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# MARYLAND DEPARTMENT OF TRANPORTATION
# STATE HIGHWAY ADMINISTRATION

# RESEARCH REPORT

# ADVANCED DATA ANALYTICS AND MESOSCOPIC MODELS FOR SPECIAL EVENT IMPACT STUDY AT MARYLAND CASINOS

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**MARYLAND TRANSPORATION INSTITUTE**
**UNIVERSITY OF MARYLAND**

**FINAL REPORT**

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**16. Abstract**

The Maryland Transportation Institute (MTI) at the University of Maryland (UMD) conducted an in-depth traffic impact analysis for three full-scale casinos recently opened in Maryland: Maryland Live! at the Arundel Mills Mall (opened in June 2012), Horseshoe in Downtown Baltimore (opened in August 2014), and MGM at the National Harbor (opened in December 2016). The multi-faceted analysis was a three-pronged effort that included before/after-scenario probe data analytics, mesoscopic simulation-based modeling, and the exploration of new methods to estimate the trip generation for full-scale casino complexes.


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# EXECUTIVE SUMMARY

Three full-scale casinos recently opened in Maryland: Maryland Live! at the Arundel Mills Mall (opened in June 2012), Horseshoe in Downtown Baltimore (opened in August 2014), and MGM at the National Harbor (opened in December 2016). While these new gaming resorts brought new jobs, economic development opportunities, and tax revenue to Maryland, they also create new travel demand patterns that may produce traffic impacts. For example, it is estimated that the MGM at the National Harbor produces 4,000 new commuters and attract as many as 17,000 visitors each day [2].

At the request of the Maryland Department of Transportation State Highway Administration (MDOT SHA), the Maryland Transportation Institute (MTI) at the University of Maryland, College Park (UMD) conducted an in-depth traffic impact analysis for all three casinos. The multi-faceted analysis was a three-pronged effort that included before/after-scenario probe data analytics, mesoscopic simulation-based modeling, and the exploration of new methods to estimate the trip generation for full-scale casino complexes, otherwise unavailable through the *ITE Trip Generation Manual*.

The primary analysis tools include the Probe Data Analytics Suite, a collection of historic traffic data query and visualization tools, and the open-source mesoscopic DTALite dynamic traffic assignment (DTA) simulation model, which is part of a suite of transportation modeling tools known as the Maryland Integrated Travel Analysis and Modeling System (MITAMS). The UMD team also leveraged several data sources including INRIX traffic data made available through the Regional Integrated Transportation Information System (RITIS), MDOT SHA traffic count data, cellular-based Airsage origin-destination (OD) trip matrices, and national ITE trip generation rates. The array of available data and analysis tools allowed the UMD team to access, process, and visualize traffic performance metrics for the before and after scenario. Additionally, the team studied the combined impact of the casinos and reoccurring special events at or near these casinos (e.g., Ravens NFL football game in Baltimore near the Horseshoe Casino, Black Friday retail event near Maryland Live!, and concert event at the MGM). The analysis covered the PM peak period (3:00 – 7:00 PM) for typical weekday traffic conditions when system-wide congestion is the greatest.

Key findings from the two-part scenario analysis include the following:

**Data Analytics Major Findings** (see details in Chapter 3):

- Mobility impact varied widely among the roadway corridors studied near each casino. Average travel time changes ranged from **a 38% decrease to a 33% increase**. Travel time increase was caused by additional casino traffic, while reduction in travel time was attributed to roadway improvement projects near the casinos.
- At over one-third of all studied corridors and months, the before/after changes in mobility performance were **not significant**.
- Performance metrics indicated mobility for 11 of 60 studied months **improved significantly** after casinos opened due to roadway improvement projects.

- The month of **April** exhibited consistent significant changes in mobility: **8 to 14% increase** in **average travel time** and **6 to 12% decrease** in **average speed** for all corridors
- The probe data's variability can also be partially attributed to the unwanted capture of roadway incidents such as crashes and work zone delays (e.g. Superstorm Sandy was identified as a major event that affected October's regionwide traffic impact results for Live! Casino).

**Mesoscopic DTALite Model Major Findings** (see details in Chapter 4):

- Regional Impact: **After-scenario** PM Peak Hour
    - Horseshoe: No significant Impact
    - Live!: **+14%** average travel time and **-12%** average speed
    - MGM: **+6%** average travel time and **-6%** average speed
- Regional Impact: **After-scenario + Special Event** PM Peak Hour
    - Horseshoe: **+30%** average travel time and -**26%** average speed (Thursday night Ravens game)
    - Live!: **+66%** average travel time and **-40%** average speed (Black Friday)
    - MGM: **+6%** average travel time and **-6%** average speed (sold-out concert at the casino)

Overall, given the results from both the data analytics and simulation models, the traffic impact of these three casinos is moderate and the changes in travel time and speed are mostly within 10% of the before-casino values. Special events such as NFL games near the Horseshoe and Black Friday shopping near the Maryland Live!, combined with casino trips, had significant negative traffic impact. The sold-out concerts at MGM had no significant impact on system-wide traffic during PM peak hour (< 0.5% change).

Since the ITE trip generation rates used in traffic impact studies are often based on national data and may not represent trip generation patterns of new developments in Maryland, the remainder of the study explored two alternative trip rate estimation methods that could be used to calibrate the ITE rates. The first method used mobile device location data provider Airsage to deliver trip estimates based on the number of visitors whose mobile devices are detected inside the casinos. The second method utilized an Origin Demand Matrix Estimation (ODME) statistical procedure to iteratively adjust seed or the default ITE-based rates until the trip counts converged close to the true value from traffic counts. Between the two methods, the second method produced rates that were closest to the trip counts provided by MDOT SHA.

At the conclusion of the analysis, the UMD team found that the casinos themselves have a moderate impact on traffic at the regional level and special events add to the congestion in various amounts given the type and size of the special events. The data analytics approach based on observed, before-and-after travel time and speed data produced results that were consistent with those from the mesoscopic DTALite modeling approach. The exploration of alternative trip generation estimation methods revealed that the ITE-based rates for full-scale casinos could significantly overestimate the trip generation rates in Maryland. Future research may further develop the mobile device big data and/or ODME approaches to improve the trip generation in traffic impact studies in Maryland.

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# CHAPTER 1: INTRODUCTION

## 1.1 Research Problem and Background

Since 2000, several new casinos have opened throughout the Mid-Atlantic region. From 2006 to 2018, at least 30 casinos of various sizes and amenities opened in five Mid-Atlantic states. Three additional casinos are expected to open by 2020.

- Maryland – 6 New / 6 Total
- D.C. – Disallows casino gambling
- Virginia – Disallows casino gambling
- West Virginia – 1 New / 5 Total
- Delaware – 0 New / 3 Total
- Pennsylvania – 12 New / 12 Total
- New Jersey – 3 New / 9 Total (Atlantic City)
- New York – 11 New / 25 Total

After casino gaming became legal in Maryland in 2008, several commercial casino licenses were awarded and the first of six casinos opened in 2010. The remaining casinos soon followed, one opening almost every successive year. By 2017, the six Maryland casinos had generated thousands of jobs and millions of dollars in tax revenue. The single-month record of casino gaming revenue collected from all the casinos was totaled at $158M in October 2018 [1]. Most of Maryland's casino developments also provide a wealth of amenities that generate additional tax revenue for the state. Restaurants, retail outlets, hotels, and various entertainment venues augment the traditional stand-alone casino into full-scale entertainment facilities that, when combined, generate a significant economic impact on state and local communities.

The increased travel demand associated with any development of a large commercial entertainment complex is a general public concern whenever a new casino license is awarded to a developer. For example, the MGM Casino, the newest Maryland casino, serves as many as 17,000 guests daily. This does not include almost 4,000 personnel employed at the casino. As more people are attracted to the site, the amount of traffic around the casino also increases. A year after opening, an MGM casino representative reported about 800 more vehicles per hour on adjacent streets totaling 2,500 vph [2].

Traffic congestion exacerbated by casino trips and inadequate infrastructure improvements can cause longer delays for drivers throughout the area. Therefore, determining the traffic impact a new casino imposes on residents and businesses at both the regional and local scale is important. This study independently analyzes the three largest Maryland casinos with the largest gaming floor areas and amenities to quantify the traffic impact produced by each casino. The three selected casinos are detailed below:

**Live! Casino** opened as the state's largest casino on June 6, 2012. Located in Anne Arundel County adjacent to the Arundel Mills Mall, the largest mall in the state, the casino currently houses nearly 4,000 slot machines and 189 table games within an approximately 160k square-foot gaming floor. This establishment's amenities are listed below [3]:

- 11 Restaurants
- 4 Bars

- 1 Retail store (gift shop)
- Live! Hotel & Event Center*
- Live! Spa*
- Live! Center Stage – 500-seat venue

* These amenities opened after this study commenced; therefore, they are not included in the analysis.

**Horseshoe Casino** opened as the state's second largest casino (122k square footage for gaming) on August 26, 2014. Located on Russell Street in an industrial zoning district in Baltimore City, the casino is less than half a mile from the iconic M&T Bank Stadium, home of the Baltimore Ravens NFL franchise. Camden Yards, home of the Orioles MLB franchise, and Baltimore's Inner Harbor are nearby as well. Horseshoe Casino supplies 2,200 slots and 178 table games. This establishment's amenities include [4]:

- 9 Restaurants, including a 20,000 square-foot marketplace
- 2 Bars

**MGM at the National Harbor** opened with a cost of $1.4B on December 8, 2016 [5]. Located just southeast of the I-295/I-495 interchange on National Avenue in Oxon Hill, the casino and hotel overlooks the Potomac River and National Harbor. In 2018, the resort expanded the gaming floor from 125k square feet to 163k square feet of gaming space, surpassing Live! Casino & Hotel to become the largest Maryland casino. The casino boasts 3,085 slot machines, 170 table games, and several amenities including the following [6]:

- 9 Restaurants
- 3 Bars
- 10 Retail stores
- Spa & Salon
- Theater – 3,000 seats
- 23-story hotel – 308 rooms


**Figure 1: Maryland casinos.**

On top of the daily casino traffic, other special events at or near the casino sites can further worsen congestion. Traffic conditions under these cumulative impact scenarios (casino traffic and special event traffic together) often represent the worst-case scenario but are not considered in traditional travel demand or traffic impact analyses. An example of prolonged congestion occurred on the grand opening day of MGM at the National

Harbor. Figure 2 shows a mile-long traffic bottleneck, the result of a queue of incoming vehicles heading toward the main entrance of the resort parking garage. Based on observed data from a Regional Integrated Transportation Information System (RITIS) performance measuring tool, the average speed decreased by 36% and the queue took hours to dissipate. Similar conditions are expected during professional sport game days in Baltimore for Horseshoe Casino and Black Friday for Live! Casino. This study analyzes such a compounding traffic impact for each casino.

## 1.2 Research Objectives

In this study the MTI research team completes three main objectives:

**1.** The team applies RITIS and other data sources with the appropriate data analytic tools to analyze the traffic impact of each Maryland casino on a typical weekday and during a special event. RITIS is an online data platform that integrates and archives multiple transportation-related data sources. The data sources feeding the system include INRIX/HERE/TomTom roadway volume and performance data, event and work-zone data, crowdsourced Waze data, weather data, and surveillance video. This is a data-based analysis approach based on historical observations (see Chapter 3).

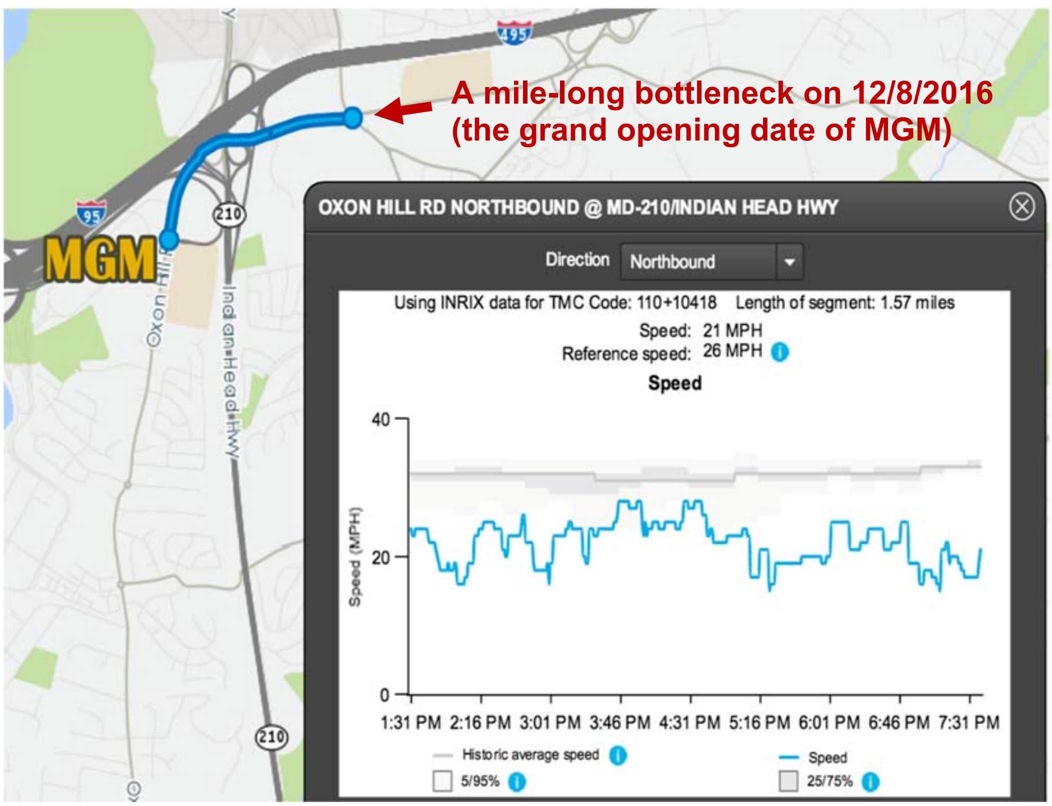



**Figure 2: Casino special event congestion.**

**2.** The team defines modeling scenarios and develops a mesoscopic dynamic traffic simulation model to evaluate the before/after traffic impact as well as the special event traffic impact generated at or near each casino. DTALite, a University of Maryland (UMD) open-source modeling software, is employed to complete this task. The mesoscopic casino traffic models are calibrated and validated against observed traffic count and travel time data for each casino. The model results are quantified via travel time, travel speed, and traffic density diagram. This is a model-based approach that can be used to forecast the travel impact of casinos and evaluate impact mitigation strategies (see Chapter 4).

**3.** The MDOT SHA requested the team explore different methods to estimate casino trip generation rates. Currently, the state-of-practice for trip generation is to estimate trip rates based on the *ITE Trip Generation Manual*. This trip generation data source is known to contain a lot of variability as well as insufficient data for different land uses, especially for large entertainment establishments like casinos. Therefore, the team experimented with two new approaches (see Chapter 5):

(1) Statistical estimation based on Origin Demand Matrix Estimation (ODME)

(2) Big data approach: OD trip matrix obtained from Airsage

## 1.3 Research Approach

The flowchart in Figure 3 illustrates the project tasks and their interdependencies. Current practices on traffic impact analysis (TIA) and the existing trip generation rates used in TIA reports are reviewed for the three Maryland casinos in this study. Then, with input from MDOT SHA, the research team defined three scenarios to analyze: (1) before casino scenario, (2) after casino scenario, and (3) and after casino + special event scenario. Based on data availability, the team evaluated traffic patterns using two analysis methods: data-driven and model-based TIA. The high-resolution RITIS traffic monitoring data and visualization tools hosted at the CATT Lab at UMD were employed to directly evaluate the before/after traffic impact for each casino. The team then developed mesoscopic DTALite models based on casino and special event trip rates to evaluate traffic impact. Finally, the team explored two new ways to estimate trip generation for a casino complex using the available data and mesoscopic modeling tools at the team's disposal.

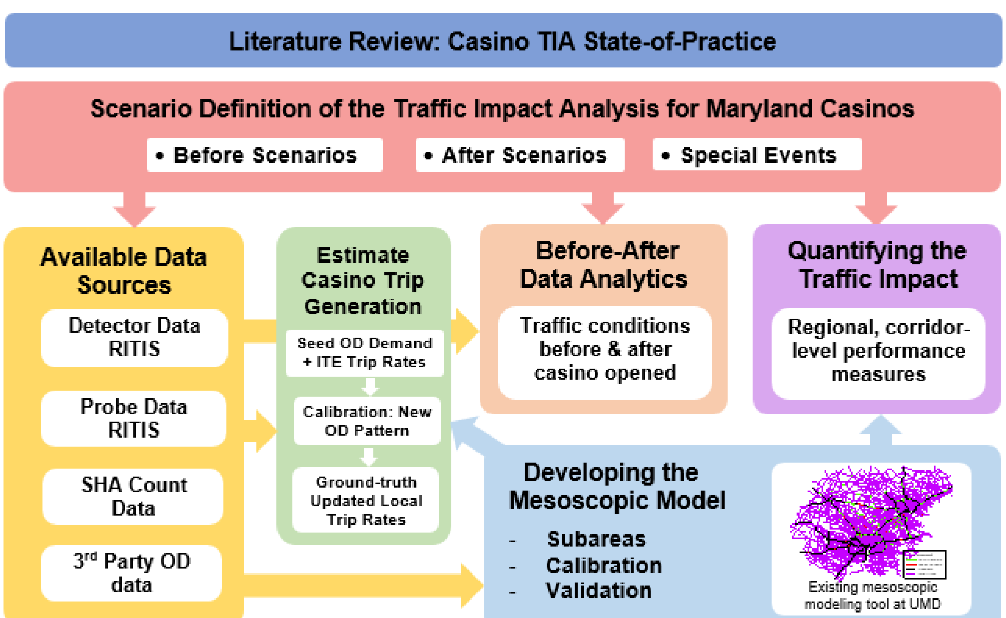



**Figure 3: Project flowchart.**

# CHAPTER 2: LITERATURE REVIEW

## 2.1 Traffic Impact Analysis for Full-Scale Casinos

The research team conducted a brief literature review on traffic impact analyses for full-scale casinos. Most of the reviewed traffic impact studies rely on empirical trip data either manually collected or borrowed from existing casino traffic studies for casinos similar in size and geographic environments as reported for Wynn Philadelphia [7], MGM in Springfield, MA [8], Mohawk Harbor Casino in Schenectady, NY [9], and Horseshoe Casino in Baltimore, MD [10]. The *ITE Trip Generation Manual* (ITE manual) is generally used to determine the trip rates for specific land uses. However, the ITE manual description for a "Casino/Video Lottery Establishment" ($10^{th}$ edition LUC 473) explicitly states that data statistics for full-service casinos (i.e., those that include food service and entertainment) and casino/hotel facilities are not included.

The majority of studies calculate individual rates based on the *ITE Trip Generation Manual* for each ancillary land use that may attract trips independently from the casino [8, 9, 10]; other studies assume that ancillary facilities either (1) do not affect casino trip generation or (2) support the casino in a way that advocates one bundled trip rate that covers multiple land uses, as indicated in the studies for Nevele Resort [11] and MGM at National Harbor [12]. In the Maryland casino studies both approaches were utilized (see Section 2.2).

Regardless of the approach used to calculate the casino's trip generation and distribution, virtually all traffic impact studies conducted an impact analysis based on criteria provided in the Highway Capacity Manual (HCM) or other intersection traffic study methods. These traditional methods often limit the analysis to a small roadway network that consists of a single corridor and several intersections. The generated trips are then assigned to this small network for level of service and intersection delay analysis. This local-level analysis is typically conducted using the HCM tool, Synchro (e.g. [8, 10]). Local turning movement counts are also usually collected for the intersection traffic analysis and for verification purposes.

The team identified several limitations with these casino traffic impact studies. First, the scenarios analyzed often ignore the influence from on-site or nearby special events that generate significant traffic. For example, sports events for the Baltimore Ravens or Orioles were not considered in the impact analysis of the Horseshoe Casino. Second, small roadway networks used in these studies cannot reflect the true regional impact of casino traffic. Third, traditional HCM and intersection delay estimation methods do not account for queue spillback from downstream roads to upstream roads. Last, these studies were often conducted before casino construction, while the actual traffic impact after a casino opening is often less understood. This project will address these limitations with new data sources, advanced data analytics tools, and regional mesoscopic modeling tools.

## 2.2 MD Casino Trip Generation Rates

This section provides a summary of findings related to local trip generation rates for the three Maryland casinos. The trip rates are taken directly from the published traffic impact studies (TIS) for each casino. These same rates are also integrated into the mesoscopic models to determine the after-scenario traffic impact of the casinos (see Section 4.2).

**Live! Casino:** Unfortunately, no TIS report was available. The weekday PM peak hour trip rates were retrieved from a Mid-Atlantic Section ITE presentation slide deck. One slide presented a comparison table of various casino studies that reported 0.31 trips IN and 0.28 trips OUT per slot position for Live! Casino [13]. Moreover, in 2011 MDOT SHA's Travel Forecasting and Analysis Division (TFAD) estimated Friday PM peak of adjacent street and Saturday peak hour of generator trip rates for the Arundel Mills Mall casino. The following TFAD rates were based on trip rates for casino facilities located near large urban centers and major transportation corridors [14]:

- 0.590 trips per gaming position during the Friday PM peak hour of generator (53/47)[1]
- 0.640 trips per gaming position during the Saturday peak hour of generator (53/47)

A pre-construction TIS for **Horseshoe Casino** was completed in 2013 for the City of Baltimore Department of Transportation. Under the "future conditions" section of the report, the author provided the estimated casino trip rates and distributions.

- 0.062 trips per gaming position during the weekday AM peak hour of generator (75/25)
- 0.246 trips per gaming position during the weekday PM peak hour of generator (60/40)
- 0.305 trips per gaming position during the Sunday peak hour of generator (53/47)

This study explicitly stated that the national rates provided in the ITE manual were insufficient. Instead, the consultant, WR&A, incorporated a combination of weekday trip rates taken from similar Maryland casinos that were approved by MDOT SHA. The 0.246 and 0.305 rates also appear to be the same rates developed by TFAD for the Friday PM peak of an adjacent street and Saturday peak hour of generator rates of a "video lottery-only facility" without a racetrack (i.e., Hollywood Casino at Perryville, Md). This is an interesting finding given Hollywood Casino is in a rural area. Separate trip rates were developed for restaurant, bar/tavern, and office space land uses. The rates and distributions were acquired from the 9th edition of the ITE manual for the three specified time analysis periods: AM peak, PM peak, & Sunday [10].

A traffic flow study was finalized for **MGM at National Harbor** in December 2013 and produced three MDOT SHA-approved trip rates:

- 0.06 trips per gaming position during the weekday AM peak hour of generator (75/25)
- 0.27 trips per gaming position during the weekday PM peak hour of generator (60/40)
- 0.33 trips per gaming position during the Saturday peak hour of generator (53/74)

The report assumed that the various land uses adjacent to the casino "support gambling operations." Therefore, all restaurants, bars, and retail outlets were bundled with the casino land use to create a single trip rate. Only the hotel and entertainment venue trip rates were generated separately. The Maryland Video Lottery Facility Location Commission approved the decision to bundle food and beverage land use with the casino trip rate; however, the commission commented that bundling nine retail outlets ranging from 1,200 to 9,500 square feet likely underestimates the number of trips generated by these establishments that would not enter the casino. Therefore, the commission recommended additional trips be included in the final trip generation [12].

[1] Estimated percentage distribution of trips (IN/OUT)

# CHAPTER 3: PROBE DATA ANALYTICS

## 3.1 Methodology

The Probe Data Analytics Suite, a traffic data analysis service supported by the Center for Advanced Transportation Technology (CATT) Lab at UMD, was utilized to compare traffic performance measures for select corridors near each casino. Historic before/after casino average speed and travel time data was collected for TMC segments along corridors adjacent to each casino. The corridors analyzed are listed below and visualized on the next page.

Live! Casino:

- Arundel Mills Boulevard
- MD-100
- MD-295

Horseshoe Casino:

- Russel Street / MD-295
- I-395 Southbound

MGM at National Harbor:

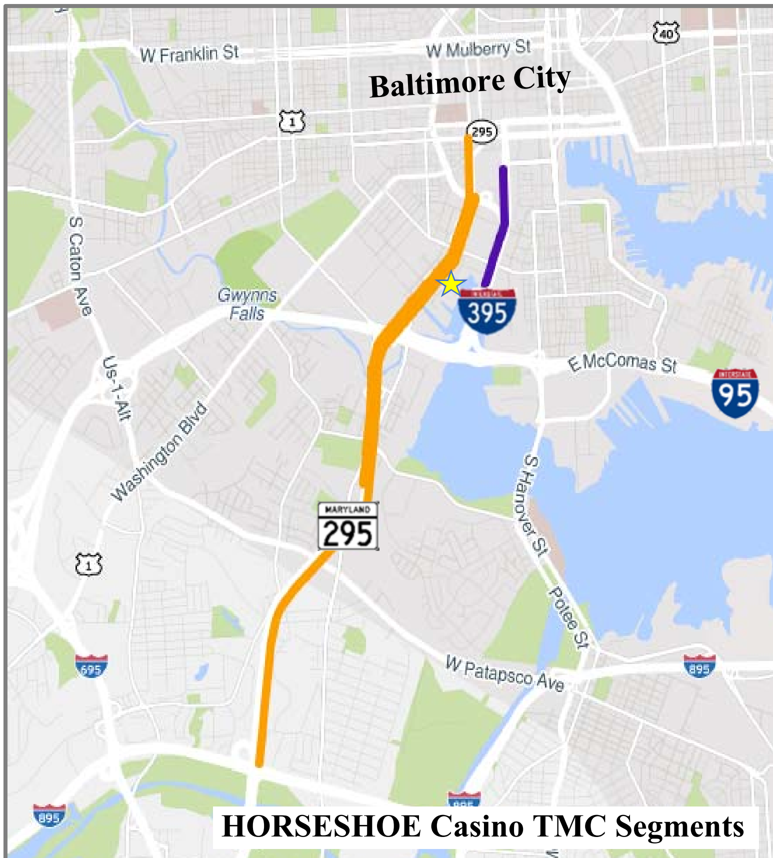
- Oxon Hill Road
- Indian Head Hwy / MD-210
- I-95 Exit 2 Ramps 3 & 9

Although casino generated traffic peaks late evenings on Fridays and weekends, this study focused on the early evening commuting hours on weekdays, the time periods that typically experience the greatest decline in traffic mobility at the regional level and casinos generate significant demand. The study's analytic results provide before and after-scenario traffic conditions during the 4-hour weekday PM peak period (3:00 -7:00 PM).

Minute-by-minute INRIX data was aggregated and averaged during the PM peak periods on Tuesdays, Wednesdays, and Thursdays for select one-month periods throughout the year – Mondays and Fridays were excluded to limit the number of data records not representative of a typical weekday. One-month study periods were chosen to formulate average values from an ample sample of weekdays without capturing excessive background noise in the form of non-recurrent traffic incidents. The months of January, April, July, and October were chosen to provide traffic impacts representative of each season. Before/after results are compared for each month and the mean difference between the PM peak speed and travel time values was tested for statistical significance via the paired t-test.

## 3.2 Traffic Impact on Major Corridors

The analytic results are organized into one summary table for each casino. Each table presents the before/after average corridor travel time and speed for only the months when the difference in means (shown as Δ) is statistically significant with 95% confidence. Values shown in RED represent unexpected improvements in traffic conditions after the opening of a casino (i.e., increase in average speed and reduced average travel time). Please note that not all before/after years are the same for each month; the years reference the opening casino date shown in the top left corner of each table.




## Russell St. / MD-295:

From: Martin Luther King Jr. Blvd.
To: Annapolis Rd. / Waterview Ave.

Northbound: 3.8 miles    Southbound: 2.1 miles

## I-395 Southbound:

From: West Conway St.
To: I-95 Interchange

Southbound: 0.7 miles

Note: Inclusion of I-395 SB was necessary due to inaccessibility of I-95 NB from casino via Russel Street.

## Arundel Mills Blvd:

From: MD-295 Interchange
To: MD-176 / Dorsey Road

Total: 4.2 miles

## MD-295:

From: I-195 Interchange
To: MD-175 Interchange

Northbound: 7.4 miles    Southbound: 6.7 miles

## MD-100:

From: West Conway St.
To: I-95 Interchange

Eastbound: 7.4 miles    Westbound: 6.7 miles

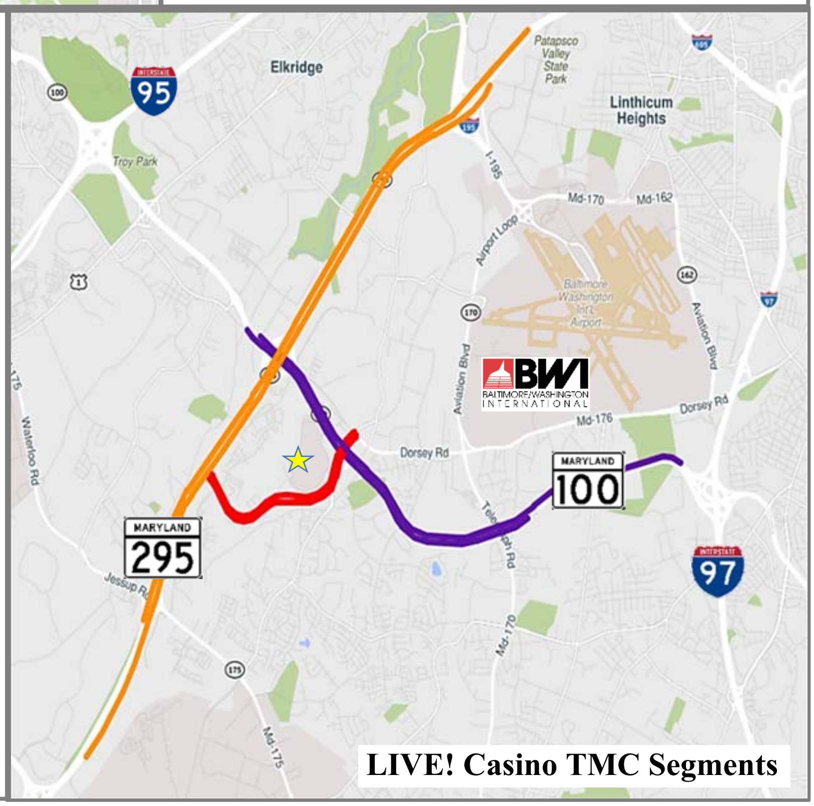



**Figure 4: Horseshoe and Live! Casino TMC segments.**

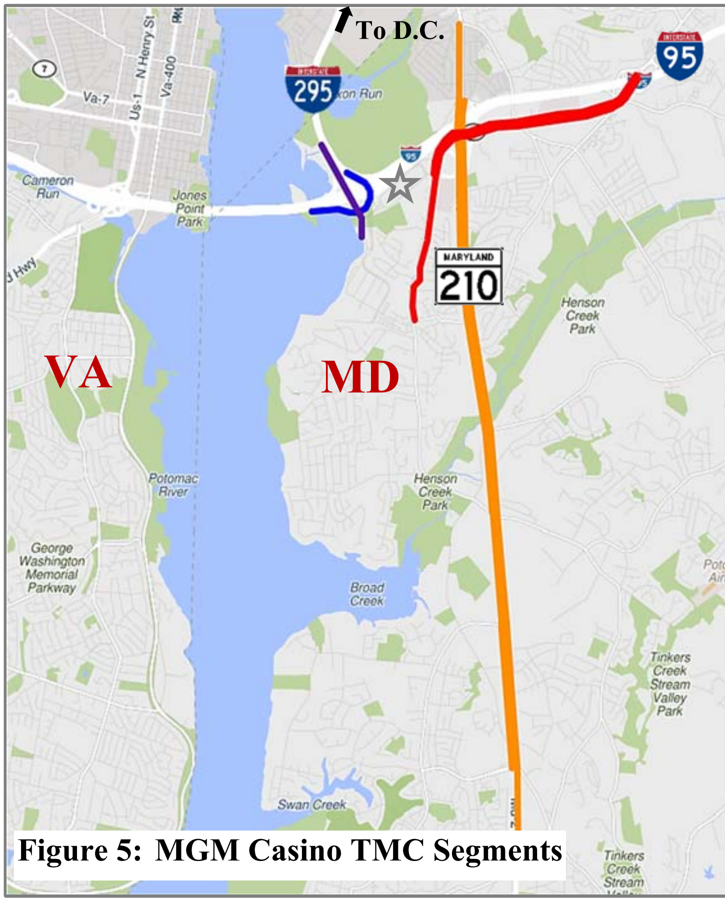



Figure 5: MGM Casino TMC Segments

**Oxon Hill Road:**

From: I-95 Interchange
To: Kerby Hill Road

Northbound: 3.1 miles   Southbound: 1.5 miles

**MD-210:**

:: From: I-95 Interchange
To: Fort Washington Road

Northbound: 5.6 miles   Southbound: 5.1 miles

**Exit 2 Ramp 9:**

From: I-295 SB
To: National Harbor

Ramp: 0.8 miles

**Exit 2 Ramp 3:**

From: I-495 EB
To: I-295 NB

Ramp: 0.9 miles

Before and after travel time comparison charts for each analyzed corridor section are provided in **Appendix I**. The charts are directly exported from the RITIS Probe Data Analytics Suite. In addition to the charts, statistical tables including the t-stats and p-values for both the average travel time and speed mean differences are provided.

