

MEMORANDUM

DATE: January 16, 2025

TO: Elizabeth Hughes, AICP, Town Planner
Town of Concord Planning Division
141 Keyes Road
Concord, MA 01742

FROM: Robert J. Michaud, P.E. – Managing Principal
Daniel A. Dumais, P.E. – Senior Project Manager

RE: Response to Comments – GPI
275 Forest Ridge Road, Concord, Massachusetts

MDM Transportation Consultants, Inc. (MDM) has prepared the following responses to transportation-related comments as issued in a letter by Greenman-Pedersen, Inc. (GPI) dated December 19, 2024. To facilitate review, specific comments are paraphrased with corresponding responses.

Comment 2: *“The Applicant has designed the site driveway in a boulevard style with a 12-foot travelway in each direction, separated by a 7-foot median island. This layout does not provide enough width for emergency vehicle bypass in the event a vehicle becomes disabled along the drive aisle.*

GPI recommends the Applicant consider one of the following options:

- a. Widen the driveway to provide a 16-foot travel way on either side of the median island for emergency vehicle bypass;*
- b. Eliminate the median island and provide a single 12-foot entrance and exit lane separated by a centerline; or*
- c. Replace the raised median island with a mountable surface, such as textured concrete, to allow for emergency vehicle bypass. This median may also be raised with sloped edges to be mountable.”*

Response: 527 CMR 1.00: Massachusetts Comprehensive Fire Safety Code states that *“Fire department access roads shall have an unobstructed width of not less than 20 feet (6.1 m). Fire department access roads constructed in the boulevard-style shall be allowed where each lane is less than 20 feet but not less than ten feet when they do not provide access to a building or structure.”* The proposed boulevard design will be modified on the final site plan set by Allen & Major to include an anticipated 18-foot entering lane and a 14-foot departing lane separated by a 6-foot median island to provide a by-pass on the inbound lane. The design will also continue to provide a break in the median island approximately every 150 feet which would allow emergency apparatus to bypass a disabled vehicle by crossing over to the other side of the boulevard. The Proponent will review the design with the fire department and will discuss the desirability of sloped edging or mountable curbing with the Fire Department.

Comment 3: *“The Applicant has provided vehicle turning path figures for a fire apparatus circulating the site. However, the Applicant has not provided a vehicle turning path analysis for a trash removal vehicle accessing and egressing the trash receptacle. In addition, the site plans do not indicate where trash will be stored on the site and how it will be accessed by trash removal vehicles. **The Applicant should provide a vehicle turning path analysis for the trash removal vehicle to ensure the site provides sufficient circulation for trash removal vehicles.**”*

Response: The trash will be stored inside the buildings and will utilize roll out totes for trash pickup curbside. The Proponent has run AutoTurn® for a fire ladder truck vehicle. Given that the trash truck is smaller, there will be adequate site access and circulation to accommodate this vehicle.

Comment 4: *“The Applicant has designated snow storage areas within the islands at the internal intersections on the site, which may create sight line obstructions for vehicles attempting to exit the parking area between Buildings A and B. **GPI recommends eliminating the snow storage areas on the inside of the parking loop around the buildings.**”*

Response: The snow storage areas will be revised on the final site plan set to be prepared by Allen & Major Associates to eliminate snow storage areas that would restrict internal sight lines.

Comment 5: *“There is an existing sidewalk along the west side of Forest Ridge Road. The Applicant has proposed a sidewalk along the northerly side of the site driveway connecting to the existing crosswalk on Forest Ridge Road at the site driveway intersection. The existing crosswalk pavement markings are faded and contain numerous sealed cracks. In addition, there is a large grass strip separating the sidewalk on the west side of Forest Ridge Road from the edge of the paved travelway. **GPI recommends that the Applicant complete a pavement overlay at the intersection of Forest Ridge Road with the proposed site driveway to provide a consistent pavement surface. In addition, the Applicant should install curb ramps at the site driveway intersection with Forest Ridge Road to allow pedestrians to cross Forest Ridge Road via an ADA-accessible connection to the sidewalk on the west side of Forest Ridge Road. The Applicant should also install MUTCD-compliant pedestrian crossing warning signage at the crosswalk.**”*

Response: Maintenance of the existing roadways and sidewalks along Forest Ridge Road and other private neighborhood streets would generally be the responsibility of the Home Owners Association(s); however, the area of pavement to be refreshed near the intersection of Forest Ridge Road and the proposed site driveway will be expanded on the final site plan set to be prepared by Allen & Major Associates to provide a consistent pavement surface in the area of the proposed driveway and crosswalk. The Proponent will also install a crosswalk with ADA compliant curb ramps with appropriate markings and MUTCD compliant pedestrian crossing signage at this location as part of the project.

