2030 Future Highway Congestion Study

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Cooperative transportation planning by the Village, City and County governments of Portage and Summit Counties, and the Chippewa Township area of Wayne County; in conjunction with the U.S. Department of Transportation, Federal Highway Administration, Federal Transit Administration, and Ohio Department of Transportation.

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Introduction

One of the initial steps in the development of a Regional Transportation Plan is to conduct a study of future highway congestion. This study is a key component of the planning process, because it is critical to have an accurate and realistic assessment of the future traffic conditions under which the area's freeways and arterials will operate.

This report quantifies the level of future traffic congestion on area roadways. In order to accomplish this task, AMATS maintains a Congestion Management System (CMS), which includes major roadways in Summit and Portage Counties and Chippewa Township in Wayne County. The CMS contains approximately 540 centerline miles of roadways. Roadways included in the CMS are shown on Map 1.

This report contains two analyses: 1) Freeway Level of Service Analysis; and 2) Arterial Level of Service Analysis. It is an update of a previous 2030 Future Highway Congestion Study that was completed three years ago.

An existing highway congestion study was completed by AMATS last year. The existing and future congestion studies are compared to each other in the summary of this report to determine how much LOS is expected to change overtime. Both analyses will then be used to develop the Congestion Management System Report, scheduled for completion in late summer 2008.

Chapter 1
2030 Freeway Level of Service Analysis

Introduction

The purpose of the 2030 Freeway Level of Service (LOS) Analysis is to determine the extent to which there will be sufficient capacity on area freeways to accommodate future peak-hour travel volumes at a reasonable LOS. All freeways shown on Map 1 were analyzed except the Ohio Turnpike. The Ohio Turnpike Commission regularly conducts capacity studies for this 34-mile section of toll-road.

This chapter is divided into three sections. The first section describes the data collection process. The second section discusses the methodology used to conduct the analysis. The third section summarizes the results of the freeway LOS analysis.

Data Collection

In order to evaluate freeway LOS, freeways were divided into segments, by direction of travel and from interchange to interchange. In all, 131 centerline (262 directional) miles of freeway were divided into 196 directional segments which were analyzed during the peak hour. Roadway characteristics needed to complete this analysis were then collected on a segment-by-segment basis. Most of the data were obtained from AMATS data files. A complete listing of the roadway segment data collected for the analysis is as follows:

Freeway Characteristic	Data Source
Future ADT volume	AMATS 2030 traffic forecast
K-factor and D-factor	ODOT Automatic Traffic Recorder data
Number of lanes	AMATS data files
Interchange spacing	AMATS data files
Length of grade	AMATS data files
Percent grade	AMATS data files
Percent trucks	ODOT Traffic Survey Report

This analysis was conducted assuming that the freeway system would remain as it is today with the exception of several upcoming improvements. These upcoming improvement projects are:

- **I-77** from Copley Road (SR 162) to SR 21
- **SR 8** from SR 303 to I-271
- **SR 8/Seasons Road** Interchange

The 2030 traffic volumes were forecasted using the AMATS travel demand model. The freeway system described above and 2030 socioeconomic data were used to complete the travel forecast.

Methodology

The methodology followed in this analysis is based on the *Highway Capacity Manual* 2000 (HCM2000) published by the Transportation Research Board of the National Research Council. It is the nationally recognized standard for evaluating LOS on highway and street facilities.

LOS is a qualitative measure describing operational conditions within a traffic stream based on service measures such as speed, travel time, freedom to maneuver, traffic interruptions, comfort, convenience, vehicle operating costs, and safety.

LOS on a freeway may range from LOS "A" to LOS "F"; with "A" being the best, representing uninterrupted traffic flow, and "F" being the worst, representing breakdowns in traffic flow. The six ranges of LOS are described in Appendix A. These descriptions were obtained from Chapter 13 of the HCM2000.

