June 2002

STAFF PAPER

Minnesota's road network: characteristics of ownership and use.

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Revised June 18, 2002

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ABSTRACT: Minnesota has 132,000 miles of state and local roads, which carry 52 billion miles of vehicle traffic each year. State government is responsible for 9-percent of the road length, and 60-percent of all vehicle traffic. Counties, cities, and towns manage the rest. Analyzed at the county-area level, traffic on these local government networks differs significantly according to government ownership, road functional class, and geographic location. Counties in the state's western and northern regions have the lowest volume roads, while roads in the Twin Cities region have the highest volume.

This report is the first in a series from the Transportation Finance Reform project, which is funded through a grant from the Local Road Research Board, Minnesota Department of Transportation.

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Introduction

Minnesota has 132,000 miles of road, which accommodated 52 billion vehicle miles of travel in 2000. This road network is the collective responsibility of state, county, city, and town/township governments. The roads themselves can be drawn into four functional classes - principal arterials, minor arterials, collectors, and local roads. This report provides an overview of the state and local road network, and distinguishes each class of road by traffic volume at the county-area level.

The analysis is based on 2000 data provided by the Minnesota Department of Transportation, Office of Transportation Data and Analysis.[1] Three elements of the road infrastructure are examined. First, road miles measure the driving distance between two points, without regard to lanes, surface, or shoulder width. Second, vehicle miles of travel are estimates of road use, based on traffic surveys over the prior year, by all vehicles, not just cars. The third element - annual average daily traffic - is the quotient of road miles and vehicle travel expressed on a daily basis.

Road miles

The combined network of all state and local roads is 132,318 miles in length, excluding some minor systems such as forest service and reservation roads. Table 1 shows the system by functional class and government ownership. *Principal arterial highways* are the heart of the state's road network. These roads are designed for traveling long distances at high speeds. They include the interstate highway system and other major statewide highways. State government is responsible for nearly the entire principal arterial network. *Minor arterial highways* are also intended for speed and distance, as well as limited property access. The state operates two-thirds of the minor arterials, and counties operate most of the rest. *Collector routes* link the arterial highway system with local roads. County governments operate 90-percent of the (29,073) collector road miles in Minnesota. *Local roads* provide the highest degree of property access and are designed primarily for neighborhood travel. Two-thirds of all roads are classified as local roads, and the majority of these are in townships.[2]

[1] The author wishes to thank MnDOT's Jonette Kreideweis, Chuck Delisi, George Cepress, and Curt Dahlin for their help and useful comments.

[2] Town and township are used interchangeably and includes organized and unorganized places.

Table 1 – Minnesota road miles by owner and functional class (miles)

	Principal arterials	Minor arterials	Collector routes	Local roads	Total network
Total network	5,287	8,626	29,073	89,332	132,318
State	5,151	5,568	1,205	13	11,937
County	80	2,432	26,002	16,879	45,393
City	36	617	1,272	16,589	18,534
Town	-	9	594	55,851	56,454

Source: Minnesota Department of Transportation, Office of Transportation Data and Analysis, 2000

Vehicle miles traveled

Minnesota's state and local road networks produced 52.1 billion vehicle miles of travel (VMT) in 2000. Half of this travel was on principal arterial highways (table 2). Minor arterial highways carried another quarter of the total traffic (12.5 billion vehicle miles of travel). Collector routes supported nearly 7.5 billion vehicle miles, slightly more than the 6.3 billion vehicle miles of travel found on local roads. Travel on principal arterials is done almost exclusively on state roads. State roads carry 60-percent of total vehicle travel, some 31.3 billion VMT. County government roads carry another 24-percent of all statewide travel.

Table 2 - Vehicle miles traveled by owner and functional class (million miles)

	Principal arterials	Minor arterials	Collector routes	Local roads	Total network
Total network	25,861	12,480	7,464	6,277	52,083
State	25,214	5,610	441	5	31,270
County	482	5,436	5,403	1,108	12,429
City	167	1,431	1,587	4,155	7,340
Town	-	3	32	1,008	1,043

Source: Minnesota Department of Transportation, Office of Transportation Data and Analysis, 2000

The scope and diversity of the state and local road network is evident when comparing road miles (table 1) and vehicle travel (table 2). For example, principal arterials account for just 4-percent of total road miles, but 49-percent of total vehicle travel. Roads classified as local, on the other hand, explain 67-percent of the total road miles, but just 12-percent of the total traffic. Smaller differences are found within road classes as well. County operated minor arterials carry the same traffic volume as state run minor arterials, but on less than half the road miles. From the government perspective, state roads are 9-percent of the road miles, but 60-percent of the vehicle travel. By contrast, town roads are 43-percent of the road miles, but carry just 2-percent of vehicle traffic. Cities have 14-percent of the road miles and 14-percent of vehicle miles traveled.

Annual average daily traffic (ADT)

The annual average daily traffic represents the number of vehicles crossing the average network mile on a typical day. This transformation is useful for comparing county-area networks that differ in length or traffic volume. On a statewide basis principal arterials have the heaviest traffic volume at 13,401 vehicles per day (table 3). The lightest ADT – 49 vehicles daily - is on town local road networks. The overall picture is about what you would expect. More vehicles cross the average state highway mile than the average town road mile. Arterials carry more traffic than collectors, which carry more traffic than local roads. Similarly, state and city road networks accommodate more travel than county or town networks.

