



2018 PAVEMENT CONDITION ANNUAL REPORT

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mn DEPARTMENT OF
TRANSPORTATION



Office of Materials and
Road Research

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INTRODUCTION

This report is prepared annually by the Minnesota Department of Transportation (MnDOT) Pavement Management Unit to provide information concerning trunk highway pavement performance. It discusses statewide performance trends compared with established targets and compares performance between the eight Area Transportation Partnerships (ATP).

BACKGROUND

MnDOT's trunk highway system consists of approximately 12,000 centerline miles of pavement. This system consists of bituminous, concrete, and composite pavement with a wide range of conditions, ages, and performance. Each year, the Pavement Management Unit collects pavement roughness and digital image data on the entire trunk highway system, in both directions, and calculates several different metrics related to pavement performance. Condition data has been collected on the trunk highway network since the late 1960s.

DATA COLLECTION

The pavement roughness and surface distress data are collected using a sophisticated digital inspection vehicle (shown below). The van is driven over every mile of trunk highway annually, in both directions. This van is equipped with two digital cameras, one facing straight ahead and one angling toward the right to collect right-of-way images. For pavement distress and rutting measurements, a 3D laser/camera system is used to produce images of the pavement surface, from which the type, severity, and amount of cracking can be determined. The van is also equipped with laser height sensors that measure the longitudinal pavement profile, from which pavement roughness is calculated. Pavement condition data is used to monitor the performance of the system, to aid in project selection, and to identify future pavement maintenance or rehabilitation needs.



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INDICES AND MEASURES

MnDOT's pavement condition data is reduced to several indices for reporting the statewide pavement performance measures in MnDOT's 20-year Transportation Plan: Ride Quality Index (RQI), Surface Rating (SR), Pavement Quality Index (PQI), and Remaining Service Life (RSL). Each index captures a different aspect of the pavement's health and can be used to rank pavement sections and predict the need for future maintenance and rehabilitation. They are each briefly described below.

RQI: Ride Quality Index

The RQI is MnDOT's ride, or smoothness, index. It uses a zero to five rating scale, rounded to the nearest tenth. The higher the RQI, the smoother the road is. The RQI is intended to represent the rating that a typical road user would give to the pavement's smoothness as felt while driving his/her vehicle. Most new construction projects have an initial RQI above 4.0. Pavements are normally designed for a terminal RQI value of 2.5. When a road has reached its terminal RQI value it does not mean the road cannot be driven on, but rather that it has deteriorated to the point where most people feel it is uncomfortable and a major rehabilitation is likely needed.

The RQI is calculated from the pavement's longitudinal profile, measured by the front mounted lasers on the digital inspection vehicle. A mathematical simulation, called the International Roughness Index (IRI), is then run to estimate the amount of vertical movement a standard vehicle would experience if driven down the road. The IRI is the roughness index used by every state DOT in the U.S. as well as most countries in the world. In the past, MnDOT has taken a rating panel of 30 to 40 people into the field and driven them over hundreds of test sections to get their perception of the smoothness of various pavement sections. Following right behind them was the digital inspection vehicle. This provides us with a direct correlation between the IRI, as measured by the van, and the perceived roughness, as felt by the rating panel.

SR: Surface Rating

Pavement distresses are those defects visible on the pavement surface. They are symptoms, indicating some problem or phenomenon of pavement deterioration such as cracks, patches, and ruts. The type and severity of distress a pavement has can provide great insight into what the future maintenance and/or rehabilitation needs will be.

MnDOT uses the SR to quantify pavement distress. The distress identification procedure used to determine the SR is done using computer workstations in the Pavement Management Unit of the Office of Materials and Road Research, located in Maplewood, MN. Specialized software is used to examine and analyze the digital images of the pavement captured by the van. The van captures several images simultaneously: front, side, and down.

Since 2017, condition surveys have been done using the AutoCrack system. The AutoCrack software looks at 3D images of the pavement surface and determines if any cracks or other distresses exist. If so, it then determines the location within the lane and also classifies distress by type and severity, and calculates length and/or width. A second system, called AutoClass, is then used to convert the AutoCrack distress types and severities into MnDOT distress types and severities. Because the system is automated, continuous distress surveys covering

100% of the length of each section are done. On undivided roadways, only the outside lane in the increasing direction (north or east) is rated when the SR is measured. On divided routes, the outside lane in both directions is rated.

The percentage of each distress in the section is determined and multiplied by a weighting factor to get a weighted distress value. The weighting factors are greater for higher severity levels of the same distress and greater for distress types that indicate more serious problems exist in the roadway such as alligator cracking or broken panels. The weighted distresses are then combined to determine the SR. The SR ranges from 0.0 to 4.0, and is reported to the nearest tenth. A higher SR means better condition. A road with no defects is rated at 4.0. A road in need of major rehabilitation or reconstruction will generally have an SR near or below 2.5.

PQI: Pavement Quality Index

The PQI is a composite index, equal to the square root of the product of RQI and SR. As such, it gives an overall indication of the condition of the pavement, taking into account both the pavement smoothness and cracking. The PQI is the index used to determine if the state highway system is meeting performance thresholds established for the Government Accounting Standards Board, Standard 34 (GASB 34).

RSL: Remaining Service Life

The RSL is an estimate, in years, until the RQI will reach a value of 2.5, which is generally considered the end of a pavement's design life. Most pavements will need some type of major rehabilitation when the RQI has reached this value. The RSL is determined from pavement deterioration curves. A regression curve is fit through the historical RQI data for each pavement section and the year the RQI will reach 2.5 is estimated. If there is insufficient historical data to make this calculation, default models, based on statewide pavement performance, are used. Rehabilitation activities with long service lives will add a considerable number of years to the RSL of a pavement. Short-term fixes, such as patching, may increase the pavement smoothness for a short time, but do not result in many additional years of RSL.

Each year, the RSL is calculated for all highway segments. From these values, a length-weighted Average Remaining Service Life (ARSL) is calculated for the entire trunk highway system as well as for each ATP. Service life is added when some type of maintenance or rehabilitation is done on a pavement section. Service life is lost when the condition of a pavement section deteriorates due to aging. The ARSL of the highway system increases if the projects being done add more life to the system than the sum of the deterioration of all the other sections.

PERFORMANCE CATEGORIES

MnDOT currently categorizes pavement condition, as measured by the RQI, into five equal categories as shown in Table 1. When reporting performance measures, the top two and bottom two categories are combined and referred to as "Good" and "Poor," respectively. These terms will be used for the remainder of this report.

Table 1. Ride Quality Index (RQI) Performance Categories

Descriptive Category	RQI Range	Performance Measure Category
Very Good	5.0 – 4.1	Good
Good	4.0 – 3.1	
Fair	3.0 – 2.1	Poor
Poor	2.0 – 1.1	
Very Poor	1.0 – 0.0	

PERFORMANCE TARGETS

For reporting statewide pavement conditions, MnDOT breaks the trunk highway system down into three systems: Interstate, Other-NHS, and Non-NHS. Each has its own set of targets.

In 2018, Minnesota’s trunk highway system mileage was comprised of 12.7 percent Interstate, 40.9 percent Other-NHS, and 46.4 percent Non-NHS. ATP-2 and ATP-8 do not have any roads on the Interstate system.

MnDOT’s targets for the Interstate system are 70 percent, or more, in “Good” condition and 2 percent, or less, in “Poor” condition. The targets for the Other-NHS system are 65 percent, or more, in “Good” condition and 4 percent, or less, in “Poor” condition. The targets for the Non-NHS system: 60 percent or more “Good” and 10 percent or less “Poor.” These are shown in Table 2.

The Federal Highway Administration (FHWA) definitions of “Good,” “Fair,” and “Poor” are different than what is described above. Since this document is not intended to be the official document regarding MnDOT’s pavement system with regard to the federal definitions and targets, the FHWA measures and targets will not be discussed in this report. That information can be obtained from MnDOT’s annual Highway Performance Monitoring System (HPMS) submittal.

RQI targets are based on the percent of miles in the “Good” and “Poor” categories as shown in Table 2. These are statewide targets. It is recognized that some ATPs’ pavements will be better than the targets and some will be worse. However, it is desirable to have the ATPs’ pavements in somewhat similar conditions so that the public will not encounter drastic differences as they drive throughout the state.

Table 2. Ride Quality Index (RQI) Targets by System

System	Ride Quality Index (RQI)	
	“Good” RQI Target	“Poor” RQI Target
Interstate	70 percent or more	2 percent or less
Other-NHS	65 percent or more	4 percent or less
Non-NHS	60 percent or more	10 percent or less

STATEWIDE HISTORICAL RQI TRENDS

In 2018, the smoothness of the state highway system declined slightly with 42 more miles in the “Good” category and 88 more miles in the “Poor” category, compared to 2017. Most of the change, was on the Non-NHS system with the other two systems changing very little.

2009-2018 “Good” RQI Trend (Figure 2)

The percent of statewide miles in “Good” condition in 2018 increased slightly, from 70.8 in 2017 to 71.1 percent in 2018. The Interstate system increased from 82.5 percent to 82.8 percent, the Other-NHS system decreased from 72.4 percent to 72.1 percent and the Non-NHS system increased from 66.3 percent to 67.0 percent. In 2018 there were 10,178 roadway miles in “Good” condition, 42 more miles than there were in 2017.

Based on the pavement projects listed in the 2019-2022 State Transportation Improvement Program (STIP), the percent of miles in “Good” condition on the Interstate system is expected to increase from its current value of 82.8 percent to 83.8 percent by 2022. The percent of miles in “Good” condition is expected to decrease on the Other-NHS system, from its current value of 72.1 percent to 70.3 percent. The Non-NHS system is also expected to have a reduction in the miles of roads in “Good” condition, from 67.0 percent to 65.4 percent. This results in an overall expected decrease of 202 miles of “Good” road over the next four years.

