VISSIM Micro-simulation Modeling of Complex Geometry and Traffic Control: A Case Study of Ocean Parkway, NY

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Abstract: The challenge associated with evaluating traffic operations within an established (pre-1900) high-density environment is finding an analysis tool that can accommodate multi-modal networks with non-standard geometric configurations and unique traffic operations strategies. In addition, the transportation infrastructure within high-density urban environments is typically compact and interdependent. Thus, a slight change in traffic signal timings within the network can impact the entire system. The advancement in micro-simulation tools has allowed traffic engineers to evaluate these unique features. Currently, there are a number of micro-simulation tools being used within the traffic engineering industry; however, there is no all encompassing tool available that can both simulate and optimize networks; therefore, a combination of these tools is often utilized to perform network analyses.

Ocean Parkway is a multi-modal urban arterial corridor within the Borough of Brooklyn in New York City that traverses high-density residential neighborhoods as well as connects principal arterial/highway facilities within the Borough. The Ocean Parkway facility has a mainline/service road configuration with designated parkland medians (less than 50 feet in width) between the service roads and the mainline. The tree-lined medians also serve as a destination for the local community because they are designated as pedestrian/bicycle ways with bench and game tables along the neighborhood side alignment.

Mainline traffic operations are controlled by traffic signals, while the service roads are controlled by a combination of traffic signals and stop signs. The traffic control strategy accommodates all turning movements to and from the side streets from both the mainline and service roads and vice versa. Traffic operations accommodate left-turn movements from the mainline through a permissive left turn strategy. This left-turn strategy increases the mainline capacity; however, it also increases pedestrian exposure to potential vehicular-pedestrian conflicts.

The New York City Department of Transportation commissioned a study to evaluate the potential impacts associated with converting the permissive left-turn phase strategy to a protected left-turn phase strategy, with respect to overall corridor operations and traffic safety. The study area consisted of 15 mainline and 30 service road intersections for a total of 45 closely spaced intersections that led to complex turning movements within the multi-modal corridor. This paper describes the challenges associated with data collection, software selection for analysis, data processing, and lessons learned for this unique geometric/operational configuration.

INTRODUCTION

The New York City Department of Transportation, which operates and maintains the roadways within the five Boroughs of the City of New York, faces the challenges of evaluating high density established roadway networks with geometric configurations and traffic operations which precede the AASHTO standards. One such facility is Ocean Parkway, a multi-modal urban arterial corridor within the Borough of Brooklyn in New York City that traverses high-density residential neighborhoods as well as connect principal arterial/highway facilities within the Borough (refer to Figure 1). The Ocean Parkway facility has a mainline/service road configuration with designated parkland medians (less than 50 feet in width) between the service roads and the mainline. The tree-lined medians also serve as a destination for the local community because they are designated as pedestrian/bicycle ways with bench and game tables along the neighborhood side alignment.

