Highway Capacity Measurements:
Grade Crossing Saturation Flows
Chicago Region, 2013

Draft
Technical Update

Chicago Metropolitan Agency for Planning

October, 2015

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Introduction and Summary

This short paper addresses measurements of highway capacity at highway-rail grade crossings. Motorist delay at such crossings is a serious transportation policy issue in the Chicago region. The Chicago Metropolitan Agency for Planning has identified grade crossing delay as a regional indicator, with measurable delay-reduction targets identified for several milestone years between now and 2040, the horizon year of the GO TO 2040 Comprehensive Regional Plan.[1] Since a literature review indicated that reduced highway capacity at grade crossings is one factor that may cause traffic delay at grade crossings, CMAP engaged in an effort to quantify the scale of such capacity reductions.

CMAP, as part of a broader effort to understand highway-rail grade crossings, collected "saturation flow rates" during the summer of 2013. Saturation flow rates are defined as "the number of vehicles that can pass a given point on a highway in a given period with no interruptions."[2] Saturation flow rates are calculated in terms of passenger vehicles.

Calculations of highway capacity use saturation flow rates as a key building block. When field data is unavailable for capacity estimates, the typical default value for optimum driving conditions is 1,900 passenger cars per hour per lane (pcphpl); this value may then be adjusted for narrow lanes, steep grades, parking, large vehicles, and the like, to arrive at a saturation flow rate for a particular location.[3] However, a field-measured value is regarded as more accurate and may be used in capacity calculations without further adjustment.[4]

The field measurements collected by CMAP in the summer of 2013 showed saturation flow rates far below the 1,900 pcphpl noted above. Following are summary statistics for the saturation flow rate data collected.

Table 1. Summary of Saturation Flow Data Collection

Measure	Units	2013 Field Values	2013 Adjusted Values
Mean (Average of 17 Sites)	Passenger Cars per Hour per Lane (pcphpl)	1,321	1,354
Median (50th Percentile of 17 Sites)	Pcphpl	1,380	1,421
Number of Sites	Each	17	17
Total Number of Observations	Each	153	153

Source: Chicago Metropolitan Agency for Planning

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[1] http://www.cmap.illinois.gov/documents/10180/332742/Update+Indicator+Methodology+FINAL.pdf. P. 62.

[2] Schroeder et al. *Manual of Transportation Engineering Studies.* 2nd Edition. Washington: Institute of Transportation Engineers. Pp. 105-109.

[3] Transportation Research Board. *Highway Capacity Manual, 2000*. Pp. 16-9 – 16-13.

[4] Ibid., p. 16-10.

The large difference between the all of the values measured at railroad grade crossings and the more optimal rates described above may call for additional data collection and, potentially, an adjustment in the calculations CMAP uses to estimate motorist delay at highway-rail grade crossings. There may also be reason to look at the calculations of delay reduction and air quality benefits associated with grade separations used for such purposes as Congestion Mitigation and Air Quality Improvement Program project rankings.

Background and Literature Review

The GO TO 2040 Comprehensive Regional Plan includes grade crossing delay as a regional indicator. This indicator uses calculations of gate-down delay periodically provided by the Illinois Commerce Commission (ICC).[5,6] It is known and understood that there may be many factors the ICC model does not account for, but the model has the advantage of having a consistent method that can be applied to all crossings in the region. Nonetheless, it has been judged advantageous to understand the broader delay factors and processes at grade crossings so as to understand whether the order of magnitude of the calculations is correct and whether improvements in the methodology would change the relative level of delay among crossings.

There is little literature on calculating delay at railroad crossings.[7] A 1973 Chicago Area Transportation Study (CATS) report proposed a theoretical framework for analyzing delay for use in prioritizing grade separations and other improvements at the then-3100 at-grade railroad crossings in the Chicago region.[8] The CATS report proposed evaluating delay for both blockages (when a train occupies a crossing) and for the additional delay related to lower speeds and queues at grade crossings even in the absence of a train.[9] The latter delays, collectively referred to in the report as "queuing costs," may be related, for example, to vehicles slowing for rough crossing surfaces or the requirement that vehicles such as tankers, hazardous cargoes, and buses carrying passengers must stop at railroad crossings; both of these conditions potentially forming vehicle queues.[10] The queueing costs were found to be difficult to quantify accurately, so a planning-level analysis was proposed.[11] Despite the collection of a large

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[5] Illinois Commerce Commission. *Motorist Delay at Public Highway-Rail Grade Crossings in Northeastern Illinois.* Working Paper 2002-03. July 2002. Posted at http://www.cmap.illinois.gov/documents/10180/29236/021114rrdelay1.pdf.

