

# Effects of Truck Restrictions on Regional Transportation Demand Estimates

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The effects of currently imposed truck restrictions on transportation demand estimates, the mix of trucks in congested traffic, and truck travel times and trip length are examined. During the past 3 years, the Chicago Area Transportation Study (CATS) has been developing the Transportation System Development Plan for 2010. The travel demand process incorporates the results of a 1986 commercial vehicle survey, 1980 and 2010 socioeconomic variables, and network characteristics in the traditional four-step demand modeling process. The CATS practice of combining truck trips with automobile trips in the form of automobile vehicle equivalences before path assignment does not accurately reflect demand on a number of major Chicago area roadways where truck restrictions exist. The assignment procedure has been adjusted to prevent trucks from being loaded to restricted roadways. The resulting traffic assignment shows the significant effects of the restrictions on the vehicle mix of congested roads. A comparison of restricted versus unrestricted demand estimates shows that truck restrictions affect truck travel times and trip lengths. It was determined that these restrictions significantly affect the transportation industry and do not appear to be effective in reducing overall congestion in selected locations.

The effects of currently imposed truck restrictions on traffic congestion, travel times, and route length of truck trips on Chicago area roadways are examined. In addition, some questions regarding truck restrictions are explored.

The Chicago Area Transportation Study (CATS) has adopted a long-range program known as the 2010 Transportation System Development (TSD) Plan (1). In creating the plan, travel demand estimates were developed for commercial vehicles as separate trip types. Many transportation planning agencies model truck travel by increasing automobile person trips by 5 to 15 percent, but CATS has traditionally used separate demand estimate models to account for truck travel. For the 2010 TSD plan, truck trip characteristics were developed for four distinct types of commercial vehicles according to the results of the CATS 1986 commercial vehicle survey (2). These truck trips were then combined with automobile trips to estimate travel demand on alternative highway networks.

The current practice of combining automobile and truck trips, before trip assignment, on the simulated networks assigns vehicles to roadways without regard to truck access limitations. This practice assumes that all vehicles have equal access to all streets and does not accurately reflect the actual circuitous routes that trucks are forced to take because of restrictions on numerous streets in the region. CATS staff have explored a new method to analyze the assignment of commercial vehicles in the regional demand modeling process,

the results of which are reported here. CATS is currently developing other methods (e.g., parallel path assignments) that may improve the modeling process further.

Truck restrictions are in place for a number of reasons:

- To improve or maintain the residential quality of neighborhoods,
- To remove trucks from roads such as parkways and boulevards,
- To reduce damage to roadways and bridges,
- To minimize noise levels,
- To restrict the movement of hazardous materials,
- To minimize pedestrian conflicts, and
- To increase the roadway capacity available to automobile drivers.

Many large trucks are also effectively restricted from access to some major streets because of low clearances under older railroad viaducts, most of which are in the city of Chicago. In addition, truck restrictions interact with many strategic decisions and operational characteristics of private-sector transportation companies, such as the location of and access to manufacturing plants and industrial complexes.

The following discussion covers the effect of truck restrictions on the local nonrestricted roadways (increasing the percentage of trucks on nonrestricted streets), the added costs to the transportation function for many businesses (from the increase in travel and delivery times), and the possible environmental implications (from longer and more circuitous truck trips).

## DEFINITIONS

In 1986, CATS embarked on a major study of commercial vehicle behavior. As presented in Table 1, the majority of commercial vehicles are divided by the Illinois Secretary of State into two separate groups for licensing purposes: (a) the Weight Plates Group (WPG), which includes local cartage companies such as United Parcel Service and Waste Management, and (b) the International Registration Program (IRP), which includes over-the-road operators such as Yellow Freight. Also included in the survey were United States Postal Service (USPS) vehicles. The USPS operates 1 percent of the total commercial vehicles in the region. As seen in Table 1, 360,000 commercial vehicles were registered in the six-county Chicago area in 1986.

The four vehicle class definitions [i.e., B truck (Illinois license plates that end with B or have B TRUCK written on

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the side), light, medium, and heavy] presented in Table 1 were necessary to model their distinct trip characteristics more accurately in the regional modeling process. Table 2 presents the average (mean and median) daily trip frequency and trip length for the four classes of commercial vehicles. The survey demonstrated that the length and type of trips made by step-vans and pickup trucks were different from the length and type of trips made by the large tractor-semitrailers.

Because the regional highway assignment allocated trips and calculated capacity in a base unit of passenger automobiles, truck trips were converted to automobile vehicle equivalents (VEQ) in the modeling process. The presence of a heavy commercial vehicle on a section of road is obviously much different from that of a passenger car. Given the various types of operational considerations (e.g., size, weight, acceleration, speed, and maneuverability) of the distinct truck classes and the various types of roadway characteristics (e.g., speed limit, level of access control, parking, intersection capacity, and lane width) throughout the region, the VEQ for each class represents an average equivalent number of passenger automobiles that a truck from that class represents on the road. For example, in the regional model, one heavy truck added to a section of road would have the assumed equivalent effect on capacity and traffic congestion of three automobiles. The VEQs applied in the development of the 2010 plan and

for this exercise are 1 VEQ for B and light trucks, 2 VEQs for medium trucks, and 3 VEQs for heavy trucks.

With the goal of adequately measuring the impact of restrictions on larger commercial vehicles, a number of resources were reviewed to determine what type of commercial vehicle classes should be defined as large trucks. These trucks would be prohibited from using the restricted streets on the regional network. It was determined that the medium and heavy groups defined in the survey would be aggregated as large trucks. This group consisted of those vehicles with a gross weight range of 28,001 to 80,000 lb, corresponding closely to the 26,000-lb threshold established for Class 7 and 8 vehicles as defined by the Motor Vehicle Manufacturers' Association (3). Examples of this large truck group include beverage trucks, concrete mixers, charter buses, dump trucks, fuel trucks, tractor-semitrailers, and multitrailer vehicles. The total number of trips for the base year of 1980 and the forecast year of 2010 are presented in Table 3.

