Minnesota Department of Transportation

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2001 Pavement Management Annual Report

ANNUAL REPORT

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Office of Materials and Road Research
Pavement Management Unit

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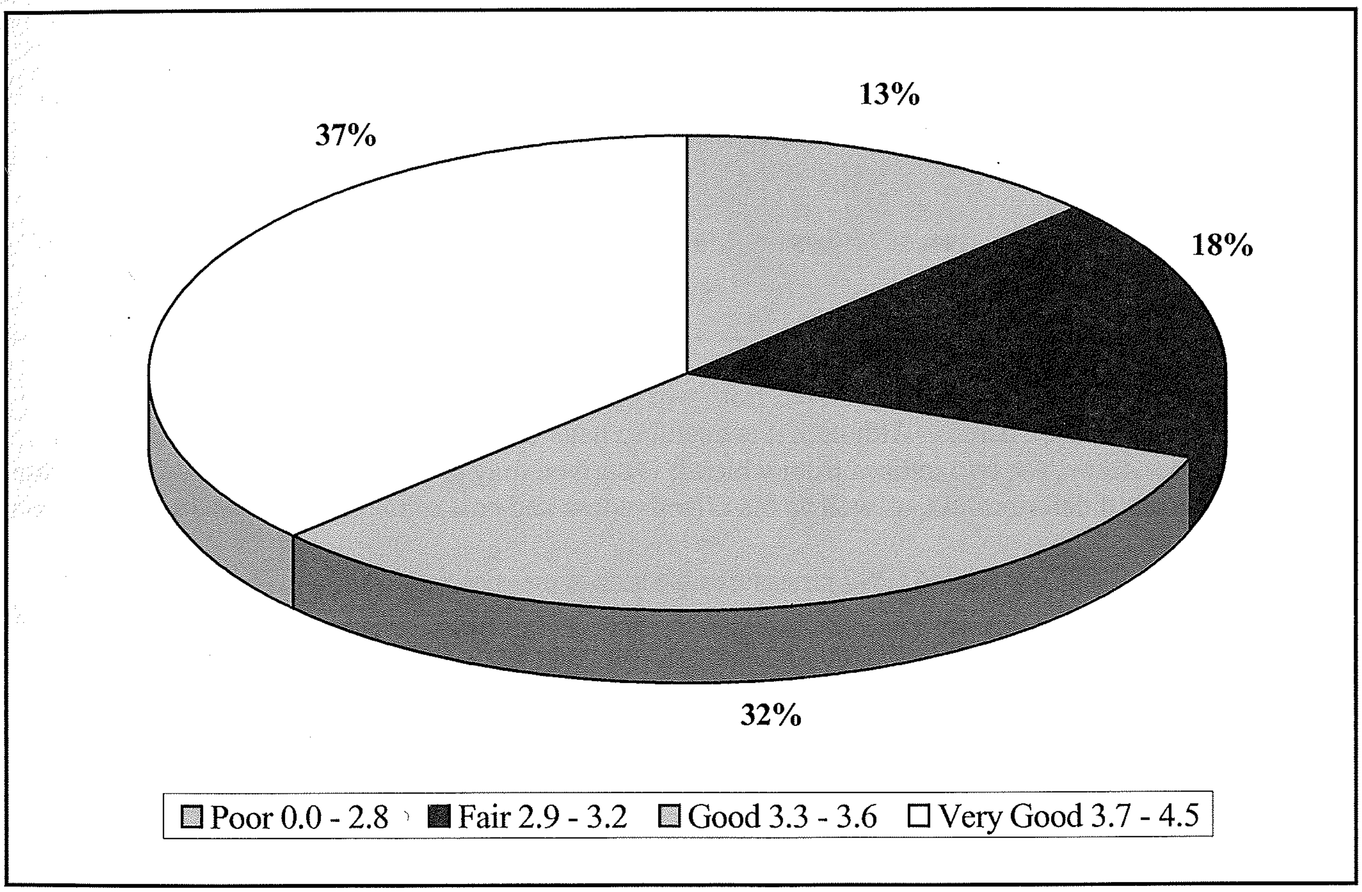
Chapter 1 Executive Summary

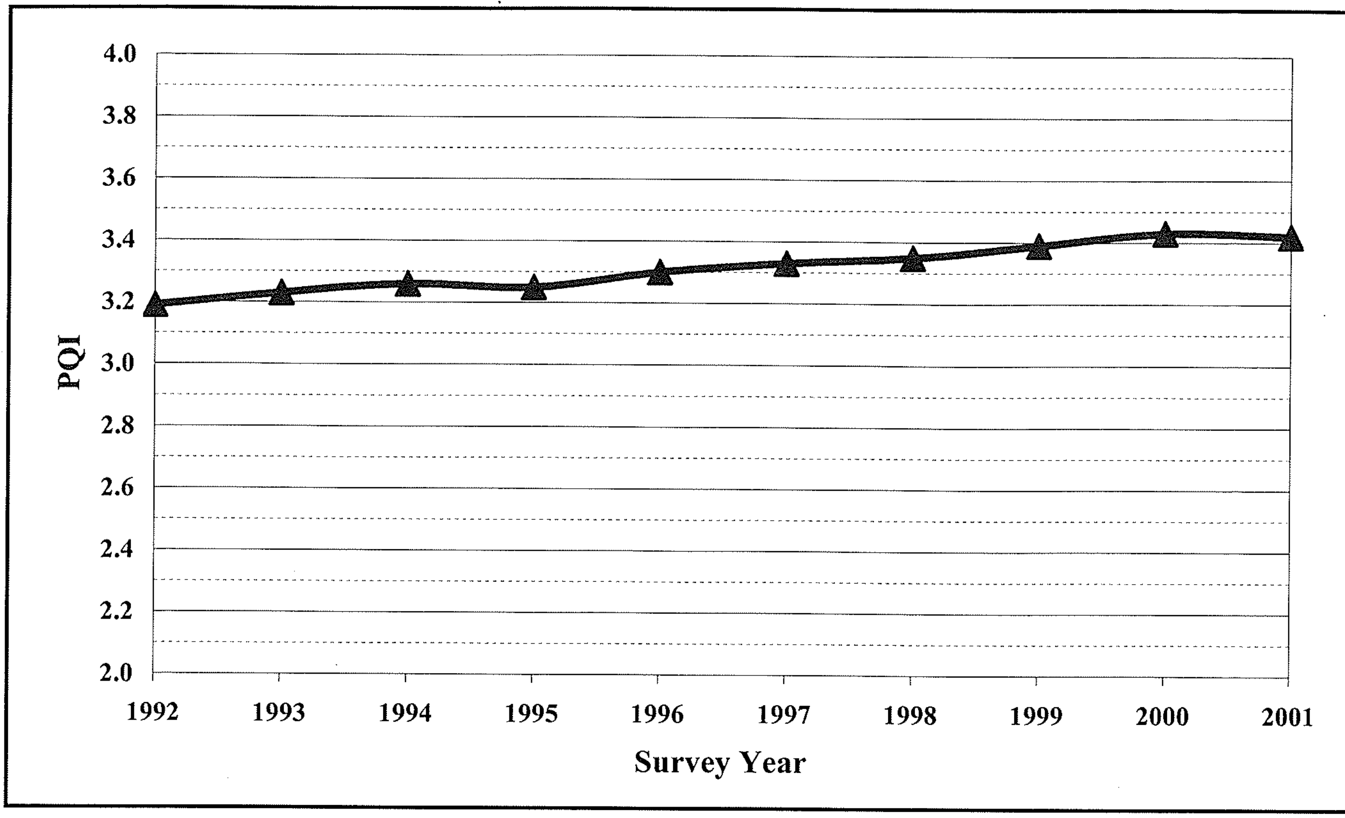
This report documents the condition of highway pavements under the jurisdiction of the Minnesota Department of Transportation (Mn/DOT). Pavement condition ratings are based upon routine surveys conducted annually for pavement smoothness and biennially for surface distress (cracking, patching, etc.). Numerical indices are calculated for both smoothness and distress based on these surveys. In addition, a composite index of these two measurements, called the Pavement Quality Index (PQI), is used to represent the overall condition of the pavement. The value of the PQI ranges from 0.0 to 4.5. The numerical value of the PQI can be distributed into four convenient classes corresponding to "poor," "fair," "good," and "very good" as shown in Figure 1-1. Figure 1-1 shows the distribution of the current PQI values of Minnesota's highways.[i]

Figure 1-1 Statewide Pavement Quality Index (PQI) Distribution



The PQI of each segment of pavement can be used to compare the present and past conditions. From this comparison, trends can be developed and predictions of future condition can be made. Figure 1-2 shows the average PQI for the trunk highway system in Minnesota from 1992 to 2001. It is apparent from this figure that the general condition of Mn/DOT's highway pavements improved steadily between 1995 and 2000, but leveled off in 2001. An overview of Mn/DOT's highway system is provided in Chapter 2.

Figure 1-2 Statewide Pavement Quality Index (PQI), 1992-2001



As mentioned previously, the PQI is derived from two other measures of pavement condition: smoothness and surface distress. Although it is useful to have one composite number like the PQI to characterize condition, the two indices from which it is derived may provide greater insight into the rate and mechanisms of deterioration, as well as the effectiveness and cost of maintenance and rehabilitation.

The Present Serviceability Rating (PSR) measures the smoothness of ride. The Surface Rating (SR) indirectly measures the condition of the pavement structure based upon surface distress. The procedures and techniques by which the PQI, SR, and PSR are developed can be found in the Mn/DOT Surface Distress Manual, available from the Pavement Management Unit, Office of Materials and Road Research.

The remainder of this report, specifically Chapters 4 through 6, presents more detailed data of the current and historical values of the three performance indices (PSR, SR and PQI). The information is further refined to allow for comparison between different functional classes or route types, as well as between districts.

The current and historical values of the PQI, SR, and PSR, together with the distress and ride measurements from which they are calculated, are maintained in a computer database. The Pavement Management Unit in the Office of Materials & Road Research maintains a computer application called Highway Pavement Management Application (HPMA). HPMA can be used to develop a wide variety of statistical information about very detailed subsets of highway pavements and to prioritize pavement segments based upon the cost-effectiveness of applicable maintenance and rehabilitation techniques. Requests to perform a specific analysis or for assistance in running HPMA should be directed to David Janisch, Pavement Management Engineer, at 651-779-5567 or dave.janisch@dot.state.mn.us.

General Observations

Some general observations that can be made regarding the data in this report are:

- The percentage of Minnesota trunk highway mileage that falls into either the "good" or "very good" categories for PSR, SR and PQI is roughly 60 percent, 80 percent, and 70 percent, respectively.
- Pavement surface distress, as characterized by the SR, dropped in 2001, the first time since 1997.
- Pavement smoothness, as characterized by the PSR, increased in 2001 after remaining relatively constant from 1997 to 2000.
- The overall pavement condition, as characterized by the PQI, remained the same in 2001 after having steadily increased from 1995 to 2000.

Endnotes for Chapter 1

[i] The pavement conditions of bridges, ramps, loops, and a portion of TH 74 that has a gravel surface are not included in this report.

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Chapter 2 Minnesota's Trunk Highway System

Minnesota's trunk highway system consists of approximately 12,000 centerline miles of pavement. Slightly less than 9,600 miles are two-lane undivided routes; the remaining 2,400 miles are multilane divided routes such as interstate routes.

In the pavement management system, roadway miles are also used to quantify the trunk highway system. A roadway mile is equal to one mile of undivided highway or one mile of divided highway, in one direction only. For example, one mile of I-94 counts as two roadway miles because the eastbound and westbound directions are counted as separate lengths of roadway. This is done to account for instances in which—due to differences in construction or design—one direction of a divided road is different from another. There currently are 14,221 rated roadway miles of trunk highway.

The final way to characterize the length of the trunk highway system is by lane-miles. This method accounts for multilane roadways and is the most accurate method for determining the total amount of pavement on the trunk highway system. There currently are 28,790 rated lane-miles of pavement in the trunk highway system.

Mn/DOT Districts

The direct management of Minnesota's trunk highway system is the responsibility of eight districts. The district staff prioritizes highway segments for maintenance, rehabilitation, and reconstruction work. The types of work performed are determined by the district staff with the concurrence of Central Office staff. The boundaries of each of the eight districts are shown in Figure 2-1.

The established district boundaries somewhat complicate the implementation of transportation improvements because they do not follow county boundaries. For the planning and implementation of transportation improvements, Mn/DOT seeks input from county and municipal officials and staff. As a result, it is helpful for county officials to have only one Mn/DOT liaison and vice versa. Area Transportation Partnership (ATP) is the term for districts with boundaries that have been modified to follow county boundaries. Figure 2-2 is a map of the ATP boundaries. Throughout this report, the data is analyzed on a district basis.

Route Types

Three route types—Interstate, U.S., and Minnesota routes—comprise the trunk highway system that is under the jurisdiction of Mn/DOT. Figure 2-3 is a pie chart showing the percentage of mileage for each of the three route types. The trunk highway system may also be characterized in a number of other ways such as by pavement type or design standards.