[6] Illinois Commerce Commission. *Motorist Delay at Public Highway-Rail Grade Crossings in Northeastern Illinois, 2011 Update*. 2011. Posted at http://www.cmap.illinois.gov/documents/10180/29236/2011-1004-Motorist-Delay_20111121_final.pdf.

[7] Review of materials posted at http://www.trb.org/AHB60/AHB60.aspx. Accessed October, 2015.

[8] Raymond T. Halagera and Mark S. Miller. *Economic Analysis of Grade Crossing Improvements.* Chicago Area Transportation Study Staff Technical Report 313-05. December, 1973.

[9] Ibid., pp. 9-10.

[10] Ibid., p. 10.

[11] Ibid., pp 11-12.

amount of data supporting the analysis, no record could be found of this theoretical foundation having been implemented at CATS, perhaps because of skepticism voiced at the end of the report about the validity of simplifying assumptions, particularly capital costs of improvements.[12] Unpublished analyses cannot be ruled out.

The most comprehensive review of delay at highway-rail grade crossings, where results were computed, is a paper by James Powell, "Effects of Rail-Highway Grade Crossings on Highway Users," dating from 1982.[13] Like the suggested CATS analysis, Powell differentiates between delay related to a gate-down condition ("occurrence delay") and delay not related to a gate-down condition ("non-occurrence delay"). In addition, Powell differentiated between crossings impacted by adjacent highway traffic controls ("non-isolated crossings") and those not impacted by such controls ("isolated crossings," the focus of his research). Moreover, Powell had a traffic engineer's understanding of how nuances in the time-of-day and occurrence-duration characteristics of traffic could substantially change estimates of delay:

> …In the estimation of delays and highway-user costs associated with train blockage of a crossing, one major study assumes highway vehicle and train volumes to be uniformly distributed over a 24-hour day. In reality, both vehicle and train traffic can follow greatly different time patterns over a day, which affects delay a good deal. Another difficulty is that blockage times are averaged such that each train is treated as though it causes the same fixed blockage time. Actually, all other things being equal, the expected vehicle delay of one 10-minute train is on the order of four 5-minute trains.[14]

Powell suggested that simplified models for train occurrences would be appropriate where accurate time-of-day train and vehicle data is available, where arrivals are random, and where the flow ratios (arrival rate divided by departure rate) are <= 0.50.[15] Powell's original models are discussed for occurrences when the conditions above are not met and for non-occurrence conditions. Non-occurrence delay is not calculated, but non-occurrence costs are calculated along with occurrence costs. Nonetheless, even for the busy railroads studied, nonoccurrence costs were found to exceed occurrence costs.[16]

Okitsu, Louie, and Lo extended Powell's work for a 2009-2010 study of 33 grade crossings in the Alameda Corridor East, with the intention that the work would be used for the prioritization of grade crossing separations and other improvements.[17] The study was focused on providing a

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[12] Ibid., pp 25-26.

[13] James L. Powell. "Effects of Rail-Highway Grade Crossings on Highway Users." *Transportation Research Record 841.* Transportation Research Board. Pp. 21 – 29.

[14] Ibid., p. 22.

[15] Ibid., p. 25

[16] Ibid.

[17] Walter Okitsu, Jonathan Louie, and Kathy Lo. "Simulation-Free Railroad Grade Crossing Delay Calculations." Paper presented at Western District, Institute of Transportation Engineers 2010 Annual Meeting. Posted at

delay estimate for each train event; train event data was collected with 24-hour video recordings of the crossings.[18] The work included not only an analysis of isolated intersections (without upstream or downstream signal preemption), but also an adjustment for the saturation flow rate for preemptions based on the number of upstream critical intersection phases and the downstream ratio of green-time to signal cycle length.[19] The adjustments rely on Transportation Research Circular 212, which has since been superseded by the Highway Capacity Manual, so the validity of these calculations needs to be determined.