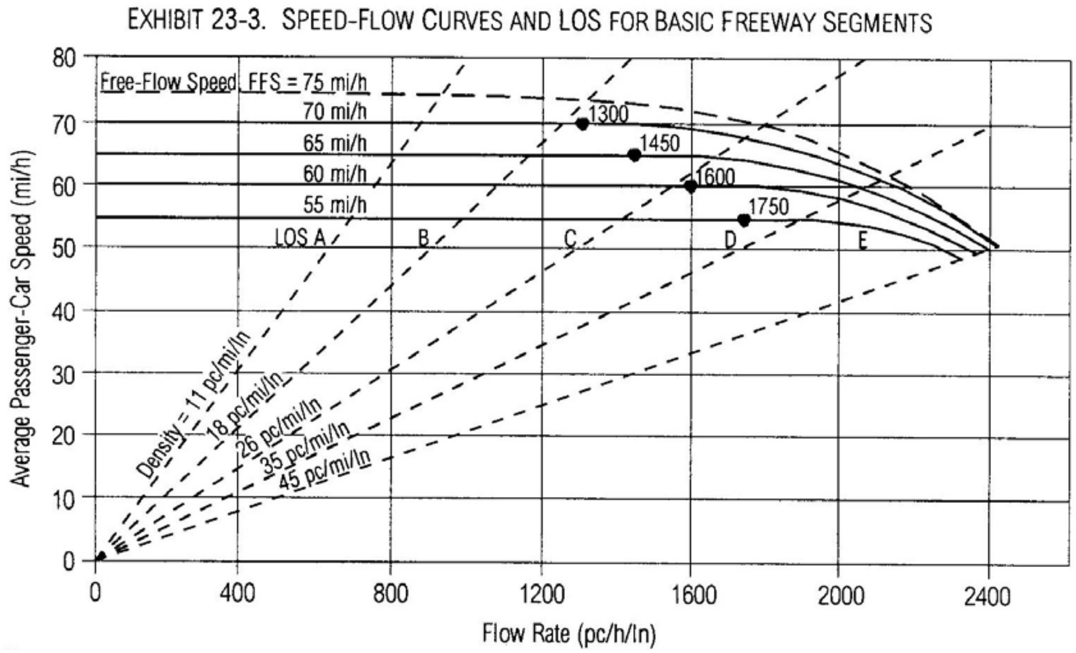
A freeway is composed of many elements: 1) basic freeway segments; 2) freeway weaving areas; and 3) ramps and ramp junctions. The Highway Capacity Manual presents methods for evaluating each of these elements, some of them quite data intensive and time consuming. For the sake of simplicity, and due to lack of readily available information regarding freeway weaving areas and ramps, only basic freeway segments and mainline ramps were evaluated in this analysis. Mainline ramps are those that carry the freeway designation through an interchange.

Essentially, the LOS of a freeway is determined based on two primary factors: the volume of traffic and the capacity of the roadway. Density takes both volume and capacity into account and is the parameter used in the HCM2000 to determine the LOS of a freeway segment. Density is measured in terms of the number of passenger cars per mile per lane (pcpmpl). Freeway segments operating at a density greater than 26 pcpmpl (LOS "D", "E", or "F") are identified as congested. Freeway LOS is determined by density range as follows:

Level of Service	Density Range (in pcpmpl)
A	0 to 11.0
B	11.1 to 18.0
C	18.1 to 26.0
D	26.1 to 35.0
E	35.1 to 45.0
F	over 45.0

The Density and LOS values of a freeway segment are based on Flow Rate and Average Speed. Figure 1, obtained from page 23-5 of the Highway Capacity Manual, demonstrates the relationship between these four variables.

Figure 1: Level of Service Criteria



Flow Rate and Average Speed, and their relationship to Density, are described in the following section:

1) Flow Rate is the equivalent hourly rate at which vehicles pass a given point on a freeway lane. It is based on the peak hour volume count (V), which is then adjusted to obtain an equivalent passenger car rate per lane (v) according to the following formula:

$$v = \frac{V}{PHF * N * f_{hv} * f_p}$$

Where,

v = Peak Hour Flow Rate – measured in passenger cars per hour per lane (pcphpl)

V = Future Peak Hour Volume (by direction of travel) – measured in vehicles per hour (vph)