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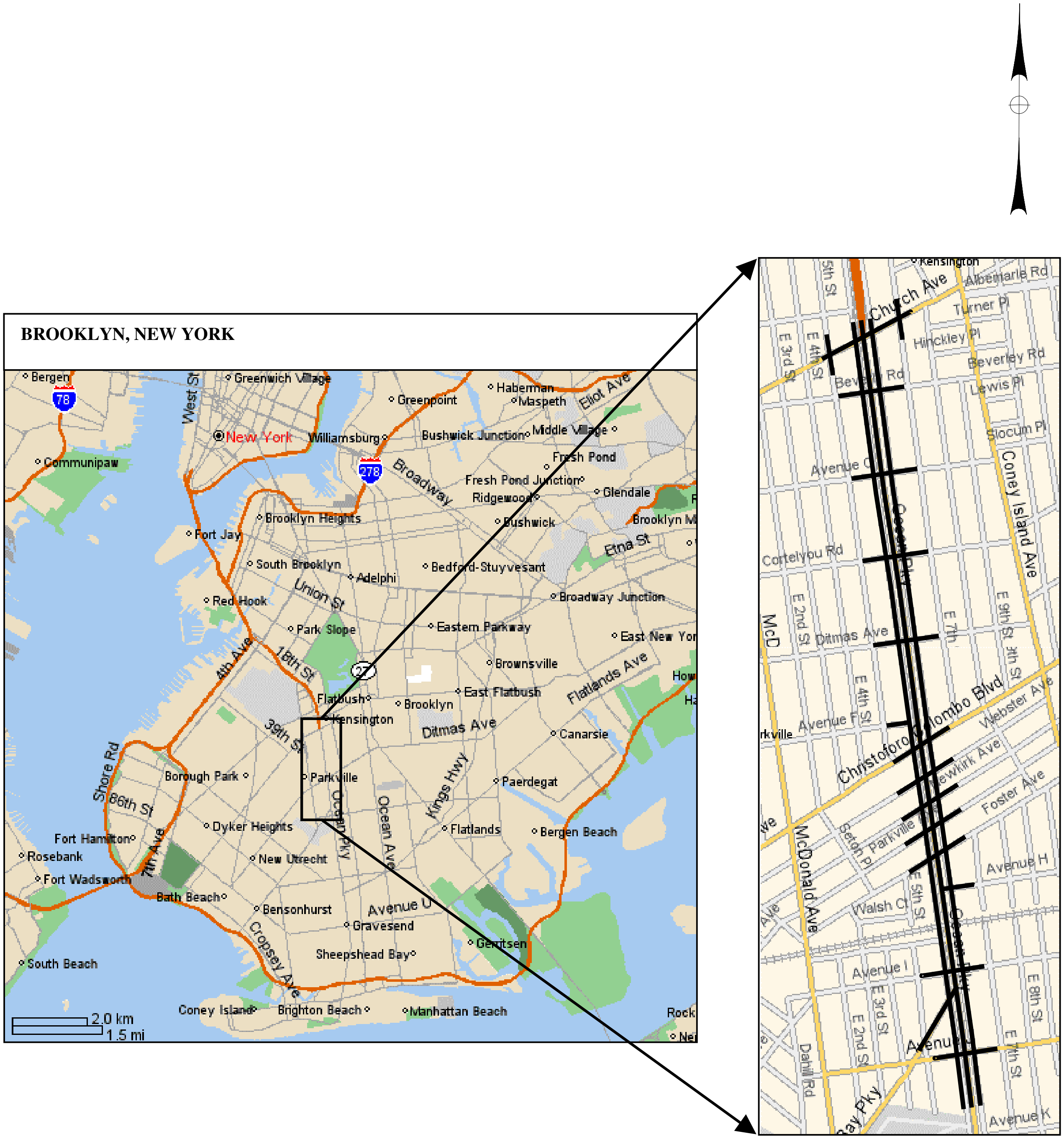
DATA COLLECTION AND REDUCTION

Data Collection

The Ocean Parkway corridor data collection program was conducted to obtain data for the weekday morning, midday, evening peak periods and the Saturday midday peak period. The data collection program included the following items within the study area:

- Classified Vehicular Manual Turning Movement counts (with limited origin-destination counts);
- Pedestrian/Bicycle Turning Movement counts;
- Automatic Traffic Recorder (ATR) counts; and,
- Travel Time Survey.



LEGEND

- STUDY AREA

Figure 1: Ocean Parkway Traffic Study - Location Plan

The typical Ocean Parkway mainline and service road combination as it intersects the cross street comprises of 26 turning movements. The potential turning movements are presented in Figure 2. To ascertain Origin-Destination (O-D) patterns at the intersections, a limited O-D study was conducted for the mainline movements (refer to Figure 3) and the cross street movements (refer to Figure 4). Finally, the pedestrian/bicycle movements were collected for the study area (refer to Figure 5).

MICRO-SIMULATION MODEL DEVELOPMENT

Model Selection

The intersections along the Ocean Parkway corridor are interdependent. A minor modification to the existing traffic signal timings may have a significant impact to the entire corridor; therefore, it was determined that micro-simulation is the most effective network analysis tool. In addition, the study corridor has the following non-standard geometrical and operational features:

- Multi-modal corridor (pedestrians, bicycles, cars, buses, and trucks on service roads and cross streets only);
- The mainline and service roads are less than 50 feet apart;
- The intersection of the mainline and service roads with a cross street has 26 possible turning movements; and,
- The mainline is controlled by traffic signals while the service roads are predominately controlled by stop signs.