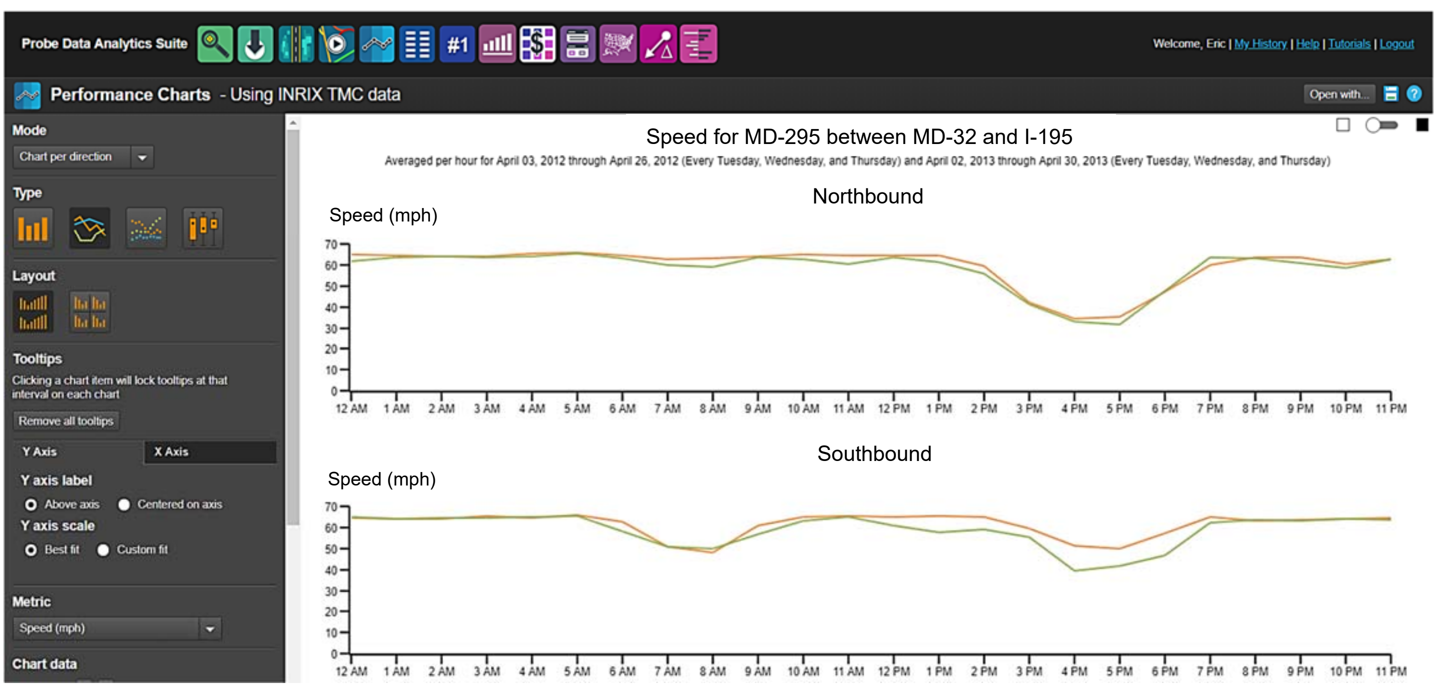



Figure 6: RITIS Probe Data Analytics Suite snapshot.

**Table 1: Horseshoe Casino Data Analytics Summary Table**

| HORSESHOE Casino (opened Aug 26, 2014) | | | Russell St. (MD-295) | | | | I-395 | |
|---|---|---|---|---|---|---|---|---|
| | | | Northbound | | Southbound | | Southbound | |
| TIME PERIOD | | | Avg. TT (min) | Avg. Speed | Avg. TT (min) | Avg. Speed | Avg. TT (sec) | Avg. Speed |
| PM Peak Period (3-7 PM) | January | bef 2014 | 4.64 | 48.33 | 4.69 | 29.52 | 141 | 16.59 |
| | | aft 2015 | 5.1 | 44.15 | 4.17 | 32.61 | 146.4 | 16.03 |
| | | Δ | **0.46** | **-4.18** | **-0.52** | **3.09** | **5.4** | **-0.56** |
| | April | 2014 | 5.18 | 43.49 | 4.04 | 33.84 | NO SIGNIFICANT CHANGE | |
| | | 2015 | 5.71 | 39.79 | 4.43 | 31.08 | | |
| | | Δ | **0.53** | **-3.7** | **0.39** | **-2.76** | | |
| | July | 2014 | 6.15 | 36.94 | 7.41 | 18.66 | 163.2 | 14.37 |
| | | 2015 | 6.85 | 33.7 | 4.96 | 27.97 | 100.2 | 27.01 |
| | | Δ | **0.7** | **-3.24** | **-2.45** | **9.31** | **-63** | **12.64** |
| | October | 2013 | 4.48 | 50.05 | NO SIGNIFICANT CHANGE | | 127.2 | 18.4 |
| | | 2014 | 5.36 | 41.96 | | | 169.2 | 13.84 |
| | | Δ | **0.88** | **-8.09** | | | **42** | **-4.56** |
| ROAD DISTANCE (mi) | | | 3.74 | | 2.27 | | 0.7 | |

Shown values significant at 95th confidence level; **RED VALUES** represent **improved** mobility performance.

Observations from the above summary table for Horseshoe Casino are listed below.

- MD 295 NB experienced 10% increase in avg. PM peak period travel time and 8% decrease in avg. speed for each month studied after casino launch
- Inconsistent results for both southbound directions of Russell St. and I-395 – major highway work zone delays on I-95 may be a reason

Only the northbound direction of Russell Street (MD 295), which runs adjacent to the casino, experienced a consistent decline in mobility after the opening of the casino. The after-month of October 2014 revealed the greatest change in mobility with a nearly 20% increase in average travel time and 16% decrease in average speed. Another reason for such significant change may be the deck replacement project for 4.4 miles of elevated highway and ramps between the Fort McHenry Tunnel and Exit 50 at Caton Avenue along I-95, parallel to the target MD 295 segment. The two-year project began in late March 2014 and caused major traffic impacts through Fall 2015. Therefore, it is possible that in October 2014 MD 295 served higher diverted commuting traffic. As an example, according to a *Washington Post* article, the I-395 southbound ramp to I-95 southbound was reduced to one lane during the month of July in 2014 [15]. This information helps explain the significant improvement in average travel time from 2014 to 2015 along I-395 southbound. The team assumes similar conditions impeded traffic traveling southbound on Russell Street.

No particular incident was discovered to justify the improved mobility in January for MD 295 South except the fact that January 2015 received 40% more snowfall than in 2014 [16].

**Table 2: Live! Casino Data Analytics Summary Table**

| LIVE! Casino (opened June 6, 2012) | | | Arundel Mills Blvd | | | | MD-100 | | | | MD-295 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Eastbound | | Westbound | | Eastbound | | Westbound | | Northbound | | Southbound | |
| TIME PERIOD | | | Avg. TT (min) | Avg. Speed (mph) | Avg. TT (min) | Avg. Speed (mph) | Avg. TT (min) | Avg. Speed (mph) | Avg. TT (min) | Avg. Speed (mph) | Avg. TT (min) | Avg. Speed (mph) | Avg. TT (min) | Avg. Speed (mph) |
| PM Peak Period (3-7 PM) | January | bef 2012 | NO SIGNIFICANT CHANGE | | 3.64 | 30.74 | NO SIGNIFICANT CHANGE | | 5.56 | 58.51 | 7.55 | 58.47 | 6.39 | 61.93 |
| | | aft 2013 | | | 3.83 | 29.19 | | | 6.09 | 54.44 | 8.38 | 52.97 | 7.41 | 53.63 |
| | | Δ | | | **0.19** | **-1.55** | | | **0.53** | **-4.07** | **0.83** | **-5.5** | **1.02** | **-8.3** |
| | April | 2012 | 3.15 | 30.96 | 3.62 | 30.9 | 4.12 | 56.21 | 5.58 | 58.14 | NO SIGNIFICANT CHANGE | | 6.36 | 62.21 |
| | | 2013 | 3.24 | 30.12 | 3.83 | 29.22 | 4.66 | 50.79 | 6.1 | 54.52 | | | 7.01 | 56.7 |
| | | Δ | **0.09** | **-0.84** | **0.21** | **-1.68** | **0.54** | **-5.42** | **0.52** | **-3.62** | | | **0.65** | **-5.51** |
| | July | 2011 | NO SIGNIFICANT CHANGE | | NO SIGNIFICANT CHANGE | | NO SIGNIFICANT CHANGE | | 5.27 | 60.48 | NO SIGNIFICANT CHANGE | | 7.19 | 55.2 |
| | | 2012 | | | | | | | 5.76 | 56.72 | | | 6.8 | 58.59 |
| | | Δ | | | | | | | **0.49** | **-3.76** | | | **-0.39** | **3.39** |
| | October | 2011 | 3.25 | 30 | NO SIGNIFICANT CHANGE | | 5 | 47.98 | 6.41 | 52.35 | 9.07 | 49.17 | 6.61 | 59.94 |
| | | 2012 | 3.15 | 30.97 | | | 4.38 | 53.44 | 5.92 | 55.92 | 8 | 55.21 | 6.33 | 62.55 |
| | | Δ | **-0.1** | **0.97** | | | **-0.62** | **5.46** | **-0.49** | **3.57** | **-1.07** | **6.04** | **-0.28** | **2.61** |
| ROAD DISTANCE (mi) | | | 2.1 | | 2.1 | | 2.6 | | 6.8 | | 7.4 | | 6.7 | |

Shown values significant at 95th confidence level; **RED VALUES** represent **improved** mobility performance.

Observations from the above summary table for Live! Casino are listed below.

- MD 295 SB experienced 10% increase in avg. travel time and 9% decrease in avg. speed in January and April following opening;
- MD 100 WB experienced 9% increase in avg. travel time and 6-7% decrease in avg. speed in January, April, and July;
- April: most segments had significantly worse congestion;
- October: unexpected mobility improvement for all segments.

Mobility deteriorated significantly across most segments during the after-months of January and April 2013. Although MD 295 south exhibited the greatest congestion increase during these months, the same section of MD 295 also experienced significant improvements in traffic conditions for July and October. This can be explained by two events. First, MDOT SHA began summer resurfacing work of southbound MD 295 (from Hanover Road to MD 100) in July 2011, closing a single lane for the duration of the work zone [17]. Second, in October 2012, Superstorm Sandy caused widespread damage that closed businesses, schools, and government offices for several days. Consequently, travel demand decreased significantly throughout the region during that time. Contrarily, the team did not observe any impact from the completion of the new diverging diamond interchange at MD 295 and Arundel Mills Blvd., which was completed a week after the casino opened.

**Table 3: MGM Casino Data Analytics Summary Table**

| MGM Casino (opened Dec 8, 2016) | | | Oxon Hill Rd (MD-414) | | | | Indian Head Highway (MD-210) | | | | Exit 2 Ramp 3 (I 95 EB to I 295 NB) | | Exit 2 Ramp 9 (I-295 to Nat'l Harbor) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Northbound | | Southbound | | Northbound | | Southbound | | | | | |
| TIME PERIOD | | | Avg. TT (min) | Avg. Speed (mph) | Avg. TT (min) | Avg. Speed (mph) | Avg. TT (min) | Avg. Speed (mph) | Avg. TT (min) | Avg. Speed (mph) | Avg. TT (sec) | Avg. Speed (mph) | Avg. TT (sec) | Avg. Speed (mph) |
| PM Peak Period (3-7 PM) | January | bef 2016 | 9.58 | 19.49 | NO SIGNIFICANT CHANGE | | NO SIGNIFICANT CHANGE | | 12.16 | 25.39 | 39.78 | 52.57 | 96.6 | 32.34 |
| | | aft 2017 | 10.24 | 18.2 | | | | | 10.99 | 27.89 | 40.74 | 51.22 | 100.8 | 31.17 |
| | | Δ | **0.66** | **-1.29** | | | | | **-1.17** | **2.5** | **1.0** | **-1.35** | **4.2** | **-1.17** |
| | April | 2016 | 8.97 | 20.75 | 4.32 | 21.29 | 8.06 | 41.96 | NO SIGNIFICANT CHANGE | | NO SIGNIFICANT CHANGE | | 96 | 32.7 |
| | | 2017 | 10.18 | 18.29 | 5.08 | 18.09 | 8.96 | 37.69 | | | | | 108 | 29.14 |
| | | Δ | **1.21** | **-2.46** | **0.76** | **-3.2** | **0.9** | **-4.27** | | | | | **12** | **-3.56** |
| | July | 2016 | 9.55 | 19.49 | NO SIGNIFICANT CHANGE | | 8.63 | 39.16 | NO SIGNIFICANT CHANGE | | 40.32 | 51.9 | NO SIGNIFICANT CHANGE | |
| | | 2017 | 11.14 | 16.78 | | | 8.89 | 38.02 | | | 39.54 | 52.79 | | |
| | | Δ | **1.59** | **-2.71** | | | **0.26** | **-1.14** | | | **-0.8** | **0.89** | | |
| | October | 2016 | NO SIGNIFICANT CHANGE | | NO SIGNIFICANT CHANGE | | NO SIGNIFICANT CHANGE | | 10.78 | 28.46 | NO SIGNIFICANT CHANGE | | 99 | 31.71 |
| | | 2017 | | | | | | | 11.75 | 26.13 | | | 111.6 | 28.3 |
| | | Δ | | | | | | | **0.97** | **-2.33** | | | **12.6** | **-3.41** |
| ROAD DISTANCE (mi) | | | 3.1 | | 1.5 | | 5.6 | | 5.1 | | 0.9 | | 0.8 | |

Shown values significant at 95th confidence level; **RED VALUES** represent **improved** mobility performance.

Observations from the above summary table for MGM Casino are listed below.

- Avg. travel time increases 12-18% and avg. speed decreases 10-15% for 3 of 4 corridors in April 2017
- Oxon Hill Road NB experienced greatest increase in congestion; Relatively little impact on SB traffic
- Exit 2 Ramp 9 (I-295 to National Harbor & Casino) experienced ~13% avg. travel time increase during April and Oct. 2017

Mobility impacts varied for the adjacent corridors and access ramps – nearly half of the study months revealed no significant change. The closest arterial to the casino, Oxon Hill Road, presented several consecutive monthly periods of heightened congestion in the northbound direction likely due to the increase in entering/exiting casino trips. However, in the southbound direction, only the after-month of April exhibited a significant decline in mobility. The reduced impact in this direction may be a result of the widening of Oxon Hill Road between the Capital Beltway and Tanger Outlets as part of a $10M road improvement plan paid for by the casino's parent company [18]. Although capacity was added in both directions, the southbound direction included two dedicated right turn lanes toward the casino and additional thru lane on top of the timing modifications of the existing signal. Of the two access ramps evaluated, Ramp 9 serving traffic south on I-295 toward National Harbor and MGM experienced significantly greater congestion. This observation is likely a result of the new casino.

# CHAPTER 4: MESOSCOPIC DTA MODELS

## 4.1 Scenario Definitions

Three scenarios were modeled for each casino: (1) before-scenario or pre-construction (i.e., base model), (2) after-scenario, and (3) after + special event. As shown in Table 4, the opening dates were used to define the before/after scenarios. The average weekday in the year before the casino opened was modeled for the before-scenario and the average weekday in the year after the casino opened was modeled for the after-scenario. The special events modeled in the after + special event scenario are listed as well. Traffic is simulated for all scenarios during the same 3:00 to 7:00 PM weekday peak period (see Section 3.1).

**Table 4: Summary of Modeling Scenarios**

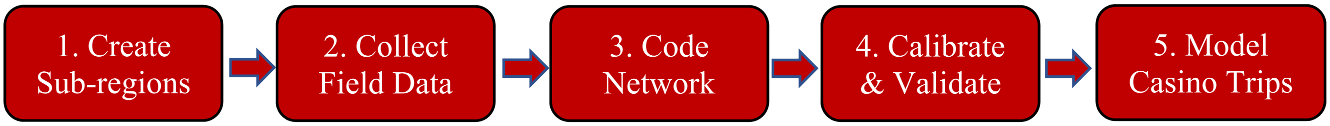
| Maryland Casino | Opening Date | Special Event |
|---|---|---|
| **Maryland Live!** | June 6, 2012 | - Black Friday (2-4 PM Peak) |
| **The Horseshoe Casino** | Aug. 26, 2014 | - Ravens NFL Game (Thursday Night Home Game) |
| **MGM at National Harbor** | Dec. 8. 2016 | - Large Concert at MGM (Bruno Mars - Dec 21, 2017) |

## 4.2 Model Specification

A mesoscopic dynamic traffic assignment (DTA) traffic simulation model was built for all three scenarios at a sub-regional scale. A DTA model's objective is to solve the dynamic user equilibrium condition (i.e., all routes used by travelers having the same origin/destination and departure time have equal and minimal experienced travel time). The model does so by finding time-dependent shortest paths, assigning traffic to these paths, and then adjusting the number of vehicles along these paths based on link-based travel times that iteratively update as the roadway conditions evolve during the simulation until a dynamic user equilibrium has sufficiently converged.

Unlike microsimulation models utilized in past traffic impact studies, a mesoscopic DTA model can simulate individual vehicles and still capture the interactions between vehicles across large networks. It also requires only a fraction of the computing power and time that is necessary to build and calibrate a large-scale microscopic simulation model. Mesoscopic models enable the integration of travel behavior and traffic simulation models that allow visualization and real-time analysis of vehicles' time-dependent route decisions, given various roadway (network) conditions.

Using the open-source mesoscopic DTA model system, DTALite, the team coded, calibrated, and validated mesoscopic models for the three casino sites. To learn more about DTALite's design and model structure, reference Zhou and Taylor's article [19]. The modeling process is broken down into five steps:




**Step 1. Create Sub-regions:** With complete coverage of the Washington-Baltimore metropolitan region provided in the Maryland Statewide Transportation Model (MSTM version 1.0) travel demand model, three sub-regional casino models were clipped from the statewide network that include 3,056 traffic analysis zones (TAZ). The boundaries of the sub-regions were strategically cut to ensure all possible alternative routes a user could take to bypass congestion near the casino were included (see Appendix II). To estimate the time-dependent demand profiles for the PM peak period, the team transformed the time-independent seed OD matrix from the MSTM 1.0 into hourly OD demand matrices based on the hour-by-hour distribution of observed traffic volumes measured within each model's sub-region.

**Step 2. Collect Field Data:** Prior to coding the network model, traffic count and historic travel time data were collected for model calibration. Hourly traffic count data was obtained from count sensors along major corridors throughout each casino network, in the MDOT SHA Internet Traffic Monitoring System (I-TMS), as well as the annual average daily traffic (AADT) for locations across the state of Maryland, up to three years before the opening day of a casino.

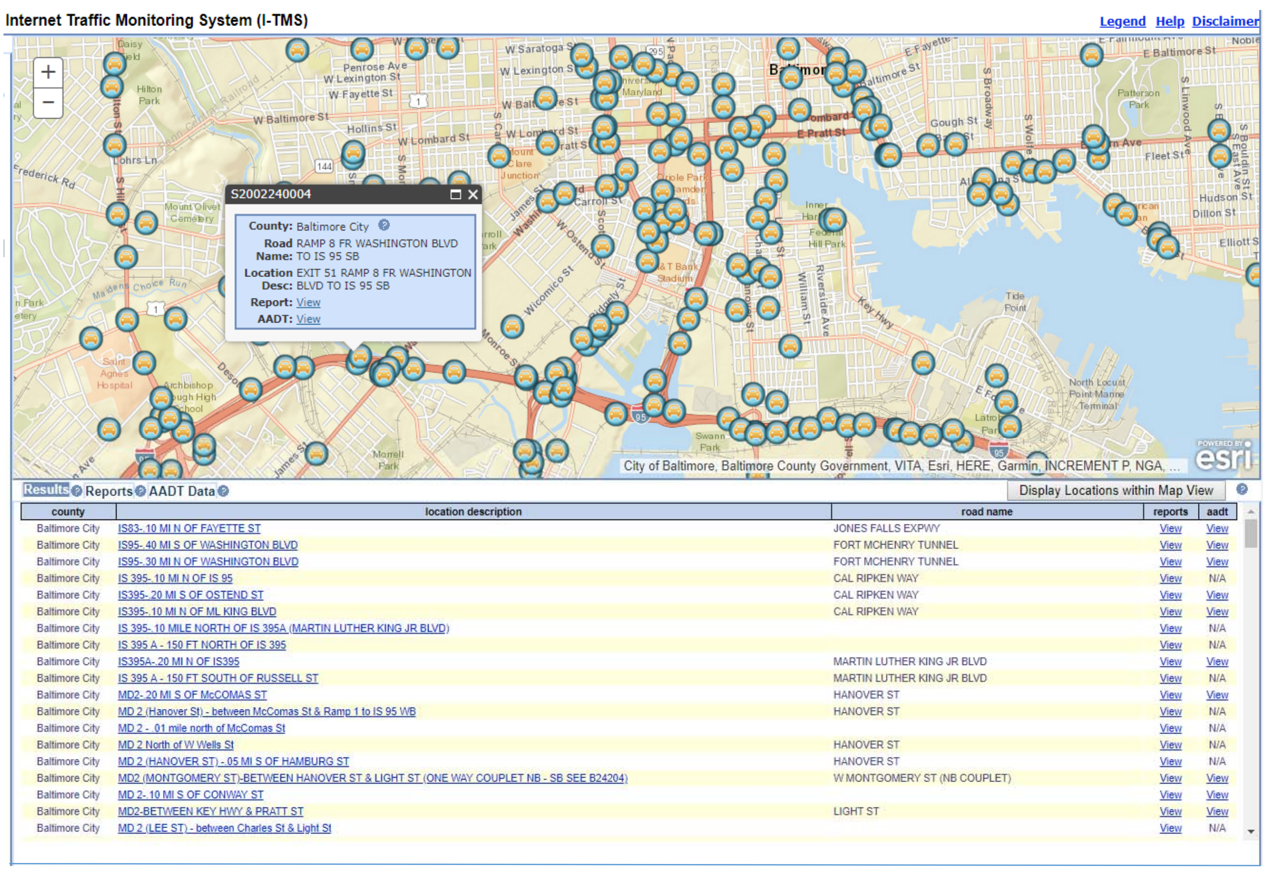



**Figure 7: SHA I-TMS computer Database system (http://maps.roads.maryland.gov/itms_public/).**

The team also obtained historic travel time data from the RITIS data system. For each freeway in the network, minute-by-minute PM peak period travel time values aggregated over a six-month period before the casino opening were gathered.

**Step 3. Network Coding:** Using Google Maps the team first corrected any major supply-side network issues that existed (i.e., incorrect # of lanes, capacities, and node connections). Next, the team modified the local road network near each casino to capture all local roads in the model and to reflect the before-scenario, supply-side road conditions. Last, signalized intersections were coded into the model. Ideally, real-world signal plans would be imported into DTALite from Synchro or other sources; however, such signal data was not available to the project team. Therefore, the imbedded phase-based signal representation model in DTALite generated default pre-timed signal phasing and timing plans based on the standard NEMA phasing convention. By default, through and right-turn movements were consolidated and received 45 seconds of green time; all left-turns were assumed to be protected and received 10 seconds of green time. Once all the major signalized intersections were coded, various timing adjustments were made during the model calibration process (Step 4) in locations where the simulated traffic conditions were unrealistic.

**Step 4. Calibration & Validation:** The DTA models were subject to a two-stage quantitative calibration process that utilized the observed traffic count and travel time data. The first stage calibrated demand-side parameters. A path-flow based optimization model calibrated the OD demand by iteratively minimizing the gap between observed sensor data and simulated volume counts. This OD adjustment process ran for K iterations until the difference between observed and estimated traffic, as well as the difference between estimated path flows and target OD flows, were minimized. The second stage of the process calibrated supply-side parameters. The simulation attempted to minimize the deviation between the simulated travel time along major corridors throughout the network and the historic average travel time obtained from RITIS. Speed is another common supply-side metric used to calibrate DTA models; however, it was not used in this study's model calibration.

To validate the models, an error calculation was performed using a weighted percent root mean square error (%WMSE) formulation:

$$\%\text{WMSE} = \sqrt{\frac{\sum_{i=1}^{N}\sum_{t=14}^{18}\left(Obs_{i,t} - Sim_{i,t}\right)^2}{\sum_{i=1}^{N}\sum_{t=14}^{18} {Obs_{i,t}}^2}} * 100$$

where $N$ denotes the total number of sensors and *Obs* and *Sim* denote the observed and simulated traffic volumes at each traffic count station $i$ during $t$ hours (14:00 to 19:00). The overall hourly traffic count %WMSE should be less than **15%** on all roadways. The error term was also applied to travel time validation, where N denotes the number of travel time intervals. The overall travel time %WMSE should be less than **20%** on all major corridors. Figure 7 visualizes the calibration of the travel time for one major corridor that provides freeway access to Live! Casino. All casino models met the %WMSE threshold criteria and the simulated corridor travel time profiles aligned temporally with the real-world observed data, as shown in Figure 7.

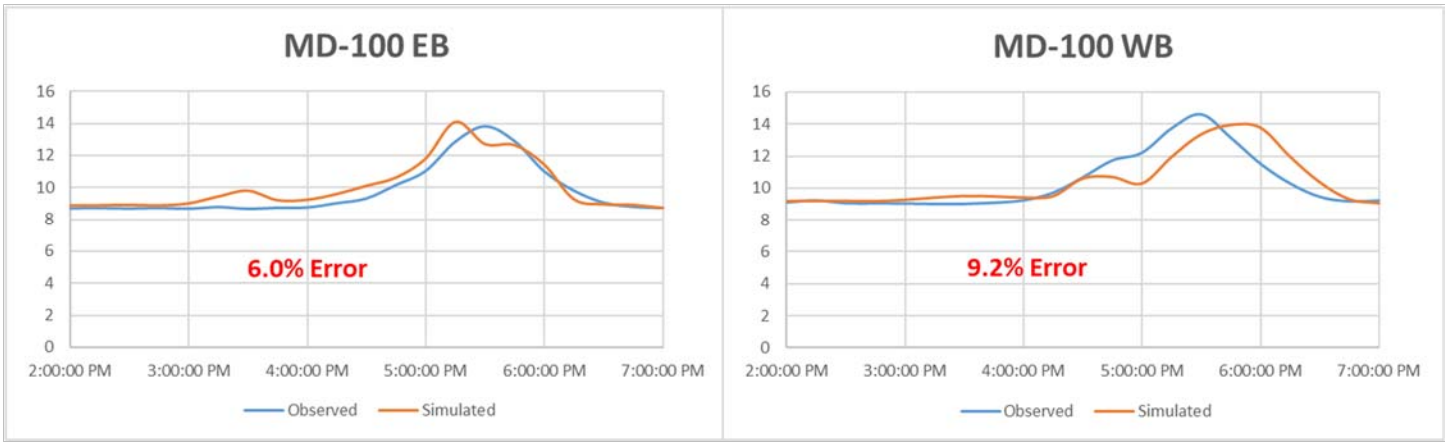
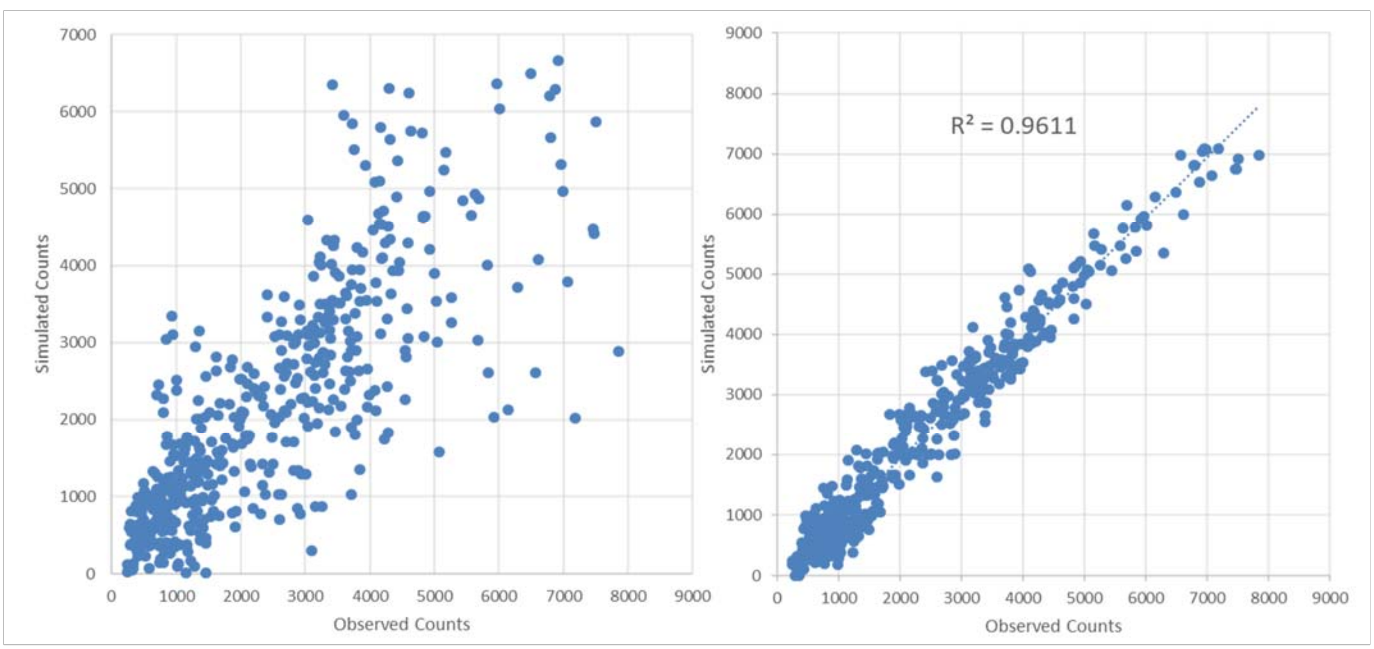



**Figure 8: Traffic travel time calibration for major corridor near Live! Casino.**

In addition to %WMSE, the comparison of coefficients of determination ($R^2$ values) is another useful validation approach. According to a FHWA model validation manual, the $R^2$ for regionwide observed versus simulated traffic counts should exceed 0.88 [20]. Figure 8 provides a scatter plot comparing the before and after traffic volume calibration for the Live! Casino base model. The after-calibrate $R^2$ surpassed the 88% threshold. Similar results were obtained for Horseshoe and MGM casino models as shown in Table 5.

Once a base model is calibrated and validated, each traveler's time-dependent trip pattern as well as the overall regional and corridor traffic performance can be measured.




(b) Seed OD (a) Calibrated OD

**Figure 9: Travel volume calibration for sub-regional Live! Casino base model.**

**Table 5: Validation Statistical Results Summary**

| CASINO | ALL Sensors | R^2 | %WMSE | Freeway Sensors | R^2 | %WMSE |
|---|---|---|---|---|---|---|
| LIVE! | 96 | 0.961 | 12.6 | 52 | 0.940 | 10.1 |
| HORSESHOE | 137 | 0.963 | 12.8 | 49 | 0.969 | 8.9 |
| MGM | 71 | 0.978 | 10.7 | 21 | 0.966 | 9.4 |

**Step 5. Add Casino Trip Data:** With the before-scenario models calibrated and validated, both casino and special event trip generation and distribution data were added into the hourly OD matrices in order to simulate the after and after + special event scenarios. The casino trip rates were borrowed directly from the existing casino TIS reports (see Section 2.2). For instances where the trip generation for particular amenities were estimated with separate trip rates, the team modified these rates as well as the directional distributions to reflect the average rates presented in the newest version of the *ITE Trip Generation Manual* (10th edition). The team also modified the variable inputs (i.e., number of gaming positions and square footage) to represent the actual values at the operational casinos. The estimated mode choice and internal capture distributions identified in the TIS reports were not modified.