**RESTRICTED ROADWAYS**

The CATS internal study area consists of six northeastern Illinois counties. In addition, CATS has divided the region into 1,542 internal zones and 101 external zones. In general,

TABLE 1 COMMERCIAL VEHICLE REGISTRATIONS IN NORTHEASTERN ILLINOIS

Vehicle Class	Weight Plates Group			Group Totals			Total No. of Vehicles	Examples
	License Plate	Gross Vehicle Weight <sup>a</sup> (lb)	No. of Vehicles Registered	WPG	IRP	USPS		
B truck	B	Up to 8,000	237,400	237,400	0	3,200	240,600	Pickup trucks, small vans, and some articulated trucks
Light	D	8,001 to 12,000	20,133	47,232	650	300	48,182	Step vans, cargo vans, panel trucks, armored cars, and school buses
	F	12,001 to 16,000	7,233					
	H	16,001 to 24,000	13,949					
	J	24,001 to 28,000	5,917					
Medium	K	28,001 to 32,000	2,217	13,850	7,950	0	21,800	Beverage trucks, concrete mixers, garbage trucks, and charter buses
	N	32,001 to 40,000	1,417					
	P	40,001 to 45,000	1,967					
	R	45,001 to 50,000	4,566					
	S	50,001 to 59,500	2,583					
Heavy	T	59,501 to 64,000	1,100	6,701	41,800	300	48,801	Semitrailers and twin trailers
	V	64,001 to 73,280	5,317					
	X	73,281 to 77,000	417					
	Z	77,001 to 80,000	967					
Total medium and heavy			20,551	20,551	49,750	300	70,601	
Total			305,183	305,183	50,400	3,800	359,383	

NOTE: Data are from 1986 commercial vehicle survey (4).

TABLE 2 TRIP FREQUENCY AND TRIP LENGTH OF COMMERCIAL VEHICLES

Vehicle Class	VEQ <sup>a</sup>	Total Registrations	Working Vehicles <sup>b</sup>	Daily Trip Frequency <sup>c</sup>		Average Trip Length <sup>d</sup>	
				Mean	Median	Mean	Median
B truck	1	240,600	129,398	6.9	5.0	11.1	7.4
Light	1	48,182	28,277	7.9	6.0	9.6	7.3
Medium	2	21,800	12,240	9.3	8.5	10.4	8.4
Heavy	3	48,801	12,854	5.9	4.8	24.9	22.4

<sup>a</sup>VEQ is automobile vehicle equivalent.

<sup>b</sup>Working vehicles is the average number of vehicles operating in commercial activity on an average day.

<sup>c</sup>Trip frequency is the number of trips per day.

<sup>d</sup>Trip length is average miles per trip.

TABLE 3 CHICAGO AREA TRUCK TRIPS

Year	No. of Trips by Type of Vehicle	
	All Commercial Vehicles	Medium and Heavy Trucks > 28,000 lb
Internal <sup>a</sup>		
1980	1,348,155	180,915
2010	1,713,488	156,805
External <sup>b</sup>		
1980	115,644	67,493
2010	131,551	77,087
Total Trips		
1980	1,463,799	248,408
2010	1,845,039	233,892

<sup>a</sup>Trips made within the region.

<sup>b</sup>Trips into, out of, or through the region.

the size of the zone is determined by the population, household, and employment density. The internal zonal system is shown in Figure 1.

The CATS highway network file contains over 18,000 links (a section of roadway that connects two intersections) that represent over 11,000 bidirectional mi of roadway. Speed, distance, capacity, impedance, and other variables are coded as network characteristics for each link. A list of restricted links was compiled and applied to the highway network file. The impedance variable on this file allows the analyst to effectively eliminate the link as a possible path for choice components.

Given that (a) not all roads and streets are coded into the highway network (especially residential streets), (b) not all types of truck restrictions apply exclusively or completely to

