by prioritizing the most efficient and cost-effective maintenance activities in terms of their impact on overall state/division route score, regardless of pre-existing plans, priorities, or ongoing projects.

[v] For these investment scenarios, we assume rates of inflation for labor, material, and equipment costs of 3%, 5%, and 8% respectively, per the 2023Q4 Engineering News-Record Cost Report. Costs for non-maintenance activities are assumed to increase at annual rate of 3%.

[vi] Spend to increase route score views pavement and roadside asset activities, only. Bridge activities that would increase score are currently not included. This may underestimate need when calculating need to improve by 10 pts.

[vii] Pipes are ingested into inventory counts via NCDOT survey

[viii] The pavement index assessment is consistent for every route and captures the entirety of the Division’s inventory. At times, the asset detection algorithm powering the pavement index may miss light / moderate rutting.

[ix] Blank cells indicate that the asset type is not present in county and therefore excluded from analysis.

[x] Asterisk denotes predominately contracted activities. Pavement markings, cable rails, impact attenuators, guardrails, curb and gutter, and induction loops are typically contracted out in D10

DIVISION 11 INSIGHTS REPORT

This report uses data on inventory, condition, and costs to provide insights at the division, county, and route levels. It identifies long-term investment needs and opportunities across the system to optimize outcomes.[i]

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2 Division Asset Inventory & Condition 131

3 Rehabilitation / Rebuilding needs 137

4 Cost Summary 138

1 Division Funding Needs

1.1 Data Background

Launched in 2020, ArTEMIS initially tracked 30+ discrete maintenance functions on state-managed routes. Since then, it has expanded to capture a "fence-to-fence" view of assets, activity-based costs, and lifecycle investment forecasting, enabling more precise, data-driven maintenance planning.

The 2023 initiative leverages image recognition and AI/ML to assess conditions across 2+ million geo-located assets statewide. By aligning new inventory data with established sources like the Pavement Condition Survey, it enhances accuracy through "Route Scores" at route, county, division, and state levels, which help forecast investment needs. Similar to weather forecasting, aligning multiple datasets strengthens accuracy and reliability.

Statewide data collected and validated from January to September 2023 includes image collection, route walkthroughs, inspections, and quality reviews. These, alongside activity-based “should-cost” estimates—based on current market and industry standards—inform the Total Cost of Ownership model, supporting comprehensive maintenance planning.

1.2 Route Score Overview

1.2.1 Methodology

The table below shows the asset conditions contributing to Division 11's overall route score and how a route score is assembled at the route level (before being aggregated up by system counties, divisions, etc). The score uses point-in-time data collected January - September 2023.

Asset	State	Division 11
Pavement Index	83	85
Bridge Index	82	77
Shoulder	98%	98%
Pipes	82%	81%
Drop Inlets	89%	92%
Curb and Gutter	96%	93%
Pavement Striping	89%	86%
Signs	94%	89%
Guardrails and barriers	98%	98%
Words and Symbols[ii]	96%	94%
Traffic devices	100%	100%

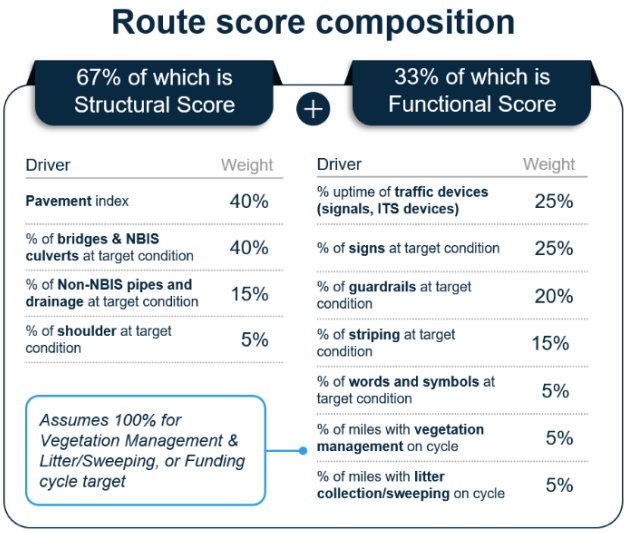
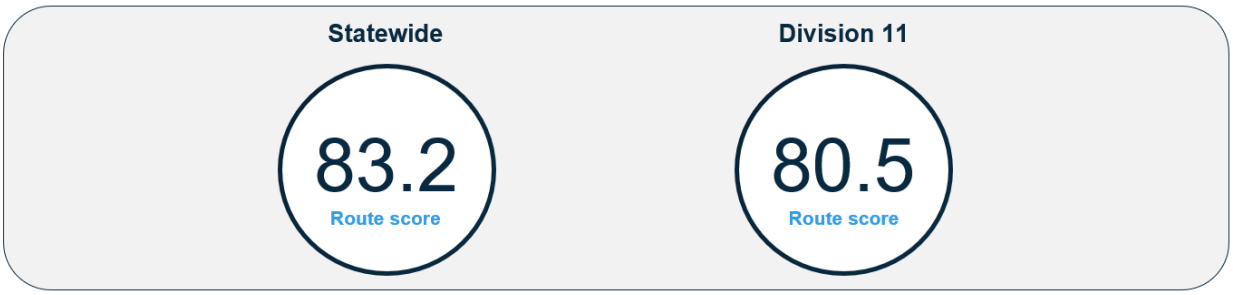


Table 1 – Asset scores (percentage of non-defective units or index score) across State and Division

1.2.2 Most Recent Outcomes

Using the scoring method shown above, the overall conditions of a division's roads can be shown with a single score that takes the weighted[iii] average of all its routes:



Route class	State	Division 11
Interstates	89	86
Primary	83	81
Secondary	82	80

Table 2 – Route scores by class

1.3 Route Score Distribution

The majority of the Division's network consists of routes in good condition, defined by a route score of 80 or higher. Over 6,100 lane miles (52% of network) are considered in good condition.

Conversely, less than 300 lane miles (2% of network) are considered in poor condition, defined by a route score lower than 60. Map 1 shows the condition of routes across the division.

Route score distribution, by lane miles

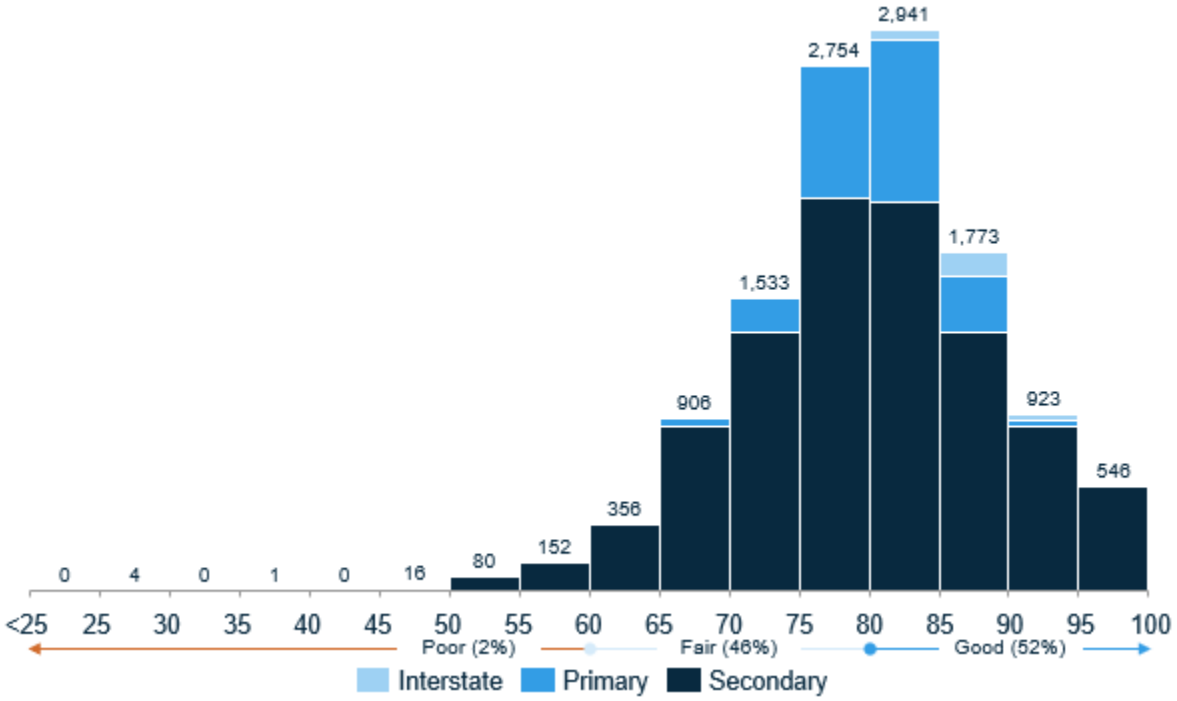
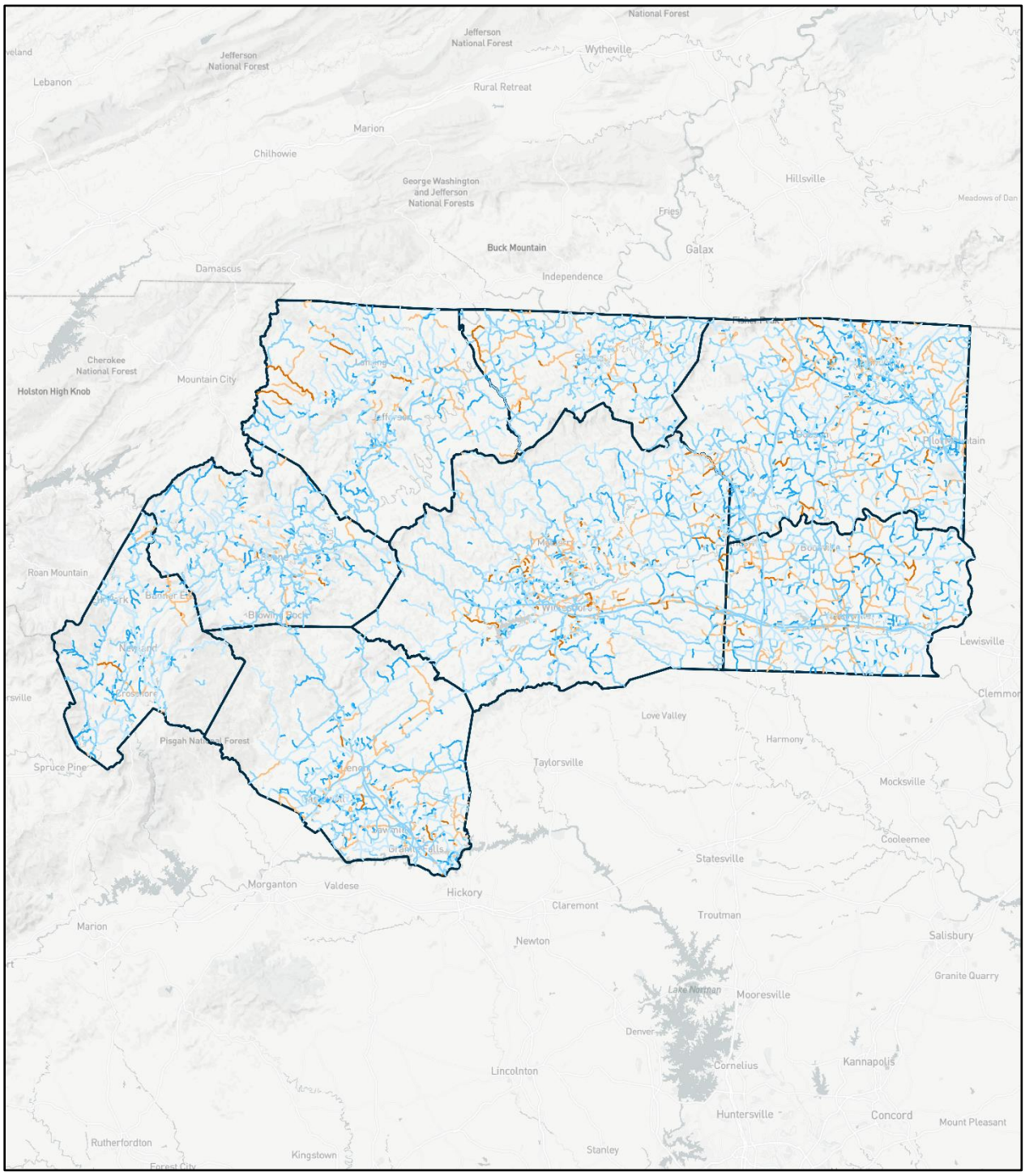


Figure 1 – Distribution of route score, measured in lane miles

Across the road network, the most common route score is between 80 and 85. Interstate and primary routes in Division 11 all have route scores of at least 65, while secondary routes exhibit route scores starting at 25.

These routes can be mapped spatially to evaluate the distribution by geography, as seen on the next page.

Route score distribution, by county



Route score legend 90 or higher | 80 - 90 | 70 - 80 | 60 - 70 | Less than 60

Map 1 – Spatial distribution of route score, grouped by county

1.4 Impact of static funding

Route Score is used to estimate the investment needed[iv] to maintain or achieve various condition levels over the next 10 years, assuming expected inflation[v] and asset deterioration.

Maintaining this division's current condition will require a year-over-year increase in funding, due to inflation and regular wear-and-tear. Static funding may lead to a decline of **-3.4** points in the following year and will potentially lower it by at least **-10.9** points over the next decade.

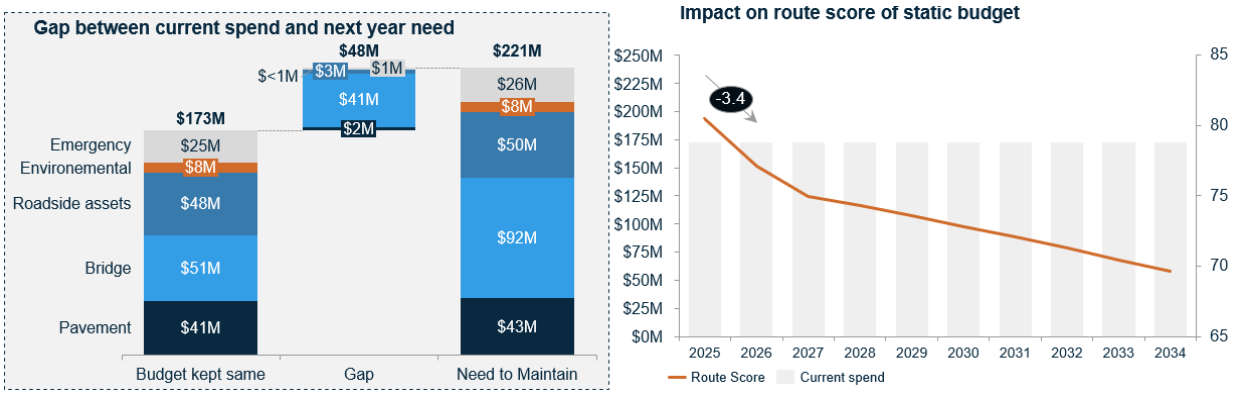


Figure 2 – Comparison of current spend and expected need; route score over time if no budget increase

1.5 Investment needs over the next 10 years

Using the Route Score, ArTEMIS can quantify investment needed to maintain or condition by raising the route score by zero points (maintain conditions), one point (slight improvement), five points (large improvement), and ten points (near-perfect conditions)[vi].

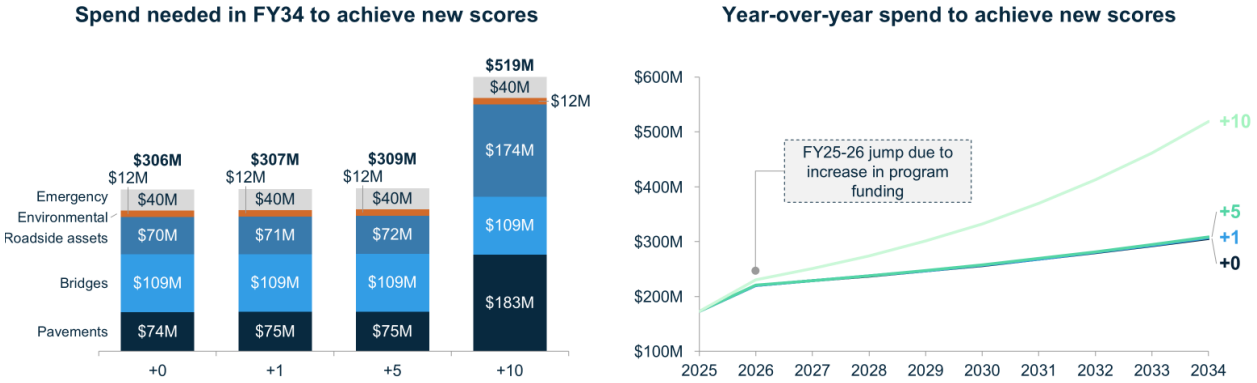


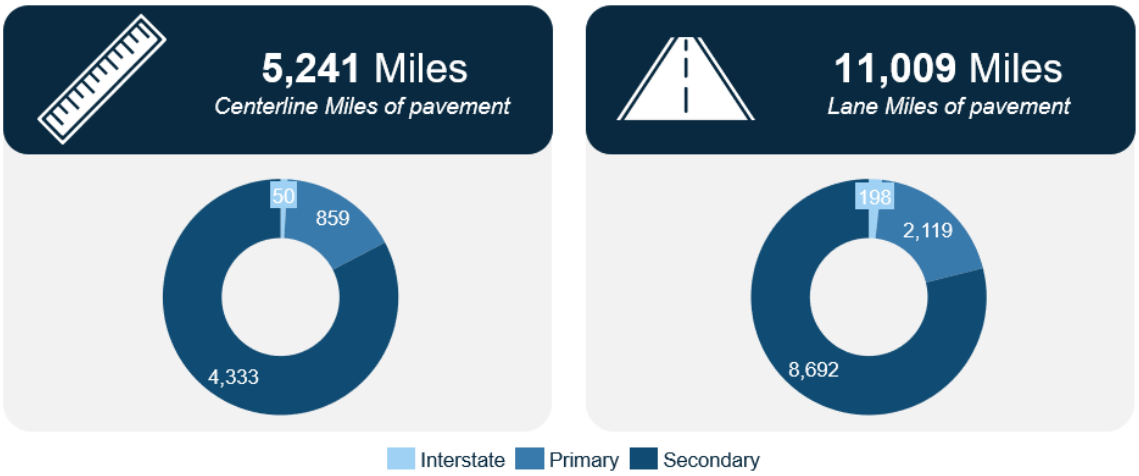
Figure 3 – Projected investment needed (YOE $) to improve route score over 10 years

As shown, maintaining and improving Division 11's Route Score requires greater investment:

- **+0** requires increasing spend to **$306M** by FY34; **$2,509M** in total investment
- **+1** requires increasing spend to **$307M** by FY34; **$2,514M** in total investment
- **+5** requires increasing spend to **$309M** by FY34; **$2,521M** in total investment
- **+10** requires increasing spend to **$519M** by FY34; **$3,325M** in total investment

2 Division Asset Inventory & Condition

2.1 Pavement & Asset Inventory



		Quantity			
Asset	**Unit**	**Interstate**	**Primary**	**Secondary**	**Overall**
Bike Lanes	LFT	0	19,658	18,968	38,627
Cablerail	MI	43	72	1	116
Concrete Barrier	MI	0	9	1	10
Crosswalk	EA	0	112	54	166
Curb and Gutter	MI	1	157	69	227
Drop Inlets	EA	32	3,181	1,366	4,579
Guardrail	MI	38	343	242	623
Impact Attenuator	EA	0	49	18	67
Induction Loop	EA	14	373	175	562
Mile marker	EA	78	82	18	178
Noise Wall*	LFT	0	0	87	87
Pavement Striping (defective only)	MI	44	350	2,213	2,607
Pipes[vii]	LFT	1,563	468,612	407,608	877,783
Retaining Wall*	LFT	0	38,079	41,205	79,285
Road Sign	EA	464	17,419	32,032	49,915
Rumble Strips*	MI	180	246	11	436
Sharrows	EA	0	53	31	84
Shoulder (defective only)	MI	0	39	158	198
Traffic Signal	EA	3	2,638	943	3,584
Variable Message Sign	EA	11	9	6	26
Word and Symbols	EA	56	8,655	2,145	10,856

Table 3 – Selection of roadside asset inventory; asterisk indicates no significance to route score

2.2 Pavement Conditions

Using Pavement Condition Survey (PCS) data, shown below is the breakdown of good, fair, and poor lane miles across the interstate, primary, and secondary systems.

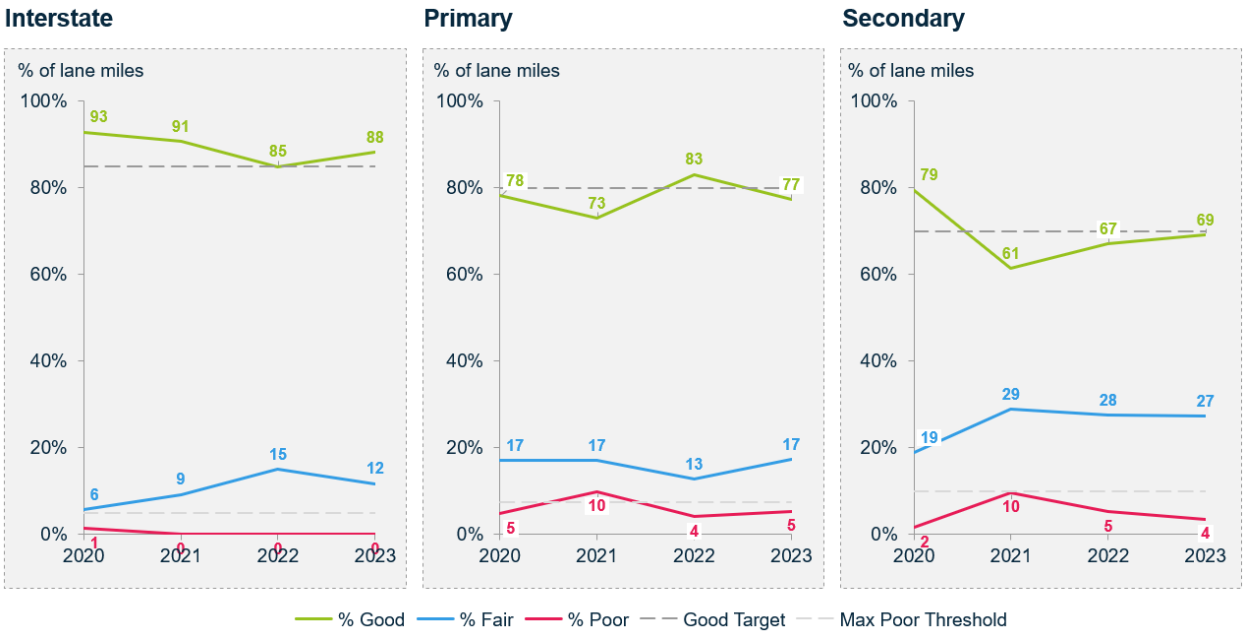


Figure 4 – Pavement conditions across interstate, primary, and secondary systems

Pavement conditions in Division 11 as evaluated via ArTEMIS analysis are above the state average, with a division-wide pavement index of **85**. Condition varies across the division by primary and secondary routes.