Figure 2-1 District Boundaries

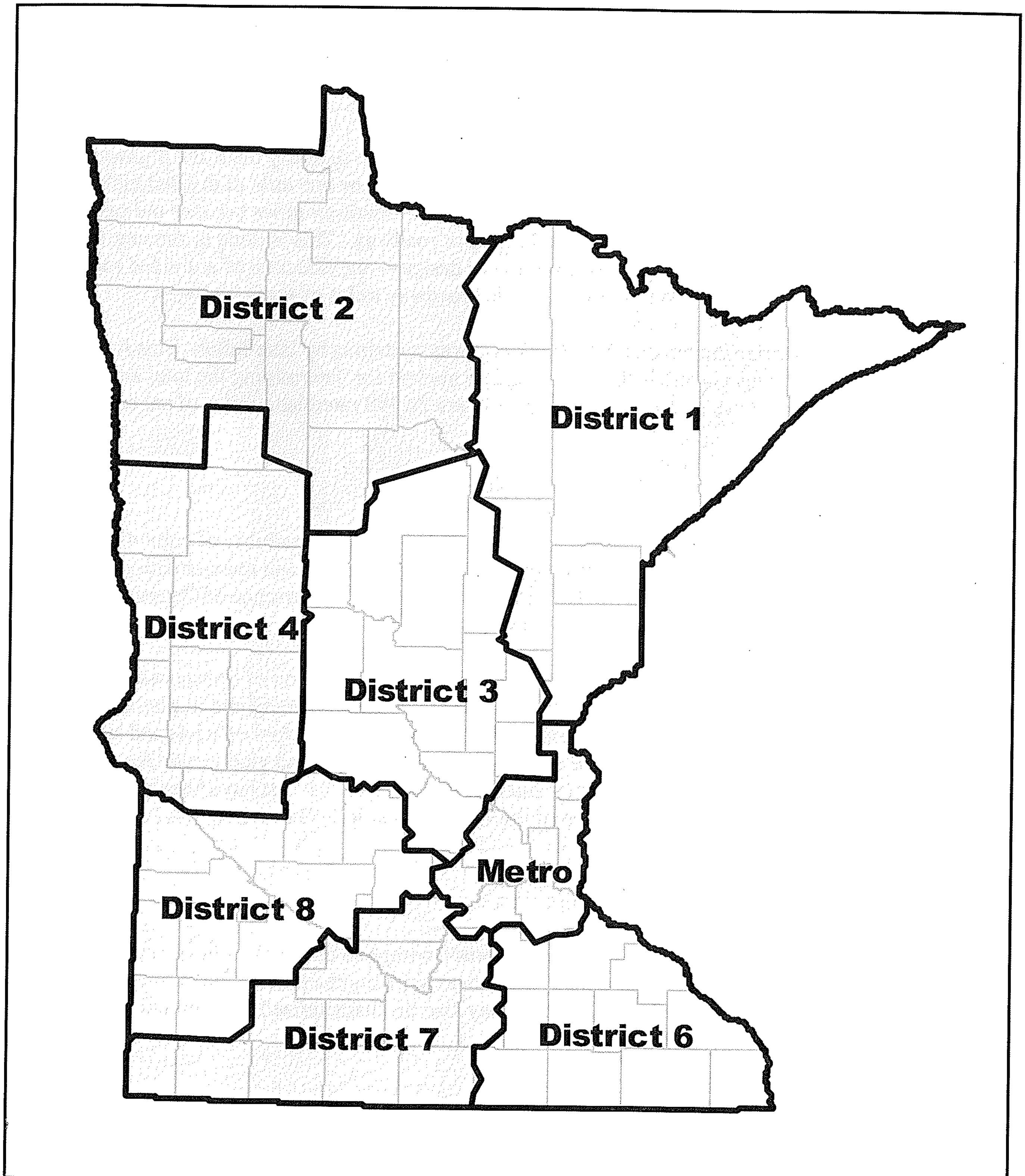


Figure 2-2 Area Transportation Partnership Boundaries

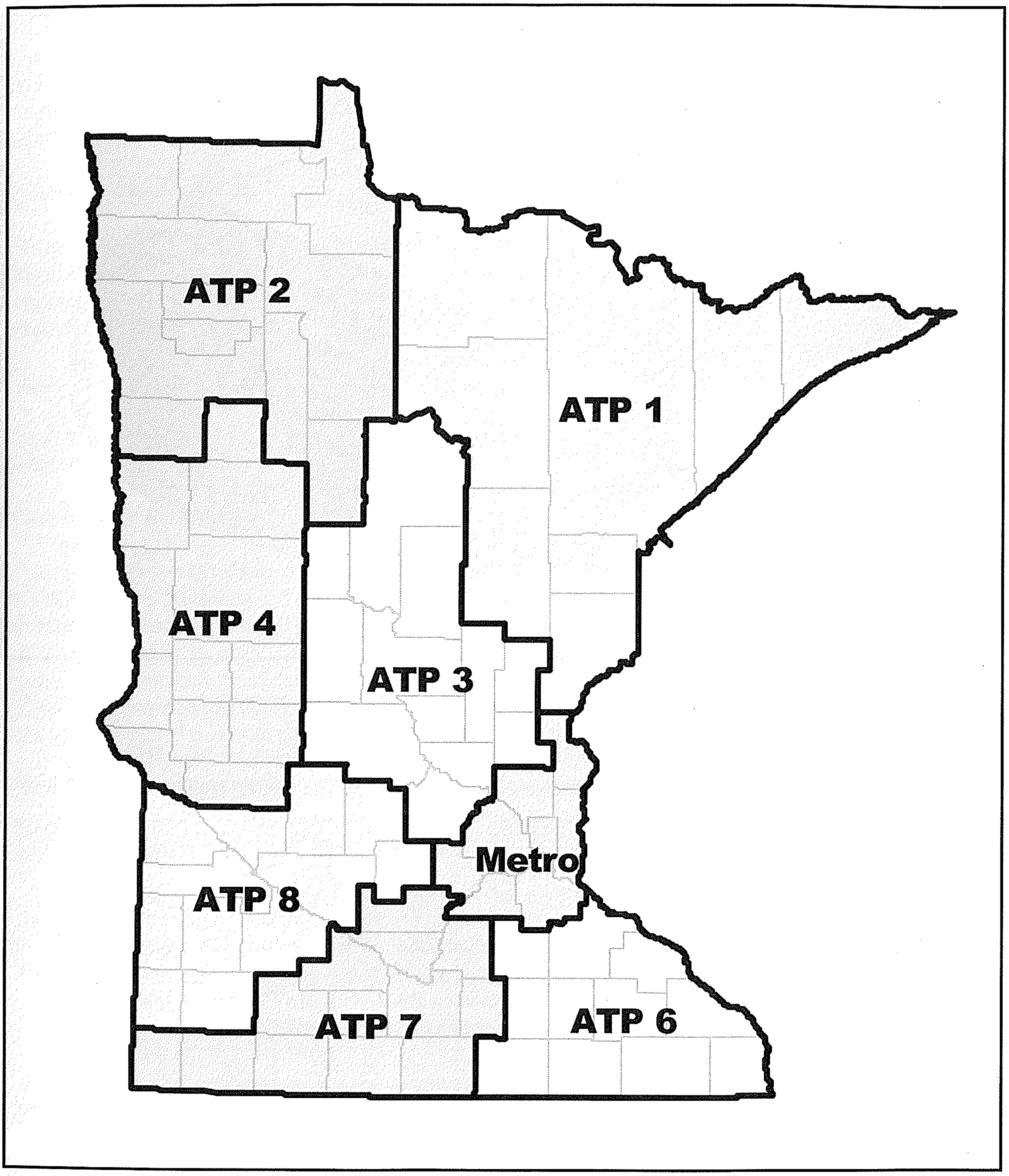
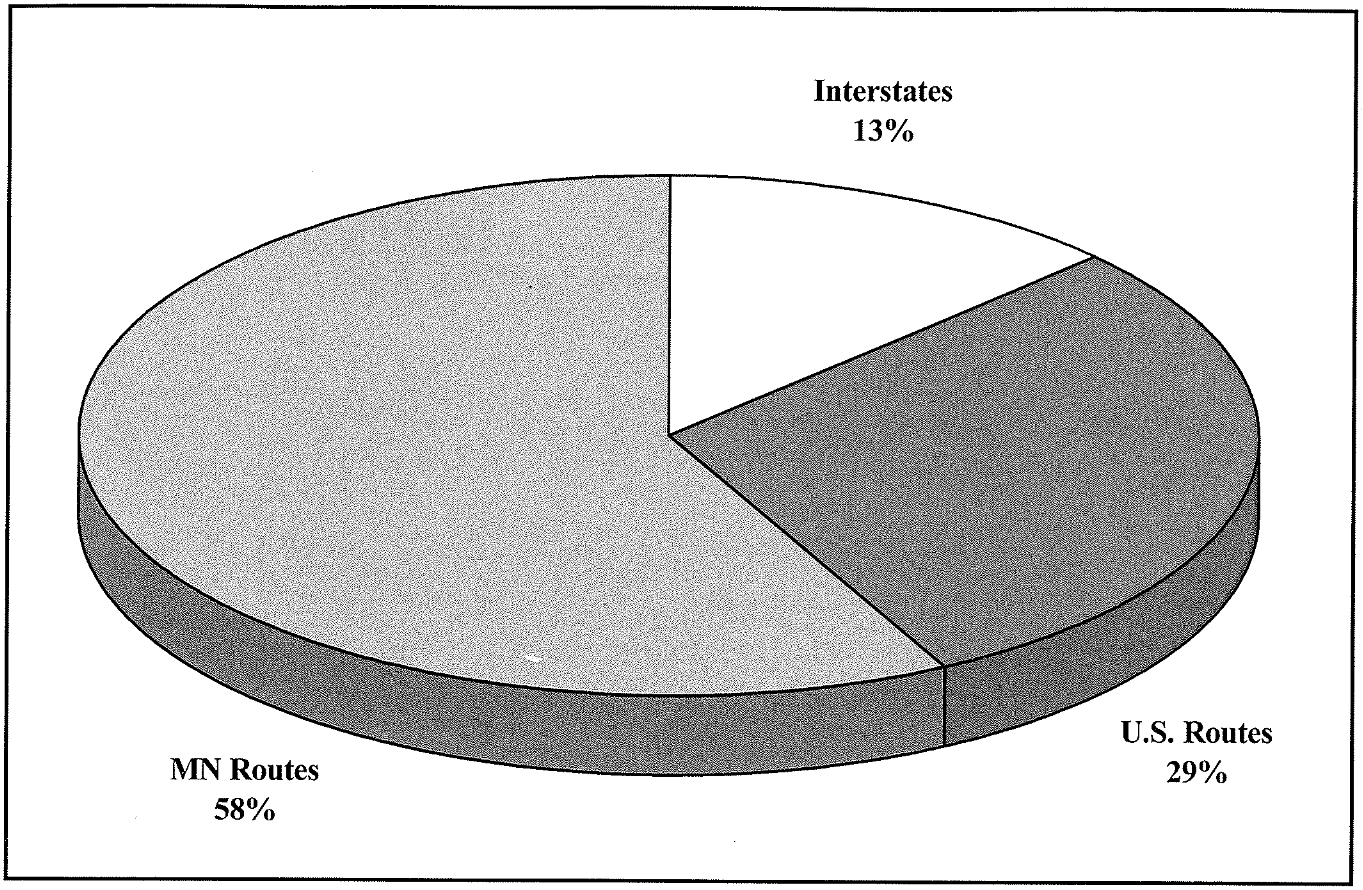


Figure 2-3 Statewide Highway Type Distribution



Pavement Types

In the pavement management system, seven different pavement types are used to characterize each section. These pavement types allow for comparison and separate deterioration models to be used. The seven pavement types are defined as follows.

Bituminous—Aggregate Base (BAB)

Bituminous pavements, which are commonly called asphalt, are utilized for both new construction and as an overlay for rehabilitation of an existing pavement surface. When used for new construction, layers of bituminous may be placed upon layers of aggregate base, which is a controlled aggregate gradation. This is termed Bituminous Aggregate Base and abbreviated BAB. Cold In Place recycling and full depth reclamation of existing bituminous pavements are also classified as BAB.

Bituminous—Full Depth (BFD)

With sufficiently increased thickness of the bituminous layers, the aggregate base may be eliminated. Such pavement is termed Bituminous Full Depth and abbreviated BFD. Although Bituminous Full Depth was used extensively in the 1970s and 1980s, its use by Mn/DOT has been discontinued because of long-term performance concerns.

Bituminous Over Bituminous (BOB) & Bituminous Over Concrete (BOC)

Bituminous that is used as an overlay on top of existing bituminous surfaces is termed Bituminous Over Bituminous or BOB, while bituminous used as an overlay on concrete pavement is abbreviated BOC. Overlays are primarily used to minimize road roughness where the underlying pavement is structurally competent, increase pavement structural capacity, or as an interim measure until the roadway can be reconstructed.

Concrete—Doweled (CD)

For new Portland Cement Concrete pavement construction, Mn/DOT currently uses only concrete with dowel bars (i.e., steel rods) connecting adjacent panels. Unbonded concrete overlays, which are used extensively by Mn/DOT on top of deteriorated concrete pavements without regrading or pavement removal, are also classified as concrete doweled pavements.

Concrete—Undoweled (CU)

Concrete without dowels between the panels is abbreviated CU and is no longer used because the differential movement between panels causes roughness.

Continuously Reinforced Concrete Pavement (CRCP)

Concrete continuously formed without panel joints but with continuous steel reinforcement is referred to as Continuously Reinforced Concrete Pavement or CRCP. CRCP is no longer used because of past performance problems caused by corrosion of the steel caused by de-icing salt.

Table 2-1 shows the total miles of different pavement types by district subtotal and state total.[i] Bituminous pavements (BAB, BFD, BOB, and BOC) account for eighty-four percent of the total mileage. Doweled concrete comprises fifteen percent of the total mileage.

Table 2-1 Roadway Miles of Pavement for State & Districts

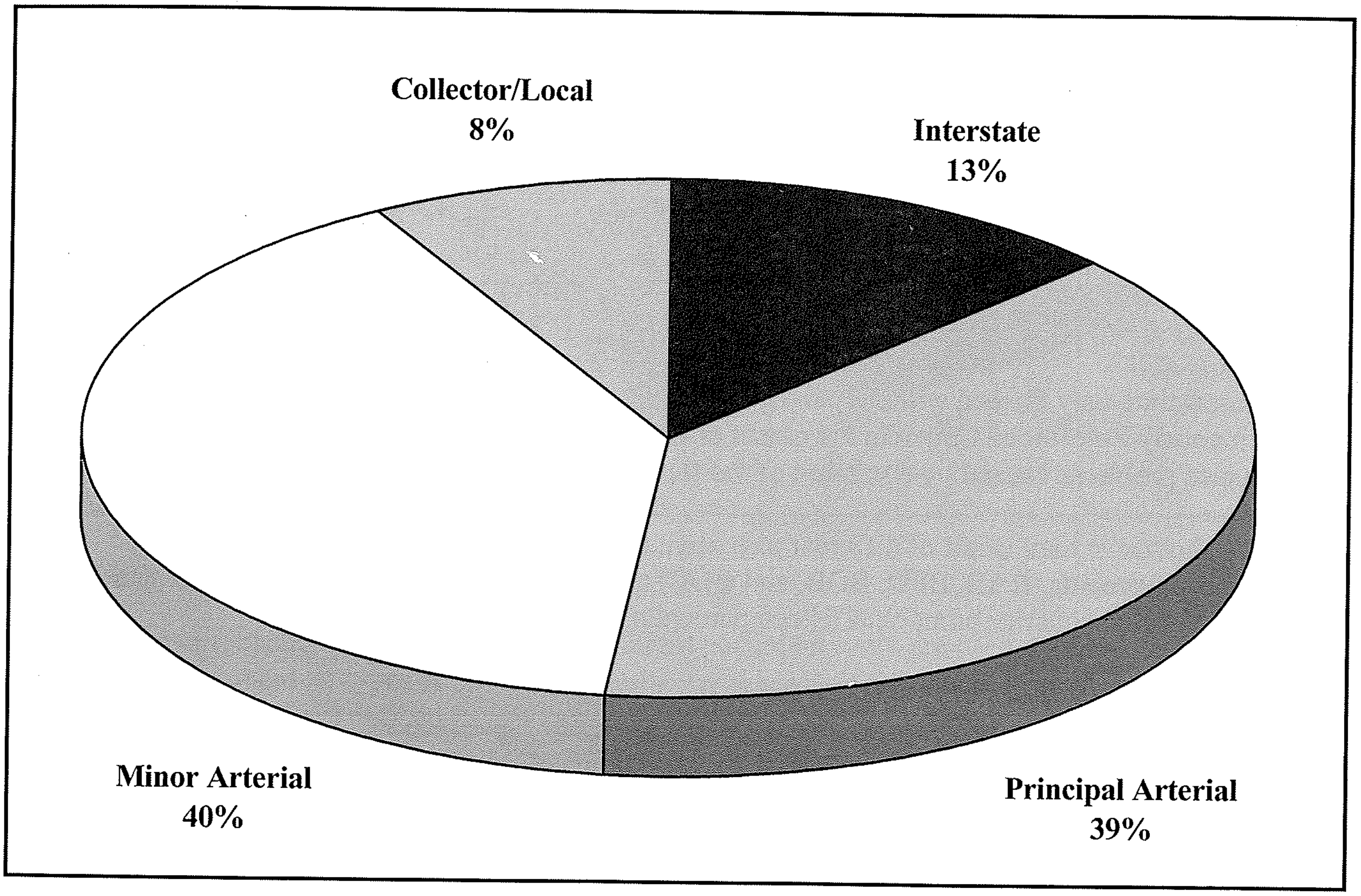
Pavement	State	D-1	D-2	D-3	D-4	D-6	D-7	D-8	Metro
BAB	1,104	243	213	267	114	76	26	34	131
BFD	231	27	4	15	16	39	29	31	71
BOB	7,561	1,097	1,349	1,250	1,024	784	610	864	584
BOC	3,067	186	291	184	500	510	531	341	523
CD	2,071	307	80	176	137	389	402	150	430
CU	155	6	14	76	6	4	15	31	4
CRCP	33	0	0	0	32	0	0	0	1
Total	**14,221**	**1,866**	**1,951**	**1,969**	**1,829**	**1,802**	**1,612**	**1,449**	**1,744**

Note: There is also a short length of TH 74 in D-6, in the Whitewater Wildlife Area, with a gravel surface. This is the only gravel surfaced trunk highway in Minnesota.

Functional Class

The safe and expedient movement of traffic conflicts with the other major goal of highway design: providing access to residences, businesses, and recreational areas. Accordingly, highways are grouped into different functional classes, which provide different combinations of mobility and access such that the integrated highway system achieves both of these goals. The design and functional class vary based upon whether the highway serves a rural or urban area. The use of the highway can be further subdivided into one of four broad classes: interstate, principal arterial, minor arterial, and collector/local. Figure 2-4 shows the percentage of mileage for these functional classes.

Figure 2-4 Statewide Functional Class Distribution



The interstate system connects every large community in the United States with controlled access, high design speed freeways. The Federal Aid Highway acts of 1944 and 1956 created the interstate system, formally the "National System of Interstate and Defense Highways." The interstate system has become such a critical part of our transportation system that Chapter 5 is devoted exclusively to its condition.

Limited access and a capacity to move relatively large volumes of traffic in an expedient manner characterize arterial highways. In rural areas, arterials provide a system of integrated continuous connections to the major urban areas at a level of service suitable for statewide travel. In urban areas, arterials are high traffic volume roadways that serve the major centers of activity within the urban area. Arterials are subdivided into principal and minor categories. This further distinction is based upon the relative distribution of providing access and mobility, the relative importance of the areas they serve, their length, and traffic volumes.

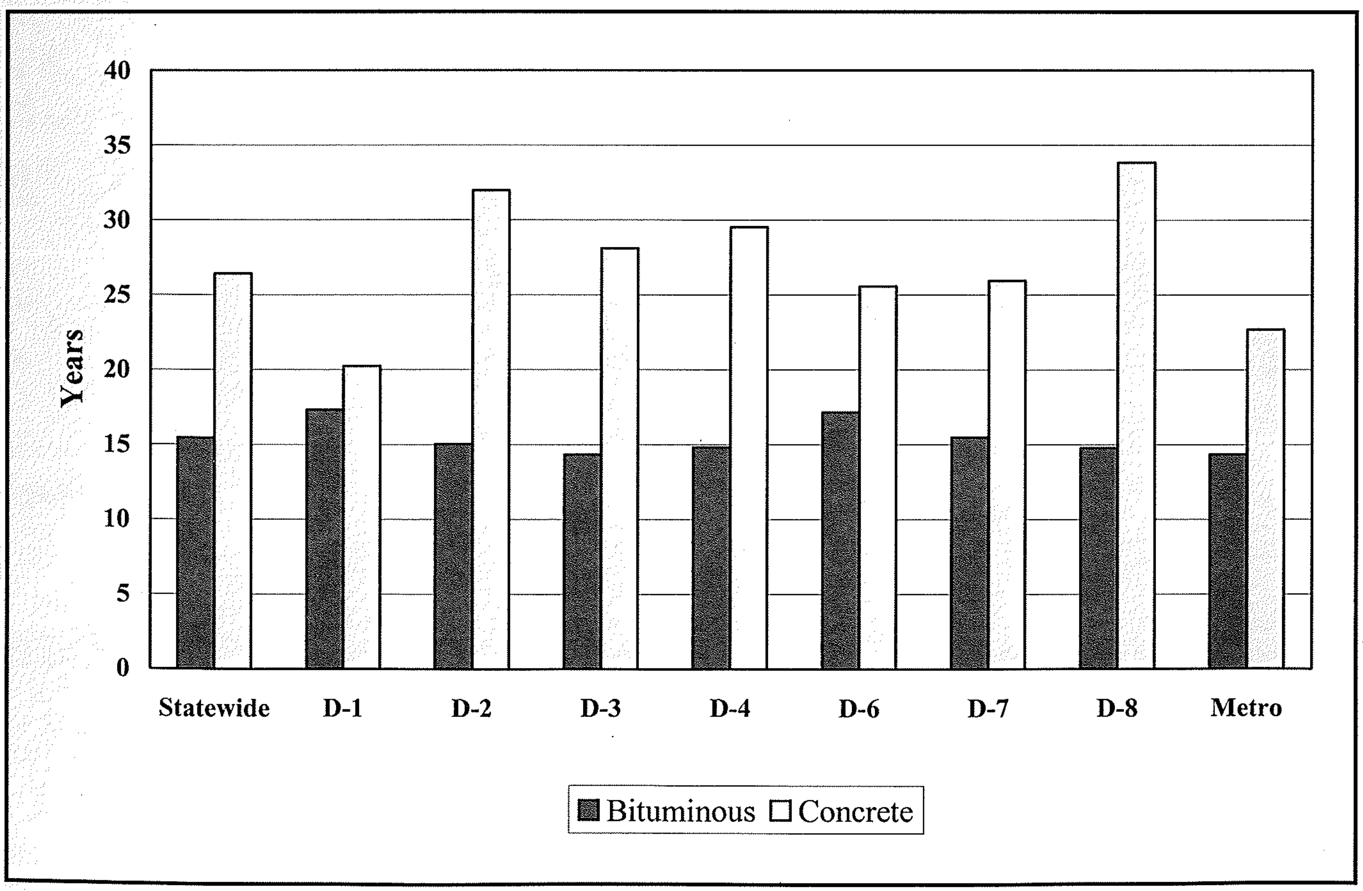
Collector routes are characterized by roughly even distribution of access and mobility with generally lower traffic volumes than arterials. In rural areas, collectors primarily serve as connections to the arterial system and provide for travel within the county. In urban areas, collectors act as an intermediate connection between the arterial system and the points of origin and destination. Collectors typically serve commercial and industrial areas.

Their many points of direct access to the surrounding area characterize local roads. Speeds and traffic volumes are lower and trip distances are shorter. Local highways connect to higher priority collectors or arterials to provide mobility over greater distances.

Pavement Rehabilitation

The effects of repeated heavy loads and weather extremes on pavement condition necessitate an ongoing program of maintenance and rehabilitation. Rehabilitation and reconstruction are activities that upgrade the pavement structure of a highway after the cumulative loads exceed its actual capacity or the pavement has deteriorated for other reasons. Rehabilitation work is frequently undertaken with safety enhancements, intersection upgrades, or bridgework. Rehabilitation projects for bituminous pavements include medium or thick overlays, with and without milling. Rehabilitation projects for concrete pavements include major joint repairs and bituminous or unbonded concrete overlays. Figure 2-5 shows the average number of years between original construction and first rehabilitation. Statewide, the average age when the first rehabilitation for bituminous and concrete pavements is performed is 15 and 26 years, respectively.

Figure 2-5 Average Time from Original Construction to First Rehabilitation/Reconstruction



Preventive Maintenance

Mn/DOT has endorsed the concept that the right preventive maintenance technique applied to the right road at the right time may extend usable service life and be more cost-effective. Beginning in 2001, a goal of forty million dollars for preventive maintenance was set. Approximately half of the trunk highway system has been identified as potentially benefiting from preventive maintenance.

Microsurfacing, crack sealing, crack repair, rut filling, chip sealing, and, in some cases, thin hot mix overlays are examples of bituminous pavement preventive maintenance activities. Joint resealing, planing, and minor Concrete Pavement Repair (which includes relatively small quantities of repair of spalled joints, cracked corners, and delaminated areas) are concrete pavement preventive maintenance activities. The performance of these more widely utilized preventive maintenance techniques as reflected in future pavement management system data will be closely scrutinized.

Endnotes for Chapter 2

[i] Distances for undivided highways are given in miles measured along the centerline of the highway, irrespective of the number of lanes. Divided highways are treated as separate roadways in each direction for the computation of distance. Due to rounding, tabular data entries do not necessarily sum to the totals displayed.

Chapter 3 Pavement Condition Measurements

The process of measuring the condition of Minnesota's trunk highway system begins with maintaining a database of a large number of attributes for each highway. The attributes include data on length, lane width, shoulder width and type, pavement type and thickness, dates of original construction and rehabilitation, traffic counts, and much more. This information is stored on Mn/DOT's Transportation Information System (TIS) as well as the pavement management software, HPMA. Currently, the link between the information stored on TIS and the events and conditions on the actual highway is a sequence of reference posts along each highway at approximately one-mile spacing.[i]

Pavement condition data is normally reported in one of two formats. The first is on a mile-by-mile basis, between consecutive reference posts and anywhere where the pavement type changes. The advantage of reporting the data in this format is that it provides the finest level of detail on the condition of the highway system. The second format is by longer project or design segments. These segments typically coincide with paving projects and tend to represent longer sections of uniform pavement. For these sections, a length-weighted condition is reported based on the mile-by-mile results. The longer sections allow for better project identification and selection.

Mn/DOT determines the pavement condition using a specially equipped Video Inspection Vehicle (VIV), manufactured by Pathways Services, Inc.

Figure 3-1 Pavement Management Van

The VIV measures the longitudinal profile of the roadway in addition to capturing video images of the pavement surface and digital images of the surrounding area. In addition, transverse oriented distress such as rutting and faulting are measured.

Mn/DOT measures two facets of pavement condition: pavement surface distress (cracks, ruts, etc.) and pavement roughness.