2009-2018 “Poor” RQI Trend (Figure 3)

Statewide, there was an increase in the amount of Poor roads in 2018, primarily due to an increase on the Non-NHS system. The Interstate system had 1.2 percent “Poor”, compared to 1.1 percent in 2017. The Other-NHS remained unchanged at 1.7 percent Poor. The Non-NHS system had an increase in “Poor” from 4.4 percent to 5.7 percent. In 2018 there were 502 roadway miles in Poor condition, roughly 88 more miles than there were in 2017.

Based on the pavement projects listed in the 2019-2022 STIP, all three systems are expected to worsen and have an increase in the percent of miles in “Poor” condition over the next four years. The Interstate system is expected to increase from 1.2 percent “Poor” to 1.9 percent. The Other-NHS system is expected increase from 1.7 percent “Poor” to 3.0 percent. The Non-NHS system is expected to increase from 5.7 percent to 5.9 percent. This results in an overall expected increase of 98 miles of “Poor” road over the next four years.

Once a pavement falls into the “Poor” category it normally will require major rehabilitation or reconstruction to restore any meaningful amount of service life. These types of repairs are expensive, thus making it much harder with a limited budget to recover once the amount of miles in this condition becomes very high.

RQI COMPARISON BY ATP

“Good” RQI Comparison (Figures 4, 6, 7 and 8)

On the Interstate system, three of the six ATPs with Interstate pavement had an increase in the number of miles in “Good” condition in 2018 while three had a decrease. All of the changes, however, were fairly small. ATP-3 had the largest increase (25 miles) while Metro had the largest decrease (21 miles). This is shown in Figure 4 and Figure 6.

On the Other-NHS system, half the eight ATP’s had an increase in the number of miles in “Good” condition and half a decrease. ATP-1 had the largest increase (34 miles) while Metro had the largest decrease (27 miles). This is shown in Figure 4 and Figure 7.

On the Non-NHS system, five ATP’s had an increase in the number of miles in the “Good” category while three had a decrease. ATP-8 had the largest increase (29 miles) followed closely by ATP-6 (25 miles). ATP-2 had the largest decrease with a loss of 32 miles in the “Good” category in 2018. This is shown in Figure 4 and Figure 8.

“Poor” RQI Comparison (Figures 5, 9, 10, and 11)

The Interstate system saw very little change in 2018, in terms of the amount of “Poor” roads. The biggest change was ATP-3 with 7 fewer miles in “Poor.” The rest had a very small increase or no change, compared to 2017. This is shown in Figure 5 and Figure 9.

The amount of “Poor” roads on the Other-NHS system was virtually the same in 2018, compared to 2017. Overall, there was 1 more mile in “Poor” condition in 2018. ATP-7 had the biggest change, with a reduction of 5 miles of “Poor” in 2018. This is shown in Figure 5 and Figure 10.

The amount of “Poor” roads on the Non-NHS system increased by 85 miles in 2018. ATP-7 had the largest increase (45 miles) followed by ATP-1 (21 miles). Only ATP-3 had a decrease in “Poor” roads in 2018 (12 miles). This is shown in Figure 5 and Figure 11.

AVERAGE REMAINING SERVICE LIFE (ARSL)

The Average Remaining Service Life (ARSL) is defined as the number of years until the RQI reaches a value of 2.5 or less. This is the point where most people begin to complain that a road’s roughness is objectionable and some type of major rehabilitation is likely needed.

2009-2018 ARSL Trend (Figure 12)

The 2018 ARSL was 15.9 years on the Interstate system, 10.6 years on the Other-NHS system, and 8.2 years on the Non-NHS. The ARSL of the Interstate system had a major increase, from 13.5 to 15.9 years, its highest level ever. The ARSL of the Other-NHS and Non-NHS systems remained nearly unchanged. The ARSL on the Other

NHS system increased from 10.4 to 10.6 years while the ARSL on Non-NHS system decreased from 8.4 to 8.2 years. This is shown in Figure 12.

Some of the increase in the RSL on the Interstate system can be attributed to a revised deterioration curve for unbonded concrete overlays. The revised curve, developed as part of the pavement investment guide, more accurately predicts longer expected life from unbonded overlays than the previous curve.

ARSL Comparison (Figure 13)

By ATP, the ARSL of the Interstate system ranges from 19.2 years (ATP-1 and 6) to 11.1 years (ATP-7). The ARSL of the Other-NHS system ranges from 12.0 years (ATP-3) to 9.1 years (ATP-7). The ARSL of the Non-NHS system ranges from 9.9 (ATP-6) to 5.3 (ATP-7). ATP-1 and 6 have the highest Interstate ARSL (19.2 years), ATP-3 has the highest Other-NHS ARSL (12.0 years), and ATP-6 has the highest ARSL on the Non-NHS (9.9 years). This is shown in Figure 13.

PREDICTED PAVEMENT CONDITIONS AND ACCURACY

Future year's pavement conditions are predicted using the pavement management system. These predictions are used to provide managers with insight into the impact different funding scenarios will have on pavement conditions. The accuracy of these predictions is reviewed yearly to reassure management that the pavement management system is operating correctly, therefore making it a reliable tool for predicting future needs.

The prediction of future pavement conditions relies on regression curves built into the pavement management system. The curves are either based on section specific historical data or statewide data. If there is adequate historical data since the last rehabilitation on a section, a regression curve is fit through the data and used to predict the RQI. If there is inadequate historical data for the section, or if the regression through the historical data results in an unrealistic curve, then a default curve is used to predict the future RQI. Default curves were developed for all pavement fixes in the pavement management system in the mid-1980s and subsequently updated in 1992 and 2008. The default curves are based on historical statewide performance. For pavement sections scheduled for work during the STIP, default regression curves are used to predict future conditions.

Table 3 compares the predicted 2018 pavement conditions, using last year's data, with the actual 2018 measured conditions.

Table 3. Comparison of Predicted 2018 and Actual 2018 RQI by System (percent of miles)

Interstate System RQI Category	Actual 2017 Data	Predicted 2018 Data *	Actual 2018 Data	Difference Actual vs. Predicted
Good RQI (RQI > 3.0)	82.5	83.2	82.8	-0.4
Poor RQI (RQI ≤ 2.0)	1.1	0.9	1.2	+0.3
Other-NHS System RQI Category	Actual 2017 Data	Predicted 2018 Data *	Actual 2018 Data	Difference Actual vs. Predicted
Good RQI (RQI > 3.0)	72.4	72.6	72.1	-0.5
Poor RQI (RQI ≤ 2.0)	1.7	1.7	1.7	0.0
Non-NHS System RQI Category	Actual 2017 Data	Predicted 2018 Data *	Actual 2018 Data	Difference Actual vs. Predicted
Good RQI (RQI > 3.0)	66.3	66.9	67.0	+0.1
Poor RQI (RQI ≤ 2.0)	4.4	5.0	5.7	+0.7

*Predictions based on the 2018-2021 STIP by 2017 M-Records

The actual 2018 conditions are very close to what they were predicted to be last year, with all predictions being within 1 percent of what was predicted. Differences between actual and predicted conditions can be attributed to one, or more, the following.

1. Construction projects being advanced, reducing “Poor” and increasing “Good”
2. Construction projects not completed, keeping “Poor” from becoming “Good”
3. Changes in the STIP, either advances, delays, or additions.
4. Maintenance work, keeping roads from falling into “Poor” or out of “Good”
5. A change in a road’s rate of deterioration (either faster or slower)
6. Unforeseen funding or projects, such as the IDIQ program, improving the road

GOVERNMENT ACCOUNTING STANDARDS BOARD, STATEMENT 34 (GASB 34)

The Government Accounting Standards Board (GASB), a private, nonprofit organization, was established in 1984 by the Financial Accounting Foundation. The Foundation oversees GASB, provides funding, and appoints the members of GASB’s board. The Foundation has a similar relationship with GASB’s sister organization, the private-sector, standard-setting Financial Accounting Standards Board. GASB’s span of influence covers over 84,000 state, county, and other local governmental units. Also impacted by GASB’s financial reporting standards are organizations such as public utilities, municipal hospitals, and state universities. GASB, which does not impact the federal government, establishes concepts and standards that guide the preparation of external financial reports. GASB establishes generally accepted accounting principles that are utilized by auditors charged with evaluating state and local government financial statements.

In June 1999, GASB established a new financial reporting standard that fundamentally changed the way state and local governments report their financial results. Among other provisions, GASB Statement 34 (GASB 34), “Basic Financial Statements—and Management’s Discussion and Analysis—for State and Local Governments,” requires that major infrastructure assets acquired or having major additions or improvements in fiscal years

beginning after June 15, 1980, be capitalized in financial statements. In addition, the cost of using the assets must be reflected. Source: U.S. Department of Transportation, Federal Highway Administration, Office of Asset Management, Primer: GASB 34 (November 2002).

One of the primary purposes of GASB 34 is to demonstrate to the public, and others, that the agency is maintaining its infrastructure in an acceptable condition and does not have any undisclosed liabilities looming in the future.

In terms of determining the cost of using the assets, GASB 34 allows governments to report either a depreciation expense or to apply an alternative modified/preservation approach. Governments may use the modified approach in lieu of depreciating their assets if they have a systematic approach to managing their assets that, at a minimum, meets the following four requirements:

- Having a current inventory of eligible assets
- Documenting the condition of those assets via a reproducible assessment procedure
- Demonstrating that assets are being preserved at a level predetermined by the government
- Estimating the actual cost to maintain and preserve the assets.