The total number of PM peak hour trips estimated to enter and exit each casino (considers all land uses at casino complex) along with the corresponding TIS casino trips rates are presented in Table 6. In comparison, the average national trip rate for the weekday PM peak hour of generator is 0.4 (ITE LUC 473), which is significantly higher than the PM peak hour of generator rates used for the Maryland casinos. Neither the ITE Manual nor the Maryland TIS reports supplied PM peak hour of adjacent street trip rates, the weighted one-hour trip rate during the morning and late afternoon peak periods. Instead, peak hour generator rates were provided representing the highest generated hourly rate, which for casinos occurs late in the evening. Ideally, this generation rate would be included in the after-scenario models to align with the defined PM peak simulation period; however, this was not possible due to the lack of data (see Appendix III for casino trip generation details).

**Table 6: After-Scenario Casino Trip Generation (Weekday PM Peak Hour)**

| CASINO | Gaming Area (SF) | TIS Weekday PM Trip Rate Per Gaming Position | # of Trips Attracted | # of Trips Produced | Peak Hour TOTAL |
|---|---|---|---|---|---|
| LIVE! | 160k | 0.31 IN \| 0.28 OUT | 886 | 549 | 1,435 |
| HORSESHOE | 122k | 0.322 | 546 | 405 | 951 |
| MGM | 163k | 0.27 | 787 | 552 | 1,339 |

The peak hour for casino trips was assigned to the last hour of the PM peak period (6:00 - 7:00pm). Each casino's seed hourly trip patterns were distributed throughout the remaining hours in the model based on the hourly distributions of casino trips estimated from OD demand matrices provided by an independent location data service provider (see Section 5.1). Table 7 provides the estimated seed hourly casino arrival and departure time patterns as percentages of the peak hour casino demand.

**Table 7: Casino Hourly Trip Distribution**

| CASINO | PM HOURLY ARRIVAL PATTERN (6:00 – 7:00PM casino demand peak hour) | | | |
|---|---|---|---|---|
| | 3:00 – 4:00pm | 4:00 – 5:00pm | 5:00 – 6:00pm | 6:00 – 7:00pm |
| LIVE! | 82.5% | 65.5% | 73% | 100% (886) |
| HORSESHOE | 94.5% | 81% | 84% | 100% (546) |
| MGM | 79.5% | 84% | 83% | 100% (787) |
| | PM HOURLY DEPARTURE PATTERN | | | |
| LIVE! | 112% | 106% | 110% | 100% (549) |
| HORSESHOE | 94.5% | 131% | 137% | 100% (405) |
| MGM | 81% | 85.5% | 91% | 100% (552) |

Furthermore, the team also estimated the trip generation for special events at or near each casino. A Thursday night Ravens football game near Horseshoe casino and a Black Friday late afternoon shopping event at Arundel Mills Mall adjacent to Live! Casino generate additional trips. The approximate number of special event trips generated are displayed in Table 8. Only Live! Casino was estimated to attract and produce trips for a Black Friday special event during the 3:00 - 7:00 PM peak period. For the other casinos, it was assumed only arrival trips would enter the area to attend an event that typically starts after 7:00 PM. A more detailed breakdown of special event trip generation and arrival/departure time patterns is available in Appendix III.

**Table 8: After + Special Event Scenario Trip Generation**

| CASINO | Special Event | Quantity | # of Trips Attracted | # of Trips Produced | TOTAL |
|---|---|---|---|---|---|
| LIVE! | Black Friday | 1,630,000 sf mall | 1,772* | 1,697* | 3,470* |
| HORSESHOE | Thursday Night NFL Game | 71,008-seat stadium | 18,620 | 0 | 18,620 |
| MGM | Sold-out Concert | 3,000-seat theatre | 600 | 0 | 600 |

* PM peak-hour counts (Total = ~16,000 for 3-7pm peak period)

With all the trip rates and hourly trip patterns determined, the information was integrated into the after-scenario models. Arundel Mills Mall and Live! Casino, as well as the concert special event and MGM casino, share one zone (i.e., the casino site). Only the trip information for the Ravens game special event was combined with a separate zone at the location of the stadium.

## 4.3 Quantifying the Regional + Corridor Traffic Impact

The mesoscopic DTA models quantify the sub-region, network-wide traffic impacts including total volume, average travel time, average travel time index (mean/FFTT), and average speed. These measures of effectiveness (MoE) for each simulated hour are tabularized in Appendix IV. Additionally, link-based peak-hour density maps as well as travel time profiles for select major corridors near each casino were generated to visualize the regional and corridor-level traffic impact.

### 4.3.1 Live! Casino

According to the model output, the traffic conditions around Arundel Mills deteriorated significantly after the opening of Live! Casino. For the 6:00 PM hour when the casino demand is at its greatest, a nearly 2% increase in the region-wide traffic volume due to the casino produces a 14% increase in average travel time and a 12% reduction in average speed. A significantly larger traffic impact, 5.4% increase in traffic volume, was measured on Black Friday. The system-wide average travel time is 66% longer and the average speed is almost 40% lower (Appendix III details the special event trip generation methodology).

To help visualize the traffic impact throughout the network, a color-coded comparison figure displaying each link's density (veh/mi/ln) or level of service (LOS) is shown in Figure 9. Green denotes LOS A (6 -10.9 veh/mi/ln), shades of yellow represent LOS B & C (11 – 24.9), orange signifies LOS D & E (25-44.9), and red represents LOS F (>45) or traffic jam. For this casino network, MD 100 revealed the largest change in LOS in both directions near the Arundel Mills interchange. Queue spillback forms at the convergence of the eastbound off-ramp exiting Arundel Mills Boulevard and the MD 100 mainline as well as a separate merging area west of the MD 295 interchange in the westbound direction of MD 100. MD 295 also experienced a decrease in mobility, but the congestion propagation appears to originate around the MD 32/MD 295 interchange. Nonetheless, both corridors exhibit significant mobility impacts as further shown in Figure 10. With the exception of MD 100 EB, the travel time increased marginally along these corridors after the introduction of casino traffic (3-7% increase in travel time; 24% MD 100 EB). As expected, the inclusion of Black Friday traffic causes a spike in trip times by over 25% for each direction of MD 100 (I-95 to I-97) and MD 295 (MD 32 to I-195).

**Table 9: 6:00 PM Peak Hour Measures of Effectiveness Region-wide Results for Live! Casino.**

| LIVE! CASINO | BEFORE CASINO | WITH CASINO | CASINO + BLACK FRIDAY SPECIAL EVENT |
|---|---|---|---|
| MOEs | Value | Value \| % Change | Value \| % Change |
| # of Vehicles | 80,099 | 81,619 \| 1.9% | 84,459 \| 5.4% |
| Average Trip Time | 16.03 | 18.33 \| 14.4% | 26.58 \| 65.8% |
| Average Trip Time Index | 1.90 | 2.16 \| 13.7% | 3.12 \| 64.2% |
| Average Speed | 25.06 | 21.96 \| - 12.4% | 15.17 \| - 39.5% |

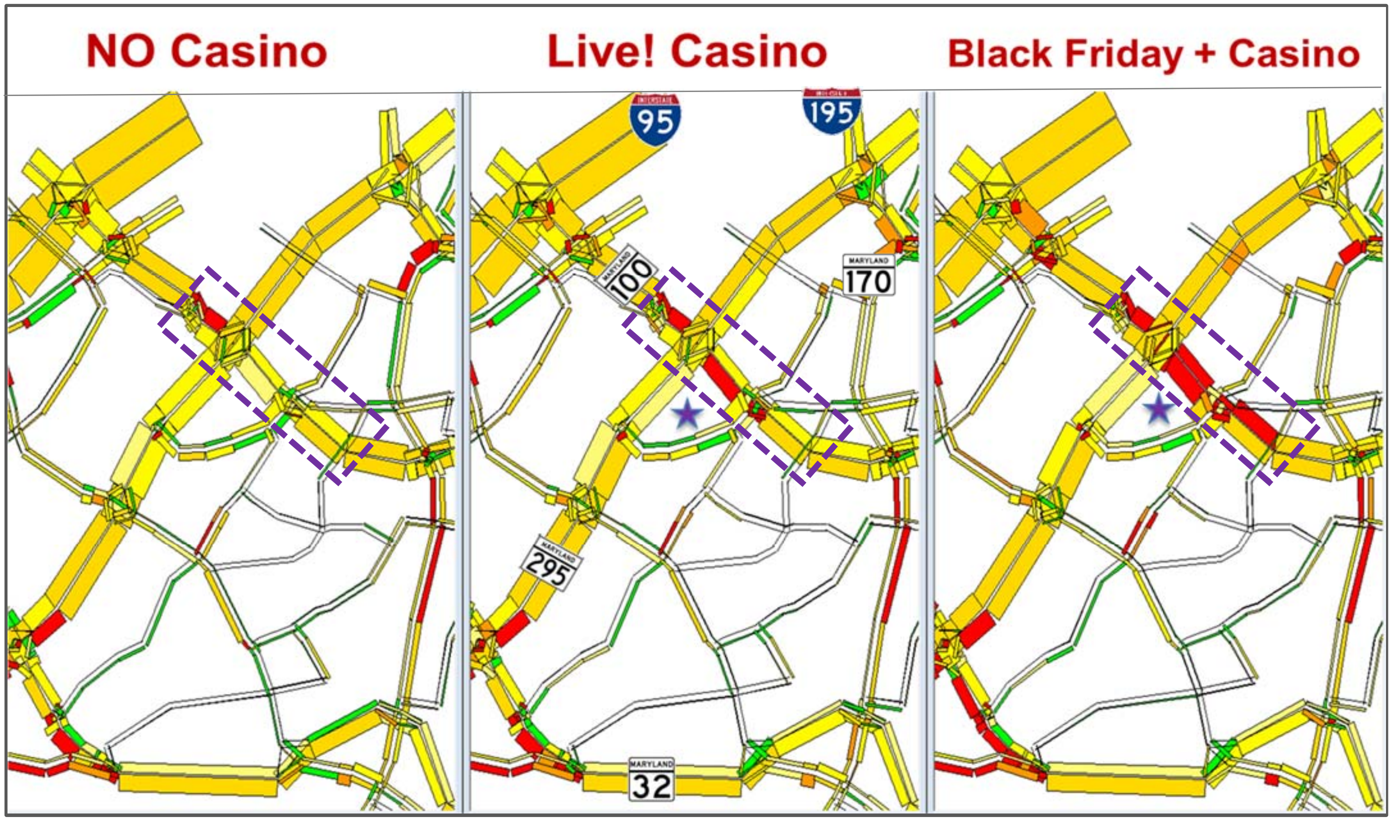


Figure 10: Live! network level of service peak hour snapshot.

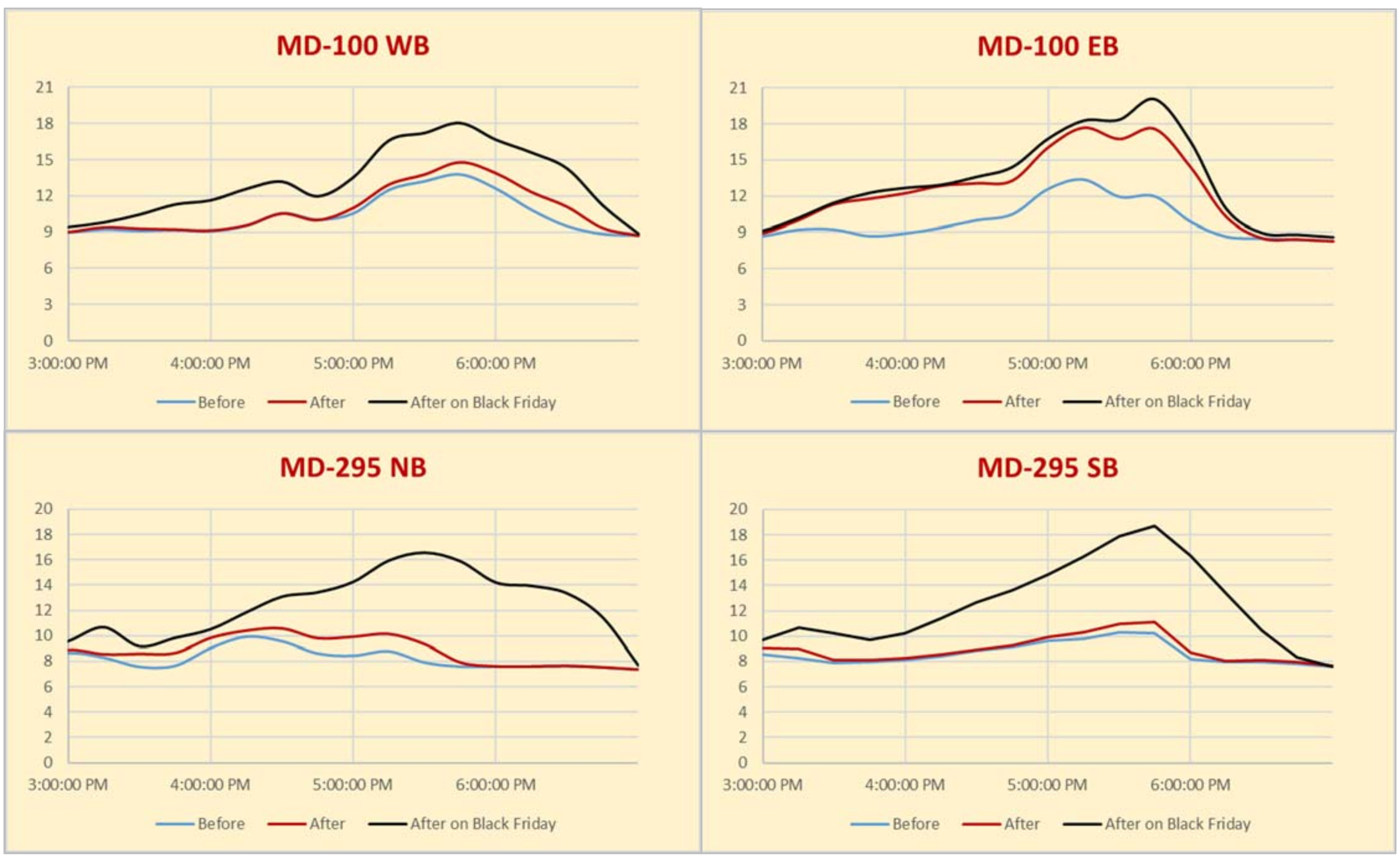


Figure 11: Live! Casino major corridor travel time profiles.

### 4.3.2 Horseshoe Casino

The Horseshoe Casino network is the largest sub-region model in network size and simulated more than twice as many vehicles as the other models. Therefore, a marginal change in the number of vehicles induced a smaller network-wide mobility impact. This notion, combined with the fact that Horseshoe casino has a smaller number of gaming positions, contribute to the overall minimal traffic impact, as shown in Table 10. During the 6:00 PM after-scenario peak hour, an additional 900 vehicles in the system (+0.5%) altered the average travel time and speed by less than 1%. As a result, it is reasoned the addition of Horseshoe Casino alone had no significant impact to mobility network-wide.

The combined casino and special event had a major traffic impact throughout the region. For a Thursday night Baltimore Ravens NFL game, of the over 18,000 game-related trips—including both stadium attendees and staff expected to arrive at the stadium during the hours leading up to the game—approximately 4,500 trips (24%) were predicted to arrive between 6:00 PM – 7:00 PM (the hourly distribution of special event trips is described in Appendix III). Given the influx of vehicles destined for the stadium and casino, the system experienced as much as a 30% decline in regional mobility.

From the density map in Figure 11, the most significant traffic impact is observed along Russell Street, which runs adjacent to the casino (star) and M&T Bank Stadium (ellipsoid). The LOS drops dramatically for both the northbound and southbound directions as well as the exit ramps of the Martin Luther King Jr. Blvd. and Russell Street interchange. A couple minor arterials east of the stadium also appear to experience severe congestion (i.e., W. Ostend St. and Fort Ave.). The model's density map indicated no major decline in LOS for other major corridors in the vicinity, including I-95, I-395, and MD 295.

With a significant impact recognized along Russell Street from the I-95 interchange to Martin Luther King Jr. Blvd., time-of-day profiles are prepared in Figure 12 to provide details regarding the corridor's simulated travel time impact for each scenario. After the casino opened, the simulated travel time increased significantly in the southbound direction (27% during the 3:00 – 7:00 PM peak period and 64% during 5:00 – 6:00 PM when travel time peaks along this corridor). Simulated game traffic also caused an 80% increase in travel time during the 3:00 – 7:00 PM peak period (156% during 5:00 – 6:00 PM) in the southbound direction. Contrarily, no travel time impact was estimated for after-scenario traffic approaching the stadium from the south; however, for game days, both southbound (80%) and northbound (550%) travel times increased greatly.

**Table 10: 6:00 PM Peak Hour Measures of Effectiveness Region-wide Results for Horseshoe Casino**

| HORSESHOE CASINO | BEFORE CASINO | WITH CASINO | CASINO + RAVEN'S GAME SPECIAL EVENT |
|---|---|---|---|
| MOEs | Value | Value \| % Change | Value \| % Change |
| # of Vehicles | 178,044 | 178,970 \| 0.5% | 183,302 \| 3.0% |
| Average Trip Time | 10.07 | 10.15 \| 0.8% | 13.12 \| 30.3% |
| Average Trip Time Index | 1.50 | 1.51 \| 0.7% | 1.94\| 29.3% |
| Average Speed | 24.29 | 24.08 \| - 0.9% | 18.74 \| - 22.8% |

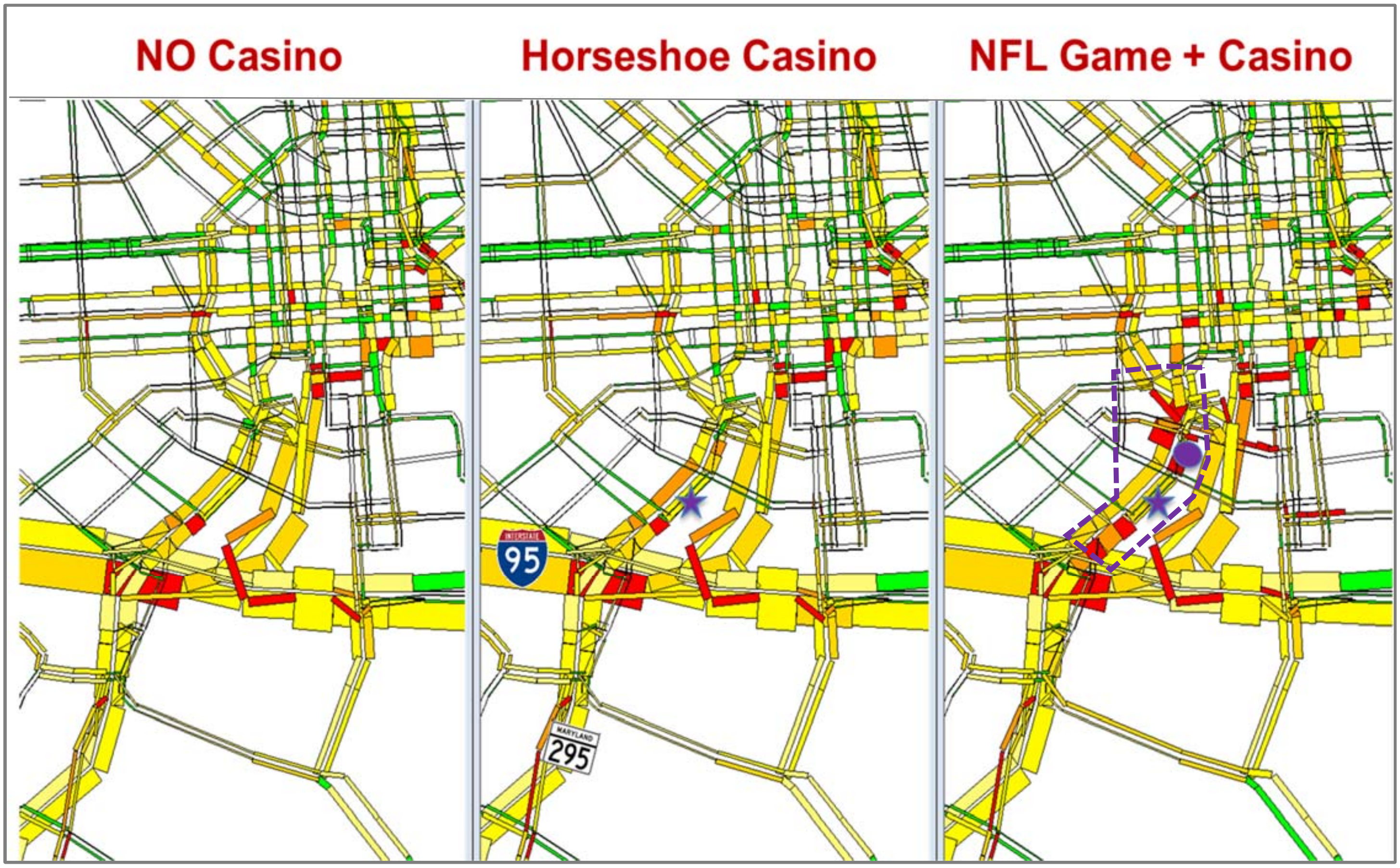



**Figure 12: Horseshoe network level of service peak-hour snapshot.**

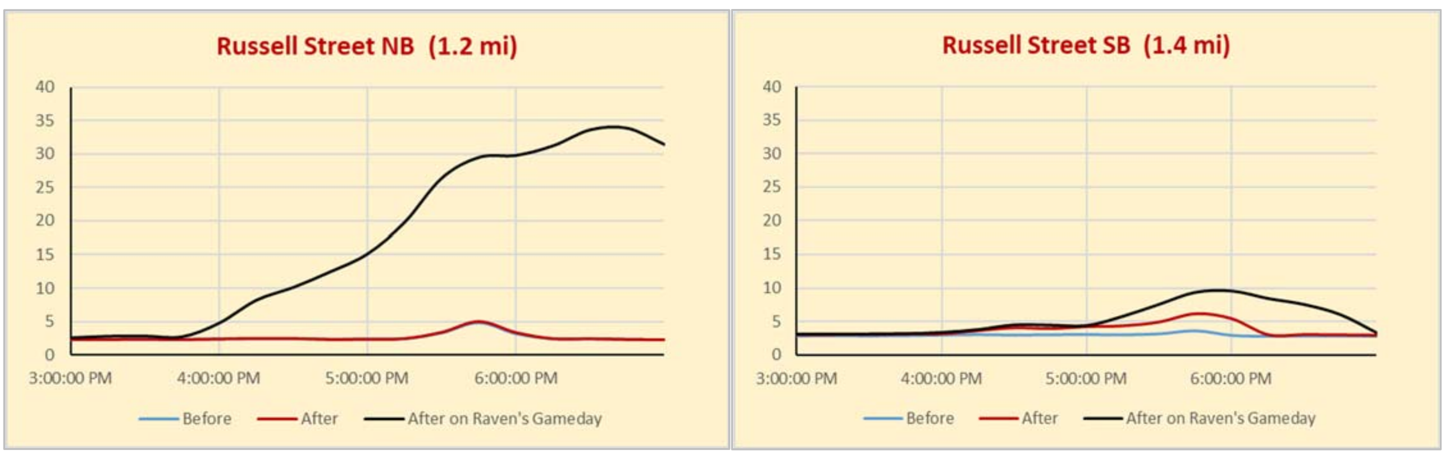



**Figure 13: Horseshoe Casino major corridor travel time profiles.**

### 4.3.3 MGM Casino

The MGM Casino model results predicted a moderate impact to regional mobility for the after-scenario. During the 6:00 – 7:00 PM hour of greatest system-wide impact, about a 6% increase in average travel time and decrease in average speed was estimated given a 2.2% increase in traffic volume (~1,400 peak-hour casino trips). The sold-out concert special event had no significant impact on system-wide traffic. A concert at the casino's 3,000-seat theater was assumed to start at 7:00 PM. All attendees driving to the concert were assumed to arrive within an hour before the concert began. 600 additional vehicle trips were produced as estimated in the Schwartz Engineering TIS report [12] (see Appendix III for additional info regarding the special event's trip generation). The regional roadway mobility impact was marginal (< 0.5% change).

The peak-hour density map in Figure 13 shows locations outside the casino's immediate area where queue spillback occurs, notably I-295 and several spots along MD 210 (Indian Head Highway). No major decline in LOS was modeled on the adjacent streets around the casino. This finding could be a direct result of the $10M in infrastructure upgrades installed with the intent to alleviate the expected increase in traffic demand induced by the new casino. As a result, new capacity was added to the adjacent access roads, including Harborview Ave., National Ave., and Oxon Hill Road between the Capital Beltway and the Tanger Outlets intersection. The improvement plan also included a new signal as well as updated signal coordination on Oxon Hill Road [18].

The time-of-day travel time profiles were analyzed for three major corridors that were expected to have significant travel time impacts (Figure 14). The first, Oxon Hill Road from Kerby Hill Road to St. Barnabus Road exhibited a large increase in simulated travel time in the southbound direction only (12%). The cause of the impact is due to a historic bottleneck located south of Tanger Outlets where the road narrows from two to one lane. Northbound traffic during the after-scenario for both Oxon Hill Road and MD 210 unveiled no significant mobility changes as those directions are opposite of the direction of peak flow. However, the southbound direction of MD 210 from the Capital Beltway to Old Fort Road experienced a 28% increase in simulated peak-hour travel time for the after-scenario. For the final corridor analyzed, I-295 south, the after-scenario casino demand impacted simulated travel time modestly by 7% for the 6:00 PM peak hour. Similar to the regional traffic impact peak-hour results, the difference in travel time associated with the addition of special event traffic across all analyzed corridors is negligible.

**Table 11: 6:00 PM Peak Hour Measures of Effectiveness Region-wide Results for MGM**

| MGM CASINO | BEFORE CASINO | WITH CASINO | CASINO + MGM CONCERT SPECIAL EVENT |
|---|---|---|---|
| MOEs | Value | Value \| % Change | Value \| % Change |
| # of Vehicles | 64,021 | 65,449 \| 2.2% | 66,083 \| 3.2% |
| Average Trip Time | 14.99 | 15.9 \| 6.1% | 15.55 \| 6.3% |
| Average Trip Time Index | 1.69 | 1.79 \| 5.9% | 1.75\| 5.9% |
| Average Speed | 23.97 | 22.57 \| - 5.8% | 22.50 \| - 6.1% |

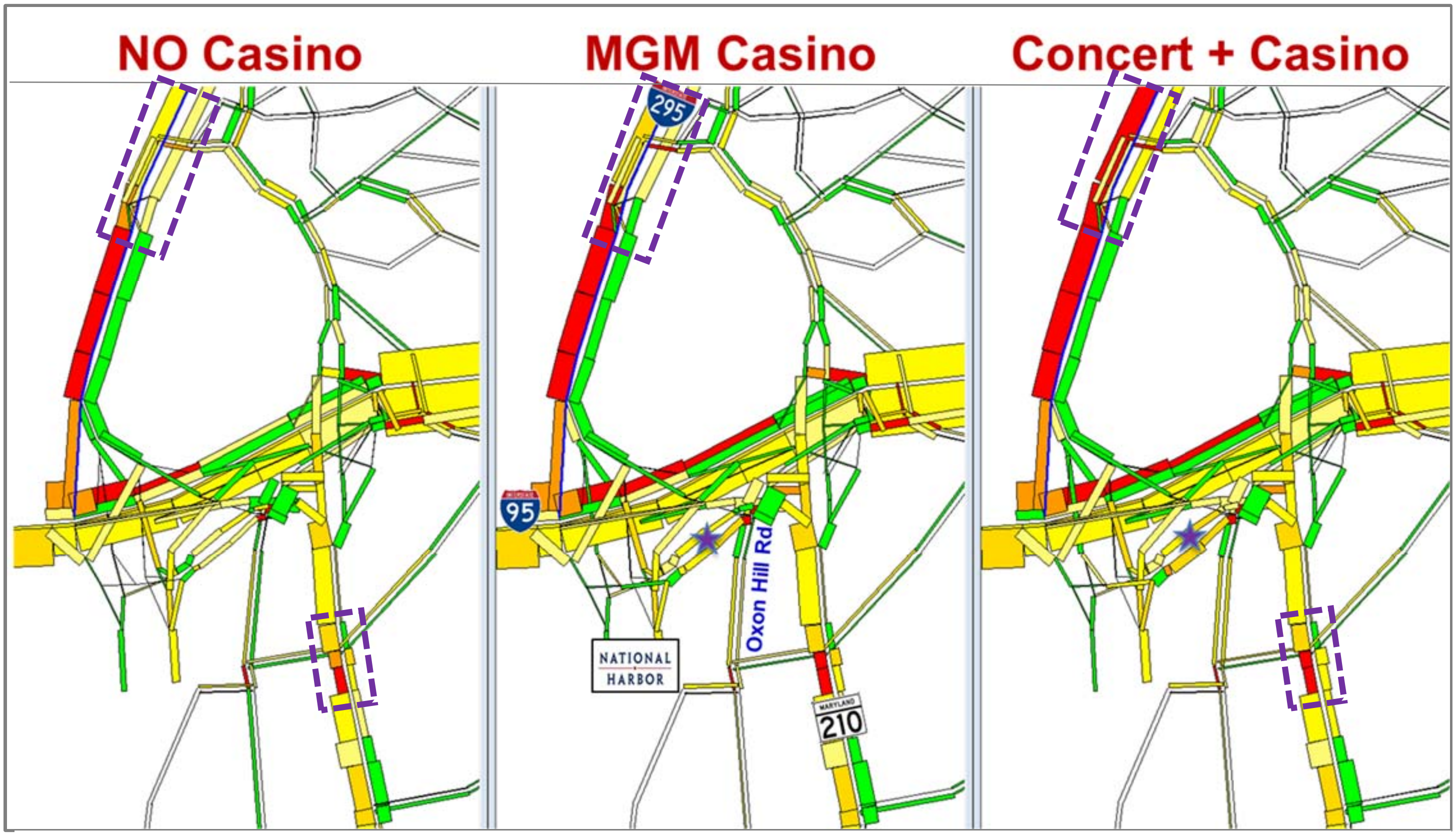



**Figure 14: MGM network level of service peak-hour snapshot.**

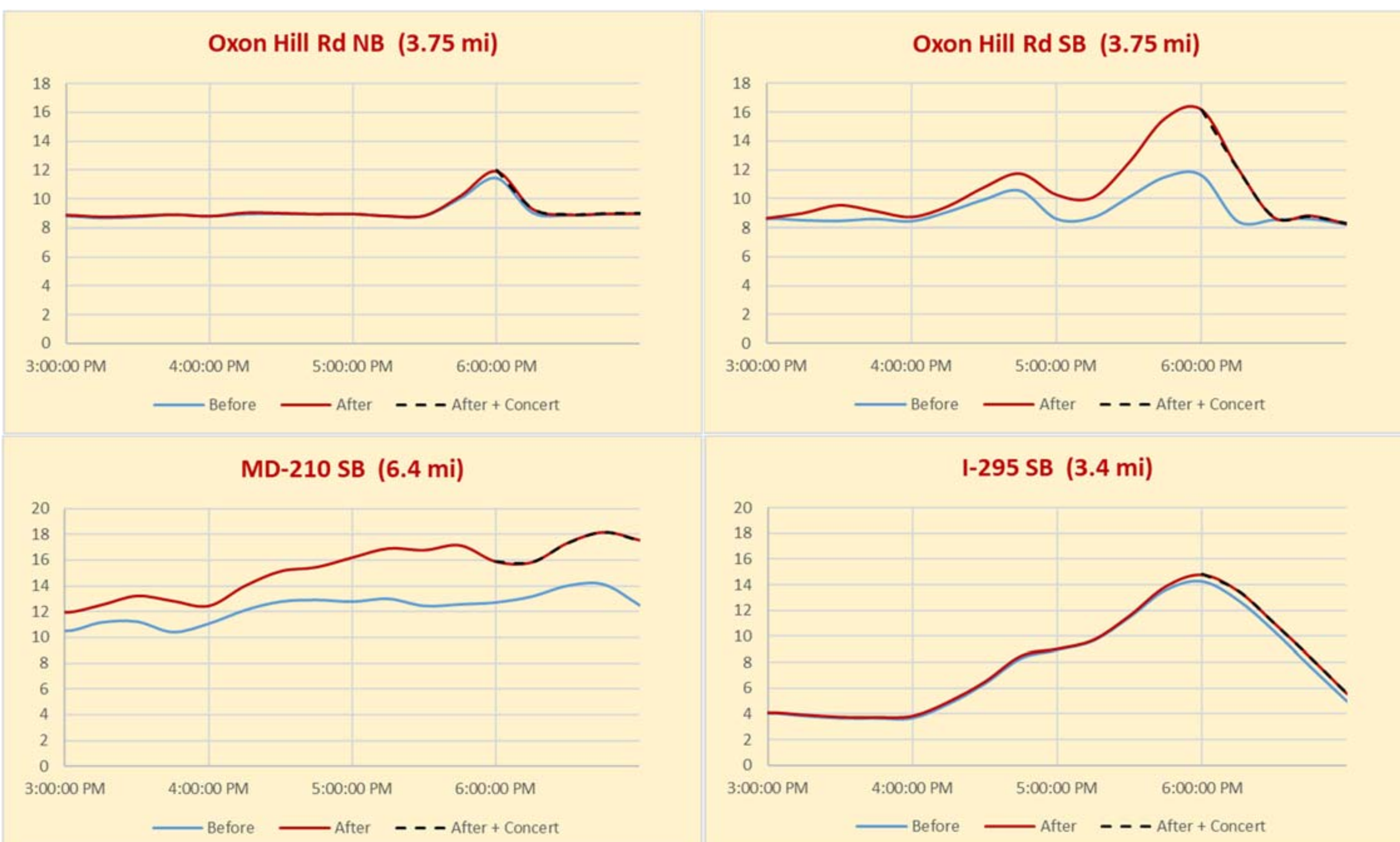



**Figure 15: MGM Casino major corridor travel time profiles.**

# CHAPTER 5: TRIP GENERATION ESTIMATION

As discussed in section 2.1, the state-of-practice for trip generation relies heavily upon the ITE Manual to attain trip rates for various land uses. However, the limitations associated with the use of a national database due to unavailability and variability of ITE data can lead to significant inaccurate estimation of trip rates, particularly for complex land uses such as a full-scale casino. Therefore, the team explored two innovative methods that may be able to augment and potentially supplant state-of-practice methodology.

