DEPARTMENT OF TRANSPORTATION

The Impacts of Deferred Maintenance in Minnesota

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APRIL 2022

Research Project
Final Report 2022-08

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Technical Report Documentation Page

1. Report No.	2.	3. Recipients Accession No.
MN 2022-08		

4. Title and Subtitle	5. Report Date
The Impacts of Deferred Maintenance in Minnesota	April 2022
	6.

7. Author(s)	8. Performing Organization Report No.
Camila Fonseca-Sarmiento, Raihana Zeerak, Haiyue Jiang, Jerry Zhao.	

9. Performing Organization Name and Address	10. Project/Task/Work Unit No.
Humphrey School of Public Affairs University of Minnesota 301 19th Ave S, Minneapolis, MN 55455	CTS #2021011
	11. Contract (C) or Grant (G) No. (c) 1036196

12. Sponsoring Organization Name and Address	13. Type of Report and Period Covered
Minnesota Department of Transportation Office of Research & Innovation 395 John Ireland Boulevard, MS 330 St. Paul, Minnesota 55155-1899	Final Report
	14. Sponsoring Agency Code

15. Supplementary Notes

https://www.mndot.gov/research/reports/2022/202208.pdf

16. Abstract (Limit: 250 words)

The roadway system is critical to social development, economic growth, and the overall quality of life. In the U.S., the condition of highways and roads is being compromised due to several reasons including age deterioration, rising costs of construction, and a decline in funding. Similarly, in Minnesota, the majority of pavements are aging and in need of significant maintenance or reconstruction, but there is an expected deficit of $17.7 billion for state roads over the next 20 years. At the local level, pavement conditions along state-aid roads and county, city, and township roads are anticipated to deteriorate significantly based on current funding levels. In addition, significant budgetary impacts on maintenance spending are expected due to the COVID-19 pandemic. Given these budget limitations, agencies often postpone planned maintenance to make funding available for other transportation purposes, but the deferred maintenance will negatively affect asset life, leading to higher future maintenance costs and lower roadway safety. This research analyzes spatial patterns of maintenance expenditures across localities in Minnesota, explores how fiscal conditions affect maintenance expenditures, and examines roadway maintenance decision-making across localities.

17. Document Analysis/Descriptors	18. Availability Statement
Highway maintenance; Expenditures; Deferred maintenance; Financing; Deterioration	No restrictions. Document available from: National Technical Information Services, Alexandria, Virginia 22312

19. Security Class (this report)	20. Security Class (this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	152	

The Impacts of Deferred Maintenance in Minnesota

FINAL REPORT

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April 2022

Published by:

Minnesota Department of Transportation
Office of Research & Innovation
395 John Ireland Boulevard, MS 330
St. Paul, Minnesota 55155-1899

ACKNOWLEDGMENTS

The research team would like to thank our project coordinators, Thomas Johnson-Kaiser and David Glyer, and the members of the Technical Advisory Panel, including Technical Liaison Paul Oehme, Todd Howard, Andrew Giesen, Erik Henricksen, Kaye Bieniek, Kristy Morter, and Mary Hurliman. We would also like to thank local officials, city staff, city and county engineers, and MnDOT district staff who helped us with important information for case studies and the survey we distributed.

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LIST OF ABBREVIATIONS

ASCE	American Society of Civil Engineers
BMS	Bridge Management Systems
BRIM	Bridge Replacement and Improvement Management
CBA	Cost-Benefit Analysis
CBA	Cost-Benefit Analysis
CHIP	Capital Highway Investment Plan
CSAH	County State Aid Highway
DTN	Decision Tree and Needs-based allocation
FASAB	Federal Accounting Standards Advisory Board
FHWA	Federal Highway Administration
HPMA	Highway Pavement Management Application
ICMA	International City/County Management Association
ILP	Integer-Linear Programming
LM	Lane Miles
LPI	Local Planning Index
LRRB	Local Road Research Board
MCE	Marginal Costs Effectiveness
MnDOT	Minnesota Department of Transportation
MnSHIP	Minnesota State Highway Investment Plan
MSAS	Municipal State Aid System
NBI	National Bridge Inventory
NHS	National Highway System
NLC	National League of Cities
NPV	Net Present Value
OCI	Overall Condition Index
PASER	Pavement Surface Evaluation and Rating
PCI	Pavement Condition Index
PMS	Pavement Management System
PQI	Pavement Quality Index
PSR	Pavement Serviceability Rating
RIC	Research Implementation Committee
RSL	Remaining Service Life

SIMS	Structure Information Management System
SR	Sufficiency Rating
TAMP	Transportation Asset Management Plan
TFAC	Transportation Finance Advisory Committee
TRIP	The Road Information Program
TRIP	The Road Information Program
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
VMT	Vehicle Miles Traveled

EXECUTIVE SUMMARY

In Minnesota, the majority of pavements are aging and in need of significant maintenance or reconstruction. While maintenance spending has increased slowly in recent years, over the next 20 years, the expected deficit for state roads will reach $17.7 billion. At the local level, pavement conditions along state-aid roads and county, city, and township roads are anticipated to deteriorate significantly based on current funding levels. In addition, significant budgetary impacts on maintenance spending are expected due to the COVID-19 pandemic. Given these budget limitations, agencies often postpone planned maintenance to make funding available for other transportation purposes. The deferred maintenance will negatively affect asset life, leading to higher future maintenance costs and threatening the safety and health of the population using the facility. This research analyzes spatial patterns of maintenance expenditures across Minnesota localities, explores how fiscal conditions affect maintenance expenditures, and examines roadway maintenance decision-making across localities. This analysis includes the challenges local government agencies face, as well as the strategies they use to close the roadway maintenance gap.

Roadway Maintenance Spending and Conditions of the Roadway System Across Minnesota

Maintenance spending at all levels of government increased slightly between 2006 and 2018. Overall, counties increased their maintenance spending more compared to their construction spending. Average county maintenance spending per lane mile increased from $3,603.1 in the 2006-10 period to $4,624.3 in the 2014-18 period. Cities also spent more on maintenance than on construction between the two periods, particularly in some of the northern counties. Average city maintenance spending per lane mile also slightly increased, from $8,488.2 for the 2006-10 period to $8,829.2 for the 2014-18 period. Townships also invested more on maintenance than on construction. Average township maintenance spending per lane mile increased 12.8 percent between the two periods.

Statewide, the conditions of roads in the interstate system and the other-National Highway System (NHS) improved between 2014 and 2019. During this period, the percentage of roadway miles in poor conditions decreased 0.6 by percentage points for the interstate system and 1.6 percentage points for the other-NHS system. On the other hand, the non-NHS deteriorated statewide by 1.8 percentage points between 2014 and 2018. In terms of bridge age, the average age of structures 10FT and over in Minnesota remained relatively stable between 2016 and 2019, with an average age of 33 years. Structures over 20FT were slightly newer, with an average age of 32.7 years in 2019. In terms of sufficiency rating, the average sufficiency ratings of both the 10FT and over and the over 20FT structures improved slightly during this period.

Conditions that affect Roadway Maintenance Expenditures

Maintenance activities for the existing roadway infrastructure may be delayed for several reasons. First, maintenance expenditures are affected by fiscal conditions, including i) the lack of resources due to continued improvements in vehicle fuel-efficiency, a decline in vehicle miles traveled (VMT), and the challenges to raise funding; and ii) the increasing costs of maintenance materials. Second, the political

environment also affects maintenance investments. Politicians and policymakers often prefer to invest in new infrastructure rather than in repairing and maintaining existing infrastructure. Officials typically prioritize more popular and visible needs over maintenance based on public perceptions. Third, most municipalities do not have the management capacity — such as information systems, staff expertise, forecasting or coordinating capacity — to consider all necessary information when evaluating roadway maintenance investments. Lastly, roadway maintenance competes with other pressing needs, particularly during economic downturns.

Regression analysis was conducted to examine the extent to which fiscal conditions affect maintenance expenditures. For this, the research team used different samples and consider two measures of maintenance expenditures (as a share of total roadway expenditures and total expenditures). The results showed that the amount counties receive in federal or state grants as a share of total revenues was negatively associated with maintenance expenditures as a share of total roadway expenditures. On the other hand, the share of debt service expenditures, VMT, and precipitation were positively associated with maintenance as a share of total roadway expenditure.

Roadway Maintenance Decision-Making Across Localities in Minnesota

Budgeting Practices — Localities develop their operating and capital budgets on an annual basis. Most localities include regular maintenance activities such as crack sealing and coat sealing in their operating budgets, while larger or more extensive projects, such as rehabilitation, major reconstructions, and constructions, are in the capital budgets. Similarly, most localities develop a multi-year Capital Improvement Plan (CIP), typically with identified project needs for the next five to ten years, which helps them identify upcoming maintenance or construction activities, project their financial budget, and inform the capital budget.

Asset Management Practices — Most localities have asset management practices in place and maintain an asset inventory as part of their asset management plan. Almost all localities include pavements and some also include non-pavement assets in their inventories. Some localities also have a pavement management program and use a GIS-based management package to assess pavement conditions regularly. Several localities have identified an acceptable pavement condition level and report pavement conditions below that acceptable level (poor to fair conditions).

Maintenance Decision-Making Processes — Localities consider different factors when making decisions about the types of projects to carry out. In most localities, pavement conditions are the primary consideration followed by safety needs. Other primary considerations include infrastructure age, roadway usage, maintenance history, and level of traffic. Other factors that localities consider when prioritizing maintenance are coordination with utilities, inputs from residents and businesses, cost of material and labor, and staff capacity. Due to funding constraints, most localities are mainly implementing corrective maintenance.

Pavement Reconstruction, Rehabilitation, and Maintenance Funding and Needs — Roadway maintenance is funded through state and local funding depending on the system. Local roads are typically funded from the general fund or from a dedicated source (e.g., wheelage tax or a sales tax),

while state-aid roads are funded through the state-aid funding. Localities reported funding needs of between $1 million to approximately $30 million. To maintain pavements at an acceptable level, localities reported annual maintenance funding needs of between $250,000 and $22 million. Two factors that affect the funding availability for maintenance projects are (1) limited local resources allocated to maintain local roads and (2) reallocating resources to maintain the state-aid system due to decreased state support. The COVID-19 pandemic has further exacerbated funding shortfalls, with most localities experiencing a reduction in their local revenues and some experiencing a reduction in state-aid funding.

Strategies Adopted to Close Maintenance Gaps — Most counties have adopted new funding sources to invest in their roadway systems. Some counties, for instance, have adopted a wheelage tax and their proceeds are dedicated to roadway improvements in general. However, the adoption of the wheelage tax has not increased the funding available for roadway maintenance since over time it has offset revenues coming from the general fund. Similarly, some cities have recently adopted a new revenue source (e.g., half-percent sales tax) and their impact on the current funding is unclear. In addition, localities have adopted other strategies to close maintenance gaps including doing as much work in-house as possible, conducting more preventative maintenance, revoking county state-aid highway (CSAH) and county highway routes and turning them over to cities and townships, and increasing the road and bridge levy.

Deferred Maintenance across Minnesota Localities

Several themes appeared in the respondent localities' definition of deferred maintenance. These included defining it as the maintenance activity that has not been performed, the resources needed to bring or meet identified pavement condition levels, specific maintenance activities, and specific asset conditions. In terms of reported deferred maintenance amounts, there was a wide variation in locality responses. Three localities reported dollar amounts, which may not necessarily only refer to maintenance needs. Six localities reported total accumulated maintenance dollar amounts that ranged from $1.2 million to $40 million.

Recommendations

Based on the research findings, the research team developed the following recommendations to support Minnesota local agencies maintain an appropriate and consistent level of funding for maintenance:

1. Adopt a standard definition of deferred maintenance
2. Identify acceptable pavement and bridge condition targets
3. Estimate funding needed to achieve and maintain pavement and bridge condition targets
4. Monitor achievement of pavement and bridge condition targets
5. Report pavement and bridge conditions, trends, and target achievement
6. Plan and coordinate maintenance activities with other stakeholders
7. Maintain a consistent funding stream for roadway maintenance activities

CHAPTER 1: INTRODUCTION

Highways and roads are critical to social development, economic growth, and overall quality of life. They play a significant role in the transportation of goods and people and create opportunities for trade and economic activity (National Academies of Sciences, Engineering, and Medicine, 2017; Kahn & Levinson, 2011). In the U.S., however, the condition of highways and roads is being compromised due to several factors, including deterioration due to age, the rising costs of construction, and a decline in funding. Moreover, current activities to maintain, repair, and rehabilitate the existing infrastructure compete with new infrastructure for priority status (Kahn & Levinson, 2011).

The system conditions of Minnesota's highways and roadways are similar to the rest of the U.S. The majority of Minnesota's pavements were originally constructed between 60 and 70 years ago and are now in need of significant maintenance or reconstruction (MnDOT, 2018). The percentage of highway miles in good condition and their remaining service life has increased over the last decade, but the percentage of highways and bridges in poor condition is expected to increase significantly over the next decade (ASCE, 2018; MnDOT, 2019). In addition, maintenance spending in real terms increased 2 percent annually, on average, between 2010 and 2018 and there is an expected deficit of $17.7 billion for state roads over the next 20 years (an annual funding gap of $885 million) (Fonseca, Zhao, & Lari, 2021; MnDOT, 2017). Without significant public investment, the roads and bridges in the system will likely continue to deteriorate.

Similarly, at the local level, it is anticipated that pavement conditions along the state-aid roads and county, city, and township roads will deteriorate significantly based on current funding levels (ASCE, 2018). The Minnesota Transportation Finance Advisory Committee (TFAC) estimated that between 2013 and 2032, an additional $9.3 billion would be needed to meet current performance on the local roadways and an additional $17.5 billion would be required to provide an economically competitive system (Minnesota Transportation Finance Advisory Committee, 2012). In addition, with the COVID-19 pandemic, significant budgetary impacts on maintenance spending are expected. At the national level, a $114 billion loss in the county-generated revenue along with a $58 billion cut in state funding for counties is projected (National Association of Counties, 2020). Some counties have reported deficits exceeding one-third of the county's general fund. In addition, 71 percent of counties have cut or delayed capital investments due to revenue shortfalls caused by the pandemic.

Given these budget limitations, agencies often postpone planned maintenance to make funding available for other transportation purposes. However, the failure to keep up with maintenance has significant negative impacts on the designed service life of the asset, leading to higher future maintenance costs and threatening the safety and health of the population using the facility (Chasey, Garza, & Drew, 2002; Westerling & Poftak, 2007). This research analyzes patterns of maintenance expenditures across Minnesota localities, explores how fiscal conditions affect maintenance expenditures, and examines the negative impact of deferred maintenance on Minnesota's local road system. This research will generate information that city and county engineers can use in discussions with elected officials to maintain an appropriate and consistent level of funding for maintenance.

CHAPTER 2: LITERATURE REVIEW

2.1 HIGHWAY AND ROADWAY SYSTEM MAINTENANCE

The Federal Highway Administration (FHWA) defines maintenance as the work that is performed to maintain the condition of the transportation system or to respond to specific conditions or events that restore the highway system to a functional state of operation (Waidelich, 2016). The Minnesota Department of Transportation (MnDOT) defines highway maintenance as the preservation of all types of roadways, roadsides, structures and facilities as close as possible to their original condition (MnDOT, 2014). Highway maintenance also consists of performing the services and operations necessary to provide safer roadways.

Roadway maintenance can be classified into two main categories: preventive and corrective maintenance. Preventive maintenance focuses on avoiding repairs and asset failure through applying cost-effective treatments that extend service life, while corrective or reactive maintenance focuses on repairing an asset once failure occurs (see Table 2.1). Preventive maintenance is performed to improve the functional surface properties without changing the properties of the pavement, while corrective maintenance can change them. Corrective maintenance is triggered when certain maintenance thresholds are reached. These thresholds vary across road agencies depending on the budget and serviceability tolerance (Qiao, Dawson, Parry, & Flintsch, 2018; USDOT, 2018).

Table 2.1 Preventive and Corrective Maintenance Activities

Maintenance	Activities
Preventive	Fog sealing, crack sealing, chip sealing, rut filling, slurry sealing, cape sealing, thin overlay, microsurfacing
Corrective	Structural overlay, mill & overlay, pothole repair, patching, full-depth patching, crack repair

Source: *Hicks, Seeds, & Peshkin* (2000)*, Johnson* (2000)*.*

Focusing on preventive maintenance increases road lifespan and saves resources over the life of the road. Preventive maintenance strategies recognize the merits of applying preventive surface treatments to newer, good quality pavements to cost-effectively retard the aging process, thereby reducing the need for more expensive corrective measures in the future (Jackson, Sebaaly, & Porritt, 2005). In an early study, Sharaf et al (1988) found that the annual maintenance costs of pavements in very poor condition would be as much as four times higher than if the pavements were maintained while they were in good condition. In another study, Jackson et al (2005) estimated that asphalt preventive surface treatments can extend pavement life by 25 percent (5 years for a 20-year pavement), which reduces construction costs by approximately 10 percent and maintenance costs by 2 percent per year. In addition, research conducted by the Cornell Local Roads Program found that average road

reconstructions cost four to five times as much as maintaining roads with routine surface treatment (Office of the New York State Comptroller, 2014). Similarly, through case studies conducted in 6 states, Baladi et al (2002) found that for every dollar spent in the preventive maintenance program, between $4 and $10 are saved in the rehabilitation program. In addition, the authors found that preventive maintenance improves the condition and ride quality of the pavement network, decreases the pavement's rate of deterioration, and increases the pavement's remaining service life (RSL). Besides the financial benefits, preventive maintenance efforts can significantly extend the longevity of pavements, to up to 60 years (Dornan, 2002).

Despite the benefits of preventive maintenance, highway and road authorities and decision-makers often focus on corrective maintenance. This is generally due to state legislative allocations of fixed budgets for capital improvement and operation, which puts preventive maintenance in the backseat when other spending needs come up. For instance, pavement maintenance may get delayed if responsive operations such as snow removal exceed anticipated levels in a given year. Given the excess of deteriorated pavements, engineers are often reluctant to treat pavements in good condition (Zaniewski & Mamlouk, 1999). In Minnesota, in particular, the main reason that MnDOT does not implement more preventive maintenance is that it has more pressing needs. MnDOT managers find it hard to justify the allocation of resources to preventive maintenance when there are roads in bad shape, deficient bridges, and other safety and congestion concerns (MnDOT, 2017). Overall, the funds available are not sufficient to address current deficiencies, to perform adequate maintenance, and to reconstruct those highways that are more cost-effective to reconstruct.

Generally, maintenance of the highway and roadway system is critical for economic and social development and growth, but it is often neglected. According to the Federal Highway Administration, each $1 spent on road, highway, and bridge improvements returns $5.20 in the form of lower vehicle maintenance costs, decreased delays, reduced fuel consumption, improved safety, lower road and bridge maintenance costs, and reduced emissions as a result of improved traffic flow (USDOT, 2008). Neglecting or improperly performing maintenance activities results in rapid deterioration of the system. The ASCE (2017) graded the U.S. roadway system with a D, reflecting the poor condition of the system, and the significant and increasing backlog of rehabilitation needs. Eighteen percent of rural roads and 37 percent of urban roads are in poor condition, while only 47 and 28 percent, respectively, are in good condition (Transportation for America, 2019).

2.2 CONDITIONS THAT AFFECT MAINTENANCE EXPENDITURES

Current activities to maintain the existing highway and roadway infrastructure are delayed for several reasons. These include fiscal conditions, the political environment, management capacity, and economic downturns.

2.2.1 Fiscal Conditions

The fiscal conditions that affect maintenance expenditures include the lack of resources and the increasing costs of maintenance.

Lack of Resources

Resource limitations are one of the main issues affecting maintenance spending at the state and local level. According to MnDOT (2017), the funds available are not sufficient to pay for the preservation of current highway system infrastructure, and even less for condition improvement. Similarly, the International City/County Management Association found that 39.2 percent of local governments need additional local, state, or federal funding to sustain even baseline maintenance (ICMA, 2017). This lack of sufficient resources can be explained by several reasons, including the slow growth of revenues, the allocation of resources toward more pressing needs, and contracted obligations.

At the state level, the motor fuel tax base is shrinking. This is mainly due to continued improvements in vehicle fuel-efficiency and the adoption of alternative power sources, which translate into lower gas consumption, and therefore, less revenues from motor fuel taxes. Schleith (2015) estimated that, up until 2015, the loss of gas tax revenue due to EV sales was $71.9 million. This accounted for 0.23% of the total gas revenue across the country but it is projected to have a significant impact on the revenue raised. In addition, vehicle miles traveled (VMT) are expected to remain relatively flat due to demographic, technological, and behavioral changes, which affect federal-aid revenues (MnDOT, 2019).

Some research looks at millennials' driving habits as they impact government budgets, but results are contradictory. Dutzik, Inglis, & Baxandall (2014) find that the VMT for millennials dropped by 23 percent between 2001 and 2009. But in a recent research, Leard et al. (2019) find that the VMT change between 1995 to 2015 is mainly explained by changes in demographics and economic characteristics rather than differences in driving habits. Knittel & Murphy (2019) find a higher personal vehicle usage in terms of VMT for millennials compared to baby boomers, but little difference in preference for vehicle ownership. Millennials delay some life choices such as getting married and having children, which may delay vehicle ownership and use early on in life. These differences are temporary and lifetime vehicle use is likely to be greater.

In addition to the declining motor fuel tax, its purchasing power has also decreased while transportation costs have increased. At the federal level, the federal motor fuel tax rate has not changed since 1993, and the motor fuel tax revenue has lost 40 percent of its purchasing power due to inflation (Peter G Peterson Foundation, 2015). While 27 states have adjusted their rates, most of them have only adjusted their rate once (Duncan, Nadella, Giroux, Browers, & Graham, 2017). Minnesota's motor fuel tax, for instance, was last increased in 2008.[1] MnDOT projects a 2 percent annual increase in the funding from

[1] The 2008 legislation increased the tax by 8.5 cents in 2008. The transition occurred gradually over the fiscal years 2008 to 2013.

the State Trunk Highway Fund, while construction costs are expected to grow at an annual rate of 4.5 percent (MnDOT, 2019). Such a gap might erode half of the purchasing power of funding by 2037.

At the local level, cities and counties are having difficulties raising funding. The City Fiscal Condition Survey shows that general fund revenues, which constitute on average more than half of total city spending, have slowly increased between 2013 and 2018, at an average rate of 1.8 percent (NLC, 2019). Important tax revenues from local sales tax and income taxes and local income taxes present a similar trend. Revenues from the local sales tax have been impacted by the development of online businesses, while revenues from the local income tax have been affected by the lack of growth in nominal wages since 2009, in addition to the widening income inequality, and exacerbating the shortfall of middle-income jobs (NLC, 2019). Officials are cautious about future revenues, some have muted expectations while others expect slight declines (NLC, 2019).

Besides the slow revenue growth, contracted obligations, such as the pressure of repaying debt, may drive the funding away from public infrastructure investments. Research has found that an increased level of public debt is associated with reduced levels of public investments. The higher the debt level is, the more significant the effect would be (Picarelli, Picarelli, & Marneffe, 2019). Empirical evidence has indicated that the local government debt and public expenditure seems to have an inverted U-shape relationship (see Figure 2.1). Although low-level debt can stimulate public investment, the stimulation effect gets weaker as the debt level rises. When there is much debt to repay, public expenditure decreases, which negatively affects public service delivery, including infrastructure maintenance (Égert, 2015; Zhao R. , Tian, Lei, Boadu, & Ren, 2019).

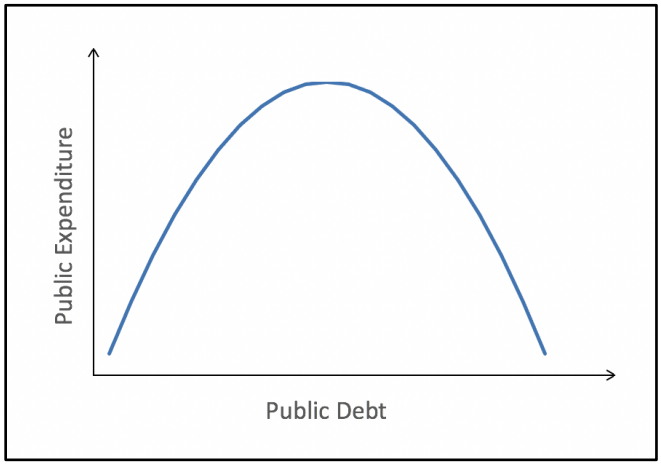


Figure 2.1 Relationship between Public Debt and Public Expenditures

Spending on highway and roadway construction has consistently been higher than spending on maintenance, repair, and general upkeep even though new construction only makes up about 1 percent of the road system. Of the total direct state and local highway road spending in 2017, 44 percent went to operational costs while the other 56 percent went toward the construction of highways and roads

(Urban Institute, 2017). Similar apportionments were found between 2009 and 2011 (Smart Growth America, 2014). Fields & Purnell (2018) found that capital and bridge disbursements and maintenance disbursements comprised 51.6 and 15.7 percent of total disbursements for state-owned roads in 2015, respectively.[2] Compared to 2013, capital and bridge disbursements grew more than maintenance disbursements (8.8 and 7.6 percent, respectively).

Governments tend to prioritize spending on projects funded through grants and other marching resources, without regard for how those projects will impact future capital maintenance needs (Marlowe J. , 2013). South Carolina, for instance, temporarily suspended resurfacing and routine maintenance activities to invest limited funding in projects that were eligible for federal funds between 2010 and 2015 (National Academies of Sciences, Engineering, and Medicine, 2015). The decision was triggered by a funding shortfall and to not lose out on federal funds. The cuts were made for more than 50 percent of the state's highway system that was not eligible for federally funded resurfacing (National Academies of Sciences, Engineering, and Medicine, 2015).

Increased Maintenance Costs

Increasing maintenance costs is another fiscal factor that affects maintenance gaps. Highway and roadway system maintenance costs are mainly affected by the costs of materials. Trends of the National Highway Construction Cost Index, a quarterly estimate of the rising cost of domestic highway construction and maintenance, indicate that these costs have increased by 67 percent since 2004 (USDOT, 2017). Between 2003 and 2016, the price of key components like asphalt, concrete, and metal, grew by 107 percent, 61 percent, and 45 percent, respectively. Labor costs also affect maintenance costs, but there is limited research on these changes.

Agencies may also restrict the types of materials that can be used for infrastructure projects. These restrictions may increase maintenance costs. Studies in the water sector estimated that municipalities that restrict materials used for infrastructure projects spend 27 to 34 percent more than municipalities that do not (Long, 2017). There is limited research on restrictions on types of material used in transportation, but similar restrictions may also apply to the highway and roadway system. For instance, in the reconstruction of Main Street in the City of Red Wing, the reconstruction costs increased significantly when the city was required to use concrete rather than bituminous (Zhao, Fonseca, Zeerak, & Bean, 2020).

Climate change can also affect the frequency and the costs of maintenance investments. Events like extreme temperatures (both, heatwaves and harsh winters), floods, and storms among others affect the transportation infrastructure (Nemry & Demirel, 2012). Several studies have shown that extreme

[2] In the study capital and bridge disbursements are defined are the costs to build new, and widen existing infrastructure; while maintenance disbursements are defined are the costs to perform routine upkeep. Total disbursements include capital and bridge, maintenance, administrative, highway and law enforcement and safety, interest and bond retirement (Fields & Purnell, 2018).

weather can negatively impact the performance of pavements (Pszczoła, Judycki, & Ryś, 2016; Kwiatkowski, Oslakovic, Hartmann, & Maat, 2016; Willway, et al., 2008). For instance, cracks are likely to occur when asphalt is exposed to long periods of cold or frequent freeze-thaw cycles (Kwiatkowski, Oslakovic, Hartmann, & Maat, 2016). As these events are expected to occur more frequently and become more severe, in certain areas, roads and highways might require more frequent maintenance and repairs, and they could become more costly to perform (Qiao, Dawson, Parry, & Flintsch, 2018; USEPA, 2017).

Vehicle electrification and automation also have the potential to affect the frequency of maintenance investments. In terms of electric vehicles, scholars have discussed that when people drive more efficient vehicles, they tend to drive more because their unit costs decrease (Portney, Parry, Gruenspecht, & Harrington, 2003). For instance, a one percent decrease in driving cost can be associated with a 0.61-0.78 percent increase in annual vehicle miles traveled (Ficano & Thompson, 2014). This could lead to severe congestion and result in more damage to the highway and roadway system. In terms of autonomous vehicles, scholars note that maintenance repair will need to be more frequent as these vehicles will run consistently in the same lane position causing greater wear and tear in the wheel tracks. This is in addition to the need to maintain the system to a higher standard[3] (Liu, Tight, Sun, & Kang, 2019).

2.2.2 Political Environment

Politicians and policymakers often prefer to invest in new infrastructure rather than invest in repairing and maintenance of the existing infrastructure that may have higher returns (Kahn & Levinson, 2011; Glaeser & Ponzetto, 2018). Politicians face regular competition, and therefore, are interested in enacting legislation and budgets that increase their electoral support (Walden & Eryuruk, 2012; Kim & Ebdon, 2020). Officials typically prioritize more popular and visible needs over maintenance, as they perceive that the public prefers spending on operations and new capital items. They often defer funding for maintenance because it is less visible than other priorities (Marlowe J. , 2013). In 2017, only 8 percent of state direct general spending and 4 percent of local direct general spending were allocated to highways and roads (Urban Institute, 2017). A large portion of these resources is allocated to the construction of infrastructure rather than maintenance.

This is intensified by the media, which usually pays more attention to new constructions (Giglio, Friar, & Crittenden, 2018). Furthermore, while politicians tend to invest in the obvious and noticeable projects - like building new roads- to attract local people's support, they ignore the future expenditures on preservation and maintenance (Glaeser & Ponzetto, 2018). Such unbalanced budgeting is also one of the

[3] Autonomous vehicles will require the update of several aspects of infrastructure including (1) higher stiffness and more deformation-resistance materials to keep up with the deterioration from the lane-keeping system; bridges with updated standard needs; and (3) traffic signs and road markings to complete the tasks of locating, navigating, and parking among others (Liu, Tight, Sun, & Kang, 2019).

causes of the infrastructure budget deficit. The increasing expansion of new infrastructure has become a growing burden for the transportation departments (Transportation for America, 2019).

Politicians may also shift the timing and location of road maintenance to increase their electoral support, particularly as the election approaches. In a study, Blemings & Bock (2020) found that municipalities that are more politically aligned with an elected official have more maintenance projects in months close to the election. According to the authors, to boost their vote shares, elected officials do extra road work in unaligned areas in the summer of an election year. With this, elected officials are credited for maintaining roads, while avoiding upsetting potential voters close to the election. To make up for this shift, officials shift additional maintenance into aligned areas near election time. The authors also found that the disruptions caused by the election cycles to infrastructure maintenance could cost over $3 million a year for a city with at least 100,000 residents.

2.2.3 Management Capacity

Strategic capital spending requires the ability to see all the long-term trade-offs around different investment opportunities. Human capacity and information systems are crucial to adequately plan and budget for capital spending, but local governments find them challenging. According to Marlowe (2013), most municipalities do not have the information systems, staff expertise, forecasting capabilities, or coordinating capacity to consider all necessary information when evaluating capital budgeting decisions. Information such as asset condition, their maintenance history, future costs of projects, and their impact on future service delivery costs are essential in the planning stage. In a study conducted across several counties, Kim & Ebdon (2020) found that these local governments are frustrated with their information systems or with the lack of them. Particularly, those with multiple systems stated that it makes analysis and reporting difficult. The authors also found that long-time employees who have the expertise to maintain assets that may be obsolete, are retiring. Studies have estimated that, in the coming years, around 40 percent of the transportation workers will be replaced (Kane & Puentes, 2014). Replacing such employees is difficult, as the government competes with private companies to hire qualified employees, who are also difficult to find (Kim & Ebdon, 2020). Such shortage of skilled labor significantly contributes to increased maintenance costs.

2.2.4 Economic Shocks

Maintenance competes with other pressing needs, particularly during economic downturns. According to Marlowe (2013), during recessions, local governments tend to cut infrastructure maintenance and increase future infrastructure costs. For instance, the Great Recession and its aftermath affected capital spending, in particular, spending on maintenance (Kim & Ebdon, 2020). In their study, Kim & Ebdon (2020) found that the maintenance that was supposed to be performed by the counties was deferred due to the Great Recession, with many of these counties still trying to catch up with their maintenance needs.

Significant budgetary impacts on maintenance spending are expected due to the COVID-19 pandemic. At the national level, the National Association of Counties (2020) forecast $114 billion of lost county-

generated revenue along with a $58 billion cut in state funding for counties. According to the survey, some counties have reported deficits exceeding one-third of the county's general fund. In addition, 71 percent of counties have cut or delayed capital investments due to the revenue shortfalls caused by the pandemic. The COVID-19 has had significant impacts on travel patterns and VMT, which affect transportation revenue. In the early months of the pandemic, VMT declined significantly, following the stay-at-home order in most states and work-from-home policies. In April, VMT was at its lowest, dropping 48 percent nationwide from pre-COVID levels (USDOT, 2020). While VMT started to recover, it remains below 2019 levels (Streetlight, 2020). This decline in VMT can have significant impacts on transportation revenue, potentially affecting maintenance expenditure in future years.

2.3 DEFERRED MAINTENANCE AND ITS IMPACTS

When the work needed to preserve or maintain the system is not performed as it should have been or was scheduled to be and is delayed for a future period, it becomes deferred maintenance (FASAB, 2012; National Academies of Sciences, Engineering, and Medicine, 2017). Deferred maintenance is generally defined as the amount of unfulfilled demands at a given point in time in explicit reference to the predefined standards to be achieved (Litzka & Weninger-Vycudil, 2012). Since each agency defines its own predefined standards, it is hard to measure the total amount of deferred maintenance. In a study of infrastructure needs across the 50 states, Zhao, Fonseca, & Tan (2019) estimated that the national total deferred maintenance cost may be at least $1 trillion. Despite the appalling gap, the authors found that many states appropriate less than 1 percent of annual expenditures to address general deferred maintenance. In terms of transportation, specifically, the ASCE (2017) found that the U.S. has an $836 billion backlog of highway and bridge capital needs. Half of this amount is needed for repairing existing highways and 14.7 percent for bridge repairs. Another study estimated that $168.6 billion would need to be spent annually on road repair to preserve the nation's roads that are currently in good and fair condition and an additional $63 billion per year to address the backlog of poor roads (Transportation for America, 2019).

Deferring maintenance has several impacts on road operators, road users, and the environment. We explore some of these impacts below. However, the consequences of deferring maintenance are usually underestimated due to a lack of practical frameworks and procedures to quantify them (National Academies of Sciences, Engineering, and Medicine, 2017).

2.3.1 Impacts on Road Operators

Deferred maintenance reduces asset life and increases the risk of failure. Highways, roadways, and bridges that are untreated continue to deteriorate as they are still subject to daily use. Without proper pavement treatment, the damage could affect lower layers, which would make the next rehabilitation more complicated and costly (Harvey, 2012). If the damage is severe, it could turn maintenance activities into replacement or reconstruction activities, which are not only costly but dangerous to users.

One of the most cited failures to the system is the collapse of the I-35W Mississippi River Bridge in Minneapolis in 2007, which killed 13 and injured 145 people.

Deferred maintenance causes extensive long-term costs. The magnitude of future costs is still debated as they accumulate and compounds at a much higher rate (Summers, et al., 2017). According to Geaslin (2014), future expenses of deferred maintenance are expected to be the cost squared. For instance, if the value of maintenance today is $15, deferring it will result in $255 in replacement costs. If this is also put off, the asset failure may cost around $50,000. In transportation, some estimates indicate that each $1 of maintenance could save $6 to $10 in future expenses, while a small delay in maintenance could lead to millions in extra costs over the life cycle of the asset (USDOT, 2007). The California DOT, for example, estimates that each dollar of maintenance funding could save between $4 to $12 by postponing the need for rehabilitation (Taylor, 2018). While the average cost per lane mile for crack sealing is just $2,211, which may extend the life cycle for 2 years, mill and resurfacing could cost $220,212 per lane mile (FHWA, 2010; Transportation for America, 2019). In another study, Cambridge Systematics, Inc. (2011) found that delaying pavement maintenance may increase costs by more than 20 percent over a period of 5 years-, and that there is only a 2- to 3- year window in which maintenance can be delayed without significant cost implications. These costs may be magnified when premature failure of the system results in additional, unplanned-for maintenance activities (Weed, 2001).

In addition, deferred maintenance and worsened road conditions also increase risks of a credit rating downgrade. Chen, Kriz, & Wang (2016) find that the lower the quality of state transportation infrastructure, the lower the probability that the state will be in the high credit rating category. According to the authors, large infrastructure deficits may increase borrowing and limit the government's ability to generate the necessary funding to cover its debt. In addition, the poor condition of transportation infrastructure may reflect the inferior performance and inability of a government to properly manage public assets, negatively affecting the state’s future financial strength.

2.3.2 Impacts on Road Users

Deferred maintenance affects safety of users of the highway and roadway system. Research has shown that poorly maintained roads are a significant factor in both the frequency and severity of motor vehicle crashes (Zaloshnja & Miller, 2009; Cambridge Systematics, Inc., 2011). Poor pavement conditions are associated with an increased frequency and severity of crashes, likely because drivers lose control of their vehicles; while very poor pavement conditions lower the crash frequency and its severity, likely because drivers drive more carefully in these roads (Chen, Saeed, & Labi, 2017; Li, Liu, & Ding, 2013). Overall, good pavement conditions are correlated with fewer fatal and injury crashes, and less property damage (Labi, 2011). Through an empirical study in rural Virginia, Zeng, Fontaine, & Smith (2014) found that pavements in good conditions led to a 26 percent reduction in fatal and injury crashes, compared to pavements in poor conditions.

Similarly, deferred maintenance increases costs to the users in terms of vehicle maintenance and travel time. Driving on roads with poor condition increases user costs through increased wear and tear in vehicles (Cambridge Systematics, Inc., 2011). Summers, et al. (2017) estimate that driving on a poorly

maintained road is equivalent to paying an extra 50-cent to 1-dollar tax per gallon of gas. According to the Road Information Program (TRIP), driving on deteriorated roads costs U.S. motorists approximately $130 billion a year, with an average of $603 per motorist (TRIP, 2020). In Minnesota, it is estimated that drivers spend $480 on average per year for additional car maintenance (MnDOT, 2018). In addition, deteriorated roads affect the stream of traffic, which causes traffic congestion and reduces vehicle speed (Setyawan, Kusdiantoro, & Syafi'i, 2015). In 2014, congestion and traffic delays cost the country $160 billion in wasted time and fuel (ASCE, 2017).

2.3.3 Impacts on Economic Activity

Deferred maintenance hinders the movement of people and goods that drive the economy. If a road needs major repairs, agencies close the road or reduce the total number of lanes, and sometimes impose weight-restrictions, all of which reduce road capacity, increase congestion, and make travel less reliable. This, in turn, slows the delivery of goods and commutes, impacts regional industries (including agriculture, tourism, manufacturing), and interferes with access to important community services (such as healthcare and education) (Cambridge Systematics, Inc., 2011).

2.3.4 Environmental Impacts

Deferred maintenance may lead to long-term negative impacts on the environment. Quantitative analysis indicates that, compared to good road conditions, poor road conditions reduce the vehicle speed, and increase emissions by 2.49 percent (Setyawan, Kusdiantoro, & Syafi, 2015). Similarly, Chang, et al (2016), found that gas emissions differ significantly across pavements in good, fair, poor, and very poor condition. In particular, gas emissions significantly drop when vehicles are running on roads with good conditions. Another study about maintenance types found that performing preventive pavement maintenance after the proper timing is associated with a significant rise in carbon emissions, while performing it on time could reduce greenhouse gas emissions by up to 2 percent and retard pavement failures (Wang, Al-Saadi, Lu, & Jasim, 2020). Similarly, compared to major reconstructions, preventive maintenance could reduce CO_2 emissions by 44 percent in 50 years. Treatments such as crack sealing, microsurfacing, thin overlay, etc., would all extend major rehabilitation much longer, reducing emission for a long period (Guistozzi, Flintsch, & Crispino, 2012).

2.4 HIGHWAY AND ROADWAY SYSTEM MAINTENANCE DECISION-MAKING AND SPENDING PROCESS

2.4.1 Maintenance Decision-Making and Spending Processes in the U.S.

Maintenance decision-making is needed to determine the maintenance priority of sections of the highway and roadway system. This is a multi-factor process that considers the characteristics of a section of the highway or roadway system (including pavement structure, age, performance, and traffic loads and its relative significance) as well as the goals of the agency and its financial constraints (Li, Ni,

Dong, & Zhu, 2018). To support their maintenance investment decisions, state and local transportation agencies use different systems and methods based on their needs, resources, and the complexity of their systems.

State highway agencies use pavement management systems (PMS) to make pavement maintenance and rehabilitation investment decisions. Many of these systems compare the pros and cons of alternative policies, programs, and projects through analytical tools (USDOT, 2017) using information about roadway condition and treatment history, traffic volume data, and other pavement characteristics. To allocate funding into different projects, agencies use a combination of engineering judgment and performance-based and/or need-based assessments. The most common methods for budget allocation are cost-benefit analysis (CBA), integer-linear programming (ILP), and a decision tree and needs-based allocation (DTN). These methods create and rate candidate projects based on a set of parameters, trends, and representative attributes and typically allocate funding to pavement sections that are most severely damaged, or to an optimal set of projects given some constraints (Jojo France-Mensah, 2018).

