2007
Pavement Condition
Executive Summary

EXECUTIVE SUMMARY

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Table of Contents

List of Tables

List of Figures

INTRODUCTION

This report is prepared annually by the Minnesota Department of Transportation (Mn/DOT) Pavement Management Unit to provide information concerning trunk highway pavement performance. It briefly discusses statewide performance trends and how they compare with established targets. In addition, comparisons are made between the eight Area Transportation Partnerships (ATP) used in statewide planning.

The two indices used to measure pavement performance in Mn/DOT's 20-year Transportation Plan are the Ride Quality Index (RQI), a measure of pavement smoothness, and Remaining Service Life (RSL), an estimate of the time until the pavement will reach the end of its design life and require major rehabilitation.

BACKGROUND

Mn/DOT's trunk highway system consists of approximately 11,900 centerline miles of pavement. This system consists of bituminous, concrete, and composite pavement with a wide range of condition, age, 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 surface distress quantities on approximately 60% of the system.

DATA COLLECTION

The pavement roughness and surface distress data (cracks, ruts, faults, etc.) are collected using a sophisticated digital inspection vehicle (shown to the right). This van films the pavement surface using four digital cameras, one looking straight ahead, one looking to the side and two looking straight down. The two down-looking cameras are used to evaluate the pavement surface distress. In addition to the cameras, the van is equipped with lasers that measure the longitudinal pavement profile, from which pavement roughness, rutting, and faulting are calculated. In 2005, a brand new van was put into service. This new van uses an improved rut measurement system. In 2006 and 2007, all eight districts were tested with this new van.

Pavement condition data is used to monitor the performance of the system, to help in the selection of projects, and identify pavements that need future maintenance and/or rehabilitation.

Mn/DOT PAVEMENT CONDITION INDICES and MEASURES

Mn/DOT's pavement condition data is reduced to two indices for reporting the statewide pavement performance measures: Ride Quality Index (RQI) 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 to predict future maintenance and rehabilitation needs. They are briefly described below.

RQI: Ride Quality Index

The RQI is Mn/DOT'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 slightly over 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 a point where most people feel it is uncomfortable and a major rehabilitation is needed.

The RQI is calculated by converting the International Roughness Index (IRI) measured by the digital inspection vehicle. The van measures the longitudinal profile of the pavement using the front mounted lasers. A mathematical simulation is then done 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, Mn/DOT has taken a rating panel of 30 to 40 people out in 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 physical roughness, as measured by the van, and the perceived roughness, as felt by the rating panel.

RSL: Remaining Service Life

The RSL is an estimate, in years, until the RQI will reach a value of 2.5, generally considered to be the end of a pavement's design life. Most pavements will need some type of major rehabilitation or reconstruction when the RQI has reached this value. The RSL is determined from pavement deterioration curves applied to the current data. A curve is fitted through the historical RQI data for each pavement section and the year the RQI will reach 2.5 is estimated. If there is inadequate 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, although they may increase the pavement smoothness for a short time, 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. The ARSL provides a measure of whether the fixes being applied to the trunk highway system are mostly long-term or short-term.

PERFORMANCE CATEGORIES

Mn/DOT 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 will be referred to as "Good" and "Poor", respectively, for the remainder of this report.

Table 1. 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	2.0 - 1.1	Poor
Very Poor	1.0 - 0.0	

PERFORMANCE TARGETS

Using the traffic functional class designation of each segment of highway, all pavements sections are assigned to one of two traffic functional groups, Principal Arterial (PA) or Non-Principal Arterial (NPA) when reporting statewide pavement performance measures. The Interstate system is considered to be part of the PA system. The current trunk highway system mileage is comprised of 53% PA and 47% NPA.

Performance targets have been established based on historical RQI values for both functional groups as shown in Table 2. The RQI targets are based on the percent of miles in the "Good" and "Poor" categories as described below.

Table 2. Ride Quality Index (RQI) Targets by Functional Group

Functional Group	Ride Quality Index (RQI)	
	"Good" RQI (RQI > 3.0)	"Poor" RQI (RQI <= 2.0)
Principal Arterial	70% or more	2% or less
Non-Principal Arterial	65% or more	3% or less

STATEWIDE HISTORICAL RQI TRENDS

Statewide, the smoothness of both the PA and NPA systems, as measured by the RQI, declined in 2007 meaning that the roads are rougher than they were last year.

1998 - 2007 "Good" RQI Trend (Figure 2)

The percent of miles on the PA system in "Good" condition in 2007 was 66.3%, below the target of 70% or more. The percent of miles on the NPA system in "Good" condition was 59.1%, below the target of 65% or more. This marks the 5th straight year the PA system has not met the "Good" RQI target and the 6th year the NPA system has not met the target. This is also the first time since 2003 that the percent of miles in "Good" condition decreased on both systems in the same year.

The amount of pavement work planned for 2008 through 2011 is not expected to turn things around. Based on the pavement projects in the 2008 – 2011 State Transportation Improvement Program (STIP), the percent of miles in the "Good" RQI category is expected to decrease on both the PA and NPA systems. The percent of miles in "Good" condition is expected to decrease to 64.7% on the PA system and 54.3% on the NPA system by 2011.