Okitsu, Louie, and Lo thus lay out a simplified method of calculating motorist delay at grade crossings, relying on the saturation flow rate, vehicle arrival rate, and gate-down duration. One item to note in the paper is the use of a default 1700 vehicles per hour per lane saturation flow rate.[20]

Like Powell, this study used methods based on classic traffic flow theory. Despite the weaknesses identified above, which can be addressed with data collection, the fundamental soundness of this method calls for additional investigation into whether it can be deployed on a regional scale in the Chicago region, at least for crossings with high traffic volumes. This is particularly true if reasonable saturation flow rates can be estimated. Gate-down event times from crossing-gate event recorders or interconnected highway traffic signal event recorders might be used to derive an accurate reading of gate-down event durations.[21]

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http://www.westernite.org/annualmeetings/sanfran10/Papers/Session%204_Papers/ITE%20Paper_4A-Okitsu.pdf. Accessed October, 2015.

[18] Ibid., p. 1.

[19] Ibid., p. 5.

[20] Ibid. Again, this value derives from the *Transportation Research Circular 212*, ("Interim Materials on Highway Capacity," Transportation Research Board, 1980) so, putting aside the fact that it may be too high for grade crossings, the value may be out of date.

[21] Using highway signal event recorders necessarily implies an interconnected signal, not an isolated signal, potentially adding complexity to the analysis. Railroad crossing gate controller event recorder data would need to be acquired from the railroads, also adding complexity.

The following formulas were used by Okitsu, Louie, and Lo for the delay calculations, illustrated with the figure to the right:[22]

$$D = \frac{[AR \cdot Q \cdot (B + LT)]}{2}$$

$$Q = (B + LT)/[1 - \left(\frac{AR}{SatFlowRate}\right)]$$

Where:

D = Total delay in vehicle-hours

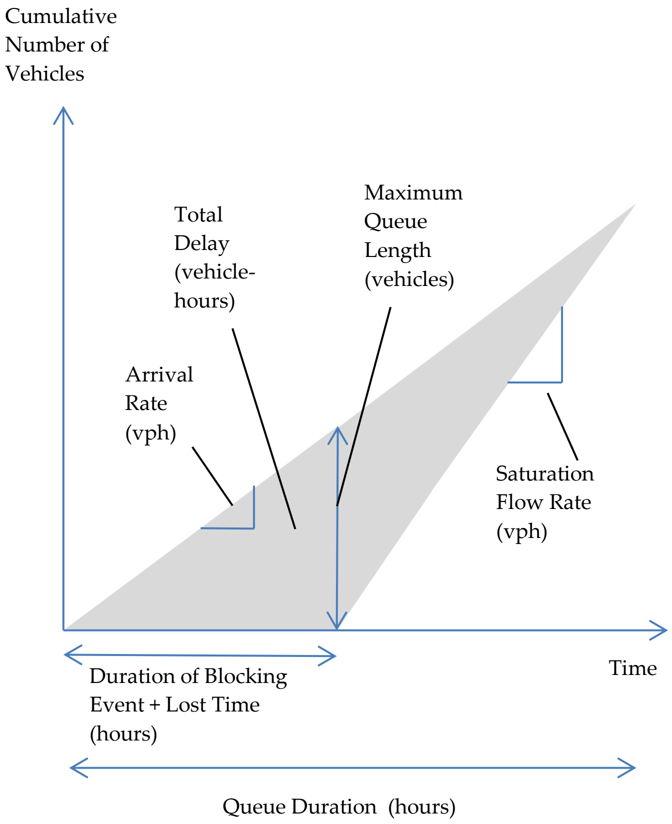
AR = Vehicle arrival rate in vehicles per hour

Q = Queue duration in hours

B = Duration of blockage event in hours;

LT = Lost time in hours

SatFlowRate = Saturation flow rate, in vehicles per hour for lane group.



Source: Okitsu, Louie, and Lo, "Simulation-Free Railroad Grade Crossing Delay Analyses."