PHF = Peak Hour Factor. PHF is the ratio of peak hour volume to the hourly flow rate based on the peak 15 minutes. For each limited area of study, the PHF is fairly consistent. In this report, the PHF for the AMATS area was assigned a default value of 0.90

N = Number of lanes in the freeway segment

f_{hv} = Adjustment factor due to the effect of heavy vehicles (e.g. trucks) in the traffic stream. "f_{hv}" depends on the percent of trucks, as well as the length and percent of grade governing the freeway segment

f_p = Adjustment factor for the effect of driver population. "f_p" reflects the proportion of drivers that are familiar with the freeway under study. In the AMATS area, "f_p" is given a value of 1.00

The following formula was employed to calculate "V" using the projected ADT volumes derived from the 2030 traffic assignment.

$$V = ADT * D * K$$

Where,

V = Future Peak Hour Volume

ADT = Future Average Daily Traffic

D = Directional Distribution Factor. "D" values were derived from ODOT's Traffic Survey Report

K = Proportion of ADT volume occurring in the peak hour, by direction of travel. "K" factors were based on hourly Automatic Traffic Recorder (ATR) data collected by ODOT in 2004

2) Average Speed of a freeway segment is defined in the Highway Capacity Manual as the average speed of all vehicles traversing that segment. Average Speed may be measured in the field, or estimated according to such freeway characteristics as design speed, number of lanes, lane width, lateral clearance, and interchange density. In this report, Average Speed was estimated, rather than measured in the field.

All Density and LOS computations were performed by utilizing the Highway Capacity Software 2000(HCS2000). This software was developed by the Transportation Research Center at the University of Florida as a means of implementing the procedures and formulas described in the Highway Capacity Manual. HCS2000 is programmed to calculate the following four variables according to the methodology described above: 1) Flow Rate, 2) Average Speed, 3) Density, and 4) LOS.

Results

In all, 196 directional freeway segments, representing 262 directional freeway miles, were analyzed. Nine segments, representing 15 directional miles, will operate at a LOS "F". 24 segments, representing 20 directional miles, will operate at LOS "E". 83 segments, representing 81 directional miles, will operate at LOS "D". These congested segments are shown on Table 1 and Map 2.

According to the AMATS Goals and Objectives "all urban freeways should operate at a LOS "D" or better". All freeway segments operating at LOS "D" in this report are within the urban area; therefore, they are considered acceptable and are unlikely to require future expansion.

Appendix B shows the LOS of all freeway segments, together with the corresponding Directional Volumes, Flow Rate, and Density.

When interpreting the final results, it is important to note that this analysis has been conducted at the planning-level as a means of identifying areas of future traffic congestion. A more detailed LOS analysis would be necessary to analyze specific projects. A project-level analysis typically includes such factors as: 1) unique peaking and directional trends; 2) seasonal traffic congestion; and 3) weaving. Such factors have an adverse effect on the LOS of a freeway, especially when adjacent interchanges are less than one mile apart.

One example of a project-level analysis was recently completed by the consulting firm URS Corporation, under contract with ODOT, as part of the Akron Central Interchange Project. This analysis illustrates the effect of weaving along I-76/I-77 from East Ave to SR 8. Map 3, taken from the URS report, demonstrates the project-level 2030 LOS results. When comparing Map 3 with Map 2, it can be seen that when weaving is taken into account the LOS of freeway segments is, on average, one “letter” worse.

Insert Table 1 (page 1)

Insert Table 1 (page 2)

Insert Table 1 (page 3)

Insert Map 2

Insert Map 3

Chapter 2
2030 Arterial Level of Service Analysis

Introduction

The purpose of the 2030 Arterial Level of Service (LOS) Analysis is to determine whether arterial roadways included in the Congestion Management System (CMS) have sufficient capacity to accommodate future traffic volumes at a reasonable level of service. Arterial level of service is evaluated using a methodology which compares the forecasted 2030 peak hour traffic volumes to planning-level peak hour roadway capacities.

This chapter is divided into three sections. The first section describes the data collection process. The second section discusses the methodology used to conduct the analysis. The third section summarizes the results of the arterial LOS Analysis.