MnDOT has chosen to use the modified/preservation approach since it can meet all the requirements listed above. For the purposes of GASB 34, MnDOT established that the state highway system will be maintained, at a minimum, at the following levels.

- Principal Arterial System: Average PQI of 3.0 or higher
- Non-Principal Arterial System: Average PQI of 2.8 or higher

Figure 14 shows how actual and predicted pavement conditions, based on the 2019-2022 STIP, compare with the established GASB 34 levels.

As shown in Figure 14, both the PA and NPA systems are expected to be safely above the GASB 34 minimum thresholds throughout the entire STIP.

ADDITIONAL INFORMATION

Additional information about the condition and performance of the state highway system, including color-coded maps of the most recent indices, can be obtained from the Pavement Management Unit's website: <http://www.dot.state.mn.us/materials/pvmtgmt.html>

Or by contacting:

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dave.janisch@state.mn.us

Figure 1. MnDOT's Area Transportation Partnership (ATP) Boundaries

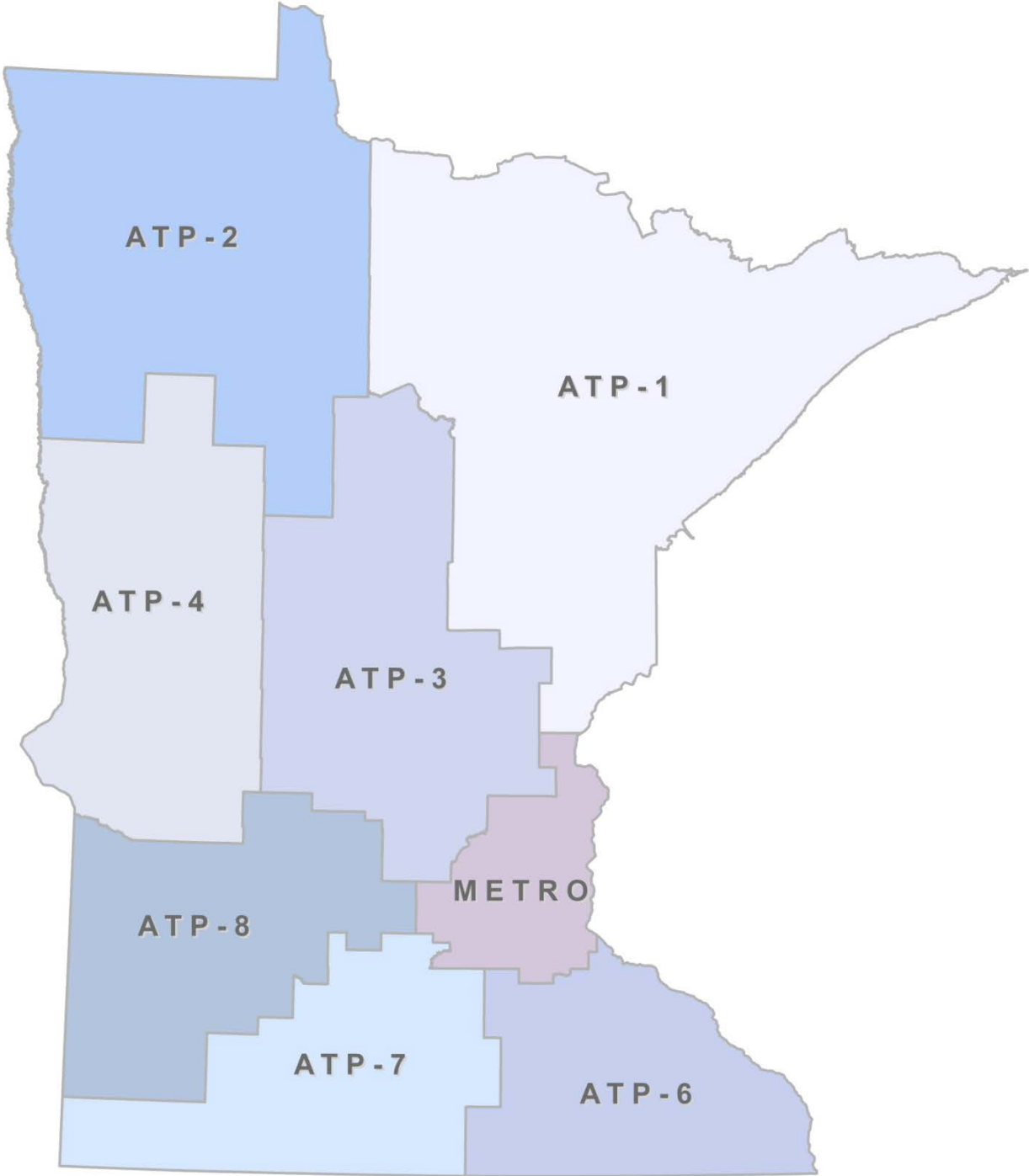


Figure 2
Statewide "Good" Ride Quality Index
 (percent of roadway miles with an RQI greater than 3.0)
 Actual 2009-2018, Predicted 2019-2022

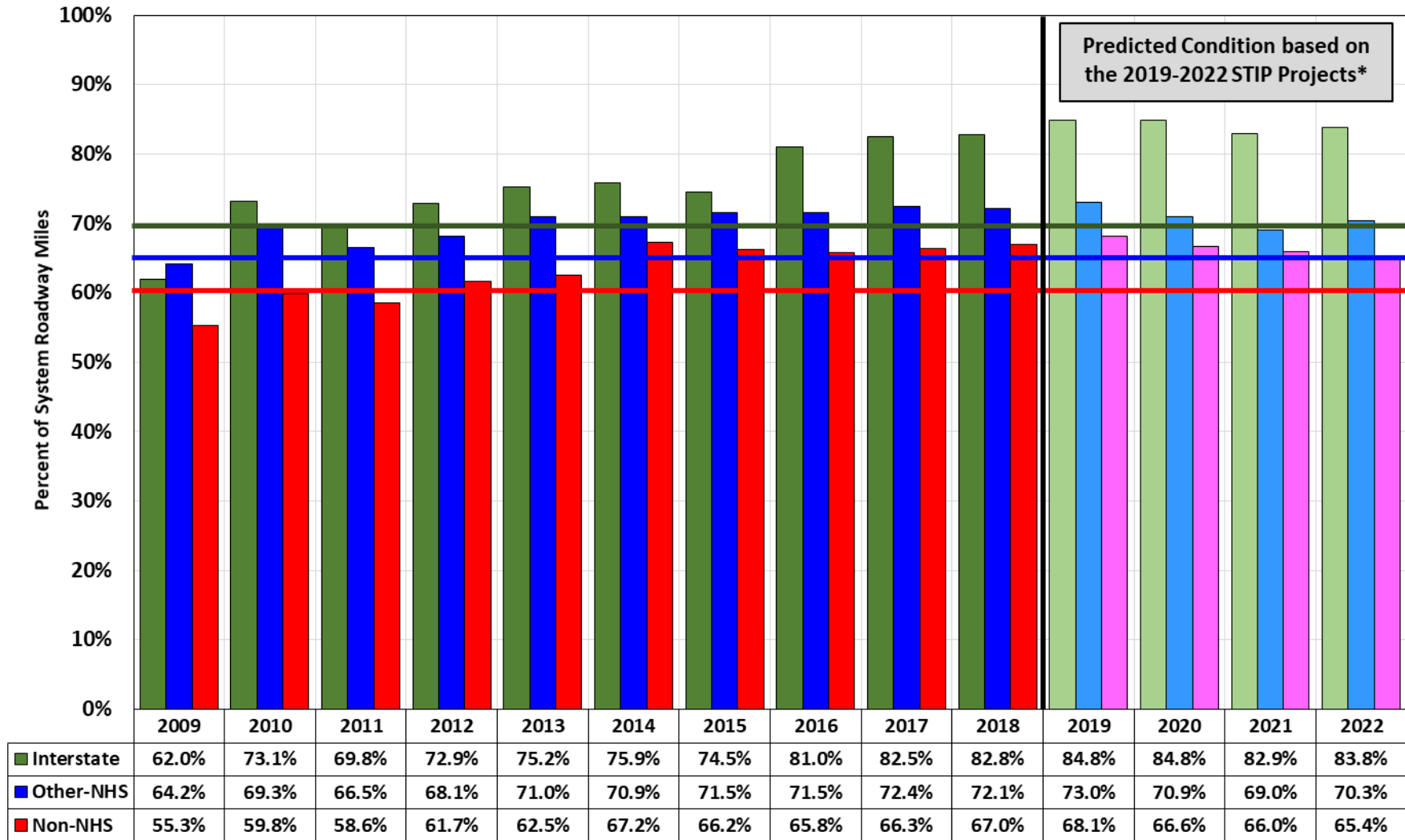


Figure 3
Statewide "Poor" Ride Quality Index
 (percent of roadway miles with an RQI of 2.0 or less)
 Actual 2009-2018, Predicted 2019-2022