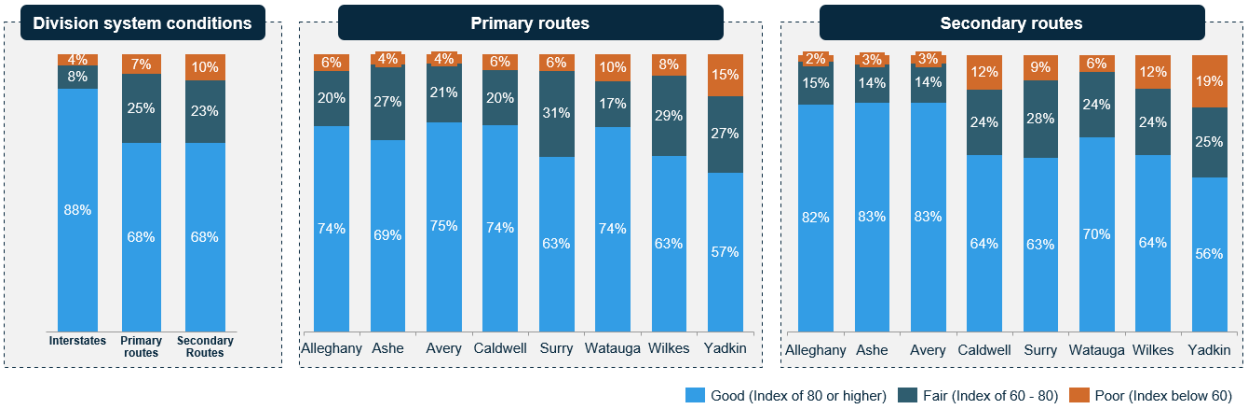


Figure 5 – Comparison of lane miles in good, fair, and poor conditions

County pavement index (weighted by lane miles) range **from 80 to 90**. Deductions are primarily driven by two distresses: (1) alligator cracking and (2) transverse cracking.

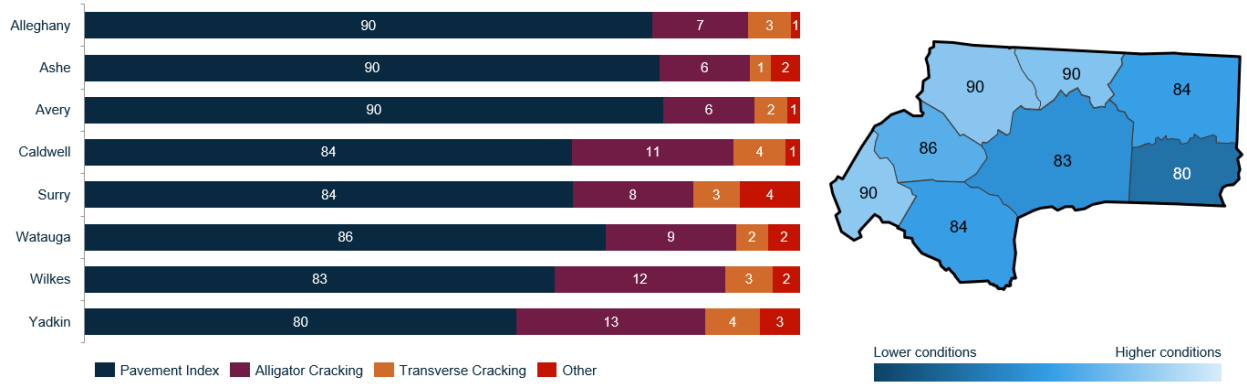


Figure 6 – Pavement index and deduction breakdown by county

Complementary models show similar assessments of pavement condition between the ArTEMIS model and the PCS model for Division 11. The pavement index utilizes the same scoring methodology as the PCS, the only differences being in how the data is collected/reviewed[viii].

	Condition			
Model	**Interstates**	**Primary**	**Secondary**	**Overall**
Pavement index (ArTEMIS)	94	85	85	85
Pavement condition score (PCS)	90	88	85	86

Table 4 – Condition comparison by pavement models for Division 11

2.3 Bridge Conditions

Bridge conditions are evaluated using a bridge index that translates general condition ratings (i.e., 1-9 scale) into a 100-point scale for easier comparison.

Overall, the Division 11 bridge index (77) scores ~5 points lower than statewide bridge index (82).

Data is ingested from FHWA bridge portal.

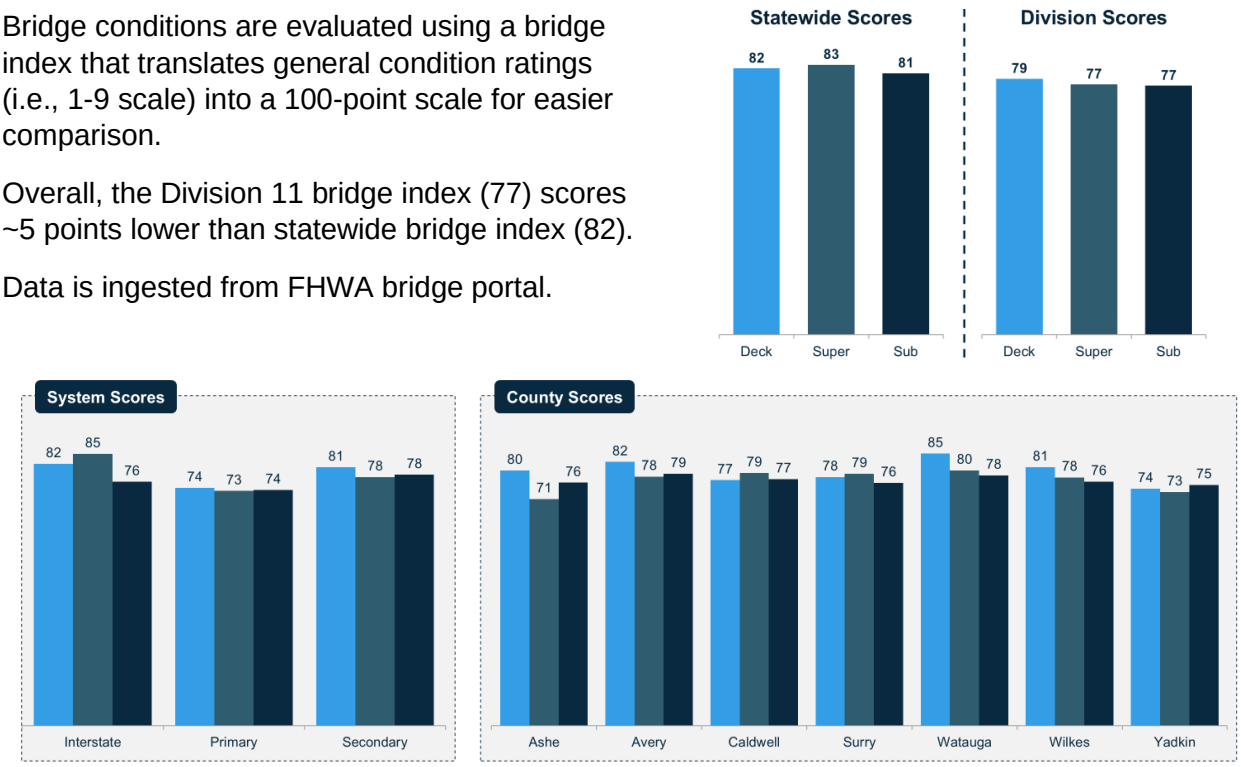


Figure 7 – Comparison of bridge conditions

The figure below displays all bridges in poor condition (index below 60) or at-risk of becoming poor (index of 60 – 69). They are mostly on the secondary system. Each circle maps one bridge by latitude and longitude; circle size indicates deck area, with at-risk bridges sized uniformly.

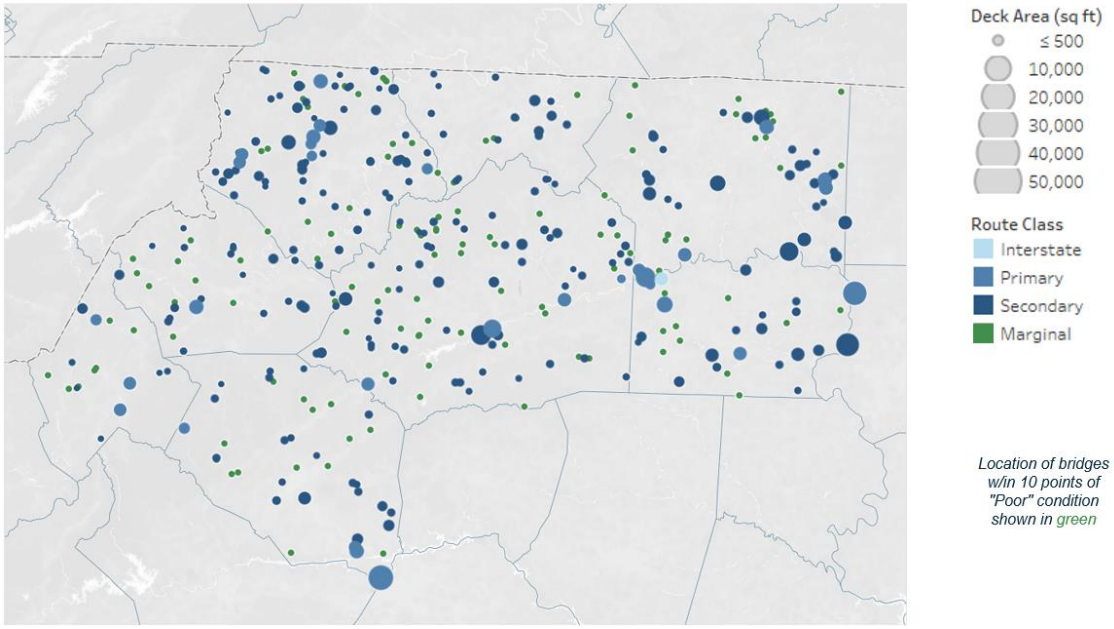


Figure 8 – Distribution of poor bridges and at-risk of becoming poor condition bridges in Division 11

Figure 9 shows how timber bridges are distributed across Division 11, and their individual condition rating. Division 11 has 219 poor condition bridges, and 74% of these poor condition bridges are timber. Divisions 11, 13, and 14 have the highest number of bridges overall – timber bridges represent 40% of their combined inventory and 70% of their combined poor condition bridges.

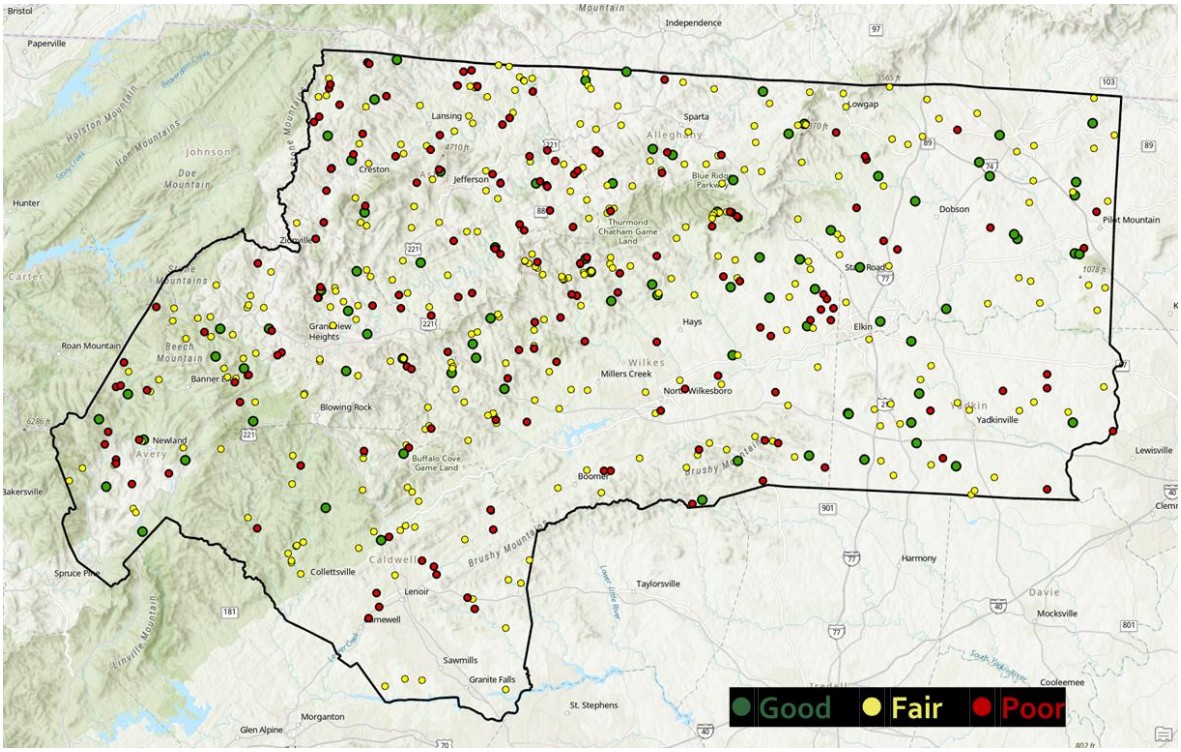


Figure 9 – Distribution and condition of timber bridges

2.4 Roadside Asset Conditions

Roadside asset condition is evaluated by measuring the proportion at which an asset is non-defective in a division, county, or route.

Asset	State	D11	Alleghany	Ashe	Avery	Caldwell	Surry	Watauga	Wilkes	Yadkin
Pavement Striping	89%	86%	83%	86%	85%	87%	85%	82%	87%	86%
Bike Lanes	78%	80%					95%	56%		85%
Word and Symbols	74%	73%	75%	67%	62%	77%	71%	69%	76%	62%
Sharrows	84%	60%				100%	70%	50%	100%	25%
Signs	94%	89%	83%	89%	89%	85%	89%	94%	91%	90%
Drop Inlets	89%	92%	96%	89%	93%	92%	89%	93%	96%	93%
Curb and Gutter	96%	93%	89%	96%	93%	94%	95%	94%	91%	92%
Guardrails	98%	98%	98%	99%	97%	98%	97%	97%	99%	98%
Shoulder	98%	98%	98%	98%	97%	98%	99%	97%	99%	98%

Most Defective — Least Defective

Figure 10 – Comparison of conditions between county functional assets [ix]

Below is roadside asset condition visualized with county boundaries, where colors are relative to the average condition across the state, for each respective asset.

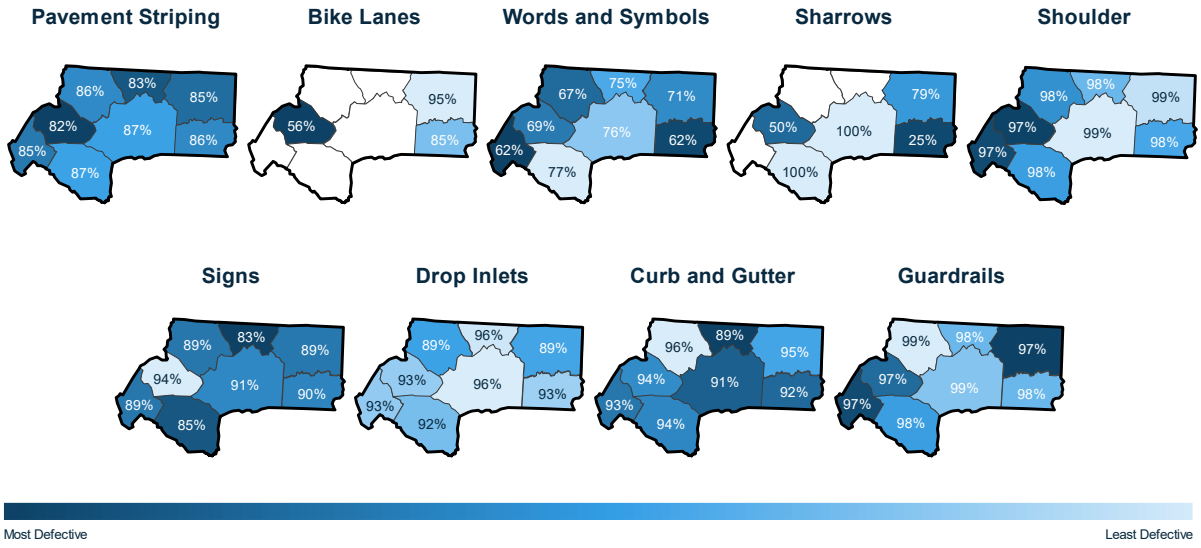


Figure 11 – Comparison of roadside asset conditions mapped to county boundaries

3 Rehabilitation / Rebuilding Needs

To develop a sense of what level of investment is required to ensure our state's ability to provide a safe and effective transportation network into the future, in the summer of 2024 the Director of Highway Operations reached out to all 14 Division Engineers and their teams, asking them to provide details on their highest priority ~35 miles of reconstruction/rehabilitation needs. The submitted sections for Division 11, along with estimated costs, are outlined below ranked in order of priority (as submitted).

Route	County	Comments	Miles	Est. Cost ($M)
US 52	Surry	Underlying concrete pavement joints/pavement are failing.	10.70	$390M
I-77	Yadkin	This is one of the last sections in need of reconstruction on I-77	3.14	$109M
US 21	Surry	This is the original concrete surface from the mid-60s and is deteriorating.	3.85	--
NC 88	Alleghany	Moderate to severe maintenance issues with asphalt overlays, heaving, rutting, etc. Connects to NC 88 section listed below	0.27	--
NC 88	Ashe	Moderate to severe maintenance issues with asphalt overlays, heaving, rutting, etc.	9.90	$127M
NC 16	Ashe	Section was recently resurfaced but has some ongoing slippage issues. Connects to NC 88 section listed above.	2.49	$32M
US 321 A	Caldwell	Old concrete joint continues to reflect through causing potholes.	11.07	$142M
US 19E	Avery	R-2520A Prelim Engineering	4.44	--
SB Off Ramp 2635	Yadkin	Skipped during recent I-77 rehab	0.11	--
SB On Ramp 2637	Yadkin	Skipped during recent I-77 rehab	0.13	--
NB Off Ramp 2632	Yadkin	Skipped during recent I-77 rehab	0.16	--
NB On Ramp 2633	Yadkin	Skipped during recent I-77 rehab	0.10	--
Total	-	-	**46.37**	**$801M**

Table 5 – Submitted rehabilitation / rebuilding priorities and estimated costs

4 Cost Summary

To inform the model of how conditions translate into maintenance investment needs, should-cost was collected – what should various maintenance activities cost? This is used to estimate costs for the most common maintenance treatments down to the activity level.

Highlighted below are the unique unit costs for assets in Division 11, where activity costs of more common treatments are weighted more heavily than less common ones for each asset[x].

Weighted average unit costs by Division

Asset	UOM	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14
Bike Lanes	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Cablerail*	LFT	$2	$1	$2	$5	$1	$1	$3	$2	$0	$5	$2	$0	$2	$1
Concrete Barrier*	LFT	$500	$8	$3	$1,350	$16	$15	$3	$182	$163	$182	$6	$42	$25	$50
Pipes	LFT	$267	$379	$315	$479	$273	$275	$327	$462	$296	$378	$395	$90	$256	$345
Crosswalk	EA	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Curb and Gutter*	LFT	$102	$132	$125	$83	$112	$144	$117	$109	$78	$112	$93	$39	$90	$88
Drop Inlets*	EA	$811	$809	$1,363	$460	$974	$714	$865	$788	$830	$1,041	$794	$744	$1,361	$1,297
Guardrail*	LFT	$16	$30	$36	$12	$1	$49	$30	$31	$12	$32	$6	$32	$50	$21
Impact Attenuator*	EA	$2,500	$12,500	$5,000	$8,840	$2,707	$1,925	$17,500	$750	$1,704	$9,250	$2,028	$2,613	$10,250	$3,000
Induction Loop	LFT	$1,381	$726	$2,777	$1,695	$825	$1,358	$748	$1,486	$573	$3,097	$1,322	$2,144	$1,167	$1,308
Mile marker	EA	$129	$171	$172	$135	$440	$268	$168	$276	$285	$164	$427	$137	$143	$192
Pavement Striping*	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Ramp Metering	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Road Sign	EA	$309	$365	$232	$288	$613	$378	$379	$366	$462	$249	$581	$249	$293	$338
Shoulder	SHM	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Timber Rail	LFT	$44	$6	$49	$313	$13	$8	$2	$49	$44	$49	$3	$23	$23	$63
Traffic Signal	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Word and Symbols	LFT	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Crack Seal	LM	$3,103	$4,000	$3,300	$3,409	$6,009	$2,100	$4,366	$4,000	$3,250	$6,000	$7,850	$4,366	$4,366	$5,000
Chip Seal	LM	$21,933	$18,625	$22,750	$17,014	$26,732	$53,875	$22,356	$49,000	$30,925	$17,500	$21,500	$22,902	$33,701	$32,500
Contract Resurfacing*	LM	$120,418	$140,000	$67,500	$96,025	$109,701	$92,500	$213,998	$97,500	$116,150	$185,000	$66,250	$87,184	$88,750	$151,250

Table 6 – Unit cost comparison between Divisions

[i] Condition and inventory data collected via ArTEMIS from January to September 2023; cost data collected from individual divisions and validated in February/March of 2024. Thus, funding scenarios outlined in this document were developed prior the impacts of Hurricane Helene & based on infrastructure condition data collected prior to the storm. As such, they do not account for the additional costs associated with the rehabilitation or reconstruction of infrastructure affected by the storm. Recognizing that rebuilding will entail significant expenses, the current scenarios focus on maintaining the regular operational budget and steady-state upkeep without reallocation of funds.

[ii] For purposes of calculating route score, "Words and Symbols" also includes bike lanes, crosswalks, sharrows.

[iii] When aggregated, route scores are weighted by lane miles and route class.

[iv] Maintenance costs are estimated solely by prioritizing the most efficient and cost-effective maintenance activities in terms of their impact on overall state/division route score, regardless of pre-existing plans, priorities, or ongoing projects.

[v] For these investment scenarios, we assume rates of inflation for labor, material, and equipment costs of 3%, 5%, and 8% respectively, per the 2023Q4 Engineering News-Record Cost Report. Costs for non-maintenance activities are assumed to increase at annual rate of 3%.

[vi] Spend to increase route score views pavement and roadside asset activities, only. Bridge activities that would increase score are currently not included. This may underestimate need when calculating need to improve by 10 pts.

[vii] Pipes are ingested into inventory counts via NCDOT survey

[viii] The pavement index assessment is consistent for every route and captures the entirety of the Division's inventory. At times, the asset detection algorithm powering the pavement index may miss light / moderate rutting.

[ix] Blank cells indicate that the asset type is not present in county and therefore excluded from analysis.

[x] Asterisk denotes predominately contracted activities. Concrete barriers, cable rails, impact attenuators, pavement markings, bike lanes, guardrails, and drop inlets are typically contracted out in D11. All cost data in this table were provided and validated by engineers from each division. Variations in costs may arise due to several factors, including the frequency of repairs, whether work is performed in-house or contracted out, and the defect severity at which interventions are initiated. For assets where specific cost data were unavailable, the average cost across all divisions was used. Data was collected and validated February - May 2024.