The unique features of Ocean Parkway required that the selected software was able to analyze and optimize the corridor traffic operations. Typically, micro-simulation software is used to simulate operations but not optimize traffic signal timing and/or network operations (e.g., TSIS-CORSIM, Paramics, AIMSUM and VISSIM). Typically, micro-simulation software based on a link-node network structure does not effectively replicate complex geometry and specific routing of vehicles associated with high density complex urban infrastructure (e.g., TSIS-CORSIM and SimTraffic). Finally, micro-simulation software primarily based on O-D tables may not be sensitive to the nuances associated with closely-spaced intersections and complex geometry (e.g., Paramics and AIMSUM). In order to overcome these software deficiencies, traffic engineers often develop techniques to "trick" the software to replicate complex geometry, O-D patterns and turning movements.

Furthermore, capacity analysis programs such as the Highway Capacity Software evaluate the capacity of a single intersection irrespective of its effects on a downstream or upstream intersection, while traffic optimization software such as Synchro can optimize a signalized corridor; however, its simulation counterpart, SimTraffic does not simulate closely-spaced intersection (less than 100 feet).

Due to the unique nature of the Ocean Parkway corridor, the study team determined that a combination of software be used to analyze the corridor: Synchro/SimTraffic for capacity analysis

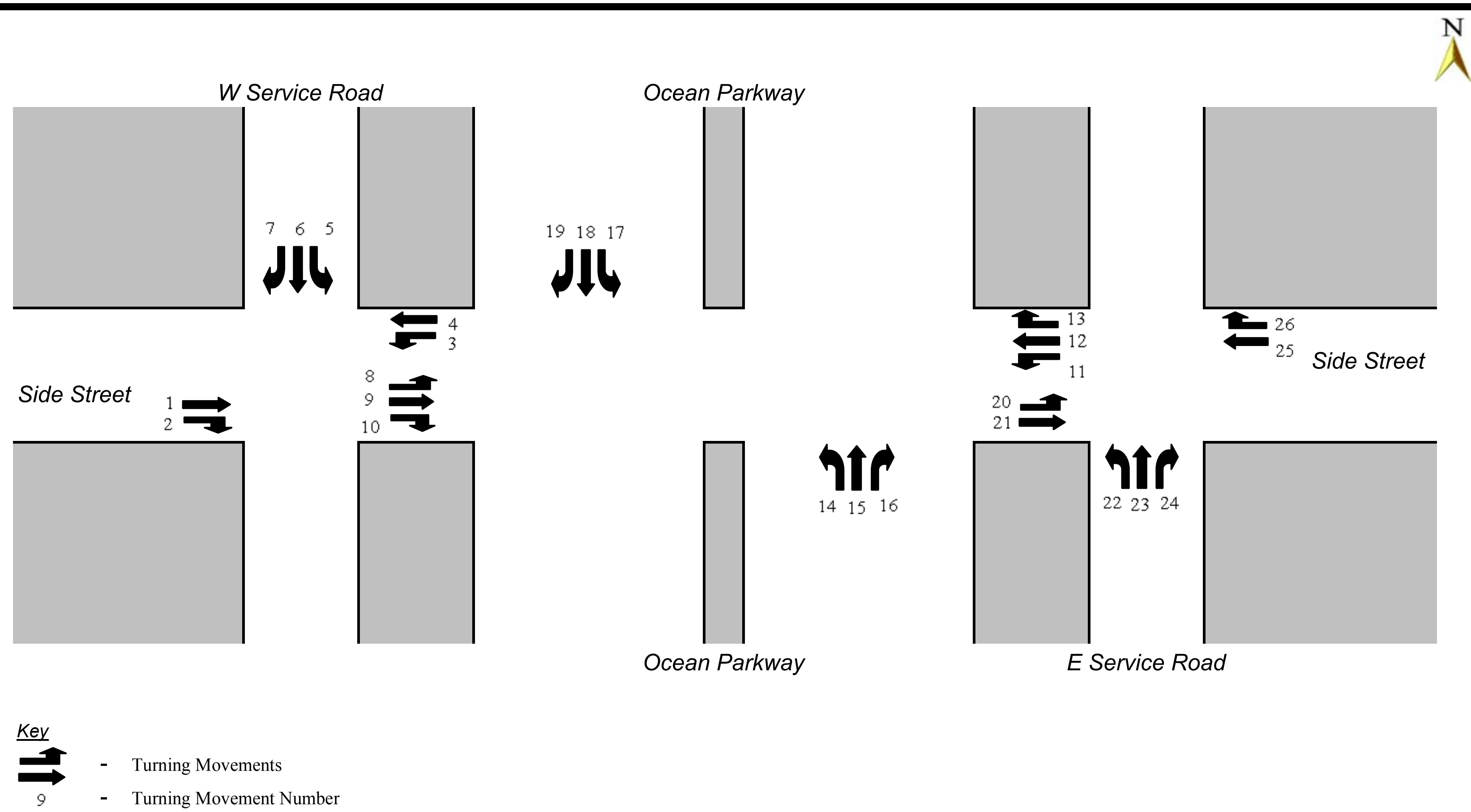
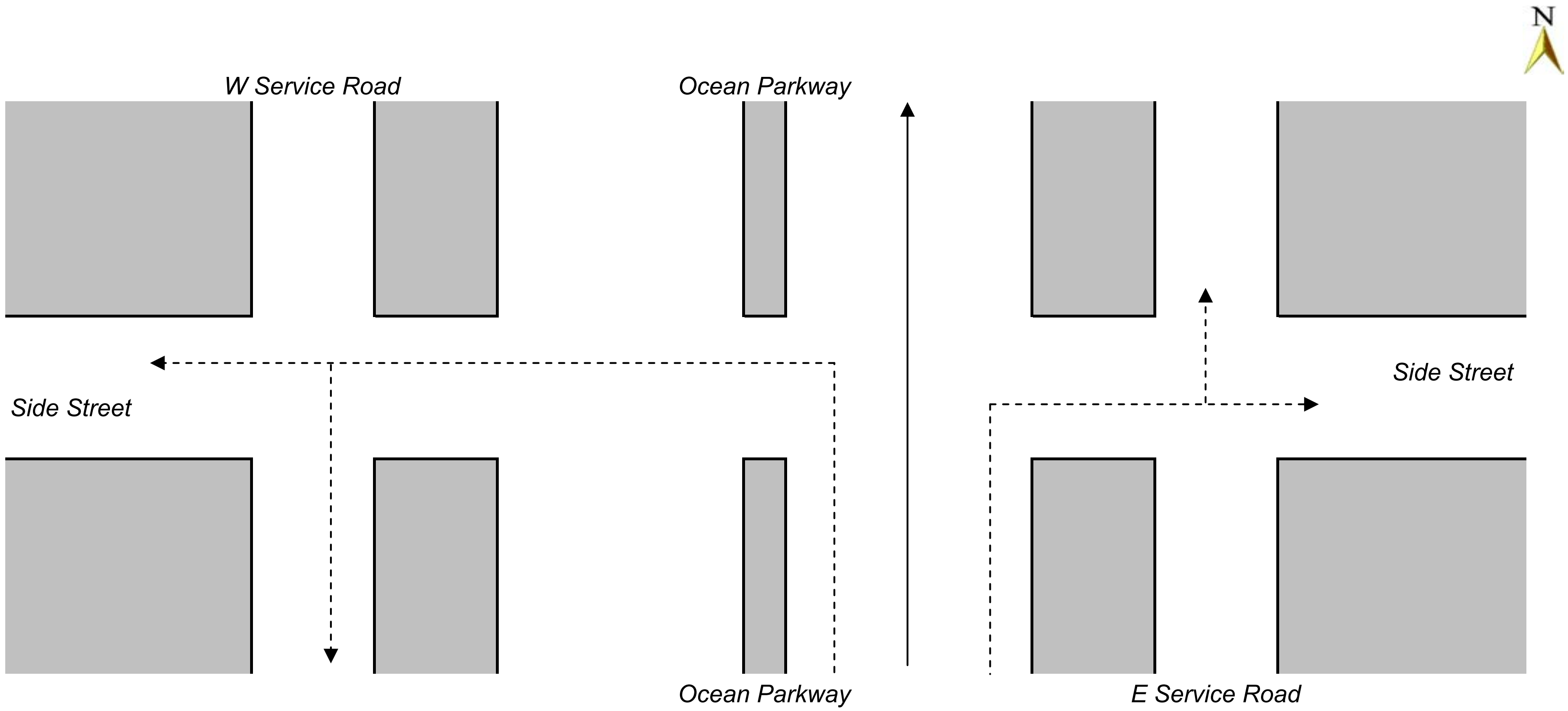


