FREIGHT TRANSPORTATION STUDY

Indianapolis Metropolitan Planning Area

Multimodal Freight Mobility

Planning Research Studies

Task 3 - White Paper

IDENTIFICATION OF REGIONAL FREIGHT BOTTLENECKS

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The Indianapolis Metropolitan Planning Organization

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Task 3: Identification of Regional Freight Bottlenecks

Introduction

Regular and irregular conditions, resulting in delays on the nation's roads and highways, were estimated to cost the U.S. motor carrier industry approximately $7.3 billion in 2006[1]. This figure, derived from an hourly cost of $32.15, is inclusive of both wages and wasted fuel. This equates to over 227 million hours of lost time to the industry, as a result of delays and congestions. A more recent 2009 ATRI study states that motor carrier overall costs of operation are $83.68 per hour or $1.73 per mile. In addition to these tangible impacts, softer and values less open to quantitative analysis are negatively influenced. In the regional, national, and global economies, shippers are faced with increasing competitive pressures. Availability of materials and cargo to the consumer is a significant factor in the capture and retention of business revenues. Difficult to identify is the lost revenues resulting from the carrier's inability to adequately service the shipper to receiver movement. Where predicted delay occurs, route assignment may be adapted to overcome the known or regularly occurring delay. This solution, though not typically an immediate cost to the cargo owner, is a direct and additional cost to the motor carrier and will eventually be passed on to the general shipping public through higher invoicing charges.

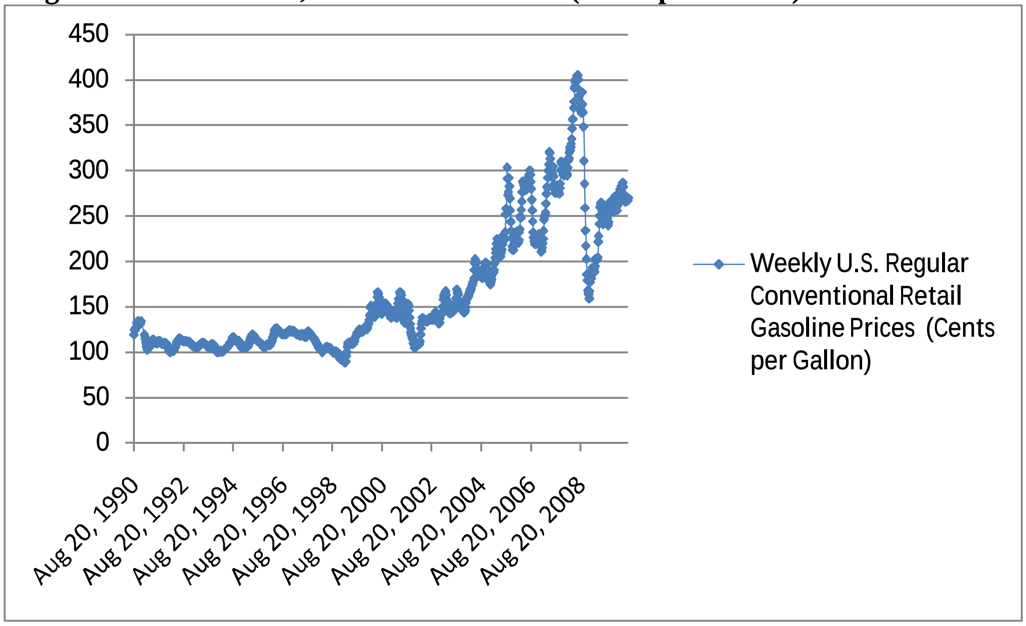
To better appreciate the effects of delays, a view to the extent that these detract from the total driving environment is necessary. Truck movement is not an independent activity and takes place with vehicles of all types. In the 439 urban areas, identified by the University Transportation Center for Mobility, Texas Transportation Institute[2], in 2007, an $87.2 billion loss was experienced, across all road users, as a result of delays. These were observed as delivery time variance, missed engagements, voluntary and involuntary relocations and other lost time events. This compares to $63.1 billion in 2000 (in 2007 dollars). The two components of this delay measure, wasted fuel (additional fuel as a result of delays) and lost time were measured at:

- 2.8 billion gallons of fuel
- 4.2 billion hours of lost time

The cost effects of wasted fuel can be exponential in their impact during conditions of higher fuel prices. As illustrated most prominently in 2008, consumer fuel prices have become more volatile. From 1990 to July 2010, gasoline pricing has fluctuated, most noticeably, from 1999 to the present, **Figure 1**.

[1] July 30, 2010, http://www.fhwa.dot.gov/policy/otps/freight.cfm
[2] *Urban Mobility Report 2009*, UTCM, TTI, July 2009, David Schrank and Thomas Lomax

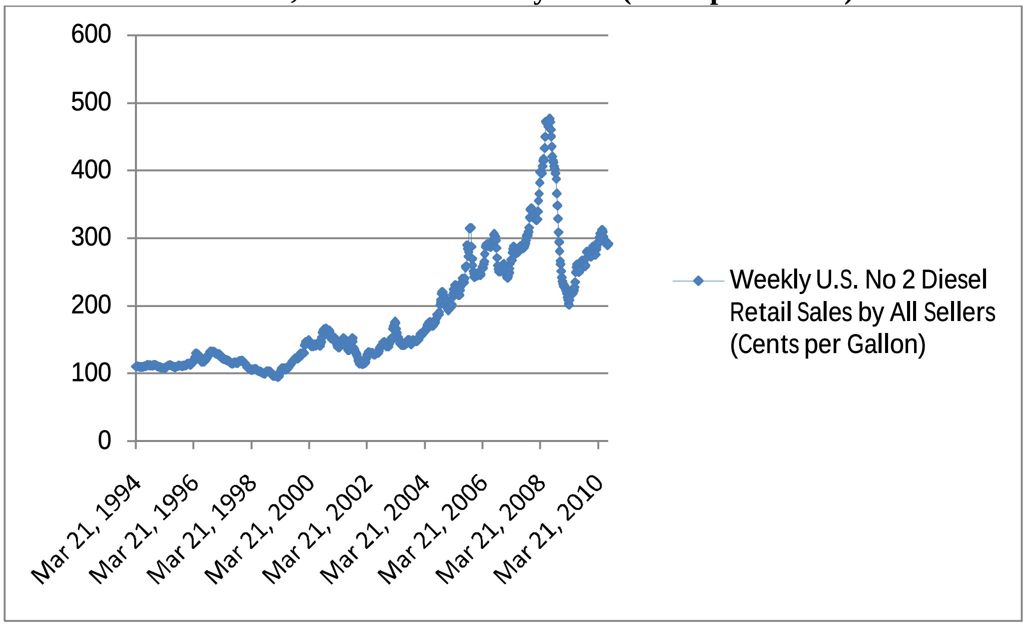
Figure 1: Regular Gasoline Price, U.S. 1990 thru 2010 (Cents per Gallon)



Source: U.S. Energy Information Administration, July 30, 2010, http://www.eia.doe.gov/oog/info/gdu/gasdiesel.asp

Diesel prices have fared similarly during the period beginning 1999 thru July 2010. The earliest year the U.S. Department of Energy provided weekly data was 1994, **Figure 2**.

Figure 2: Number 2 Diesel Price, U.S. 1994 thru July 2010 (Cents per Gallon)



Source: U.S. Energy Information Administration, July 30, 2010, http://www.eia.doe.gov/oog/info/gdu/gasdiesel.asp

Therefore, the cost of 2.8 billion gallons, in August of 2010, would be approximately $7.7 billion (at an average cost per gallon of gasoline or diesel of $2.75). With 2.8 billion gallons of fuel, in conjunction with the resulting green house gases (GHG) and emissions released and the effects on both natural and social environments, the identification of delays for future prioritization and assignment of appropriate mitigation strategy is of significant importance.

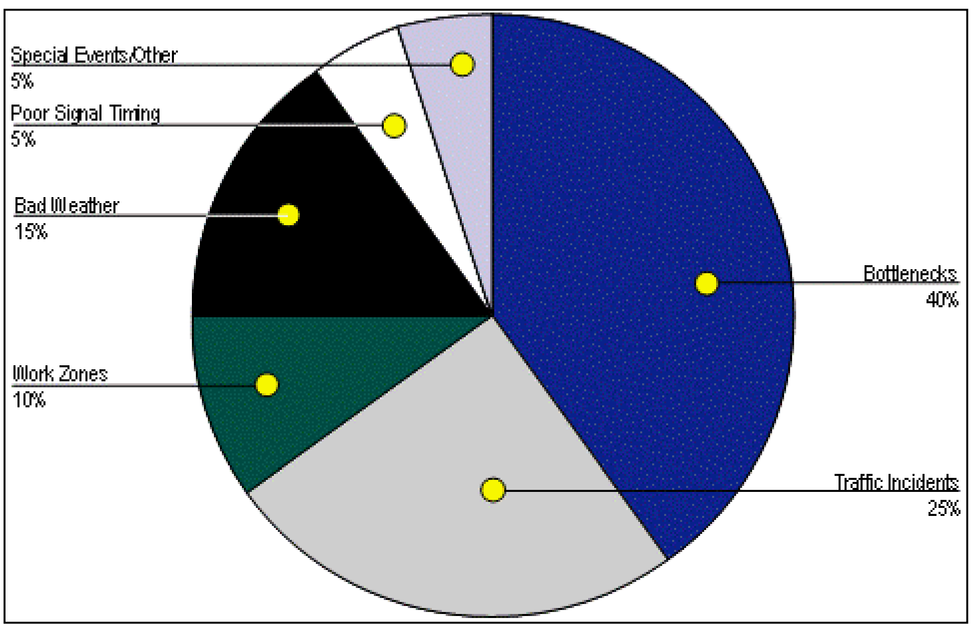
Types of Delay

Two forms of delay exist, non-recurring and recurring. Non-recurring are delays caused by single episode events. These may be a crash completely or partially blocking a given length of roadway until clean-up efforts are concluded; or a special event such as a weather delay or sporting event. Each delay can be somewhat unique. This uniqueness may not allow for the road user to adapt their route selection to avoid and thus delay is incurred.

Recurring delays are typically not representative of a single event. These are conditions that exist repetitively and are predictable to some degree. Common illustrations are infrastructural; lane reduction, inadequately timed signals, and restrictive turning radii, as they relate to truck navigation of an intersection. These are also inclusive of non-“concrete” causes; rush hour, presence of schools or residential areas, and industrial or commercial zones, where the arrival and departure of work shifts can disrupt otherwise navigable travel.

The Federal Highway Administration (FHWA) describes the contribution to delays or congestion by recurring conditions as 45 percent. This includes five percent as poor signal timing and forty percent as bottleneck, **Figure 3**.

Figure 3: Sources of Congestion (National Summary) 2002



Source: U.S. Department of Transportation, July 30, 2010, http://ops.fhwa.dot.gov/congestion_report/chapter3.htm

Bottlenecks

Bottlenecks can be present as specific points along a roadway otherwise determined to be free flowing. That these occur in such finite locations and, in conjunction with roadways where volume to capacity ratios (V/C) are considerably less than a value of 1.0[3], in national or regional studies of the most impacted bottlenecks, Indianapolis fares considerably better than other metropolitan areas. In the American Transportation Research Institute's (ATRI) 2009 analysis of the 100 most severe bottlenecks in the U.S., none are located in the state of Indiana. This is replicated throughout several additional studies, including the Urban Mobility Report 2009[4].

Unlike the conditions experienced in those metropolitan areas where bottlenecks have significantly impacted the ability of that transportation system to provide a quality service, Indianapolis is in a position to address bottlenecks prior to disruptions of national significance. These bottlenecks, identified by additional studies and stakeholder inputs, have real impacts on the current system. Referring back to the FHWA assignment of costs in 2002, $32.15 per hour in delay, and considering the more recent 2009 ATRI study, that motor carrier overall costs of operation are $83.68 per hour or $1.73 per mile, these emerging bottlenecks may have already begun to influence the competitiveness of the local freight community, as carriers modify pricing to recoup increased costs.

Identification

Three source materials were utilized to identify the locations of existing bottlenecks in the Indianapolis MPO region. These include: Level of Service (LOS) analysis for general traffic as a whole and for commercial vehicles exclusively; bottleneck analysis identified from previous studies; and, bottlenecks identified by operators of commercial vehicles within the region.

Level of Service (LOS)

This review process reflects the current capabilities and data resources readily available to the MPO. Encompassing a comparison of identified locations of LOS F and >F (significantly worse than F) with land use designation, a reliable predictor of those locations where truck activity would be expected can be made. Much of LOS based bottleneck studies, unless specific truck travel time data is available, specify locations of general traffic conditions. Without sufficient granularity to the arterial, collector, and local roadways when viewing AADT for truck percentages, comparing land use that is equated to higher levels of freight activity to those LOS conditions can provide the user with a strong prediction of truck activity.

Comparing land use designations with much of the available AADT and LOS conditions better than F (ranging from A to E), can assist in the identification of roadway usage, though lacking significant volumes, where truck could be an expected high percentage of the vehicle count.

LOS is defined as a qualitative description of roadway operation based on delay and maneuverability. It can range from "A" representing free flow conditions to "F" representing gridlock[5]. The element of maneuverability is measured as the ability of traffic to efficiently and effectively change lanes and traverse the roadway's design. When selecting a standard, many metropolitan areas assign a level of “C” as acceptable or as the lowest level of performance before improvement enhancements are evaluated and acted upon. Significant portions of the interstate and arterial roadways within the Indianapolis MPO region experience “C” thru “F” conditions during peak travel conditions.