## 5.1 Method 1: Big Data

The growing availability of big data in transportation is reshaping the way the industry analyzes and manages traffic-related problems. As telecommunication and location-based technologies provide increasingly larger and more sophisticated datasets, transportation agencies can now manage large-scale, complex traffic demand and operations with the aid of big data suppliers and analytic services.

In search of regional origin-destination demand data to estimate casino trip rates, the research team procured a one-month statewide OD trip matrices from Airsage, a national leading location data service provider. Airsage offers both accurate and secure trip information used for modeling and forecasting trip patterns, point of interest trip generation, and traveler behavior through the collection and analysis of real-time mobile phone and GPS data.  The spatiotemporal qualities and coverage of the Airsage data allowed the research team to calculate the casino trip rates and compare them with the ITE-based rates used in the TIS reports.

The acquired OD demand matrices capture trips to and from each casino from zones (i.e. census tracts) that cover the state of Maryland, D.C., and northern Virginia. Separate casino zone areas were drawn to encompass the casino building and parking garage footprints. The trip matrices were weighted to represent the resident population of the census tracts that produced casino trips and aggregated for the month of April 2017, during the weekday PM peak period. With this dataset, the research team compared the Airsage casino OD demand with the ITE-based casino trip volumes as shown in Table 12.

Upon comparison, it is apparent that the peak hour estimates (6-7pm) based on location data greatly differ from the ITE-based trip values. Among the three casinos studied, the number of arrival trips based on the Airsage dataset averages about 30% the total number of trips estimated in their TIS reports – about 36% for trips exiting the casinos. The largest difference was observed for Live! Casino where more than four times as many arrival peak hour trips were estimated using the ITE-based method versus the Airsage trip data (182 vs. 886).

Consequently, it is easy to assume the custom Maryland casino rates, already modified lower from the ITE manual's average trip rate of 0.4 for casino establishments (see Section 4.3 step 5), still significantly overestimate the trip generation for full-scale casinos. It is important to note that the overestimation can be somewhat attributed to the Maryland casino rates representing the peak hour of generator traffic, which occurs outside the analyzed time period (i.e. late evening). Moreover, the data provided by Airsage has not been validated and should not be assumed to be the true values. Details surrounding the extraction and postprocessing of location data from telecommunication devices are unknown, but the team suspects the final data product may contain inaccuracies that would affect the trip estimates. For example, the added casino zones were relatively small in comparison with typical zonal structures (i.e. census blocks/tracts, TAZs); therefore, it is likely not all cell phone devices that entered the casino zone were detected, resulting in an underestimate of trips. This notion is also supported by the small number of internal trips reported during the analyzed time period.

Also included in Table 12 are count estimates based on a third data source for MGM casino. With tube counters installed at the start and end of both National and Harborview Avenue, the team was able to estimate casino trips based on MDOT SHA hourly count data with the intention to ground-truth the results of both trip analysis methods (see Appendix V for details). Although the placement of the counters away from the direct access points of the casino complex prevented the team from determining a more accurate estimation of MGM's trip generation (i.e. assume no trips loop around casino and a 50/50 in/out distribution), this estimation is likely the most accurate representation of the casino's trip generation for the weekday PM peak period in comparison with all other trip estimations presented in this report. Upon review, the count-based 6-7 PM trip estimate (i.e. 1,142 total) is significantly closer to the total number of estimated trips based on the default ITE-based method (i.e. 1339) than Airsage's OD data (i.e. 689).

**Table 12: Airsage OD Trip + MGM Counts Summary**

| 2017 | LIVE! | | | | | HORSESHOE | | |
|---|---|---|---|---|---|---|---|---|
| Weekdays 4/1 - 4/27 | Airsage Trip Estimates | | | | | Airsage Trip Estimates | | |
| | IN | OUT | Internal | FROM MALL | TO MALL | IN | OUT | Internal |
| 3-4PM | 150 | 140 | 28 | 0 | 8 | 136 | 104 | 21 |
| 4-5PM | 119 | 202 | 16 | 0 | 0 | 117 | 144 | 8 |
| 5-6PM | 133 | 137 | 20 | 0 | 0 | 121 | 151 | 7 |
| **6-7PM** | **182** | **125** | 16 | 3 | 4 | **144** | **110** | 5 |
| **TOTAL** | **584 (49%)** | **604 (51%)** | **80** | **3** | **12** | **518 (50%)** | **509 (50%)** | **41** |
| ***Default Trips** | **886** | **549** | | | | **546** | **405** | |

| 2017 | MGM NATIONAL HARBOR | | | | | | |
|---|---|---|---|---|---|---|---|
| Weekdays 4/1 - 4/27 | Airsage Trip Estimates | | | | | SHA Counts (Sept. 2018) | |
| | IN | OUT | Internal | FROM NAT'L HBR | TO NAT'L HBR | IN | OUT |
| 3-4PM | 292 | 271 | 31 | 0 | 2 | 418 | 418 |
| 4-5PM | 296 | 281 | 35 | 2 | 7 | 436 | 436 |
| 5-6PM | 281 | 305 | 24 | 6 | 0 | 517 | 517 |
| **6-7PM** | **353** | **336** | 29 | 32 | 15 | **571** | **571** |
| **TOTAL** | **1222 (51%)** | **1193 (49%)** | **119** | **40** | **24** | **1942** | **1942** |
| ***Default Trips** | **787** | **552** | | | | | |

* Default trip volumes represent the peak hour of generator and are based on trip generation rates from casino impact studies

## 5.2 Method 2: Statistical Estimation Based on ODME

The second trip rate estimation approach incorporates a module embedded within the mesoscopic DTA model: Origin Demand Matrix Estimation (ODME). ODME is the same path-flow optimization model used in calibration of the DTA models to match the observed and simulated traffic counts. After vehicle shortest paths are assigned based on a user's experienced travel time which accounts for dynamic traffic conditions as time progresses, ODME is performed to adjust the OD demand along these paths to satisfy the dynamic user equilibrium condition. For the purpose of estimating local trip rates, ODME is introduced to attempt to match the number of estimated trips based on ITE rates (MDOT SHA approved casino rates for this study) with ground-truth data such as local traffic counts or OD probe data.

Figure 15 displays the illustrative framework of the ODME trip rate analysis. The procedure begins with preparing a calibrated and validated before-scenario, sub-region model with supplemental OD demand (i.e. seed OD demand). Next, a new OD pattern based on national trip rates is generated and integrated into the base model via a newly created TAZ. The new zone's trip distribution can be determined from an adjacent network zone with a similar land use. Using traffic counts obtained for years after the site began operation, the sub-region model is again calibrated, and the OD demand is re-estimated in an attempt to match the model's simulated local traffic with post-construction ground-truth data. Finally, the adjusted peak hour OD trip volumes supplant the default ITE trip rates and provide the opportunity to augment the ITE trip generation database. In short, the analysis starts with a base scenario OD pattern based on existing trip generation rates, then updates the trip generation rates using after-scenario count data through the implementation of a DTA simulation-based model. This analysis procedure was completed for the MGM casino network using the calibrated before-scenario MGM model and after-scenario traffic counts (i.e. counts collected 2017-18 after casino opened). Volume estimates produced from hourly MDOT SHA traffic count data collected in September 2018 were used to ground-truth the results.

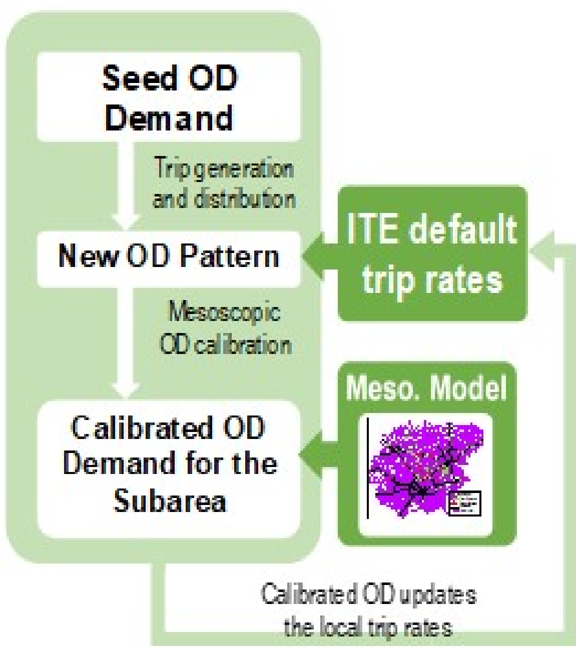



**Figure 16: Trip Rate Estimation Framework**

Figure 16 presents the analysis results. Starting with seed ITE-based casino volumes of 886 trips in and 549 trips out of the casino, both entering/exiting casino trip volumes converge to a smaller value after applying ODME using after-scenario sensor count data. Originally, all 96 count sensors throughout the network were included in the ODME procedure to adjust the local casino trip volumes; however, due to both the variability and unavailability of volume data at many of the sensor locations, the initial results were inconclusive. Therefore, the number of sensors used in the estimation procedure was narrowed to approximately ten sensors within the casino vicinity. After completing twelve runs of ODME with the reduced number of sensors, the final estimated trip volumes equated to 565 and 410. The updated volumes adjusted by over 35%; however, the end results underestimated the casino traffic counts provided by MDOT SHA. The number of 6-7 PM peak hour trips entering and exiting the casino area based on 2018 count data totaled at 1,142. The ODME method estimated a total of 975 trips, a 17% difference. Interestingly, the ODME results fell closer to the MDOT SHA counts than the trip estimates provided by Airsage and the ITE-based default trip rates (see Table 12). It is important to note that the team was not able to obtain an accurate IN/OUT distribution of the casino trips, so a 50/50 distribution was assumed for the MDOT SHA counts.

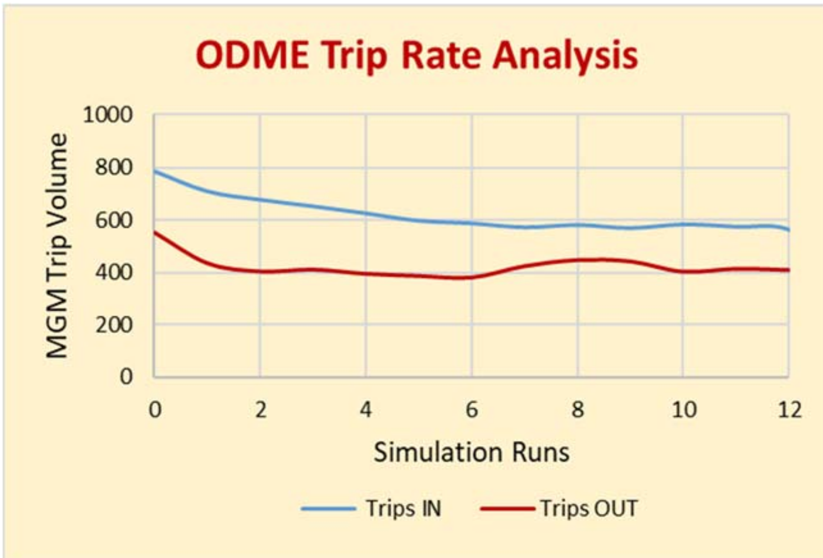



**Figure 17: Trip Rate Analysis Results**

**Table 12: Trip Rate Estimation Results Comparison Summary**

| MGM CASINO | Peak Hr Trips | | TOTAL | % Change |
|---|---|---|---|---|
| **Estimation Method** | **IN** | **OUT** | | |
| **Default Rates (ITE-based)** | 787 (59%) | 552 (41%) | 1,339 | **17.3%** |
| **Airsage OD Matrices** | 353 (51%) | 336 (49%) | 689 | **-39.7%** |
| **ODME (DTA Model)** | 565 (58%) | 410 (42%) | 975 | **-14.6%** |
| **SHA Counts*** | **571 (50%)** | **571 (50%)** | **1,142** | - |

*** Trip Distribution assumed to be 50/50**

# CHAPTER 6: SUMMARY AND CONCLUSIONS

With the recent opening of three full-scale casinos in Maryland, this traffic impact study evaluated regional and local traffic conditions at each casino for three different scenarios: before casino, after casino, and after casino during a special event (e.g. an NFL football game). Two methodological approaches were implemented to perform the analysis: (1) before/after-scenario probe data analytics and (2) mesoscopic DTA simulation-based modeling. Two approaches yielded different results due to the disparities in data sources and methodological framework. The first method analyzed raw traffic data which averaged over an entire month and likely contained abnormal traffic patterns (i.e. crashes or work zone delays). The DTA model controls for the untypical travel behaviors but is influenced more by the accuracy of the model's network features and availability of count data. The result summaries for both methods are described below.

**Data Analytics:**

The traffic impact results varied widely depending on the corridor under review and the month from which aggregated INRIX data was analyzed (i.e., January, April, July, or October). For example, I-395 South, the average travel time decreased during the month of July by 38%, one year after the casino opened and increased 33% for the month of October. Another important finding was the large number of months that exhibited no significant impact (21) or improved traffic performance (11) after the opening of the casinos. The improvement in mobility could sometimes be attributed to temporary work zones, large-scale disruption like Superstorm Sandy, and roadway improvement projects.

Nonetheless, the team discovered that probe data aggregated for the month of April presented consistent performance results for all corridors. The results relayed a worsening of the average travel time and speed performance along all studied corridors except I-395 South and Exit 2 Ramp 3 near the MGM casino. For the remainder of the corridors, the traffic impact resulted in an approximate 8 to 14% increase in average travel time and a 6 to 12% decrease in average speed; these changes account for any roadway improvements that were completed in conjunction with the casino. Therefore, the team concludes that the casinos did create additional congestion on roadways near the casinos after they became operational, but the impact was moderate.

**Mesoscopic DTALite Simulation-based Modeling:**

According to the model outputs, the traffic conditions around Arundel Mills deteriorated the most after the opening of Live! Casino in comparison with the model results for Horseshoe and MGM casinos. The Horseshoe Casino model simulated no major impact to regional mobility; the MGM Casino model simulated a moderate impact of 6% for the after-scenario. However, the after-scenario for the Live! Casino model – this model is about the same size as the MGM model in terms of number of simulated vehicles – estimates a 14% increase in average travel time and 12% decrease in average speed system-wide.

The significant differences in traffic impact for each casino can be explained by the size of the network, after-scenario network changes, and number of casino gaming positions. Horseshoe Casino simulated almost twice as many vehicles and introduced about a third less casino demand based on the Maryland casino trip rates; hence, the result of adding only a couple hundred vehicles per hour to the entire network had little effect on the system's performance. The only significant impact realized was at the corridor level along Russell Street. Although the MGM and Live! Casino models are similar in size and load roughly the same number of casino trips into the network, the MGM Casino model includes network changes that reflect the $10M worth of infrastructure improvements completed on all the adjacent streets to the casino. This network difference could help explain why the Live! Casino exhibited the largest traffic impact among the three casinos studied in this project.

For the after-scenario + special event, again Live! Casino model estimates the largest regional impact (+66% average travel time and -40% average speed) after an additional 16,600 Black Friday trips were loaded into the model. It should be noted that Black Friday is a holiday for most, so the increase in traffic congestion may not be a major concern for those who travel to the Live! Casino or the shopping mall (compared to commute trips). The Horseshoe Casino added approximately 18,500 Raven's NFL game-day special event trips, yet the regional impact was less (+30% average travel time and -26% average speed), likely due to the larger size of the network. A sold-out concert at MGM Casino would have no significant regional traffic impact according to the model.

The final section of this report introduced two trip generation estimation methods in search for an alternative tool to the *ITE Trip Generation Manual*. The big data approach utilized Airsage mobile device data to extrapolate OD pairs from tracking cell phone devices that entered one of the casinos during April 2017. This data provided weighted trip estimates that underestimated both the default ITE-based casino rates and the volume estimates based on the September 2018 MDOT SHA count data. As discussed in Section 5.1, trip generation estimates produced by Airsage have not been validated with Maryland observations. The big data approach requires further calibration and validation before they are introduced as an alternative to the ITE trip generation manual. The second estimation method is the ODME statistical procedure embedded within the mesoscopic DTALite model. The testing of this method resulted in a trip estimate that slightly underestimates the MDOT SHA count data. The ODME estimate out-performed both the ITE-based and Airsage supplied trip estimates. The ODME requires after-scenario traffic count data and is more appropriate for developing calibration/adjustment factors for the default ITE trip generation manual for Maryland traffic impact studies.

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# APPENDIX I:
## PROBE DATA ANALYTICS COMPARISON CHARTS + TABLES

# MD-295 / Russell Street (1/3)

**3.8 miles NB; 2.2 miles SB**

**Opened in August 2014**

**Table 13: Probe Data Analytic Results for Russel St. (January + April)**

| Avg Travel Time (min) | | January 2014 | January 2015 | Difference | t-stat | p-value | | April 2014 | April 2015 | Difference | t-stat | p-value | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NB | (3 - 7PM) | 4.64 | 5.10 | **0.46** | -5.78 | 0.000 | *** | 5.18 | 5.71 | **0.53** | -2.90 | 0.011 | ** |
| | PM Peak Hr | 4.69 | 5.50 | **0.81** | -20.49 | 0.000 | *** | 5.06 | 6.44 | **1.37** | -13.70 | 0.001 | *** |
| SB | (3 - 7PM) | 4.69 | 4.17 | **-0.51** | 4.33 | 0.001 | *** | 4.04 | 4.43 | **0.39** | -6.17 | 0.000 | *** |
| | PM Peak Hr | 5.57 | 4.42 | **-1.15** | 16.87 | 0.000 | *** | 4.56 | 5.06 | **0.50** | -9.81 | 0.002 | *** |
| Avg Speed (mph) | | | | | | | | | | | | | |
| NB | (3 - 7PM) | 48.33 | 44.15 | **-4.18** | 6.10 | 0.000 | *** | 43.49 | 39.79 | **-3.69** | 2.82 | 0.013 | ** |
| | PM Peak Hr | 47.82 | 40.75 | **-7.06** | 28.23 | 0.000 | *** | 40.63 | 34.86 | **-5.77** | 3.68 | 0.035 | ** |
| SB | (3 - 7PM) | 29.52 | 32.61 | **3.09** | -4.76 | 0.000 | *** | 33.84 | 31.08 | **-2.77** | 6.87 | 0.000 | *** |
| | PM Peak Hr | 24.42 | 30.70 | **6.28** | -16.10 | 0.001 | *** | 29.80 | 26.90 | **-2.90** | 10.65 | 0.002 | *** |

Note: PM Peak Hour comprises 4 consecutive 15-min intervals that yield overall highest average travel time value within 3-7pm period.

**Table 14: Probe Data Analytic Results for Russell St. (July + October)**

| Avg Travel Time (min) | | July 2014 | July 2015 | Difference | t-stat | p-value | | Oct 2013 | Oct 2014 | Difference | t-stat | p-value | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NB | (3 - 7PM) | 6.15 | 6.85 | **0.70** | -4.92 | 0.000 | *** | 4.48 | 5.36 | **0.88** | -14.13 | 0.000 | *** |
| | PM Peak Hr | 7.28 | 8.70 | **1.42** | -11.47 | 0.001 | *** | 4.56 | 5.64 | **1.07** | -10.79 | 0.002 | *** |
| SB | (3 - 7PM) | 7.41 | 4.96 | **-2.45** | 11.21 | 0.000 | *** | 4.13 | 4.01 | **-0.12** | 1.26 | 0.228 | |
| | PM Peak Hr | 8.04 | 6.10 | **-1.95** | 20.35 | 0.000 | *** | 4.83 | 4.18 | **-0.65** | 9.14 | 0.003 | *** |
| Avg Speed (mph) | | | | | | | | | | | | | |
| NB | (3 - 7PM) | 36.94 | 33.70 | **-3.24** | 5.63 | 0.000 | *** | 50.05 | 41.96 | **-8.09** | 16.85 | 0.000 | *** |
| | PM Peak Hr | 30.89 | 25.89 | **-5.01** | 13.42 | 0.001 | *** | 49.17 | 39.85 | **-9.32** | 12.96 | 0.001 | *** |
| SB | (3 - 7PM) | 18.66 | 27.97 | **9.31** | -9.72 | 0.000 | *** | 33.35 | 33.96 | **0.61** | -0.83 | 0.417 | |
| | PM Peak Hr | 16.82 | 22.36 | **5.54** | -7.69 | 0.005 | *** | 28.19 | 32.55 | **4.36** | -9.00 | 0.003 | *** |

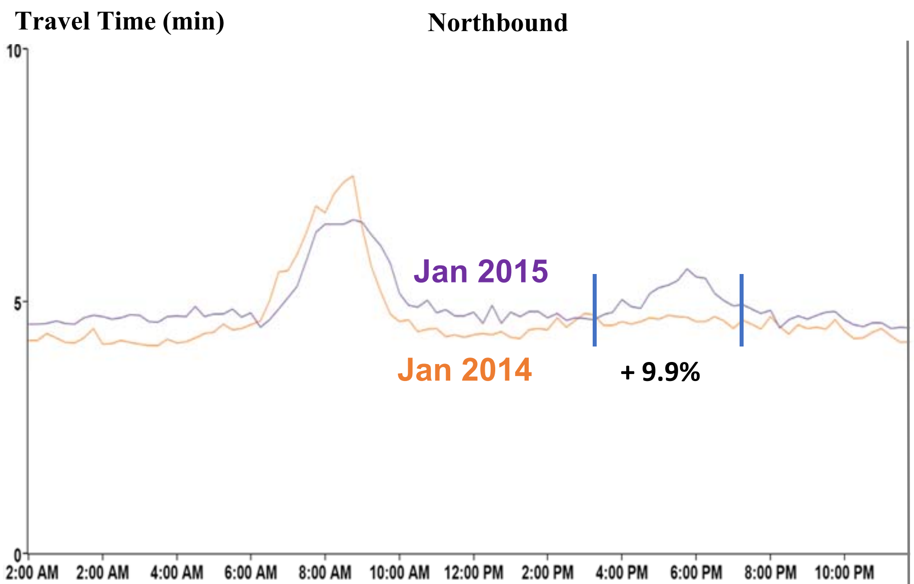
***Significant at p < 0.01 **Significant at p < 0.05 *Significant at p < 0.1 ; **RED VALUES** represent improved mobility performance.

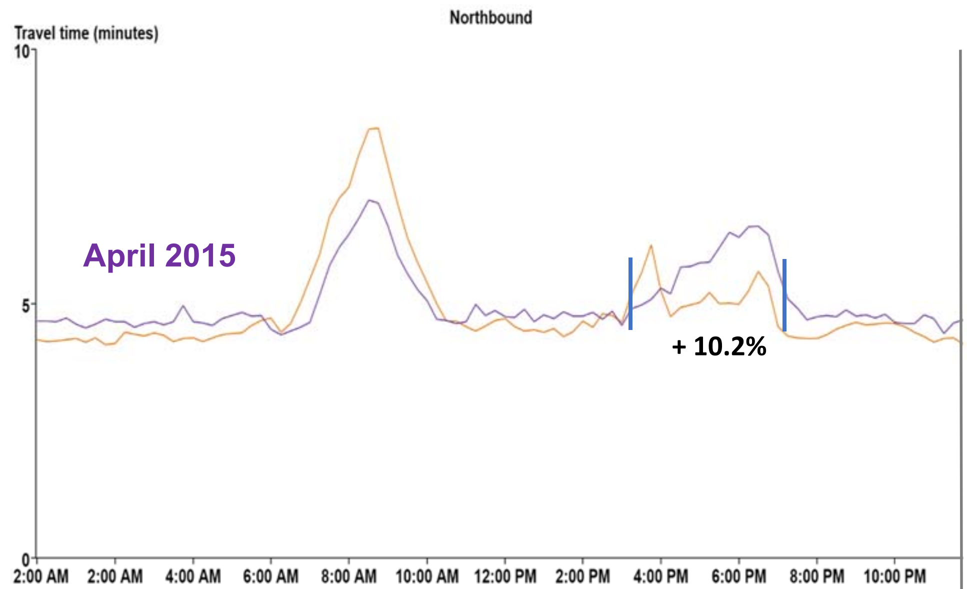
HORSESHOE CASINO

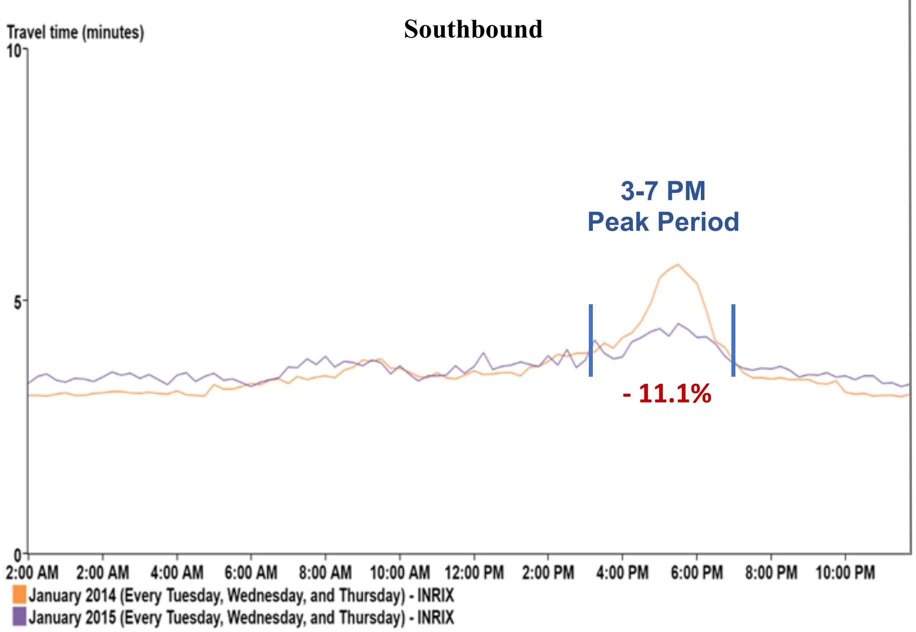
# MD-295 / Russell Street (2/3)

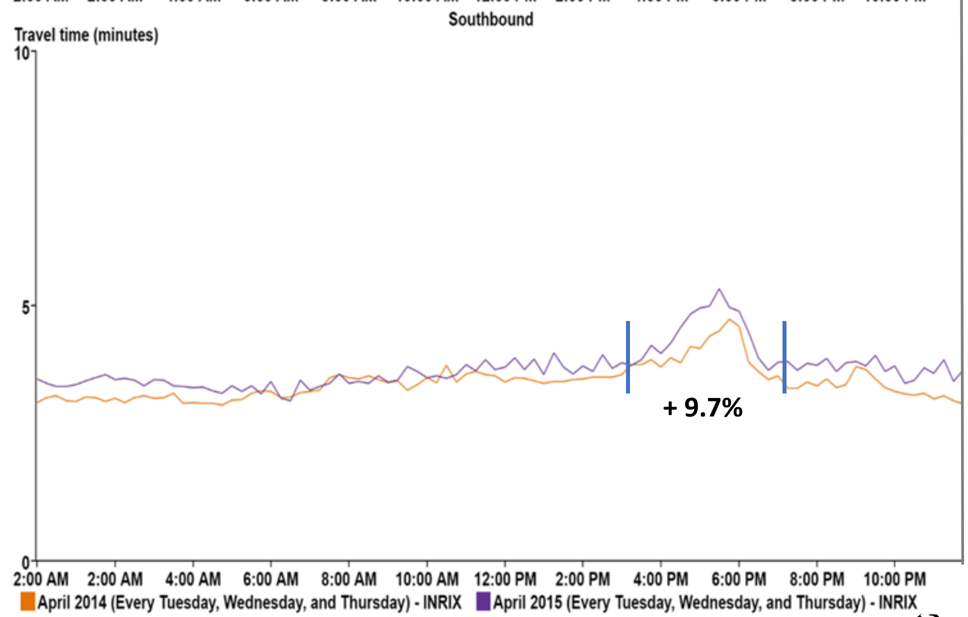
**3.8 miles NB; 2.2 miles SB**

**Opened in August 2014**



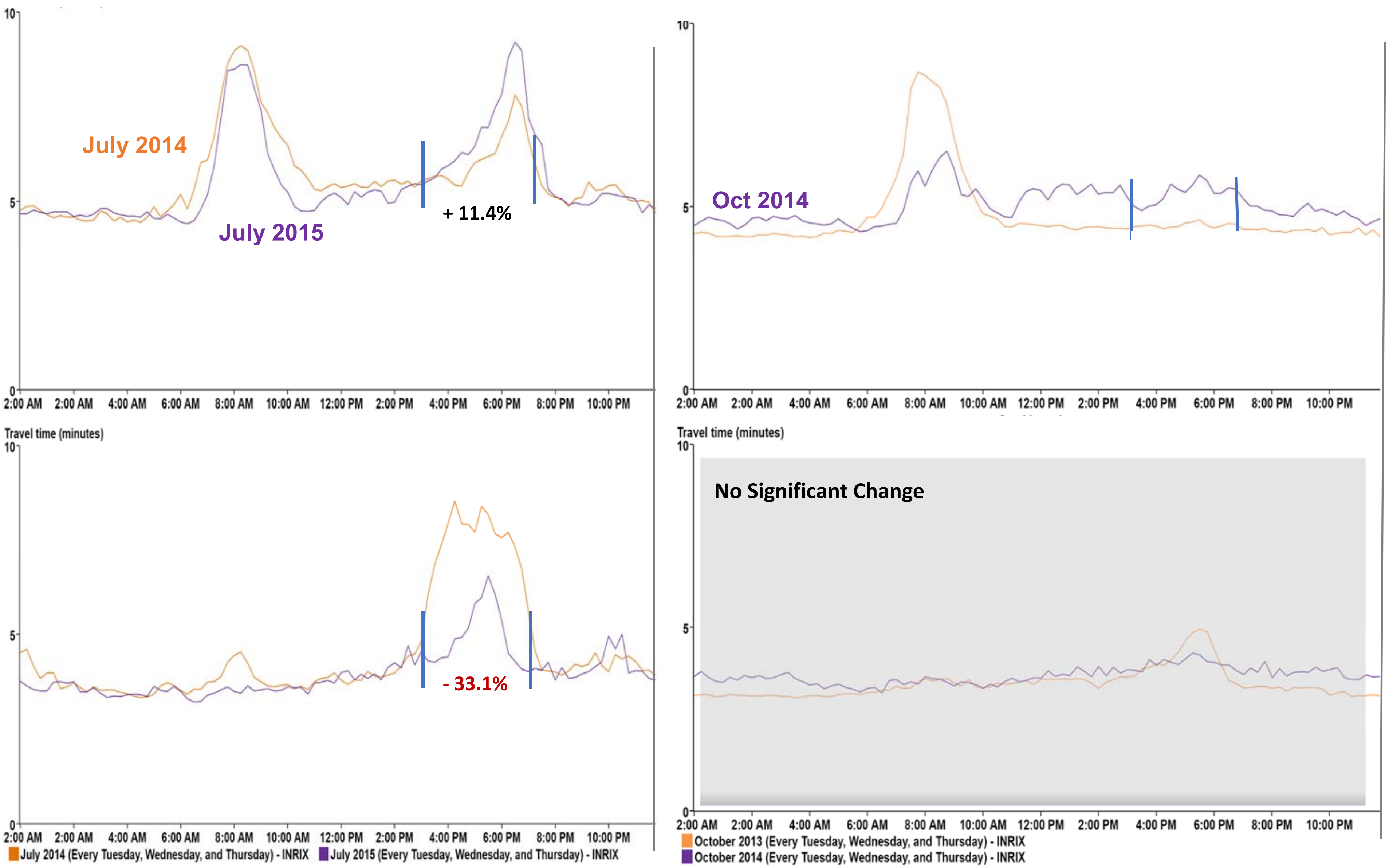



# MD-295 / Russell Street (3/3)

**3.8 miles NB; 2.2 miles SB**

**Opened in August 2014**



HORSESHOE CASINO

# I-395 SB (1/2)

## 0.7 mile

**Opened in August 2014**

**Table 15: Probe Data Analytic Results for I-395 (January + April)**

| Avg Travel Time (min) | | Jan 2014 | Jan 2015 | Difference | t-stat | p-value | | April 2014 | April 2015 | Difference | t-stat | p-value | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SB | (3 - 7PM) | 2.35 | 2.44 | **0.08** | -3.22 | 0.006 | *** | 2.36 | 2.42 | **0.05** | -1.20 | 0.248 | |
| | PM Peak Hr | 2.43 | 2.52 | **0.09** | -1.88 | 0.157 | | 2.49 | 2.78 | **0.29** | -4.08 | 0.027 | ** |
| **Avg Speed (mph)** | | | | | | | | | | | | | |
| SB | (3 - 7PM) | 16.59 | 16.03 | **-0.56** | 3.15 | 0.007 | *** | 16.54 | 16.29 | **-0.25** | 0.90 | 0.384 | |
| | PM Peak Hr | 16.04 | 15.47 | **-0.58** | 7.44 | 0.005 | *** | 15.70 | 14.08 | **-1.62** | 4.23 | 0.024 | ** |

Note: PM Peak Hour comprises 4 consecutive 15-min intervals that yield overall highest average travel time value within 3-7pm period.