DIVISION 12 INSIGHTS REPORT

This report uses data on inventory, condition, and costs to provide insights at the division, county, and route levels. It identifies long-term investment needs and opportunities across the system to optimize outcomes.[i]

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2 Division Asset Inventory & Condition 144

3 Rehabilitation / Rebuilding needs 149

4 Cost Summary 150

1 Division Funding Needs

1.1 Data Background

Launched in 2020, ArTEMIS initially tracked 30+ discrete maintenance functions on state-managed routes. Since then, it has expanded to capture a "fence-to-fence" view of assets, activity-based costs, and lifecycle investment forecasting, enabling more precise, data-driven maintenance planning.

The 2023 initiative leverages image recognition and AI/ML to assess conditions across 2+ million geo-located assets statewide. By aligning new inventory data with established sources like the Pavement Condition Survey, it enhances accuracy through "Route Scores" at route, county, division, and state levels, which help forecast investment needs. Similar to weather forecasting, aligning multiple datasets strengthens accuracy and reliability.

Statewide data collected and validated from January to September 2023 includes image collection, route walkthroughs, inspections, and quality reviews. These, alongside activity-based “should-cost” estimates—based on current market and industry standards—inform the Total Cost of Ownership model, supporting comprehensive maintenance planning.

1.2 Route Score Overview

1.2.1 Methodology

The table below shows the asset conditions contributing to Division 12's overall route score and how a route score is assembled at the route level (before being aggregated up by system counties, divisions, etc). The score uses point-in-time data collected January - September 2023.

Asset	State	Division 12
Pavement Index	83	85
Bridge Index	82	79
Shoulder	98%	99%
Pipes	82%	81%
Drop Inlets	89%	88%
Curb and Gutter	96%	95%
Pavement Striping	89%	91%
Signs	94%	94%
Guardrails and barriers	98%	98%
Words and Symbols[ii]	96%	98%
Traffic devices	100%	100%

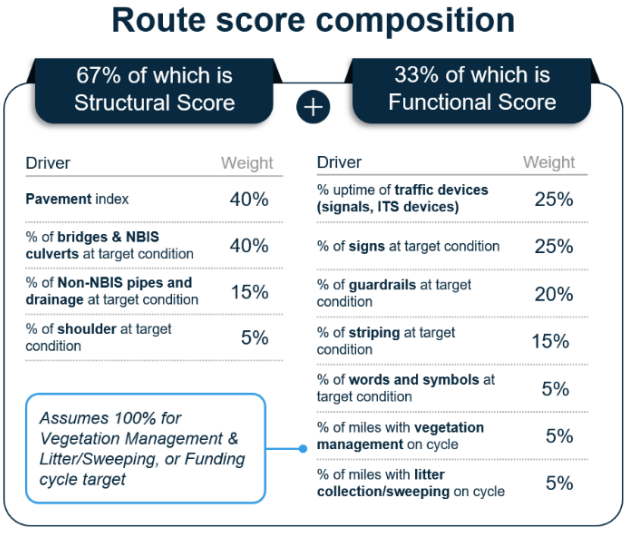
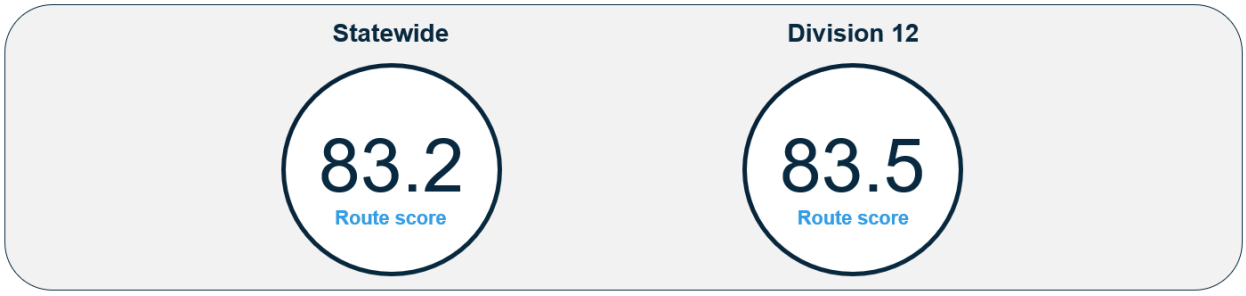


Table 1 – Asset scores (percentage of non-defective units or index score) across State and Division

1.2.2 Most Recent Outcomes

Using the scoring method shown above, the overall conditions of a division's roads can be shown with a single score that takes the weighted[iii] average of all its routes:



Route class	State	Division 12
Interstates	89	86
Primary	83	84
Secondary	82	83

Table 2 – Route scores by class

1.3 Route Score Distribution

The majority of the Division's network consists of routes in good condition, defined by a route score of 80 or higher. Nearly 9,000 lane miles (69% of network) are considered in good condition.

Conversely, about 205 lane miles (2% of network) are considered in poor condition, defined by a route score lower than 60. Map 1 shows the condition of routes across the division.

Route score distribution, by lane miles

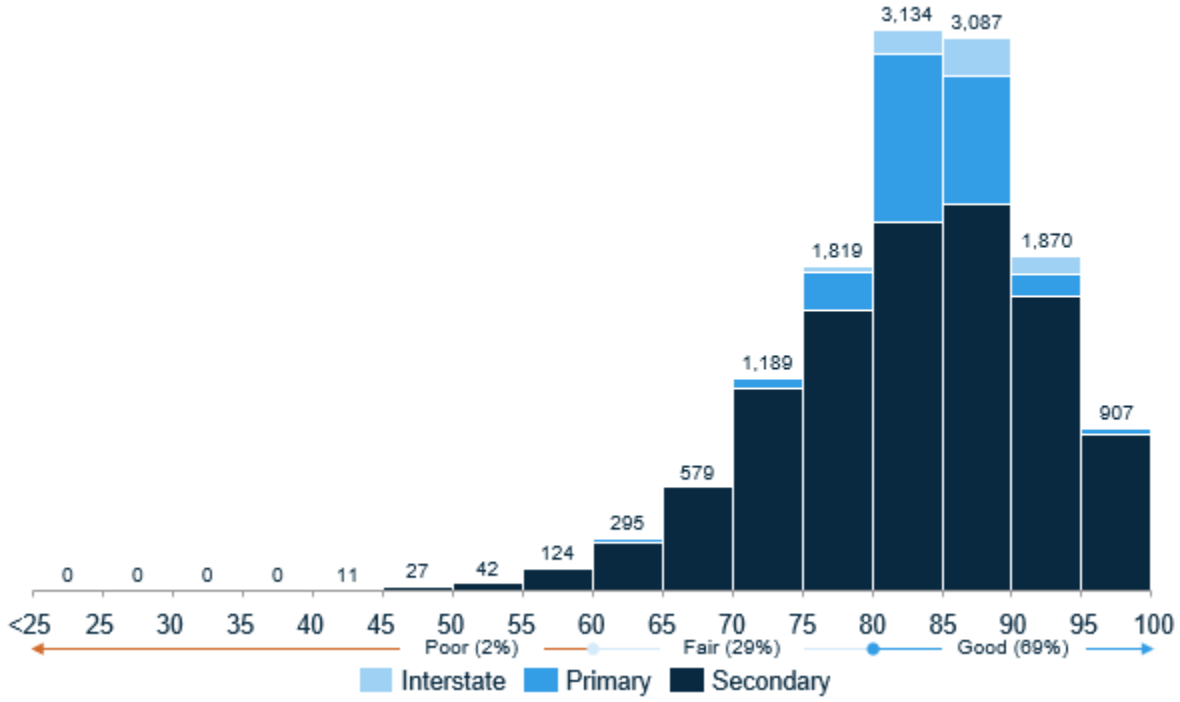
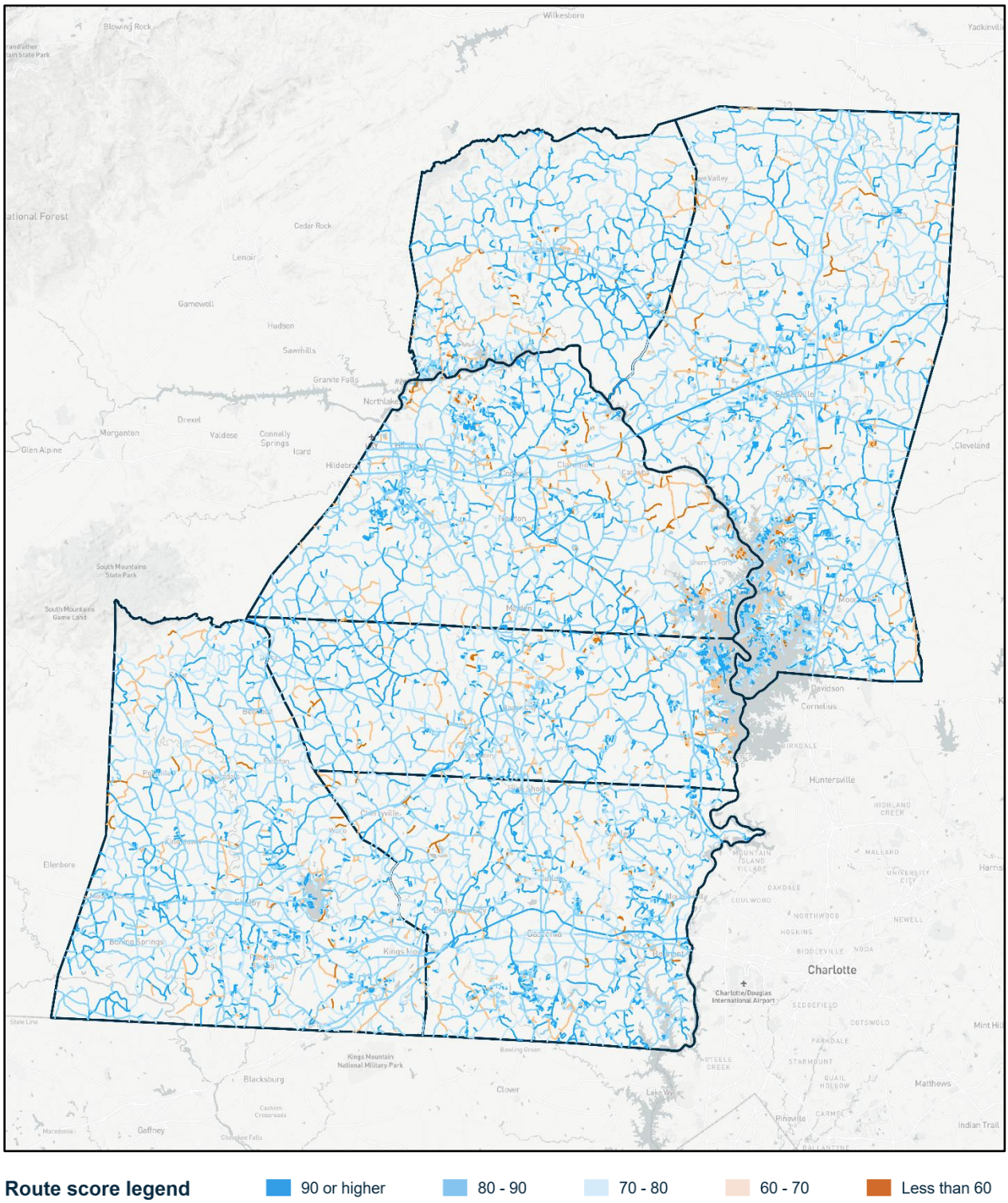


Figure 1 – Distribution of route score, measured in lane miles

Across the road network, the most common route score is between 80 and 85. Interstate and primary routes in Division 12 all have route scores of at least 60, while secondary routes exhibit route scores starting at 40.

These routes can be mapped spatially to evaluate the distribution by geography, as seen on the next page.

Route score distribution, by county



Map 1 – Spatial distribution of route score, grouped by county

1.4 Impact of static funding

Route Score is used to estimate the investment needed[iv] to maintain or achieve various condition levels over the next 10 years, assuming expected inflation[v] and asset deterioration.

Maintaining this division's current condition will require a year-over-year increase in funding, due to inflation and regular wear-and-tear. Static funding may be sufficient to maintain current route score next year but may lead to a decline of **-1.8** points in the following year and will potentially lower it by at least **-8.3** points over the next decade.

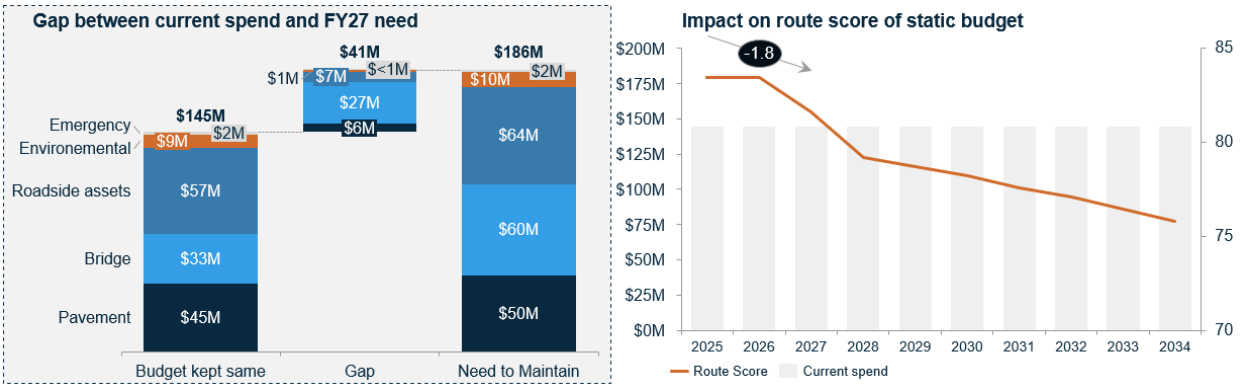


Figure 2 – Comparison of current spend and expected need; route score over time if no budget increase

1.5 Investment needs over the next 10 years

Using the Route Score, ArTEMIS can quantify investment needed to maintain or improve condition by raising the route score by zero points (maintain conditions), one point (slight improvement), five points (large improvement), and ten points (near-perfect conditions)[vi].

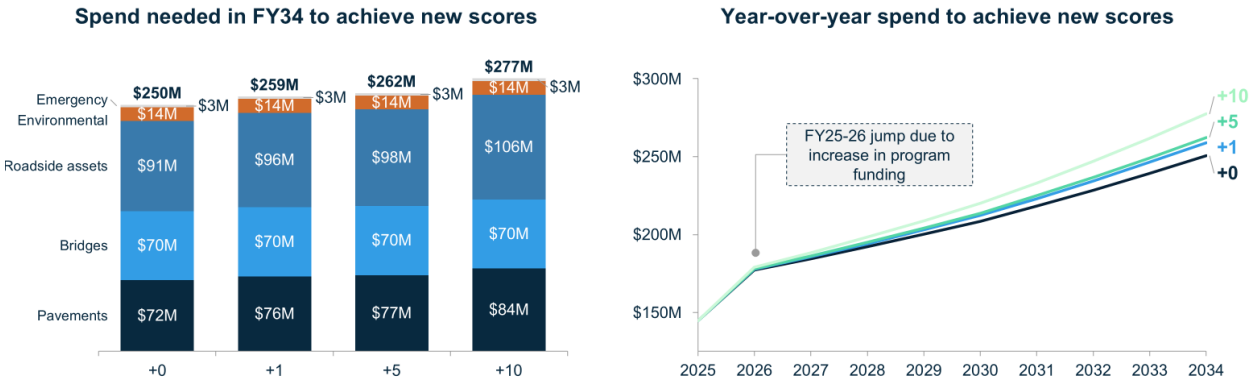


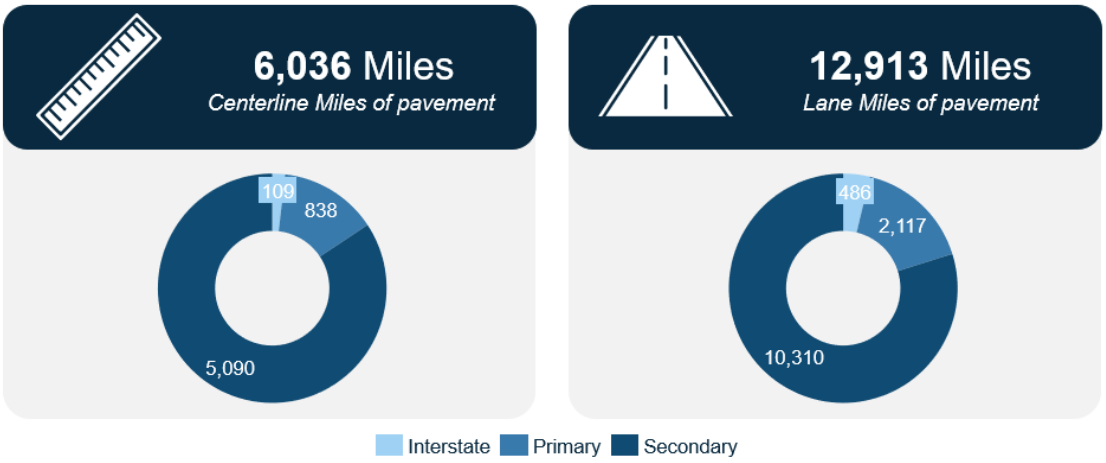
Figure 3 – Projected investment needed (YOE $) to improve route score over 10 years

As shown, maintaining and improving Division 12's Route Score requires greater investment:

- **+0** requires increasing spend to **$250M** by FY34; **$2,043M** in total investment
- **+1** requires increasing spend to **$259M** by FY34; **$2,080M** in total investment
- **+5** requires increasing spend to **$262M** by FY34; **$2,094M** in total investment
- **+10** requires increasing spend to **$277M** by FY34; **$2,158M** in total investment

2 Division Asset Inventory & Condition

2.1 Pavement & Asset Inventory



		Quantity			
Asset	**Unit**	**Interstate**	**Primary**	**Secondary**	**Overall**
Bike Lanes	LFT	0	33,562	41,772	75,334
Cablerail	MI	32	86	11	129
Concrete Barrier	MI	40	4	5	49
Crosswalk	EA	0	213	154	367
Curb and Gutter	MI	3	323	377	703
Drop Inlets	EA	322	3,120	6,689	10,131
Guardrail	MI	135	148	124	406
Impact Attenuator	EA	29	15	4	48
Induction Loop	EA	42	2,010	1,594	3,646
Mile marker	EA	275	137	37	449
Noise Wall*	LFT	2,709	0	3,484	6,194
Pavement Striping (defective only)	MI	88	358	1,239	1,685
Pipes[vii]	LFT	40,837	353,000	274,846	668,683
Retaining Wall*	LFT	2,212	7,575	7,543	17,329
Road Sign	EA	1,322	16,362	55,867	73,551
Rumble Strips*	MI	353	283	92	728
Sharrows	EA	0	57	124	181
Shoulder (defective only)	MI	1	12	80	93
Traffic Signal	EA	10	5,666	3,951	9,627
Variable Message Sign	EA	16	59	21	96
Word and Symbols	EA	302	11,416	7,670	19,388

Table 3 – Selection of roadside asset inventory; asterisk indicates no significance to route score

2.2 Pavement Conditions

Using Pavement Condition Survey (PCS) data, shown below is the breakdown of good, fair, and poor lane miles across the interstate, primary, and secondary systems.

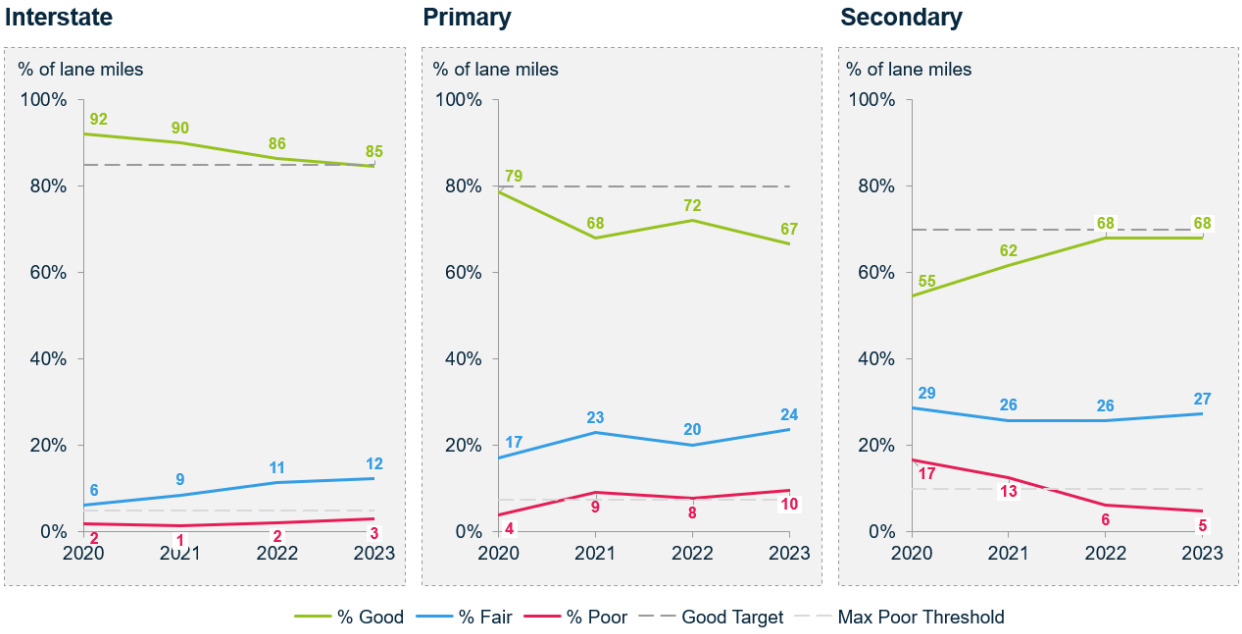


Figure 4 – Pavement conditions across interstate, primary, and secondary systems

Pavement conditions in Division 12 as evaluated via ArTEMIS analysis are above the state average, with a division-wide pavement index of **85**. Condition varies across the division by primary and secondary routes.

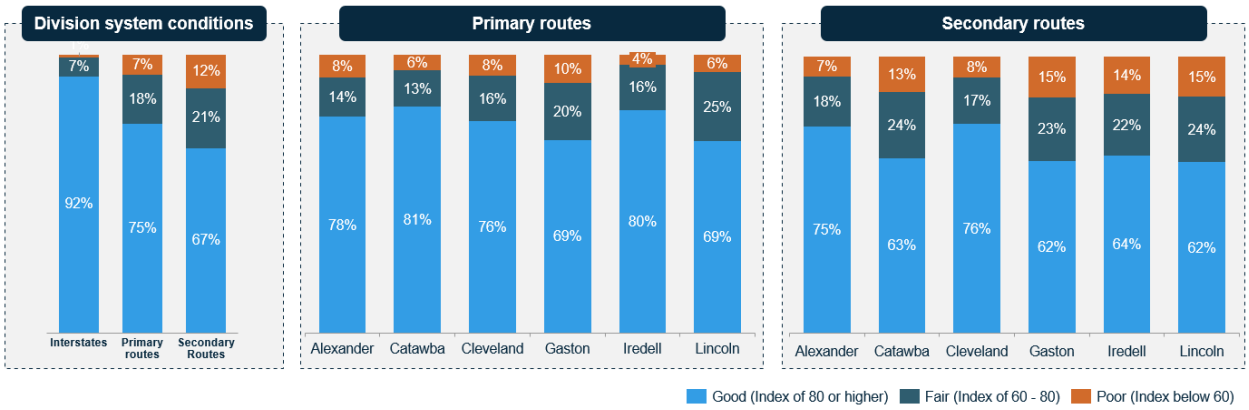


Figure 5 – Comparison of lane miles in good, fair, and poor conditions

County pavement index (weighted by lane miles) range **from 82 to 87**. Deductions are primarily driven by two distresses: (1) alligator cracking and (2) transverse cracking.