Pavement Surface Distress

Generally, pavement distress measurements are made over the first 500 feet of every mile, beginning at each reference post or change in pavement type.[ii] The pavement surface is videotaped with two downward-looking video cameras mounted on the VIV. Two trained technicians at the Office of Materials and Road Research view the videos and determine the type, severity and amount of the various types of pavement distress using special computer/video workstations. This procedure provides consistent measurement of surface distresses for all trunk highway pavements throughout the state, as well as a permanent record of conditions at the time of rating. An index called the Surface Rating (SR) is calculated from the distress information. The SR is intended to correspond to a rating by a panel of experienced pavement engineers. SR values range from 0.0 to 4.0. An SR of 4.0 corresponds to a new pavement with no surface distresses. An extremely distressed pavement will have an SR below 2.0.

The VIV is also equipped with five lasers mounted across the front of the vehicle. The lasers measure the distance from the van's reference bar to the pavement surface. Rutting and faulting are types of surface distress measured with the lasers. By comparing the value of the five lasers mounted across the front of the VIV, a rough estimate of the transverse profile can be made. Rut depths exceeding 0.5 inches are classified as a surface distress because they allow water to pond in the rut, resulting in icing or hydroplaning safety hazards. Excessive rut depths also indicate a lack of required structural strength for the loads to which the pavement is subjected. On concrete pavements, faulting over 0.25 inches is considered large enough to warrant attention. If either of these thresholds is exceeded, the SR is reduced.

Pavement Roughness

As the VIV travels down the highway, the lasers are continuously firing. This data is used to determine the longitudinal profile of the roadway. If the roadway were perfectly smooth, the measurements would always be the same as the vehicle traveled along it. However, as bumps and dips are encountered the distance to the pavement surface changes. These deviations from a perfectly smooth road are defined as pavement roughness. The road surface profile is continuously measured over the mile-by-mile sections. For each section, an internationally based parameter termed the International Roughness Index (IRI) is calculated. The IRI is typically reported in meters/kilometer or inches/mile. It is based on the total vertical departure, from perfectly smooth, a standard vehicle would experience if it were driven over the section of roadway. To correlate the IRI measured by the VIV to how it is perceived or tolerated by drivers, Mn/DOT periodically assembles groups of people to rank pavement roughness on a scale of 0.0 to 5.0. An equation is then developed to compute the Present Serviceability Rating (PSR) from the IRI values. A PSR value of 5.0 would correspond to a perfectly smooth pavement surface. New pavements typically have a PSR of about 4.3. Most people feel a pavement is uncomfortable to drive long distances on when the PSR is about 2.5.

The Pavement Quality Index (PQI) is a composite index derived from SR and PSR values to give an overall rating to each pavement segment. The PQI value is the geometric mean of the SR and PSR values. That is, the PQI is the square root of the product of the SR and PSR. The PQI ranges from 0.0 to 4.5.

The procedures and techniques by which the PQI, SR, and PSR are developed can be found in the Mn/DOT Surface Distress Manual, available from the Pavement Management Unit, Office of Materials and Road Research.

New Pavement Condition Activities for 2001

The following items were done for the first time in 2001.

- The condition of the longitudinal joint between lanes and along the shoulder was assessed and the SR adjusted accordingly. In the past, the outer 12-inches of the lane was ignored.

- The PSR was determined for every mile of trunk highway, in both directions. In the past, only about 60 percent of the system was measured annually, in one direction only.

- In addition to the normal pavement profile and surface distress, the VIV was used to capture digital video-log images. These images, which provide a driver's perspective of the roadway, are used for preliminary design, traffic studies, material investigations and other purposes. Using special software, the images can be viewed from the comfort and safety of the user's office. In the past, these images were collected with a separate vehicle.

Endnotes for Chapter 3

[i] The actual distance between reference posts is accurately maintained in the database. Numbering of reference posts begins at the state's western or southern border or at the most southerly or westerly terminus of the highway.

[ii] Generally, only the outermost lane of multilane highways is measured. Divided highways are considered separate roadways. The 500 feet past each reference post and intermediate changes in pavement type are measured for surface distresses.

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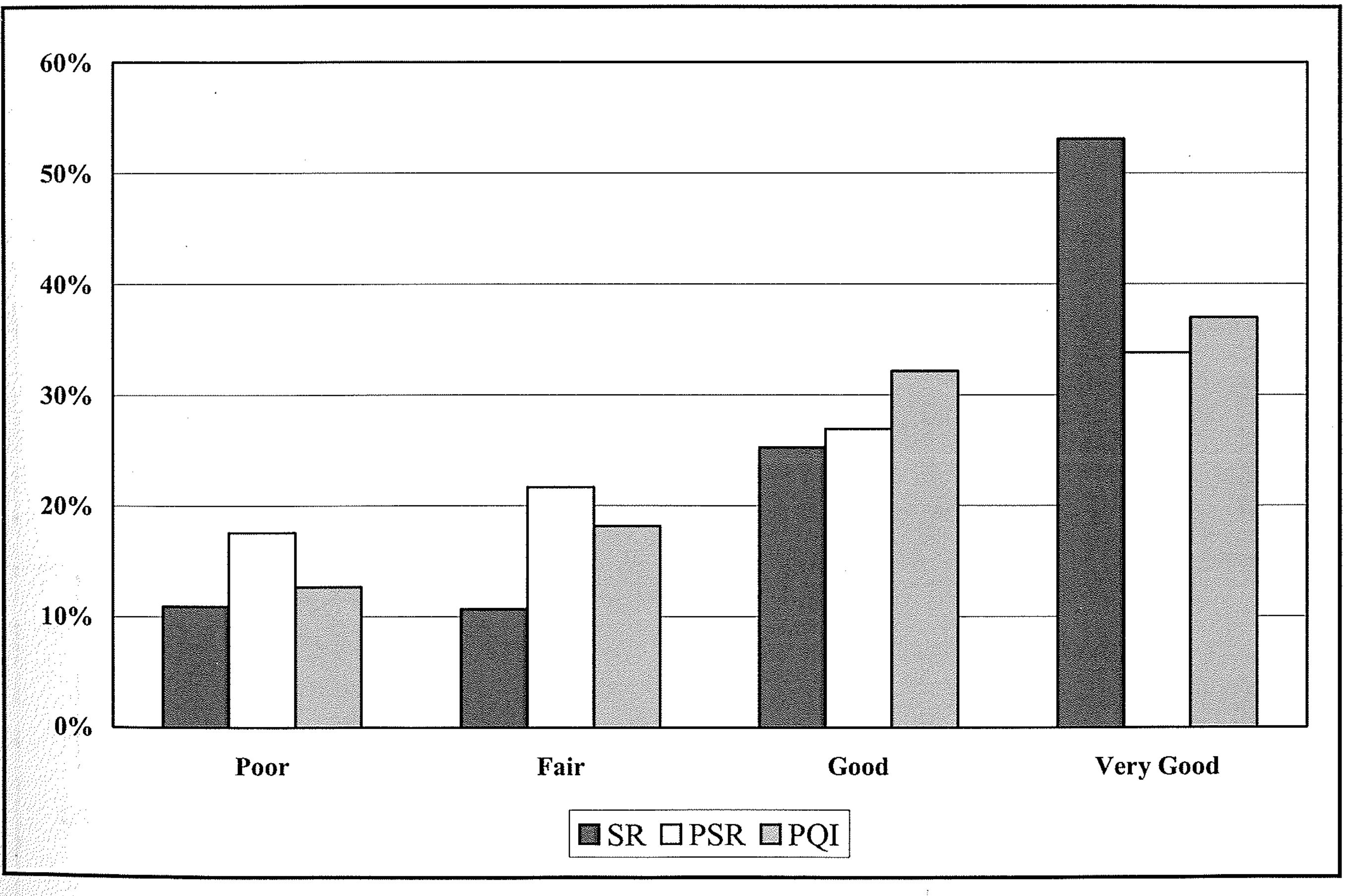
Chapter 4 Statewide Conditions

Figure 4-1 is a distribution of the current values of the PQI, PSR, and SR into four categories: "Poor," "Fair," "Good," and "Very Good." The category ranges are show in Table 4-1. Beginning with next year's annual report, the pavement conditions will be broken down into five categories to be consistent with guidelines from the Federal Highway Administration (FHWA). The categories will be "Very Poor," "Poor," "Fair," "Good," and "Very Good."

Table 4-1 Descriptive Categories of Pavement Condition

Index	Poor	Fair	Good	Very Good
PSR	0.0 – 2.8	2.9 – 3.2	3.3 – 3.6	3.7 – 5.0
SR	0.0 – 2.8	2.9 – 3.2	3.3 – 3.6	3.7 – 4.0
PQI	0.0 – 2.8	2.9 – 3.2	3.3 – 3.6	3.7 – 4.5

Figure 4-1 Statewide Performance Indices by Performance Classification



In order to provide more detailed information about the historical shifts in pavement condition, cumulative distribution graphs are shown in Figures 4-2, 4-3 and 4-4 for SR, PSR and PQI, respectively. These distribution plots show the percentage of roadway miles with an index value equal to or less than the values shown on the horizontal axis.[i]

Figures 4-2, 4-3, and 4-4 show the distribution curves for the SR, PSR, and PQI, respectively, for each of the last five years. Figure 4-2 shows a decrease in the SR from 2000 to 2001 (curve is shifted to the left). One likely cause of this shift is the adding the longitudinal joint distress in 2001 as described in Chapter 3.

The change in the PSR distribution over the past five years is much more modest. In 2001, the data shows that there was an increase in the number of roads with a PSR above 3.3 compared with 2000 (a shift to the right). The range of PSR values more evenly spans the classifications from "Poor" to "Very Good" than that of the SR. The situation for the PQI is intermediate, since it is a composite of the SR and PSR.

Figure 4-2 Cumulative Distribution of Statewide Surface Rating (SR), 1997-2001

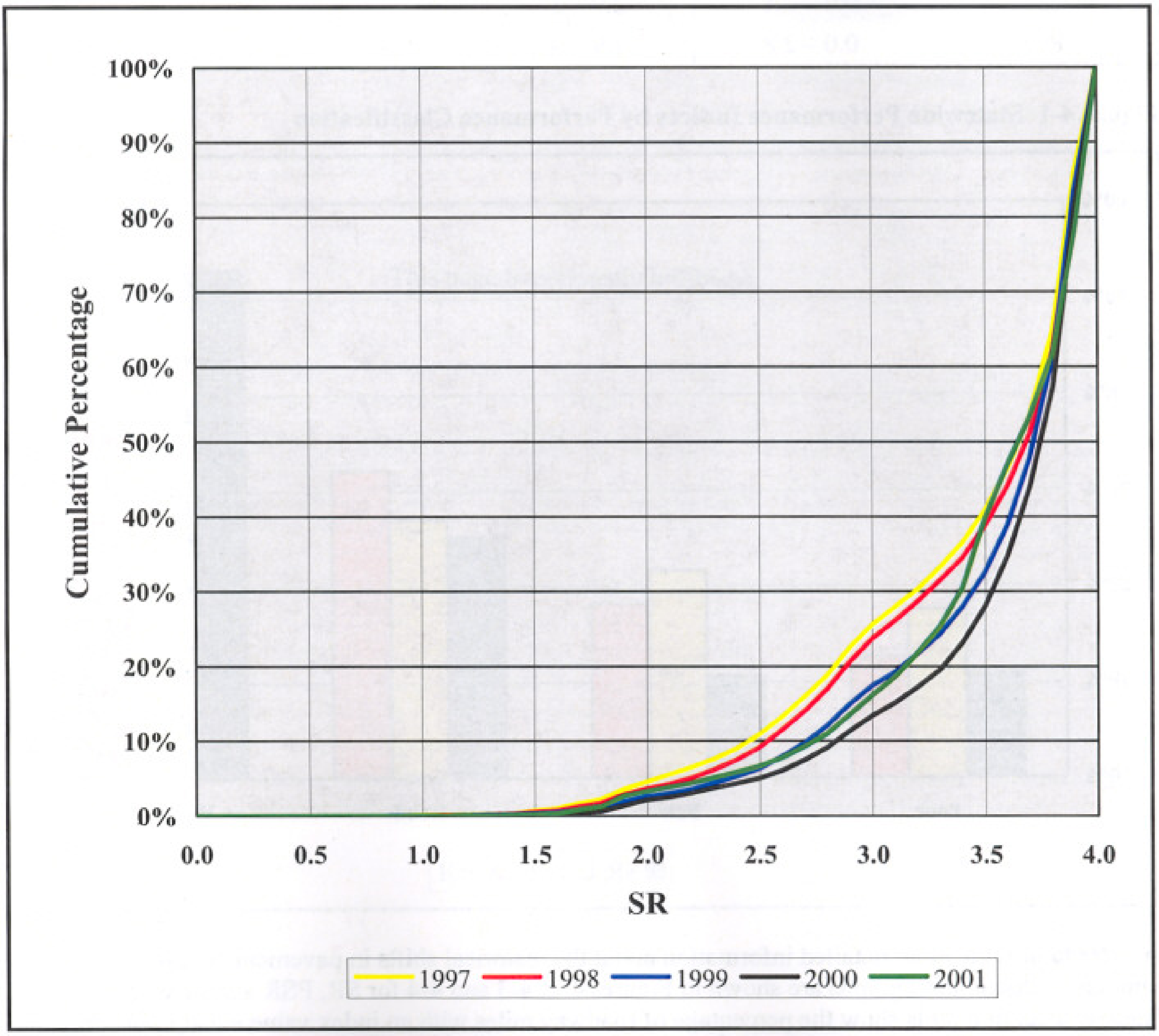


Figure 4-3 Cumulative Distribution of Statewide Present Serviceability Rating (PSR), 1997-2001

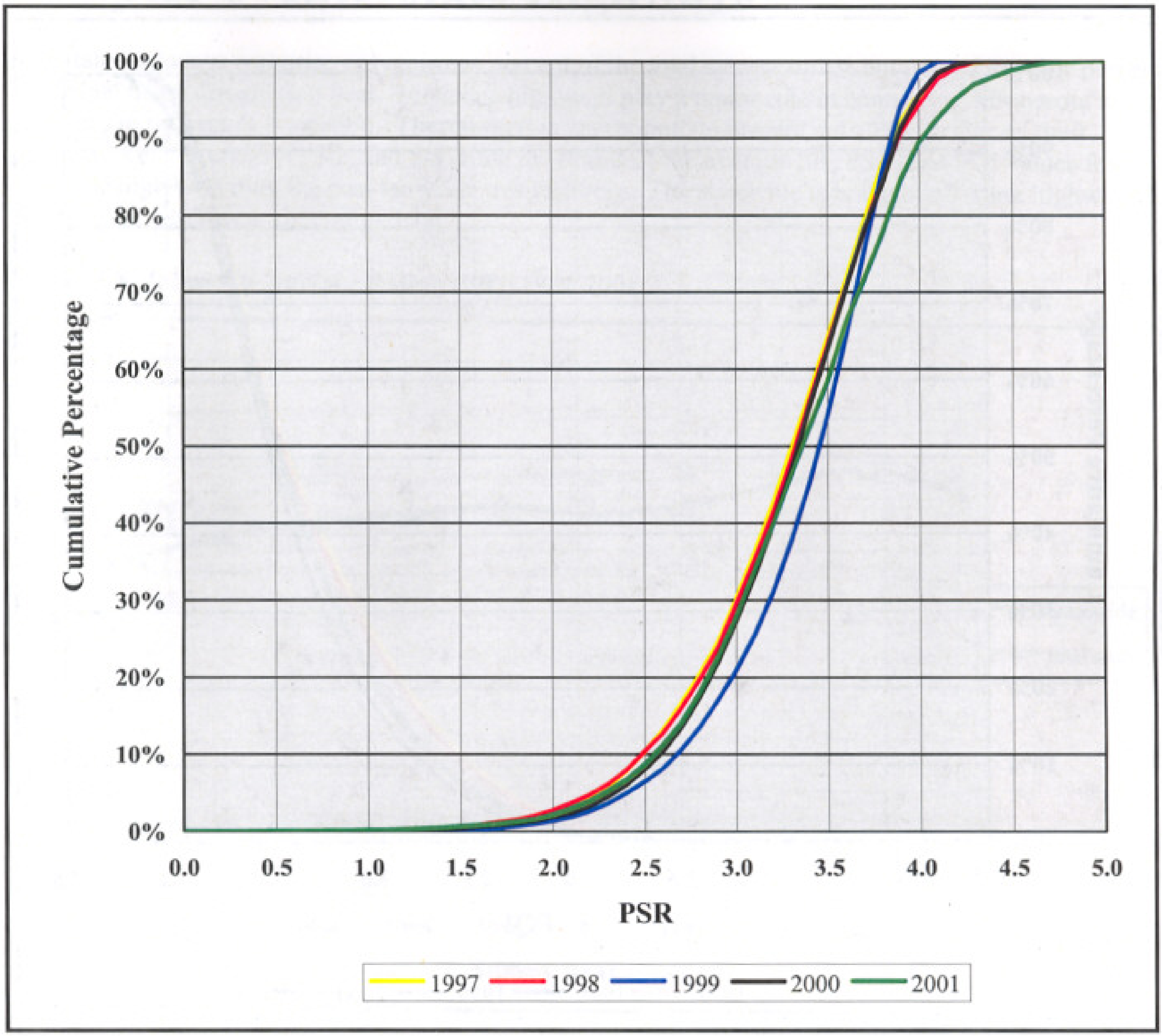
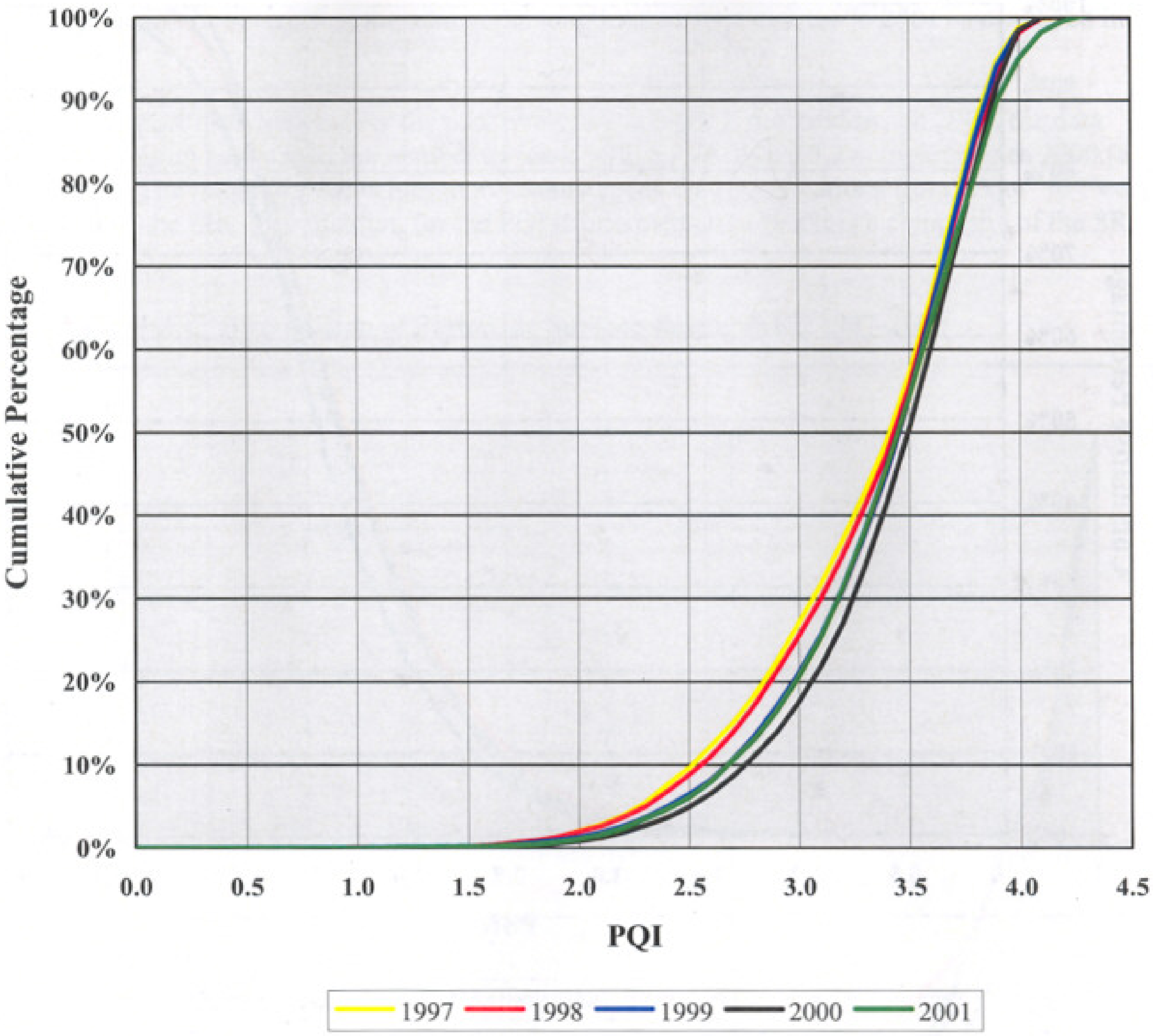