**Table 16: Probe Data Analytic Results for I-395 (July + October)**

| Avg Travel Time (min) | | July 2014 | July 2015 | Difference | t-stat | p-value | | Oct 2013 | Oct 2014 | Difference | t-stat | p-value | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SB | (3 - 7PM) | 2.72 | 1.67 | **-1.04** | 6.79 | 0.000 | *** | 2.12 | 2.82 | **0.70** | -30.65 | 0.000 | *** |
| | PM Peak Hr | 2.78 | 2.50 | **-0.29** | 1.57 | 0.214 | | 2.24 | 2.92 | **0.69** | -20.27 | 0.000 | *** |
| **Avg Speed (mph)** | | | | | | | | | | | | | |
| SB | (3 - 7PM) | 14.37 | 27.01 | **12.64** | -4.80 | 0.000 | *** | 18.40 | 13.84 | **-4.56** | 30.98 | 0.000 | *** |
| | PM Peak Hr | 14.14 | 15.89 | **1.75** | -1.47 | 0.237 | | 17.46 | 13.37 | **-4.10** | 22.97 | 0.000 | *** |

***Significant at $p < 0.01$ **Significant at $p < 0.05$ *Significant at $p < 0.1$ ; **RED VALUES** represent improved mobility performance.

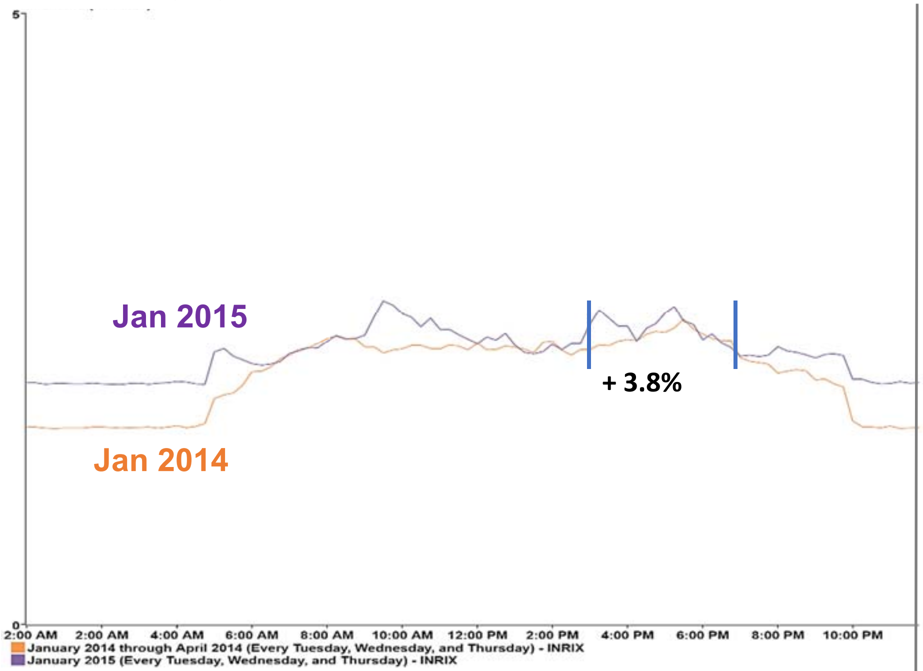
HORSESHOE CASINO

# I-395 SB (2/2)

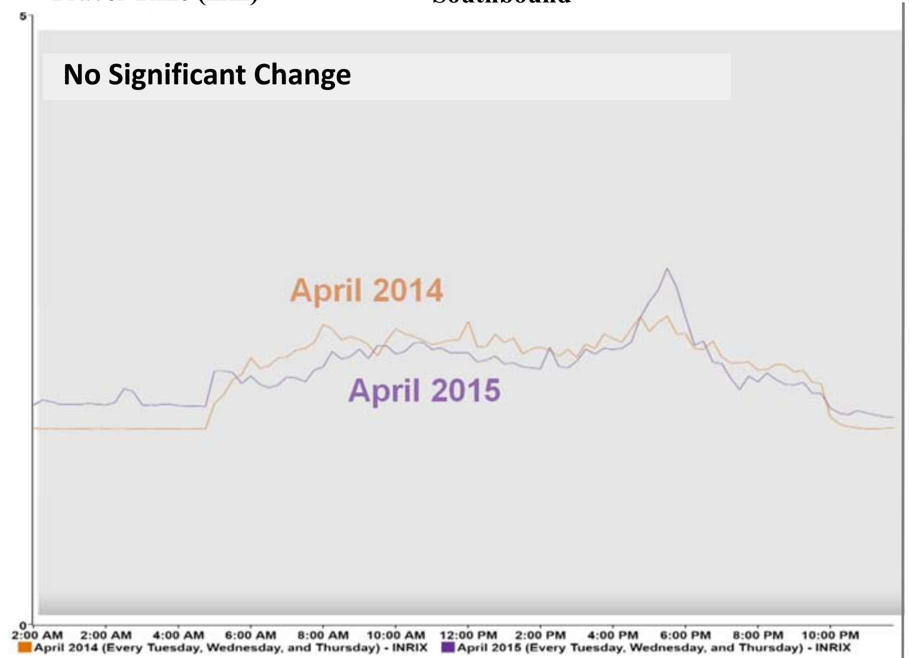
## 0.7 mile

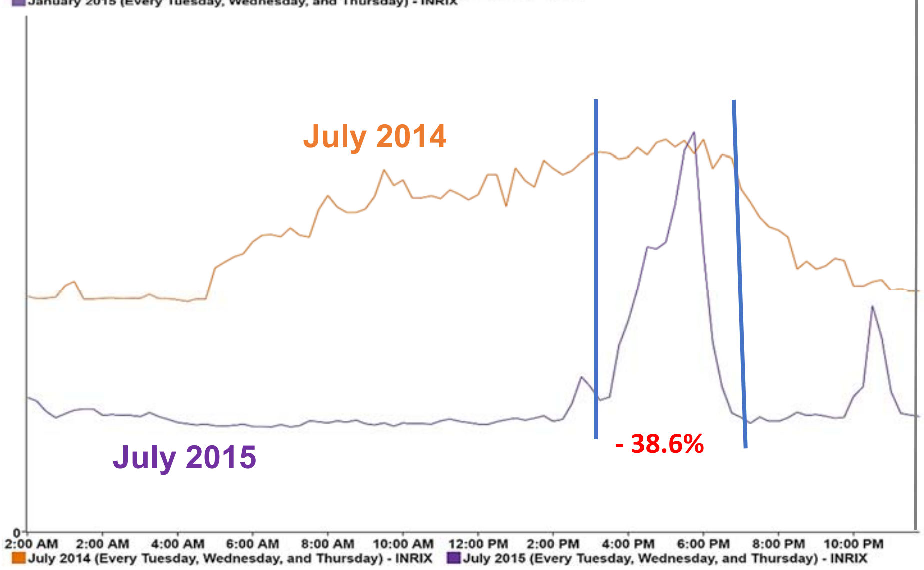
**Opened in August 2014**

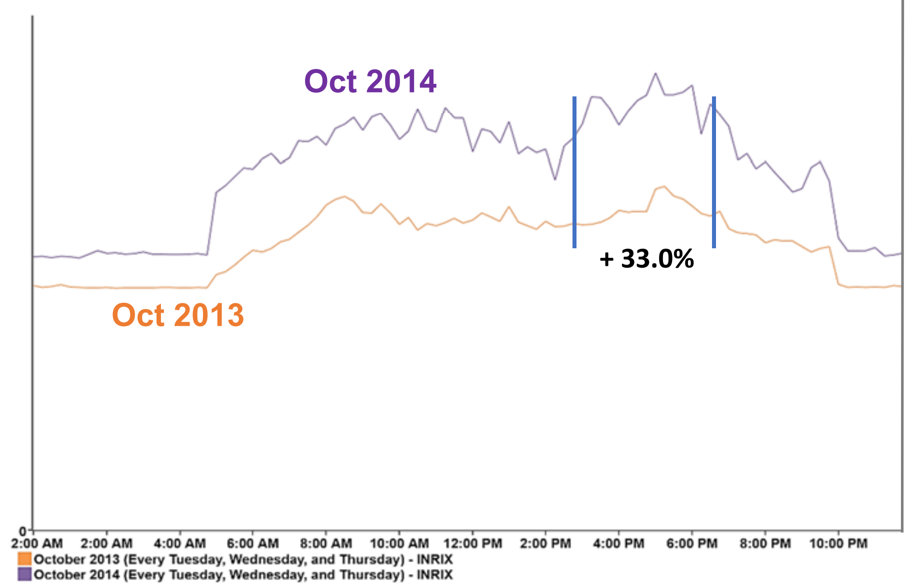
Travel Time (min) Southbound




Travel Time (min) Southbound



LIVE! CASINO

# MD-100 (1/3)

## 2.5 miles EB; 5.3 miles WB

**Opened in June 2012**

**Table 17: Probe Data Analytic Results for MD-100 (January + April)**

| Avg Travel Time (min) | | Jan 2012 | Jan 2013 | Difference | t-stat | p-value | | April 2012 | April 2013 | Difference | t-stat | p-value | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NB | (3 - 7PM) | 4.19 | 4.10 | **-0.10** | 1.27 | 0.222 | | 4.12 | 4.66 | **0.54** | -4.52 | 0.000 | *** |
| | PM Peak Hr | 5.33 | 4.89 | **-0.44** | 2.62 | 0.079 | * | 4.99 | 6.03 | **1.04** | -10.95 | 0.002 | *** |
| SB | (3 - 7PM) | 5.56 | 6.09 | **0.52** | -3.56 | 0.003 | *** | 5.58 | 6.10 | **0.52** | -3.09 | 0.007 | *** |
| | PM Peak Hr | 7.11 | 8.16 | **1.05** | -3.99 | 0.028 | ** | 6.97 | 8.31 | **1.34** | -2.80 | 0.068 | * |
| Avg Speed (mph) | | | | | | | | | | | | | |
| NB | (3 - 7PM) | 55.57 | 56.18 | **0.62** | -0.83 | 0.418 | | 56.21 | 50.79 | **-5.43** | 4.43 | 0.000 | *** |
| | PM Peak Hr | 42.84 | 46.51 | **3.67** | -2.97 | 0.059 | * | 45.69 | 37.70 | **-7.99** | 7.20 | 0.006 | *** |
| SB | (3 - 7PM) | 58.51 | 54.44 | **-4.08** | 3.63 | 0.002 | *** | 58.14 | 54.52 | **-3.61** | 3.34 | 0.004 | *** |
| | PM Peak Hr | 45.09 | 39.41 | **-5.68** | 4.27 | 0.024 | ** | 45.94 | 38.72 | **-7.22** | 2.89 | 0.063 | ** |

Note: PM Peak Hour comprises 4 consecutive 15-min intervals that yield overall highest average travel time value within 3-7pm period.

**Table 18: Probe Data Analytic Results for MD-100 (July + October)**

| Avg Travel Time (min) | | July 2011 | July 2012 | Difference | t-stat | p-value | | Oct 2011 | Oct 2012 | Difference | t-stat | p-value | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NB | (3 - 7PM) | 4.33 | 4.38 | **0.05** | -0.56 | 0.586 | | 5.00 | 4.38 | **-0.62** | 4.72 | 0.000 | *** |
| | PM Peak Hr | 5.36 | 5.73 | **0.37** | -3.30 | 0.046 | ** | 6.55 | 5.55 | **-1.00** | 4.08 | 0.027 | ** |
| SB | (3 - 7PM) | 5.27 | 5.76 | **0.49** | -2.49 | 0.025 | ** | 6.41 | 5.92 | **-0.50** | 4.22 | 0.001 | *** |
| | PM Peak Hr | 5.72 | 7.39 | **1.67** | -5.00 | 0.015 | ** | 8.97 | 8.04 | **-0.94** | 3.58 | 0.037 | ** |
| Avg Speed (mph) | | | | | | | | | | | | | |
| NB | (3 - 7PM) | 53.73 | 53.70 | **-0.03** | 0.03 | 0.979 | | 47.98 | 53.44 | **5.46** | -5.19 | 0.000 | *** |
| | PM Peak Hr | 42.51 | 39.69 | **-2.82** | 2.87 | 0.064 | * | 34.76 | 41.03 | **6.28** | -4.08 | 0.027 | ** |
| SB | (3 - 7PM) | 60.48 | 56.72 | **-3.76** | 2.37 | 0.031 | ** | 52.35 | 55.92 | **3.57** | 1.75 | 0.000 | *** |
| | PM Peak Hr | 55.64 | 43.13 | **-12.52** | 5.15 | 0.014 | ** | 35.59 | 39.92 | **4.33** | 2.35 | 0.066 | * |

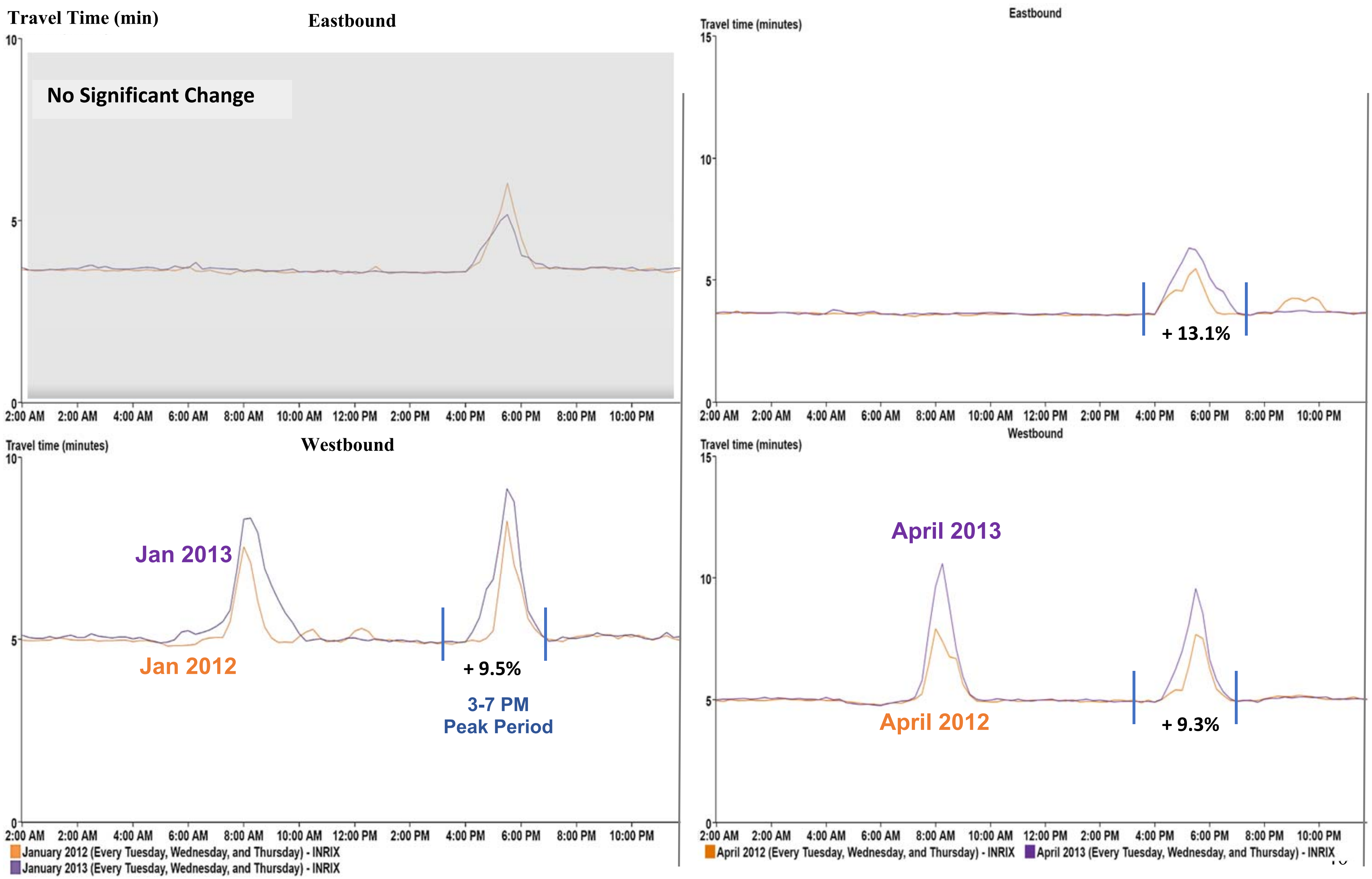
***Significant at $p < 0.01$ **Significant at $p < 0.05$ *Significant at $p < 0.1$ ; **RED VALUES** represent improved mobility performance.

LIVE! CASINO

# MD-100 (2/3)

## 2.5 miles EB; 5.3 miles WB

**Opened in June 2012**

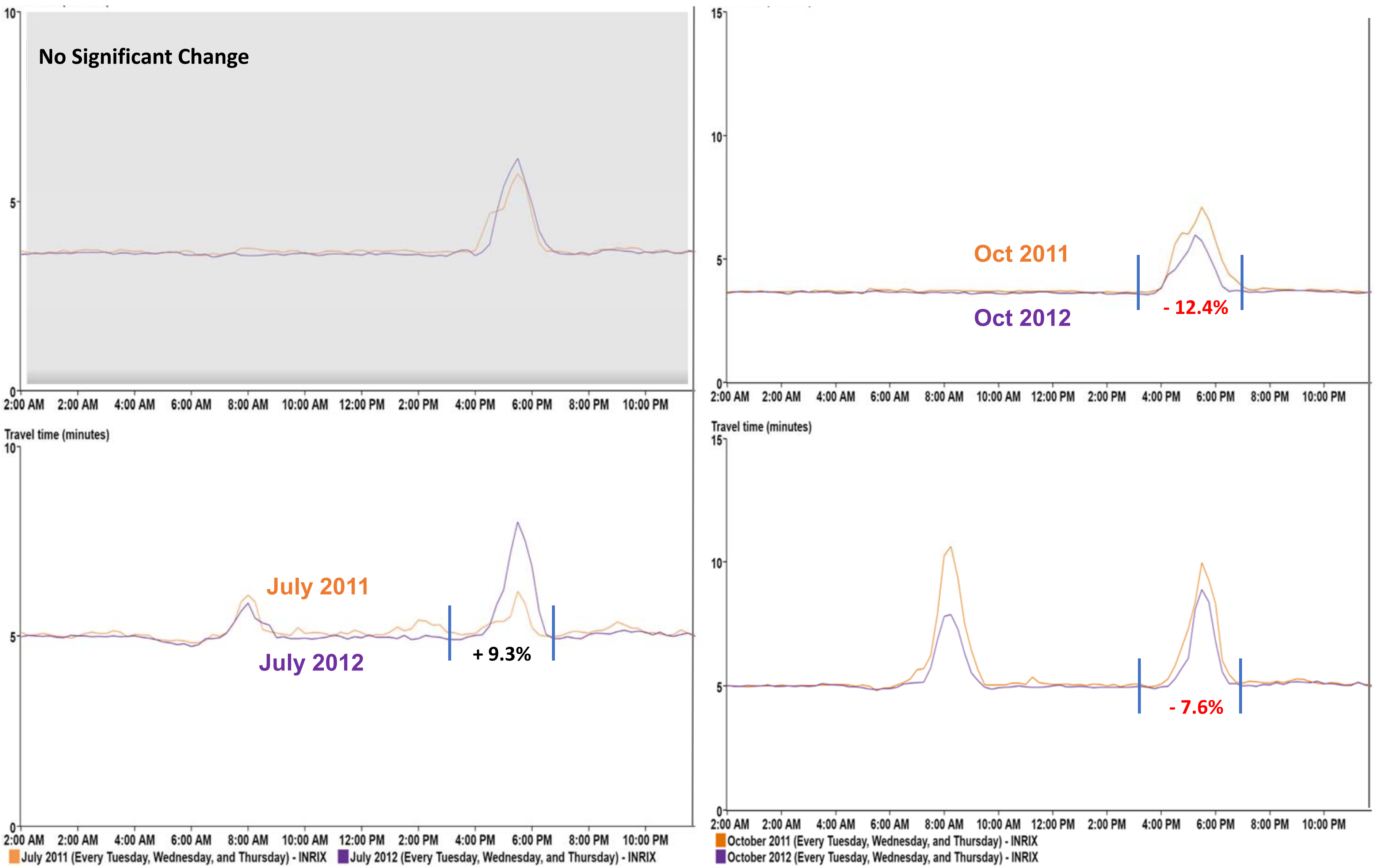


**LIVE! CASINO**

# MD-100 (3/3)

## 2.5 miles EB; 5.3 miles WB

**Opened in June 2012**



LIVE! CASINO

# MD-295 / Baltimore & Washington Parkway (1/3)

## 7.4 miles NB; 6.7 miles SB

**Opened in June 2012**

**Table 19: Probe Data Analytic Results for MD-295 (January + April)**

| Avg Travel Time (min) | | Jan 2012 | Jan 2013 | Difference | t-stat | p-value | | April 2012 | April 2013 | Difference | t-stat | p-value | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NB | (3 - 7PM) | 7.55 | 8.38 | **0.83** | -5.90 | 0.000 | *** | 8.34 | 8.38 | **0.04** | -0.26 | 0.795 | |
| | PM Peak Hr | 7.91 | 9.30 | **1.39** | -4.37 | 0.022 | ** | 8.69 | 9.51 | **0.82** | -14.24 | 0.001 | *** |
| SB | (3 - 7PM) | 6.39 | 7.41 | **1.01** | -8.46 | 0.000 | *** | 6.36 | 7.01 | **0.64** | -6.57 | 0.000 | *** |
| | PM Peak Hr | 6.77 | 7.89 | **1.12** | -9.35 | 0.003 | *** | 6.72 | 7.56 | **0.84** | -4.23 | 0.024 | ** |
| Avg Speed (mph) | | | | | | | | | | | | | |
| NB | (3 - 7PM) | 58.47 | 52.97 | **-5.51** | 7.14 | 0.000 | *** | 52.98 | 53.17 | **0.18** | -0.22 | 0.832 | |
| | PM Peak Hr | 55.76 | 47.57 | **-8.18** | 4.89 | 0.016 | ** | 50.34 | 46.46 | **-3.89** | 1.93 | 0.149 | |
| SB | (3 - 7PM) | 61.93 | 53.63 | **-8.30** | 9.05 | 0.000 | *** | 62.21 | 56.70 | **-5.51** | 6.89 | 0.000 | *** |
| | PM Peak Hr | 58.46 | 50.17 | **-8.29** | 10.54 | 0.002 | *** | 58.96 | 52.30 | **-6.66** | 4.01 | 0.028 | ** |

Note: PM Peak Hour comprises 4 consecutive 15-min intervals that yield overall highest average travel time value within 3-7pm period.

**Table 20: Probe Data Analytic Results for MD-295 (July + October)**

| Avg Travel Time (min) | | July 2011 | July 2012 | Difference | t-stat | p-value | | Oct 2011 | Oct 2012 | Difference | t-stat | p-value | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NB | (3 - 7PM) | 8.17 | 8.08 | **-0.09** | 1.40 | 0.183 | | 9.07 | 8.00 | **-1.07** | 5.75 | 0.000 | *** |
| | PM Peak Hr | 8.79 | 8.55 | **-0.24** | 3.68 | 0.035 | ** | 10.47 | 8.32 | **-2.15** | 15.21 | 0.001 | *** |
| SB | (3 - 7PM) | 7.19 | 6.80 | **-0.40** | 3.76 | 0.002 | *** | 6.61 | 6.33 | **-0.28** | 4.73 | 0.000 | *** |
| | PM Peak Hr | 7.67 | 7.78 | **0.11** | -1.26 | 0.296 | | 7.04 | 6.56 | **-0.47** | 2.90 | 0.063 | ** |
| Avg Speed (mph) | | | | | | | | | | | | | |
| NB | (3 - 7PM) | 54.20 | 54.76 | **0.56** | -1.31 | 0.210 | | 49.17 | 55.21 | **6.03** | -7.02 | 0.000 | *** |
| | PM Peak Hr | 50.17 | 51.60 | **1.43** | -3.77 | 0.033 | ** | 42.13 | 53.02 | **10.89** | -16.34 | 0.000 | *** |
| SB | (3 - 7PM) | 55.20 | 58.59 | **3.39** | -4.19 | 0.001 | *** | 59.94 | 62.55 | **2.60** | -5.09 | 0.000 | *** |
| | PM Peak Hr | 51.52 | 50.80 | **-0.71** | 1.32 | 0.277 | | 56.21 | 60.27 | **4.06** | -2.94 | 0.061 | * |

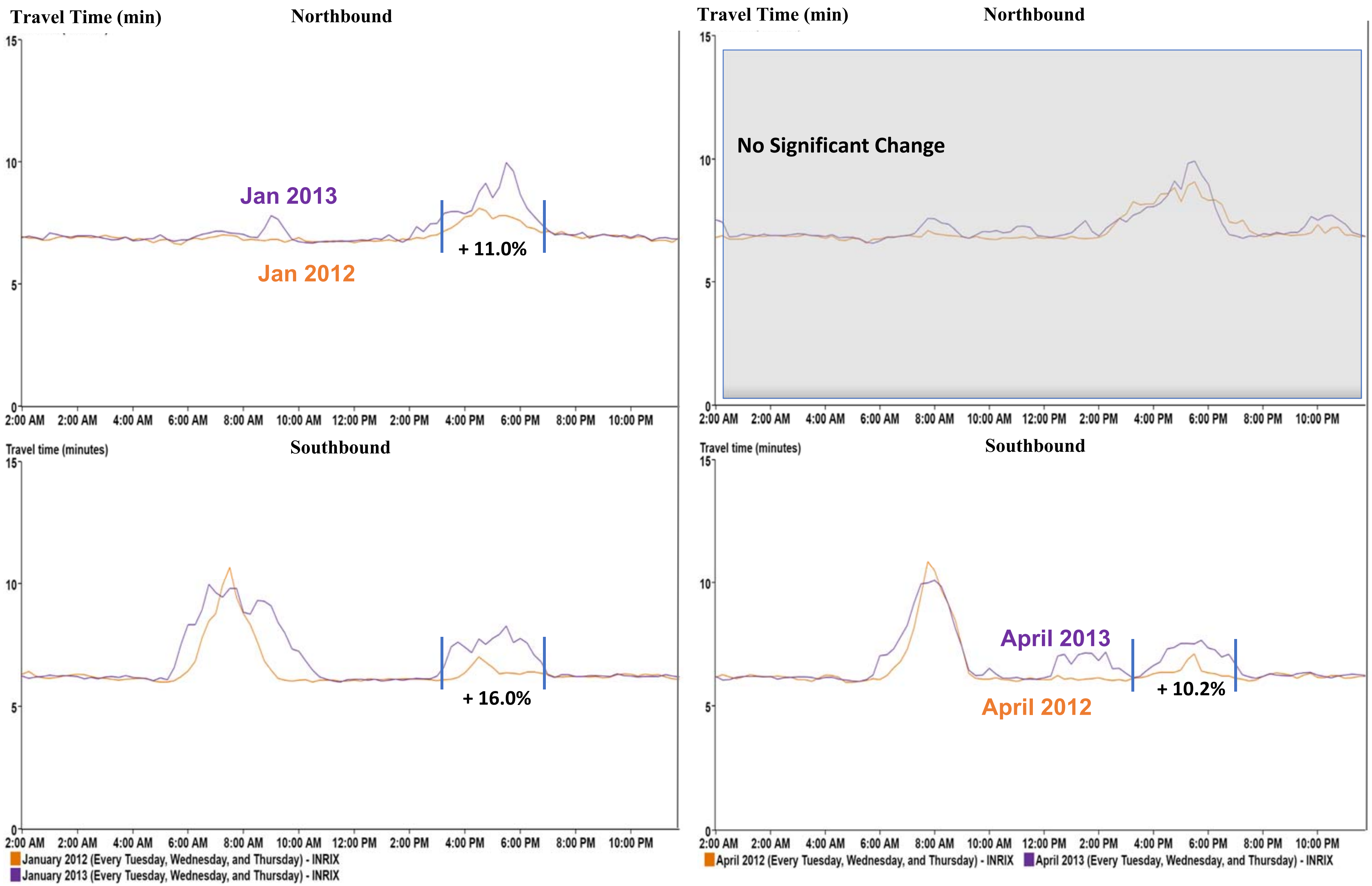
***Significant at $p < 0.01$ **Significant at $p < 0.05$ *Significant at $p < 0.1$ ; **RED VALUES** represent improved mobility performance.

