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Subject: Indian Lake Intersections Study

Burgess \& Niple has conducted an intersection study of the Indian Lake intersections. A draft version of the study was submitted on September 22, 2020. Review comments were provided by ODOT and are included in the Appendix. An Indian Lake Transportation Study was conducted by TEC Engineering, Inc. in 2016. The previous study recommended that the study intersections be revaluated in the future. Based on discussion with CCSTCC, the purpose of this study is to conduct capacity and crash analysis in order to develop a concept plan and cost estimate for potential intersection improvements that create a more attractive, comfortable, and safe multimodal environment.

## Kick-Off Meeting

A kickoff meeting was held on 9/16/19 at the Russells Point Municipal Building. Attendees included LUC, Logan County, Russells Point, CCSTCC, ODOT District 7, and Burgess \& Niple. Study intersections, wayfinding, crash, and pedestrian concerns, and project schedule were discussed.

## Stakeholder Meeting

A Stakeholder Meeting was held on March 31, 2020 using Skype. Attendees included LUC, Logan County, Russells Point, CCSTCC, ODOT District 7 and Burgess \& Niple. Initial conceptual alternatives were discussed. During this meeting, some of the initial concepts were modified and additional concepts were developed.

## Data Collection

Based on discussion with CCSTCC, this study includes the following intersections:

- US-33 \& SR 235
- SR 366 \& SR 235
- US-33 \& Sunnyside Avenue
- SR 366 \& Sunnyside Avenue
- US-33 \& SR 708
- SR 366 \& SR 708
- US-33 \& Lincoln Boulevard
- SR 366 \& Lincoln Boulevard

The study intersections are shown in Figure 1. Traffic volume counts were provided by CCSTCC at the eight existing study intersections. Weekday counts were collected on September 17 and September 19, 2019. Existing weekday peak hour traffic counts are illustrated in Figure 2. Saturday traffic counts were

## Indian Lake Intersections Study

Page 2
conducted at the study intersections on July 23, 2016 as part of the previous Indian Lake Transportation Study. The Saturday peak hour was determined to be 12:00-1:00 PM and the 2016 volumes were grown to 2019. Note that some volumes have been increased and balanced as necessary to account for existing driveways between intersections. Raw traffic counts are summarized in the Appendix.

Note that the previous study did not provide Saturday data for the intersection of US-33 \& SR 708 and the intersection of SR 366 \& SR 708. Comparing the weekday PM peak hour counts to the Saturday peak hour counts shows that the Saturday counts were approximately $9 \%$ higher than the total weekday PM peak hour counts. Saturday peak volumes were calculated at the SR 708 study intersections by increasing the PM peak hour volume by $9 \%$ for each turning movement. Figure 2 shows the traffic counts for the Saturday peak at the six counted intersections, as well as the calculated turning values for the remaining two study intersections. As shown in Figure 2, the conversion provides volumes along the corridor that are a close match to the Saturday counts.

## Growth Rate for Background Volumes

In accordance with Section 7.21 of the Ohio Department of Transportation State Highway Access Management Manual, Joshua Kieselbach provided a growth rate for the study area using the ODOT SHIFT Tool. The provided annual growth rates ranged from $0.34 \%$ to $0.93 \%$ along the US-33 corridor and $0.0 \%$ to $0.21 \%$ along the SR 366 corridor (see Appendix). To be a little more conservative with the forecasts, it was decided that a $0.75 \%$ annual growth rate would be used for the mainline US-33 movements, and that a $0.25 \%$ annual growth rate would be used for all other movements. The 2045 volumes with the growth rate applied are shown in Figure 3.

## Crash Analysis

Crash data for the most recent three calendar years (2016-2018) and any data available for 2019 was obtained from ODOT's GIS Crash Analysis Tool (GCAT) in TIMS. The OH-1 report for each documented crash was reviewed to correct information where necessary and to locate crashes properly at the study intersection. There were 35 total crashes in the three-year study period with no fatalities and 9 injury crashes. 10 crashes occurred in 2016, 13 in 2017, and 12 in 2018. There were 12 rear-end crashes, 10 left-turn crashes, 8 angle crashes, 4 fixed-object crashes, and 1 pedestrian crash. Crash diagrams for the study intersections are included in the Appendix.
Given the various crash locations and types, there were no discernable crash patterns within the study area that need to be addressed.

## Conceptual Alternatives

Conceptual alternatives for each pair of intersections were developed based on feedback received from the stakeholders at the Kick-Off Meeting. The conceptual alternatives were then presented to the stakeholders at the Stakeholders Meeting on March 31, 2020. The list of conceptual alternatives was further refined at this meeting. The following alternatives were carried out of the Stakeholders Meeting and are included in this report.
Existing represents current conditions.
No-Build represents the 2045 volumes with no improvements.
US-33 \& SR 235, SR 235 \& SR 366
For this pair of intersections, the geometric and operational concerns from the stakeholders included the location of the access for the Villa Motel driveway. Also, there is concern with queueing as westbound

Indian Lake Intersections Study
Page 3
vehicles on SR 235 get stopped at the US-33 signal and extend back through the SR 366 intersection. This makes it difficult to make a left turn from SR 366 onto SR 235. The conceptual alternatives were developed to address these concerns. The following alternatives were developed to address these concerns:

Alternative 1 (see Figure 4) includes the following improvements for the "Cluster Signal" scenario:

- Install a "cluster" signal at the US-33 \& SR 235 and SR 366 \& SR 235 intersections. With a clustered signal, the two closely spaced intersections are signalized and operate together with one signal controller cabinet
- Relocate the Villa Motel driveway to create a new driveway on US-33

Alternative 2 (see Figure 5) includes the following improvements for the "Quadrant Roadway" scenario:

- Close the westbound approach on SR 235 at the US-33 \& SR 235 / West Lake Street intersection to create a three-leg intersection
- Construct a "quadrant" roadway approximately 0.50 miles south of the US-33 \& SR 235 and SR 366 \& SR 235 intersections with full movement access, inbound left and right-turn lanes, and two outbound lanes
- Relocate the Villa Motel driveway to create a new driveway on US-33

Alternative 3 (see Figure 6) includes the following improvements for the "Roundabout" scenario:

- Install a five-leg, one-lane roundabout at the US-33 \& SR 235 and SR 366 \& SR 235 intersections
- Relocate the Villa Motel driveway to create a new driveway on US-33


## US-33 \& Sunnyside, SR 366 \& Sunnyside

For this pair of intersections, the geometric and operational concerns from the stakeholders included the very short length for the segment between US-33 and SR 366 that only provides enough room for one vehicle. Vehicles coming into the SR 366 intersection from US-33 do not have to stop, however, unfamiliar drivers will occasionally get confused and stop. This can leave the rear of their vehicle hanging out onto US-33 creating a possibility for a crash. The following alternatives were developed to address these concerns:

Alternative 1 (see Figure 7) includes the following improvements for the "SR 366 Closed, Sunnyside Full Access" scenario:

- Modify the US-33 \& Sunnyside Avenue intersection to close the SR 366 access approach
- This eliminates the SR 366 \& Sunnyside Avenue intersection

Alternative 2 (see Figure 7) includes the following improvements for the "SR 366 Right-In / Right-Out, Sunnyside Open" scenario:

- Modify the US-33 \& Sunnyside Avenue intersection to reconfigure the east approach on Sunnyside to right-in / right-out access only. West approach will allow left ins and outs but through movement across US-33 will not be allowed.

Alternative 3 (see Figure 7) includes the following improvements for the "SR 366 Right-In / Right-Out, Sunnyside Right-In / Right-Out" scenario:

- Modify the US-33 \& Sunnyside Avenue intersection to reconfigure both the east and west approaches on Sunnyside to right-in / right-out access only. No left turns will be allowed at the intersection. Through movements across US-33 will also be prohibited.

Alternative 4 (see Figure 7) includes the following improvements for the "Cluster Signal" scenario:

- Install a "cluster" signal at the US-33 \& Sunnyside and SR 366 \& Sunnyside intersections. With a clustered signal, the two closely spaced intersections are signalized and operate together with one signal controller cabinet.
- Install northbound and southbound left turn lanes on US-33.

Indian Lake Intersections Study
Page 4

Alternative 5 (see Figure 8) includes the following improvements for the "Roundabout" scenario:

- Install a one-lane roundabout at the US-33 \& Sunnyside and SR 366 \& Sunnyside intersections.
- Install new access roads from US-33 to Fairview Avenue and Bristol Circle. These access roads, in combination with the roundabout, will allow for all movements at the intersections.
There are several geometric challenges to making a roundabout work at this location The roundabout at this location will be a non-traditional shape. The "dogbone" shape at this location minimizes the effects of the severe skew of the intersection. It allows for the legs of the roundabout to be spaced out in a way that allows for the design performance checks to be more easily met, while also keeping a small enough footprint to stay within the environmental and R/W constraints of the area. As shown in Figure 8, there is just under 3 feet from the back of curb to the Doughnut Shop. This can probably be increased by adjusting the alignment of SR 366, decreasing the exit radius of SR 366 and/or using an 11' lane for SR 366, but it is still going to be close. Also, some parking spaces will be affected at Rite Aid.


## US-33 \& Lincoln Boulevard, SR 366 \& Lincoln Boulevard

For this pair of intersections, the geometric and operational concerns from the stakeholders were related to the very short spacing between US-33 and SR 366. Westbound vehicles make a right turn onto this short access road followed by a left turn onto SR 366. These turns are made at a high speed making it difficult for westbound vehicles on SR 366 to judge when they have an acceptable gap. Based on these concerns, the following alternatives were developed:
Alternative 1 (see Figure 9) includes the following improvements for the "Lincoln Full Access" scenario:

- Modify the US-33 \& Lincoln Boulevard intersection to close the SR 366 access approach from the north
- This eliminates the SR 366 \& Lincoln Boulevard intersection

Alternative 2 (see Figure 9) includes the following improvements for the "Lincoln Full Closure" scenario:

- Modify the US-33 \& Lincoln Boulevard intersection to close the SR 366 access approach to the north the Lincoln Boulevard access to the south. This will eliminate both the US-33 \& Lincoln and SR 366 \& Lincoln intersections.
- Add cul-du-sac on Lincoln Boulevard with access to adjacent businesses


## US-33 \& SR 708 (Orchard Island Road), SR 366 \& SR 708 (Orchard Island Road)

This pair of intersections was not part of the original scope for this study. However, the alternatives developed for the Sunnyside Avenue and Lincoln Boulevard intersections will likely add additional traffic through this pair of intersections. The SR 708 \& SR 366 intersection is an all-way stop that currently experiences some congestion. There is a concern from the stakeholders that additional traffic through these intersections would increase congestion and create queues that block the US-33 \& SR 708 intersection. Analysis will be conducted on these intersections to determine potential impacts related to Sunnyside Avenue and Lincoln Boulevard alternatives.

## Traffic Analysis

Capacity analysis for traffic signals and stop-controlled intersections was conducted using Synchro software with results reported using the Highway Capacity Manual methodology. Roundabout analysis was conducted in Sidra software using the Highway Capacity Manual methodology.

