Using Travel Time Data from the National Performance Management Research Data Set (NPMRDS) to Characterize Hourly Railroad Grade Crossing Delays and Inform Grade Crossing Improvements

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ABSTRACT

This paper describes and applies a methodology to utilize travel time data from the National Performance Management Research Data Set (NPMRDS) to evaluate at-grade railroad crossings and the performance of roadway segments intersected by these crossings. The methodology uses crossing inventories from the Illinois Department of Transportation (IDOT) and the Federal Railroad Administration (FRA) to identify at-grade crossing locations throughout Illinois. Since these sets provide complementary information, the study used both to form a more complete view of the crossings' characteristics. The NPMRDS provides travel times along roadway segments leading into, following, and through many of these crossings. The study estimated delay performance by calculating the proportion of observations along these segments that had estimated speeds under 5mph across each daytime hour during five months of weekday periods. Performance characteristics could be affected by differences in crossing configurations, roadway geometry, traffic, train operations, and other factors.

The methodology is oriented towards understanding site level conditions and the impact of spatial arrangements rather than evaluating the impacts of signage, geometry, and signaling. By using these observations, agencies can assess multiple crossings and derive performance measures to prioritize the evaluation of individual crossings. The study uses five case examples that represent different street connectivity, signalization, and traffic behavior characteristics and analyzes these crossings using the travel time estimates. Since detailed crossing evaluations can be costly, this methodology can help agencies to allocate limited funds and limited resources more effectively.

KEYWORDS: Railroad Grade Crossings, Performance Indicators, NPMRDS Data, Roadway Delay Improvements

INTRODUCTION

In the State of Illinois, railroads operate over 12,800 route miles *(1)*. The seven North American Class I Freight Railroads, the Norfolk Southern, the Canadian National, the Canadian Pacific, the CSX, the Union Pacific, the Burlington Northern Santa Fe, and the Kansas City Southern, all have terminal and interchange operations in the state. Five passenger service providers, Amtrak, Metra Commuter Rail, the Northern Indiana Commuter Transportation District, the St. Louis Area Metrolink, and the Chicago Transit Authority, operate transit, commuter, and intercity trains across the state. The Illinois Department of Transportation (IDOT) public inventory counts over 7,700 at-grade crossings between railroad tracks and roadways *(2)*. The most recent Federal Railroad Administration (FRA) crossings inventory included over 22,000 at-grade crossings in Illinois *(3) (4)*. The study team identified 7,522 crossings in common between the two inventories for the year 2014. The FRA had 5,036 crossings that were unique to its inventory; IDOT had 164 crossings that were unique to its inventory *(4) (5)*. Many of the crossings in both of these inventories are inactive or are located on decommissioned rail corridors. Several of these crossings are used by multiple railroads and rail operations.

Freight and passenger rail traffic in Illinois is concentrated in the state's northeast region around the City of Chicago *(6)*. According to the Texas A&M Transportation Institute 2015 Urban Mobility Scorecard, the Chicago-IL-IN area ranked 7th in the country for congestion cost per auto commuter in 2014 *(7)*. The combined impact of heavy road and heavy rail traffic in the Chicago area become evident when these networks intersect at the region's many at-grade crossings.

Two large projects, the Chicago Region Environmental and Transportation Efficiency (CREATE) Program and the Chicago-St. Louis 110mph High Speed Rail project, have led to design, signaling, and operational changes at grade crossings across the state. The CREATE Program specifies 25 locations for highway-rail grade separation projects *(8)*; the Chicago-St. Louis High Speed Rail Project plans include the re-engineering of grade crossings and signals along the entire 284-mile corridor and the installation of highway-rail grade separations at several locations *(9)*.

The latest version of the FHWA Railroad-Highway Grade Crossings Handbook was released in August 2007 and specifies decision criteria for grade crossing improvements that used Average Annual Daily Traffic (AADT) estimates along affected roadways, roadway classifications, reported emergency route and school route uses, land use characteristics, railroad operational characteristics, the number of intersecting tracks, train counts, train speeds, and other attributes. The FHWA criteria recommended the use of observed and reported performance criteria to estimate Crossing Exposure, evaluate risks, and establish priorities for grade crossing modifications. Crossing Exposure is defined as the product of AADT and the number of daily trains *(10)*. In this study, Crossing Exposure values are calculated using daily traffic estimates and railroad reported traffic volumes.

Grade crossings also differ by the types of roadway and train traffic that use the crossing; the roadside land uses, rail customer sites, and railroad facilities connected by the roads and rails; the connectivity of the roadway and rail networks; the value and availability of buildable land near the crossings; signalization and signage; and other factors *(11) (12) (13)*. The Crossing Exposure, AADT, and Daily Train Traffic criteria are not defined to fully capture the influences and impacts of these other crossing characteristics *(14)*.

This paper defines a methodology to combine grade crossing inventory data sets and travel time data and enable initial evaluations of grade crossing delays. These evaluations can help to prioritize the selection of crossings to conduct more detailed and costly field studies and evaluations. The recently passed Fixing America's Surface Transportation Act (the FAST Act) includes several provisions for the use of performance data and performance measurements to prioritize projects and allocate limited funds *(15)*.

DATA SOURCE

In 2013, the FHWA started to publish hour-to-hour roadway segment travel time estimates. These estimates are derived from global positioning system (GPS) navigation devices, mobile devices, and embedded vehicle systems and are reported in the National Performance Management Research Data

Set (NPMRDS) *(16) (17)*. The NPMRDS includes data for over 11,000 National Highway System (NHS) roadway segments in Illinois. The data set reports up to 12 periods or epochs each hour for each day in a month. Each epoch observation can report the estimated travel time for an individual roadway segment during a 5-minute period. The NPMRDS data set uses vehicle location reports to estimate the number of seconds required for a vehicle to travel from the beginning of a segment to the end of a segment in the same direction. During the time period of this study, the NPMRDS data set provided over 20 million travel time estimates per month for Illinois roadways *(18)*. These estimates can allow analysts to evaluate how roadway traffic behaviors near a grade crossing can change over time and how roadway traffic could be affected by the train operations at a particular grade crossing.

