Associates *Traffic, Transportation & Civil Engineering*
Ali R. Khorasani, P.E. *P.O. Box 804, Spencer, MA 01562, Tel: (508) 560-4041*

Updated
Traffic Impact Study

Prepared For

Upland Commons
Residential Development

Located at
49 Upland Street
Worcester, Massachusetts

December 2023

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INTRODUCTION

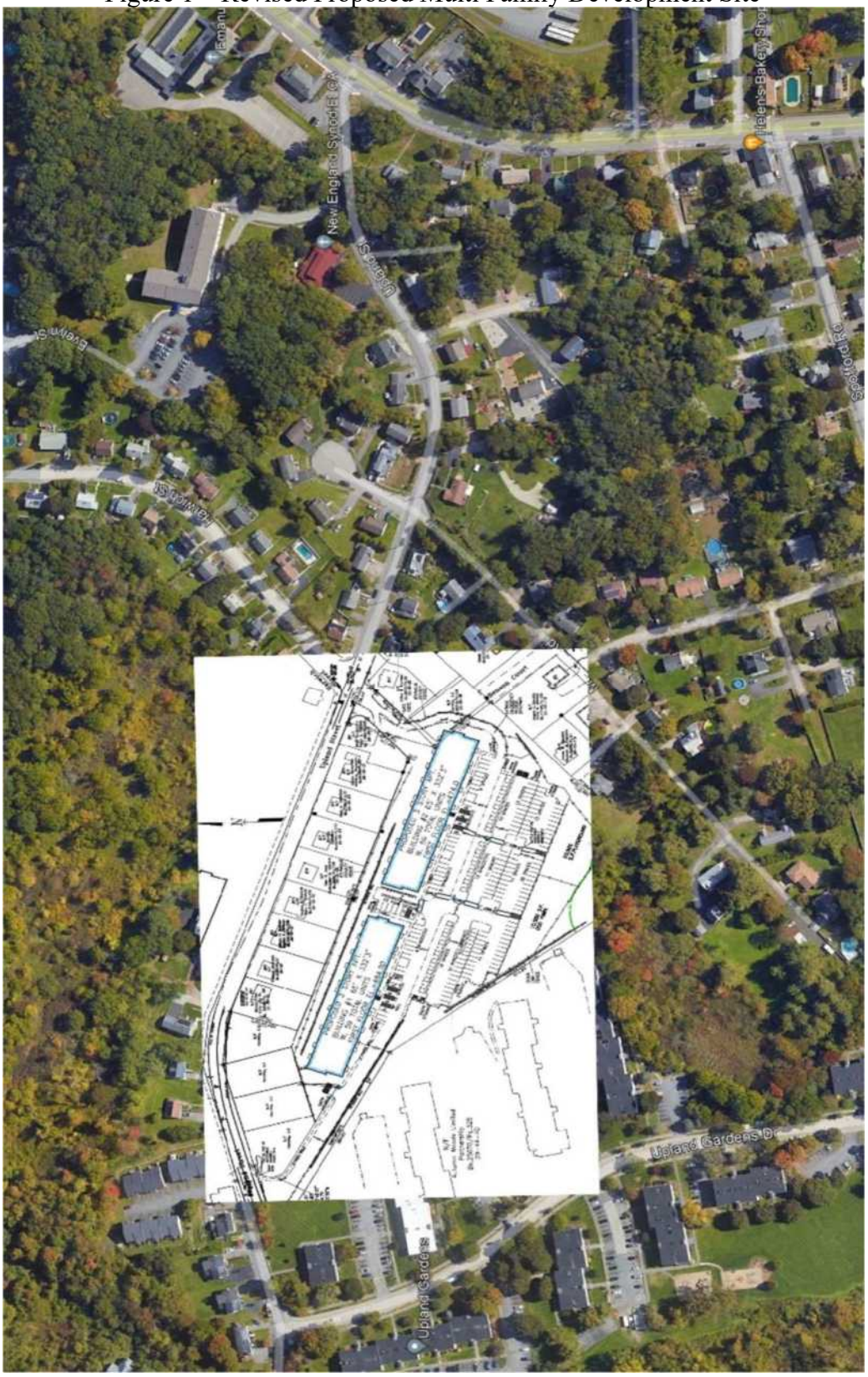
Henchey LLC, hereafter referred to as the applicant, is proposing the development of a parcel of land totaling 6.25 acres to construct a two, three-story apartment building complex. The proposed development is located on the south side of Upland Street, between Mallard Road and Upland Gardens Drive. The applicant is proposing to evaluate the impact of this development site on area roadway traffic and consider any improvements that may be necessary to make this development feasible and acceptable. This traffic study, which is an update of the traffic study prepared by AK Associates dated July 2023, is prepared to make this evaluation. The revised site plan calls for a total of 118 apartment units in two, three-story buildings, 213 parking spaces, and a single access point compared to the previously proposed site plan that called for 120 apartment units, 217 parking spaces, and two access points. Also, to provide for healthy transportation initiatives and to promote the use of bicycles, interior bicycle storage areas are proposed in each building, and covered bicycle parking areas are included to the right of both building entrances. Finally, to provide access to the bus stop on Upland Street, a five-foot sidewalk is proposed that will extend from the front of both buildings all the way to Upland Street. The purpose of this traffic study is to develop an understanding of existing traffic operations and concerns, forecast future site generated traffic, assess the adequacy of the existing roadway system to accommodate the proposed development into the future, and to identify and recommend appropriate mitigation strategies, should any be deemed necessary.

Project description

The applicant proposes to develop a 6.25-acre parcel of land and construct two, three-story buildings totaling 127,580 square feet (sf) to house a total of 118 apartment units. These residential buildings will be three-story structures with recreational amenities. A total of 213 parking spaces will be provided. A total of 45 spaces are proposed as EV and EV ready parking spaces to accommodate on site charging, and 54 parking spaces are designed for compact cars.

The site will be accessed via a private driveway (Upland Way) approximately 220' east of Upland Gardens Drive at its westerly terminus. This private driveway will be serving the entire site and all parking spaces including the handicapped parking spaces. The easterly end of this private driveway which will be located across from Harwich Street, and which is approximately 1,300' from the Greenwood Street intersection, will serve as an emergency access point for use by emergency apparatus only. The proposed 213 parking spaces will be accessed from the westerly end of this private driveway. Although the proposed site is in Residential Limited, 7,000 SF Min. Lot Size (RL-7) zoning district, it is adjacent to another similar but larger multifamily development, Autumn Woods Apartments. The site is currently vacant, and its approximate location is shown in the aerial photograph in Figure 1.

Figure 1 – Revised Proposed Multi Family Development Site



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EXISTING CONDITIONS

Evaluation of the transportation impacts associated with the proposed multifamily residential development project requires a thorough understanding of the existing transportation system in the immediate vicinity of the site. Evaluating existing roadway network operating conditions necessitates an examination of existing roadway traffic volumes, geometric features, and local community traffic-related issues. Each of these elements is described below.

Study Area Roadway Network

The study area for this traffic impact report, which is the same as that in the previous July 2023 report, is defined to include the evaluation of the following three intersections located within 1,300' of the proposed site as they were identified in consultation with the City of Worcester Engineering Division staff.

- Upland Street at Upland Gardens Drive
- Upland Street at Harwich Street
- Upland Street at Greenwood Street

Upland Street is a two-way roadway with one travel lane in each direction. The roadway has a grade ranging from 3% to 11% and its width also varies from 26' for the most part to 32' in front of house #64, to 28' at/near the proposed driveway, and finally, 33' at its intersection with Greenwood Street. A Google Earth aerial photo depicting the general profile of Upland Street is included herein below under Safety Concerns section. There are no defined sidewalks on either side along its length. There is no sign of on-street parking activity on Upland Street, most likely since all properties along the street have provisions for off-street parking in driveways and/or garages. Upland Street intersects with Harwich Street and Greenwood Street to the right of the proposed driveway and with Upland Gardens Drive and Arboretum Drive to the left of the proposed driveway in the vicinity of the proposed residential development site. Upland Street forms a three-legged intersection with each of the streets mentioned herein above. It is a local residential street with exclusively residential land uses. It traverses in easterly and westerly directions and provides access to Greenwood Street to the east and connects with Pakachoag Street to the west in the town of Auburn forming a "Y" intersection at its westerly terminus.

Upland Street is serviced by the Worcester Regional Transit Authority (WRTA) Bus Route #11 with multiple stops along its entire length. WRTA's Route #11 operates with a frequency of every 30 minutes during weekdays and on an hourly basis on weekends. A copy of the WRTA Route #11 map is included in the Technical Appendix section of this report.

Finally, there are no speed limit signs posted on Upland Street. Therefore, the Massachusetts statutory prima facie speed limit of 30 miles per hour (mph) applies to this area.

Greenwood Street is a two-way street with one lane of travel in each direction. It is an urban minor arterial street connecting McKeon Road and Route 146 at its northerly terminus to Route 20 at its southerly limit. It traverses in the northerly and southerly directions. Its pavement width is 44' with one 14' travel lane and an eight-foot shoulder in each direction. Greenwood Street intersects with Upland Street at approximately 75 degrees forming a "Y" intersection near the proposed development site. Sidewalks and on-street parking are provided on both sides of the street. The land use along the east side of Greenwood Street is a mixture of residential, business and manufacturing, and it is primarily residential on the west side of the street. Greenwood Street is also serviced by WRTA's Bus Route #11. Finally, Greenwood Street is posted with 30 miles per hour speed limit signs.

Intersection of Upland Street and Greenwood Street is a three-legged "Y" intersection with one-lane approaches. However, the eastbound approach of this intersection widens to approximately 20' for nearly a distance of 25', thus providing a very short unofficial lane for right-turn maneuvers. The eastbound traffic of Upland Street at this intersection is not controlled by a stop sign even though it has a stop bar. A crosswalk is provided across the Upland Street leg of the intersection and another crosswalk is provided at the northerly leg of this intersection.

Intersection of Upland Street and Harwich Street is a three-legged "T" intersection with single lane approaches. Also, there is no stop sign to control the southbound approach of Harwich Street. The proposed development's easterly private way, which is directly across from Harwich Street, will be used as an emergency access only for use by the Worcester Fire Department apparatus. Therefore, no traffic associated with this development will be using this intersection.

Intersection of Upland Street and Upland Gardens Drive is also a three-legged "T" intersection with one lane approaches. The Upland Gardens Drive leg of this intersection primarily serves the Autumn Woods Apartments development. The northbound approach on Upland Gardens Drive is controlled by a stop sign.

Traffic Volumes

Due to the reductions in traffic volumes caused by the COVID-19 pandemic, taking new traffic counts in 2021 was believed to possibly undercount the baseline for which future years were based in the original December 2021 traffic study. Therefore, the peak hour traffic counts were compared with the *massDOT* historic traffic data and adjusted to pre-COVID-19 growth patterns using the *massDOT* guidelines in the original December 2021 traffic study.

The peak hour turning movement counts (TMCs) were collected on Thursday, November 18, 2021, during two two-hour periods between the hours of 7-9 AM and 4-6 PM commuter peak periods to identify the critical peak hour. This standard practice is designed to help determine the traffic impacts of the proposed multifamily residential development on nearby roadways and intersections under worst-case scenario.

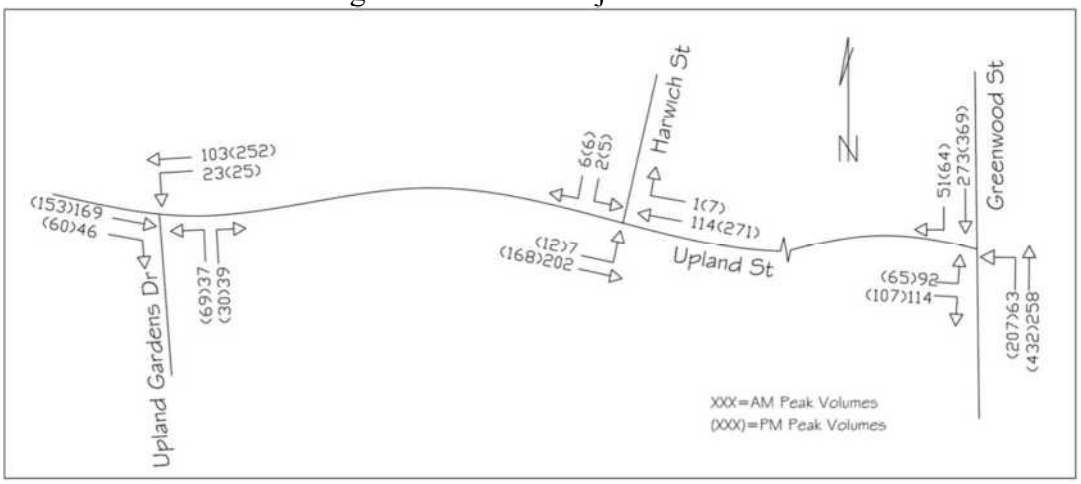
As mentioned herein above, the COVID-19 pandemic has caused a drop in vehicular traffic over the past few years. In April 2020, *massDOT* published the Guidance on Traffic Count Data and how to estimate existing and future traffic counts taken after March 13, 2020. However, most places of business and schools have reopened since then and traffic has approached the normal (pre-COVID) conditions. Nonetheless, the turning movement counts were adjusted per the *massDOT* directive. The procedure to adjust the TMCs to pre-COVID conditions requires the use of historical data, seasonally adjust the historical data, and then forecast the historical data to the existing year.

There is one permanent counting station (ID #250894) which is located on Greenwood Street north of Southwest Cutoff (Route 20), though not in the study area. The data was collected in June 2018. Also, *massDOT* provides seasonal adjustment factors last collected in 2019. Finally, based on the *massDOT* Traffic Volume and Roadway Classification, Upland Street falls within group U4-U7 in the Growth Factors and Seasonal Adjustment Factors charts.

A more concise adjustment method is using the *massDOT* guidance as prescribed in their engineering directive. The *massDOT* Yearly Growth Rates data from 2014-2019 are shown in the Technical Appendix Section of this report. The growth rates go back to 2014, and therefore, the rates were averaged and then expanded to a two-year period to adjust for the COVID-19 pandemic. The average annual growth rate was calculated at 0.0034 or 0.34%. This rate was multiplied by two to get the total increased rate of 0.68% for the COVID-19 adjustment. Therefore, the turning movement counts were increased by this factor. The COVID-19 adjusted peak hour turning movement counts are shown in the following Figure 2. As per *massDOT* guidance, this increase also accounts for all future traffic from any other additional developments that may take place in the general area of the proposed multi-family residential development site. It should also be noted that Mr. Nick Lyford, Engineering Division's liaison to the Planning Department, as well as for the City Planning and Zoning Boards was consulted regarding any other future developments in the general area of the proposed site. Mr. Lyford informed us that upon his conversation with the Planning Department, no other developments in the vicinity of the proposed site were identified.

Finally, the traffic survey of the intersections in the study area showed that only one pedestrian was observed going in the northerly direction along Greenwood Street at its intersection with Upland Street. Similarly, one pedestrian was observed going in the easterly direction along Upland Street at its intersection with Upland Gardens Drive. No pedestrians or bicyclists were observed at the intersection of Upland Street and Harwich Street.

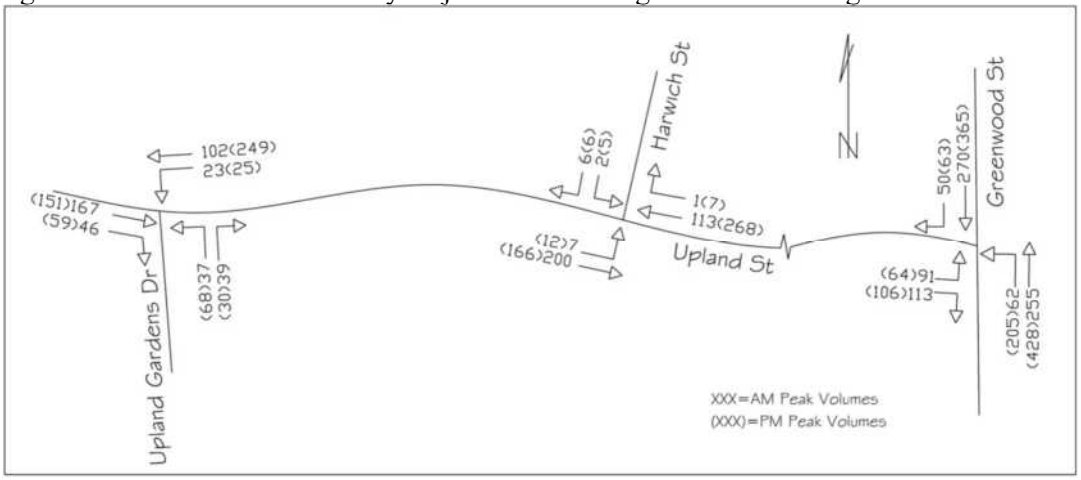
Figure 2 COVID - Adjusted TMCs



Also, as stated herein above, the *massDOT* Highway Division provides statewide traffic data collection that includes weekday seasonal factors. To evaluate the potential for seasonal fluctuation of traffic volumes on roadways near the proposed site, weekday seasonal factors were obtained from the *massDOT* Statewide Traffic Data Collection. The review of the *massDOT* seasonal adjustment factors shows that roadways having characteristics like Upland Street (U4-U7) have an adjustment factor of 0.99 for traffic data collected in November, thus the counts are multiplied by that factor. A copy of the *massDOT* seasonal adjustment factors is included in the Technical Appendix section of this report.