Table 3 - Annual average daily traffic (ADT)

	Principal arterials	Minor arterials	Collector routes	Local roads	Total network
Total network	13,401	3,964	703	193	1,100
State	13,411	2,761	1,003	1,054*	7,177
County	16,204*	6,124	569	180	750
City	10,333*	6,355	3,419	686	1,085
Towns	-	861*	148	49	50

Source: Minnesota Department of Transportation, Office of Transportation Data and Analysis, 2000
* based on less than 100 miles of road, and therefore highly variable.

Minor arterial networks operated by counties and cities carry about the same 6,000 vehicles a day, more than double the level on state-operated minor arterials. The significant contribution of the state minor arterial network however is evident in the total minor arterial network averaging closer to 4,000 vehicles per day. County government's dominant role in operating collector systems is clear in the overall class average of 703 vehicles. The annual average daily traffic is about 200 vehicles per day on the entire local road network, although it is more than three times higher on city local roads.

EXHIBIT: *Aid for local roads*

Of particular interest to any road discussion is the subset of roads eligible for state aid programs. The Minnesota constitution mandates that counties and cities receive a share of the Highway Users Tax Distribution Fund.[3] Aid transfers are made, specifically for road spending, to all 87 counties and to cities with populations over 5,000 persons. Roads included in the programs are designated respectively as County State Aid Highways (CSAH) or Municipal State Aid Streets (MSAS).

[3] Minnesota constitution article 14.

Two-thirds of county government road miles are in the CSAH program (table 4). This includes virtually all the arterial and collector roads, and close to a quarter of all local roads. These aid roads also carry 92-percent of county network traffic.

Table 4 – County roads eligible for CSAH road aid

All Counties	Principal arterials	Minor arterials	Collector routes	Local roads	Total
Miles of road	80	2,432	26,001	16,879	45,393
% CSAH roads	*100%*	*96%*	*93%*	*23%*	*67%*
Network VMT*	481	5,436	5,403	1,108	12,429
% CSAH roads	*100%*	*98%*	*94%*	*44%*	*92%*

Source: Minnesota Department of Transportation, Office of Transportation Data and Analysis, 2000
**Vehicle miles traveled in 2000 statewide (million miles)*

The comparison for city aid roads is less direct. All Minnesota cities are included in the road network analysis, but only cities with populations over 5,000 persons are eligible for aid.[4] Nevertheless, with only 15-percent of city road miles in the aid program, MSAS roads carry 55-percent of all city road travel (table 5). Across the four road classes vehicle travel on aid roads is higher than on non-aid segments. For instance, with only 82-percent of the city minor arterial network designated aid roads, these roads carry 97-percent of city minor arterial traffic.

Table 5 – City roads eligible for MSAS road aid

All Cities	Principal arterials	Minor arterials	Collector routes	Local roads	Total
Miles of road	55	617	1,272	16,589	18,534
% MSAS roads	*40%*	*82%*	*75%*	*8%*	*15%*
Network VMT*	166	1,431	1,587	4,155	7,340
% MSAS roads	*81%*	*97%*	*94%*	*24%*	*55%*

Source: Minnesota Department of Transportation, Office of Transportation Data and Analysis, 2000
**Vehicle miles traveled in 2000 statewide (million miles)*

Roads eligible for CSAH and MSAS aid are the most heavily traveled in their functional class. In addition, far fewer local roads are eligible compared to collectors and arterials, and those that are carry a disproportionate share of the (local road) vehicle traffic.

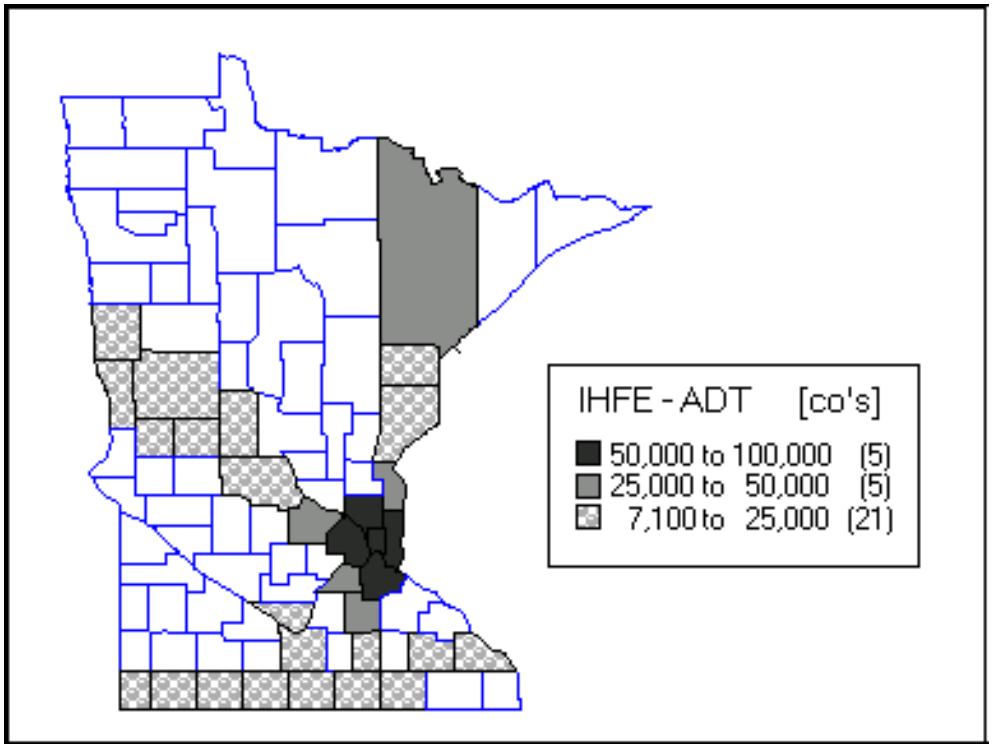
[4] If the subset of aid cities were examined alone the total aid share would not doubt be closer to 20-percent, the maximum percent of city miles allowed in the MSAS program.