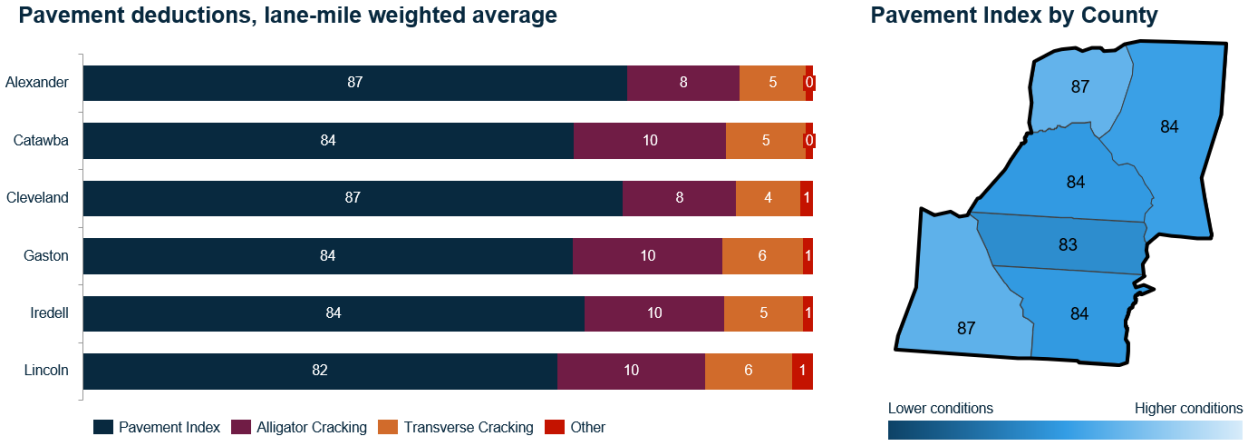


Figure 6 – Pavement index and deduction breakdown by county

Complementary models show similar assessments of pavement condition between the ArTEMIS model and the PCS model for Division 12. The pavement index utilizes the same scoring methodology as the PCS, the only differences being in how the data is collected/reviewed[viii].

	Condition			
Model	**Interstates**	**Primary**	**Secondary**	**Overall**
Pavement index (ArTEMIS)	93	87	84	85
Pavement condition score (PCS)	85	84	84	84

Table 4 – Condition comparison by pavement models for Division 12

2.3 Bridge Conditions

Bridge conditions are evaluated using a bridge index that translates general condition ratings (i.e., 1-9 scale) into a 100-point scale for easier comparison.

Overall, the Division 12 bridge index (79) scores ~3 points lower than statewide bridge index (82).

Data is ingested from FHWA bridge portal.

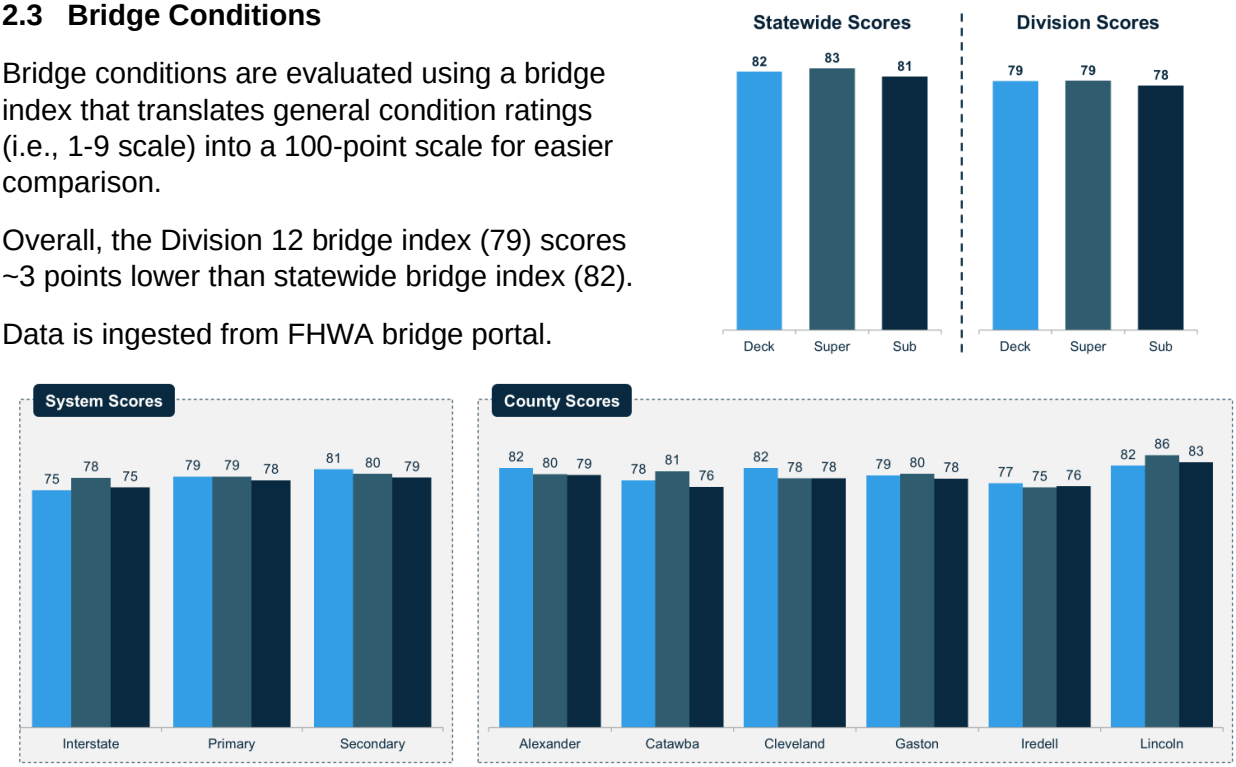


Figure 7 – Comparison of bridge conditions

The figure below displays all bridges in poor condition (index below 60) or at-risk of becoming poor (index of 60 – 69). They are mostly on the secondary system. Each circle maps one bridge by latitude and longitude; circle size indicates deck area, with at-risk bridges sized uniformly.

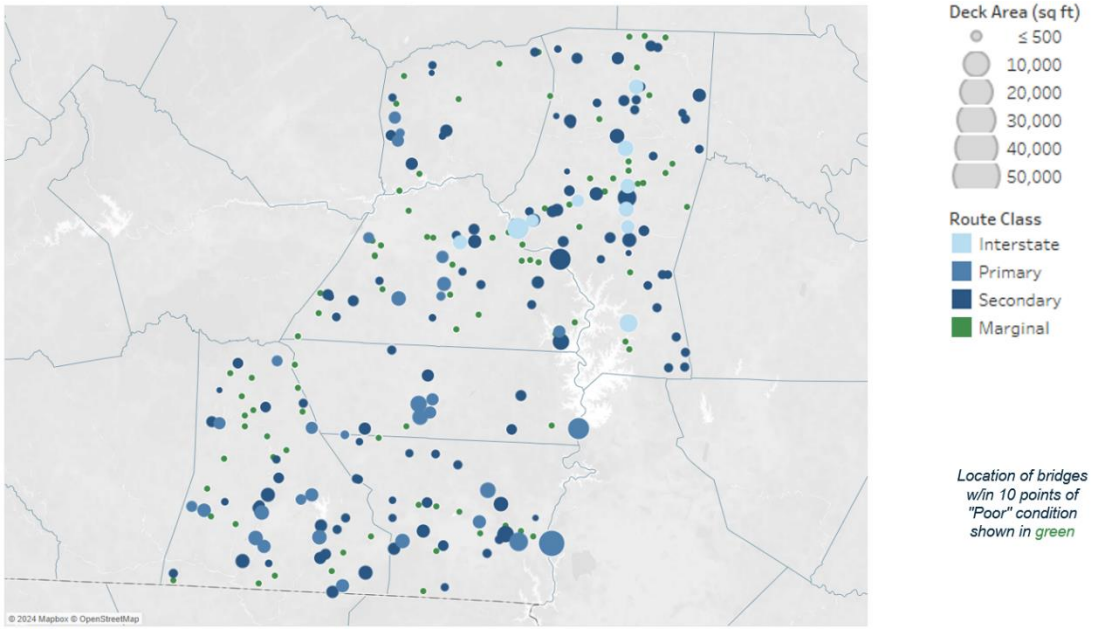


Figure 8 – Distribution of poor bridges and at-risk of becoming poor condition bridges in Division 12

2.4 Roadside Asset Conditions

Roadside asset condition is evaluated by measuring the proportion at which an asset is non-defective in a division, county, or route.

Asset	State	D12	Alexander	Catawba	Cleveland	Gaston	Iredell	Lincoln
Pavement Striping	89%	91%	93%	93%	88%	92%	91%	92%
Bike Lanes	78%	89%		100%	90%	85%	91%	
Word and Symbols	74%	71%	71%	76%	66%	65%	78%	81%
Sharrows	84%	85%		100%	94%	97%	29%	100%
Signs	94%	94%	94%	94%	93%	93%	96%	95%
Drop Inlets	89%	88%	91%	91%	81%	87%	91%	87%
Curb and Gutter	96%	95%	83%	97%	95%	96%	94%	97%
Guardrails	98%	98%	99%	98%	98%	99%	99%	98%
Shoulder	98%	99%	99%	99%	99%	99%	99%	99%

Most Defective — Least Defective

Figure 9 – Comparison of conditions between county functional assets [ix]

Below is roadside asset condition visualized with county boundaries, where colors are relative to the average condition across the state, for each respective asset.

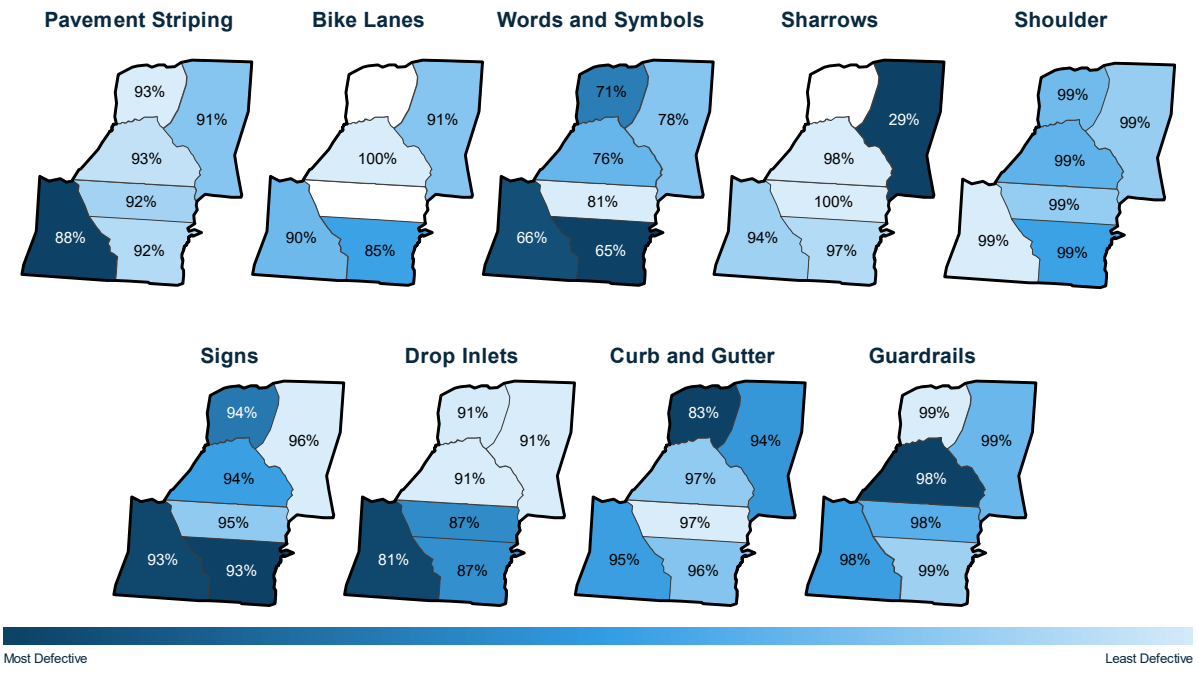


Figure 10 – Comparison of roadside asset conditions mapped to county boundaries

3 Rehabilitation / Rebuilding Needs

To develop a sense of what level of investment is required to ensure our state's ability to provide a safe and effective transportation network into the future, in the summer of 2024 the Director of Highway Operations reached out to all 14 Division Engineers and their teams, asking them to provide details on their highest priority ~35 miles of reconstruction/rehabilitation needs. The submitted sections for Division 12, along with estimated costs, are outlined below ranked in order of priority (as submitted).

Route	County	Comments	Miles	Est. Cost ($M)
I-85	Cleveland	Pavement failures from concrete slab movement/settlement. Thin asphalt lifts over concrete 2"-3" of asphalt in places.	8.24	$327M
I-85	Gaston	Pavement failures from concrete slab movement/settlement. Thin asphalt lifts over concrete 2"-3" of asphalt in places.	8.60	$418M
I-40	Catawba	Pavement failures from concrete slab movement/settlement. Thin asphalt lifts over concrete 2"-3" of asphalt in places.	12.10	$484
I-40	Iredell	Deterioration due to age, transverse cracks	8.00	$264
I-40	Davie	.25 Miles into Davie county (Gap Section)	0.25	--
Total	-	-	**37.19**	**$1,492M**

Table 5 – Submitted rehabilitation / rebuilding priorities and estimated costs

4 Cost Summary

To inform the model of how conditions translate into maintenance investment needs, should-cost was collected – what should various maintenance activities cost? This is used to estimate costs for the most common maintenance treatments down to the activity level.

Highlighted below are the unique unit costs for assets in Division 12, where activity costs of more common treatments are weighted more heavily than less common ones for each asset[x].

Weighted average unit costs by Division

Asset	UOM	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14
Bike Lanes	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Cablerail*	LFT	$2	$1	$2	$5	$1	$1	$3	$2	$0	$5	$2	$0	$2	$1
Concrete Barrier*	LFT	$500	$8	$3	$1,350	$16	$15	$3	$182	$163	$182	$6	$42	$25	$50
Pipes	LFT	$267	$379	$315	$479	$273	$275	$327	$462	$296	$378	$395	$90	$256	$345
Crosswalk	EA	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Curb and Gutter*	LFT	$102	$132	$125	$83	$112	$144	$117	$109	$78	$112	$93	$39	$90	$88
Drop Inlets*	EA	$811	$809	$1,363	$460	$974	$714	$865	$788	$830	$1,041	$794	$744	$1,361	$1,297
Guardrail*	LFT	$16	$30	$36	$12	$1	$49	$30	$31	$12	$32	$6	$32	$50	$21
Impact Attenuator*	EA	$2,500	$12,500	$5,000	$8,840	$2,707	$1,925	$17,500	$750	$1,704	$9,250	$2,028	$2,613	$10,250	$3,000
Induction Loop	LFT	$1,381	$726	$2,777	$1,695	$825	$1,358	$748	$1,486	$573	$3,097	$1,322	$2,144	$1,167	$1,308
Mile marker	EA	$129	$171	$172	$135	$440	$268	$168	$276	$285	$164	$427	$137	$143	$192
Pavement Striping*	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Ramp Metering	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Road Sign	EA	$309	$365	$232	$288	$613	$378	$379	$366	$462	$249	$581	$249	$293	$338
Shoulder	SHM	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Timber Rail	LFT	$44	$6	$49	$313	$13	$8	$2	$49	$44	$49	$3	$23	$23	$63
Traffic Signal	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Word and Symbols	LFT	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Crack Seal	LM	$3,103	$4,000	$3,300	$3,409	$6,009	$2,100	$4,366	$4,000	$3,250	$6,000	$7,850	$4,366	$4,366	$5,000
Chip Seal	LM	$21,933	$18,625	$22,750	$17,014	$26,732	$53,875	$22,356	$49,000	$30,925	$17,500	$21,500	$22,902	$33,701	$32,500
Contract Resurfacing*	LM	$120,418	$140,000	$67,500	$96,025	$109,701	$92,500	$213,998	$97,500	$116,150	$185,000	$66,250	$87,184	$88,750	$151,250

Table 6 – Unit cost comparison between Divisions

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[iii] When aggregated, route scores are weighted by lane miles and route class.

[iv] Maintenance costs are estimated solely by prioritizing the most efficient and cost-effective maintenance activities in terms of their impact on overall state/division route score, regardless of pre-existing plans, priorities, or ongoing projects.

[v] For these investment scenarios, we assume rates of inflation for labor, material, and equipment costs of 3%, 5%, and 8% respectively, per the 2023Q4 Engineering News-Record Cost Report. Costs for non-maintenance activities are assumed to increase at annual rate of 3%.

[vi] Spend to increase route score views pavement and roadside asset activities, only. Bridge activities that would increase score are currently not included. This may underestimate need when calculating need to improve by 10 pts.

[vii] Pipes are ingested into inventory counts via NCDOT survey

[viii] The pavement index assessment is consistent for every route and captures the entirety of the Division’s inventory. At times, the asset detection algorithm powering the pavement index may miss light / moderate rutting.

[ix] Blank cells indicate that the asset type is not present in county and therefore excluded from analysis.

[x] Asterisk denotes predominately contracted activities. Bike lanes, curb and gutter, guardrails, concrete barriers, impact attenuators, cable rails, and pavement markings are typically contracted out in D12. All cost data in this table were provided and validated by engineers from each division. Variations in costs may arise due to several factors, including the frequency of repairs, whether work is performed in-house or contracted out, and the defect severity at which interventions are initiated. For assets where specific cost data were unavailable, the average cost across all divisions was used. Data was collected and validated February - May 2024.

DIVISION 13 INSIGHTS REPORT

This report uses data on inventory, condition, and costs to provide insights at the division, county, and route levels. It identifies long-term investment needs and opportunities across the system to optimize outcomes.[i]

1 Division Funding Needs 151

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1 Division Funding Needs

1.1 Data Background

Launched in 2020, ArTEMIS initially tracked 30+ discrete maintenance functions on state-managed routes. Since then, it has expanded to capture a "fence-to-fence" view of assets, activity-based costs, and lifecycle investment forecasting, enabling more precise, data-driven maintenance planning.

The 2023 initiative leverages image recognition and AI/ML to assess conditions across 2+ million geo-located assets statewide. By aligning new inventory data with established sources like the Pavement Condition Survey, it enhances accuracy through "Route Scores" at route, county, division, and state levels, which help forecast investment needs. Similar to weather forecasting, aligning multiple datasets strengthens accuracy and reliability.

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1.2 Route Score Overview

1.2.1 Methodology

The table below shows the asset conditions contributing to Division 13's overall route score and how a route score is assembled at the route level (before being aggregated up by system counties, divisions, etc). The score uses point-in-time data collected January - September 2023.

Asset	State	Division 13
Pavement Index	83	87
Bridge Index	82	77
Shoulder	98%	98%
Pipes	82%	84%
Drop Inlets	89%	87%
Curb and Gutter	96%	95%
Pavement Striping	89%	92%
Signs	94%	92%
Guardrails and barriers	98%	99%
Words and Symbols[ii]	96%	95%
Traffic devices	100%	100%

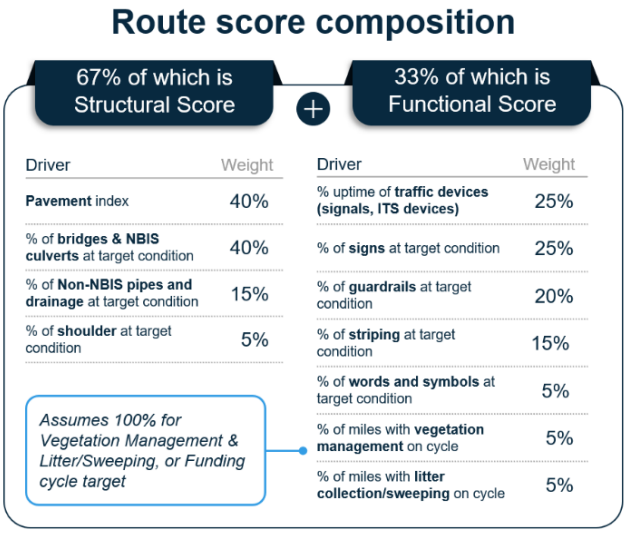
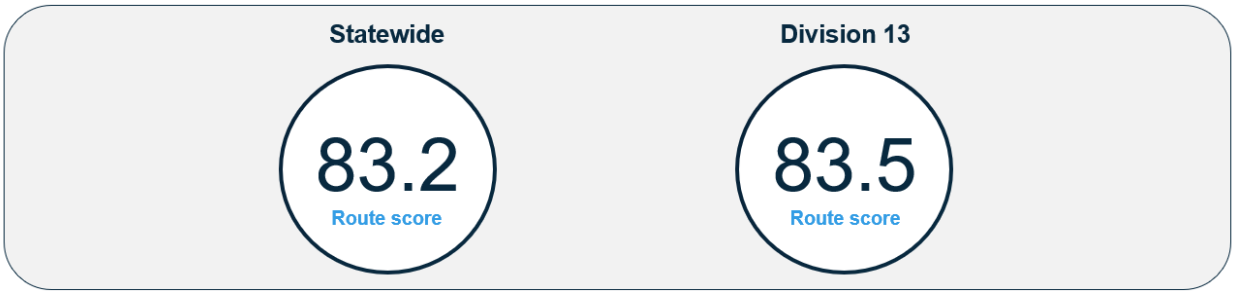


Table 1 – Asset scores (percentage of non-defective units or index score) across State and Division

1.2.2 Most Recent Outcomes

Using the scoring method shown above, the overall conditions of a division's roads can be shown with a single score that takes the weighted[iii] average of all its routes:



Route class	State	Division 13
Interstates	89	88
Primary	83	84
Secondary	82	82

Table 2 – Route scores by class

1.3 Route Score Distribution

The majority of the Division's network consists of routes in good condition, defined by a route score of 80 or higher. Over 7,100 lane miles (67% of network) are considered in good condition.

Conversely, less than 130 lane miles (1% of network) are considered in poor condition, defined by a route score lower than 60. Map 1 shows the condition of routes across the division.