Comment 8: *“GPI generally concurs with the description of the existing intersection geometries. Although, GPI notes that TIAS states that the Sweet Birch Lane approach to the traffic circle at Forest Ridge Road / Sweet Birch Lane / Black Birch Lane operates under STOP sign control; however, there is currently no STOP sign or STOP line provided on the Sweet Birch Lane approach to the traffic circle. GPI recommends the Applicant install a STOP sign (R1-1) on the Sweet Birch Lane approach.”*

Response: Maintenance of the existing roadways and sidewalks along Forest Ridge Road and other private neighborhood streets would generally be the responsibility of the Home Owners Association(s); however, the Proponent is willing to work with the neighborhood to install a “STOP” sign on the Sweet Birch Lane approach to Forest Ridge Road.

Comment 9: *“The Applicant has performed an updated collision history assessment based on MassDOT collision data for the five-year period from 2019 – 2023. The MassDOT crash portal notes that crash data for the year 2023 has not yet been closed, which indicates that some crashes may be missing from the data. However, the available crash data demonstrates the crash rate at the study area intersections is well below the state and District-wide average, indicating that no significant safety pattern exists.”*

Response: MDM concurs. No further response required.

Comment 10: *“The Applicant has utilized a 0.5 percent annual growth rate to project traffic volumes to 2030 No-Build conditions based on MassDOT permanent count station data from Station #403 located on Route 2 east of the Concord Rotary. GPI concurs that this is the closest permanent count station to the site and is appropriate in considering seasonal variation in the traffic volumes in the area. However, GPI notes that there is also a count station (#4003) located on Main Street (Route 62) just west of Forest Ridge Road that provides traffic count data for the years 2011-2013 and 2015-2019 that may provide a better estimate of the traffic growth within the study area. In addition, upon review of the traffic volumes utilized in the TIAS for Station #403, GPI was unable to reconcile the traffic volumes for the years except 2011 and 2013. Further, MassDOT provides count data for the year 2019 that was not included in the evaluation of the growth rate at this count station. GPI has estimated the growth rate based on the count station data available on MassDOT’s Transportation Data Management System for count stations #403 and #4003, and determined that traffic has generally been growing at a rate of 1.0 percent per year from 2010 to 2019. This growth rate is consistent with the rate utilized in recent traffic studies for other development projects in the surrounding area. Therefore, GPI recommends the Applicant update the analysis using a 1.0 percent per year annual growth rate to project volumes to 2030 No-Build conditions.*

The Applicant has included traffic to be generated by the Apartments at Powder Mill, a 230-unit residential development in Acton, within the 2031 No-Build traffic-volume projections. GPI concurs with the inclusion of trips generated by the Apartments at Powder Mill.”

Response: MDM has expanded the data for MassDOT’s permanent count station 403 to include the latest data for the years 2023 and 2024. The data for 2019 was incomplete and missing several months and therefore was not included. Likewise, MDM reviewed the count station data for station 4003 and has determined that this is not a permanent count station location, and it includes limited data for approximately two days a year with some of the data estimated by growth of older volumes per the footnotes. The updated permanent count station data indicates a growth rate below 0.5% per year; therefore, the result of the TIAS remain appropriate and valid. As a sensitivity, MDM also updated the No-Build and Build condition traffic volume networks and analysis to provide the requested 1% per year growth rate (see **Attachments**) and the results of the TIAS remain valid that the project will not have a material impact to the study locations.

Comment 11: “The sight distance calculations were based on an assumed turning speed of 15 miles per hour (MPH) exiting the circle at Forest Ridge Road / Sweet Birch Lane / Black Birch Lane; however, the Applicant has not provided any evidence to support this travel speed. Although none of the signs are MUTCD compliant, Forest Ridge Road is posted with a speed limit of 25 MPH. Therefore, the Applicant should provide documentation of speed measurements or utilize a 25 MPH design speed for estimating sight distance requirements.”