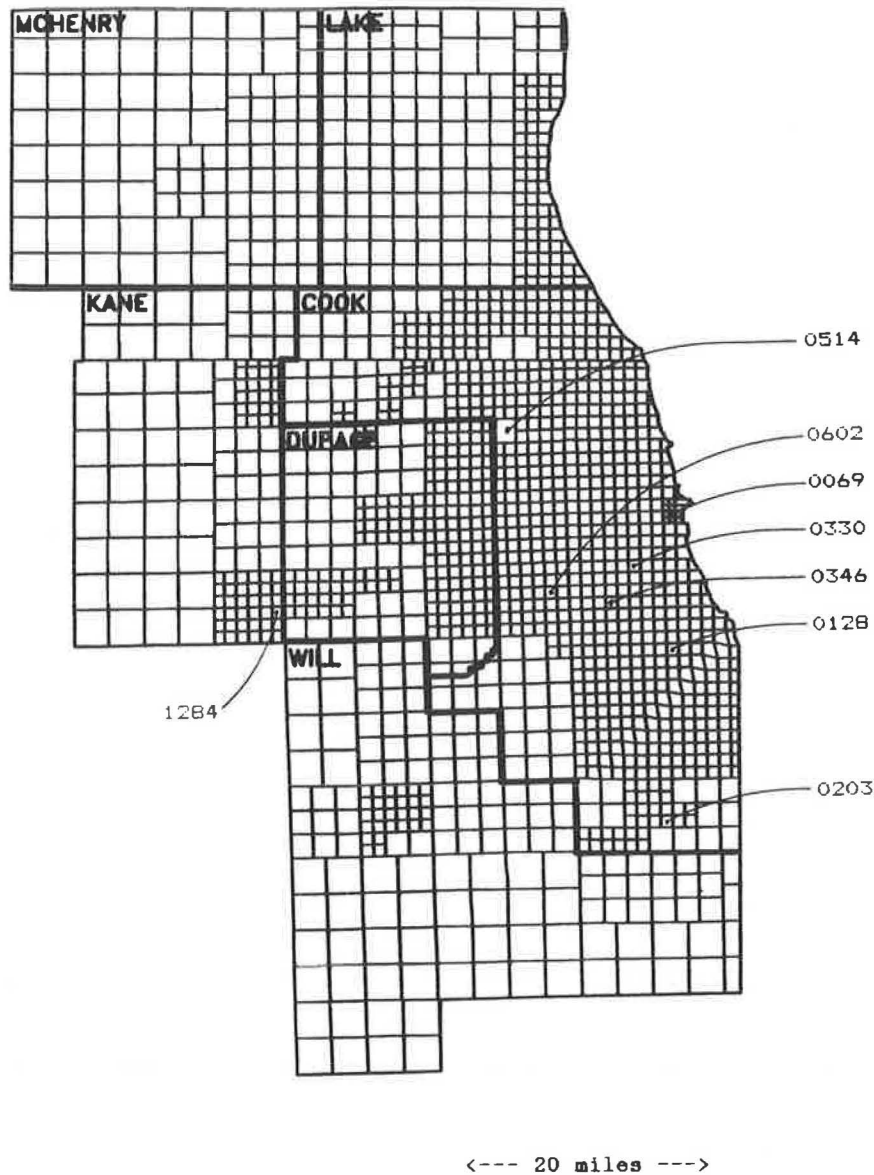


FIGURE 1 Traffic assignment zone system (revised 1984).

the large truck group as defined, (c) not all truck operators comply with the restrictions as posted, and (d) staff-hour and computer-time constraints exist, it was determined that only one network with all of these restricted links would be necessary for this exercise. If the results were determined to be significant (measurable), then further research would be warranted.

Examples of restricted links in this study include the express lanes of I-90/94 (Kennedy and Dan Ryan expressways), Lake Shore Drive (US-41), the boulevard system in the city of Chicago, and locations where height restrictions (viaduct clearances less than 13 ft) prohibit tractor-semitrailer activity. In fact, many truck drivers avoid clearances in the 13 ft 0 in. to 13 ft 6 in. range because of variances between the posted sign and the actual clearance. These restricted roads and the limits of the restricted links are presented in Tables 4 and 5, respectively. Only a few of these roads are not on the CATS highway network.

In total, 568 links representing 377 directional mi were effectively removed from the network as restricted roads. Table 6 presents the 2010 base network file's directional miles and number of links. The last two columns indicate the number of links and miles that were removed. Most of these links are in the city of Chicago, and a significant percentage is in the older industrial section of the south and southeast portions of the city.

#### TRAVEL DEMAND ANALYSIS

Future travel demand estimates are generated from forecast socioeconomic data and proposed network improvements using the four-step transportation demand modeling process. Internal truck trip productions and attractions were generated for

each zone from rates developed in the 1986 commercial vehicle survey and applied to household and employment levels (4). Trip distributions were then developed from the productions and attractions using a doubly constrained intervening opportunities model (IOM), in which trip destinations are a function of production and attraction values for each zone matched against the distribution of trips from all zones. To properly measure the total activity level of commercial vehicles, CATS applied the results of a 1984 external survey (5). This survey determined the number of truck trips into, out of, and through the region. Commercial vehicle trips in the external analysis were divided into comparable classes of commercial vehicles and then combined with the results of the 1986 survey. Total commercial vehicle and large-truck trips are presented in Table 3.

In trip or vehicle assignment, truck trips are traditionally combined with automobile trips in the network as VEQs and then an equilibrium assignment process is used. Paths are chosen on the basis of minimum times and loaded using a series of all-or-nothing (AON) assignments. Link impedances are computed after each AON assignment and used to calculate a new set of paths, which are then reloaded. Five iterations of this process are combined to compute the equilibrium volumes. The five sets of paths from the assignment on the restricted network are saved.

The large-truck trips were reloaded onto these paths and combined using the equilibrium weights from the initial assignment to get the final large-truck link loads (6). This process was run using both an unrestricted and a restricted network. The loads on unrestricted streets in a restricted network were then compared with the unrestricted large-truck link loads from the original assignment. The analysis of this procedure generates some ideas concerning the effect restrictions have on the mix of vehicles on congested unrestricted streets.

TABLE 4 TRUCK-RESTRICTED ROUTES DUE TO BOULEVARD DESIGNATION, LOAD LIMIT, OR LENGTH LIMIT

Route Name	From	To
100th Boulevard	Escanaba Blvd.	Avenue "L" Blvd.
103rd Street	Western Ave.	Vincennes Ave.
107th Street	Western Ave.	M.L. King Dr.
112th Boulevard	Avenue "L" Blvd.	Indiana state line
115th Street	Western Ave.	Vincennes Ave.
24th Boulevard	Marshall Blvd.	California Ave.
26th Street	Kostner Ave.	Kedzie Ave.
31st Boulevard	California Blvd.	Western Ave.
31st Street	Ogden Ave.	IL 50 (Cicero Ave.)
33rd Boulevard	Michigan Ave.	South Pkwy.
43rd Street	Archer Ave.	Western Blvd.
51st Street	Cottage Grove Ave.	Lake Park Ave.
57th Boulevard	IC Railroad	Stony Island Ave.
59th Street	IL 50 (Cicero Ave.)	California Ave.
71st Street	Ashland Ave.	I-94 (Dan Ryan)
71st Street	Pulaski Rd.	Western Ave.
83rd Street	Kedzie Ave.	Halsted Ave.
92nd Boulevard	Jeffery Ave.	Anthony Blvd.
Adams Boulevard	Central Ave.	Austin Blvd.
Anthony Boulevard	92nd Blvd.	Escanaba Blvd.
Ashland Avenue	Irving Park Rd.	Clark St.
Ashland Boulevard	Pratt Blvd.	Fargo Ave.
Ashland Boulevard	Roosevelt Rd.	Lake St.
Augusta Boulevard	Elston Ave.	Austin Blvd.
Austin Boulevard	Cermak Rd.	North Ave.
Avenue "L"	100th Blvd.	112th Blvd.