The 2045 build volumes used for analysis are illustrated in Figure 10 for the SR 235 intersections, Figure 11 for the Sunnyside Avenue intersections and Figure 12 for the Lincoln Boulevard and SR 708

Indian Lake Intersections Study
Page 5
intersections. These build volumes manually reassigned the future background volumes (Figure 3). Conceptual plan layouts for each scenario are provided in Figure 4 through Figure 9.
Analysis results for the US-33 \& SR 235 and SR 235 \& SR 366 intersection alternatives are illustrated in Table 1. Analysis results for the US-33 \& Sunnyside Avenue and SR 366 \& Sunnyside Avenue intersection alternatives are illustrated in Table 2. Analysis results for the US-33 \& Lincoln Boulevard and SR 366 \& Lincoln Boulevard intersection alternatives are illustrated in Table 3. Finally, analysis results for the US-33 \& SR 708 and SR 366 \& SR 708 intersections are illustrated in Table 4. Level of Service (LOS) and average delay per vehicle (seconds/vehicle) are provided. Output from Synchro and Sidra is provided in the Appendix.
As outlined in the State Highway Access Management Manual, the goals for the traffic analysis are a minimum Level of Service (LOS) of D for the overall intersection and LOS D for each individual movement during the peak hour. As shown in Tables 1 all alternatives at the US-33 \& SR 235 and SR 235 \& SR 366 intersections will meet the operational goals during the AM, PM and Saturday peak hours. All approaches and overall intersection operations are expected to operate at LOS C or better under all scenarios. Compared to the No-Build condition, Alternative 1 (cluster signal) will have slightly higher delays at the US33 \& SR 235 intersection and Alternative 2 (quadrant roadway) and Alternative 3 (roundabout) will have lower delays.
As shown in Table 2, all the alternatives for the US-33 \& Sunnyside Avenue and SR 366 \& Sunnyside Avenue intersections will meet the operational goals during the AM, PM and Saturday peak hours. All approaches are expected to operate at LOS C or better under all scenarios, except for the northbound approach on SR 366, which is expected to operate at LOS D during the PM peak of Alternative 4 (cluster signal). Overall, Alternatives 1, 2 and 3 will operate similar to the No-Build condition. Because Alternative 4 (cluster signal) and Alternative 5 (roundabout) eliminates the free-flowing approaches on US-33, there will be more a little more delay compared to the No-Build condition. However, only Alternatives 4 and 5 provide for all movements at the two intersections.
As shown in Table 3, both alternatives for the US-33 \& Lincoln Boulevard and SR 366 \& Lincoln Boulevard intersections will meet the operational goals during the AM, PM and Saturday peak hours. Because both alternatives will eliminate the SR 366 \& Lincoln Boulevard intersection and eliminate several movements at the US-33 \& Lincoln Boulevard intersection, the delay at the intersections will be lower than the No-Build condition.
Most alternatives at the US-33 \& Sunnyside Avenue and US-33 at Lincoln Boulevard intersections will restrict turning movements at these intersections. The traffic on these restricted movements will likely divert to SR 708 and the intersection at US-33 and SR 708. Along SR 708 there is only 170 feet between the traffic signal at US-33 and the all-way stop at SR 366. The all-way stop currently experiences some congestion and there is a concern that adding more traffic to this corridor may create queues in the northbound direction that extend back and block the US-33 intersection. As shown in Table 4, the Build condition for this intersection will have an increase in delay, especially for the northbound direction. The Build condition assumes that Alternative 1 is constructed for both the Sunnyside Avenue and Lincoln Boulevard intersections. The expected queue lengths in the northbound direction will be close to the 170 feet of available storage. Should one of the build alternatives at Sunnyside Avenue or Lincoln Boulevard move forward in the future, ODOT certified traffic would need to be developed for these intersections to determine the design traffic on SR 708. Additional analysis would be needed at that time to determine what improvements would be needed to SR 708. Potential improvements could include a northbound right turn lane between US-33 and SR 366 to provide additional storage and reduce queue lengths. Also, a traffic signal at the US-33 \& SR 720 (Wilgus Street) intersection may divert some of the Sunnyside Avenue traffic to the west and away from SR 708.