Response: The turning speeds used in the report were not based on measured speeds, they were based on the default turn speeds from an intersection from simulation modeling. The analysis has been revised, and the sight lines are adequate for the higher 25-mph design speed as shown in **Table R1** and **Table R2**. The sight distance calculations are provided in the **Attachments**.

**TABLE R1
STOPPING SIGHT DISTANCE SUMMARY
THOREAU CLUB DRIVEWAY APPROACHES TO PROPOSED SITE DRIVEWAY**

Approach/ Travel Direction	Available SSD	AASHTO Recommended ¹	
		Speed Limit (25 mph) ²	Criteria Satisfied
Northbound	275± Feet	155 Feet	Yes
Southbound	350± Feet	155 Feet	Yes

¹Recommended sight distance based on AASHTO, A Policy on Geometric Design of Highways and Streets. Based on driver height of eye of 3.5 feet to object height of 2.0 feet with adjustments for average grade within the sight line area.

²Based on 25 mph.

**TABLE R2
INTERSECTION SIGHT DISTANCE SUMMARY
SITE DRIVEWAY DEPARTURES TO THE THOREAU CLUB DRIVEWAY**

View Direction	Available ISD	AASHTO Minimum ¹	AASHTO Ideal ¹
		Speed Limit (25 mph) ²	Speed Limit (25 mph) ²
Looking North	350± Feet	155 Feet	280 Feet
Looking South	275± Feet	155 Feet	240 Feet

¹Recommended sight distance based on AASHTO, A Policy on Geometric Design of Highways and Streets. Based on driver height of eye of 3.5 feet and an object height of 3.5 feet. Minimum value as noted represents SSD per AASHTO guidance.

²Based on 25 mph.

Comment 12: “The sight distance was measured from a decision point 10 feet back from the edge of the roadway as part of the December 2023 TIAS. The October 2024 TIAS does not indicate where the decision point was located in measuring sight distances. AASHTO Green Book states that intersection sight distances should be measured at 14.5 feet back from the edge of the travel way where applicable. GPI previously recommended that the Applicant provide a sight line plan with the decision point being located 14.5 feet back instead of 10 feet. No such plan was included in the October TIAS or site plan set. GPI recommends the Applicant prepare a sight line plan that depicts the available sight lines and required clear zones to meet AASHTO recommendations for minimum stopping sight distance (SSD) and desirable intersection sight distance (ISD) at the proposed site driveway intersection with Forest Ridge Road based on a posted speed of 25 MPH.”

Response: AASHTO metrics cites that “measurements of passenger cars indicate the distance from the front of the vehicle to the driver’s eye for the current U.S. passenger car population is nearly always 8 feet or less.” Therefore, while a 14.5 setback is cited in AASHTO, a commonly observed vehicles secondary stopped position is well forward of a STOP line/STOP sign to a point where the driver eye position is within 8 to 10 feet of the travel way. That said, the sight distance measurements shown in **Table R1** and **Table R2** are satisfied from 14.5 feet back.

The sight line triangles for the site driveway will be provided on the final Site Layout Plan set to be prepared by Allen & Major Associates. The Site Layout Plan will include a note citing that “Signs, landscaping and other features located within sight triangle areas shall be designed, installed, and maintained so as not to exceed 2.0-feet in height. Snow windrows located within sight triangle areas that exceed 3.5-feet in height or that would otherwise inhibit sight lines shall be promptly removed.”

Comment 17: *“The Applicant has applied the existing Peak Hour Factor (PHF) to the 2031 No-Build and Build analysis conditions as part of the Synchro analysis. MassDOT guidelines for traffic impact analysis require that all future year conditions utilize a default PHF of 0.92. The Synchro analysis worksheets provided by the Applicant for the Forest Ridge Road / Sweet Birch Lane / Black Birch Lane intersection did not provide input data for PHFs or heavy vehicle percentages. The Applicant should provide these worksheets.”*

Response: The *Highway Capacity Manual* (HCM) suggests a design value of 0.92 for congested urban areas and 0.88 for rural areas, if no field measurements are available. In this case the peak hour factors for the study intersections were measured based on the traffic counts conducted. It does not make sense to lower the peak hour factors arbitrarily to 0.92 for future year condition, which would lower the capacity of the intersection when actual field measurements are available, that said a sensitivity analysis has been prepared (see **Attachments**) using the default PHF of 0.92. The capacity analysis results indicate that the project will have no material impact on operations at the study intersections and the result of the TIAS remains valid. The HCM printout for the roundabout do not include PHF’s or heavy vehicle percentages; therefore, supplemental traffic volume and peak hour factor calculation sheets are included in the **Attachments**.