Road use by functional class

Statewide averages provide a convenient overview, but a county-level assessment adds important detail about the geographic distribution of network traffic. Road use is characterized in this analysis by the annual average daily traffic (ADT), and is studied from two perspectives. First, each functional road class is described at the county-area level, without regard for government ownership. Then, the road networks of local governments are examined at the county-area level, without regard to functional class.

The state's 87 counties are sorted into three groups according to the annual average daily traffic on the network in question. About half the counties (45) are assumed to have "average" traffic volumes. Networks in the remaining two groups – 21 counties each – are therefore either high volume (above average) or low volume (below average). This classification is applied to each functional road class, with the exception of the interstate highway portion of the principal arterial network, where just 31 counties are affected (map 1).

Map 1 - Interstates, freeways and expressways (annual average daily traffic)



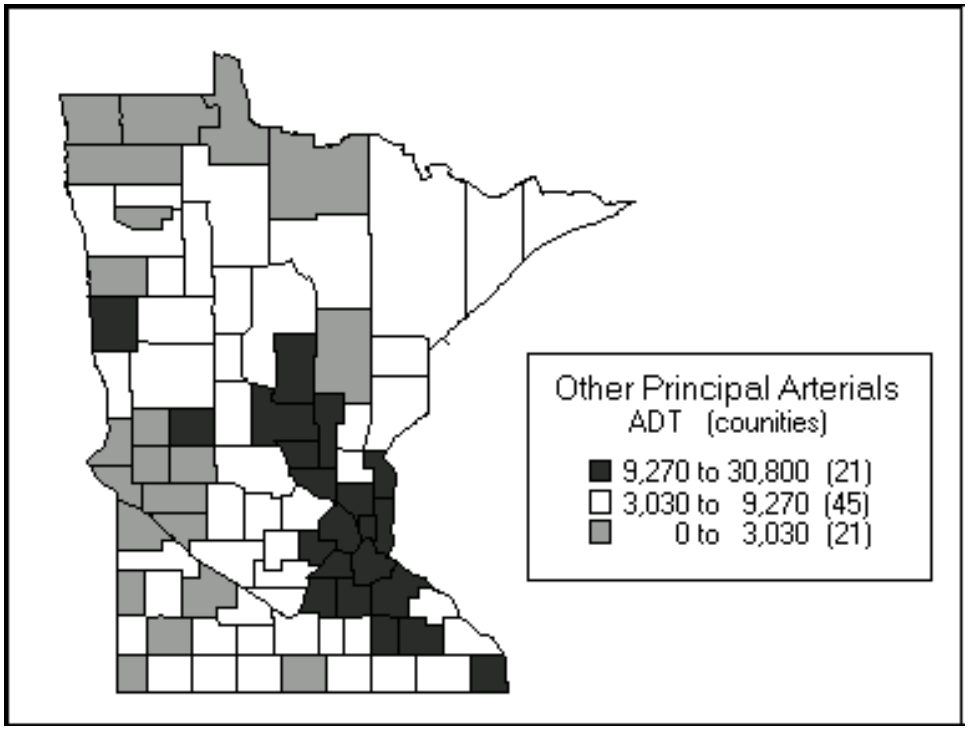
Source: MnDOT, *Office of Transportation Data and Analysis, 2000* (see appendix table A1)

Principal arterials

The most notable principal arterial highways are Interstate Highways I35, I90, and I94.[5] Minnesota has 914 miles of federal interstate highway, accommodating 12.0 billion vehicle miles of travel in 2000. Similar in nature, are other freeways and expressways, which add another 143 miles of road and 3.0 billion vehicle miles of travel. The combination of *interstate highway plus other freeways and expressways* (IHFE) is a road system of 1,057 miles. On less than 1-percent of the Minnesota's total road miles, the IHFE network carries 29-percent of the total statewide vehicle traffic.