Table 1: US-33 \& SR 235 and SR 235 \& SR 366 Traffic Analysis Results

|  | 2019 Existing | 2045 Design Year |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Movement | Existing LOS/Delay | $\begin{gathered} \hline \text { No Build } \\ \text { LOS/Delay } \end{gathered}$ | Build Alt 1 <br> LOS/Delay | Build Alt 2 <br> LOS/Delay | Build Alt 3 LOS/Delay |
| AM Peak Hour |  |  |  |  |  |
| US-33 \& SR 235 (Signalized) |  |  |  |  |  |
| Northbound | A/3.9 | A / 3.8 | B / 13.0 | A / 3.5 | A/ 6.2 |
| Southbound | A / 4.3 | A / 4.3 | B/15.9 | A / 3.7 | A / 8.1 |
| Eastbound | C / 24.5 | C / 29.1 | C / 26.8 | C / 29.5 | A / 5.8 |
| Westbound | C / 25.2 | C / 29.9 | C / 24.7 |  |  |
| Northwest bound |  |  |  |  | A / 4.3 |
| Southwest bound |  |  |  |  | A / 5.3 |
| Overall | A / 10.0 | B / 10.7 | B / 17.6 | A / 6.5 | A / 6.7 |
| SR 366 \& SR 235 (Stop Controlled) |  |  |  |  |  |
| Northbound (Stop) | A/ 9.1 | A/9.1 | B / 19.01 |  |  |
| Southbound | [A / 7.4] | [A / 7.4] | A / 3.9 |  |  |
| Eastbound |  |  | A / 1.5 |  |  |
| Overall |  |  | A / 5.1 |  |  |
| PM Peak Hour |  |  |  |  |  |
| US-33 \& SR 235 (Signalized) |  |  |  |  |  |
| Northbound | A / 8.2 | A / 10.0 | B / 17.8 | A / 6.3 | B / 16.9 |
| Southbound | A/ 6.9 | A / 8.0 | B/14.2 | A / 5.4 | B/10.6 |
| Eastbound | C / 25.0 | C/25.7 | C/34.8 | C / 30.4 | A / 9.3 |
| Westbound | C / 27.3 | C / 28.3 | C / 21.1 |  |  |
| Northwest bound |  |  |  |  | A / 8.9 |
| Southwest bound |  |  |  |  | B/10.1 |
| Overall | B / 13.8 | B / 14.8 | C / 20.1 | B / 10.7 | B / 12.5 |
| SR 366 \& SR 235 (Stop Controlled) |  |  |  |  |  |
| Northbound (Stop) | B/11.5 | B/12.2 | B 13.1 |  |  |
| Southbound | [A / 8.1] | [A / 8.3] | A / 3.2 |  |  |
| Eastbound |  |  | A/ 1.1 |  |  |
| Overall |  |  | A / 6.0 |  |  |
| Saturday Peak Hour |  |  |  |  |  |
| US-33 \& SR 235 (Signalized) |  |  |  |  |  |
| Northbound | A / 8.7 | B/10.1 | C / 25.1 | A/ 6.2 | B / 12.2 |
| Southbound | A / 7.7 | A / 8.6 | C / 21.4 | A / 5.6 | A / 9.8 |
| Eastbound | C/21.9 | C/21.8 | C/35.0 | C 27.8 | A / 9.3 |
| Westbound | C / 24.5 | C / 24.4 | B / 19.1 |  |  |
| Northwest bound |  |  |  |  | B/12.0 |
| Southwest bound |  |  |  |  | A / 9.4 |
| Overall | B / 14.3 | B / 14.7 | C / 24.7 | B / 10.9 | B / 10.7 |
| SR 366 \& SR 235 (Stop Controlled) |  |  |  |  |  |
| Northbound (Stop) | B/13.2 | B/14.3 | B / 10.6 |  |  |
| Southbound | [A / 8.3] | [A / 8.5] | A/6.8 |  |  |
| Eastbound |  |  | A / 2.4 |  |  |
| Overall |  |  | A/ 6.4 |  |  |

[ $\mathrm{x} / \mathrm{x} . \mathrm{x}]$ - Uncontrolled Left Turn Movement Delay

Table 1 (Continued): US-33 \& SR 235 and SR 235 \& SR 366 Traffic Analysis Results

|  | 2045 Design Year |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Movement | AM Peak <br> LOS/Delay | PM Peak <br> LOS/Delay | Weekend Peak <br> LOS/Delay |  |
| Build Alternative 2 |  |  |  |  |
| US-33 \& Quadrant Roadway (Signalized) |  |  |  |  |
| Eastbound | $\mathrm{A} / 8.0$ | $\mathrm{~A} / 6.9$ | $\mathrm{~A} / 7.2$ |  |
| Westbound | $\mathrm{A} / 6.6$ | $\mathrm{~A} / 5.6$ | $\mathrm{~A} / 5.7$ |  |
| Southbound | $\mathrm{A} / 9.7$ | $\mathrm{~B} / 15.5$ | $\mathrm{~B} / 13.8$ |  |
| Overall | $\mathrm{A} / 7.9$ | $\mathrm{~A} / 7.7$ | $\mathrm{~A} / 8.0$ |  |
| SR 366 \& Quadrant Roadway (Stop Controlled) |  |  |  |  |
| Eastbound |  |  |  |  |
| Westbound | $[\mathrm{A} / 7.6]$ | [A/8.0] | $[\mathrm{A} / 8.2]$ |  |
| Northbound | $\mathrm{A} / 9.2$ | $\mathrm{~B} / 11.9$ | $\mathrm{C} / 23.1$ |  |

[x/x.x] - Uncontrolled Left Turn Movement Delay

Table 2: US-33 \& Sunnyside Avenue and SR 366 \& Sunnyside Avenue Traffic Analysis Results