Comment 18: *“The Applicant has provided an assessment of the parking supply that would be required to satisfy zoning requirements, which noted that 2.0 spaces per dwelling unit are required for multi-family developments. However, Table IV in Section 7 of the Concord Zoning Bylaws notes that only 1.5 spaces per dwelling unit are required for subsidized low and moderate incoming housing developments. As this project is being developed as a Chapter 40B development, the lower parking provision of 1.5 spaces per dwelling unit is applicable for at least the affordable units within the development. Applying the 1.5 spaces per unit parking rate to the entire 237 units would result in a parking requirement of 356 spaces.”*

Response: At 394 spaces for 237 units the proposed parking supply as proposed is 1.66 spaces per unit. The Proponent will continue to work with the Town to provide a parking supply that is appropriate for the proposed development to accommodate the needs of residents and visitors.

Comment 19: *“The Applicant has also provided an assessment of the parking demand anticipated to be generated by the proposed development based on ITE parking generation rates for LUC 221 (Multifamily Housing (mid-rise)) and empirical parking demand data collected at six multifamily residential developments within the I-495 belt of Massachusetts. The results of this analysis indicate that the peak parking demand may range from 292 to 344 parking spaces. ITE recommends that the peak parking demand not exceed the parking supply by more than 90 percent to avoid illegal parking and excessive recirculation of vehicles to find empty spaces. Therefore, based on ITE and the empirical data, a total of 382 parking spaces would be required to meet peak parking demands. GPI concurs with the Applicant’s assessment that the 394 parking spaces proposed will be adequate to accommodate the peak parking demand anticipated for the proposed residential development.”*

Response: MDM concurs, the Proponent is looking at revised parking layouts per working sessions with the Town. The Proponent will continue to work with the Town to provide a parking supply that is appropriate for the proposed development to accommodate the needs of residents and visitors.

Comment 20: *“The Applicant has proposed several Transportation Demand Management (TDM) measures to reduce single-occupant vehicle trips generated by the proposed development. In addition to the measures described in the TIAS, GPI recommends the Applicant consider the following additional TDM strategies:*

a. An on-site Transportation Coordinator (TC) will be established to distribute information to residents on available transportation options in the area and provide incentives for utilizing alternatives means of travel;

b. The TC will provide all new residents with information on registering with NuRIDE upon move-in. Nu-RIDE offers incentives for making green trips (walking, biking, using public transit, carpooling, or ridesharing) and provides assistance to commuters in identifying appropriate ride-share matches in their area. In addition, Nu-RIDE offers a guaranteed ride home for any commuters making green trips that need to leave work in emergency or inclement weather.

c. Consider providing at least one ride-share parking space near the entrances to each building.

d. The Applicant should consider transit subsidies or rental reductions for residents utilizing the commuter rail, and/or providing shuttle service from the site to the nearest commuter rail station at key times in the morning and evening.”

Response: The Proponent will include the additional TDM strategies as outlined above in a, b, and c.

Comment 21: *“GPI notes that Applicant has not provided an assessment of the available public transportation services in the surrounding area. However, the site is located approximately two miles from the West Concord MBTA Commuter Rail station and less. GPI recommends the Applicant review available public transportation near and around the site to assess whether additional transportation demand management (TDM) measures may be included to encourage use of public transportation by residents.”*

Response: There are limited public transportation services in the area. There are no buses, and the commuter rail (Fitchburg line) has two stops in Concord. The closest, West Concord Station is approximately 3 miles away from the Site. The Proponent will include the additional TDM strategies a, b, and c per **Response 20**.

