

December 8, 2014

Ed H. Parvin
Town of Carolina Beach
1121 N. Lake Park Blvd.
Carolina Beach, NC 28428
P: 910-458-2526

Subject: Canal Drive Circulation Study

Dear Mr. Parvin:

This letter presents the findings of a traffic circulation study prepared by Ramey Kemp and Associates, Inc. (RKA) for the Town of Carolina Beach. This study was prepared to evaluate options for modifying traffic flow on Canal Drive and Cape Fear Boulevard in the vicinity of the boardwalk to improve pedestrian safety, while also maintaining an acceptable level of operation for vehicular traffic.

Through discussions with the Town, it is our understanding that during summer months and special events, there is a significant increase in pedestrian activity in the vicinity of the boardwalk. This increase in pedestrian activity, coupled with a similar increase in vehicular volumes, creates a potentially unsafe situation as the number of pedestrian/vehicle conflicts rises. Conflicts between pedestrians and vehicles are especially prevalent along heavily-walked Canal Drive. Canal Drive has a right-of-way width of approximately 25 feet, and thus is narrow and has no sidewalk or marked crosswalks. This makes it difficult for two-way vehicular traffic to safely and efficiently maneuver with large groups of pedestrians. Widening of Canal Drive to provide sidewalks or additional pavement width is not a viable option to improve safety conditions, since this segment of Canal Drive has a right-of-way of only 25 feet.

The study analyzes options for changes to vehicular circulation along Canal Drive and the block bounded by Harper Avenue to the north, N. Lake Park Boulevard (US 421) to the west, and Cape Fear Boulevard to the south. The intersections which would be impacted most by changes to vehicular circulation around the block were identified as study intersections and include the following:

- N. Lake Park Boulevard (US 421) and Harper Avenue
- N. Lake Park Boulevard (US 421) and Cape Fear Boulevard
- Canal Drive and Harper Avenue
- Canal Drive and Cape Fear Boulevard

At the Town's request, this study analyzes 2014 summer peak hour and special event traffic volumes in the study area with a left, or counter-clockwise, one-way circulation pattern for the block. With this circulation pattern, Canal Drive would be converted to a one-way northbound roadway and Cape Fear Boulevard could remain as a two-way roadway or be converted to one-way eastbound.

Additional circulation conditions, including right, or clockwise, circulation, and complete or partial closure of Canal Drive, were also evaluated. A “do-nothing” condition in which lanes and traffic flow were kept as-is was also analyzed to provide a baseline comparison for traffic operations. A detailed description of each of the evaluated circulation plans is provided in the *Circulation Scenarios and Diverted Traffic Volumes* section of this letter.

Existing (2014) Traffic Conditions

Existing (2014) summer peak traffic volumes at the study intersections were estimated based on traffic count data obtained from the TIA (Traffic Impact Analysis) prepared for the Hampton Inn located just north of the boardwalk on Canal Drive. The traffic data from the TIA showed that the typical (non-special event) peak hour during the summer occurs midday on Saturday.

Since the traffic data from the TIA was collected in 2006, it was necessary to apply a growth rate to project the traffic volumes to the year 2014. Based on historical traffic data available from the North Carolina Department of Transportation (NCDOT), it was determined that the traffic volumes from 2006 would be increased by approximately 8.3% to estimate existing summer Saturday peak hour traffic volumes. An 8.3% increase in volume is representative of an average annual growth rate over the past eight (8) years of approximately 1% per year. Special event peak hour traffic volumes were estimated by increasing all Saturday peak hour traffic volumes, except through movement volumes on N. Lake Park Boulevard, by 50%. Traffic volumes were balanced where appropriate.

The count data from the Hampton Inn TIA includes pedestrian counts at each of the study intersections; however, it is likely that the count data did not capture all of the pedestrian crossings, as many pedestrians choose to cross midblock or at locations other than an intersection. Therefore, the pedestrian volumes that were analyzed in this study are higher than those indicated in the count data.

Refer to Figure 1, attached, for an illustration of the existing (2014) Saturday and special event peak hour traffic volumes with the current vehicular circulation plan (do-nothing). Copies of the raw traffic and pedestrian count data taken from the Hampton Inn TIA are provided as an attachment to this letter.

Circulation Scenarios and Diverted Traffic Volumes

The existing (2014) traffic volumes shown in Figure 1 (attached) were diverted as necessary to reflect projected traffic conditions under each of the circulation plans analyzed. Refer to the following for a brief discussion of each circulation plan and the associated traffic diversions.

Counterclockwise Circulation Scenario

Under the counterclockwise circulation plan, Cape Fear Boulevard would be converted to a one-way roadway with traffic flow in the eastbound direction toward the boardwalk, and Canal Drive would be converted to a one-way roadway with traffic flow in the northbound direction toward Harper Avenue. With this plan, vehicles would make consecutive left turns at each of the study intersections in order to circle the block in a counterclockwise direction.