TABLE 4 (continued on next page)

TABLE 4 (continued)

Route Name	From	To
California Avenue	51st St.	67th St.
California Avenue	Archer Ave.	47th St.
California Boulevard	24th Blvd.	31st Blvd.
California Boulevard	Roosevelt Rd.	18th St.
Campbell Park Boulevard	Oakley Blvd.	Leavitt St.
Central Avenue	State Rd.	103rd St.
Central Avenue	31st St.	Pershing Rd.
Central Avenue	Cermak Rd.	26th St.
Central Park Boulevard	Jackson Blvd.	5th Ave.
Central Park Boulevard	Madison St.	Jackson Blvd.
Central Park Boulevard	West Service Dr.	Garfield Sq.
Chicago Avenue	Thatcher Ave.	Austin Blvd.
Damen Avenue	47th St.	87th St.
Dearborn Parkway	Burton Place	North Blvd.
Diversey Parkway	Cannon Dr.	Oakley Blvd.
Division Street	Thather Ave.	Austin Blvd.
Douglas Boulevard	Independance Sq.	Douglas Park
Drexel Square	Drexel Blvd.	Cottage Grove Ave.
Escanaba Boulevard	Anthony Blvd.	100th Blvd.
Franklin Boulevard	Sacramento Sq.	Central Park Blvd.
Fullerton Parkway	Lincoln Park West	Orchard St.
Fulton Boulevard	Sacramento Blvd.	Central Park Blvd.
Garfield Boulevard	M.L. King Dr.	Western Avenue
Garfield Square Boulevard	Monticello Ave.	Central Park Ave.
Hamlin Boulevard	Lake St.	5th Ave.
Humboldt Boulevard	Palmer Square	North Ave.
Hyde Park Boulevard	Drexel Blvd.	56th St.
Independance Boulevard	Garfield Park	Independance Sq.
Independance Square	Independance Blvd.	Independance Sq.
I-90/94	Express lanes of the	Kennedy Expressway
I-90/94	Express lanes of the	Dan Ryan Expressway
Jackson Boulevard	Austin Blvd.	S Lake Shore Dr.
Jeffery Avenue	Jackson Park	92nd Blvd.
Kedzie Boulevard	Logan Sq.	Madison St.
King Drive	I-94 (Calumet)	115th St.
King Drive	I-90 (Skyway)	US 12/20 (95th St.)
King Drive	26th St.	63rd St.
Lake Shore Drive	Hollywood	Hayes Dr.
Laramie Avenue	Lake St.	I-290
Lincoln Park West	Clark St.	Fullerton Pkwy.
Logan Boulevard	Diversey Pkwy.	Logan Square
Logan Square	Troy St.	Kedzie Blvd.
Loomis Boulevard	47th St.	87th St.
Marine Drive	Sheridan Rd.	Foster Dr.
Marquette Road	IL 50 (Cicero Ave.)	Stony Island Ave.
Marshall Boulevard	Douglas Park	24th Blvd.
Michigan Avenue	Oak St.	Garfield Blvd.
Midway Plaisance	Stony Island Ave.	Cottage Grove Ave.
Normal Boulevard	Garfield Blvd.	72nd St.
North Avenue	Clark St.	East End Turnabout
Oak Park Avenue	North Ave.	Cermak Rd.
Oakley Boulevard	Roosevelt Rd.	North Ave.
Oakwood Boulevard	M.L. King Dr.	Drexel Blvd.
Ogden Boulevard	Oakwood Blvd.	Albany Ave.
Palmer Boulevard	Kedzie Blvd.	Humboldt Blvd.
Pershing Avenue	Kedzie Ave.	Archer Ave.
Pratt Boulevard	Lake Michigan	CNW RR
Randolph Drive	Lake Shore Dr.	Michigan Ave.
Ridge Boulevard	Devon Ave.	Howard St.
Ridgeland Avenue	North Ave.	Roosevelt Rd.
Roosevelt Road	Ashland Blvd.	Ogden Ave.
Sacramento Boulevard	Augusta Blvd.	Douglas Park
Sacramento Square	Sacramento Blvd.	Sacramento Blvd.
Sheridan Road	Melrose St.	Diversey Pkwy.
Sheridan Road	Chicago city limits	Lake Shore Dr. feeder
South Shore Drive	Jackson Park	83rd Pl.
State Parkway	Schiller St.	North Blvd.
Warren Boulevard	Ogden Ave.	Garfield Park
Washington Boulevard	Harlem Ave.	1st Ave.
Washington Boulevard	Canal St.	Austin Blvd.
Western Boulevard	Garfield Blvd.	31st Blvd.
Yates Boulevard	71st St.	87th St.

TABLE 5 TRUCK-RESTRICTED ROUTES DUE TO LOW CLEARANCE (CLEARANCE < 13 ft 0 in.)