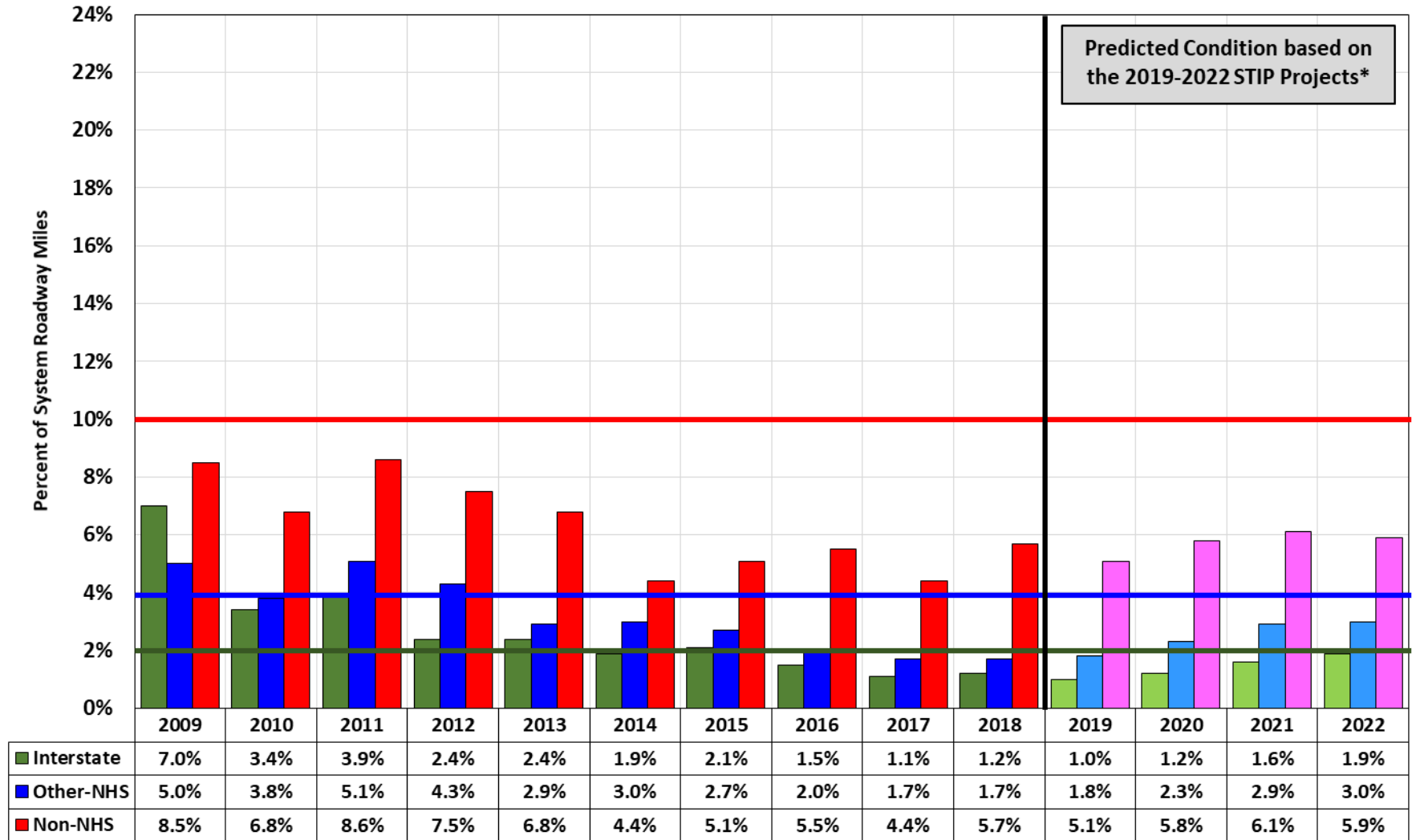


Figure 4 "Good" Ride Quality Index

(percent of roadway miles with an RQI greater than 3.0)

Comparison of 2018 Data by ATP

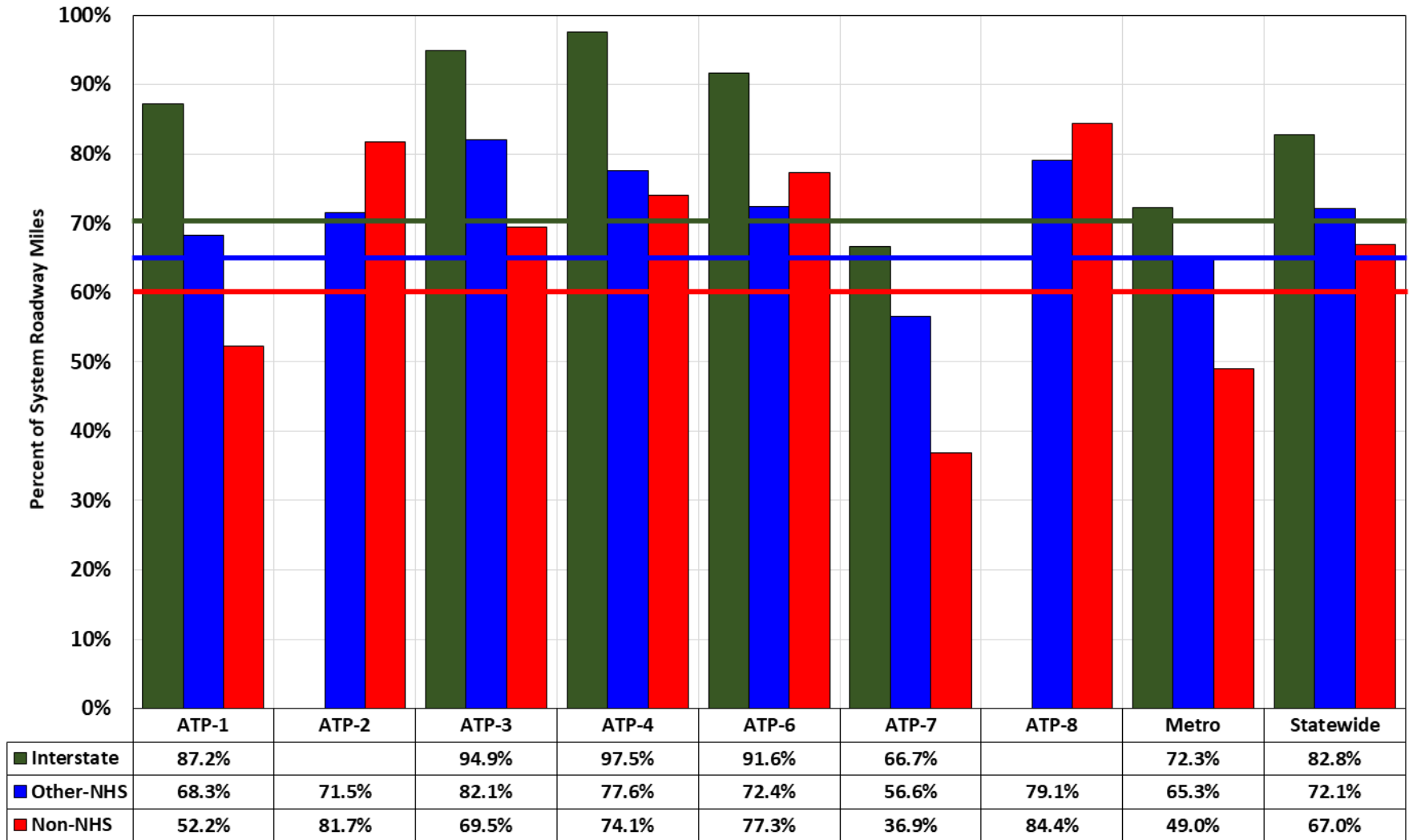


Figure 5
"Poor" Ride Quality Index
 (percent of roadway miles with an RQI of 2.0 or less)
 Comparison of 2018 Data by ATP