Figure 4-4 Cumulative Distribution of Statewide Pavement Quality Index (PQI), 1997-2001



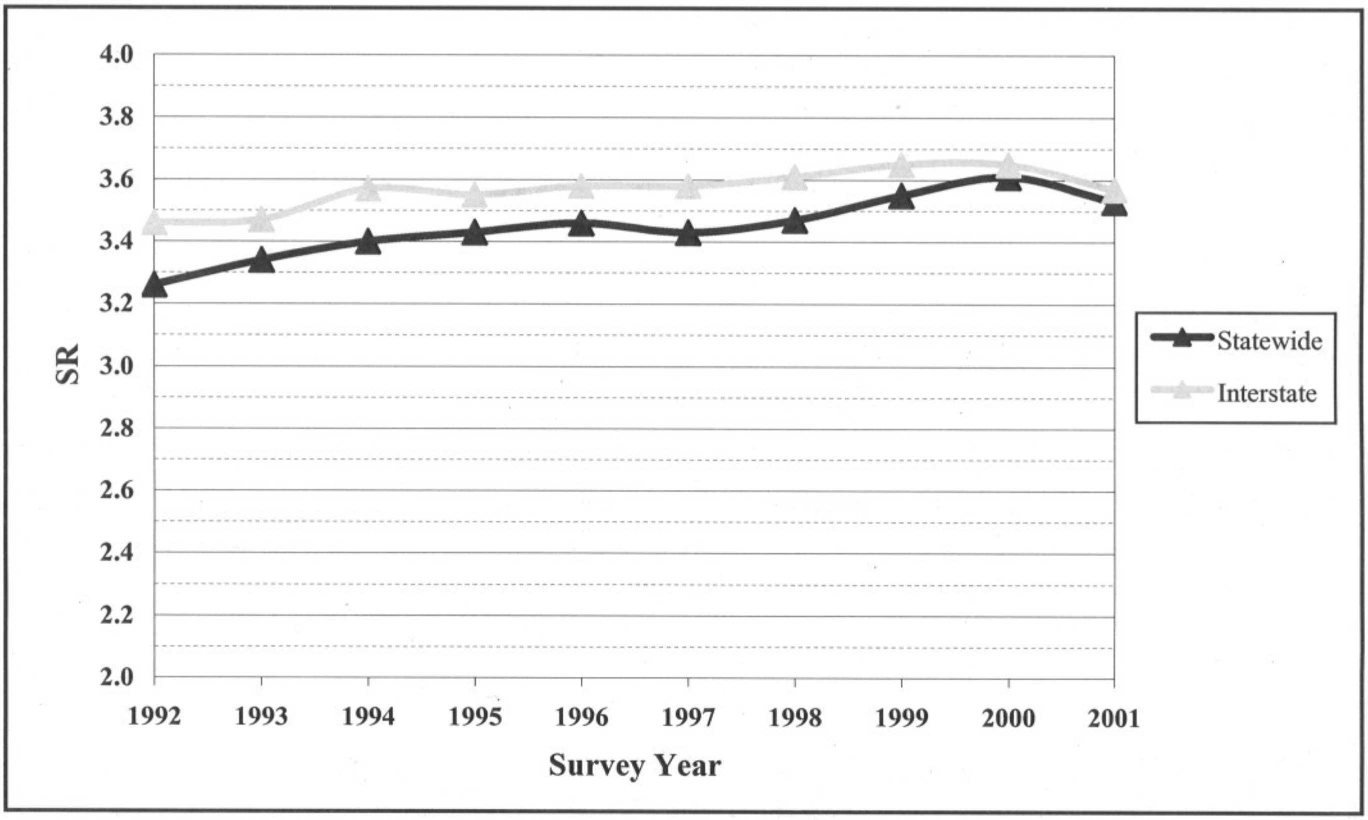
Endnotes for Chapter 4

[i] The index value for which fifty percent of the pavement mileage has an equal or lower index value is not the mean value. Rather, it is the median value. It is not equivalent to the average or mean values presented herein, which are length-weighted averages.

Chapter 5 Interstate Highways

Interstate highways comprise only thirteen percent of the total system miles, but carry forty-five percent of vehicle miles driven each year. Interstate highways play a major role in connecting Minnesota's economy to the rest of the nation. Therefore, it is appropriate to present data specifically on their performance. Figures 5-1, 5-2, and 5-3 show the trends of the average SR, PSR, and PQI values for interstate highways over the past ten years, respectively. The statewide average of all trunk highways is displayed for each year for comparison.

Figure 5-1 Interstate Surface Rating (SR), 1992-2001



The average SR of both the entire trunk highway system, as well as the interstate system, shows a fairly large drop in 2001. This is primarily related to a new distress being measured for the first time in 2001. In years prior to 2001, the condition of the pavement surface at the edges of the lane was ignored. However, since the lack of density along this paving seam can lead to premature pavement failure, it was decided to include any distress in this area in the SR calculation. The result is a lower SR for any road with this type of distress in 2001 compared to 2000. It is felt that including this distress type provides a more realistic evaluation of the pavement condition.

The data also shows that the average PSR on the interstate system remained relatively unchanged in 2001 while the entire state system had an increase. However, the condition of the interstate system remains slightly better than the statewide average for all three indices.

Figure 5-2 Interstate Present Serviceability Rating (PSR), 1992-2001

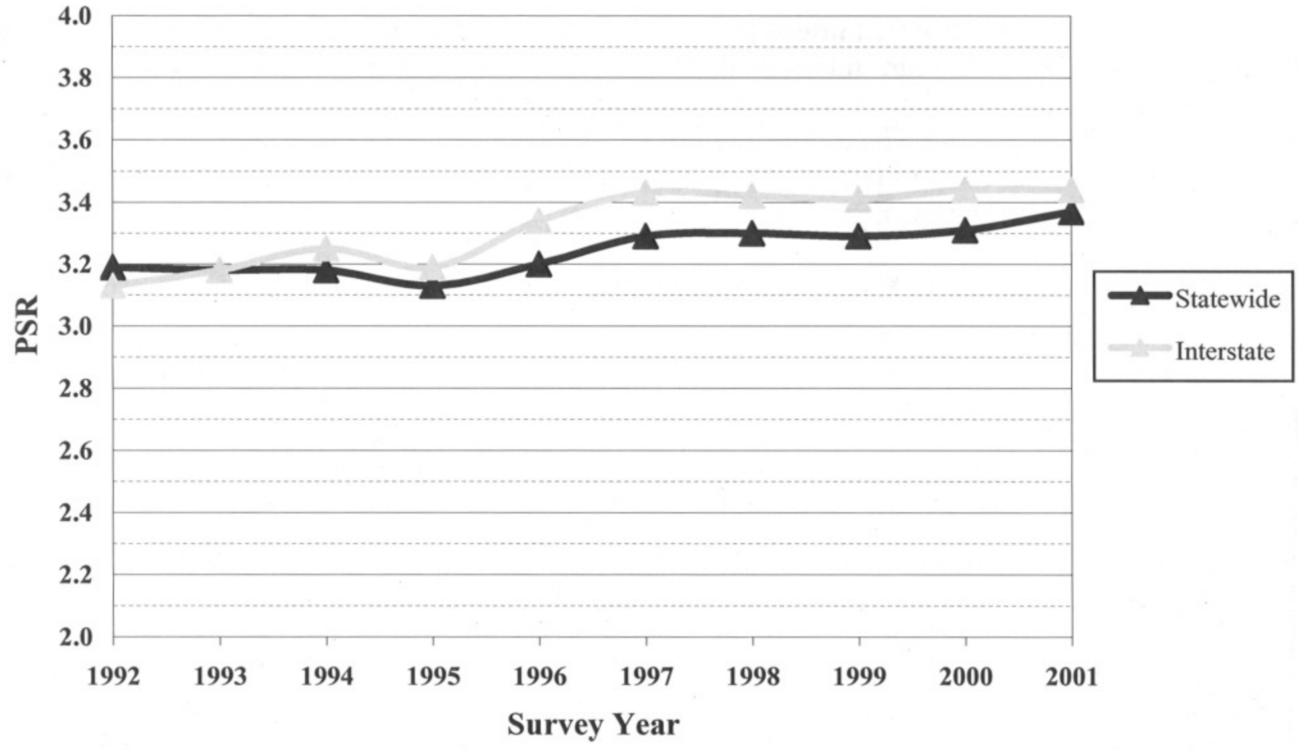
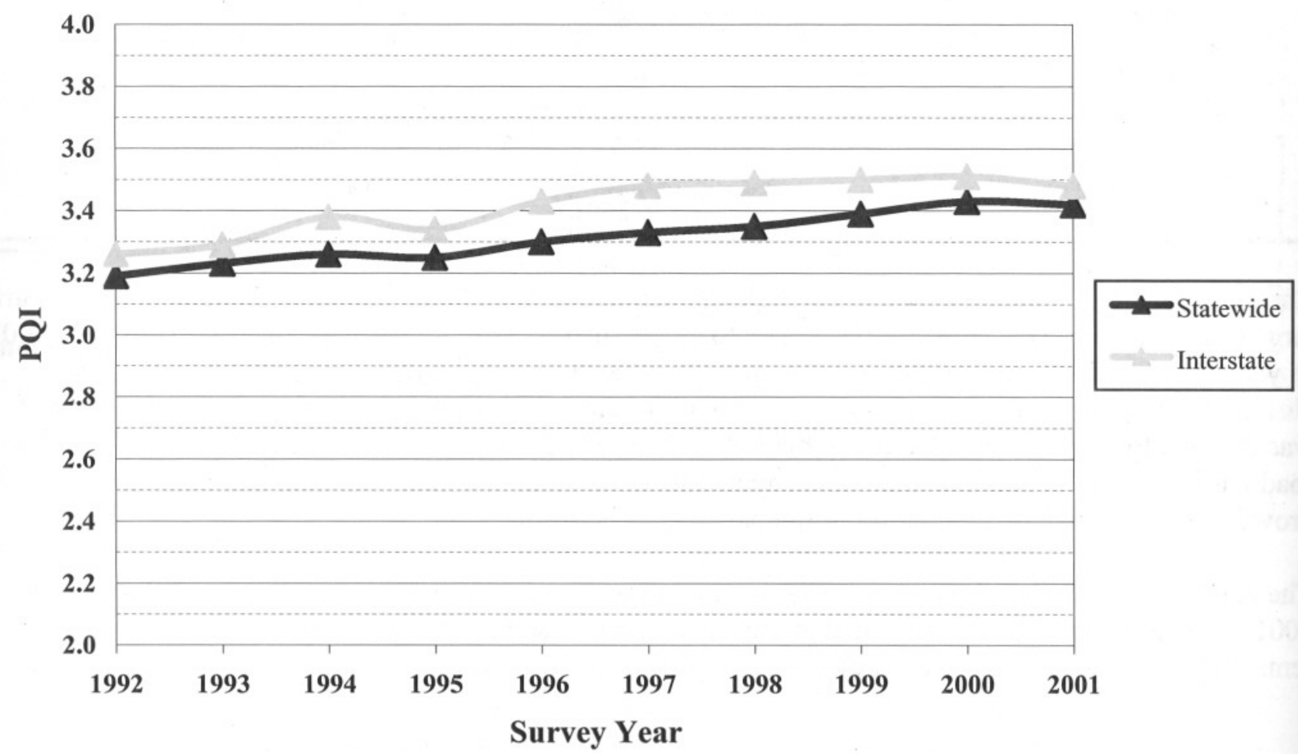


Figure 5-3 Interstate Pavement Quality Index (PQI), 1992-2001



Chapter 6 District Historical Trends

To put the current conditions in perspective, it is useful to review historical trends. Figures 6-1 to 6-24 are plots comparing each district with the overall trunk highway system from 1992 through 2001. The statewide average for each year is displayed for comparison. Differences in the relative performance of districts for average index values may be attributable to a higher percentage of high priority functional classes (which have higher trigger values), more severe climatic extremes, or the balance of funds devoted to rehabilitation as contrasted with those allocated to maintenance.

Due to the size of the system, the effects of recent actions are relatively difficult to discern regardless of their magnitude. As a result, consistent action or inaction over a long period of time has a profound impact on the current results. To make valid inferences about causal relationships requires that the independent variables be adequately controlled and the data be evaluated over a long enough period of record.

Observations

Surface Rating (SR)

As explained above, the SR in 2001 includes the condition of the area along the edges of the lane being surveyed. As a result, most districts' average SR dropped in 2001. Although not all of the decrease in SR can be attributed to this new distress, it is likely responsible for the majority of the decrease.

D-1 continues the large increase in SR that began in 1999. Since then, they have increased the average SR nearly 13 percent and are now above the state average for the first time since 1987. District 3 is the only other district that had an increase in SR in 2001.

D-2, D-6, and D-7 had drops in SR large enough to put them below the state average in 2001.

Present Serviceability Rating (PSR)

The plots also show that D-1 had a large increase in PSR in 2001 as a result of the one-time increased funding and is now nearly at the state average. D-6 had the largest drop in PSR in 2001, falling below the state average for the first time since 1993. Metro also had a drop in PSR and is now below the statewide average, the first time since 1986. All other districts had a slight increase in PSR or remained virtually the same in 2001.

Pavement Quality Rating (PQI)

Since the PQI is derived from the PSR and SR, it tends to follow the same trends. D-6, D-7, and Metro had the largest drops in PQI in 2001. D-6 and D-7 are now below the statewide PQI average.

D-1 and D-3 were the only two districts that had an increase in PQI in 2001. In fact, they were the only two districts that had an increase in all three indices in 2001.