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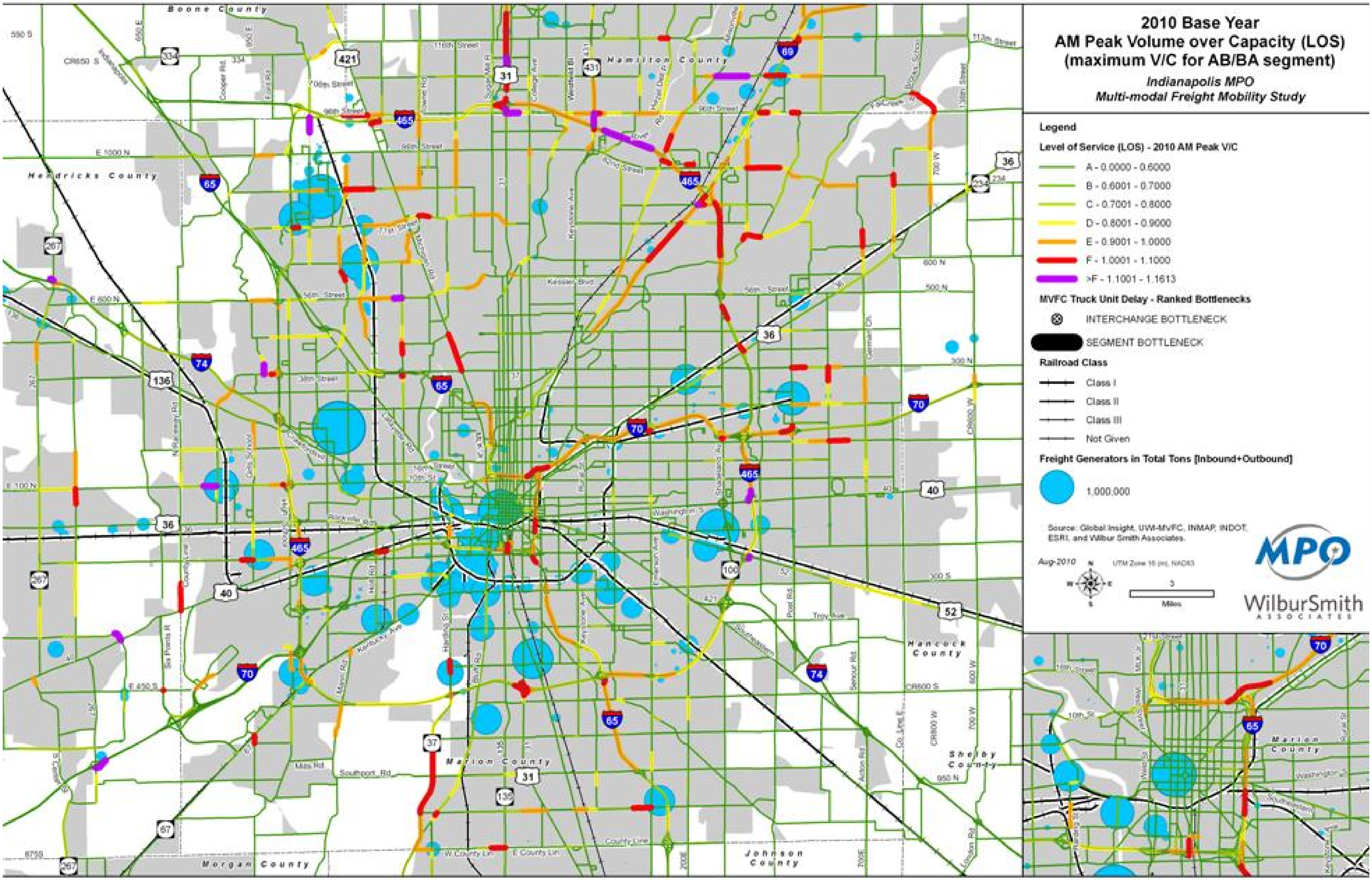
[3] Total traffic volume capacity / Total traffic volume = Volume-Capacity Ratio: As values approach or exceed one, roadway design capacity becomes a hindrance to free flow conditions.
[4] *Urban Mobility Report 2009*, UTCM, TTI, July 2009, David Schrank and Thomas Lomax
[5] August 4, 2010, www.dot.ca.gov/dist4/sfobb/appendixD.html

With fluctuating capacity needs during the span of 24 hours of roadway operations, LOS is typically established during peak volume hours. The two peak periods, “AM”, between 6:00 a.m. local and 9:00 a.m. local, and “PM”, between 4:00 p.m. local and 7:00 p.m. local, were used to evaluate conditions that illustrate bottlenecks. As LOS describes maneuverability and that maneuverability is directly a result of the presence of increased traffic volumes, the formula of “*Total Traffic Volume / Total Capacity Volume”* describes the traffic moving from free flow to grid lock. As the volume of traffic increases, the V/C ratio approaches, or exceeds, 1.0. During the peak volume levels experienced during the AM peak period, **Figure 4**, in consideration of all vehicle types, the region experiences significant segments of LOS D thru F in the northern and eastern areas of the region.

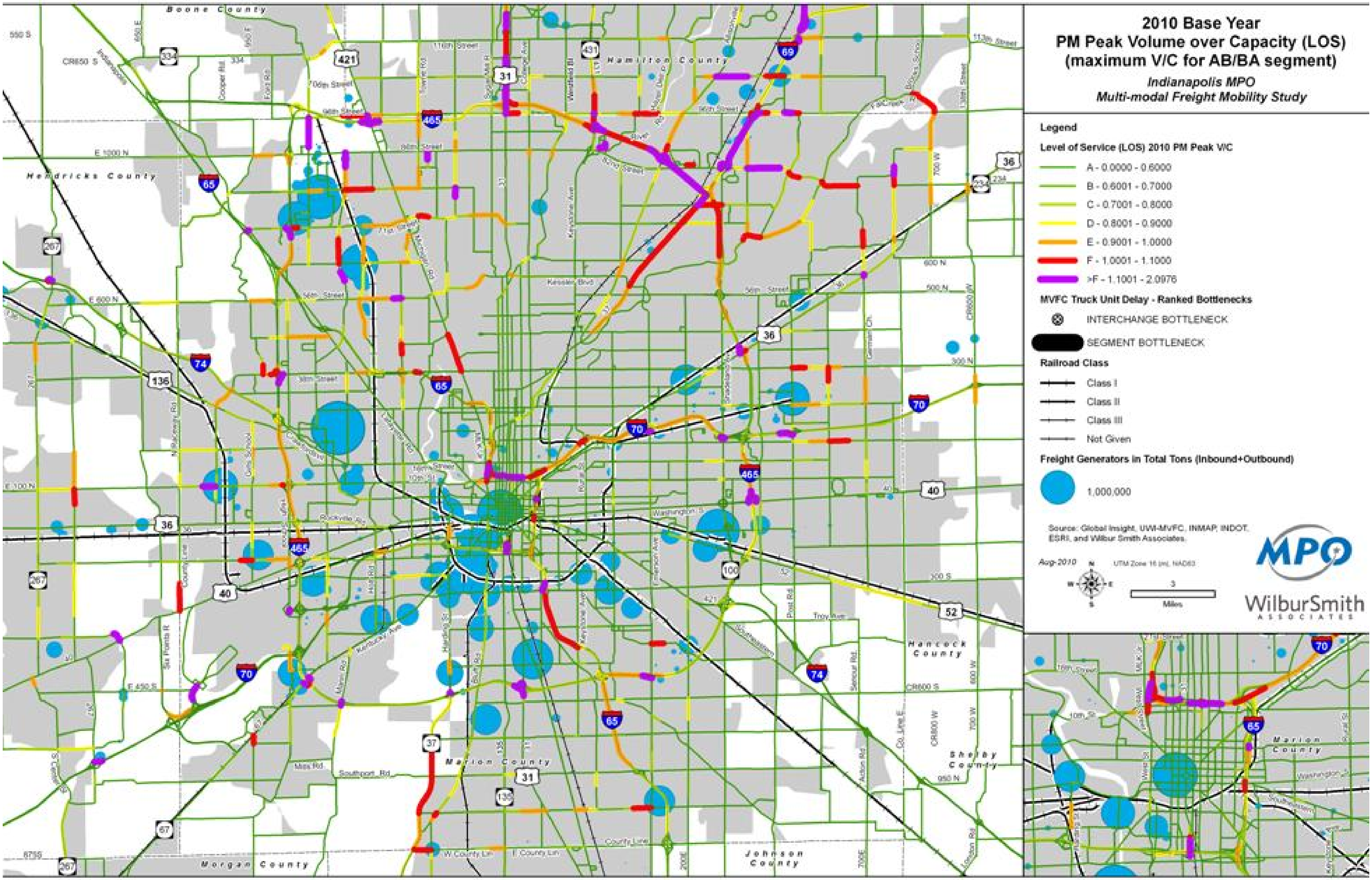
Continuing this same view towards overall traffic LOS, during the PM Peak period, **Figure 5**, conditions in these same two areas are noticeably poorer in performance. In conjunction with this degradation, the southern and western areas do not experience this general worsening of level of service. **Figure 6** provides a view of the region as whole.

igure 4: AM Peak Level of Service (LOS) Performance, 2010 Base Year



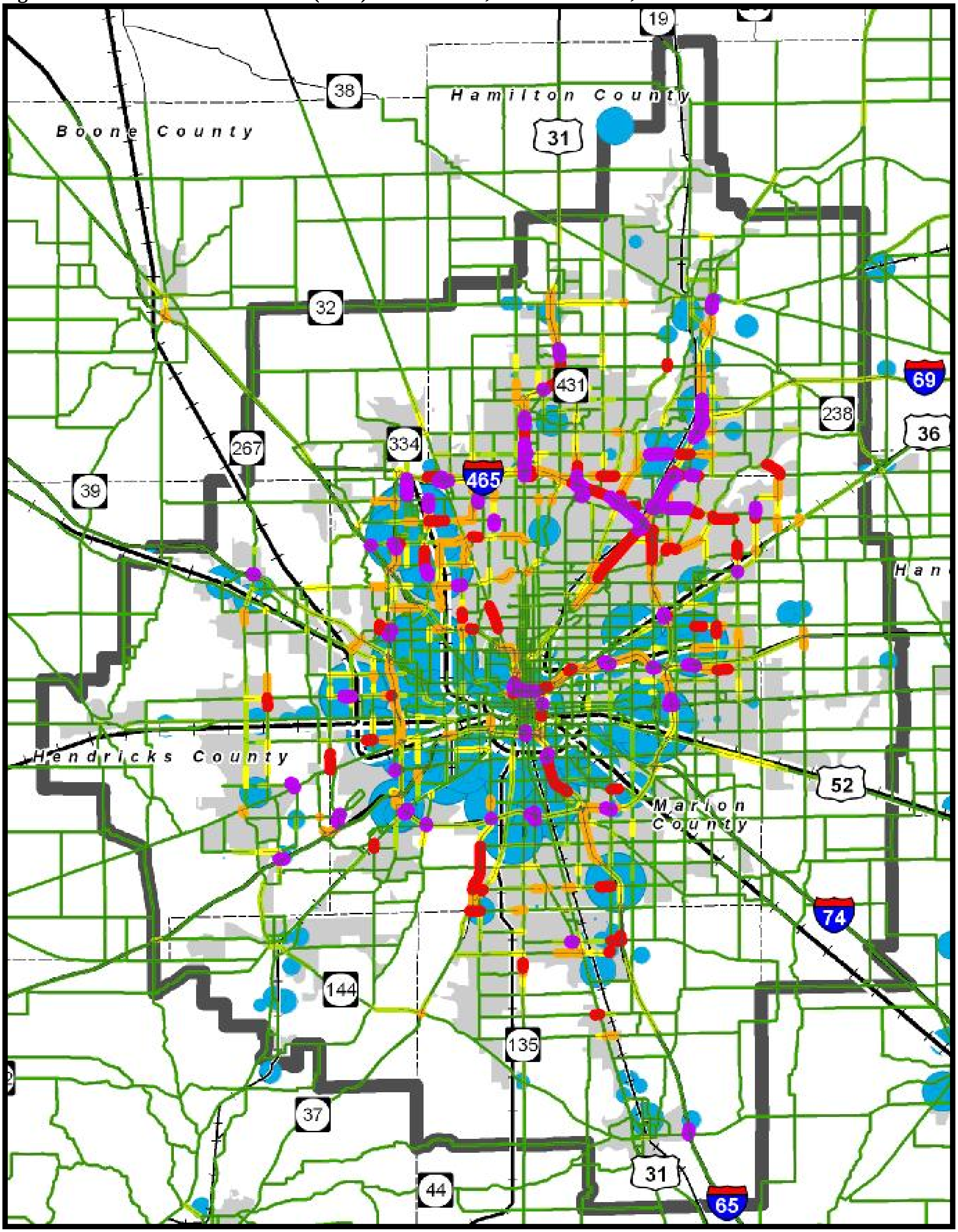
ource: INDOT, Indianapolis MPO, Wilbur Smith Associates

igure 5: PM Peak Level of Service (LOS) Performance, 2010 Base Year



ource: INDOT, Indianapolis MPO, Wilbur Smith Associates

Figure 6: PM Peak Level of Service (LOS) Performance, 2010 Base Year, MPO Wide View



Source: INDOT, Indianapolis MPO, Wilbur Smith Associates

Citing conditions where LOS D thru F exists adjacent to significantly improved upstream roadway segments provides a layman's approach to identifying problematic areas. These areas may reveal road segments where less travel lanes exist, reduced posted speeds in response to land use, road design, or public sentiment exist, notable grade changes, and even where roadways direct the vehicle operator's line of sight into the path of the rising or setting sun. Each of these would be recurrent conditions requiring mitigation strategies.

An additional characteristic of Point versus Continuous is applicable to this review. Point identifies the bottleneck as resulting from a fixed location. This location may again be where a lane reduction occurs or specific signal light is present. Continuous is the result of not one fixed obstacle to the flow of traffic but may be a culmination of effects along a segment of roadway. These are more formally defined as interferences with the free flow of traffic volumes along a facility that do not occur along the entire length of the facility. These may be the presence of sequential retail outlets, multiple interchanges or intersections within close proximity of each other or similar events that, together, restrict the flow of traffic.