In order to model the counterclockwise circulation plan, traffic was diverted from some intersection movements and added to other movements. Traffic that would have previously traveled through the Canal Drive/Harper Avenue intersection to head southbound on Canal Drive must be diverted to the intersection of N. Lake Park Boulevard and Cape Fear Boulevard to access the boardwalk area. Traffic that would have accessed N. Lake Park Boulevard via Cape Fear Boulevard must be diverted to exit the boardwalk area via Canal Drive at Harper Boulevard. The diversion of this traffic would be expected to moderately to significantly increase traffic volumes for the following traffic movements:

- southbound right turn movement on Canal Drive at Harper Avenue
- northbound left turn and through movements on Canal Drive at Harper Avenue
- westbound left and right turn movements on Harper Avenue at N. Lake Park Boulevard
- southbound left turn movement on N. Lake Park Boulevard at Cape Fear Boulevard
- eastbound left turn movement on Cape Fear Boulevard at Canal Drive

Except for traffic movements which would be eliminated with the counterclockwise circulation plan, the only traffic movements which may be expected to decrease in volume are the northbound through movement on N. Lake Park Boulevard and the southbound left turn movement on N. Lake Park Boulevard at Harper Avenue. Volume changes for other movements would likely be minimal.

Refer to Figure 2, attached, for an illustration of the existing (2014) Saturday and special event peak hour traffic volumes with the counterclockwise vehicular circulation plan.

Clockwise Circulation Scenario

Under the clockwise circulation plan, Canal Drive would be converted to a one-way roadway with traffic flow in the southbound direction toward Cape Fear Boulevard, and Cape Fear Boulevard would be converted to a one-way roadway with traffic flow in the westbound direction toward N. Lake Park Boulevard. With this plan, vehicles would make consecutive right turns at each of the study intersections in order to circle the block in a clockwise direction.

In order to model the counterclockwise circulation plan, traffic that would have previously traveled through the Canal Drive/Harper Avenue intersection to head southbound on Canal Drive must be diverted to the intersection of N. Lake Park Boulevard and Cape Fear Boulevard to access the boardwalk area. Traffic that would have accessed N. Lake Park Boulevard via Cape Fear Boulevard must be diverted to exit the boardwalk area via Canal Drive at Harper Boulevard. The diversion of this traffic would be expected to moderately to significantly increase traffic volumes for the following traffic movements:

- southbound left turn movement on N. Lake Park Boulevard at Harper Avenue
- northbound right turn movement on N. Lake Park Boulevard at Harper Avenue
- eastbound left and right turn movements on Harper Avenue at Canal Drive
- westbound left, through, and right turn movements on Cape Fear Boulevard at N. Lake Park Boulevard
- southbound right turn movement on Canal Drive at Cape Fear Boulevard

In addition to the traffic movements which would be eliminated with clockwise circulation, the following movements may see a slight to moderate decrease in traffic volumes with under this plan:

- southbound through movement on N. Lake Park Boulevard at Harper Avenue
- eastbound right turn movement on Harper Avenue at N. Lake Park Boulevard
- westbound left turn movement on Harper Avenue at N. Lake Park Boulevard

With this plan, it is possible that the traffic signal at the intersection of Canal Drive and Harper Avenue could be removed and replaced by stop-control on the southbound and westbound approaches (of Canal Drive and the Hampton Inn driveway, respectively) and free-flow conditions on the westbound approach of Harper Avenue. While this change in intersection control would benefit the westbound approach and help keep westbound left turn movement queues low, it could result in significantly more delay for the southbound approach of Canal Drive and would make conditions for pedestrians crossing Harper Avenue more dangerous. Maintaining signal control at this intersection could allow for pedestrians to cross Harper Avenue in a safer condition. It is our understanding that the existing traffic signal would be upgraded in the future. As part of the upgrade, it would be recommended to consider installing signalized pedestrian crosswalks with countdown heads.

Refer to Figure 3, attached, for an illustration of the existing (2014) Saturday and special event peak hour traffic volumes with the clockwise vehicular circulation plan.

Canal Drive Closure

The Canal Drive closure plan consists of the complete closure of Canal Drive to automobiles between Cape Fear Boulevard and Harper Avenue. A three-lane cross-section and two-way traffic flow would be maintained on Cape Fear Boulevard and a turnaround area would be provided at the end nearest the boardwalk. With this plan, all vehicles would utilize the N. Lake Park Boulevard/Cape Fear Boulevard intersection to access the boardwalk area and Canal Drive would be a pedestrian only facility. This plan would turn Raleigh Avenue, which is one-way toward Canal Drive, into a dead end, leaving no way out for vehicles that turn onto Raleigh Avenue from N. Lake Park Boulevard. Under this plan, Raleigh Avenue would need to be closed or converted to a two-way facility.

In order to model the Canal Drive closure plan, all traffic entering or exiting the boardwalk area via the Canal Drive/Harper Avenue intersection was diverted to enter and exit the block via the intersection of N. Lake Park Boulevard and Cape Fear Boulevard. The diversion of this traffic would be expected to moderately to significantly increase traffic volumes for the following traffic movements:

- southbound right turn movement on Canal Drive at Harper Avenue
- eastbound left turn movement on Harper Avenue at Canal Drive
- northbound right turn movement on N. Lake Park Boulevard at Harper Avenue
- westbound left turn movement on Harper Avenue at N. Lake Park Boulevard
- northbound left turn and through movements on N. Lake Park Boulevard at Harper Avenue
- southbound left turn movement on N. Lake Park Boulevard at Cape Fear Boulevard
- westbound left, through, and right turn movements on Cape Fear Boulevard at N. Lake Park Boulevard

The diversion of traffic for the Canal Drive closure plan would not be expected to significantly decrease volume for any traffic movements, except those movements which would be eliminated under the plan (movements entering and exiting block via Canal Drive/Harper Avenue intersection).