Figure 6-1 District 1 Surface Rating (SR), 1992-2001

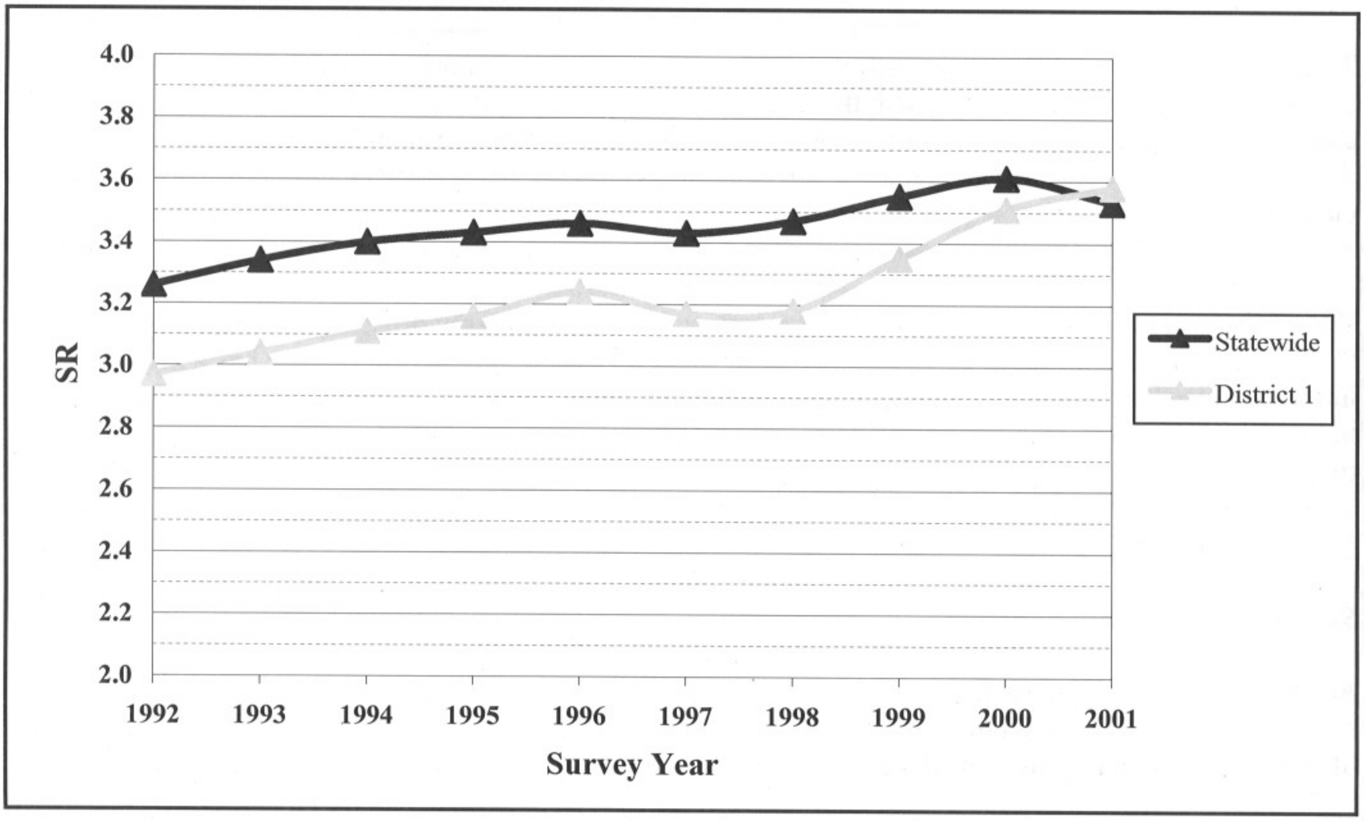


Figure 6-2 District 2 Surface Rating (SR), 1992-2001

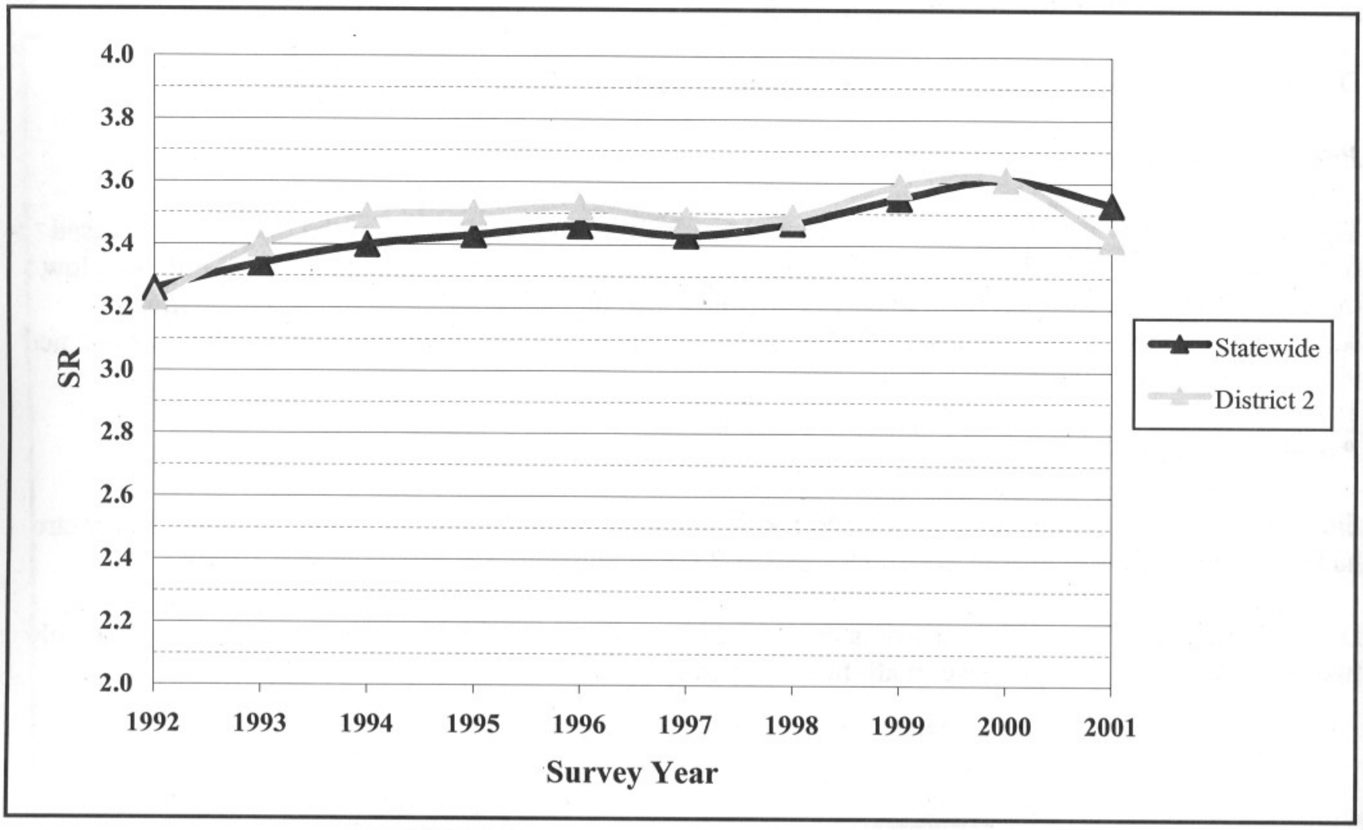


Figure 6-3 District 3 Surface Rating (SR), 1992-2001

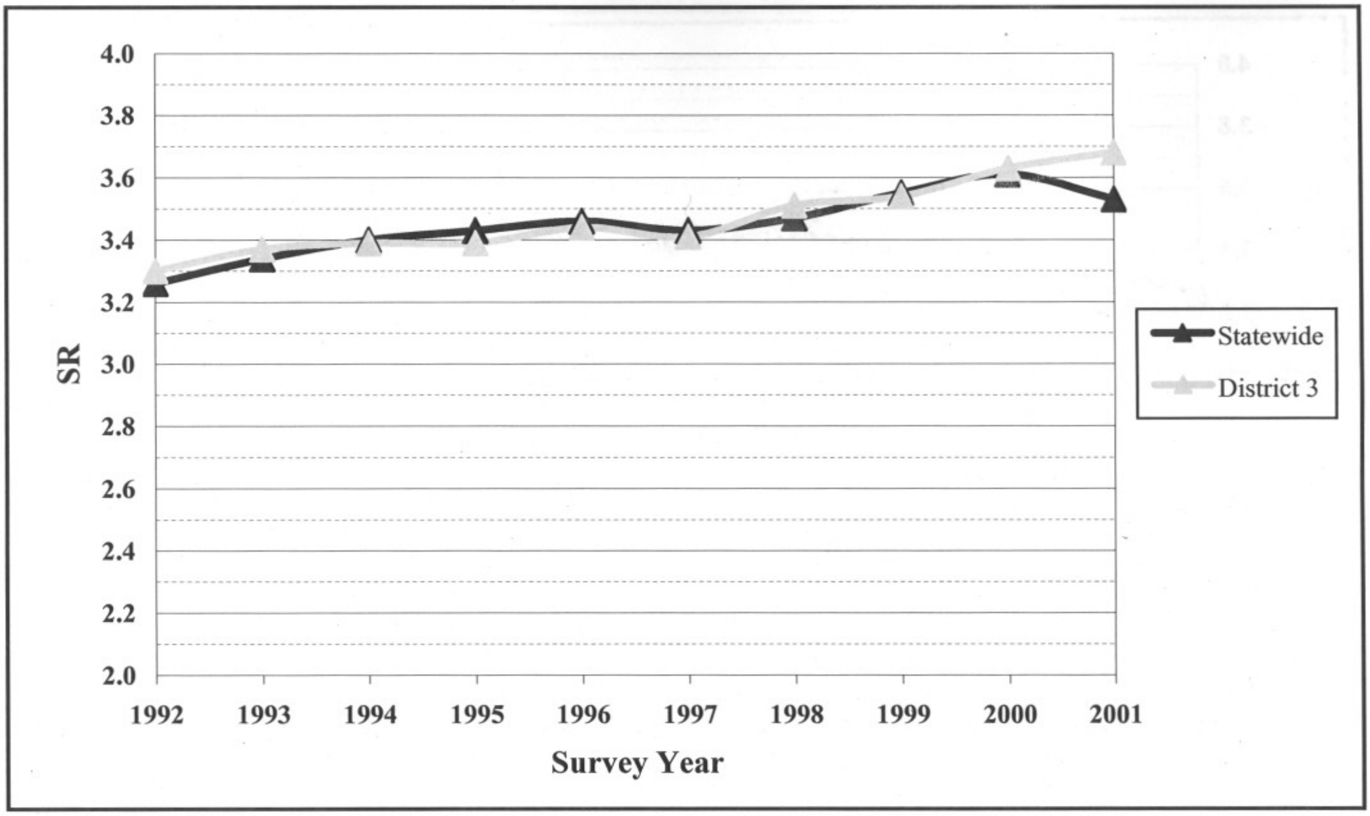


Figure 6-4 District 4 Surface Rating (SR), 1992-2001

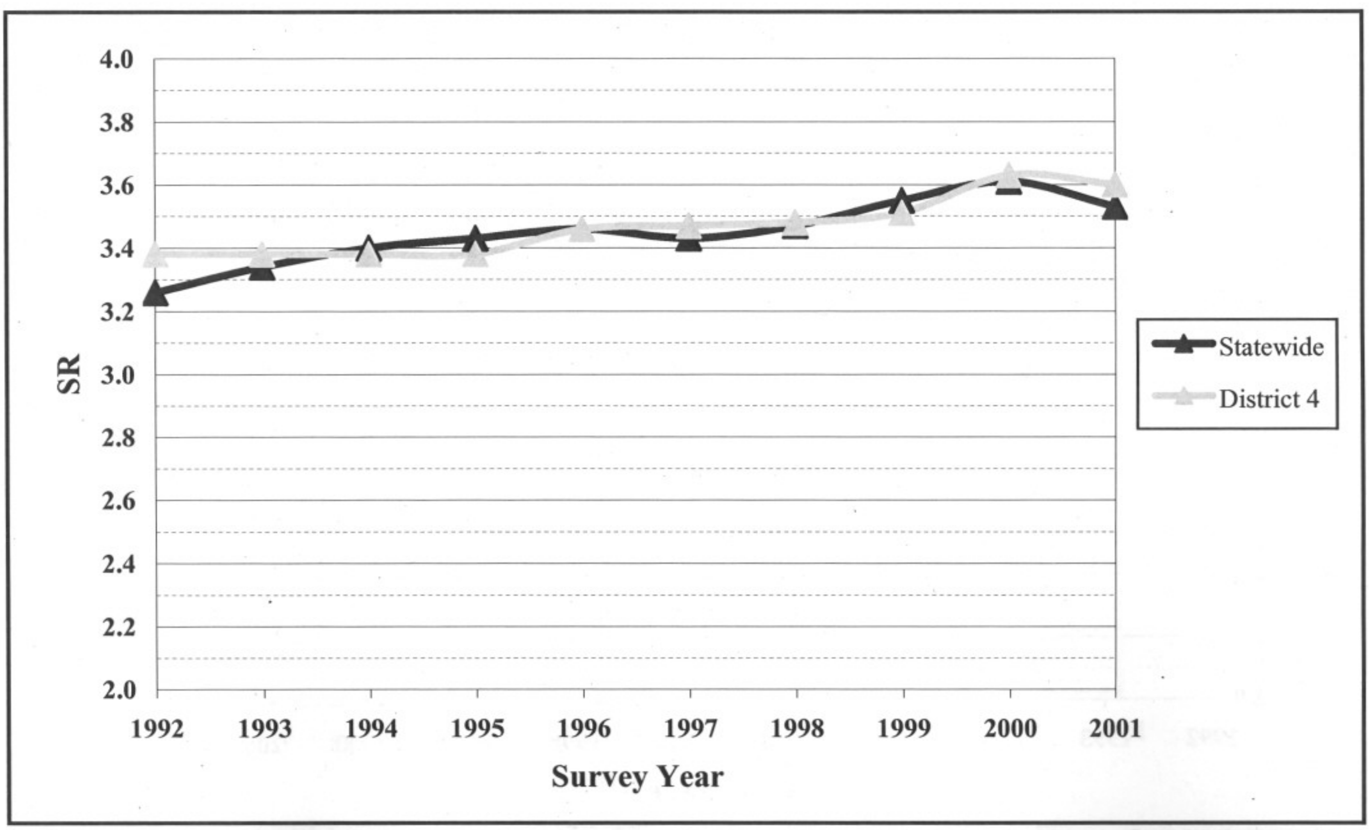


Figure 6-5 District 6 Surface Rating (SR), 1992-2001

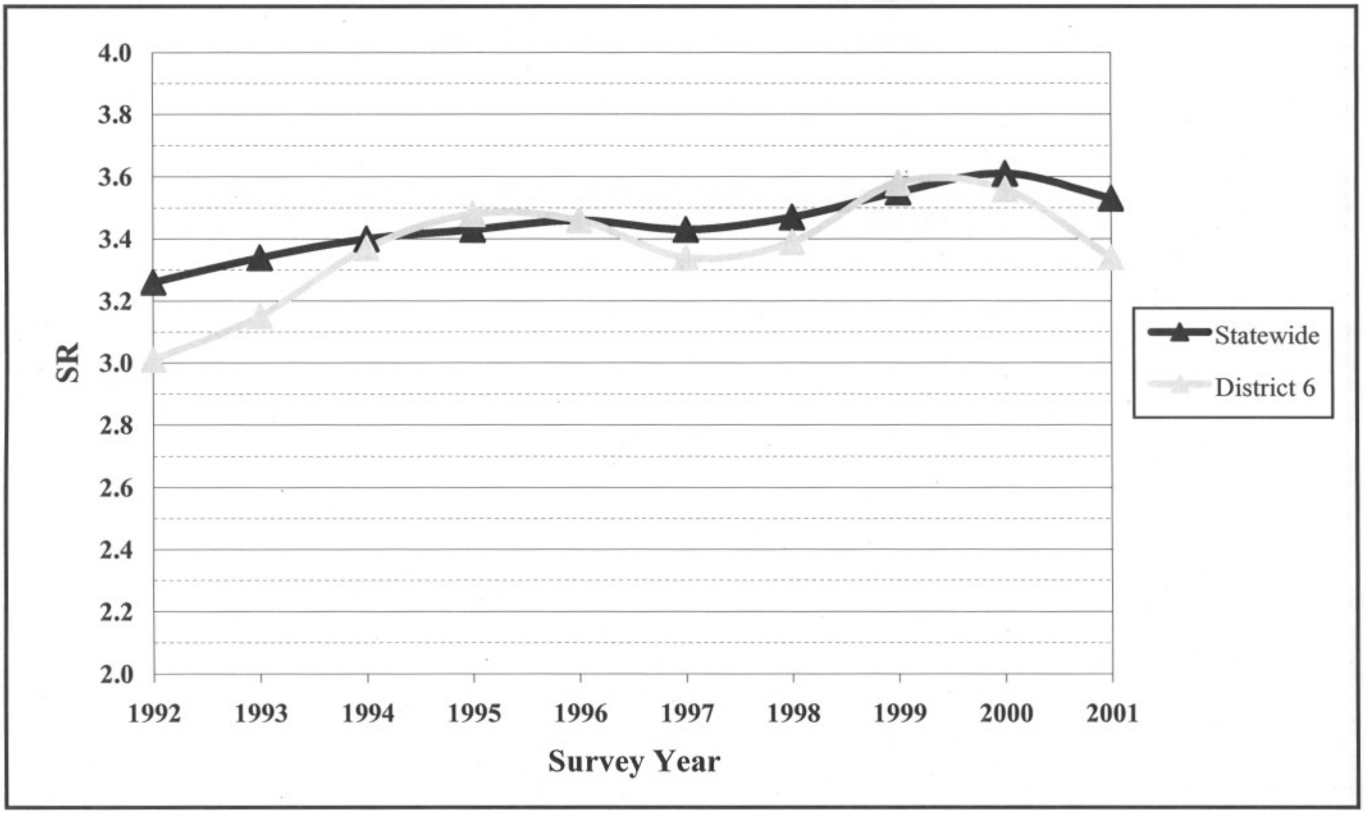


Figure 6-6 District 7 Surface Rating (SR), 1992-2001

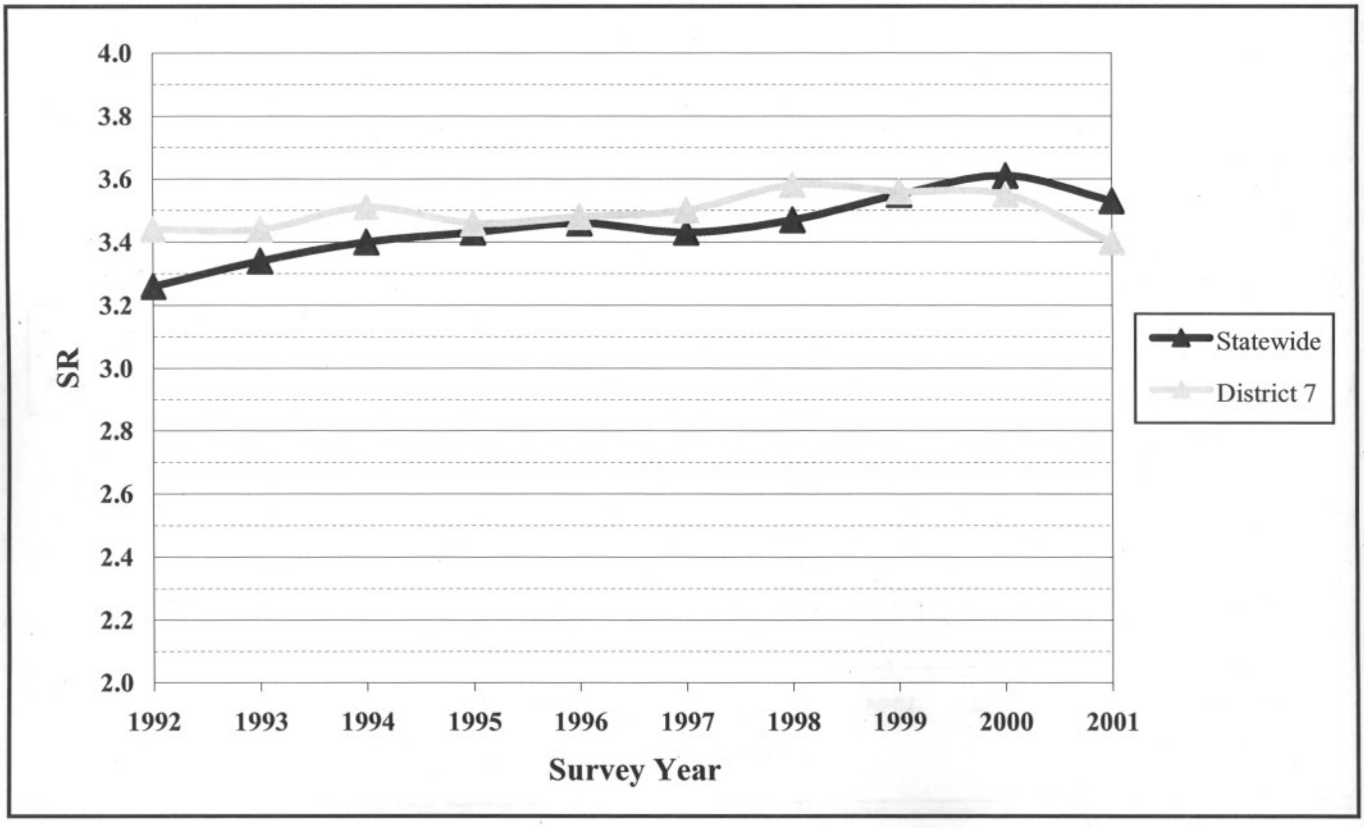


Figure 6-7 District 8 Surface Rating (SR), 1992-2001