This identification begins the process of narrowing bottlenecks to those that influence truck movement by generating the greatest number of possible locations.

Readily Identified Bottlenecks

These readily identified through an evaluation of LOS, are done so during evaluation of the PM Peak period. With the highest level of concentrated vehicular activity occurring during this period, the greatest number of and the highest level of contrasting flows may be identified. Utilizing the LOS standard of F or greater than F, seventy-four total bottlenecks are identified. Fifty-one are point and twenty-three are continuous, **Table 1**.

Table 1: Bottlenecks Identified Using Level of Service (LOS)

POINT OR CONTINUOUS	LOCATION	POOREST LOS	CORRIDOR MOST IDENTIFIED WITH BOTTLENECK EFFECT
Point	Allisonville Road and I-465	>F	Allisonville Road
Point	S Emerson Drive and E Stop 11 Road	F	E Stop 11 Road
Point	Eagle Creek Parkway and W 38th Street	F	Eagle Creek Parkway
Point	Fall Creek Road and Brooks School Road	F	Fall Creek Road
Point	E 65th Street and Fall Creek Road	F	Fall Creek Road
Point	Georgetown Road and W 86th Street	>F	Georgetown Road
Point	Georgetown Road and W 62nd Street	>F	Georgetown Road
Point	I-65 and E Raymond Street	>F	I-65
Point	E New York Street and I-65/70	>F	I-65/70
Point	E 116th Street and I-69	>F	I-69
Point	I-70 and Perimeter Road	>F	I-70

POINT OR CONTINUOUS	LOCATION	POOREST LOS	CORRIDOR MOST IDENTIFIED WITH BOTTLENECK EFFECT
Point	Madison Avenue and I-70	>F	Madison Ave
Point	W 10th Street and N Dan Jones Road	F	N Dan Jones Road
Point	Nabb Road and W 86th Street	>F	Nabb Road
Point	North Keystone Ave and 96th Street	>F	North Keystone Ave
Point	Oaklandon Road and Fox Road	>F	Oaklandon Road
Point	North Keystone Ave and I-465	>F	Shared
Point	I-69 and I-465	>F	Shared
Point	I-465 and US Highway 36	>F	Shared
Point	I-70 and N Post Road	>F	Shared
Point	I-70 and N Shadeland Ave	>F	Shared
Point	I-465 and US Highway 40	>F	Shared
Point	I-70 and N Emerson Ave	>F	Shared
Point	I-465 and S Emerson Drive	>F	Shared
Point	US Highway 31 (S East Street) and I-465	>F	Shared
Point	S Harding Street and I-465	>F	Shared
Point	I-465 and Mann Road	>F	Shared
Point	I-465 and Kentucky Ave	>F	Shared
Point	I-70 and Quaker Blvd	>F	Shared
Point	I-65 and IN 44	>F	Shared
Point	I-65 and County Road 950 N	F	Shared
Point	IN 135 and W Fairview Road	F	Shared
Point	US Highway 31 and Tracy Road	F	Shared
Point	N Green Street and I-74	>F	Shared
Point	W 38th street and I-465	>F	Shared
Point	Michigan Road and I-465	>F	Shared
Point	W 71st Street and I-465	>F	Shared
Point	W 71st Street and I-65	>F	Shared
Point	W 38th Street and I-65	F	Shared
Point	I-69 and IN 37	>F	Shared
Point	IN 37 and Greenfield Ave	>F	Shared
Point	E Washington Street and I-65/70	F	Shared
Point	Sunnyside Road and Pendleton Pike	>F	Sunnyside Road
Point	US Highway 31 and 96th Street	>F	US 31
Point	US Highway 31 and I-465	>F	US 31
Point	US Highway 31 and Keystone Avenue	>F	US 31

POINT OR CONTINUOUS	LOCATION	POOREST LOS	CORRIDOR MOST IDENTIFIED WITH BOTTLENECK EFFECT
Point	W 10th Street and N Racetrack Way	>F	W 10th Street
Point	I-465 and W 10th Street	F	W 10th Street
Point	W 56th Street and Cooper Road	>F	W 56th Street
Point	W 71st Street and Township Line Road	F	W 71st Street
Point	South Girls School Road and W Morris Street	F	W Morris Street
Continuous	96th Street, Gray Road and Hazel Dell Pkwy	F	96th Street
Continuous	Ditch Road, Grandview Drive and W 79th Street	>F	Ditch Road
Continuous	E 106th Street, Allisonville Road and E 7th	>F	E 106th Street
Continuous	E 106th Street, Crosspoint Blvd and Cumberland Road	F	E 106th Street
Continuous	E 21st Street, Faithaven Drive and N Mitthoeffer Road	F	E 21st Street
Continuous	E 38th Street, N Post Road and N Mitthoeffer Road	F	E 38th Street
Continuous	E 82nd Street, Hague Road and Sargent Road	>F	E 82nd Street
Continuous	E 82nd Street, Fall Creek Road and Sunnyside Road	F	E 82nd Street
Continuous	E Churchman Ave, S Emerson Drive and Ritter Street	F	E Churchman Ave
Continuous	I-465, E 75th Street and Fall Creek Road	F	I-465
Continuous	I-65, Exit 114 and I-70	>F	I-65
Continuous	I-65, S Keystone Ave and E Raymond Street	F	I-65
Continuous	I-69, 96th Street and E 82nd Street	>F	I-69
Continuous	I-69, I-465 and Kessler Blvd E Drive	F	I-69
Continuous	IN 37, W Banta Road and W County Line Road	F	IN 37
Continuous	Kessler Blvd N Drive, W 42nd Street and W 44th Street	F	Kessler Blvd N Dr
Continuous	Mendenhall Road, Milhouse Road and Kentucky Ave	F	Mendenhall Road
Continuous	N Michigan Road, W 38th Street and Cold Spring Road	F	N Michigan Road
Continuous	S Raceway Road, E County Road 200 S and US Highway 40	F	S Raceway Road
Continuous	Sunnyside Road, Indian Lake Blvd S and E 63rd Street	F	Sunnyside Road

POINT OR CONTINUOUS	LOCATION	POOREST LOS	CORRIDOR MOST IDENTIFIED WITH BOTTLENECK EFFECT
Continuous	Township Line Road, Smith Road and E Main Street	>F	Township Line Road
Continuous	W 79th Street, Georgetown Road and N Payne Road	F	W 79th Street
Continuous	Zionsville Road, W 96th Street and Mall Entrance (Approx 6766 Zionsville Road)	>F	Zionsville Road

Commercial Vehicle Activity

Two types of commercial vehicle or truck activity impact the existence of bottlenecks in the region; through and local. Through traffic is trucks originating their trip from outside the region and destined to points outside the region. Typically utilizing the interstate or U.S. highway network, these trucks contribute only slightly to the non-interstate roadway congestion and delay. Significant contributors are trucks originating and/or destined to points within the area. These drivers have more potential to be aware of local roadways and alternative routes that will allow them to access the interstate system or remain on the arterial, collector, and even local functional class infrastructure.

To understand the potential use of a roadway, by an individual or collection of truck operators, appreciation of the location of freight generation nodes, or land use designated parcels that participate in truck related movements, is required. Noted in purple, blue and red in **Figure 7** are the areas within the region with high levels of expected freight activity. These begin to present a picture of where truck activity is attempting to gain access. These are representative of manufacturing, industrial, commercial and other distribution activities. Light green and grey are locations of offices, institutions or utilities where freight movement is lower. These areas can also be expected to influence traffic performance. Yellows and brown are residential areas. Though not normally considered, these generate light truck activity through local residence deliveries of goods and services.

Figure 8 illustrates, in greater detail the region's areas where medium and high levels of freight activity would be expected to exist. Though the land use of higher activity levels is sparsely present in all quadrants of the MPO region, the larger zones of high intensity activity are:

- Northwest, inside of I-465: encompassed by I-465, I-65, and Michigan Road
- Southwest, inside of I-465: encompassed by I-465, I-70, and IN 31
- Southwest, outside of I-465: encompassed by I-465, I-70, and IN 267

Medium intensive activity is likewise largely represented by several concentrated areas:

- Northwest, outside of I-465: I-465, I-74, I-65 and the county line between Boone and Marion are the boundaries
- Southwest, outside of I-465: encompassed by I-465, US 40, IN 67 and the MPO's own boundary
- Northeast, outside of I-465: encompassed by I-465, I-69, and IN 67, within Marion County

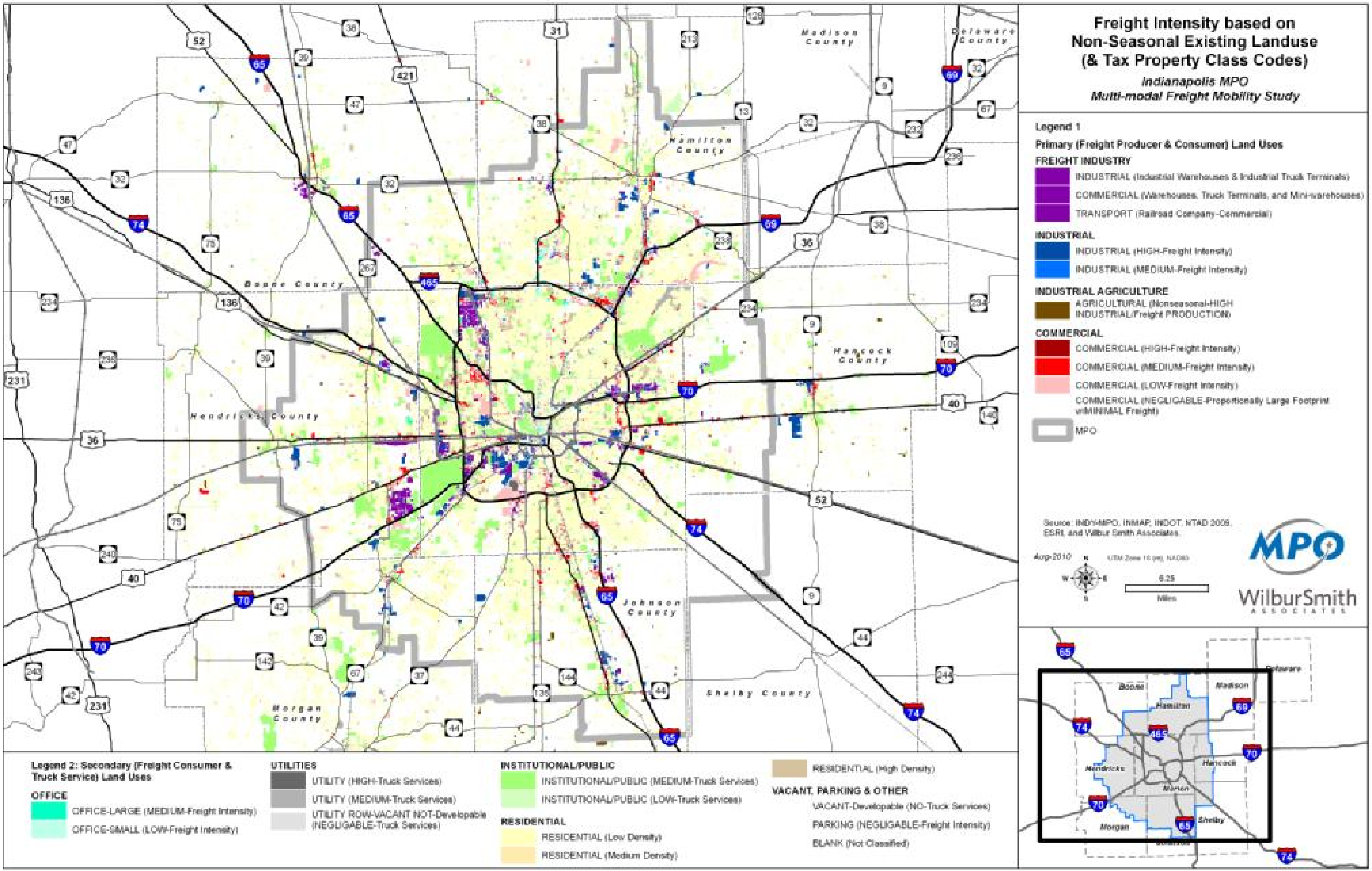
In all levels of activity there are other, less dense nodes of activity that contribute to truck traffic in the region.

Indiana Department of Transportation (INDOT) maintains truck activity records for only major roadways within the MPO, **Figure 9**. This lack of more granular data allows this data to only illustrate part of, but a continuing pattern of greater truck activity in the areas around freight generator nodes. This data does, however, include through truck movement, thus interstate volumes are inflated as a result.