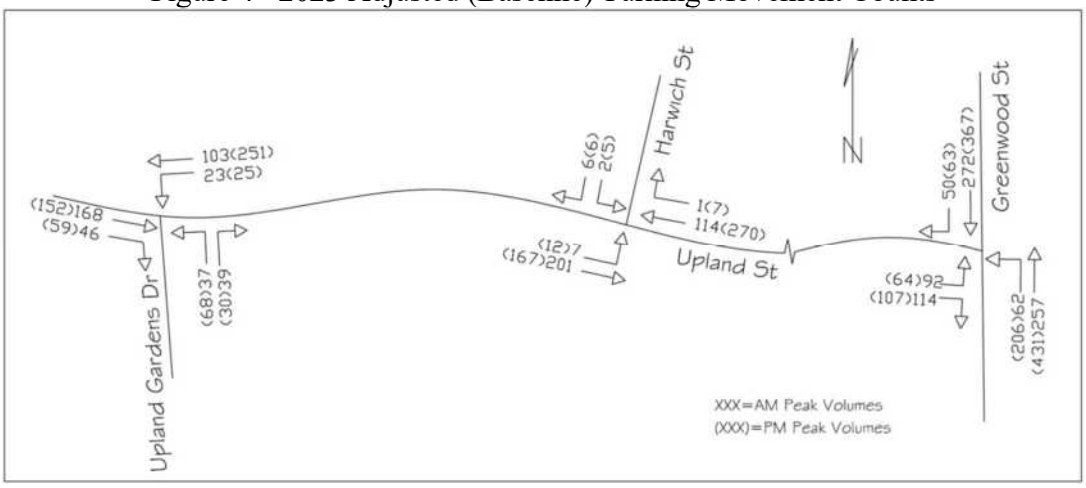
Typically, the PM peak period has the higher volumes, and is considered the critical peak. As is the case here, higher traffic volumes also occur during the PM peak period at these intersections. The percentage of truck traffic at the above-mentioned *massDOT* permanent counting station (ID #250894) along Greenwood Street was last recorded by *massDOT* at approximately 1.3%. This value is considered below the average of 2% for roadways having similar characteristics. The following Figure 3 depicts the TMCs with the above-mentioned adjustments to reflect the year 2021 (baseline) in the original traffic study.

Figure 3 – COVID and Seasonally Adjusted or Existing Baseline Turning Movement Counts



Finally, although the pandemic is behind us, for the purpose of updating the original December 2021 traffic study, the Covid-19 adjusted factors were used to further adjust the peak hour traffic volumes by increasing them by a factor of 0.68% to reflect the present baseline traffic volumes. The baseline (2023) adjusted peak hour turning movement counts are shown in the following Figure 4.

Figure 4 - 2023 Adjusted (Baseline) Turning Movement Counts



Safety Concerns

Sight Distances: Sight distance is defined in the *massDOT* Project Development and Design Guide as the length of roadway ahead that is visible to road users. In most cases, specific sight distance measures apply to motor vehicles and bicyclists. The sight distances are related to the design speed (posted speed) of the roadway and are based on the standards of the American Association of State Highway and Transportation Officials (AASHTO) document titled *A Policy on Geometric Design of Highways and Streets,* also referred to as the Green Book.

Stopping Sight Distance is further described in the *massDOT* Project Development and Design Guide as the distance necessary for a vehicle traveling at the design speed (posted speed) before reaching a stationary object in its path. The sight distance at every point along a roadway should be at least the stopping sight distance.

The sight distances for vehicles leaving the site via the proposed driveway to the right (east) and left (west) were measured in the field. The measured distances are those from a point 5' back of a stop bar (approximately 15' from the street line) and 3.5' above grade to represent drivers' eye height to an object 3.5' above roadway grade. The field review of Upland Street showed the available sight distances for the proposed driveway were measured at approximately 310' to the right (east) and 372' to the left (west) all the way through its intersection with Upland Gardens Drive. As stated earlier, the Massachusetts statutory prima facie speed limit of 30 mph applies to Upland Street.

Based on Basic Design Controls for roadway design, the stopping sight distance is calculated using the formula d=(V*V)/(30*f), plus the time required for perception and reaction by a driver (2.5 seconds). V is approach speed in mph, and f=0.28-0.35. The stopping sight distances are calculated

and are provided in Exhibit 3-8 of the *massDOT* Project Development and Design Guide. A copy of this exhibit is presented in the Technical Appendix section of this report. Due to the 3% upgrade and 7% downgrade of Upland Street's roadway profile, the required stopping sight distances are 215' to the right (east) and 200' to the left (west). The following photographs illustrate the available sight distances visually for both directions on Upland Street at the proposed driveway. It should be noted that, as evident in the following photographs, a significant amount of vegetation along the frontage of the proposed site partially impedes the line of site at the proposed driveway and thus needs to be trimmed or removed.

As demonstrated herein above, available sight distances are greater than the required values for stopping sight distances. Therefore, proper sight distances can be provided in either direction for the proposed driveway.

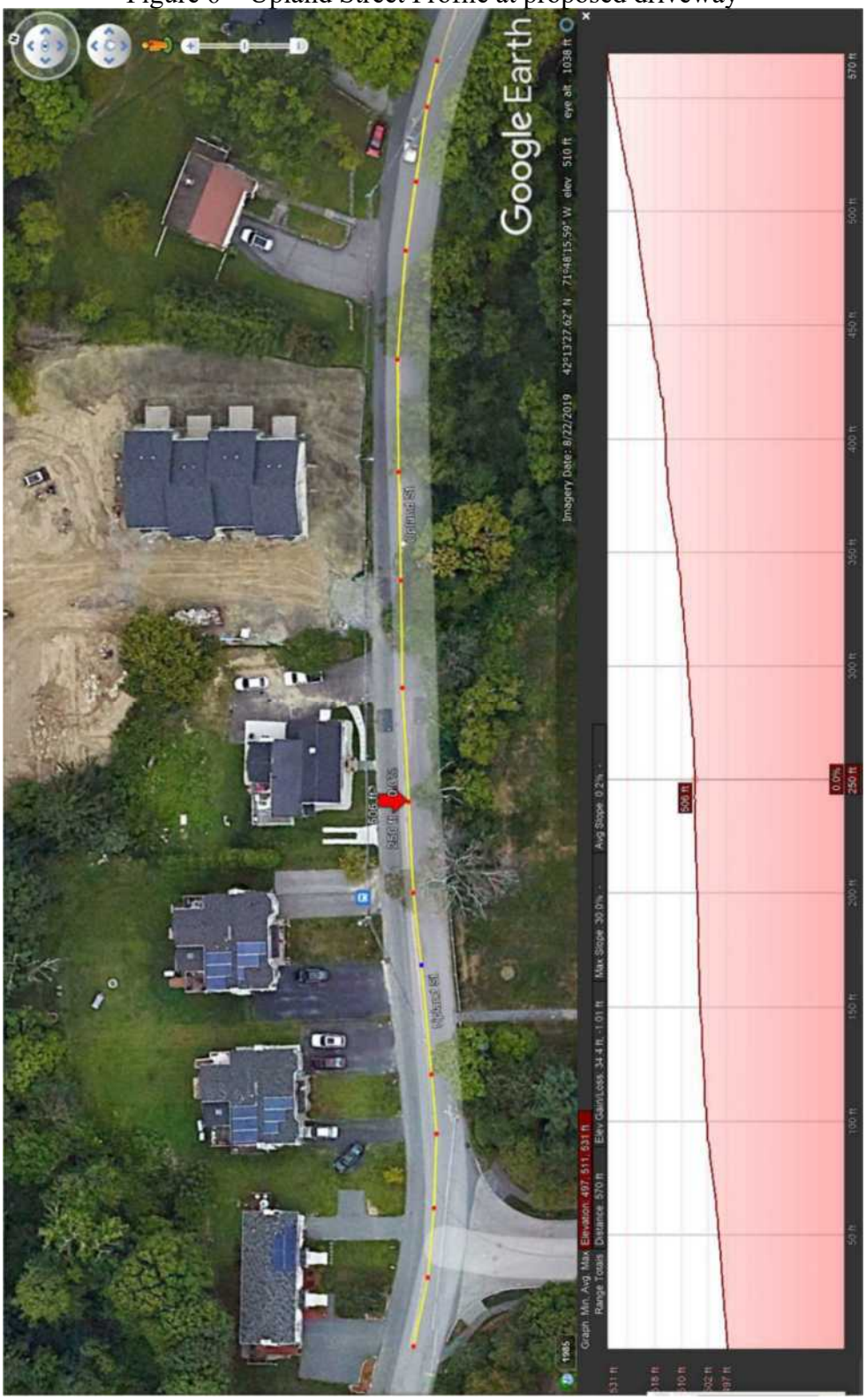
The sight distances were examined both horizontally and vertically. The following Figure 5 is a Google Earth aerial photograph that shows the general profile of Upland Street between Upland Gardens Drive and Greenwood Street. The following Figure 6 is also a Google Earth aerial photograph that depicts a closeup view of the Upland Street profile at the proposed driveway.

From proposed westerly driveway looking to the right (east)

From proposed westerly driveway looking to the left (west)

Figure 5 - Upland Street General Profile

Figure 6 – Upland Street Profile at proposed driveway



Accidents: The latest accident data compiled by the *massDOT* were obtained and reviewed for a seven-year period of 2017- July 2, 2023. This review summarizes the total number of accidents that occurred at each of these three intersections during this seven-year period, and is listed in Table 1, below. It is noted that only one accident each was reported for the intersections of Upland Street with Upland Gardens Drive and with Harwich Street during the seven-year period of 2017-July 2, 2023, and finally, a total of seven accidents occurred at the intersection of Upland Street and Greenwood Street during this same period.

Of all the nine accidents reported at these intersections, one occurred during morning peak hours and two accidents were reported during afternoon peak hours. There were no fatalities reported at any of these intersections, and only three accidents involved non-life-threatening injuries. The breakdown of all accidents at these three intersections is also presented below in Table 1.

Using the baseline turning movement counts compiled during traffic surveys of these three intersections, accident rates were calculated in accidents per million vehicles entering each intersection. Utilizing the *massDOT* prescribed methodology, the accident rates for these intersections were calculated at much lower than the *massDOT*'s latest available rate of 0.61 for unsignalized intersections on roadways in District 3 of the *massDOT*, in which the City of Worcester is located. A summary of the accident rates is also included in the following Table 1. A copy of the accident rate calculation is included in the Technical Appendix section of this report. Also included in the Technical Appendix section of this report is a copy of the *massDOT* Average Crash Rates for signalized and unsignalized intersections throughout the Commonwealth of Massachusetts.

The above accident analysis indicates there are no safety deficiencies associated with any of these intersections.

Table 1 - Vehicle Crash Summary (2017-2023)

	Upland St Greenwood St	Upland St Harwich St	Upland St Upland Gardens
Intersection	Unsignalized	Unsignalized	Unsigignalized
Calculated Crash Rate	0.2	0.08	0.06
massDOT Av Rate 0.61		0.61	0.61
Year			
2017	2	0	0
2018	0	0	0
2019	3	0	0
2020	1	0	0
2021	1	1	0
2022	0	0	0
2023	0	0	1
Toal	**7**	**1**	**1**
Collision Type			
Angle	5	0	1
Rear-end	1	0	0
Sideswipe	0	1	0
Single Vehicle	1	0	0
Total	7	**1**	**1**
Severity			
Fatal Injury	0	0	0
Non-Fatal Injury	2	1	0
Property Damage	5	0	1
Total	**7**	**1**	**1**
Time of Day			
7:00 AM to 9:00 AM	1	0	0
4:00 PM to 6:00 PM	1	0	1
Other Times	5	1	0
Total	**7**	**1**	**1**
Pavement Conditions			
Dry	7	1	0
Wet	0	0	1
Snow	0	0	0
Total	**7**	**1**	**1**

Source: massDOT Crash Portal 2017-July 2, 2023

Existing Conditions Summary

Upland Street can be characterized as a two-way roadway with one travel lane in each direction along its length in the vicinity of the proposed multifamily residential development site. Upland Street at its intersections with Upland Gardens Drive, Harwich Street, and Greenwood Street has one-lane approaches. The roadway width varies from 26' to 32'. Upland Street connects to Greenwood Street at its easterly end, and it intersects with Upland Gardens Drive, Arboretum Drive, and Pakachoag Street in the town of Auburn in the westerly direction. It has several WRTA bus stops for both inbound and outbound directions along its path. The current land use designation for the proposed multifamily residential development site is Residential Limited, 7,000 SF Min. Lot Size (RL-7) and the site is currently undeveloped.

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FUTURE CONDITIONS

Where possible, traffic volumes in the study area are projected to post-development levels. Projected traffic volumes include the existing traffic data obtained from the turning movement counts adjusted and normalized into the year 2021 to account for the COVID-19 pandemic and additionally adjusted to the year 2023 to represent the baseline, further projected into the future 2028-year peak hours to reflect increases due to future area projects and added to the new traffic expected to be generated by the proposed multifamily residential development site.

Site-Generated Traffic

As in the original December 2021 traffic study, the magnitude of traffic volumes that will be generated by the proposed multifamily residential development site was projected by using the 10th edition of the *Trip Generation Manual* published by the Institute of Transportation Engineers (ITE).

Based on the ITE *Trip Generation Manual*, the rates at which the proposed land use generates traffic vary depending upon the time of day and the size of the development. These rates were used to calculate the number of trips expected to be generated by the proposed multifamily residential development during an average weekday, morning, and afternoon peak traffic periods. To obtain the most accurate forecast and to be consistent with the *massDOT* recommended procedures, when available, the values in the fitted curves in the *Trip Generation Manual* were used to forecast trips to and from the proposed site for daily, AM and PM peak hours. The ITE Trip Generation manual pages for the previous July 2023 traffic study that included 120 apartment units are presented in the Technical Appendix section of this report. The previous July 2023 study was for a development containing 120 apartment units. However, the trip rates per apartment unit for Daily, AM Peak and PM peak are the same as those for 118 apartment units as is proposed now. Therefore, resulting in 32 trips in and 20 trips out during PM peak period, which is the critical peak period. Again, a copy of the ITE Trip Generation manual for Mid-Rise Housing (LU Code 221) is added to the Appendix section of this report. The resulting trips and their directional distribution for the new proposed site with 118 apartment units are shown in the following Table 2.

TABLE 2
ITE Trip Generation for Clinics
118 Units Multi-Family - Mid-Rise Housing ITE LU Code 221

Daily	%In	%Out	AM Pk	%In	%Out	PM Pk	%In	%Out
5.44	50%	50%	0.36	26%	74%	0.44	61%	39%
642*	321*	321*	42*	11*	31*	52*	32*	20*

* *Fitted Curve values were used as per massDOT recommendation*

As can be seen in Table 2 above, the total number of new trips expected to be generated by the proposed multifamily residential development results in the highest traffic during PM peak period.