Refer to Figure 4, attached, for an illustration of the existing (2014) Saturday and special event peak hour traffic volumes with the Canal Drive closure plan.

Partial Canal Drive Closure

The partial Canal Drive closure plan consists of the closure of Canal Drive to automobiles between Raleigh Avenue and Cape Fear Boulevard. North of Raleigh Avenue, Canal Drive would operate as a one-way facility with traffic flow in the northbound direction toward Harper Avenue. This plan would allow automobiles and delivery trucks utilizing Raleigh Avenue to exit the block without making Raleigh Avenue a two-way facility. As in the complete closure plan, three-lane cross-section and two-way traffic flow would be maintained on Cape Fear Boulevard and a turnaround area would be provided at the end nearest the boardwalk.

The partial Canal Drive closure plan was modeled in the same way as the complete Canal Drive closure plan, except that traffic on Raleigh Avenue was assigned to the northbound approach of the Canal Drive/Harper Avenue intersection to exit the block. Traffic volumes on Raleigh Avenue are low, so traffic volumes on the northbound approach of Canal Drive at Harper Avenue would also be expected to be low. It is possible, however, that some people might use Raleigh Avenue (to Canal Drive, to Harper Avenue, to N. Lake Park Boulevard) to circle the block.

Anticipated increases and decreases in traffic volume movements under the partial Canal Drive closure plan are similar to those expected with the complete Canal Drive closure plan.

Refer to Figure 5, attached, for an illustration of the existing (2014) Saturday and special event peak hour traffic volumes with partial closure of Canal Drive.

Capacity Analysis and Measures of Effectiveness (MOEs)

Each of the above circulation scenarios was modeled using the Synchro version 9 traffic analysis software to evaluate traffic operations. Study intersections were analyzed twice for each scenario: once with existing (2014) Saturday peak hour traffic volumes and once with existing (2014) special event peak hour traffic volumes. Large pedestrian crossing volumes were analyzed at each of the intersections, and pedestrian signal calls were assumed to be placed every cycle or two at study intersections which have pedestrian signals. It should be noted that the analysis models evaluate vehicle capacity in the study area with measures such as vehicle delay and queues. The models do not evaluate safety measures of the alternatives.

Table 1 provides a summary of analysis results and a comparison of several MOEs for each of the circulation scenarios.

Table 1
Analysis Results and MOEs

Circulation Scenario	Intersection Level-of-Service (Saturday / Special Event)			Average Circulation Delay	Canal Drive Pedestrian Safety
	Lake Park and Harper Ave.	Lake Park and Cape Fear	Canal Dr. and Harper Ave.		
Existing/“Do Nothing”	B / C	B / D	A / B	Low	Unchanged
Counterclockwise	C / E	C / D	A / B	High	Improved
Clockwise	D / E	B / C	B / B	Low/Moderate	Improved
Canal Drive Closure	C / E	B / D	B / B	Moderate/High	Significantly Improved
Partial Canal Drive Closure	C / E	B / D	B / C	Moderate/High	Improved

Conclusions

Based on the findings of this study, analysis models show that the current two-way traffic pattern provides the best operational results for vehicles at the study intersections. This occurs since the traffic is more dispersed at the study intersections given the two-way traffic flow on Canal Drive. The model cannot simulate the impact of pedestrians crossing mid-block and the delays that this creates. This option results in more pedestrian – vehicle interaction, which increases the potential for pedestrian crashes. Perhaps the main conclusion from this circulation study is that the option that provides the better results for vehicle operations also results in the worst pedestrian operations (fewest pedestrian accommodations and more vehicle-pedestrian conflicts). Given the type of area with high pedestrian volumes, a large number of special events, limited number of parking spaces, and other points of roadway connectivity, it would be desirable to accommodate a safe design for pedestrians and allow vehicles to be slightly inconvenienced.

It was determined that a counterclockwise circulation plan could improve pedestrian safety along Canal Drive by implementing one-way traffic flow, but it would adversely impact traffic operations at the study intersections and create a situation where circulating vehicles experience a significant amount of delay. With counterclockwise circulation, vehicles would make consecutive left turns at each of the study intersections to circle the block. Left turn movements incur more delay than any other intersection movement.