The annual average daily traffic on the IHFE system is highest in the Twin Cities metropolitan area, where five counties exceed 50,000 vehicles per day. Hennepin County has the longest network (155 miles), and average daily traffic (95,715 vehicles per day) second only to Ramsey County. Five more metro area counties have IHFE networks that carry between 25,000 and 50,000 vehicles per day. In the remaining 21 counties the IHFE network traffic is generally more modest. For example, the average daily traffic on a typical mile of Interstate 90 in southwest Minnesota between Rock and Faribault Counties ranges from 7,000 to 9,000 vehicles.

Map 2 - Other principal arterial highways (annual average daily traffic)



Source: MnDOT, *Office of Transportation Data and Analysis, 2000* (see appendix table A2)

[5] In the Twin Cities metropolitan region others would include 35E, 35W, 394, 494, and 694.

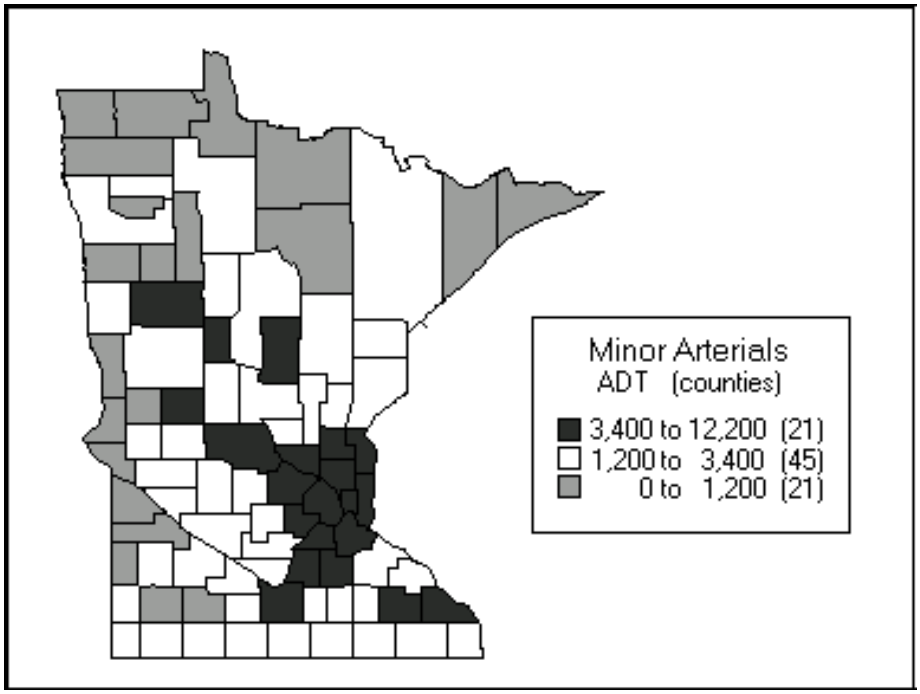
The remaining non-IHFE principal arterials are the state's *other principal arterial highways* (OPA). These include roads like State Highway 2 across northern Minnesota, or Highway 14 across southern Minnesota.[6] Other principal arterials account for 4,230 miles of road, and 10.9 billion miles of annual vehicle travel. Again, principal arterial roads are primarily a state operating responsibility.

Traffic levels on the other principal arterial networks for the average volume group of counties are between 3,030 and 9,270 vehicles per day (map 2). In the high volume group, Washington County has the busiest OPA network. Houston County has only 3 miles of OPA highways, yet it too falls into the high volume group. Saint Louis County has the longest other principal arterial network (261 miles), while Norman County is the only county with no roads in this class.

Minor arterials

Minor arterials (MA) provide a level of service between principal arterials and collector routes. Statewide the minor arterial network includes 8,626 miles of road, and carried 12.5 billion vehicle miles of traffic in 2000. State and county governments have the primary responsibilities. The state controls 65-percent of the MA network, accommodating 45-percent of the MA network traffic. On just 28-percent of the MA road length, county government networks carry another 45-percent of MA traffic.

Map 3 – Minor arterial highways (annual average daily traffic)



Source: MnDOT, *Office of Transportation Data and Analysis, 2000* (see appendix table A3)

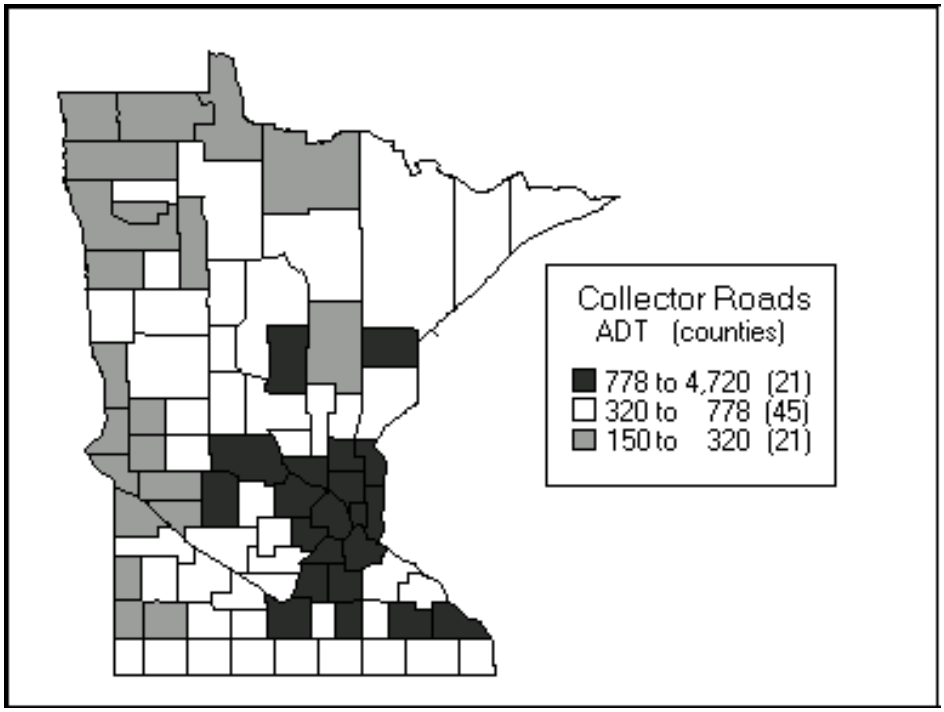
[6] Minnesota statute chapter 161, trunk highway routes.