States use bridge management systems (BMS) to make decisions about their bridge planning, programming, and resource allocation. States differ in their specific procedures based on various factors such as their bridge management philosophies; planning; programming; and budgeting approaches; transportation system and infrastructure characteristics; and policy, financial, technical, and institutional environment. In addition, decisions are influenced by the agency's use of their BMS. The systems' capabilities range from simple data repository to management systems with forecasting models, comparative analysis, and optimization procedure or decision rules. While agencies with sophisticated tools have the ability to apply various analyses including budget scenarios, generally, they do not utilize these capabilities. Many agencies use their BMS to manage bridge inspection data with a limited number of agencies using it to conduct economic analysis on the entire bridge network. Agencies commonly use cost-benefit analysis for major bridge projects, and life-cycle cost comparisons of rehabilitation versus replacement options for specific structures (Markow & Hyman, 2009).

Little is known about the maintenance decision-making and spending processes at the local level. Local governments' approaches to asset management vary greatly due to the variation in the responsibilities and the resources available to them (USDOT, 2017). Through a study of the 40 largest U.S. counties, Ebdon (2004) found that counties do not have comprehensive information available about their maintenance needs. In the study, 47 percent of counties claimed to conduct annual condition assessments and 69 percent had formal estimates of the costs of bringing assets to good condition. In many cases, assessments were not comprehensive as they did not include all assets and formal cost estimates were only prepared for assets being considered in capital improvement plans. Overall, the author found that these counties were strong in project management and capital planning, but they have weaknesses in asset maintenance**.**

In a recent study of 63 districts in 26 states, Arif & Bayraktar (2018) found that a majority of districts make maintenance investment decisions on an annual basis (63%) and allocate resources for 1-5 years (45% and 40% make allocations for 1-3 and 3-5 years, respectively). Roadway investments are made for

a 1- to 3-year period, while structural investments (like bridges) are made for a 3- to 5-year period. In addition, most districts consider infrastructure's physical condition (92%) and infrastructure utilization (67%) as common decision parameters for maintenance activities. In terms of constraints, most districts make maintenance investment decisions for a known budget (81%), for a known threshold condition (52%), and some have a predefined priority of the infrastructure for investment decision making (43%).

2.4.2 Maintenance Decision-Making and Spending Process in Minnesota

In Minnesota, the owners of the roadway system are responsible for maintenance activities and this ownership is divided between different government jurisdictions. MnDOT constructs, improves, and maintains the state trunk highway system, which includes trunk highways, state highways, and interstate highways. Counties are responsible for county state-aid highways and county roads, while cities are responsible for municipal state-aid streets and city streets, and townships for town roads (Public Health Law Center, 2014). Townships and counties own a large portion of the roadway system (40% and 31% of the roadway system, by lane-mile, respectively), followed by cities (15.5%), MnDOT (10%) and others (3.5%) (MnDOT, 2018). However, local units of government may participate in cooperative projects with other local governments or MnDOT to determine the appropriate division of construction and maintenance responsibilities. The participation in cooperative projects should be commensurate with the benefits accruing to their own system. These agreements may take away funding available from the locality's maintenance projects.

Maintenance Decision-Making and Spending Processes at the State Level

MnDOT builds, operates, and maintains the state highway system (MnDOT, 2019). The state uses its Transportation Asset Management Plan (TAMP) to analyze life cycle costs, evaluate risks and develop mitigation strategies, establish asset condition performance measures and targets, and develop investment strategies. The TAMP was developed in response to the MAP-21 Act that required states to develop a risk-based transportation asset management system plan for the National Highway System (NHS) to improve and preserve the condition of the roadway and bridge assets and the performance of the system.

MnDOT manages pavement conditions through its Highway Pavement Management Application (HPMA) software (MnDOT, 2019). The condition of the network is measured annually using a special digital inspection vehicle. All state highways, including interstate roads, and NHS roads that are not part of the state highway system are driven in both directions to collect data. This data is processed to calculate roughness, rutting, faulting, and cracking. When maintenance and rehabilitation analysis is done, each section of road goes through a pavement treatment decision tree, which helps to develop a matrix of all possible treatments, their effectiveness, costs, and cost-effectiveness. Then, constraints are set, identifying available budget and/or desired conditions. Depending on the data available, the analysis will determine funding needed to meet conditions identified, or the best conditions achievable given a certain budget, or the most cost-effective projects (if both points are available). Then, the HMPA uses a Marginal Costs Effectiveness (MCE) process, an optimal technique, to select projects. This process results in a combination of projects that yield the highest cumulative effectiveness over the network for

a given budget. The analysis provides a set of recommended projects, their anticipated cost, and expected impact on the condition of the network.

MnDOT also manages and reports inspection, inventory, and condition data for all bridges in the state. The agency uses a Structure Information Management System (SIMS) to collect bridge inventory and inspection data, which is then copied to MnDOT's databases. The agency uses an analysis tool called Bridge Replacement and Improvement Management (BRIM) to predict bridge condition. There are seven deterioration curves based on districts assigned to each bridge to forecast future condition. BRIM provides a recommended work type, timeframe, and cost for each bridge based on life cycle cost principles. These treatment options include a mixture of preservation, rehabilitation, and replacement alternatives that consider the remaining life of the bridge. The output is reviewed annually by experts in the districts and Bridge Office (Kumar, Oliveira, Schultz, & Marasteanu, 2018; MnDOT, 2019).

In addition, MnDOT uses a network level life cycle cost analysis through probabilistic deterioration modeling to compare investment scenarios and prioritize bridge investments by treatment category. BRIM's treatment logic recommends a work type and timeframe, after which unit costs are applied to each bridge. The results determine short-term and long-term budget needs. In addition to the treatment logic and deterioration modelling, BRIM also includes a risk management component that considers eight risk factors and four important factors. All of this information contributes to the development of a list of candidate bridge projects by the districts. However, additional scoping work by local experts determines the appropriate repair (Kumar, Oliveira, Schultz, & Marasteanu, 2018; MnDOT, 2019).

The results from these management systems are used to create a preliminary list of potential projects. Projects are selected through the Statewide Performance Program, and then MnDOT districts modify the list based on a number of considerations (including local knowledge of conditions, inputs from stakeholders, and timing of other projects in the area for pavements; and other planned projects for bridges) (MnDOT, 2017). The results are included in the 10-year Capital Highway Investment Plan (CHIP) and the 4-year State Transportation Improvement Plan (STIP). Projects listed in these plans are the basis of annual work plans for needed maintenance and operations activities. Based on the investment guidance in the 20-year State Highway Investment Plan (MnSHIP), MnDOT divides available funding into programs and categories within which projects are selected. For projects selected within each of the agency's eight districts, MnDOT distributes anticipated funding using formulas, which consider the condition of pavement and bridges, size of the network, and use of the system within each district (MnDOT, 2017).

The decision-making and spending processes are crucial to effective maintenance investments given the funding shortage and the increasing needs. In 2017, it was estimated that the total need for the state highway system is $39 billion through 2037, but only an estimated $21 billion will be available, leaving an $18 billion funding gap. Of the total needed funding, over 34 percent will be needed for pavement condition and 7 percent for bridge condition (MnDOT, 2017). The gaps in bridge funding are widening as funding levels are dropping substantially with the conclusion of the Chapter 152 program in 2018, a program targeted to improve trunk highway bridges post the I-35W bridge collapse (ASCE, 2018).

Besides the funding shortage, the percentage of highways and bridges that will be in poor condition in the next decade is anticipated to increase significantly, see Table 2.2 (MnDOT, 2019).

Table 2.2: Current and projected pavement and bridge conditions

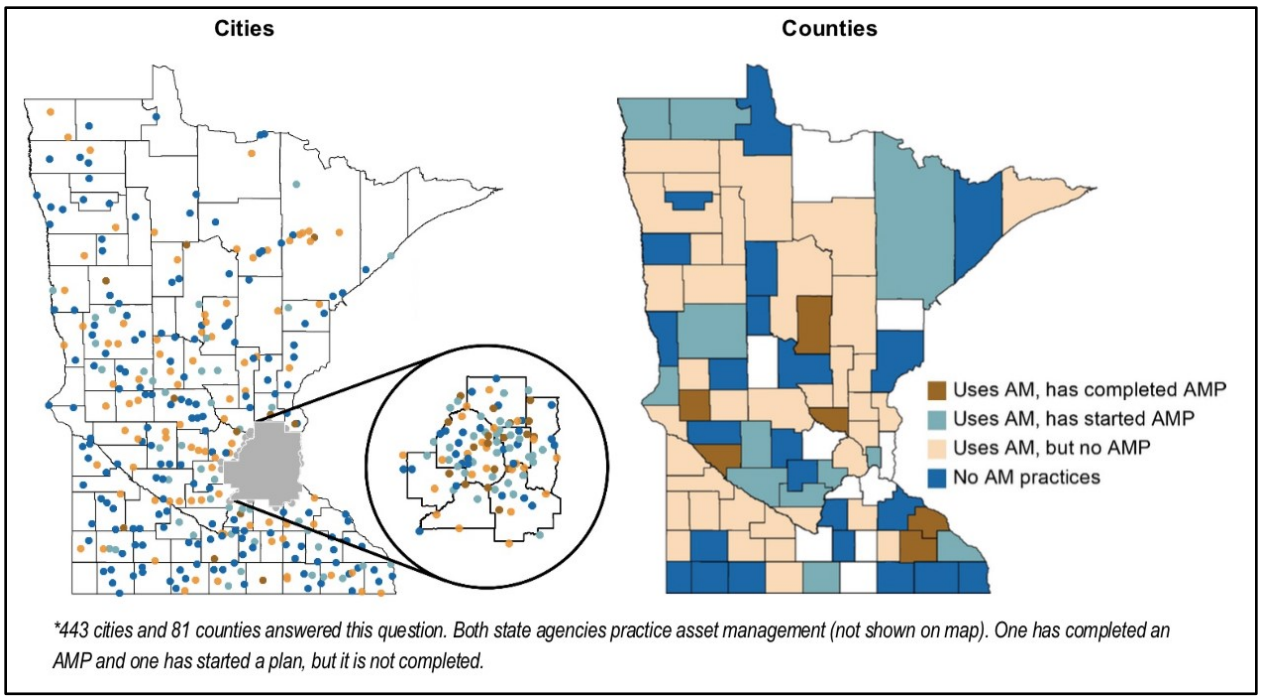
Investment Category	Poor Conditions in 2017	Poor Conditions in 2037
Pavement Condition	Interstate 1.9% NHS 3% Non-NHS 4%	Interstate 4% NHS 8% Non-NHS 18%
Bridge Condition (1)	NHS 4.5% Non-NHS 1.3%	NHS 5% Non-NHS 7-8%

Notes: *(1) Each year, approximately 80 bridges are reaching the end of their design life (50 years in Minnesota), replacement of which costs an average of $2 million each, resulting in funding needs of $160 million per year* (ASCE, 2018). ***Source:*** *MnDOT* (2017)***.***

Maintenance Decision Making and Spending Processes at the Local Level

In Minnesota, asset management is not required, funded, or standardized, unlike other states, like Indiana and Michigan, that require public road authorities to prepare and maintain an up-to-date Asset Management Plan (Robjent, Clark, Marti, Freese, & Johnson, 2020). In 2020, the Local Road Research Board (LRRB) and the Research Implementation Committee (RIC) prepared a Guidebook to provide guidance in developing an asset inventory and condition assessment, establishing performance measures and goals, identifying and rating risks, determining lifecycle planning and funding strategies, and creating asset management plans and programs using existing and new resources (Robjent, Clark, Marti, Freese, & Johnson, 2020).

Asset management is not used consistently across counties, cities, and townships in Minnesota. Bartholomay & MartinRoger (2016) found that half of Minnesota jurisdictions practice some form of asset management to preserve, maintain, and extend the life of infrastructure assets, including roads and bridges (see Figure 2.2). Besides, few municipalities provide details of the decision making and spending processes of operating, maintaining, and improving physical assets.



***Source**: Bartholomay & MartinRoger* **(2016)**

Figure 2.2 Cities and Counties that Use Asset Management Practices and have an Asset Management Plan

A large portion of counties and large cities know the condition of their assets, but smaller cities have challenges in knowing this information (Bartholomay & MartinRoger, 2016). Eighty-six percent of counties, 82 percent of large cities, and 59 percent of small cities know the conditions of their road; while 97 percent of counties, 83 percent of large cities, and 51 percent of small cities know the conditions of their bridges. Although some condition data exist scattered throughout the county and city systems, the data is not collected, rated (MnDOT, 2017) or stored in a uniform way (ASCE, 2018). Agencies across Minnesota use a variety of tools (including MS Excel, ESRI GIS, and pencil and paper) and systems (like MnDOT SIMS, Icon, Simple Signs, Pontis, and Cartegraph) to conduct asset management (Bartholomay & MartinRoger, 2016).

A funding shortage and increasing needs are also expected at the local level. While there is limited data about the condition of the state aid roads and county, city, and township roads, it is anticipated that pavement condition along these roads will deteriorate significantly based on current funding levels (ASCE, 2018). In addition, the Minnesota Transportation Finance Advisory Committee (TFAC) estimated in 2012 that between 2013 to 2032, an additional $9.3 billion would be needed to meet current performance on the local roadways and an additional $17.5 billion would be required to provide an economically competitive system (Minnesota Transportation Finance Advisory Committee, 2012). The estimates include the cost of bridges as well.

CHAPTER 3: MAINTENANCE SPENDING ACROSS MINNESOTA

In this chapter we present a spatial analysis of maintenance spending across cities, counties, and townships in Minnesota. We use data available from the Minnesota Transportation Finance Database (MTFD) (Zhao, Lari, Fonseca, & Bean, 2020) as well as from the Minnesota Department of Transportation (MnDOT). From the MTFD, we use data for counties, cities and townships including maintenance and construction spending, and lane miles.[4] These data are available from 2006 to 2018 and aggregated at the county level. We present these data using 2018 constant dollars and a five-year average to smooth-out the high annual variation by county. Roadway condition data includes conditions of the trunk highway system from 2012 to 2019 (excluding 2018), and conditions of bridge structures (10 and 20FT) available from 2016 to 2019. These data come from MnDOT pavement condition annual reports and bridge condition reports. There is no compiled data available regarding the conditions of the roadway system in counties, cities, and townships.

3.1 TRENDS OF MAINTENANCE EXPENDITURES IN MINNESOTA

This subsection presents the trends of maintenance expenditures of counties, cities, and townships. For each government level we present the overall maintenance spending, maintenance spending per lane mile in the respective roadway system,[5] and the ratio of maintenance to construction spending. Governments may contribute to the maintenance of lane miles in roadway systems owned by other governments due to cost sharing agreements. Data for the contributions under these agreements is not available, therefore, the maintenance spending per lane mile in the respective roadway may overestimate the actual amount.

3.1.1 Maintenance Expenditures in Local Minnesota

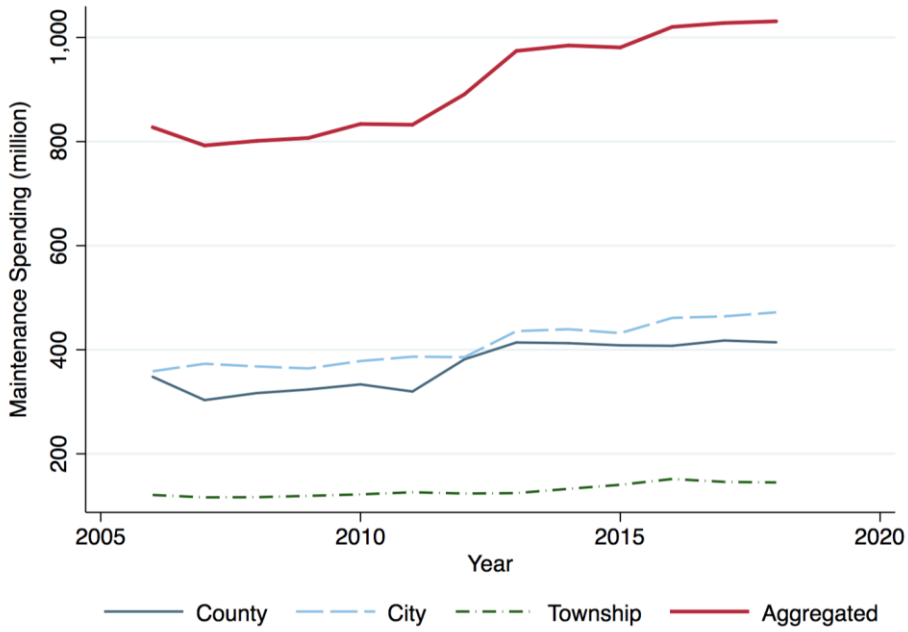
Maintenance spending at all levels of local government has increased in Minnesota. While the aggregated maintenance spending had the biggest increase at the city level (with an annual average growth rate of 2.4 percent), per lane mile, it had the greatest increase at the county level (with an annual average growth rate of 1.8 percent). Similarly, maintenance spending per lane mile at the transportation district level increased in all districts, with District 2 (Bemidji) experiencing the highest annual growth rate of 3.3 percent.

Local maintenance spending increased between 2006 and 2018 at an average annual rate of 1.91 percent (Figure 3.1). Prior to 2011, the aggregated maintenance spending was relatively stable, growing at an average rate of 0.15 percent, possibly due to the 2007-08 financial crisis. Between 2012 and 2013

[4] Lane mile data do not include 2015 values. These are calculated by the authors as the 2014-2016 average.
[5] Total county lane miles include lane miles in county roads and county state-aid highways. Total city lane miles include lane miles in municipal streets and municipal state-aid streets. Total township lane miles include lane miles in township roads.

the maintenance spending recovered, experiencing an average increase of 8.2 percent. Following 2013, the aggregated maintenance spending had a conservative increase of 1.15 percent on average. County and city maintenance spending explain the variation at the aggregated level.

Cities, counties, and townships experienced an average annual growth of 2.4, 1.7, and 1.6 percent between 2006 and 2018, respectively. County maintenance spending increased from $348 million in 2006 to $414 million in 2018 (19 percent). County maintenance spending saw a decline in 2007, from $348 in 2006 to $303 million in 2007 (12.9 percent). It remained relatively stable until 2010, after which it experienced a significant increase, from $319 million in 2011 to $381 million in 2012 (19.4 percent). Similarly, city maintenance spending experienced a major increase from $385.6 million in 2012 to $435.7 million in 2013 (13 percent). Township maintenance spending remained more stable, while it also experienced an annual growth rate of 1.5 percent.

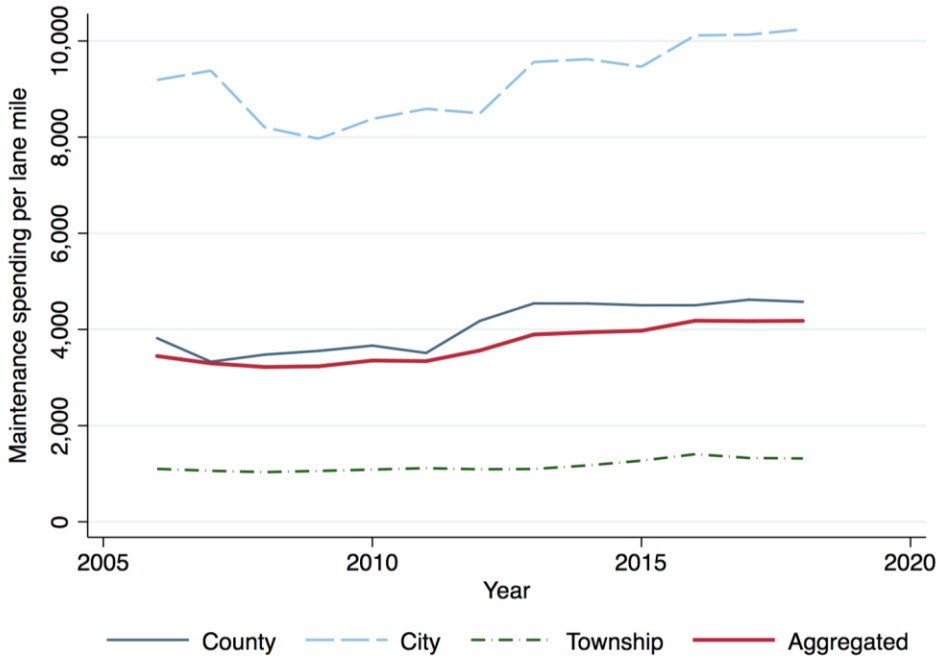


Note: *Authors' calculations. Values in 2018 constant dollars.* ***Source:*** *Zhao, Lari, Fonseca, & Bean* (2020)
Figure 3.1: Maintenance Spending

Maintenance spending per lane mile at all levels of government increased between 2006 and 2018, at an average annual rate of 1.7 percent (Figure 3.2). Similarly, per lane mile maintenance increased 1.8 percent in counties, 1.1 percent in cities, and 1.6 percent in townships, on average. During the same period, all levels of government spent $3,676.5, on average, on maintenance per lane mile.

Per lane mile maintenance spending was higher in cities compared to counties and townships ($9,180.9 compared to $4,062.5 and $1,163.7, respectively). County maintenance spending per lane mile experienced a 12.8 percent decline in 2007 and a 19 percent increase in 2012. After 2012, it has

remained stable. Similarly, city maintenance spending per lane mile declined significantly in 2008 (12.6 percent), but it experienced a major increase in 2013 (12.6 percent). Township spending per lane mile, on the other hand, has been the most stable during this period. It increased from $1,099.8 in 2006 to $1,316.2 in 2018 (19.7 percent).



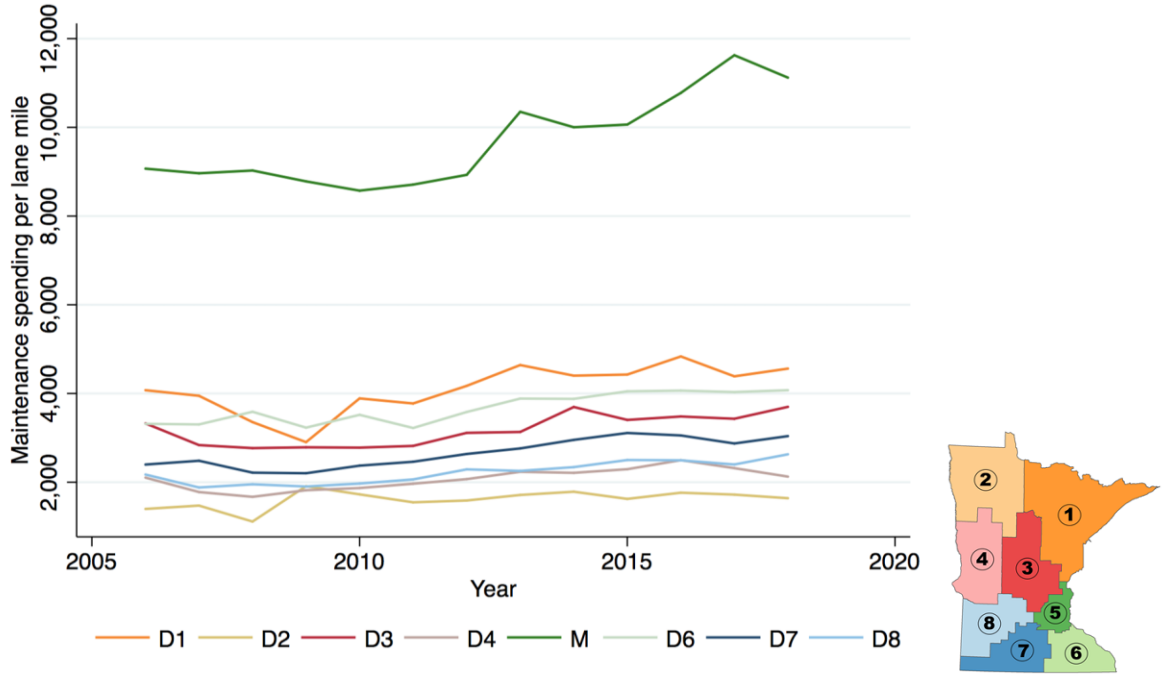
Note: *Authors' calculations. Values in 2018 constant dollars.* ***Source:*** *Zhao, Lari, Fonseca, & Bean* (2020)

Figure 3.2: Maintenance Spending per Lane Mile

At the district level, the aggregated maintenance spending per lane mile also increased in the period 2006-2018 (Figure 3.3). During that period, the Metro district had the highest maintenance spending per lane mile with an average annual spending of $9,691.5, and District 2 (Bemidji) had the lowest maintenance spending per lane mile with an average annual spending of $1,614.7. In addition, all districts experienced an average annual growth rate between 0.4 percent (in District 4 - Detroit Lakes) and 3.3 percent (in District 2).

The majority of these districts experienced major fluctuations in their maintenance spending per lane mile during the data period. District 1 (Duluth), for instance, experienced a significant drop in 2008 (15 percent) and 2009 (13.5 percent), after which its maintenance per mile spending increased 34 percent in 2010. Overall, it experienced an annual average growth rate of 1.7 percent. Similarly, District 2 experienced a significant decline of 24.5 percent in 2008 followed by a 71.7 percent increase in 2009. After 2011, it remained relatively stable. District 3 (Brainerd) also experienced a 14.7 percent decline in

2007 and significant increases in 2012 (10.4 percent), and 2014 (18 percent). It experienced an annual average growth rate of 1.2 percent. Maintenance spending in District 4 and District 8 (Willmar) remained relatively more stable throughout the period.

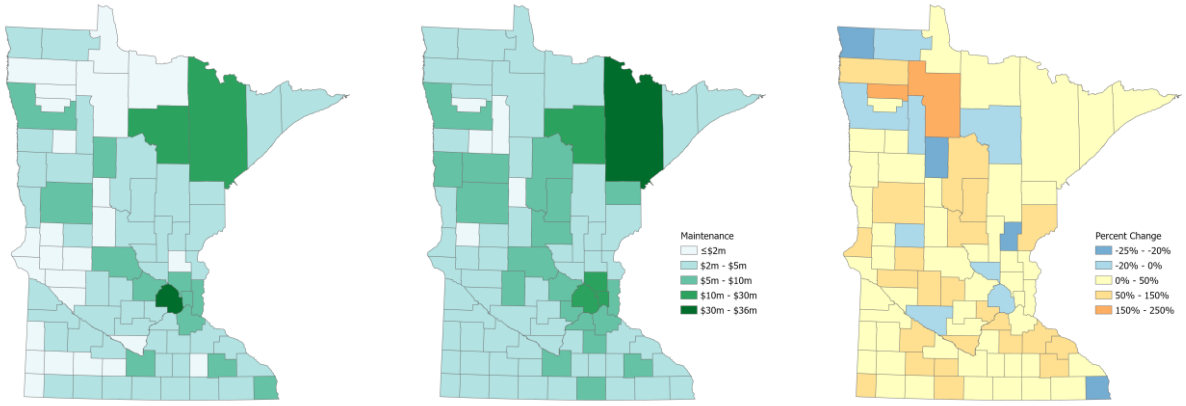


Note: *Authors' calculations. Values in 2018 constant dollars.* ***Source:*** *Zhao, Lari, Fonseca, & Bean* (2020)

Figure 3.3: Maintenance Spending per Lane Mile by Transportation District

3.1.2 County Maintenance Expenditures

County average maintenance expenditures increased from $3.7 million in the 2006-10 period to $4.8 million in the 2014-18 period (Figure 3.4). Between the two periods, some counties experienced significant changes. Pennington county, for instance, experienced the largest increase between the two periods (228 percent), followed by Beltrami, and Scott experiencing 215 and 137.5 percent increases, respectively. On the other hand, Hubbard County experienced the largest decrease (28.5 percent), followed by Kittson and Houston (experiencing a 24.6 and 22.1 percent decrease, respectively). Similarly, Hennepin County decreased its maintenance expenditure from $35.2 million to $29.7 million (a 15.7 percent decrease).



(a) Average County Maintenance Spending (2006-2010)

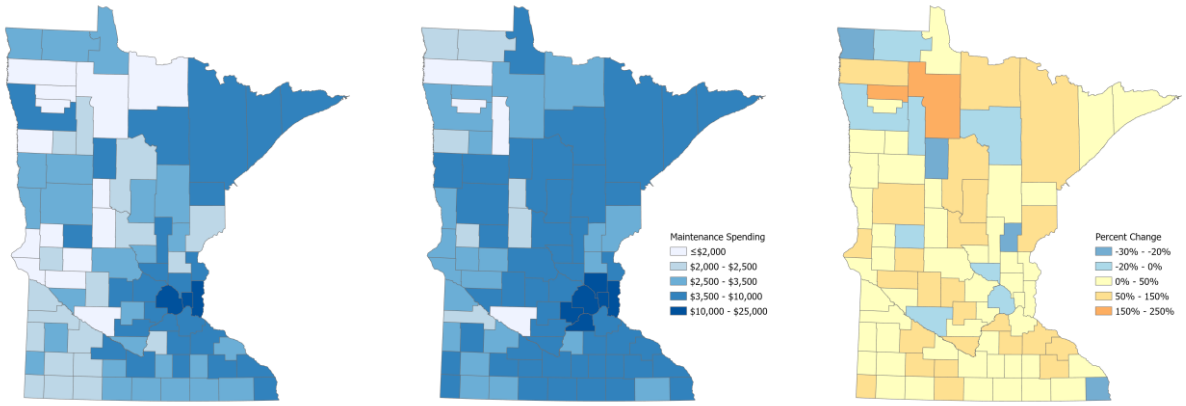
(b) Average County Maintenance Spending (2014-2018)

(c) % Change in Average Maintenance

Note: *Authors' calculations. Average maintenance spending in 2018 constant dollars.* ***Source:*** *Zhao, et al* (2020)

Figure 3.4: Average County Maintenance Spending

Similarly, average county maintenance spending per lane mile has increased across most counties (Figure 3.5). It increased from an average of $3,603.1 in the 2006-10 period to $4,624.3 in the 2014-18 period. Majority of counties experienced increases ranging from 0.25 percent (Dakota) to 232.6 percent (Pennington). Few counties, particularly those in the northwest, experienced a decrease. Hubbard county, for instance, decreased its maintenance spending per lane mile by 28 percent.



(a) Maintenance Spending per Lane Mile (2006-2010)

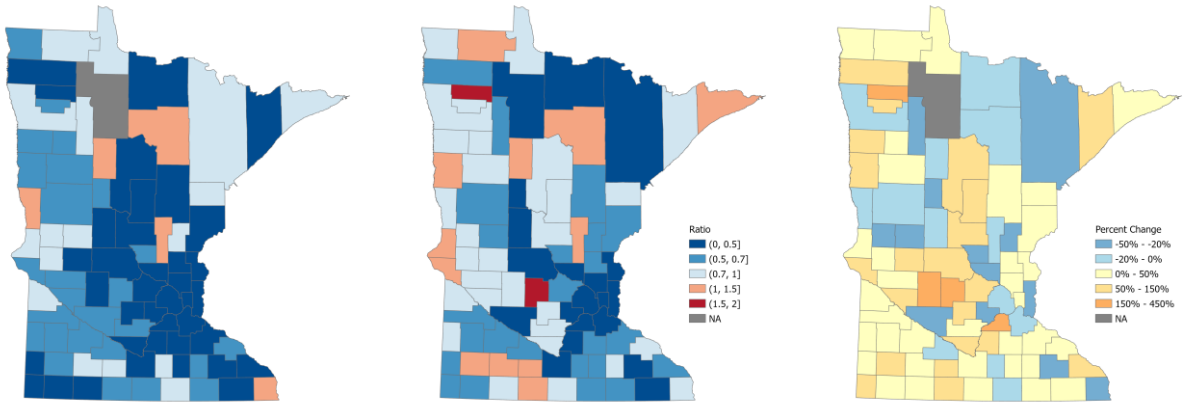
(b) Maintenance Spending per Lane Mile (2014-2018)

(c) % Change in Maintenance Spending per Lane Mile

Note: *Authors' calculations. Amounts calculated as the average county maintenance spending divided by average lane miles of county roads and county state-aid highways.* ***Source:*** *Zhao, Lari, Fonseca, & Bean* (2020)

Figure 3.5: Average County Maintenance Spending per Lane Mile

Overall, counties increased their maintenance spending more compared to their construction spending between the two periods (Figure 3.6). Average ratio of county maintenance to construction increased from 0.45 in the 2006-10 period to 0.53 in the 2014-18 period. In addition, while only five counties had ratios above 1 in the 2006-10 period, this number increased to fourteen counties in the 2014-18 period. Pennington increased the ratio by 421 percent, which is the largest increase, followed by Meeker (235.8 percent) and Kandiyohi (161.8 percent). The three counties with the largest decrease were Houston (42.9 percent), Saint Louis (41.1 percent), and Washington (39.1 percent).



(a) Average Ratio of Maintenance to Construction (2006-2010)

(b) Average Ratio of Maintenance to Construction (2014-2018)

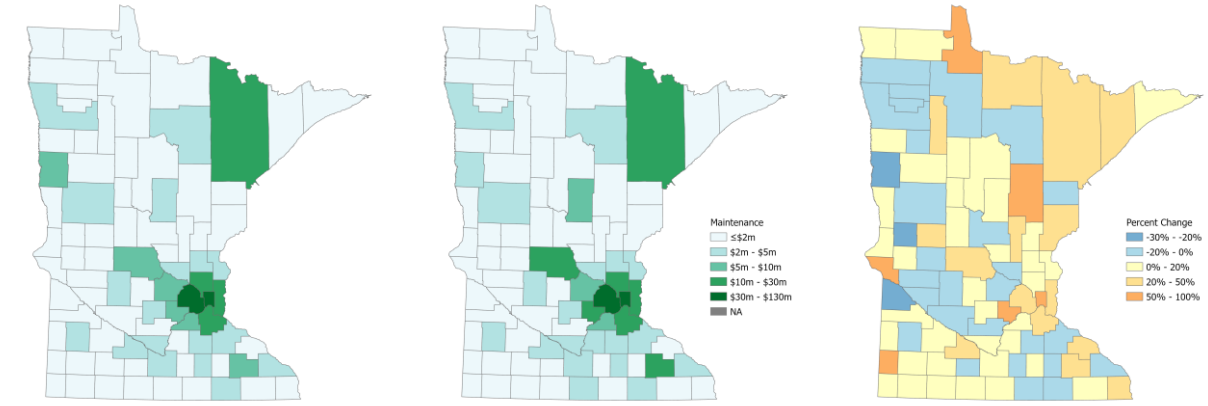
(c) % Change in Maintenance to Construction Ratio

Note: *Authors' calculations. Amounts calculated as the average maintenance spending divided by average construction spending per county.* ***Source:*** *Zhao, et al* (2020)

Figure 3.6: Average County Maintenance vs. Construction Spending

3.1.3 City Maintenance Expenditures

Overall, city average maintenance spending also experienced an increase between the two periods (Figure 3.7). City average maintenance spending for the 2006-10 period was $4.2 million and increased to $5.2 million for the 2014-18 period (23.2 percent). Cities in the Metro area and northeastern counties have been investing more on maintenance as well as cities in southwest counties. Between the two periods, average city maintenance spending in fifty-seven counties increased, with cities in Ramsey County experiencing the highest increase (96.4 percent) and cities in Anoka County experiencing the lowest increases (0.1 percent). On the other hand, cities in Clay County experienced the highest decline (23.5 percent).



(a) Average City Maintenance Spending (2006-2010)

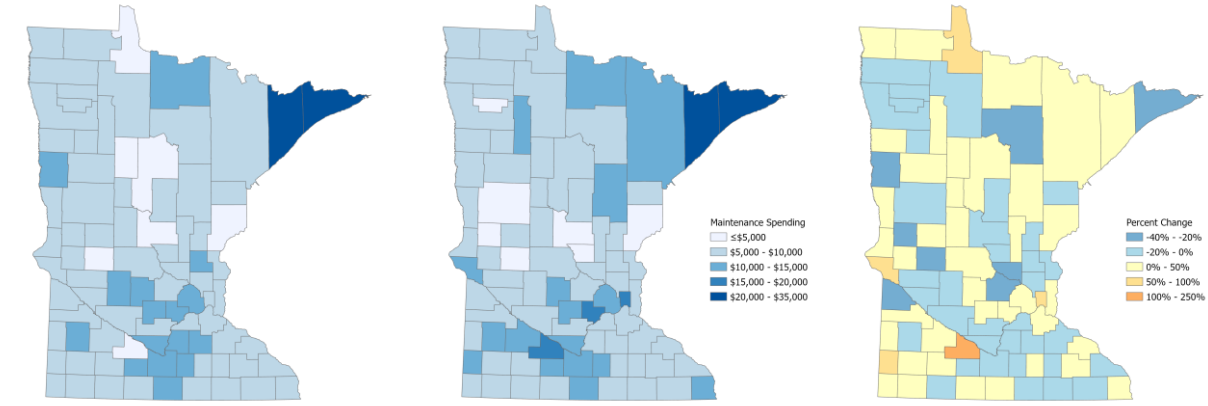
(b) Average City Maintenance Spending (2014-2018)

(c) % Change in Average Maintenance Spending

Note: *Authors' calculations. Average maintenance spending in 2018 constant dollars.* ***Source:*** *Zhao, et al* (2020)

Figure 3.7: Average City Maintenance Spending

Average city maintenance spending per lane mile slightly increased from $8,488.2 for the 2006-10 period to $8,829.2 for the 2014-18 period (Figure 3.8). Between the two periods, cities in southeastern and northwestern counties experienced a decline in their maintenance spending per lane mile ranging from -0.1 (Jackson) to -31.5 (Clay) percent. Cities in Brown County experienced the largest increase (240.7 percent).



(a) Maintenance Spending per Lane Mile (2006-2010)

(b) Maintenance Spending per Lane Mile (2014-2018)

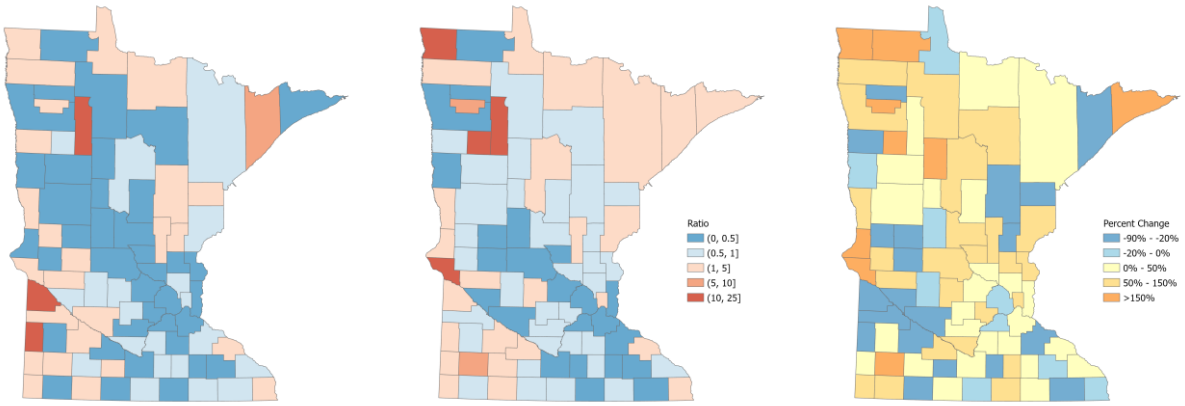
(c) % Change in Maintenance Spending per Lane Mile

Note: *Authors' calculations. Amounts calculated as the average city maintenance spending divided by average lane miles of municipal streets and municipal state-aid streets.* ***Source:*** *Zhao, et al* (2020)

Figure 3.8: Average City Maintenance Spending per Lane Mile

Cities also spent more on maintenance than on construction between the 2006-10 and 2014-18 periods (Figure 3.9), particularly in some of the northern counties. The overall maintenance to construction ratio

increased from 0.50 of the 2006-2010 period to 0.56 of the 2014-2018 period. In addition, cities in some counties experienced significant changes between the two periods. For instance, cities in Traverse County experienced the largest increase (1,328.9 percent), followed by cities in Mahnomen and Cook counties, experiencing increases of 1,274.5 and 1,184.5 percent, respectively. On the other hand, cities in Lac Qui Parle County experienced an 88.1 percent decrease.