|  | $2019$ <br> Existing | 2045 Design Year |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Movement | $\begin{gathered} \text { Existing } \\ \text { LOS/Delay } \end{gathered}$ | No Build LOS/Delay | Build Alt 1 LOS/Delay | Build Alt 2 LOS/Delay | Build Alt 3 LOS/Delay | Build Alt 4 LOS/Delay |
| AM Peak Hour |  |  |  |  |  |  |
| US-33 \& Sunnyside Avenue (Stop Controlled) |  |  |  |  |  |  |
| Northbound | [A / 8.2] | [A / 8.5] | [A / 8.3] | [A / 8.7] |  | B / 13.6 |
| Southbound | [A / 7.9] | [A / 8.1] |  |  |  | B / 15.5 |
| Eastbound (Stop) | B / 13.0 | C / 16.3 | B / 12.6 | B / 13.6 | B / 11.1 | C / 26.2 |
| Westbound (Stop) | B / 12.6 | C / 14.7 |  | A/9.9 | A/9.9 | A / 1.2 |
| Overall |  |  |  |  |  | B / 14.5 |
| SR 366 \& Sunnyside Avenue (Stop Controlled) |  |  |  |  |  |  |
| Northbound (Stop) | A / 9.5 | A / 9.9 |  | A / 9.5 | A / 9.5 | C / 33.4 |
| Southbound (Stop) | A / 9.4 | A / 9.6 |  | A/9.5 | A/9.5 | C / 26.0 |
| Eastbound | [A / 7.2] | [A / 7.2] |  | [A / 7.2] | [A / 7.2] | A / 0.1 |
| Overall |  |  |  |  |  | C / 20.2 |
| PM Peak Hour |  |  |  |  |  |  |
| US-33 \& Sunnyside Avenue (Stop Controlled) |  |  |  |  |  |  |
| Northbound | [A / 8.2] | [A / 8.5] | [A / 8.6] | [A / 8.8] |  | C / 26.0 |
| Southbound | [A / 8.9] | [A / 9.4] |  |  |  | C/ 22.9 |
| Eastbound (Stop) | C / 22.6 | E/38.8 | C / 15.4 | C / 22.8 | B / 11.9 | C / 34.3 |
| Westbound (Stop) | C / 16.9 | C / 23.0 |  | B / 12.2 | B / 12.2 | A / 1.1 |
| Overall |  |  |  |  |  | C / 23.6 |
| SR 366 \& Sunnyside Avenue (Stop Controlled) |  |  |  |  |  |  |
| Northbound (Stop) | B / 13.7 | B / 14.9 |  | B / 12.8 | B / 12.8 | D / 36.4 |
| Southbound (Stop) | B / 11.6 | B / 12.2 |  | B / 10.9 | B / 10.9 | C / 25.9 |
| Eastbound | [A / 7.3] | [A / 7.3] |  | [A / 7.3] | [A / 7.3] | A / 0.3 |
| Overall |  |  |  |  |  | C / 23.1 |
| Saturday Peak Hour |  |  |  |  |  |  |
| US-33 \& Sunnyside Avenue (Stop Controlled) |  |  |  |  |  |  |
| Northbound | [A / 8.2] | [A / 8.5] | [A / 8.7] | [A / 8.7] |  | C / 26.9 |
| Southbound | [A / 8.5] | [A / 8.8] |  |  |  | C / 26.0 |
| Eastbound (Stop) | C / 19.8 | D / 27.8 | C / 15.5 | C / 18.6 | B / 12.1 | C / 30.4 |
| Westbound (Stop) | C / 15.3 | C / 19.9 |  | B / 12.0 | B / 12.0 | A / 3.2 |
| Overall |  |  |  |  |  | C / 25.1 |
| SR 366 \& Sunnyside Avenue (Stop Controlled) |  |  |  |  |  |  |
| Northbound (Stop) | B / 14.3 | C / 16.9 |  | B / 13.4 | B / 13.4 | C / 33.4 |
| Southbound (Stop) | B / 11.9 | B / 12.9 |  | B / 11.3 | B / 11.3 | A/6.1 |
| Eastbound | [A / 7.3] | [A / 7.3] |  | [A / 7.3] | [A / 7.3] | A/ 0.2 |
| Overall |  |  |  |  |  | B / 18.6 |

[^0]|  | 2045 Design Year |  |  |
| :---: | :---: | :---: | :---: |
| Movement | AM Peak LOS/Delay | PM Peak LOS/Delay | Weekend Peak LOS/Delay |
| Build Alternative 5 |  |  |  |
| US-33 \& SR 366 (Roundabout) |  |  |  |
| Northeast bound (US-33) | A / 6.6 | B / 12.6 | B / 10.7 |
| Southeast bound (US-33) | A 7.3 | A/9.1 | B/11.2 |
| Northwest bound (SR 366) | A 4.8 | B/10.8 | B/11.5 |
| Southwest bound (SR 366) | A / 4.5 | A / 7.6 | A / 8.7 |
| Overall | A / 6.7 | B/10.5 | B/10.7 |


|  | 2019 Existing | 2045 Design Year |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Movement | Existing LOS/Delay | No Build LOS/Delay | Build Alt 1 LOS/Delay | Build Alt 2 <br> LOS/Delay |
| AM Peak Hour |  |  |  |  |
| US-33 \& Lincoln Boulevard (Stop Controlled) |  |  |  |  |
| Northbound (Stop) | B / 12.9 | C / 16.3 | B / 12.3 |  |
| Southbound (Stop) | B/12.4 | C / 15.4 |  |  |
| Eastbound | [A / 7.9] | [A / 7.9] |  |  |
| Westbound | [A / 8.1] | [A / 8.0] | [A / 8.1] |  |
| SR 366 \& Lincoln Boulevard (Stop Controlled) |  |  |  |  |
| Northbound | [A / 7.3] | [A / 7.3] |  |  |
| Eastbound (Stop) | A/9.5 | A / 9.5 |  |  |
| Westbound (Stop) | B/ 10.2 | B/ 10.6 |  |  |
| PM Peak Hour |  |  |  |  |
| US-33 \& Lincoln Boulevard (Stop Controlled) |  |  |  |  |
| Northbound (Stop) | C / 20.0 | C / 25.7 | B / 14.2 |  |
| Southbound (Stop) | C / 15.3 | C / 18.3 |  |  |
| Eastbound | [A/8.6] | [A / 9.0] |  |  |
| Westbound | [A / 8.1] | [A / 8.3] | [A / 8.1] |  |
| SR 366 \& Lincoln Boulevard (Stop Controlled) |  |  |  |  |
| Northbound | [A / 7.3] | [A / 7.3] |  |  |
| Eastbound (Stop) | B/ 11.1 | B/11.7 |  |  |
| Westbound (Stop) | B / 12.5 | B/13.3 |  |  |
| Saturday Peak Hour |  |  |  |  |
| US-33 \& Lincoln Boulevard (Stop Controlled) |  |  |  |  |
| Northbound (Stop) | C / 22.1 | D / 32.9 | C / 15.2 |  |
| Southbound (Stop) | C / 19.2 | D / 28.3 |  |  |
| Eastbound | [A / 8.6] | [A / 9.0] |  |  |
| Westbound | [A/8.1] | [A/8.3] | [A / 8.3] |  |
| SR 366 \& Lincoln Boulevard (Stop Controlled) |  |  |  |  |
| Northbound | [A / 7.3] | [A / 7.4] |  |  |
| Eastbound (Stop) | B/ 13.6 | C / 15.4 |  |  |
| Westbound (Stop) | C / 17.1 | C / 21.3 |  |  |