Analysis indicates the clockwise circulation plan would be expected to improve pedestrian safety on Canal Drive by modifying traffic flow to one-way on Canal Drive, while also keeping circulating delay to a minimum. With clockwise circulation, vehicles would make consecutive right turns at each of the study intersections to circle the block. Right turn movements, especially those where right turn on red is allowed, typically experience significantly less delay per vehicle than left turn movements (and especially permitted, or unprotected, left turn movements). With this pattern, it is likely that Cape Fear Boulevard would need to remain a two-way street to allow access to businesses along the street. If Cape Fear Boulevard remains with two-way traffic, it would be recommended to provide a turnaround area at the end of Cape Fear Boulevard. An option to provide the turnaround is a traffic circle with the maximum diameter that could fit within the existing right-of-way. It would not be desirable to allow vehicles to back up to turn around since this would be less safe for pedestrians and would take longer to accomplish which creates concerns with queuing.

Analysis of the complete or partial closure of Canal Drive scenarios shows that both plans would have a similar impact to study intersections. However, the complete closure of Canal Drive to vehicles would eliminate the only way for vehicles that enter one-way Raleigh Avenue to exit. Complete closure of Canal Drive would necessitate either the closure of Raleigh Avenue, or the modification of Raleigh Avenue to have two-way traffic flow. Closure of part, or all, of Canal Drive to vehicles would also create the need for a turnaround area at the end of Cape Fear Boulevard. If Raleigh Avenue cannot be used by delivery trucks, this turnaround would need to be large enough to accommodate delivery trucks, which may not be feasible to construct. Although not captured by the traffic model, it is likely that vehicles circulating Cape Fear Boulevard could experience additional delay if large delivery trucks were to use this area.

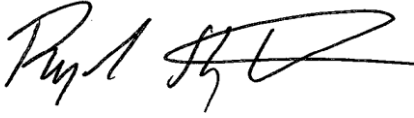
A comparison of positive and negative attributes of each of the alternatives is attached. It should be noted that the attributes are not weighted in importance or relevance.

Recommendations

- Provide additional pedestrian accommodations, such as signalized pedestrian crosswalks be installed at the Canal Drive/Harper Avenue intersection. Perhaps this can be done as part of the traffic signal upgrade at the intersection.
- Develop a traffic control plan to try the one-way traffic pattern on a temporary basis, perhaps early in the summer season or during a few special events. If this temporary plan is utilized, it would be recommended to advertise the new plan as much as possible and use it multiple times to allow drivers and pedestrians to adjust to the new patterns. If the one-way circulation plan does not work well, it can easily be converted back to the existing two-way operation.
- For the clockwise circulation plan, it would be desirable to maintain two-way traffic on Cape Fear Boulevard if a turnaround area could be provided at the end of the street. Further investigation may be needed to determine the appropriate design for the turnaround area.
- Consider dense landscaping or decorative fencing to help channelize pedestrians from the parking areas to designated pedestrian crossings. These features can provide aesthetics and minimize pedestrian mid-block crossings that are less safe.

If you should have any questions or comments relative to this parking study, please feel free to contact me at 919-872-5115.

Sincerely,



Rynal Stephenson, P.E.
Regional Manager
Ramey Kemp and Associates, Inc.
NC Corporate License # C-0910

Attachments: Traffic Figures
Hampton Inn Traffic Count Data

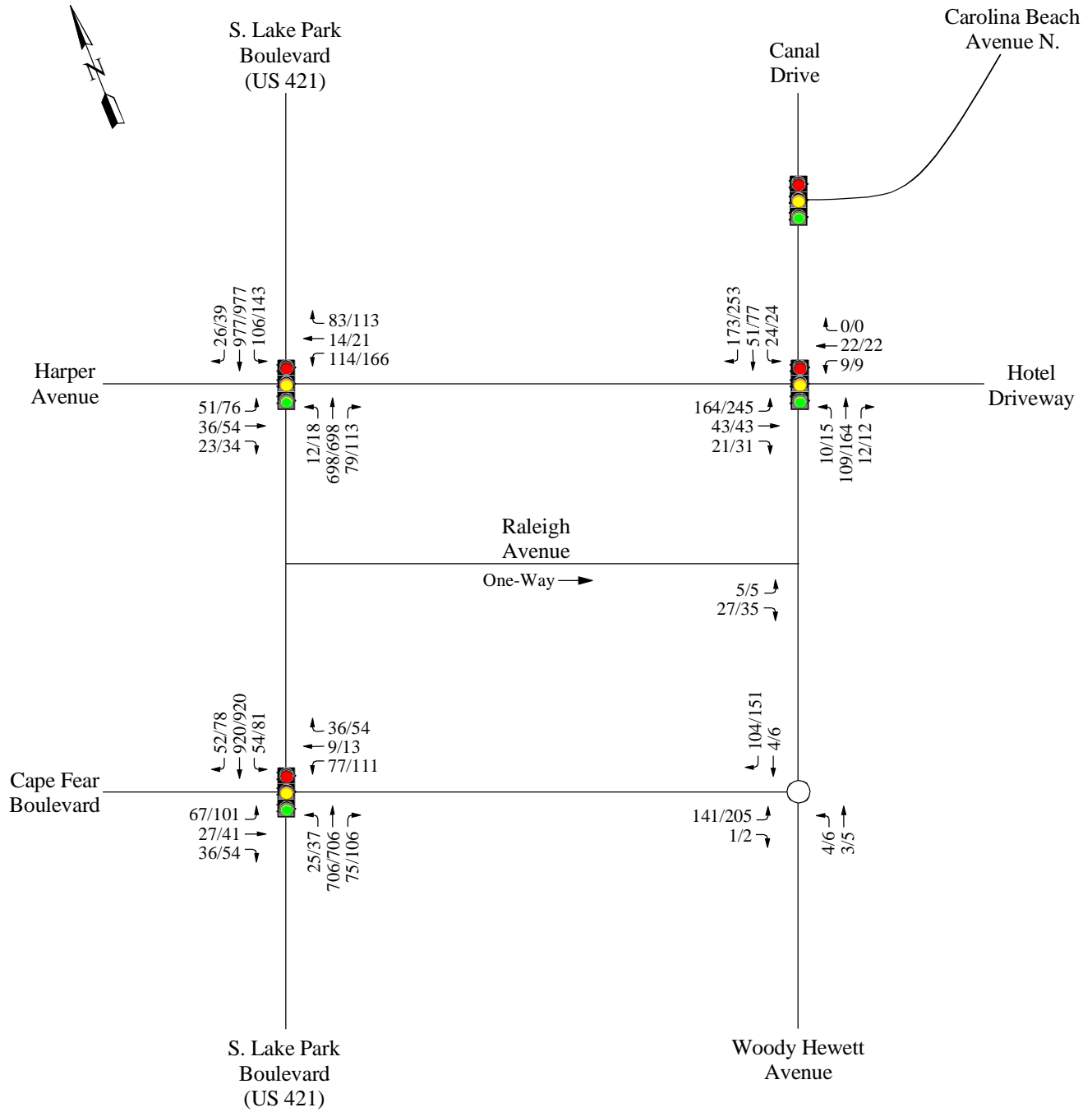
cc: Ryan Hambleton, PE, Stewart
Brian Cox, PE, Engineering Services, PA