1998 - 2007 "Poor" RQI Trend (Figure 3)

The percent of miles on the PA system in "Poor" condition in 2007 was 2.6%, slightly above the target of 2% or less. The percent of miles on the NPA system in "Poor" condition was 6.5%, over twice the target amount of 3% or less. The "Poor" RQI target on both the PA and NPA systems has not been met on a statewide basis since 2002.

Of most concern is the predicted amount of miles in "Poor" condition based on the 2008-2011 STIP. The percent of miles in the "Poor" RQI category is expected to increase to 7.6% on the PA system and 11.4% on the NPA system by 2011. This is nearly four times the target amount in each functional group. 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 very expensive, thus making it much harder to recover once the amount of miles in this condition gets very high.

RQI COMPARISON by ATP

2007 was the first time since the pavement measures were established that not a single ATP met all four of the RQI targets in a given year. Although they did not meet all of the targets, it should be noted that ATP-7, which met three of the four targets, improved in every RQI measure in 2007. ATP-1, 6, and Metro did not meet any of the RQI targets in 2007.

"Good" RQI Comparison (Figure 4)

For the second year in a row, ATP-2, 4 and 7 met the target of having at least 70% of the PA system in "Good" condition. Last year, ATP-3 and 8 also met this target.

ATP-2, 3, and 7 met the target of having 65% or more of the NPA system in "Good" condition. This was the second year in a row that ATP-7 met this target, the third year in a row for ATP-3.

Only ATP-2 and 7 met the "Good" RQI targets on both the PA and NPA system. Last year, only ATP-3, 4, and 8 met both of the "Good" targets.

"Poor" RQI Comparison (Figure 5)

Only ATP-2, 3, and 8 met the target of having no more than 2% of the PA system in "Poor" condition. Last year, every ATP except 6 and 7 met the target. This continues the undesirable trend of an increasing number of state highways in "Poor" condition.

ATP-3, 4, 7, and 8 met the target of having 3% or less of the NPA system in "Poor" condition. This was also the case last year.

Only ATP-3 and 8 met the "Poor" RQI targets on both the PA and NPA system. Last year, ATP-4 was also in this group.

AVERAGE REMAINING SERVICE LIFE (ARSL)

Due to the updated prediction models in the pavement management program in 2007, comparisons with previous year's Average Remaining Service Life (ARSL) cannot be made directly. However, since nearly all RQI values decreased in 2007 and the predicted RQI values based on the 2008-2011 STIP are even lower, it is safe to assume the ARSL also declined in 2007.

1998 - 2007 Average RSL Trend (Figure 6)

The ARSL of the PA system in 2007 was 9.2 years. The ARSL of the NPA system in 2007 was 7.4 years.

Average RSL Comparison (Figure 7)

By ATP, the ARSL ranges from 8.1 to 11.3 years on the PA system and from 4.9 to 10.1 years on the NPA system. ATP-2 has the highest ARSL on the PA system while ATP-3 has the highest ARSL on the NPA system.

ATP-6 continues to have the lowest ARSL on both the PA and NPA systems (8.1 and 4.9 years, respectively).

RQI TARGET SUMMARY

The table below provides a visual picture of which ATPs met the pavement targets in 2007. It uses the following legend:

- Green = Met the target
- Red = Missed the Target
- Yellow = Missed the target, but was "close"

"Close" means within 1% of target for the "Poor" RQI and within 5% for "Good".

Table 3. Overview of Ride Quality Index (RQI) Targets by ATP

ATP	Ride Quality Index (RQI) Targets Met in 2007			
	Good RQI (RQI > 3.0)		Poor RQI (RQI <= 2.0)	
	PA (target = 70% or more)	NPA (target = 65% or more)	PA (target = 2% or less)	NPA (target = 3% or less)
1	61.0%	57.7%	3.1%	7.7%
2	80.5%	66.2%	1.2%	6.6%
3	65.8%	74.3%	1.4%	2.1%
4	74.2%	58.6%	2.6%	2.8%
6	55.9%	36.3%	5.9%	17.1%
7	73.9%	69.0%	2.6%	2.3%
8	61.3%	62.9%	1.2%	0.6%
M	64.6%	46.5%	2.5%	13.7%

PREDICTING PAVEMENT CONDITION

Each year, a prediction of the next year's pavement condition is done using the pavement management system. Last year, this was done by taking the 2006 pavement condition data, adding the list of pavement projects scheduled for 2007 from the State Transportation Improvement Program (STIP), and predicting the impact they will have on pavement condition. When this is done, the predicted pavement condition will nearly always be better than the actual condition because the prediction assumes that all of the STIP projects are complete at the time the Pathway van drives over the roadway. In an attempt to improve the accuracy of the predicted pavement conditions, changes were made to this process.

Using the 2006 pavement data and 2007 to 2010 STIP, the construction year listed for some of the projects in the STIP was modified as follows to better resemble the status of construction projects when the Pathways van was in each district:

D-6, 7, and Metro:
The construction year for all pavement projects listed in the STIP was increased by one year. This was done because these three districts are normally tested early in the spring, when almost none of the construction projects slated for the year have begun.

D-3 and 4:
No changes were made to the project construction year since these two districts are normally tested late in the fall, when most of their pavement projects are completed for the year.

D-1, 2, and 8:
Half of the projects in these districts had the construction year increased by one year. This was done because at the time the van is filming the pavements, some of their projects were completed, some were under construction, and others had not begun. Since there is no way to predict which ones will be complete when the van is there and which ones will not, the projects were randomly chosen.