Again, county-area networks are sorted into low, average, and high volume systems. Minor arterial roads in the average volume group have traffic levels between 1,200 and 3,400 vehicles per day (map 3). The longest network (651 miles) is in Hennepin County, where the traffic count is nearly 11,000 vehicles per day -- once more second only to Ramsey County. Wadena County is also in the high volume group, even though it only has one mile of minor arterial roadway. Cook County is the only county-area without any minor arterial roads, although it does have 80 miles of principal arterials.

Collector routes

Collector roads provide a link between arterial highways and local roads. The statewide network is 29,073 miles in length and carries 7.5 billion vehicle miles of travel per year. County governments are responsible for operating the majority (90-percent) of collector road miles. Cities operate just 4-percent of the remaining collector networks, but carry 21-percent of the total collector system traffic.

Map 4 - Collector roads (annual average daily traffic)



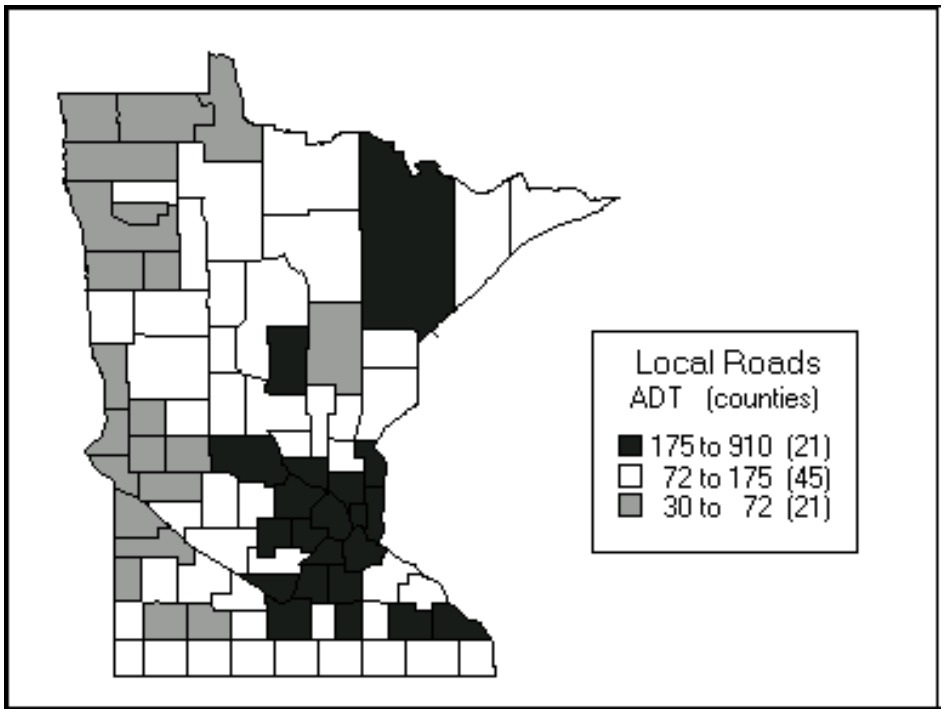
Source: MnDOT, *Office of Transportation Data and Analysis, 2000* (see appendix table A4)

Collector roads in the average volume group of county-areas have traffic levels between 320 and 778 vehicles per day (map 4). Hennepin County has the highest ADT at 4,718 vehicles, on 474 miles of network. The longest collector network is in Saint Louis County (1,256 miles), while the shortest is in Red Lake County (137 miles).

Local roads

Local roads as a functional class provide for property access and neighborhood travel. Statewide there are 89,332 miles of local roads, accommodating 6.3 billion vehicle miles of travel per year. The annual average daily traffic is highest on local roads in the 7-county Twin Cities metropolitan area, where traffic tops 400 vehicles per day on the typical network mile (map 5). The local road network in Hennepin County exceeds 900 vehicles per day, and is also the most extensive (3,597 miles). Counties in the average volume group had traffic levels between 72 and 175 vehicles per day. Polk and Marshall Counties are both in the low volume group. Each has over 2,000 miles of local roads, and average daily travel is less than 70 vehicles a day.