LIVE! CASINO

# MD-295 / Baltimore & Washington Parkway (2/3)

**7.4 miles NB; 6.7 miles SB**

**Opened in June 2012**

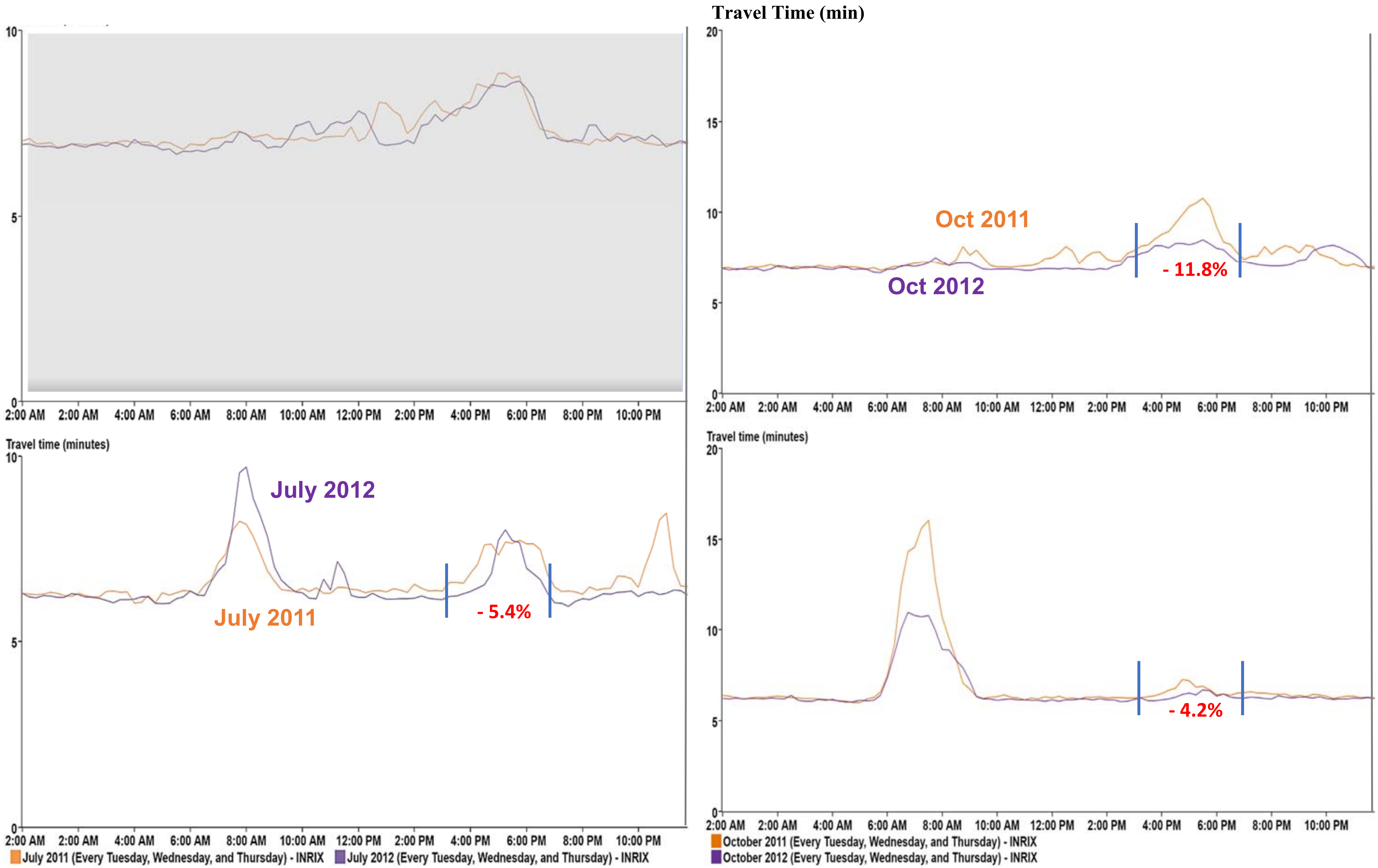


LIVE! CASINO

# MD-295 / Baltimore & Washington Parkway (3/3)

**7.4 miles NB; 6.7 miles SB**

**Opened in June 2012**



LIVE! CASINO

# MD-713 / Arundel Mills Blvd (1/3)

## 4.2 miles

**Opened in June 2012**

**Table 21: Probe Data Analytic Results for Arundel Mils Blvd. (January + April)**

| Avg Travel Time (min) | | Jan 2012 | Jan 2013 | Difference | t-stat | p-value | | April 2012 | April 2013 | Difference | t-stat | p-value | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NB | (3 - 7PM) | 3.18 | 3.24 | **0.06** | -2.05 | 0.058 | * | 3.15 | 3.24 | **0.09** | -2.64 | 0.019 | ** |
| | PM Peak Hr | 3.23 | 3.32 | **0.09** | -1.04 | 0.377 | | 3.19 | 3.37 | **0.18** | -2.45 | 0.091 | * |
| SB | (3 - 7PM) | 3.64 | 3.83 | **0.20** | -5.03 | 0.000 | *** | 3.62 | 3.83 | **0.21** | -11.33 | 0.000 | *** |
| | PM Peak Hr | 3.71 | 3.99 | **0.28** | -2.59 | 0.081 | * | 3.66 | 3.95 | **0.29** | -18.57 | 0.000 | *** |
| Avg Speed (mph) | | | | | | | | | | | | | |
| NB | (3 - 7PM) | 30.72 | 30.14 | **-0.58** | 2.01 | 0.062 | * | 30.96 | 30.12 | **-0.83** | 2.63 | 0.019 | ** |
| | PM Peak Hr | 30.17 | 29.41 | **-0.76** | 1.03 | 0.380 | | 30.63 | 29.01 | **-1.62** | 2.51 | 0.087 | * |
| SB | (3 - 7PM) | 30.74 | 29.19 | **-1.55** | 5.21 | 0.000 | *** | 30.90 | 29.22 | **-1.67** | 11.99 | 0.000 | *** |
| | PM Peak Hr | 30.09 | 28.00 | **-2.09** | 8.99 | 0.003 | *** | 30.47 | 28.31 | **-2.16** | 5.00 | 0.015 | ** |

Note: PM Peak Hour comprises 4 consecutive 15-min intervals that yield overall highest average travel time value within 3-7pm period.

**Table 22: Probe Data Analytic Results for Arundel Mils Blvd. (July + October)**

| Avg Travel Time (min) | | July 2011 | July 2012 | Difference | t-stat | p-value | | Oct 2011 | Oct 2012 | Difference | t-stat | p-value | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NB | (3 - 7PM) | 3.10 | 3.14 | **0.04** | -1.63 | 0.124 | | 3.25 | 3.15 | **-0.10** | 4.72 | 0.000 | *** |
| | PM Peak Hr | 3.15 | 3.20 | **0.05** | -0.95 | 0.411 | | 3.29 | 3.21 | **-0.08** | 1.89 | 0.156 | |
| SB | (3 - 7PM) | 3.67 | 3.71 | **0.04** | -1.48 | 0.159 | | 3.74 | 3.70 | **-0.04** | 1.04 | 0.315 | |
| | PM Peak Hr | 3.79 | 3.77 | **-0.02** | 0.51 | 0.647 | | 3.81 | 3.83 | **0.02** | -0.15 | 0.893 | |
| Avg Speed (mph) | | | | | | | | | | | | | |
| NB | (3 - 7PM) | 31.51 | 31.10 | **-0.41** | 1.62 | 0.126 | | 30.00 | 30.97 | **0.97** | -4.74 | 0.000 | *** |
| | PM Peak Hr | 30.98 | 30.47 | **-0.52** | 0.99 | 0.397 | | 29.69 | 30.38 | **0.69** | -0.89 | 0.440 | |
| SB | (3 - 7PM) | 30.46 | 30.12 | **-0.34** | 1.55 | 0.142 | | 29.91 | 30.26 | **0.35** | -1.27 | 0.224 | |
| | PM Peak Hr | 29.52 | 29.64 | **0.11** | -0.22 | 0.843 | | 29.32 | 29.26 | **-0.06** | 0.06 | 0.955 | |

***Significant at $p < 0.01$ **Significant at $p < 0.05$ *Significant at $p < 0.1$ ; **RED VALUES** represent improved mobility performance.

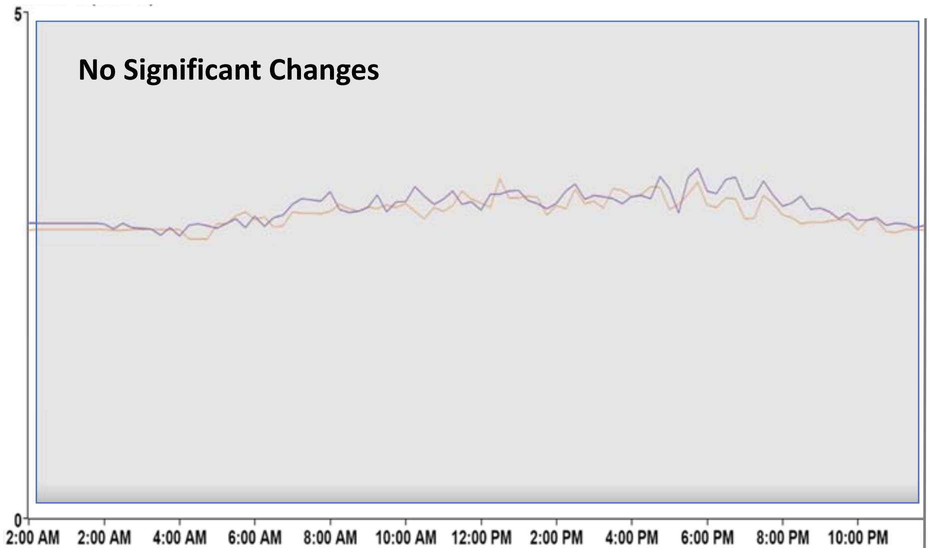
LIVE! CASINO

# MD-713 / Arundel Mills Blvd (2/3)

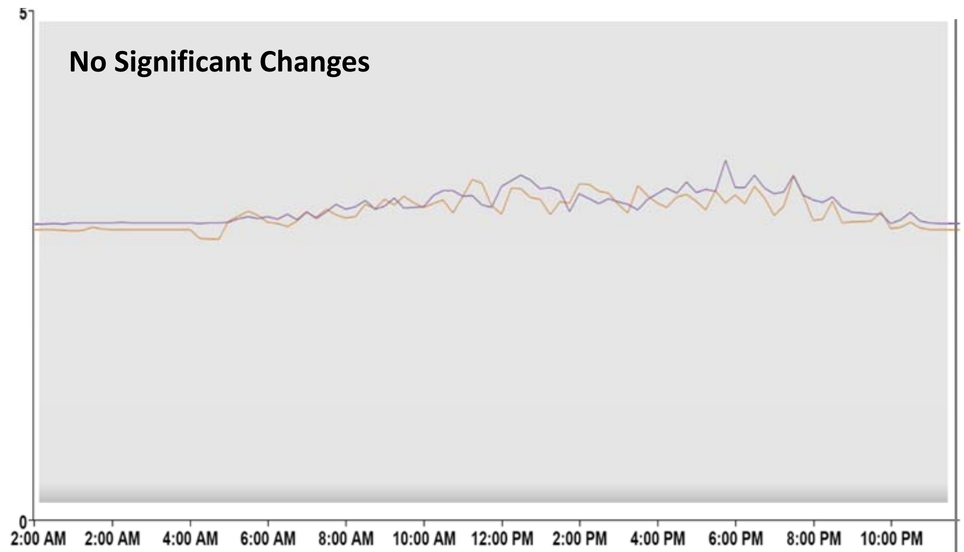
## 4.2 miles

**Opened in June 2012**

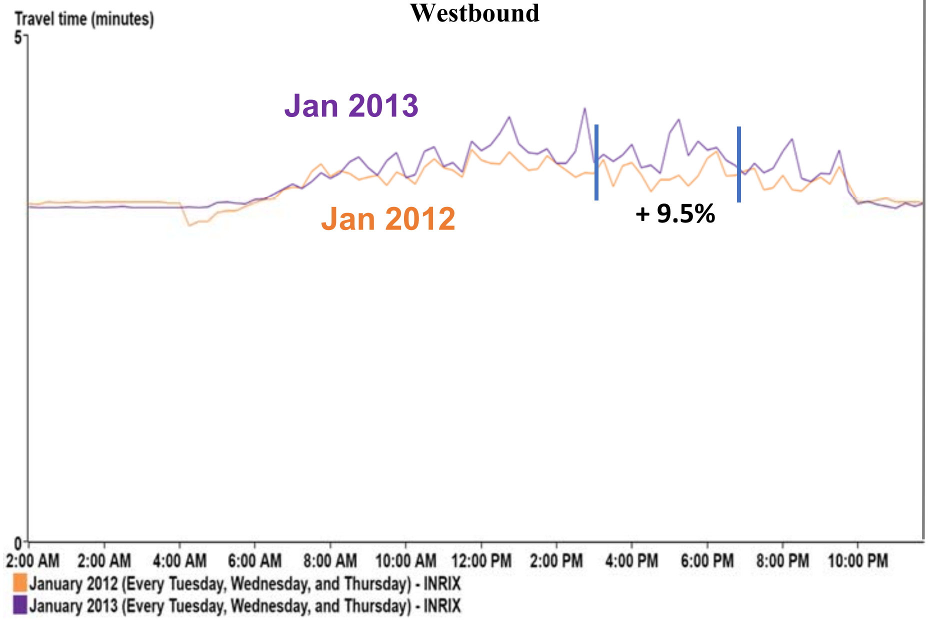
Travel Time (min) Eastbound



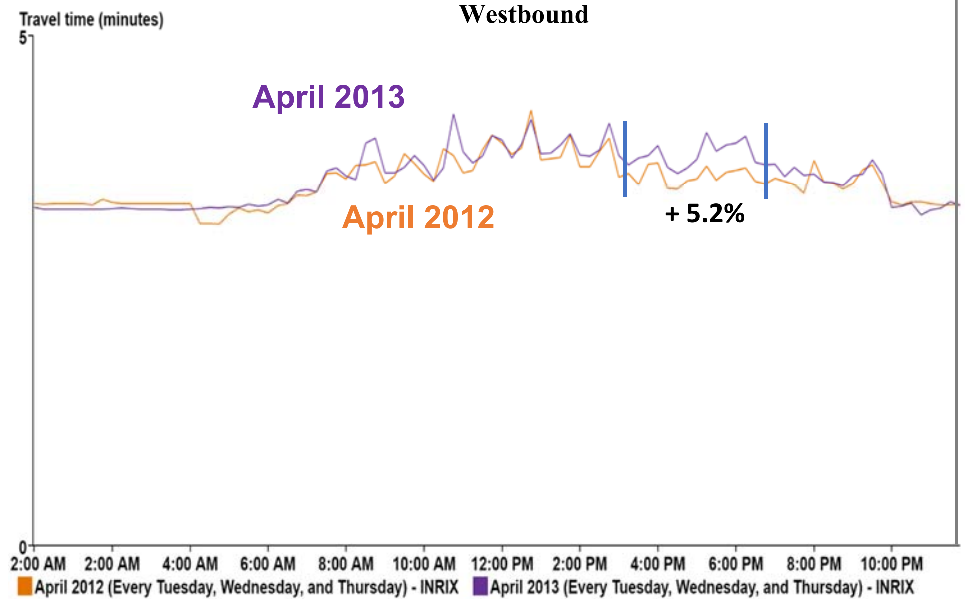

Travel Time (min) Eastbound




Westbound




Westbound

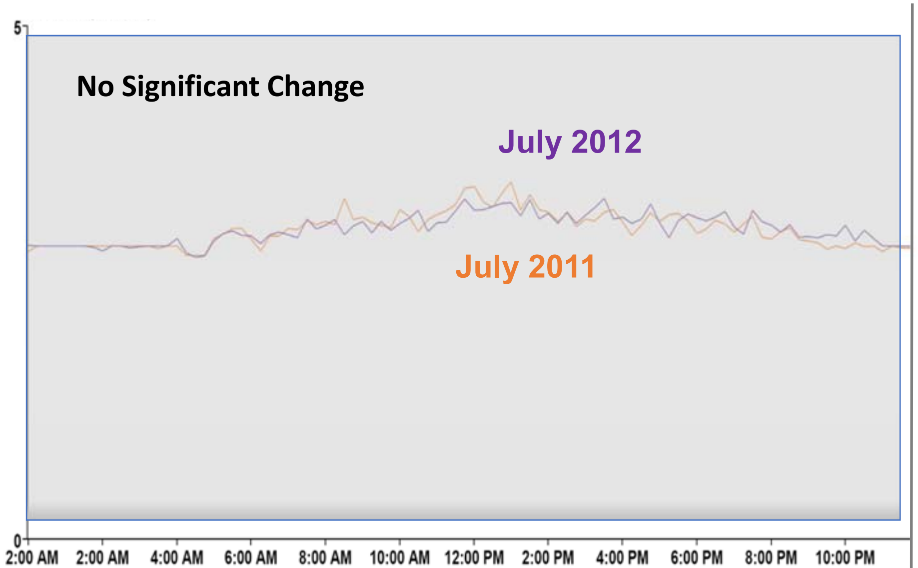


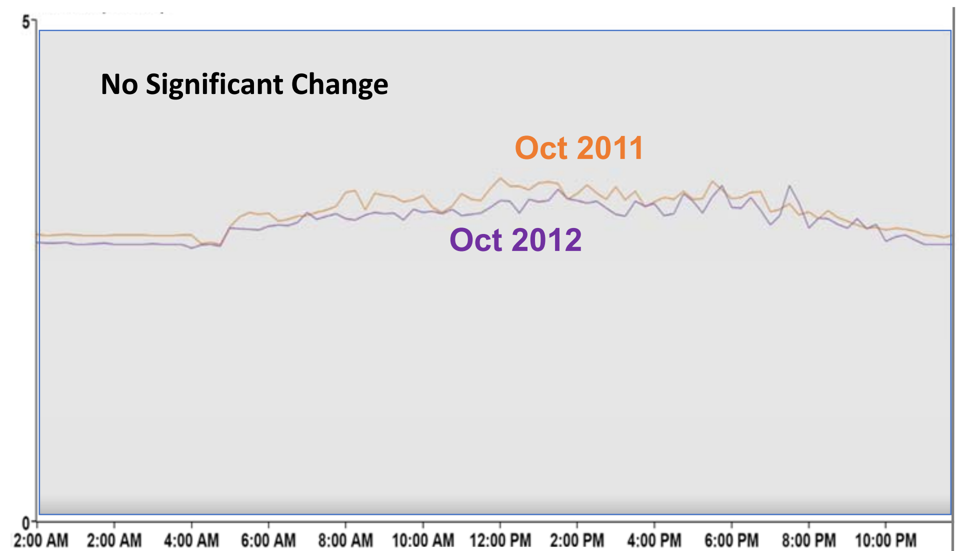
LIVE! CASINO

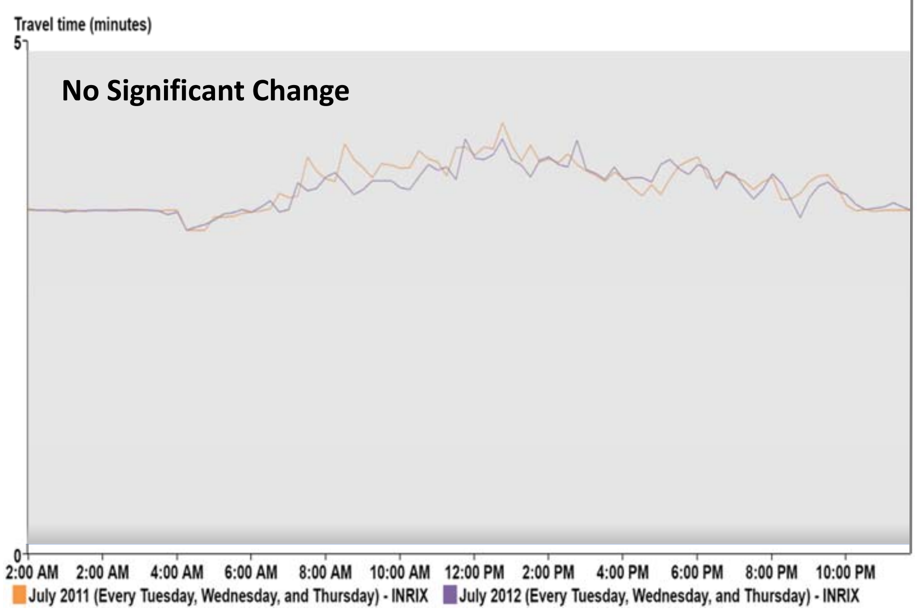
# MD-713 / Arundel Mills Blvd (3/3)

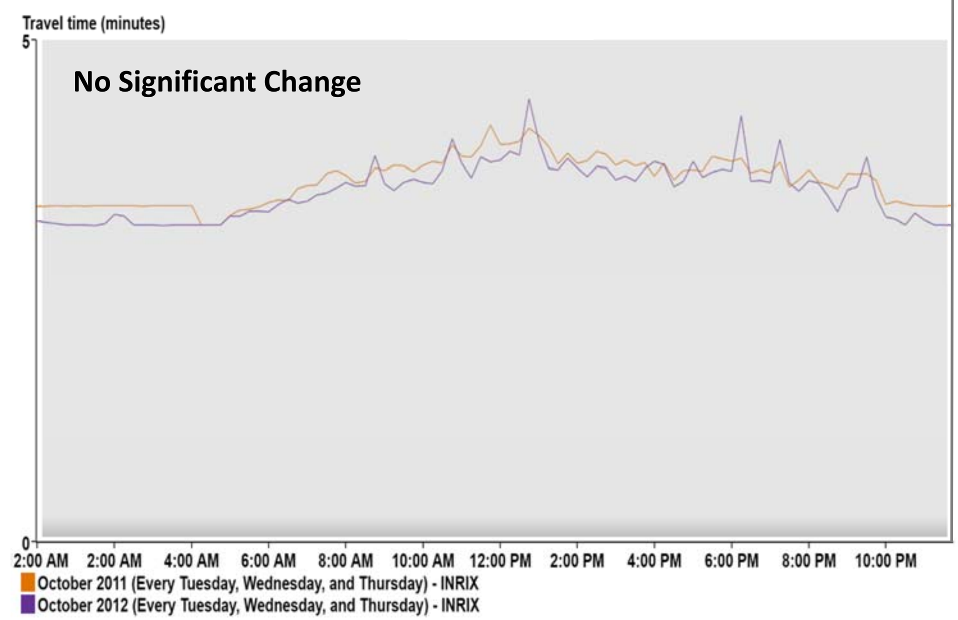
## 4.2 miles

**Opened in June 2012**



MGM at NAT'L HARBOR

# Oxon Hill Road (1/3)

## 3.1 miles NB; 1.5 miles SB

**Opened in December 2016**

**Table 23: Probe Data Analytic Results for Oxon Hill Road (January + April)**

| Avg Travel Time (min) | | Jan 2016 | Jan 2017 | Difference | t-stat | p-value | | April 2016 | April 2017 | Difference | t-stat | p-value | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NB | (3 - 7PM) | 9.58 | 10.24 | **0.65** | -5.50 | 0.000 | *** | 8.97 | 10.18 | **1.21** | -8.24 | 0.000 | *** |
| | PM Peak Hr | 10.27 | 10.66 | **0.39** | -1.74 | 0.180 | | 9.25 | 10.73 | **1.48** | -7.25 | 0.005 | *** |
| SB | (3 - 7PM) | 5.39 | 5.22 | **-0.17** | 1.45 | 0.168 | | 4.32 | 5.08 | **0.76** | -14.96 | 0.000 | *** |
| | PM Peak Hr | 5.78 | 5.44 | **-0.34** | 1.15 | 0.335 | | 4.54 | 5.25 | **0.71** | -12.58 | 0.001 | *** |
| Avg Speed (mph) | | | | | | | | | | | | | |
| NB | (3 - 7PM) | 19.49 | 18.20 | **-1.29** | 5.31 | 0.000 | *** | 20.75 | 20.75 | **-2.46** | 8.35 | 0.000 | *** |
| | PM Peak Hr | 18.13 | 17.47 | **-0.66** | 1.72 | 0.184 | | 20.11 | 20.11 | **-2.77** | 7.86 | 0.004 | *** |
| SB | (3 - 7PM) | 17.12 | 17.58 | **0.46** | -1.32 | 0.205 | | 21.29 | 21.29 | **-3.20** | 14.19 | 0.000 | *** |
| | PM Peak Hr | 15.99 | 16.87 | **0.89** | -1.04 | 0.375 | | 20.21 | 20.21 | **-2.73** | 17.11 | 0.000 | *** |

Note: PM Peak Hour comprises 4 consecutive 15-min intervals that yield overall highest average travel time value within 3-7pm period.

**Table 24: Probe Data Analytic Results for Oxon Hill Road (January + April)**

| Avg Travel Time (min) | | July 2016 | July 2017 | Difference | t-stat | p-value | | Oct 2016 | Oct 2017 | Difference | t-stat | p-value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NB | (3 - 7PM) | 9.55 | 11.14 | **1.59** | -9.44 | 0.000 | *** | 10.60 | 10.77 | **0.16** | -0.98 | 0.343 |
| | PM Peak Hr | 9.84 | 12.09 | **2.25** | -60.79 | 0.000 | *** | 11.28 | 11.36 | **0.08** | -0.35 | 0.748 |
| SB | (3 - 7PM) | 5.07 | 5.20 | **0.12** | -1.75 | 0.101 | | 5.29 | 5.25 | **-0.03** | 0.62 | 0.547 |
| | PM Peak Hr | 5.16 | 5.34 | **0.18** | -1.48 | 0.235 | | 5.51 | 5.42 | **-0.09** | 0.83 | 0.466 |
| Avg Speed (mph) | | | | | | | | | | | | |
| NB | (3 - 7PM) | 19.49 | 16.78 | **-2.71** | 10.54 | 0.000 | *** | 17.60 | 17.32 | **-0.28** | 1.06 | 0.307 |
| | PM Peak Hr | 18.91 | 15.38 | **-3.53** | 44.68 | 0.000 | *** | 16.49 | 16.38 | **-0.12** | 0.37 | 0.737 |
| SB | (3 - 7PM) | 18.11 | 17.68 | **-0.43** | 1.65 | 0.120 | | 17.40 | 17.48 | **0.08** | -0.45 | 0.659 |
| | PM Peak Hr | 17.85 | 17.19 | **-0.66** | 1.90 | 0.154 | | 16.67 | 16.92 | **0.24** | -1.67 | 0.193 |

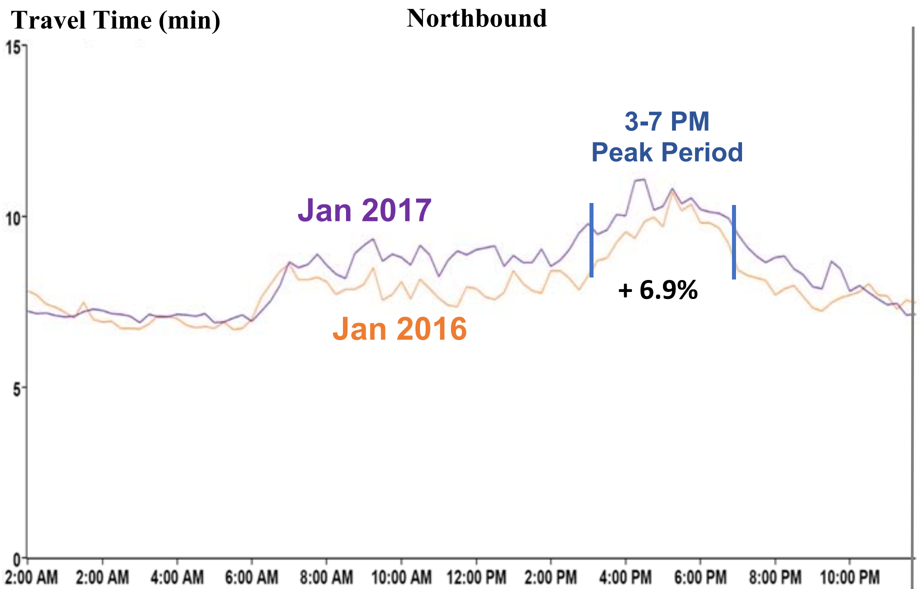
***Significant at p < 0.01 **Significant at p < 0.05 *Significant at p < 0.1 ; **RED VALUES** represent improved mobility performance.

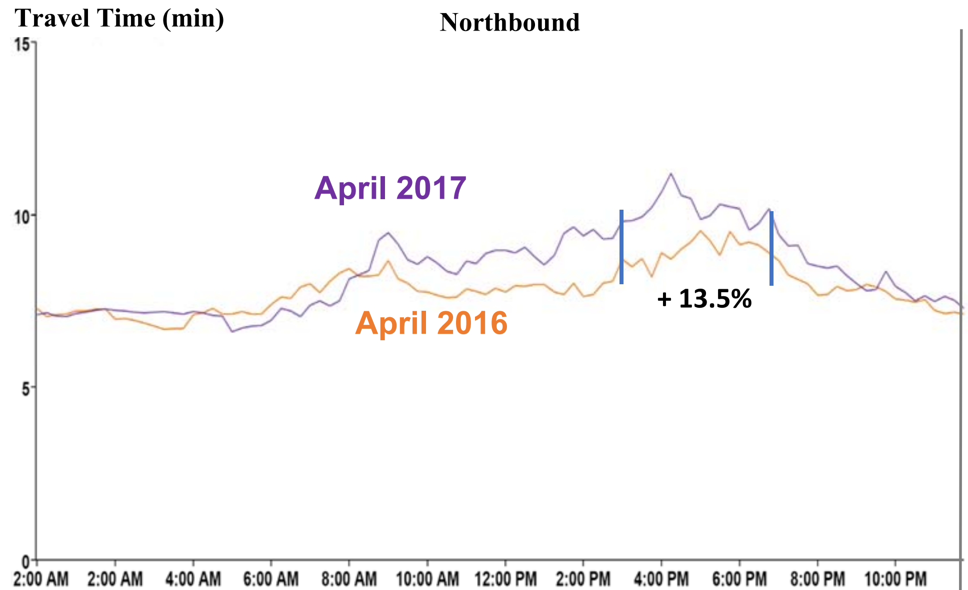
MGM at NAT'L HARBOR

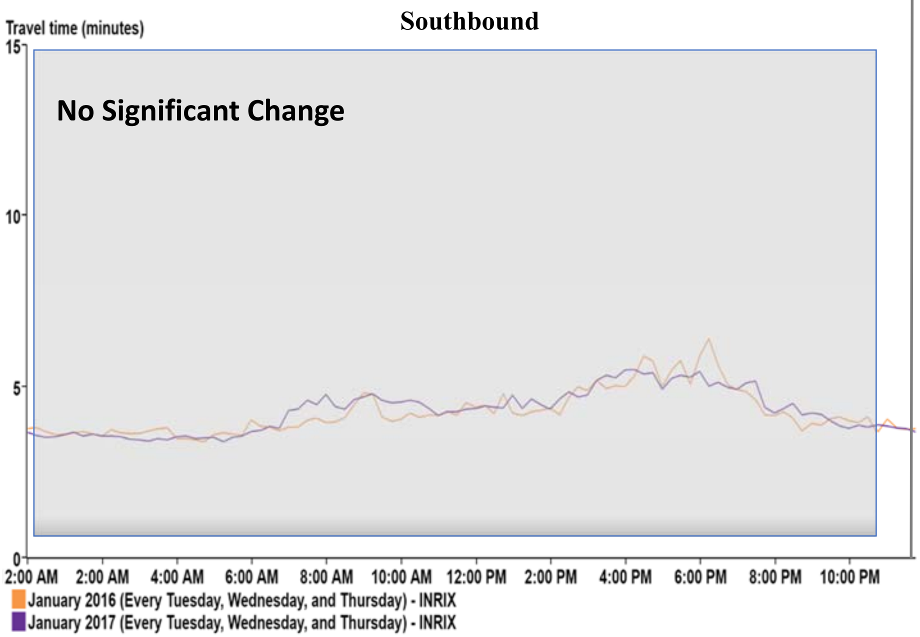
# Oxon Hill Road (2/3)