Comparative Analysis – Level of Service and Freight Intensive Activities

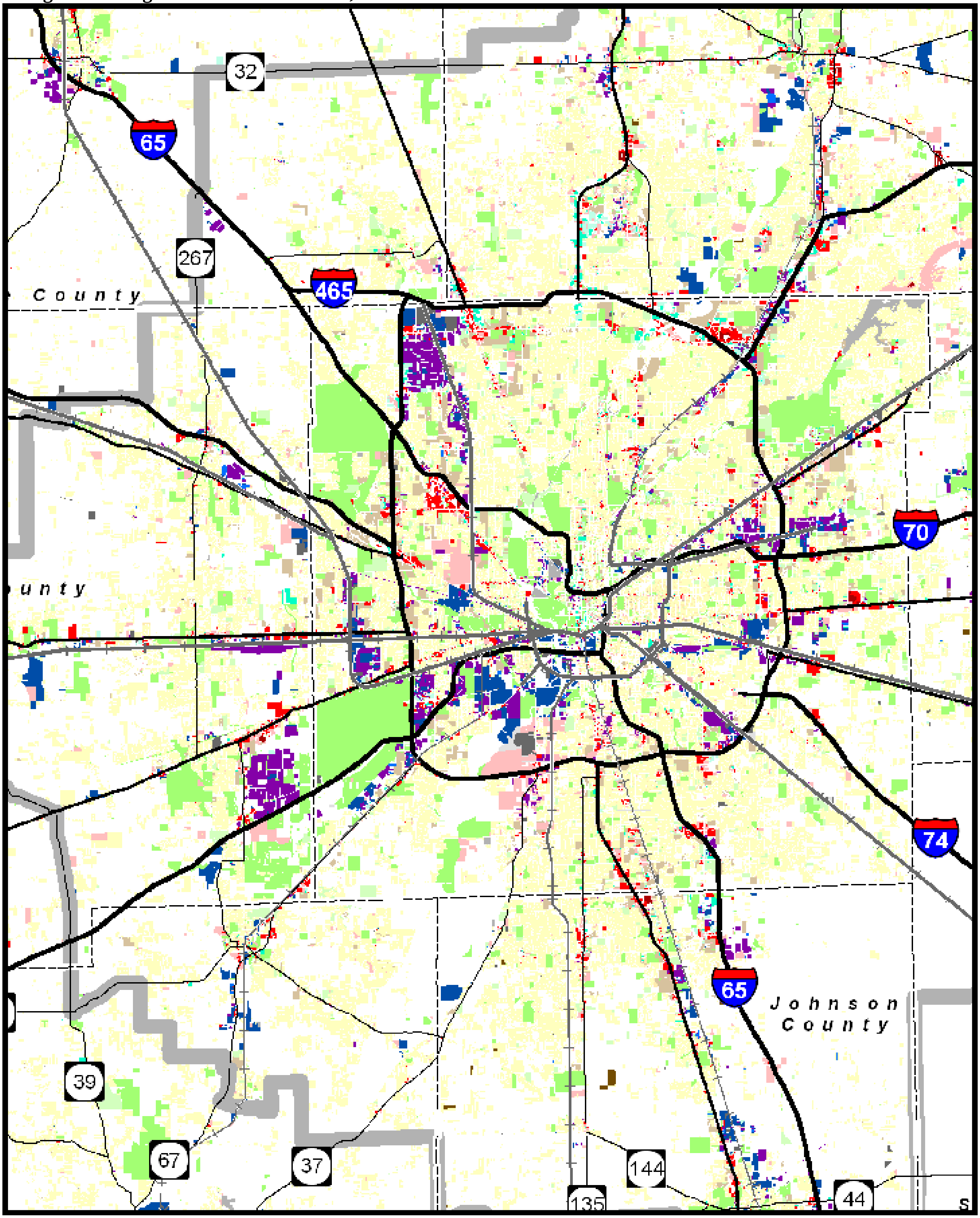
The ability to overlay current LOS data with those land use designations of high and medium freight activity emphasizes those expected bottlenecks affecting truck traffic, **Figure 10**.

Figure 7: Freight Generators Within the MPO Region by Land Use Parcel Designation



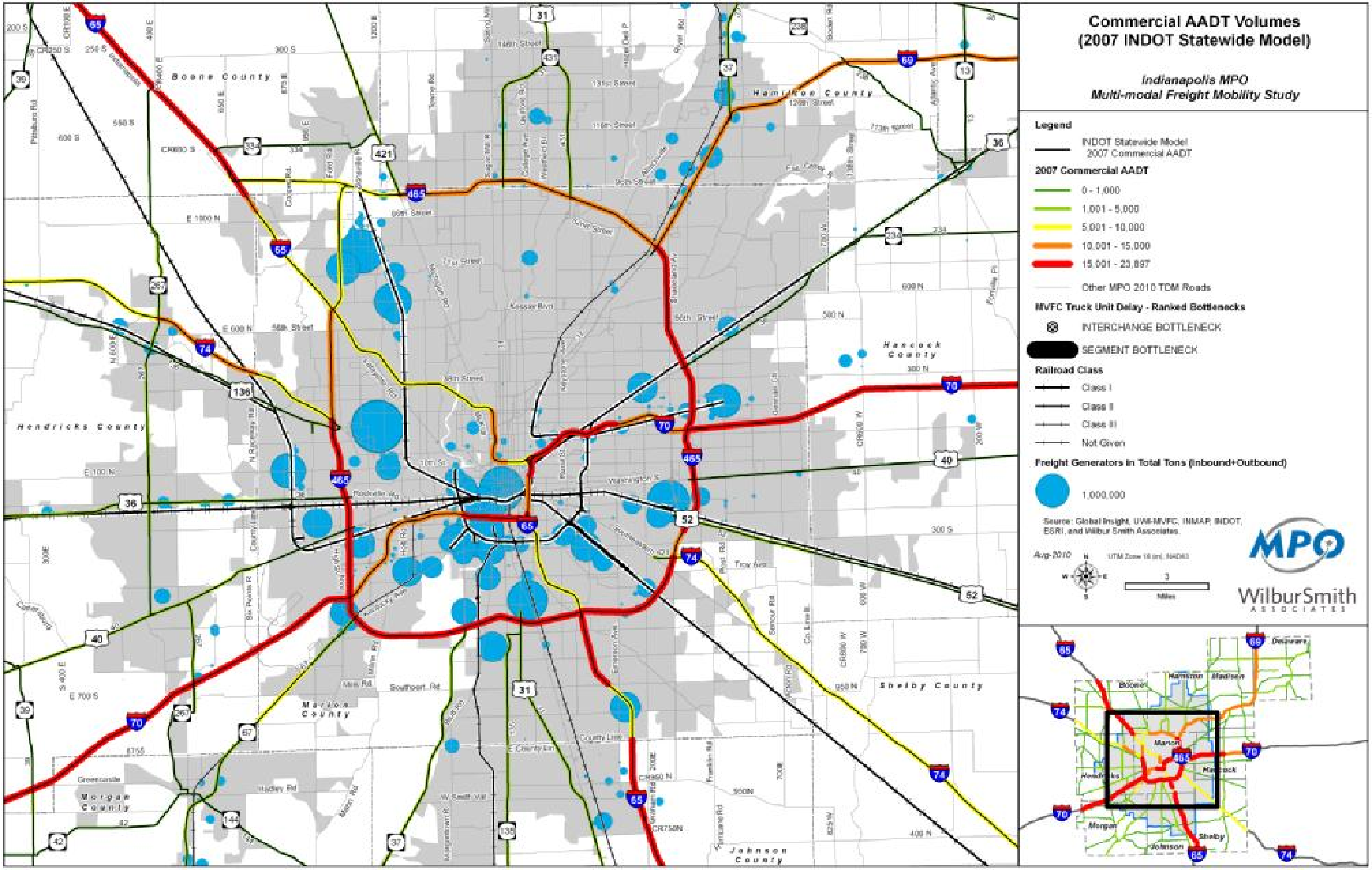
ource: INDOT, Indianapolis MPO, Wilbur Smith Associates

Figure 8: Freight Generator Locations, Smaller Scale



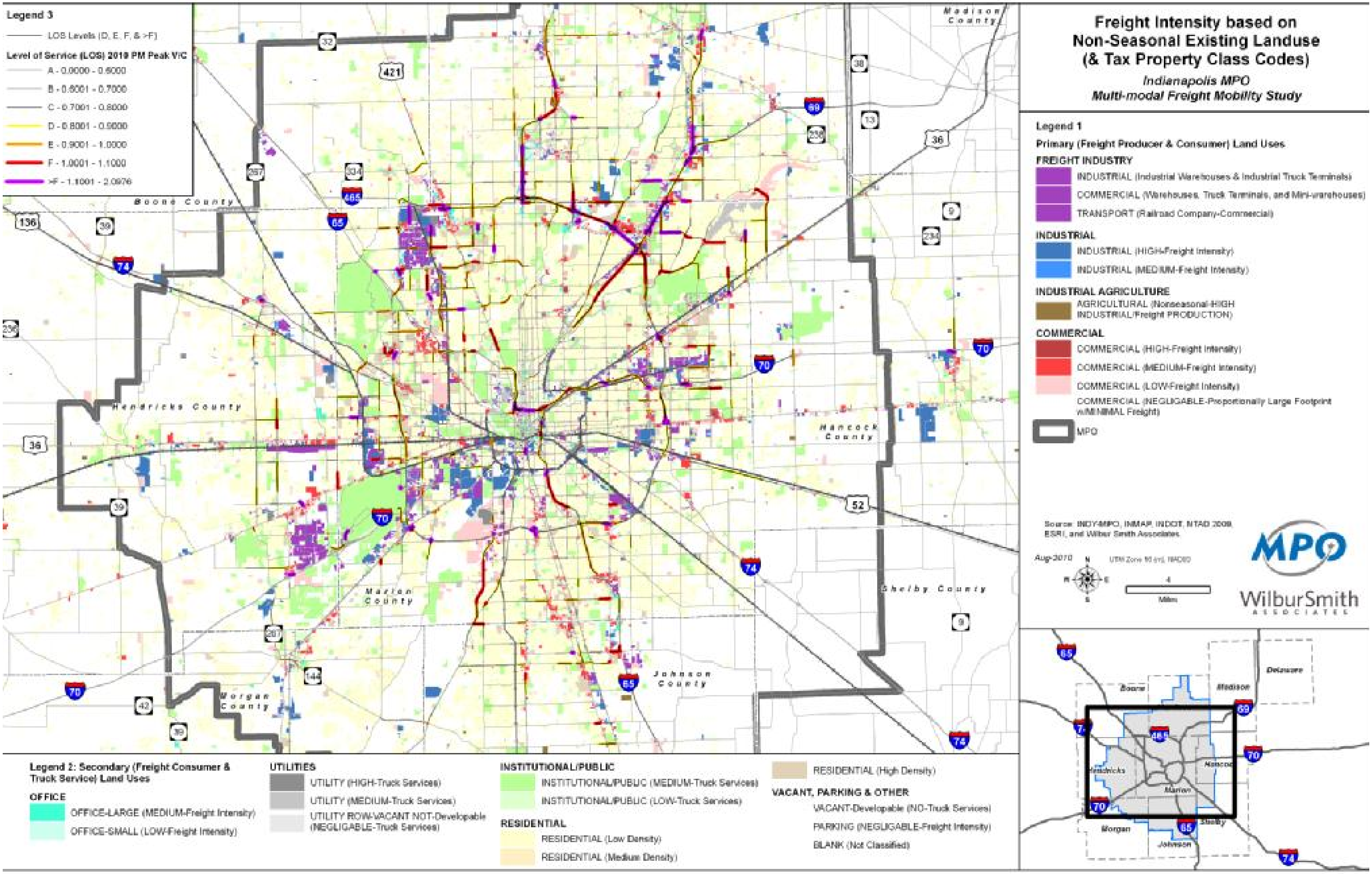
Source: INDOT, Indianapolis MPO, Wilbur Smith Associates

Figure 9: Commercial Vehicle Activity Levels provided by INDOT



ource: INDOT, Indianapolis MPO, Wilbur Smith Associates

igure 10: Land Use Designations within the MPO Region with LOS D, E, F

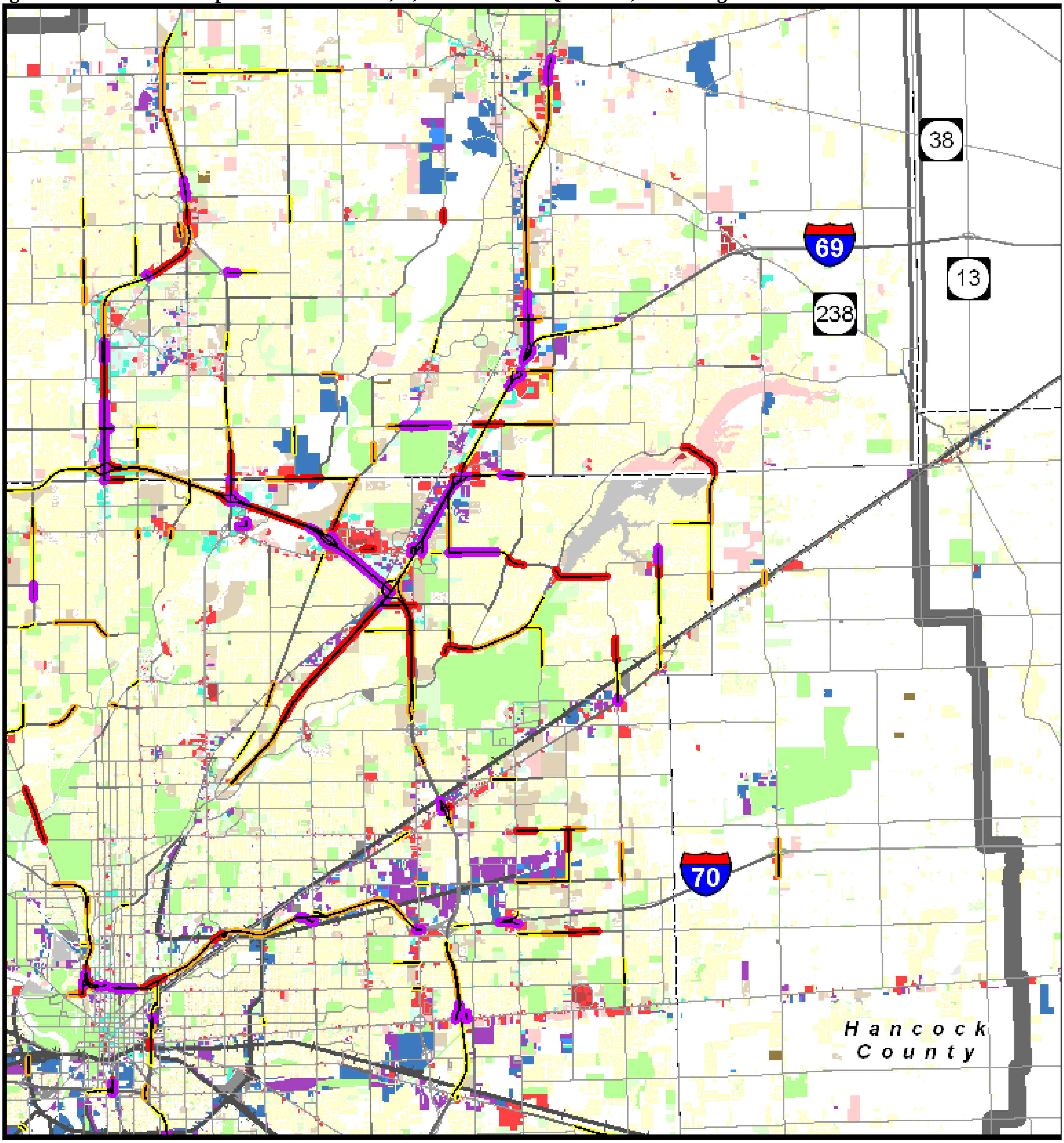


ource: INDOT, Indianapolis MPO, Wilbur Smith Associates

Using this comparative analysis, many of the identified bottlenecks are associated with areas of low freight activity. These occur within or immediately adjacent to residential areas. In conjunction, points or roadway segments associated with access to and from the major traffic corridors and these residential areas are another significant proportion of identified bottlenecks. **Figure 11** thru **Figure 15** provide greater visualization of these cases.