[x/x.x] - Uncontrolled Left Turn Movement Delay

Table 4: US-33 \& SR 708 and SR 708 \& SR 366 Traffic Analysis Results

|  | 2019 Existing | 2045 Design Year |  |
| :---: | :---: | :---: | :---: |
| Movement | Existing <br> LOS/Delay | No Build <br> LOS/Delay | Build <br> LOS/Delay |
| AM Peak Hour |  |  |  |
| US-33 \& SR 708 (Signalized) |  |  |  |
| Northbound | $\mathrm{C} / 27.6$ | $\mathrm{C} / 29.8$ | $\mathrm{C} / 26.3$ |
| Southbound | $\mathrm{C} / 26.2$ | $\mathrm{C} / 28.7$ | $\mathrm{C} / 28.5$ |
| Eastbound | $\mathrm{A} / 5.0$ | $\mathrm{~A} / 5.5$ | $\mathrm{~A} / 7.1$ |
| Westbound | $\mathrm{A} / 4.9$ | $\mathrm{~A} / 5.3$ | $\mathrm{~A} / 6.6$ |
| Overall | $\mathrm{B} / 12.9$ | $\mathrm{~B} / 13.4$ | $\mathrm{~B} / 15.5$ |
|  |  |  |  |


| Northbound (Stop) | A / 8.0 | A/8.3 | B/ 10.4 |
| :---: | :---: | :---: | :---: |
| Southbound (Stop) | A/8.0 | A/8.2 | A / 8.9 |
| Eastbound (Stop) | A/7.7 | A/8.0 | A / 8.5 |
| Westbound (Stop) | A/8.4 | A/7.9 | B/10.2 |
| Overall | A/8.1 | A/ 8.6 | A/9.8 |
| PM Peak Hour |  |  |  |
| US-33 \& SR 708 (Signalized) |  |  |  |
| Northbound | C/27.1 | C/27.8 | C / 26.5 |
| Southbound | C/25.6 | C / 25.9 | C / 7.1 |
| Eastbound | A/6.3 | A/7.7 | B / 15.4 |
| Westbound | A/ 6.7 | A/8.3 | B / 10.5 |
| Overall | B/13.6 | B / 14.5 | B / 18.3 |
| SR 366 \& SR 708 (Stop Controlled) |  |  |  |
| Northbound (Stop) | A/9.3 | A/9.9 | D / 25.2 |
| Southbound (Stop) | A/9.0 | A/9.3 | B / 10.7 |
| Eastbound (Stop) | A/9.1 | A/9.5 | B/11.0 |
| Westbound (Stop) | A/9.7 | B/ 10.3 | B/13.9 |
| Overall | A/9.3 | A/9.8 | C/ 18.9 |
| Weekday Peak Hour |  |  |  |
| US-33 \& SR 708 (Signalized) |  |  |  |
| Northbound | C / 25.2 | C / 26.3 | C / 25.3 |
| Southbound | C/23.9 | C / 24.8 | C / 25.8 |
| Eastbound | A / 7.0 | A/8.0 | B / 14.6 |
| Westbound | A/7.1 | A/8.3 | B/11.7 |
| Overall | B / 13.5 | B / 14.1 | B / 18.2 |
| SR 366 \& SR 708 (Stop Controlled) |  |  |  |
| Northbound (Stop) | B / 10.4 | B/11.1 | D / 30.2 |
| Southbound (Stop) | A/9.8 | B/10.2 | B/11.9 |
| Eastbound (Stop) | B / 10.5 | B / 11.1 | B/14.1 |
| Westbound (Stop) | B / 11.7 | B / 12.7 | C / 15.9 |
| Overall | B / 10.8 | B/11.5 | C/21.5 |

Indian Lake Intersections Study
Page 11

## Traffic Signal Warrants

Traffic signal warrants were conducted for the study intersections using the Manual on Uniform Traffic Control Devices (MUTCD) signal warrants. The signalized intersections of US-33 \& SR 235 and US-33 \& SR 708 meet the requirements for a traffic signal. The unsignalized study intersections do not currently meet the MUTCD signal warrant requirements. Under build conditions, the traffic volumes for the revised configurations are similar to, or a reduction compared to the existing configuration except for the all-way stop at the SR 366 \& SR 708 intersection. However, this location is expected to operate at an overall acceptable level of service and is not anticipated to be signalized. The proposed intersection of US-33 \& Quadrant Roadway (Alternative 3) could potentially warrant a signal as well. Results for the traffic signal warrants for the existing condition summarized in Table 5 below. Detailed signal warrant outputs are included in the Appendix.

| Table 5: Signal Warrant Summary |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Number of Hours Met |  |  |  |  |
| Intersection | Warrant 1 A <br> $\mathbf{1 0 0 \%}$ | Warrant 1 A <br> $\mathbf{8 0 \%}$ | Warrant 1 B <br> $\mathbf{1 0 0 \%}$ | Warrant 1 B <br> $\mathbf{8 0 \%}$ | Signal <br> Warranted? |
| US 33 \& SR 235 | 9 | 14 | 5 | 13 | Yes |
| SR 366 \& SR 235 | 3 | 5 | 1 | 1 | No |
| US 33 \& Sunnyside Ave | 1 | 2 | 1 | 9 | No |
| SR 366 \& Sunnyside Ave | 0 | 0 | 0 | 0 | No |
| US 33 \& SR 708 | 13 | 15 | 7 | 12 | Yes |
| SR 366 \& SR 708 | 0 | 0 | 0 | 0 | No |
| US 33 \& Lincoln Blvd | 0 | 1 | 7 | 12 | No |
| SR 366 \& Lincoln Blvd | 0 | 0 | 0 | 0 | 0 |

## Bicycle, Pedestrian, and Wayfinding Treatments

This portion of Indian Lake has seasonal traffic and pedestrian traffic due to the proximity to the boat ramps. We understand there are concerns about wayfinding, pedestrian and bicycle. B\&N has identified several treatments to promote a safer multimodal roadway system.
US-33 \& SR 235, SR 235 \& SR 366:

- Access: Currently, vehicles exiting Villa Motel driveway must exit onto West Lake Street right at the stop line for the US-33 signal. This can become a difficult maneuver as this exit will often be blocked by vehicles waiting at the signal. In addition, it is very challenging for exiting vehicles to enter the eastbound left turn lane on West Lake Street. To simplify the configuration and create a more traditional situation, we recommend closing the existing access point on West Lake Street and creating a new connection on US-33.
- Pedestrian: There is currently a sidewalk along West Lake Street to the west of US-33. and a shared use path running along the east side of SR 366 . However, the connection between these two pedestrian features is incomplete. There is a marked crosswalk across US-33 and sidewalk in the area between US-33 and SR 366, but there is nothing between SR 366 and the shared use path. We recommend installing a marked crosswalk across SR 366 and adding sidewalk to tie the crosswalk into the shared use path.

Along SR 366, south of the intersection with SR 235, there are several boat docks and parking lot for the Lakeview Harbor boat ramp. Across SR 366 from the boat docks is a restaurant. Several pedestrians cross SR 366 at this location to go between the boat docks/parking lot and the

## Indian Lake Intersections Study

Page 12
restaurant. This is in a midblock location along SR 366 and pedestrians at this location are unexpected, especially to the high number of out-of-town drivers. We recommend installing a marked pedestrian crosswalk at this location and rectangular rapid flashing beacon (RRFB) to provide warning to the drivers.

- Signage: These intersections serve as a primary access point for traffic on US-33 to access the Lakeview Harbor boat ramp on SR 366 and the various parks along the west bank. We recommend additional point of interest signing on both directions of US-33 to direct motorists to these destinations.

US-33 \& Sunnyside, SR 366 \& Sunnyside:

- Pedestrians: There are sidewalks along both sides of SR 366 and marked crosswalks at the intersection of SR 366 \& Sunnyside Avenue. There are also sidewalks along Sunnyside Avenue that connect SR 366 to Fairview Avenue. However, there are no marked crosswalks across US-33, which is a concern since US-33 is free-flowing and high speed. Traffic counts show that approximately 100 pedestrians a day cross US-33. There has been one pedestrian crash in the last three years. We recommend installing a marked pedestrian crosswalk across US-33 and a RRFB for the unsignalized options and a marked pedestrian crosswalk with pedestrian signal heads for the signalized option to provide warning to the drivers and improve pedestrian safety.
- Signage: We recommend additional advanced pedestrian crosswalk ahead warning signs for the crosswalk across US-33 in addition to the signs at the RRFB.

US-33 \& SR 708 (Orchard Island Road), SR 366 \& SR 708 (Orchard Island Road):

- Access: Out of all the study intersections, SR 708 provides the longest distance between US-33 and SR 366. There are also no free-flow movements to access US-33 or SR 366. We do not recommend any improvements to this set of intersections currently. However, should movements be restricted at either Sunnyside Avenue or Lincoln Boulevard in the future, the segment of SR 708 between US-33 and SR 366 should be reevaluated to determine if additional capacity is required to accommodate the diverted traffic.
- Pedestrians: There are sidewalks and marked crosswalks on all four approaches at the SR 366 and SR 708 intersection. At the intersection of US-33 and SR 708 there is a marked crosswalk with pedestrian signal heads on the east approach at the intersection. The west approach at this intersection is signed to prohibit pedestrians and directs them to the crosswalk on the east approach. The only concern is if pedestrians are using the sidewalk on the west side of SR 708, south of US-33, how do they get to the east side? They are likely making a mid-block crossing at various points along SR 708. We recommend pedestrian heads and a marked crosswalk across the south approach of SR 708 at the US-33 intersection. A short sidewalk connection will be needed to connect the sidewalk on the west side of SR 708 to the intersection
- Signage: We do not recommend additional signing at this intersection.


## US-33 \& Lincoln Boulevard, SR 366 \& Lincoln Boulevard:

- Pedestrians: At the SR 366 \& Lincoln Boulevard intersection there is a marked crosswalk across the eastbound approach. However, it is located prior to the stop line. At a minimum, the stop line should be relocated so that it is prior to the crosswalk. However, given the land uses in the area of the intersection, it appears that the number of pedestrians crossing SR 366 would be very low in this area. Most pedestrian activity on SR 366 would be concentrated farther to the west. We recommend discouraging pedestrian crossings at Lincoln Boulevard by removing the crosswalk and relocating it farther west. A mid-block crosswalk near McDonalds would be a more desirable location and receive more use. This midblock crossing could be signed as an RRFB or with standard pedestrian crosswalk signs. For the intersection of US-33 \& Lincoln, there are no
sidewalks or crosswalks. Pedestrian activity should be very low at this intersection as well. To discourage pedestrian crossings at this location, we recommend leaving the intersection as is without sidewalks and crosswalks.
- Signage: We recommend pedestrian signage for a new mid-block crossing on SR 366 near McDonalds.


## Cost Estimate

Preliminary cost estimates were developed geometric alternatives and other recommendations for the study intersections. Detailed cost calculations for the geometric alternatives are included in the Appendix.