(a) Average Ratio of Maintenance to Construction (2006-2010)

(b) Average Ratio of Maintenance to Construction (2014-2018)

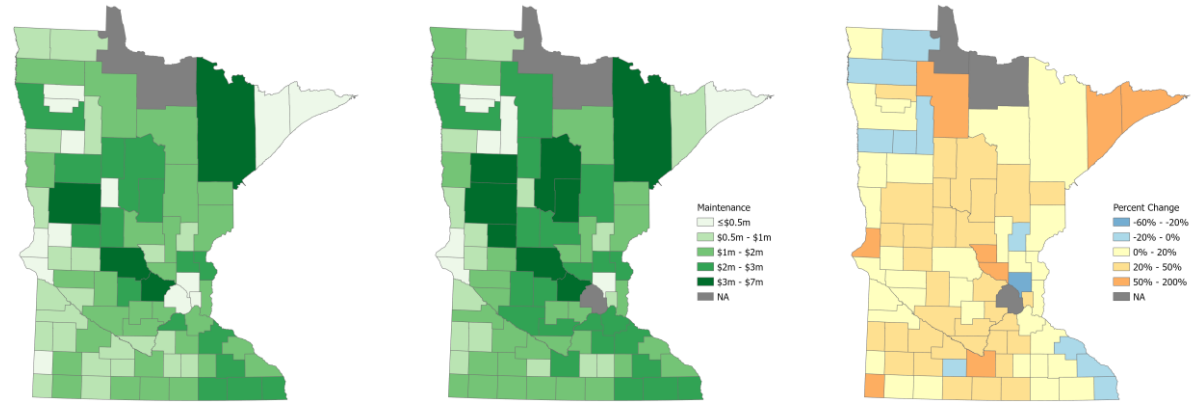
(c) % Change in Maintenance to Construction Ratio

Note: *Authors' calculations. Amounts calculated as average maintenance spending divided by average construction spending by city (aggregated at the county level).* ***Source:*** *Zhao, et al* (2020)

Figure 3.9: Average City Maintenance vs. Construction Spending

3.1.4 Township Maintenance Expenditures

Average township investment on maintenance increased from $1.4 million in the 2006-10 period to $1.7 million in the 2014-18 period, showing a 21.7 percent increase (Figure 3.10). Overall, townships in most of the counties increased their maintenance spending, with townships in Cook County experiencing the highest increase (180 percent), and townships in Olmsted experiencing the lowest increase (0.2 percent). On the other hand, townships in Anoka County had a significant decrease of 52.9 percent, which is the lowest.



(a) Average Township Maintenance Spending (2006-2010)

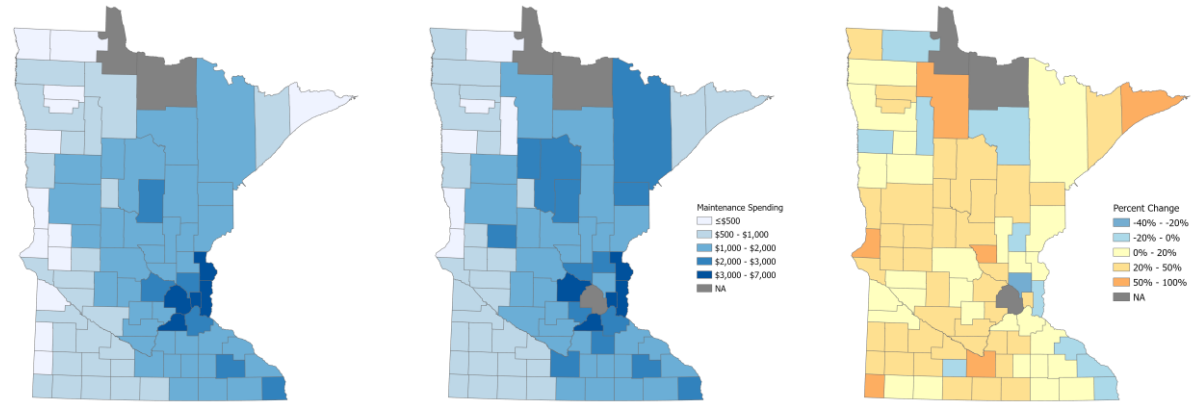
(b) Average Township Maintenance Spending (2014-2018)

(c) % Change in Average Maintenance Spending

Note: *Authors' calculations. Average maintenance spending in 2018 constant dollars.* ***Source:*** *Zhao, et al* (2020)

Figure 3.10: Average Township Maintenance Spending

Average township maintenance spending per lane mile increased 12.8 percent from $1,285.2 in the 2006-10 period to $1,449.7 in the 2014-18 period (Figure 3.11). Overall, townships in most of the counties increased their maintenance per lane spending between the two periods. Townships in Cook County experienced significant increases in maintenance spending per lane mile (96.7 percent), followed by townships in Rock (74.9 percent) and Traverse (71.7 percent). On the other hand, townships in Anoka County experienced a significant decrease (31.4 percent), followed by townships in Houston (14.8 percent), and Clearwater (11.9 percent).



(a) Maintenance Spending per Lane Mile (2006-2010)

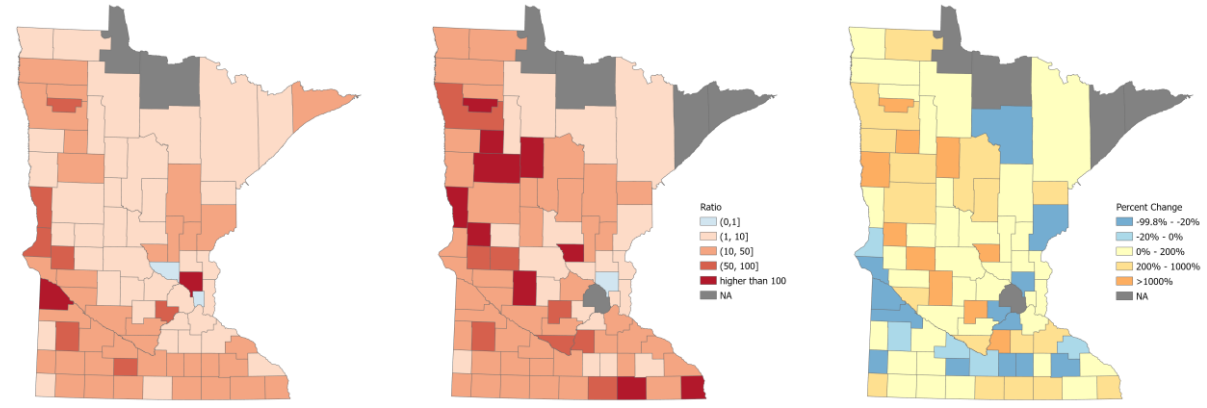
(b) Maintenance Spending per Lane Mile (2014-2018)

(c) % Change in Maintenance Spending per Lane Mile

Note: *Authors' calculations. Amounts calculated as the average township maintenance spending divided by average lane miles of township roads.* ***Source:*** *Zhao, et al* (2020)

Figure 3.11: Average Township Maintenance Spending per Lane Mile

Overall, townships invested more on maintenance than on construction between the 2006-10 and 2014-18 periods (Figure 3.12). Average ratio of township maintenance to construction increased from 5.1 in the first period to 13.4 in the second period studied. Townships in northwestern counties, in particular, experienced increased maintenance to construction ratios. For instance, townships in Benton County experienced the highest increase (13,937 percent), followed by townships in Red Lake (3,341.7 percent), and Grant (3,030.9 percent), while cities in Renville experienced the lowest increase (3.1 percent). On the other hand, townships in Anoka experienced a significant decrease (99.8 percent), followed by townships in Carver (93.3 percent) and Watonwan (79.4 percent).



(a) Average Ratio of Maintenance to Construction (2006-2010)

(b) Average Ratio of Maintenance to Construction (2014-2018)

(c) % Change in Maintenance to Construction Ratio

Note: *Authors' calculations. Amount calculated as the average maintenance spending divided by average construction spending by townships (aggregated at the county level).* ***Source:*** *Zhao, et al* (2020)

Figure 3.12: Average Township Maintenance vs. Construction Spending

3.2 CONDITIONS OF THE ROADWAY SYSTEM IN MINNESOTA

This subsection explores the conditions of the roadway system in Minnesota including the pavement conditions of the trunk highway system and bridges. This section does not report conditions of the roadway system in counties, cities, and townships as there is no compiled data available on this.

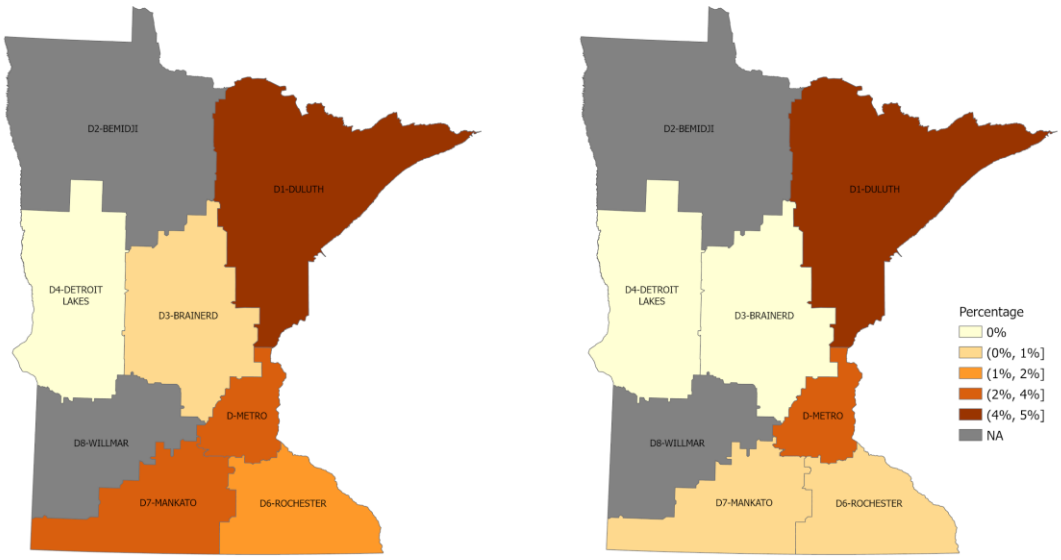
Minnesota's trunk highway system includes three systems: Interstate, Other National Highway System (NHS), and Non-NHS. The system mileage in 2019 was 12.7 percent Interstate, 40.5 percent other-NHS, and 46.8 percent non-NHS. This section presents the Ride Quality Index (RQI) that represents the rating a typical road user would give to the pavement's smoothness as felt while driving a vehicle. The index uses a zero to five rating scale as follows: good (3.1 to 5), fair (2.1 to 3), and poor (0 to 2). Each system has its own RQI targets based on the percent of miles in good and poor condition as presented in Table 3.1.

Table 3.1: RQI Targets by System

System	Ride Quality Index	
	"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

Source: MnDOT (2020, p. 8)

Statewide, the percentage of roadway miles in poor conditions in the interstate system improved between 2014 and 2019, decreasing from 1.9 percent in 2014 to 1.3 percent in 2019 (Pavement Condition Annual Report 2019 - 2014). District 3 (Brainerd), District 6 (Rochester), and District 7 (Mankato) experienced an improvement in their pavement condition, while District 1 (Duluth) and the Metro District experienced a decline in their pavement conditions (from 4.1 to 4.3 and from 2.1 to 2.6 percent, respectively) (Figure 3.13). District 4 (Detroit Lakes) is the only district that remained with all its roadway miles in good or fair condition.



(a) Percentage of Interstate Roadway Miles in Poor Condition (2014)

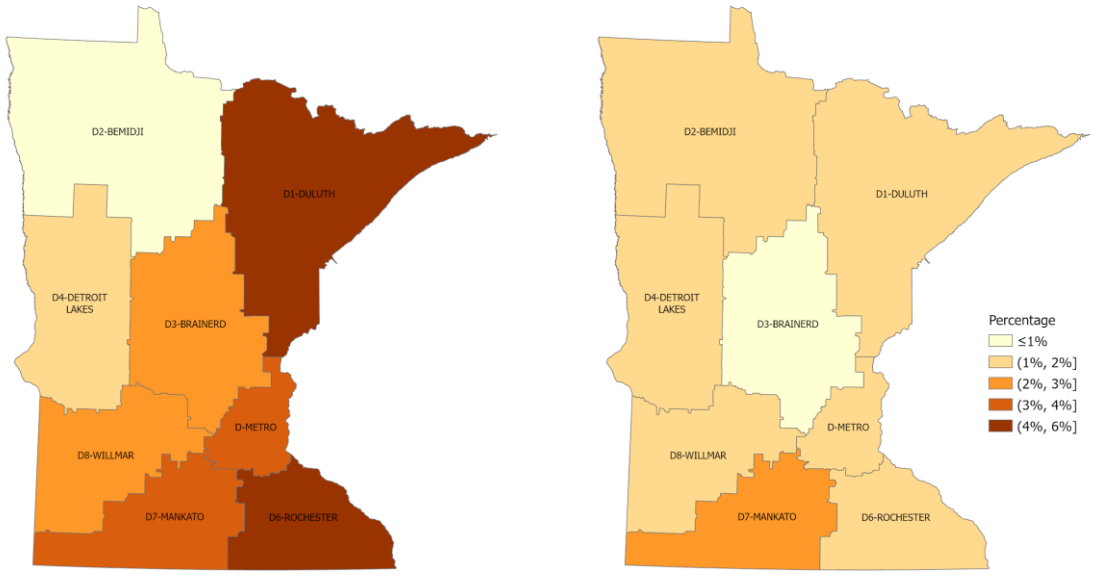
(b) Percentage of Interstate Roadway Miles in Poor Condition (2019)

Note: *ATP 2 and 8 did not have any rods on the interstate system.* ***Source:*** MnDOT (2015) (2020)

Figure 3.13: Interstate Roadway Miles in Poor Condition

Statewide, the percentage of roadway miles in poor conditions in the other-NHS system declined between 2014 and 2019, from 3 percent in 2014 to 1.4 percent in 2019 (Pavement Condition Annual Report 2019 - 2014). Most districts experienced an improvement in their pavement condition (Source: MnDOT

Figure 3.14), except for District 2 (Bemidji) and District 4 (Detroit Lakes). The percentage of roadway miles in poor conditions in District 2 increased from 0.6 in 2014 to 1.5 in 2019, while District 4 experienced a slight increase from 1.3 to 1.4 percent.



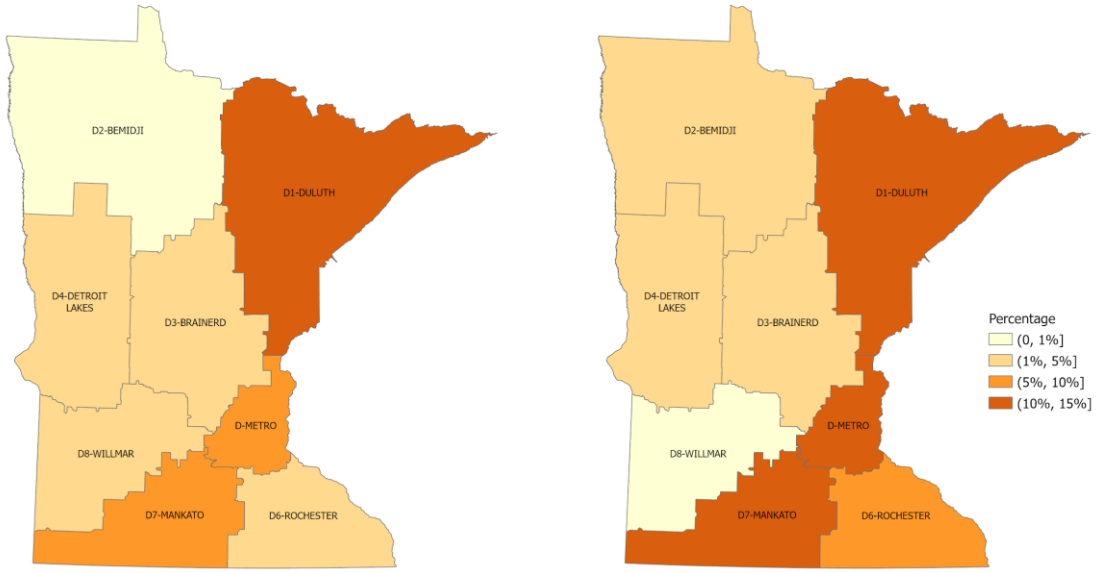
(a) Percentage of Other NHS Roadway Miles in Poor Condition (2014)

(b) Percentage of Other NHS Roadway Miles in Poor Condition (2019)

Source: MnDOT (2015) (2020)

Figure 3.14: Other-NHS Roadway Miles in Poor Condition

Contrary to the interstate and the other-NHS, the non-NHS deteriorated between 2014 and 2018 (Figure 3.15). The percent of roadway miles in poor condition increased from 4.4 percent in 2014 to 6.2 percent in 2019, statewide. By districts, only District 4 (Detroit Lakes) and District 8 (Willmar) experienced an improvement in their roadway conditions, decreasing their percent of roadway miles in poor condition from 1.6 to 1.4 and from 2.4 to 0.7, respectively.



(a) Percentage of Non-NHS Roadway Miles in Poor Condition (2014)

(b) Percentage of Non-NHS Roadway Miles in Poor Condition (2019)

Source: MnDOT (2015) (2020)

Figure 3.15: Non-NHS Roadway Miles in Poor Condition

MnDOT reports conditions for structures 10FT and over, and over 20FT (Table 3.2). MnDOT reports age and sufficiency ratings for these types of structures by county. Overall, Minnesota bridges have a design lifespan of 50 years, on average (Transportation for America, 2015). The sufficiency rating evaluates the condition of a structure by looking at four factors.[6] The rating ranges from 0 to 100, with a rating of 100 representing a bridge that is entirely sufficient for its current use (Constable & Blades, 2013). Structures with sufficiency rating of 80 or below are considered structurally deficient.

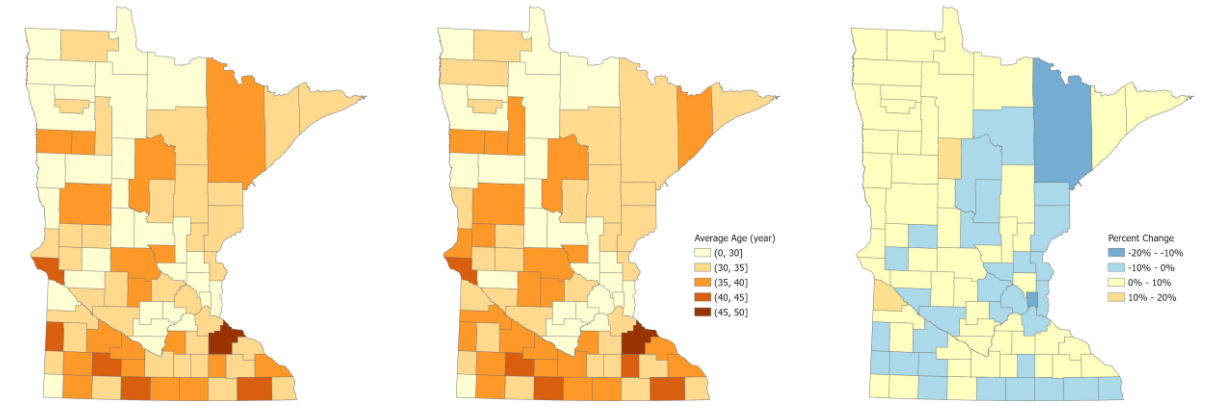
[6] The four factors are structural adequacy and safety, serviceability and functional obsolescence, essentiality for public use, and special reductions **Invalid source specified.**.

Table 3.2: Minnesota Highway on Bridge

Route System	Highway on Bridge - 10FT and over	Highway on Bridge - over 20FT
Trunk Highway	4,599	3,654
Local Highway	15,182	9,551
Total	19,781	13,205

Source: MnDOT (2019)

Average age of structures 10FT and over in Minnesota remained relatively stable between 2016 and 2019 (Figure 3.16). In 2019, the average age of these structures was 34 years, compared to 33 years in 2016. Structures 10FT and over in some southern counties were older, particularly those in the district of Rochester, with an average age of 36.8 years in 2019. The county with the oldest structures was Goodhue, with an average age of 47 years, nearing the end of their design life. Between 2016 and 2019, the counties of Hubbard and Lac Qui Parle experienced the largest average age increases (between 10 and 12 percent), while structures in Ramsey and St. Louis County experienced a decline in their average age (from 29 to 25 and from 39 to 35, respectively).



(a) Average Age of all Structures over 10 FT by County (2016)

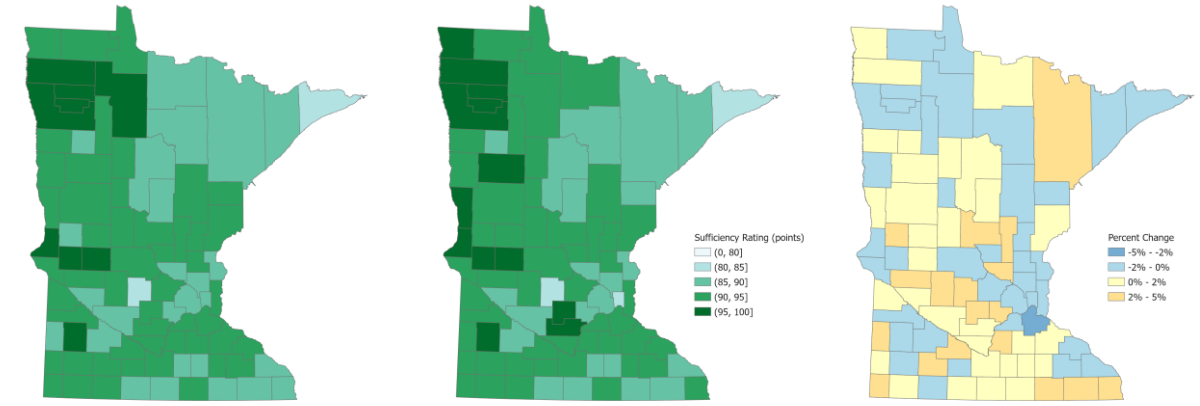
(a) Average Age of all Structures over 10 FT by County (2019)

(c) % Change in Average Age of all Structures over 10 FT

Source: MnDOT (2016) (2019)

Figure 3.16: Average Age of Structures 10FT and Over

The average sufficiency rating of the structures over 10FT in Minnesota increased between 2016 and 2019, from 91.8 to 92.4 (Figure 3.17). During this period, Meeker County experienced the largest improvement in the average sufficiency rating (increasing 3.70 percent), while Dakota county experienced the largest decline (decreasing 2.13 percent). Structures over 10FT in some northwestern counties had sufficiency ratings of over 95. Overall, the average sufficiency rating indicates that these structures are in good condition statewide.



(a) Average Sufficiency Ratings of all Structures over 10 FT by County (2016)

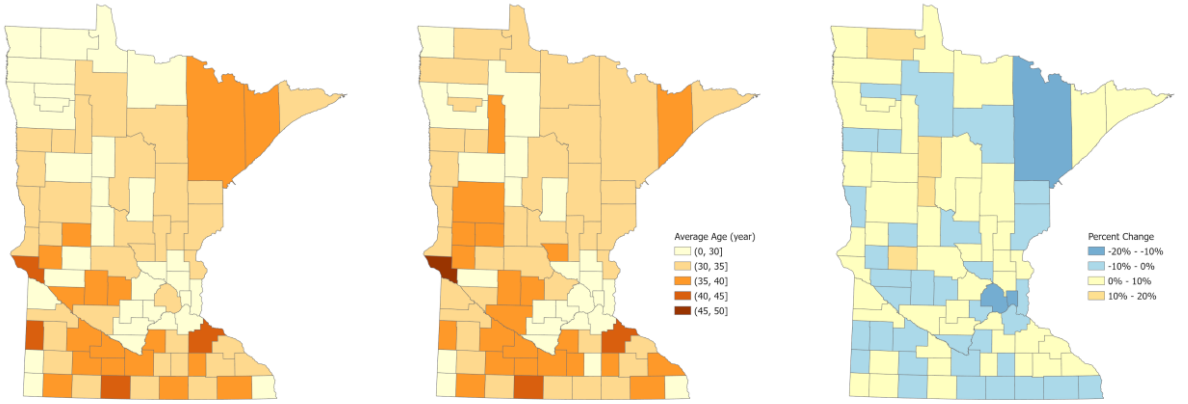
(b) Average Sufficiency Ratings of all Structures over 10 FT by County (2019)

(c) % Change in Average Sufficiency Ratings of all Structures over 10 FT

Source: MnDOT (2016) (2019)

Figure 3.17: Sufficiency Rating for Structures 10FT and Over

Similarly, the average age of structures over 20FT in Minnesota remained relatively stable between 2016 and 2019, slightly increasing from 32.2 to 32.7 years (Figure 3.18). During this period, Ramsey County reported an improvement in the average age of its structures (a reduction of 17.2 percent) and Hubbard County reported a decline in the average age of its structures (an increase of 16 percent). Structures over 20FT in the metro area and some northwestern counties were relatively newer, with an average age of less than 30 years in 2019 (with a minimum of 24 years). Big Stone County had structures with an average age of 48 years in 2019, the oldest in the state.



(a) Average Age of all Structures over 20 FT by County (2016)

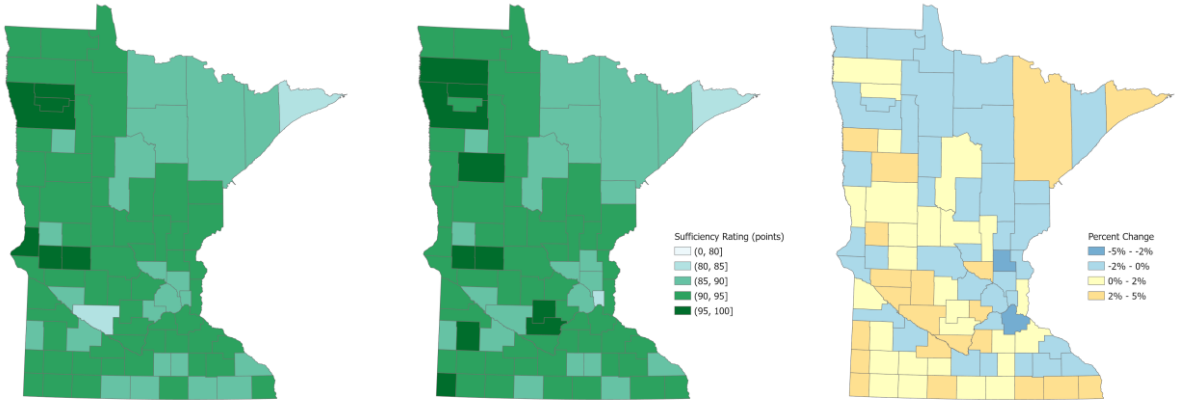
(b) Average Age of all Structures over 20 FT by County (2019)

(c) % Change in Average Age of all Structures over 20 FT

Source: MnDOT (2016) (2019)

Figure 3.18: Average Age of Structures Over 20FT

The average sufficiency rating for structures over 20FT also increased between 2016 and 2019 from 91.6 to 92.3 (Figure 3.19). During this period, northern counties experienced a slight decline in their sufficiency ratings, while southern counties experienced a slight improvement. Lincoln county experienced the largest improvement increasing its sufficiency rating from 86 to 90. In 2019, ten counties had sufficiency ratings of over 95 for these structures and all counties reported sufficiency ratings above 80 (with a minimum of 83 in Cook County).



(a) Average Sufficiency Ratings of all Structures over 20 FT by County (2016)

(b) Average Sufficiency Ratings of all Structures over 20 FT by County (2019)

(c) % Change in Average Sufficiency Ratings of all Structures over 20 FT

Source: MnDOT (2016) (2019)

Figure 3.19: Sufficiency Rating for Structures Over 20FT

CHAPTER 4: PANEL DATA REGRESSIONS

4.1 PANEL DATA REGRESSIONS METHODOLOGY AND DATA

To examine the extent to which fiscal conditions affect maintenance expenditures panel data analysis is used. This statistical method serves to analyze multi-dimensional data of an observation that is measured repeatedly over time (Lavrakas, 2008). This type of modelling accounts for individual heterogeneity and allows researchers to control for variables that are not observable or measurable, and for variables that change over time but not across individuals. Panel data usually contains more information, which gives more degrees of freedom, and variability, which improves the efficiency of the estimates (Hsiao, 2007).

There are several techniques to analyze panel data such as fixed effects and random effects. Fixed effects (FE) explore the relationship between predictor and outcome variables within an entity (county in this case). Each entity has its own individual characteristics that may or may not influence the predictor variables. When using this technique, it is assumed that something within the entity may bias the predictor or outcome variables and therefore it is important to control for such effects. FE removes the effect of those time-invariant characteristics to assess the net effect of the predictors on the outcome variable. Another important assumption of the FE model is that those time-invariant characteristics are unique to the individual and should not be correlated with other individual characteristics (Torres-Reyna, Panel Data Analysis Fixed and Random Effects using Stata, 2007). In contrast, random effects assume that individual, unobserved heterogeneity is uncorrelated with the independent variables. In the event that there is neither significant individual nor significant temporal effects, the data can be pooled, and an ordinary least squares (OLS) regression could be estimated. This technique is called constant coefficients, or pooled regression model (Yaffee, 2005).

The following regression model is used to capture the extent to which fiscal conditions affect maintenance expenditures:

$$Y_{i,t} = \alpha + \beta X_{i.t} + E_{i,t}$$

where i and t are the indexes for the county and the year, respectively. β is a vector of parameters to be estimated and reflects the degree of change in the outcome variable for every unit of change in the predictor variable. α is the intercept and E is the error term.[7] The regressions are estimated at the county level due to limited information available at the city and township levels.

Maintenance expenditures are the dependent variable (Y) in the model. The maintenance expenditure reflects the costs associated with the maintenance and repair of local highways, streets, bridges, and street equipment. Common expenditures include patching and seal coating among others (OSA, 2018).

[7] An error term is added to the regression equation to capture all of the variation in the dependent variable that cannot be captured by the independent/explanatory variables included.

Maintenance expenditures is used in two forms: (1) as a share of total roadway expenditures, which includes maintenance, construction, engineering, administration, snow and ice removal, and other street and highway capital outlay; and (2) as a share of total expenditures in the county.

Based on the literature review, several factors affect maintenance expenditures including fiscal conditions, political environment, and climate among others. In addition, demographics are included as control variables. All of these variables are included in the model as independent variables (X).

Fiscal conditions are captured in the literature through several measures including the following (McDonald, 2017; Marlowe J. , 2013; Zhao R. , Tian, Lei, Boadu, & Ren, 2019; Égert, 2015):

- *Intergovernmental revenues* - An increasing amount of intergovernmental revenues as a percentage of total revenues is viewed unfavorably, as it may indicate an overdependence on these revenue sources. This helps determine the government's vulnerability to reductions of such revenues.
- *Own-source revenues* - These revenues are controlled by the local government and include revenues from all taxes such as property tax as well as user charges, fees, and fines - which are dedicated to specific purposes. Proceeds from all taxes as a share of own-source revenues capture the stability of a government and its ability to address fiscal stress.
- *Debt service* - Public expenditure decreases when there is much debt to repay, this negatively affects public service delivery, including infrastructure maintenance.
- *Total revenues* - Assuming the cost of services is directly related to population size, a decline in per capita revenues over time suggests the government may be unable to maintain existing service levels unless there are new revenue sources or savings.
- *State transportation grants* - Governments tend to prioritize spending on projects funded through grants and other matching resources, without regard for how those projects will impact future capital maintenance needs.

Other variables included in the literature review include the political environment and climate. The share of ballots for a political party in presidential elections is included as a proxy of the political environment in the county. Research shows that political party affiliation at the state level has an impact on budgetary decisions, but it is unclear whether it affects budgetary decisions at the local level. For instance, Beland and Oloomi (2016) found that Democratic governors allocate a higher share of their budget to education, health, and public safety than to other sectors such as highway. In addition, Yu et al (2019) found that the Republican Party shifts state budgets toward developmental spending, which corresponds to spending to enhance the economy including spending in highways, parks, and natural resources. On the other hand, in terms of climate, annual precipitations and minimum temperature are included to capture the effect of climate. Wang and Zhao (2017) find that higher (warmer) temperature in the winter is associated with less highway spending. Snow falls data at the county level was not found but could be included to account for climate.

Demographics are also included in the model as they affect preferences and demand for public goods and predict government spending on them. The following variables are included in the model:

- *Population* - Literature shows that population growth is likely to impose a fiscal strain on state and local governments (Ladd, 1994). Population density has been found to be associated with higher per capita government expenditures (Fisher & Wassmer, 2015; Holcombe & Williams, 2008).
- *Age* - Literature shows that there are differences in service preferences among age groups. An increase in the share of the senior population increases the demand for other services such as healthcare and other public welfare, which may negatively affect roadway maintenance spending.
- *Median income* - Research consistently shows that growth in income significantly affects the size of local government budgets. Higher-income households often demand more and better services from the government (ICMA, 2016).
- *Unemployment rate* – Unemployment rate is included to capture fluctuations in demand for roadway investment in response to economic cycles. At the state level, a higher unemployment rate tends to decrease state and local highway investment (Wang & Zhao, 2017). Similar, outcomes may be expected at the local level.
- *Education* – A higher education level is associated with increased income as well as tax payments (National Academies of Sciences, Engineering, and Medicine, 2017). This may increase government revenue and spending. In addition, higher levels of education attainment can increase the demand for public goods and services.
- *Race* - Previous research shows a strong relationship between racial inequality and allocation of resources. States and localities with higher Black populations tend to have lower expenditures on welfare and public goods (An, Levy, & Hero, 2018).

Other variables utilized in the model as controls include vehicle miles traveled (VMT) on county roads and having the wheelage tax. VMT is a proxy for roadway usage. The adoption of the wheelage tax is included may have an impact on maintenance spending as the revenues generated through it must be used for road and bridge needs and do not have to be spent exclusively on the State-Aid system (Minnesota Department of Public Safety, 2021).

The information used comes from several publicly available sources. This includes the Minnesota Transportation Finance Database, the U.S. Census Bureau, the Minnesota Departments of Administration and Employment and Economic Development, MIT Election Lab, and the National Center for Environmental Information. The data is annually available for all counties from 2007 to 2018. Researchers imputed the data for VMT in 2015 using the average of 2014-2016. Similarly, data for the share of the population aged between 18-65, high school attainment rate, median household income, and share of nonwhite population for years before 2010 was also imputed, assuming that they were linearly changing over time. Table 4.1 presents descriptions and summary statistics of the variables used.

Table 4.1 Description and Summary Statistics

Variable	Description	Observations	Mean	Std. Dev.	Min	Max
Dependent variable						
ShareMtn	Transportation maintenance expenditures divided by total expenditures (%)	1,044	0.10	0.05	0.00	0.45
ShareMtnTrans	Transportation maintenance expenditures divided by total transportation expenditures (%)	1,044	0.34	0.13	0.02	0.95
lnMtnPC	Transportation maintenance expenditures per capita (log)	1,044	4.88	0.82	1.55	7.08
Independent variables						
Fiscal conditions						
ShareInter	Total intergovernmental revenues divided by total revenue (%)	1,044	0.43	0.08	0.21	0.74
ShareTax	Total tax divided by tax plus fees (%)	1,044	0.83	0.06	0.56	0.95
ShareDebtS	Debt service divided by total expenditure (%)	1,044	0.04	0.04	0.00	0.30
Wheelage	Dummy variable: (1) County with wheelage tax, (0) otherwise	1,044	0.32	0.46	0.00	1.00
RevenuePC	Total revenue per capita (thousand USD)	1,044	1.65	0.64	0.77	5.01
RevChange	Total revenue annual change (%)	1,044	0.01	0.10	-0.40	0.56
StateGrPC	State transportation grants per capita (thousand USD)	1,044	0.30	0.23	0.00	1.70
Other conditions						
Democrat	Share of ballots for democratic party in presidential election (2008-2012-2016)	1,044	0.44	0.09	0.21	0.66
Precipitation	Total annual precipitation (inch)	1,044	29.84	6.08	14.57	52.15
MinTemp	Minimum temperature of the year (Fahrenheit degree)	1,044	0.17	6.34	-15.30	14.60
CountyVMT	VMT in County State-Aid Highway and county roads (in billion)	1,044	0.16	0.28	0.01	2.09
Metro	Dummy variable: (1) County in Metro District (0) County in other	1,044	0.09	0.29	0.00	1.00
Demographics						
lnPopDens	Population Density (log)	1,044	3.52	1.35	1.07	8.20
PopChange	Annual population change (%)	1,044	0.00	0.01	-0.11	0.08
ShareAge18_65	Population over 18 and under 65 as a share of total population (%)	1,044	0.59	0.04	0.50	0.69
HighSchool	People attained high school or equivalency as a share of total	1,044	0.34	0.05	0.18	0.49
MedIncome	Median household income (thousand USD)	1,044	52.24	10.49	28.99	97.90
Unemply	Unemployment rate (%)	1,044	5.54	1.90	2.10	14.70
ShareNonWhite	Share of non-white people as a share of total population (%)	1,044	0.07	0.07	0.00	0.54

4.2 PANEL DATA REGRESSIONS FINDINGS

This section presents the regression analysis results from seven different specifications of the two models. The first column shows results of the pooled model and the second column shows the results when controlled for time effects. The results of these two models are presented for reference as the first one assumes all observations are different individuals in the same cohort, and the second assumes that there is a different sample for each year of the panel data. The third column presents results from a model that controls both individual (county) and time fixed effects.[8] The fourth and fifth column present

[8] A Hausman test was performed to choose between a fixed effect and a random effect model. This test tries to detect if there are any correlations between the unique errors and the independent variables (Torres-Reyna,

results considering two different time periods. Since the study time frame is long (more than 10 years) and includes a period of financial crisis, the sample was divided into two periods to capture any differences between the two: 2007-12 (years of financial crisis and recovery) and 2013-18 (recent years). The last two columns present results for metro and non-metro counties to see if there are any differences between these two groups. All tables include the statistical significance of each variable.[9] For all cases the variance inflation factor (VIF) was less than 10 for all variables, indicating that there is no collinearity among variables.

Table 4.2 presents the effects on the maintenance expenditures as a share of total roadway expenditures. The results suggest that the share of intergovernmental revenues has a negative and significant association on the share of maintenance expenditures. When controlling for individual and time fixed effects, an increase of one percentage point of intergovernmental revenues as a share of total revenue is associated with a decrease in maintenance expenditures as a share of roadway expenditures by 0.44 percentage points holding everything else constant. This variable is also significant for the period 2013-18 with a bigger effect (maintenance expenditures as a share of roadway expenditures decrease by 0.68 percentage points) and for non-metro counties (maintenance expenditures as a share of roadway expenditures decrease by 0.36 percentage points). The results from this variable suggest that when counties receive federal or state grants resources are invested in other roadway expenditures other than maintenance (e.g., construction).

In the recent period between 2013 and 2018, the share of debt service expenditures and VMT in county roads also have a positive and significant effect (at a 5 percent significance level). In particular, a one percentage point increase in debt service as a share of total expenditures is associated with an increase in maintenance as a share of total roadway expenditures by 0.34 percentage points. It is possible that debt has allowed counties in recent years to invest in maintenance projects, either directly by putting more resources for maintenance projects, or indirectly by freeing some resources that were going to be used to address other expenditures (such as construction). It is also possible that in the presence of increased debt, localities do not want to invest in construction as much and therefore, more funding is available for maintenance activities. Similarly, as expected, an increase in VMT in county roads is associated with an increase in maintenance expenditures as a share of total roadway expenditures. An increase of one million VMT is associated with an increase in maintenance expenditures as a share of total roadway expenditures by 0.165 percentage points. Lastly, precipitation is also positive and significant (at a 10 percent significance level). A one-inch increase in annual precipitation is associated with an increase in maintenance expenditures as a share of roadway expenditures by 0.2 percentage

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Getting Started in Fixed/Random Effects Models Using R, 2020). The results rejected the random effects model in favor of the fixed effects model; therefore, the table only presents results for the fixed effects model.

[9] The significance level is the probability of rejecting the null hypothesis that the variable is equal to zero. The statistical significance of a variable is presented at the 1%, 5%, and 10% significance level (or at the 99%, 95%, and 90% confidence level, respectively).

points. This effect may be due to changing weather conditions that have been more noticeable in recent years.

None of the demographic variables are significant across models. Only annual population change is significant for the period between 2013 and 2018, but its magnitude is small.

Table 4.2 Maintenance Expenditures as a Share of Total Roadway Expenditures

	Dependent Variable: Share of Maintenance over Roadway Expenditures						
	Pooled	Time.FE	Ind.Time.FE	2007-12	2013-18	Metro	Not Metro
ShareInter	-0.456 ***	-0.400 ***	-0.443 ***	-0.128	-0.682 ***	-0.718	-0.366 **
ShareTax	0.173 ***	0.198 ***	0.017	-0.190	-0.031	0.250	0.022
ShareDebtS	0.007	0.020	0.181	0.236	0.343 **	0.435	0.102
Wheelage	0.030 ***	-0.011	-0.009	0.000	-0.006	-0.016	-0.001
RevenuePC	0.001	0.005	-0.065	-0.164 **	-0.039	-0.111	-0.063
RevChange	-0.000	-0.000	-0.000	0.000	0.000	0.000	0.000 *
StateGrPC	-0.027	-0.044	-0.110	-0.125	-0.097	0.184 *	-0.109
Democrat	0.056	0.184 ***	0.284	0.109	-0.091	-0.696	0.411
Precipitation	-0.000	-0.001	0.000	-0.001	0.002 *	0.001	0.001
MinTemp	0.000	-0.002	-0.001	0.005	-0.004	-0.016	-0.001
CountyVMT	-0.027	-0.053 **	0.076	0.304	1.650 **	0.507	-0.917
lnPopDens	-0.053 ***	-0.033 ***	-0.436	-0.491	-0.643	1.222	-0.274
PopChange	0.000	0.000	-0.000	0.000	0.000 **	-0.000	0.000
ShareAge18_65	0.119	0.021	0.281	1.457	-0.993	-2.489	0.409
HighSchool	0.020	0.089	-0.177	-0.306 *	-0.124	-0.043	-0.188
MedIncome	-0.001	-0.001 **	-0.001	0.003	-0.001	-0.004	-0.000
Unemply	-0.001	0.003	0.010	0.001	0.022	-0.120	0.014
ShareNonWhite	0.108 *	-0.046	0.239	-0.311	-0.040	-0.895	-0.054
N	1044	1044	1044	522	522	96	948
adj. R-sq	0.207	0.199	0.197	0.151	0.216	0.123	0.207
N of County	87	87	87	87	87	8	79
Time. FE	no	yes	yes	yes	yes	yes	yes
Individual. FE	no	no	yes	yes	yes	yes	yes

* p<0.1
** p<0.05
*** p<0.01

Maintenance expenditures as a share of total expenditures was also included as a dependent variable. This variable captures expenditures in areas other than transportation. Table 4.3 presents the results.