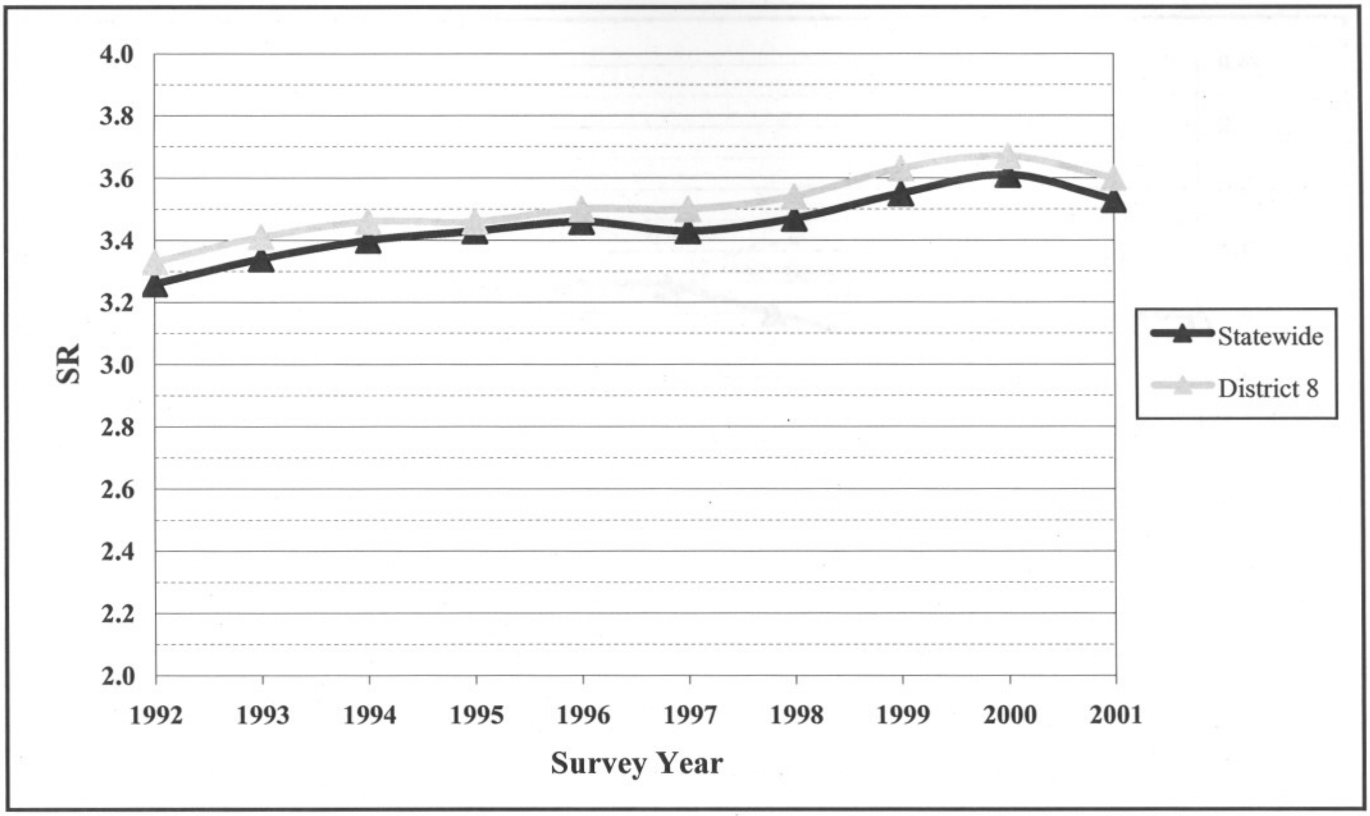


Figure 6-8 Metro Surface Rating (SR), 1992-2001

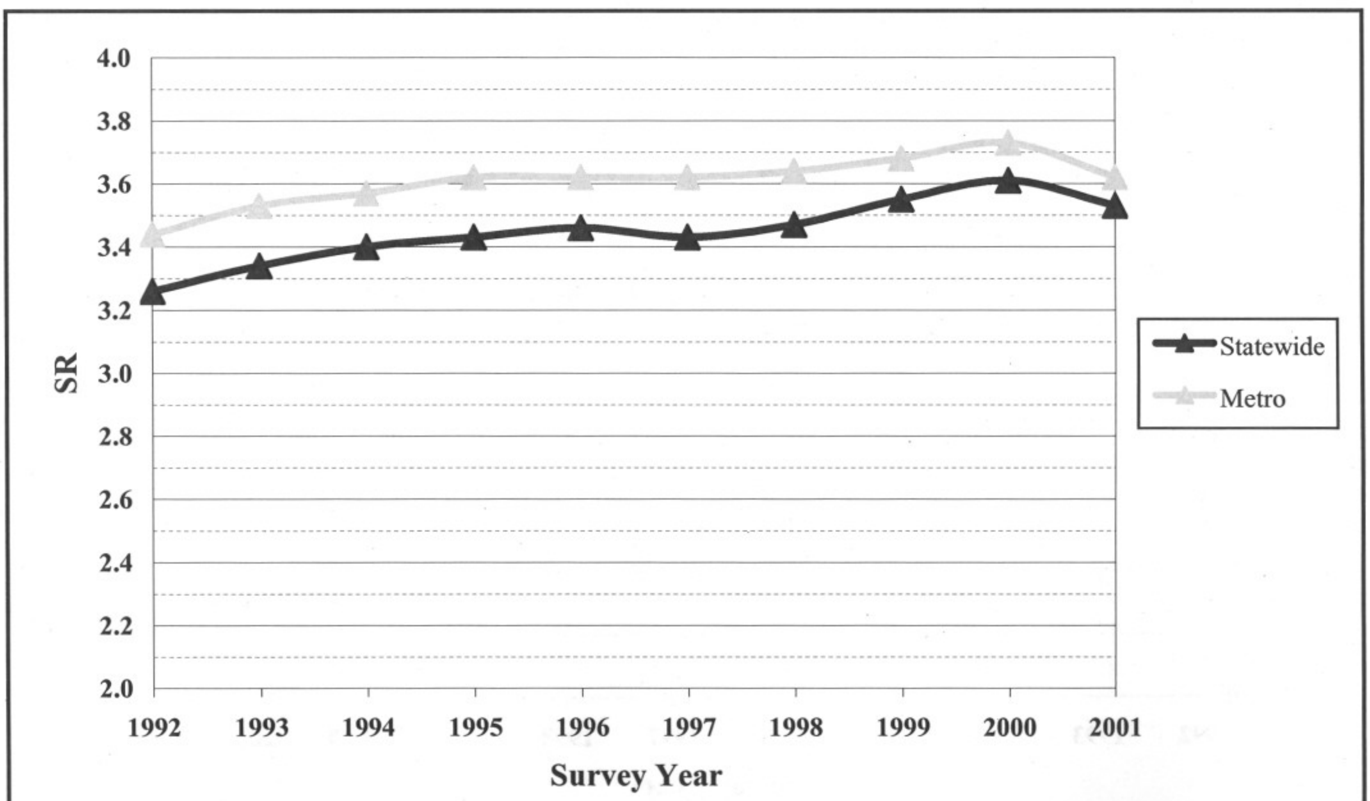


Figure 6-9 District 1 Present Serviceability Rating (PSR), 1992-2001

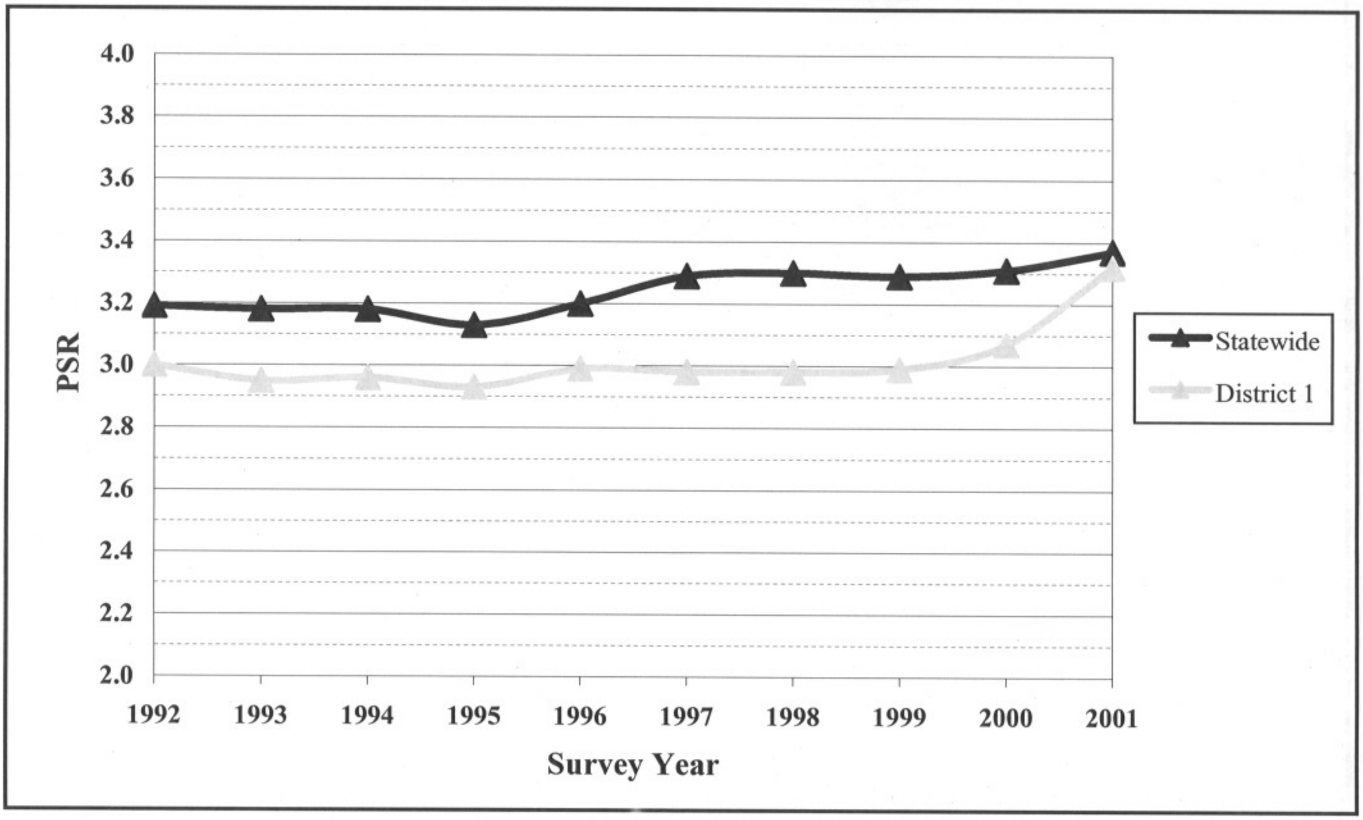


Figure 6-10 District 2 Present Serviceability Rating (PSR), 1992-2001

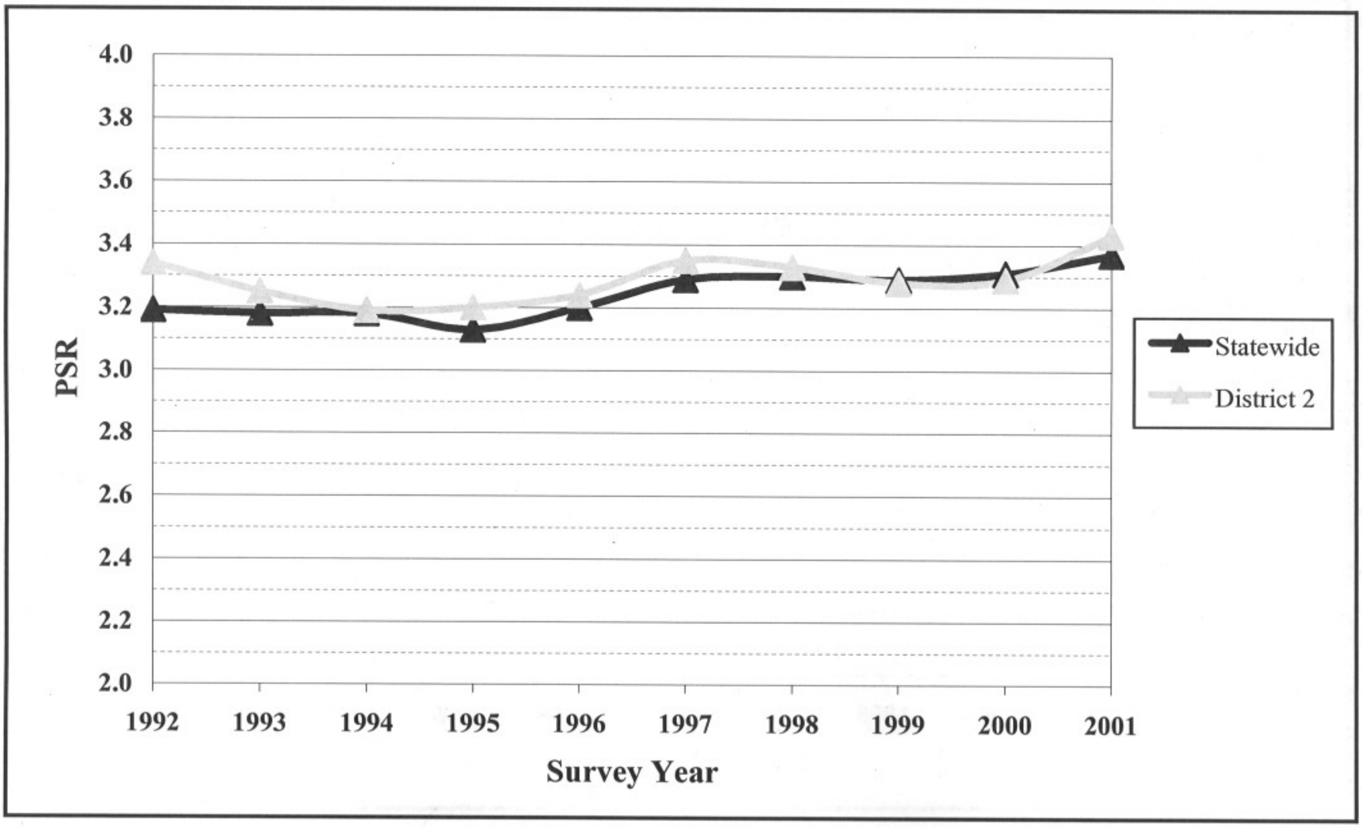


Figure 6-11 District 3 Present Serviceability Rating (PSR), 1992-2001

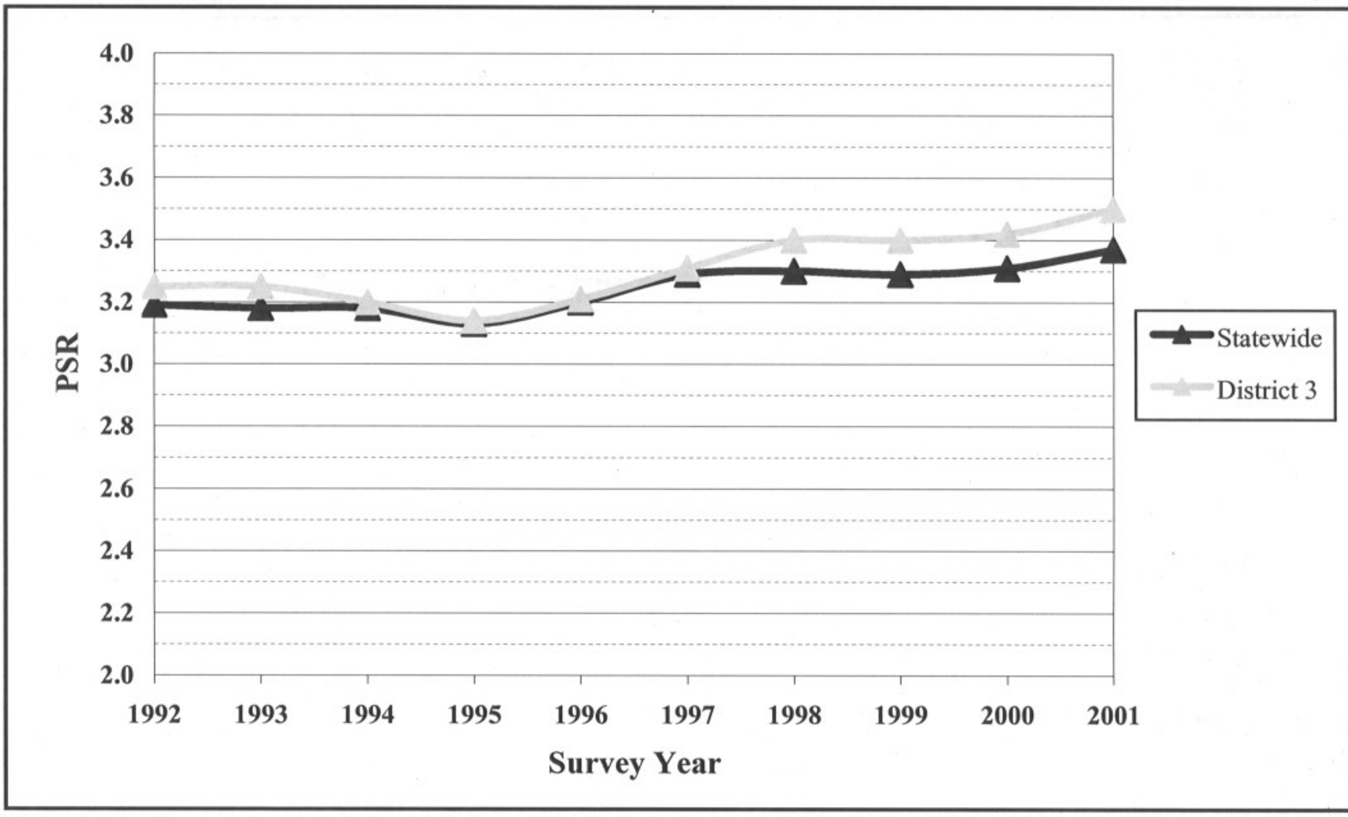


Figure 6-12 District 4 Present Serviceability Rating (PSR), 1992-2001

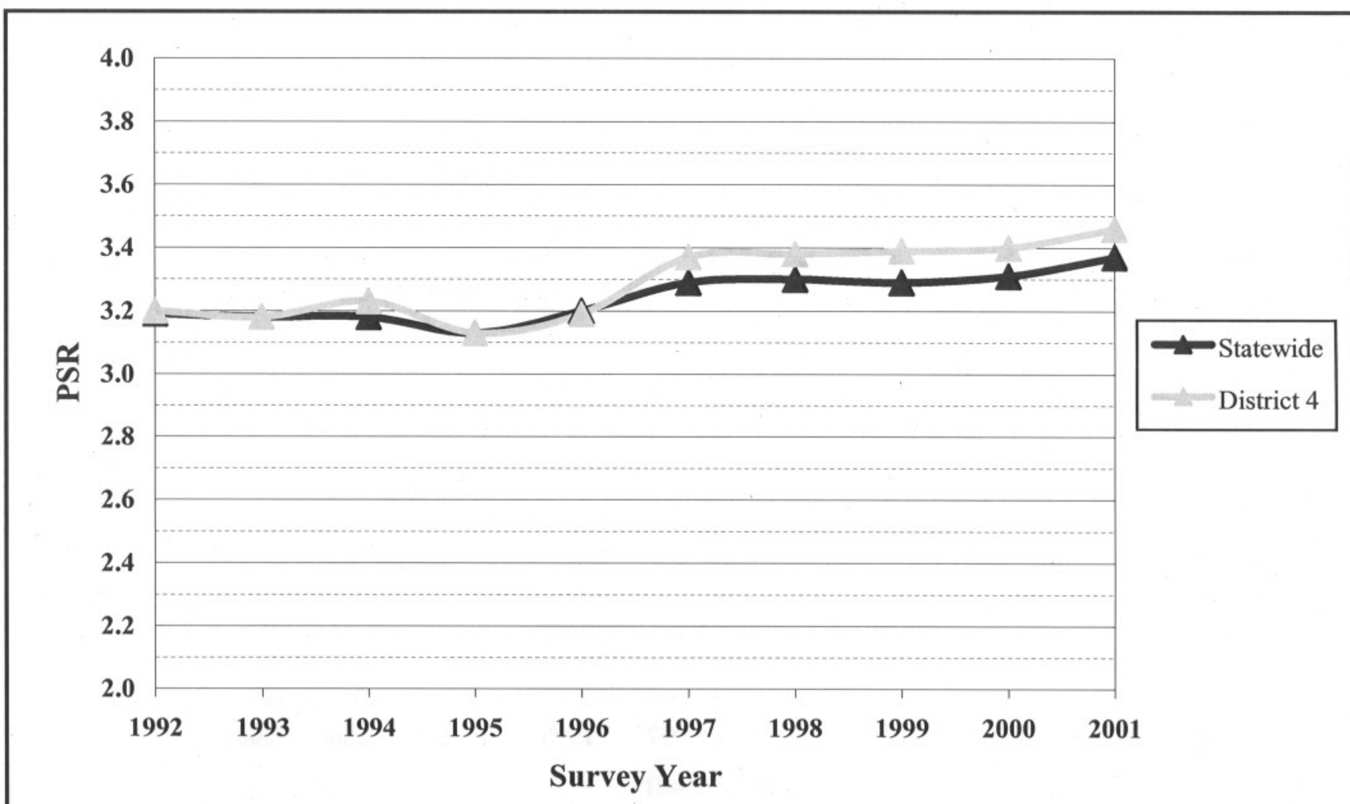


Figure 6-13 District 6 Present Serviceability Rating (PSR), 1992-2001