Figure 2: Typical Ocean Parkway Intersection Turning Movement Counts



Key

→ Already counted as part of intersection turning movement counts

⇢ Additional O-D Count

Notes

Also applies to southbound movements.

Figure 3: Typical Ocean Parkway Northbound Mainline O-D Counts

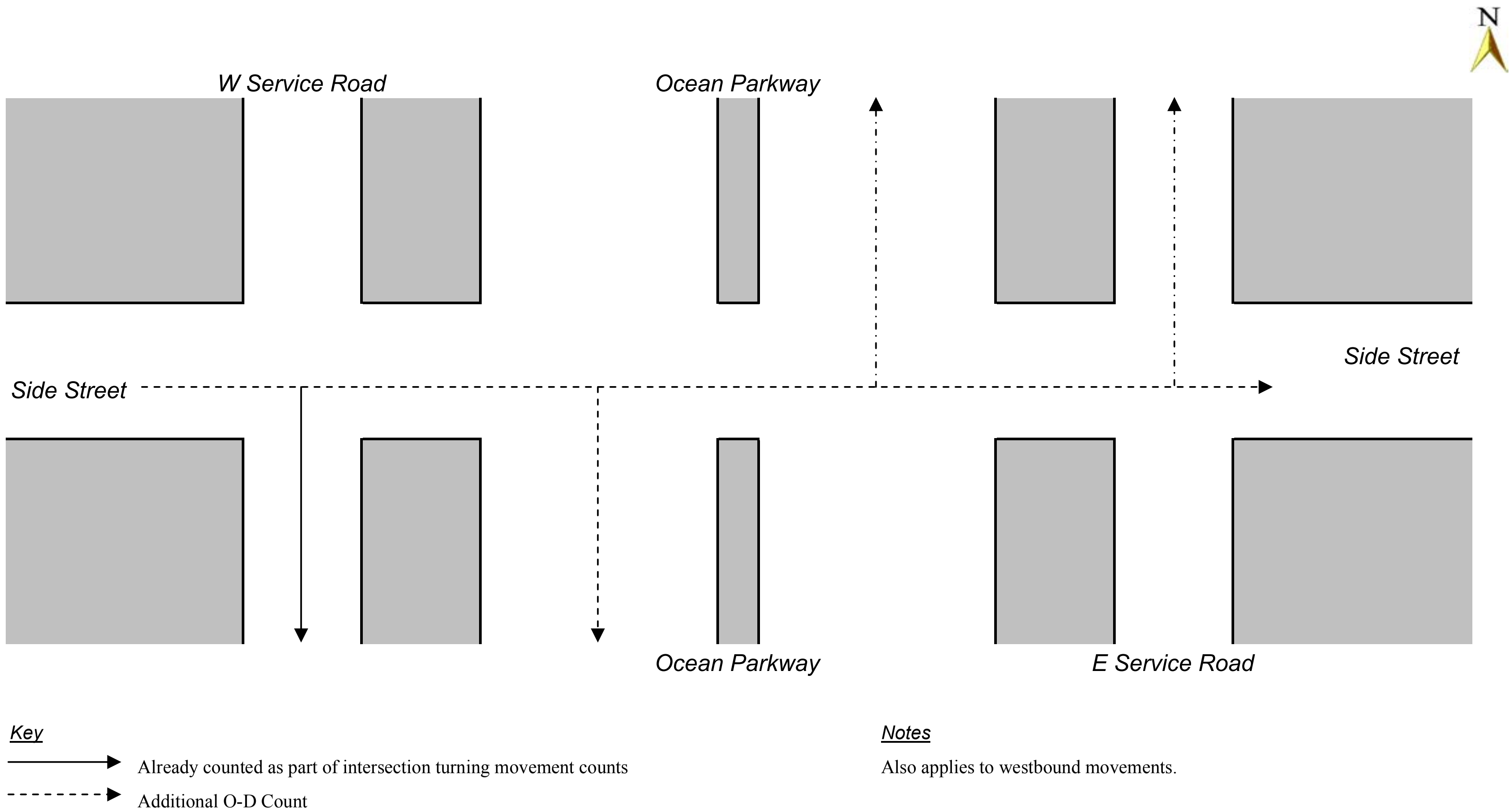


Figure 4: Typical Ocean Parkway Cross Street O-D Counts

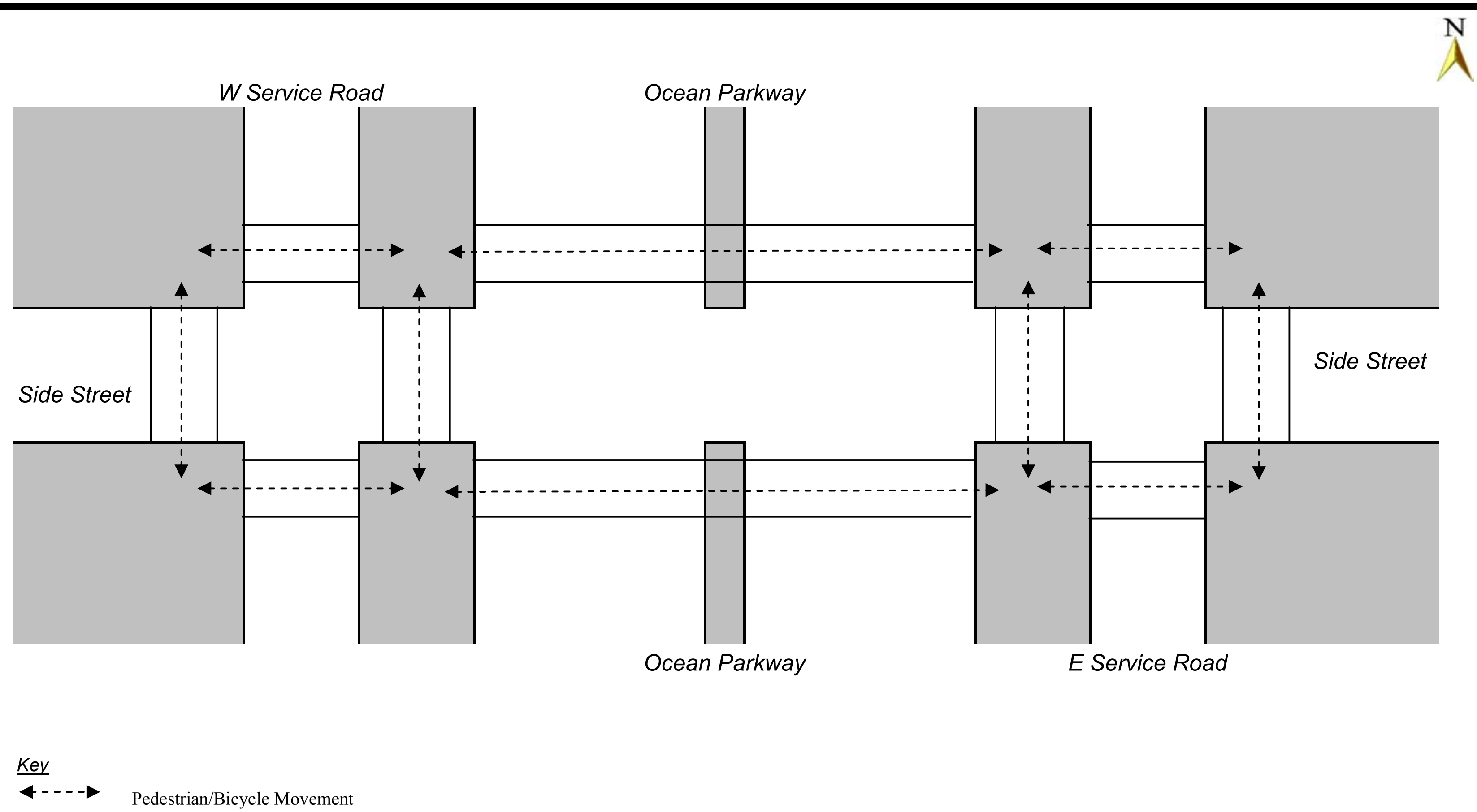


Figure 5: Typical Ocean Parkway Pedestrian and Bicycle Movements Counts

and signal optimization and VISSIM for detailed micro-simulation of the network. VISSIM is a microscopic, stochastic, driver behavior simulation program that can analyze vehicular traffic including transit, pedestrian and bicycle operations under constraints such as lane use configuration, traffic composition, traffic signals, and transit stops. VISSIM does not follow the conventional link/node modeling system; instead it uses a link/connector system that allows complex geometry to be modeled. In addition, the link/connector system allows different traffic control (traffic signal, stop or yield sign) to be utilized anywhere in the model. Furthermore, the model allows individual vehicles to be routed through multiple intersections within the network. Therefore, VISSIM was used because of its unique ability to simulate vehicular-pedestrian interaction, complex geometry, O-D patterns, and unique traffic operations.