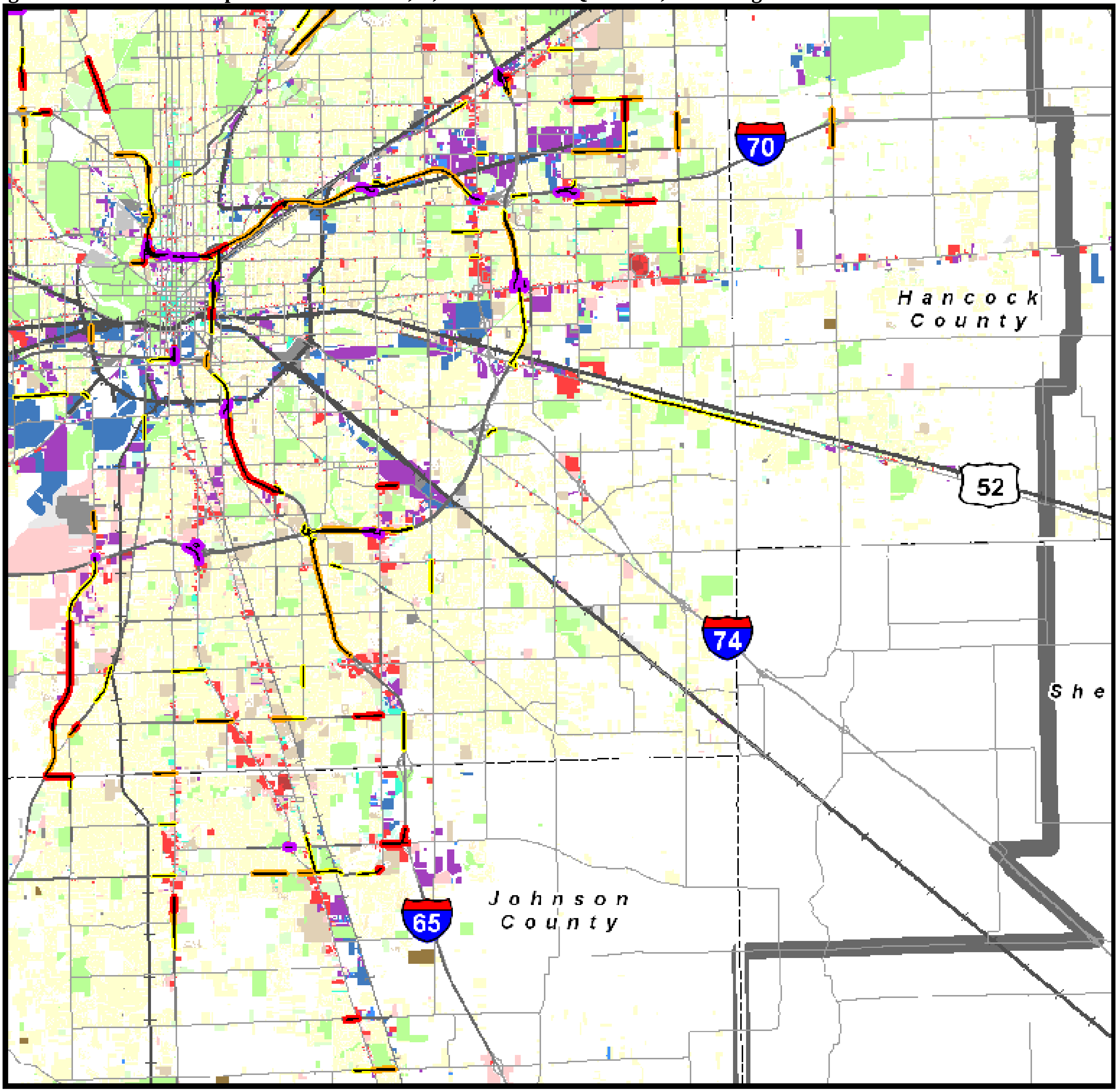
Figure 11: Legend Notations for Residential Land Use Designated Areas

igure 12: Land Use Comparison with LOS D, E, F – Northeast Quadrant, MPO Region



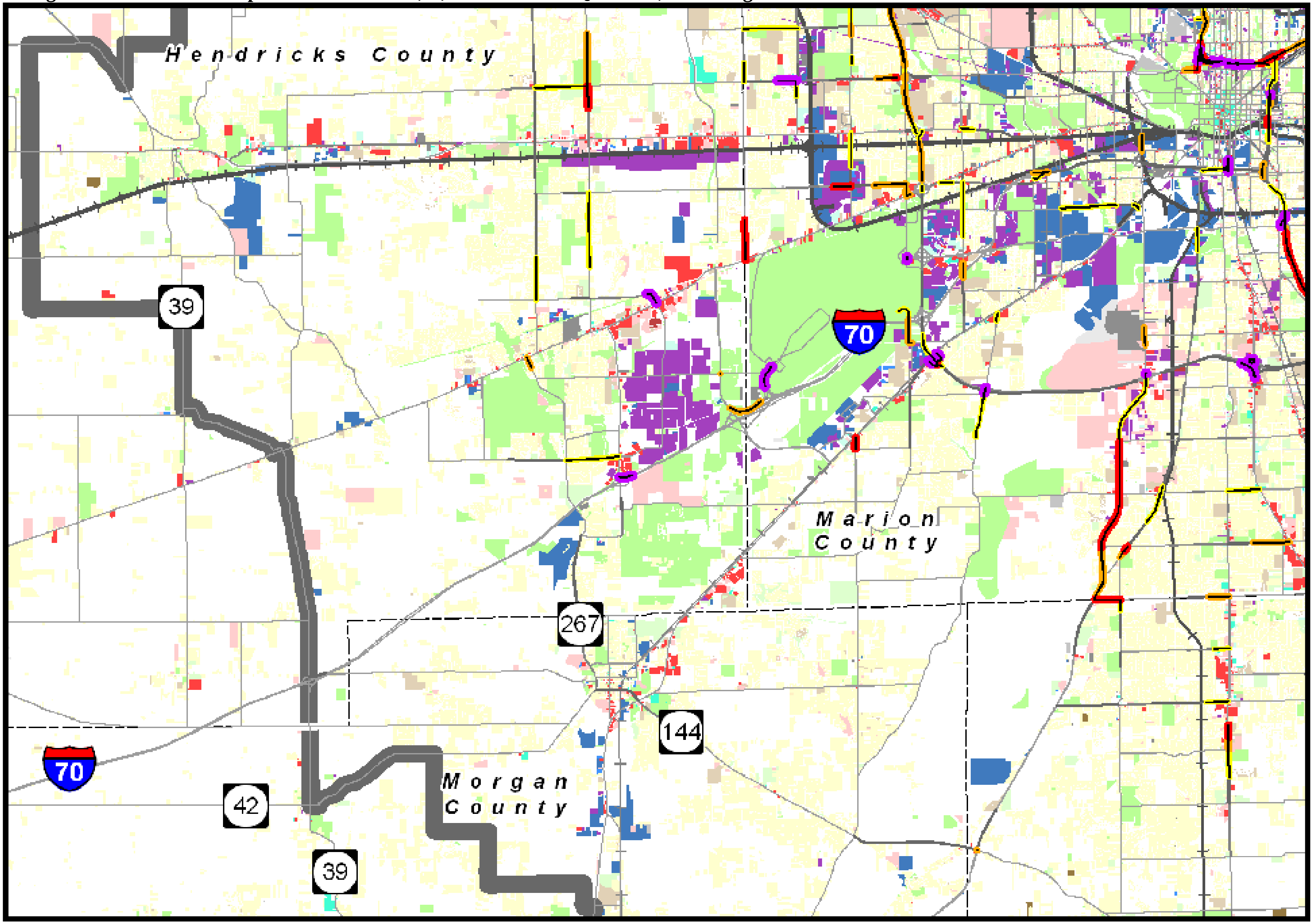
ource: INDOT, Indianapolis MPO, Wilbur Smith Associates

igure 13: Land Use Comparison with LOS D, E, F – Southeast Quadrant, MPO Region



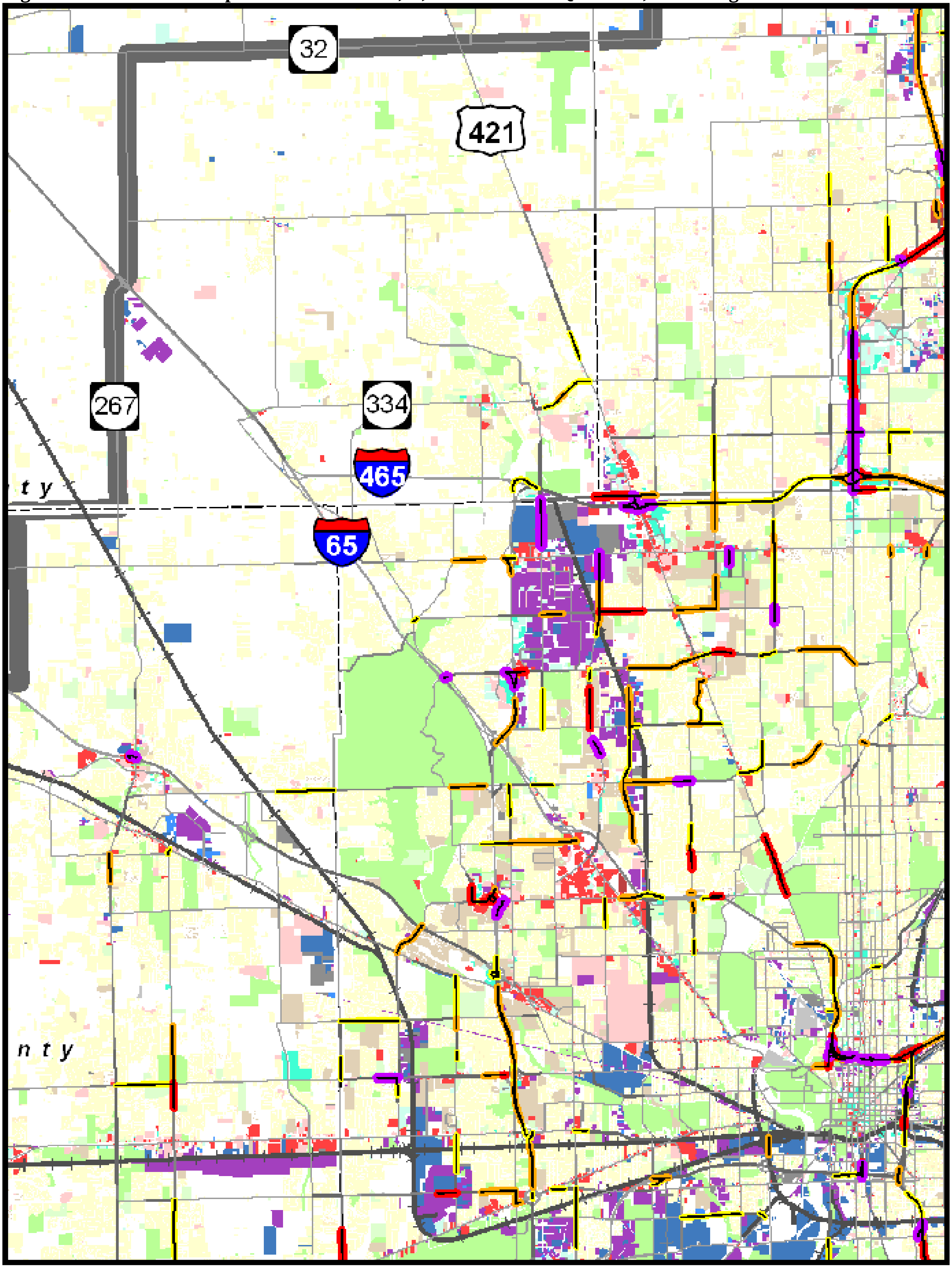
ource: INDOT, Indianapolis MPO, Wilbur Smith Associates

Figure 14: Land Use Comparison with LOS D, E, F – Southwest Quadrant, MPO Region



Source: INDOT, Indianapolis MPO, Wilbur Smith Associates

Figure 15: Land Use Comparison with LOS D, E, F – Northwest Quadrant, MPO Region



Source: INDOT, Indianapolis MPO, Wilbur Smith Associates

Another category of bottlenecks are associated with access to and from institutional facilities. These locations include hospital and school sites. Low to medium freight activity may occur at these locations, though the majority of traffic volume associated with these parcels is again passenger oriented.