Route score distribution, by lane miles

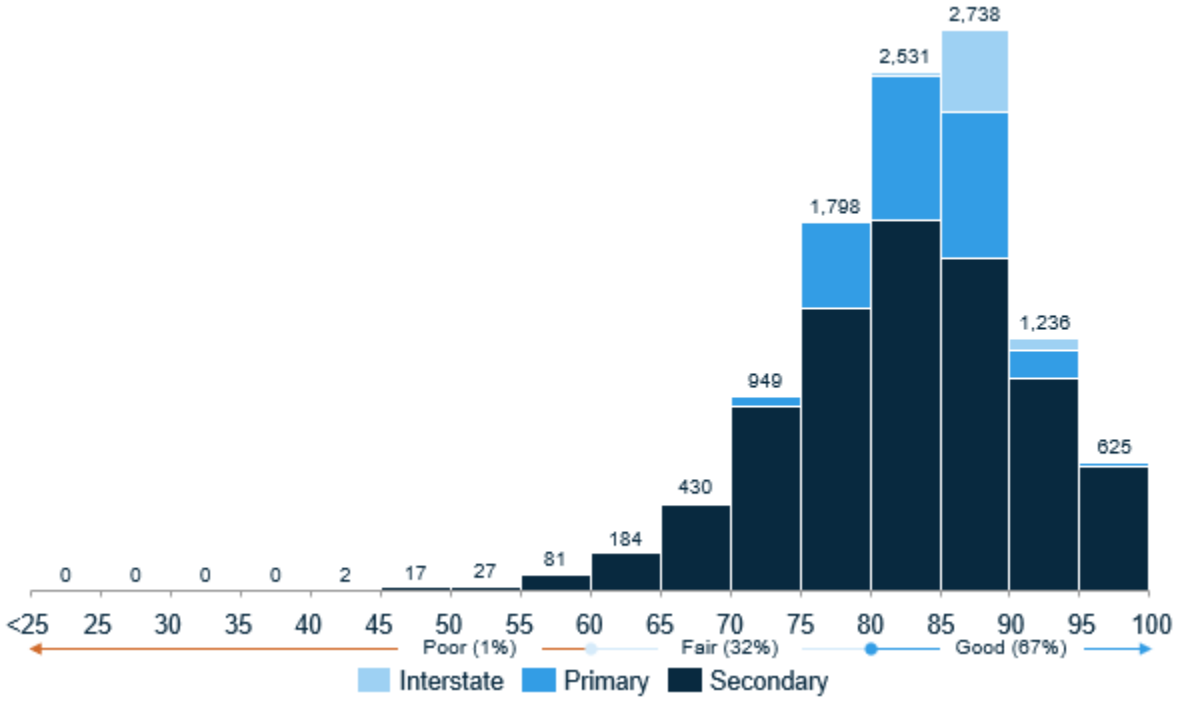
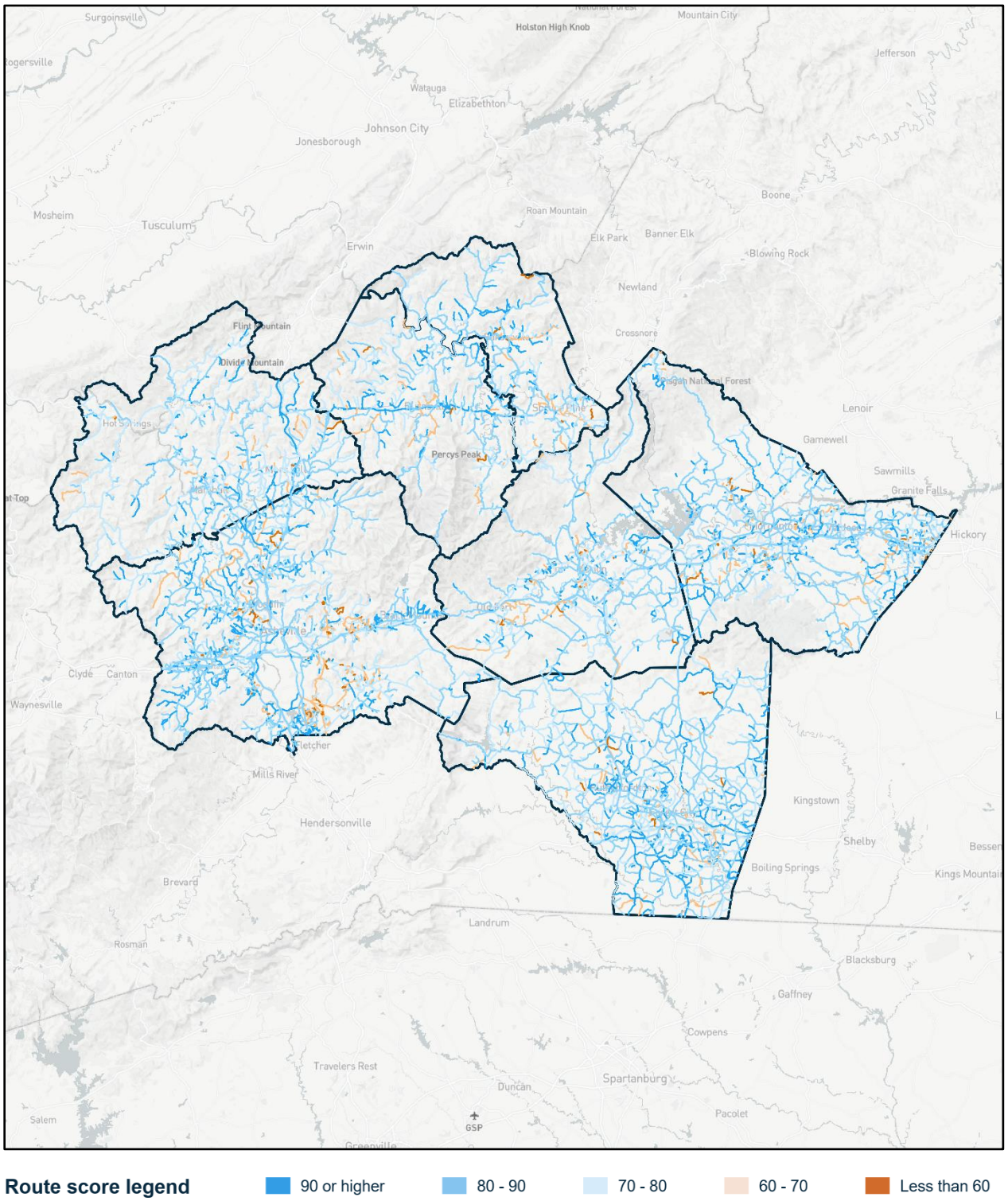


Figure 1 – Distribution of route score, measured in lane miles

Across the road network, the most common route score is between 85 and 90. Interstate and primary routes in Division 13 all have route scores of at least 70, while secondary routes exhibit route scores starting at 40.

These routes can be mapped spatially to evaluate the distribution by geography, as seen on the next page.

Route score distribution, by county



Route score legend 90 or higher | 80 - 90 | 70 - 80 | 60 - 70 | Less than 60

Map 1 – Spatial distribution of route score, grouped by county

1.4 Impact of static funding

Route Score is used to estimate the investment needed[iv] to maintain or achieve various condition levels over the next 10 years, assuming expected inflation[v] and asset deterioration.

Maintaining this division's current condition will require a year-over-year increase in funding, due to inflation and regular wear-and-tear. Static funding may lead to a decline of **-3.3** points in the following year and will potentially lower it by at least **-10.4** points over the next decade.

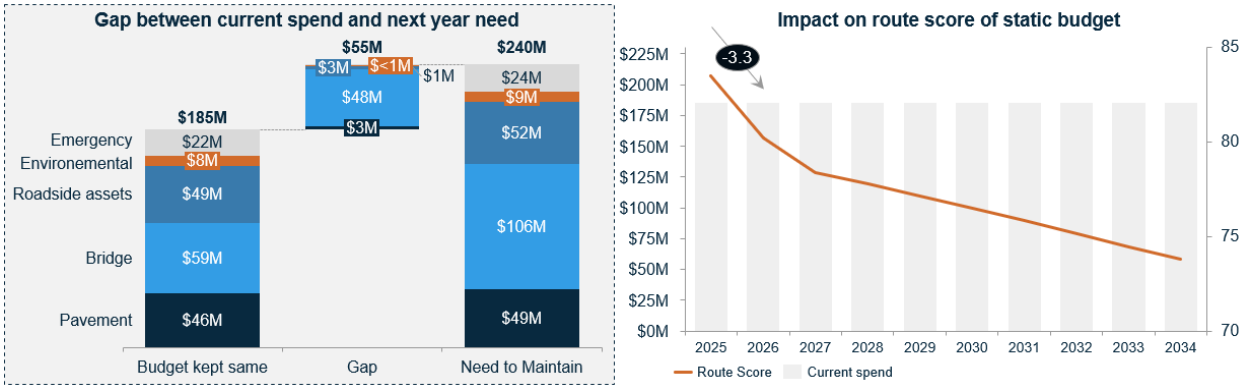


Figure 2 – Comparison of current spend and expected need; route score over time if no budget increase

1.5 Investment needs over the next 10 years

Using the Route Score, ArTEMIS can quantify investment needed to maintain or improve condition by raising the route score by zero points (maintain conditions), one point (slight improvement), five points (large improvement), and ten points (near-perfect conditions)[vi].

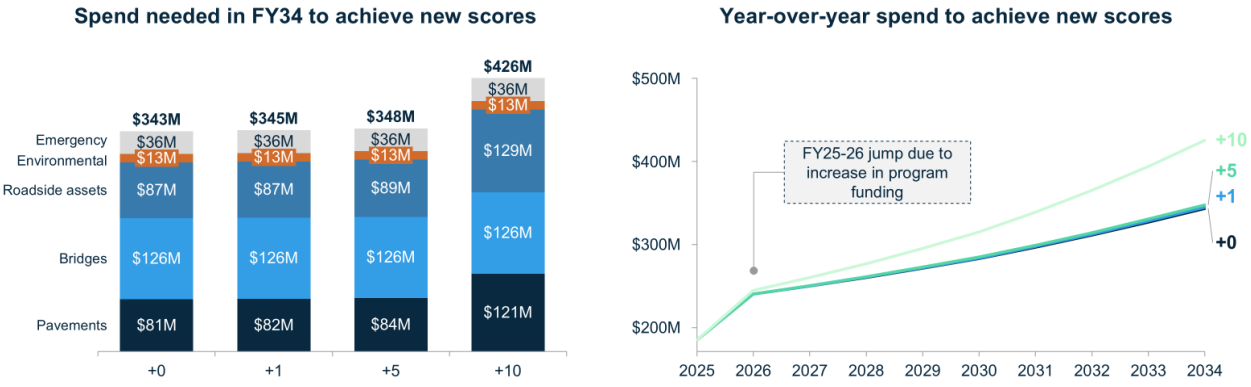


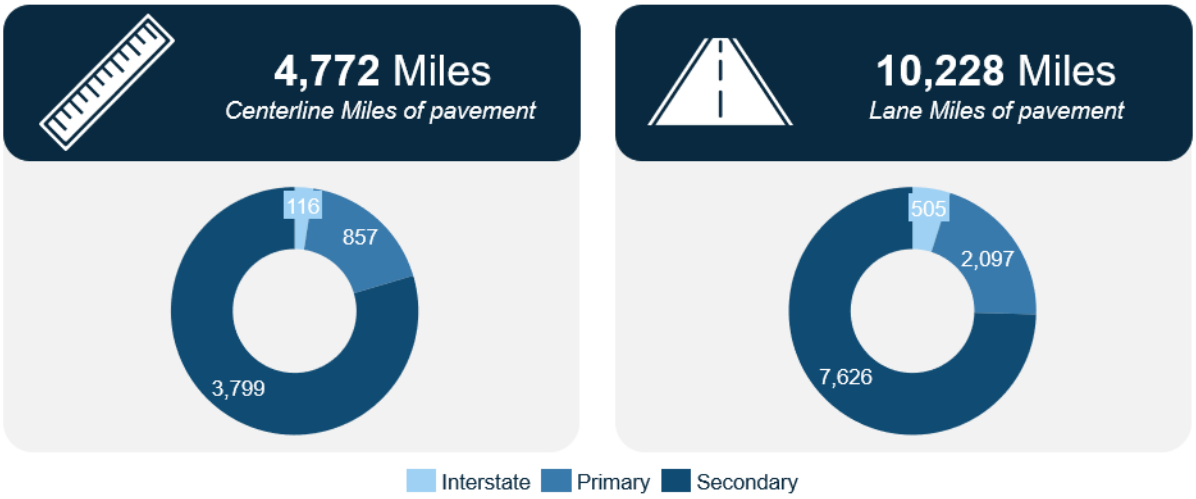
Figure 3 – Projected investment needed (YOE $) to improve route score over 10 years

As shown, maintaining and improving Division 13's Route Score requires greater investment:

- **+0** requires increasing spend to **$343M** by FY34; **$2,768M** in total investment
- **+1** requires increasing spend to **$346M** by FY34; **$2,774M** in total investment
- **+5** requires increasing spend to **$348M** by FY34; **$2,787M** in total investment
- **+10** requires increasing spend to **$426M** by FY34; **$3,101M** in total investment

2 Division Asset Inventory & Condition

2.1 Pavement & Asset Inventory



		Quantity			
Asset	**Unit**	**Interstate**	**Primary**	**Secondary**	**Overall**
Bike Lanes	LFT	0	27,817	13,227	41,044
Cablerail	MI	4	11	2	16
Concrete Barrier	MI	33	12	2	48
Crosswalk	EA	0	169	115	284
Curb and Gutter	MI	5	199	107	311
Drop Inlets	EA	343	2,676	2,274	5,293
Guardrail	MI	236	315	183	734
Impact Attenuator	EA	34	31	12	77
Induction Loop	EA	16	956	820	1,792
Mile marker	EA	294	86	40	420
Noise Wall*	LFT	9,309	563	703	10,576
Pavement Striping (defective only)	MI	41	240	998	1,278
Pipes[vii]	LFT	15,212	391,474	336,923	743,609
Retaining Wall*	LFT	174	28,652	61,759	90,586
Road Sign	EA	1,726	17,916	57,900	77,542
Rumble Strips*	MI	355	277	105	736
Sharrows	EA	0	161	15	176
Shoulder (defective only)	MI	3	59	151	213
Traffic Signal	EA	12	2,998	1,941	4,951
Variable Message Sign	EA	11	18	20	49
Word and Symbols	EA	272	6,868	2,568	9,708

Table 3 – Selection of roadside asset inventory; asterisk indicates no significance to route score

2.2 Pavement Conditions

Using Pavement Condition Survey (PCS) data, shown below is the breakdown of good, fair, and poor lane miles across the interstate, primary, and secondary systems.

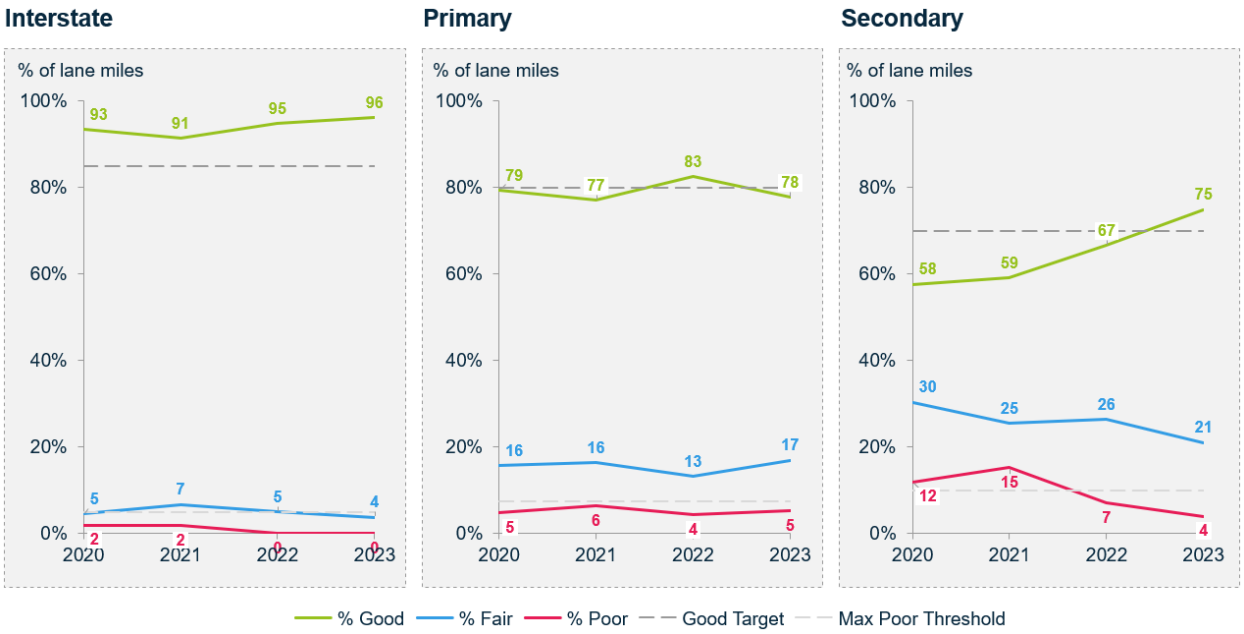


Figure 4 – Pavement conditions across interstate, primary, and secondary systems

Pavement conditions in Division 13 as evaluated via ArTEMIS analysis are above the state average, with a division-wide pavement index of **87**. Condition varies across the division by primary and secondary routes.

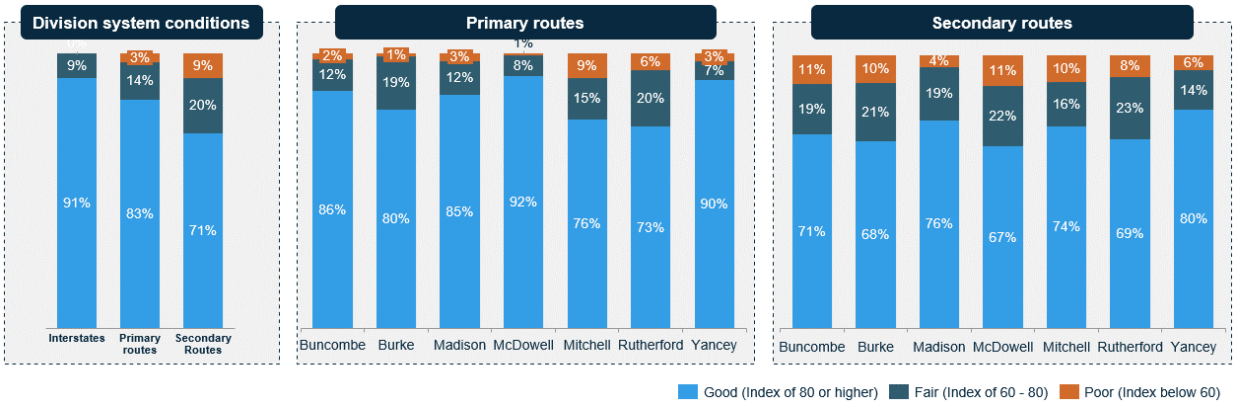


Figure 5 – Comparison of lane miles in good, fair, and poor conditions

County pavement index (weighted by lane miles) range **from 85 to 90**. Deductions are primarily driven by two distresses: (1) alligator cracking and (2) transverse cracking.

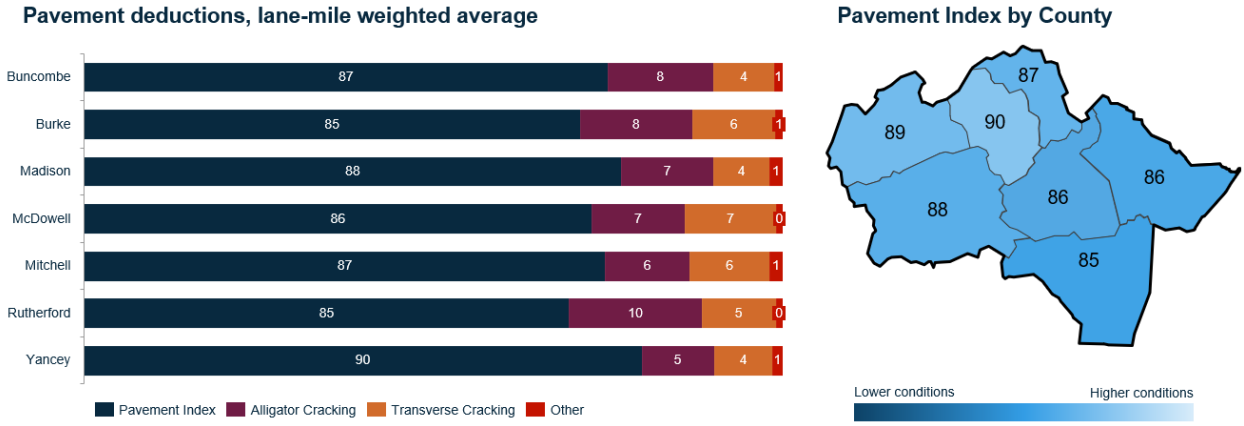


Figure 6 – Pavement index and deduction breakdown by county

Complementary models show similar assessments of pavement condition between the ArTEMIS model and the PCS model for Division 13. The pavement index utilizes the same scoring methodology as the PCS, the only differences being in how the data is collected/reviewed[viii].

	Condition			
Model	**Interstates**	**Primary**	**Secondary**	**Overall**
Pavement index (ArTEMIS)	94	90	86	87
Pavement condition score (PCS)	95	87	86	86

Table 4 – Condition comparison by pavement models for Division 13

2.3 Bridge Conditions

Bridge conditions are evaluated using a bridge index that translates general condition ratings (i.e., 1-9 scale) into a 100-point scale for easier comparison.

Overall, the Division 13 bridge index (77) scores ~5 points lower than statewide bridge index (82).

Data is ingested from FHWA bridge portal.

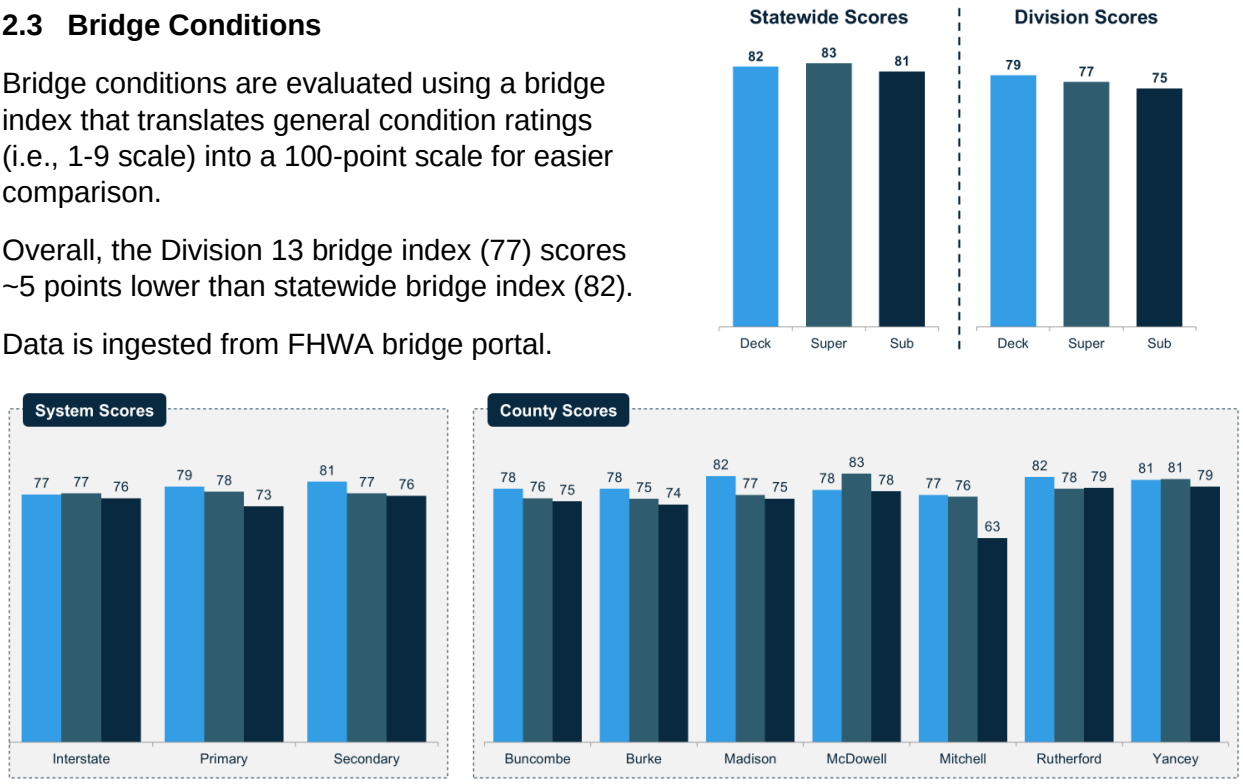


Figure 7 – Comparison of bridge conditions

The figure below displays all bridges in poor condition (index below 60) or at-risk of becoming poor (index of 60 – 69). They are mostly on the secondary system. Each circle maps one bridge by latitude and longitude; circle size indicates deck area, with at-risk bridges sized uniformly.