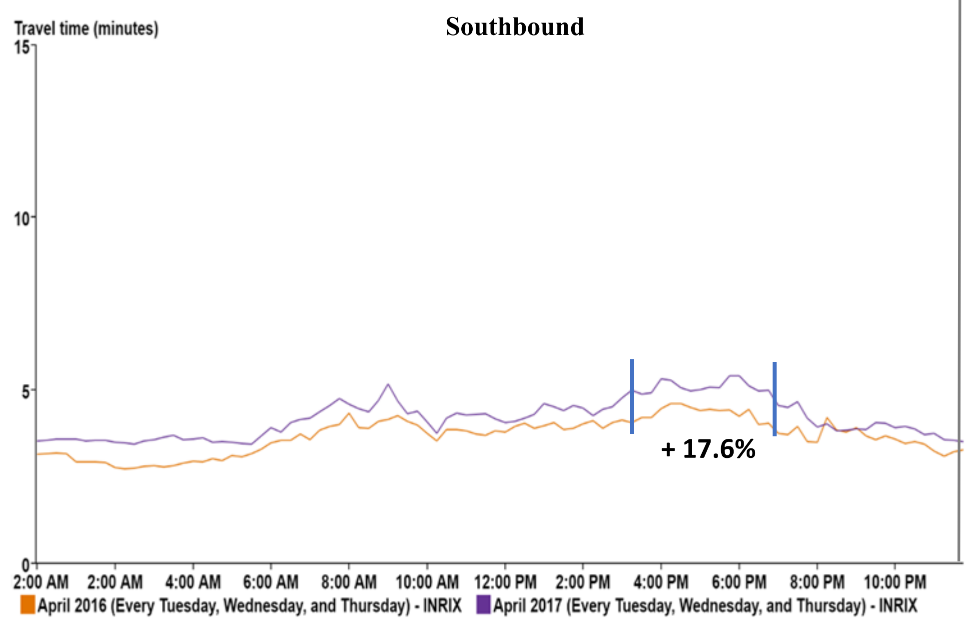
## 3.1 miles NB; 1.5 miles SB

**Opened in December 2016**



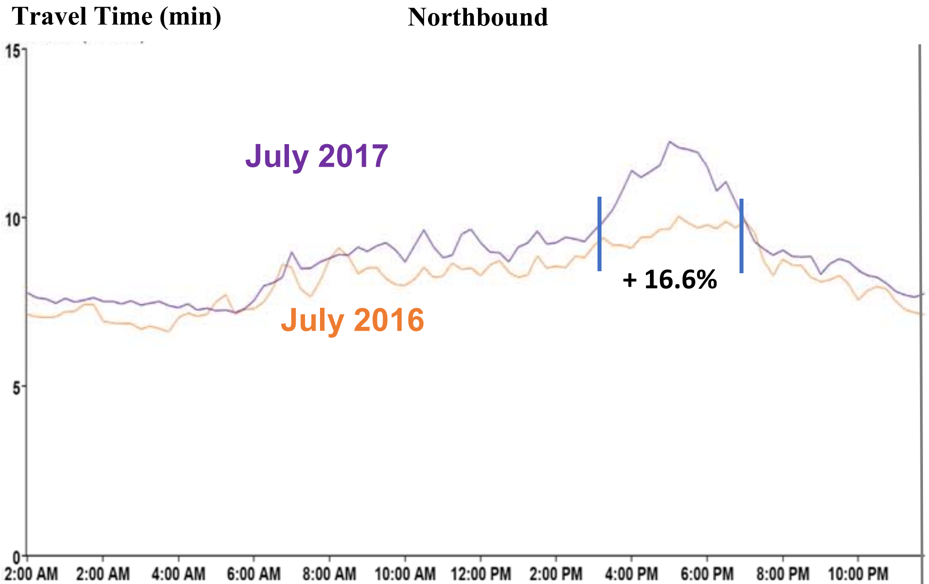



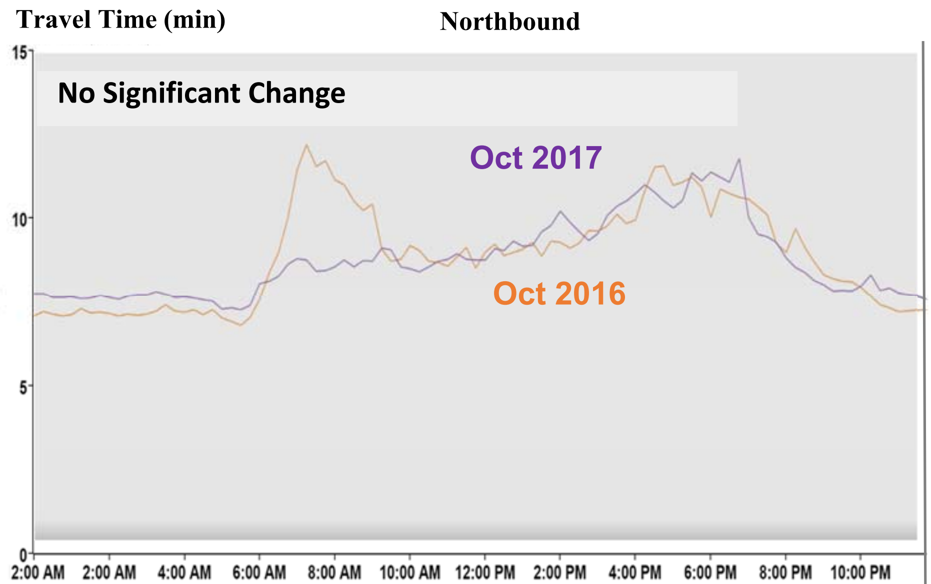
MGM at NAT'L HARBOR

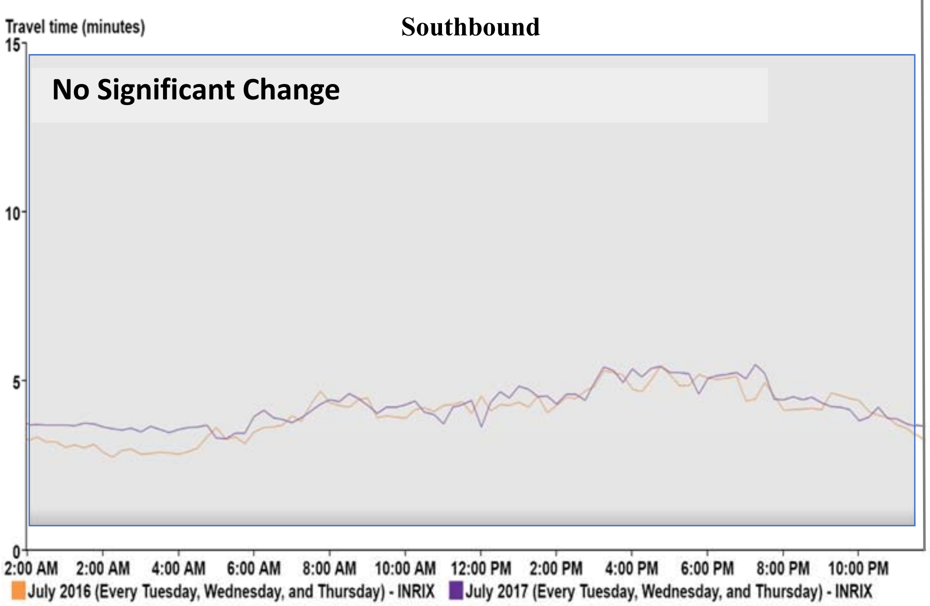
# Oxon Hill Road (3/3)

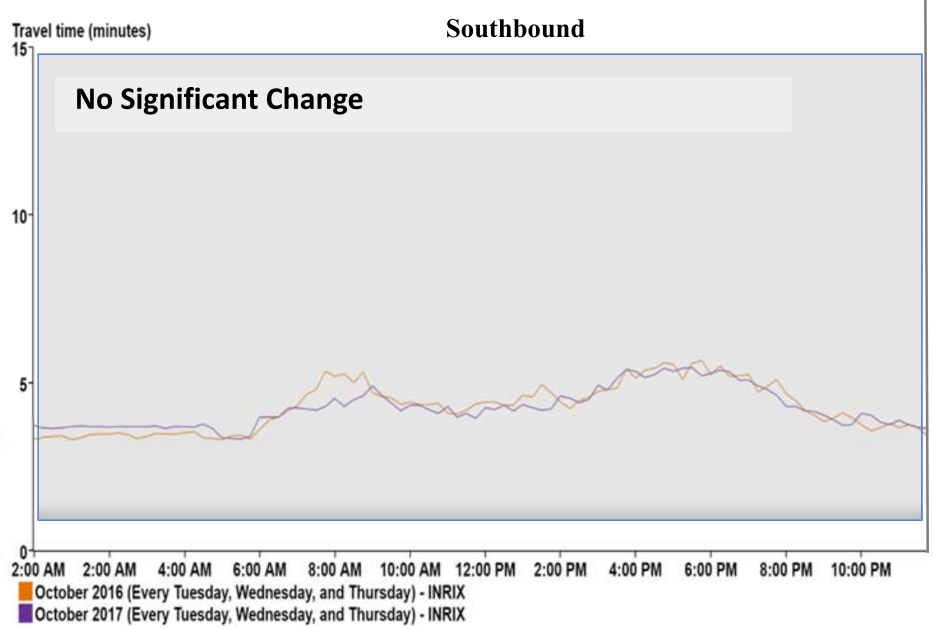
## 3.1 miles NB; 1.5 miles SB

**Opened in December 2016**



MGM at NAT'L HARBOR

# MD-210 / Indian Head Highway (1/3)

## 5.6 miles NB; 5.1 miles SB

**Opened in December 2016**

**Table 25: Probe Data Analytic Results for MD-210 (January + April)**

| Avg Travel Time (min) | | Jan 2016 | Jan 2017 | Difference | t-stat | p-value | April 2016 | April 2017 | Difference | t-stat | p-value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NB | (3 - 7PM) | 8.93 | 8.90 | -0.03 | 0.53 | 0.603 | 8.06 | 8.96 | 0.90 | 5.99 | 0.000 *** |
| NB | PM Peak Hr | 9.03 | 9.04 | 0.01 | -0.09 | 0.936 | 8.25 | 9.02 | 0.77 | -10.06 | 0.002 *** |
| SB | (3 - 7PM) | 12.16 | 10.99 | -1.17 | 6.56 | 0.000 *** | 10.64 | 10.80 | 0.16 | -2.02 | 0.062 * |
| SB | PM Peak Hr | 13.32 | 11.70 | -1.62 | 6.19 | 0.008 *** | 11.26 | 11.38 | 0.12 | -0.70 | 0.535 |
| **Avg Speed (mph)** | | | | | | | | | | | |
| NB | (3 - 7PM) | 37.86 | 37.99 | 0.13 | -0.55 | 0.589 | 41.96 | 37.69 | -4.27 | 5.95 | 0.000 *** |
| NB | PM Peak Hr | 37.45 | 37.39 | -0.06 | 0.10 | 0.926 | 40.96 | 37.47 | -3.49 | 10.07 | 0.002 *** |
| SB | (3 - 7PM) | 25.39 | 27.89 | 2.51 | -7.26 | 0.000 *** | 28.80 | 28.35 | -0.45 | 2.07 | 0.056 * |
| SB | PM Peak Hr | 22.92 | 26.07 | 3.15 | -6.70 | 0.007 *** | 27.13 | 26.83 | -0.30 | 0.71 | 0.527 |

Note: PM Peak Hour comprises 4 consecutive 15-min intervals that yield overall highest average travel time value within 3-7pm period.

**Table 26: Probe Data Analytic Results for MD-210 (July + October)**

| Avg Travel Time (min) | | July 2016 | July 2017 | Difference | t-stat | p-value | Oct 2016 | Oct 2017 | Difference | t-stat | p-value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NB | (3 - 7PM) | 8.63 | 8.89 | 0.26 | -5.07 | 0.000 *** | 8.82 | 8.78 | -0.04 | 0.59 | 0.566 |
| NB | PM Peak Hr | 8.76 | 8.95 | 0.19 | -3.07 | 0.054 * | 8.96 | 8.89 | -0.07 | 0.69 | 0.542 |
| SB | (3 - 7PM) | 10.53 | 10.55 | 0.02 | -0.16 | 0.872 | 10.78 | 11.75 | 0.97 | -17.46 | 0.000 *** |
| SB | PM Peak Hr | 10.78 | 11.04 | 0.26 | -2.20 | 0.115 | 11.50 | 12.72 | 1.22 | -15.73 | 0.001 *** |
| **Avg Speed (mph)** | | | | | | | | | | | |
| NB | (3 - 7PM) | 39.16 | 38.02 | -1.14 | 5.00 | 0.000 *** | 38.31 | 38.49 | 0.18 | 0.36 | 0.727 |
| NB | PM Peak Hr | 38.57 | 37.74 | -0.84 | 1.55 | 0.219 | 37.69 | 38.02 | 0.32 | 0.73 | 0.520 |
| SB | (3 - 7PM) | 28.99 | 29.03 | 0.04 | -0.10 | 0.925 | 28.46 | 26.13 | -2.33 | 7.83 | 0.000 *** |
| SB | PM Peak Hr | 28.35 | 27.64 | -0.71 | 2.29 | 0.106 | 26.53 | 23.99 | -2.54 | 14.42 | 0.001 *** |

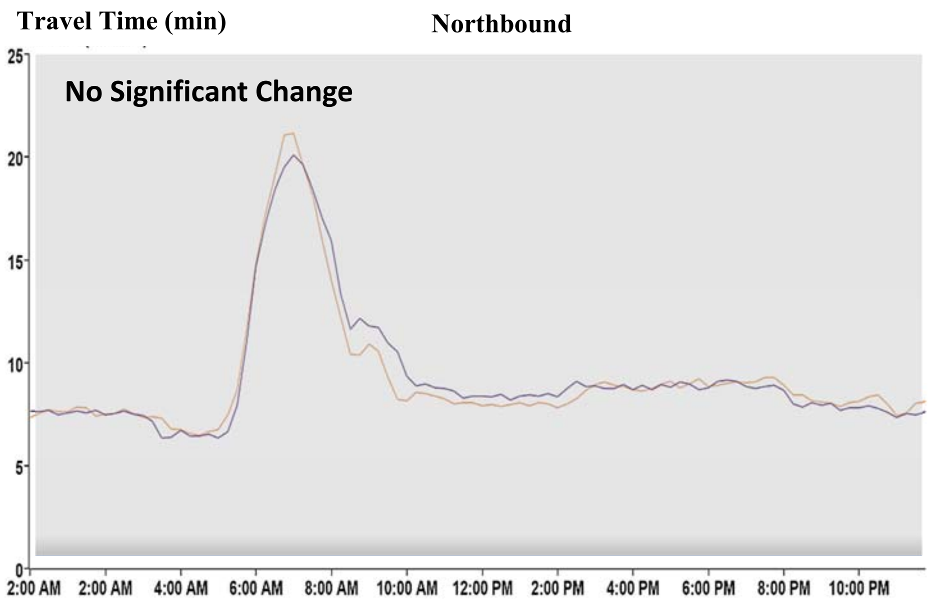
***Significant at $p < 0.01$ **Significant at $p < 0.05$ *Significant at $p < 0.1$ ; **RED VALUES** represent improved mobility performance.

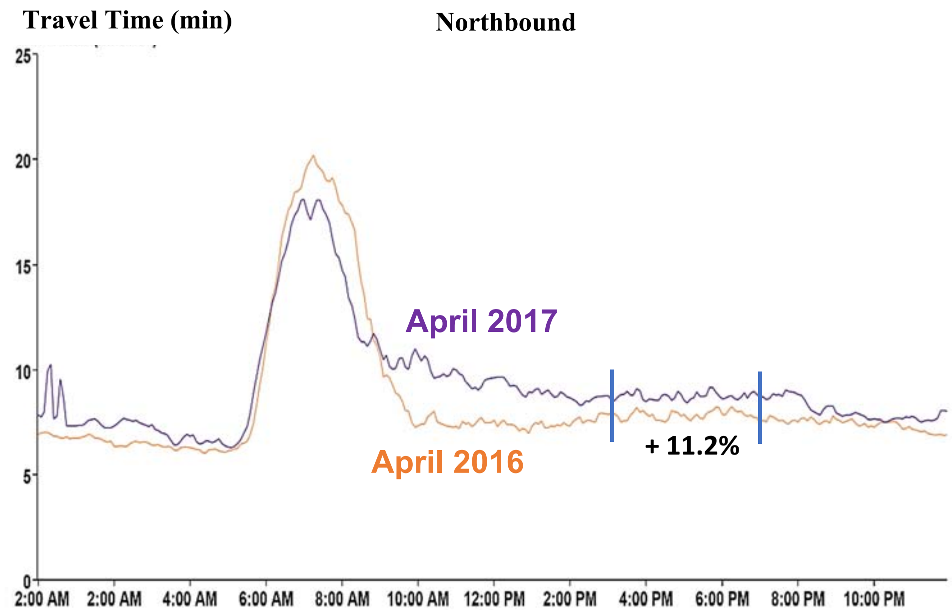
MGM at NAT'L HARBOR

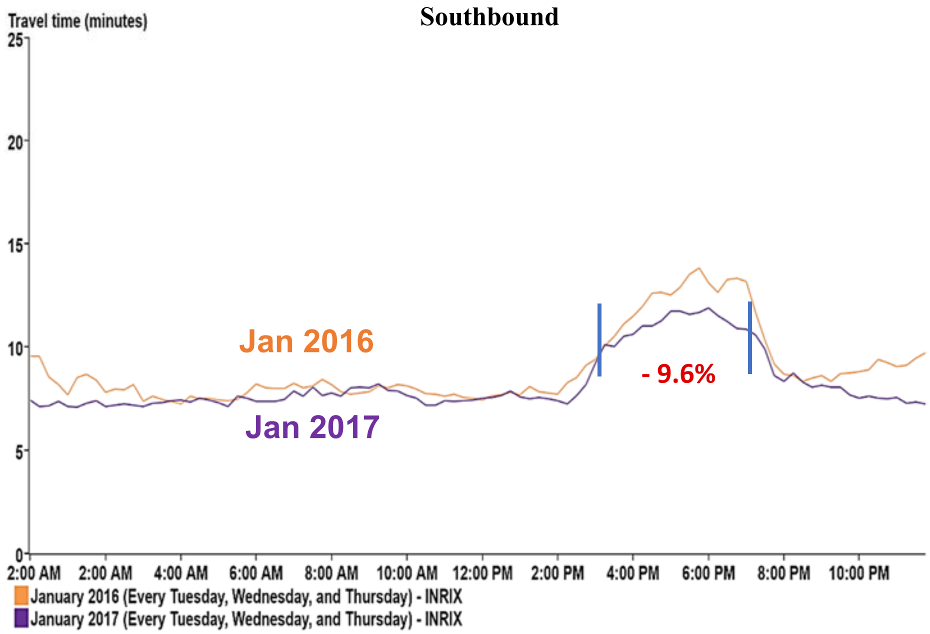
# MD-210 / Indian Head Highway (2/3)

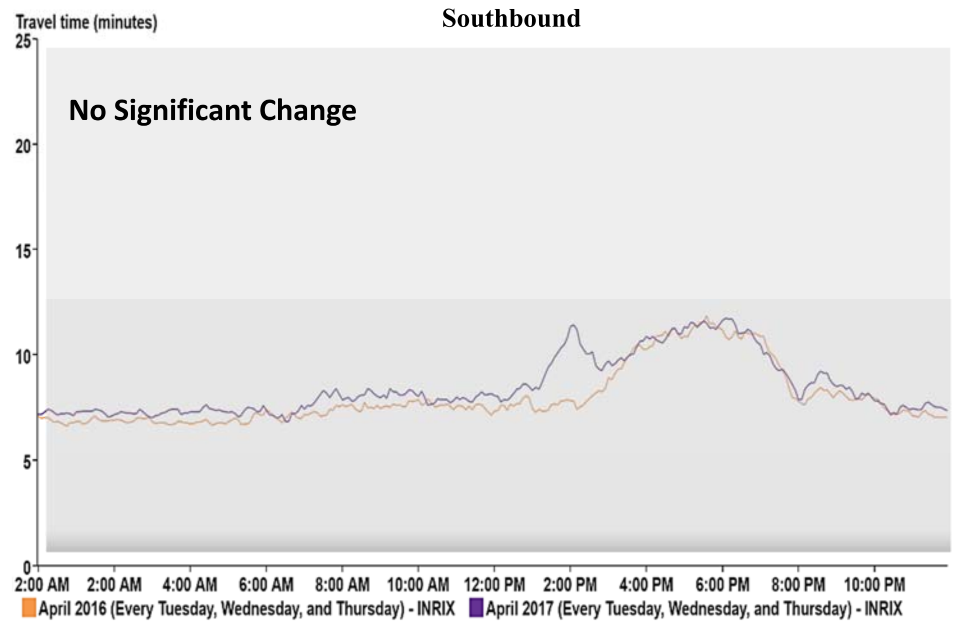
5.6 miles NB; 5.1 miles SB

**Opened in December 2016**



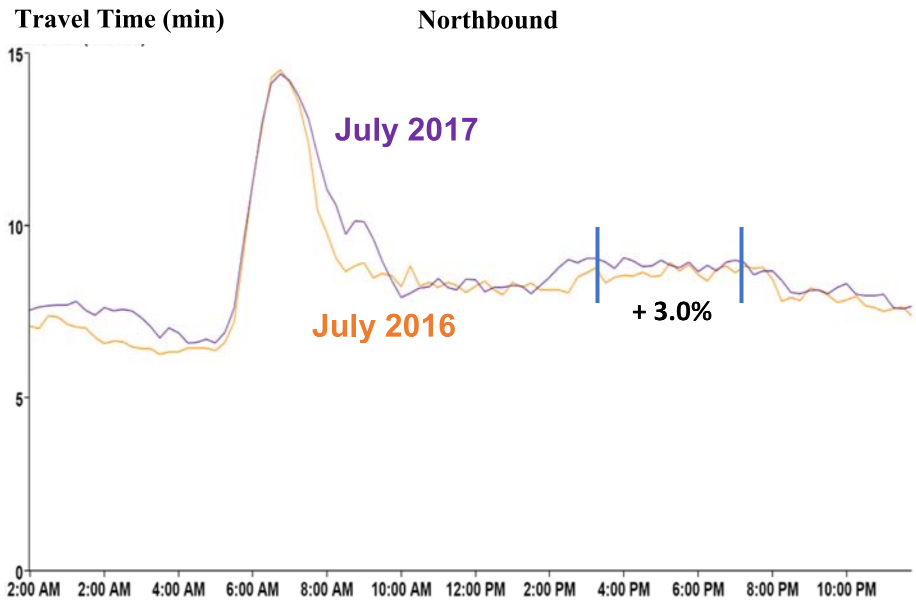



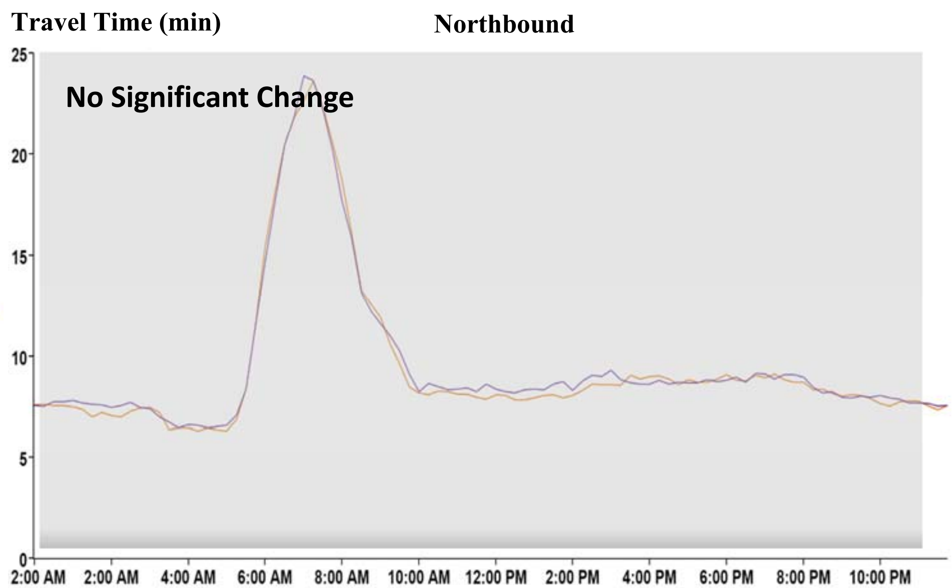
MGM at NAT'L HARBOR

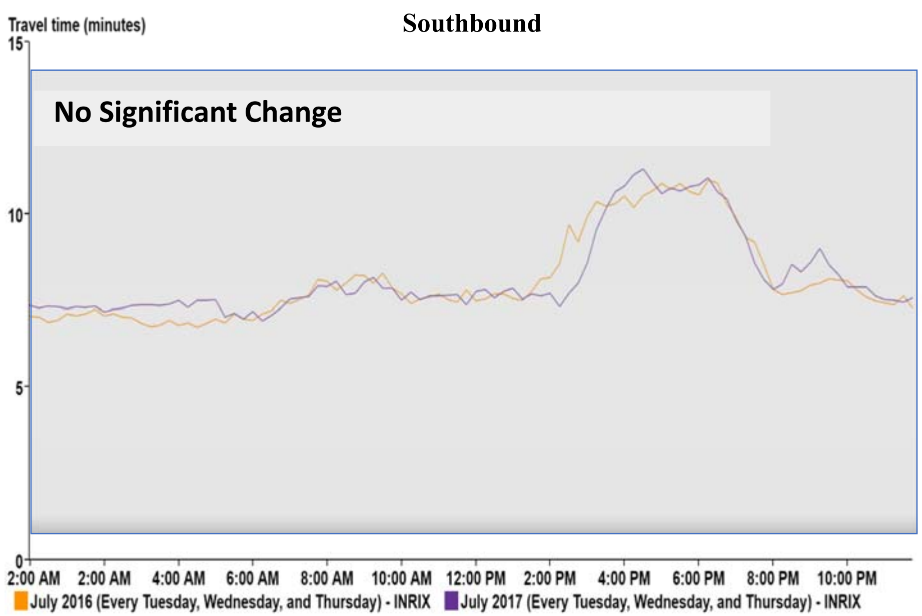
# MD-210 / Indian Head Highway (3/3)

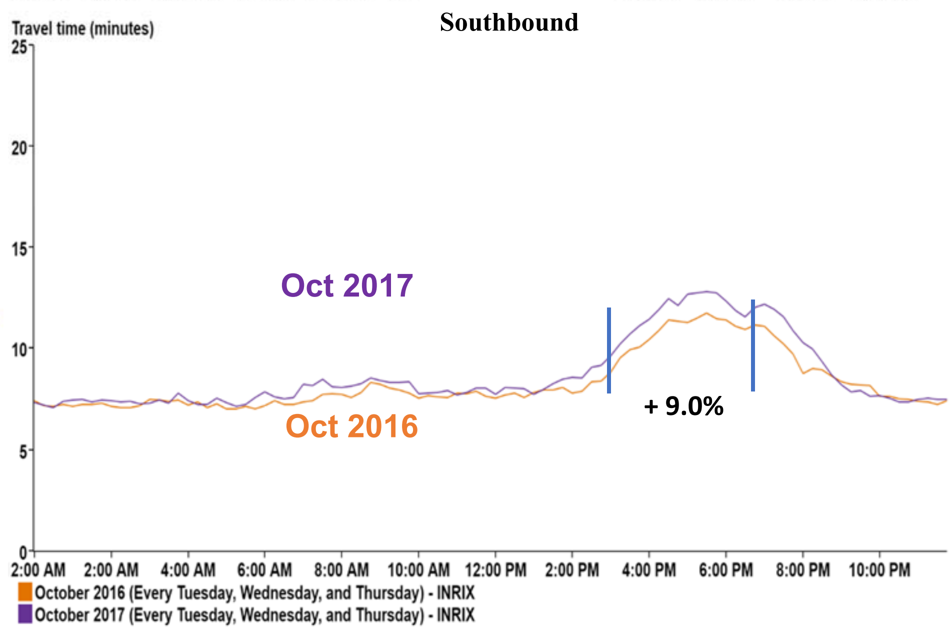
5.6 miles NB; 5.1 miles SB

**Opened in December 2016**



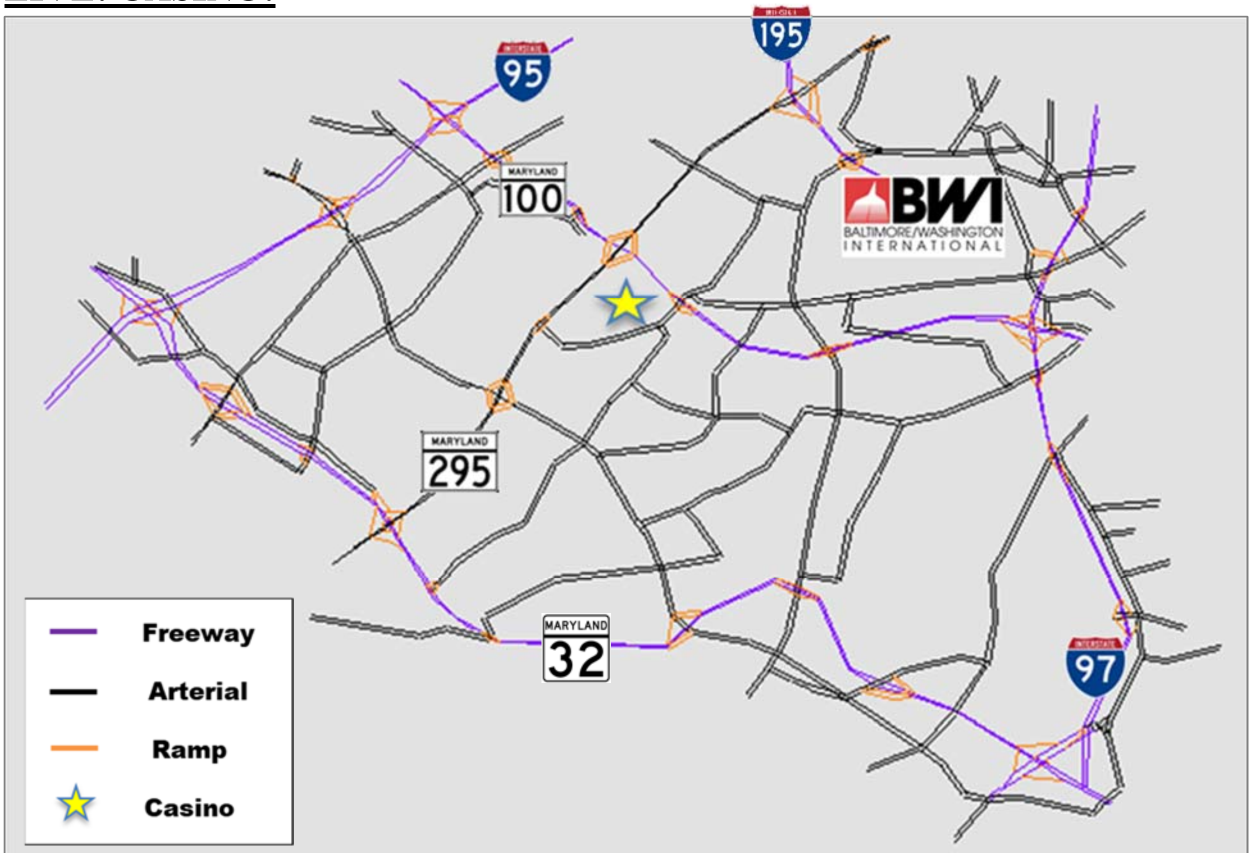



# APPENDIX II:
## MESOSCOPIC DTA MODEL SUB-REGIONS

## LIVE! CASINO:




MAJOR CORRIDORS:

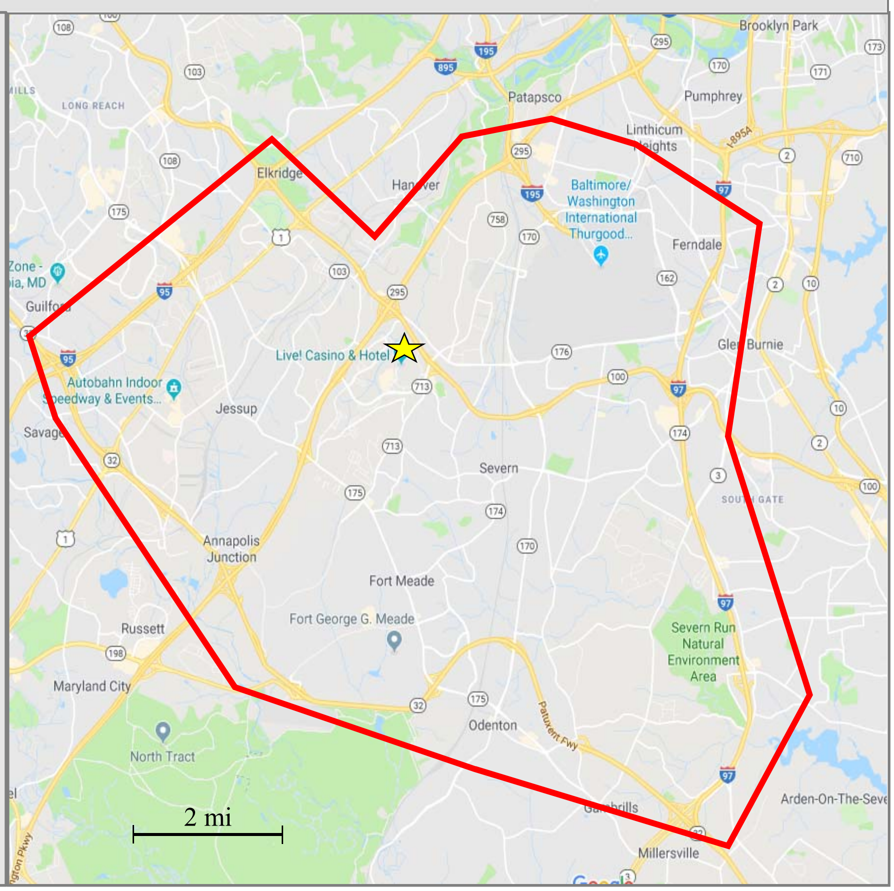
- I-95
- I-97
- I-195
- MD-295
- MD-100
- MD-32