The table below compares the predicted 2007 pavement conditions with the actual conditions, using the method described above. The table demonstrates the accuracy resulting from modifying the construction year of the STIP projects. This same technique was then used with the actual 2007 pavement condition data and 2008 to 2011 STIP projects to predict the 2008 to 2011 pavement condition shown in Figures 2 and 3.

Table 3. Comparison of 2007 Predicted and Actual RQI

Principal Arterial System			
RQI Category	**Actual 2006 Data**	**Predicted 2007 Data***	**Actual 2007 Data**
Good RQI (RQI > 3.0)	68.9%	67.5%	66.3%
Poor RQI (RQI <= 2.0)	2.3%	2.7%	2.6%
Non-Principal Arterial System			
RQI Category	**Actual 2006 Data**	**Predicted 2007 Data***	**Actual 2007 Data**
Good RQI (RQI > 3.0)	61.1%	60.1%	59.1%
Poor RQI (RQI <= 2.0)	5.2%	6.6%	6.5%

***Predictions based on the 2007-2010 STIP, with adjustments to construction year.

DEFAULT PREDICTION MODELS

The projects not scheduled for any work in the 2008-2011 STIP use one of two types of deterioration curve to predict future condition. If there is enough historical data since the last rehabilitation was done on a section, a regression curve is fitted through the data. This curve is then used to predict the expected RQI for the section. If there is not enough historical data 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-1980's and subsequently updated in 1992. The curves are based on historical statewide performance.

In 2007, the default models were updated using more recent performance data. The new models result in slightly steeper decay rates than the previous models. The result is lower remaining service life as well as lower expected RQI when predicting future conditions.

ADDITIONAL INFORMATION

Additional information about the condition and performance of the state highway system can be obtained from the Pavement Management Unit's website:

http://www.mrr.dot.state.mn.us/pavement/PvmtMgmt/pavemgmt.asp

Or by contacting:

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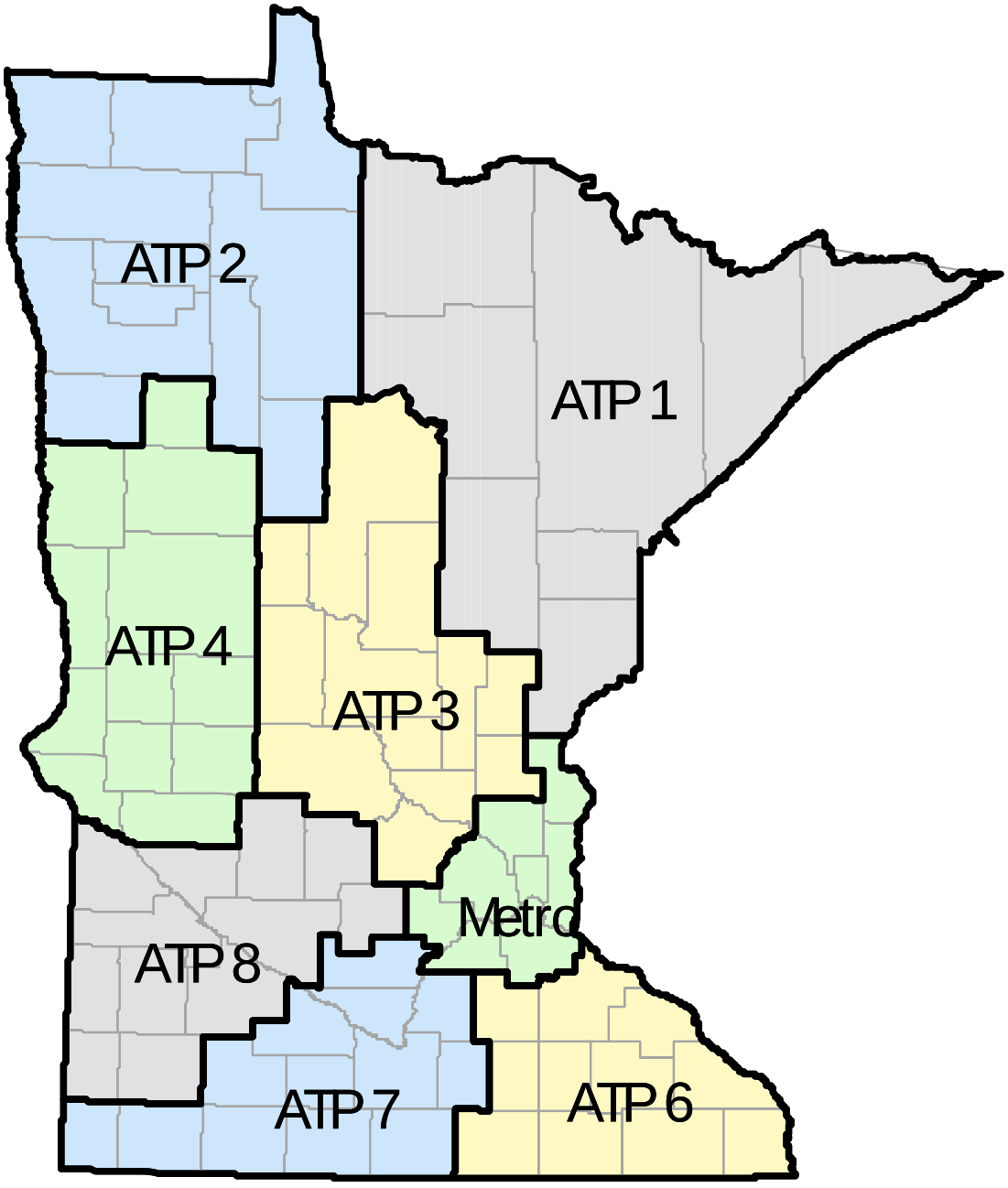


Figure 1. Mn/DOT's Area Transportation Partnership (ATP) Boundaries.