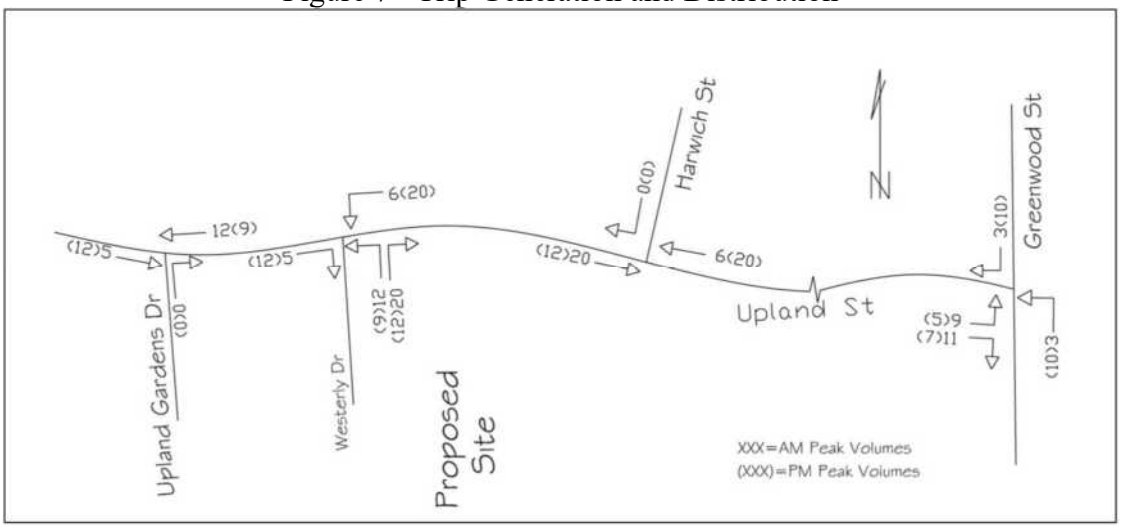
Also, generally, and as is the case here, the higher traffic or critical peak period along public roadways occurs during PM peak period. In standard traffic engineering practice, the critical peak period trips are usually used to assess the worst-case scenario for roadway conditions. However, both peak traffic periods were evaluated for all three intersections.

Trip Distribution and Assignment

Because such factors as population density, land use, availability of major highways in the area, and other demographics that make up the traffic patterns within a community, the directional distribution of the projected site-generated trips to and from the proposed multifamily residential development site was based on the existing traffic patterns within the immediate vicinity of the site and based on the knowledge of the local traffic patterns. The turning movement traffic counts for the three intersections near the proposed site are good indicators of the traffic patterns in this area.

Using this information, the projected new site-generated trips from Table 2 are proportionally assigned to each approach of these intersections. As shown in Table 2 above, during AM peak period, a sum of 11 vehicles would be arriving at the proposed development site and 31 vehicles would be departing from the site in both directions along Upland Street via the proposed driveway. During PM peak period, a total of 32 vehicles are expected to arrive and 20 vehicles would be departing from the proposed site via the proposed driveway. Finally, a total of 321 vehicles will be arriving at and 321 vehicles will be departing from the proposed site during a 24-hour period on an average weekday. The following Figure 7 shows the above-mentioned distribution of trips associated with the proposed site along Upland Street and the intersections within the study area.

Figure 7 - Trip Generation and Distribution



[1] *Trip Generation, 10th Edition,* Institute of Transportation Engineers; Washington, D

Site Access, Circulation and Parking

Site access and internal pedestrian and vehicular traffic circulation were evaluated as part of assessing the proposed multifamily residential development site. Access to the proposed site will be achieved via a single driveway, located approximately 220' east of Upland Gardens Drive forming a three-legged "T" intersection. The proposed driveway will provide full access to all 213 parking spaces within the site. The access driveway is designed to have a pavement width of 24' to accommodate two-way traffic, while the width of an emergency access is proposed at 14 feet. As stated earlier, a second emergency access point is proposed directly across from Harwich Street for use by emergency apparatus only. The entrance from Upland Street is designed with a 40' radius to safely accommodate Worcester Fire Department apparatus.

The magnitude of parking spaces that will be required by the proposed multifamily residential development was projected by using the *Parking Generation*[1] manual also published by the ITE. Based on the 3rd edition of the ITE *Parking Generation* manual, the rates at which Low/Mid-Rise Apartments (land use 221) generate demand for parking vary depending upon the location of the project. The demand for off-street parking is lower for facilities located in urban areas primarily due to the availability of public transportation and shorter distances from daily conveniences. Based on the ITE *Parking Generation* manual for land use 221, a copy of which is included in the Technical Appendix section of this report, the 85th percentile or peak period parking demand rate for multifamily residential developments located in urban areas is 1.17 parking spaces per dwelling unit on a weekday and on a Saturday. As stated earlier, a total of 213 parking spaces are proposed for this site. Thus, the proposed parking supply is calculated at 1.81 spaces per unit. Although the proposed number of parking spaces is 9.5% lower than that required by the City of Worcester zoning regulations, it is 54.7% greater than that of the ITE *Parking Generation* manual, or the national average. Thus, explaining multifamily residential developments in urban areas benefit from available public transportation such as WRTA's bus route #11 with a 30-minute interval, as well as potential use of bicycles for commuting purposes. Therefore, based on the above assessment, it is concluded that sufficient parking spaces are proposed.

As stated earlier, a five-foot sidewalk that traverses from in front of both buildings to Upland Street is also proposed. Additionally, well defined walk paths with painted crosswalks and appropriate handicap ramps to guide residents to their vehicles within the parking areas in a safe manner are proposed.

Furthermore, the traffic survey of the intersections under study showed only one pedestrian or bicyclist traveling northbound along Greenwood Street at its intersection with Upland Street during PM peak hour. Similarly, only one pedestrian/bicyclist was traveling eastbound along Upland Street at its intersection with Upland Gardens Drive. Finally, the survey did not show any pedestrian/bicycle activities at the intersection of Upland Street and Harwich Street. Although pedestrian/bicycle volumes are negligible, several bicycle racks and inside bicycle storage areas are proposed throughout the development as shown on the revised site plan to accommodate bicycle traffic should the need arise. Also, proper sidewalks, crosswalks and proper handicap ramps are added to the revised site plan to address the needs of those residents wishing to use the

[1] *Parking Generation,* Institute of Transportation Engineers; Washington, DC

WRTA bus stops at the driveway intersection, as well as at the emergency access point.

As stated earlier, Upland Street is currently served by WRTA Route #11 with inbound stops in front of #20, #39, #45, #51 and #67, and outbound stops in front of #20, #42, and #92 which is located approximately 150 feet east of the Upland Gardens Drive intersection. To better serve potential bus riders from the proposed residential development and potentially those from the Autumn Woods development, it is best to relocate the current inbound stop from in front of #67 and the outbound stop from in front of #92 to a point between Upland Gardens Drive and the proposed development driveway with a crosswalk across Upland Street between the two stops to allow riders to cross the street. Such a change would likely necessitate concurrence from WRTA.

4
TRAFFIC OPERATIONS

Measuring existing traffic volumes and projecting future traffic volumes quantify traffic flow within the study area. To assess the quality of traffic flow, intersection capacity analyses were performed to measure existing baseline conditions and for projected future design year (2028) conditions with and without the implementation of the proposed multifamily residential development project. Intersection capacity analyses provide an indication of how well roadway facilities and their components serve the traffic demands placed upon them. This section includes potential on-site and off-site mitigation improvements should any be deemed necessary to minimize the impact of the proposed multifamily residential development on the surrounding roadways.

Traffic Operations Measures

Level of Service (LOS) is the term used to demonstrate the different operating conditions which occur on a given roadway segment or at an intersection under different traffic volume conditions. LOS is a qualitative measure of the effect of several other factors including roadway geometry, speed, travel delay, signal timing, freedom to maneuver and safety. The criteria used to analyze the intersections in proximity of the proposed development site are based on the Highway Capacity Manual and its computer software.

The LOS concept is an indicator of the operational qualities of a roadway or an intersection. Six LOSs are defined for each type of facility. They are given letter designations from "A" to "F". LOS "A" represents the best operating conditions with little or no delays, while LOS "F" represents the worst conditions with long vehicular delays. Typically, LOS "D" is considered acceptable during peak hour conditions, but LOS "E" may also be acceptable under some circumstances.

The LOS designation is reported differently for signalized and unsignalized intersections. For signalized intersections, the analysis considers the operation of all traffic entering the intersection, and a LOS designation can be calculated for overall conditions at the intersection. For an unsignalized intersection, however, the analysis assumes that through traffic on major roadways is not affected by traffic on side streets (streets with lower volumes and/or ones under stop/yield sign control). Therefore, a LOS designation is typically calculated for the controlled movements (minor street approaches and major street left-turn movements). As described in the following paragraphs, capacity or LOS analyses were considered for year 2023 existing, year 2028 future no build, and year 2028 future build conditions for morning and evening peak hour periods at the above-mentioned three intersections. Additionally, the proposed driveway was also analyzed under future build conditions.

Existing Conditions

Intersection capacity analyses were performed for all three intersections during morning and evening peak traffic periods. These intersections are the only locations in the vicinity of the proposed

multifamily residential development site that were identified by the city engineering staff as locations that may be affected by the traffic expected to be generated by the proposed residential development. As mentioned earlier, all three intersections are unsignalized.

The analysis concluded that LOS "B" or better is calculated for all approaches of the intersections of Upland Street with Upland Gardens Drive and Harwich Street during AM and PM peak periods. Both intersections currently operate at LOS "A". The eastbound approach of Upland Street at Greenwood Street, however, is operating at LOS "C" during morning peak hour and at LOS "F" during afternoon peak hour. This intersection operates at LOS "B" during morning peak hour and at LOS "D" during afternoon peak hour. A summary of the intersection analyses results for existing conditions is shown below in Table 3.

Future Conditions

Capacity analyses for the future year peak hour traffic operations were performed for the year 2028 volumes during both AM and PM peak periods with and without the proposed multifamily residential development project in place. A summary of the intersection analyses results for both future no-build and future build conditions is also shown below in Table 3.

As noted earlier in this report, based on the *massDOT* Traffic Volume and Classification data, Upland Street is included in group U4-U7 for the Growth Factor and Seasonal Factor. Based on roadways in group U4-U7, the yearly growth rate for this group of roadways is 0.0034, or 0.34% per year. Therefore, the baseline (COVID-19 Adjusted) volumes were increased by that rate over five years or compounded at 1.9% to reflect future no-build conditions. Figure 8 shows the volumes for the future no-build conditions for all three intersections within the study area. Again, as stated earlier in this report, the projected future no-build year (2028) traffic should account for any future developments in the general area of the proposed site. It should also be noted that Mr. Nick Lyford, Engineering Division's liaison to the Planning Department, as well as for the City Planning and Zoning Boards was consulted and no other potential developments in the vicinity of the proposed site were identified.

Build traffic volumes were determined by projecting site-generated traffic volumes and distributing those volumes over the intersections within the study area roadway network (Figure 7), and finally, adding them to the future no-build conditions volumes. The following Figure 9 shows future build conditions traffic volumes for all three intersections, including the proposed driveway off Upland Street.

Figure 8 – Turning Movement Counts, Future No Build Conditions

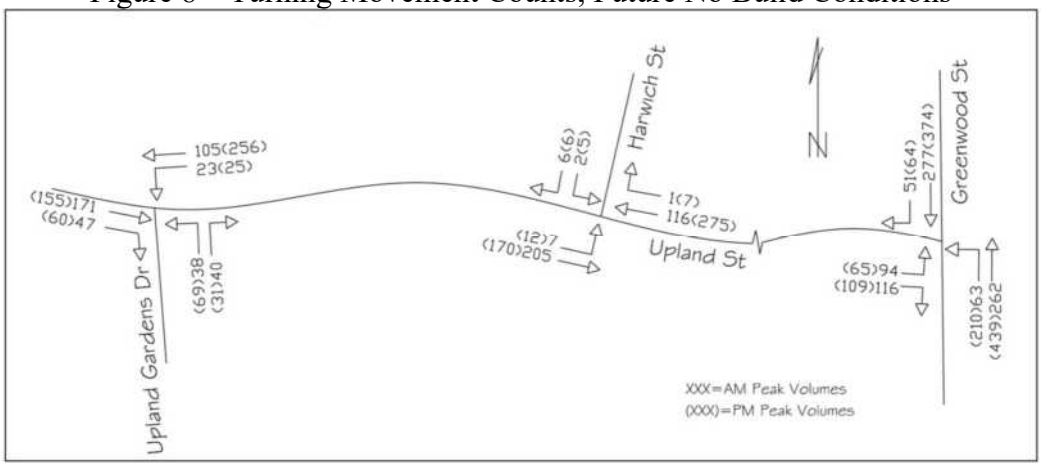
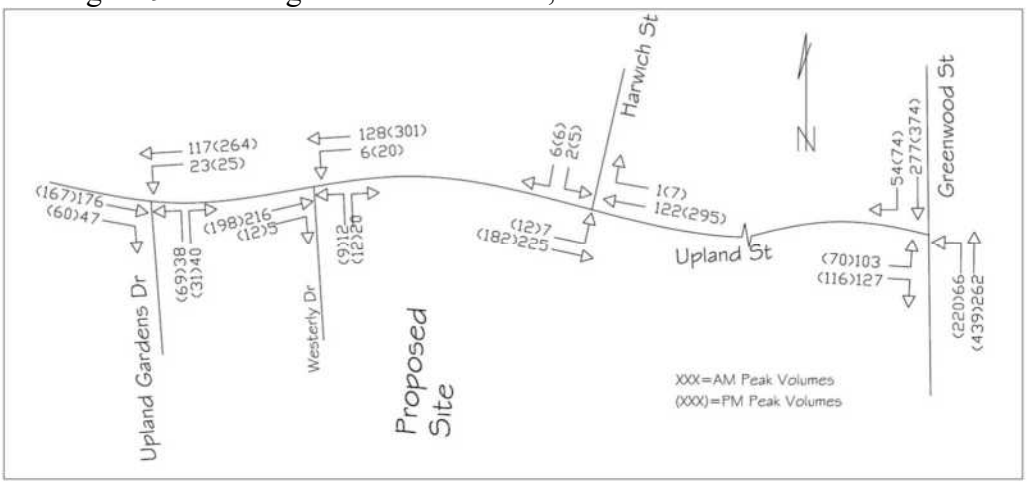


Figure 9 – Turning Movement Counts, Future Build Conditions



The intersection LOSs for the year 2028 no-build conditions were calculated for the approaches of these intersections and are expected to remain at "B" or better during both AM and PM peak periods for the intersections of Upland Street with Upland Gardens Drive and Harwich Street, and the eastbound approach of Upland Street at its intersection with Greenwood Street that will continue to operate at LOS "C" during AM peak and at LOS "F" during PM peak period, the same as those under existing conditions. Again, the intersection of Upland Street and Greenwood Street will continue to operate at LOS "D".

To assess the potential traffic impact of the proposed development on these intersections, all traffic from the proposed site was distributed along Upland Street and the three intersections within the study area. This should result in the assessment of all three intersections under the worst-case scenario. The above Figures 3, 8 and 9 show the volumes at all three intersections for both AM and PM peak hours under existing, future no-build, and future build conditions.

The intersection analyses for the year 2028 build conditions were performed for the approaches of all three intersections including the intersection of Upland Street with the proposed site driveway. The analyses revealed that under future build conditions, the approaches of the intersections of Upland Street with Upland Gardens Drive and Harwich Street will be operating the same as the future no-build with LOS "B" or better. Again, the eastbound approach of Upland Street at Greenwood Street will continue to operate at LOS "C" during morning peak and at LOS "F" during afternoon peak hour. The same is true for the intersection LOS "D" under future build conditions for Upland Street at Greenwood Street. The analysis also showed that the approaches of the intersection of Upland Street and the proposed driveway will be operating at LOS "B" or better during both peak periods.

Again, the above-mentioned LOS "B" or better for all intersection approaches except the eastbound approach of Upland Street at Greenwood Street which will continue to operate at LOS "C" and "F" future no-build and future build conditions are indicative of little, or no impact associated with the development of the proposed multifamily residential project.

A summary of intersection analyses for all intersections, including the proposed new driveway, is incorporated in Table 3 below. The duplicate in the Summary Table 3 has been revised and corrected to reflect the LOS analyses for both AM and PM peak periods.

Finally, the computer printout of the above-mentioned analyses is included in the Technical Appendix section of this report.