During a previous study using this data set, the study team validated the correspondence between travel time impacts and the time and duration of delays indicated by crash data reported through the NHTSA Fatality Analysis Reporting System (FARS). Between October 2011 and December 2013, the NPMRDS data recorded overall speed reductions during the time periods that matched the times of recorded crash incidents and during subsequent time periods that matched expected incident response and incident recovery periods *(18) (19)*. Although at-grade crossing delays are more common than crashes, the crash data provides specific time and location details that are not readily available from the publicly available crossing data sets used in this study.

This study uses crossing data, track alignments, and roadway attributes recorded for the year 2014 by IDOT and the FRA. The IDOT *RRX 2014: Railroad Crossings* data set and the FRA *Crossing History* inventories were used to locate active grade crossings across the state. The *Crossing History* inventory was used instead of the *Current Crossing* inventory to account for changes in crossing attributes that occurred between 2014 and June 2016, the time of this study. The study selected the latest updates for crossings identified by the Crossing ID field that occurred between December 16, 2003 and June 30, 2015 to attempt to identify crossing conditions that existed in 2014. Several crossings in Illinois had crossing inventory updates that were more than a decade old.

Both inventories include many of the same crossings and are derived from the same regulatory crossing data provided by railroad operators. The inventories differ by the data fields reported from these reports and by their formats. The Illinois DOT data is distributed as a geographic information systems (GIS) spatial data set and appears to include validation and corrections to line up crossings locations with streets and rail lines *(5)*. Spatial locations in the FRA data set are derived from railroad reported latitude and longitude positions. These positions can change with different types of GPS equipment, different recording methods, and the use of different datum standards to measure the degrees *(4)*. This study used both inventories to capture a more complete view of grade crossing characteristics across the state.

The study combines these existing data sets to locate grade crossings, rail lines, land use patterns, and roadways and matches them with travel time estimates from the NPMRDS. These additional pieces of information can help agencies to prioritize and plan improvements to signalization, crossing design, alternative routing, and other changes to reduce the cost and delay impacts of rail traffic on roadway traffic *(20)*.

METHODOLOGY

The analysis used a Daily Crossing Exposure of 250,000 as an initial cutoff to limit the inventories to the highest impact crossings. This cutoff is one of the values that the FHWA recommended to identify candidates for grade separation projects *(10)*. The cutoff reduced the number of crossings selected from the IDOT inventory to 128 and the number of crossings selected from the FRA inventory to 112.

The highest concentration of rail crossings, rail traffic, rail route miles, and roadway congestion in the state are located in IDOT District 1. This area includes Cook County and the City of Chicago. Since about 80% of the grade crossings from the two inventories that meet the Daily Crossing Exposure cutoff are located in IDOT District 1, the study divided the inventories between crossings located within IDOT District 1 and crossings located Outside of IDOT District 1. About 2/3 of the IDOT District 1 grade crossings meeting the cutoff are also located in Cook County *(4) (5)*. The study team divided the IDOT District 1 inventories further between Cook County and areas outside of Cook County.

The geoprocessing tools in *ArcMap 10.3* were utilized to create a buffer of 200ft around each at-grade crossing to identify roadway segments in the May to September 2014 NPMRDS data sets that could approach, pass through, or follow these at-grade crossings. This distance is based on the FHWA *Manual on Uniform Traffic Control Devices* recommendation to use a 200ft distance to identify signals that should be preempted by a train *(21)*. Since the corresponding NPMRDS segments often were not configured to highlight crossing performance, the intersections between the rail lines and the NPMRDS segments occur at different locations along the roadway segments. The performance measurements derived from the NPMRDS apply to these roadway segments rather than to the crossings themselves.

A series of manual validation checks using *ArcMap 10.3*, *Google Maps*, roadway and crossing attribute inventories, and aerial views removed segments that did not intersect with the associated grade crossings, duplicates between the IDOT and FRA inventories, and grade crossings that were grade separated or were not located along an NPMRDS roadway segment. These checks identified 311 unique NPMRDS roadway segments and 138 unique grade crossings. These segments and crossings were grouped into 320 combinations. The statewide distribution of the identified grade crossings is shown in **FIGURE 1**. About 80% of the grade crossings had 2 associated NPMRDS segments. Some grade crossings only had a single associated segment; other crossings had up to 8 associated segments. Roadway segments could also include more than one grade crossing. These combinations were used to extract 3,658,600 travel time observations from the NPMRDS during the 5-month study period *(4) (5) (18) (22)*.