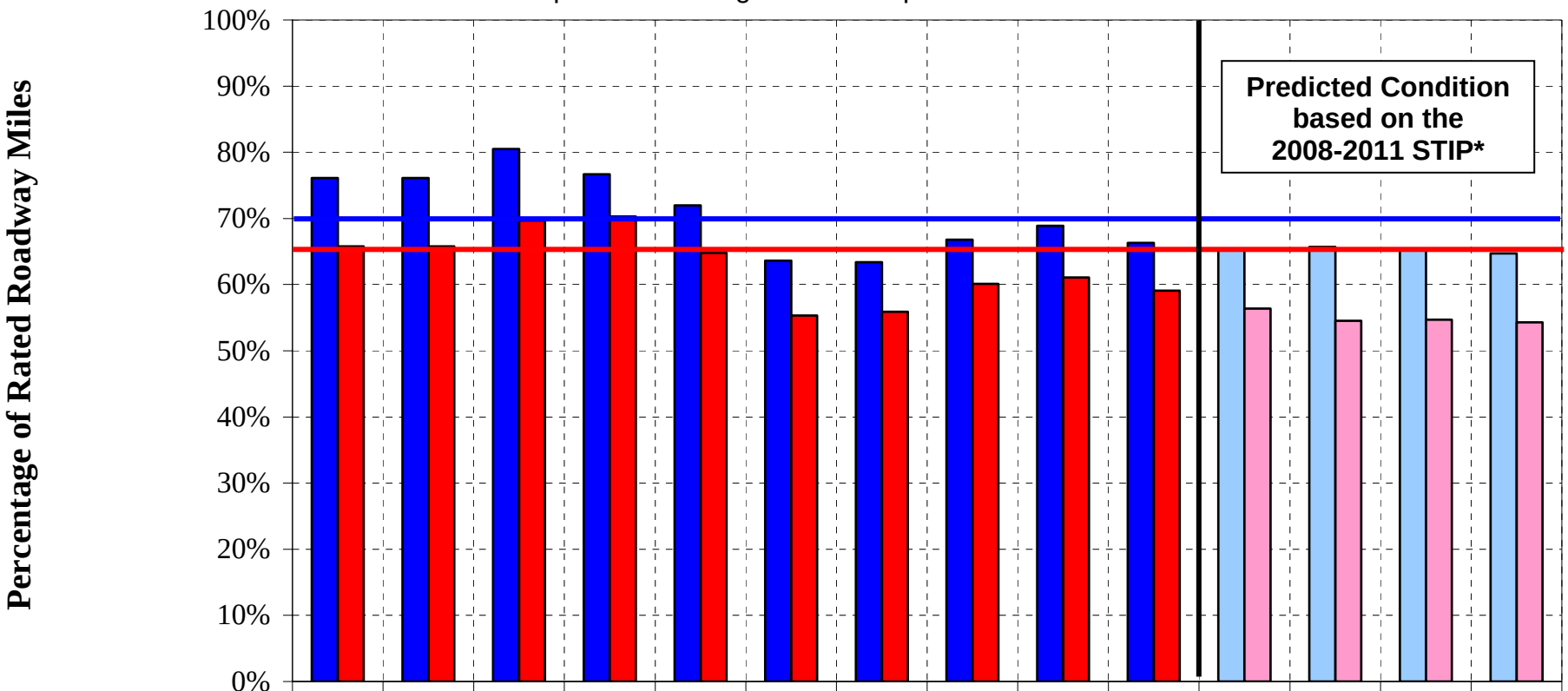
Figure 2

Statewide "Good" Ride Quality Index

(RQI above 3.0)

1998 - 2007

Principal Arterial Target = 70 percent or more
Non-Principal Arterial Target = 65 percent or more



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Principal Art.	76.1%	76.1%	80.5%	76.7%	72.0%	63.6%	63.4%	66.8%	68.9%	66.3%	65.4%	65.7%	65.2%	64.7%
Non-Principal Art.	65.8%	65.8%	69.7%	70.3%	64.8%	55.3%	55.9%	60.1%	61.1%	59.1%	56.4%	54.5%	54.7%	54.3%