The share of debt service appears to have a significant and negative impact on the maintenance spending as a share of total expenditure as expected. As found in the literature, contracted obligations, such as the pressure of repaying debt, may drive the funding away from general public infrastructure

investments. When controlled for both individual and time effects, the results suggest that a one percentage point increase in the share of county debt service is associated with a decrease in maintenance expenditure as a share of total expenditure by 0.09 percentage points, holding everything else constant. The results are similar in direction and significance when considering the period between 2013-2018 and for counties outside of the metro district, although the magnitudes are different. When considering only recent years, an increase of one percentage point in the share of county debt service decreases counties' maintenance spending as a share of total expenditure by 0.08 percentage points. Similarly, for counties outside the metro district, the results suggest that a one percentage point increase in the share of county debt service leads to a 0.1 percentage point decrease in the county's maintenance spending as a share of total expenditure, holding everything else constant.

In the second period, precipitation and VMT in county roads also have a positive and significant impact on maintenance spending, similar to the previous set of results. A one-inch increase in annual precipitation is associated with an increase in maintenance expenditures as a share of total expenditures by 0.1 percentage points. In addition, the results suggest that a one million increase in county VMT increases maintenance spending as a share of total expenditures by 0.02 percentage points.

When considering only counties in the metro area, there are several fiscal factors that are significant. This includes the share of governmental revenues, the share of taxes over own-source revenues, having the wheelage tax, and state grants per capita. The share of intergovernmental revenues, and the wheelage tax have a negative impact on maintenance spending. The results indicate that a one percentage point increase in the share of intergovernmental revenues is associated with a decrease in maintenance spending as a share of total expenditure by 0.1 percentage points, while holding the effect of the other variables constant. For the wheelage tax, the results indicate that it decreases counties' maintenance spending as a share of total expenditures by 1.4 percentage points for counties that have adopted it compared to those that have not. This is interesting and worth exploring in the in-depth case studies as metro and non-metro counties might spend their wheelage tax revenues in different ways. Conversely, the share of tax and state transportation grants have a positive impact. The results suggest that a one percentage point increase in the share of taxes increased maintenance spending as a share of total expenditure by 0.08 percentage points, while a one thousand dollar increase in state grants per capita increases maintenance spending as a share of total spending by 7.2 percentage points.

In metro counties, some environmental and demographic variables also have a significant impact on maintenance spending as a share of total expenditures. For environmental factors, as expected, the results suggest that a one Fahrenheit increase in the minimum temperature (warmer weather) decreases maintenance spending as a share of total spending by 0.3 percentage points, holding everything else constant. In terms of demographic variables, variables such as population density, the share of population with a high school diploma (or equivalent), the share of non-white population, and median household income are also significant in this model. As expected, the population density has a positive impact, and suggests that a one percent increase in population density results in 0.3 percentage points increase in maintenance spending. Conversely, and contrary to what was expected, a one percentage point increase in the share of population with a high school diploma (or equivalent) is

associated with a decrease in maintenance spending as a share of total expenditures by 0.08 percentage points. Similarly, the share of nonwhite people has a negative impact on maintenance spending. As a result of one percentage point increase in the share of nonwhite people, maintenance spending as a share of total expenditures declines by 0.2 percentage points. Lastly, an increase of a thousand dollars in the median household income decreases maintenance spending as a share of total expenses by 0.1 percentage points.

Table 4.3 Maintenance Expenditures as a Share of Total Expenditures

	Dependent Variable: Share of Maintenance over Total Expenditures						
	Pooled	Time.FE	Ind.Time.FE	2007-12	2013-18	Metro	Not Metro
ShareInter	-0.131 ***	-0.102 ***	-0.069	0.052	-0.090 *	-0.108 **	-0.054
ShareTax	0.042 **	0.041 **	0.002	-0.108	0.025	0.088 **	-0.004
ShareDebtS	-0.129 ***	-0.130 ***	-0.091 ***	-0.035	-0.078 ***	-0.030	-0.108 ***
Wheelage	0.005	-0.001	-0.001	0.000	-0.000	-0.014 ***	0.000
RevenuePC	-0.013 ***	-0.009 **	-0.000	-0.028	0.007	-0.036	-0.001
RevChange	-0.000	-0.000	-0.000	0.000	-0.000	0.000	-0.000
StateGrPC	0.098 ***	0.083 ***	-0.007	-0.023	-0.010	0.072 ***	-0.006
Democrat	0.042 **	0.049 **	0.081	0.035	0.015	-0.066	0.093
Precipitation	-0.000	-0.000	0.000	0.000	0.001 ***	0.001	0.001 *
MinTemp	0.000	0.000	0.000	0.001	-0.000	-0.003 *	-0.000
CountyVMT	0.009	0.007	0.008	0.027	0.202 *	0.032	-0.309
lnPopDens	-0.021 ***	-0.018 ***	-0.101	-0.209	0.095	0.330 **	-0.054
PopChange	0.000	0.000	-0.000	0.000	0.000	-0.000	0.000 *
ShareAge18_65	-0.028	-0.044	0.350 *	0.720	-0.320	-0.118	0.381 *
HighSchool	0.049	0.060 *	-0.054 *	-0.108 *	-0.040	-0.078 *	-0.053
MedIncome	0.000	0.000	-0.000	0.001	-0.000	-0.001 **	0.000
Unemply	-0.002 **	-0.002	0.002	0.001	0.003	-0.001	0.003
ShareNonWhite	-0.027	-0.053 ***	0.011	-0.067	-0.237	-0.207 **	-0.080
N	1044	1044	1044	522	522	96	948
adj. R-sq	0.491	0.486	0.171	0.108	0.107	0.406	0.182
N of County	87	87	87	87	87	8	79
Time. FE	no	yes	yes	yes	yes	yes	yes
Individual. FE	no	no	yes	yes	yes	yes	yes

* p<0.1
** p<0.05
*** p<0.01

The results for the period between 2013 and 2018 are robust across both sets of results. In particular, the share of intergovernmental revenues, precipitations, and VMT in county roads significantly impact roadway maintenance expenditures. While the share of intergovernmental revenues has a negative impact, precipitation and VMT in county roads have a positive impact. These variables are worth exploring in the in-depth case studies, as well as the share of debt service, which was only significant when considering maintenance expenditures as a share of total roadway expenditures.

CHAPTER 5: CASE STUDIES

5.1 CASE STUDIES METHODOLOGY

Case studies are used in this research to understand roadway maintenance decision-making processes in Minnesota cities and counties. The selection of case studies is based on literature review, changes in roadway maintenance patterns from Task 3 report, and suggestions from the Technical Advisory Panel (TAP) members. In selecting the localities, a variety of characteristics were considered including geographic location, population size, the use of asset management plans or practices, the adoption of wheelage tax or local option sales tax, and the condition of the roadway system (when available).

A total of nine cases, four counties and five cities were selected for in-depth analysis (Figure 5.1). Of the four counties, two are in the metro area and two are in non-metro areas. Similarly, of the five cities, two are in the metro area and three are non-metro cities.

Figure 5.1 Map of Selected Case Studies

Data sources include interviews with relevant staff at the county level and publicly available documents from the localities. Structured interviews were conducted with relevant staff at the local level such as city or county engineers, director of public works, or maintenance managers between April and June 2021. The interviews were anonymous.

The questionnaire included three main topics: Capital budgeting practices, roadway maintenance decision-making, and funding sources affecting roadway maintenance investments. Questions regarding capital budgeting practices included the budgeting process, the creation of a multi-year transportation investment plan, the use of a transportation asset inventory and asset condition assessment, and overall current asset condition and needs. Questions regarding maintenance decision-making included factors and methods considered in the process that affect the type of maintenance and maintenance versus construction as well as impacts of the political environment, the COVID-19 pandemic, and the adoption of electric vehicles (EVs). Lastly, the questionnaire included funding sources that could affect roadway maintenance investments (Appendix A includes the questionnaire used). During the interviews, researchers defined maintenance as the expenditures that reflect the costs associated with the maintenance and repair of local highways, streets, bridges, and street equipment. Common expenditures include patching and seal coating among others and excluded other roadway maintenance operations such as snow removal.

Information from interviews was supplemented with a document review of available documents from the localities. These documents included adopted budgets, capital improvement plans (CIPs), transportation improvement plans (TIPs), comprehensive plans, asset management reports, pavement management programs, and Public Works Department websites.

5.2 SELECTED CASE STUDIES

5.2.1 Hennepin County

Hennepin County is responsible for the planning, design, construction, maintenance and operation of roads in the CSAH system and in the County Road system (Hennepin County, 2019). To carry these activities, the County has two transportation departments: The Project Delivery department, responsible for carrying out the capital projects, and the Transportation Operations department, responsible for roadway maintenance and traffic maintenance among others. The county roadway system includes 532 centerline miles of road (2,105 lane miles) in the county state-aid system (representing 95% of total roadway lane miles), 38 centerline miles (109 lane miles) of county roads, and 148 transportation bridges.

Capital and Operating Budgeting Practices

The County has a capital and operating budget that is updated annually. The County's capital budget for transportation includes state-aid construction funds as the primary funding source as well as some local funding coming from the property taxes and some county-specific bonding.[10] Sometimes the County

[10] In 2020, the interest rate was lower, therefore, the County received more bonding in their capital budget than the previous years. The bond is paid back over time with proceeds from the property taxes.

also receives federal funding for some of its capital projects. In addition, the County has a five-year[11] capital improvement program (CIP) that identifies upcoming projects including pavement and bridge reconstruction and rehabilitation projects.[12] Projects are selected based on an annual review of transportation needs submitted internally and externally by other agencies, which are then evaluated and undergo a comprehensive revenue before inclusion in the CIP (Hennepin County, 2019). The 2021-2025 CIP allocated over $72 million for roadways and bridges in 2021 (Hennepin County, 2021).

The County's preservation programs for roadway pavement, drainage, traffic, and roadside assets are funded through the Transportation Operation Department's operating budget. The total operating budget for the Operations Department is around $37 million in 2021,[13] which also includes snow and ice removal operations, right of way use management, and management of an Advanced Transportation Management System (ATMS). Of the total operating budget, $3.6 million is allocated for in-house maintenance work such as crack sealing, and spot patching. In addition, $6.8 million is allocated for contract mill and overlay and chip seal work as well as some draining/culvert work. The pavement preservation program includes mill and overlay, chip sealing, micro surfacing, Ultra-Thin Bonded Wearing Course (UTBWC), and crack sealing.[14] However, sometimes the operating budget is used for pavement rehabilitation projects as well. Other preservation activities include traffic signal maintenance and upgrades, pavement markings, sign maintenance, guardrail repairs, catch basin, curb, culver and ditch maintenance and repairs. The operating budget is funded through state and local funding sources. The funding coming from state-aid is around $16 million in 2021 and is used for the CSAH system. Local funding sources are the wheelage tax, property tax, and some other miscellaneous items such as permit fees.

The county's preservation programs for bridges and retaining walls are funded through the Transportation Project Delivery Department's operating budget. The total operating budget for the Project Delivery Department is approximately $18 million in 2021. [15]

Asset Management Practices

The County's Transportation Operations department has established an asset management program to evaluate, maintain, and improve its transportation system. The department uses an asset inventory for transportation assets, which is used for asset maintenance purposes and updating condition indexes. Asset condition information is provided in the County's asset management report that is updated every two or three years. The report also identifies future investment needs and is used to help advocate for short- and long-term funding needs. In addition, the County has a dashboard that is annually updated to

[11] The County is in the process of developing a 10-year work plan.
[12] Some bridge preservation activities are also included in the capital budget.
[13] This covers the compensation and benefits for 129 full-time employees (FTEs).
[14] Crack sealing is done in-house by the department crew.
[15] This covers the compensation and benefits for 129 full-time employees (FTEs).

help document the health of the system and to share with county leadership.[16] The department is currently working on completing asset inventories and condition ratings for some asset categories. The asset management information is used by staff to make proactive, data-drive decisions.

Transportation assets are divided into five groups: Roadway pavement, traffic, drainage, roadside, and bridge. These groups are further divided into 28 asset categories that range from signals and signs, to culverts, curb sections and catch basins. Each asset category has its own attributes, some of which are used to evaluate the asset's overall condition. Currently, the county has approximately 13 assets with attributes that are surveyed regularly to document current condition and maintenance needs/history (Hennepin County, 2017).

The department has a pavement management program and assesses pavement conditions regularly. Pavement condition is updated annually as well as when maintenance occurs. The county looks at the PSR[17] as a starting point and targets addressing pavements with a rating below 2.5. Then on-site inspections and pavement history are considered in order to prioritize projects. The department also uses a PCI[18] scoring system to assess the condition of pavements, completing surveys of 50 percent of the roadway system annually. Other assets such as culverts and catch basins also have condition index scores based on a 100-point scale, similar to the PCI scale.[19] Asset condition information is managed through ICON software.[20] Currently, the department does not use structural condition scoring for all of its assets and relies on the age of the system or compliance with current design standards to assess needs.

The department's target is to have 67 percent of its pavements with PSR and PQI[21] ranking of good or better (Hennepin County, 2019). Currently, most of the county's pavements are ranked at fair to good (see Table 5.1).[22] As of their most recent assessment, the system-wide PSR average is 3.18, the PCI is 65, the PQI is 64, the average road age is 41, and 42 percent of roadway systems are over 50 years old (923 LM out of 2,214 LM). Between 2010 and 2017, funding allowed for the resurfacing of approximately 140

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[16] The Hennepin County asset management dashboard is available in the following link: https://www.hennepin.us/residents/transportation/asset-management

[17] One measure of the system's overall health is the Present Serviceability Rating (PSR) of the roadway pavement asset group system-wide (Hennepin County, 2017). This is on a 0 to 5 point scale.

[18] PCI is a 100 point scale score where 85-100 is considered excellent; 60-85 is considered good; 40-60 is considered Fair; and 0-40 is considered poor.

[19] The County started collecting data about the condition of other assets based on research about other localities' practice around 2012.

[20] Currently, the County is in the process of transitioning to a new software that is more efficient, user-friendly, and connected to the condition of assets.

[21] The Pavement Quality Index (PQI) is a composite of the ride rating (PSR) and the surface condition (PCI). It provides a good indication of the overall condition of the roadway and can be used to prioritize roadway maintenance, as well as optimize roadway treatment options.

[22] While as of 2019, the overall system was also ranked fair to good, roughly one third of the system was more than 50 years old, which required an estimated $2 billion to maintain, upgrade or replace (Hennepin County, 2019).

LM annually, which increased the PSR rating and reduced the number of pothole filling needed annually (Hennepin County, 2017). In 2018, the annual mill and overlay program was reduced to 104 miles, which included deeper mill and overlay segments as well as other preservation activities to extend the life of the roadway system (Hennepin County, 2019). Over the last 10 years, the county has averaged approximately 120 LM of mills and overlays and 25 LM of reconstruction projects annually.

Table 5.1 Hennepin County Roadway Pavement Target and Condition

	Target	Condition		
		Good or better	Fair	Poor
Pavement Surface Rating (PSR)	67% Good or better	**63%**	**34%**	**3%**
Overall Pavement Condition (PQI)	67% Good or better	**60%**	**33%**	**7%**

Source: *Hennepin County Asset Management Dashboard, 2020*

Bridges in the county are in fair condition overall. The County's bridge division[23] is in charge of the inspection and maintenance of bridges. The division implements preventative maintenance such as cleaning of seasonal debris and concrete sealing of decks and bridges, as well as reactive maintenance and reconstructions (Hennepin County, 2019). The County has a target of having over 50 percent of its bridges in good condition and no more than 4 percent in poor condition. As of 2021, 96 percent of the total bridge area is ranked at fair to good condition (see Table 5.2). In terms of age, over 67 percent of the County's bridges are younger than 50 years old.

[23] The division is part of the Transportation Project Delivery Department and was created in 2017.

Table 5.2 Hennepin County Bridge Age and Condition

Condition			
	Good	**Fair**	**Poor**
Percent of total bridge area in 2021	41%	55%	4%
Targets	>50%		<4%

Age	
Bridge age	**Percent**
50 years and older	33%
40 to 49 years	16%
15 to 39 years	29%
Younger than 15 years	22%

Maintenance Decision-Making

The department uses a formal scoring process focused on condition, roadway usage, safety, equity, and pavement history, to prioritize its capital projects. Corridors are scored annually or every two years with the scoring being adjusted to ensure it is in line with County priorities. Overall, the roadway system in Hennepin County is old and while the department tries to implement the right treatment at the right time, there are a lot of roads ready for reconstruction. However, due to funding limitations, the department has been implementing overlays or incorporated more pavement rehabilitation projects such as cold in-place recycling and full depth reclamation. These treatments have been funded out of the operating budget, but efforts are underway to transition to completely fund the pavement rehabilitation projects out of the capital budget. Another factor that may affect the timing and delivery of some projects is the need for community input. For instance, if the department has a four-lane undivided roadway striping that they want to convert to three lanes for a safety reason, sometimes it may involve more efforts, which requires community engagement and input.

Maintenance projects for roadways and bridges are primarily based on current asset conditions. In addition, the department takes pavement history and the length of time that treatments last into account to ensure that it is "getting the service life out of the last treatment" prior to programming reconstruction or additional preservation activities. The department has been implementing more rehabilitation projects in rural areas rather than reconstruction because of its cost-effectiveness. As a result, the department has cut down on mill and overlay projects and implemented new preservation treatments such as chip sealing and micro surfacing for some of the younger roads that are still in good condition. However, in some situations, the department has been implementing mill and overlay or other preservation treatments to hold the road together for another five to ten years before reconstruction.

Other factors that the department considers when prioritizing maintenance projects are coordination with other agencies, community inputs, and resident complaints. The department is in the process of

developing a three- to a five-year pavement preservation program to better coordinate with other agencies that may impact the road. As part of this, the county officially launched its GIS-based Utility Infrastructure Integration (UI2) program in 2017 to help improve efficiencies of construction and lessen the impact on those using county roads.[24] This system was developed in collaboration with utility companies, municipalities, and other government agencies to allow for improved project planning and coordination agencies (Hennepin County, 2019).[25] Similarly, resident complaints are taken into consideration when prioritizing maintenance projects. The dispatch center reports problems or receives calls such as pothole concerns. Road Operations staff are proactively responding to service requests and address roadway repair needs. While resident complaints do not generally dictate where roads are overlaid, they are connected to roadway condition to some extent. If there are a lot of potholes on a road, that is an indication that the roadway condition is poor, resulting in a maintenance activity sooner rather than later.

Generally, the political environment does not have a significant impact on projects. However, sometimes construction projects are politically driven, which affects department resources such as funding and staff. Maintenance projects are generally condition-driven based on asset condition and maintenance history information. Similarly, while crew size may impact the type of activities the department can perform, in Hennepin County, this has not had any significant impacts.

Roadway Maintenance Funding and Needs

Hennepin County's operating budget for roadways is funded through state and local funding sources. The state-aid funding is around $16 million in 2021 and is used for roads in the CSAH system. Local funding sources are the wheelage tax, property tax, and some other miscellaneous items such as permit fees.[26] Over the last decade, the improvements in the condition of the county transportation system in part have been attributed to the 2013 decision by the Hennepin County Board of Commissioners to invest in the system using wheelage tax. Prior to that investment, transportation activities outside capital improvement projects were limited mostly to routine maintenance, with less funding available for improvements in preservation, safety, modernization, and efficiency (Hennepin County, 2017).[27]

The current $20 wheelage tax brings around $20 million annually into the budget. Of this total amount, $17.3 million goes to the operating budget of the Operations department and the remainder contributes to the Project Delivery department. Property taxes bring around $2 million and the permit fees bring about $500,000 annually. Other miscellaneous items bring around $1 million in total. These local funding

[24] For example, Centerpoint -a private utility company- tends to proactively make improvements to their system. Therefore, the County does utility coordination for all of their projects to ensure everyone is informed and does their work before the road is paved.

[25] This program has received national recognition including an information technology award from the National Association of Counties (NACo) (Hennepin County, 2019).

[26] The County also adopted a 0.5% local option sales tax and the proceeds are earmarked for transit capital projects.

[27] Since 2014 the wheelage tax was $10. This was increased to $20 beginning in 2020 (Hennepin County, 2021).

sources are used to maintain both the county roadways that are not considered state-aid eligible as well as roads in the CSAH system.

The department does not have enough funding to keep its system at its current condition of fair to good. One important limitation is that the total funding received from state-aid is not sufficient to address maintenance needs on the state-aid system. Typically, the department uses approximately 91 percent of its local funding on the CSAH system, with the remainder going to the county roads (annually, the department invests $16,700 per lane mile of roadway on average). The department estimates that if the state-aid funding were the only source of funding for the state-aid system, it would have to cut its staff in half due to resource limitations. In addition, another limitation is that the adoption of the wheelage tax has not necessarily increased the funding available for roadway maintenance since over time property tax revenues have been reduced from the Transportation Operations budget to address other county needs/priorities.

Given the age of the county's transportation assets, particularly roadway pavements and bridges, there is a need for increased investment to maintain current asset conditions. The department estimates that in order to keep its assets in their current condition of fair to good, it would need $100 million annually in its capital budget. This equates to a $30 million annual funding gap in the CIP budget.[28]

In addition, the department estimates that the current funding of $37 million in the operating budget would be adequate to implement the current maintenance activities. However, if the department does not get additional funding for its capital budget, it estimates that it would need an increase of around $5 to $10 million over time in its operating budget as the roadway system will deteriorate at a higher rate as it continues to age. The department estimates that to improve the roadway system beyond the acceptable level of fair to good, it would need an additional $50 million in its capital budget, in addition to the current $100 million recommendation.

The department plans its maintenance activities based on its available budget and has not estimated the amount of maintenance it has deferred. Currently, there are hundreds of lane miles of roadways in need of reconstruction, but funding is not available for this work. The department continues to implement mill and overlay projects or other maintenance activities to keep these miles in a drivable state until a reconstruction or rehabilitation is programmed. As of 2018, 40 percent of the roadways and 30 percent of bridges exceeded the service life of their designs and it is expected that as the system continues to age, it will deteriorate at an increasing rate.

The COVID-19 pandemic has further increased the funding shortfall and delayed maintenance activities. For instance, in 2020, the County received $1 million less on wheelage tax than anticipated, which may have been due to the COVID-19 pandemic. Similarly, the County received around $3 million (10%) less state-aid funding in its operating budget last year and anticipates a slight decrease in this funding this

[28] This was shared with the county commissioners at a board briefing in spring 2021.

year as well due to the pandemic. In terms of maintenance activities, the department also had to postpone some of their crack sealing in winter 2020-21 to limit work proximity of crew members. The department currently anticipates that it will catch up on that work in the summer of 2021.

5.2.2 Washington County

The department of Public Works in Washington County manages the roadway system in the county. The roadway system includes 513 lane miles of roads in the CSAH system, 116 lane miles of local roads, and 37 bridges among other assets. In Washington County, preservation maintenance refers to crack seals, micro-surfacing, overlays, cold in-place recycling, and minor drainage improvements. These improvements focus mainly on improving the roadway surface and drivability of the roadway (Washington County, 2019).

Operating and Capital Budgeting Practices

Washington County develops its operating and capital budget on an annual basis. In addition, the County has a five-year CIP, with projects in the first year included in the annual budget. This document includes a list of projects programmed for funding based on need and the County's ability to finance them. This list is annually updated to reflect changing conditions, circumstances, priorities, and needs (Washington County, 2019; Washington County, 2020). Public Works prepares a list of projects related to transportation infrastructure, makes recommendations to the County Board, prepares budgets and capital plans, submits these documents for their review, and then ultimately the County Board adopts and approves the plans and appropriates funding.

According to its 2020 operating and capital budget, the County spent $13.5 million in the maintenance and repair of county-owned highways, streets, bridges, and street equipment. Common expenditures included patching, street lighting, street cleaning, and snow removal. In addition, the County spent $32 million in the construction of transportation infrastructure, pavement improvement, railroad crossing improvements, and right-of-way acquisition (Washington County, 2020). Maintenance activities such as patching and culvert maintenance are incorporated into the operating budget, but if it is a larger project or more intensive, it might be included in the capital budget. For instance, a mill and overlay or a major drainage rehabilitation project would be included in the capital budget.

Asset Management Practices

The department of Public Works uses an asset management system to regularly track the roadways and the condition of various assets. Policy documents such as the comprehensive plan for regional policy guide the assessment of capital needs. Similarly, the department uses the intersection control ranking system (ICRS) to assess improvement needs, whether there are safety reasons for improvement, and assess a capacity need. In addition, a lot of the capital planning reflects the input cities and townships within the county given through regular communications. Cities decide land use and with it, they decide where the developments go, their density, and how much traffic they generate; while the County reacts

to those developments and builds and maintains a highway system that provides the mobility and safety to accommodate that growth.

The department uses several programs for asset management, but the main asset management package is a GIS-based software. This software geo-references transportation assets such as culverts, signs, traffic signals, separated trails, sidewalks, bridges, curb and gutter, pavement markings, guardrails, and at-grade railroad crossings. The department also uses ICON to track pavement conditions, which department staff regularly updates and runs some scenarios with different investment levels to assess how performance measures would be impacted.

Staff at the local agency works with MnDOT to assess the condition of the roads. MnDOT has a van that can be driven down a road with cameras and sensors, which gives an indication of the condition of the road, its smoothness, and the number of cracks among others. The staff visually inspects other transportation assets to assess their condition. The assessment is updated on different schedules depending on the asset. For instance, pavements and bridges are updated every two years, pavement markings are updated annually, and box culverts are updated every four years. Other assets are assessed as needed, typically either before or after a project on the respective corridor.

The department uses the PCI to determine the surface quality of the pavement and set several performance measures related to it. First, the department has established a countywide average PCI of 72 or better. As of May 2021, the countywide average PCI is at 68. Second, the department has established that no pavement should be below 40. As of May 2021, the county has 12 miles of roads (4% of the system) below 40 or in the “red zone”. For bridges, the overall sufficiency rating is 93 and the average age is 31. The PCI, as well as ride roadway history, are used to prioritize capital project needs.

Maintenance Decision-Making

The department currently focuses more on corrective maintenance projects and less on preventative maintenance. Overall, the maintenance program is between 90 to 100 percent reactive. The staff is responding either to system failures or to complaints from residents, the sheriff’s department, cities, and watershed districts among others and trying to keep the roadway system in as good of a serviceable condition as possible. Given that the department is in a reactive mode and it is not able to do proactive and preventive maintenance, it is not doing a lot of prioritization or analysis as far as cost benefit.

There are several issues that affect maintenance decision-making. First, there are budgeting issues, particularly the lack of sufficient resources to cover all the needs. This is further accentuated given that a portion of the local resources are invested in the state system as the state cannot keep up with the needs of its system. Second, there are staffing issues. The department utilizes existing staff for maintenance activities and even though sometimes it contracts out some of its activities, currently it is two to three maintenance workers short. Besides, there are several assets to maintain in addition to pavements like culverts (1,110 in the county) and ditches, some of which are not visible to drivers but that are important. Third, some political interests may affect maintenance investments. There have been some cases, for instance, in which elected officials might say they have not had any project in their

district for a few years, and the department may have to develop a project that might not be a top priority.

Roadway Maintenance Funding and Needs

The main funding sources for the county roadway system are state-aid funds and revenues from the wheelage tax.[29] Other funding sources available include revenues from the gravel tax and the lease vehicle sales tax. The County also issues bonds but typically for major capital construction projects.[30] Roughly, of the total budget for roadway improvements, two-thirds come from state-aid and one-third from local revenues. State-aid funds are all restricted for the CSAH system, and, on average, half of the local revenues are used in the CSAH system, while the remaining is used in local roads. In the last decade, the County estimates an annual average investment of around $3 to $5 million of local funding in the state-aid system.

Proceeds from the wheelage tax became an important funding source for the local roadway system. Since last raised in 2019, the $20 wheelage tax brings an annual revenue of $4.5 million, which is used mostly for pavement preservation projects, but also for the crack seal program, and management and safety projects in 2020 (Washington County, 2021). Overall, the wheelage tax provides resources to resurface about eight miles a year. The total revenue for the local roadway system has not increased with the adoption of the wheelage tax as it replaces revenue previously coming from the property tax.

The County estimates that it would need to invest between $7 to $8 million annually to keep the roadway system in its target condition of 72. Currently, the department funds about 50 percent of the maintenance needs ($4.5 million). In addition, the department estimates that the maintenance it has deferred in the county highway system, understood as roadways that have not been resurfaced for the last 20 years, would cost $18 million to resurface. Given the current funding, it would take the department three to four years to cover the maintenance it has deferred.

A major challenge cited by the department's staff is the lack of resources at the state level to keep with the needs of its system. This situation pushes the County to redirect local funding to develop state projects on their behalf, which takes money away from county programs. In addition, if problems related to the state system are not solved, they increase the pressure on local roads as drivers may use them to avoid state roads in poor condition. According to the staff, these situations are happening more

[29] The Washington County Board of Commissioners approved the collection of the wheelage tax in Washington County, beginning in 2007. Before its adoption, Washington county used proceeds from the property tax to fund its roadway system. The wheelage tax takes pressure off the county property tax to pay for transportation needs, including highway preservation projects, expansion projects, and transit improvements (Washington County, 2021).

[30] Capital projects have to have a life cycle of more than 20 years, otherwise it is not appropriate to bond for it as 20 years is the time the county takes to pay bonds back. Typically, smaller projects such as mill and overlay do not have a 20 year life. Over the years, resources from bonds are used more for buildings than for roads.

often and several metro counties have used local funds to deal with state issues that are important to the locality.

The COVID-19 pandemic has also affected roadway maintenance investments in several ways. First, the County experienced a loss in revenue. Revenue coming from the State decreased by around 15 percent. It is projected that it will take the county until 2025 to get back to 2020 levels of funding. Second, the pandemic has made maintenance activities more expensive. For instance, the department usually has four staff members riding a truck, but with the pandemic, they all had to take a separate truck to the improvement site. Other activities have become slowed down because it is logistically hard to coordinate. Overall, the department had to push a few maintenance projects back a year or two due to the pandemic.

5.2.3 St. Louis County

The St. Louis County Public Works Department is responsible for the maintenance of over 3,000 miles of County-State Aid Highways (CSAH), county roads, and unorganized township (UT) roads (Table 5.3). In addition, the Department is responsible for the oversight of approximately 600 bridges,[31] which consists of conducting the annual safety inspection of these structures, the design and construction of new bridges each year, and the surveying requirements that go along with each project.

Table 5.3 St. Louis County Roadway System

System	Paved miles	Gravel Miles	Total
CSAH	1,107	237	1,380
County Roads	277	1,018	1,295
UT	74	255	329

Source: *St. Louis County* (2021).

The Department has two sides to its operation: The Engineering side and the Maintenance Operations Side. The Engineering side is responsible for the construction improvement plans (CIP) on the roads and bridge network, which includes new constructions, reconstructions, reclaim and overlays, overlays, mill and overlays, and chip sealing. The Maintenance Operations side is responsible for maintenance

[31] These are State recognized bridges over 10 feet in length. The Department is also responsible for the oversight of 300 bridge structures under 10 feet in length.

activities such as snow plowing, right of way clearing, regraveling, ditching, culvert replacements, sweeping, and roadside mowing.

Capital and Operating Budgeting Practices

St. Louis County develops its budget on an annual basis and has a five-year capital improvement program (CIP) that informs the annual budget. The CIP addresses immediate and long-term capital needs and is updated annually as part of the annual budget process. Projects included in the CIP require a total expenditure of at least $100,000 and must provide for or extend the useful life of the asset for at least 5 years. All CIP projects that are proposed to be funded by General Fund revenues are included in the budget in the appropriate year. Funds for such projects are not available until they are included in the budget approved by the County Board of Commissioners (St. Louis County, 2020).

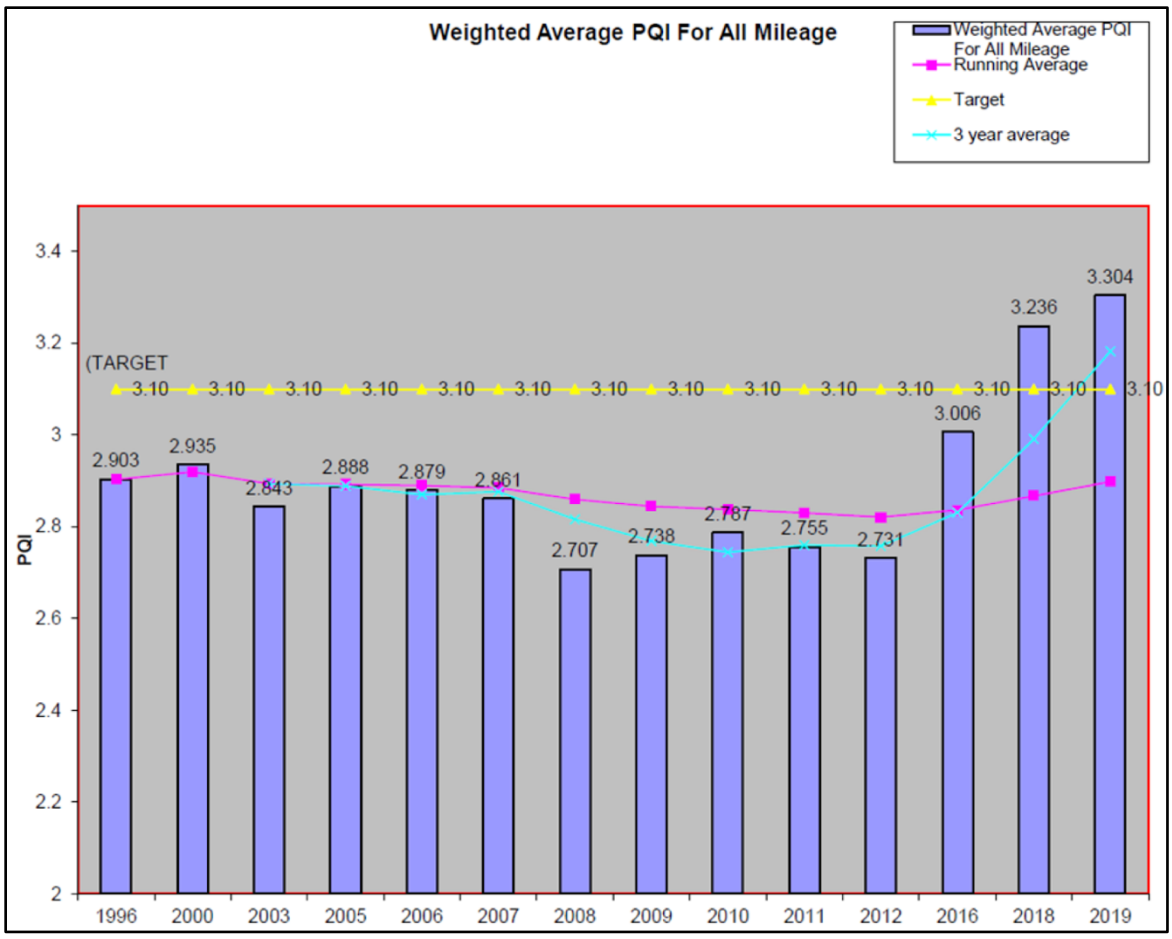
The Department of Public Works develops its CIP building on the 10-year State Transportation Improvement Plan. Projects included in the CIP are road construction, maintenance overlays, and bridge construction and repairs. The projects are funded through various sources including federal, state, and local funds that average at over $40 million per year. According to the 2021-25 CIP, the total amount budgeted for road and bridge projects is $52.7 million for 2021 (St. Louis County, 2020).

Asset Management Practices

The Department uses ICON through Goodpoint software as an evaluation system for pavements.[32] The Department contracts with MnDOT to rate the pavement network annually. MnDOT drives all the paved roadways with their van, video and laser scan, and determines the PQI ratings and shares the information with the Department.

The condition of pavements in the county is improving and overall pavements are in very good condition (Figure 5.2). As of 2021, the county-wide PQI for roads in the CSAH system and county roads is 3.2. The good condition of pavements is mostly due to a major influx of money in the last five years as a result of a transportation sales tax (TST) enacted in 2015. However, before the adoption of the TST, the roadway was in poor condition with an average PQI of 2.58 for the overall system. Roads in the CSAH system were in a slightly better condition at a PQI of 2.7 to 2.8, while county roads were in the PQI range of 2.0 to 2.1. Over the last five years, the Department has made a 60 percent improvement in the quality of its roads. As of 2020, only 12 percent of county paved roads (180 miles) are in poor condition (St. Louis County, 2021). As of 2021, only 51 bridges are considered deficient (St. Louis County, 2021).

[32] The Department is in the process of evaluating a different software called StreetSaver that is more intuitive. ICON is a powerful software package, but it is very intensive and hard to use.



Source: *St. Louis County* (2020).

Figure 5.2 Pavement Condition in St. Louis County Over Time

Decision-Making Processes

The political environment does not play a role in the decision-making. The county board has allowed the Department to make data-driven decisions. From time to time the Department receives a complaint or a question about why they implemented a particular maintenance work, but with their data-driven approach, the political entities usually understand and support them.

The Department experiences some challenges in its maintenance decision-making. The biggest challenge the Department faces is coordination with city utilities that are in the county roadways. For instance, when the roadways are old and in need of replacement and the utilities are 80 percent through their life cycle, the city decides not to replace utilities due to budget limitations while the county repairs the roadway. And inevitably a water main break occurs within the first two to three years and they will tear the pavement to dig into it. Another challenge the Department faces is that with its current staff capacity and the size of the roadway network, it is limited to field visit all roads.

Maintenance Funding and Needs

The Department receives funding from five different sources for its CIP projects. Federal, state-aid, local levy, unorganized township (UT) fund, and a half-percent transportation sales tax (TST) that is levied within the county on all sales tax transactions. Maintenance operations are funded with different revenue sources.

Different revenue sources provide funding for different road networks. Federal funding is the annual apportionment for MnDOT District 1, which is distributed based on needs and road network. This funding is typically around $4 million annually and is spent on major collectors and arterials. State-aid funding is around $15-$16 million and is used for state-aid roads. Revenues from this funding source depend on gas tax revenues of the previous year. Local levy dollars are $5.5- $6 million depending on revenues and can be used on the county roads or UT roads. Around 85 to 90 percent of the local levy is used on the county road system. UT budget is roughly $600,000- $700,000 and can be used only on utilities. Lastly, the TST revenue is budgeted for about $14 million, but the Department has been receiving roughly $15.5- $16.5 million over the last two to three years. The TST funding is spent on projects that are already on their CIP list.

Prior to 2015, the Department was struggling to keep up and maintain the roadway network at an acceptable rate. The Department conducted several evaluations of its roadway system to rationalize and justify the implementation of the TST. It put together an overall plan and forecasted an acceptable level of funding to maintain the system. Comparing that amount to their revenues at the time demonstrated the system was over $20 million underfunded annually.

To accelerate investment and improve the quality of the roadway network, the county adopted the half-percent TST along with an excise tax of $20 on motor vehicles sold by licensed dealers. Initially, the TST was estimated to raise $10.5 million annually. Of this amount, the county planned to spend $7 million to improve the pavements in the poorest conditions and apply preventative maintenance, $2 million in bridge projects, $1 million in safety and multi-modal projects, and the remaining in the Gravel Road Investment Plan (St. Louis County, 2021).

In addition, the County Board approved bonding for roads and bridges to be repaid with TST revenues. It approved $40 million in 2015 and an additional $25 million in 2016. In five years, the county invested a total of $120 million in TST-related funding; including $65 million in bonding. The Department expects an additional $25.4 million to make more improvements on its roadway network. This is in addition to $210 million invested from traditional road and bridge revenue streams (St. Louis County, 2021). The Department repays between $7 to $8 million of these bonds annually for the next 10 years.

Currently, with the amount of funding coming from these various sources, the Department has sufficient funds to maintain its road network. Particularly, with the influx of bonding from the TST and the pay-as-you-go TST that remains, they are in good shape and will be able to maintain the roadway system moving forward.

The COVID-19 pandemic has not had any impacts on the Department's maintenance work. However, the CSAH funding decreased by $3 million due to reduced gas tax revenues.

5.2.4 Pennington County

The Pennington County Highway Department is responsible for constructing and maintaining the roadway system in the county. As of December 2020, the system included 257.14 miles in the regular CSAH system, 1.8 miles in the municipal CSAH system, 385.1 miles of county roads, and 100 bridges (Pennington County, 2020; Pennington County, 2021). Of the total miles in the system, 177 miles of roads in the CSAH system are paved, and the rest are gravel; while only 4 miles of county roads are paved, and the remaining 380 miles are gravel. Pennington is one of the top counties in the state for the quality of ride. In general, it does not face funding shortfalls in terms of maintaining its roadway system, partly because a large proportion of the roads is gravel.