Similarly, commercial parcels (RED) attract medium to low freight activity as these entities restock or move items out for delivery.

Completing this comparative analysis of activity to LOS degradation, the bottlenecks originally identified are ordered based on interpretive analysis of the level of freight activity present, **Table 2**. A mitigating factor in this designation is the expected presence of through truck traffic. This designation is determined to elevate the activity at the location to a category of high. One exception is the Mendenhall Road location. This is interpreted to be activity bypassing the intersection of Kentucky Avenue and Milhouse Road, accomplishing a right turn onto Kentucky Avenue.

Table 2: Ordered Bottlenecks, Based on Level of Freight Activity

POINT OR CONTINUOUS	LOCATION	CORRIDOR MOST IDENTIFIED WITH BOTTLENECK EFFECT	EXPECTED FREIGHT ACTIVITY LEVEL	FREIGHT INDUSTRY	INDUSTRIAL	COMMERCIAL	OFFICE	UTILITY	INSTITUTIONAL	RESIDENTIAL	THROUGH
Continuous	Zionsville Road, W 96th Street and Mall Entrance (Approx 6766 Zionsville Road)	Zionsville Road	High	X	X	X		X			
Continuous	96th Street, Gray Road and Hazel Dell Pkwy	96th Street	High		X	X					
Point	Michigan Road and I-465	Shared	High to Medium	X	X	X	X				X
Point	Georgetown Road and W 86th Street	Georgetown Road	High to Medium	X	X			X			
Point	Allisonville Road and I-465	Allisonville Road	High to Medium			X					X
Continuous	Township Line Road, Smith Road and E Main Street	Township Line Road	High to Medium	X		X					
Point	I-70 and N Shadeland Ave	Shared	High to Low	X	X	X		X		X	X
Point	I-69 and I-465	Shared	High to Low	X	X	X			X	X	X
Point	I-465 and US Highway 36	Shared	High to Low	X	X	X			X	X	X
Point	I-70 and N Post Road	Shared	High to Low	X	X	X			X	X	X
Point	I-465 and US Highway 40	Shared	High to Low	X	X	X			X	X	X
Point	I-65 and County Road 950 N	Shared	High to Low	X	X	X			X	X	
Point	I-465 and Kentucky Ave	Shared	High to Low	X	X				X	X	
Point	South Girls School Road and W Morris Street	W Morris Street	High to Low	X	X				X	X	
Point	S Harding Street and I-465	Shared	High to Low	X		X		X		X	X
Point	I-70 and Quaker Blvd	Shared	High to Low	X		X			X	X	X
Point	N Green Street and I-74	Shared	High to Low	X		X				X	X

POINT OR CONTINUOUS	LOCATION	CORRIDOR MOST IDENTIFIED WITH BOTTLENECK EFFECT	EXPECTED FREIGHT ACTIVITY LEVEL	FREIGHT INDUSTRY	INDUSTRIAL	COMMERCIAL	OFFICE	UTILITY	INSTITUTIONAL	RESIDENTIAL	THROUGH
Point	W 71st Street and I-465	Shared	High to Low	X			X			X	
Point	I-70 and N Emerson Ave	Shared	High to Low	X				X	X	X	X
Point	Georgetown Road and W 62nd Street	Georgetown Road	High to Low	X					X	X	
Point	Eagle Creek Parkway and W 38th Street	Eagle Creek Parkway	High to Low		X	X			X	X	
Point	IN 37 and Greenfield Ave	Shared	High to Low		X	X			X	X	
Point	Madison Avenue and I-70	Madison Ave	High to Low		X					X	
Point	I-69 and IN 37	Shared	High to Low			X	X			X	X
Point	US Highway 31 and 96th Street	US 31	High to Low			X	X			X	X
Point	I-465 and S Emerson Drive	Shared	High to Low			X			X	X	X
Point	US Highway 31 (S East Street) and I-465	Shared	High to Low			X				X	X
Point	US Highway 31 and I-465	US 31	High to Low				X			X	X
Point	North Keystone Ave and I-465	Shared	High to Low						X	X	X
Point	W 38th street and I-465	Shared	High to Low						X	X	X
Point	I-65 and E Raymond Street	I-65	High to Low							X	X
Point	US Highway 31 and Keystone Avenue	US 31	High to Low							X	X
Continuous	I-69, 96th Street and E 82nd Street	I-69	High to Low	X	X	X			X	X	X
Continuous	E Churchman Ave, S Emerson Drive and Ritter Street	E Churchman Ave	High to Low	X	X			X	X	X	
Continuous	W 79th Street, Georgetown Road and N Payne Road	W 79th Street	High to Low	X	X				X	X	
Continuous	I-465, E 75th Street and Fall Creek Road	I-465	High to Low						X	X	X
Continuous	I-65, Exit 114 and I-70	I-65	High to Low						X	X	X
Continuous	I-65, S Keystone Ave and E Raymond Street	I-65	High to Low						X	X	X
Continuous	I-69, I-465 and Kessler Blvd E Drive	I-69	High to Low							X	X
Point	I-70 and Perimeter Road	I-70	Medium to Low	X	X					X	
Point	W 71st Street and I-65	Shared	Medium to Low	X					X	X	
Point	I-65 and IN 44	Shared	Medium to Low		X				X	X	
Point	Nabb Road and W 86th Street	Nabb Road	Medium to Low			X	X		X	X	

POINT OR CONTINUOUS	LOCATION	CORRIDOR MOST IDENTIFIED WITH BOTTLENECK EFFECT	EXPECTED FREIGHT ACTIVITY LEVEL	FREIGHT INDUSTRY	INDUSTRIAL	COMMERCIAL	OFFICE	UTILITY	INSTITUTIONAL	RESIDENTIAL	THROUGH
Point	North Keystone Ave and 96th Street	North Keystone Ave	Medium to Low			X	X		X	X	
Point	Oaklandon Road and Fox Road	Oaklandon Road	Medium to Low			X			X	X	
Point	E 116th Street and I-69	I-69	Medium to Low			X				X	
Point	IN 135 and W Fairview Road	Shared	Medium to Low			X				X	
Point	Sunnyside Road and Pendleton Pike	Sunnyside Road	Medium to Low			X				X	
Point	Fall Creek Road and Brooks School Road	Fall Creek Road	Medium to Low			X				X	
Point	E Washington Street and I-65/70	Shared	Medium to Low				X		X	X	
Point	W 10th Street and N Dan Jones Road	N Dan Jones Road	Medium to Low						X	X	
Point	W 56th Street and Cooper Road	W 56th Street	Medium to Low						X	X	
Point	W 71st Street and Township Line Road	W 71st Street	Medium to Low						X	X	
Point	S Emerson Drive and E Stop 11 Road	E Stop 11 Road	Medium to Low						X		
Continuous	Sunnyside Road, Indian Lake Blvd S and E 63rd Street	Sunnyside Road	Medium to Low	X				X	X	X	
Continuous	E 38th Street, N Post Road and N Mitthoeffer Road	E 38th Street	Medium to Low			X				X	
Continuous	E 106th Street, Crosspoint Blvd and Cumberland Road	E 106th Street	Medium to Low				X			X	
Continuous	E 106th Street, Allisonville Road and E 7th	E 106th Street	Medium to Low						X	X	
Continuous	E 21st Street, Faithaven Drive and N Mitthoeffer Road	E 21st Street	Medium to Low						X	X	
Continuous	E 82nd Street, Fall Creek Road and Sunnyside Road	E 82nd Street	Medium to Low						X	X	
Continuous	N Michigan Road, W 38th Street and Cold Spring Road	N Michigan Road	Medium to Low						X	X	
Continuous	Mendenhall Road, Milhouse Road and Kentucky Ave	Mendenhall Road	Medium to Low							X	X
Point	I-465 and Mann Road	Shared	Low						X	X	
Point	W 38th Street and I-65	Shared	Low						X	X	
Point	E New York Street and I-65/70	I-65/70	Low							X	

POINT OR CONTINUOUS	LOCATION	CORRIDOR MOST IDENTIFIED WITH BOTTLENECK EFFECT	EXPECTED FREIGHT ACTIVITY LEVEL	FREIGHT INDUSTRY	INDUSTRIAL	COMMERCIAL	OFFICE	UTILITY	INSTITUTIONAL	RESIDENTIAL	THROUGH
Point	US Highway 31 and Tracy Road	Shared	Low							X	
Point	W 10th Street and N Racetrack Way	W 10th Street	Low							X	
Point	I-465 and W 10th Street	W 10th Street	Low							X	
Continuous	Ditch Road, Grandview Drive and W 79th Street	Ditch Road	Low							X	
Continuous	E 82nd Street, Hague Road and Sargent Road	E 82nd Street	Low							X	
Continuous	IN 37, W Banta Road and W County Line Road	IN 37	Low							X	
Continuous	Kessler Blvd N Drive, W 42nd Street and W 44th Street	Kessler Blvd N Dr	Low							X	
Continuous	S Raceway Road, E County Road 200 S and US Highway 40	S Raceway Road	Low							X	

Though individual locations are not being investigated, in a later section, a discussion of general approaches to mitigation strategies will be offered.

Bottlenecks Identified in Additional Studies

Utilizing a somewhat dissimilar methodology than previously performed bottleneck analyses, the University of Wisconsin prepared a study for the Mississippi Valley Freight Coalition[6]. This analysis was based on the Highway Performance Monitoring System (HPMS) data for the year 2006. Founded on the analysis approach of other investigators, this study provided findings to that project's steering committee, receiving feedback, further defined its methodology. These published findings identified eight Indiana locations that were included in the top 100 bottlenecks for that study area; Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Ohio, Wisconsin.

Further application of the methodology to candidate locations within individual member states of the coalition was conducted. Within the state of Indiana, 103 significant bottleneck locations were found. Of those, sixteen are in the member counties of the MPO; fifteen in Marion and one in Hamilton, **Table 3.** Sixteen were captured as a result of the influence the interchange design or presence of the interchange itself had on the free flow of traffic. Two were assigned due to lane drop (one of these were in conjunction with interchange issues) and one for signaling. A fourth category of constraints, steep grade, failed to be recognized as an area of concern in the MPO region.

[6] Top 100 Highway Freight Bottlenecks throughout the Mississippi Valley Region, prepared September 2009, University of Wisconsin, Jessica Guo, principal Investigator

Table 3: Bottlenecks Identified by the University of Wisconsin

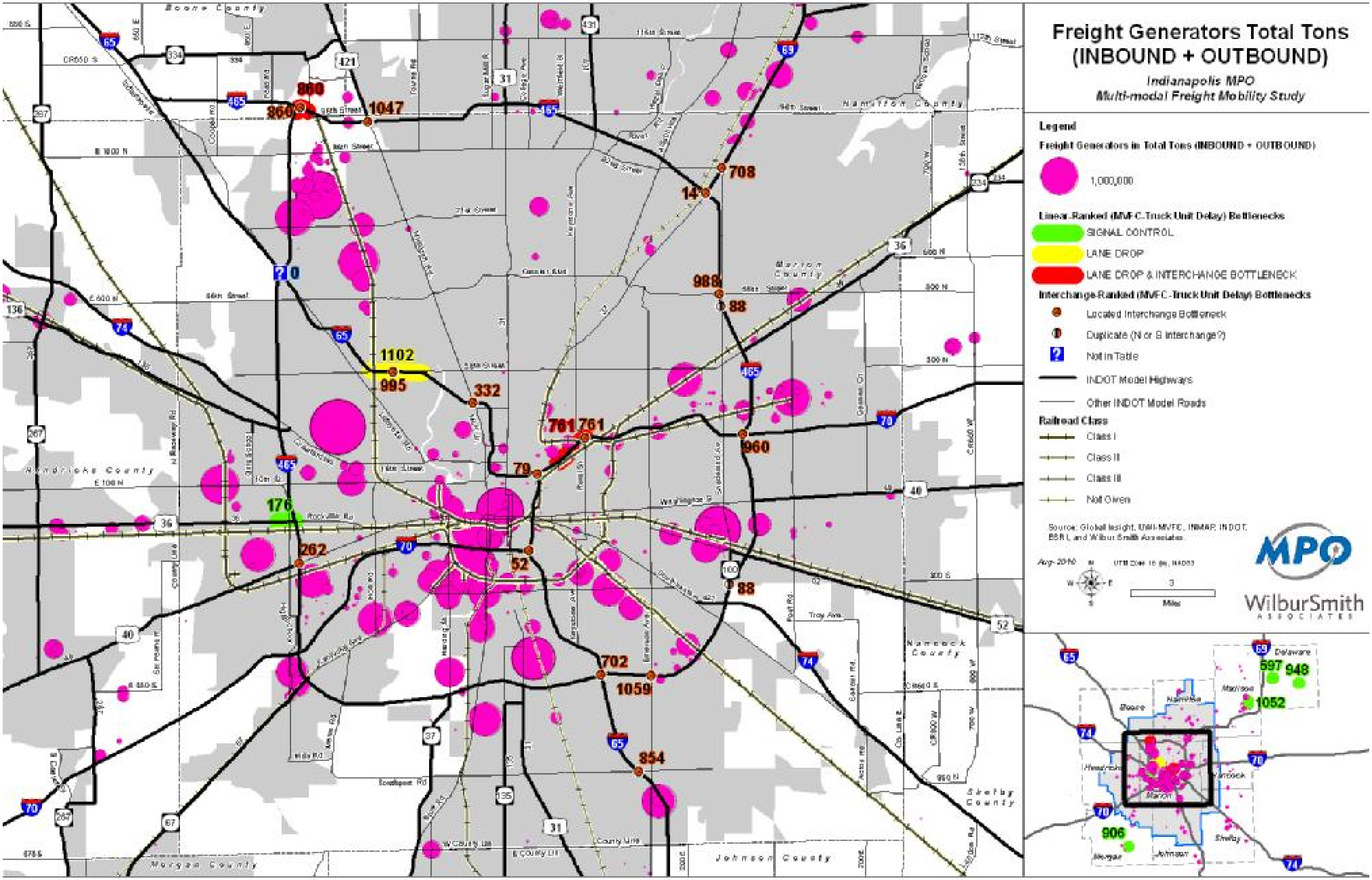
GENERAL INFORMATION			TRAFFIC COUNT		EXISTING CONSTRAINT		
MS VALLEY RANKING	COUNTY	LOCATION	AADT	AADT (TRUCK)	INTERCHANGE	LANE DROP	SIGNAL
14	Marion	I-465 at I-69 Interchange	173,320	31,198	X		
52	Marion	I-65 at I-70 Interchange (Southern)	151,370	34,058	X		
79	Marion	I-65 at I-70 Interchange (Northern	143,030	32,182	X		
88	Marion	I-465 at Shadeland Ave Interchange	162,000	16,200	X		
176	Marion	US 36 Begin Milepost: 68.19	42,770	3,422			X
262	Marion	I-74/I-465 at US 40 Interchange	129,180	21,961	X		
332	Marion	I-65 at MLK Jr Street Interchange	120,450	27,101	X		
702	Marion	I-65 at I-74/465 Interchange	114,640	19,489	X		
708	Hamilton	I-69/IN 37 at 82nd Street Interchange	113,572	20,443	X		
761	Marion	I-70 at Keystone Ave Interchange	182,180	23,683	X	X	
960	Marion	I-465/US 421 at I-70 Interchange	113,960	14,815	X		
988	Marion	I-465 at East 56th Street Interchange	107,030	19,801	X		
995	Marion	I-65 at 38th Street Interchange	73,820	16,610	X		
1047	Marion	I-465 at US 421 Interchange	117,970	11,207	X		
1059	Marion	I-465 at Emerson Ave Interchange	116,900	11,690	X		
1102	Marion	I-65 Begin Milepost: 117.47	72,730	16,364		X	