Route Name	Overhead Facility	[----- Link closed -----] From	To
16th Street	BRC	IL 50	Kostner
18th Street	ATSF	Wentworth	Clark
18th Street	ATSF	Canal	Wentworth
26th Street	CR	Ryan Feeder	State
43rd Street	CR	Ryan	State
47th Street	IHB	Halsted	Racine
63rd Street	Metra	Ryan	State
67th Street	Metra	Normal	Vincenes
67th Street	CR	State	M.L. King
67th Street	CWI	Halsted	State
71st Street	IC/Metra	Cottage Grove	Stoney Island
71st Street	CWI	Halsted	Normal
71st Street	Metra	Normal	Wentworth
83rd Street	Metra	Halsted	Vincenes
Armitage Avenue	CNW	IL 50	Kostner
Belmont Avenue	Metra	Kostner	Pulaski
Broadway Street	Metra	Western	Francisco
Canal Street	ATSF	Cermak	Archer
Central Avenue	CNW/CTA	Lake EB	Lake WB
Chicago Avenue	CNW	Kedzie	Sacramento
Clyborn Avenue	CNW	Fullerton	Diversey
Colfax Avenue	BRC	95th	93rd
Diversey Avenue	CTA	Lincoln	Halsted
Diversey Avenue	CNW	Damen	Ashland
Elston Avenue	CNW	North	Courtland
Foster Avenue	CNW	Damen	Ashland
Foster Avenue	CTA	Broadway	Sheridan
Fullerton Avenue	Metra	Kostner	Pulaski
Halsted Street	ATSF	Archer	Cermak
Halsted Street	CR	Pershing	43rd
Halsted Street	BN/CNW	16th	Roosevelt
Homan Avenue	CSX	Roosevelt	Eisen
Howard Street	CNW	Clark	Ridge
Howard Street	CTA	Clark	Rogers
Indiana Avenue	IC/Metra	130th	138th
Jeffery Avenue	BRC	95th	93rd
Kedzie Avenue	WC	North Ave.	Armitage
Kedzie Avenue	CNW	Chicago	Augusta
Kimball Avenue	CNW	Addison	Kennedy
Kostner Avenue	BN	Ogden	26th
Lake Street	CTA	IL 50	Kostner
Laramie Avenue	CNW	Lake	Chicago
Lawrence Avenue	CTA	Broadway	Sheridan
Madison Avenue	CNW	California	Western
North Avenue	CNW	Elston	Kennedy
Ogden Avenue	CTA	Cermak	Central Park
Racine Avenue	BN/CNW	16th	Blue Island
Ridge Boulevard	CNW	Peterson	Devon
State Street	CR	63rd	Skyway
Touhy Avenue	CNW	Clark	Ridge

Key to Overhead Facilities:

ATSF	Atchison, Topeka and Santa Fe Railway Company
BN	Burlington Northern Railroad Company
BRC	Belt Railway Company of Chicago
CNW	Chicago and North Western Transportation Company
CR	Consolidated Rail Corporation
CSX	CSX Transportation, Inc.
CTA	Chicago Transit Authority
CWI	Chicago and Western Indiana Railroad Company
IC	Illinois Central Railroad Company
IHB	Indiana Harbour Belt Railroad
Metra	Metropolitan Rail (commuter railroad)
WC	Wisconsin Central

TABLE 6 2010 BASE NETWORK MILES AND NUMBERS OF LINKS ON TOTAL AND RESTRICTED NETWORKS

	[ ---- Total Directional Miles	---- ] Number of Links	[ -- Restricted -- ] Directional Miles	Number of Links
Total	22,450.29	18,036	376.79	568
Facility Type				
Arterial	16,526.12	13,756	329.39	501
Expressway	819.51	768	47.04	65
Ramps	267.52	835	0.00	0
Other	4,837.14	2,677	0.36	2
Functional Class				
Freeway	726.34	634	14.92	10
Major Highway	975.79	833	0.00	0
Area Service	1,388.30	1,190	12.94	19
Principal Arterial	451.63	518	42.54	70
Minor Arterial	3,325.18	3,335	73.73	121
Urban Collector	2,703.49	3,292	209.66	317
Rural Local Road	4,828.83	2,967	22.64	29
Rural Collector	2,943.37	1,758	0.00	0
Other	5,107.37	3,509	0.36	2

TABLE 7 TRAVEL AND CONGESTION FORECAST

Year	VEQ Miles of Travel			Bidirectional Miles of Roadway		
	Total Automobile and Truck	Excess	Congested	Total	Congested	Percent
1980	108,229,548	8,180,174	43,543,539	9,437	1,377	14.59
2010	143,846,969	16,372,952	75,343,521	9,579	2,275	23.75

NOTE: Congestion is defined as exceeding level-of-service D.

TABLE 8 SUM OF TRAVEL TIMES AND DISTANCES BETWEEN ALL 1,542 INTERNAL ZONES

Year	Travel Times (min)			Distances (mi)		
	Unrestricted	Restricted	Percent Increase	Unrestricted	Restricted	Percent Increase
1980	5,397,756.36	5,989,457.71	10.96	3,009,173.30	3,046,229.65	1.23
2010	5,896,105.15	6,503,624.99	10.30	3,237,160.37	3,281,369.49	1.37

TABLE 9 VMT, EXCESS TRAVEL, AND COST DUE TO RESTRICTED NETWORK

	1980	2010
VMT (VEQ mi of travel)		
Unrestricted	7,093,414	7,047,696
Restricted	11,268,955	11,294,243
Percent increase	58.87	60.25
Avg daily excess hours of travel	52,631.73	53,526.75
Avg daily cost to trucking industry (\$)	1,003,844.26	1,016,374.46
Annual cost <sup>a</sup> (\$)	250,961,065.50	254,093,614.88

NOTE: For March 1988 there were 46,319 trucking company employees in the Chicago area. Their average salary was \$14.70/hr. Fuel cost is estimated at \$1.00/gal.

<sup>a</sup>At 250 trading days per year.

The results of the 2010 TSD plan modeling process indicate that congestion is a problem in the Chicago area. From the 1980 simulations, it was estimated that 15 percent of the road mileage was congested, defined by exceeding level of service E. The congested mileage will increase to 24 percent in 2010. As presented in Table 7, 40 percent of the total vehicle miles of travel (VMT) is on congested roads; this will increase to 52 percent in 2010. One of the basic assumptions made in this analysis was that, as trucks (in VEQs) are removed from the restricted routes, they will be replaced by an equivalent number of automobiles (in VEQs). Similarly, where the truck link volumes increase, an equivalent number of automobiles is removed. Therefore, the total congestion on both the restricted and nonrestricted roads is assumed to remain constant. This assumption appears to be reasonable for this analysis because

the modeled unrestricted traffic volumes (which included trucks as VEQs) on truck-restricted routes are close to the actual automobile counts.

## RESULTS

The sum of travel times and the sum of the miles required to travel between each of the 1,542 internal zonal pairs increased from the unrestricted networks to the restricted networks. As presented in Table 8, increases were seen for both 1980 and 2010. The sum of restricted 2010 travel times increased 10.3 percent, and the sum of the miles required to travel increased 1.4 percent. These network characteristics are in minutes and miles. They are not weighted by the number of trips between each zone and converted to vehicle minutes and vehicle miles. For example, a single truck making a trip between a zonal pair will travel an average of 1.4 percent longer distance on a restricted network and will take an average of 10.3 percent more time.