Comment 22: *“Although there is a sidewalk around the majority of the traffic circle at Forest Ridge Road / Black Birch Lane / Sweet Birch Lane, there is not sidewalk on the northeast quadrant between Black Birch Lane and Forest Ridge Road SB. GPI recommends that the Applicant install a sidewalk along this portion of the traffic circle to provide a continuous pedestrian path around the circle for improved pedestrian connectivity. In addition, the Applicant should install curb ramps and a crosswalk on the Forest Ridge Road southbound approach to the circle to provide access to the sidewalk along the west side of Forest Ridge Road.”*

Response: The sidewalk system is already in place along the desired line along Forest Ridge Road. Sidewalks along Forest Ridge Road and other private neighborhood streets would be the responsibility of the Homeowners Association(s). This section of sidewalk in question would not provide much of a benefit to the neighborhood or club and is outside the scope of this project.

Comment 23: *“A sidewalk currently exists along the west side of Forest Ridge Road between the Black Birch Lane / Sweet Birch Lane circle and Main Street (Route 62), which is in fair – good condition along its entire length with the exception of a few areas of cracking around utilities and some areas where grass has grown through the pavement joints. However, none of the curb ramps at the crosswalks are ADA-compliant. None have level landing areas and some do not provide tactile warning strips. In addition, the existing crosswalk pavement markings are faded and the crosswalk warning signage is not mounted at the correct height. The Applicant should consider upgrading these ramps to meet ADA guidelines and restripe the crosswalks consistent with Manual on Uniform Traffic Control Devices (MUTCD) standards.”*

Response: Maintenance of the existing roadways and sidewalks along Forest Ridge Road and other private neighborhood streets would generally be the responsibility of the Homeowners Association(s); however, the Proponent is willing to work with the neighborhood to install ADA compliant ramps and refresh the crosswalk markings were applicable along Forest Ridge Road.

Comment 24: *“The Applicant has concluded that the project will have minimal impact on the operations of the study area intersections and that no additional improvements are required to mitigate the impacts of the proposed development. GPI concurs that the proposed development will have limited impact on the traffic operations of the study area intersection. However, GPI notes there are several existing deficiencies that warrant safety enhancements to ensure that the additional traffic generated by the proposed development does not result in increased collisions.*

- a. *At the intersection of Main Street (Route 62) / Forest Ridge Road, the existing STOP sign is faded and provides no retro-reflectivity for nighttime visibility. In addition, the existing STOP line is faded and narrow. GPI recommends the Applicant install a new STOP sign and STOP line on the Forest Ridge Road approach to Main Street (Route 62), compliant with Manual on Uniform Traffic Control Devices (MUTCD) standards.*
- b. *Similarly, the existing STOP sign (R1-1) is faded, is not retro-reflective, and is partially obscured by vegetation along the easterly side of the roadway. GPI recommends the Applicant replace the existing STOP sign with a new MUTCD-compliant sign and install STOP AHEAD warning signage in advance of the intersection to further alert drivers to the approaching stop condition.*
- c. *Separate left- and right-turn lanes are provided on the Forest Ridge Road approach to Main Street (Route 62). However, the existing pavement markings are faded and partially covered with pavement crack sealant. In addition, the lane markings were paved over during the most recent pavement overlay for the 40 feet closest to Main Street (Route 62). GPI recommends the Applicant install new lane markings, including lane lines, turn arrows, and a centerline within 100 feet of the STOP line on Forest Ridge Road approaching Main Street (Route 62).*
- d. *GPI also notes that Forest Ridge Road northbound approaches Main Street (Route 62) on a downhill grade. When Main Street (Route 62) was last resurfaced, the first 50 feet of Forest Ridge Road were also resurfaced. However, the roadway was regraded at that time so that the last 50 feet of Forest Ridge Road slopes upward toward Main Street (Route 62) to match the finished elevation of Main Street (Route 62). As a result, a low point has been created on Forest Ridge Road just south of the intersection where water ponds and freezes during the winter months, causing vehicles to slide into the intersection. GPI recommends the Applicant consider regrading Forest Ridge Road as it approaches Main Street to eliminate the low point and/or properly direct water toward the existing catch basins on Forest Ridge Road."*

Response: Maintenance of the existing roadways and signage along Forest Ridge Road and other private neighborhood streets would generally be the responsibility of the Homeowners Association(s); however, the Proponent is willing to work with the neighborhood to replace the signs and refresh the pavement markings. The Proponent is also in discussions with the HOA to provide a mill and overlay of Forest Ridge Road. As part of this work the pavement marking will be updated.