Operating and Capital Budgeting Practices

Pennington County develops its budget on an annual basis. The operating budget includes the maintenance and repairs that do not add to the value of the assets or materially extend asset lives, while the capital budget includes the major outlays for capital assets as well as the construction projects (Pennington County, 2015). At the end of each year, the Department develops an annual report, indicating the details of the various accounts within the road and bridge fund pertaining to revenue and expenditures, as well as a proposed budget of the projected revenue and expenditures for the state aid highways and county roads for the next year. In 2020, the department spent around $3 million in maintenance costs and $8.4 million in construction costs (Pennington County, 2020). Maintenance costs include $1.5 million in the regular CSAH system, $1.5 million in county roads, and $26,427 in the CSAH municipal system. All construction costs were incurred in the regular CSAH system.

The County also develops a five-year plan every year to budget for future projects. The plan includes a brief summary of the projected construction and maintenance expenditure, as well as a map indicating all the roads that are in need of maintenance, such as overlay, paving, regrading, grade wodening, bridge rehab, etc (Pennington County, 2021). Between 2021 and 2025, the Department is projected to spend $2.2 million on CSAH maintenance, and $12.4 million on CSAH construction. In addition to the regular pavement crack sealing, mill and overlay, there would also be two bridge replacements. Around $3.5 million would be spent on other improvement projects, such as intersection lighting, intersection improvements, etc. The Department has not planned for the repair of the local roads for the next five years as there are no resources budgeted for them (Pennington County, 2021).

Asset Management Practices

The Department does not assess or determine the condition of its pavements. According to county staff, county gravel roads are in fair condition in general, but the conditions vary with the season. From April through June, gravel roads are soft and receive heavy traffic from farmers that are transporting their

crops, while from June through fall the roads improve and are in good condition. Regarding the condition of the roads in the CSAH system, the Department receives a PQI assessment from MnDOT. Usually, Pennington County is one of the top counties in the state for quality of ride. Similarly, the bridges in the county are in very good condition. As of May 2020, the Department staff believe that they do not have a deficient bridge in the county and inform that they have planned the replacement of three span bridges on the CSAH system for 2024.

Maintenance Decision-Making

Most of the decision-making relies on the current conditions of the roads and the age of pavements. The Department reviews the roads and determines what improvements to perform. Typically, the Department does an overlay project to roads 18 to 20 years old, and a crack sealing usually three years after the overlay project. In addition, the Department performs striping and shoulder work each year. The staff divides work areas into three sections, so that each section expects new maintenance every third year.

Information from operators and residents may also guide some maintenance work. The Department staff conducts a certain amount of graveling in county roads and gets information from blade operators regarding which roads are short for gravel. Similarly, when the Department receives complaints from residents, the staff drives the roads to assess the needs and comes up with areas that need improvements. In addition, the Department may coordinate maintenance work with agencies from cities within the county, but these do not affect the internal decision-making process.

Few factors affect the maintenance decision-making process. The political environment does not have a big effect on maintenance decisions, but it does on construction projects. In particular, residents have complained about high taxes and have questioned how resources are spent. On the other hand, staff capacity affects maintenance activities. While a lot of regular maintenance could be done with their own staff, the Department does not have enough people and would have to contract out a lot of work, such as shouldering and crack sealing.

Roadway Maintenance Funding and Needs

Funding for the county roads comes from property taxes and the wheelage tax, while funding for roads in the CSAH system comes from state-aid. The $10 wheelage tax, adopted in 2014, brings around$130,000 annually to maintain the local roadway system. After the adoption of the wheelage tax, the Highway Department has not experienced an increase in funding as it has offset revenues from property taxes. Typically, the County does not use local funds in the CSAH system. Bridge maintenance is funded through property tax, while bridge replacement is funded through bridge bonding. Typically, bonding does not pay a hundred percent of the replacement, and therefore, the Department has to use funding from the state-aid or the local property tax for the remaining portion, depending on whether the bridge is included in the CSAH system or local road system.

On average, the County annually allocates $1.3 million of property taxes and wheelage tax for the maintenance of county roads, and $1.3 million of state-aid for roads in the state-aid system. Typically, on an annual basis, the Department spends around $140,000 on crack sealing, and $100,000 on shouldering. When state-aid funding is reduced, the Department might cut back on these activities.

While currently the Department is able to carry all of its planned maintenance activities, the resources are not enough to maintain the assets as they should be. The Department has not quantified the accumulated maintenance it has deferred.

The COVID-19 pandemic has affected roadway maintenance investments. In particular, state-aid funds are expected to decrease by about 15 percent in 2021. This would affect maintenance and construction projects planned for roads in the CSAH system.

5.2.5 City of Rochester

The City of Rochester, Public Works Department is responsible for the maintenance of over 500 miles of roads and alleys, 540 cul-de-sacs, and 40-plus miles of sidewalks and bike paths within the city limits.[33] Of the total roadway miles, around 491 miles are city-owned streets, 38 miles are county roadways, and 23 miles are state trunk highways. The city has 81 bridges that include pedestrian bridges over roadways, skyways in their downtown area, as well as other roadway bridges and culverts.[34]

Capital and Operating Budgeting Practices

The Street Maintenance Division is responsible for the maintenance of the city's infrastructure including streets, bridges, walks, sanitary/storm sewers, and flood control structures. On-going maintenance costs for these activities are provided for in the City's general operating budget. For fiscal year 2021, the adopted budget includes around $9 million for street infrastructure maintenance, which includes mill and overlays, seal coating, patching, sidewalk and curb replacement, crack filling, street sweeping, bike trail maintenance, storm sewer, and snow and ice control operations. This budget identifies mill and overlay of 40 lane miles, chip sealing of 60 lane miles, seal coating of 40 centerline miles, and bike paths fog sealing of 15 centerline miles among others (City of Rochester, 2021).

In addition, the City has a six-year capital improvement program for rehabilitation, reconstruction, resurfacing, and preservation projects that is updated annually. The CIP identifies capital projects and funding sources, and provides a planning schedule. Generally, the City gets around $6.5 million in the CIP, but tries to get $7 million worth of road work done. Of this, $1.5 million goes towards maintenance and of the remaining $5 million, the Department tries to get $7 million worth of road work. It can charge

[33] The Department also tracks the sanitary sewer system, but only on pipes of a certain/larger size and some of the trunk sewer pipes.
[34] A bridge is considered any type bigger than 10 ft wide and in Rochester most bridges are box culverts and non-traditional bridges.

the water department for a portion of the street repair as the water main is below the street for reconstruction projects. The 2021-26 CIP budgets approximately $6.2 million for major streets. Of this, approximately $1.7 million comes from the tax levy, $1.4 million from federal funds, and $3.2 million from state funds (City of Rochester, 2021). Of the total state funding, $1.9 million is coming from state-aid funding, $1 million from state funds (including bond funds), and $300,000 from project reserves (City of Rochester, 2021).

Asset Management Practices

The Public Works Department maintains an inventory of all its assets to fulfill the Government Accounting Standards Board (GASB) requirements. Since 2003, all cities and counties have been required to have an inventory of all their assets, their day-to-day age, and their year of construction to depreciate the new value over time, to be reported to the government annually. Since the City has this data to fulfill those requirements, the Department can also use the data for their traffic signals or water mains to decide the appropriate treatment on roads. For instance, whether the road or the sewer below is old, and therefore the street needs to be constructed. Or, whether the sewer below the underground utilities is old, but the pavement is new, so they should not reconstruct those underground utilities. This data is one of the factors the Department uses in the process of deciding which roads to reconstruct.

The Department has a robust data and reporting system to track their infrastructure and has been using the ICON[35] asset management system since 1997 to track all of its streets, alleys, and trail systems. In addition, the Department has a robust pavement preservation program and assesses pavement condition regularly to identify different preservation projects and needs. Pavements are rated annually in a way that all of them are rated every other year. Some of the pavement preservation's team is strictly on pavement rating. Typically, the Department puts together a three-year pavement preservation program where they do a big mill and overlay project annually as well as a large chip seal project. They have these projects programmed on a cycle where they are doing a mill and overlay and two to three years later they are back to do it again. On their more major roadways, they do a double chip seal with a fog seal over the top of it.

Overall, 67 percent of the pavements are between 1-40 years old; 9 percent are 41-50 years; and 24 percent are 51 years and older (City of Rochester, 2019). The overall condition of the pavements is in the 80 to 81 PCI range.[36] However, this is a false indicator as the pavement condition is rated by looking at the surface of the street, counting the distress, the cracks, and does not consider the conditions below the surface. And as the maintenance crews fill the potholes, overlay the street or chip seal it, the rating goes up such that even if the street may be 50 years old, due to the fresh overlay on it, it gets a score of 100. Due to budget limitations, the Department has had to constantly overlay and chip seal roadways, painting a layer over the top of the pavement, which hides cracks and results in false ratings. This is also

[35] The City is exploring changing to a different system.
[36] When the pavement rating program started 20 years ago, pavements were at 65.

one of the downfalls of the program that it does not indicate the subgrade order and the soil conditions, so the Department takes into account other factors such as utility condition, etc. In addition, the system does not take into account the traffic volume and the functional classification of the roads.

The Department is also required to do their bridge safety inspection and share the workload with MnDOT. While MnDOT typically does all the roadway bridge inspections, the City does the skyway bridge inspection as well as the pedestrian bridge inspection over roadways. The bridges are on different inspection cycles based on the type and condition. Some are inspected annually, while others are inspected every two years. Those on a two-year cycle are split up over the cycle to spread the workload. Culverts are inspected every four years if they are in good condition.

Overall, the bridges in Rochester are in fairly decent condition. The Department has two to three bridges that are scheduled to be reconstructed shortly, but they are not in a situation where they have several that do not have sufficient ratings and they are struggling to maintain. The biggest issue they have had with their bridges is having structural issues. While overall, all of the bridges are in fairly decent condition, the department anticipates that in the next 20 to 25 years, they will have to replace many bridges and do more preservation projects. Right now, they are not getting that funding locally.

The Department also has a sidewalk program. The Department assesses the condition of sidewalks in 20 zone rotations over an approximately 20-year period where they fix any safety defects, or panels that need to be replaced due to trippers, cracks or other things that they need to replace from an ADA perspective. However, they do not necessarily have the condition mapped. The staff goes out to spot the defects the year before they do the repairs.

Maintenance Decision-Making

The Department takes two primary factors into consideration in its decision-making, particularly for capital projects. These factors are the condition of the pavement and whether there is a need for a utility replacement. At times, a major utility issue can drive projects more than pavement conditions. For instance, if the roadway is not ready for full reconstruction, but the utilities are failing such as water main breaks or if there is a sewer capacity issue in areas where they have to upsize trunk sewer, these factors drive projects more than the pavement condition at times.

Similarly, when selecting between different project types, the Department looks at the condition and the life of the pavement and determines the appropriate treatment to improve the condition. For instance, the Department evaluates whether they can implement a mill and overlay, or the pavement condition has not become so degraded that mill and overlay is out of the question and they have to consider doing a reclaim or full replacement. The Department aims to perform chip seals in the 80-100 range, overlays in the 50-80 range, and reconstruct anything below that range. However, due to funding limitations, they are not able to implement the right repair at the right time, and are implementing overlays on some of the older streets.

The Department has more money for preservation than for reconstruction, but in some cases, they defer the work they cannot perform as it would be a waste of resources. For instance, if there are segments that are due for preservation, but maybe the utilities underneath the roadway are also due for reconstruction, the Department may defer the work until they have funding for utilities and can do a full reconstruction. In addition, the Department defers some work due to funding limitations and neighborhood reluctance to the assessment. For instance, a road that was built 15 years ago is in poor condition given that the construction was poorly done.[37] The Department currently cannot conduct any road work in that area given the public's opposition to the assessment.

In addition, the city has a lot of streets that do not have concrete curb and gutters. As most of the streets are built in an urban section, where there could be curb and gutter, the stormwater from the house drains across the sidewalk into the street. This water standing in the pavement wrecks the pavement along the edges and if the street maintenance crew cannot get the drainage to flow when paving the street. The Department has tried to assess them to the abutting property owners, but it is very difficult to get the money out of the homeowners to increase the funding for that source. So, maybe one project annually would be an assessment type project where they charge homeowners for the curb and gutter to improve the street.

The political environment also drives projects from time to time. While the Department can use the $2 million in one subdivision to fix all the roads in bad condition in one area, they cannot do that as it would not share the funding equally among the city's six council wards. The Department has to spread it out so that each council ward gets some work done every year. Similarly, as the town grows outwards, all of the new roads are located further away from the downtown core, which is where the old streets are and where the funding is needed. However, these roads do not always get the funding, some of which has to go even on those newer (20-25 years old) streets rather than the older streets that were built in the early 1900s in the downtown core.

In addition, the Department has been challenged to deliver some of their work due to a lack of support from neighborhoods or the Council. Typically, neighborhood opposition comes down to special assessments. The Department has a special assessment policy and by statute, it can assess a portion of the cost of the project to abutting property owners who benefit from the improvement. However, they have had projects where for example property owners along the corridor contest their assessment. The Department then has to explore other funding options so they could lower the assessment such that it would feel like property owners are getting that benefit and not contest the assessment, or delay the project for a year.

Sometimes neighborhood opposition is less about payment and more about the project design. For instance, there is a neighborhood right now that is adamant about not wanting a roundabout where a signal is not warranted. The current signal is 60 years old, so the Department does not want to replace

[37] This was done before the oversight program was established.

and maintain it when it is not warranted; and a roundabout is a safer solution. Similarly, sometimes the Council may also change the proposed project from what the Department as a professional team brings forward as a preferred alternative. These kinds of challenges with projects appear pretty frequently as well.

Labor and material costs play a role to some extent. These depend on the bidding environment and whether the Department can get what it projected, it has to scale back the project, or get more work done. For instance, bituminous pricing has fluctuated over the years, which has played a role in how far they can stretch that tax levy money that they are getting. In recent years, the Department has got good unit prices, so it has been able to add a fair amount of roadways to the project and been able to do a few more blocks of streets.

The Department is currently trying to chip seal closer to 30 miles of roads annually because it is more cost-effective. The maintenance still gets the same amount of money, but maybe a small percentage has shifted from overlay towards the chip sealing because the overlays are much more expensive. The Department doubled the number of miles it chip seals compared to 15-20 years ago when it would chip seal, fog seal 15 miles of roads.

The Department does not have a formulaic model that takes into account pavement condition, utility condition, etc. to aid in their decision-making process. However, they have a long-term goal to develop a more analytic approach to this process through the use of an asset management software. On a rare occasion, a project may be driven by reactions from homeowners or council members. The Department conducts a cost-benefit analysis when applying for federal grants when it is a requirement.

Since the maintenance work is done through a combination of contractors and in-house crew,[38] staff capacity can affect the work. For instance, when some of the staff are on vacation or there is a snowstorm, the Department struggles. Overlay work is bid out to the asphalt plant in town with some of the work done by department staff.[39] Previously, chip seals or fog seals were joint efforts where some of the arduous work was done by the in-house crew.[40] However, lately due to limitations to staff growth, they are switching over and having a contractor bid.[41] The downfall to this new practice is that lately due to the complete streets policy that involves adding bike lanes to roads, painting of the lines and bike

[38] There are around 60 to 75 people.
[39] For instance, if the Department wants 10,000 tons of bituminous, the asphalt plant supplies the paving machine and the crew that runs the pavers. The Department staff hauls the asphalt mix and sets up the traffic control and staging. Department staff also mills the streets and lower the manholes and the gate valves. However, the actual paving work is done by the contractor.
[40] The staff had to drive to Winona or Dresser, WI in the springtime to haul chip seals with pea rocks to Rochester because the rocks in town are limestone, which disintegrates. Then they would go to the coke refinery in Rosemount and get a tanker load of emulsion and do a lot of work themselves.
[41] In the last three years, the contractor comes into town, takes the pile of chips, and gets his oil from wherever he needs it, and then completes the work. The Department crew takes care of the traffic control, the staging, and seals the cracks first. All the contractor needs to come into town and get the chip seal done.

symbols is no longer done in-house. This is currently tied to the contractor who completes the chip seals. However, the Department is planning to shuffle their crews and purchase a new truck next year to deliver this work done in-house.

Maintenance Funding and Needs

The primary sources of funding are tax levy, state-aid funding, and federal grants. The Department receives around $1- $2 million annually for the preservation projects coming out of the tax levy. This funding goes to bituminous roadways. The Department also receives funding for concrete rehabilitation projects such as joint repairs, joint sealing, and full joint replacements along different corridors, but not every year even though a lot of streets in the downtown area, as well as major collectors and arterials, are concrete. Due to this small amount of tax levy, the Department relies on state-aid or federal funding for pavement reconstruction projects. In addition, due to funding shortfalls, the Department overlays or chip seals most streets on a 20-year cycle and uses in-house staff to save costs.

The federal funding that comes to District 6 or Southeast Minnesota counties is around $4 million annually. Typically, the Department has to submit applications to get the grant and compete with projects in smaller counties. In addition, some of the smaller counties and cities do not have the resources to manpower a federal grant. For instance, while the City of Rochester has 30 staff in their engineering department and submits a project every year, some cities may have five staff and may submit a federal project every three or four years. Therefore, it was decided that because Rochester is much bigger compared to the surrounding communities, rather than competing for funding every year, Rochester-Olmsted Council of Governments (ROCOG) MPO would get $2- $3 million annually. And that the rest of federal funding would go to the surrounding counties. This way those other counties would have one project every three to four years and Rochester and Olmsted County are taking turns implementing a reconstruction project every other year through their MPO. These projects include more than the pavement, such as stormwater and utilities, and sidewalks. In addition, the City is limited in the use of federal dollars, which should be used on roads meeting a specific functional classification.

The state aid funding has to be used on state-aid roads, but local funding is also used on MSAS roads. However, the Department tries to use their local dollars as little as possible on their state streets. Currently, the Department estimates that approximately 20 percent of the state-aid roads are paid for by local funds. A portion of this local funding comes from assessments to property owners. The Department's goal is to get 25 percent of project costs from assessments, but in reality, they are getting around 15-20 percent. The Department estimates that around three to five years ago they would assess the homeowners for the project, and get around $3,000-$5,000 maximum for a house, which would generate around $75,000-$100,000 worth of assessments on a million-dollar project (around 10%).

Typically, the County prefers to maintain rural county highway roads where there are fewer traffic signals and curb and gutters. For the county streets in the city that have traffic signals, curb and gutter, and manholes, the county pays a certain dollar amount annually to the City to maintain the roads as well

as the traffic signals due to lack of traffic staff as well as familiarity with the roads.[42] As a result, county share through the cooperative agreements is bigger in such cases. Similarly, the state also turns back on some state roadways within the city with traffic signals, intersections, and curbs.[43] Around eight to ten years ago, the State turned over the maintenance of Broadway Avenue (former TH 63) to the City and stopped paying for the maintenance of that corridor. Therefore, these roads are City responsibility with MnDOT paying some turn back money to account for routine maintenance (but not reconstruction).

In addition, sometimes the city's water utility Department or electric company helps pay for some of the road improvement costs. For instance, currently, there is not enough electricity going into the downtown area, so there is a new duct bank electrical project tearing up a road to develop an electric line in the downtown area. For this particular project, the company is paying a little more than their required share.[44] For the other projects this works in the opposite way where if the City widens the road, and it requires the electric utility to move, it is up to them to move their lines 100 percent on their own.

The Department does not borrow for maintenance projects, but has used a transportation revolving loan fund (TRL) for some pedestrian bridges in the past that were paying back over 20 years.[45] The City Council has not dedicated a line item in the capital or operating budget for bridge improvements. To fund bridge repairs, the Department applies for bridge bond funds or the local bridge replacement program and even though it has not always been successful, they always apply for it. The Department is using federal funds and state-aid funds for bridge improvement next year.

The Department has accumulated a backlog of roads that are older than 50 years old. When the Department conducted their latest pavement study, it mapped out its needs based on maintaining their pavements at different ratings over a 50-year life cycle. It estimates that it needs an additional $100 million right now to get every street that is 50 years and older up to standards and from that point moving forward, it would need $16-$20 million annually to maintain the streets on a 50-year rotation. Table 5.4 presents the estimated amount the Department needs to invest on average every year in order to maintain a certain PCI level.

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[42] After getting federal dollars, a joint city-county federal project is done on a county road within the city limits. Then the brand-new road is turned over to the City, and from that point moving forward, the City will be responsible for 100 percent of its maintenance. Typically, the County prefers to deal with 55 mile per hour two-lane rural roads.

[43] The State has only one person in charge of traffic signals for the entire district. If this person is in another city or county that is far away from Rochester, the City traffic staff can develop a joint agreement to maintain those signals in town that relieves the State staff to deal with the surrounding communities. The City has dedicated traffic signals staff that work on 180 traffic signals in the city and the ones that are on and off the ramps that are considered state traffic signals.

[44] This is a $2.5 million project and an electric company is going to pay for their share plus around $500,000, which will be around $800,000 of the total.

[45] These were built in the early 2000s, so they may be repaid or close to being repaid.

Table 5.4 Level of investment to maintain a particular PCI in Rochester

PCI level	Average investment needed on annual basis
65	$12.3 million
70	$13.2 million
75	$14.9 million
80	$16.2 million
85	$17.6 million

Source: *City of Rochester* (2019).

The Department has identified potential funding strategies to make these improvements. These include increasing the tax levy by $750,000 (or 1%) in the City's annual CIP budget and selling bonds to be paid through special assessments to fund the Pavement Management Plan (PMP) improvements 100 percent out of one of these sources. Other options include using a combination of tax levy and assessments, adopting a natural gas franchise fee, and establishing sidewalk improvement districts and assessing costs to benefiting properties (City of Rochester, 2019). The Department notes that its needs are so staggering and the council support is so small that this is mostly a paper exercise because it is unlikely that the tax levy will be increased, which is what would be needed to help fund the roads. Or they need another funding source, but they do not have it.

The COVID-19 pandemic has further exacerbated the funding shortfalls. The Department received less state-aid funding, froze hiring, and did not increase the tax levy. The state-aid funding was reduced by around 15 percent. Since the Department is not sure when this funding will recover to the pre-pandemic levels, their projections are showing less funding. As a result, the Department has to delay projects a year or two in their CIP. In addition, due to the hiring freeze as well as staff having to quarantine or being sick with COVID-19, their workforce was affected. Despite the challenges, the Department was able to deliver on their preservation projects in 2020.

5.2.6 City of Duluth

The Public Works and Utilities Department is responsible for street maintenance activities in the city of Duluth. In addition to this, the Department is responsible for engineering services, water, natural gas, sanitary sewer, stormwater, and street lighting. The primary street maintenance activities include crack filling; pothole patching; roadside debris removal; gravel road maintenance; right of way (ROW) weed control, fencing, and mowing; sidewalk repair and maintenance; street line painting and marking; traffic

sign management, installation, and maintenance; traffic control; and snow and ice control (City of Duluth, 2021).

There are 452 miles of roads overseen by the City of Duluth. The Department is responsible for 90 miles of roads in the MSAS system and 362 miles of city roads. Roads within the City of Duluth under the jurisdiction of St. Louis County and MnDOT increase the total mileage to 559.

Operating and Capital Budgeting Practices

The City of Duluth develops an operating budget and a capital improvement budget on an annual basis. The City develops a five-year capital improvement program, whose first year corresponds to the capital improvement budget for that given year. Street maintenance activities such as pothole patching and repair, crack filling, and gravel road maintenance are included in the operating budget. According to the 2021 budget, the City allocated $8.1 million to the Street Maintenance division for such activities (City of Duluth, 2021). Major projects such as those in the Street and Bridge Reconstruction and Preservation program are included in the capital improvement budget. According to the CIP, the City budgeted around $10 million in 2021 for this program and a total of $66.7 million for the 2021-25 period (City of Duluth, 2021).

The Public Works and Utilities Department identifies capital needs for the next five years and plans for annual capital improvements. Projects with federal or state funding are typically programmed several years in advance. For street preservation projects using discretionary local funds, the Department develops a list prior to each construction year with some project options and submits it to the mayor. The mayor reviews the list and typically accepts staff recommendations with some minor changes. This version is later presented into the proposed budget to the City Council, who finally approves it. For projects programmed for the coming construction season, the Department goes through public outreach and gets public opinions.

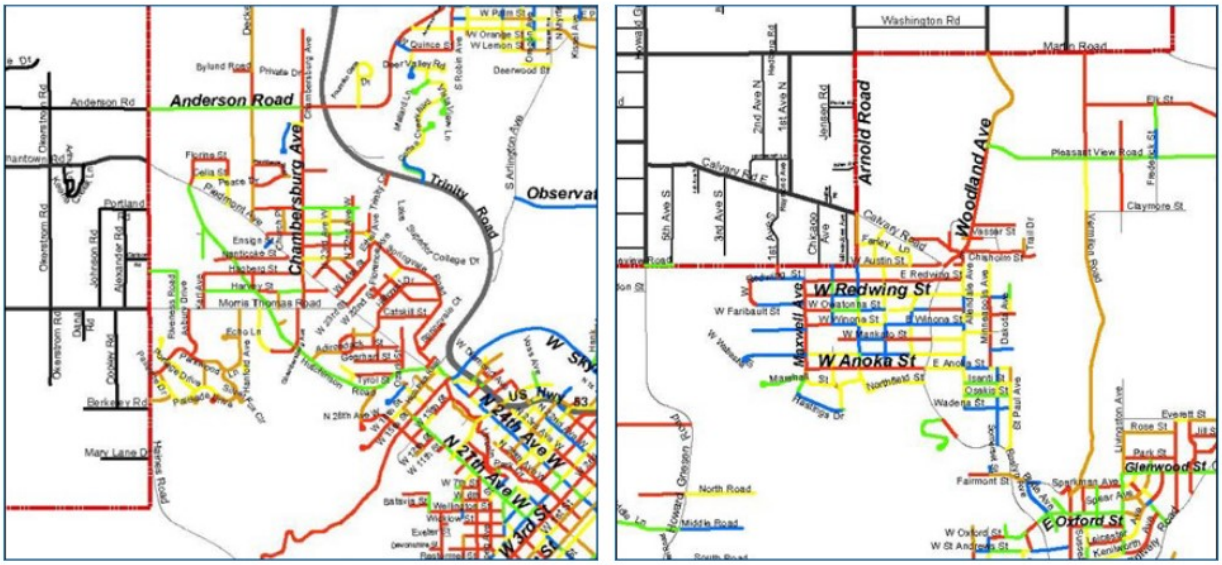
Asset Management Practices

The Department has a GIS-based asset management program to keep an inventory of the assets. Assets such as retaining walls, lighting signalizations, signs, pavement, and non-pavement assets are included in various other computer programs. Usually, the Department updates the inventory on an ongoing basis when the construction programs are off season with the information they get from the work that was conducted during the previous season. All assets identified within the GIS system have installation dates recorded, which serves to determine the age of the assets. These assets are assessed based on age and condition.

The Department uses ICON software through Good Point Technologies as the pavement management system. This system helps with assessing the capital needs on the roadways, identifying the age of existing pavements, and determining the condition rating based on a periodic sealed inventory. Typically, the department updates the pavement inventory every five years using a field survey. The

most recent field survey was conducted about three years ago with a cost of $90,000 and the Department recently started conversations to refresh it. The last field survey took over two years to complete with half of the system done in each year.

The Department uses the PCI scoring system to assess pavement conditions of local roads. Currently, the adopted comprehensive plan includes a strategy to maintain a minimum PCI rating of 70 for streets as an acceptable pavement condition. However, a lack of resources has led to a large maintenance backlog. The average condition of city pavements is 43, which reflects the poor pavement condition in the city. According to 2017 estimates, 55 percent of the city's roadway mileage was in poor condition, and little has changed since 2017. In addition, when there are freeway reconstruction projects that detour traffic into local roads, they increase the pressure on the local roadway system. Given the importance of roads and their current conditions, the City's comprehensive plan identifies several strategies in terms of maintenance, reconstruction, and incremental improvements (City of Duluth, 2018). Figure 5.3 presents pavement conditions in the neighborhoods of Piedmont (left image) and Woodland (right image) in Duluth.



Note: *Streets in poor condition are in red; streets in fair condition are in yellow; streets in good condition are in green.* ***Source:*** *City of Duluth* (2018).

Figure 5.3 Street Conditions in Two Duluth Neighborhoods

The State delegates authority to the City to inspect its bridges, and the City completes all bridge inspections. The State shares the sufficiency ratings with the City.

Maintenance Decision-Making

Several policy documents developed through community outreach and policy standing guide the Department's priorities. The comprehensive plan, for instance, designates commercial centers and neighborhood service centers as core investment areas. These areas along with safe routes to schools are prioritized for infrastructure investment. The City also adopted the bikeways plan prepared by the Metropolitan Interstate Council. This plan helps the Department identify the road segments where bikeways need to be incorporated in conjunction with improvement projects. Lastly, the Department also receives guidance from the Duluth Transit Authority who identifies transit routes that need to address ADA considerations and pedestrian system needs along transit routes.

The Department takes several considerations into account to prioritize roadway maintenance projects. First, the Department has to maintain some geographical equity to make sure different parts of the city get comparable levels of investment. The Department is currently trying to focus on relatively easy projects to maximize the improved mileage and minimize high spending in one particular area. Second, the Department prioritizes business districts with high traffic volumes that have an economic component. Third, the Department also prioritizes projects based on safety needs, such as areas around schools and transit routes.[46] Lastly, in its annual street preservation program, the Department tries to include projects that ensure that the improvements last longer such as addressing storm drainage issues, adding and replacing culverts, and some ditching.

Information from the maintenance crew and coordination with utilities impact roadway maintenance decision-making in Duluth. For instance, the maintenance crews that are involved in patching also keep track of the quantities of the materials used on different roadway sections. The information they gather informs ongoing maintenance costs as well as where it would be more cost-effective for the Department to do a pavement project or where to save the most. In addition, the Department coordinates with utility replacement needs (water, sewer, stormwater, gas, etc.) to avoid paving a street that has a utility project planned in the future. Such coordination also allows the Department to identify the financial resources and staff capacity needed for roadway improvements after the utility work and determine the resources available for other pavement projects in that year. If the remaining resources after the utility work are limited, the Department can program other pavement projects for the following year. Although water and gas utilities have resources to cover the costs of repairing the roadway after a utility project, there are other utilities that cannot bear the costs and the Department has to be aware and plan for the reconstruction of the roadway.

[46] Most of the transit routes are on arterial streets, which tend to be on the MSAS system. However, the department invests in these roads given that they serve the community in an important way.

Opinions from the residents and the business community also impact roadway maintenance decision-making. As part of the adoption of the half-percent sales tax,[47] the City invited people to nominate their street to help the Department identify where conditions were the worst and where funding should be directed. With this information, the Department generated a Street Preservation Project list that has continued to grow. On a regular basis, the Department updates the list and adds new projects based on resident complaints. As of May 2021, the list of candidate projects includes projects totaling $87.4 million. Currently, the Department is trying to provide proper repair while responding to the public's requests. The Department can perform relatively minor maintenance projects like chip sealing and meet people's expectations, but there are major underground infrastructure problems that need to be addressed concurrently with the pavement work. There have been cases in which residents and businesses complain about decaying pavements, curbs, and sidewalks and would like to have them all replaced, but for the Department it is impractical to invest in streetscape renewal without undertaking a mayor reconstruction project.

Roadway Maintenance Funding and Needs

Funding for the local roadway system comes from the half-percent sales tax and property taxes, while funding for roads in the MSAS system comes from state-aid and infrequent federal funds. Occasionally, there is some bonding for selected projects which are paid back mostly with resources from TIF. In addition, there is some funding coming from transfers from Public Utility Funds and Tourism Taxes (City of Duluth, 2021).

The City enacted a half-percent sales tax in 2017 and came into effect in October 2019. 2020 was the first year this tax generated revenue to invest in the city's local roadway network. This tax generates approximately $7 million a year and in 2020 the proceeds allowed the Department to program improvements for 10 to 20 miles of roadway (out of a network of 452 miles). The Department has set aside less than five percent of the sales tax per year for preventive maintenance, including crack sealing, chip sealing, and seal coating. This percentage has not been programmed for individual projects and, in some cases, it has been used to address resident complaints that do not warrant a mill and overlay or a more regular overlay.

The main challenge the Department has encountered for roadway maintenance is the lack of resources for the local roadway system. Roads in the state-aid system are generally in better condition since they have state-aid funding available on a regular basis. In addition, the department sometimes uses local funding to invest in them given that they serve the community in an important way. Contrarily, funding

[47] The City enacted a half-percent sales tax in 2017 and came into effect in October 2019. The sales tax resulted from a public referendum that was passed in 2017 by a large majority. It took two years to get permission from the State Legislature to enact the sales tax. An important factor that played a role in the approval of the sales tax was the City's status as a regional employment center and a tourism destination, mainly because the sales tax helps distribute the burden beyond the residential population.

for the local street system is limited and the level of investment is not keeping pace with the wear and tear that happens on an annual basis. Due to this limitation, there has been a very rapidly growing backlog. Currently, on average, between 10 to 20 percent of the roadway maintenance needs are funded annually.

Estimates from the pavement management consultant suggest that the backlog will continue growing and that the city would need to invest significantly more to maintain its roadway system. For the Department to achieve a PCI of 70 (per comprehensive plan), it would need to increase current investment by about 7 to 10 times, from about $10 million to somewhere between $80 and $100 million a year for 10 years. After achieving a PCI of 70, the Department would have to invest about two to four times the current investment, or $20 to $40 million per year in order to maintain the 70 rating.

The COVID-19 pandemic has also posed an additional funding challenge for the Department. The pandemic-related shutdowns led to a drop in the tax revenue in the 15 to 20 percent range. The revenue from the tourism industry, for instance, is expected to decrease by about 25 percent, which may further reduce the availability of funds for maintenance.

According to the draft policies and strategies of Imagine Duluth 2035 project, the transportation focus group proposed three ways of minimizing the maintenance expenditure (City of Duluth, 2017). First, they proposed prioritizing the basic maintenance activities for the streets and paved rails to extend their life cycle length. In particular, the department would develop an asset management plan with annual pavement updates, so that they could conduct regular maintenance activities and extend the life span at the maximum efficiency. Second, in order to minimize the cost of construction and long-term maintenance, the group proposed to maximize the use of the existing infrastructures by prioritizing the areas for development and redevelopment. During reconstruction, the department would consider narrowing the width of the streets to save cost. Third, the City has been considering reducing street use by changing citywide policies. This is in response to challenges associated with heavy-weight vehicles such as trucks and waste haulers given that their street use brings extra maintenance burdens.

5.2.7 City of Chanhassen

The City of Chanhassen defines its street improvement activities in its comprehensive plan. New construction is defined as construction of new streets or utilities or a significant upgrade from the previous facilities. Reconstruction is defined as removal of existing streets and construction of new streets, which may include sanitary sewer or water main and stormwater improvements, and may recycle the existing asphalt as gravel base. Rehabilitation is defined as repair of problem areas to full depth, milling of edge or full width or existing pavements, repair to existing catch basins and/or curb and gutter, pavement overlay.

The roadway system in Chanhassen includes approximately 153 miles of road. Of this, approximately 22 miles are MSAS roads, and 88 miles are local roads (City of Chanhassen, na).[48] City owns a total of seven bridges as of 2020 2020 (City of Chanhassen, 2020).[49] The department of Public Works is responsible for the construction, maintenance, and preservation of roadways under city jurisdiction. Rehabilitation and reconstruction projects are typically conducted by a contractor under the supervision of the city's Engineering Department (City of Chanhassen, na). The department implements the pothole patching and a small amount of striping maintenance in-house.

Capital and Operating Budgeting Practices

The City of Chanhassen has a five-year capital improvement program (CIP) that focuses on improving the existing system rather than on its expansion. The City's annual street improvement program is included in the CIP and identifies annual rehabilitation and reconstruction projects. The plan is updated every fall to review priorities and needs. According to the City's CIP, the annual street improvement program cost for the next five years has been estimated at approximately $59 million, but the City estimates it will have funding for approximately $26.9 million. For 2021, the construction cost is $6.8 million.

Similarly, the department has a pavement management program in the CIP that includes annual pavement maintenance activities such as crack sealing, seal coating, pothole patching, replacement of curb and gutter and sidewalk repairs for City streets. The pavement management program began in 2004 to identify long-term needs, to have a realistically funded plan, and to give residents a sense of when their streets will be proposed for improvements (City of Chanhassen, 2020). The City has estimated its total program needs for the next five years at approximately $5.8 million, but will have an estimated $1.7 million coming from the tax levy. For 2021, maintenance funding in the pavement management program is $353,000.

The department of Public Works, through its Engineering division staff, conducts all evaluations related to maintenance needs and proposes them to the City Council for approval. Generally, for projects like seal coat patching, pothole patching, and crack sealing, they do not receive too much Council input. However, for bigger projects such as mill and overlays and full-depth reclamation, they receive more inputs from the Council.

[48] Of the remainder, approximately 21 miles are Trunk Highways, 19 miles are county state-aid, and two miles are County roads.

[49] Two more bridges will be added once the Hwy 101 project is completed. Bridges include storm sewer culverts larger than 96" and pedestrian/trail tunnels (City of Chanhassen, 2020).

Asset Management Practices

The department uses an operation management system called Cartegraph to track and assess the condition of its assets.[50] Transportation assets included in the inventory are streets, bridges, striping on the streets, signage, streetlights, and traffic signals. The department is currently assessing the condition of pavements, bridges, and signage.[51] The remaining assets, while may be inspected annually or every three years, do not have conditions associated with them.

All assets with bituminous are inspected every three years, with a third of them inspected annually. The inspections utilize the US army corps of engineers standards for bituminous inspection. They use the OCI[52] rating, which is defined by the extent to which assets are failing and the extent and severity of their failure. The department's target is to have an average OCI of 70 for pavements. The current citywide OCI is averaging at 72 and their 2021-25 CIP aims to maintain the OCI at its current level.

The department inspects the bridges on an annual basis and provides the reports to MnDOT. Bridge condition is incorporated into the asset management tool and the National Bridge Inventory (NBI) standards are used. The department is currently in the process of improving the management of their locally owned and maintained bridges. As of July 2020, the average NBI was 7.42, with one bridge with an NBI appraisal rating of 6.

The department faces some challenges in its asset management. These include keeping the assets up to date with accurate and current information, accurately locating the assets, and the ability to use all financial and projecting features of the software. In particular, the software has a lot of capabilities that are currently not used due to a lack of specialized staff to dive deeper into the modeling features the software has.

Maintenance Decision-Making

Roadway capital project needs are assessed based on the condition, utility needs, institutional knowledge, and resident complaints. Initial assessment of projects occurs through evaluation of the pavement condition through their operation management system Cartegraph. The system is managed in-house by a GIS specialist, but the department augments their resources through consultants to run scenarios for certain assets such as transportation assets. While the system is used daily for updating or

[50] This system tracks all of the City's assets including not only transportation assets but also water main and its appurtenances, and sanitary systems and its impermanence.
[51] Signage is assessed through visual inspection or through the readers in them. The asset management tool provides an OCI rating that is on a 0-5 scale.
[52] The OCI goes from a scale of 0 to 100, where 0 indicates that the road is impassable and 100 indicates that a road is in excellent condition.

tracking asset condition, scenarios may be run every five years. The system is used to generate particular outcomes, which are then analyzed in an excel spreadsheet.

In addition to asset conditions, the department prioritizes capital project needs based on utility needs such as water main breaks and old sanitary sewer among others. Similarly, in selecting projects institutional knowledge and resident complaints are taken into consideration. Staff who have been at the department for a long time can guide the next steps. Construction projects typically generate more resident input. For instance, mill and overlay and rehabilitation projects involve a lot of public hearings and public notices and meetings, which may influence them if a neighborhood is very vocal. However, for maintenance projects such as seal coat, crack sealing, pothole patching, these do not have a significant impact.

To prioritize maintenance projects, the department follows the 3R policy of right time, right place, and right road using a pavement treatment decision tree that is based on the OCI rating. Typically for seal coating and mill and overlays, the department prioritizes projects based on their OCI ratings. For instance, for seal coating, the department tries to prioritize the streets that are seven to eight years old, which are considered to have an OCI of 85 to 90. Prioritizing those roads will improve their OCI and keep them in good condition. In addition, for mill and overlays the department conducts a field inspection where a sample of the area of the road is taken to a laboratory for a more technical evaluation for appropriate treatment.

There are other factors that the department takes into account in its decision-making process. The health and safety of the roadway, for instance, are taken into consideration to a small extent in maintenance projects. Other factors that the department takes into account are the availability of budget, whether there are critical failures, and whether there is a need for public outreach. For instance, while the department tries to go around the whole city with pothole patching, it tries to prioritize the hotspots that have not been scheduled for a full-depth reclamation rehabilitation. Similarly, the department takes user feedback submitted digitally seriously and considers them when making maintenance decisions.

On the other hand, construction costs such as labor and material costs, political environment, and staff capacity do not play a big role in maintenance decision-making. While the department considers the cost of material and labor, it is hard to predict those until bids are open. Sometimes, if the bids come very high due to high material costs, the department has to reevaluate the project, or lessen the project scope and move forward with some of the work. Similarly, the political environment does not have an impact on maintenance decisions as everything is built into the city's CIP. Staff capacity does not have an impact on maintenance decision-making either as most maintenance work is done through contractors.