Synchro was selected as an optimization tool for the mainline to analyze the permissive versus protected left-turns, traffic signal phasing, and corridor offsets. Microsoft Excel and Visual Basic macros were utilized to process and manipulate input data and results, and transfer data between Synchro and VISSIM.

Data Input/Sharing Methods

The study required existing and proposed simulation models to be prepared for the four individual peak hours to be analyzed. To minimize data analysis with respect to the determination of the peak hour, vehicle classification, and peak hour factors, the data collected was linked to a master spreadsheet developed to perform these analyses. Upon determining critical traffic characteristics, the spreadsheet was used to develop balanced vehicular and pedestrian/bicycle flow diagrams. The peak hour spreadsheets were designed with an open architecture that could easily be linked to both VISSIM and Synchro.

A generic VISSIM base model with dummy data was developed and established as the template for the VISSIM input file. Relevant portions of the template input file were converted to spreadsheet formats that were then linked to the balanced volumes and vehicle classification. In addition, the relevant traffic signal timing and offset portions of the template input file were also converted into a spreadsheet format and linked to traffic signal phasing, timing and offsets exported from Synchro using its Universal Traffic Data Format (UTDF) function. After linking the balanced traffic volumes and the traffic signal timings data to their respective template input files, the spreadsheets were exported back into the template VISSIM input file to create the appropriate peak hour VISSIM input files. In addition, the study team developed a series of Visual Basic macros to expedite the data transfer process.

Therefore, through the use of spreadsheets, the processed data, Synchro models, and VISSIM models were electronically linked; thus, allowing the study team to minimize the time required to develop base and alternative models and eliminate most of the required manual updates between the selected software. This was particularly useful when analyzing optimized signal timings in VISSIM that were created within Synchro.

Lessons Learned

- Study corridors with unique geometry and traffic operations may require multiple software applications. The selection of the software should be based on technical merits as well as the ability to share data between the software.
- The limitation of individual traffic software applications should be weighed against the purpose of the study.
- Data collection planning is vital in obtaining good data.
- Data reduction and manipulation through spreadsheets has become a necessity due to data quantity and size; however, the spreadsheets must be thoroughly reviewed for accuracy.
- The use of Visual Basic macros can minimize data processing time and enhances quality control, particularly where repetitive processes are required.

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