Overall Comparison Summary Table



Counterclockwise One-Way on Canal	
Positive	Negative
<p>Drop-off occurs on right side of car</p> <p>Do not necessarily need turnaround area</p> <p>Allows Canal to be partially used for peds</p> <p>Maintains delivery truck access</p>	<p>Maintains sight distance issue at Harper/Canal (bar building)</p> <p>Pattern causes left turns at intersections on block</p> <p>Longest intersection delays of alternatives</p> <p>Longer queues turning left from Harper onto Lake Park</p>

Clockwise One-Way on Canal	
Positive	Negative
<p>Pattern causes right turns at intersections (less delay than lefts)</p> <p>Eliminates sight distance issue at Harper/Canal</p> <p>Allows Canal to be partially used for peds</p> <p>Maintains delivery truck access</p>	<p>Requires turnaround area at end of Cape Fear</p> <p>Slightly longer delay turning from Cape Fear onto Lake Park</p> <p>Drop-off at end of Cape Fear less efficient</p>

Canal Closure	
Positive	Negative
<p>Optimum for pedestrians on Canal</p> <p>Eliminates pedestrian/vehicle conflicts on Canal</p>	<p>Eliminates delivery truck routes</p> <p>Eliminates vehicle connectivity, forces more traffic on Lake Park</p> <p>Requires turnaround area at end of Cape Fear</p>



LEGEND

-  Signalized Intersection
-  Unsignalized Intersection
- X/Y → Saturday/Special Event Peak Hour Traffic