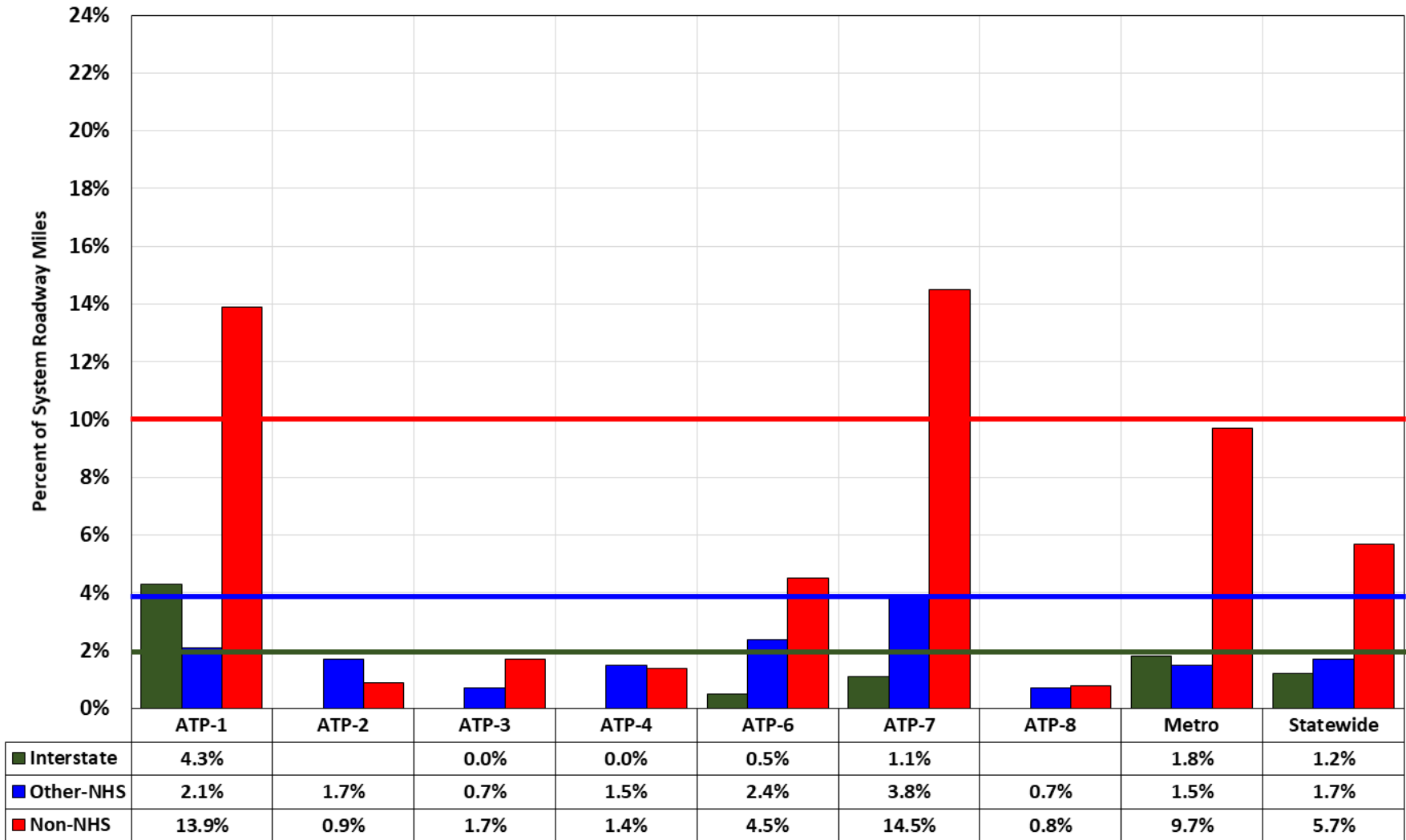


Figure 6
Comparison of "Good" Ride Quality Index
 (roadway miles with an RQI greater than 3.0)
Interstate System, 2017 -vs- 2018 Condition

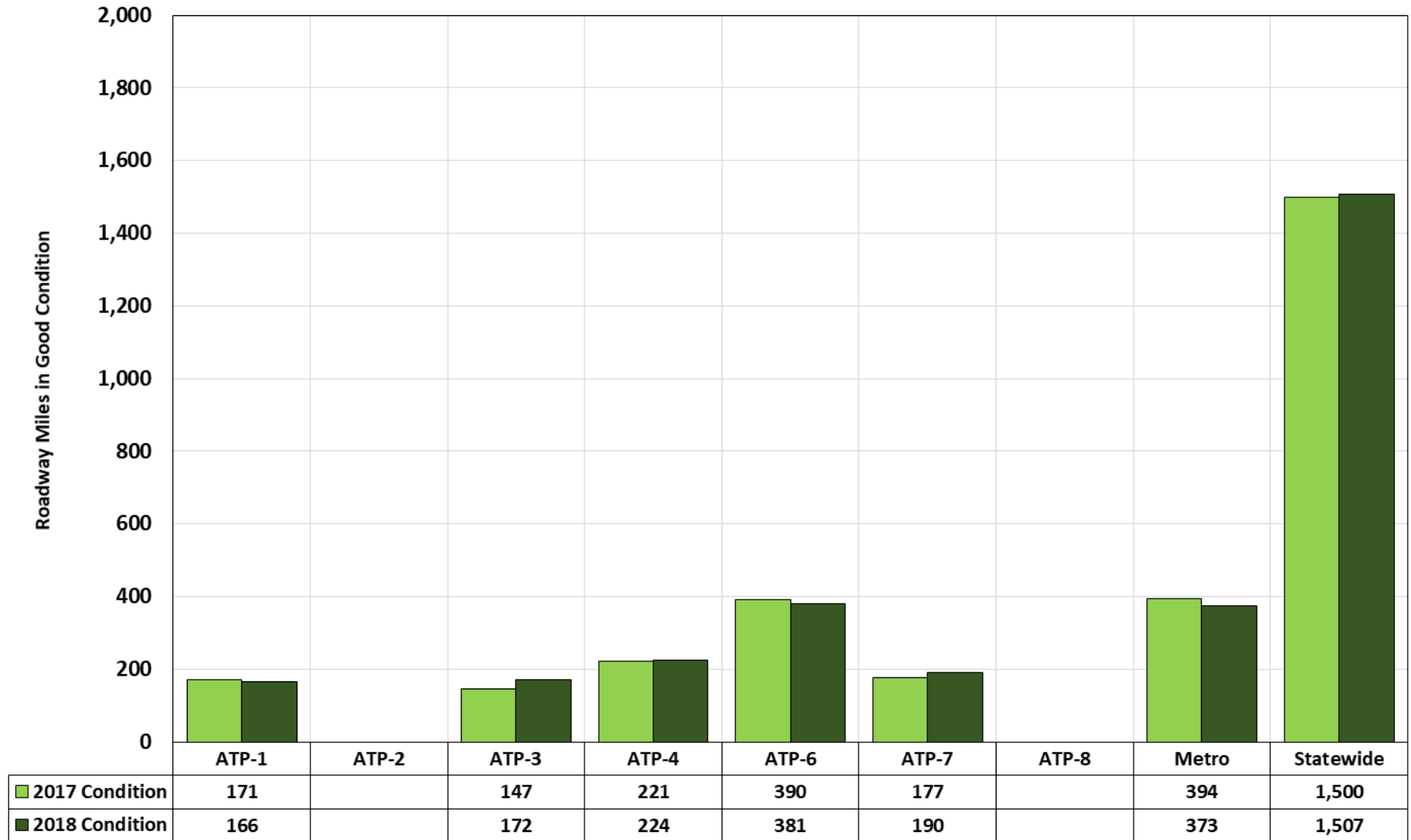
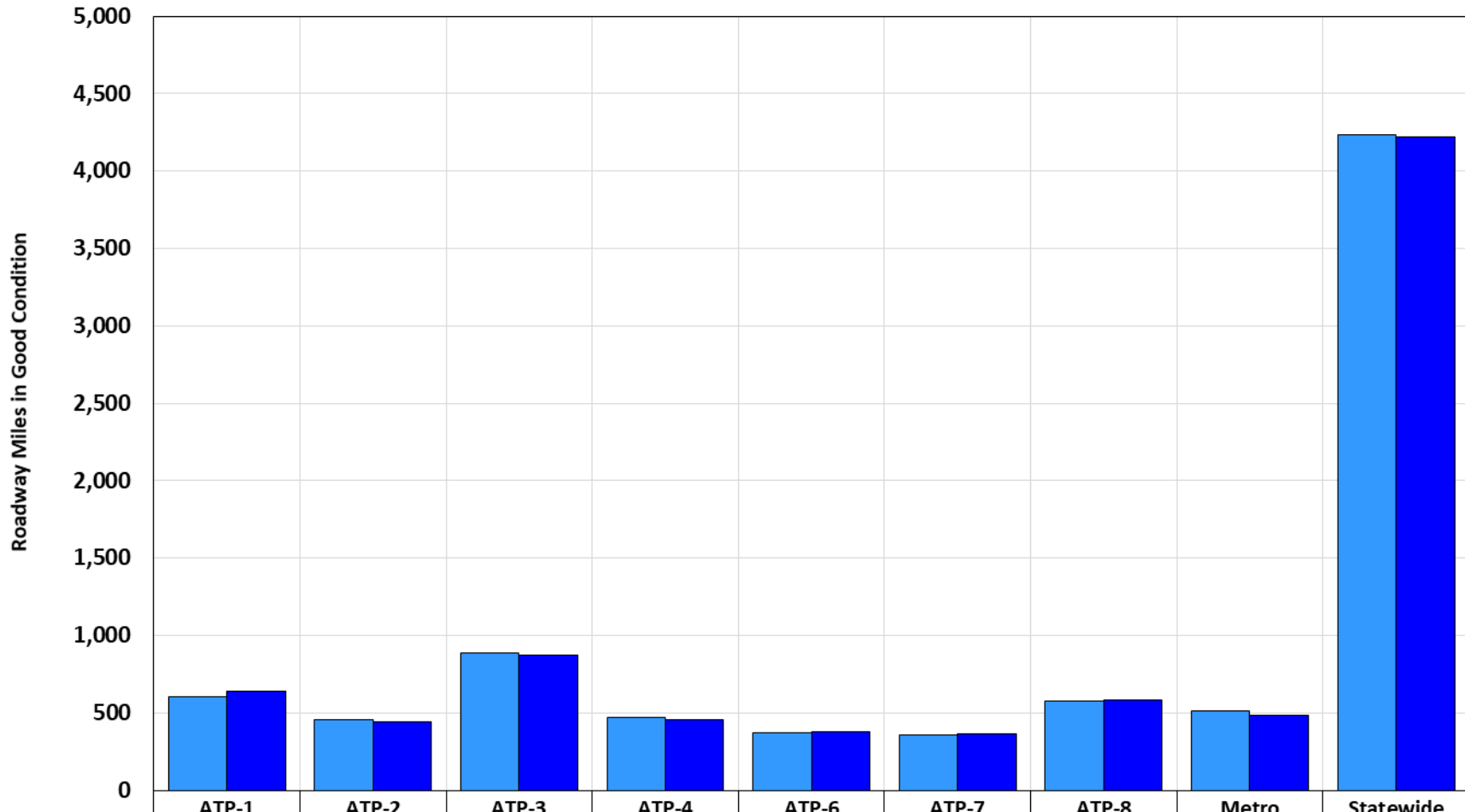


Figure 7
Comparison of "Good" Ride Quality Index
 (roadway miles with an RQI greater than 3.0)
Other-NHS System, 2017 -vs- 2018 Condition



2017 Condition	606	455	885	468	374	355	574	513	4,231
2018 Condition	640	442	874	454	376	364	583	486	4,220

Figure 8
Comparison of "Good" Ride Quality Index
 (roadway miles with an RQI greater than 3.0)
Non-NHS System, 2017 -vs- 2018 Condition