Comment 25: *“Sheet C-106A of the site plan package depicts snow storage areas along both sides and within the median on the proposed site driveway. This snow has the potential to obstruct sight lines for vehicles entering and exiting the site driveway. In addition, the fire truck turning path diagram on Sheet C-107A indicates that the truck chassis will extend over the snow storage area when making a left turn into the site driveway. GPI recommends that all snow storage areas within 25 feet of an intersection be eliminated to avoid sight line obstructions, avoid icing of intersections due to snow melt, and ensure adequate turning movements for fire apparatus.”*

Response: The snow storage areas will be revised on the final site plan set to be prepared by Allen & Major Associates.

Comment 26: *“Although the Applicant has proposed sidewalks along the perimeter of Buildings A and B, the Applicant has not provided any connections between these two sidewalk systems. GPI recommends the Applicant extend the sidewalk at either end of Buildings A and B out to the internal roadway and provide curb ramps and a crosswalk across both ends of the parking aisle separating Buildings A and B.”*

Response: The onsite sidewalk system will be revised on the final site plan set to be prepared by Allen & Major Associates to provide adequate connectivity.

Comment 27: *“The Civil Site Plan Narrative describes that “the Applicant will work with the Concord school system on providing school bus accommodations for any school aged children, however, it is anticipated that the bus service provider may not enter the private property and require stopping on Forest Ridge Road.” GPI recommends that the Applicant provide a bus shelter and curb ramps for ADA accessibility at the location of the proposed bus stop. As the existing sidewalks are separated from the roadway by a large grass strip, the Applicant may need to wide the sidewalk to the roadway in the area of the bus stop.”*

Response: Based on the turning movement counts the school buses do in fact appear to travel along Forest Ridge Road. The Proponent will work with the Town and HOA to accommodate an ADA complaint bus stop were appropriate. A bus shelter at the appropriate location will be considered if deemed necessary.

Comment 28: *“While the Applicant has provided an assessment of the adequacy of the parking supply on the site, the Applicant has not provided an assessment of the adequacy of the parking at the adjacent Thoreau Club. The proposed driveway configuration will require the elimination of 42 parking spaces from the Thoreau Club parking lot. The Applicant should provide an assessment of the adequacy of the remaining parking to accommodate the peak parking demand generated by the Thoreau Club.”*

Response: As shown on the zoning table on Layout and Materials plan (Sheet C-103C) for the site development set the remaining parking for the Thoreau Club will continue to satisfy the parking requirements by zoning. Furthermore, the loss of spaces within the Thoreau Club are anticipated to be made up through reconfiguring and remarking a number of spaces to “compact only”.

Comment 29: “A speed table is proposed on the site driveway approximately 30 feet southwest of the first internal intersection. The location of this speed table may make turning maneuvers through the internal intersection difficult, especially for trucks and emergency vehicles. Therefore, no speed tables should be located within 100 feet of an intersection unless the entire intersection is proposed to be raised. The main reason to install a speed table is to slow traffic at a location where traffic may otherwise be moving quickly. Generally, these are installed along straight, flat sections of roadway for the greatest traffic calming benefits. Drivers will already be slowing near the internal intersection and there is an S-curve in the driveway to the southwest of the internal intersection. Therefore, a speed table is not warranted between the S-curve and the internal intersection. The most effective location for a speed table is near the center of the straight section of the driveway between the S-curve and Forest Ridge Road.”

Response: The locations of the speed tables will be revised on the final site plan set to be prepared by Allen & Major Associates.

Comment 30: “While a STOP sign and STOP line are provided on the northbound approach to the parking aisle that separates Buildings A and B, there is not STOP line or STOP sign proposed on the opposing approach exiting the northerly parking aisle. The Applicant should install a STOP line and STOP sign on this approach.”

Response: The STOP sign and STOP line will be provided on the final site plan set to be prepared by Allen & Major Associates.

Comment 31: “The Applicant should consider a pedestrian connection between the pool area and the perimeter sidewalk around Building A to provide a direct pedestrian connection between the parking along the north side of Building A and the pool area.”

Response: The onsite sidewalk system will be revised on the final site plan set to be prepared by Allen & Major Associates to provide adequate connectivity.