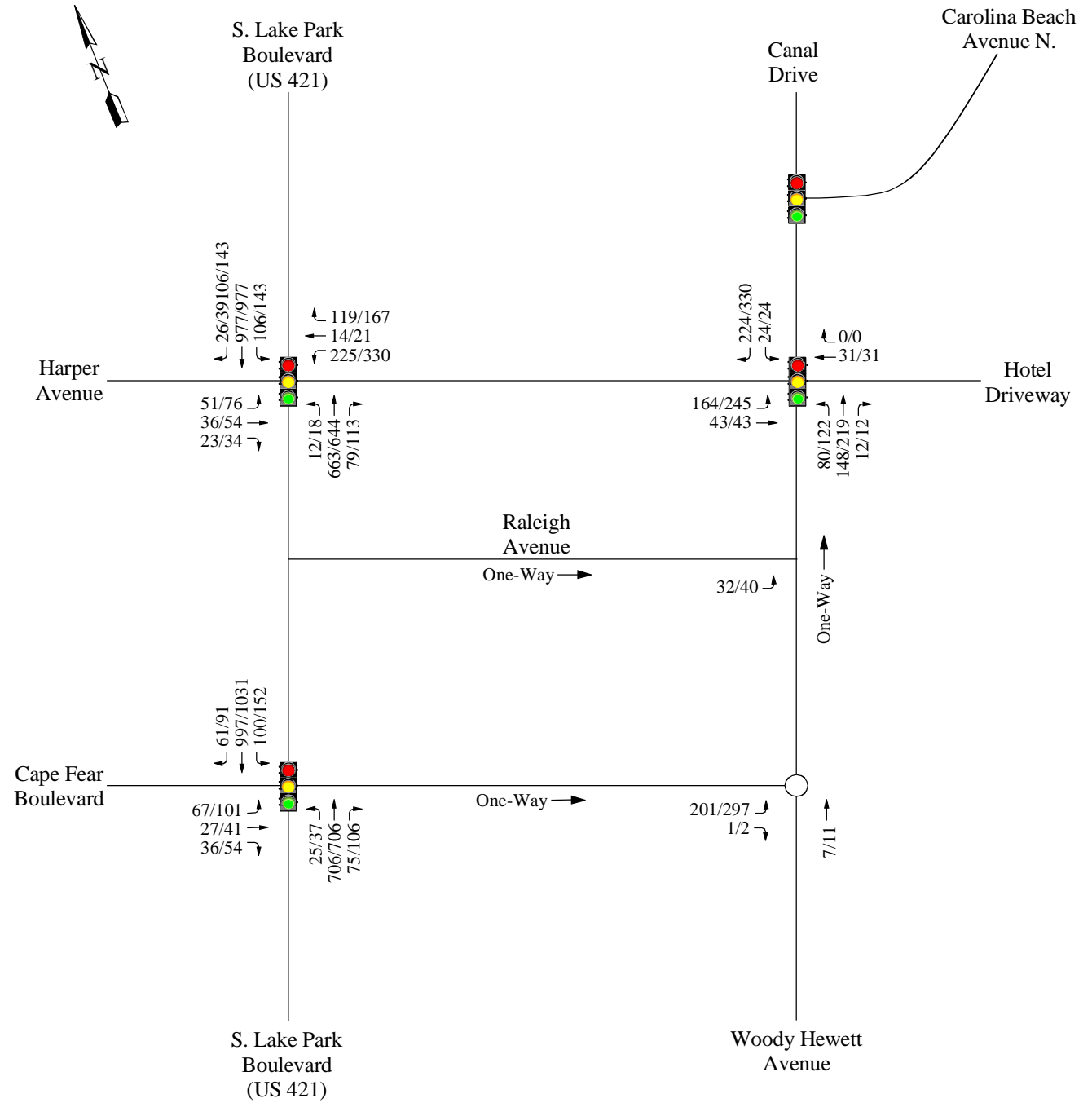


Canal Drive Circulation Study
Carolina Beach, North Carolina



Existing 2014
Peak Hour Traffic
Do-Nothing Scenario

Scale: Not to Scale

Figure 1



LEGEND

-  Signalized Intersection
-  Unsignalized Intersection
- X/Y → Saturday/Special Event Peak Hour Traffic