Map 5 - Local roads (annual average daily traffic)

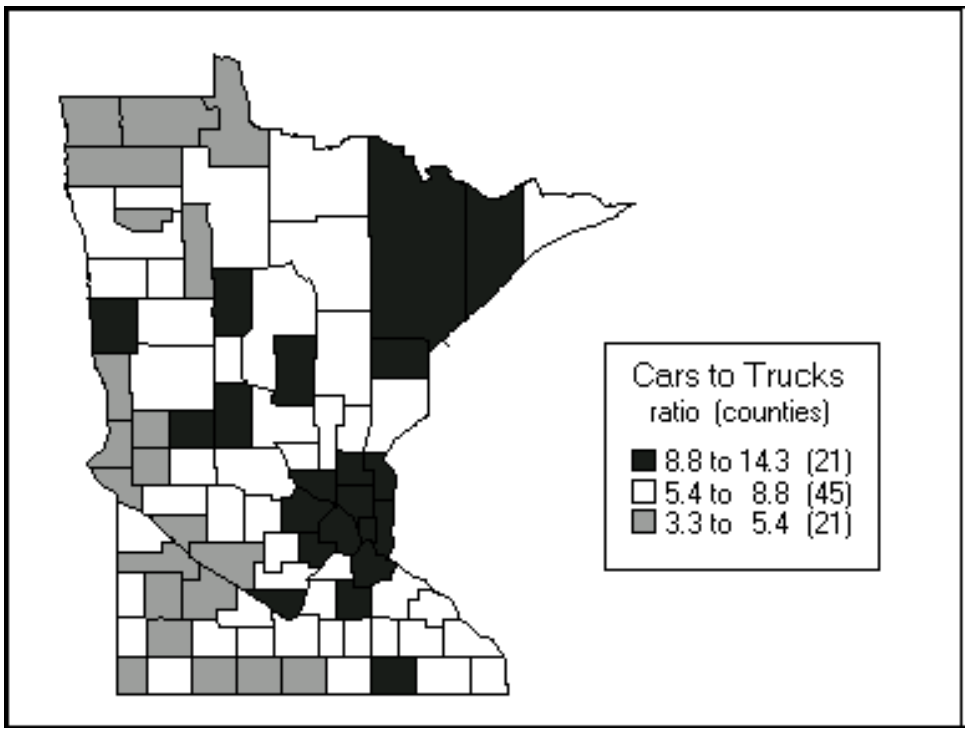


Source: MnDOT, *Office of Transportation Data and Analysis, 2000* (see appendix table A5)

Exhibit: *Commercial trucks and passenger vehicles*

The type of vehicle using the road is as important as the level of vehicle travel. While a detailed assessment of road use by vehicle type is beyond the scope of this report, a simple breakdown of 1998 vehicle registration data offers some perspective on the ratio of light passenger vehicles to heavy commercial

trucks registered in each county (Map 6). The average group of counties has between 5.4 and 8.8 registered passenger vehicles for every heavy truck.
Map 6 - Ratio of passenger vehicle to commercial truck registrations



Source: Minnesota Department of Public Safety, county registration data 1998

Not surprisingly the ratio of cars to trucks is highest in the Twin Cities metropolitan area. Notably, counties on the state's western and northern borders are prominent among the lowest car to truck ratio group. Many of these counties also have low traffic volume network.