\# of TAZs:
- **100**

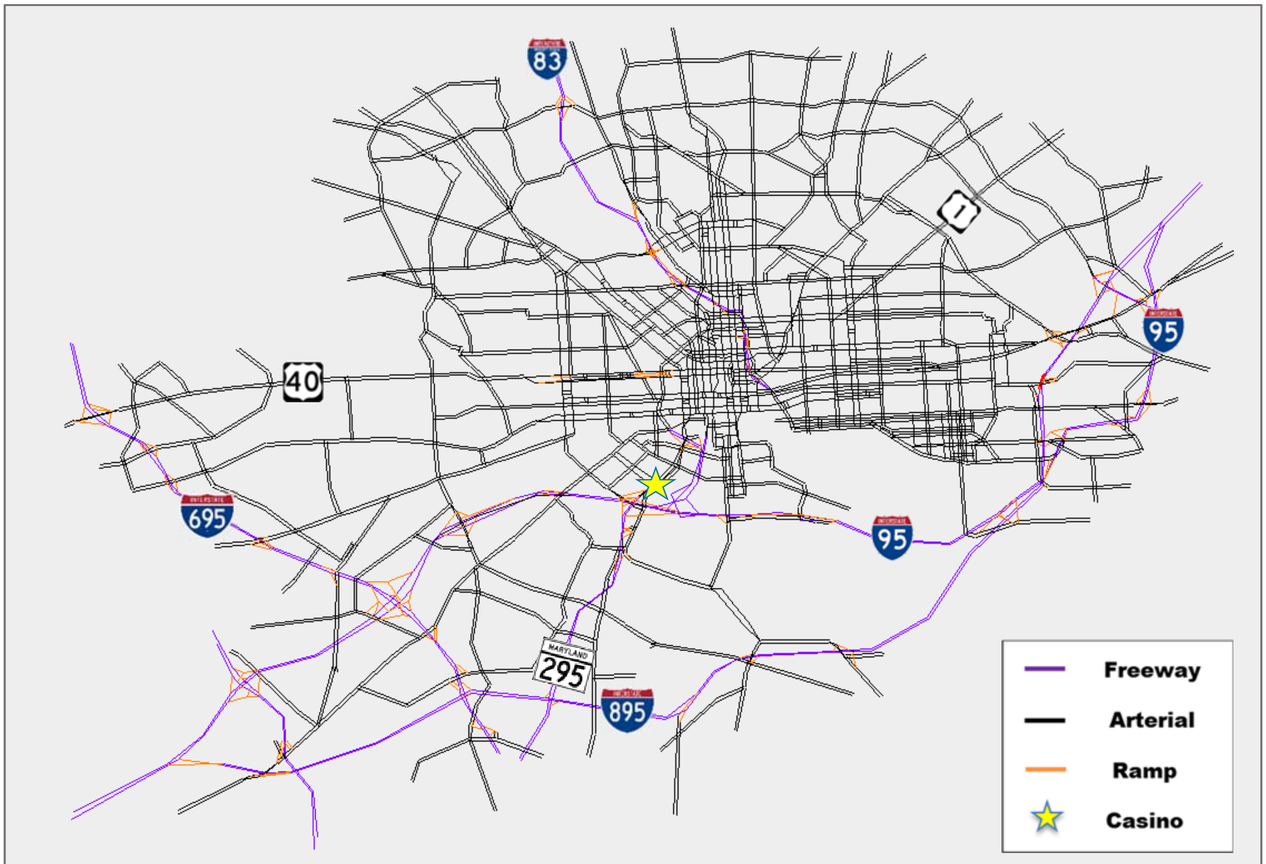
\# of Links:
- **1,048**

\# of Nodes:
- **626**

\# of Signalized Nodes:
- **39**



# HORSESHOE CASINO:




MAJOR CORRIDORS:

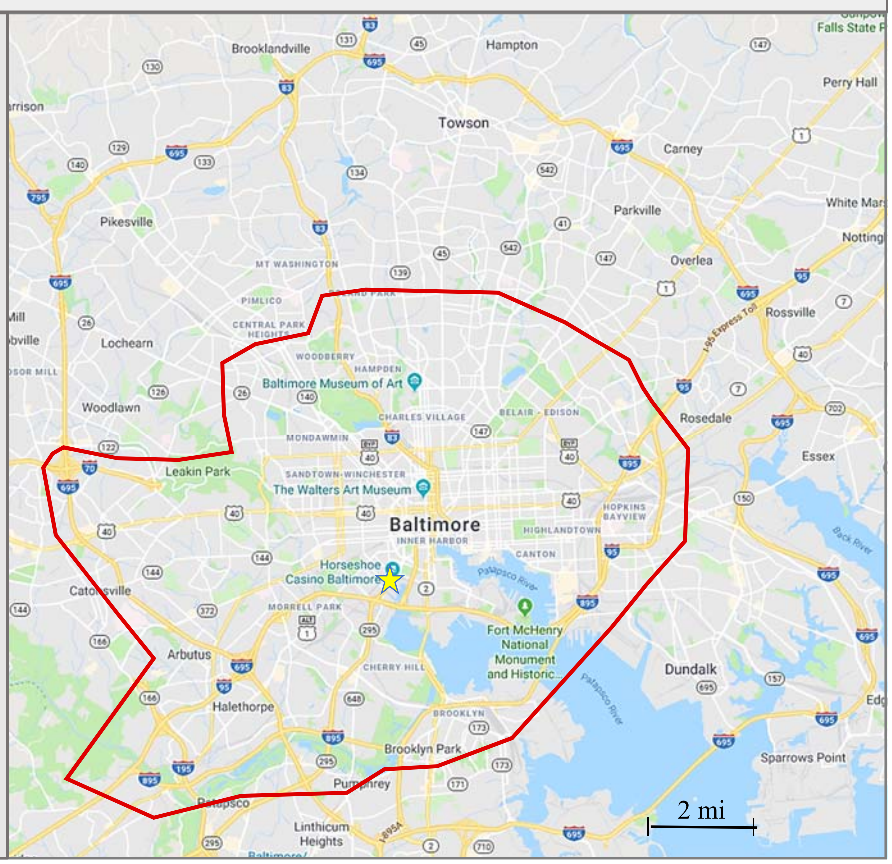
- I-95
- I-395
- I-83
- I-695
- I-895
- MD-295 / Russell Street
- US-40
- US-1

\# of TAZs:
- **179**

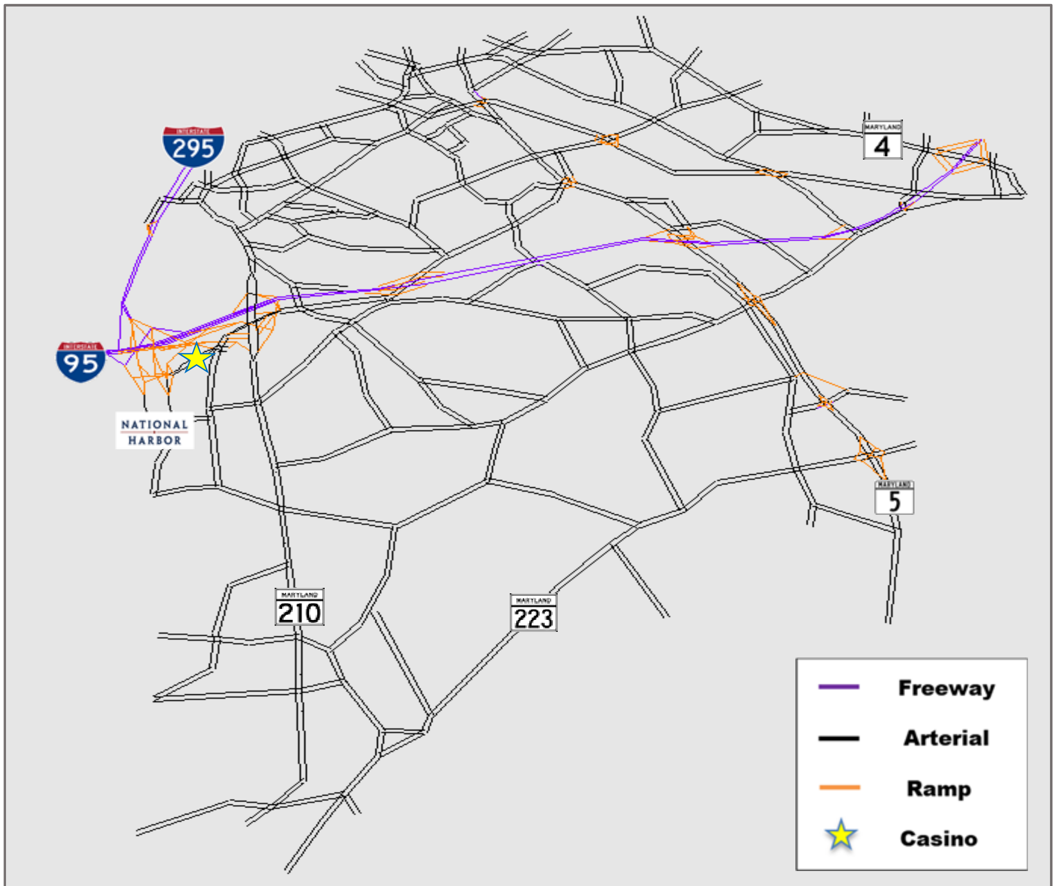
\# of Links:
- **4,272**

\# of Nodes:
- **2,127**

\# of Signalized Nodes:
- **191**



# MGM at NAT'L HARBOR:




MAJOR CORRIDORS:

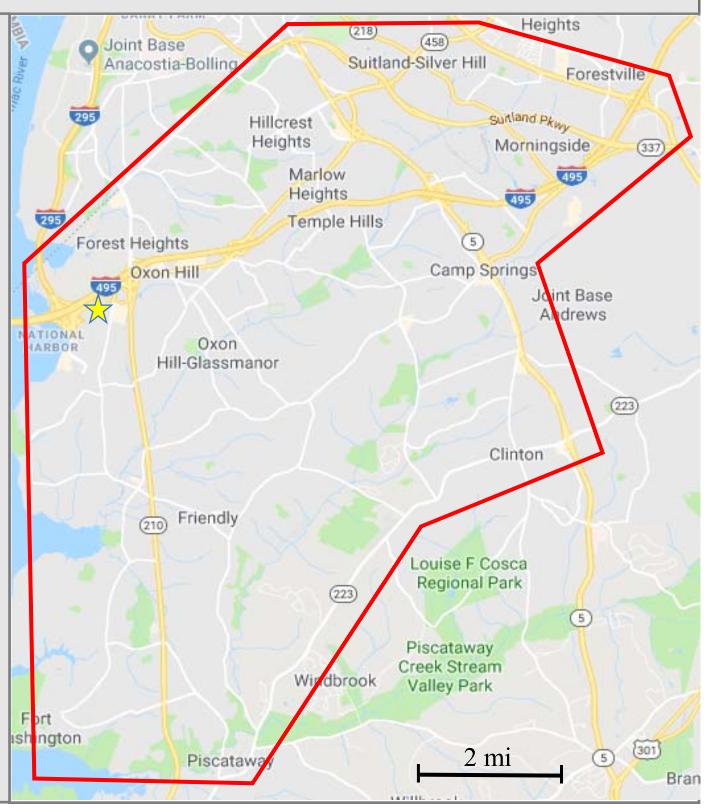
- I-95 / I-495
- I-295
- MD-210
- Oxon Hill Rd
- MD-5
- MD-4
- Suitland Parkway

# of TAZs:
- **104**

# of Links:
- **1,084**

# of Nodes:
- **561**

# of Signalized Nodes:
- **48**



# APPENDIX III:
## ITE-BASED CASINO TRIP GENERATION

## HORSESHOE CASINO:

Table 27 details the trip generation for Horseshoe Casino. The total trip estimates rely on information presented in the 2013 casino traffic impact study (TIS), which derive from PM peak hour of generated values recorded in the $9^{th}$ edition of the *ITE Trip Generation Manual*. Peak hour of adjacent street traffic values were not used in the calculation due to this study's analysis time period extending outside the designated 4:00 – 6:00 PM peak hour time restraint. Furthermore, the shown number of gaming positions of 3,446 is lower than the original estimate of 3,750 estimate provided in the TIS. The updated estimate accounts for 2,200 slot machines and 178 poker tables, assumed to have seven seats each.

**Table 27: Horseshoe Casino ITE-based Trip Generation**

| Land Use: | Quantity | Unit | Avg Trip Rates | Trips | PM Directional Distribution | | Internal Capture | Non Auto | TOTAL TRIPS | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | IN (%) | OUT (%) | (%) | (%) | IN | OUT |
| **Full-Scale Casino** | 3,446 | # of Seats | 0.246* | 842 | 60* | 40* | | 20* | 407 | 271 |
| **Restaurant (LUC 931)** | 40,858* | 1000 sq ft | 7.49* | 306 | 67* | 33* | 40* | 20* | 82 | 40 |
| **Bar/Tavern (LUC 925)** | 15,089* | 1000 sq ft | 11.34* | 171 | 66* | 34* | 40* | 20* | 45 | 23 |
| **Office (LUC 710)** | 72,735* | 1000 sq ft | 1.49* | 108 | 17* | 83* | | 20* | 15 | 72 |
| | | | | | | | **TOTAL** | | **549** | **407** |

* Values taken directly from 2013 Horseshoe Casino traffic impact study

Figure 17 presents the arrival trip patterns for special event trips generated by a Baltimore Ravens NFL Thursday night game (distribution percentages are based on study for proposed NFL stadium in San Diego[1]). The capacity of M&K Bank Stadium in Baltimore is approximately **71,000**. A Thursday night game's start time is around **8:30pm**; therefore, only arrival trips are simulated. The estimated total number of game-day trips is based on a sold-out game managed by **2,500 staff** as well as several assumptions taken from transportation impact studies conducted for other exiting/proposed NFL football stadiums. The assumptions include the following:

- **Mode split**: automobile mode share varied widely (i.e. 57 – 76%) among all NFL stadium sites compared in a Las Vegas[2] site study. Therefore, the team assumed **67%** or two-thirds of attendee trips are taken by automobile (**60%** for stadium staff trips).
- **Passengers per vehicle**: based on the San Diego study, an average of **2.7 game attendees** were assumed to arrive per automobile for a weekday game; **1.5 game staff** per auto.

### TOTAL SPECIAL EVENT TRIPS: 17,620 Attendee Trips by Auto | 1,000 Staff Trips by Auto

| Hour | Attendees | Staff |
|---|---|---|
| 7:30 - 8:30pm | 0% | 40% |
| 6:30 - 7:30pm | 10% | 20% |
| 5:30 - 6:30pm | 40% | 15% |
| 4:30 - 5:30pm | 30% | 15% |
| 3:30 - 4:30pm | 15% | 10% |
| 2:30 - 3:30pm | 5% | 5% |

**Interpolation**

| Hour | Attendees | Staff | A Trips | S Trips |
|---|---|---|---|---|
| 7 - 8pm | 5.0% | 30.0% | 881 | 300 |
| **6 - 7pm** | **25.0%** | **17.5%** | **4405** | **175** |
| **5 - 6pm** | **35.0%** | **15.0%** | **6167** | **150** |
| **4 - 5pm** | **22.5%** | **12.5%** | **3965** | **125** |
| **3 - 4pm** | **10.0%** | **7.5%** | **1762** | **75** |
| 2 - 3pm | 2.5% | 2.5% | 441 | 25 |

**Figure 18: Trip Arrival Patterns for Horseshoe Casino Special Event**

[1] Qualcomm Stadium, San Diego Chargers (AECOM 2015)

[2] Las Vegas Stadium, Las Vegas Raiders (CH2M 2016)

## LIVE! CASINO:

Table 28 displays the trip generation for Live! Casino. With the TIS report unavailable to the research group, the Maryland casino trip rates were found in a Mid-Atlantic Section ITE presentation slide deck[1]. The team estimated the restaurant and bar square footage quantities using a basic floor plan[2]. Designated office space was not delineated on the plan; therefore, the quantity was derived from the proportion of casino employees in comparison with Horseshoe Casino. Again, PM peak hour of generator trip rates from the 9th edition of the *ITE Trip Generation Manual* were employed. The number of gaming positions (5,323) includes 4,000 slot machines and 189 poker tables.

**Table 28: Live! Casino ITE-based Trip Generation**

| Land Use: | Quantity | Unit | Avg Trip Rates | | Trips | | PM Directional Distribution | | Internal Capture | Non-Auto | TOTAL TRIPS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | IN | OUT | IN | OUT | IN (%) | OUT (%) | (%) | (%) | IN | OUT |
| **Full-Scale Casino** | 5,323 | # of Seats | 0.31 | 0.28 | 1650 | 1490 | 60 | 40 | | 0.2 | 792 | 477 |
| **Restaurant (LUC 931)** | 40,000 | 1000 sq ft | 7.49 | | 300 | | 67 | 33 | 0.4 | 0.2 | 80 | 40 |
| **Bar/Tavern (LUC 925)** | 2,500 | 1000 sq ft | 11.34 | | 28 | | 66 | 34 | 0.4 | 0.2 | 7 | 4 |
| **Office (LUC 710)** | 58,000 | 1000 sq ft | 1.49 | | 86 | | 17 | 83 | | 0.2 | 6 | 29 |
| | | | | | | | | | **TOTAL** | | **886** | **549** |

The estimation of Black Friday special event trips required a different approach. Using a combination of the ITE rates, Airsage location data, and independent Black Friday shopping trend analytics, the team estimated the trip generation and hourly arrival and departure patterns for trips entering and exiting the Arundel Mills Mall during the PM peak period on Black Friday. Starting with 10th edition ITE trip volumes for a Shopping Center (LUC 820), the 1.6 million square-foot mall – the largest in Maryland - would generate approximately **4,287** (48% In; 52% Out) during the weekday PM peak hour and **5,614** (52% In; 48% Out) during the Saturday peak hour. It is assumed Black Friday aligns more with the traffic patterns of a busy Saturday rather than a typical weekday due its designation as a state holiday.

According to a ShopperTrak analysis[3] of historic Black Friday trends, the shopper traffic peaks at 3:00 PM. Therefore, the team utilized Airsage trip estimates for 3:00 PM to determine the Black Friday trip generation for the mall and surrounding outlets. The total estimate equaled 2,132 (51% in; 49% out). The Saturday peak hour volume was estimated to be 2,800 based on a 1.31 multiplication factor derived from the ITE peak hour estimates (5,614 / 4287). To estimate the total number of Black Friday peak hour trips, the Saturday peak hour trip estimates were conservatively doubled to **5,602**. This decision was based on a ShopperTrak volume profile of Thanksgiving weekend shopping traffic showing about twice as many people shop on Black Friday than on the following Saturday. The final number of added trips due to Black Friday was obtained by subtracting the typical weekday trip volumes from the overall number of Black Friday trips (**Table 29**). The hourly distribution of trips follows a similar distribution to the time-of-day chart shown in the ShopperTrak analysis article.

**TOTAL SPECIAL EVENT TRIPS: 3,470**

[1] Subhani, R. – WR&A, & Silberman, P. – SW&A. (2014). *Casino Trip Generation* [Powerpoint Slides].

[2] https://adc3ef35f321fe6e725a-fb8aac3b3bf42afe824f73b606f0aa4c.ssl.cf1.rackcdn.com/staticmaps/5201.gif

[3] McCarthy, Bill. (2016). *What Store Traffic Data Reveals about Black Friday Shopping Trends.* https://www.shoppertrak.com/article/traffic-reveals-black-friday-shopping-trends/

**Table 29: Live! Casino Special Event Trip Generation**

| | AIRSAGE Weekday Trip Estimates(3pm) | Sat. Peak Hr. Trip Estimates | TOTAL Black Friday Trip Estimates | ADDED Black Friday Trip Estimates |
|---|---|---|---|---|
| TRIPS | A | B = A * 1.31 | C = 2*B | D = C-A |
| IN | 1089 | 1431 | 2861 | 1772 |
| OUT | 1043 | 1370 | 2740 | 1697 |
| **TOTAL** | **2132** | **2801** | **5602** | **3470** |

## <u>MGM at Nat'l Harbor:</u>

Table 30 details the trip generation for MGM Casino. The total trip estimates utilize information published in a 2013 final review of a TIS. The TIS presents a single trip generation rate that represents traffic to all types of facilities within the casino complex except the hotel (PM peak hour rate = 0.27). With the bundled rate, the estimated vehicle trips is still determined by the number of gaming positions. Similar to Horseshoe Casino, the TIS overestimated the number of gaming positions to be 4,580. Currently, 4,275 positions spread out between 3,085 slot machines and 170 tables exist at the casino.

The special event assumed to be a sold-out concert at the casino's 3,000-seat theatre. For a 7:00 PM or later weeknight show, it is assumed all vehicle trips will arrive within the 6:00 – 7:00 PM hour. The number of vehicle trips (600 or 20% of theatre capacity) is taken directly from the TIS report. The report states "10% would be occupied by MGM hotel guests, 10% would be occupied by persons coming from National Harbor on shuttle buses, and 40% would be occupied by casino guests and would not generate new traffic." The report also assumes a vehicle occupancy of 2.0.

**Table 30: MGM Casino ITE-based Trip Generation**

| Land Use: | Quantity | Unit | Avg Trip Rates | TRIPS | PM Directional Distribution | | TOTAL TRIPS | |
|---|---|---|---|---|---|---|---|---|
| | | | | | IN (%) | OUT (%) | IN | OUT |
| **Casino/Restaurant/Shops (TIS)** | 4275 | # of Seats | 0.27 | 1154 | 60 | 40 | 693 | 462 |
| **Hotel** | 308 | # of Rooms | 0.6 | 185 | 51 | 49 | 94 | 91 |
| | | | | | | **Sub-Total** | **787** | **552** |
| **Theater (special event)** | 3000 | # of Seats | 0.2 | 100 | 0 | 600 | 600 | 0 |
| | | | | | **TOTAL** | | **1387** | **552** |

# APPENDIX IV:
# MESOSCOPIC DTA MODEL RESULTS

**Table 31: Live! Casino Model Hourly Measures of Effectiveness Results**

| LIVE! CASINO MODEL MOE RESULTS | | | |
|---|---|---|---|
| TIME (PM Peak Period) | BEFORE CASINO | WITH CASINO | CASINO + BLACK FRIDAY SPECIAL EVENT |
| | # of Vehicles | # of Veh \| % Change | # of Veh \| % Change |
| 3:00 - 4:00 | 90,242 | 91,676 \| 1.59% | 95,134 \| 5.42% |
| 4:00 - 5:00 | 103,011 | 104,871 \| 1.81% | 107,696 \| 4.55% |
| 5:00 - 6:00 | 104,672 | 106,023 \| 1.29% | 109,214 \| 4.33% |
| 6:00 - 7:00 | 80,099 | 81,619 \| 1.90% | 84,459 \| 5.44% |
| | Average Trip Time | Avg. TT \| % Change | Avg. TT \| % Change |
| 3:00 - 4:00 | 10.77 | 11.12 \| 3.25% | 15.04 \| 39.64% |
| 4:00 - 5:00 | 12.97 | 14.09 \| 8.64% | 20.5 \| 58.06% |
| 5:00 - 6:00 | 15.44 | 17.58 \| 13.86% | 25.15 \| 62.9% |
| 6:00 - 7:00 | 16.03 | 18.33 \| 14.35% | 26.58 \| 65.81% |
| | Average Trip Time Index | TTI \| % Change | TTI \| % Change |
| 3:00 - 4:00 | 1.31 | 1.35 \| 3.05% | 1.81 \| 38.17% |
| 4:00 - 5:00 | 1.57 | 1.70 \| 8.28% | 2.46 \| 56.69% |
| 5:00 - 6:00 | 1.84 | 2.09 \| 13.59% | 2.98 \| 61.96% |
| 6:00 - 7:00 | 1.90 | 2.16 \| 13.68% | 3.12 \| 64.21% |
| | Average Speed | Avg Speed \| % Change | Avg Speed \| % Change |
| 3:00 - 4:00 | 36.25 | 35.16 \| - 3.01% | 26.09 \| - 28.03% |
| 4:00 - 5:00 | 29.80 | 27.44 \| - 7.92% | 18.94 \| - 36.44% |
| 5:00 - 6:00 | 25.30 | 22.25 \| - 12.06% | 15.59 \| - 38.38% |
| 6:00 - 7:00 | 25.06 | 21.96 \| - 12.37% | 15.17 \| - 39.47% |

Note: Model simulates greatest mobility impact during 6:00 - 7:00PM for both after scenarios.

**Table 32: Horseshoe Casino Model Hourly Measures of Effectiveness Results**

| HORSESHOE CASINO MODEL MOE RESULTS | | | |
|---|---|---|---|
| TIME (PM Peak Period) | BEFORE CASINO | WITH CASINO | RAVEN'S GAME SPECIAL EVENT |
| | # of Vehicles | # of Veh \| % Change | # of Veh \| % Change |
| 3:00 - 4:00 | 182,190 | 183,221 \| 0.57% | 184,980 \| 1.53% |
| 4:00 - 5:00 | 232,809 | 233,820 \| 0.43% | 237,841 \| 2.16% |
| 5:00 - 6:00 | 227,465 | 228,499 \| 0.45% | 234,904 \| 3.27% |
| 6:00 - 7:00 | 178,044 | 178,970 \| 0.52% | 183,302\| 2.95% |
| | Average Trip Time | Avg. TT \| % Change | Avg. TT \| % Change |
| 3:00 - 4:00 | 9.15 | 9.16 \| 0.11% | 9.19 \| 0.44% |
| 4:00 - 5:00 | 9.29 | 9.34 \| 0.54% | 9.73 \| 4.74% |
| 5:00 - 6:00 | 10.42 | 10.51 \| 0.86% | 12.48 \| 19.77% |
| 6:00 - 7:00 | 10.07 | 10.15 \| 0.79% | 13.12 \| 30.29% |
| | Average Trip Time Index | TTI \| % Change | TTI \| % Change |
| 3:00 - 4:00 | 1.32 | 1.32 \| 0.0% | 1.33\| 0.76% |
| 4:00 - 5:00 | 1.45 | 1.46 \| 0.69% | 1.52\| 4.83% |
| 5:00 - 6:00 | 1.56 | 1.57 \| 0.64% | 1.86\| 19.23% |
| 6:00 - 7:00 | 1.50 | 1.51 \| 0.67% | 1.94\| 29.33% |
| | Average Speed | Avg Speed \| % Change | Avg Speed \| % Change |
| 3:00 - 4:00 | 27.93 | 27.84 \| - 0.32% | 27.76 \| - 0.61% |
| 4:00 - 5:00 | 25.11 | 24.97 \| - 0.56% | 24.06\| - 4.18% |
| 5:00 - 6:00 | 23.28 | 23.06 \| - 0.95% | 19.50\| - 16.24% |
| 6:00 - 7:00 | 24.29 | 24.08 \| - 0.86% | 18.74 \| - 22.85% |

Note: Model simulates greatest mobility impact with casino during 5:00 - 6:00PM and casino + Raven's game during 6:00 - 7:00PM.

**Table 33: MGM Casino Model Hourly Measures of Effectiveness Results**

| MGM CASINO MODEL MOE RESULTS | | | |
|---|---|---|---|
| TIME (PM Peak Period) | BEFORE CASINO | WITH CASINO | THEATER CONCERT SPECIAL EVENT |
| | # of Vehicles | # of Veh \| % Change | # of Veh \| % Change |
| 3:00 - 4:00 | 71,671 | 72,817 \| 1.60% | - |
| 4:00 - 5:00 | 76,577 | 77,720 \| 1.49% | - |
| 5:00 - 6:00 | 78,060 | 79,186 \| 1.44% | - |
| 6:00 - 7:00 | 64,021 | 65,449 \| 2.23% | 66,083 \| 3.22% |
| | Average Trip Time | Avg. TT \| % Change | Avg. TT \| % Change |
| 3:00 - 4:00 | 10.65 | 10.82 \| 1.60% | - |
| 4:00 - 5:00 | 12.01 | 12.34 \| 2.75% | - |
| 5:00 - 6:00 | 14.60 | 15.21 \| 4.18% | - |
| 6:00 - 7:00 | 14.99 | 15.9 \| 6.07% | 15.94 \| 6.34% |
| | Average Trip Time Index | TTI \| % Change | TTI \| % Change |
| 3:00 - 4:00 | 1.30 | 1.33 \| 2.31% | - |
| 4:00 - 5:00 | 1.46 | 1.5 \| 2.74% | - |
| 5:00 - 6:00 | 1.68 | 1.75 \| 4.17% | - |
| 6:00 - 7:00 | 1.69 | 1.79 \| 5.92% | 1.79\| 5.92% |
| | Average Speed | Avg Speed \| % Change | Avg Speed \| % Change |
| 3:00 - 4:00 | 30.87 | 30.37 \| - 1.62% | - |
| 4:00 - 5:00 | 27.50 | 26.76 \| - 2.69% | - |
| 5:00 - 6:00 | 23.80 | 22.84 \| - 4.03% | - |
| 6:00 - 7:00 | 23.97 | 22.57 \| - 5.84% | 22.50 \| - 6.13% |

Note: Model simulates greatest mobility impact during 6:00 - 7:00PM for both after scenarios.

# APPENDIX V:
## MGM CASINO SENSOR COUNT DATA COMPARISON

**Table 34: Before/After Sensor Counts Comparison (MGM Casino)**

| Hour (PM peak pd.) | Sensor Location: Adjacent to Casino | BEFORE Count | BEFORE Year | AFTER Count | AFTER Year | % Change | Sensor Location: Nearby Corridors | BEFORE Count | BEFORE Year | AFTER Count | AFTER Year | % Change |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 - 3:00 | Harborview Ave (EB) | 226 | Jan-14 | 591 | Dec-17 | 161.5% | I-295 (NB) | 1910 | Oct-15 | 2243 | Nov-18 | 17.4% |
| 3 - 4:00 | | 294 | | 791 | | 169.0% | | 1760 | | 2131 | | 21.1% |
| 4 - 5:00 | | 496 | | 979 | | 97.4% | | 1618 | | 1780 | | 10.0% |
| 5 - 6:00 | | 641 | | 866 | | 35.1% | | 1660 | | 1570 | | -5.4% |
| 6 - 7:00 | | 395 | | 790 | | 100.0% | | 1669 | | 1653 | | -1.0% |
| 2 - 3:00 | National Ave (WB) | 136 | Jan-14 | 432 | Dec-17 | 217.6% | I-295 (SB) | 4467 | Oct-15 | 2972 | Nov-18 | -33.5% |
| 3 - 4:00 | | 139 | | 406 | | 192.1% | | 4799 | | 4110 | | -14.4% |
| 4 - 5:00 | | 240 | | 406 | | 69.2% | | 4327 | | 4694 | | 8.5% |
| 5 - 6:00 | | 277 | | 401 | | 44.8% | | 4183 | | 4489 | | 7.3% |
| 6 - 7:00 | | 173 | | 410 | | 137.0% | | 4283 | | 3913 | | -8.6% |
| 2 - 3:00 | Exit 2 Ramp 9 from I-295 to Nat'l Harbr | 278 | Mar-16 | 388 | Jul-17 | 39.6% | MD-210 (NB) | 1808 | Aug-15 | 1933 | Jun-18 | 6.9% |
| 3 - 4:00 | | 446 | | 537 | | 20.4% | | 1727 | | 1818 | | 5.3% |
| 4 - 5:00 | | 569 | | 574 | | 0.9% | | 1702 | | 1839 | | 8.0% |
| 5 - 6:00 | | 587 | | 656 | | 11.8% | | 1649 | | 1913 | | 16.0% |
| 6 - 7:00 | | 417 | | 569 | | 36.5% | | 1606 | | 1935 | | 20.5% |
| 2 - 3:00 | Oxon Hill Rd (NB) | 354 | Jun-15 | 405 | Aug-18 | 14.4% | MD-210 (SB) | 3070 | Aug-15 | 2584 | Jun-18 | -15.8% |
| 3 - 4:00 | | 327 | | 372 | | 13.8% | | 3251 | | 3201 | | -1.5% |
| 4 - 5:00 | | 317 | | 352 | | 11.0% | | 3284 | | 3462 | | 5.4% |
| 5 - 6:00 | | 336 | | 404 | | 20.2% | | 3174 | | 3437 | | 8.3% |
| 6 - 7:00 | | 356 | | 396 | | 11.2% | | 3142 | | 2967 | | -5.6% |
| 2 - 3:00 | Oxon Hill Rd (SB) | 600 | Jun-15 | 801 | Aug-18 | 33.5% | I-95 W of MD-414 (NB) | 5691 | Oct-15 | 5808 | Jan-18 | 2.1% |
| 3 - 4:00 | | 918 | | 779 | | -15.1% | | 6823 | | 7154 | | 4.9% |
| 4 - 5:00 | | 1150 | | 720 | | -37.4% | | 6928 | | 7061 | | 1.9% |
| 5 - 6:00 | | 1005 | | 878 | | -12.6% | | 6562 | | 6823 | | 4.0% |
| 6 - 7:00 | | 942 | | 708 | | -24.8% | | 6547 | | 6439 | | -1.6% |
| 2 - 3:00 | | | | | | | I-95 W of MD-414 (SB) | 4426 | Oct-15 | 4372 | Jan-18 | -1.2% |
| 3 - 4:00 | | | | | | | | 4978 | | 5035 | | 1.1% |
| 4 - 5:00 | | | | | | | | 5467 | | 5319 | | -2.7% |
| 5 - 6:00 | | | | | | | | 5595 | | 5225 | | -6.6% |
| 6 - 7:00 | | | | | | | | 4885 | | 4758 | | -2.6% |

Note: Change in volume after MGM Casino opened varies significantly at different count sensor locations.