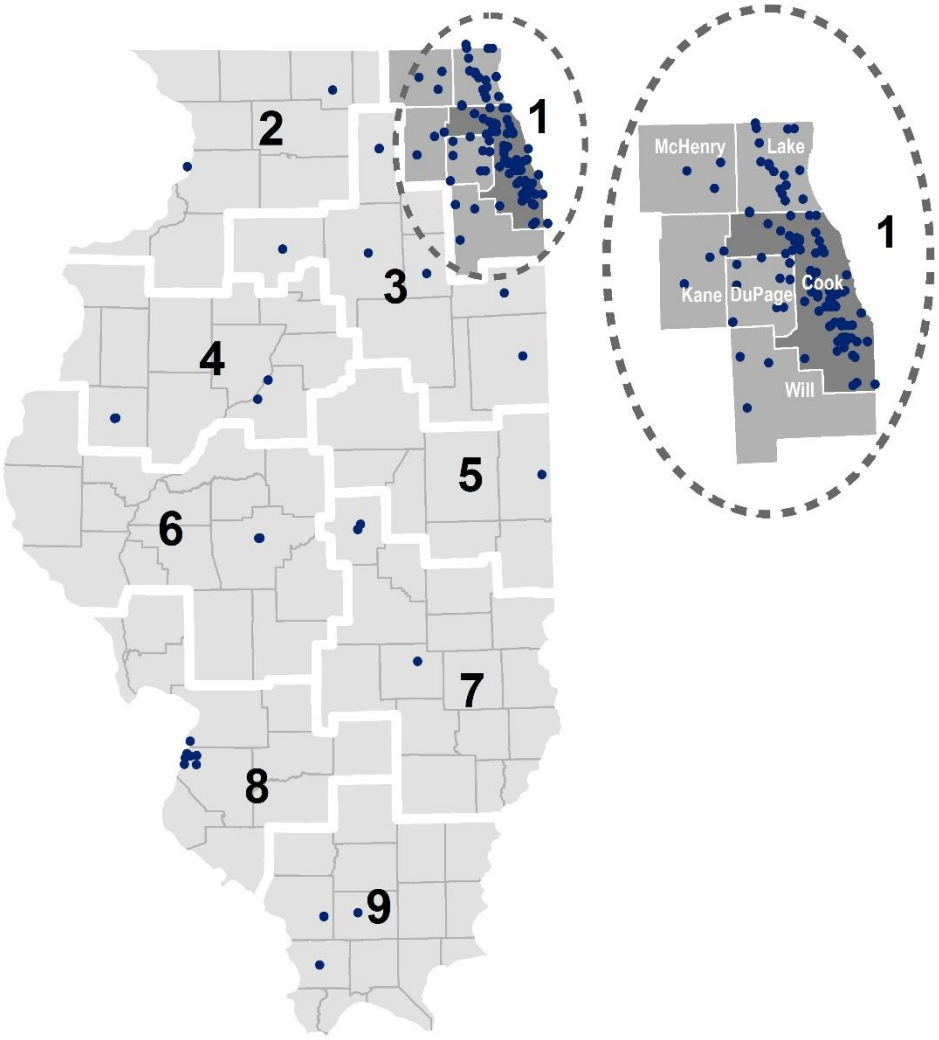

FIGURE 1. Location of Illinois grade crossings intersecting roadway segments in the NPMRDS data set and meeting the 250,000 daily crossing exposure threshold

The study estimated two performance measures during the FRA defined Weekday Daytime hours between 6am and 6pm *(23)*: (1.) The frequency counts of the number of time periods that traffic speeds along a roadway segment were less than 5mph divided by the total number of observations for that segment during the Weekday Daytime hours; and (2.) the number of Weekday Daytime hours when the observed speed was less than 5mph for an average of one or more 5-minute interval. This measure is used to estimate the number of hours when the segment intersecting the crossing could be consistently blocked by train traffic or by other traffic obstructions. This criterion is not considered if the hour of the day did not record at least 12 observations for an NPMRDS segment in the same direction across the five months of data. These measures are estimated from the NPMRDS travel time observations for each roadway segment. Measurements suggesting that a vehicle did not complete travel across the length of an entire segment are not included in this study.

Different threshold values of these performance measures were applied to the following three geographic areas to select a set of crossings to examine in further detail: Outside of IDOT District 1, IDOT District 1 Outside of Cook County, and Within Cook County. All crossings had an estimated Daily Crossing Exposure of at least 250,000 and had at least one NPMRDS segment with a consistently blocked

Daytime Weekday Hour. Six (6) crossings Outside of IDOT District 1 were selected by applying a 5% minimum threshold for the total frequency count of observations under 5mph for at least one roadway segment; seven (7) crossings in IDOT District 1 Outside of Cook County were identified by applying a 7% minimum threshold to this frequency count. Nine (9) crossings in Cook County met a 10% minimum threshold for the frequency count and had an estimated AADT across the grade crossing of 15,000 or above. These crossings were assessed to identify geometric characteristics; the relative locations of the grade crossings, railroad facilities, signalization and crossing configurations; roadway connectivity, and other characteristics for each grade crossing *(4) (5) (18)*.

These 22 grade crossings were categorized into the following three groups by their surrounding land uses and roadway characteristics: Commuter/Transit Rail Access Crossings, Non-Passenger Access Crossings, and Special Cases. In **TABLE 1**, roadway blockage estimates are reported for the roadway segments that met the selection thresholds. Commuter/Transit Rail crossings are considered separately from Non-Passenger Access Crossings since these crossings are often used by passenger vehicle traffic that is seeking to mode-shift to commuter and transit rail trains. At these crossings, the same train that a person is waiting to board can block vehicles that are trying to park alongside a station. Passenger trains near a station also have different operating and scheduling characteristics than through or switch traffic across other rail segments *(24)*. The Special Cases include two crossings where the rail lines crossed diagonally through the middle of the intersections and can block traffic in four directions.