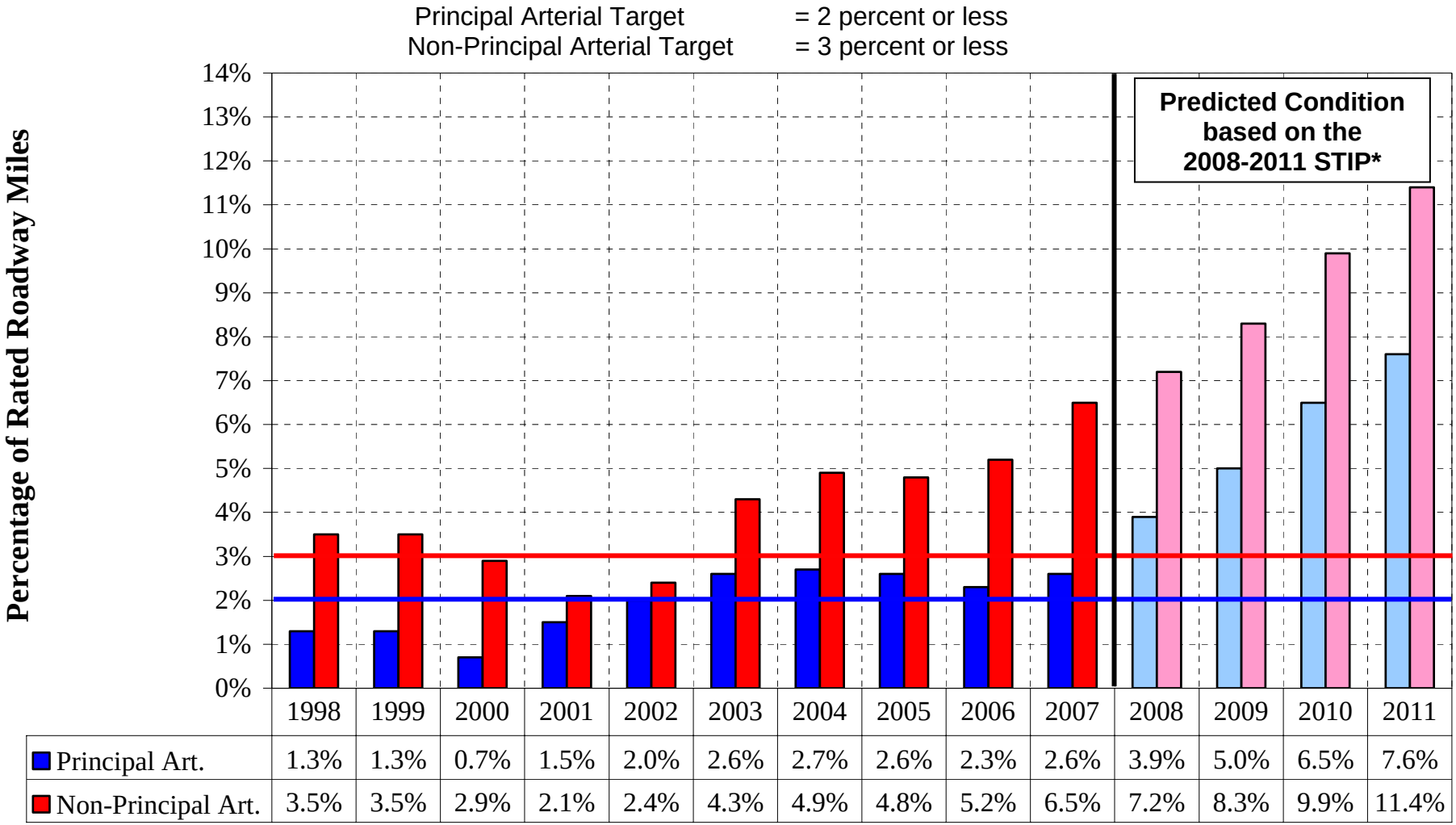
*2008 to 2011 Pavement Conditions are predicted as described on Page 5

Figure 3

Statewide "Poor" Ride Quality Index

(RQI of 2.0 or less)

1998 - 2007



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Principal Art.	1.3%	1.3%	0.7%	1.5%	2.0%	2.6%	2.7%	2.6%	2.3%	2.6%	3.9%	5.0%	6.5%	7.6%
Non-Principal Art.	3.5%	3.5%	2.9%	2.1%	2.4%	4.3%	4.9%	4.8%	5.2%	6.5%	7.2%	8.3%	9.9%	11.4%