In the original unrestricted network simulations, average trip distances for the four truck classes were calibrated to match the results of the 1986 commercial vehicle survey. However, most of the restricted links, along with many manufacturing facilities, truck terminals, and intermodal yards, are in

the city of Chicago and therefore a significant portion of the large truck travel is in the older portions of the city.

As shown in Table 9, the actual increase in total VMT for the large-truck group, as measured in VEQ, was 60 percent on the restricted network. The economic effects of restrictions and the concentration of truck activity can be seen when the data are broken down to examine the actual average daily excess hours of travel required (53,527 hr for 2010) on a restricted network, the additional truck fuel consumption (250,000 gal), and the average daily cost to the trucking industry (\$1,016,000) from restrictions and circuitous routes.

Tables 10 through 13 present travel times and distances for selected zones in the region for 1980 and 2010 for unrestricted and restricted assignments. Travel times between zones increased more than the miles required to travel, and the effect on trips made from zones in the older, industrial regions of the city (e.g., CATS zone 0330) was larger than the effect on zones in other areas. If the previous routes were based on minimum times in a larger, less restricted network, it is obvious that minimum time paths on a smaller, more restricted network would be less direct and therefore more time-consuming. This rerouting forces trucks off the unrestricted minimum time paths onto slower, more congested parallel or alternative streets.

Table 14 shows that trucks, as a percentage of the total loadings, increased dramatically on the unrestricted links. As

TABLE 10 TRAVEL TIMES BETWEEN SELECTED ZONES: 1980

Zone	To:	Time (min) from:							
		Loop	Roseland	Chicago Heights	Brighton Park	West Lawn	O'Hare	McCook	Aurora
0069	Loop								
	Unrestricted	0.00	27.67	54.74	17.79	26.52	32.56	28.09	64.20
	Restricted	0.00	43.43	70.68	28.70	28.82	34.13	29.77	64.26
0128	Roseland*								
	Unrestricted	24.39	0.00	29.85	22.32	19.90	51.27	36.93	73.14
	Restricted	37.62	0.00	30.28	35.60	25.26	62.83	40.71	75.62
0203	Chicago Heights								
	Unrestricted	51.35	29.64	0.00	50.48	42.97	65.81	46.95	77.51
	Restricted	65.42	29.72	0.00	63.75	48.88	69.77	50.14	77.45
0330	Brighton Park-- 4300 S. Archer								
	Unrestricted	15.94	22.95	51.29	0.00	10.64	40.33	18.09	57.96
	Restricted	28.03	35.61	63.91	0.00	22.64	51.22	28.16	67.42
0346	West Lawn-- 6700 S. Cicero								
	Unrestricted	24.66	20.48	44.81	10.47	0.00	48.58	19.06	60.21
	Restricted	28.22	27.75	49.96	21.65	0.00	49.88	20.52	60.40
0514	O'Hare								
	Unrestricted	33.50	55.18	69.82	42.17	50.55	0.00	33.91	53.34
	Restricted	38.04	66.28	75.73	55.75	53.41	0.00	34.76	53.70
0602	McCook--Summit								
	Unrestricted	26.60	39.12	49.43	18.72	19.40	32.71	0.00	47.00
	Restricted	28.67	41.09	53.73	27.83	19.49	33.34	0.00	46.45
1284	Aurora								
	Unrestricted	63.06	75.78	78.08	59.94	61.59	52.37	47.95	0.00
	Restricted	63.82	77.08	78.09	69.82	62.59	52.88	47.91	0.00
Total	Unrestricted	73,444.34	86,415.35	103,225.98	76,260.06	80,464.06	66,074.88	67,830.42	86,987.00
	Restricted	89,174.69	101,735.68	115,729.07	103,179.49	92,408.82	76,661.09	77,427.23	96,663.10
Mean	Unrestricted	47.63	56.04	66.94	49.46	52.18	42.85	43.99	56.41
	Restricted	54.28	61.92	70.44	62.80	56.24	46.66	47.13	58.83
Percent increase		13.95	10.49	5.22	26.98	7.79	8.89	7.13	4.29

NOTE: Total equals total travel time between Zone *i* and all other zones (1,542) in the six-county region. Mean equals the average travel time between Zone *i* and all other zones.

\*Junction of I-57 and I-94.



TABLE 11 TRAVEL DISTANCES BETWEEN SELECTED ZONES: 1980

Zone	To:	Distance (mi) from:							
		Loop	Roseland	Chicago Heights	Brighton Park	West Lawn	O'Hare	McCook	Aurora
0069	Loop								
	Unrestricted	0.00	13.38	32.24	7.32	11.61	17.84	15.17	40.93
0128	Restricted	0.00	14.93	33.43	8.64	13.03	17.87	15.58	41.09
	Roseland*								
0203	Unrestricted	12.83	0.00	14.30	10.25	9.21	29.83	22.69	43.49
	Restricted	13.40	0.00	14.30	10.21	10.31	34.90	17.05	43.82
0330	Chicago Heights								
	Unrestricted	32.05	14.30	0.00	23.88	22.41	44.38	27.50	51.59
0346	Restricted	34.40	14.30	0.00	31.21	23.41	44.38	29.58	52.09
	Brighton Park- 4300 S. Archer								
0514	Unrestricted	7.01	10.30	23.69	0.00	4.34	21.25	10.31	40.65
	Restricted	6.97	10.26	25.20	0.00	5.27	21.54	10.31	40.98
0602	West Lawn- 6700 S. Cicero								
	Unrestricted	11.62	9.26	22.92	4.34	0.00	30.99	7.50	39.19
1284	Restricted	13.05	10.24	23.92	4.44	0.00	32.29	7.50	40.82
	O'Hare								
0602	Unrestricted	18.60	30.83	46.45	21.71	31.84	0.00	21.29	36.93
	Restricted	18.24	36.08	46.45	22.00	24.01	0.00	21.29	36.93
1284	McCook-Summit								
	Unrestricted	14.92	17.05	30.17	10.35	7.50	20.46	0.00	30.47
1284	Restricted	15.39	17.19	30.41	10.35	7.50	20.51	0.00	30.80
	Aurora								
Total	Unrestricted	41.35	45.97	48.16	41.37	39.67	36.36	31.14	0.00
	Restricted	41.57	45.88	48.33	42.33	40.63	36.58	32.10	0.00
Total		45,798.63	51,899.95	66,424.45	45,617.40	47,807.88	43,702.73	42,024.86	56,621.53
Mean		50,668.00	57,248.28	69,820.66	50,549.09	51,169.93	49,712.62	47,295.22	62,733.58
Percent increase		29.70	33.66	43.08	29.58	31.00	28.34	27.25	36.72
Mean		30.84	34.84	42.50	30.77	31.14	30.26	28.79	38.18
Percent increase		3.83	3.52	-1.35	4.00	0.46	6.76	5.62	3.98