Maintenance Funding and Needs

Roadway construction[53] and maintenance projects are funded through a variety of resources including ad valorem taxes, special assessments, development fees, Municipal State-Aid, state and federal project funding, and tax increment financing (TIF). Sixty percent of the rehabilitation and reconstruction project costs are paid by the City, which may be from MSAS funds, General Fund, federal or state grants, or financed through TIF. The remainder 40 percent is assessed to abutting property owners (City of Chanhassen, na).[54] Maintenance costs (pothole filling, patching, crack sealing, seal coat) are not assessed to abutting property owners. Maintenance is financed through the City's Annual Budget Process (City of Chanhassen, na).

The City receives annual funding from MnDOT for MSAS roads, which comes in both a construction allotment and a maintenance amount. The department uses the MSAS funds for MSAS roads and strives to utilize these funds on all their MSAS routes and not use any of their locally generated funds. If there is a need greater than the funding, MSAS does allow for advancing funds from future years' funding, but requires special approval.[55] The department plans maintenance, rehabilitation, and/or reconstruction of roads on the MSA system based on available funding and needs. However, if funding is not available, they cancel the project. For instance, two of the MSAS projects the department had planned for this current year, are not moving forward due to lack of funding. State-aid funding can also be used for the City's share of County or MnDOT projects (City of Chanhassen, 2020). According to the 2021 budget, the total MSAS funding is $1.1 million.

For the local roadway system, the City has two funding mechanisms: The City adopted a utility franchise fee in 2018 to provide funding for expanding street rehabilitation of the city's aging infrastructure. The collections began in 2019 and trickle up slightly annually. The CIP was adjusted to invest the franchise fees into additional street improvement projects (City of Chanhassen, 2020). In addition, the City has a tax levy for funding the roadway system.

The department plans its local road maintenance projects around its available funding. The department's current estimates indicate that in order to maintain its goal of an OCI of 70-75, it will need about $3.6 million annually. The preventative maintenance budget for seal coat application[56] has also

[53] New construction costs are 100% assessed to the benefitting properties.
[54] In order to assess a property owner, it must be demonstrated that the property will benefit from the improvement. Replacement of water main and other utility assets are not assessed to the property owners. Only the improvements on the street itself are assessed. Similarly, work done by city crews may be maintenance, rehabilitation or new construction and is not typically assessed. Exceptions would include work associated with an assessment agreement signed by the property owner and approved by City Council and work specifically authorized by the City Council to be done by city crews and assessed to the abutting properties (City of Chanhassen, na).
[55] Due to the COVID-19 pandemic, no advancements are being approved by MSA until further notice (City of Chanhassen, 2020).
[56] Pothole patching and crack sealing also comes out of this budget.

been reviewed for a five-year period, and it is determined that generally that funding will meet the department's expectations to keep the target OCI and that budget is about $350,000 a year.

The department estimates that it will be able to maintain approximately 7 miles of roadway with the franchise fee proceeds. The seven miles would be rehabilitation (either full-depth reclamation or mill and overlay). However, the franchise fee will also fund reconstruction of new streets, so the number of miles it can maintain may fluctuate in future years. In addition, while the newly adopted franchise fee is currently sufficient, the department anticipates that there will be a need for increased funding as more and more roads are built.

Before adopting the franchise fee in 2019, the department implemented treatments as a band aid approach where they were not able to afford the right treatment at the right time. Therefore, the department was able to apply sub-standard treatments as a result of which some roads may have deteriorated past the point where it could have been a mill and overlay, but has gone to a full depth reclamation, which has also increased the costs. While the department has deferred some of its maintenance needs in the past, it has not quantified them. The department notes that deferring maintenance lowers the OCI ratings for the system and causes negative financial impacts as the right treatment is not applied at the right time.

The COVID-19 pandemic resulted in funding reduction as well as cancellation of some of the projects. In 2021, the department received 15 percent less funding for the MSAS construction allotment. The funding for canceled projects has been incorporated into the 2021 is year's budget. The department has not experienced any more impacts this year.

5.2.8 City of West St. Paul

The department of Public Works is responsible for roadway projects in the City of West St. Paul. In addition, the department is tasked with the maintenance of the sewer system, storm and surface water, and stormwater utility. As part of the street activities, the department is responsible for the maintenance, reconstruction, and construction of the local roadway system, which includes 12.33 miles of MSAS roads and 45.11 miles of city roads (City of West St. Paul, 2020). There are no city-owned bridges in the city, but there are county-owned bridges within city limits.

The department defines a reconstruction, a major rehabilitation project, or a mill and overlay project as major maintenance, while minor maintenance would include seal coating, crack sealing, and patching projects (City of West St. Paul, 2018).

Operating and Capital Budgeting Practices

The City develops its operating budget on an annual basis. All departments submit their budget request to the city manager, who in coordination with the finance director, develops the proposed budget. The City Council reviews the proposed budget and adopts a final budget (City of West St. Paul, 2020). Additionally, the City also develops a capital improvement plan to help identify infrastructure needs for

the following 10 years. This plan includes planned projects for streets, parks, sewer system, and city facilities.

Roadway maintenance activities are included in the operating budget. In the 2020 adopted budget, there is $434,250 budgeted to maintain the street infrastructure, which includes crack sealing, seal coating, spray patching, snow plowing, tree trimming, striping, equipment maintenance, lighting, and signage (City of West St. Paul, 2020). In addition, there is $1.1 million budgeted for the mill and overlay program and $1.4 million for snow plowing and de-icing, street sweeping, and tree removal.

Budget allocations toward the annual pavement management program are on average $4 million. According to the CIP, between 2008 and 2015, the City allocated typically $2.4 million toward the annual pavement management program (City of West St. Paul, 2019). The amount increased between 2014 and 2017 due to a major improvement project on Robert Street. Between 2017 and 2018, projects totaled $10.9 million in part due to county-led projects with a local cost-share. 2019 also had a large allocation due to joint projects with the County and the reconstruction of a commercial collector roadway. Upon completion of these projects, the annual pavement management program will be moderated.

Between 2014 and 2017, the City developed a $45 million improvement project on Robert Street that left the city with a significant amount of debt. Due to this debt, in 2019, the City Council adopted financial policies restricting facility, street, and park improvements to a pay-as-you-go (PAYGO) model (City of West St. Paul, 2020). This model is a budget enforcement mechanism that forces the government to pay for its priorities without expanding the current deficit. Any increase in spending or a decrease in revenues must be offset by other spending or revenue changes (Center on Budget and Policy Priorities, 2019; Peter G Peterson Foundation, 2020). In order to fund street improvement projects under the PAYGO model, the City approved the collection of a half-cent sales tax beginning January 2020 through December 2040. This new source will pay for future road projects until 2035 when the existing debt is expected to be paid off (City of West St. Paul, 2021).

Asset Management Practices

The department uses ICON software through Good Point Technologies as the pavement management system and regularly updates pavement conditions. The department uses the software to keep an inventory of pavements in the city and no other transportation assets are included or inventoried in any other software. The Good Point's staff visually assesses the condition of the pavements. The staff walks and collects data about the number, length, and types of pavement cracks and distresses (City of West St. Paul, 2018). Typically, the pavement condition assessment occurs on a third of the city roads every year.

The department uses the PCI to assess the condition of the local roadway system. Streets with a PCI in the 80-100 range are subject to crack sealing and seal coating, streets with a PCI in the 45-70 range are candidates for mill and overlay (surface rehabilitation), and streets with a PCI below 45 are candidates for major rehabilitation or reconstruction (City of West St. Paul, 2018). Pavement conditions have been

deteriorating and given the funding constraints, the conditions are expected to further deteriorate (Figure 5.4). As of 2020, the average PCI for city streets is 56 and there is no plan on how to get the system back into a PCI of 70. According to the department, of the 60 miles of streets in the city, there are about 20 miles of streets ready for reconstruction.

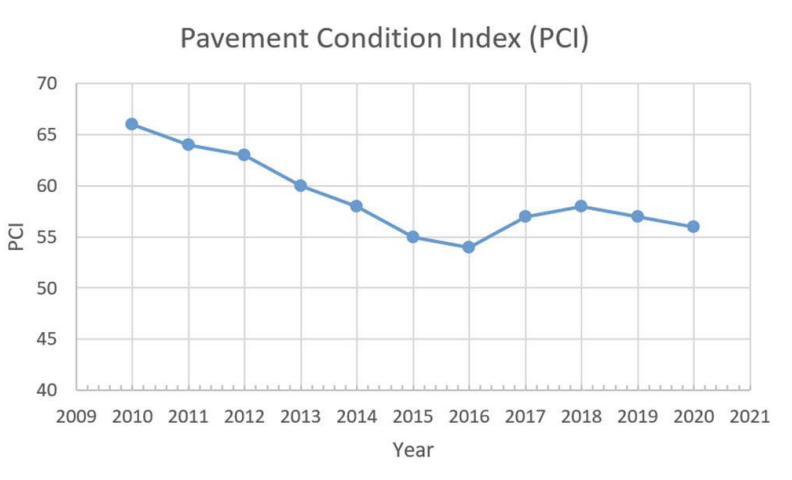


Figure 5.4 Annual Condition of Local Roads in West St. Paul

Maintenance Decision-Making

Most of the maintenance activities in the city are preventive. It is important for the department to invest in city streets while they are in decent condition to keep them in that condition and get the most life out of them (City of West St. Paul, 2018). In addition, it is more cost-effective to perform crack sealing, seal coating, and mill and overlays to maintain local roads rather than let the street deteriorate at its natural rate and conduct expensive reconstruction projects later. Currently, the department is focusing on maintenance activities that extend the life of the road for five or six years, which includes annual patching and crack filling, or a small amount of band-aid type work. Then, after that time, the department tries to do corrective work. The department is able to do some overlays in-house but there are not enough resources to get into structural mill and overlays or full depth reclamation projects.

To determine project priority, the department lists the top 12 worst streets that it plans to overlay in the year and then conducts a visual inspection to determine their priority (or the order they go in) and the extension that needs to be covered. In addition to the visual inspection, the department takes the price of the asphalt and the level of traffic on the road into account. Currently, the department tries to cover between 8 to 10 streets with asphalt, so that they do not have to do pothole patching every other week on them.

The list of maintenance projects the department plans to conduct does not get affected by inputs of other stakeholders. The department receives complaints from residents but these do not determine or

affect priorities. The staff typically addresses maintenance activities on roads in poor conditions that also tend to be the roads that generate more complaints. Similarly, interests from elected officials do not affect maintenance priorities. The department's staff states that they can easily explain the reasons behind giving priority to some projects and not to others. Generally, the condition of the road speaks for itself. Lastly, the department coordinates with the St. Paul Regional Water for reconstruction projects, but there is no coordination for maintenance projects. As the department is also responsible for other utilities in the city, there is internal coordination.

The staff capacity dictates some of the maintenance work that the department performs. Currently, the department does not have excess staff, and if someone takes a day off it may push some of the activities back. Sometimes, depending on the staff availability, instead of doing a pavement project, the department ends up doing some smaller tree trimming or signage work. Ideally, the department would like to pave five days a week for a month and complete its maintenance work, but usually, it is more about two to three days a week.

Maintenance Funding and Needs

Funding for the maintenance of city streets comes from the general fund, while for roads in the MSAS system it comes from state-aid. State-aid funding does not cover all the needs of the state-aid system and the department has to use local funding to address the needs of those roads. The department also receives some funding from assessments for reconstruction projects.[57]

As mentioned earlier, the City approved the collection of a half-cent sales tax to allow to "pay as you go" for future road projects until 2035 (City of West St. Paul, 2021). The department estimates this tax will raise about $1.2 million of revenue annually that will be used to reconstruct or repair critical roadway infrastructure (not maintenance). This additional funding, combined with state-aid funding, assessments, and general tax levy will provide resources for road projects in the future.

The department estimates it would need to invest around $6.7 million per year to reconstruct and mill and overlay the city's local roads and get them to reach an overall PCI score of 70. In 2018, the department adopted a prioritization of future street reconstruction and mill and overlay projects. Table 5.5 shows the estimated amount needed as of 2020 (in net present value - NPV) to bring different priority streets to a better condition and get closer to an overall PCI of 70. The department plans to address all priority 1 and 2 streets as major maintenance projects over the next 20 years and for this, it would require an annual investment of $6.7 million. However, the current street investment is about a

[57] The assessment policy was amended during 2018. For reconstructed streets, the assessment to benefitting properties continues at 25 percent of total project costs, while for mill and overlay projects it changed from a cost share of 25 to 35 percent (City of West St. Paul, 2019).

third or a quarter of that amount. According to the staff, the department has one street reconstruction project a year that is between half-mile or one-mile long for a 65-mile system.

Table 5.5 2018 Pavement Management Plan in West St. Paul

Roadway Priority	NPV of projected need over the next 20 years (1)
Priority 1 Streets (PCI < 45)	$65,826,405
Priority 2 Streets (PCI between 45-79)	$68,817,690
Priority 3 Streets (with recent major maintenance)	Future contingent cost of $65,736,840

Note: *(1) The amount corresponds to reconstructions and mill and overlays. Does not include maintenance. Estimates assume $15 per square foot for reconstruction.* ***Source:*** *City of West St. Paul* (2018)**.**

Between 2023 and 2025, funding available for street projects is expected to be limited as the City participates in cooperative agreements. Between 2023-2024, the department has planned the reconstruction of a border street with the City of St. Paul[58] and in 2025 it has planned to participate in a cooperative agreement with Dakota County. Entering into these agreements, not only limits funding but also decision-making in the city, given that three of the next five years have already been decided for.

The COVID-19 pandemic affected roadway maintenance activities. Overall, the department was able to complete its patching, the potholes, and painting work during 2020, but it had to delay some maintenance activities and reprioritize projects to get more asphalt work done. The streets department was running with split shifts[59] and with one person per vehicle to maintain social distancing. In addition, it was hard to hire seasonal staff due to the limited space and time to split them into separate groups. Overall, the maintenance budget was not significantly affected by the pandemic.

5.2.9 City of Marshall

The city of Marshall department of Public Works is responsible for the maintenance and repair of the local road system. In addition to the streets, street lighting, engineering, and public way maintenance responsibilities, the department is responsible for wastewaters and the airport. The local roadway system consists of 14.10 miles of roads in the MSAS system (City of Marshall, 2021), 70 miles of local roads, and la total of 9 bridges.

[58] This project has been in the works for 10 years, but both cities needed to align their CIPs to find out when they have funding available to proceed with the project. This is a needed project as it has a PCI of zero.
[59] Split shifts included three to four different starting times and lunchtimes.

Operating and Capital Budgeting Practices

The City of Marshall develops its fiscal budget on an annual basis. In addition, the City has a five-year capital plan that is produced using the plan-it capital planning software and lists capital projects with their funding sources and their priority level. All departments submit their budgets on an annual basis. According to the 2021 Budget, the City approved $1.5 million for street administration in 2021 that includes road maintenance operations. In addition, $675,000 was included in the 5-year capital plan for street mill and overlays and ADA improvements in 2021 (City of Marshall, 2019).

The department of Public Works budgets for the seal coating, mill and overlay, and surfacing and reconstruction programs on an annual basis. Seal coat is included in the operating budget; mill and overlay is included in the capital budget; and reconstruction is included in the capital budget. In addition, the department develops a 10-year CIP that lists reconstruction and major projects. The CIP is updated as needed as transportation needs evolve.

Asset Management Practices

The department of Public Works started a formal pavement management system in fall 2020. Department staff developed their own rating system with a 0 to 5 scale, where 5 is a brand new road, 3 is a road with moderate cracking but no real severe damage, 1 is a road with a lot of settlement issues, patching, and potholes, and 0 is unserviceable. The rating system not only considers pavement condition, but also other factors such as whether there are drainage issues, the age, the type of surface (bituminous or concrete), level of traffic volumes, utility needs, and connectivity development. The staff assesses road segments and includes all the inputs in an excel file that has a formula that gives the overall rating for the road segment.

The new system aims to make the decision-making process more efficient and the capital improvement plan more robust. Once the department has all the streets filled in the excel file and evaluated, the staff will be able to sort road segments based on pavement condition as well as on the overall rating and determine the projects with the highest priority that could use a reconstruction, mill and overlay, or resurfacing project. The system will not only help the department to plan investments on an annual basis, but also on a five-year basis. The department aims to complete the assessment in fall 2021/winter 2022 but acknowledges time and staff limitations to get all the information into a usable format and incorporate it into the system.

The department is also responsible for all maintenance and capital investments in the bridges, but works with Lyon County for their inspection. The County staff has the necessary training and background to complete bridge inspections on behalf of the City, and the City certifies it and conducts the maintenance and capital improvements on them. Overall, bridges have an average NBI Condition Rating of 8 (out of 9).

Local roads are in good condition but roads in the state-aid system are getting into poor condition. Based on the new assessment, the department estimates that the pavement condition of local roads has an overall rating of between 3.5 and 4. Roads in the state-aid system, however, are in poor condition. About half of the 14 miles of state-aid roads were overlaid 20 years ago and there was no preventive maintenance investment at that time. Those surfaces are currently in need of an improvement project and are planned for a state-aid mill and overlay in the coming years.

Maintenance Decision-Making

Maintenance decision-making in Marshall is highly driven by utility needs. The department of Public Works works hand in hand with water utility and wastewater staff to prioritize roadway projects. This coordination prevents the department from investing first in a mill and overlay and then having to reconstruct the road again when there are utility improvements. Typically, the department reviews the pavement inventory, assesses the needs based on the visual inspection, and compares pavement needs with utility needs to pick the best candidates for reconstruction based on where they are, their age, their pavement surface material, and their condition.[60] For the mill and overlay program, the decision-making is more subjective, but the department also looks at past history of the roads and is currently shifting to cover areas all at once instead of just picking spots across town. Lastly, as part of the seal coat program, the department tries to seal coat all newly reconstructed roads the year following their reconstruction. The department staff believes that getting the seal coat on the road early is the best method to keep the roadway system in a good condition.

The department, through the street division, is trying to focus more on preservation maintenance. The staff is doing more patchwork, some curve replacement work, gutter work, and overall small work that can help with the longevity of the pavement. Most of this work is driven by staff that takes note of the condition of roads in some areas of the city or brought up from residents' complaints.

The department has faced some challenges as it moves into developing more preventive maintenance projects. These challenges are mostly associated with negative perceptions stakeholders have toward these types of activities. Although the chip sealing process has shown to help extend the life of the roadway, there are stripping issues around cheap sealed roadways that make the public and especially politicians start raising questions regarding whether the department is spending its resources appropriately. In addition, some staff at the street department are skeptical of activities such as crack sealing. In the past, street departments did not perform crack-sealing or chip-sealing and preventative maintenance was a "dirty word". Moving past that stigma is challenging as the department tries to move forward with more preventive maintenance.

[60] Water utility needs consider whether there is a high concentration of water main breaks, age and condition of water pipes, while sanitary sewer needs consider whether there is a crack or an infiltration.

Overall, there are several factors that affect maintenance decision-making. Although the department has adequate staff to administer roadway programs, staff capacity keeps them from doing as much analysis as they would like to do sometimes. In addition, construction costs such as labor and material costs play a role after the bids are open. If the bids come very high, the department has to reevaluate the project to lessen the project scope, reduce the number of projects to be undertaken and postpone some projects. The department also identifies some political challenges but mostly related to reconstruction projects. When business or property owners indicate some dissatisfaction regarding a project identified by the department, the City Council may direct them to take it out from the list of projects. The dissatisfaction, in most cases, is mainly because of the special assessment that property owners will have to pay to cover a portion of project costs. In such cases, the department keeps patching the roads until the City Council requests a major project.

Roadway Maintenance Funding and Needs

Funding for seal coat, mill and overlay, and surfacing and reconstruction programs come from several sources. Funding for the seal coat program comes from the general fund, while funding for the mill and overlay program comes from the general fund and bonds. Lastly, most of the funding for the reconstruction program comes from special assessment, the general fund, some utility funds,[61] and eventually from grants. The department also receives state-aid funding for roads in the MSAS system, and typically does not spend local funding on the MSAS system.

Table 5.6 shows current funding for each roadway program and the budget needed to maintain the local roads in a good condition. Ideally, budgets should be growing at least to keep up with inflation, but increasing funding is challenging given the political pressure to keep budgets down.

Table 5.6 Budgets vs Ideal Investment Levels in the City of Marshall

Program	2020 Budget	Ideal Investment
Crack Seal	$15,000	$30,000
Seal Coat/Chip Seal	$140,000	$200,000
Mill and Overlay	$675,000	$750,000

[61] Municipal utilities help pay for the reconstruction of roads when utility work is needed, and that work affects local roads.

As the department starts investing more on preservation activities, their budget on overlays would go down. The department shifted the maintenance approach they used to have and is trying to do more activities to preserve the condition of the roadways that are in good shape. The department expects that in the future -around 10 years- the overlay budget would be able to decrease considerably given that most of the system is in such a good shape that they will be still doing preventative maintenance.

The department does not have an estimate of the amount of maintenance it has deferred in its local roads, but estimates a need of about $2 million for the roads in the MSAS system. The department argues that with the current funding they are not able to tackle all the needs in a single year and that some additional funding could be used to overlay or chip seal local roads to catch up with the needs of the system.

COVID-19 froze some of the budgets at the department of public works but did not delay any maintenance projects planned. The department typically would have pushed to do some incremental adjustments to seal coat and mill and overlay programs, but these were frozen out of uncertainty over what would happen. Despite the budget, the department carried through with their seal coat and mill and overlay projects. Overall, the department lost a year of increases in its budgets, which will come with a compound effect every year given that the budget was not able to keep up with rising costs.

Most of the challenges due to COVID-19 were related to reconstruction projects and state-aid roads. Reconstruction projects were challenging as the Council was not sure about investing resources in them while trying to address residents and business concerns as well as in state-aid roads. Similarly, there was a decrease of state-aid funds allocated to the department that will negatively impact state-aid roads in the city.

5.3 POTENTIAL ADDITIONAL IMPACTS ON MAINTENANCE INVESTMENTS

The adoption of electric vehicles (EVs) and connected and automated vehicles (CAVs) may impact future roadway maintenance investments. In most localities EVs are still a very small percentage of total vehicles and have not had a significant impact on roadway maintenance investments. However, localities are concerned regarding future roadway funding and the investments needed to meet future needs and support future infrastructure.

Localities are currently concerned about the methods used to generate transportation funding given that the motor fuel tax becomes less relevant. In particular, a decrease in revenues from the motor fuel tax affects the state-aid funding that localities receive to fund maintenance projects in state-aid system roads. According to the localities, there is a need for a sustainable long-term solution to funding transportation in general. In addition, it is also important to them to not only replace the current funding stream, but also to increase it.

Similarly, localities are concerned about the investments needed to support future infrastructure. This includes charging stations, striping widths, signs, and maintenance of areas adjacent to roads among others.

CHAPTER 6: SURVEY ANALYSIS

6.1 SURVEY METHODOLOGY

The research team developed a survey that was administered to city and county officials across Minnesota. The development of the survey was informed by findings from the case studies developed for a previous task.[62] The survey was administered to better understand the challenges local government agencies face when making decisions regarding roadway maintenance investments, the strategies they are taking to balance funding for roadway maintenance, and other options they are considering to close the roadway maintenance gap. The questionnaire consisted of a total of 25 questions[63] that included single-choice, multiple-choice, open-ended, and rank order questions (see questionnaire in APPENDIX B: Survey Questionnaire). Localities were asked about the size of their roadway network, condition of the roadway system, maintenance funding and gaps, decision-making processes, deferred maintenance, and strategies they use to address maintenance gaps.

The survey was developed in Qualtrics[64] and distributed through the City Engineers Association of Minnesota (CEAM) and Minnesota County Engineers Association (MCEA) email list with MnDOT support. The CEAM email list serves MSAS cities in Minnesota (cities over 5,000 people) reaching 241 people, while the MCEA lists serve all counties in Minnesota reaching 224 people. Overall, the survey was distributed among 148 cities and 87 counties in Minnesota, and reached city and county engineers, as well as some assistant, technicians, and public works directors. The survey was available from June 24 to July 9, 2021.

Maintenance, rehabilitation, and reconstruction activities were defined throughout the survey to get consistent data. Maintenance activities reflect the maintenance and repair of local highways, streets, bridges, and street equipment. Common activities include patching, seal coating, micro-surfacing, and mill and overlay, among others. This excludes other roadway maintenance operations such as snow removal. Rehabilitation and reconstruction activities include major roadway improvements such as removal of existing streets and construction of new streets, which may include sanitary sewer or water main and stormwater improvements, repair of problem areas to full depth, milling of edge or full width or existing pavements, and repair to existing catch basins and/or curb and gutter.

[62] The research team conducted case studies of four Minnesota cities and five counties about their operating and capital budgeting practices, asset management practices, and decision-making processes around maintenance investments. The case studies involved interviews with staff involved in roadway maintenance decision-making in the localities as well as a review of publicly available documents from the localities.
[63] The actual number of questions each locality responded to may be less. Some prompts were included depending on the respondents' answers to particular questions.
[64] Qualtrics is a web-based survey tool.

6.2 FINDINGS FROM SURVEY ANALYSIS

A total of 31 localities completely or partially filled the survey. Out of 87 counties and 148 cities in Minnesota, a total of 19 counties and 12 cities completed the survey. This represents a response rate of 22 percent and 8.1 percent for counties and cities, respectively. The response rate may be low due to the complexity of the topic coupled with staffing levels in some smaller cities. Roadway maintenance decision-making, including the challenges local government agencies face, the strategies they use to fund roadway maintenance and close the roadway maintenance gap involve multiple individuals (and in some cases multiple departments) and therefore requires specific knowledge and a high level of engagement with the topic that one person may not have by themselves. Some representatives of local government agencies responded to the initial questions and left the remainder of the survey incomplete. This also became evident when conducting interviews for the case studies. [65] Capturing such information required group interviews, and for interviews with a single interviewee, interviewees often mentioned having to request information from peers.

6.2.1 Pavement and Bridge Conditions

Localities were asked about the ratings they use to assess the condition of their pavements (Table 6.1). A total of 14 counties and 12 cities responded to the question. Most of the counties reported using the PQI. Four of them mentioned using an additional method to assess the condition of their pavements including visual inspections, time in service, and other indexes such as the RQI, IRI, and PCI. Most cities, on the other hand, reported using the PCI, few reported using other indexes such as the OCI and PASER.[66]

[65] The research team conducted case studies of four Minnesota cities and five counties about their operating and capital budgeting practices, asset management practices, and decision-making processes around maintenance investments. The case studies involved interviews with staff involved in roadway maintenance decision-making in the localities as well as a review of publicly available documents from the localities.

[66] The PQI is often used to report pavement performance at the state level. This measure is based on the collected roughness, rutting, cracking, and faulting data and combines the surface rating and the present serviceability rating (FHWA, 2013). The PCI is a simple index that measures surface distresses. The limitation is that two segments of pavements could have the same PCI but the distresses could be significantly different and require different solutions. Typically, other information, such as visual inspection, should be considered in the decision-making (UC PRC, 2021; City of Waseca, 2020).

Table 6.1 Pavement Condition Ratings used by Localities in Minnesota

Pavement Condition Ratings	Number of Counties (1)	Number of Cities (1)
Pavement Quality Index (PQI)	12	-
Pavement Condition Index (PCI)	2	7
Overall Condition Index (OCI)	-	2
Pavement Surface Evaluation and Rating (PASER)	-	2
Other (2)	2	1

Notes: *(1) The number corresponds to the number of localities mentioning the index. It does not add to the total number of respondents as some localities may use more than one index. (2) Other includes time in service, general age and condition for counties; and Windshield condition rating for cities. Two counties mentioning other indexes that are used to get an overall index such as PCI or RQI were removed from this category.*

Localities were also asked about the overall acceptable level for the condition of the pavements and their current condition. A total of 12 counties and 11 cities responded to the question.

There is some variation in terms of acceptable levels for the condition of the pavements in counties. Most counties mentioned having one target. Of the five counties that measure their PQI on a scale from 1 to 5, two target a PQI above 2.5, two target a PQI above 3.0, and one has not formally set a target but assumes a target of 3.0. Similarly, three counties that measure their PQI on a scale from 0 to 100 have set targets above a PQI of 60, with one of them having a tiered system.[67] Additionally, two counties mentioned having two targets. Dakota County's goals, for instance, are first to keep a PQI of or better on 95 percent of the roadway system, and second to keep a PQI of good or better on 75 percent of the roadway system.[68] Similarly, Washington County targets having a PCI above 72 and having no roadway with a PCI below 40.

Most of the respondent cities target an acceptable level for the condition of the pavements equal to or above an average PCI of 70. There are two cities for which acceptable levels are equal to or above an average PCI of 60, but these are cities with relatively small roadway systems (with less than 80 centerline miles in total). In addition, one city that also reports the largest roadway extension (with a total of 257.2 centerline miles), targets an average PCI of 80. Of all the respondent cities, only one

[67] Otter Tail County adopted a tiered system to optimize funding allocation for paved roads. The priorities of the system are preventing roads in "fair" condition from falling into "poor" condition (by avoiding a worst-first approach) and prioritizing preservation strategies over reconstruction fixes (Otter Tail County, 2019).
[68] In the County, a fair PQI is defined between 2.2 and 2.9, and a good PQI is defined between 3.0 and 4.0.

reported having two different targets for collector & arterial roadways and for local roadways, with the target being lower for local roadways (see Appendix C, Table C.1).

Overall, more localities report pavement conditions below the acceptable level (Figure 6.1). Of the counties, five reported pavement conditions that met or exceeded their target condition and four reported pavement conditions below the acceptable levels. One county defined the acceptable level in terms of the PQI and reported the current condition in another metric (PCI). Lastly, two reported not knowing the current condition of their pavements, one of which attributed this to staffing levels. Please see Appendix D, Figure D.1 for separate county and city maps.

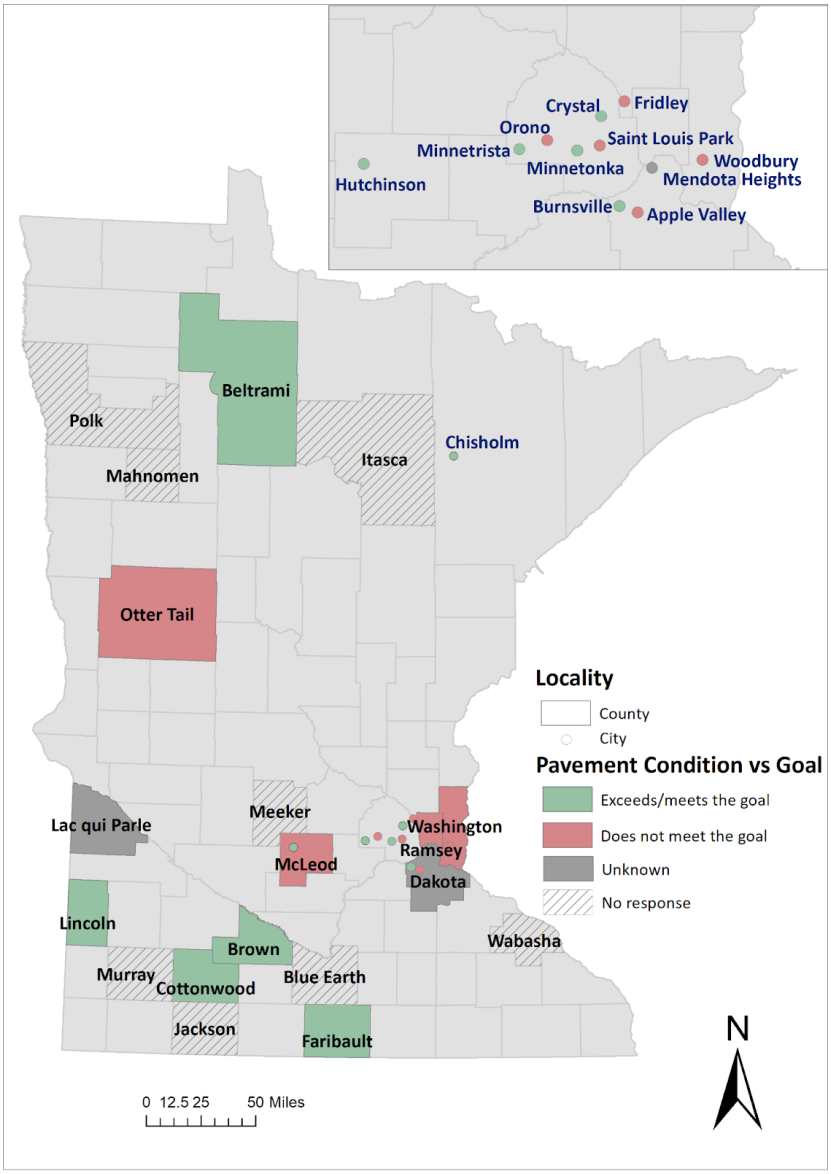


Figure 6.1 Current Pavement Conditions vs Acceptable Condition Level

Note: *Pavement goals established by each locality. The ´Unknown´ category includes a locality that uses one index to define the acceptable condition level and another index to identify current pavement conditions, as well as localities that do not know the condition of their pavements.*

Of the cities, six reported pavement conditions that met or exceeded the acceptable level, four reported pavement conditions below the acceptable level, and one did not know the conditions of its pavements.

Localities were also asked to list the ratings they use to assess the conditions of their bridges. A total of 22 localities (13 counties and 9 cities) responded to this question. Localities use the Local Planning Index (LPI) and the National Bridge Inventory (NBI) Appraisal Rating to assess bridge conditions as a result of updates in the funding eligibility requirements in 2020. Before this, localities used sufficiency ratings. Overall, a majority of the counties use the LPI (selected by nine counties) with three of them also still using the sufficiency rating, while most respondent cities (7) use the NBI (Table 6.2). Only two counties and a city reported using solely sufficiency ratings. A number of counties also reported using the NBI and average bridge age. Four counties and two cities reported using multiple indexes to assess the condition of their bridges.

Table 6.2 Ratings used by Minnesota Localities to Assess Bridge Conditions

Index	Number of Counties (1)	Number of Cities (1)
Local Planning Index (LPI) (2)	9	0
Sufficiency rating (SF)	6	2
National Bridge Inventory (NBI) rating	3	7
Average bridge age	2	0
Other (3)	2	0

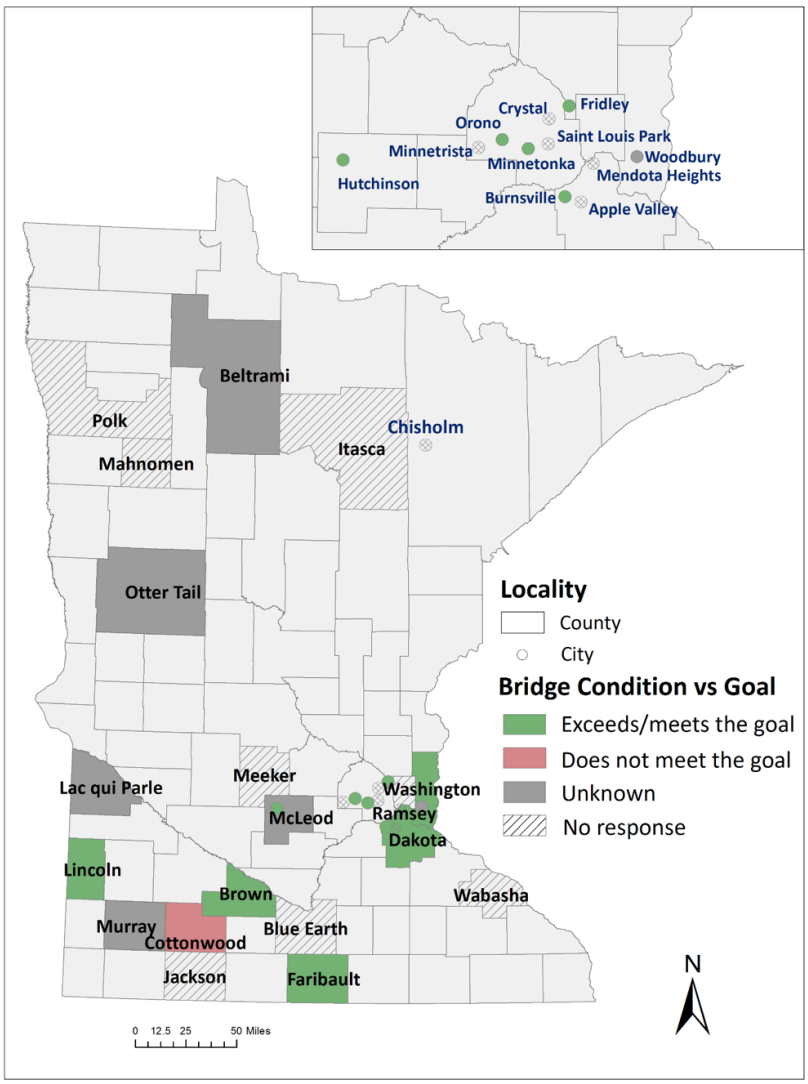
Notes: *(1) The number corresponds to the number of localities mentioning the index. It does not add to the total number of respondents as some localities may use more than one index. (2) This includes two counties that did not list LPI as an index they use, but reported an LPI for target and reported current conditions. (3) Two counties reported using bridge information modeling (BRiM) and Structural Element.*

Similarly, localities were asked about their identified acceptable bridge condition. The majority of the counties (6 out of 9) that use an LPI rating to define their acceptable bridge conditions, target an average LPI rating of 60 or above with two of them targeting an LPI of 70 or above.[69] One other county

[69] One of the counties with an LPI goal of 60 noted that their funding does not allow replacing all bridges below their set goal and therefore, several other factors are taken into account to prioritize such as traffic level, load rating etc.

that uses LPI ratings mentioned their target was to have no bridges below an LPI rating of 60 or less and another one mentioned to have no bridges with LPI below 70 as its target. Similarly, respondent cities reported a range of ratings as their set targets. Four cities have set a target NBI rating of 5 or higher, one has a target of 6 (only trail bridges), and one has a target NBI of 8. Of the localities that reported using a sufficiency rating, a respondent county mentioned an average sufficiency rating of over 50, while a respondent city mentioned an average sufficiency rating of 65-75 percent as their targets. Three localities (two counties and one city) have not established an acceptable bridge condition.

Overall, more counties meet or exceed their target bridge condition ratings than cities (Figure 6.2). Five counties and five cities reported bridge conditions that met or exceeded their target. In addition, of the respondent counties, one did not meet its target, five did not know its bridge condition, and another one reported a sufficiency rating of 96 as of 2019 while it has recently switched to using LPI ratings. Three localities, two of which did not have set targets, reported current bridge conditions. Please see Appendix D, Figure D.2 for separate county and city maps.



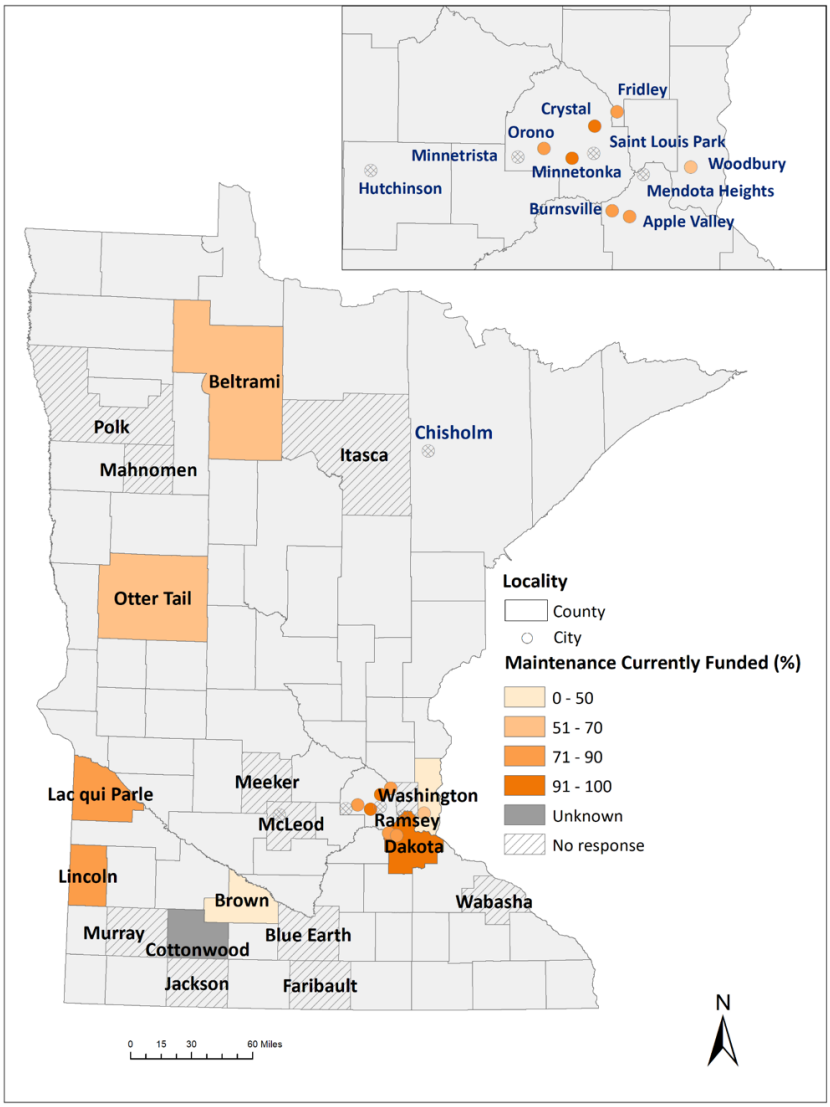
Note: *Bridge goals established by each locality. The 'Unknown' category includes two localities with no established acceptable conditions, two localities that did not know or were not sure about their current bridge conditions, and one that recently switched from using SR to LPI index.*

Figure 6.2 Current Bridge Conditions vs Acceptable Condition Level

For more detailed information regarding the acceptable condition levels and current conditions for pavements and bridges refer to Appendix C.