Data Collection

In order to evaluate arterial LOS, arterials were first divided into smaller segments, using intersecting roadways as termini. The roadways were then further subdivided into segments wherever roadway characteristics that have a significant effect on capacity (e.g. the number of lanes) changed.

In all, the approximately 375 centerline miles of arterial roadways included in the analysis were divided into 588 separate segments. Roadway characteristics needed to complete this analysis were collected on a segment-by-segment basis. Most of these data were obtained from AMATS data files. A complete listing of the data collected for this analysis is as follows:

Arterial Characteristic	Data Source
Forecasted 24-hour traffic volume	AMATS traffic forecast
Peak hour traffic volume	AMATS traffic forecast
Number of through lanes	AMATS data files
Left turn bays and median turn lanes	AMATS data files
Traffic signal locations	AMATS data files
Segment length	AMATS data files
Functional classification	Federal Functional Classification
Posted speed	AMATS data files
Area type	AMATS data files

This analysis was conducted assuming that the arterial system would remain as it is today with the exception of several upcoming improvements. These upcoming improvement projects are:

- **Arlington Road** between September Drive and I-77 (widen to 4 or 5 lanes, additional turn lanes on SR 619, Jarvis Road relocation)

- **Crain Avenue** between Fairchild Avenue and Water Street (new bridge, additional turn lanes)
- **Glenwood Boulevard at Liberty Road** (new roundabout)
- **South Main Street** between Althea Avenue and Swartz Road (widen to 5 lanes)
- **South Main Street** between I-277 and Waterloo Road (widen to 5 lanes)
- **West Market Street** between Revere Road and Pershing Avenue (standard lanes widths)
- **Steels Corners Road** between Steels Pointe Drive and Hudson Drive (additional turn lanes)
- **Tallmadge Ave** between Gorge Boulevard and Home Avenue (standard lanes widths)
- **Wheatley Road** at I-77 Southbound ramps (new traffic signal)
- **White Pond Drive** between Mull Avenue and Frank Boulevard (widen to 3 lanes, add traffic signal at Pine Grove Drive)
- **SR 21** at Eastern Road (additional turn lanes)
- **SR 59** between CSX RR and Menough Rd (widen to 3 lanes)
- **SR 82** between South Bedford Road and Crow Drive (widen to 5 lanes)
- **SR 93** between Robinson Avenue and Cormany Road (widen to 5 lanes)
- **SR 241** between Steese Road and Boettler Road (widen to 4 lanes with additional turn lanes, new roundabout at Steese Road)

The 2030 traffic volumes were forecasted using the AMATS travel demand model. The arterial system described above and 2030 socioeconomic data were to complete the travel forecast.

Methodology

Unlike the Freeway Level of Service Analysis, which use analytical techniques described in the *Highway Capacity Manual* (HCM) 2000, the Arterial Level of Service Analysis is based on a planning-level approach. The HCM 2000 arterial analysis is both data-intensive and time consuming; therefore, it is more appropriate for analyzing one roadway, rather than the entire regional transportation system. Consequently, a planning-level approach is used in this analysis, due to the large number of arterial segments involved.

Arterial level of service is evaluated using a methodology which compares the future peak hour traffic volumes to planning-level peak hour roadway capacities developed by AMATS. These capacities are based on ODOTS's Capacity Calculator. The future peak hour volume was determined by applying the existing K-factor (proportion of average daily traffic occurring in the peak hour) to the forecasted 24-hour traffic volume.

The peak hour capacity was determined based on number of lanes, presence of dedicated turn lanes, and number of traffic signals. The resulting planning-level peak hour capacities are listed in Table 2-1.

Table 2: AMATS Planning-Level Peak Hour Capacities*

Number of Through Lanes	Traffic Signal Spacing	Area Type	Capacity Without Turn Lanes	Capacity With Turn Lanes
2	Less than 2 per mile	Rural/Suburban	1,133	1,416
2	2 to less than 4 per mile	Suburban/Urban	899	1,124
2	4 or more per mile	Urban/CBD	819	1,024
4	Less than 2 per mile	Rural/Suburban	2,190	2,738
4	2 to less than 4 per mile	Suburban/Urban	1,749	2,186
4	4 or more per mile	Urban/CBD	1,600	2,000
6	Any	Any	2,488	3,110

*NOTE: The planning-level peak hour capacities listed in this table represent the total number of vehicles that can traverse a given section of roadway in the peak hour, while still operating at LOS "C".