*2008 to 2011 Pavement Conditions are predicted as described on Page 5

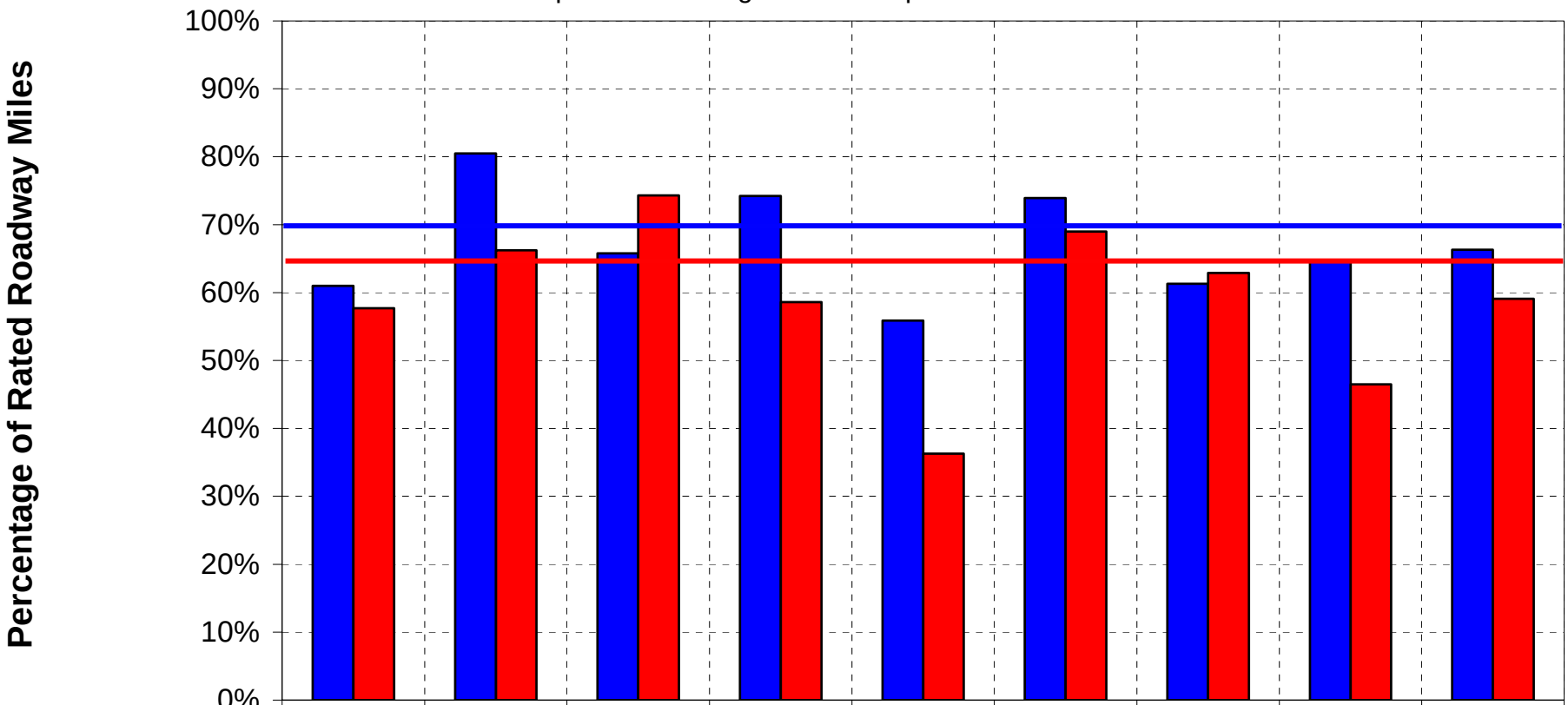
Figure 4

"Good" Ride Quality Index

(RQI above 3.0)

Comparison of 2007 Data by ATP

Principal Arterial Target = 70 percent or more
Non-Principal Arterial Target = 65 percent or more



	ATP-1	ATP-2	ATP-3	ATP-4	ATP-6	ATP-7	ATP-8	Metro	State
Principal Art.	61.0% ▼	80.5% ▲	65.8% ▼	74.2% ▼	55.9% ▼	73.9% ▲	61.3% ▼	64.6% ▼	66.3% ▼
Non-Principal Art.	57.7% ▼	66.2% ▲	74.3% ▲	58.6% ▼	36.3% ▼	69.0% ▲	62.9% ▼	46.5% ▼	59.1% ▼

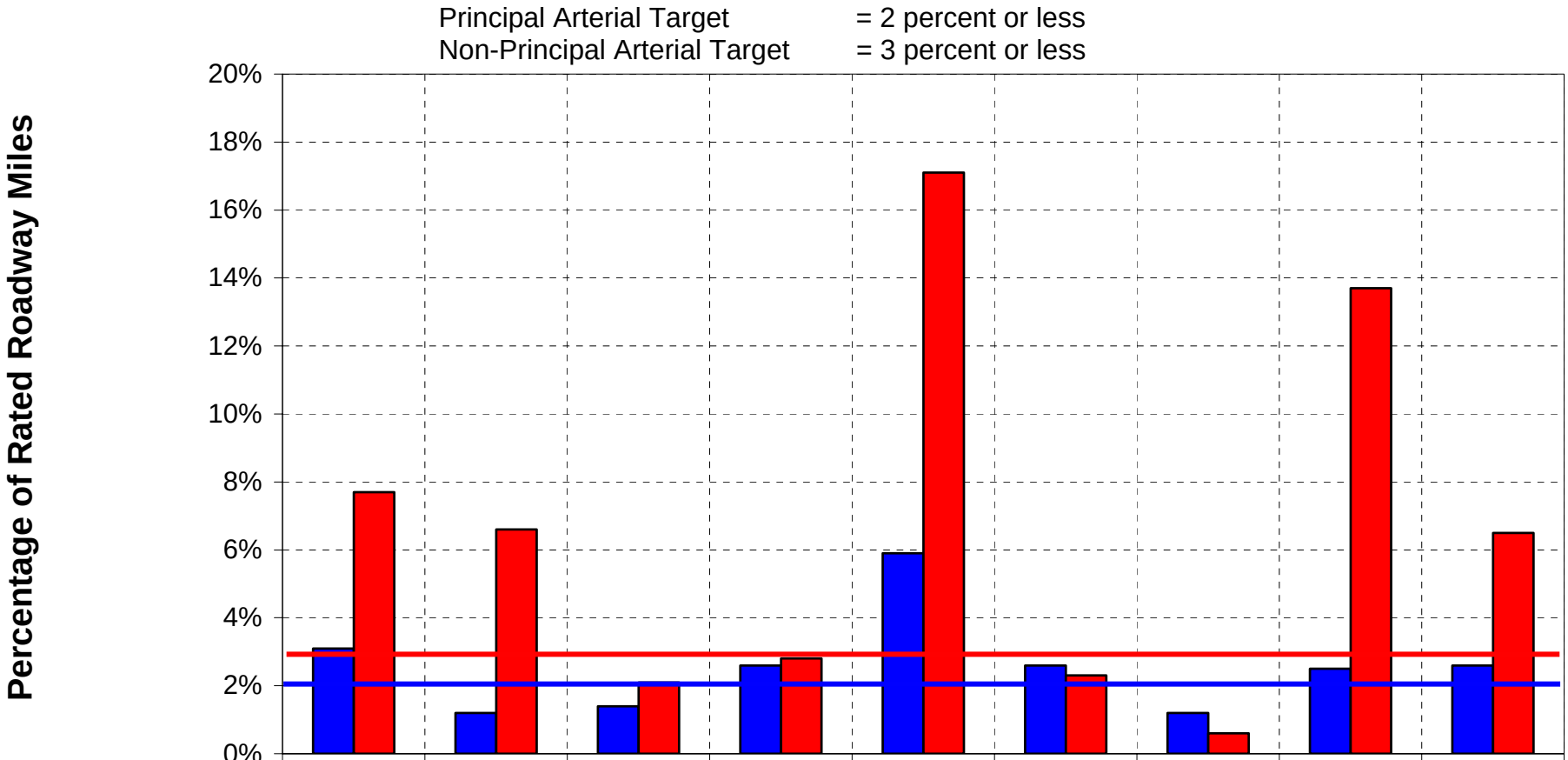
▲ = Better than 2006 ▼ = Worse than 2006