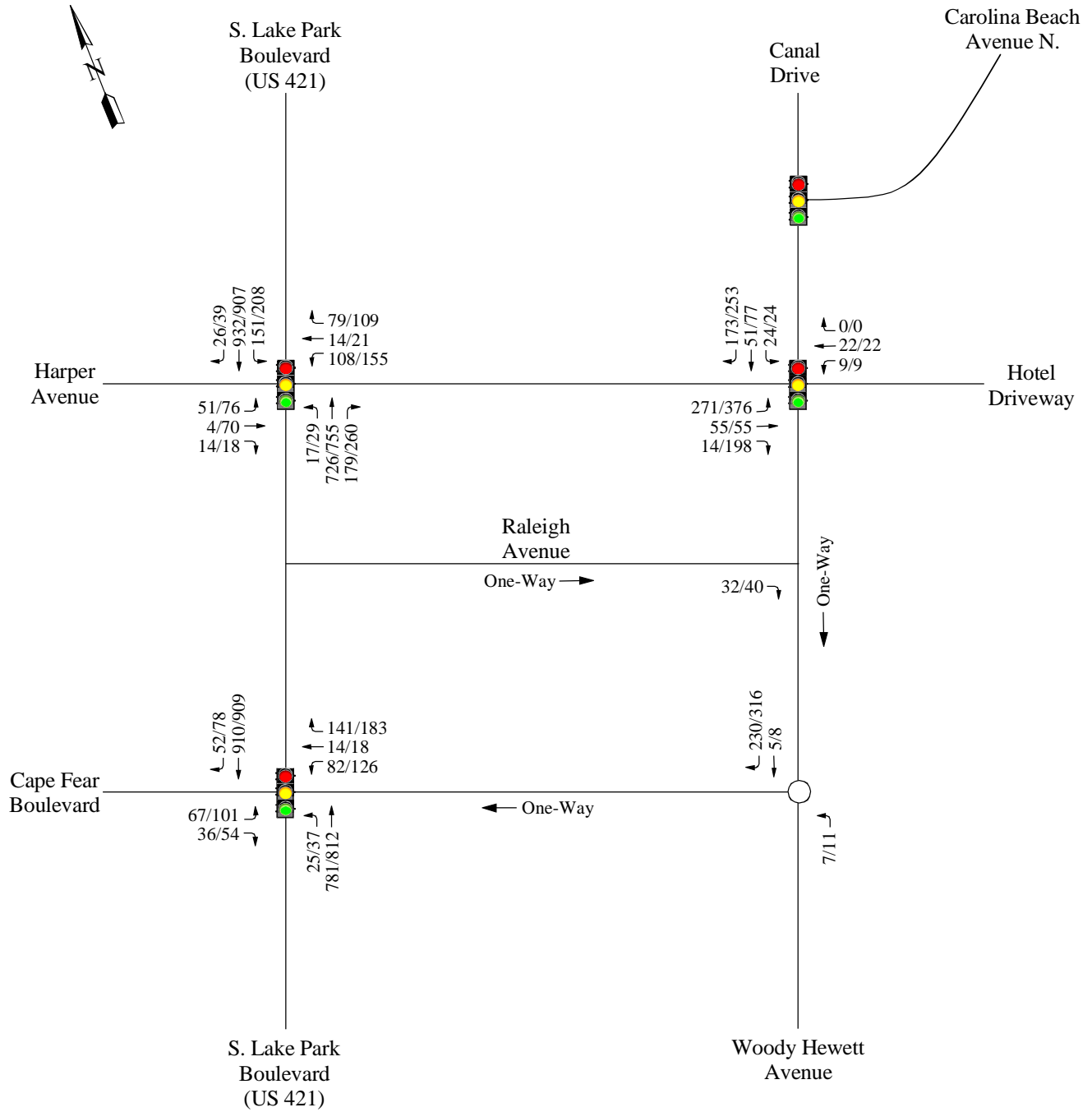


Canal Drive Circulation Study
Carolina Beach, North Carolina



Existing 2014
Peak Hour Traffic
Counterclockwise Circulation

Scale: Not to Scale

Figure 2



LEGEND

-  Signalized Intersection
-  Unsignalized Intersection
- X/Y → Saturday/Special Event Peak Hour Traffic

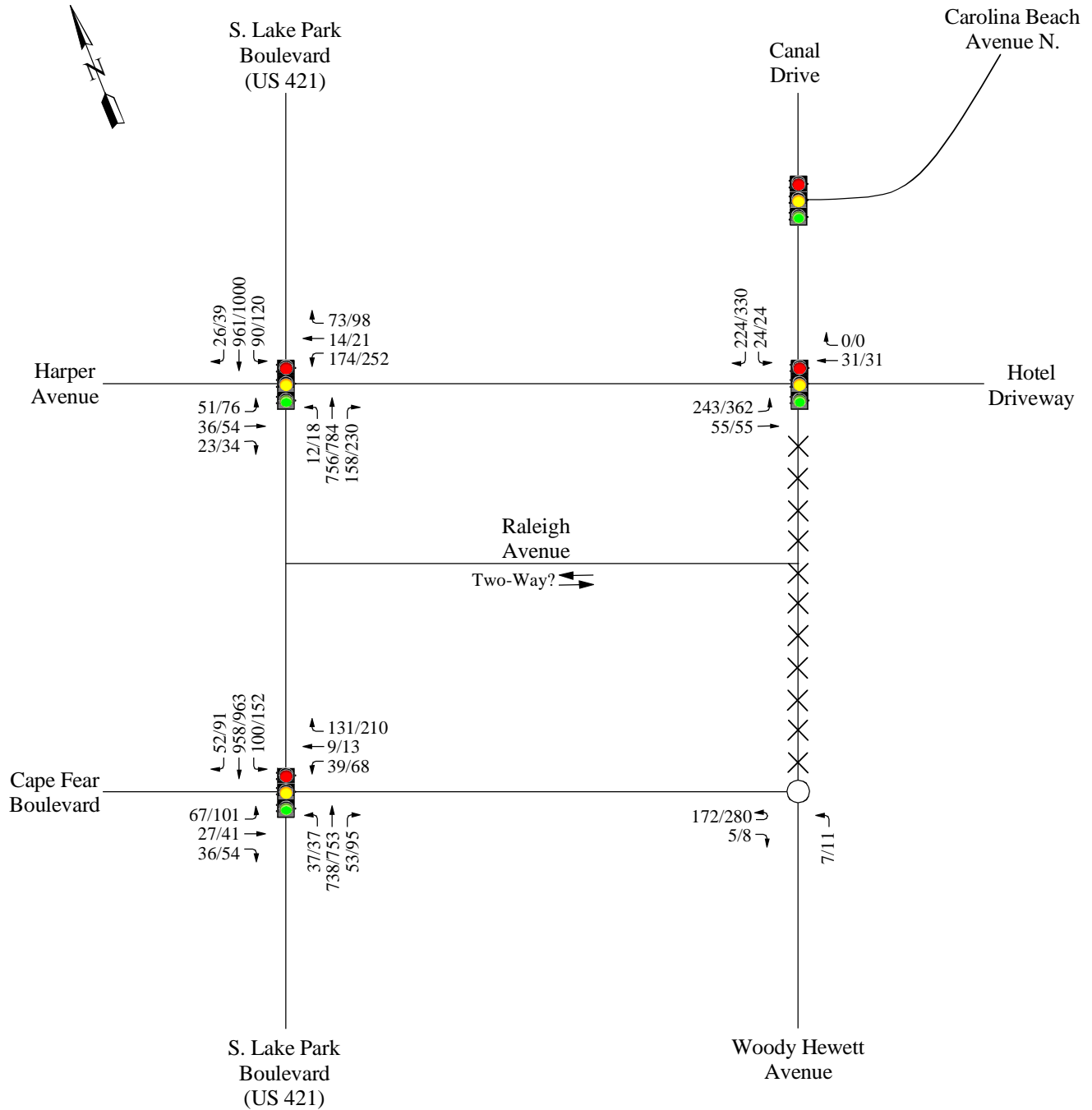


Canal Drive Circulation Study
Carolina Beach, North Carolina



Existing 2014
Peak Hour Traffic
Clockwise Circulation

Scale: Not to Scale

Figure 3



LEGEND

-  Signalized Intersection
-  Unsignalized Intersection
- X/Y → Saturday/Special Event Peak Hour Traffic