Figure 1. Grade Crossing Delay

Lastly, the Texas Transportation Institute has prepared an "impedance model" for highway-rail grade crossings, and applied the model in the Houston-Galveston metropolitan area for a study of 2005 data,[23] with an update in 2014 to inform TxDOT's Houston Region Freight Study;[24] the studies identified and prioritized grade crossings for improvements, including separations. Like Powell's model, the TTI impedance model is a comprehensive model of grade crossings, providing estimates of delay, lost fuel, emissions, and crashes. The model's estimates are based

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[22] Ibid., p. 3.

[23] Protopapas et al, "Quantifying the Public Impacts of Highway-Rail Grade Crossings on Surface Mobility: Regional Impact Model." *Transportation Research Record: Journal of the Transportation Research Board, no 2149.* Transportation Research Board of the National Academies, Washington DC.

[24] Texas Transportation Institute Multi-Modal Freight Transportation Programs (TTI MFTP). "Technical Memorandum for Houston-Area Highway-Railroad Grade Crossing Impedance Model Update." Posted at http://www.h-gac.com/taq/tip/call-for-projects-uploads/300837112201550537PM.pdf.

on train and traffic activity by time of day. The TTI model also includes vehicle behavior, including acceleration and deceleration around the crossing. However, it's unclear from the available reports whether variations in train length or crossing gate-down times are included in the model; only "average" characteristics are reported in the papers.[25] The scale of the TTI studies is large; the focus is the entire Houston region. However, the detailed analysis of crossings in such a large region was facilitated by limiting the analysis to crossings with current or projected AADT levels above 10,000 vehicles per day.[26]

One notable aspect of the Houston studies is the collection of railroad information. For the initial study, the Union Pacific and BNSF Railroads

> …provided records of daily traffic data from a period in August, 2005…. The railroads provided data from their respective computer-aided dispatching systems. These data came in the form of train movements past various 'control points' (CPs), which read train identification data and record the time of day that a train passes. By accumulating this information, it was possible to determine the movement of trains past pairs of CPs and calculate the frequency, speed, direction of travel, and time of day that trains moved during the August sample period. To assign crossing closure time, each highway-rail grade crossing was place on the network relative to CP pairs.[27]

For the more recent TTI study, "gate-arm activated" video capture was used to collect delay time per hour caused by train activity and also the number of trains per day."[28]

Lessons from Literature Review

Based on the papers described above, a few lessons can be drawn for estimating motorist grade crossing delay in the Chicago region:

- Event durations matter. Basing delay estimates on the average event duration or the total daily gate-down time will substantially underestimate motorist delay. Ideally, this data would come from event recorders at crossings. This would require cooperation from railroads. Video records would provide a second-best alternative.
- Since highway traffic levels matter, an analysis by time of day will yield better results. In addition, unlike some cities, Chicago has substantial commuter train peak-period activity that affects the time of day profile for both freight and commuter trains. Unlike the situation in Houston, time-of-day activity estimates for trains would be useful in Chicago.
- Non-occurrence delay at crossings, when the crossing gate is in the up position, may be substantial. An effort to quantify this delay may be useful in understanding the full

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[25] Ibid., p. 10.

[26] Ibid., pp. 8-9.

[27] Protopapas, et al, op cit., pp. 103-104.

[28] TTI MFTP, op cit., p 9.

impact of a crossing when evaluating and prioritizing a crossing for various improvements, including expensive separations.
- The bottom line is that a traffic-engineering approach is necessary for evaluating delay at some grade crossings. Working from Figure 1, any delay after the gates are raised (represented by the area to the right of the line labeled "maximum queue length") are not accounted for in the current calculations used by CMAP. If the arrival rate (traffic volume) at a crossing is high, or if the saturation flow rate is low, this additional delay could be substantial. Conversely, this detailed calculation is not necessary for crossings with low traffic volumes.
- Working from the summary point immediately above, reducing delay at grade crossings may not always require a grade separation. In some cases, improving crossing quality to raise saturation flow rates or adding lanes for the highway section may also substantially reduce delay. Thus, an understanding of saturation flow rates is necessary to understand highway capacity across grade crossings. This requires more investigation.