Source: Top 100 Highway Freight Bottlenecks throughout the Mississippi Valley Freight Coalition, University of Wisconsin. September 2009

When mapped in relation to the freight activity, as presented in total tons both inbound to and outbound from the area[7], again the proximity of truck associated bottlenecks to areas of freight activity is narrow, **Figure 16**.

[7] Representing 80 percent of the total tonnages identified. These are produced or attracted by 20 locations within the region. This 80/20 ratio is typical of all regions.

igure 16: University of Wisconsin Identified Bottlenecks with Significant Truck Volumes



ource: University of Wisconsin, INDOT, Indianapolis MPO, Wilbur Smith Associates

Bottlenecks Identified by Motor Carriers

Twelve motor carriers were asked to participate in a driver survey conducted between July 22nd and July 30th, 2010. Each facility manager was contacted and explained the purpose of the survey, to identify experienced bottlenecks by drivers of commercial vehicles in the region. A generic road map of the eight-county MPO region was provided and placed in the driver break room or dispatch area of the participating carrier. The methodology was for each driver to note bottlenecks on the map by circling the location, either point or continuous, and provide an explanation of observed conditions influencing the congestion. With anonymity of both driver and specific motor carrier, the results can be expected to be free of bias.

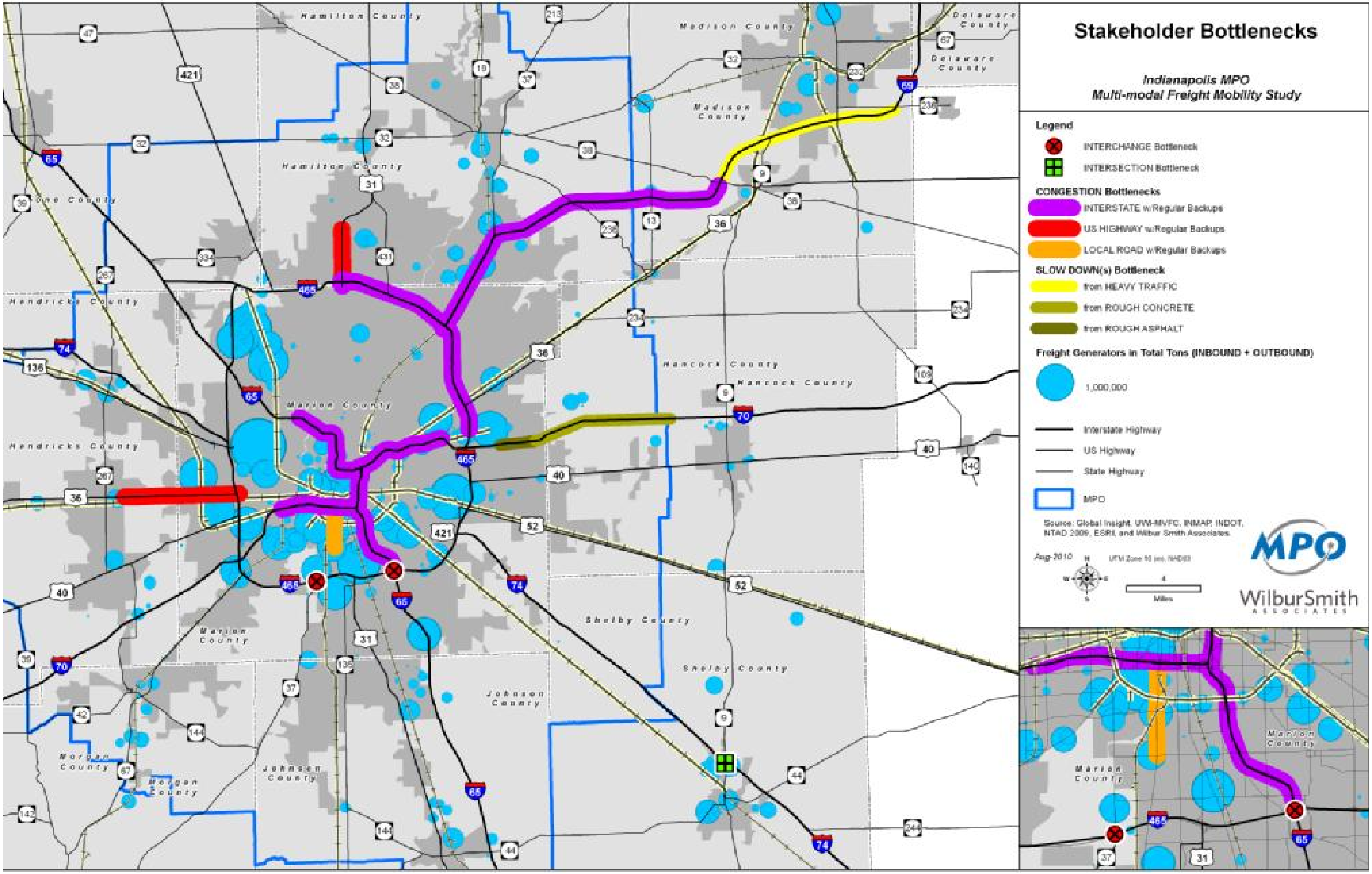
Of the twelve, four carriers agreed to participate; three less than truckload and one local delivery. The equipment operated ranged from a tractor-semitrailer combination, class 8, for a maximum length of 65 feet, to a single unit truck with dry box for a total length of greater than 15 feet.

Many of the observations were of continuous in nature. These were attributed to heavy traffic volume, rough pavement, and continuing construction. The point locations were:

- I-65 at I-465 (Southern Interchange)
- IN 37 and I-465
- IN 9 and I-74 absence of light, difficulty to proceed north on IN 9, from southbound I-74

Figure 17 provides an illustration of those locations identified. Driver feedback is paramount to the understanding of effects of bottlenecks on truck traffic. Many drivers, experienced in operating within a given area, select alternative routes to compensate for routes, though better suited to their driving activity, are constrained in some manner. The lack of truck volumes on a given roadway may reverse significantly should an intersection or travel lane width be modified to be more “truck friendly”. Interaction with the freight community, transportation providers or shippers, on a regular basis will establish the dialogue whereby the MPO can ascertain the more efficient route that the driver does not choose, due to issues with the design or other facets.

igure 17: Motor Carrier Stakeholder Provided Bottlenecks, Point and Continuous



ource: INDOT, Indianapolis MPO, Wilbur Smith Associates

Mitigation Strategies

Numerous conditions exist related to the cause of the bottlenecks identified; signage practices, lane reductions, open or less restrictive access to roadways, intersection design, and infrastructural capacities. Strategies to mitigate these conditions are similarly diverse, providing a spectrum of responses ranging from short term and low cost solutions to long term choices requiring substantial investment. In this section, general considerations and strategies are outlined as possible solutions to individual conditions. More specific strategies would require "per bottleneck" investigation of the specific condition.

Signage Practices

A low cost solution to those issues generating bottlenecks where truck traffic enters non-friendly roadway design is the failure to provide adequate advance notice, for the truck driver, to special considerations adjacent to or on the roadway and provide sufficient time for decision making. Each opportunity to communicate conditions to the truck driver requires increased separation between the vehicle and the event than for the average automobile. Where conditions require alternative route selection or driving action, an additional consideration is that the truck driver must have adequate roadway and an adequate traffic interaction zone to remedy a poor decision.

Restricted or posted weight limits on bridges, left turn exits, prohibited routes and minimum vertical clearances are the more common scenarios faced by drivers unfamiliar with local road conditions. In each case where inadequate placement has reduced reaction time, once recognized, the driver is presented with either radical vehicle movement or continuing on, possibly into areas not "truck friendly". Each of these alternatives may present a regularly recurring episode and thus open to mitigation condition. The Manual on Uniform Traffic Control Devices (MUTCD) 2009 provides guidance not only for the type and size of signage, but also on placement. Section 2C.27 of the MUTCD discusses conditions and placement of a Low Clearance sign. Sub section 03 notes:

Section 2C.27 <u>Low Clearance Signs (W12-2 and W12-2a)</u>

Standard:

01 **The Low Clearance (W12-2) sign (see Figure 2C-5) shall be used to warn road users of clearance less than 12 inches above the statutory maximum vehicle height.**

Guidance:

02 *The actual clearance should be displayed on the Low Clearance sign to the nearest 1 inch not exceeding the actual clearance. However, in areas that experience changes in temperature causing frost action, a reduction, not exceeding 3 inches, should be used for this condition.*

03 *Where the clearance is less than the legal maximum vehicle height, the W12-2 sign with a supplemental distance plaque should be placed at the nearest intersecting road or wide point in the road at which a vehicle can detour or turn around.*

04 *In the case of an arch or other structure under which the clearance varies greatly, two or more signs should be used as necessary on the structure itself to give information as to the clearances over the entire roadway.*

05 *Clearances should be evaluated periodically, particularly when resurfacing operations have occurred.*

Option:

06 The Low Clearance sign may be installed on or in advance of the structure. If a sign is placed on the structure, it may be a rectangular shape (W12-2a) with the appropriate legend (see Figure 2C-5).

Though signage may be present and follow the MUTCD placement guidelines, interaction with the motor carrier industry and drivers who operate within the region will assist in identifying those placements that may require additional spacing.

Public and private sector interaction may additionally generate ordinance development and promote awareness where the shipper or receiver may not have adequately signed a property. The lack of visibility to signs erected by a warehousing or manufacturer may contribute greatly to a given bottleneck area, **Figure 18**. As truck traffic slows to avoid missing an intended turn-in, all traffic is slowed. The greater the truck traffic utilizing a specific entrance, in conjunction with significant general traffic volumes, the greater the issues of congestion and safety.