6.2.2 Pavement Reconstruction, Rehabilitation, and Maintenance Needs

Few localities currently fully fund pavement reconstruction, rehabilitation, and maintenance needs. Out of 15 respondent localities, three mentioned funding 100 percent of their needs (Figure 6.3). Crystal City is one of them, and although they fund between 90 and 100 percent of street maintenance, they mentioned having a gap in utilities. Brown and Washington County are the localities that fund a lower percentage of their pavement needs, funding 25 and 50 percent, respectively. In Cottonwood County maintenance needs are funded adequately, but pavement rehabilitation and reconstruction needs are funded at 75 and 50 percent, respectively. Please see Appendix D, Figure D.3 for separate county and city maps.



Note: *In Cottonwood County maintenance needs are funded adequately, but a percentage was not specified.*

Figure 6.3 Percentage of Maintenance Currently Funded across Minnesota Localities

Localities with pavement conditions above their target levels fund a higher percentage of their annual pavement reconstruction, rehabilitation, and maintenance needs, between 90 and 100 percent; while localities with pavement conditions below their target levels fund a lower percentage of their needs (between 50 and 80 percent).

Funding Needed to Reach and Maintain the Identified Acceptable Level for Pavements

Localities were asked about the amount of funding they would need to reach their identified acceptable level for pavements if their pavement conditions were below that level. A total of 12 localities (7 counties and 5 cities) responded to this question. The reported total funding needs range from $1 million to approximately $30 million (Table 6.3). Some localities reported annual needs rather than total needs.

Table 6.3 Locality Funding Needs to Reach their Identified Acceptable Pavement Condition Level

Locality	Targets not met	Targets met or exceeded
Counties	~$7 million annually $10- $12 million (or $3.5 million annually) Not sure	$2 million more by the end of 2027 $25 million $225,000 per mile (2020)
Cities	$1 million $2.6 million $3 million annually ~$30 million	

Respondent counties reported needing between $2 million to $25 million to reach their identified acceptable pavement level. Two counties with pavement conditions below their target level reported funding needs ranging from $3.5 to $7 million annually. One county with pavement conditions below its target was not sure about the amount of its funding needs. Cities with pavement conditions below target levels reported funding needs of around $2 million to reach their identified acceptable levels. The City of Woodbury identified a need of approximately $30 million to reach pavement condition goals.

Three counties that met or exceeded their pavement target conditions also reported funding needs. Interestingly, the identified funding needs are significantly higher than those of counties with pavements below target conditions. Another county noted that while they meet their identified target level, their current funding only allows for reconditioning projects and is not sufficient to keep the pavements at that acceptable level or to rebuild the roadway to meet 10 ton standards. One city that exceeds its identified acceptable pavement condition level emphasized that for them utilities such as the water, wastewater, and stormwater facilities with an annual funding gap of $750,000 were the issue, and addressing this funding gap would address the issue of the roads. It is possible that this City has

deteriorating utilities underneath a roadway that may be within their acceptable condition level and replacing or repairing the utilities would require them to tear apart the street.

Finally, two counties, one that did not report its acceptable pavement condition levels and another that reported a pavement condition in an index other than the one used to establish its acceptable level, also reported funding needs to reach their identified pavement target levels. The first county reported funding needs of two to three times their current level of funding from state-aid. The second one reported an estimated annual need of $7.71 million.

Similarly, localities were asked about their funding needs to maintain pavement conditions at an acceptable level. A total of 19 localities, 10 counties and 9 cities, responded to this question. Overall, the needs of counties are higher than the needs of cities given the size of their roadway networks, and as the roadway network gets bigger the funding needs increase as well (Figure 6.4).

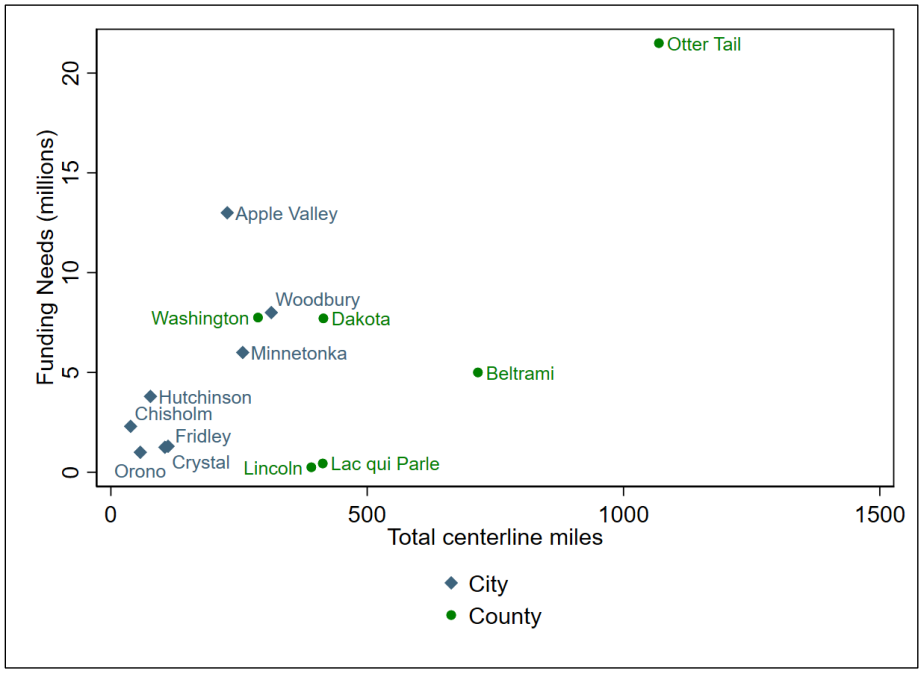


Figure 6.4 Funding Needs to Maintain Pavement Conditions at an Acceptable Level and Roadway System Size

Respondent counties reported annual funding needs of between $250,000 to $22 million to maintain pavement conditions at their acceptable level, with most of them reporting funding needs of $5 to $8 million annually. In addition, two counties reported needs relative to their current level of funding. One of them reported a 25 percent increase and another reported a funding need of 1.5 to 2 times their current funding level from the state-aid. Respondent cities reported annual funding needs of between $1 million to $13 million. Finally, a city and a county were not sure or did not know about their funding needs.

6.2.3 Selection of Maintenance Projects

Factors considered in the selection of maintenance projects

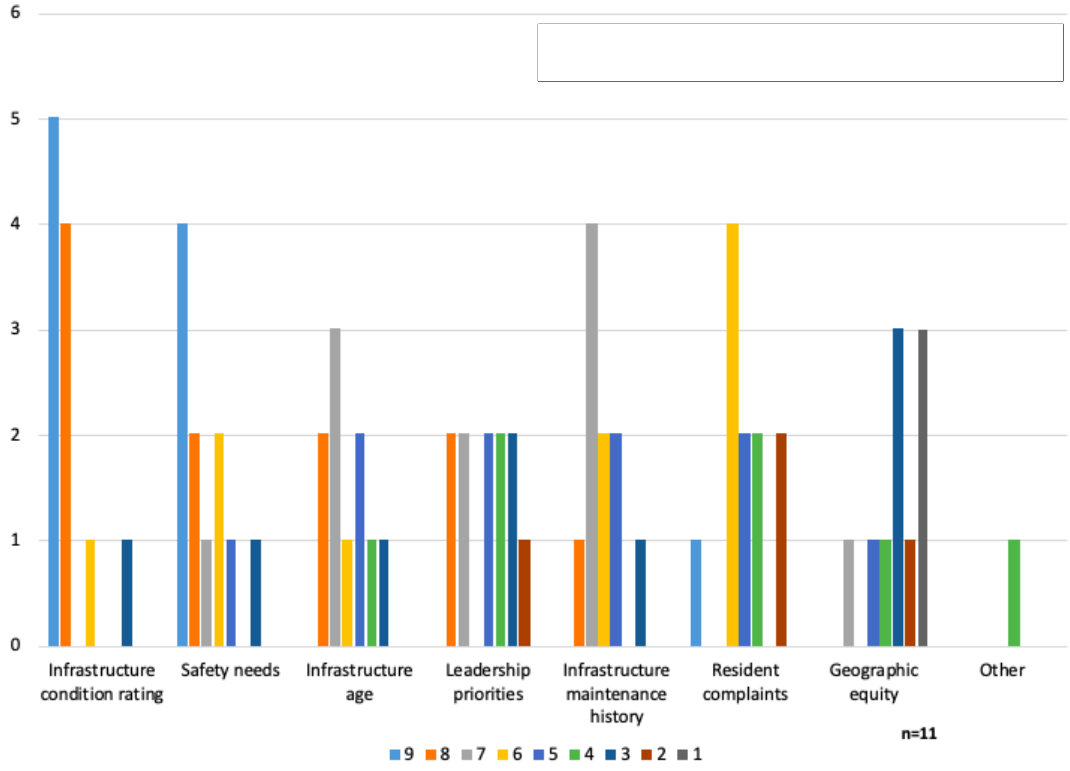
Localities were asked to rank factors they take into account when selecting maintenance projects. The ranking was on a scale of 1 to 9, with 1 being the least important and 9 the most important. The factors listed in the survey were informed by the case study findings but an "other" category was included in case additional factors were considered by the localities. The factors included infrastructure condition rating, infrastructure age, infrastructure maintenance history, safety needs, geographic equity, utility needs, resident complaints, leadership priorities, and other. Figure 6.5 presents responses by type of locality. A total of 19 localities responded to the question, 11 counties (Panel A) and 8 cities (Panel B).

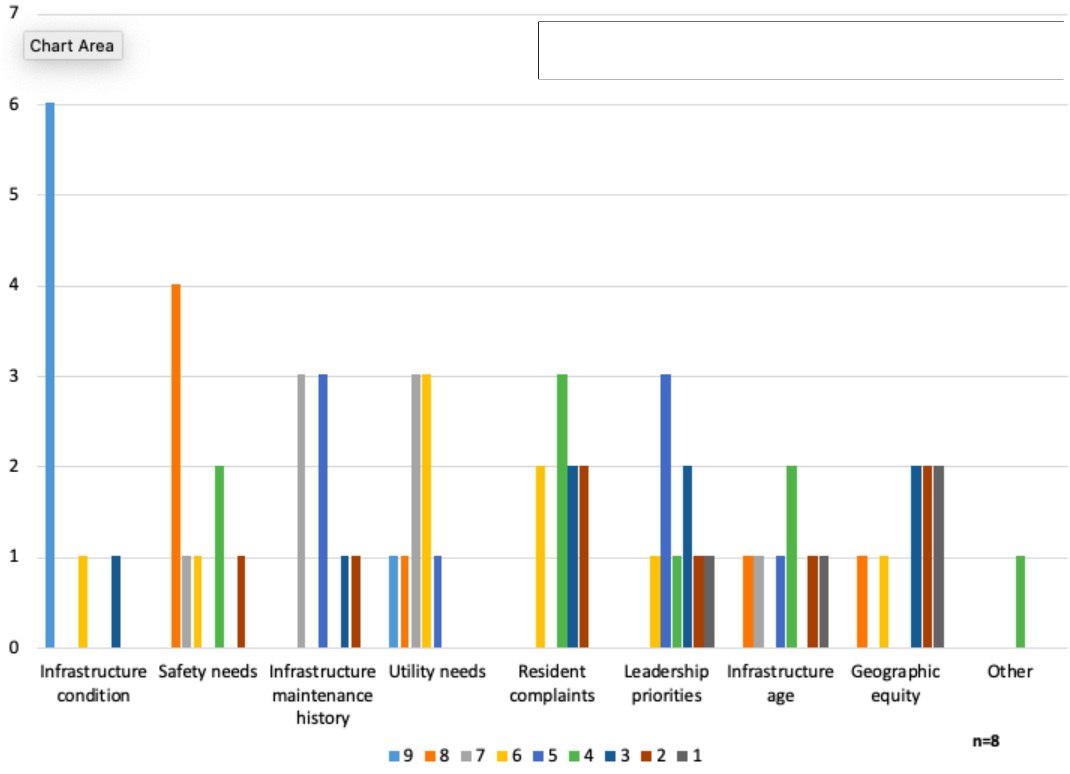
According to the survey respondents, infrastructure condition rating is the most important factor taken into consideration when selecting maintenance projects (selected by 11 localities). When considering only cities, this is the most important factor (selected by 6 out of 8 cities), while when considering only counties, the infrastructure condition rating almost competes with safety needs. Of the 11 respondent counties, five ranked higher infrastructure condition rating against four counties that ranked higher safety needs.

The second most important factor taken into consideration when selecting maintenance projects is safety needs (selected by 6 localities). This is the second most important factor when considering only cities (selected by 4 out of 8 cities), but when looking at only counties, the second most important factor is not clear. Infrastructure age, safety needs, and leadership priorities were ranked as the second most important factors by two counties each.

The third most important factor when selecting maintenance projects is the infrastructure maintenance history (selected by 7 localities). Cities ranked infrastructure maintenance history and utility needs similarly (each selected by 3 cities), while for counties this competes with infrastructure age (selected by 4 and 3 counties, respectively).

Geographic equity is the least important factor considered when selecting maintenance projects (selected in 5 localities, 3 counties and 2 cities). For counties, the second least important factor is utility needs.





Note: *Other category includes engineer's opinion (for a county) and tied project work (for a city).*

Figure 6.5 Factors Considered When Selecting Maintenance Projects

Challenges localities experienced when making roadway maintenance investments

Localities were asked to rank the various challenges they have experienced when making roadway maintenance investments. Findings from the case study suggested the challenges localities faced included coordination with the local utility department, coordination with local transportation agencies (at the city or county level), staff capacity, size of the roadway network, existing old pavements, and funding. An "other" category was included in case localities experienced additional challenges. Figure 6.6 presents locality responses. A total of 20 localities responded to the question, 11 counties (Panel A) and 9 cities (Panel B).

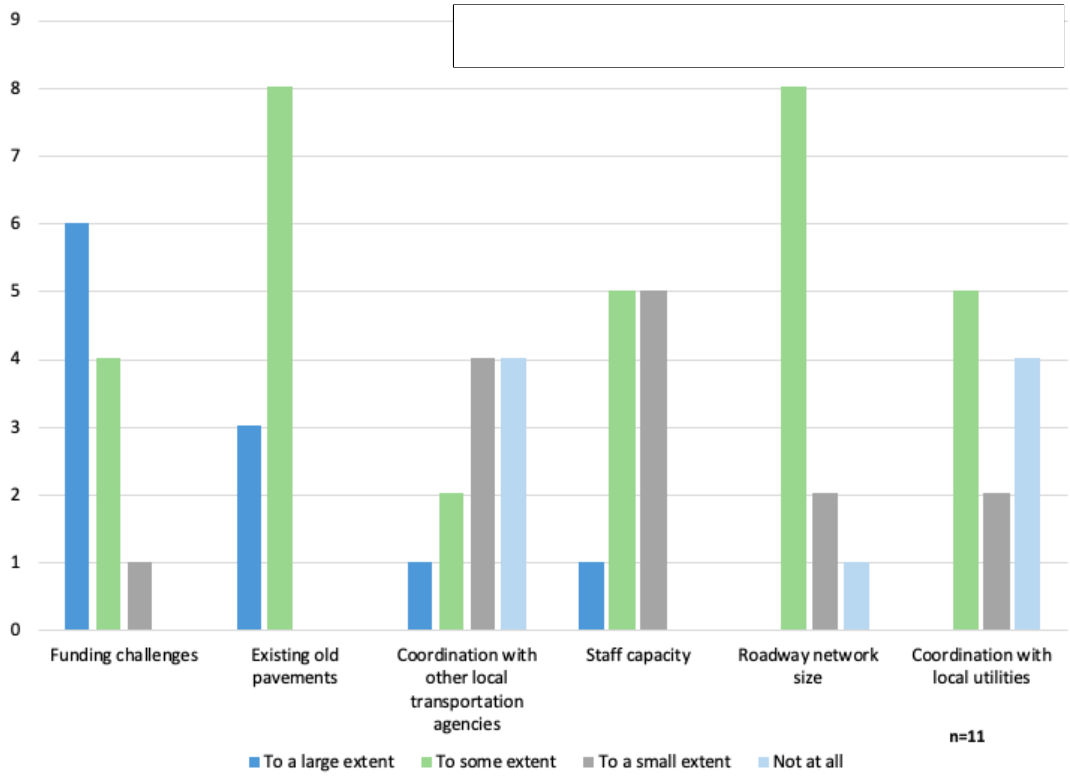
According to the respondents, all of the listed challenges affect their localities' roadway maintenance investments to an extent. Funding and existing old pavements are the factors that respondent localities consider challenging when making maintenance investments.

Funding challenges are an issue that affects roadway maintenance investments to a large extent (selected by 13 out of 20 localities). When looking at counties and cities separately, this factor remains the most important challenge, however, 54 percent of the respondent counties consider it affects them to a large extent compared to 77 percent of the respondent cities.

Existing old pavements is the second challenge that affects localities to some extent and to a large extent when making maintenance decisions (selected by 12 and 6 localities, respectively). When considering only cities, four cities considered it affects them to some extent and three considered it affects them to a large extent. When looking at counties, an equal number of counties considered existing old pavements and the size of the roadway network affect their decisions to some extent (both categories selected by 8 counties).

Lastly, a high percentage of respondents believe that coordination with the local utility department and coordination with other local transportation agencies does not pose any challenges to roadway maintenance investments.

When considering the localities with current pavement conditions below targeted levels, the funding challenges are mentioned by all of them as a factor affecting maintenance investments to a large extent. In addition, 60 percent of the localities with current pavement conditions below targeted levels listed existing old pavements as a second challenge that affects maintenance investments to some extent. Similarly, the county with bridge conditions below its target level selected funding challenges, existing old pavements, and coordination with other local transportation agencies as factors that affect its maintenance investments to a large extent.



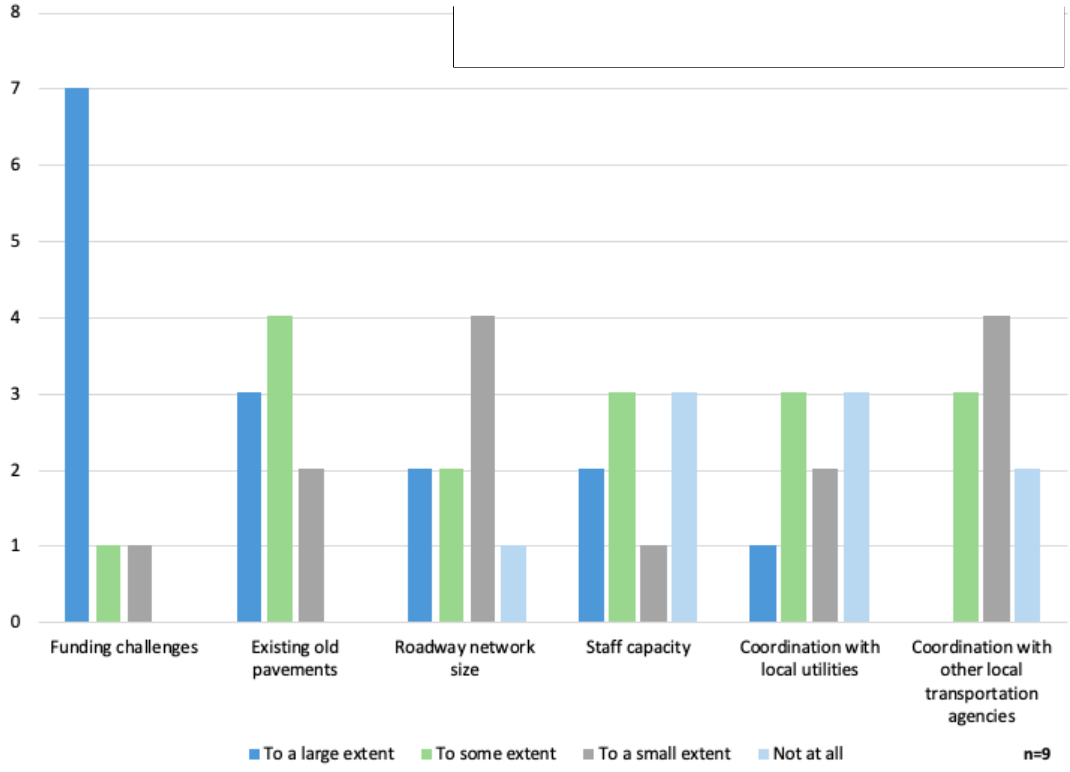
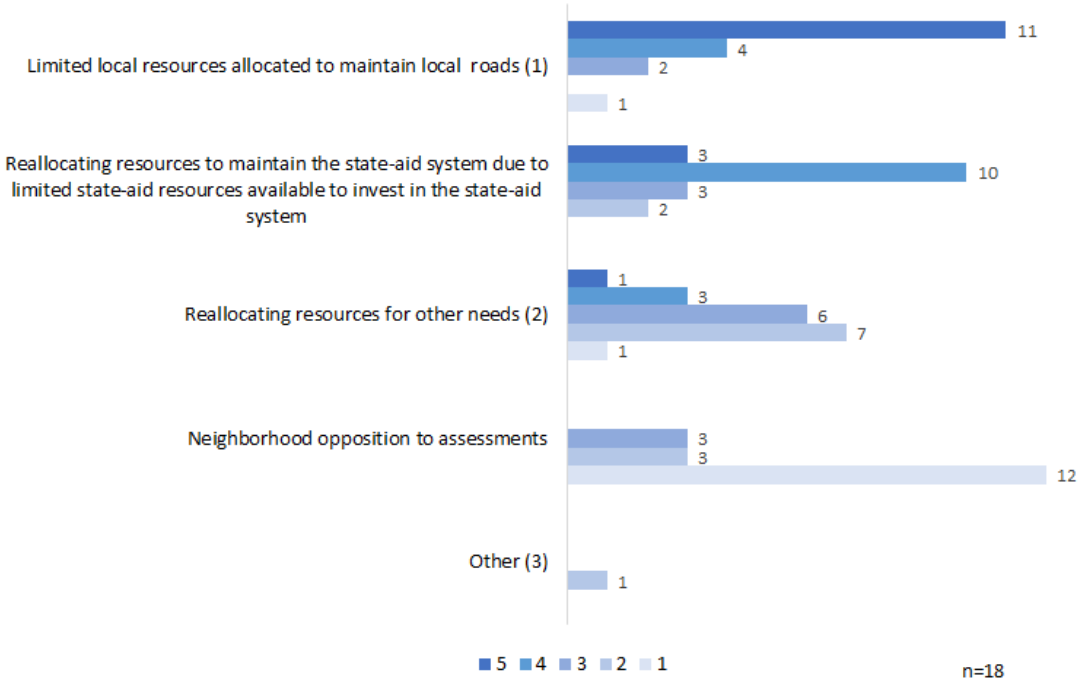


Figure 6.6 Challenges the Localities have Experienced when Making Roadway Maintenance Investments

Factors that affect funding availability for maintenance projects

Localities that mentioned to have experienced funding challenges when making roadway maintenance investments were asked to rank factors that affect funding availability for maintenance projects. The ranking was on a scale of 1 to 5, with 1 being the least important and 5 the most important. The factors listed in the survey were informed by case studies but another category was included for localities to list additional factors. The factors that affect funding availability included limited local (non-state-aid) resources allocated to maintain local (non-state-aid) roads, relocating resources to maintain the state-aid system due to limited state-aid resources available to invest in the state-aid system, reallocating resources for other needs (e.g. snow removal operations, addressing resident complaints), neighborhood opposition to assessments, and other. Figure 6.7 presents locality responses. A total of 18 localities, ten counties and eight cities, responded to this question.



Notes: *(1) Local resources refers to non-state-aid resources and local roads are non-state-aid roads. (2) Other needs include, for example, snow removal, operations, and addressing residents' complaints. (3) Other selected by one city includes competing general fund priorities.*

Figure 6.7 Factors Affecting Funding Availability for Maintenance Projects

According to the survey results, the most important factor that affects funding availability for maintenance projects is limited local resources allocated to maintain local roads, selected by 11 respondent localities. However, this factor is more important for cities than for counties. Seven out of eight cities selected it. For counties, this is the most important factor (selected by 4 of them), but competes with reallocating resources to maintain the state-aid system (selected by 3 of them).

The second most important factor that affects funding availability for maintenance projects is reallocating resources to maintain the state-aid system due to limited state-aid resources available. This factor was selected by ten localities (5 counties and 5 cities).

Neighborhood opposition to assessments is the least important factor affecting funding availability for maintenance projects. This factor is the least important for counties than for cities (selected by 8 counties out of 10 and half of the cities). This goes in line with the findings from the case study since assessments were mostly used for construction, reconstruction, and rehabilitation projects.

Localities that selected reallocating resources to maintain the state-aid system due to limited state-aid resources available to invest in the state-aid system were asked about the percentage of local (non-state-aid) funding used to maintain roads in the state-aid system annually. A total of 16 localities, eight counties and eight cities, responded to this question (Figure 6.8). Respondent localities reported spending between 5 to 50 percent of their local funding on the state-aid system. Please see Appendix D, Figure D.4 for separate county and city maps.

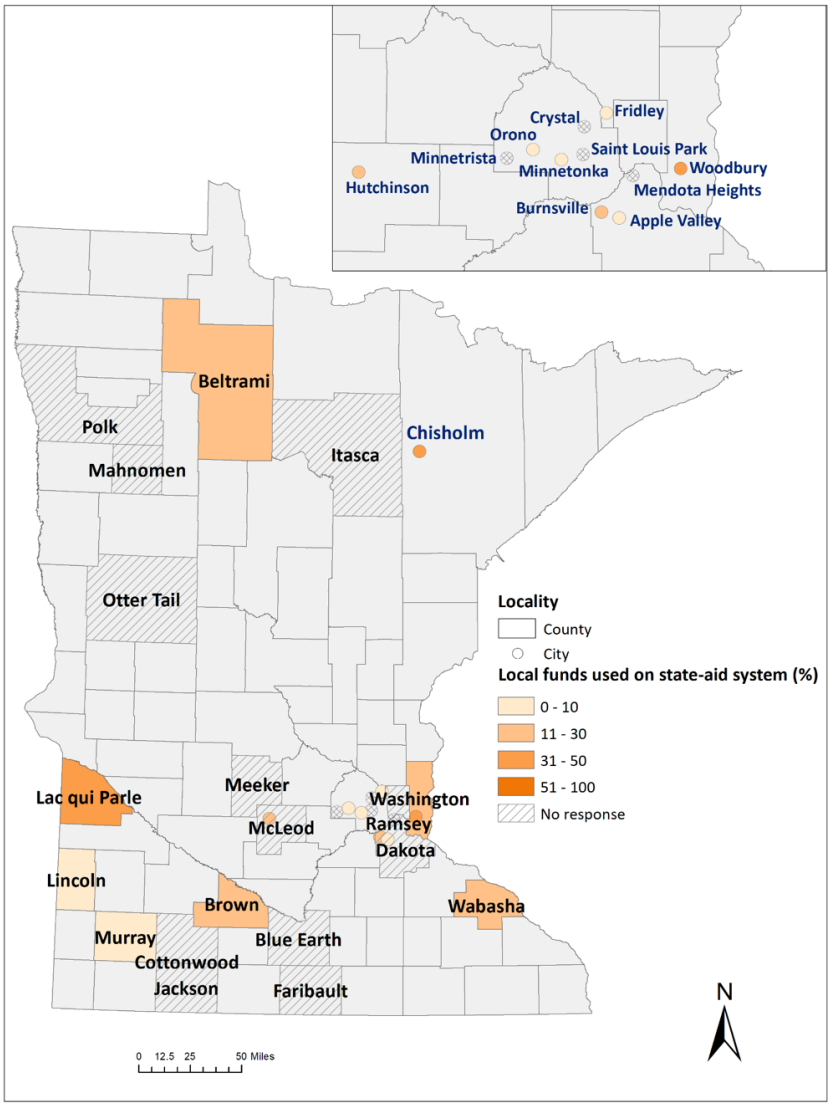


Figure 6.8 Percentage of Local Funds Used on the State-Aid System

Table 6.4 presents locality responses by selected levels of importance (presented in Figure 6.7). More counties reported spending between 25 and 30 percent of their local funding on roads on the state-aid system, while more cities reported spending around 10 percent. Interestingly, one city reports not spending any local resources on the state-aid system, despite selecting it as the second most important factor affecting funding availability for maintenance projects. Similarly, one of the counties reports not being sure about the percentage of local funding spent on the state-aid system, although this factor was selected as the most important factor affecting funding availability for maintenance projects.

Table 6.4 Percentage of Local Funds Used on the State-aid System

	Percentage of Local Funding used on the State-aid System															
	Counties								Cities							
Importance	0%	5%	10%	20%	25%	30%	50%	DNK	0%	5%	10%	20%	25%	30%	50%	DNK
5	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-
4	-	1	-	-	1	1	1	-	1	-	3	-	-	-	1	-
3	-	-	-	-	-	1	-	-	-	-	-	1	-	-	1	-
2	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-

Notes: *One city mentioned spending 11% of local funding on the state-aid system, for simplicity this was captured in one of the three cities with an importance level of 4 and having spent 10% of local funding on the state-aid system.*

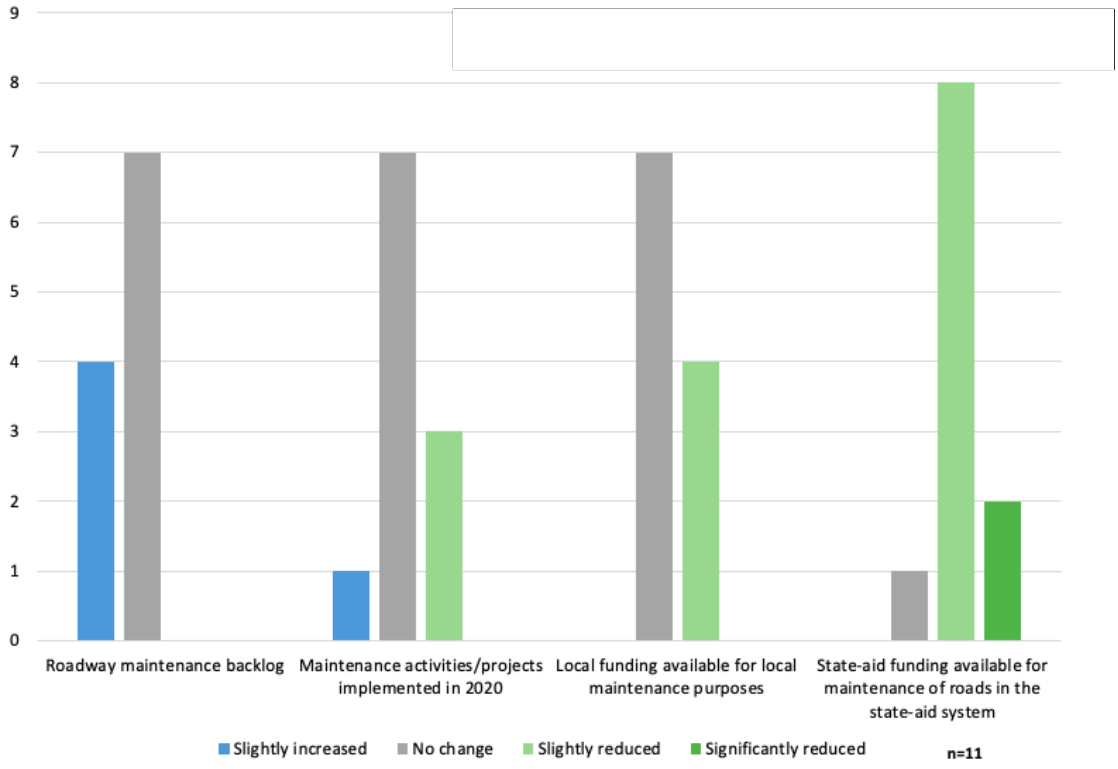
Impacts of the COVID-19 pandemic on roadway maintenance

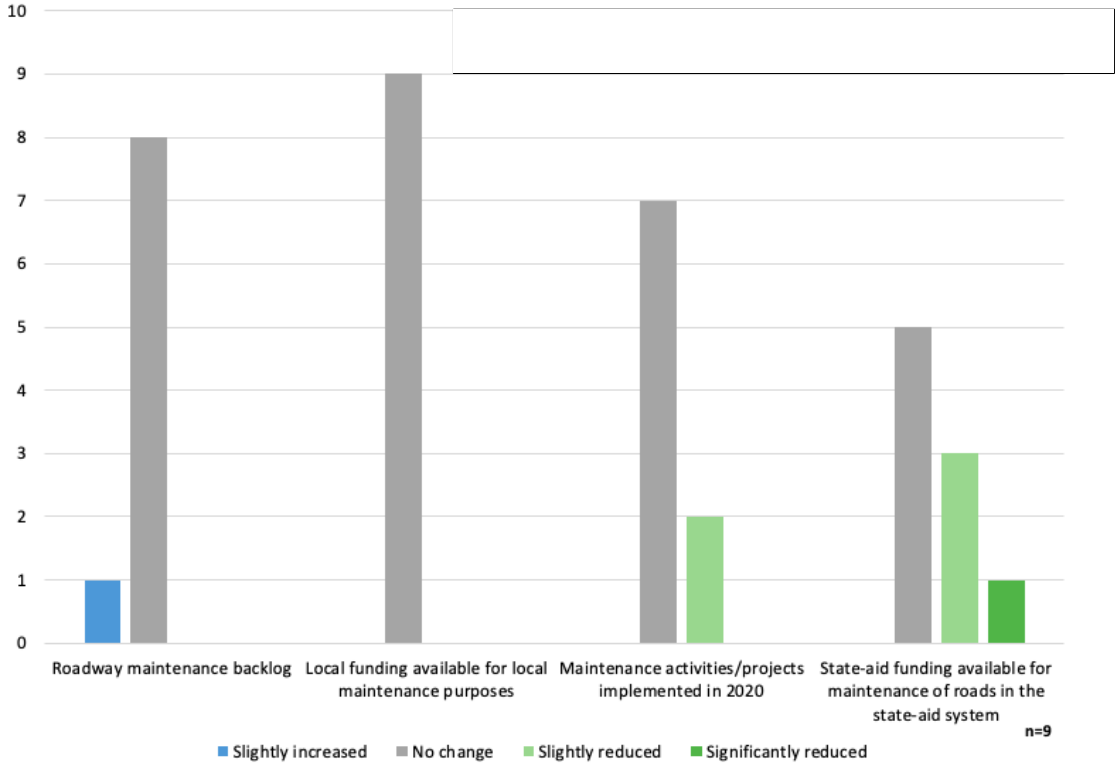
Localities were asked about the impacts of the COVID-19 pandemic on their roadway maintenance funding and activities. Respondents were asked to rank the extent to which the local funding available for local maintenance purposes, state-aid funding available for maintenance of roads in the state-aid system, roadway maintenance backlog, and maintenance activities/projects implemented in 2020 were affected during the pandemic. Figure 6.9 presents locality responses. Panel A presents responses for 11 counties and Panel B presents responses for 9 cities. A total of 20 localities responded to this question.

Most respondent localities did not experience any changes in their maintenance activities or in the local funding available for such purposes during the COVID-19 pandemic. However, during the pandemic, most counties experienced a slight decrease in state-aid funding available for maintenance of roads in the state-aid system (selected by 8 out of 11 respondents). For two other counties, the reduction of state-aid funding was significant.

In terms of maintenance funding, some localities experienced reduced local and state-aid funding. Four counties experienced a slight decrease in both local and state-aid funding and four more only reported a slight decrease in state-aid funding. Cities, on the contrary, did not experience any changes in local funding, but four reported a decrease in state-aid funding (three of them experienced a slight decrease while one experienced a significant decrease).

In terms of maintenance activities, five localities (three counties and two cities) experienced a slight decrease in maintenance activities/projects implemented in 2020. Similarly, roadway maintenance backlog slightly increased in five localities (four counties and one city). Two localities (a county and a city) that reported slightly reduced maintenance activities, also reported a slightly increased maintenance backlog. However, three counties that reported no changes or a slight increase in maintenance activities also reported a slight increase in maintenance backlog.





Notes: *(1) Local resources refers to non-state-aid resources and local roads are non-state-aid roads. (2) Other needs include, for example, snow removal, operations, and addressing residents' complaints. (3) Other selected by one city includes competing general fund priorities.*

Figure 6.9 The COVID-19 Pandemic Impacts on Locality Roadway Maintenance

Most respondent localities did not experience any changes in their maintenance activities or in the local funding available for such purposes during the COVID-19 pandemic. However, during the pandemic, most counties experienced a slight decrease in state-aid funding available for maintenance of roads in the state-aid system (selected by 8 out of 11 respondents). For two other counties, the reduction of state-aid funding was significant.

In terms of maintenance funding, some localities experienced reduced local and state-aid funding. Four counties experienced a slight decrease in both local and state-aid funding and four more only reported a slight decrease in state-aid funding. Cities, on the contrary, did not experience any changes in local funding, but four reported a decrease in state-aid funding (three of them experienced a slight decrease while one experienced a significant decrease).

In terms of maintenance activities, five localities (three counties and two cities) experienced a slight decrease in maintenance activities/projects implemented in 2020. Similarly, roadway maintenance backlog slightly increased in five localities (four counties and one city). Two localities (a county and a city) that reported slightly reduced maintenance activities, also reported a slightly increased maintenance backlog. However, three counties that reported no changes or a slight increase in maintenance activities also reported a slight increase in maintenance backlog.

6.2.4 Deferred Maintenance Across Minnesota Localities

Findings from case studies suggested that there are variations in how localities define deferred maintenance. The definition localities use impacts greatly the dollar amount of maintenance that has been deferred and accumulated over the years (or the total maintenance backlog). In the survey, localities were asked about their definition of deferred maintenance as well as the total amount of money the locality has deferred and accumulated in roadway maintenance. A total of 18 localities, ten counties and eight cities, responded to this question.

Several themes appeared in the respondent localities' definition of deferred maintenance (Table 6.5).

Table 6.5 Deferred Maintenance Across Minnesota Localities

Locality	Definition (1)	Estimated Dollar Amount Deferred
First Theme		
City	Stuff we have not done due to funding shortfalls	$0 for streets. High amount for utilities (that affects streets too)
City	Deferred maintenance or maintenance backlog means delaying timely maintenance activities due to insufficient funding	$0
City	Maintenance that is needed that isn't getting done or has been postponed	N.A.
County	Repairs or maintenance of infrastructure and assets that is delayed and backlogged due to budget limitations or lack of funding (not lack of staff or public support)	$150 million (includes work that is needed for safety and capacity improvements, in addition to maintenance)
County	Projects that should be done but are not due to insufficient funding	$42 million
County	Maintenance you don't have money to fund	Not sure. If you have a method to calculate then you could get a statewide consistent response.
County	Maintenance that we don't have the resources to perform	$0
County	Maintenance that has not been performed that would preserve the current condition or function of roads or bridges	N.A.
Second Theme		
City	The dollars needed to provide maintenance to meet the roadway PCI goals	$6 million
City	Projects necessary to bring infrastructure condition to target levels of 65-75	$23.8 million
County	Defined as the amount of work to bring roads up to pavement preservation performance measure (goal)	Currently nearly meeting goal backlog of about $7 million
Third Theme		
County	Roadway rehab that doesn't get completed when desired due to a constraint	$1.2 million
County	Delay surface rehabilitation projects	$4 million
Fourth Theme		

City	Streets and alleys rated as in poor or failing condition	Around $20 million for streets and double that amount for street and utility replacement
County	We approach it like triage, the worst condition gets repaired first. We have a list of maintenance projects and do what we can with available money, workforce availability and skill level.	$2 million, could be higher. Do not track these wish list costs.

Notes: *(1) Verbatim responses taken from the survey.*

First, a higher number of respondent localities defined deferred maintenance as the maintenance activity that has not been performed (five counties and three cities) and attributed it to insufficient funding (except in two cases). One county, in particular, emphasizes that maintenance is delayed due to budget limitations and not due to lack of staff or public support. These definitions do not specify the activities that are considered maintenance. Within this group, two counties identified a dollar amount that may not only refer to maintenance needs but also to construction needs. Two other localities (a county and a city) mentioned not having any deferred maintenance accumulated and two others did not provide an amount. One county highlights the need for having a standard method to calculate deferred maintenance and thus a consistent measure of the roadway maintenance that has been postponed and accumulated over the years.

Second, some localities defined deferred maintenance as the resources needed to bring or meet identified target pavement condition levels (two cities and one county). Of these, a county and a city identified total accumulated maintenance of $6 to $7 million. One of the cities within this group identified a dollar amount that may not necessarily only refer to maintenance needs.

Third, some localities defined deferred maintenance tied to specific activities. Specifically, two counties defined maintenance investments as rehabilitation projects that were delayed and estimated $1.2 and $4 million in total accumulated dollar amounts.

Fourth, two localities defined deferred maintenance tied to specific asset conditions. One city defines it as the streets and alleys that are in poor condition and reports a need for a $20 million investment in streets and around $40 million for street and utility replacement. One county mentioned approaching deferred maintenance as a triage where the worst condition gets repaired first. The county estimates deferred maintenance of $2 million but noted the amount could be higher as they do not track these costs.