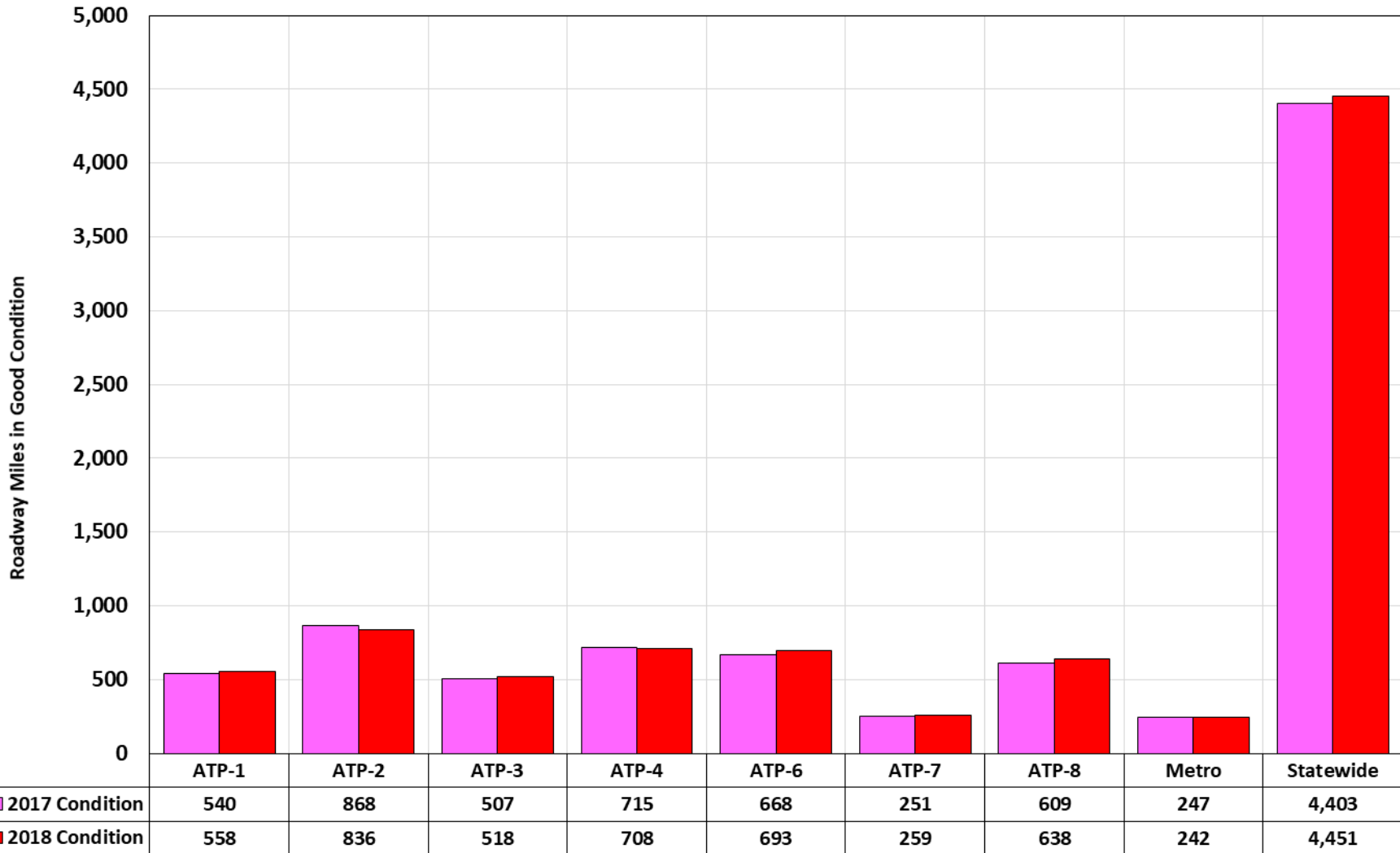
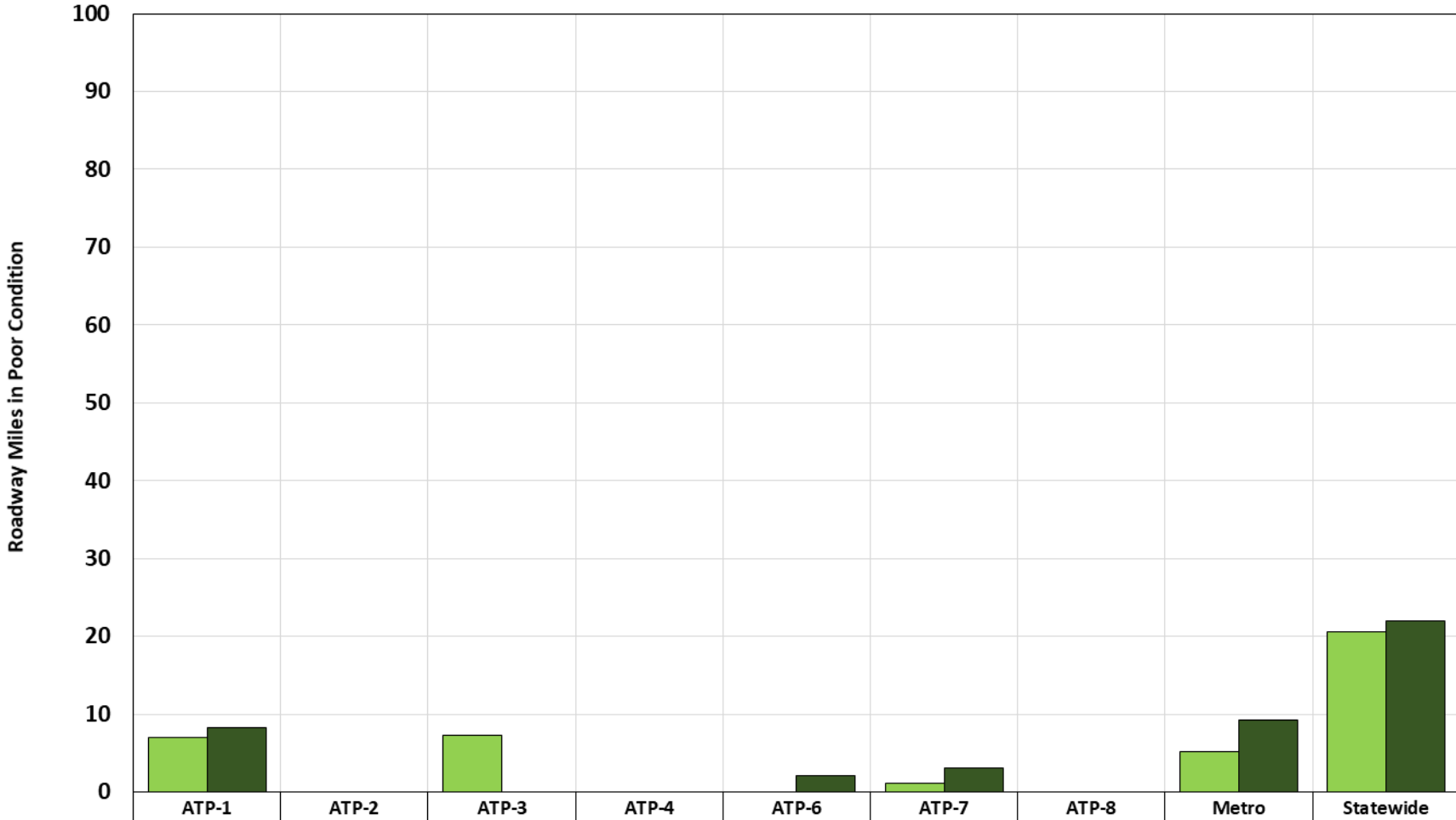
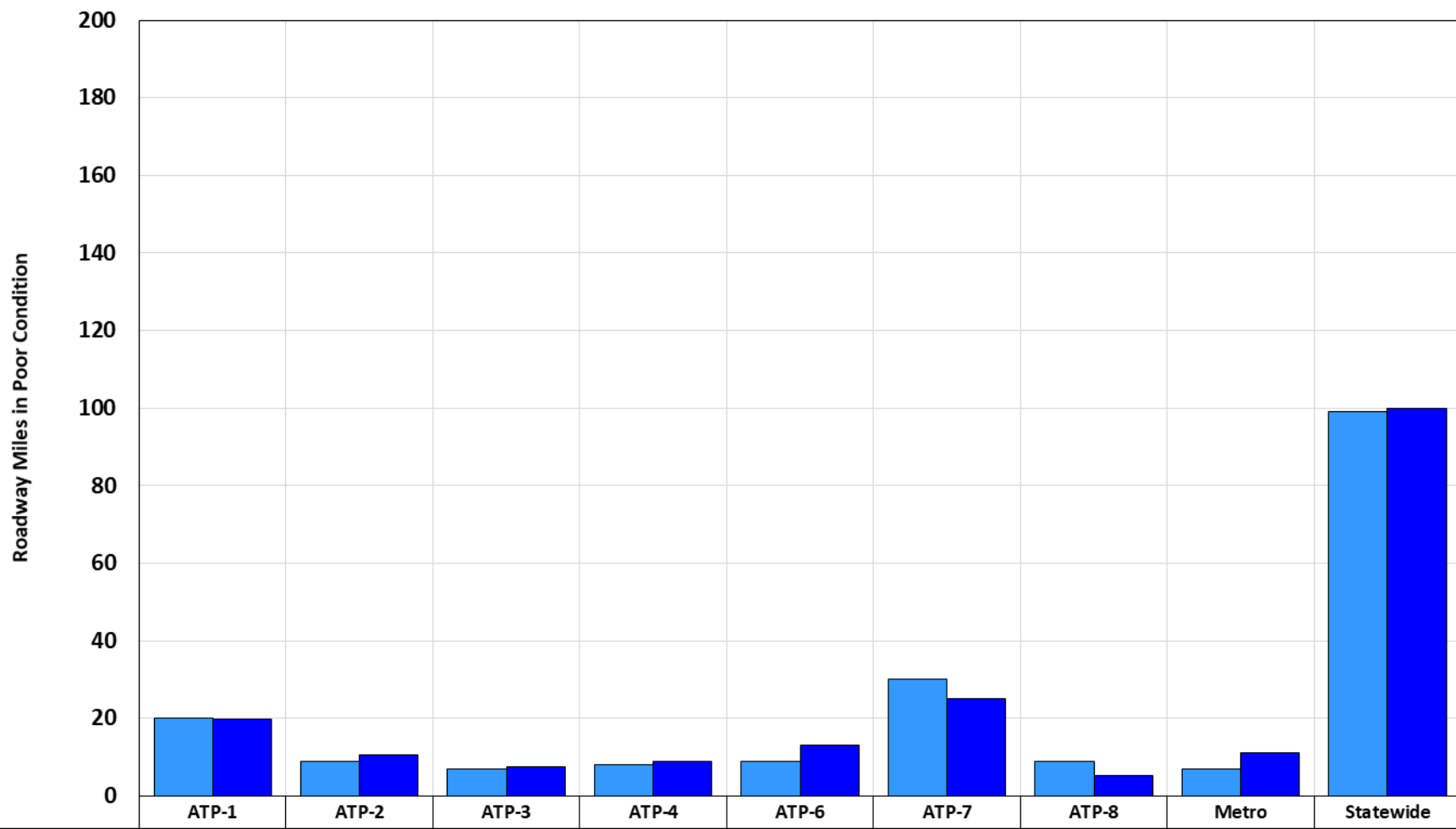