Table 3
Level Of Service Analysis Results Summary

AM Peak Hour

Upland Street at Upland Gardens Drive AM Peak	Existing 2023			No Build 2028			Build 2028		
Approach	EB	WB	NB	EB	WB	NB	EB	WB	NB
App Delay	0	1.6	11.1	0.0	1.6	11.2	0	1.4	11.3
v/c	0.15	0.02	0.13	0.15	0.02	0.14	0.15	0.02	0.14
App LOS		A	B		A	B		A	B
Int Av Dela	2.5			2.6			2.5		
Int LOS	A			A			A		

Upland Street at Harwich Street AM Peak	Existing 2023			No Build 2028			Build 2028		
Approach	EB	WB	SB	EB	WB	SB	EB	WB	SB
App Delay	0.3	0	9.6	0.3	0	9.6	0.3	0	9.7
v/c	0.01	0.09	0.02	0,01	0.09	0.02	0.01	0.09	0.02
App LOS	A		A	A		A	A		A
Int Av Dela	0.5			0.5			0.5		
ICU LOS	A			A			A		

Upland Street at Greenwood Street AM Peak	Existing 2023			No Build 2028			Build 2028		
Approach	EB	NB	SB	EB	NB	SB	EB	NB	SB
App Delay	19.1	2,1	0	19.8	2.1	0	21.6	2.2	0
v/c	0.48	0.06	0.21	0.50	0.06	0.21	0.55	0.06	0.21
App LOS	C	A		C	A		C	A	
Int Av Dela	5.5			5.6			6.4		
Int LOS	B			B			B		

PM Peak Hour

PM Peak	Existing 2023			No Build 2028			Build 2028		
Approach	EB	WB	NB	EB	WB	NB	EB	WB	NB
App Delay	0	0.9	13	0	0.9	13.1	0	0.9	13.4
v/c	0.13	0.02	0.19	0.14	0.02	0.2	0.15	0.02	0.2
App LOS		A	B		A	B		A	B
Int Sig Dela	2.5			2.6			2.5		
Int LOS	A			A			A		

PM Peak	Existing 2023			No Build 2028			Build 2028		
Approach	EB	WB	SB	EB	WB	SB	EB	WB	NB
App Delay	0.6	0	11.2	0.6	0	11.2	0.6	0	11.5
v/c	0.01	0.19	0.03	0.01	0.19	0.03	0.01	0.21	0.03
App LOS	A		B	A		B	A		B
Int Sig Dela	0.6			0.6			0.5		
Int LOS	A			A			A		

PM Peak	Existing 2023			No Build 2028			Build 2028		
Approach	EB	NB	SB	EB	NB	SB	EB	NB	SB
App Delay	58.2	4.9	0	66.3	5	0	88.7	5.2	0
v/c	0.78	0.22	0.27	0.83	0.22	0.27	0.93	0.24	0.28
App LOS	F	A		F	A		F	A	
Int Av Dela	10.6			11.7			15.4		
Int LOS	D			D			D		

Upland Street at Site Driveway 2028 Build Conditions	AM Peak			PM Peak		
Approach	EB	WB	NB	EB	WB	NB
App Delay	0	0.4	10.3	0.0	0.6	11.1
v/c	0.14	0.00	0.05	0.13	0.02	0.04
App LOS		A	B		A	B
Int Av Dela	1			0.8		
Int LOS	A			A		

5
FINDINGS

This traffic study has been conducted to evaluate the potential traffic impacts associated with the proposed multifamily residential development site located on the south side of Upland Street in the City of Worcester, Massachusetts. This study includes the evaluation of three intersections in proximity of the proposed site which are likely to be impacted by the proposed development project. Evaluation of the area to identify capacity constraints was performed for existing, future no-build, and future build conditions. Future analyses have determined that the site-generated traffic volumes are not substantial, thus they will have little or no impact on the area roadways, and they can easily be accommodated with the existing roadways and the proposed new driveway off Upland Street. These analyses demonstrated that with the additional traffic volumes associated with the proposed multifamily residential development, the intersection LOS will stay the same as those under existing and future no build conditions. The analysis concluded that the intersection of Upland Street and the proposed access driveway will be operating at LOS "B" or better during both AM and PM peak periods.

Also, the accident analysis for the intersections in the study area indicates there are no safety deficiencies associated with any of these intersections.

As stated earlier, the percentage of truck traffic at permanent counting station #250894 along Greenwood Street was recorded by the *massDOT* at 1.3%. This value is considered below the average of 2% for roadways having similar characteristics.

Conclusion & Recommendations

It is concluded that the intersections within the study area have experienced very low accident rates, and therefore, no safety issues can be related to these intersections.

There are ample sight distances to safely allow motorists to enter and exit the development site via the proposed driveway.

The volumes of traffic associated with the proposed 118-unit multifamily residential development are not considered significant, and therefore, the area roadways within close vicinity of the proposed site have enough capacity to safely serve the anticipated additional traffic. The level of service evaluation presented above is an indicator of the quality of traffic flow through the area. This evaluation indicates that little or no impact is expected from the proposed development and the intersection LOS will not fall below "A" for Upland Gardens Drive and Harwich Street and below "D" for Upland Street at Greenwood Street. The analysis showed the LOS "B" for the approaches of the intersections of Upland Street with Upland Gardens Drive and Harwich Street and LOS "F" for the eastbound approach of Upland Street at Greenwood Street during PM peak period will remain the same as those under the existing conditions. It should be noted that the analysis considered the eastbound approach of Upland Street at Greenwood Street to be a single lane. However, as stated in the Existing Conditions section of

this report, the eastbound approach of this intersection widens to approximately 20' for a length of nearly 25', thus, allowing for the separation of the left-turn traffic from the right-turn traffic. This short distance essentially creates an informal separate right lane for the right-turn traffic to bypass the left-turn traffic, thus reducing delays significantly. As a result, this approach is most likely operating at a much better LOS than that analyzed in this report under all three conditions. Therefore, if this approach is widened to officially provide two lanes of travel for a short distance of 30'-40', a much better LOS could be realized. It should be noted that the above-mentioned situation is an existing condition, and therefore, irrespective of this project, the city should consider the addition of a right-turn lane at this location which may require a small land taking since the Right-Of-Way is only 33' along the entire length of Upland Street. It is also noted that such land acquisition could only be undertaken by the city.

As shown in the photographs, vegetation along the south side of Upland Street around the westerly driveway impedes visibility for motorists leaving the site via the proposed driveway. Therefore, the applicant should make efforts to remove any existing vegetation and to keep all landscaping along the frontage of the proposed site to a minimum to provide ideal sight distances. Therefore, to maintain optimum safety and efficiency, the following improvements are recommended.

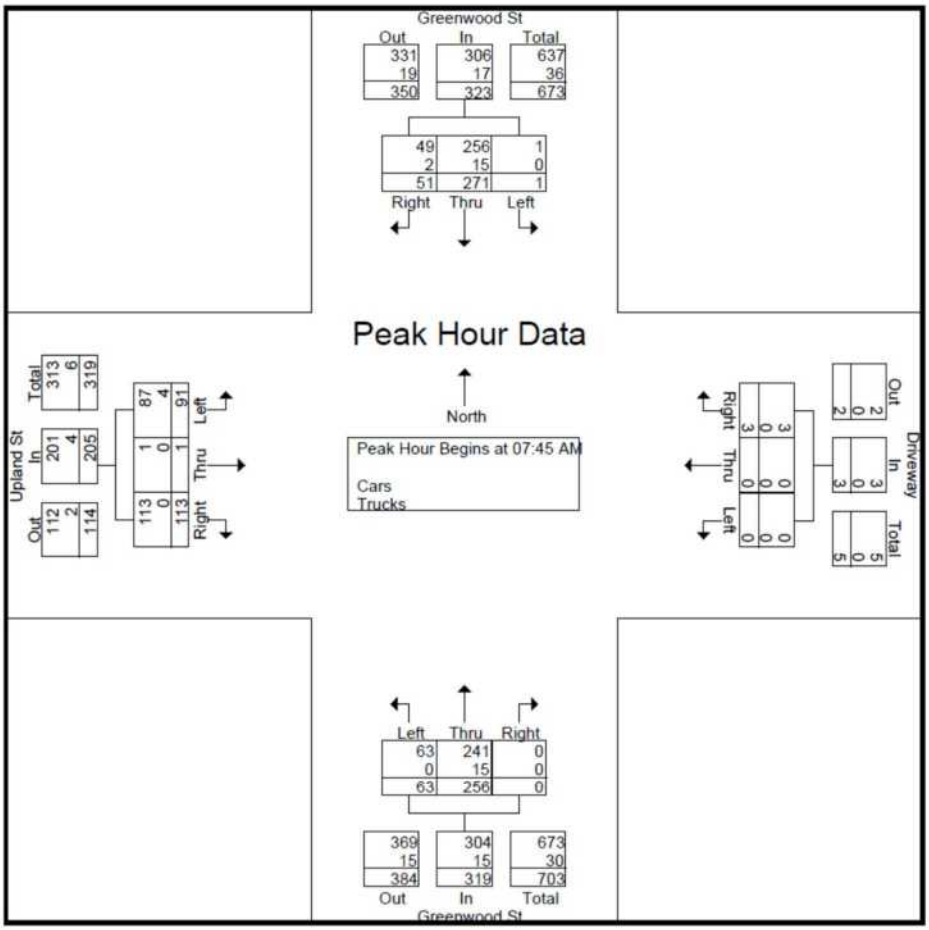
- The site frontage on the south side of Upland Street around the proposed driveway should be cleared of all existing vegetation to further improve the sight distances in both easterly and westerly directions.
- Any landscaping along the frontage of the proposed site on Upland Street, including those at the driveway, should be limited to vegetation varieties that do not grow taller than 2.5' to ensure the best sight lines are maintained.
- The northbound approach of the proposed driveway should be posted with a MUTCD standard stop sign and marked with a stop bar.
- The southbound approach of Harwich Street is not currently controlled. It is recommended that this approach be posted with a MUTCD standard stop sign and a stop bar.
- Although there is a stop bar for the eastbound approach of Upland Street at Greenwood Street, it was noted that this approach is not currently controlled by a stop sign. It is therefore recommended that this approach also be posted with a MUTCD standard stop sign.
- Since the gate for the emergency access point is 90’ in from Upland Street, an adequate number of signs should be clearly posted to discourage and prevent motorists from entering.
- Regardless of the implementation of the proposed residential development project, the City of Worcester should consider the installation of a short right-turn lane for the eastbound approach of Upland Street at Greenwood Street.
- Finally, in accordance with the City of Worcester subdivision regulations, it is recommended that leveling areas should be provided at the approaches of the proposed driveway, and the street grade at which shall not exceed three percent (3%) for a distance of one hundred (100) feet from the nearest exterior line of the intersecting street.

Technical Appendix

Accurate Counts
978-664-2565

N/S Street : Greenwood Street
E/W Street : Upland Street
City/State : Worcester, MA
Weather : Clear

File Name : 19180001
Site Code : 19180001
Start Date : 11/18/2021
Page No : 2



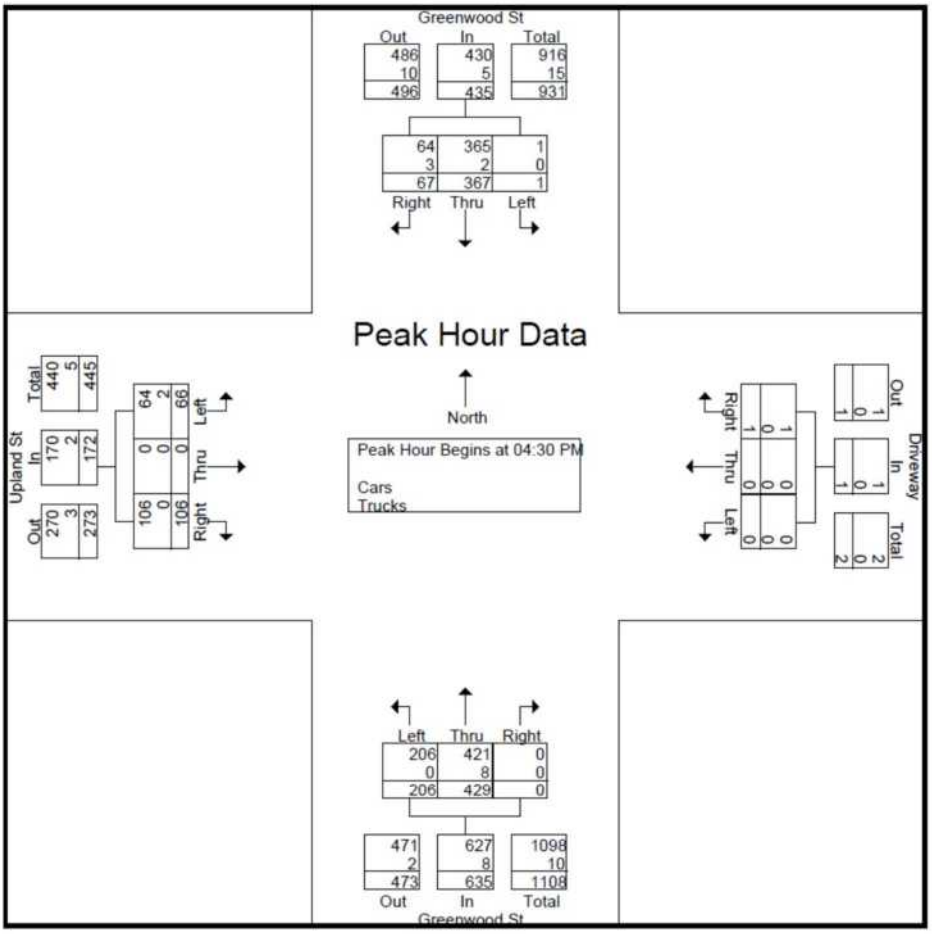
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1
Peak Hour for Each Approach Begins at:

	08:00 AM				07:00 AM				07:30 AM				07:45 AM			
+0 mins.	**1**	55	**17**	73	0	**1**	0	1	15	52	0	67	**28**	**1**	29	**58**
+15 mins.	0	63	14	77	0	0	0	0	16	75	0	91	22	0	27	49
+30 mins.	0	77	13	**90**	0	0	0	0	**19**	**76**	0	**95**	17	0	**31**	48
+45 mins.	0	**80**	9	89	0	0	**3**	**3**	17	56	0	73	24	0	26	50
Total Volume	1	275	53	329	0	1	3	4	67	259	0	326	91	1	113	205
% App. Total	0.3	83.6	16.1		0	25	75		20.6	79.4	0		44.4	0.5	55.1	
PHF	.250	.859	.779	.914	.000	.250	.250	.333	.882	.852	.000	.858	.813	.250	.911	.884
Cars	1	261	51	313	0	1	3	4	67	245	0	312	87	1	113	201
% Cars	100	94.9	96.2	95.1	0	100	100	100	100	94.6	0	95.7	95.6	100	100	98
Trucks	0	14	2	16	0	0	0	0	0	14	0	14	4	0	0	4
% Trucks	0	5.1	3.8	4.9	0	0	0	0	0	5.4	0	4.3	4.4	0	0	2

Accurate Counts
978-664-2565

N/S Street : Greenwood Street
E/W Street : Upland Street
City/State : Worcester, MA
Weather : Clear

File Name : 19180001
Site Code : 19180001
Start Date : 11/18/2021
Page No : 2



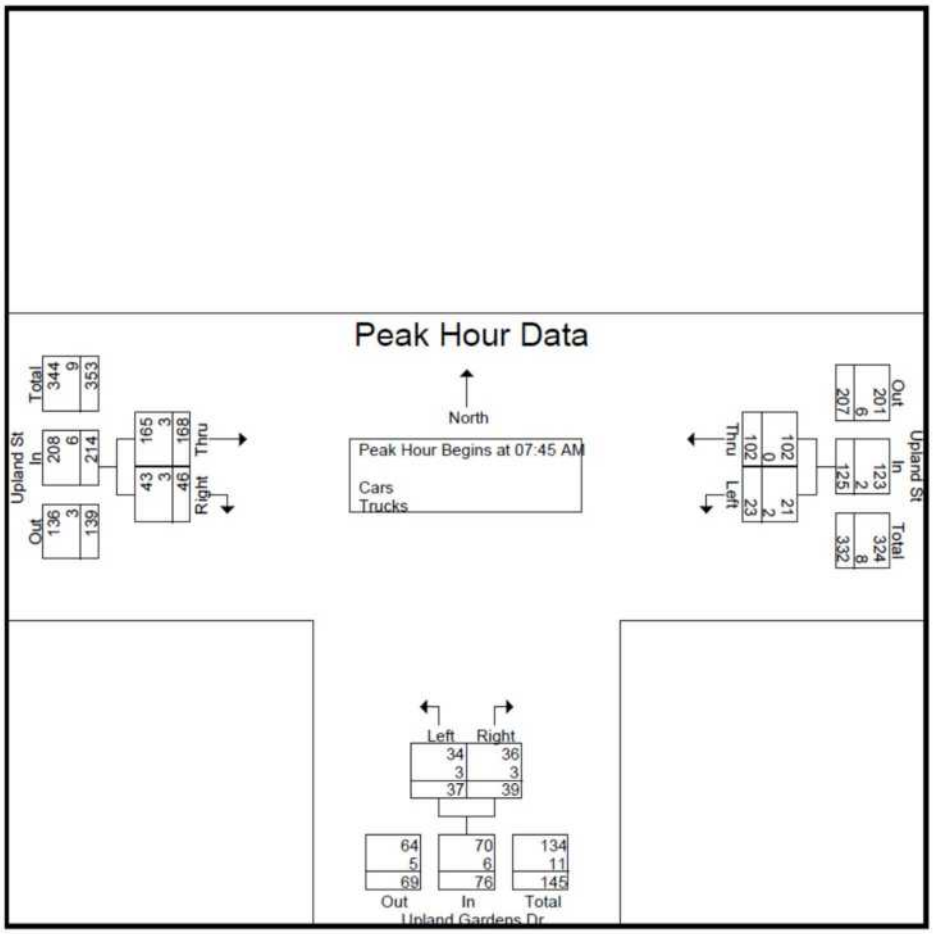
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1
Peak Hour for Each Approach Begins at:

	04:15 PM				04:45 PM				04:30 PM				04:30 PM			
+0 mins.	0	101	13	114	0	0	0	0	41	116	0	157	16	0	23	39
+15 mins.	0	87	17	104	0	0	0	0	43	73	0	116	**20**	0	28	**48**
+30 mins.	**1**	94	**24**	**119**	0	0	**1**	**1**	52	**124**	0	176	14	0	23	37
+45 mins.	0	**103**	12	115	0	**1**	0	1	**70**	116	0	**186**	16	0	**32**	48
Total Volume	1	385	66	452	0	1	1	2	206	429	0	635	66	0	106	172
% App. Total	0.2	85.2	14.6		0	50	50		32.4	67.6	0		38.4	0	61.6	
PHF	.250	.934	.688	.950	.000	.250	.250	.500	.736	.865	.000	.853	.825	.000	.828	.896
Cars	1	381	63	445	0	1	1	2	206	421	0	627	64	0	106	170
% Cars	100	99	95.5	98.5	0	100	100	100	100	98.1	0	98.7	97	0	100	98.8
Trucks	0	4	3	7	0	0	0	0	0	8	0	8	2	0	0	2
% Trucks	0	1	4.5	1.5	0	0	0	0	0	1.9	0	1.3	3	0	0	1.2

Accurate Counts
978-664-2565

N/S Street : Upland Gardens Drive
E/W Street : Upland Street
City/State : Worcester, MA
Weather : Clear

File Name : 19180002
Site Code : 19180002
Start Date : 11/18/2021
Page No : 2



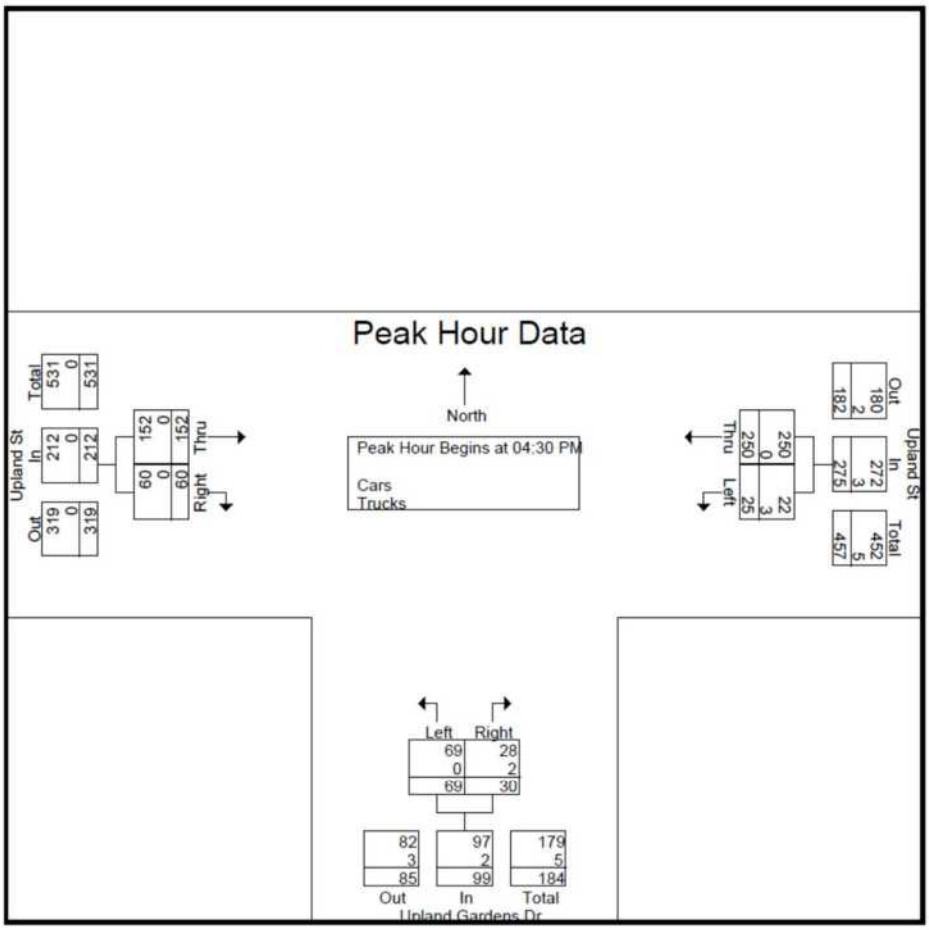
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1
Peak Hour for Each Approach Begins at:

	07:45 AM			07:45 AM			07:30 AM		
+0 mins.	2	24	26	12	8	20	39	**15**	54
+15 mins.	6	**34**	**40**	**15**	8	**23**	**50**	13	**63**
+30 mins.	**10**	22	32	7	9	16	42	11	53
+45 mins.	5	22	27	3	**14**	17	35	11	46
Total Volume	23	102	125	37	39	76	166	50	216
% App. Total	18.4	81.6		48.7	51.3		76.9	23.1	
PHF	.575	.750	.781	.617	.696	.826	.830	.833	.857
Cars	21	102	123	34	36	70	164	47	211
% Cars	91.3	100	98.4	91.9	92.3	92.1	98.8	94	97.7
Trucks	2	0	2	3	3	6	2	3	5
% Trucks	8.7	0	1.6	8.1	7.7	7.9	1.2	6	2.3

Accurate Counts
978-664-2565

N/S Street : Upland Gardens Drive
E/W Street : Upland Street
City/State : Worcester, MA
Weather : Clear

File Name : 19180002
Site Code : 19180002
Start Date : 11/18/2021
Page No : 2



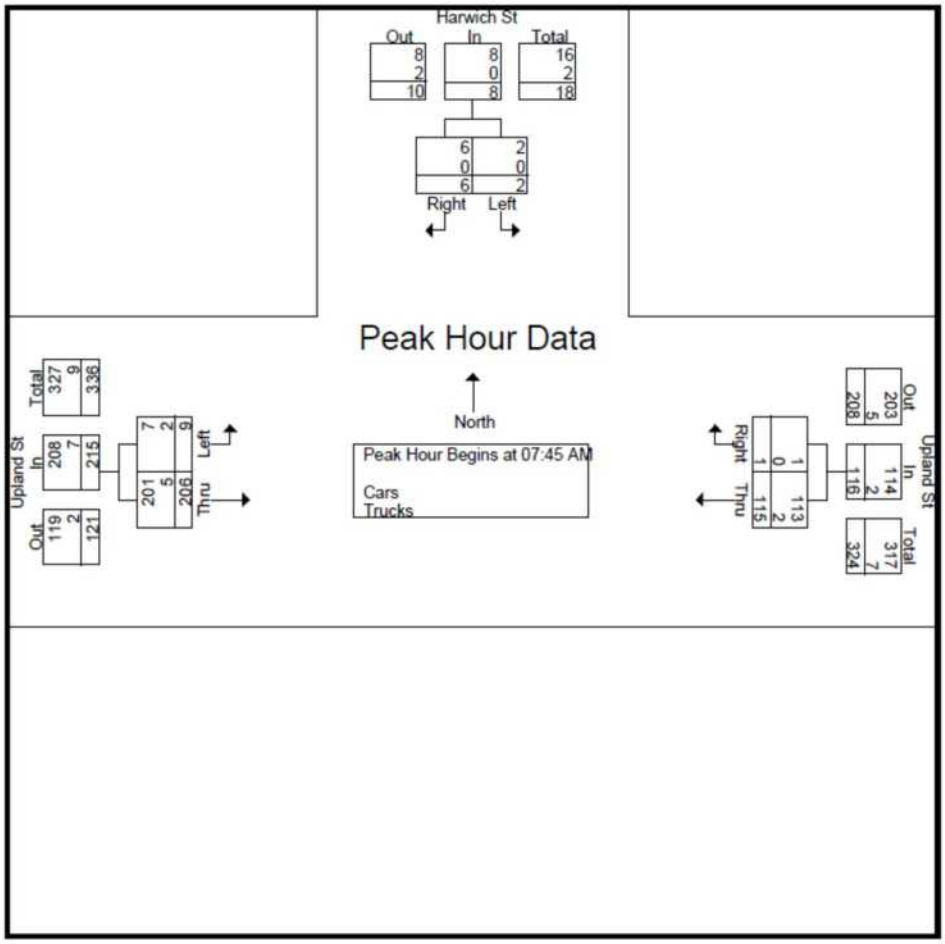
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1
Peak Hour for Each Approach Begins at:

	04:45 PM			04:15 PM			04:30 PM		
+0 mins.	7	58	65	17	4	21	**42**	16	**58**
+15 mins.	6	59	65	16	**11**	**27**	39	9	48
+30 mins.	4	**78**	**82**	**20**	7	27	36	**22**	58
+45 mins.	**8**	57	65	17	7	24	35	13	48
Total Volume	25	252	277	70	29	99	152	60	212
% App. Total	9	91		70.7	29.3		71.7	28.3	
PHF	.781	.808	.845	.875	.659	.917	.905	.682	.914
Cars	22	252	274	70	28	98	152	60	212
% Cars	88	100	98.9	100	96.6	99	100	100	100
Trucks	3	0	3	0	1	1	0	0	0
% Trucks	12	0	1.1	0	3.4	1	0	0	0

Accurate Counts
978-664-2565

N/S Street : Harwich Street
E/W Street : Upland Street
City/State : Worcester, MA
Weather : Clear

File Name : 19180003
Site Code : 19180003
Start Date : 11/18/202
Page No : 2



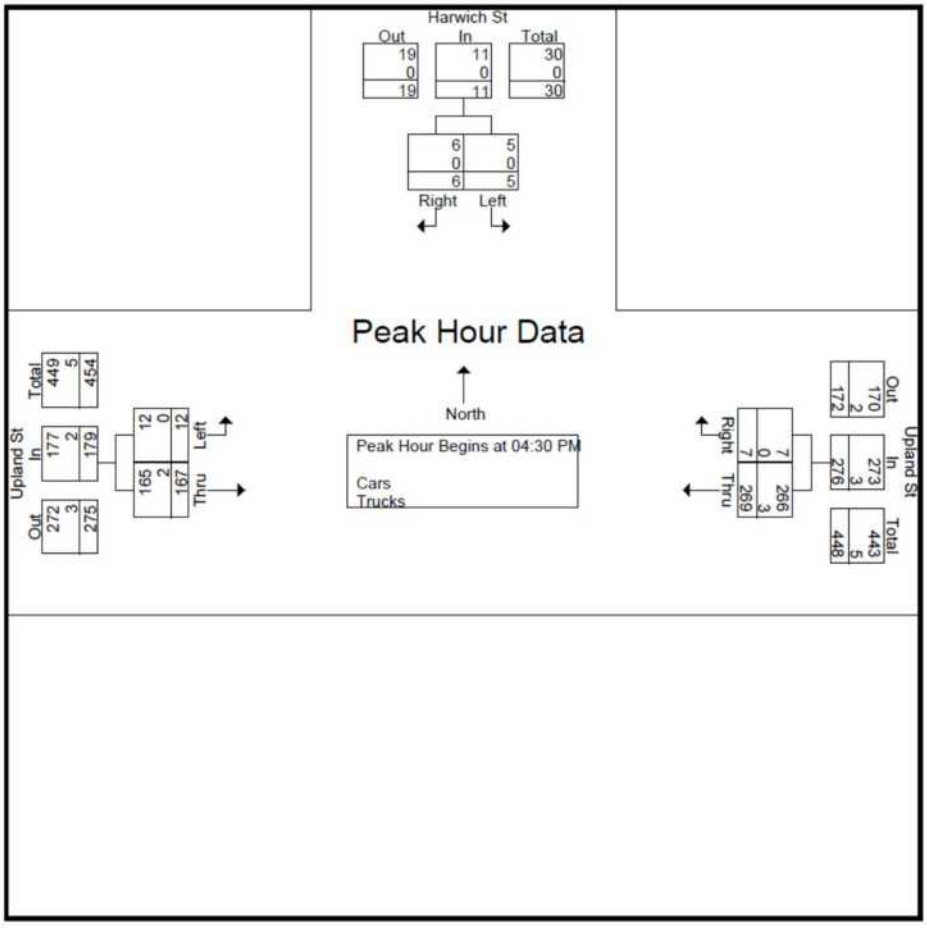
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1
Peak Hour for Each Approach Begins at:

	07:00 AM			07:45 AM			07:45 AM		
+0 mins.	0	4	4	23	**1**	24	2	**61**	**63**
+15 mins.	**1**	2	3	**36**	0	**36**	1	43	44
+30 mins.	1	**5**	**6**	31	0	31	2	52	54
+45 mins.	1	0	1	25	0	25	**4**	50	54
Total Volume	3	11	14	115	1	116	9	206	215
% App. Total	21.4	78.6		99.1	0.9		4.2	95.8	
PHF	.750	.550	.583	.799	.250	.806	.563	.844	.853
Cars	3	11	14	113	1	114	7	201	208
% Cars	100	100	100	98.3	100	98.3	77.8	97.6	96.7
Trucks	0	0	0	2	0	2	2	5	7
% Trucks	0	0	0	1.7	0	1.7	22.2	2.4	3.3

Accurate Counts
978-664-2565

N/S Street : Harwich Street
E/W Street : Upland Street
City/State : Worcester, MA
Weather : Clear

File Name : 19180003
Site Code : 19180003
Start Date : 11/18/2021
Page No : 2



Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1
Peak Hour for Each Approach Begins at:

	04:00 PM			04:45 PM			04:30 PM		
+0 mins.	0	**4**	4	65	**3**	68	**5**	**47**	**52**
+15 mins.	**3**	2	**5**	65	0	65	3	40	43
+30 mins.	1	2	3	**81**	2	**83**	3	44	47
+45 mins.	1	1	2	66	2	68	1	36	37
Total Volume	5	9	14	277	7	284	12	167	179
% App. Total	35.7	64.3		97.5	2.5		6.7	93.3	
PHF	.417	.563	.700	.855	.583	.855	.600	.888	.861
Cars	5	9	14	274	7	281	12	165	177
% Cars	100	100	100	98.9	100	98.9	100	98.8	98.9
Trucks	0	0	0	3	0	3	0	2	2
% Trucks	0	0	0	1.1	0	1.1	0	1.2	1.1