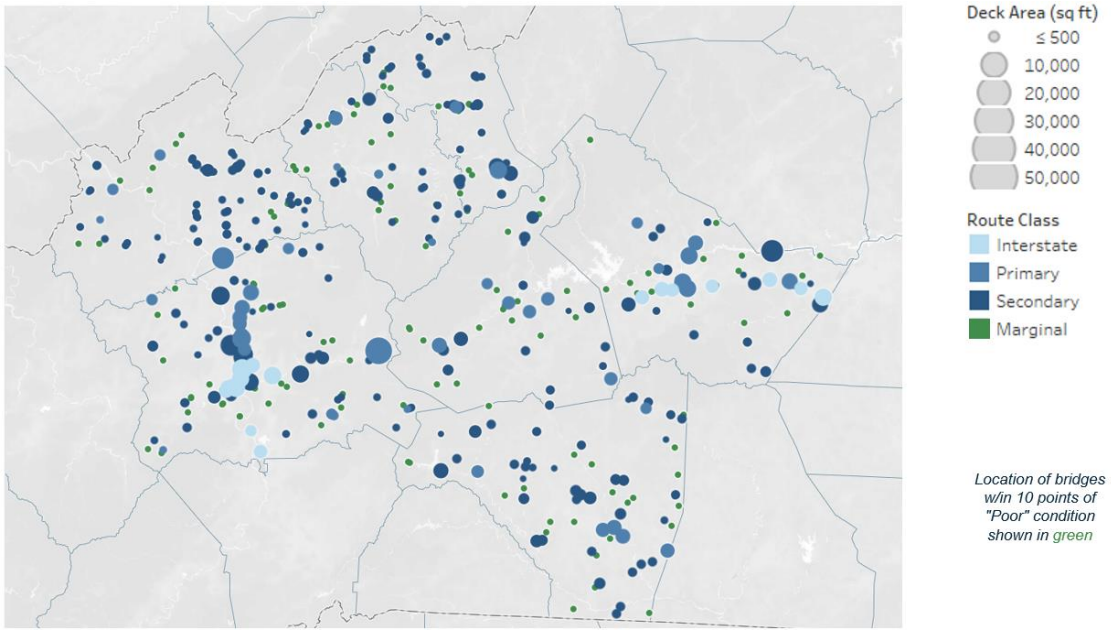


Figure 8 – Distribution of poor bridges and at-risk of becoming poor condition bridges in Division 13

Figure 9 shows how timber bridges are distributed across Division 13, and their individual condition rating. Division 13 has 211 poor condition bridges, and 60% of these poor condition bridges are timber. Divisions 11, 13, and 14 have the highest number of bridges overall – timber bridges represent 40% of their combined inventory and 70% of their combined poor condition bridges.

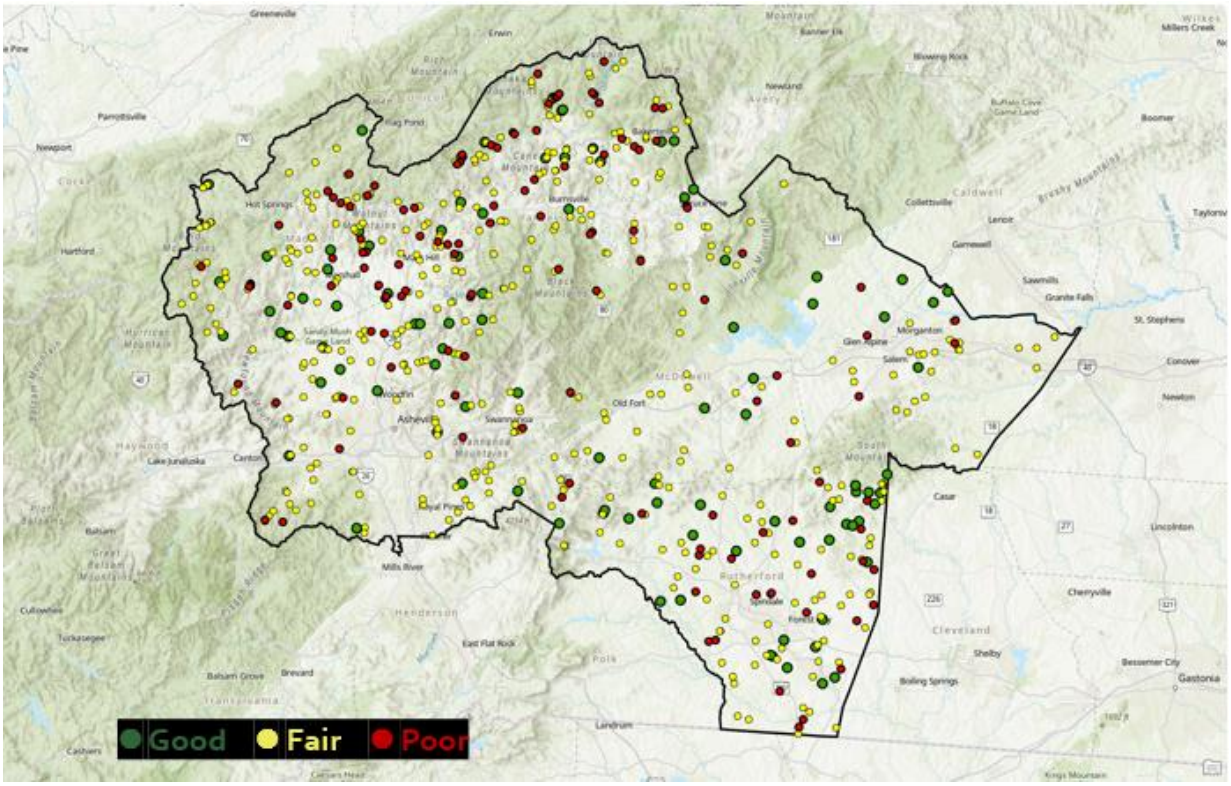


Figure 9 – Distribution and condition of timber bridges

2.4 Roadside Asset Conditions

Roadside asset condition is evaluated by measuring the proportion at which an asset is non-defective in a division, county, or route.

Asset	State	D13	Buncombe	Burke	Madison	McDowell	Mitchell	Rutherford	Yancey
Pavement Striping	89%	92%	94%	94%	89%	91%	94%	91%	89%
Bike Lanes	78%	66%	92%	2%					62%
Word and Symbols	74%	75%	80%	79%	78%	58%	59%	76%	70%
Sharrows	84%	63%	40%	67%	5%		100%	57%	89%
Signs	94%	92%	91%	93%	91%	91%	92%	95%	92%
Drop Inlets	89%	87%	85%	91%	89%	87%	72%	81%	93%
Curb and Gutter	96%	95%	93%	98%	97%	97%	85%	96%	97%
Guardrails	98%	99%	98%	100%	98%	99%	98%	99%	98%
Shoulder	98%	98%	97%	99%	94%	99%	98%	99%	97%

Most Defective — Least Defective

Figure 10 – Comparison of conditions between county functional assets [ix]

Below is roadside asset condition visualized with county boundaries, where colors are relative to the average condition across the state, for each respective asset.

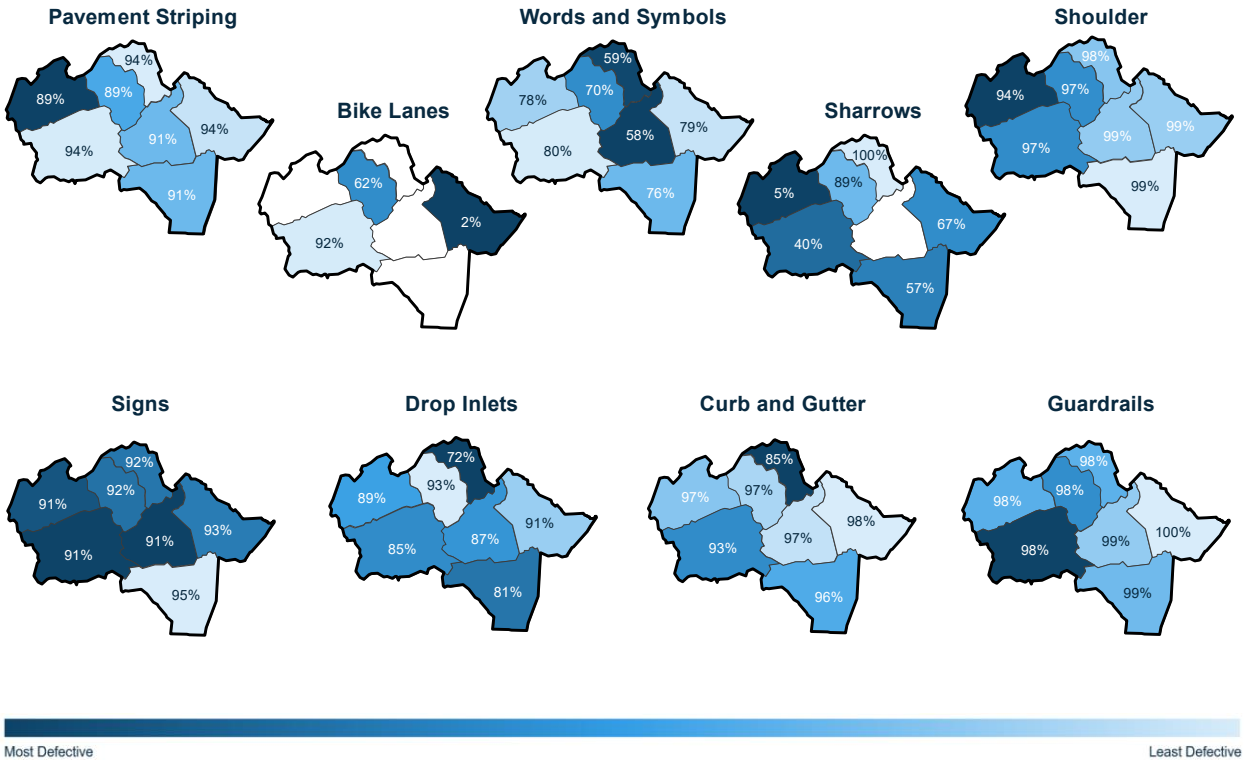


Figure 11 – Comparison of roadside asset conditions mapped to county boundaries

3 Rehabilitation / Rebuilding Needs

To develop a sense of what level of investment is required to ensure our state's ability to provide a safe and effective transportation network into the future, in the summer of 2024 the Director of Highway Operations reached out to all 14 Division Engineers and their teams, asking them to provide details on their highest priority ~35 miles of reconstruction/rehabilitation needs. The submitted sections for Division 13, along with estimated costs, are outlined below ranked in order of priority (as submitted).

Route	County	Comments	Miles	Est. Cost ($M)
I-240	BUNCOMBE	Needs to be resurfaced	4.69	$404M
I-40	MCDOWELL	CRACK SEAT CONCRETE UNDERNEATH NEEDS EITHER TO BE REPLACED OR ADDITIONAL STRUCTURE ADDED 4" +/- INCHES	8.00	$292M
I-40	MCDOWELL	CRACK SEAT CONCRETE UNDERNEATH NEEDS EITHER TO BE REPLACED OR ADDITIONAL STRUCTURE ADDED 4" +/- INCHES	4.97	$214M
US 221	MCDOWELL	POOR RATING IN SECTION ON 26 HMIP PLAN	9.28	$141M
NC 126	MCDOWELL	POOR RATING (70) BAD SHAPE	3.85	$45M
NC 126	BURKE	POOR RATINGS (76,60) BAD SHAPE	3.60	$42M
US 25	BUNCOMBE	ASPHALT WORN, DRAINAGE REPAIRS NEEDED	0.92	$28M
Total	-	-	**30.62**	**$1,166M**

Table 5 – Submitted rehabilitation / rebuilding priorities and estimated costs

4 Cost Summary

To inform the model of how conditions translate into maintenance investment needs, should-cost was collected – what should various maintenance activities cost? This is used to estimate costs for the most common maintenance treatments down to the activity level.

Highlighted below are the unique unit costs for assets in Division 13, where activity costs of more common treatments are weighted more heavily than less common ones for each asset[x].

Weighted average unit costs by Division

Asset	UOM	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14
Bike Lanes	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Cablerail*	LFT	$2	$1	$2	$5	$1	$1	$3	$2	$0	$5	$2	$0	$2	$1
Concrete Barrier*	LFT	$500	$8	$3	$1,350	$16	$15	$3	$182	$163	$182	$6	$42	$25	$50
Pipes	LFT	$267	$379	$315	$479	$273	$275	$327	$462	$296	$378	$395	$90	$256	$345
Crosswalk	EA	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Curb and Gutter*	LFT	$102	$132	$125	$83	$112	$144	$117	$109	$78	$112	$93	$39	$90	$88
Drop Inlets*	EA	$811	$809	$1,363	$460	$974	$714	$865	$788	$830	$1,041	$794	$744	$1,361	$1,297
Guardrail*	LFT	$16	$30	$36	$12	$1	$49	$30	$31	$12	$32	$6	$32	$50	$21
Impact Attenuator*	EA	$2,500	$12,500	$5,000	$8,840	$2,707	$1,925	$17,500	$750	$1,704	$9,250	$2,028	$2,613	$10,250	$3,000
Induction Loop	LFT	$1,381	$726	$2,777	$1,695	$825	$1,358	$748	$1,486	$573	$3,097	$1,322	$2,144	$1,167	$1,308
Mile marker	EA	$129	$171	$172	$135	$440	$268	$168	$276	$285	$164	$427	$137	$143	$192
Pavement Striping*	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Ramp Metering	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Road Sign	EA	$309	$365	$232	$288	$613	$378	$379	$366	$462	$249	$581	$249	$293	$338
Shoulder	SHM	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Timber Rail	LFT	$44	$6	$49	$313	$13	$8	$2	$49	$44	$49	$3	$23	$23	$63
Traffic Signal	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Word and Symbols	LFT	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Crack Seal	LM	$3,103	$4,000	$3,300	$3,409	$6,009	$2,100	$4,366	$4,000	$3,250	$6,000	$7,850	$4,366	$4,366	$5,000
Chip Seal	LM	$21,933	$18,625	$22,750	$17,014	$26,732	$53,875	$22,356	$49,000	$30,925	$17,500	$21,500	$22,902	$33,701	$32,500
Contract Resurfacing*	LM	$120,418	$140,000	$67,500	$96,025	$109,701	$92,500	$213,998	$97,500	$116,150	$185,000	$66,250	$87,184	$88,750	$151,250

Table 6 – Unit cost comparison between Divisions

[i] Condition and inventory data collected via ArTEMIS from January to September 2023; cost data collected from individual divisions and validated in February/March of 2024. Thus, funding scenarios outlined in this document were developed prior the impacts of Hurricane Helene & based on infrastructure condition data collected prior to the storm. As such, they do not account for the additional costs associated with the rehabilitation or reconstruction of infrastructure affected by the storm. Recognizing that rebuilding will entail significant expenses, the current scenarios focus on maintaining the regular operational budget and steady-state upkeep without reallocation of funds.

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DIVISION 14 INSIGHTS REPORT

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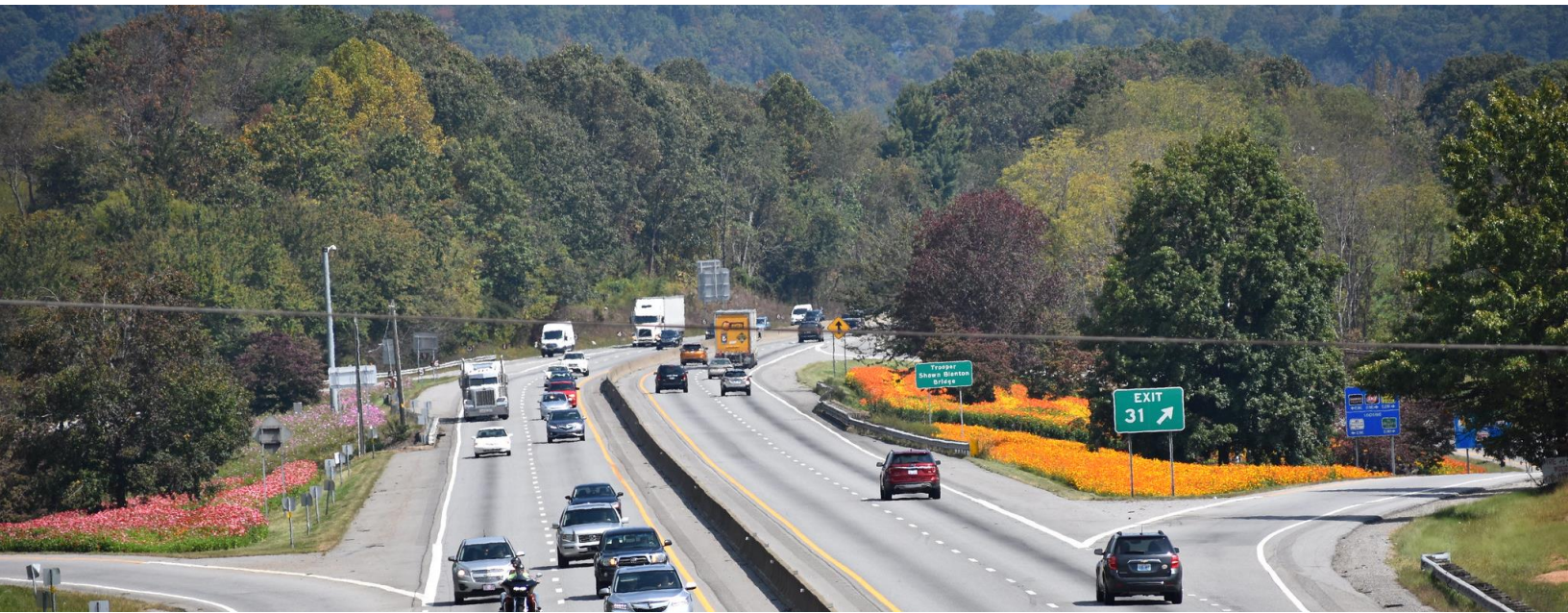

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Pavement Striping	89%	78%
Signs	94%	93%
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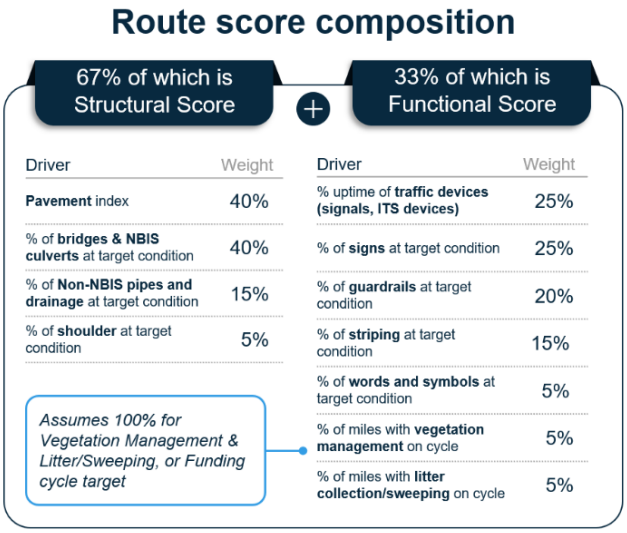

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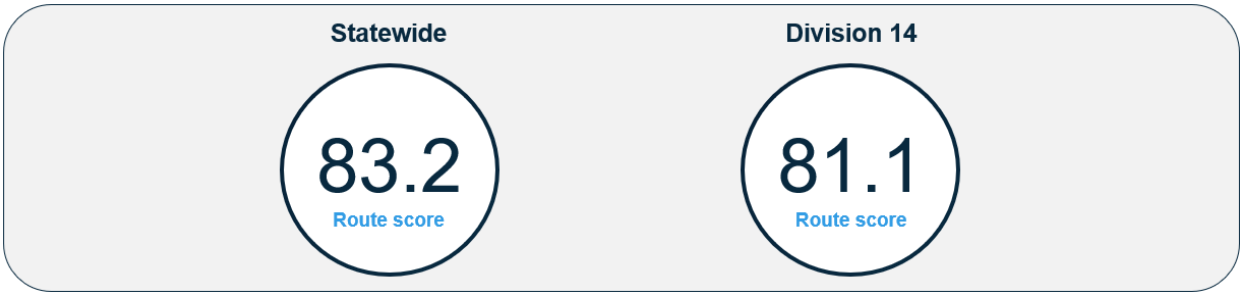
1.2.2 Most Recent Outcomes

Using the scoring method shown above, the overall conditions of a division's roads can be shown with a single score that takes the weighted[iii] average of all its routes:



Route class	State	Division 14
Interstates	89	85
Primary	83	81
Secondary	82	81

Table 2 – Route scores by class

1.3 Route Score Distribution

The majority of the Division's network consists of routes in good condition, defined by a route score of 80 or higher. Over 5,700 lane miles (57% of network) are considered in good condition.

Conversely, 170 lane miles (2% of network) are considered in poor condition, defined by a route score lower than 60. Map 1 shows the condition of routes across the division.