Commuter / Transit Rail Access Crossings							
Crossing ID	County	Municipality	Road	AADT	Crossing Exposure	Frequency of Daytime Observations Under 5mph	Hours with Consistent Observations Under 5mph
914403P	St. Clair	East St. Louis	Broadway Blvd.	9,400	1,861,200	6.5-7.3%	2-3 hours
917334U*	St. Clair	Washington Pk, East. St. Louis	Kingshighway	5,200	868,400	5.5%	2 hours
079535V	DuPage (District 1)	Downers Grove	Main St.	16,500	2,640,000	8.6%	6 hours
174022F	DuPage (District 1)	Elmhurst	York Rd.	4,350	426,300	9.6-11.1%	8-10 hours
689751X	Lake (District 1)	Antioch	Main St.	9,800	450,800	8.5%	4 hours
176953C	Lake (District 1)	Barrington	N. Hough St.	19,800	1,306,800	10.4%	9 hours
176951N	Lake (Dist 1) and Cook	Barrington	Lake-Cook Rd.	11,700	819,000	8.4-10.7%	5-9 hours
289752A	Will (District 1)	Lockport	9th St.	18,700	299,200	7.2%	4 hours
386378A	Cook	Chicago	Caldwell Ave.	39,500	3,239,000	11.5%	9 hours
079508Y*	Cook	La Grange	La Grange Rd.	19,500	3,120,000	16.9-17.6%	12 hours
176912X	Cook	Mount Prospect	Main St.	15,700	1,161,800	14.4-14.9%	12 hours
478755S	Cook	Oak Lawn	Cicero Ave.	43,100	1,810,200	10.6%	10 hours
Non-Passenger Access Crossings							
Crossing ID	County	Municipality	Road	AADT	Crossing Exposure	Frequency of Daytime Observations Under 5mph	Hours with Consistent Observations Under 5mph
167536U	Kankakee	Kankakee	Indiana Ave.	5,400	297,000	6.1%	2 hours
801678J	Tazewell	East Peoria	Main St.	31,000	682,000	7.1-11.4%	3-11 hours
479862K	Vermillion	Danville	Main St. (MLK)	11,100	555,000	6.9%	1 hour
689719E*	Lake (District 1)	Grayslake	E. Belvidere	17,600	809,600	8.7%	7 hours
326918E	Cook	Chicago	Central St.	21,900	481,800	14.7%	12 hours
371890K	Cook	Chicago	North Ave.	37,000	370,000	10.3-13.6%	8-9 hours
174107H*	Cook	Des Plaines	N. River Rd.	21,100	569,700	10.6%	11 hours
283177X	Cook	Harvey, Phoenix	Halsted St.	16,000	384,000	10.3%	9 hours

Special Cases							
Crossing ID	County	Municipality	Road	AADT	Crossing Exposure	Frequency of Daytime Observations Under 5mph	Hours with Consistent Observations Under 5mph
175042V*	DeKalb	DeKalb	Lincoln Hwy, 4th St.	8,100-8200 5,350-5,500	860,800-876,800	6.2-11.2%	1-10 hours
478752W	Cook	Chicago	87th St, Pulaski	18,900-26,300 23,500	1,780,800-2,091,600	7.2%	3 hours

TABLE 1: Grade Crossings in Illinois Meeting Selection Criteria for Study *(4) (5) (18)*

From these 22 grade crossings, the study team selected five grade crossings to review in detail. The following crossings were chosen because they exhibit different combinations of street connectivity, signalization, and traffic behaviors characteristics:

- Crossing 917334U / Kingshighway / Washington Park and East St. Louis in St. Clair County
- Crossing 079508Y / La Grange Rd. / La Grange in Cook County
- Crossing 689719E / E. Belvidere Rd. / Grayslake in Lake County (District 1)
- Crossing 174107H / N. River Rd. / Des Plaines in Cook County
- Crossing 175042V / Lincoln Highway and 4th St. / DeKalb in DeKalb County

The hourly impacts of train traffic at these grade crossings are evaluated using the proportion of hourly observations indicating an average traffic speed under 5mph. The alignments between the crossings and the NPMRDS roadway segments are shown in **FIGURE 2(a)-(e)**.