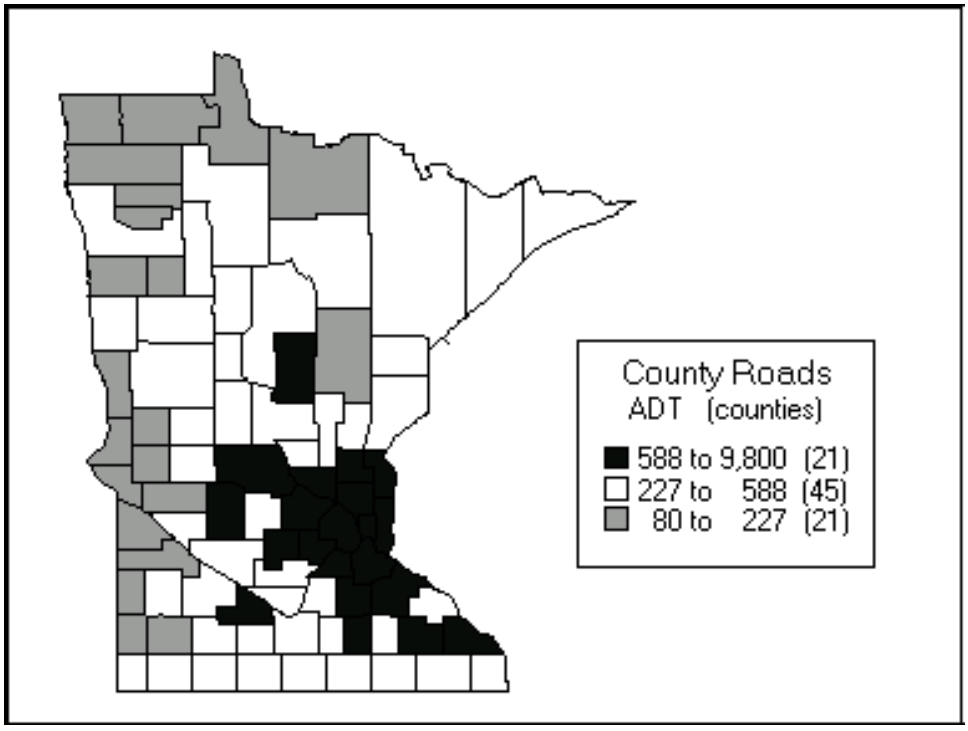
Road use by government ownership

Analyzing roads according to their functional class is informative, but local governments report spending for their entire road network. To better understand local government road spending in the next report, it is first necessary to examine road use at the government ownership level. This is again done at the county-area level, and includes all functional class in the local government's road network. The county-area is the political boundary for county governments, so the county road network is the responsibility of one entity. But a county-area can have numerous cities and towns, each with its own road network. For simplicity, all the city or township road networks are combined at the county-area level. As before, the annual average daily traffic (ADT) is the total vehicle miles traveled in 2000 on the network, divided by the total number of centerline road miles, divided by 365 days.

County road networks

County governments are responsible for more than 45,000 miles of road, carrying 12.4 billion miles of vehicle travel in 2000 statewide. The regional distribution of traffic at the government ownership level - in this case, county networks - is similar to the functional class analysis (map 7). Counties around the Twin Cities metropolitan area have the heaviest road use. Hennepin County tops the list with a network average volume of 9,800 vehicles per day. The average volume group of counties has network traffic ranging from 227 to 588 vehicles per day. Vehicle traffic is lowest in the western and northern border counties. Counties in the lowest volume group include Traverse (84), lake of the Woods (107), and Big Stone (111).

Map 7 – County road networks (annual average daily traffic)



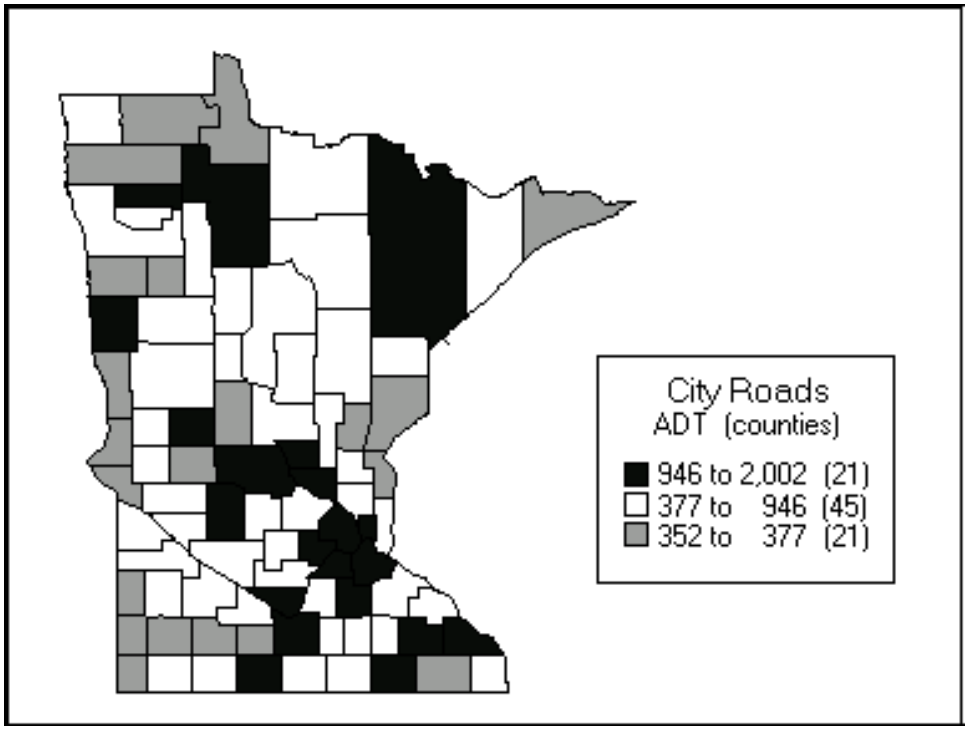
Source: MnDOT, *Office of Transportation Data and Analysis, 2000* (see appendix table A6)

City road networks

Analyzing city road use is more difficult, in part, because cities are not dispersed evenly around the state. Nearly all of the state's largest cities are in the 7-county metropolitan area, particularly Hennepin County. In rural counties the county seat is typically the largest city, and some counties may have several smaller, scattered cities. This analysis combines the road miles and vehicle travel for all cities in the county. Some of the busiest city networks are in the Twin

Cities metropolitan area, but at the county-area level Blue Earth County (Mankato) has the highest traffic volume at 2,001 vehicles per day (map 8). Olmsted County, another outstate county-area with a large city (Rochester), has the second highest ADT at 1,458 vehicles.