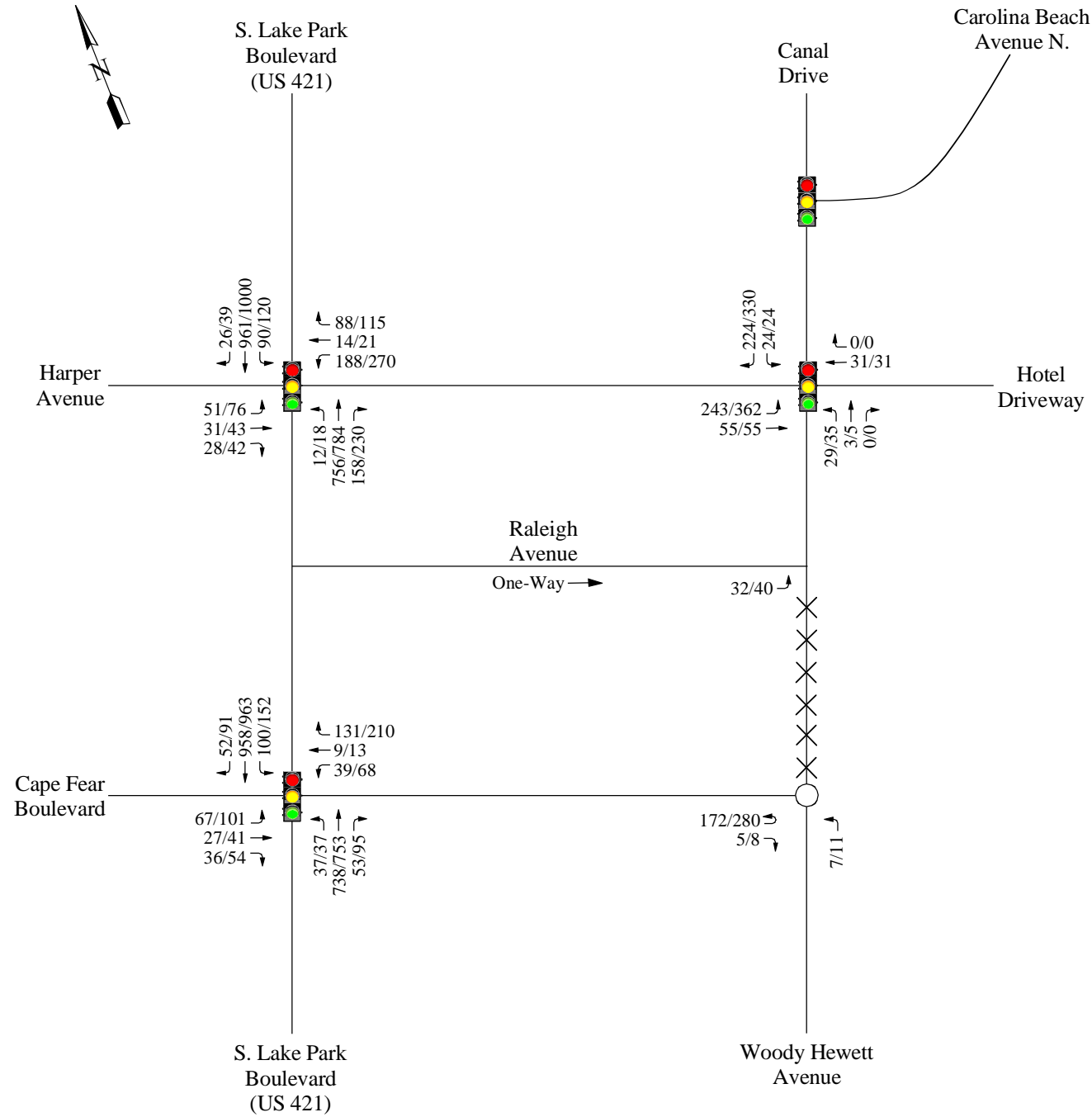


Canal Drive Circulation Study
Carolina Beach, North Carolina



Existing 2014
Peak Hour Traffic
Canal Drive Closure

Scale: Not to Scale

Figure 4



LEGEND

-  Signalized Intersection
-  Unsignalized Intersection
- X/Y → Saturday/Special Event Peak Hour Traffic



Canal Drive Circulation Study
Carolina Beach, North Carolina

Existing 2014 Peak Hour Traffic Partial Canal Drive Closure	
Scale: Not to Scale	Figure 5