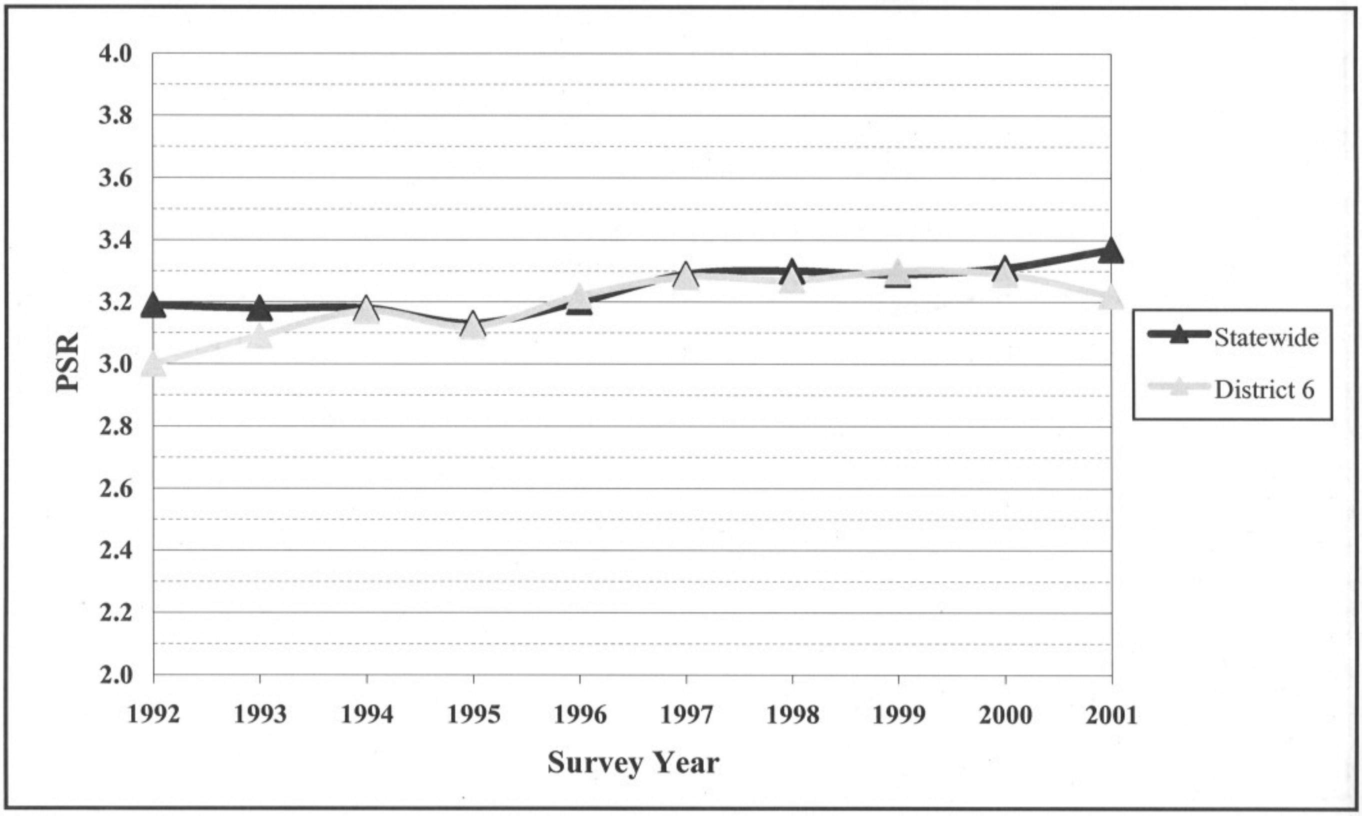


Figure 6-14 District 7 Present Serviceability Rating (PSR), 1992-2001

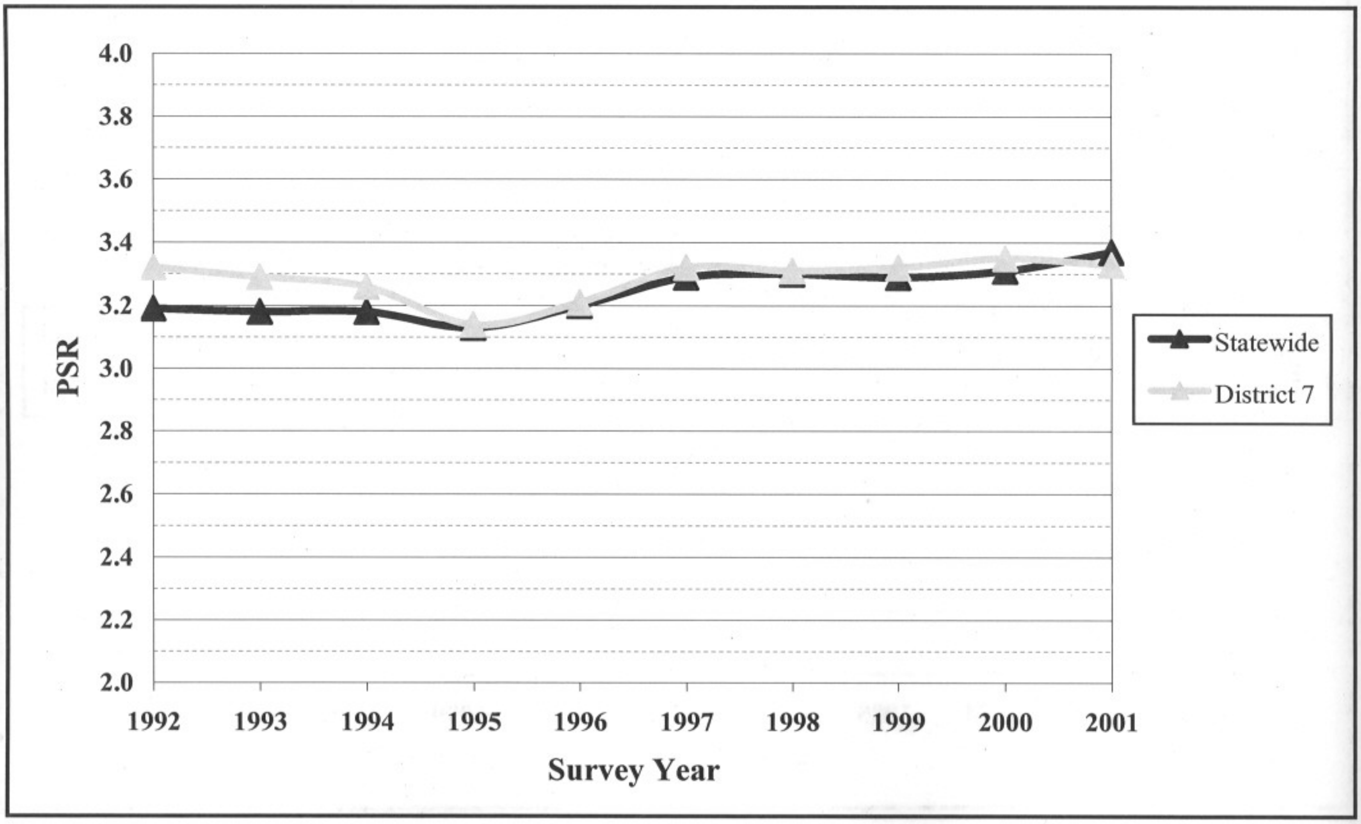


Figure 6-15 District 8 Present Serviceability Rating (PSR), 1992-2001

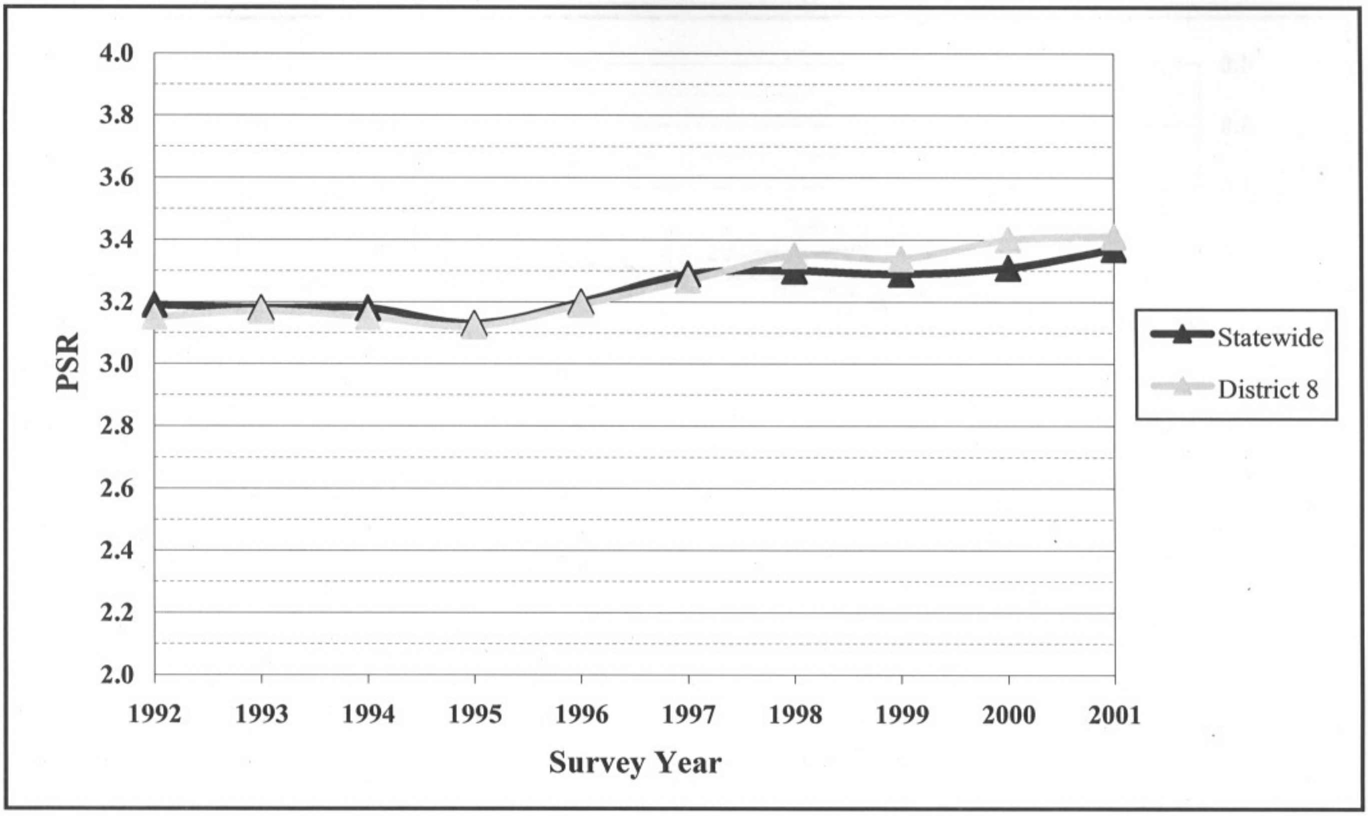


Figure 6-16 Metro Present Serviceability Rating (PSR), 1992-2001

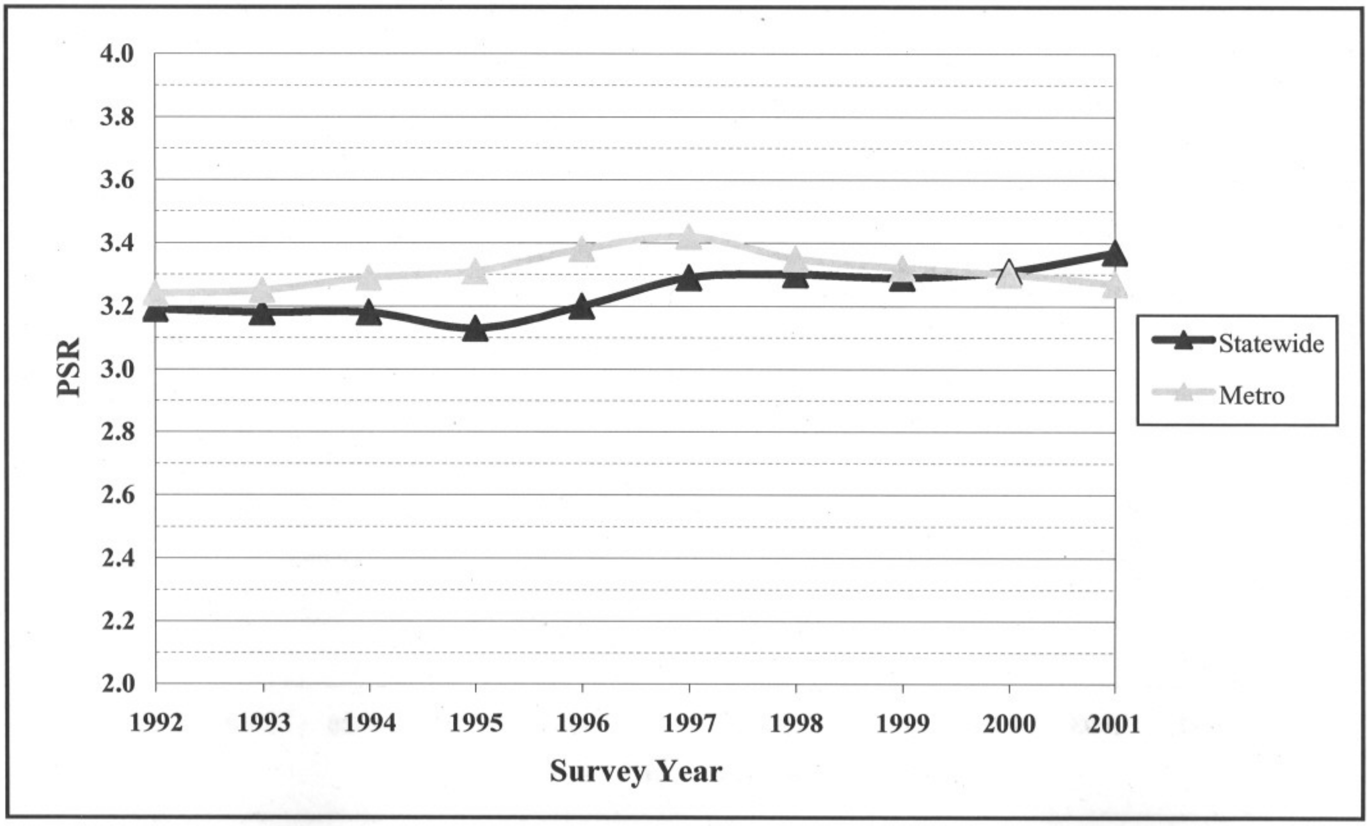


Figure 6-17 District 1 Pavement Quality Index (PQI), 1992-2001

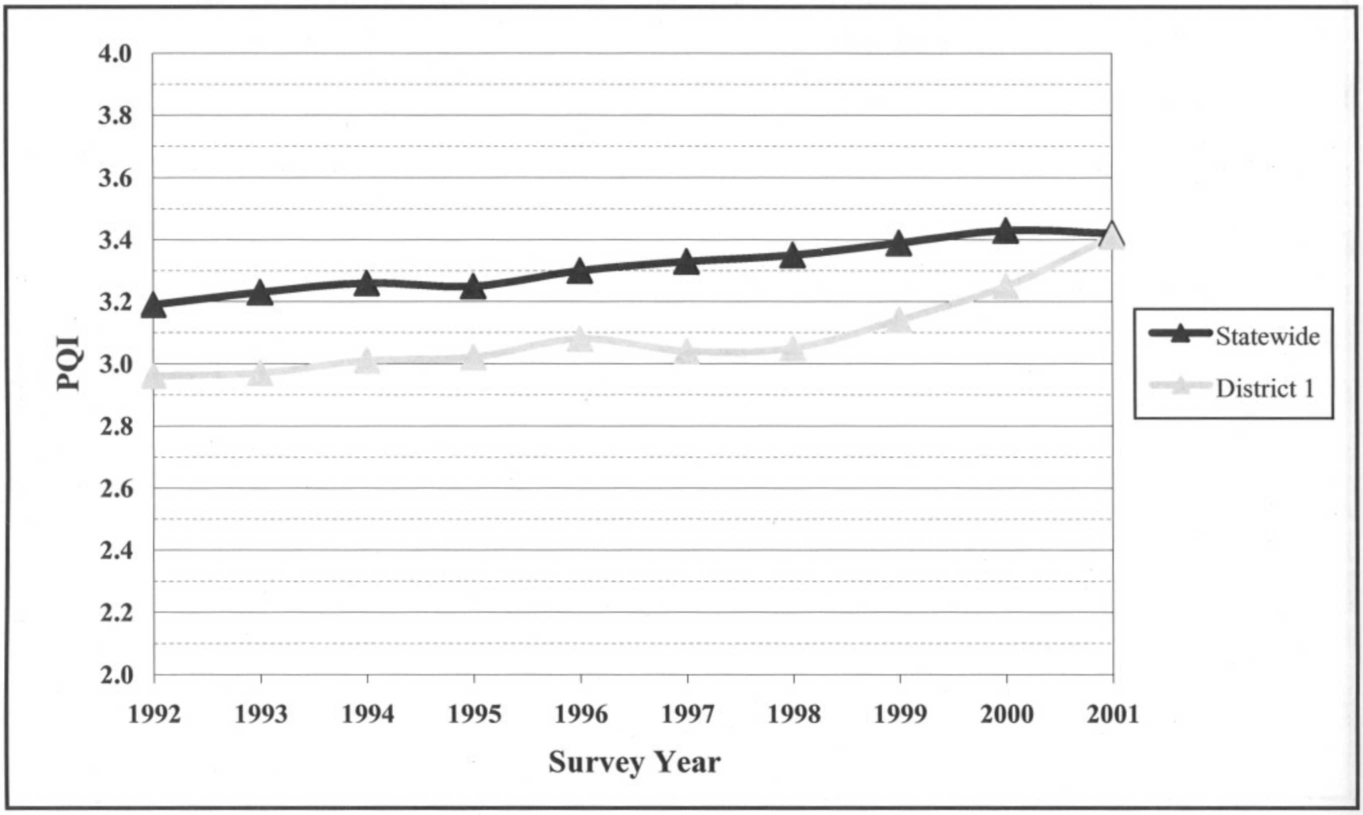


Figure 6-18 District 2 Pavement Quality Index (PQI), 1992-2001

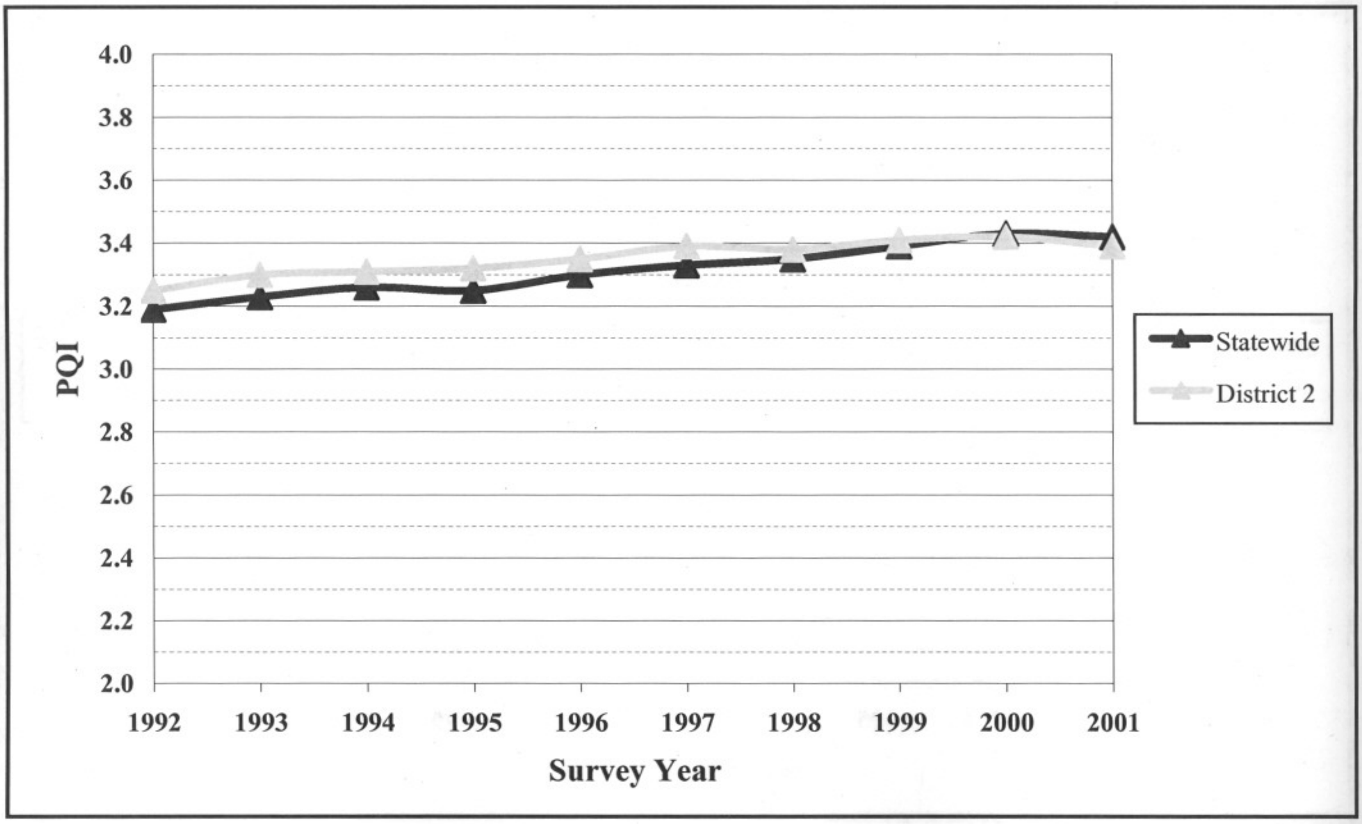


Figure 6-19 District 3 Pavement Quality Index (PQI), 1992-2001