Figure 18: Truck Entrance Identification to a Local Indianapolis Business

Source: Google Maps

Truck Route Designation

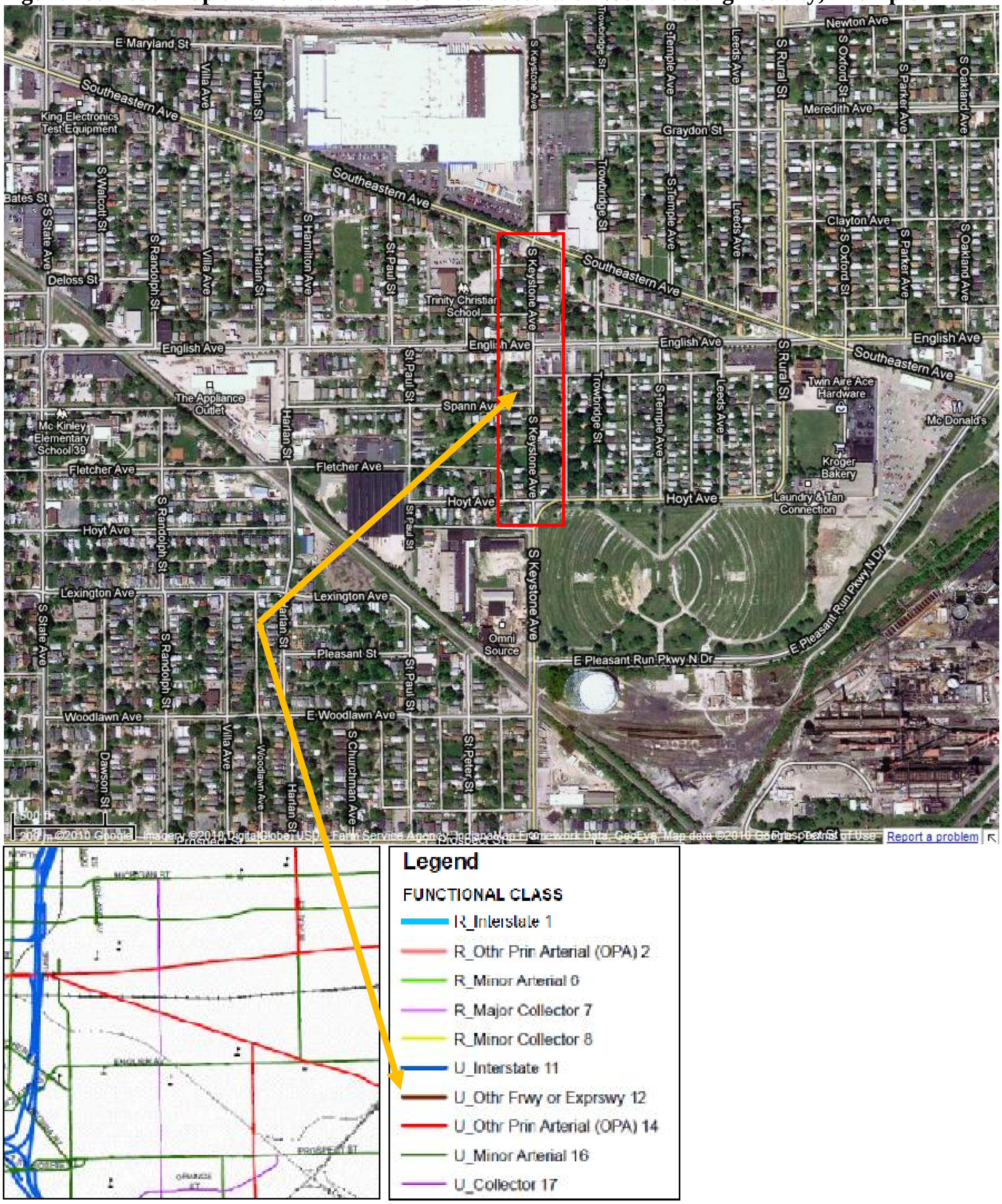
The development of a designated truck system of roadways to guide truck movements across the region, and then into close proximity of freight intensive nodes, provides many benefits to the mitigation of truck related bottlenecks. Without the presence of a defined network, truck traffic may attempt to utilize non-truck friendly designed roadways when accessing or departing areas of freight activity. In addition, in areas adjacent to or leading to nodes of freight intensive activity, there may be numerous inadequately designed routes. The ability of local jurisdictions or agencies to address construction or improvement needs may not be capable of mitigating these multiple, potential bottlenecks. The truck route designated network would concentrate significant numbers of trucks on a specific roadway and thus provide more focused application of available manpower and monies to efficiently and effectively design roadway improvements.

As noted previously, that truck movements do not operate in isolation of general traffic, these concentrations and improvements may generate value for the overall traffic volumes.

Continuing to utilize the previously noted location of truck activity in Figure 18, **Figure 19** illustrates the local roads providing access to the facility and the associated functional class. It is important to note that the highlighted section of S Keystone Avenue is classified as Other Principal Arterial.

Without a designated truck system to guide movement, truck operators seek to identify and travel the most direct route. **Figure 20** provides a street level view of that segment.

Figure 19: Road Map and Functional Class Associated with Warehousing Activity, Example



Source: Google Maps, INDOT, Wilbur Smith Associates

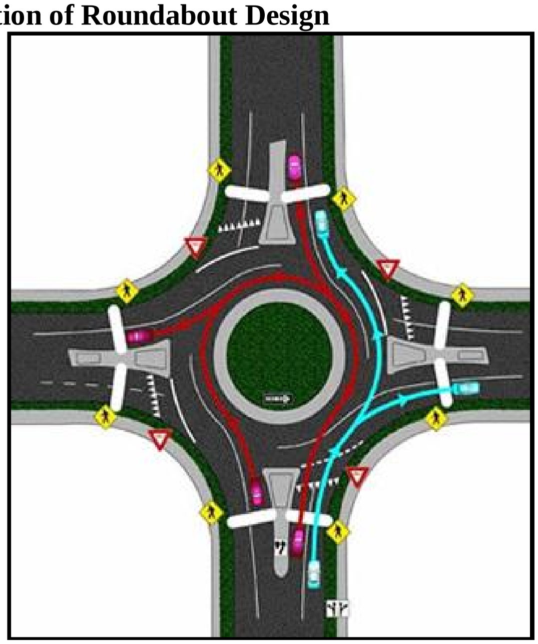
Figure 20: Street Level View of S Keystone Avenue, as Noted in Figure 19

Source: Google Maps

Roundabout Designs and Implementation

General Design

Figure 21: Example Illustration of Roundabout Design



Source: 02/03/2010, http://www.ci.watertown.mn.us/images/pics/roundabout_diagram_small.jpg

Traditional intersections, with appropriately equipped signaling, continue to increase in cost and implementation. A less costly alternative for many agencies is initial placement or replacement with continuous flow intersections such as roundabout designs, example illustration **Figure 21**. Continuous flow intersections do not only facilitate traffic movement but they also are less expensive. Efficient truck movements are much better and more easily promoted through the creative use of continuous flow intersection. The operation of a truck in stop and go conditions costs travel time, wastes brakes and other equipment, creates environmental issues and exposes truck and surrounding vehicles to potential safety concerns. As a result, continuous flow intersections, creatively implemented would benefit trucking as well as the traveling public.

Roundabouts may be constructed in urban and rural conditions, as well as part of single or multiple lane roadways. Several jurisdictions are requiring studies be submitted that state why a roundabout should not be proposed instead of the traditional justification for imposing a roundabout in lieu of a traditional intersection. In a statement intended to guide future considerations and implementations of safety countermeasures, "…,they should be considered as an alternative for all proposed new intersections on federally-funded highway projects,…"[8] With adoption of a pro-roundabout strategy by state and local DOT's, the roundabout initially must overcome opposition by the driving public and the freight community. Trucking firms and drivers with preconceived concerns and experience with other similar designs such as traffic circles cite safety and access issues in opposition. Trucks that choose to avoid these designs elevate concerns by shippers that rates may increase and reduced coverage by trucking companies may occur; resulting in raised transportation costs. It is important to realize the benefits of steady and continuous flow of traffic and reduction of adverse safety conditions, design and education should be a priority.

As larger roundabout designs may incorporate a greater right-of-way than traditional intersections, much design effort is geared to mitigate the cost and designs such as the mini-roundabout are applied. These have the capacity to accommodate large tractor-trailer combinations with appropriate planning and design. In either combination of the designs, several solutions can be evaluated for construction. It is important to note that each supplemental "truck friendly" design strategy has compromises of efficiency and safety, for all traffic modes; truck, automobile, bike, and pedestrian.

[8] Memorandum, USDOT, FHWA, July 10, 2008, "ACTION: Considerations and Implementation of Proven Safety Countermeasures", Jeffery A. Lindley, Associate Administrator for Safety

Truck Aprons

Figure 22: Truck Apron

Source: 02/03/2010, http://www.ksdot.org/roundabouts/images/truck.jpg

As vehicle length increases, the need to provide an expanded lane width during turning is necessary. Where truck traffic is expected, placement of truck aprons, road surface between the travel lanes and the landscape interior of larger roundabouts, accommodates the “trailing” movement of the trailer. To mitigate other vehicle usage and/or abuse, and to identify the road surface as such, a different surface, such as pavers, concrete, etc. is utilized, **Figure 22**. Striping that is recognizable by all drivers may also be used in tandem with surface changes. Without this added lane width, longer trucks will avoid the roundabout due to both equipment and cargo damage as a result of driving over elevated curb heights. Where this damage does occur, either alternative routing should be provided to commercial vehicles or continuing maintenance dollars can be expected to be repetitively required to reconstruct the curb and landscape.

Traversable Islands

Figure 23: Traversable Island Construction

Source: 02/03/2010, http://safety.fhwa.dot.gov/intersection/roundabouts/presentations/safety_aspects/long.cfm

In extremely space restricted areas such as roundabouts of other facilities, introducing islands, which may be driven over by trucks, while still directing automobile and other traffic in the traditional circular flow, is an accepted practice, **Figure 23**. Construction of this type is typically for intersections with lower truck volumes, as there is added wear on the materials used in the construction of the island. Islands may create a diminished rate of flow; because trucks must reduce speeds to reduce load shift and possible resulting cargo damage.

Decision Sight Distance

To accommodate multi-lane roundabout designs sufficient advance signing is required. Though discussed later in this report, as each lane proceeding into the roundabout is designed to accommodate a left or right turn or straight through traffic pattern, signage must be highly visible and provide the truck driver ample reaction time to select and then move to the appropriate lane, **Figure 24**.

Figure 24: Multi-lane Roundabout with Signage, VanDyke Blvd, Sterling Heights, MI

Source: Google Maps

Education Documentation

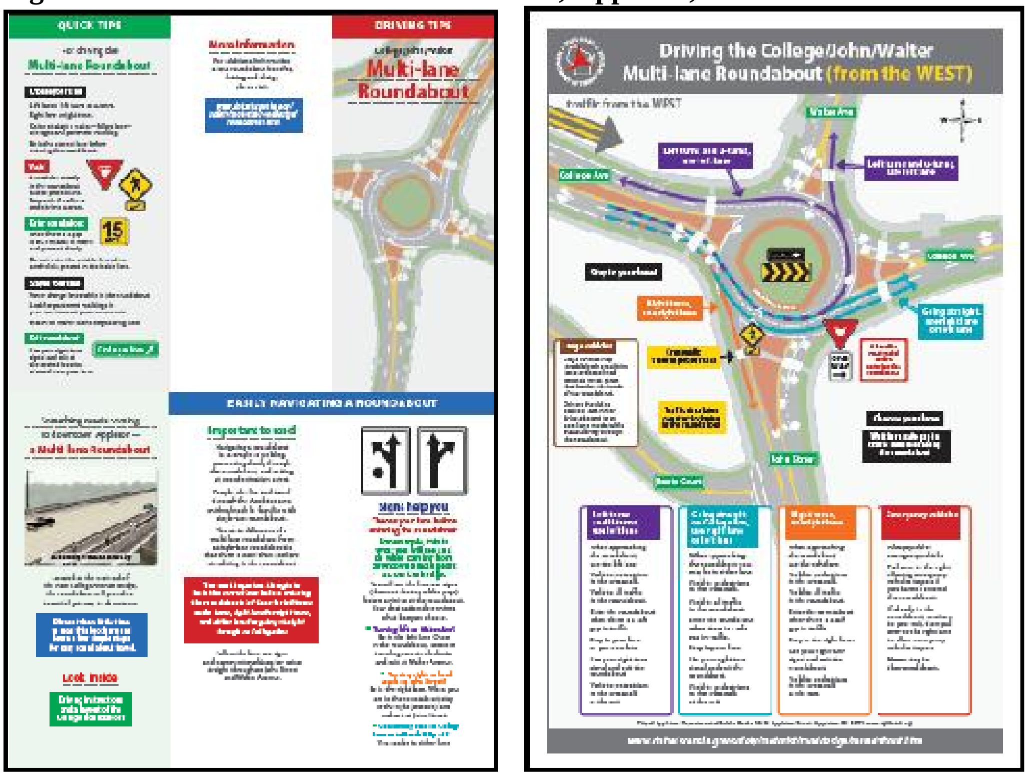
Where the roundabouts have been pursued, adverse opinions have existed as to the safety and the concern over proper use; affecting productivity of the vehicle using the roundabout. Two strategies to mitigate these concerns:

- How-to Guidebooks
- Safety Awareness

“How To” Guides

Supplying driver-user friendly documentation to truck drivers at welcome centers, truck stops, and local facilities where truck operations exist can assist in the successful negotiation of roundabouts. State DOT’s, Wisconsin and Virginia among that group, have been instrumental in presenting written and visual education products for the driving public on the “why’s” and “how’s” of roundabout utilization. This process can easily be replicated at the MPO level. The City of Appleton, Wisconsin hosts location specific guides on roundabouts within their limits, **Figure 25.** These guides describe through graphics and verbiage the design and specific actions necessary to navigate. Targeting automobile traffic, notes and discussions of decision points related to truck traffic are noted as well.

Figure 25: Roundabout Education Brochure, Appleton, WI



Source: 02/05/2010, http://www.appleton.org/departments/public/traffic/roundabouts/files/CJW%20Brochure.pdf

Safety Related Statistics

Accident frequency rates and levels of severity have been proven to drop significantly as a result of roundabouts. Presentation within the brochures and online avenues mentioned previously can disseminate those figures. Posting of statistics in a manner that does not impair flow and safety but clearly advises truck users of roundabout benefits is an effective marketing tool. Truck driver communication consists of a great deal of one-on-one discussions over radios and at collection points, such as truck stops and places of work. An effective program relating safety, utilization methods, and efficiency metrics can reach a larger audience than simply those directly targeted, as a result.

Summary

Bottlenecks present real cost impediments to the efficient operation of the motor carrier industry. These costs, typically relayed to the users of the mode, influence the attractive qualities of the affected area for future capture and retention of freight intensive operations.

The Indianapolis MPO region has many locations that an initial view of LOS conditions can be readily identified as areas that could benefit from strategies to address bottleneck conditions. Though numerous, only a percentage can be predicted as having a significant influence on truck movements. Utilizing a methodology of comparative analysis, combining LOS and land use designation, a preliminary segregation of those bottlenecks associated with more general automotive and truck traffic may be performed. By detailing the land use through a hierarchy of degrees of freight intensity, a prioritization can be conducted. This process will allow the MPO to approach both the current list of bottlenecks for improvement, as well as apply the methodology throughout the future, as traffic and freight generator conditions change.

Using the three methods of identification proposed in this study,

- Level of Service and Land Use Comparison,
- Results from the University of Wisconsin study for the Mississippi Valley Freight Coalition,
- Direct observations from the motor carrier industry,

and identifying those that are present in all three, a total of six predicted bottlenecks, influencing truck movements in the MPO region are identified:

- I-70 and I-465 (West)
- I-69 and I-465 (North)
- I-70 and I-65 (North)
- I-70 and I-65 (South)
- I-465 and N Keystone Ave/N Rural Ave (Exit 85)
- I-465 and E 96th Street