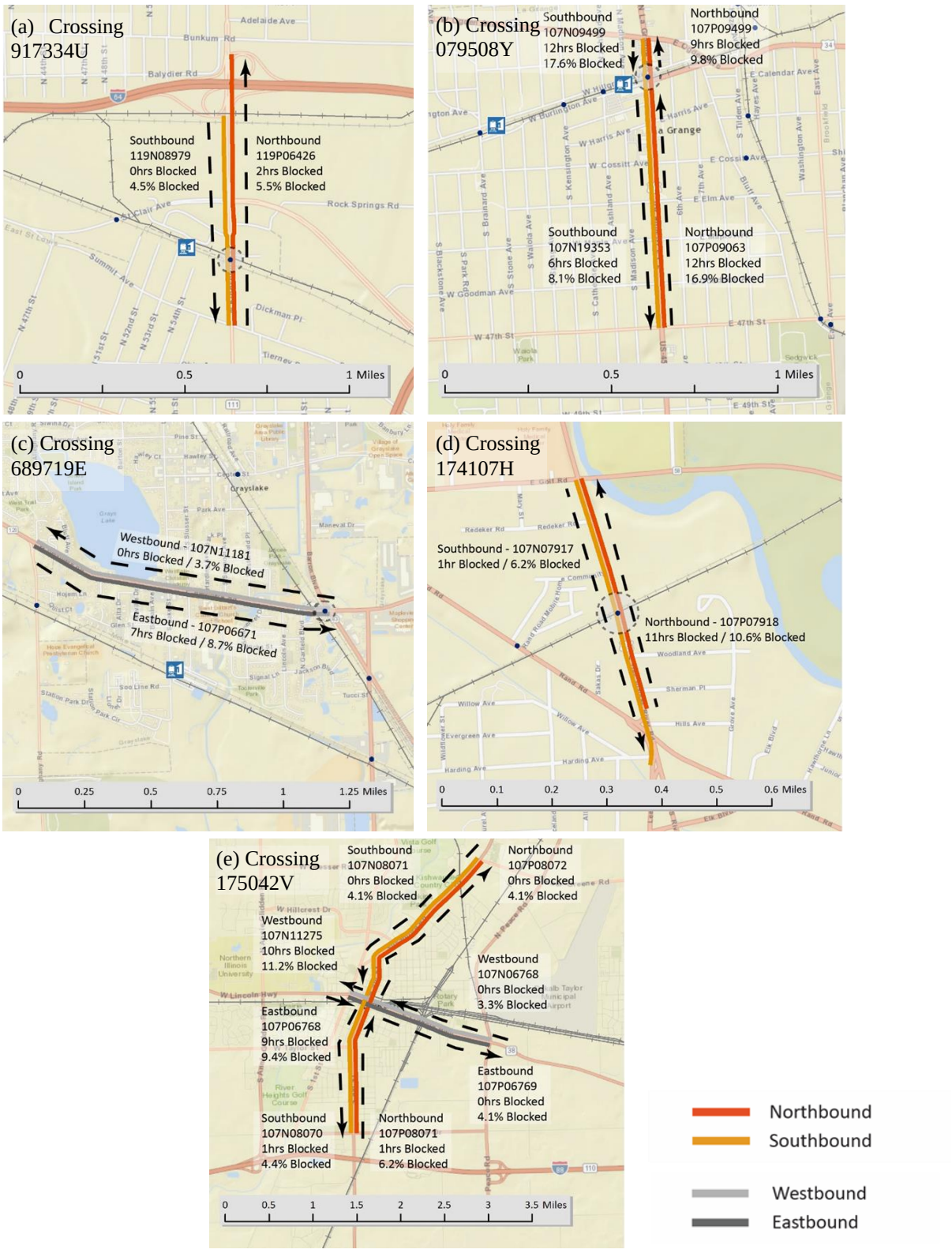

FIGURE 2(a)-(e). NPMRDS segments and blockage estimates for roadways intersecting the five Illinois railroad grade crossings chosen for the case studies *(1) (4) (5) (18) (25)*

CHARACTERISTICS OF SELETED CROSSINGS

Commuter / Transit Rail Access

Crossing 917334U / Kingshighway / Washington Park and East St. Louis in St. Clair County

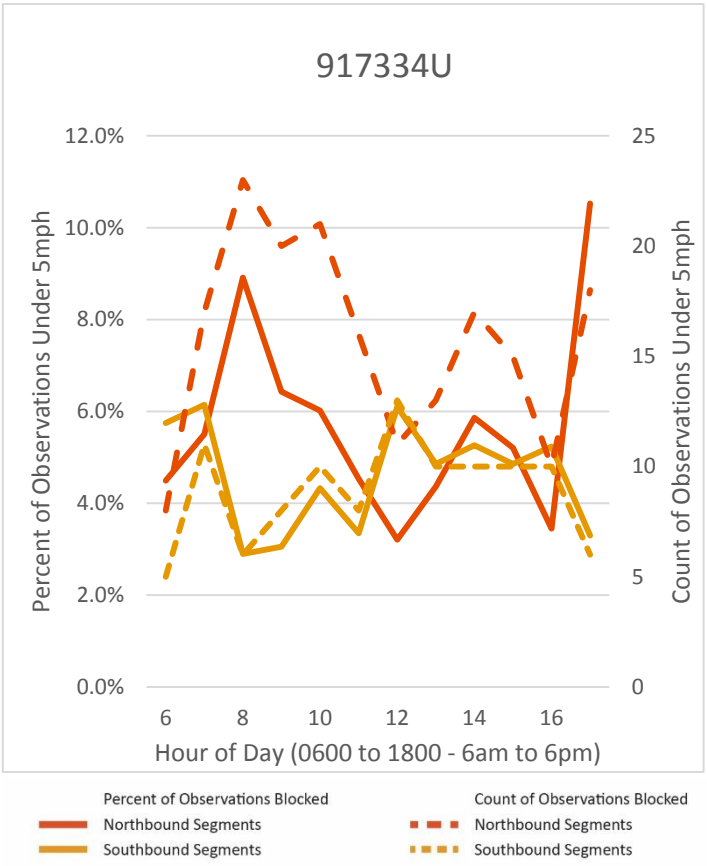

FIGURE 3. Weekday daytime hourly roadway blockage observations, May 2014-September 2014 for crossing 917334U *(18)*

Crossing 917334U is along the St. Louis Metrolink transit line and is near the Washington Park Station. The crossing carries Kingshighway North-South across the tracks. The NPMRDS segments extend between Summit Avenue to the South and I-64 to the North. Near I-64, Kingshighway is grade separated from the Union Pacific tracks. The travel time data in **FIGURE 3** suggests a higher proportion of roadway blockages on Northbound traffic than on Southbound traffic. The correlations of both graphs with the graphs of observation counts suggest that the difference in the percentage estimates are related to the total number of observations in each direction.

The Washington Park Station and the I-64 interchange are both located North of Crossing 917334U. South of the tracks, Kingshighway leads through a forested area and a residential area before intersecting Summit Avenue. Since travel times are recorded for vehicles that cross the beginning and end of an NPMRDS-defined segment, times for Southbound vehicles entering the parking lot for the Washington Park Station or other destinations North of the tracks are not recorded. Blockage patterns on the Northbound segment have local maximums during the morning peak periods, during the mid-afternoon, and at the start of the evening peak periods. These patterns may relate to higher frequency transit service levels and other traffic patterns during these times.