## US-33 \& SR 235, SR 235 \& SR 366

- Alternative 1 (Cluster Signal) - \$507,000
- Alternative 2 (Quadrant Roadway) - \$1,250,000
- Alternative 3 (Roundabout) - \$2,550,000
- RRFB and crosswalk across SR 366-\$17,500
- Relocate Villa Motel driveway - \$60,000
- Marked crosswalk and sidewalk to connect to SUP - \$15,000


## US-33 \& Sunnyside, SR 366 \& Sunnyside

- Alternative 1 (SR 366 Closed, Sunnyside Full Access) - \$181,000
- Alternative 2 (SR 366 RI/RO, Sunnyside Open) - \$191,000
- Alternative 3 (SR 366 RI/RO, Sunnyside RI/RO) - \$197,000
- Alternative 4 (Cluster Signal) - $\$ 685,000$
- Alternative 5 (Roundabout) - $\$ 2,175,000$
- RRFB, advance signs and crosswalk across US-33-\$20,000


## US-33 \& SR 708 (Orchard Island Road), SR 366 \& SR 708 (Orchard Island Road)

- Marked crosswalk, pedestrian heads and sidewalk connection to cross SR 708-\$20,000


## US-33 \& Lincoln, SR 366 \& Lincoln

- Alternative 1 (SR 366 closed, Lincoln Full Access) - \$239,000
- Alternative 2 (SR 366 closed, Lincoln closed) - \$187,000
- Mid-block marked crosswalk and RRFB - \$15,000


## Conclusions

Based on the safety analysis, capacity analysis and cost estimates presented in this report, the following recommended improvements were identified for each pair of intersections. Recommended improvements were grouped into short and medium / long-term designations. The short-term recommendations are typically small, low-cost improvements that can be implemented in less than three years and provide some immediate benefits. The medium / long term recommendations have a longer implementation period of four years or longer. These recommendations typically require a longer period to obtain funding and plan development or may not be needed for capacity or safety reasons for several years.

Indian Lake Intersections Study
Page 14

US-33 \& SR 235, SR 235 \& SR 366

## Short-Term Recommendations

The short-term recommendations for this pair of intersections focus on completing pedestrian connections and improving pedestrian safety. The recommended improvements are:

- Providing a marked crosswalk across SR 366 and providing missing sidewalk sections to provide a continuous sidewalk connection from the west side of US-33 to the shared use path running along the east side of SR 366/235.
- Provide a mid-block pedestrian crossing and rectangular rapid flashing beacon on SR 366 across from the boat docks.


## Medium/Long-Term Recommendations

This pair of intersections currently has acceptable level of service and does not have as identifiable crash concern. The primary operational issue is the short distance between the intersections and occasional delay to left turning vehicles on SR 366 caused by the SR 235 queues. From the analysis, it does not appear that this delay is significant and would warrant immediate attention. Also, the Villa Motel driveway is in an unusual location. However, the traffic volume on this driveway is very low and there were no crashes reported in the last three years resulting from this driveway location. It is recommended that the left turning delay on SR 366 and the Villa Motel driveway be monitored. If these become a significant issue in the coming years, the following improvements are recommended:

- Relocate the Villa Motel driveway from SR 235 to US-33.
- Construct Alternative 3 (Roundabout) at this pair of intersections.


## US-33 \& Sunnyside, SR 366 \& Sunnyside

## Short-Term Recommendations

The short-term recommendation for this pair of intersections focus on improving pedestrian safety. The recommended improvements are:

- Provide a marked crosswalk, RRFB and advance crosswalk warning signs across US-33.


## Medium/Long-Term Recommendations

This pair of intersections currently has acceptable level of service but there is a potential safety concern with the high travel speed on US-33 combined with left turns and through movements on Sunnyside Avenue. Also, there is very little distance between US-33 and SR 366. This makes it difficult for vehicles on SR 366 to judge when there is an acceptable gap to travel through the intersection. The following alternative is recommended to address these concerns:

- Construct Alternative 4 (Cluster Signal). This alternative will improve the safety of this pair of intersections. In addition, it will not add additional traffic to the SR 708 corridor.

US-33 \& SR 708 (Orchard Island Road), SR 366 \& SR 708 (Orchard Island Road)
Short-Term Recommendations
The short-term recommendation for this pair of intersections focus on improving pedestrian safety. The recommended improvements are:

- Provide a marked crosswalk, pedestrian heads and sidewalk connections for the northbound approach at the US-33 intersection


## Indian Lake Intersections Study

Page 15

## Medium/Long-Term Recommendations

This pair of intersections is expected to have acceptable operations provided there is not a significant change to traffic patterns in the area. Should the changes at Sunnyside Avenue and Lincoln Boulevard result in a significant increase in traffic on SR 708, the following improvement options should be evaluated:

- A mini-roundabout to replace the all-way stop at SR 366 and SR 708. Preliminary capacity analysis shows acceptable levels of service and queue lengths that are not expected to extend from SR 366 to US 33.
- Widen northbound SR 708 between US-33 and SR 366 to provide a second travel lane. This lane will become a right-turn only lane at the SR 366 intersection. Note that there is no room for utility relocation which may be a barrier to this improvement.


## US-33 \& Lincoln, SR 366 \& Lincoln

## Short-Term Recommendations

The short-term recommendation for this pair of intersections focus on improving pedestrian safety. The recommended improvements are:

- Eliminate the marked crossing at the SR 366 intersection and install a new mid-block crossing with pedestrian warning signs near McDonalds.


## Medium/Long-Term Recommendations

This pair of intersections currently has acceptable level of service but there is a potential safety concern with the high travel speed on US-33 combined with left turns and through movements on Lincoln Boulevard. Also, there is very little distance between US-33 and SR 366. This makes it difficult for vehicles on SR 366 to judge when there is an acceptable gap to travel through the intersection. The following improvement is recommended to address this concern:

- Construct Alternative 1 (SR 366 Closed, Lincoln Full Access). This alternative will improve the safety of this pair of intersections.











AL TFRNATIVF 2



## US-33 \& LINCOLN BLVD

SR 366 \& LINCOLN BLVD


Al TFRNATIVF.


> US-33 \& SR 708
> SR 708 \& SR 366
> (ASSUMES ALTERNATIVE 1 AT
> SUNNYSIDE AVE AND LINCOLN BLVD)


[^0]:    [x/x.x] - Uncontrolled Left Turn Movement Delay