NOTE: Total equals total distance between Zone *i* and all other zones (1,542) in the six-county region. Mean equals the average distance between Zone *i* and all other zones.

\*Junction of I-57 and I-94.

TABLE 12 TRAVEL TIMES BETWEEN SELECTED ZONES: 2010

Zone	To:	Time (min) from:							
		Loop	Roseland	Chicago Heights	Brighton Park	West Lawn	O'Hare	McCook	Aurora
0069	Loop								
	Unrestricted	0.00	31.34	57.32	19.86	28.87	42.12	30.95	71.68
0128	Restricted	0.00	46.58	72.43	34.66	38.08	51.84	37.00	77.31
	Roseland*								
0203	Unrestricted	29.14	0.00	29.39	22.64	20.42	62.52	38.34	80.19
	Restricted	46.72	0.00	29.10	37.92	27.28	71.15	40.38	80.09
0330	Chicago Heights								
	Unrestricted	55.82	29.09	0.00	49.77	42.97	72.35	47.87	81.37
0346	Restricted	72.66	28.94	0.00	64.70	50.47	78.42	51.02	79.39
	Brighton Park- 4300 S. Archer								
0514	Unrestricted	18.58	22.91	50.76	0.00	10.57	48.73	18.58	66.10
	Restricted	30.00	37.71	65.48	0.00	22.13	64.06	28.87	77.41
0602	West Lawn- 6700 S. Cicero								
	Unrestricted	27.08	20.44	44.23	10.35	0.00	54.50	18.83	67.51
1284	Restricted	32.57	25.60	51.41	21.70	0.00	57.53	19.37	69.20
	O'Hare								
0602	Unrestricted	37.99	58.22	76.00	46.23	54.35	0.00	38.85	60.50
	Restricted	47.22	77.22	82.00	62.86	58.04	0.00	40.56	61.56
1284	McCook-Summit								
	Unrestricted	28.17	37.55	49.79	17.52	18.19	38.11	0.00	52.94
1284	Restricted	30.79	39.81	53.67	26.86	18.90	39.87	0.00	53.26
	Aurora								
Total	Unrestricted	67.12	79.43	81.25	63.30	64.87	59.47	51.37	0.00
	Restricted	66.74	78.98	80.21	72.59	65.54	57.28	51.33	0.00
Total		78,842.90	88,608.92	106,066.94	77,747.99	81,019.99	73,998.49	69,961.80	93,886.73
Mean		96,441.44	103,377.58	117,627.35	104,773.42	93,739.93	85,758.38	78,868.34	103,943.60
Percent increase		51.13	57.46	68.79	50.42	52.54	47.99	45.37	60.89
Mean		58.70	62.92	71.59	63.77	57.05	52.20	48.00	63.26
Percent increase		14.80	9.50	4.08	26.48	8.59	8.77	5.80	3.91

NOTE: Total equals total travel time between Zone *i* and all other zones (1,542) in the six-county region. Mean equals the average travel time between Zone *i* and all other zones.

\*Junction of I-57 and I-94.

TABLE 13 TRAVEL DISTANCES BETWEEN SELECTED ZONES: 2010

Zone	To:	Distance (mi) from:							
		Loop	Roseland	Chicago Heights	Brighton Park	West Lawn	O'Hare	McCook	Aurora
0069	Loop								
	Unrestricted	0.00	15.00	32.28	7.70	11.99	17.77	15.55	41.09
	Restricted	0.00	13.96	32.82	7.58	12.88	18.71	15.43	40.97
0128	Roseland*								
	Unrestricted	13.02	0.00	14.30	10.24	9.25	29.83	17.22	43.28
	Restricted	15.21	0.00	14.30	10.21	10.32	34.90	17.08	45.69
0203	Chicago Heights								
	Unrestricted	32.24	14.30	0.00	22.98	22.41	44.38	27.50	47.88
	Restricted	34.68	14.30	0.00	25.82	23.41	44.38	27.50	52.80
0330	Brighton Park- 4300 S. Archer								
	Unrestricted	7.20	10.25	25.78	0.00	4.34	20.98	10.31	44.73
	Restricted	7.69	10.21	25.89	0.00	4.34	23.38	10.31	41.92
0346	West Lawn- 6700 S. Cicero								
	Unrestricted	11.64	9.21	21.50	4.34	0.00	30.99	7.50	43.27
	Restricted	13.26	10.27	24.31	4.38	0.00	30.99	7.50	40.46
0514	O'Hare								
	Unrestricted	17.19	29.78	45.03	23.05	23.74	0.00	16.12	34.70
	Restricted	19.04	40.50	46.45	21.26	22.55	0.00	20.63	34.70
0602	McCook-Summit								
	Unrestricted	15.11	17.03	28.75	10.35	7.50	20.46	0.00	28.32
	Restricted	15.60	17.08	30.17	10.35	7.50	20.46	0.00	28.32
1284	Aurora								
	Unrestricted	41.35	45.97	48.06	41.41	39.71	35.72	31.18	0.00
	Restricted	41.36	45.68	52.38	41.05	39.35	35.72	29.26	0.00
Total									
	Unrestricted	45,768.43	51,775.31	64,947.16	46,554.89	46,040.26	41,446.66	41,506.43	56,805.55
	Restricted	52,392.58	60,912.32	70,429.54	51,195.16	51,372.12	47,521.60	45,654.51	62,694.45
Mean									
	Unrestricted	29.68	33.58	42.12	30.19	29.86	26.88	26.92	36.84
	Restricted	31.89	37.07	42.87	31.16	31.27	28.92	27.79	38.32
Percent increase		7.44	10.41	1.78	3.21	4.72	7.61	3.23	4.03