Crossing 079508Y / La Grange Rd. / La Grange in Cook County

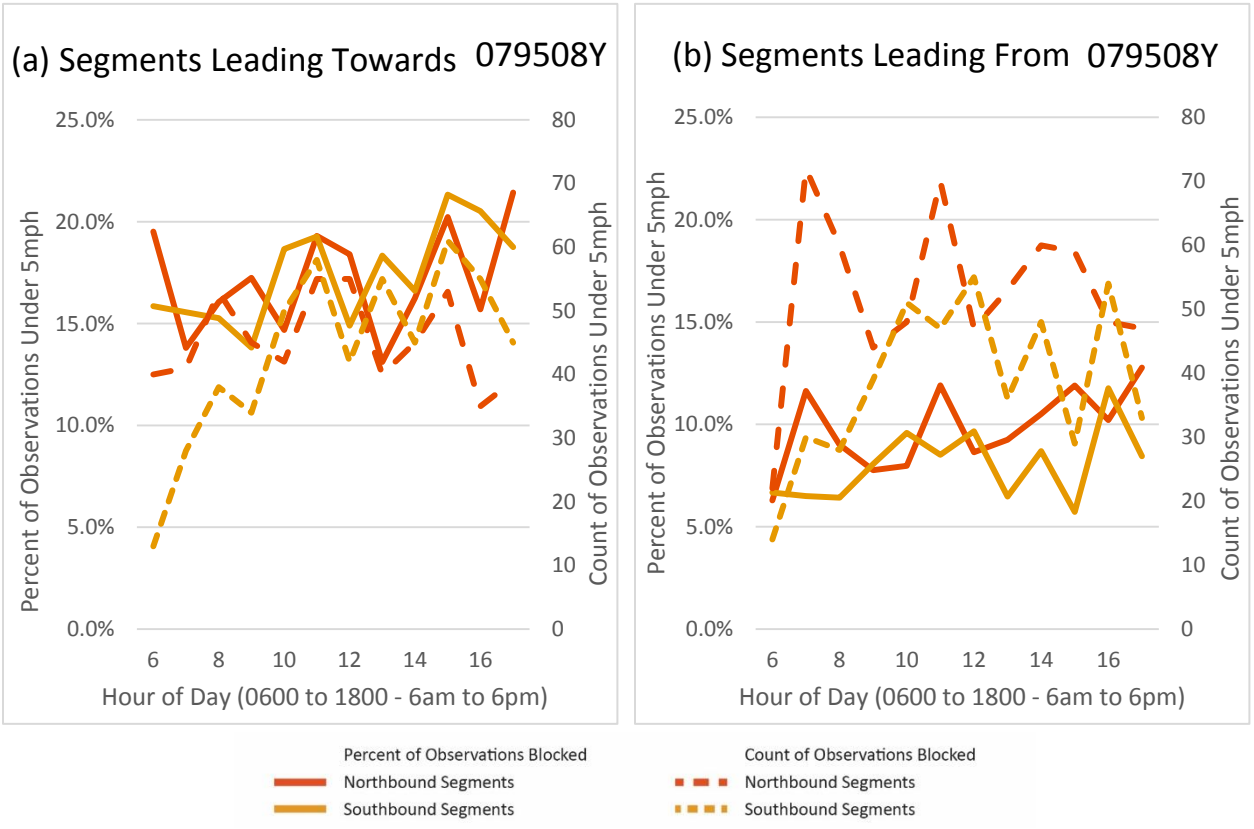

FIGURE 4(a)-(b). Weekday daytime hourly roadway blockage observations, May 2014-September 2014 for segments leading towards 079508Y and segments leading from 079508Y *(18)*

Crossing 079508Y is located along the Burlington Northern Santa Fe (BNSF) tracks in La Grange, Illinois. La Grange Road (US-20/US-12) uses this crossing through the Downtown La Grange commercial district between West 47th Street and West Ogden Avenue (US-34). The LaGrange Metra station is located South of the tracks and West of the crossing along West Burlington Avenue. **FIGURE 4(a)** plots the NPMRDS estimates of roadway blockages for segments leading towards this grade crossing. These estimates correspond to blockages of between 5 minutes and 13.5 minutes during each Daytime Hour between 6am and 6pm. In both directions, the proportions of roadway blockages have local peaks during the 11am hour and the 3pm hour. Since these peaks are during off-peak hours for the commuter service, the roadway blockages are more likely to result from freight train traffic or vehicle traffic congestion than commuter traffic. **FIGURE 4(b)** plots roadway blockage patterns just after the crossing. These patterns suggest that overall vehicle traffic volumes and roadway congestion also contribute to the blockage patterns leading into the crossing. For some hours, the segments after the crossing have a higher number of observations than the segments leading into the crossing. These results may suggest higher overall traffic throughput on the segments that start after the crossing.

Ogden Avenue curves from the North end of the NPMRDS roadway segments and passes underneath the BNSF tracks to the East of this crossing. Although this underpass can provide a detour for some traffic, it is unclear from the travel time data and signage visible from *Google Maps* whether drivers can easily identify and use this route to avoid delays at the grade crossing *(22)*.

Non-Passenger Access Crossings

Crossing 689719E / E. Belvidere Rd. / Grayslake in Lake County

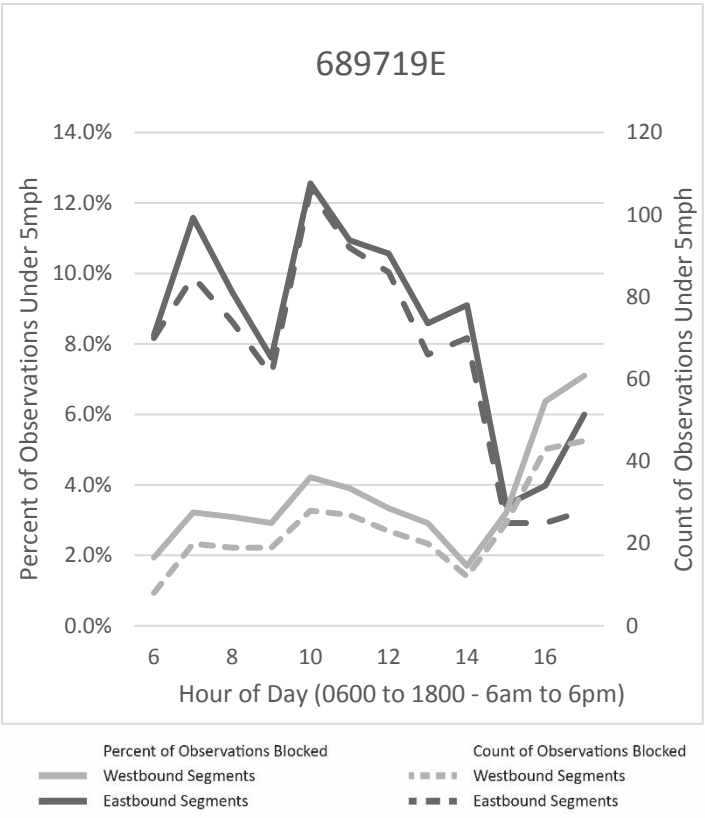

FIGURE 5. Weekday daytime hourly roadway blockage observations, May 2014-September 2014 for crossing 689719E *(18)*

Crossing 689719E is located along the Canadian National railroad in Grayslake. The rail line is used by the Metra North Central Service (NCS) commuter service. The crossing is about 1.5 mile from the nearest NCS station at Prairie Crossing in Libertyville. East Belvidere Road (IL-120) crosses East-West across the tracks. Barron Boulevard (IL-83) runs parallel to the tracks for about one mile. The NPMRDS segments used in this study begin and end at Barron Boulevard. As shown in **FIGURE 2(c)**, Crossing 689719E is almost immediately West of the East Belvidere Road-Barron Boulevard intersection.