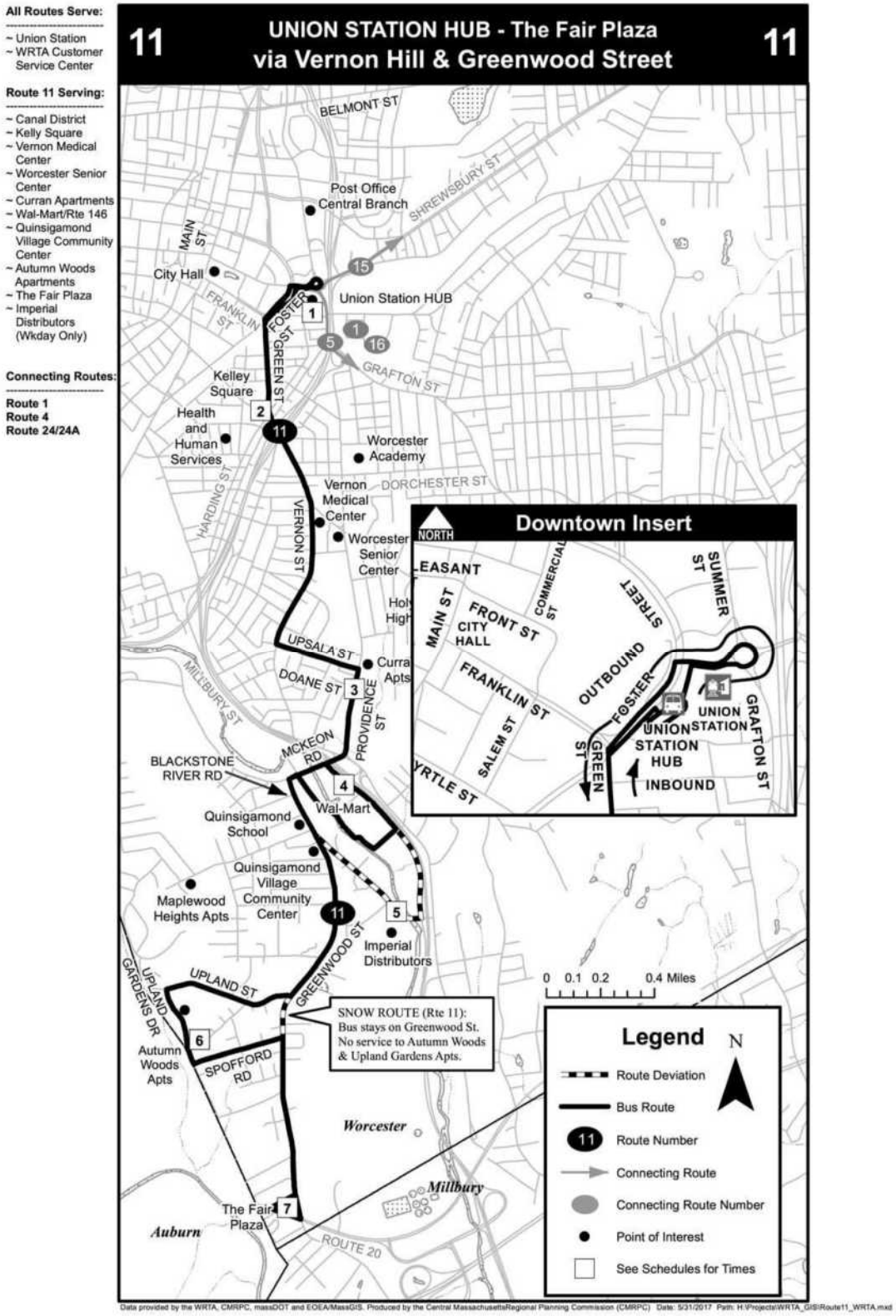

All Routes Serve:
~ Union Station
~ WRTA Customer Service Center
Route 11 Serving:
~ Canal District
~ Kelly Square
~ Vernon Medical Center
~ Worcester Senior Center
~ Curran Apartments
~ Wal-Mart/Rte 146
~ Quinsigamond Village Community Center
~ Autumn Woods Apartments
~ The Fair Plaza
~ Imperial Distributors (Wkday Only)
Connecting Routes:
Route 1
Route 4
Route 24/24A
11
UNION STATION HUB - The Fair Plaza
via Vernon Hill & Greenwood Street
11
BELMONT ST
Post Office
Central Branch
SHREWSBURY ST
MAIN ST
City Hall
FRANKLIN ST
FOSTER ST
GREEN ST
Union Station HUB
GRAFTON ST
Kelley Square
Health and Human Services
HARDING ST
Worcester Academy
DORCHESTER ST
Vernon Medical Center
VERNON ST
Worcester Senior Center
UPSALA ST
DOANE ST
MILLBURY ST
PROVIDENCE ST
MCKEON RD
BLACKSTONE RIVER RD
Wal-Mart
Quinsigamond School
Quinsigamond Village Community Center
Maplewood Heights Apts
Imperial Distributors
GREENWOOD ST
UPLAND ST
UPLAND GARDENS DR
Autumn Woods Apts
SPOFFORD RD
SNOW ROUTE (Rte 11):
Bus stays on Greenwood St.
No service to Autumn Woods & Upland Gardens Apts.
Worcester
Millbury
Auburn
The Fair Plaza
ROUTE 20
Downtown Insert
NORTH
PLEASANT
MAIN ST
FRONT ST
CITY HALL
COMMERCIAL ST
SUMMER ST
STREET
FRANKLIN ST
SALEM ST
MYRTLE ST
OUTBOUND
FOSTER
GREEN ST
UNION STATION
UNION STATION HUB
INBOUND
GRAFTON ST
0 0.1 0.2 0.4 Miles
Legend
N
Route Deviation
Bus Route
Route Number
Connecting Route
Connecting Route Number
Point of Interest
See Schedules for Times

Exhibit 3-8
Motor Vehicle Stopping Sight Distances

	Stopping Sight Distance (ft) by Percent Grade (%)						
		Downgrade			Upgrade		
Design Speed	0	3	6	9	3	6	9
20	115	116	120	126	109	107	104
25	155	158	165	173	147	143	140
30	200	205	215	227	200	184	179
35	250	257	271	287	237	229	222
40	305	315	333	354	289	278	269
45	360	378	400	427	344	331	320
50	425	446	474	507	405	388	375
55	495	520	553	593	469	450	433
60	570	598	638	686	538	515	495
65	645	682	728	785	612	584	561
70	730	771	825	891	690	658	631
75	820	866	927	1003	772	736	704

Source: A Policy on Geometric Design of Streets and Highways, AASHTO, Washington DC, 2004. Chapter 3 Elements of Design

Massachusetts Highway Department
Statewide Traffic Data Collection
2019 Weekday Seasonal Factors

Factor Group	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Axle Factor
R1	1.22	1.14	1.12	1.06	1.00	0.96	0.87	0.85	0.96	0.99	1.04	1.12	0.85
R2	0.95	0.96	0.98	0.97	0.97	0.93	0.97	0.94	0.96	0.90	0.92	0.93	0.96
R3	1.15	1.06	1.07	1.00	0.89	0.88	0.89	0.89	0.95	0.92	1.02	1.01	0.97
R4-R7	1.09	1.09	1.11	1.02	0.96	0.92	0.89	0.89	0.99	0.98	1.09	1.13	0.98
U1-Boston	1.03	1.01	0.98	0.94	0.94	0.92	0.95	0.93	0.94	0.94	0.97	1.04	0.96
U1-Essex	1.09	1.06	1.03	0.99	0.94	0.90	0.88	0.86	0.93	0.94	0.99	1.06	0.93
U1-Southeast	1.06	1.05	1.01	0.97	0.95	0.93	0.93	0.90	0.94	0.94	0.98	1.04	0.98
U1-West	1.19	1.14	1.09	0.95	0.92	0.89	0.89	0.86	0.91	0.95	0.97	1.07	0.84
U1-Worcester	1.02	1.04	0.97	0.94	0.93	0.91	0.95	0.91	0.93	0.92	0.95	1.10	0.88
U2	1.01	1.00	0.94	0.93	0.91	0.89	0.93	0.90	0.90	0.91	0.94	1.02	0.99
U3	1.06	1.03	0.98	0.94	0.93	0.91	0.95	0.91	0.92	0.93	0.97	1.00	0.98
U4-U7	1.01	1.00	0.95	0.92	0.88	0.86	0.92	0.91	0.92	0.94	0.99	1.04	0.99
Rec - East	1.04	1.16	1.12	0.98	0.92	0.88	0.77	0.81	0.94	1.02	1.08	1.12	0.99
Rec - West	1.30	1.23	1.32	1.18	0.95	0.82	0.70	0.69	0.97	0.96	1.16	1.15	0.98

Round off:
0-999 = 10
>1000 = 100

U = Urban
R = Rural

1 - Interstate
2 - Freeway and Expressway
3 - Other Principal Arterial
4 - Minor Arterial
5 - Major Collector
6 - Minor Collector
7 - Local Road and Street

Recreational - East Group - Cape Cod (all towns) including the town of Plymouth south of Route 3A (stations 7014,7079,7080,7090,7091,7092,7093,7094,7095,7096,7097,7108 and 7178), Martha's Vineyard and Nantucket.
Recreational - West Group - Continuous Stations 2 and 189 including stations 1066,1067,1083,1084,1085,1086,1087,1088,1089,1090,1091,1092,1093,1094,1095,1096,1097,1098,1099,1100,1101,1102,1103,1104,1105,1106,1107,1108,1113,1114, 1116,2196,2197 and 2198.

5/31/2020

MassDOT Yearly Growth Rates

for data from 2014 to 2018

Growth Factors					
Group	Grow 2014 to 2015	Grow 2015 to 2016	Grow 2016 to 2017	Grow 2017 to 2018	Grow 2018 to 2019
R1	0	0.023	0.004	0.018	0.016
R2	0.05	0.068	0.004	0.014	0.014
R3	-0.038	0.002	0.008	0.011	0.06
R4-7	-0.01	0.003	0.001	0.011	0.012
Rec – East		0.032	0.02	0.041	0.025
Rec – West		0.051	-0.008	0.029	0
U1-Boston	0.061	0.07	-0.003	0.012	0.006
U1-Essex	0.024	0.025	0.007	0.014	0.011
U1-Southeast	0.05	0.062	0.021	0.014	0
U1-West	0.03	-0.027	0.02	0.028	0.013
U1-Worcester	0.042	0.005	0.018	0.01	0.01
U2	0.04	0.048	0.008	0.01	0.02
U3	0.011	0.013	0.011	0.014	0.004
U4-7	0.023	0.062	0.017	0.003	-0.004

Average Crash Rates, per Million Entering Vehicles, by Intersection Type
(Based upon crash information queried on June 26, 2018)

Location	Signalized Intersections	Unsignalized Intersections
Statewide	0.78	0.57
District 1*	0.80*	0.44*
District 2	0.89	0.62
District 3	0.89	0.61
District 4	0.73	0.57
District 5	0.75	0.57
District 6	0.71	0.52

Location	Signalized Intersections

* - District 1 should use Statewide Rates due to low sample total

Accident Data

RMV Crash Number	City Town Name	Crash Date	Crash Time	Crash Severity	Maximum Injury Severity Reported	Number of Vehicles	Total Non-fatal Injuries	Total Fatal Injuries	Manner of Collision	Vehicle Action Prior to Crash	Vehicle Travel Directions	Most Harmful Events	Vehicle Configuration	Road Surface Condition	Ambient Light	Weather Condition	At Roadway Intersection	Distance From Nearest Roadway Intersection	Distance From Nearest Milemarker	Distance From Nearest Exit
4344221	WORCESTER	17-Jan-2017	7:21 AM	Not Reported	Not reported	1	0	0	Angle	V1: Not reported	V1: Not Reported			Dry	Dark - lighted roadway	Clear/Cloudy	GREEN WOOD STREET / UPLAND STREET	GREENWOOD STREET / UPLAND STREET		
4333896	WORCESTER	19-Feb-2017	10:25 PM	Non-fatal injury	Non-fatal injury - Possible	3	1	0	Angle	V1: Slowing or stopped in traffic / V2: Slowing or stopped in traffic / V3: Travelling straight ahead	V1: S / V2: S / V3: S	V1:(Collision with motor vehicle in traffic) / V2:(Collision with motor vehicle in traffic) / V3:(Collision with motor vehicle in traffic)	V1:(Passenger car) / V2:(Light truck(van, mini-van, pickup, sport utility)) / V3:(Passenger car)	Dry	Dark - lighted roadway	Clear	GREEN WOOD STREET / UPLAND STREET /	GREENWOOD STREET / UPLAND STREET /		
4690355	WORCESTER	16-Jan-2019	3:21 PM	Property damage only (none injured)	No injury	2	0	0	Rear-end	V1: Turning left / V2: Travelling straight ahead	V1: Not Reported / V2: Not Reported	V1:(Collision with motor vehicle in traffic) / V2:(Collision with motor vehicle in traffic)	V1:(Light truck(van, mini-van, pickup, sport utility)) / V2:(Passenger car)	Dry	Daylight	Clear/Clear	GREEN WOOD STREET / UPLAND STREET	GREENWOOD STREET / UPLAND STREET		
4902863	WORCESTER	14-Aug-2019	3:39 PM	Property damage only (none injured)	No Apparent Injury (O)	2	0	0	Angle	V1: Turning left / V2: Turning left	V1: Not Reported / V2: Not Reported	V1:(Collision with motor vehicle in traffic) / V2:(Collision with motor vehicle in traffic)	V1:(Light truck(van, mini-van, pickup, sport utility)) / V2:(Light truck(van, mini-van, pickup, sport utility))	Dry	Daylight	Clear/Clear	GREEN WOOD STREET / UPLAND STREET	GREENWOOD STREET / UPLAND STREET		

4844234	WORCESTER	05-Dec-2019	4:40 PM	Property damage only (none injured)	No Apparent Injury (O)	2	0	0 Angle	V1: Turning right / V2: Overtaking/passing	V1: Not Reported / V2: Not Reported	V1:(Collision on with motor vehicle in traffic) / V2:(Collision on with motor vehicle in traffic)	V1:(Light truck(van, mini-van, pickup, sport utility)) / V2:(Passenger car)	Dry	Dark - lighted roadway	Clear		GREENWOOD STREET / UPLAND STREET
4898218	WORCESTER	21-Feb-2020	10:30 AM	Non-fatal injury	Suspected Minor Injury (B)	2	0	0 Angle	V1: Travelling straight ahead / V2: Turning left	V1: S / V2: N	V1:(Collision on with motor vehicle in traffic) / V2:(Collision on with motor vehicle in traffic)	V1:(Light truck(van, mini-van, pickup, sport utility)) / V2:(Light truck(van, mini-van, pickup, sport utility))	Dry	Daylight	Clear/Cloudy	GREEN WOOD STREET / UPLAND STREET	GREENWOOD STREET / UPLAND STREET
4963816	WORCESTER	05-May-2021	11:50 AM	Non-fatal injury	Possible Injury (C)	3	0	0 Sideswipe, opposite direction	V1: Travelling straight ahead / V2: Travelling straight ahead / V3: Parked	V1: W / V2: E / V3: S	V1:(Collision on with motor vehicle in traffic) / V2:(Collision on with motor vehicle in traffic) / V3:(Collision on with motor vehicle in traffic)	V1:(Light truck(van, mini-van, pickup, sport utility)) / V2:(Passenger car) / V3:(Passenger car)	Dry	Daylight	Clear	HARWICH STREET / UPLAND STREET	HARWICH STREET / UPLAND STREET
5047329	WORCESTER	21-Oct-2021	8:22 PM	Unknown	Not reported	1	0	0 Single vehicle crash	V1: Travelling straight ahead	V1: W	V1:(Collision on with tree)	V1:(Passenger car)	Dry	Dark - lighted roadway	Clear		GREENWOOD STREET / UPLAND STREET

5263056	WORCESTER	20-May-2023	4:00 PM	Property damage only (none injured)	No Apparent Injury (O)	2	0	0	Angle		V1: Turning left / V2: Slowing or stopped in traffic	V1: S / V2: N		V1:(Collision with motor vehicle in traffic) / V2:(Collision with motor vehicle in traffic)	V1:(Light truck(van, mini-van, pickup, sport utility)) / V2:(Passenger car)	Wet	Daylight	Rain/Cloudy	UPLAND GARDENS DRIVE Rte N / UPLAND STREET Rte W	UPLAND GARDENS DRIVE Rte N / UPLAND STREET Rte W

massDOT Highway

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Worcester COUNT DATE : Nov-21

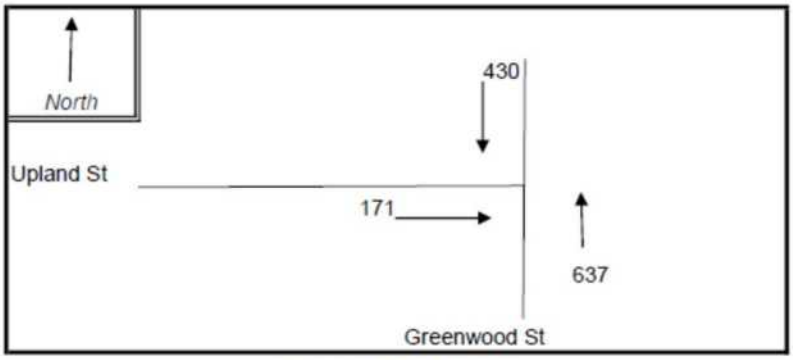
DISTRICT : Dist 3 UNSIGNALIZED : X SIGNALIZED :

~ INTERSECTION DATA ~

MAJOR STREET : Greenwood Street

MINOR STREET(S) : Upland Street

INTERSECTION DIAGRAM (Label Approaches)



PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	EB	NB	SB			
PEAK HOURLY VOLUMES (AM/PM) :	171	637	430			1,238

" K " FACTOR :	0.090	INTERSECTION ADT (V) = TOTAL DAILY APPROACH VOLUME :	13,756

TOTAL # OF CRASHES :	7	# OF YEARS :	7	AVERAGE # OF CRASHES PER YEAR (A) :	1.00

CRASH RATE CALCULATION : 0.20 RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : Much lower than the rate of 0.61 for unsignalized in tersection in Dist 3 of the massDOT

Project Title & Date: 49 Upland St July 2023

massDOT Highway

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Worcester COUNT DATE : Nov-21