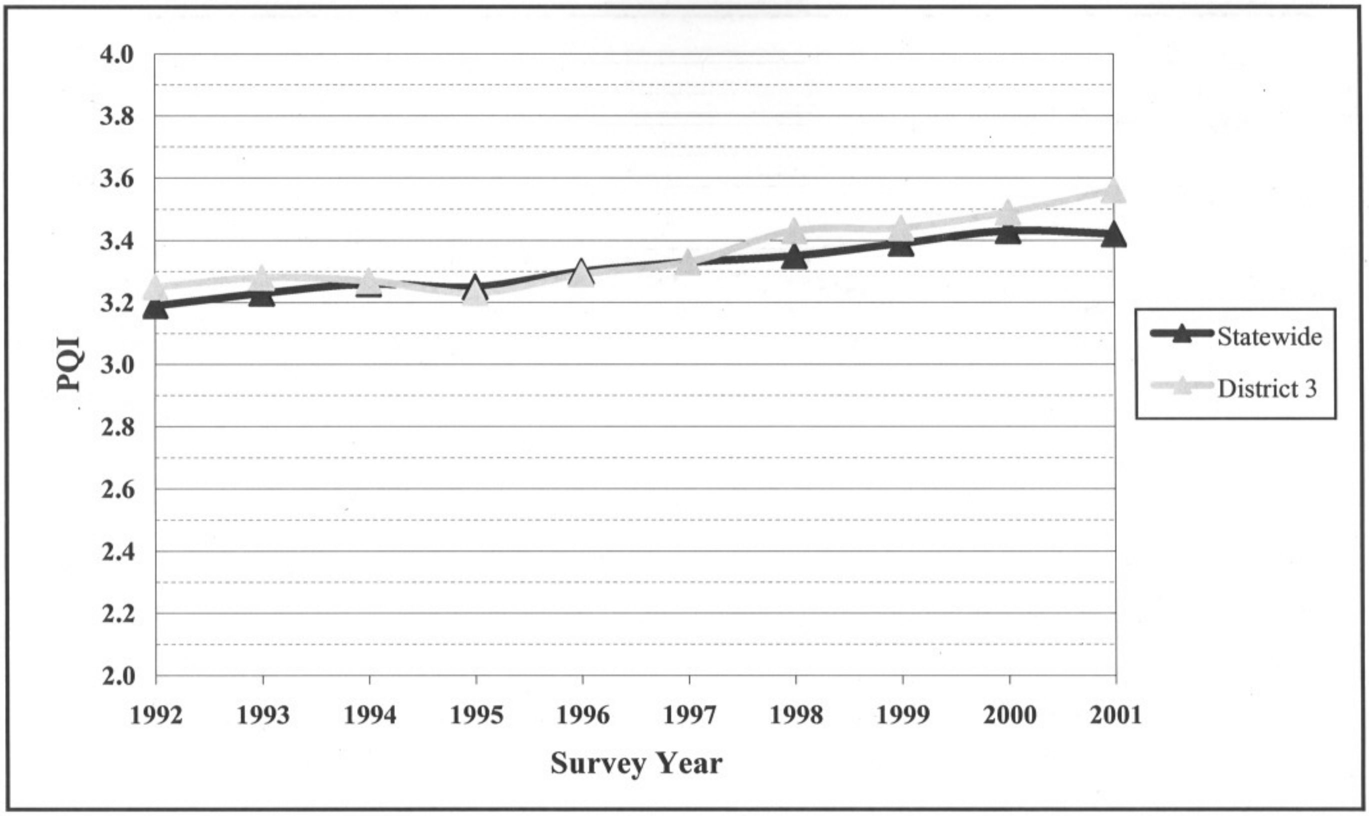


Figure 6-20 District 4 Pavement Quality Index (PQI), 1992-2001

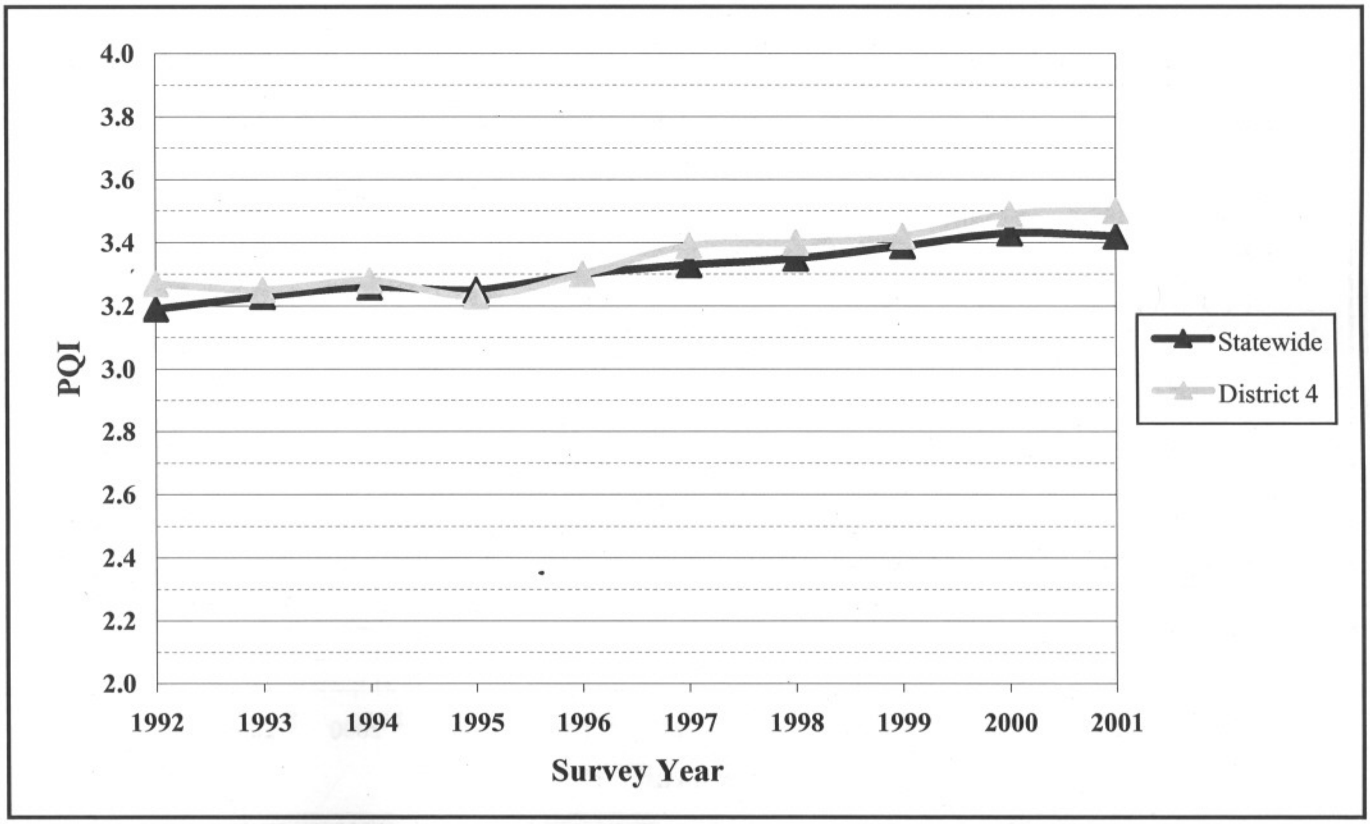


Figure 6-21 District 6 Pavement Quality Index (PQI), 1992-2001

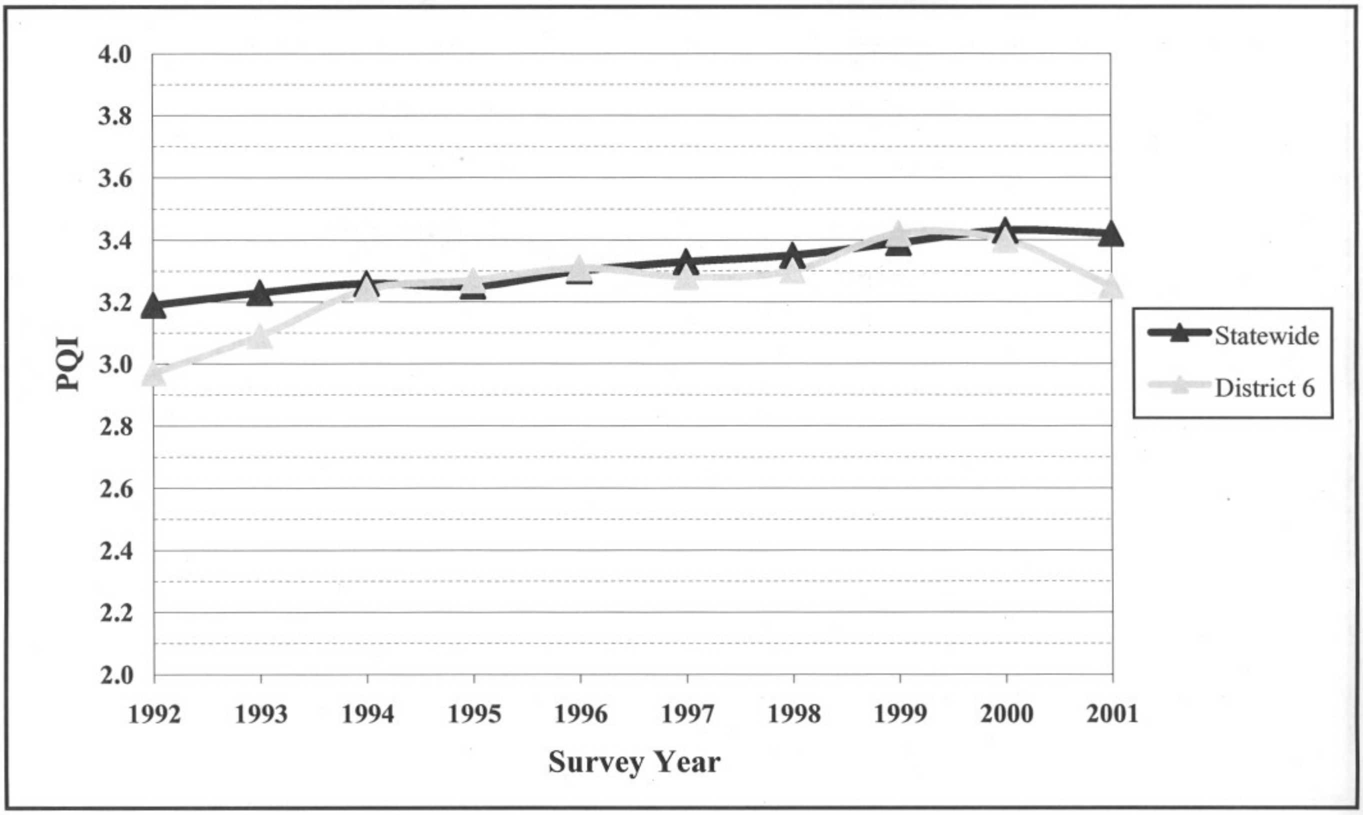


Figure 6-22 District 7 Pavement Quality Index (PQI), 1992-2001

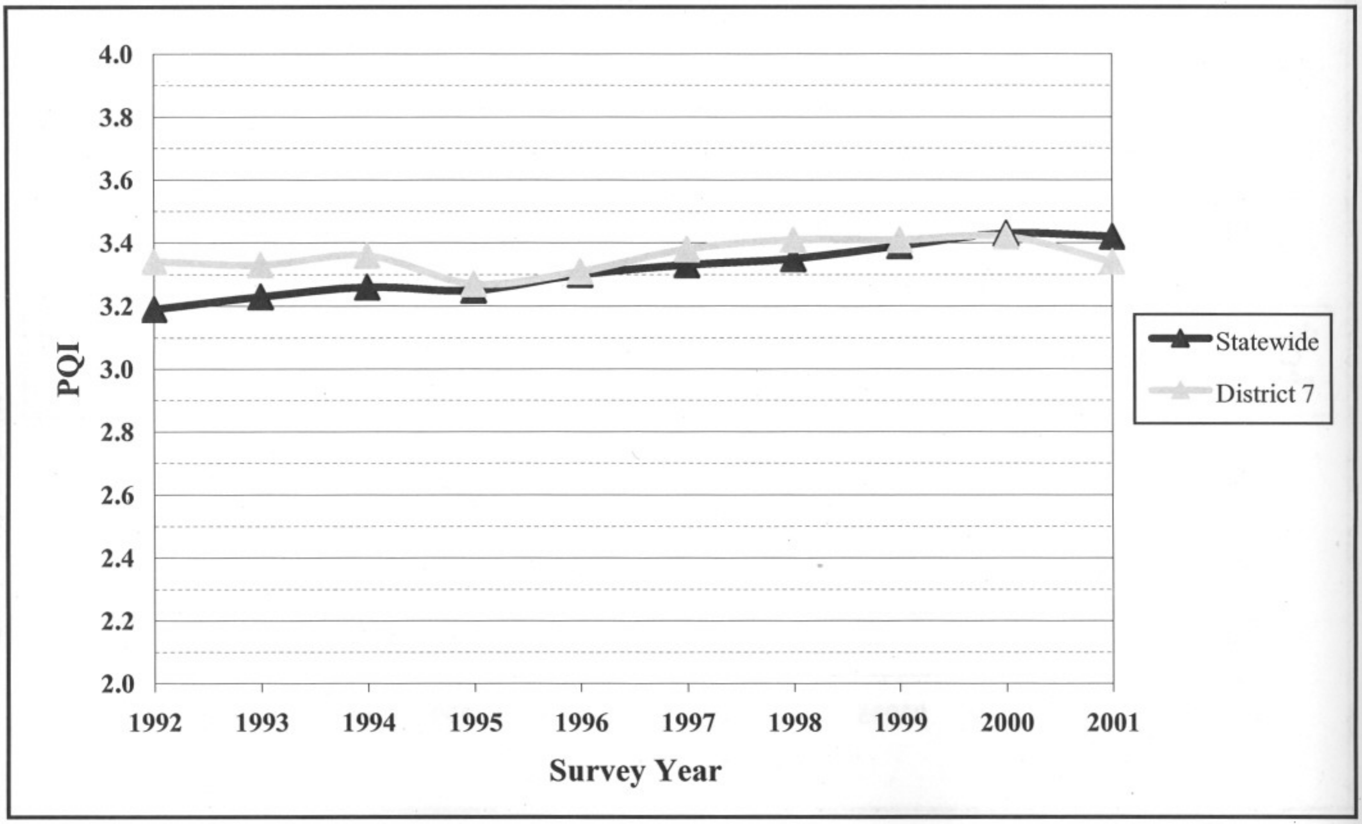


Figure 6-23 District 8 Pavement Quality Index (PQI), 1992-2001

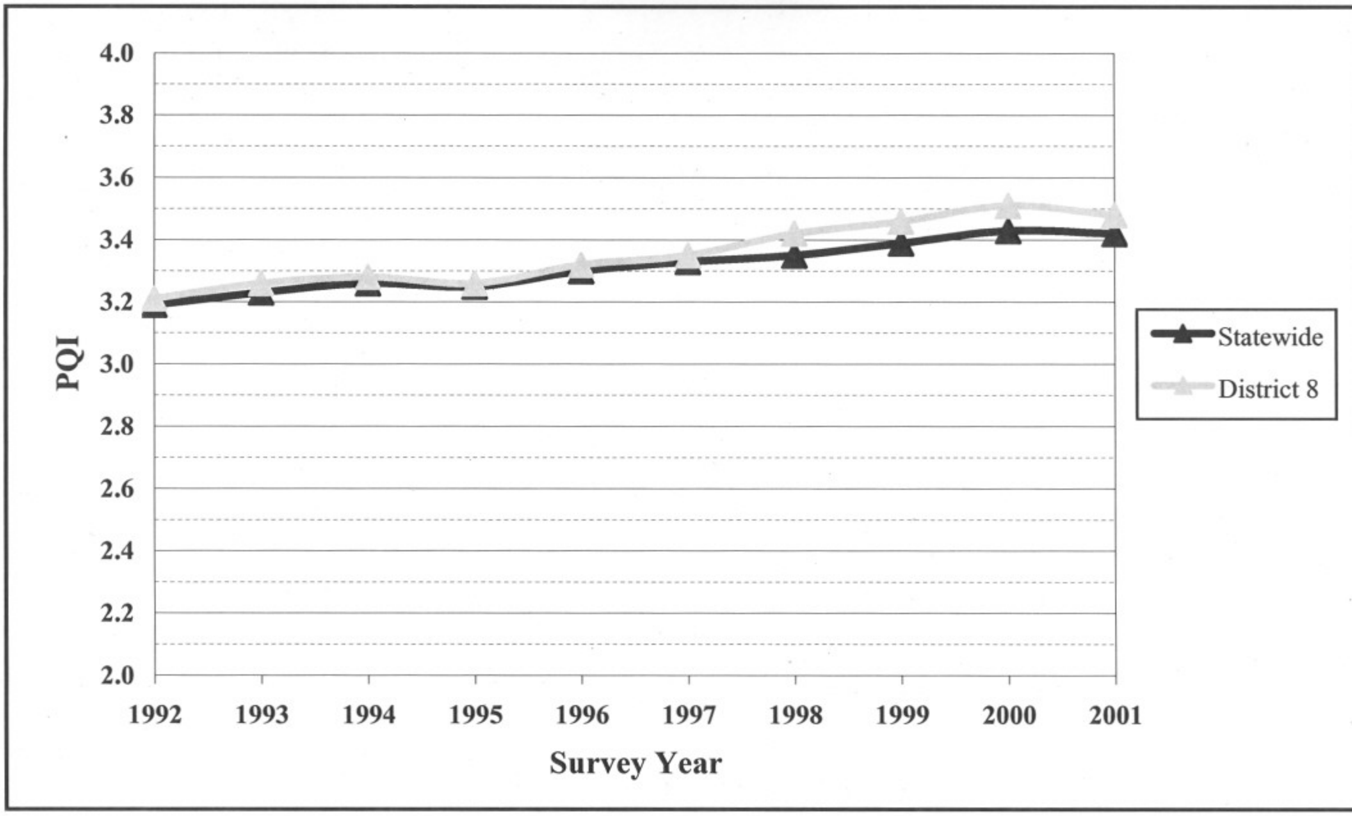
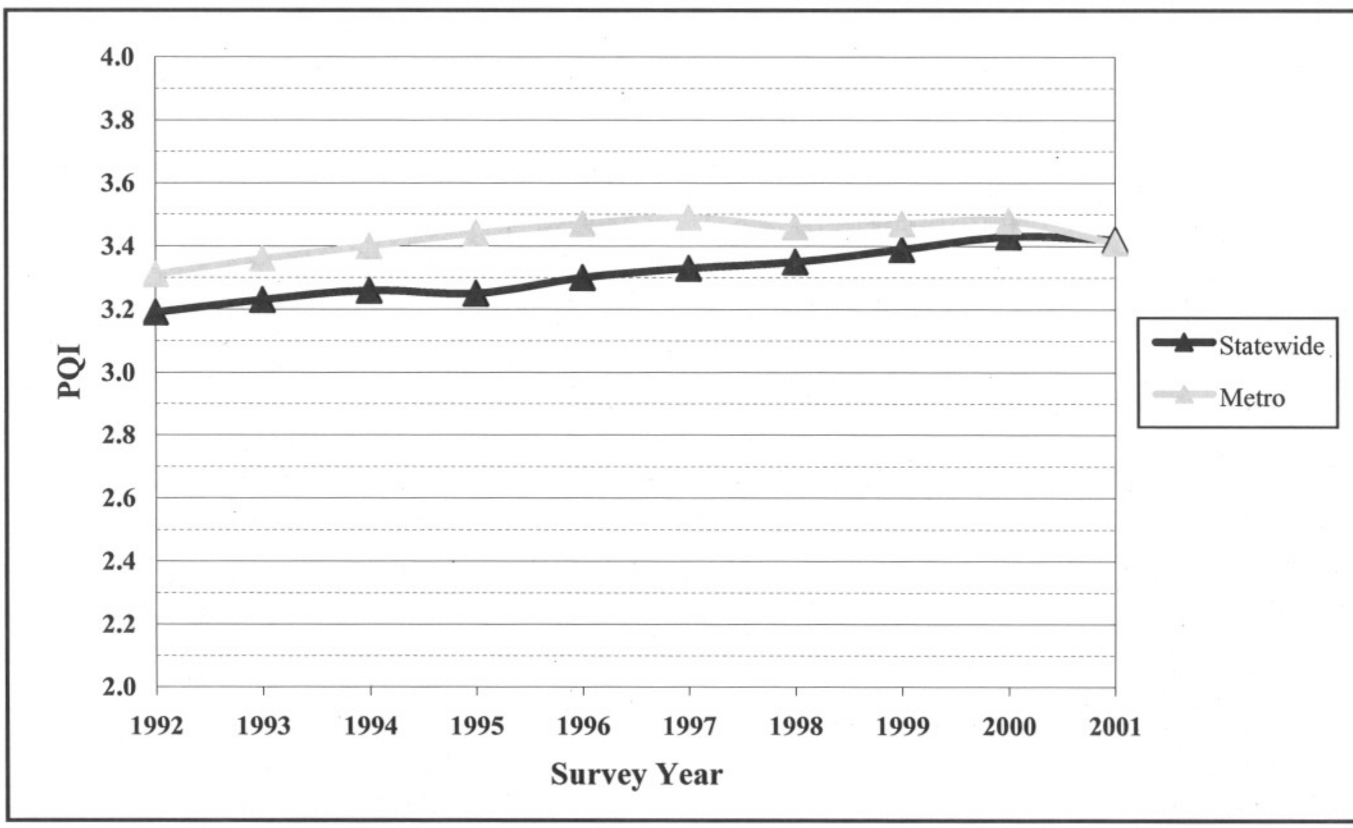


Figure 6-24 Metro Pavement Quality Index (PQI), 1992-2001



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