Data Collection and Analysis Procedures

Data Collection

CMAP's saturation flow rate data collection procedures follow those laid out in the Institute of Transportation Engineers' *Manual of Transportation Engineering Studies.*[29] The procedure, typically applied to highway traffic signals, is also easily applied methodologically and theoretically to gate-down conditions at railroad grade crossings. For grade crossings, this analysis estimates the "ideal" traffic flow past the stop bar in a lane in a hypothetical hour of uninterrupted gate-up condition given rail crossing characteristics. At the beginning of a gate-up period, a data collection intern will determine the elapsed time from when the rear wheel of the fourth vehicle crosses the stop bar and when the tenth vehicle crosses the stop bar. The calculation only applies to passenger vehicles, so if a truck or bus is among the first seven vehicles crossing the stop bar, that observation is scrubbed. If a truck or bus is among the seventh to the tenth vehicles, the data collection is truncated at the previous vehicle. If there are not at least seven vehicles in the queue of vehicles waiting to cross the railroad at the beginning of the gate-up period, that observation is also scrubbed.

Site Selection

Saturation flow rate data was collected as an adjunct data collection process while other basic data collection was being conducted for select grade crossings. The grade crossings were selected for study based on three factors:

- CREATE Program grade separation projects (6 of the 17 sites are proposed CREATE grade separation projects);
- Sites estimated as high-delay by the Illinois Commerce Commission (ICC);
- Freight planning stakeholder suggestions.

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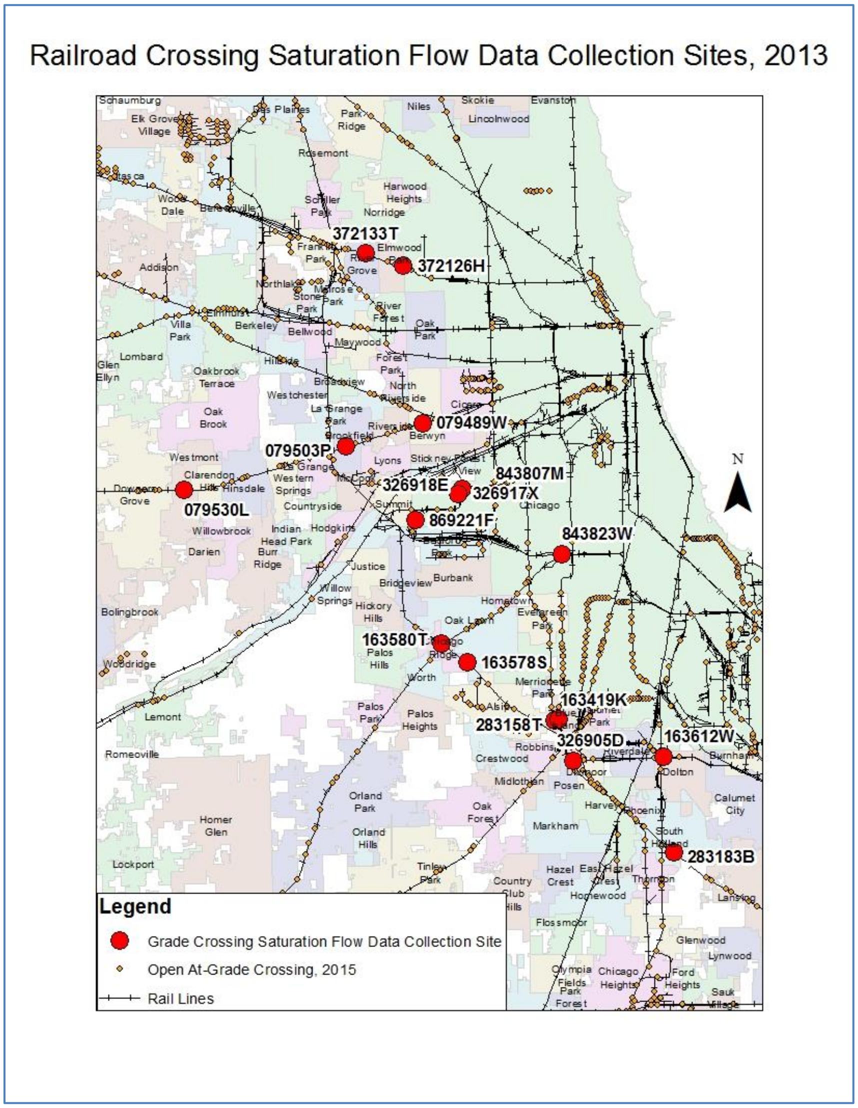
[29] Shroeder et al, op cit., pp 105-109.