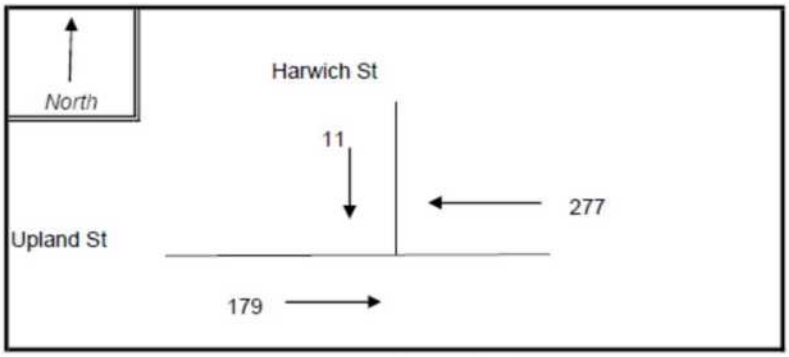
DISTRICT : Dist 3 UNSIGNALIZED : X SIGNALIZED :

~ INTERSECTION DATA ~

MAJOR STREET : Upland Street

MINOR STREET(S) : Harwich Street

INTERSECTION DIAGRAM (Label Approaches)



PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	EB	WB	SB			
PEAK HOURLY VOLUMES (AM/PM) :	179	275	11			465

" K " FACTOR :	0.090	INTERSECTION ADT (V) = TOTAL DAILY APPROACH VOLUME :	5,167
TOTAL # OF CRASHES :	1	# OF YEARS : 7	AVERAGE # OF CRASHES PER YEAR (A) : 0.14

CRASH RATE CALCULATION : 0.08 RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : Much lower than the rate of 0.61 for unsignalized in tersection in Dist 3 of the massDOT

Project Title & Date: 49 Upland St July 2023

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Worcester COUNT DATE : Nov-21

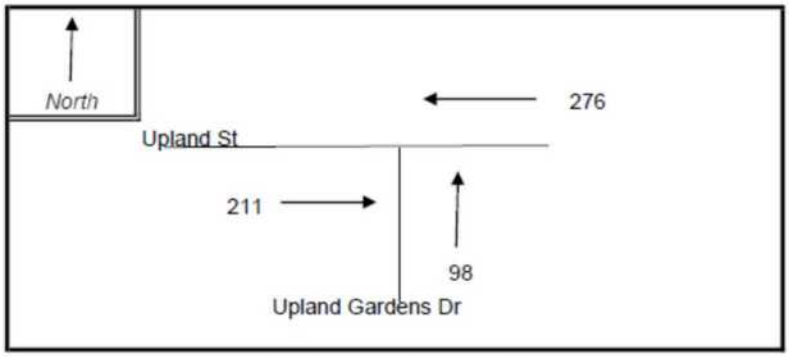
DISTRICT : Dist 3 UNSIGNALIZED : X SIGNALIZED :

~ INTERSECTION DATA ~

MAJOR STREET : Upland Street

MINOR STREET(S) : Upland Gardens Drive

INTERSECTION DIAGRAM (Label Approaches)



PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	EB	WB	NB			
PEAK HOURLY VOLUMES (AM/PM) :	210	274	98			582

" K " FACTOR : 0.090 INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : 6,467

TOTAL # OF CRASHES : 1 # OF YEARS : 7 AVERAGE # OF CRASHES PER YEAR (**A**) : 0.14

CRASH RATE CALCULATION : 0.06 RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : Much lower than the rate of 0.61 for unsignalized in tersection in Dist 3 of the massDOT

Project Title & Date: 49 Upland St July 2023

Multifamily Housing (Mid-Rise)
(221)

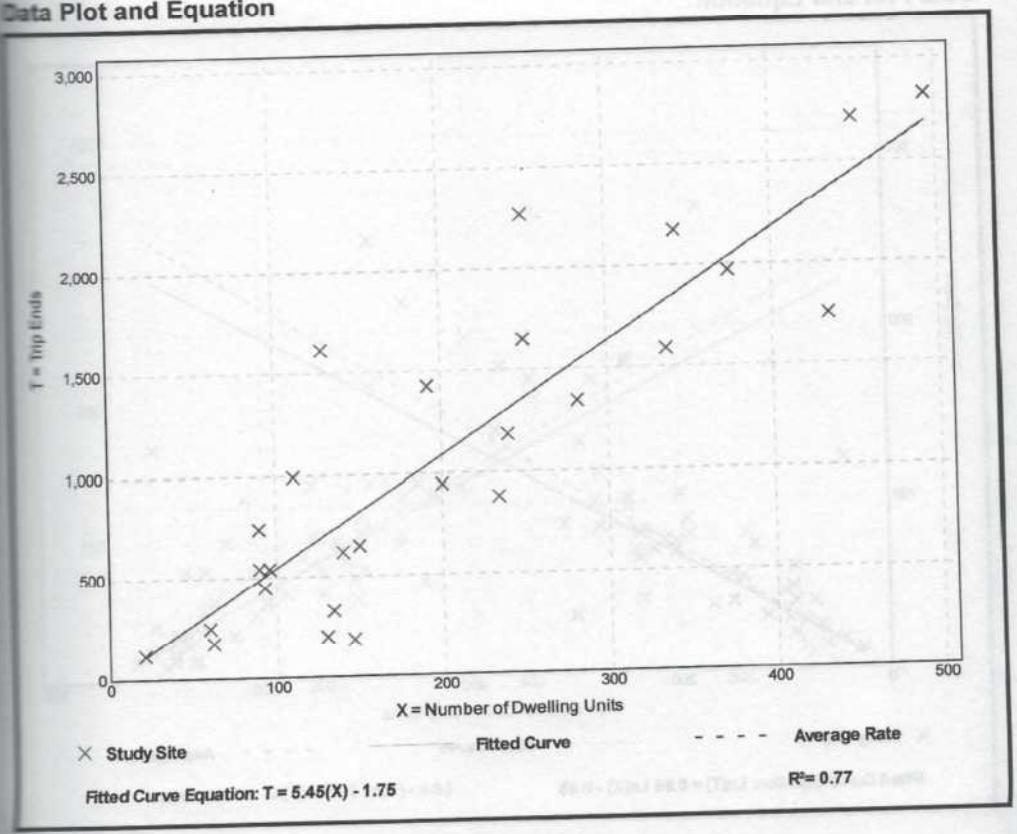
Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Setting/Location: General Urban/Suburban
Number of Studies: 27
Avg. Num. of Dwelling Units: 205
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
5.44	1.27 - 12.50	2.03

Data Plot and Equation



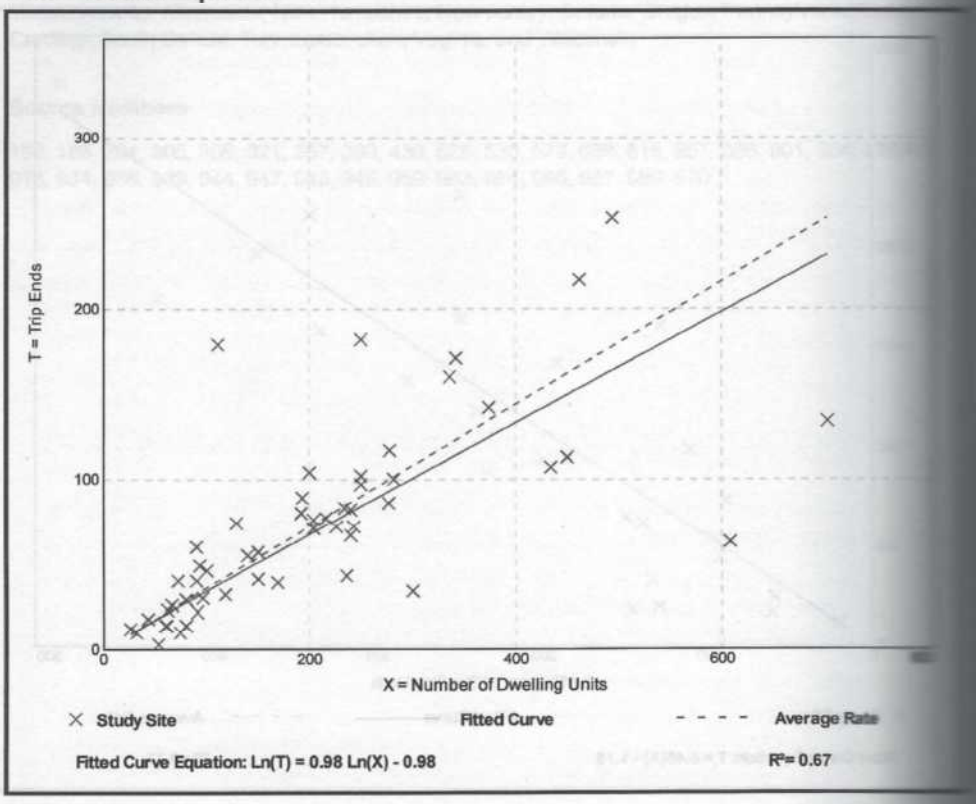
Multifamily Housing (Mid-Rise)
(221)

Vehicle Trip Ends vs:	***Dwelling Units***
On a:	**Weekday,**
	Peak Hour of Adjacent Street Traffic,
	One Hour Between 7 and 9 a.m.
Setting/Location:	**General Urban/Suburban**
Number of Studies:	53
Avg. Num. of Dwelling Units:	207
Directional Distribution:	26% entering, 74% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.36	0.06 - 1.61	0.19

Data Plot and Equation



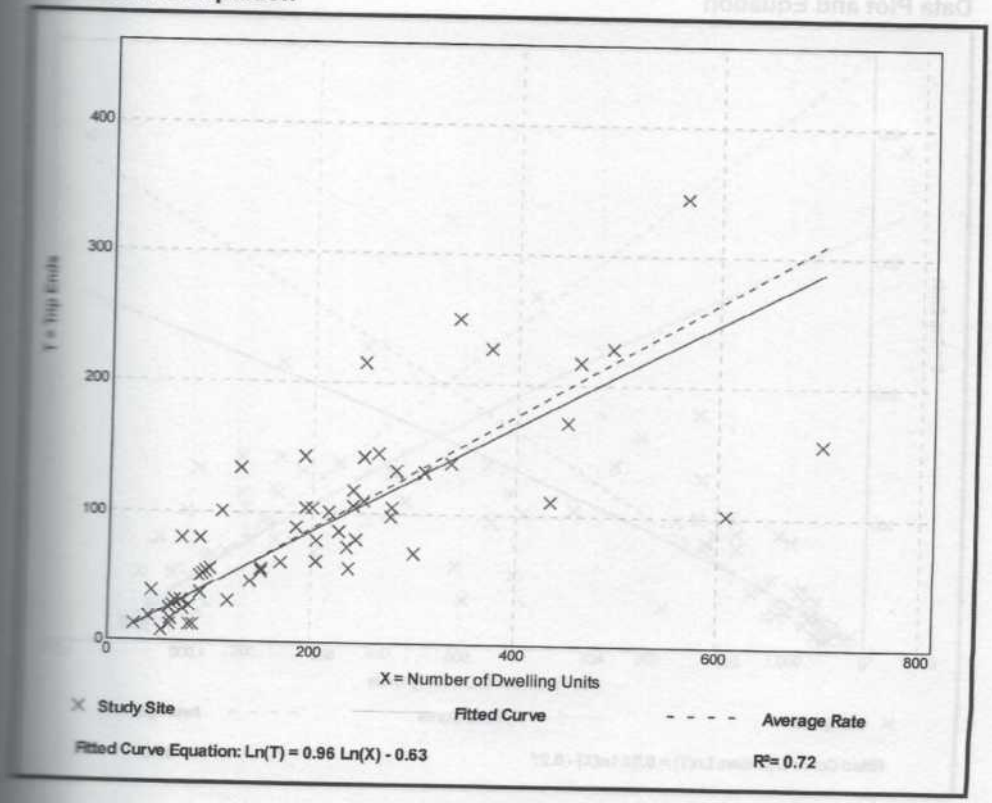
Multifamily Housing (Mid-Rise)
(221)

Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.
Setting/Location: General Urban/Suburban
Number of Studies: 60
Avg. Num. of Dwelling Units: 208
Directional Distribution: 61% entering, 39% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.44	0.15 - 1.11	0.19

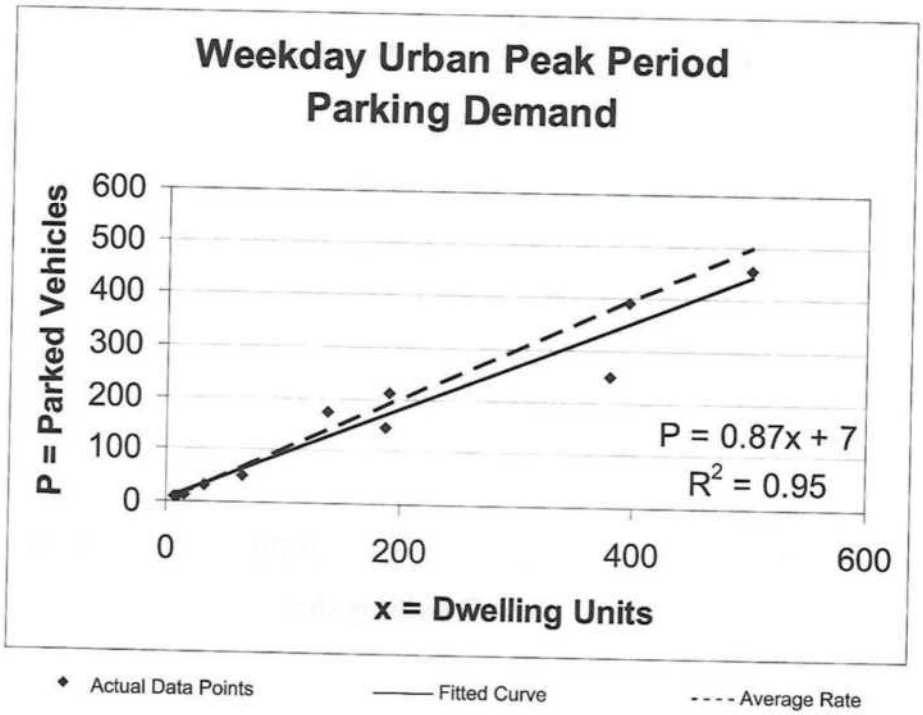
Data Plot and Equation



Land Use: 221
Low/Mid-Rise Apartment

Average Peak Period Parking Demand vs: Dwelling Units
On a: Weekday
Location: Urban

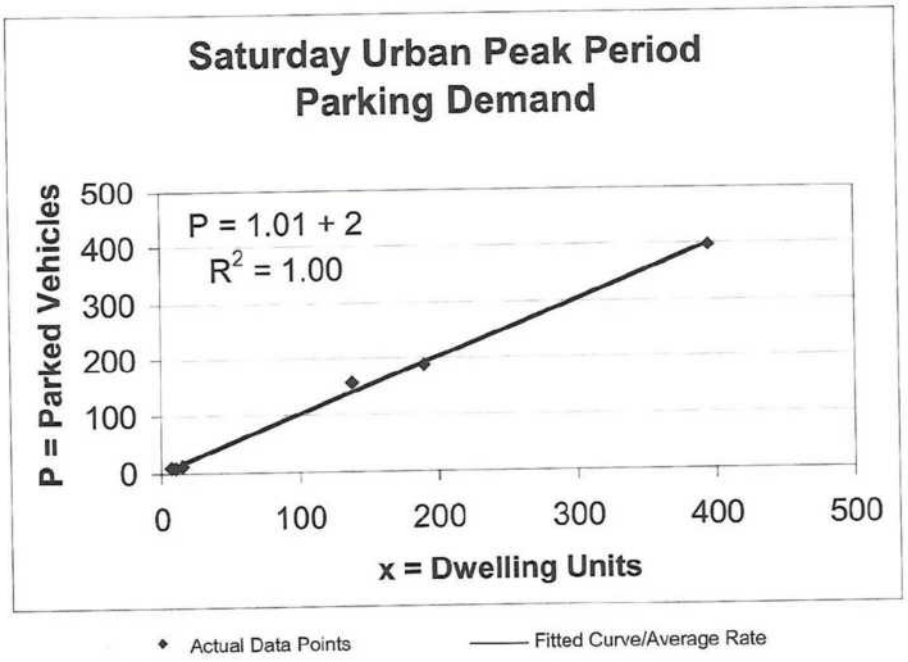
Statistic	Peak Period Demand
Peak Period	9:00 p.m.–5:00 a.m.
Number of Study Sites	12
Average Size of Study Sites	165 dwelling units
Average Peak Period Parking Demand	1.00 vehicles per dwelling unit
Standard Deviation	0.22
Coefficient of Variation	22%
Range	0.66–1.43 vehicles per dwelling unit
85th Percentile	1.17 vehicles per dwelling unit
33rd Percentile	0.92 vehicles per dwelling unit