NOTE: Total equals total distance between Zone *i* and all other zones (1,542) in the six-county region. Mean equals the average distance between Zone *i* and all other zones.

\*Junction of I-57 and I-94.

large-truck trips were removed from the restricted roads, the trips were forced onto unrestricted roads. As presented in Table 14, the level of truck activity on unrestricted roads showed a significant increase when this shift occurred. For example, in 1980 the average percentage of large trucks (in VEQ) over the total assignment load was 7 percent (on the unrestricted expressway sections). After the trucks were removed from the restricted links and forced onto unrestricted roads, this value increased to 28 percent. In the case of express lanes, most trucks were shifted to the local, unrestricted lanes. In the case of arterial restrictions, trucks were forced onto parallel arterial sections.

**RECOMMENDATIONS**

Truck restrictions significantly affect the vehicle mix on unrestricted roadways and increase the travel times of total (and individual) truck movements. Therefore, proposed restrictions or removal of restrictions should not be viewed in isolation. Methods of accounting for truck travel and truck restrictions throughout the planning process must be explored. The processes that define commercial vehicles by size and weight, account for restrictions in network coding and simulation, and determine the VEQ factors should be evaluated so that restrictions that do not adversely affect traffic can be chosen or removed.

Restrictions increase the costs of transportation. These increases inflate the cost of goods to manufacturers and eventually to end users. The excess fuel consumption (and corresponding increase in pollution) caused by these inefficiencies could also be a significant factor. However, these negative consequences must be balanced against the many social, political, and economic pressures that support the benefits of truck restrictions, such as residential quality of life, pedestrian and automobile safety, and the cost of removing restrictions (e.g., viaduct rehabilitation or reconstruction and a possible increase in automobile-truck accidents).

Truck restrictions can be seen as a proactive measure, such as designating specified truck routes, or as a reactive measure, such as restricting truck traffic to allow commuters and automobiles to have access to larger levels of roadway capacity. In many cases, the restrictions are part of the historical nature of the road system and do not change with employment and housing patterns. Planners and highway agencies do not have to reevaluate the truck impact and the automobile-truck conflicts every few years to validate the original reasons for specific truck restrictions. However, agencies should be prepared to respond to questions concerning specific restrictions.

Two choices planners have in directing commodity flow (e.g., hazardous materials and steel coils) are to implement a designated or preferred truck route network or to restrict one set of roads while improving access on alternative or preferred routes. The process of implementing such plans on

TABLE 14 AVERAGE PERCENTAGE OF LARGE TRUCKS (IN VEO) (FOR UNRESTRICTED 1980 NETWORK LINKS ONLY)

Facility Type	Unrestricted	Restricted	# of Obs.
Arterial	0.72 %	5.01 %	13,332
Expressway	6.79 %	28.10 %	732
Ramps	2.03 %	12.58 %	762

Functional Class	Unrestricted	Restricted	# of Obs.
Freeway	6.98 %	29.57 %	653
Major Highway	1.90 %	6.88 %	841
Area Service	1.04 %	5.28 %	1,177
Principal Arterial	0.97 %	5.04 %	454
Minor Arterial	0.67 %	5.32 %	3,242
Urban Collector	0.63 %	6.34 %	2,997
Rural Local Road	0.45 %	3.45 %	2,942
Major Collector	0.80 %	4.37 %	1,257
Minor Collector	0.57 %	3.50 %	508

(for the Unrestricted 2010 Network Links only)

Facility Type	Unrestricted	Restricted	# of Obs.
Arterial	0.58 %	4.20 %	13,247
Expressway	6.02 %	24.85 %	701
Ramps	1.60 %	8.75 %	754

Functional Class	Unrestricted	Restricted	# of Obs.
Freeway	6.20 %	26.36 %	625
Major Highway	1.70 %	6.22 %	833
Area Service	0.93 %	4.58 %	1,171
Principal Arterial	0.69 %	4.38 %	448
Minor Arterial	0.57 %	4.63 %	3,214
Urban Collector	0.46 %	5.00 %	2,975
Rural Local Road	0.37 %	2.98 %	2,930
Major Collector	0.57 %	3.30 %	1,251
Minor Collector	0.46 %	2.90 %	507

a large scale in mixed-use neighborhoods requires a significant level of coordination and continual interplay among representatives of the community, industry, land use planners, and transportation agencies.

As part of the 2010 TSD plan, CATS has developed a network of strategic regional arterials. This 1,300-mi network will be studied over the next 5 years. One of the key elements in the plan of study for these arterials will be an evaluation of the long-haul truck traffic options.

Other truck restriction programs, such as restrictions that are based on the hour of day or number of trucks, may require an exorbitant level of personnel to administer. Although the elimination of some current restrictions (e.g., increased viaduct clearances) is generally supported for economic and safety reasons, such activities will change traffic patterns and should be evaluated.

It has been shown that truck restrictions can be reasonably incorporated into the traditional travel demand modeling process. The effect of truck restrictions on model outputs is significant on the regional level. To provide more effective

regional transportation system plans, analysts must consider the effect of restrictions and the ways they affect unrestricted, alternative roads and other transportation-related activities.

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