Figure 9
Comparison of "Poor" Ride Quality Index
 (roadway miles with an RQI of 2.0 or less)
Interstate System, 2017 -vs- 2018 Condition



2017 Condition	7		7	0	0	1		5	21
2018 Condition	8		0	0	2	3		9	22

Figure 10
Comparison of "Poor" Ride Quality Index
 (roadway miles with an RQI of 2.0 or less)
Other-NHS System, 2017 -vs- 2018 Condition



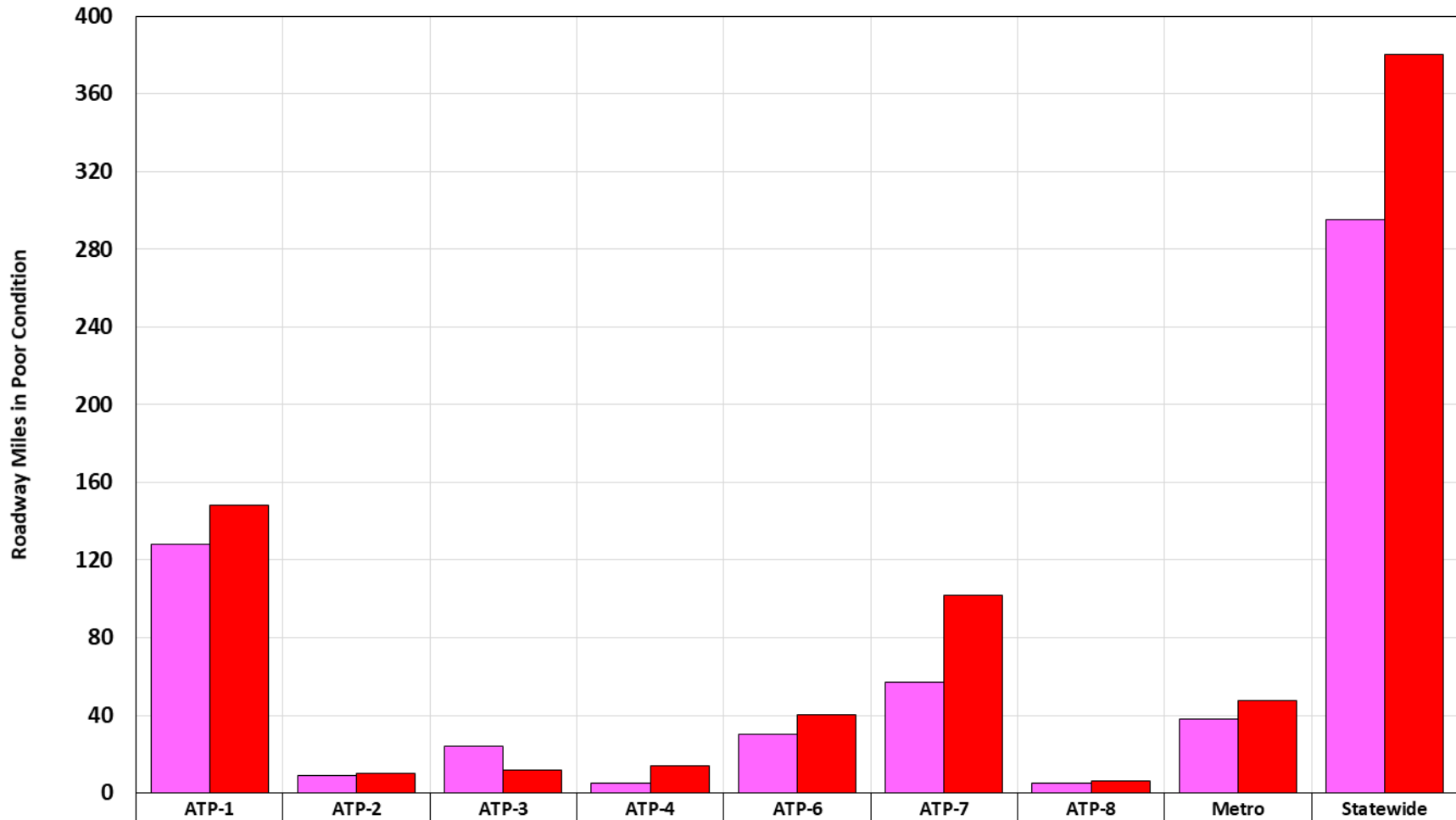
2017 Condition	20	9	7	8	9	30	9	7	99
2018 Condition	20	11	7	9	13	25	5	11	100

Figure 11

Comparison of "Poor" Ride Quality Index

(roadway miles with an RQI of 2.0 or less)

Non-NHS System, 2017 -vs- 2018 Condition



2017 Condition	128	9	24	5	30	57	5	38	295
2018 Condition	148	10	12	14	40	102	6	48	380

Figure 12
Statewide Average Remaining Service Life (ARSL)
 (years until RQI is predicted to reach 2.5, assuming no future work is done)
 Actual 2009-2018 data