The intersection between East Belvidere Road and Barron Boulevard marks the beginning of the Westbound segment and the end of the Eastbound segment. While the crossing is blocked by train traffic, the intersection signals should hold traffic away from the crossing and the start of the Westbound segment. During these times, a very small number of vehicles should cross the start of the Westbound segment.

FIGURE 5 plots the roadway blockage patterns along East Belvidere Road. These patterns suggest frequent periods of roadway blockages Eastbound between 10am and 3pm. Since the number of blockage observations appears to match up with the pattern of the percentage of observations, the travel time data suggests that the change in percentage of observations is due to changes in the number of roadway blockage observations. Westbound travel times show fewer blockages at the same times. Crossing blockages would likely queue Westbound vehicles behind the intersection or divert Westbound vehicles away from the crossing. Eastbound travel times are recorded for vehicles that entered the segment about one mile West of the crossing. These vehicles are more likely to queue directly behind

this crossing. The inflection during the 3pm hour between Westbound and Eastbound traffic blockage patterns may result from changes in traffic directions and other types of delays that occur West of the crossing.

Crossing 174107H / N. River Rd. / Des Plaines in Cook County

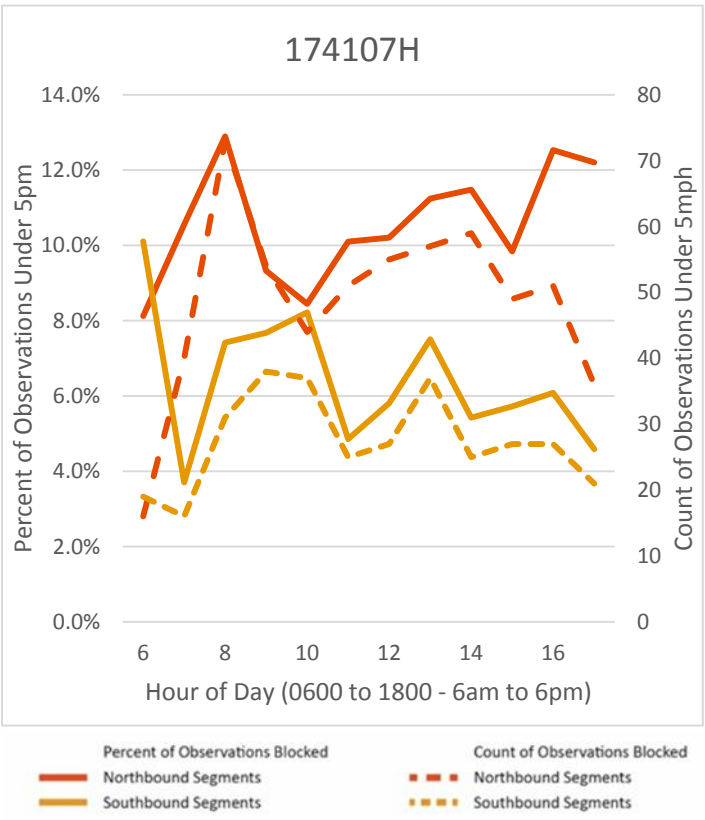

FIGURE 6. Weekday daytime hourly roadway blockage observations, May 2014-September 2014 for crossing 174107H *(18)*

Crossing 174107H is along the Union Pacific Railroad in Des Plaines. This rail line is not used by the Metra Commuter Railroad. The crossing carries North River Road across the railroad lines between the East Golf Road and Rand Road intersections. A potential alternate route could divert traffic away from this crossing and Eastbound along East Golf Road. This route, however, is about a 2-mile detour around this crossing *(22)*.

The Northbound segment recorded an average of 5 to 8 minutes of roadway blockages for each Daytime Hour. The Southbound segment only recorded consistent roadway blockages or more than one roadway blockage per equivalent hour of observations during the 6am hour. In **FIGURE 6**, the alignment between the percentage of observations and the number of roadway blockage observations for both Northbound and Southbound segments suggest that changes in the percentages of observations do not directly result from changes in the total number of observations. The Northbound segment shows a local minimum for roadway blockages during the 10am hour. This same hour is a local maximum for the Southbound segment. During the other hours of the day, the Northbound and Southbound patterns follow opposing blockage patterns.

Since crossing delays should affect both directions at the same time, the patterns of delays across these segments suggest causes other than crossing delays. The Northbound blockage patterns could also result from delays leading into the East Golf Road intersection.