Figure 5

"Poor" Ride Quality Index

(RQI of 2.0 or less)

Comparison of 2007 Data by ATP



	ATP-1	ATP-2	ATP-3	ATP-4	ATP-6	ATP-7	ATP-8	Metro	State
Principal Art.	3.1% ▼	1.2% ▼	1.4% ▼	2.6% ▼	5.9% ▼	2.6% ▲	1.2% ▲	2.5% ▼	2.6% ▼
Non-Principal Art.	7.7% ▼	6.6% ▼	2.1% ▼	2.8% ▼	17.1% ▼	2.3% ▲	0.6% ▲	13.7% ▼	6.5% ▼

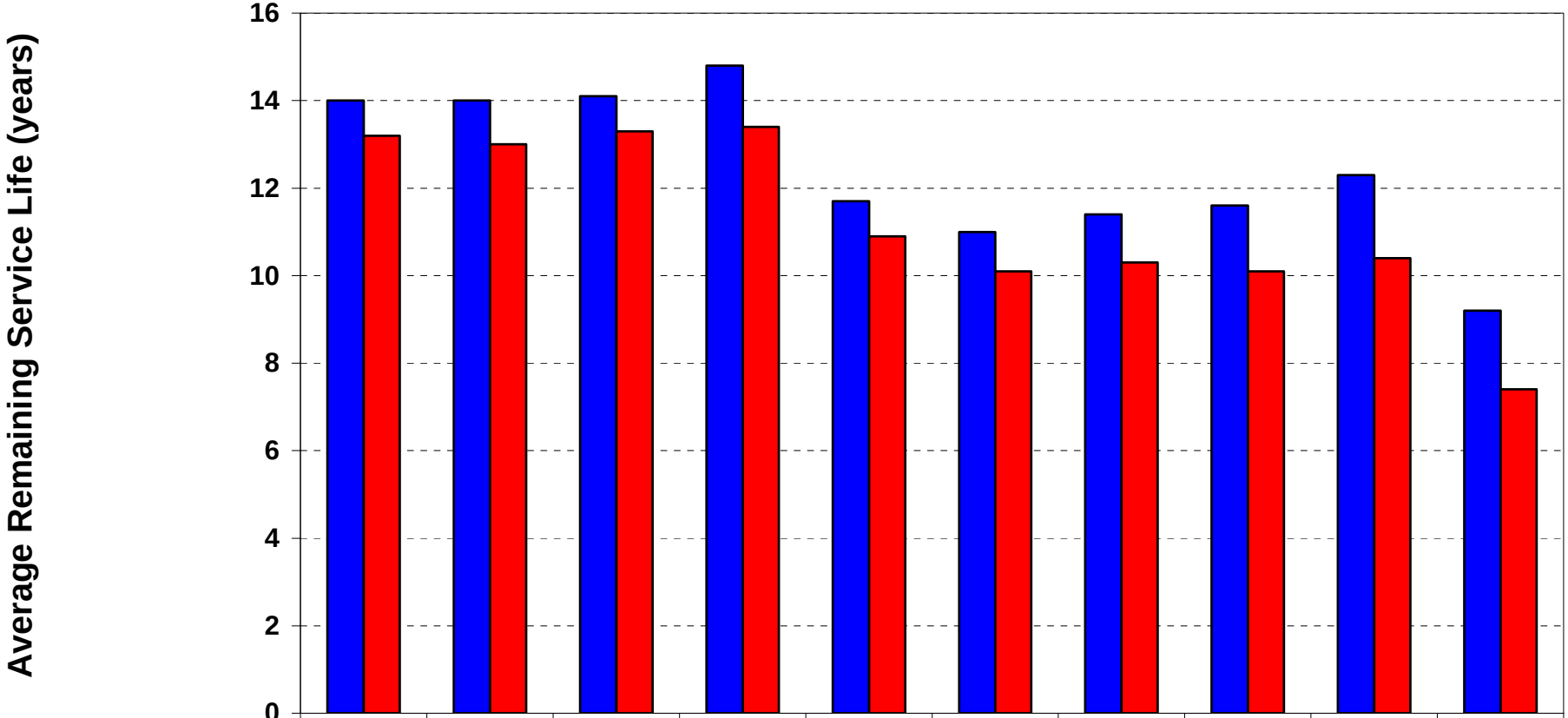
▲ = Better than 2006 ▼ = Worse than 2006