Note that the ICC method does not take into account saturation flow rates or, more generally, crossing conditions, but rather gate-down times and crossing volumes. So the results of this study are independent of the ICC delay estimates.

Thus, for this study, the data collection sites were not selected randomly. In the future, in order to assure an unbiased estimate, random site selection may be preferable, with the caveat that only crossings with moderate to high volumes of train traffic and automobile traffic are suitable for such data collection.

The sites selected for this data collection are shown in Figure 2.

Figure 2. Data Collection Sites



Prepared by CMAP, 2015

Processing and Analysis

From the elapsed time from the fourth vehicle for each observation, the saturation flow rate is calculated using the following formula:

$$Mean\ Saturation\ Flow\ Rate = \frac{3600\ \cdot Total\ Number\ of\ Observations}{\frac{\sum_{i=1}^{n}[t(7)-t(4)]}{3}+\frac{\sum_{i=1}^{p}[t(8)-t(4)]}{4}+\frac{\sum_{i=1}^{q}[t(9)-t(4)]}{5}+\frac{\sum_{i=1}^{r}[t(10)-t(4)]}{6}}$$

Where

$n = Number\ of\ valid\ observations\ with\ 7\ vehicles;$

$p = Number\ of\ valid\ observations\ with\ 8\ vehicles;$

$q = Number\ of\ valid\ observations\ with\ 9\ vehicles;$

$r = Number\ of\ valid\ observations\ with\ 10\ vehicles;$ and

$t(k) - t(4) = Elapsed\ time\ in\ seconds\ from\ rear\ wheel\ of\ fouth\ vehicle\ crossing\ stop\ bar\ to\ rear\ wheel\ of\ kth\ vehicle\ crossing\ stop\ bar.$

A full compilation of the data collected is available in the Appendix. The compilation also includes supplementary traffic and roadway data from IDOT and the ICC. In addition, the data collectors also used the saturation flow rate data collection form available in the ITE *Manual;* a sample of a completed form is also in the Appendix.

An adjusted saturation flow rate was calculated based on narrow lane widths at some locations. Based on the formula for lane width adjustments in Exhibit 16-7 in the *2000 Highway Capacity Manual,* the "ideal" saturation flow rates were adjusted up 3.33% for each foot difference between 12-feet and the actual lane width reported in IDOT's highway inventory.[30] The resulting adjusted saturation flow rates, shown in Tables 1 through 3 and the Appendix, allow for a comparison of saturation flows without the effects of reduced lane widths.

Challenges

Collecting saturation flow rates at highway-rail grade crossings presents a number of technical challenges.

Trucks and Buses

In the Chicago area, particularly in freight-oriented areas of the region, the biggest challenge to collecting saturation flow rates is the large number of trucks and buses on the roadways. If a truck or bus is within the first seven vehicles crossing a rail crossing, the observation is scrubbed, since the saturation flow rates are in terms of passenger cars.

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[30] Transportation Research Board. *Highway Capacity Manual 2000*. Exhibit 16-7. P. 16-11.

Low Numbers of Trains and Passenger Cars

The number of data collection points per day is limited by the number of trains in the period. Thus, while saturation flow rates may sometimes be collected at the rate of about 24 per hour or more at highway traffic signals, only a few saturation flows may be collected at train crossings.

Saturation flow data collection is limited to higher-volume roads, owing to the need to have seven vehicles queued at the beginning of a gate-up period to achieve a valid observation. However, in general, successful observations tended to be at the high end of the potential vehicle counts; of the 153 valid observations, 10 were with the minimum of seven vehicles; 14 were with eight vehicles, 22 were with nine vehicles, and 107 – more than three-fourths – were with the maximum ten vehicles. The seventeen data collection sites had an average of 16,800 AADT.

The peak period for passenger cars may yield high numbers of trains per hour for analysis on commuter rail lines. Thus, the highest numbers of valid observations were on the BNSF line, a busy commuter corridor. During peak travel periods for passenger cars, some crossings may have a curfew for some freight trains, resulting in low productivity on freight-only rail lines.

Results

Following is a summary of the measures of saturation flow rates.