Special Cases

Crossing 175042V / Lincoln Highway and 4th St. / DeKalb in DeKalb County

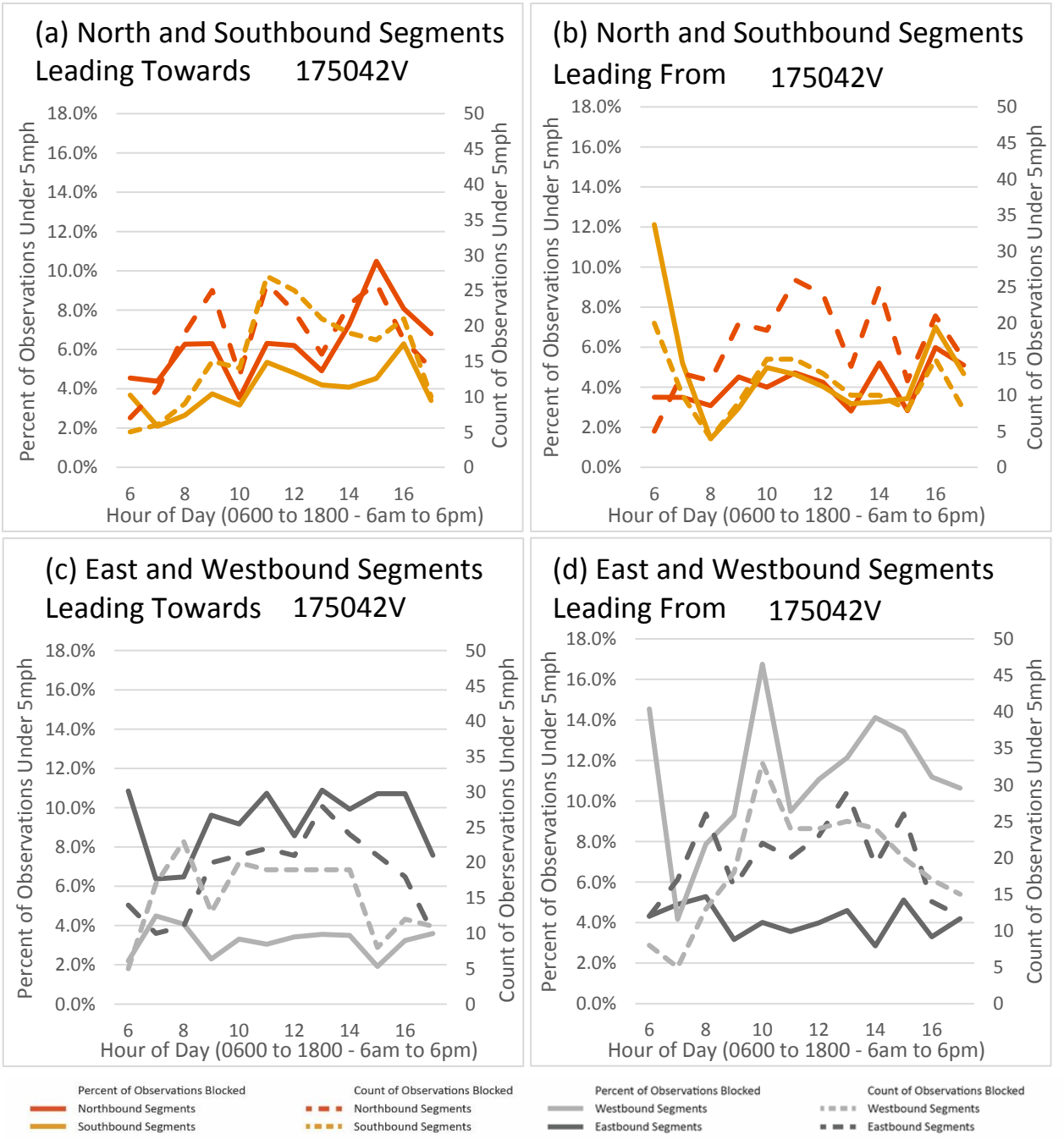

FIGURE 7(a)-(d). Weekday daytime hourly roadway blockage observations, May 2014-September 2014 for segments leading towards 175042V and segments leading from 175042V *(18)*

Crossing 175042V is located in DeKalb, Illinois, along the Union Pacific Railroad. This line is not used by commuter trains or by other transit rail services. The crossing is located in the middle of the

intersection between Lincoln Highway (East-West, IL-38) and 4th Street (North-South, IL-23). A train crossing through this intersection would block road traffic from four directions *(22)*. As shown in **FIGURE 2(e)**, the intersection and the crossing are also the beginnings or ends of eight NPMRDS segments. Although train traffic should block all traffic into the intersection and across the grade crossing, the travel time observations suggest that train traffic may cause different impacts for each segment. These differences could result from variances in how the ends of the approaching segments and the starts of the departing segments are identified and from differences in roadway traffic behaviors across these segments. The unusual crossing configuration could also introduce ambiguities about where to begin and end the individual vehicle observations.

Travel time observations for the two roadway segments along Lincoln Highway leading West of the crossing suggest a larger proportion of roadway blockages than observations for any of the other six segments leading to or from this intersection and crossing. Both of the segments West of the intersection are about 0.22 miles in length and are much shorter than the other segments *(22)*. Since these segments are shorter, roadway blockages and traffic congestion on adjacent roadways are likely to have greater impacts on travel times across these segments than on travel times across the longer segments.

In **FIGURE 7(b)**, the Southbound roadway segment from the crossing recorded blockages of over 12% during the 6am hour. **FIGURE 7(a)** plots over 10% blockage for the Northbound roadway segment leading towards the crossing recorded during the 3pm hour. Except for the two segments West of the intersection, the other hour periods and roadway segments recorded blockage percentages of less than 8%.

CONCLUSIONS AND RECOMMENDATIONS

The National Performance Management Research Data Set (NPMRDS) can provide useful insights into the operations and travel time performance of rail at-grade crossings and the traffic impacts of crossings on adjacent roadways. To use this data set effectively, however, it is also important to evaluate the unique characteristics of each crossing and the configurations of the roadways, rail lines, and land use patterns on either side of the tracks. The five case scenarios demonstrate several approaches for interpreting this data set for different grade crossing configurations and how to identify opportunities to improve traffic flows across these locations. Since the NPMRDS is oriented towards roadway segment performance rather than crossing performance, further details about the dates, times, and locations of train operations could help to distinguish delays caused by rail crossings from delays caused by other factors.

The Illinois statewide NPMRDS data sets can provide information to compare roadway delays leading into and following a crossing, to assess how vehicles use crossings, and to identify how vehicles either queue behind or divert away from a blocked crossing. The resolution of these data sets can also identify how roadway behaviors near or through the crossings change from day to day and from hour to hour. This data can capture conditions that are not easily observable by on-site methods. These insights can inform decisions about how to prioritize the limited funds available to conduct detailed site observations. Further studies enabled by this data can help agencies to select options to reconfigure crossings, enact signaling and signal coordination changes, provide diversions and detours, locate signage, and make other improvements to reduce delays and improve traffic flow at these grade crossing locations.

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