Map 8 – City road networks (annual average daily traffic)



Source: MnDOT, *Office of Transportation Data and Analysis, 2000* (see appendix table A6)

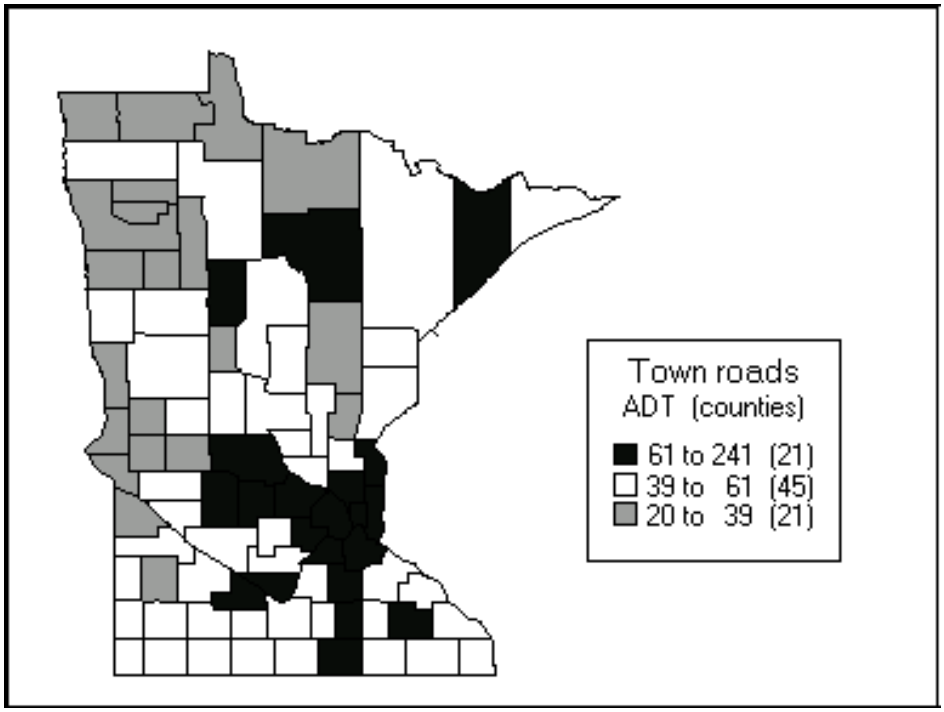
Statewide there are 18,500 miles of city roads, with the vast majority in the local road functional class. In the average volume group of counties, vehicle traffic on city roads range from 377 to 946 vehicles per day. Yet even in the low volume group the range is very narrow, clustering between 373 and 377 vehicles per day. This results from the use of engineering estimates for traffic volumes where obtaining regular survey data is not feasible. The net effect is to set a lower bound for city road use, particularly in those county-areas with small city networks. In counties with large cities this is less of an issue. For example, some outstate high traffic city networks include Clay County (Moorhead), Olmsted County (Rochester), and Saint Louis County (Duluth).

Town road networks

The analysis of town road data has limitations similar to the city data. There are few town road networks in the metropolitan area, yet they are among the most heavily traveled in the state (map 9). Ramsey County has the highest annual average daily traffic at 241 vehicles per day. This network is only 39 miles

in length, but carries 3.4 million vehicle miles of traffic per year. By contrast, Big Stone County township networks support 3.1 million vehicle miles of travel, on a network over 400 miles in length.

Map 9 – Township road networks (annual average daily traffic)



Source: MnDOT, *Office of Transportation Data and Analysis, 2000* (see appendix table A6)

The ADT on township roads, for the average volume group of counties, is between 39 and 61 vehicles per day. The geographic distribution of township network traffic is very similar to the other network maps. High traffic roads are ordinarily in the metropolitan area, and low volume networks are most common in the western and northern counties.

Summary

State and local government roads are a combined 132,000 miles in length, and carry over 52 billion vehicle miles of travel each year. Four levels of government manage this network of diverse road types. By functional class, principal arterials carry the largest volume of traffic, despite being the shortest in length (table 6). Local roads, on the other hand, make up two-thirds of all road miles, and have the lowest volume of traffic.

Table 6 - Road miles and vehicle travel by functional class

State and local roads	Road miles	Vehicle travel
Principal arterial highways	4.0 %	49.6 %
Minor arterials	6.5 %	24.0 %
Collector routes	22.0 %	14.3 %
Local roads	67.5 %	12.1 %

Classifying roads by government ownership reveals a similar distribution. State government is responsible for 9-percent of the statewide road length, and 60-percent of statewide vehicle travel (table 7). By contrast, township roads carry only 2-percent of statewide vehicle travel, but account for 43-percent of the total road length.

Table 7 - Road miles and vehicle travel by government ownership

Government level	Road miles	Vehicle miles
State	9%	60%
County	34%	24%
City	14%	14%
Town/township	43%	2%

Road network use, whether measured by functional class or government ownership, has a clear geographic bias. More vehicle travel occurs on the roads in the Twin Cities area than in rural Minnesota. The least traveled roads in the state are in the western and northern counties.

The annual average daily traffic measures the volume of traffic on a typical mile of network road on an average day. Township road networks typically have an ADT of less than 100 vehicles a day. County and city road networks often have 3 or 4 times that level of traffic. Similarly, local roads have less traffic than collector routes, which in turn are lower volume than arterial highways. When measured at the county-area level, traffic across these road types can vary from fewer than 30 vehicles a day to nearly 100,000 vehicles per day.