Route score distribution, by lane miles

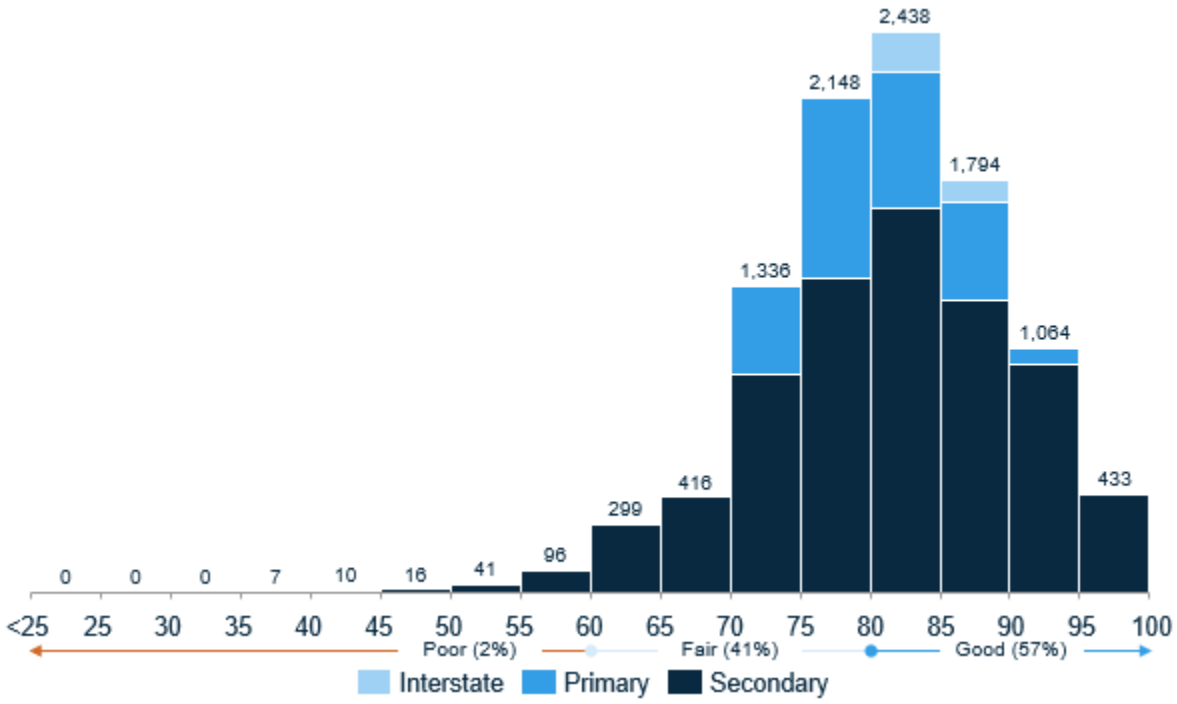
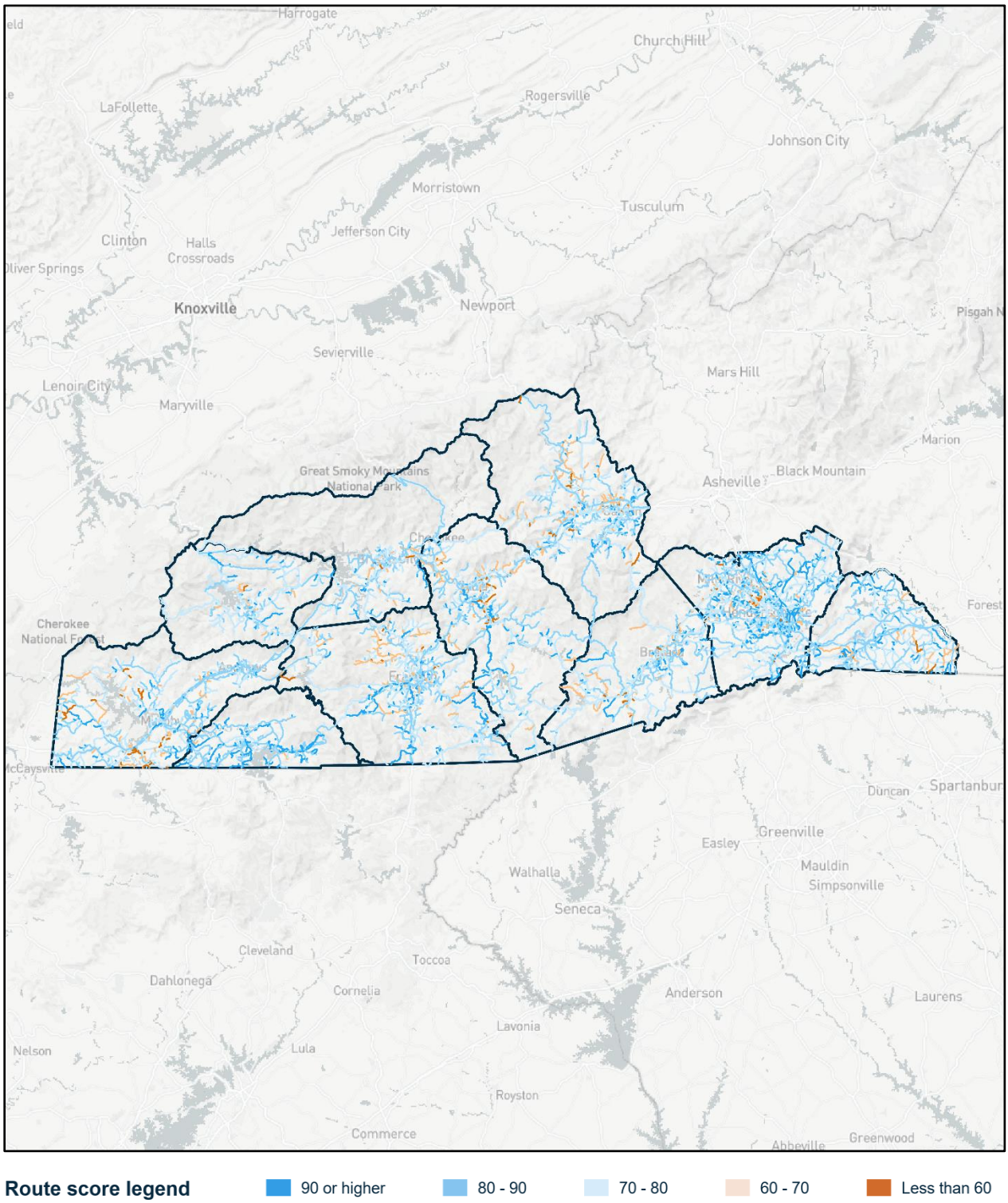


Figure 1 – Distribution of route score, measured in lane miles

Across the road network, the most common route score is between 80 and 85. Interstate and primary routes in Division 14 all have route scores of at least 70, while secondary routes exhibit route scores starting at 35.

These routes can be mapped spatially to evaluate the distribution by geography, as seen on the next page.

Route score distribution, by county



Map 1 – Spatial distribution of route score, grouped by county

1.4 Impact of static funding

Route Score is used to estimate the investment needed[iv] to maintain or achieve various condition levels over the next 10 years, assuming expected inflation[v] and asset deterioration.

Maintaining this division's current condition will require a year-over-year increase in funding, due to inflation and regular wear-and-tear. Static funding may lead to a decline of **-2.2** points in the following year and will potentially lower it by at least **-8.5** points over the next decade.

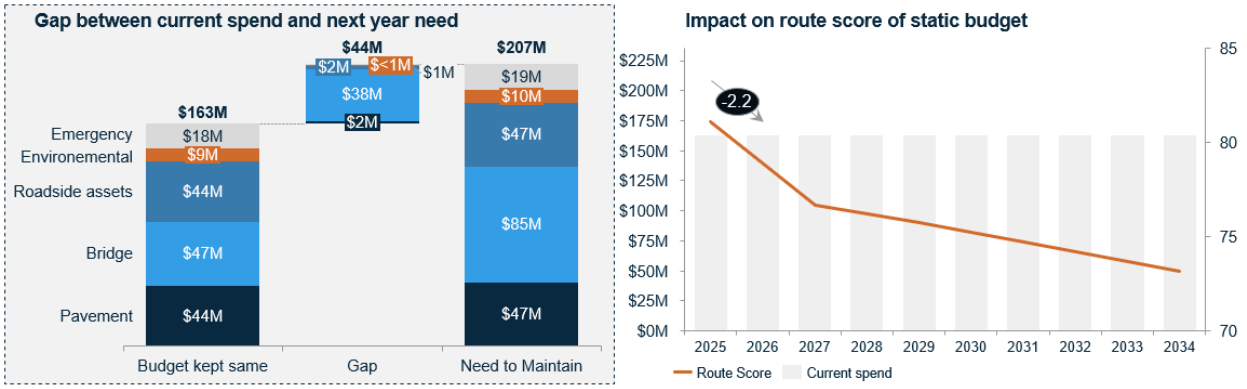


Figure 2 – Comparison of current spend and expected need; route score over time if no budget increase

1.5 Investment needs over the next 10 years

Using the Route Score, ArTEMIS can quantify investment needed to maintain or improve condition by raising the route score by zero points (maintain conditions), one point (slight improvement), five points (large improvement), and ten points (near-perfect conditions)[vi].

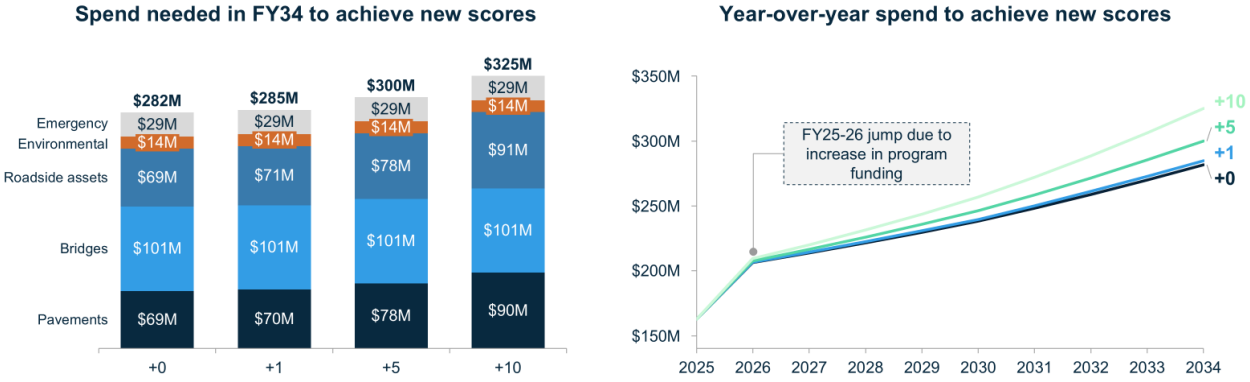


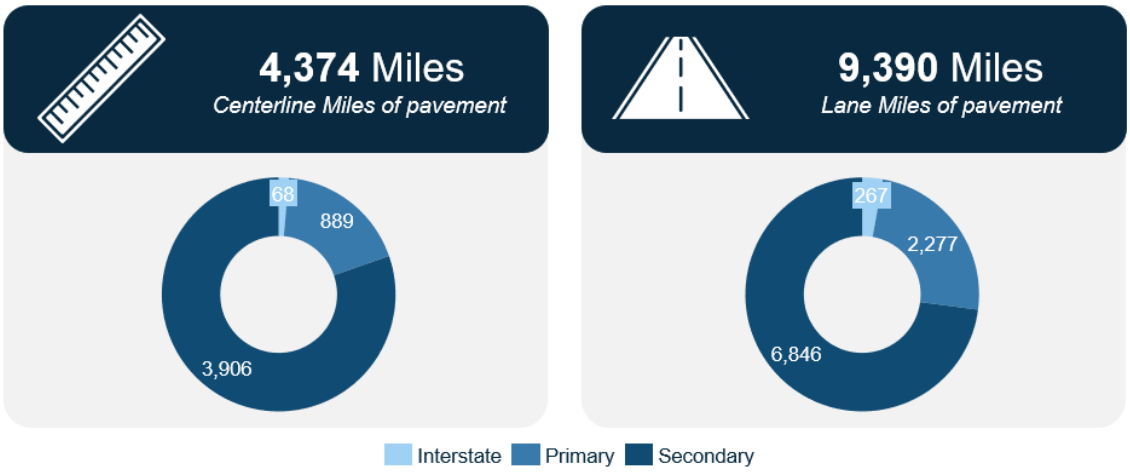
Figure 3 – Projected investment needed (YOE $) to improve route score over 10 years

As shown, maintaining and improving Division 14's Route Score requires greater investment:

- **+0** requires increasing spend to **$282M** by FY34; **$2,331M** in total investment
- **+1** requires increasing spend to **$285M** by FY34; **$2,334M** in total investment
- **+5** requires increasing spend to **$300M** by FY34; **$2,410M** in total investment
- **+10** requires increasing spend to **$325M** by FY34; **$2,515M** in total investment

2 Division Asset Inventory & Condition

2.1 Pavement & Asset Inventory



		Quantity			
Asset	**Unit**	**Interstate**	**Primary**	**Secondary**	**Overall**
Bike Lanes	LFT	0	83,132	12,496	95,627
Cablerail	MI	0	25	0	25
Concrete Barrier	MI	82	11	4	97
Crosswalk	EA	0	482	308	790
Curb and Gutter	MI	7	234	159	400
Drop Inlets	EA	338	3,340	2,328	6,006
Guardrail	MI	135	597	209	941
Impact Attenuator	EA	53	51	22	126
Induction Loop	EA	2	1,238	644	1,884
Mile marker	EA	202	299	4	505
Noise Wall*	LFT	0	0	0	0
Pavement Striping (defective only)	MI	76	669	2,579	3,324
Pipes[vii]	LFT	7,153	492,275	433,811	933,239
Retaining Wall*	LFT	1,237	35,336	115,943	152,516
Road Sign	EA	862	16,591	40,064	57,517
Rumble Strips*	MI	183	633	61	877
Sharrows	EA	1	59	26	86
Shoulder (defective only)	MI	8	94	315	417
Traffic Signal	EA	14	3,249	1,559	4,822
Variable Message Sign	EA	9	15	4	28
Word and Symbols	EA	192	9,405	1,889	11,486

Table 3 – Selection of roadside asset inventory; asterisk indicates no significance to route score

2.2 Pavement Conditions

Using Pavement Condition Survey (PCS) data, shown below is the breakdown of good, fair, and poor lane miles across the interstate, primary, and secondary systems.

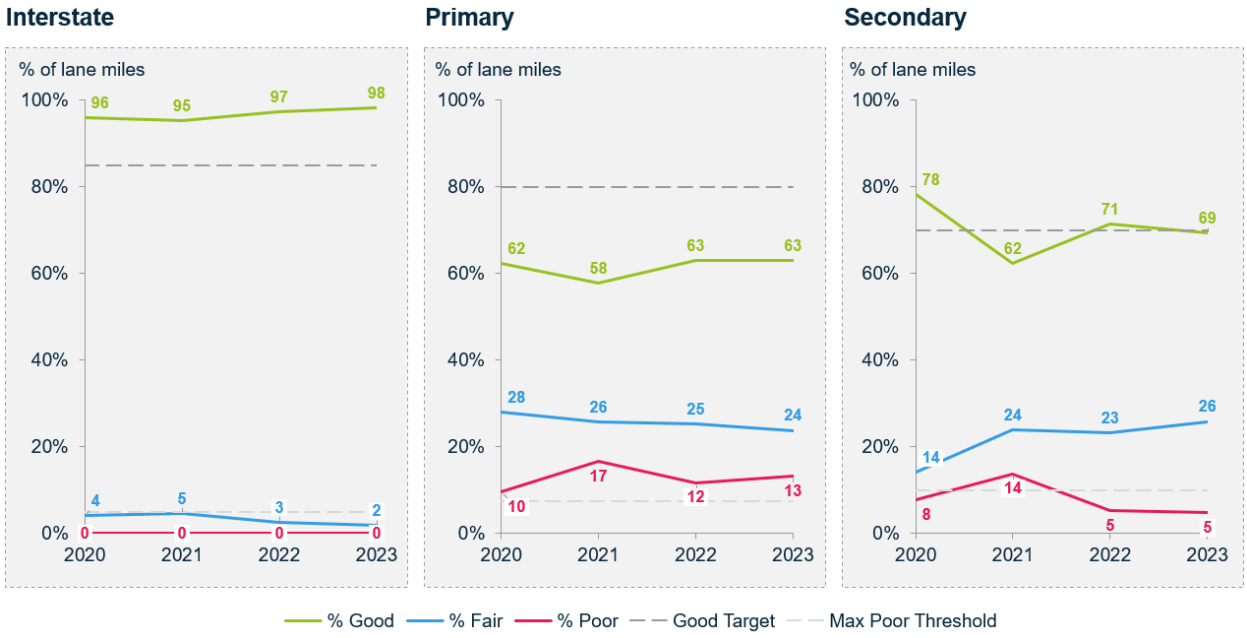


Figure 4 – Pavement conditions across interstate, primary, and secondary systems

Pavement conditions in Division 14 as evaluated via ArTEMIS analysis are above the state average, with a division-wide pavement index of **87**.

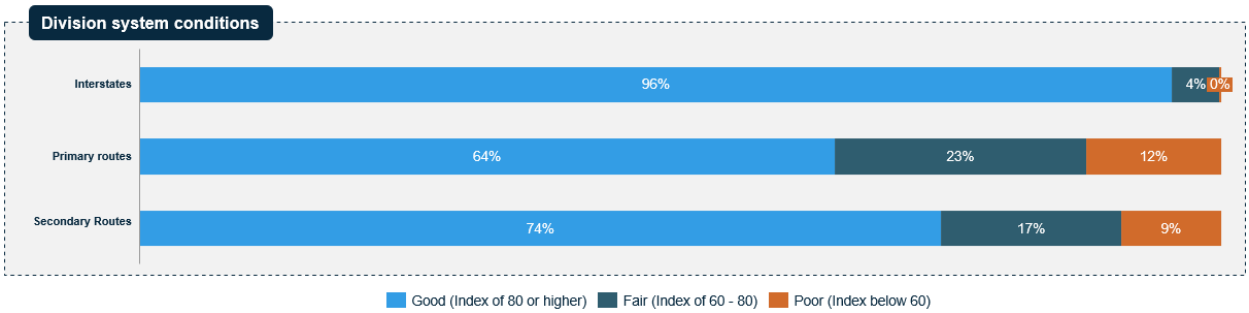


Figure 5.1 – Comparison of lane miles in good, fair, and poor conditions across Division 14

Condition varies across the division by primary and secondary routes.

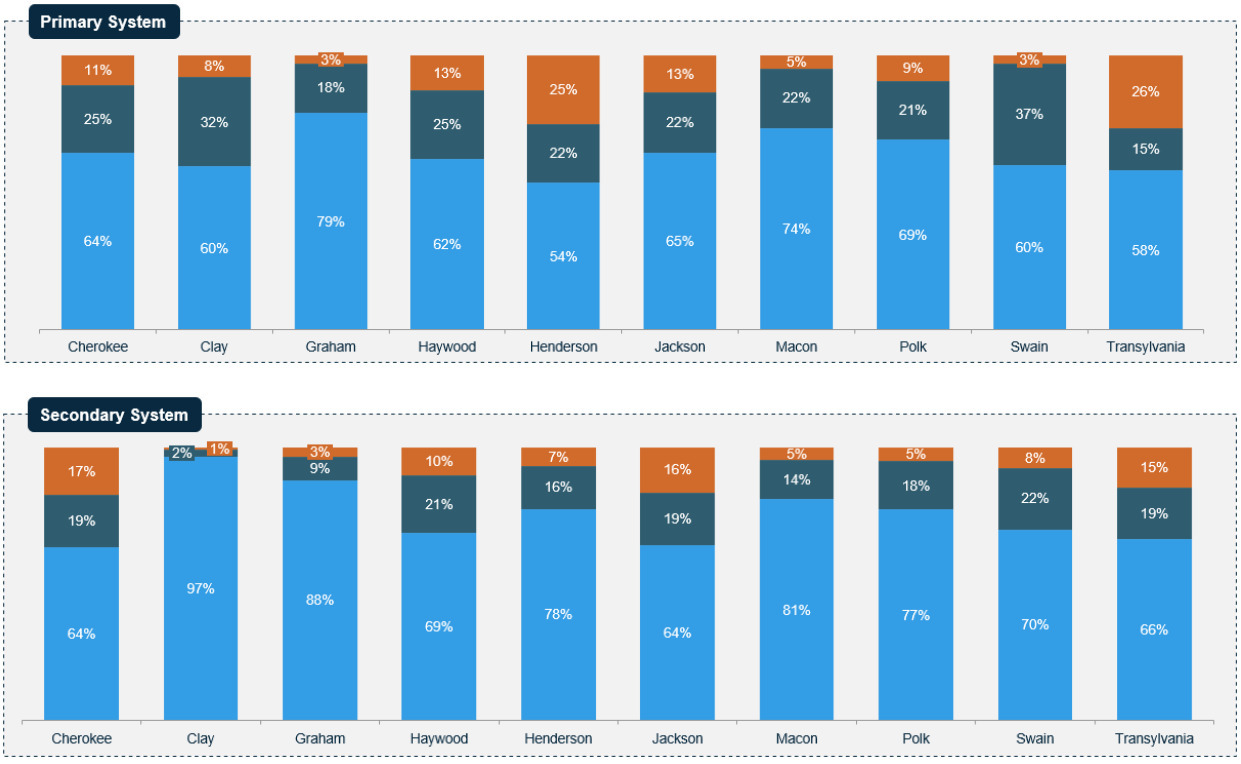


Figure 5.2 – Comparison of lane miles in good, fair, and poor conditions by primary and secondary systems

County pavement index (weighted by lane miles) range from 76 to 87. Deductions are primarily driven by two distresses: (1) alligator cracking and (2) transverse cracking, as seen in figure 5.

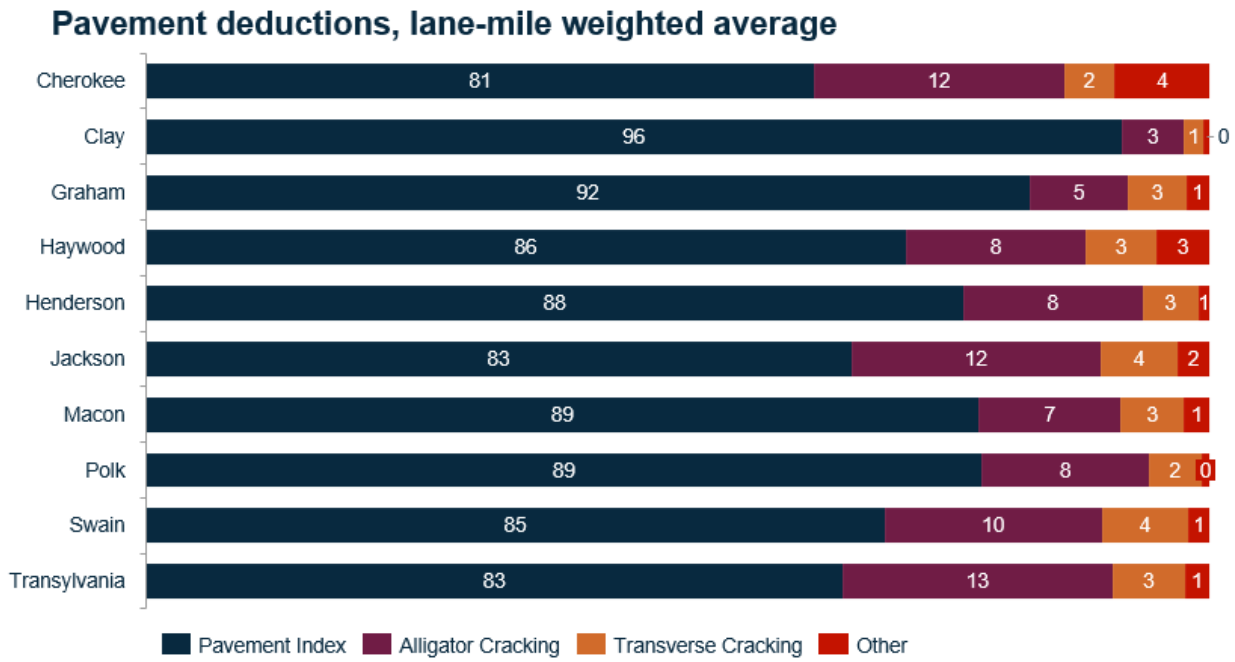


Figure 6 – Pavement index and deduction breakdown by county

Complementary models show similar assessments of pavement condition between the ArTEMIS model and the PCS model for Division 1. The pavement index utilizes the same scoring methodology as the PCS, the only differences being in how the data is collected/reviewed.