In some cases arterial segments are unique. Factors such as driveway spacing and signal coordination have an impact on the capacity an arterial segment. For example, since SR 261 in Kent has controlled access, it was given the highest capacity for a 4-lane roadway. Another example is SR 91 from Twinsburg Rd to I-480. Since the traffic signals are coordinated, it was given the highest capacity for a 4-lane roadway.

In order to calculate arterial LOS, the future peak hour traffic volumes were compared to the peak hour capacities on a segment-by-segment basis. Roadway segments operating at a volume-to-capacity ratio greater than 1.00 (LOS "D", "E", or "F") were identified as congested. The operating conditions at each level of service are described in detail in Appendix C. The volume-to-capacity ratios corresponding to each level of service are summarized below.

Level of Service	V/C Ratio
A	less than 0.50
B	0.50 to 0.75
C	0.75 to 1.00
D	1.00 to 1.25
E	1.25 to 1.60
F	greater than 1.60

Results

In all, 588 arterial segments, representing 375 centerline miles, were analyzed. Three segments, representing 3 miles, will operate at a LOS “F”. 32 segments, representing 25 miles, will operate at LOS “E”. 120 segments, representing 82 miles, will operate at LOS “D”. The congested segments are shown on Table 3 (ranked according to their volume-to-capacity ratio) and on Map 4.

Appendix D shows the LOS for all of the arterial segments and is sorted first by county; then by state route in numerical order; and finally, by non-state route in alphabetical order. In addition to displaying the level of service and volume-to-capacity ratio of each segment, Appendix D also shows the hourly capacity.

When interpreting the final results, it is important to note that this analysis has been conducted at the planning-level as a means of identifying areas of future traffic congestion. A more detailed LOS analysis would be necessary to analyze specific projects. A project-level analysis typically includes such factors as: 1) unique directional trends; 2) seasonal traffic congestion; 3) degree of traffic signal coordination; and 4) percentage of turns. Such factors have an adverse effect on the LOS of an arterial.

Insert Table 3 (page 1)

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Insert Map 4

Chapter 3
Summary

This chapter summarizes the 2030 LOS for both freeways and arterials. It also compares these 2030 values to the 2006 existing LOS analysis completed last year. Table 4 compares mileages from the existing and future freeway LOS analysis. Table 5 compares mileages from the existing and future arterial LOS analysis.

Table 4: 2006 and 2030 Freeway Level of Service comparison

	2006		2030		Change in Mileage
LOS	Directional Miles	Percentage of miles	Directional Miles	Percentage of miles	
F	0	0%	15	6%	15
E	15	6%	20	8%	5
D	66	27%	81	31%	15
C or better	167	67%	146	56%	-21
Total	248	100%	262	100%	14

Table 5: 2006 and 2030 Arterial Level of Service comparison

	2006		2030		Change in Mileage
LOS	Centerline Miles	Percentage of miles	Centerline Miles	Percentage of miles	
F	2	1%	3	1%	1
E	5	1%	25	7%	20
D	39	10%	82	22%	43
C or better	336	88%	265	71%	-71
Total	382	100%	375	100%	-7

As shown in the tables above, both freeways and arterials are expected to become more congested between now and 2030. However, freeways are not expected to get worse quite as fast as arterials. This is partly due to major freeway improvements that will be completed in the near future.

Please note that the total mileages changed between 2006 and 2030. Seven arterial centerline miles became 14 directional freeway miles due to the fact that SR 8 between SR 303 and the new I-271 ramps and US 224 between Kelly Ave and SR 241 are now considered freeways based on recent construction projects.

The results of both of these analyses will be used, in conjunction with the *2006 Existing Highway Congestion Study*, to develop the Congestion Management System Report. The report will contain recommendations for reducing traffic congestion in the AMATS area between now and 2030.