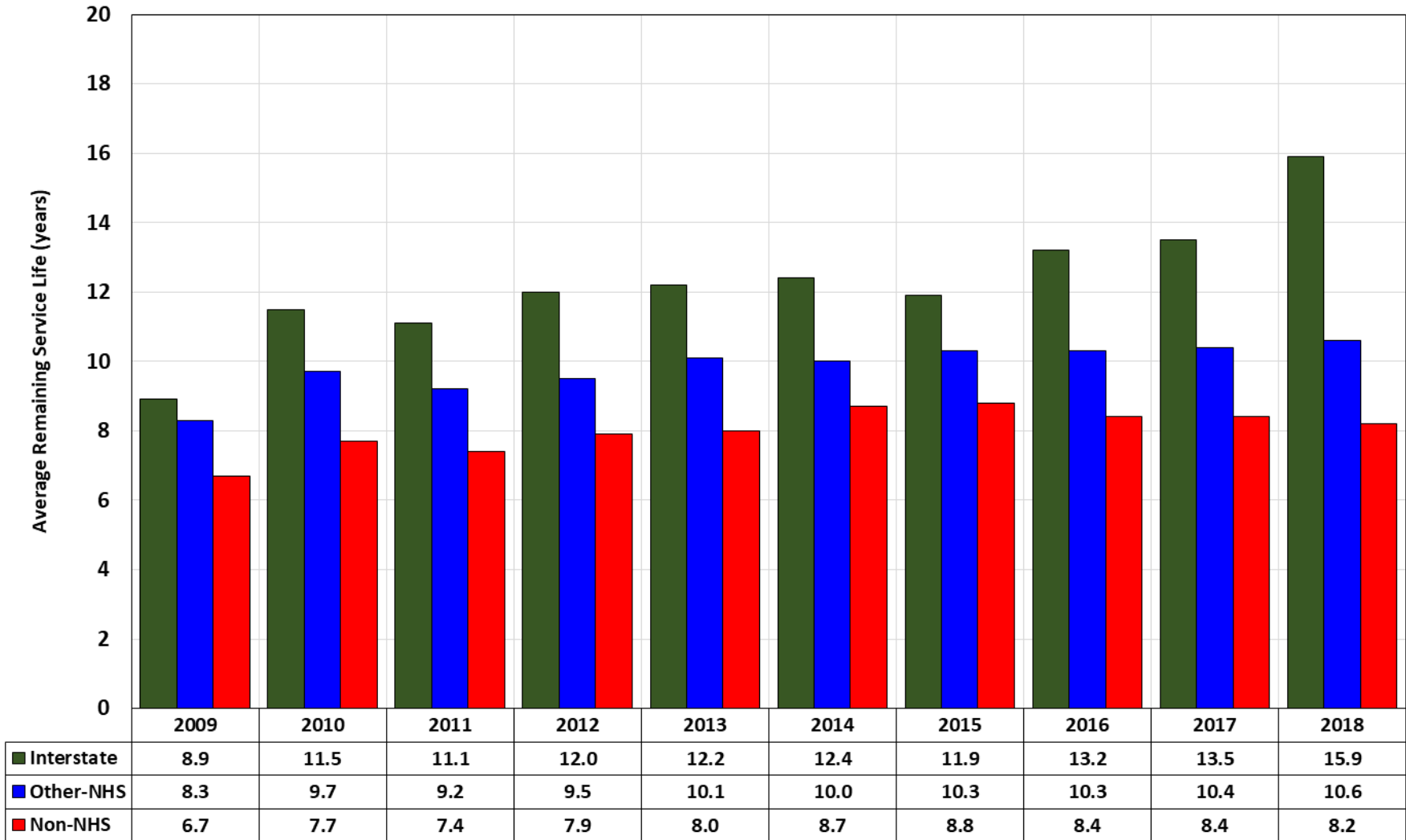
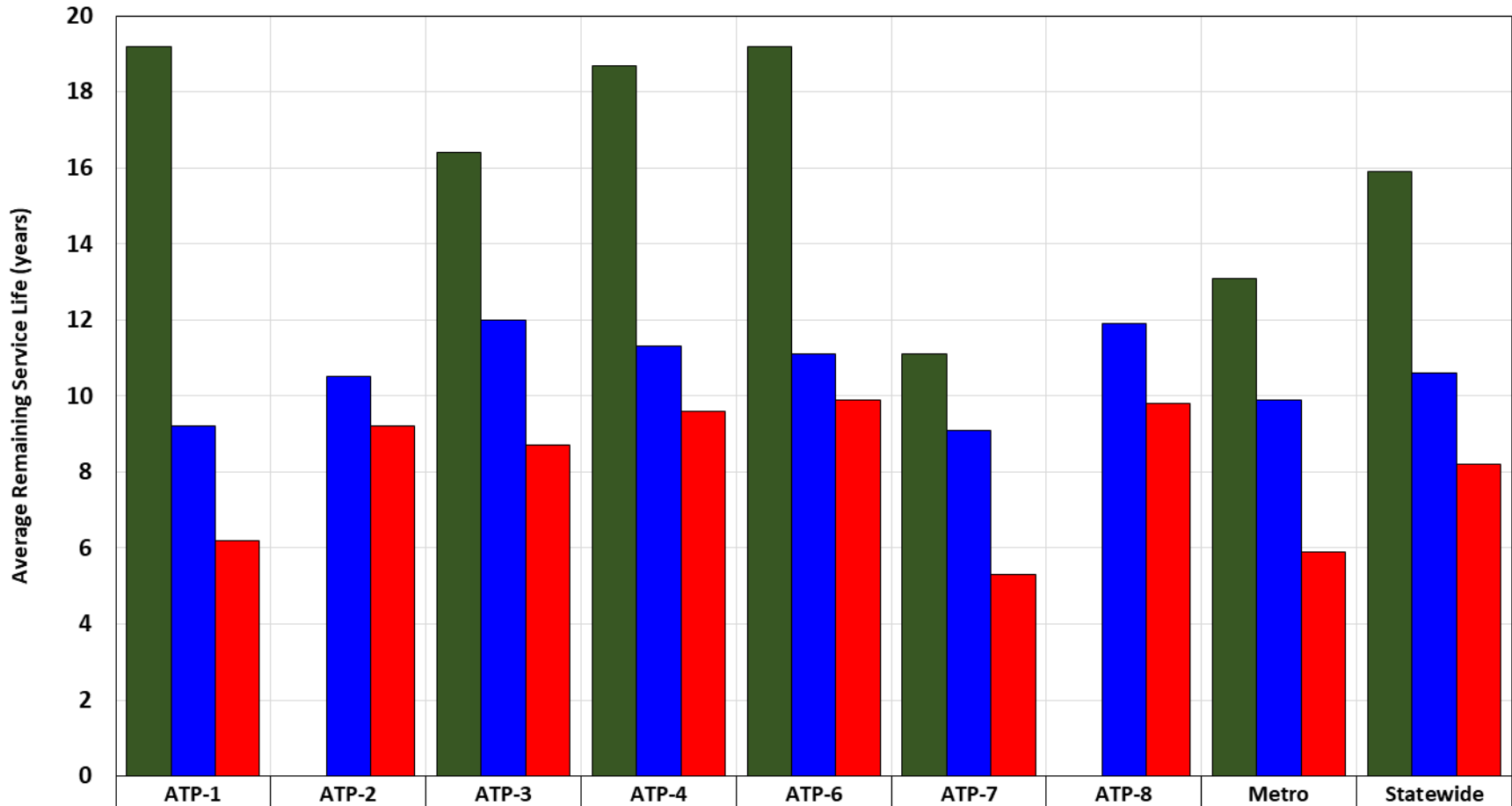


Figure 13
Average Remaining Service Life (ARSL)
 (years until RQI is predicted to reach 2.5, assuming no future work is done)
 Comparison of 2018 Data by ATP



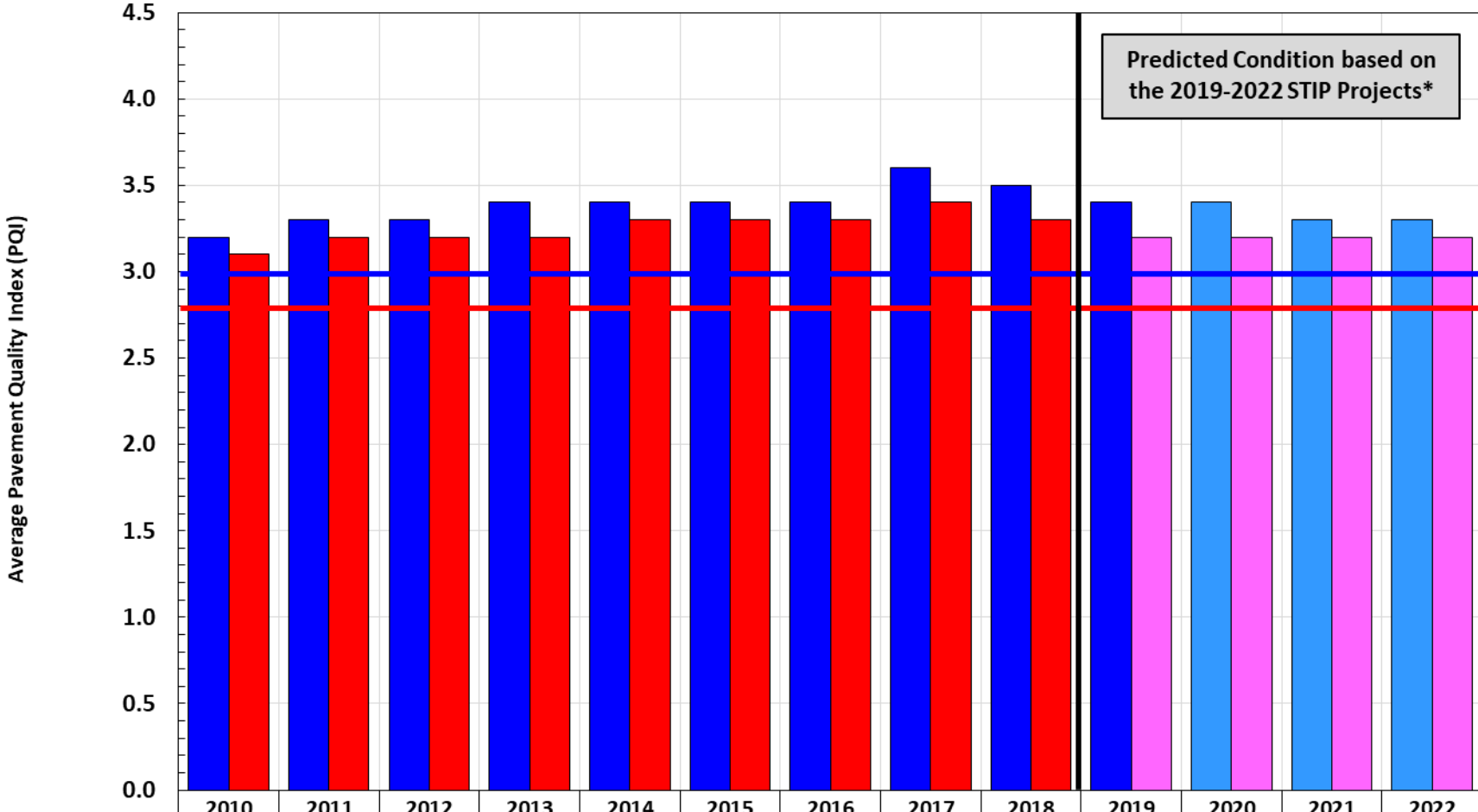
■ Interstate	19.2		16.4	18.7	19.2	11.1		13.1	15.9
■ Other-NHS	9.2	10.5	12.0	11.3	11.1	9.1	11.9	9.9	10.6
■ Non-NHS	6.2	9.2	8.7	9.6	9.9	5.3	9.8	5.9	8.2

Figure 14

Statewide Average Pavement Quality Index (PQI)

for GASB 34 Reporting

(PQI = Combined Index of Pavement Smoothness and Cracking)



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
■ Principal Art.	3.2	3.3	3.3	3.4	3.4	3.4	3.4	3.6	3.5	3.4	3.4	3.3	3.3
■ Non-Principal Art.	3.1	3.2	3.2	3.2	3.3	3.3	3.3	3.4	3.3	3.2	3.2	3.2	3.2