Figure 6

Statewide Average Remaining Service Life (ARSL)

(Years until RQI reaches 2.5)

1998 - 2007



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Principal Art.	14.0	14.0	14.1	14.8	11.7	11.0	11.4	11.6	12.3	9.2
Non-Principal Art.	13.2	13.0	13.3	13.4	10.9	10.1	10.3	10.1	10.4	7.4

No official targets have been established for ARSL

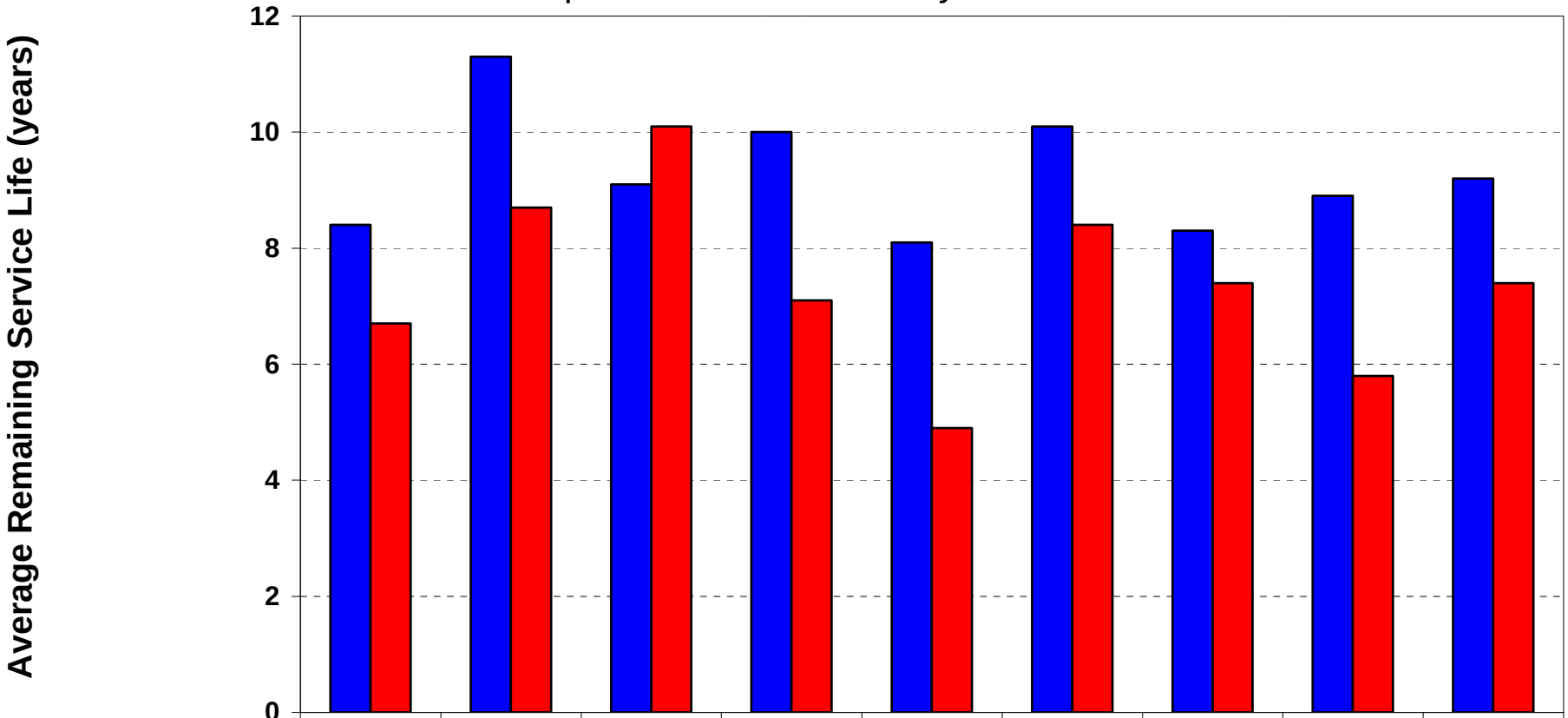
Note: 2007 ARSL estimates are based on updated prediction models

Figure 7

Average Remaining Service Life

(Years until RQI reaches 2.5)

Comparison of 2007 Data by ATP



	ATP-1	ATP-2	ATP-3	ATP-4	ATP-6	ATP-7	ATP-8	Metro	State
Principal Art.	8.4	11.3	9.1	10.0	8.1	10.1	8.3	8.9	9.2
Non-Principal Art.	6.7	8.7	10.1	7.1	4.9	8.4	7.4	5.8	7.4

No official targets have been established for ARSL

Note: 2007 ARSL estimates are based on updated prediction models