Lastly, two localities, a city and a county, do not have a definition for deferred maintenance and do not know the amount of deferred maintenance they have accumulated.

The variation in how localities understand deferred maintenance highlights the need for a clear definition of deferred maintenance. In addition, it calls for a standardization of the set of activities that

are considered as maintenance, and a method to calculate the maintenance that has been deferred over time. With the current information, it is hard to estimate the dollar amount of maintenance that has been accumulated by localities in Minnesota.

Additional Funding Sources to Address Roadway Needs

Localities were asked whether they had adopted new funding sources, as well as other strategies implemented or considered to address roadway needs and close maintenance gaps. A total of 20 localities, 11 counties and 9 cities, provided insights (Table 6.6).

Table 6.6 New Funding Sources Adopted by Localities

County	Funding Sources and Uses	Increased Funding
Beltrami (2014)	Local Option Sales Tax - primarily used to address backlog of roadway rehabilitation and reconstruction projects	75% increase in funding Could do very little without it
Brown (2014/2016)	Wheelage Tax - Used primarily for surface rehabilitation projects Sales Tax - Surface rehabilitation (spent $7.8 million to date) State-aid bonds - For surface rehabilitation on 28.5 miles of highway with a poor rating	75% increase funding for surface rehabilitation projects Before their adoption, the five-year program showed a $26 million need in surface rehabilitation and shoulder widening projects $5 million in state-aid bonds in 2017
Cottonwood (2014)	Wheelage tax, gravel tax - Used to fund seal coating and gravel operations	
Dakota (2014)	Sales and use tax Wheelage tax	Have allowed state-aid funds to be used for more pavement preservation and maintenance
Lac qui Parle (2015)	Wheelage tax - Used to keep levy increase down in 2015. In subsequent years it has been phased into a gravel road maintenance line item.	It provides about $80,000/year that is used to replace culverts, make subgrade repairs to gravel roads, and apply dust control to limited sections.
Lincoln	Wheelage tax - For overlays, patching, and bridge replacement	inc. $75,000
McLeod (2019)	Local Option Sales Tax	
Murray (2014)	Wheelage tax	Brings $100,000. We have far more needs that this could even begin to help.

Otter Tail (2016/2016/ 2019)	Local Option Sales Tax Wheelage tax Local Bonding - Majority for road work. A small portion for new garage	Local Option Sales Tax gets about $3.8 million/year Wheelage tax gets $1.2 million/year These two sources help reduce the shortfall but are not enough Local Bonding: $12 million for road work & $2 million for a new garage.
Wabasha	N.A.	N.A.
Washington (2013/2021)	Wheelage tax - Used for pavement preservation Local Option Sales Tax	Wheelage tax brings $4.4 million The county will be able to address more issues on non-state-aid routes with the revenues from the local option sales tax

All of the respondent counties have adopted new sources of funding to invest in their roadway systems. The wheelage tax and the local option sales tax are the two funding sources more commonly adopted. Eight counties adopted the wheelage tax, of which two also adopted a local options sales tax. In addition, two other counties also adopted a local options sales tax. In Beltrami and Brown counties, the additional revenues raised through these taxes have increased the funding available for rehabilitation projects, both experiencing a 75 percent increase. In Murray and Otter Tail counties, the additional resources help fund roadway projects but are not enough. Two counties have also used state-aid and local bonds to finance road work.

In addition to adopting new funding sources, several counties have adopted other strategies to close maintenance gaps. These include doing as much work in-house as possible and conducting more preventative maintenance. A county mentioned revoking CSAH and county highway routes and turning them to cities and townships, and another mentioned increasing the road and bridge levy rather than adopting new funding sources. Only one county that already implemented a wheelage tax mentioned having considered increasing the rate.

Of the eight respondent cities, only one has adopted franchise fees to address roadway needs. However, all of them reported other strategies used to close maintenance gaps. These include performing as much road work in-house as possible, increasing the pavement levy, and increasing special assessments. One city mentioned utilizing bio-based road preservation, and another mentioned looking for funding opportunities such as grants and agency partnerships.

A county and a city have considered but not implemented a sales tax (local option sales tax in the case of the county and a sales tax in case of the city). According to the county, there are too few people and industries or retail sales in the county that the tax would only hurt the locals.

Additional comments:

Localities were provided the opportunity for additional comments. One respondent city emphasized the importance of fixing the utilities below the streets not just focusing on the streets, while another respondent city noted that there is a need for other funding sources or flexibility in the use of existing funding sources. However, this respondent did not elaborate. A respondent county noted that they are doing the best they can with their available funding.

CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

Based on the research findings, the research team developed some recommendations to support Minnesota local agencies to communicate effectively with elected officials to maintain an appropriate and consistent level of funding for maintenance. Following are recommendations for Minnesota localities:

1. Adopt a standard definition of deferred maintenance

Localities should consider adopting a standard definition of deferred maintenance and standardizing the set of activities considered maintenance. Currently, there are variations in how localities define deferred maintenance. For instance, while some localities consider deferred maintenance as the resources needed to bring infrastructure condition to target levels, other localities refer to it as a set of activities that are delayed (e.g., surface rehabilitation projects, roadway rehabilitation). In addition, there are variations in the set of activities that localities consider to be maintenance. For instance, some localities consider mill and overlays as maintenance, while others consider them as rehabilitation. Such confusion was also present among staff of the same local agency.

The Federal Accounting Standards Advisory Board (FASAB) provides guidance on deferred maintenance and repairs in the Statement of Federal Financial Accounting Standards (SFFA) 42.[70] This statement defines deferred maintenance as maintenance and repairs directed toward keeping fixed assets in an acceptable condition, but not performed when planned or scheduled and therefore delayed for a future period. In addition, the statement defines maintenance activities as preventive maintenance; replacement of parts, systems, and components; and other activities designed to maintain the asset at an acceptable performance level. This excludes activities directed toward expanding the capacity of an asset or upgrading it to serve needs different from its current use. Localities can use these guidelines to guide the standardization of their maintenance activities and to measure their deferred maintenance.

Having a clear definition of deferred maintenance and the activities considered to be maintenance will help localities and their staff have a common understanding of deferred maintenance, and standard deferred maintenance estimates that are comparable across localities.

2. Identify acceptable pavement and bridge condition targets

Localities should identify local acceptable pavement and bridge condition level targets to guide their roadway maintenance investment strategies. These local targets should be quantifiable and regularly adjusted/updated. In addition, localities should identify the measure selected as the standard (index)

[70] FASAB (2012) Statement of Federal Financial Accounting Standards 42: Deferred Maintenance and Repairs: Amending Statements of Federal Financial Accounting Standards 6, 14, 29 and 32. Retrieved from https://files.fasab.gov/pdffiles/handbook_sffas_42.pdf

and the limitations of using it.[71] The targets should be locally determined from asset management analysis and procedures. Having acceptable pavement and bridge condition level targets could help localities develop maintenance investment strategies, track the progress achieved, re-evaluate the investment strategies if needed, and manage expectations.

3. Estimate funding needed to achieve and maintain pavement and bridge condition targets

Localities should estimate roadway maintenance funding needs through regular assessment of pavement and bridge conditions. This should include regularly assessing current pavement and bridge conditions and comparing with their target condition levels to estimate funding needed to reach that target. These estimates could serve as a basis to estimate the deferred maintenance that has accumulated over time. In addition, localities should estimate funding needs to maintain pavements and bridges in the target level once they reach the targets. These estimates may serve as a basis to compare actual maintenance expenses and thus estimate deferred maintenance. Overall, having this information will help localities depict their funding needs and inform funding allocation decision-making.

4. Monitor achievement of pavement and bridge condition targets

Localities should monitor/assess progress toward achieving their established pavement and bridge condition targets. For this, localities should update asset conditions on a regular basis. Localities should report progress using the same measure/index as those used to set acceptable targets.

5. Report pavement and bridge conditions, trends, and target achievement

Localities should communicate pavement and bridge conditions to their stakeholders and the public through reports or other tools (such as dashboards on their websites). The report or communication tool should contain information regarding current pavement and bridge conditions (by type of facility, locally owned and state-aid roads and bridges; and facility age), trends (e.g., 10-year trends), and their progress toward achieving established pavement and bridge condition targets. In addition, localities could report funding needs including those associated with achieving and maintaining pavement condition and bridge targets as well as the resources reallocated to maintain the state-aid system. The information should be updated on a regular basis (e.g., annually, biannually) and easy to access. Such communication tools could help localities communicate their roadway maintenance funding needs and help inform funding allocation decision-making.

6. **Plan and coordinate maintenance activities with other stakeholders**

Localities should plan and coordinate their maintenance activities with other stakeholders, particularly with those in charge of adjacent infrastructures such as utilities. The coordination should consider

[71] Based on information from case studies, some indexes only consider the condition of the surface but do not take into account the conditions of the overall infrastructure (including the infrastructure below pavements).

project prioritization, budget availability, and schedules. Better planning and coordination among agencies could help save costs and avoid additional work in the future.

7. Maintain a consistent funding stream for roadway maintenance activities

Localities should maintain a consistent funding stream for roadway maintenance activities. Consistency in funding enables better planning and coordination with other agencies/departments. In the case of a locality adopting a new revenue stream for roadway maintenance purposes, the possibility to maintain funding from the general fund (for a period, for instance) should be evaluated to ensure the new funding source provides additional funding for roadway maintenance activities rather than replace funding coming through the general fund.

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APPENDIX A: QUESTIONNAIRE

Consent Form

You are being asked to participate in a research study of deferred maintenance in Minnesota. We ask that you read this form and ask any questions you may have before agreeing to be in the study.

Background Information: This research project is designed to explore the conditions that affect roadway maintenance investments, and to examine the negative impact of deferred maintenance on Minnesota's local road system. As part of this project, we are interviewing staff at local transportation agencies across Minnesota. This study is being conducted by the Institute for Urban and Regional Infrastructure Finance at the Humphrey School of Public Affairs at the University of Minnesota, in partnership with the Local Road Research Board.

Procedures: Your participation in the research study involves participating in a 30- or 60-minute interview about the budgeting planning and decision-making process around maintenance investments. With your permission, we will record the interview in order to transcribe your statements accurately. The study has no risks or benefits for you personally. You will not receive any compensation for participating.

Confidentiality & Voluntary Nature of the Study: The records of this interview will be kept private. In any report we might publish, we will not include any information that will make it possible to identify you. Research records will be stored securely and only researchers will have access to the records.

Participation in the study is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University of Minnesota. If you decide to participate, you are free to not answer any question or withdraw at any time.

Contacts and Questions: If you have questions now or later, you are encouraged to contact Camila Fonseca-Sarmiento at fonse024@umn.edu or Raihana Zeerak at zeera001@umn.edu.

Questionnaire

The ***maintenance expenditures*** reflect the costs associated with the maintenance and repair of local highways, streets, bridges, and street equipment. Common expenditures include patching and seal coating among others. This excludes other roadway maintenance operations such as snow removal.

Capital Budget Planning

a. Could you explain the budgeting process for the roadway system of the county/city?
   i. Does the transportation agency have a capital budgeting separate from operating budgeting?
      1. Is roadway maintenance included in the capital budget?
   ii. How does the transportation agency assess capital project needs?
      1. How are transportation needs prioritized?
      2. Does the transportation agency have an improvement plan?
b. Does the transportation agency use asset management practices for transportation?
   i. Does the transportation agency have an asset management plan for transportation?
   ii. What are some of the challenges, if any, the transportation agency faces in the asset management process?
c. Does the transportation agency use asset inventory for transportation asset management (or asset replacement)?
   i. [If uses an asset replacement inventory]- Is this inventory used for asset maintenance purposes as well?
   ii. What transportation assets are included in the inventory?
   iii. How does the transportation agency assess the conditions of the transportation assets?
      1. Does the agency use a software (or another tool) to maintain asset condition data?
      2. How is asset condition defined?
      3. How frequent is this assessment updated?
   iv. What is the overall condition of the roadway system in the county/city?
      1. Roads (PCI, RQI, OCI, PQI)
      2. Bridges (sufficiency rating, age)
d. **Maintenance** of the roadway system
   i. How much money does the county/city need to invest to keep its roadway system in:
      1. Acceptable level based on the county/city's expectations (typically 70)
      2. At the defined "good" value for PCI/OCI (typically 85+)
   ii. Annually, on average, what percentage of roadway maintenance is funded?
      1. On average, how many years do you estimate it takes to address the maintenance that is deferred in one year?
e. **Deferred maintenance** of the roadway system
   i. How does the agency fund the maintenance that has been deferred and accumulated?
   ii. Currently, how much money does the county/city need to invest to address its deferred maintenance? (Accumulated dollar amount of maintenance that has been deferred?)
   iii. In what ways does the deferred maintenance affect your local roadway system?

Decision-Making Process

a. How are maintenance projects prioritized?
b. Can you explain the maintenance decision-making process?
    i. Can you explain how maintenance decisions are made between
        1. the different types of maintenance: preservation vs corrective
        2. Maintenance vs construction

Activity	**Activity Definition/Examples**
Construction	Adding new capacity or tearing a roadway asset and reconstructing it again
Maintenance	
Preventive	Fog sealing, crack sealing, chip sealing, rut filling, slurry sealing, cape sealing, thin overlay, microsurfacing
Corrective	Structural overlay, mill & overlay, pothole repair, patching, full-depth reclamation, cold-inplace-recycling, full-depth patching

    ii. What methods, if any, are used to make maintenance decisions? (e.g. cost benefit analysis (CBA), life cycle cost analysis, pavement treatment decision tree, etc.)
        1. What type of software / tool is used to make maintenance investment decisions?
    iii. To what extent does the decision-making process rely on the following factors:
    (1. Asset condition; 2. Material costs; 3. Labor costs)
    iv. To what extent additional inputs are taken into account? (including inputs from relevant stakeholders, different software etc.)
    v. What agencies/individuals are involved in the decision-making process?
    vi. What challenges has the city/county faced when making maintenance decisions (and deferred maintenance decisions)?
c. How does the political environment affect maintenance decision-making?
    i. Are there any preferences in undertaking construction vs maintenance projects (or between different maintenance projects) based on constituents' support?
d. How does staff capacity affect maintenance decision-making?
e. How has COVID-19 affected (or will affect) maintenance decision-making in future years?
f. How does the adoption of EVs affect (or will affect) maintenance decision-making in future years?

Funding-related

All

a. What are the funding sources for maintenance projects?
    - General revenues vs special revenues
    - Borrowing -- what revenues are used to pay back?

County

b. How has the adoption of a wheelage tax affected, if at all, maintenance investments?
    - For those without: Why hasn't the county adopted a wheelage tax?
c. How has the adoption of a local option sales tax affected, if at all, maintenance investments?
    - For those without: Why hasn't the county adopted a local option sales tax?

City

d. Has the city adopted any additional funding source to fund maintenance of the roadway system?

All

e. How does intergovernmental revenues affect maintenance investments?
    - And deferred maintenance
f. How has participation in cooperative agreements with MnDOT or with counties affected investment in maintenance projects?
    - And deferred maintenance
g. How has debt issued for transportation purposes affected investment in maintenance projects? (construction vs maintenance)

APPENDIX B: SURVEY QUESTIONNAIRE

Deferred Maintenance in Minnesota

The purpose of this survey is to better understand the challenges local government agencies face when making decisions regarding roadway maintenance investments, the strategies they are taking to balance funding for roadway maintenance, and other options they are considering to close the roadway maintenance gap.

This survey is part of research conducted by the Institute for Urban and Regional Infrastructure Finance (IURIF) at the Humphrey School of Public Affairs. This research is funded by the Local Road Research Board (LRRB).

This survey will take about 20-30 minutes to complete. You can save your responses and complete the survey later using the same link. We greatly appreciate you taking the time to respond to this survey.

If you agree to take this survey, please click next.

General Questions

1. City/County representing: _____

Please provide the following information regarding the systems your locality is responsible for:

2. Number of centerline miles in the state-aid system: _____
3. Number of centerline miles in the local system: _____
4. Number (or percentage) of centerline miles in the local system that are paved: _____
5. Number of bridges (structures above 10ft): _____

Condition of the Roadway System

The ***maintenance expenditures*** reflect the costs associated with the maintenance and repair of local highways, streets, bridges, and street equipment. Common expenditures include patching, seal coating, micro-surfacing, and mill and overlay among others. This excludes other roadway maintenance operations such as snow removal.

Rehabilitation and reconstruction activities include major roadway improvements such as removal of existing streets and construction of new streets, which may include sanitary sewer or water main and stormwater improvements, repair of problem areas to full depth, milling of edge or full width or existing pavements, and repair to existing catch basins and/or curb and gutter.

For the following questions please specify whether your responses are about local roads (county/city roads), state-aid roads (CSAH/MSAS roads), or both.

6. Which of the following ratings are used to assess the condition of the pavements in the locality? (Select all that apply)
    a) Pavement Condition Index - PCI
    b) Overall Condition Index - OCI
    c) Pavement Serviceability Rating - PSR
    d) Pavement Quality Index - PQI

e) Other (please specify the name and the scale): _____

7. What is the overall **acceptable level** for the condition of the pavements in the locality? (please specify rating, acceptable level, and the roadway system, e.g. PCI = 70, local and state-aid roads)

8. What is the overall condition rating of the pavements **currently**? (please specify rating, overall condition, and the roadway system, e.g. PCI = 50)

9. Which of the following ratings are used to assess the condition of the bridges in the locality? (select all that apply)
   a) Sufficiency rating
   b) National Bridge Inventory (NBI) rating
   c) Average bridge age
   d) Other (please specify the name and the scale):_____
10. What is the overall **acceptable level** for the condition of the bridges in the locality? (please specify rating and acceptable level, e.g. NBI = 8)

11. What is the overall condition rating of the bridges **currently**? (please specify rating and overall condition, e.g. NBI = 7)

Funding and Maintenance Gaps

12. If pavements are below the identified acceptable level, approximately how much funding is needed **to reach the identified acceptable level?** (N/A if pavement are in good condition)

13. Approximately, how much funding does the locality need to **maintain the pavements at that acceptable level**?

The ***maintenance expenditures*** reflect the costs associated with the maintenance and repair of local highways, streets, bridges, and street equipment. Common expenditures include patching, seal coating, micro-surfacing, and mill and overlay, among others. This excludes other roadway maintenance operations such as snow removal.

Rehabilitation and reconstruction activities include major roadway improvements such as removal of existing streets and construction of new streets, which may include sanitary sewer or water main and stormwater improvements, repair of problem areas to full depth, milling of edge or full width or existing pavements, and repair to existing catch basins and/or curb and gutter.

14. Approximately, what percentage of pavement reconstruction, rehabilitation, and maintenance needs are **currently** funded in the locality?

Roadway Maintenance *Decision-Making Processes*

15. Rank the following factors considered when selecting the maintenance projects? (10 being the most important, and 1 the least important)
    - Infrastructure condition rating
    - Infrastructure age
    - Infrastructure maintenance history
    - Safety needs
    - Geographic equity
    - Utility needs
    - Resident complaints
    - Leadership priorities
    - Other (please specify):_____
16. Rank the following challenges the locality has experienced when making roadway maintenance investments
    - Coordination with the local Utility department
    - Coordination with other local transportation agencies (at the city or county level)
    - Staff capacity
    - Size of the roadway network
    - Existing old pavements
    - Funding challenges (logic question - Go to Q17)
    - Other (please specify):_____
17. (logic question - From Q16) Rank the following factors that affect funding availability for maintenance projects (*5 - The most important factor - 1 The least important factor; NA if it does not apply*)
    - Limited local (non-state-aid) resources allocated to maintain local (non-state-aid) roads
    - Reallocating resources to maintain the state-aid system due to limited state-aid resources available to invest in the state-aid system (logic question - Go to Q18)
    - Reallocating resources for other needs (e.g. snow removal operations, addressing resident complaints)
    - Neighborhood opposition to assessments
    - Other (please specify):_____
18. (logic question - From Q17) On average, what percentage of local (non-state-aid) funding is used to maintain roads in the state-aid system annually?

19. In what ways did the COVID-19 pandemic affect your roadway maintenance funding and activities?

	Significantly increased	Slightly increased	No change	Slightly reduced	Significantly reduced
Local funding available for local maintenance purposes					
State-aid funding available for maintenance of roads in the state-aid system					
Roadway maintenance backlog					
Maintenance activities/projects implemented in 2020					

Roadway Maintenance Gaps

20. How does the locality define “deferred maintenance” or “maintenance backlog”?

21. Approximately, what is the total amount of money the locality has deferred and accumulated in roadway maintenance?

Strategies to close Roadway Maintenance Gaps

22. Has the locality adopted a new source of funding for roadway needs (e.g. wheelage tax, local option sales tax, etc.)? (logic question - If yes go to Q23 / If no go to Q25)
23. (yes) Please specify the funding source, year of adoption, usage of the proceeds in terms of roadway rehabilitation, reconstruction, and maintenance activities.
24. (yes) In what ways has the newly adopted funding affected the amount of funding available for roadway maintenance?
25. (No) What other strategies has the locality implemented or considered to close roadway maintenance gaps?
26. Do you have any other comments about roadway maintenance to share with us?

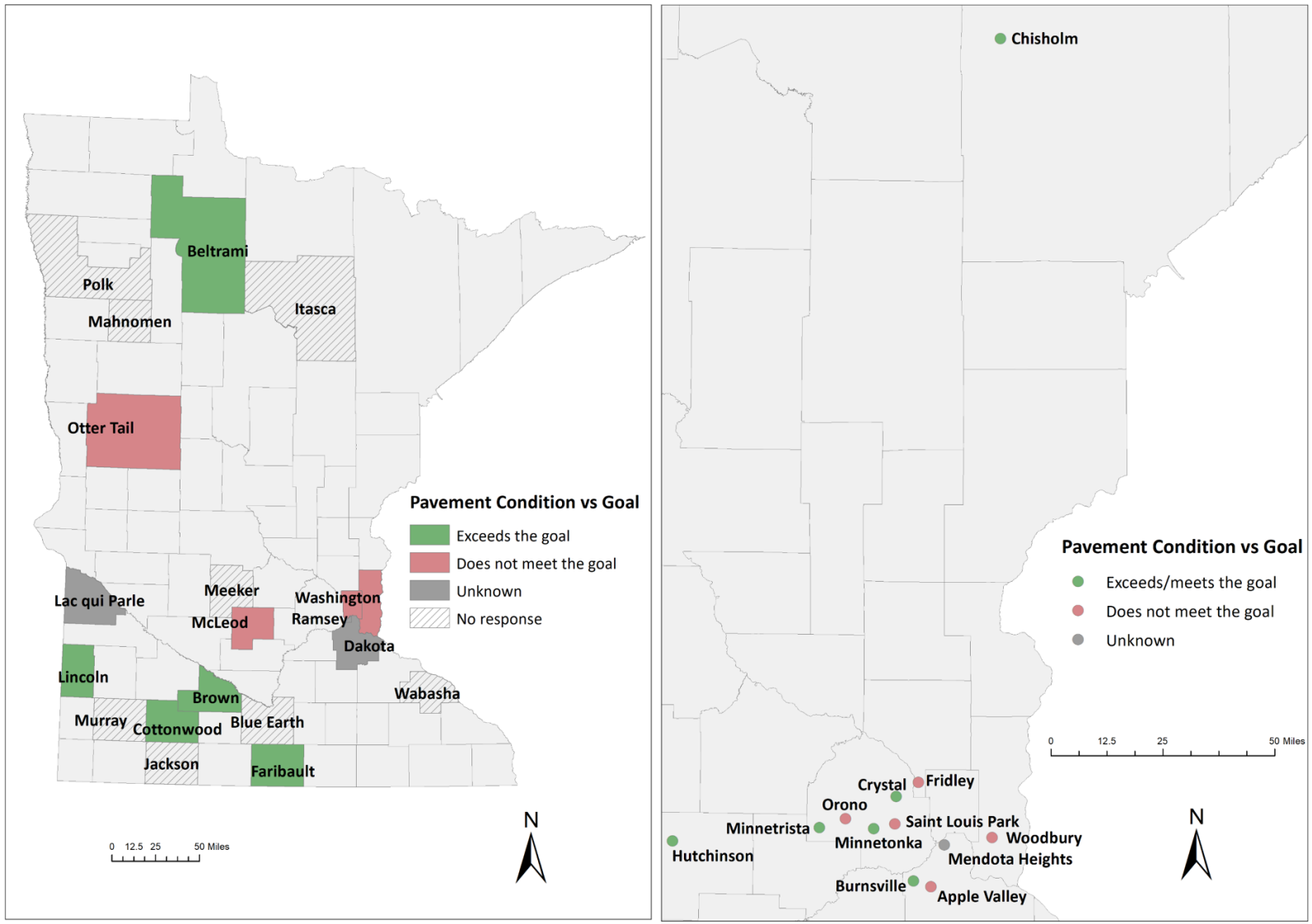
APPENDIX C: ACCEPTABLE CONDITION LEVELS AND CURRENT CONDITIONS OF ROADWAYS AND BRIDGES BY LOCALITIES

Table C.1 Acceptable Condition Levels and Current Conditions of Roadways and Bridges by Localities

City	Pavement Target Condition	Current Pavement Condition	Bridge Target Condition	Current Bridge Condition
Burnsville	PCI = 70	PCI = 70	NBI = 8	NBI = 8.5
City of Apple Valley	OCI = 73 (for paved streets)	OCI = 71 (2020)	-	-
City of Chisholm	Trying to achieve an average rating on all streets w/ priority given to state aid streets as well as other local collector-arterial streets	Probably about half of the way to getting all streets up to an average condition, but have nearly all of our state aid and local collector and arterial streets in an average or better condition.	N. A.	N. A.
City of Fridley	PASER >= 7.0 (for state-aid and local roads)	PASER = 6.84	NBI = 6 (trail bridges only)	NBI = 7 (trail bridges only)
City of Hutchinson	PCI = 65-75 (system target)	PCI = 76 (overall system) Excellent (PCI 86-100) 33.5 mi. 45% Good (PCI 71-85) 17.8 mi. 24% Adequate (PCI 51-70) 12.2 mi. 16% Marginal (PCI 36-50) 4.4 mi. 6% Poor (PCI 0-35) 6.7 mi. 9%	Acceptable level for bridge conditions = 65% - 75% 2nd Ave sufficiency rating = 86.2% 5th Ave sufficiency rating = 99.6% School Rd sufficiency rating = 88.6% South Grade Rd sufficiency rating = 96.8%	Overall sufficiency rating = 92.3% 2nd Ave sufficiency rating = 86.2% 5th Ave sufficiency rating = 99.6% School Rd sufficiency rating = 88.6% South Grade Rd sufficiency rating = 96.8%
City of Minnetonka	PCI = 80 (local and state-aid roads)	PCI = 80.3 (local and state-aid roads)	NBI >= 5	NBI = 6
City of Woodbury	PCI > 75 (Collector & Arterial Roadways) PCI > 70 (Local Roadways)	PCI = 61.4 (Collector & Arterial Roadways) PCI = 70.9 (Local Roadways)	No goal set	NBI = 5
Crystal	PASER = 6 (also depends on road's functionality)	N.A.	-	-
Minnetrista	PCI = 70	PCI = 78	-	-
Orono	PCI = 60	PCI = 59	NBI=8	NBI=8
St. Louis Park	OCI = 70	OCI = 62.4	-	-

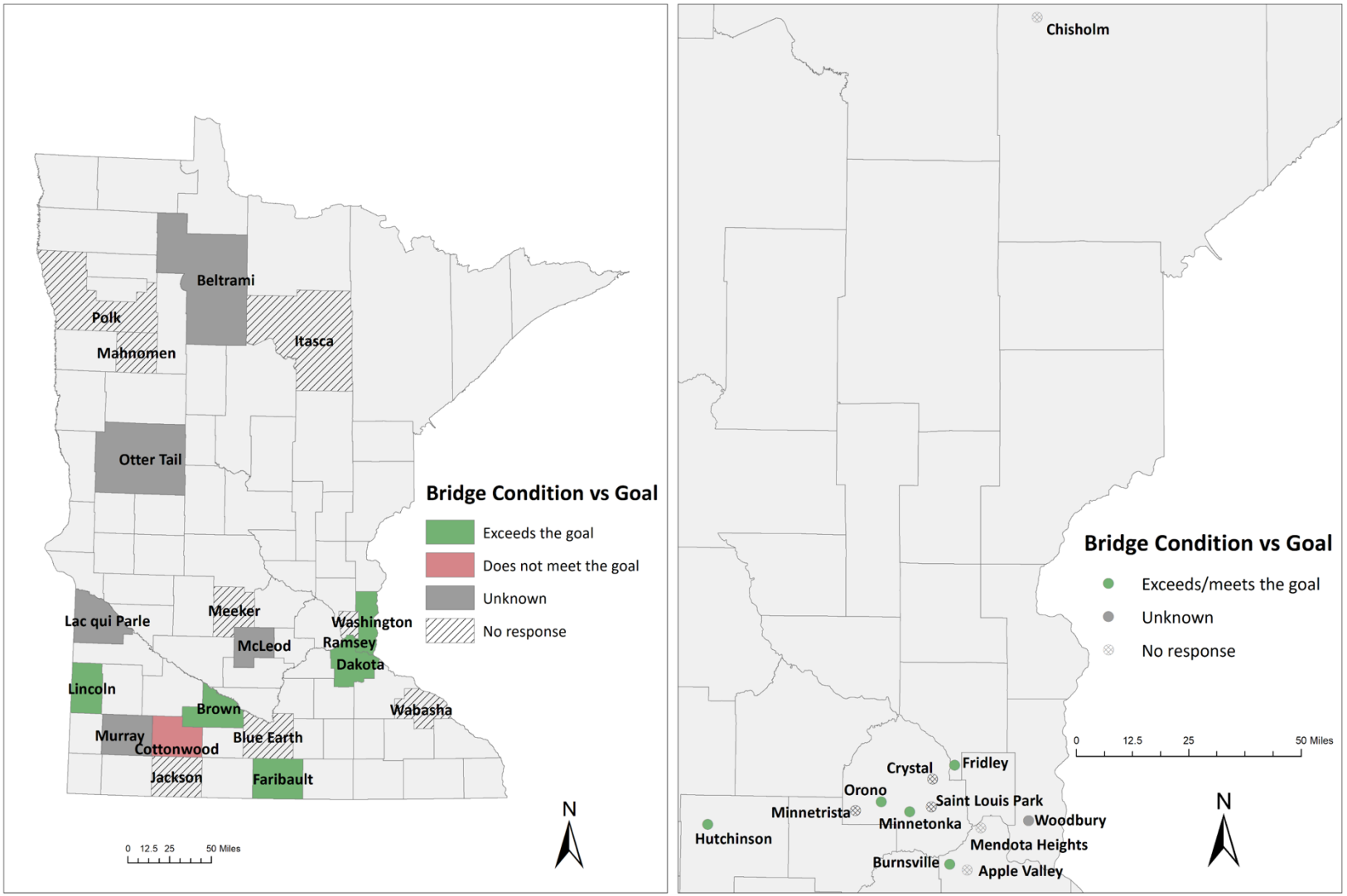
County	Pavement Target Condition	Current Pavement Condition	Bridge Target Condition	Current Bridge Condition
Beltrami County	No goal set (assume PQI = 3.0)	PQI = 3.1	No goal set	LPI = 93
Blue Earth County	Do not track	Do not track	-	-
Brown County	PQI = 3.0	PQI = 3.4	SR > 50	SR = 92
Cottonwood County	PQI > 3.0	PQI = 3.1	No bridges LPI< 70 No bridges Load Posted	15 Bridges < LPI 70 26 Bridges are Load Posted
Dakota County	Keep a Pavement Quality Index (PQI) of Fair or better on 95 percent of the highway system and Good or better on 75 percent of the highway system.	PCI = 72	No bridges LPI <= 60	SR = 96 (2019)
Faribault County	PQI = 70	PQI = 73	LPI = 61	LPI = 80.3
Lac qui Parle County	Rehab after 18 years of service	Do not know	LPI = 60	Unknown
Lincoln County	PQI = 2.5 CSAH	PQI = 3.2 CSAH	LPI = 60	LPI = 86 Range LPI = 44 to 100
McLeod County	PQI = 2.5	PQI = 1.9 or better	LPI >70	Not sure
Murray County			SR > 80 LPI > 60	Most bridges LPI > 60
Otter Tail County	 Platinum Tier PQI = 80 Gold Tier PQI = 75 Silver Tier PQI = 70 Bronze Tier PQI = 60	Overall PQI = 68 Platinum Tier PQI = 77 Gold Tier PQI = 74 Silver Tier PQI = 69 Bronze Tier PQI = 63	N.A.	SR = 90
Ramsey County	PQI = 68	PQI = 62.1	-	-
Washington County	PCI >= 72 (for system) No roadway below 40.	PCI = 68	LPI > 60	All bridges LPI >=70

APPENDIX D: CURRENT PAVEMENT AND BRIDGE CONDITIONS VS TARGETS, FUNDED MAINTENANCE, AND LOCAL FUNDS SPENT ON STATE-AID SYSTEM BY LOCALITY



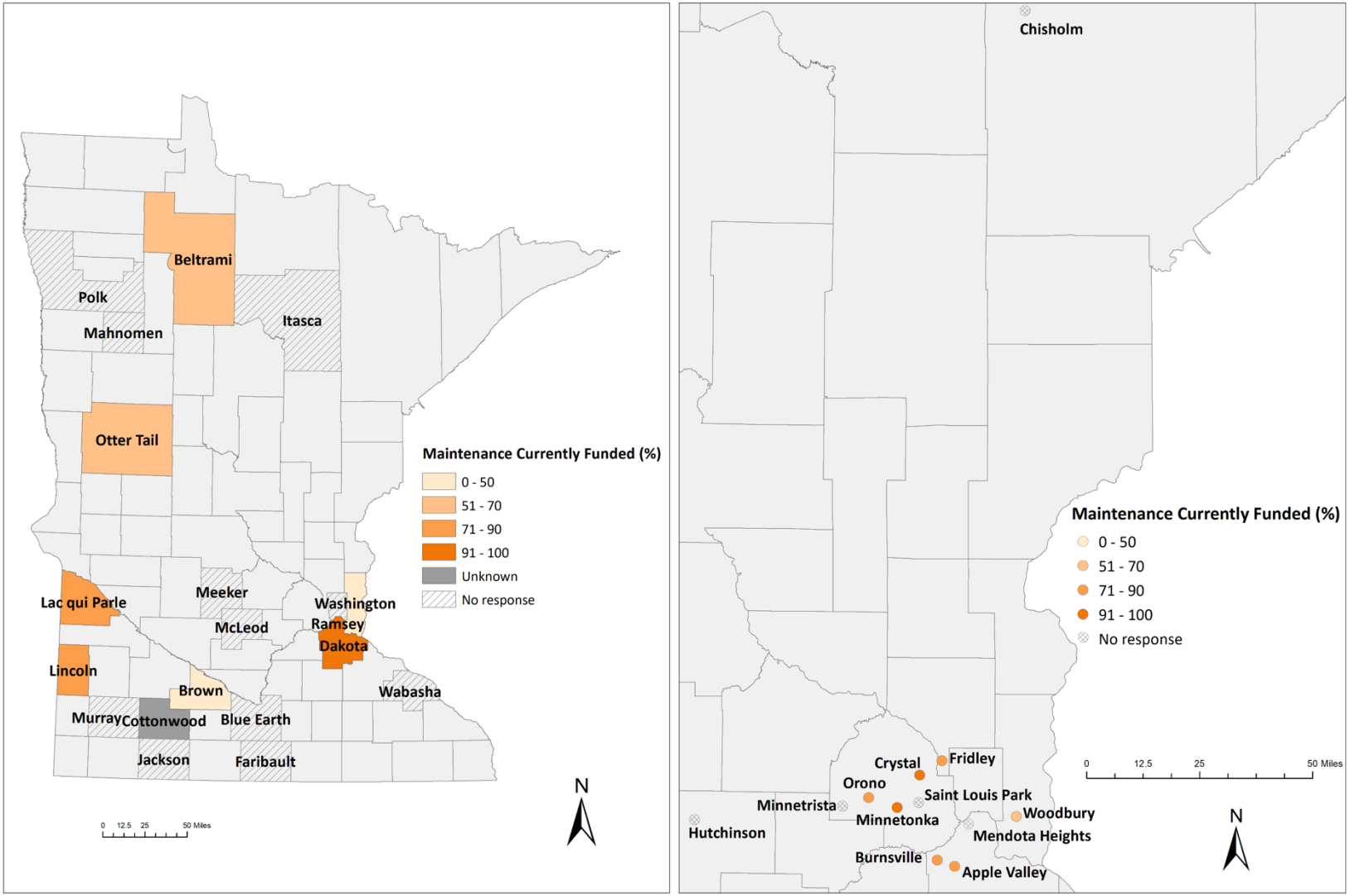
Panel A: County Current Pavement Conditions vs Acceptable Condition *Panel B: City Current Pavement Conditions vs Acceptable Condition*

Figure D.1 Current Pavement Conditions vs Acceptable Condition Level by Locality



Panel A: County Current Bridge Conditions vs Acceptable Condition *Panel B: City Current Bridge Conditions vs Acceptable Condition*

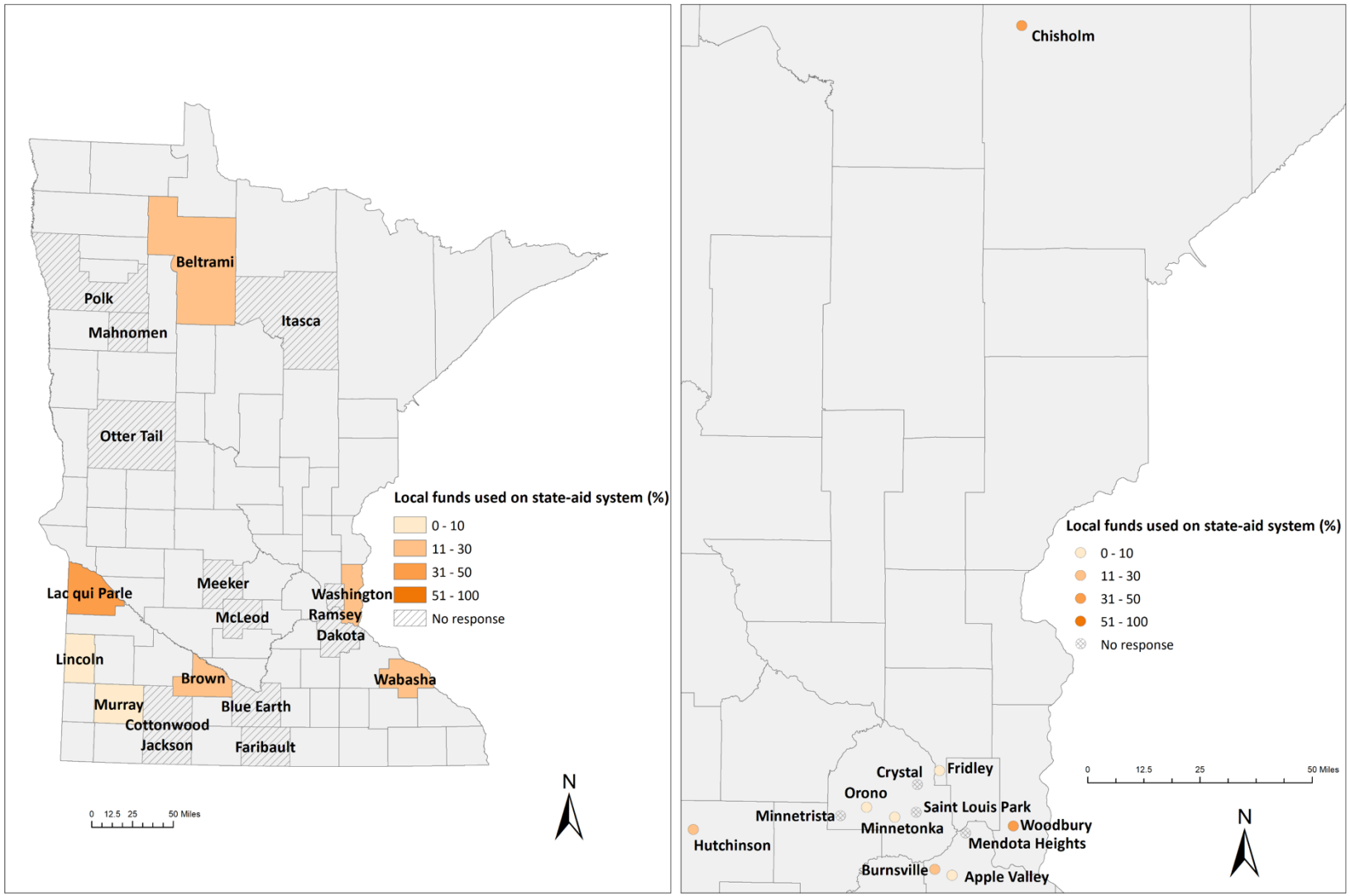
Figure D.2 Current Bridge Conditions vs Acceptable Condition Level by Locality



Panel A: County Percentage of Maintenance Currently Funded

Panel B: City Percentage of Maintenance Currently Funded

Figure D.3 Percentage of Maintenance Currently Funded across Minnesota by Locality



Panel A: County Percentage of Local Funds Used on the State-Aid System Panel B: City Percentage of Local Funds Used on the State-Aid System

Figure D.4 Percentage of Local Funds Used on the State-Aid System by Locality