APPENDICES

Appendix A
Freeway Level of Service Descriptions

(As described in the *2000 Highway Capacity Manual*, pages 13-8 through 13-11)

LOS A describes free-flow operations. Free-flow speeds prevail. Vehicles are almost completely unimpeded in their ability to maneuver within the traffic stream. The effects of incidents or point breakdowns are easily absorbed at this level.

LOS B represents reasonably free flow, and free-flow speeds are maintained. The ability to maneuver within the traffic stream is only slightly restricted, and the general level of physical and psychological comfort provided to drivers is still high. The effects of minor incidents and point breakdowns are still easily absorbed.

LOS C provides for flow with speeds at or near the free-flow speed of the freeway. Freedom to maneuver within the traffic stream is noticeably restricted, and lane changes require more care and vigilance on the part of the driver. Minor incidents may still be absorbed, but the local deterioration in service will be substantial. Queues may be expected to form behind any significant blockage.

LOS D is the level at which speeds begin to decline slightly with increasing flows and density begins to increase somewhat more quickly. Freedom to maneuver within the traffic stream is more noticeably limited, and the driver experiences reduced physical and psychological comfort levels. Even minor incidents can be expected to create queuing, because the traffic stream has little space to absorb disruptions.

At its highest density value, **LOS E** describes operation at capacity. Operations at this level are volatile, because there are virtually no usable gaps in the traffic stream. Vehicles are closely spaced, leaving little room to maneuver within the traffic stream at speeds that still exceed 49 mph. Any disruption to the traffic stream, such as vehicles entering from a ramp or a vehicle changing lanes, can establish a disruption wave that propagates throughout the upstream traffic flow. At capacity, the traffic stream has no ability to dissipate even the most minor disruption, and any incident can be expected to produce a serious breakdown with extensive queuing. Maneuverability within the traffic stream is extremely limited, and the level of physical and psychological comfort afforded the driver is poor.

LOS F describes breakdowns in vehicular flow. Such conditions generally exist within queues forming behind breakdown points. Breakdowns occur for a number of reasons:

- Traffic incidents can cause a temporary reduction in the capacity of a short segment, so that the number of vehicles arriving at the point is greater than the number of vehicles that can move through it.
- Points of recurring congestion, such as merge or weaving segments and lane drops, experience very high demand in which the number of vehicles arriving is greater than the number of vehicles discharged.
- In forecasting situations, the projected peak-hour (or other) flow rate can exceed the estimated capacity of the location.

Insert Appendix B (Page 1)

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Insert Appendix B (Page 6)

Appendix C
Arterial Level of Service Descriptions

(As described in the *2000 Highway Capacity Manual*, page 10-5)

LOS A describes primarily free-flow operations at average travel speeds, usually about 90 percent of the free-flow speed for the given street class. Vehicles are completely unimpeded in their ability to maneuver within the traffic stream. Control delay at signalized intersections is minimal.

LOS B describes reasonably unimpeded operations at average travel speeds, usually about 70 percent of the free-flow speed for the street class. The ability to maneuver within the traffic stream is only slightly restricted, and control delays at signalized intersections are not significant.

LOS C describes stable operations; however, ability to maneuver and change lanes in midblock locations may be more restricted than in LOS B, and longer queues, adverse signal coordination, or both may contribute to lower average travel speeds of about 50 percent of the average free-flow speed for the street class.

LOS D borders on a range in which small increases in flow may cause substantial increases in delay and decreases in travel speed. LOS D may be due to adverse signal progression, inappropriate signal timing, high volumes, or some combination of these factors. Average travel speeds are about 40 percent of free-flow speed.

LOS E is characterized by significant delays and average travel speeds of 33 percent or less of the free-flow speed or less. Such operations are caused by a combination of adverse progression, high signal density, high volumes, extensive delays at critical intersections, and inappropriate signal timing.

LOS F is characterized by urban street flow at extremely low speeds, typically one-third to one-fourth of the free-flow speed. Intersection congestion is likely at critical signalized locations, with high delays, high volumes, and extensive queuing.

Insert Appendix D (pages 1-15)