Table 2: Summary of Saturation Flow Rates

Measure	Units	2013 Field Values	2013 Adjusted Values (see text)
Mean (Average of 17 Sites)	Passenger Cars per Hour per Lane (pcphpl)	1,321	1,354
Median (50th Percentile of 17 Sites)	Pcphpl	1,380	1,421
Maximum (of 17 Sites)	Pcphpl	1,574	1,574
Minimum (of 17 Sites)	Pcphpl	646	689
Number of Sites	Each	17	17
Total Number of Observations	Each	153	153

Source: Chicago Metropolitan Agency for Planning

Table 3 shows the estimates of saturation flow rates by crossing. Detailed information by crossing, including crossing characteristics, is located in the Appendix.

Table 3. Saturation Flow Estimates by Crossing

Crossing ID	Street Name	Municipality	Saturation Flow Rate	Adjusted Saturation Flow Rate	Railroad Crossed
079489W	Oak Park Avenue (sb)	Berwyn	646	689	BNSF
079503P	Maple Avenue (nb and sb)	Brookfield	1,382	1,382	BNSF
079530L	Cass Avenue (nb and sb)	Westmont	1,396	1,443	BNSF
163419K	127th Street (eb)	Blue Island	1,446	1,543	CSX
163578S	Central Avenue (sb)	Chicago Ridge / Oak Lawn	1574	1,574	IHB
163580T	Ridgeland Avenue (sb)	Chicago Ridge	1368	1,368	CSX
163612W	Lincoln Avenue (sb)	Dolton	1452	1,452	CSX
283158T	127th Street (wb)	Blue Island	1406	1,500	CN (Now CSX)
283183B	170th Street (wb)	South Holland	1253	1,337	CSX
326905D	Western Avenue (sb)	Posen, Dixmoor	975	975	IHB
326917X	55th Street (wb)	Chicago	1,434	1,434	BRC
326918E	Central Avenue (nb)	Chicago	1328	1,417	BRC
372126H	IL 43/ Harlem Avenue (nb)	Chicago, Elmwood Park	1219	1,219	NIRC
372133T	IL 171/ Thatcher Avenue (nb)	River Grove	1380	1,426	NIRC
843807M	55th Street (wb)	Chicago	1469	1,469	BRC
843823W	Columbus Avenue (wb)	Chicago	1375	1,421	BRC
869221F	63rd Street (wb)	Chicago	1362	1,362	BRC

Source: Chicago Metropolitan Agency for Planning

Conclusion

The foregoing shows the necessity and results of a study of saturation flow rates at highway-rail grade crossings in the Chicago region. These flow rates will help understand impaired queue clearance times at rail crossings with high traffic volumes and a substantial number of daily trains.

The paper showed that such data collection is possible, though time consuming, so should be limited to a select few crossings. Table 3 showed that the measurements are clustered together near the median, but there are a few crossings with very low values. To better understand the distribution of values, and to assure a more random sample, additional grade crossing saturation flow data collection is suggested for summer, 2016. It is also suggested that other data be collected simultaneously, including vehicle delay in the absence of trains ("non-occurrence delay"). The scope, scale, and process for this data collection will need to be determined over the course of the next several months.

In the interim, it is suggested that a value of 1,421 passenger vehicles per hour per lane (the adjusted median saturation flow rate) be used as a default value for highway-rail grade crossings. This number can support highway-rail delay analyses.

The suggested saturation flow rate of 1,421 pcphpl for highway-rail grade crossings is substantially below the 1,900 pcphpl default value typical of traffic flow analyses.

Based on the literature review, it is suggested that further improvements to the motorist delay estimation procedures for highway-rail grade crossings continue. Improvements to consider include:

- An incident-based delay calculation, using the saturation flow rates, arrival rates, and variations in the length of the gate-down intervals. The use of this improved method is suggested only for high-volume locations (perhaps using 7,500 minimum AADT and 10 trains per day as a starting point);
- Distributions of vehicle traffic and train traffic by time of day;
- Non-occurrence delay.

Lastly, estimating the effectiveness of alternative delay mitigation strategies is suggested. Such strategies might include (1) additional highway lanes across critical grade crossings and (2) smoother crossings.