Land Use: 221
Low/Mid-Rise Apartment

Average Peak Period Parking Demand vs: Dwelling Units
On a: Saturday
Location: Urban

Statistic	Peak Period Demand
Peak Period	9:00 p.m.–7:00 a.m.
Number of Study Sites	7
Average Size of Study Sites	110 dwelling units
Average Peak Period Parking Demand	1.02 vehicles per dwelling unit
Standard Deviation	0.21
Coefficient of Variation	20%
Range	0.80–1.43 vehicles per dwelling unit
85th Percentile	1.17 vehicles per dwelling unit
33rd Percentile	0.90 vehicles per dwelling unit



Upland at Greenwood AM Peak Existing Conditions

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	-5%			0%	-1%	
Volume (veh/h)	92	114	62	257	272	50
Peak Hour Factor	0.88	0.88	0.86	0.86	0.91	0.91
Hourly flow rate (veh/h)	105	130	72	299	299	55
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
vC, conflicting volume	769	326	354			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	70	82	94			
cM capacity (veh/h)	348	715	1205			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	234	371	354
Volume Left	105	72	0
Volume Right	130	0	55
cSH	486	1205	1700
Volume to Capacity	0.48	0.06	0.21
Queue Length (ft)	64	5	0
Control Delay (s)	19.1	2.1	0.0
Lane LOS	C	A	
Approach Delay (s)	19.1	2.1	0.0
Approach LOS	C		

Intersection Summary			
Average Delay		5.5	
Intersection Capacity Utilization		62.5%	ICU Level of Service B

Upland at Greenwood PM Peak Existing Conditions

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	-5%			0%	-1%	
Volume (veh/h)	64	107	206	431	367	63
Peak Hour Factor	0.90	0.90	0.85	0.85	0.95	0.95
Hourly flow rate (veh/h)	71	119	242	507	386	66
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
vC, conflicting volume	1411	419	453			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	40	81	78			
cM capacity (veh/h)	119	634	1108			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	190	749	453
Volume Left	71	242	0
Volume Right	119	0	66
cSH	243	1108	1700
Volume to Capacity	0.78	0.22	0.27
Queue Length (ft)	144	21	0
Control Delay (s)	58.2	4.9	0.0
Lane LOS	F	A	
Approach Delay (s)	58.2	4.9	0.0
Approach LOS	F		

Intersection Summary			
Average Delay	10.6		
Intersection Capacity Utilization	85.7%	ICU Level of Service	D

Upland St at Harwich AM Peak Existing Conditions

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	7	201	114	1	2	6
Peak Hour Factor	0.83	0.83	0.79	0.79	0.58	0.58
Hourly flow rate (veh/h)	8	242	144	1	3	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume	146				404	145
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				99	99
cM capacity (veh/h)	1437				599	902

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	251	146	14
Volume Left	8	0	3
Volume Right	0	1	10
cSH	1437	1700	801
Volume to Capacity	0.01	0.09	0.02
Queue Length (ft)	0	0	1
Control Delay (s)	0.3	0.0	9.6
Lane LOS	A		A
Approach Delay (s)	0.3	0.0	9.6
Approach LOS			A

Intersection Summary			
Average Delay		0.5	
Intersection Capacity Utilization		24.8%	ICU Level of Service A

Upland St at Harwich PM Peak Existing Conditions

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	12	167	270	7	5	6
Peak Hour Factor	0.86	0.86	0.86	0.86	0.70	0.70
Hourly flow rate (veh/h)	14	194	314	8	7	9
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume	322				540	318
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				99	99
cM capacity (veh/h)	1238				497	723

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	208	322	16
Volume Left	14	0	7
Volume Right	0	8	9
cSH	1238	1700	599
Volume to Capacity	0.01	0.19	0.03
Queue Length (ft)	1	0	2
Control Delay (s)	0.6	0.0	11.2
Lane LOS	A		B
Approach Delay (s)	0.6	0.0	11.2
Approach LOS			B

Intersection Summary			
Average Delay		0.6	
Intersection Capacity Utilization		27.0%	ICU Level of Service

Upland at Upland Garden AM Peak Existing

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	168	46	23	104	37	39
Peak Hour Factor	0.86	0.86	0.78	0.78	0.83	0.83
Hourly flow rate (veh/h)	195	53	29	133	45	47
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			249		414	222
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		92	94
cM capacity (veh/h)			1317		581	817

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	249	163	92
Volume Left	0	29	45
Volume Right	53	0	47
cSH	1700	1317	682
Volume to Capacity	0.15	0.02	0.13
Queue Length (ft)	0	2	12
Control Delay (s)	0.0	1.6	11.1
Lane LOS		A	B
Approach Delay (s)	0.0	1.6	11.1
Approach LOS			B

Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	25.8%	ICU Level of Service	A

Upland St at Upland Gardens Dr PM Peak Existing Conditions

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	4%			-5%	2%	
Volume (veh/h)	152	59	25	251	68	30
Peak Hour Factor	0.92	0.92	0.85	0.85	0.92	0.92
Hourly flow rate (veh/h)	165	64	29	295	74	33
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			229		551	197
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		85	96
cM capacity (veh/h)			1339		484	844

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	229	325	107
Volume Left	0	29	74
Volume Right	64	0	33
cSH	1700	1339	557
Volume to Capacity	0.13	0.02	0.19
Queue Length (ft)	0	2	18
Control Delay (s)	0.0	0.9	13.0
Lane LOS		A	B
Approach Delay (s)	0.0	0.9	13.0
Approach LOS			B

Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	43.2%	ICU Level of Service	A

Upland at Greenwood AM Peak Future No Build Conditions

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	-5%			0%	-1%	
Volume (veh/h)	94	116	63	263	277	51
Peak Hour Factor	0.88	0.88	0.86	0.86	0.91	0.91
Hourly flow rate (veh/h)	107	132	73	306	304	56
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
vC, conflicting volume	785	332	360			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	69	81	94			
cM capacity (veh/h)	340	710	1198			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	239	379	360
Volume Left	107	73	0
Volume Right	132	0	56
cSH	477	1198	1700
Volume to Capacity	0.50	0.06	0.21
Queue Length (ft)	69	5	0
Control Delay (s)	19.8	2.1	0.0
Lane LOS	C	A	
Approach Delay (s)	19.8	2.1	0.0
Approach LOS	C		

Intersection Summary			
Average Delay	5.6		
Intersection Capacity Utilization	63.6%	ICU Level of Service	B

Upland at Greenwood PM Peak Future No Build Conditions

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	-5%			0%	-1%	
Volume (veh/h)	65	109	210	439	374	64
Peak Hour Factor	0.90	0.90	0.85	0.85	0.95	0.95
Hourly flow rate (veh/h)	72	121	247	516	394	67
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
vC, conflicting volume	1438	427	461			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	37	81	78			
cM capacity (veh/h)	114	628	1100			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	193	764	461
Volume Left	72	247	0
Volume Right	121	0	67
cSH	234	1100	1700
Volume to Capacity	0.83	0.22	0.27
Queue Length (ft)	158	22	0
Control Delay (s)	66.3	5.0	0.0
Lane LOS	F	A	
Approach Delay (s)	66.3	5.0	0.0
Approach LOS	F		

Intersection Summary			
Average Delay		11.7	
Intersection Capacity Utilization		87.1%	ICU Level of Service D

Upland St at Harwich AM Peak Future No Build Conditions

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	7	205	116	1	2	6
Peak Hour Factor	0.83	0.83	0.79	0.79	0.58	0.58
Hourly flow rate (veh/h)	8	247	147	1	3	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume	148				411	147
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				99	99
cM capacity (veh/h)	1433				593	899

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	255	148	14
Volume Left	8	0	3
Volume Right	0	1	10
cSH	1433	1700	797
Volume to Capacity	0.01	0.09	0.02
Queue Length (ft)	0	0	1
Control Delay (s)	0.3	0.0	9.6
Lane LOS	A		A
Approach Delay (s)	0.3	0.0	9.6
Approach LOS			A

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	25.1%	ICU Level of Service	A

Upland St at Harwich PM Peak Future No Build Conditions

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	12	170	275	7	5	6
Peak Hour Factor	0.86	0.86	0.86	0.86	0.70	0.70
Hourly flow rate (veh/h)	14	198	320	8	7	9
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume	328				549	324
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				99	99
cM capacity (veh/h)	1232				491	717

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	212	328	16
Volume Left	14	0	7
Volume Right	0	8	9
cSH	1232	1700	593
Volume to Capacity	0.01	0.19	0.03
Queue Length (ft)	1	0	2
Control Delay (s)	0.6	0.0	11.2
Lane LOS	A		B
Approach Delay (s)	0.6	0.0	11.2
Approach LOS			B

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	27.3%	ICU Level of Service	A

Upland St at Upland Gardens Dr AM Peak Future No Build Conditions

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	4%			-5%	2%	
Volume (veh/h)	171	47	23	105	38	40
Peak Hour Factor	0.86	0.86	0.78	0.78	0.83	0.83
Hourly flow rate (veh/h)	199	55	29	135	46	48
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			253		420	226
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		92	94
cM capacity (veh/h)			1312		577	813

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	253	164	94
Volume Left	0	29	46
Volume Right	55	0	48
cSH	1700	1312	678
Volume to Capacity	0.15	0.02	0.14
Queue Length (ft)	0	2	12
Control Delay (s)	0.0	1.6	11.2
Lane LOS		A	B
Approach Delay (s)	0.0	1.6	11.2
Approach LOS			B

Intersection Summary			
Average Delay	2.6		
Intersection Capacity Utilization	26.1%	ICU Level of Service	A

Upland St at Upland Gardens Dr PM Peak Future No Build Conditions

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	4%			-5%	2%	
Volume (veh/h)	155	60	25	256	69	31
Peak Hour Factor	0.92	0.92	0.85	0.85	0.92	0.92
Hourly flow rate (veh/h)	168	65	29	301	75	34
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			234		561	201
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		84	96
cM capacity (veh/h)			1334		478	840

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	234	331	109
Volume Left	0	29	75
Volume Right	65	0	34
cSH	1700	1334	551
Volume to Capacity	0.14	0.02	0.20
Queue Length (ft)	0	2	18
Control Delay (s)	0.0	0.9	13.1
Lane LOS		A	B
Approach Delay (s)	0.0	0.9	13.1
Approach LOS			B

Intersection Summary			
Average Delay		2.6	
Intersection Capacity Utilization		44.0%	ICU Level of Service A

Upland at Greenwood AM Peak Future Build Conditions

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	-5%			0%	-1%	
Volume (veh/h)	103	127	66	262	277	54
Peak Hour Factor	0.88	0.88	0.86	0.86	0.91	0.91
Hourly flow rate (veh/h)	117	144	77	305	304	59
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
vC, conflicting volume	792	334	364			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	65	80	94			
cM capacity (veh/h)	336	708	1195			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	261	381	364
Volume Left	117	77	0
Volume Right	144	0	59
cSH	473	1195	1700
Volume to Capacity	0.55	0.06	0.21
Queue Length (ft)	82	5	0
Control Delay (s)	21.6	2.2	0.0
Lane LOS	C	A	
Approach Delay (s)	21.6	2.2	0.0
Approach LOS	C		

Intersection Summary			
Average Delay	6.4		
Intersection Capacity Utilization	65.2%	ICU Level of Service	B

Upland at Greenwood PM Peak Future Build Conditions

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	-5%			0%	-1%	
Volume (veh/h)	70	116	220	439	374	74
Peak Hour Factor	0.90	0.90	0.85	0.85	0.95	0.95
Hourly flow rate (veh/h)	78	129	259	516	394	78
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
vC, conflicting volume	1467	433	472			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	28	79	76			
cM capacity (veh/h)	108	623	1090			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	207	775	472
Volume Left	78	259	0
Volume Right	129	0	78
cSH	223	1090	1700
Volume to Capacity	0.93	0.24	0.28
Queue Length (ft)	196	23	0
Control Delay (s)	88.7	5.2	0.0
Lane LOS	F	A	
Approach Delay (s)	88.7	5.2	0.0
Approach LOS	F		

Intersection Summary			
Average Delay	15.4		
Intersection Capacity Utilization	89.2%	ICU Level of Service	D

Upland St at Harwich AM Peak Future Build Conditions

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	7	225	122	1	2	6
Peak Hour Factor	0.83	0.83	0.79	0.79	0.58	0.58
Hourly flow rate (veh/h)	8	271	154	1	3	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume	156				443	155
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				99	99
cM capacity (veh/h)	1424				569	891

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	280	156	14
Volume Left	8	0	3
Volume Right	0	1	10
cSH	1424	1700	780
Volume to Capacity	0.01	0.09	0.02
Queue Length (ft)	0	0	1
Control Delay (s)	0.3	0.0	9.7
Lane LOS	A		A
Approach Delay (s)	0.3	0.0	9.7
Approach LOS			A

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	26.6%	ICU Level of Service	A

Upland St at Harwich PM Peak Future Build Conditions

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	12	182	295	7	5	6
Peak Hour Factor	0.86	0.86	0.86	0.86	0.70	0.70
Hourly flow rate (veh/h)	14	212	343	8	7	9
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume	351				587	347
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				98	99
cM capacity (veh/h)	1208				467	696

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	226	351	16
Volume Left	14	0	7
Volume Right	0	8	9
cSH	1208	1700	569
Volume to Capacity	0.01	0.21	0.03
Queue Length (ft)	1	0	2
Control Delay (s)	0.6	0.0	11.5
Lane LOS	A		B
Approach Delay (s)	0.6	0.0	11.5
Approach LOS			B

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	28.5%	ICU Level of Service	A

Upland St at Upland Gardens Dr AM Peak Future Build Conditions

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	4%			-5%	2%	
Volume (veh/h)	176	47	23	117	38	40
Peak Hour Factor	0.86	0.86	0.78	0.78	0.83	0.83
Hourly flow rate (veh/h)	205	55	29	150	46	48
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			259		441	232
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		92	94
cM capacity (veh/h)			1305		560	807

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	259	179	94
Volume Left	0	29	46
Volume Right	55	0	48
cSH	1700	1305	665
Volume to Capacity	0.15	0.02	0.14
Queue Length (ft)	0	2	12
Control Delay (s)	0.0	1.4	11.3
Lane LOS		A	B
Approach Delay (s)	0.0	1.4	11.3
Approach LOS			B

Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	27.7%	ICU Level of Service	A

Upland St at Upland Gardens Dr PM Peak Future Build Conditions

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	4%			-5%	2%	
Volume (veh/h)	167	60	25	264	69	31
Peak Hour Factor	0.92	0.92	0.85	0.85	0.92	0.92
Hourly flow rate (veh/h)	182	65	29	311	75	34
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			247		584	214
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		84	96
cM capacity (veh/h)			1319		463	826

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	247	340	109
Volume Left	0	29	75
Volume Right	65	0	34
cSH	1700	1319	536
Volume to Capacity	0.15	0.02	0.20
Queue Length (ft)	0	2	19
Control Delay (s)	0.0	0.9	13.4
Lane LOS		A	B
Approach Delay (s)	0.0	0.9	13.4
Approach LOS			B

Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	44.9%	ICU Level of Service	A

Upland at Site Drive AM Future Build Conditions

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	216	5	6	128	12	20
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (veh/h)	235	5	7	139	13	22
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			240		390	238
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	97
cM capacity (veh/h)			1326		611	801

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	240	146	35
Volume Left	0	7	13
Volume Right	5	0	22
cSH	1700	1326	718
Volume to Capacity	0.14	0.00	0.05
Queue Length (ft)	0	0	4
Control Delay (s)	0.0	0.4	10.3
Lane LOS		A	B
Approach Delay (s)	0.0	0.4	10.3
Approach LOS			B

Intersection Summary			
Average Delay		1.0	
Intersection Capacity Utilization		22.7%	ICU Level of Service

Upland at Site Drive PM Future Build Conditions

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	198	12	20	301	9	12
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (veh/h)	215	13	22	327	10	13
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			228		592	222
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		98	98
cM capacity (veh/h)			1340		461	818

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	228	349	23
Volume Left	0	22	10
Volume Right	13	0	13
cSH	1700	1340	614
Volume to Capacity	0.13	0.02	0.04
Queue Length (ft)	0	1	3
Control Delay (s)	0.0	0.6	11.1
Lane LOS		A	B
Approach Delay (s)	0.0	0.6	11.1
Approach LOS			B

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	37.0%	ICU Level of Service	A