Comment 32: “The December 2023 TIAS was based on traffic counts collected in October 2023. As part of the October 2024 TIAS, new turning movement counts were collected at the study area intersections in October 2024. Section 2.2.2 of the TIAS indicates that the 2023 traffic volumes were grown by 0.5 percent and increased to represent additional activity from the Thoreau Club in order to represent 2024 Baseline conditions. No calculations or detailed data have been provided within the October 2024 TIAS to explain how these adjustments were completed. The Applicant should provide the back-up calculations to support the estimation of 2024 Baseline traffic volumes.”

Response: The Main Street intersection with Forest Ridge Road was counted in both October 2023 and October 2024. The remaining internal study intersections were only counted in October 2023. To adjust the 2023 data to 2024 Baseline conditions the extra turns to and from Forest Ridge Road observed in the 2024 counts were added to the through movements along Forest Ridge Road to and from the Thoreau Club. Detailed back up sheet are provided in the **Attachments**.

Comment 33: *“The Applicant has provided a signal warrant analysis for the intersection of Main Street / Forest Ridge Road within the October 2024 TIAS. GPI has numerous comments regarding the signal warrant analysis, which are summarized below:*

a. The TIAS provides turning movement count data for the Main Street / Forest Ridge Road intersection from 7:00 AM – 9:00 AM and 4:00 PM – 6:00 PM. However, the signal warrant analysis is based on 12-hours of count data from 6:00 AM – 6:00 PM. The TIAS does not provide any count data for the period from 9:00 AM – 4:00 PM, nor does the TIAS describe how traffic volumes were estimated for this time period. If 12-hour turning movement counts were collected at the subject intersection, the Applicant should provide the detailed count data as part of the TIAS. Otherwise, the Applicant should provide a description and detailed calculations to demonstrate how volumes were estimated from 9:00 AM to 4:00 PM.

b. The TIAS states that the volumes used as part of the signal warrant analysis were based on the 2024 Baseline volumes plus the site-generated vehicle trips. The TIAS does not provide an estimation of site-generated vehicle trips for any hours other than the weekday AM and PM peak hours. The Applicant should describe and provide detailed calculations demonstrating how site-generated trips were calculated for all hours of the day.

c. GPI compared the traffic volumes contained in the signal warrant analysis worksheets to the raw turning movement counts at the Main Street / Forest Ridge Road intersection for the weekday morning (7:00 AM – 9:00 AM) and weekday evening (4:00 PM – 6:00 PM) peak periods for which turning movement count data was provided in the TIAS. The comparison indicates that in many cases the volumes used in the signal warrant analysis were lower than the raw turning movement count data despite the Applicant describing that the volumes were based on 2024 Baseline plus site-generated trips. The Applicant should provide a detailed description and supporting calculations to demonstrate how the hourly traffic volumes were estimated on all movements through the intersection.

d. It appears that the Applicant has included only the northbound left-turn volume on Forest Ridge Road as part of the signal warrant analysis; however, Forest Ridge Road has been evaluated as a two-lane roadway. When evaluating traffic signal warrants for two-lane minor streets where separate left- and right-turn lanes are provided, it is common to run the analysis under two scenarios:

- i. As a two-lane approach with all left- and right-turn movements included; or*
- ii. As a one-lane approach with only the left-turn movement included.*

If the approach is evaluated with two lanes, then the entire volume in both lanes should be included. Otherwise, the approach should be evaluated as a single-lane approach. Although GPI has provided several comments above regarding the accuracy of the traffic volumes included in the signal warrant analysis, GPI has reevaluated the signal warrant conditions based on the volumes provided in the TIAS and the results of the analysis indicate that based on a one-lane approach using the left-turn volume only on Forest Ridge Road, the volumes will exceed the thresholds for Warrant 2 – Four-Hour Warrant. The Applicant should update the signal warrant analysis to evaluate the warranting condition as a one-lane approach with only the left-turn volume and as a two-lane approach with all turning movements on Forest Ridge Road.

e. The Applicant has evaluated the need for traffic signal at the Main Street / Forest Ridge Road intersection based on the conditions of only Warrant 2 – Four Hour and Warrant 3 – Peak Hour despite providing 12-hours of traffic volume data. While only one warrant needs to be met to justify installation of a traffic signal, MassDOT prefers that the conditions of Warrant 1 – Eight Hour be met prior to installing a signal. The Applicant should conduct a review of the warranting criteria for Warrant 1 – Eight Hour. Based on a preliminary review of the criteria using the volumes provided in the TIAS, it appears that the conditions of Warrant 1B will be met for 10 hours of the day.”