Appendix: Detailed Observation Information

Crossing ID	CREATE Project?	Street Name	Municipality	Saturation Flow Rate	Adjusted Saturation Flow Rate	Number of Observations	Lanes	Railroad Crossed	AADT	Crossing Surface	Smallest Crossing Angle	Weather	Date of Observations
079489W	N	Oak Park Avenue (sb)	Berwyn	646	689	23	2 @ 10′	BNSF	10,050	Rubber	60 to 90 Degrees	Sunny, Warm	8/1/2013
079503P	Y	Maple Avenue (nb and sb)	Brookfield	1,382	1,382	16	2 @ 12′	BNSF	7,800	Rubber	60 to 90 Degrees	Sunny, Warm	7/25/2013
079530L	N	Cass Avenue (nb and sb)	Westmont	1,396	1,443	27	4 @ 11′	BNSF	14400	Rubber	60 to 90 Degrees	Cloudy, Light Rain	7/26/2013
163419K	N	127th Street (eb)	Blue Island	1,446	1,543	3	4 @ 10′	CSX	25,500	Concrete	60 to 90 Degrees	Sunny	8/15/2015
163578S	Y	Central Avenue (sb)	Chicago Ridge / Oak Lawn	1574	1,574	8	4 @ 12′	IHB	15,100	Asphalt	30 to 59 Degrees	Cloudy, Warm	8/2/2013
163580T	N	Ridgeland Avenue (sb)	Chicago Ridge	1368	1,368	10	4 @ 12′	CSX	19,100	Asphalt	60 to 90 Degrees	Sunny	7/24/2013
163612W	N	Lincoln Avenue (sb)	Dolton	1452	1,452	4	2 @ 12′	CSX	7,450	Asphalt	0 to 29 Degrees	Cloudy	7/30/2015
283158T	N	127th Street (wb)	Blue Island	1406	1,500	1	4 @ 10′	CN (Now CSX)	25,500	Rubber	60 to 90 Degrees	Sunny	8/15/2013
283183B	N	170th Street (wb)	South Holland	1253	1,337	3	4 @ 10′	CSX	8,450	Rubber	30 to 59 Degrees	Sunny, Warm	8/12/2013
326905D	Y	Western Avenue (sb)	Posen, Dixmoor	975	975	5	4 @ 12′	IHB	7,700	Rubber	60 to 90 Degrees	Sunny, Hot	8/15/2013
326917X	N	55th Street (wb)	Chicago	1,434	1,434	6	2 @ 12′	BRC	19,700	Asphalt	60 to 90 Degrees	Sunny	8/8/2013
326918E	Y	Central Avenue (nb)	Chicago	1328	1,417	4	4 @ 10′	BRC	21,900	Asphalt	30 to 59 Degrees	Sunny, Warm	8/9/2013

Crossing ID	CREATE Project?	Street Name	Municipality	Saturation Flow Rate	Adjusted Saturation Flow Rate	Number of Observations	Lanes	Railroad Crossed	AADT	Crossing Surface	Smallest Crossing Angle	Weather	Date of Observations
372126H	N	IL 43/ Harlem Avenue (nb)	Chicago, Elmwood Park	1219	1,219	15	3 @ 12′	NIRC	29,300	Rubber	60 to 90 Degrees	Sunny	7/29/2013
372133T	N	IL 171/ Thatcher Avenue (nb)	River Grove	1380	1,426	15	4 @ 11′	NIRC	26,800	Rubber	60 to 90 Degrees	Sunny	7/23/2013
843807M	N	55th Street (wb)	Chicago	1469	1,469	3	2 @ 12′	BRC	21,100	Other	60 to 90 Degrees	Sunny, Warm	8/16/2013
843823W	Y	Columbus Avenue (wb)	Chicago	1375	1,421	5	4 @ 11′	BRC	11,500	Asphalt	0 to 29 Degrees	Cloudy, Drizzle	8/5/2013
869221F	Y	63rd Street (wb)	Chicago	1362	1,362	5	2 @ 12′	BRC	14900	Asphalt	60 to 90 Degrees	Sunny, Warm	8/7/2013

Source: Chicago Metropolitan Agency for Planning, except lanes, lane widths, and AADTs (Illinois Department of Transportation); and crossing surface, smallest crossing angle (Illinois Commerce Commission).