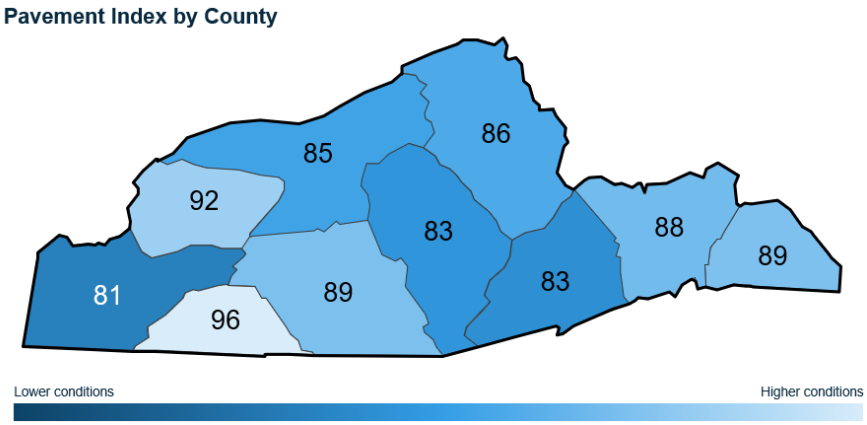


Figure 7 (shown on right) – Pavement index by county

Complementary models show similar assessments of pavement condition between the ArTEMIS model and the PCS model for Division 14. The pavement index utilizes the same scoring methodology as the PCS, the only differences being in how the data is collected/reviewed[viii].

	Condition			
Model	**Interstates**	**Primary**	**Secondary**	**Overall**
Pavement index (ArTEMIS)	96	83	87	87
Pavement condition score (PCS)	92	83	85	85

Table 4 – Condition comparison by pavement models for Division 14

2.3 Bridge Conditions

Bridge conditions are evaluated using a bridge index that translates general condition ratings (i.e., 1-9 scale) into a 100-point scale for easier comparison.

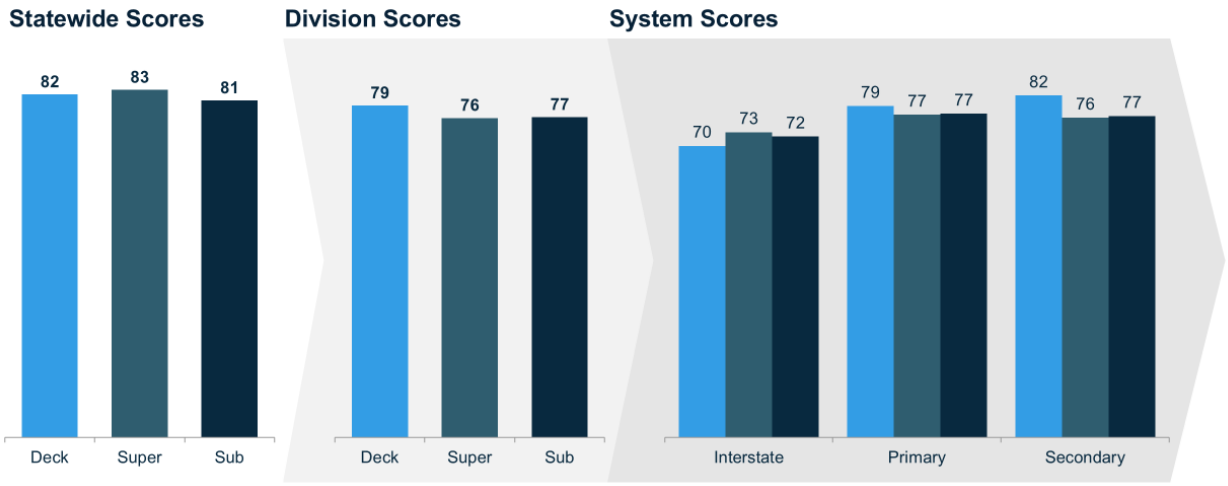


Figure 8.1 – Comparison of bridge deck, substructure, and superstructure conditions by system

Overall, the Division 14 bridge index (77) scores ~5 points lower than statewide bridge index (82). Data is ingested from FHWA bridge portal.

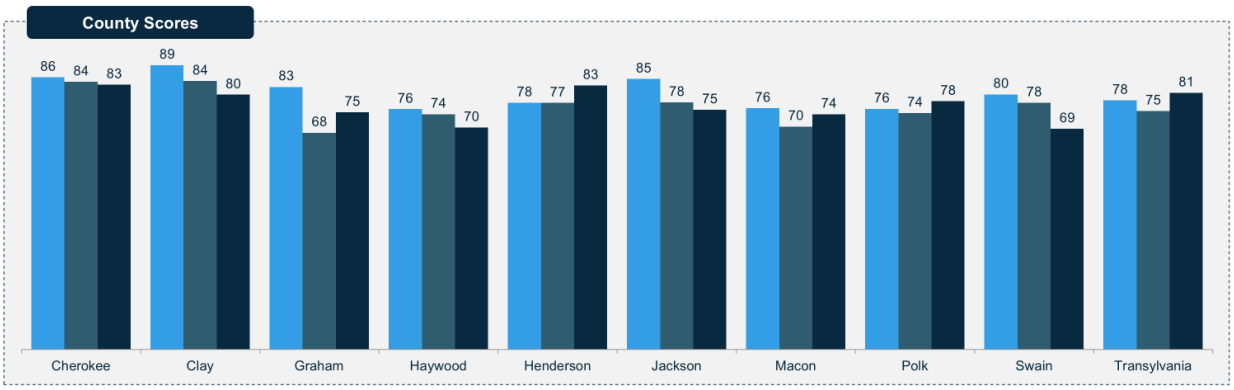


Figure 8.2 – Comparison of bridge deck, substructure, and superstructure conditions by county

The figure on the following page displays all bridges in poor condition (index below 60) or at-risk of becoming poor (index of 60 – 69). They are mostly on the secondary system. Each circle maps one bridge by latitude and longitude; circle size indicates deck area, with at-risk bridges sized uniformly.

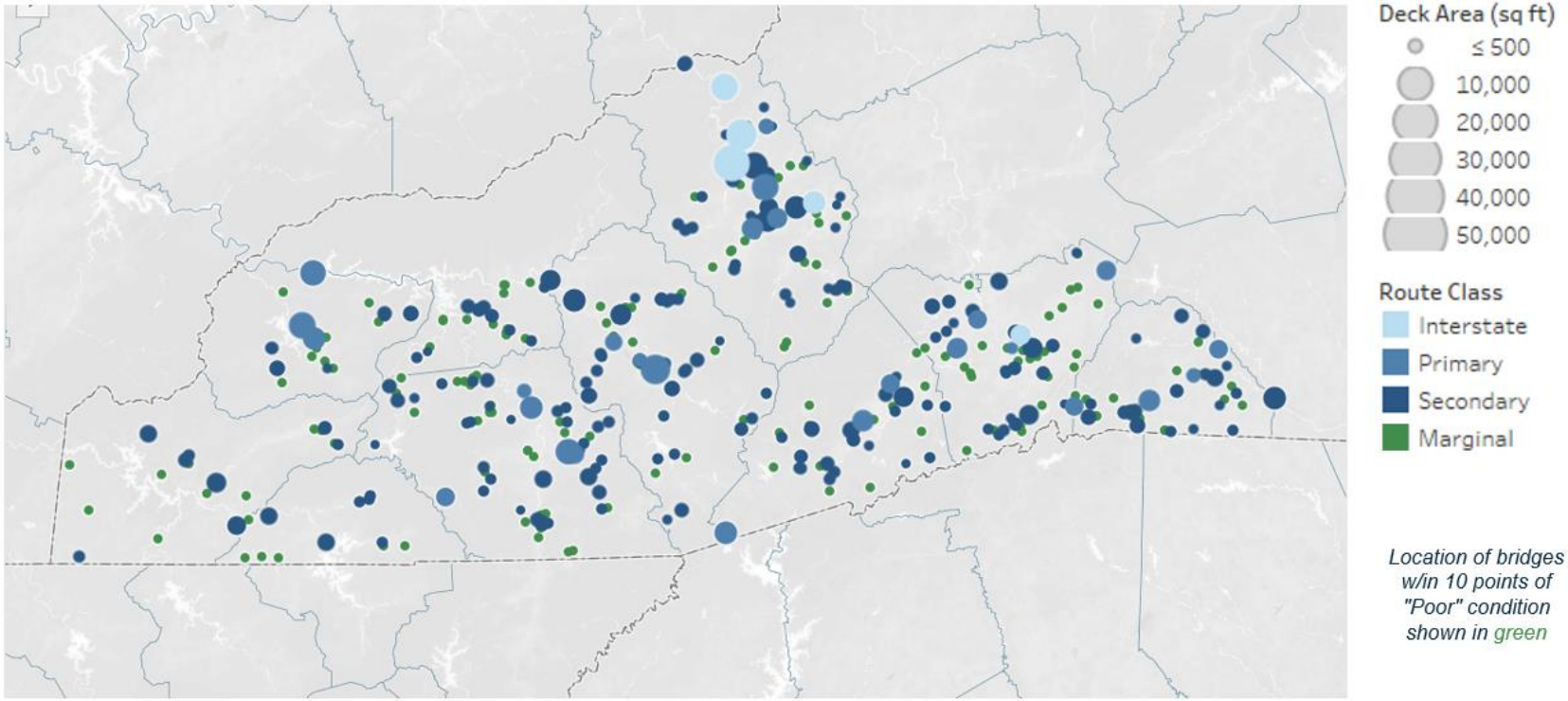


Figure 9– Distribution of poor bridges and at-risk of becoming poor condition bridges in Division 14

Figure 10 shows how timber bridges are distributed across Division 14, and their individual condition rating. Division 14 has 227 poor condition bridges, and 76% of these poor condition bridges are timber. Divisions 11, 13, and 14 have the highest number of bridges overall – timber bridges represent 40% of their combined inventory and 70% of their combined poor condition bridges.

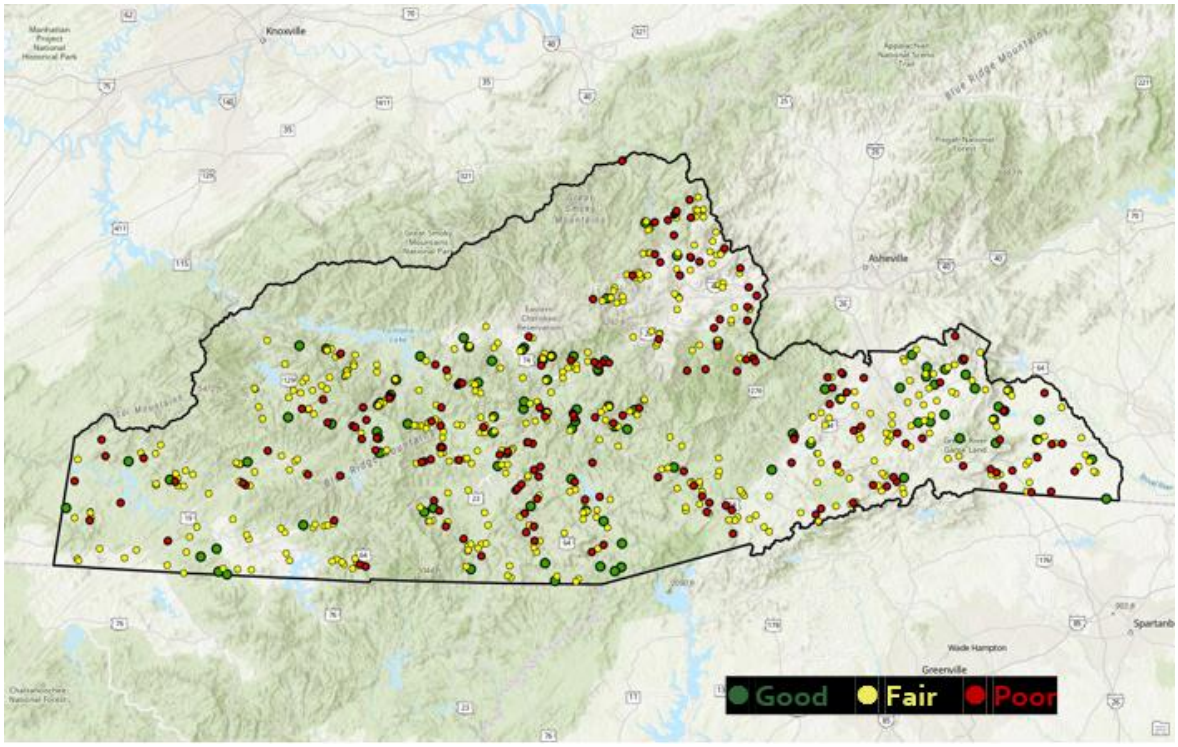


Figure 10 – Distribution and condition of timber bridges

2.4 Roadside Asset Conditions

Roadside asset condition is evaluated by measuring the proportion at which an asset is non-defective in a division, county, or route.

Asset	State	D14	Cherokee	Clay	Graham	Haywood	Henderson	Jackson	Macon	Polk	Swain	Transylvania
Striping	89%	78%	75%	80%	73%	75%	87%	78%	75%	79%	83%	72%
Bike Lanes	78%	26%	100%					20%			100%	
Word & Symbols	74%	66%	51%	52%	63%	64%	60%	80%	80%	69%	78%	56%
Sharrows	84%	79%	71%			100%	67%	82%	100%	100%	50%	
Signs	94%	93%	92%	94%	89%	93%	93%	93%	93%	92%	93%	92%
Drop Inlets	89%	87%	89%	95%	89%	86%	87%	85%	93%	82%	91%	83%
Curb & Gutter	96%	87%	92%	98%	70%	86%	82%	94%	93%	76%	95%	87%
Guardrails	98%	98%	99%	99%	98%	98%	98%	98%	98%	99%	98%	96%
Shoulder	98%	96%	96%	95%	97%	94%	96%	95%	95%	98%	95%	94%

Most Defective — Least Defective

Figure 11 – Comparison of conditions between county functional assets [ix]

Below is roadside asset condition visualized with county boundaries, where colors are relative to the average condition across the state, for each respective asset.

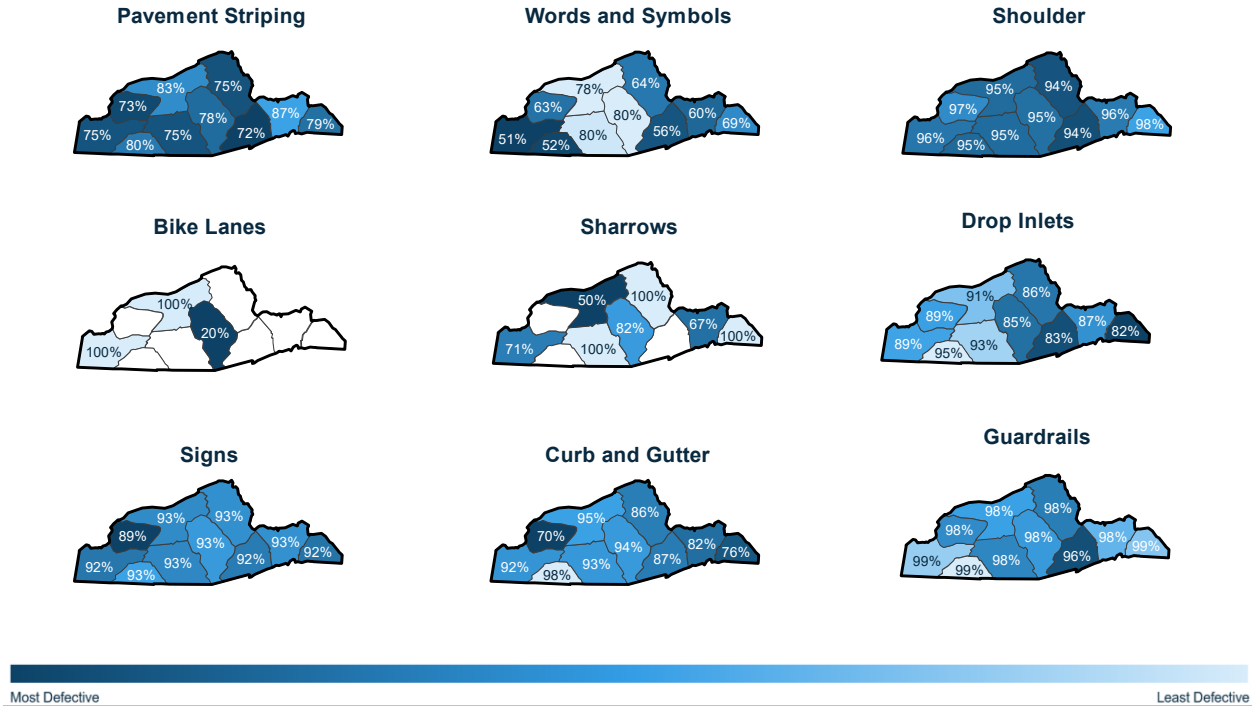


Figure 12 – Comparison of roadside asset conditions mapped to county boundaries

3 Rehabilitation / Rebuilding Needs

To develop a sense of what level of investment is required to ensure our state's ability to provide a safe and effective transportation network into the future, in the summer of 2024 the Director of Highway Operations reached out to all 14 Division Engineers and their teams, asking them to provide details on their highest priority ~35 miles of reconstruction/rehabilitation needs. The submitted sections for Division 14, along with estimated costs, are outlined below ranked in order of priority (as submitted).

Route	County	Comments	Miles	Est. Cost ($M)
US-74	Polk	Mill 3" & Fill inside and outside lanes. Add 10' emergency shoulder & upgrade guardrail to MASH standards	23.97	$601M
US-74WB	Haywood	Mill 3" & Fill inside and outside lanes. Upgrade guardrail to MASH standards	3.71	$101M
US-74WB	Haywood	Mill 3" & Fill inside and outside lanes. Upgrade guardrail to MASH standards	1.57	$76M
US-74EB	Haywood	Mill 3" & Fill inside and outside lanes. Upgrade guardrail to MASH standards	1.69	$20M
US-74EB	Haywood	Mill 3" & Fill inside and outside lanes. Upgrade guardrail to MASH standards	2.44	$57M
US-74EB	Haywood	Mill 3" & Fill inside and outside lanes. Upgrade guardrail to MASH standards	1.16	$42M
Total	-	-	**30.62**	**$897M**

Table 5 – Submitted rehabilitation / rebuilding priorities and estimated costs

4 Cost Summary

To inform the model of how conditions translate into maintenance investment needs, should-cost was collected – what should various maintenance activities cost? This is used to estimate costs for the most common maintenance treatments down to the activity level.

Highlighted below are the unique unit costs for assets in Division 14, where activity costs of more common treatments are weighted more heavily than less common treatments asset[x].

Weighted average unit costs by Division

Asset	UOM	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14
Bike Lanes	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Cablerail*	LFT	$2	$1	$2	$5	$1	$1	$3	$2	$0	$5	$2	$0	$2	$1
Concrete Barrier*	LFT	$500	$8	$3	$1,350	$16	$15	$3	$182	$163	$182	$6	$42	$25	$50
Pipes	LFT	$267	$379	$315	$479	$273	$275	$327	$462	$296	$378	$395	$90	$256	$345
Crosswalk	EA	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Curb and Gutter*	LFT	$102	$132	$125	$83	$112	$144	$117	$109	$78	$112	$93	$39	$90	$88
Drop Inlets*	EA	$811	$809	$1,363	$460	$974	$714	$865	$788	$830	$1,041	$794	$744	$1,361	$1,297
Guardrail*	LFT	$16	$30	$36	$12	$1	$49	$30	$31	$12	$32	$6	$32	$50	$21
Impact Attenuator*	EA	$2,500	$12,500	$5,000	$8,840	$2,707	$1,925	$17,500	$750	$1,704	$9,250	$2,028	$2,613	$10,250	$3,000
Induction Loop	LFT	$1,381	$726	$2,777	$1,695	$825	$1,358	$748	$1,486	$573	$3,097	$1,322	$2,144	$1,167	$1,308
Mile marker	EA	$129	$171	$172	$135	$440	$268	$168	$276	$285	$164	$427	$137	$143	$192
Pavement Striping*	LFT	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Ramp Metering	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Road Sign	EA	$309	$365	$232	$288	$613	$378	$379	$366	$462	$249	$581	$249	$293	$338
Shoulder	SHM	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Timber Rail	LFT	$44	$6	$49	$313	$13	$8	$2	$49	$44	$49	$3	$23	$23	$63
Traffic Signal	EA	$582	$310	$817	$547	$534	$627	$435	$754	$230	$489	$466	$504	$486	$356
Word and Symbols	LFT	$461	$244	$255	$591	$325	$652	$474	$373	$798	$350	$441	$397	$344	$495
Crack Seal	LM	$3,103	$4,000	$3,300	$3,409	$6,009	$2,100	$4,366	$4,000	$3,250	$6,000	$7,850	$4,366	$4,366	$5,000
Chip Seal	LM	$21,933	$18,625	$22,750	$17,014	$26,732	$53,875	$22,356	$49,000	$30,925	$17,500	$21,500	$22,902	$33,701	$32,500
Contract Resurfacing*	LM	$120,418	$140,000	$67,500	$96,025	$109,701	$92,500	$213,998	$97,500	$116,150	$185,000	$66,250	$87,184	$88,750	$151,250

Table 6 – Unit cost comparison between Divisions

[i] Condition and inventory data collected via ArTEMIS from January to September 2023; cost data collected from individual divisions and validated in February/March of 2024. Thus, funding scenarios outlined in this document were developed prior the impacts of Hurricane Helene & based on infrastructure condition data collected prior to the storm. As such, they do not account for the additional costs associated with the rehabilitation or reconstruction of infrastructure affected by the storm. Recognizing that rebuilding will entail significant expenses, the current scenarios focus on maintaining the regular operational budget and steady-state upkeep without reallocation of funds.

[ii] For calculating route score, "Words and Symbols" includes bike lanes, crosswalks, sharrows.

[iii] When aggregated, route scores are weighted by lane miles and route class.

[iv] Maintenance costs are estimated solely by prioritizing the most efficient and cost-effective maintenance activities in terms of impact on overall state/division route score, regardless of pre-existing plans, priorities, or ongoing projects.

[v] For these investment scenarios, we assume rates of inflation for labor, material, and equipment costs of 3%, 5%, and 8% respectively, per the 2023Q4 Engineering News-Record Cost Report. Costs for non-maintenance activities are assumed to increase at annual rate of 3%.

[vi] Spend to increase route score views pavement and roadside asset activities, only. Bridge activities that would increase score are currently not included. This may underestimate need when calculating need to improve by 10 pts.

[vii] Pipes are ingested into inventory counts via NCDOT survey

[viii] The pavement index assessment is consistent for every route and captures the entirety of the Division's inventory. At times, the asset detection algorithm powering the pavement index may miss light / moderate rutting.

[ix] Blank cells indicate that the asset type is not present in county and therefore excluded from analysis.

[x] Asterisk denotes predominately contracted activities. Guardrails, cable rails, timber rails, impact attenuators, curb and gutter, concrete barriers, and pavement markings are typically contracted out in D14. All cost data in this table were provided and validated by engineers from each division. Variations in costs may arise due to several factors, including the frequency of repairs, whether work is performed in-house or contracted out, and the defect severity at which interventions are initiated. For assets where specific cost data were unavailable, the average cost across all divisions was used. Data was collected and validated February - May 2024.