Response: a. The Main Street data is based on the October 2024 ATR count and the Forest Ridge Road data is based on the October 2023 ATR count. As the data collected was not a turning movements count, it did not differentiate between a left or right turn onto Main Street. Supplemental turning movement count data has been processed for the 9:00 AM to 4:00 PM period from the October 2024 count and is now available for signal warrant review. The supplemental traffic count data is provided in the **Attachments**.

b. The hourly breakdown of site generated trips was based on ITE’s estimate of daily trips and the time-of-day data provided in ITE’s *Vehicle Time of Day Distribution for ITE TripGen Appendices – 2022*. The calculation sheet is provided in the **Attachments**.

c. Updated signal warrant sheets for Warrant 1 (8-hour), Warrant 2 (4- hour), and Warrant 3 (Peak Hour) are provided based on the more detailed 7:00 AM to 6:00 PM turning movement count data from October 2024. Backup data and calculations are provided in the **Attachments**.

d. Per the MUTCD, *“The study should consider the effects of the right turning vehicles from the minor street approaches. Engineering judgement should be used to determine what, if any, portion of the right turning traffic is subtracted from the minor street traffic count when evaluating the count against the signal warrants...right turning traffic should not be included in the minor street volume if the movement enters the major street with minimal conflict...”*. A review of the traffic volumes at the intersection indicates right turns from Forest Ridge Road operate with minimal conflict and delay, indicating that a traffic signal is not warranted for these movements. Engineering judgement indicates that the right turn traffic should be removed from the minor street traffic count and the warrants should be for a single left turn lane minor street approach to Main Street. This

criterion is also consistent with MassDOT's preferred criteria for traffic signal Warrant 1. The updated analysis utilizing the expanded turning movement count data at the Main Street at Forest Ridge Road intersection has been used to provide a revised analysis to include Warrant 1 (8-Hour), Warrant 2 (4-Hour), and Warrant 3 (Peak Hour) using a one lane approach (left turns only – scenario ii above) on Forest Ridge Road (see **Attachments**). A review of Warrants 1, 2, and 3 indicates that under 2024 Baseline conditions plus the full buildout of the project, none of the minimum warrants criteria are met; therefore, a traffic signal is not warranted at the Main Street at Forest Ridge Road intersection.

e. See above, a review of the warranting criteria for Warrant 1 – (8-Hour) indicates that based on the one lane approach (left turns only), the critical left turn volume from Forest Ridge Road, under 2024 Baseline plus project trips, onto Main Street does not satisfy a single hour of MassDOT's preferred traffic signal Warrant 1 (see **Attachments**). Given a review of the various warrants and capacity analysis provided, a traffic signal is not warranted at the Main Street intersection with Forest Ridge Road. As summarized in the TIAS, the critical left turn movements from Forest Ridge Road onto Main Street will continue to operate well below capacity (70% reserve capacity) at LOS D or better during the peak hours with the project in place. Likewise, right turns onto Main Street will continue to operate with minimal delay and queueing.

Comment 34: "The capacity analysis for the Main Street / Forest Ridge Road intersection during the weekday AM peak hour utilizes a Peak Hour Factor (PHF) of 0.94 for all movements except the northbound right-turn on Forest Ridge Road. The same intersection PHF should be utilized for all movements through the intersection."

Response: MDM concurs that the PHF for the right turn onto Forest Ridge Road should have been 0.94. This was a scrivener's error, and the analysis has been updated accordingly. The result indicates that there is no change in the reported operations (see **Attachments**).

Comment 35: "There is data from a delay study provided in the Appendix of the October 2024 TIAS; however, there is not explanation in the TIAS of how or why this was conducted or how the data was used. A review of the Synchro analysis worksheets indicates that it appears the Applicant used the results of the delay study to reduce the critical headway or critical gap for vehicles exiting Forest Ridge Road onto Main Street. The critical headway represents the minimum time gap that a driver exiting a side street movement will accept between successive vehicles on the mainline in order to enter the roadway. The default critical headway used in HCM 6 analysis methodology for the left-turn exiting Forest Ridge Road should be 6.43 seconds and the critical headway for the right-turn exiting Forest Ridge Road should be 6.3 seconds. The Applicant has reduced the critical headways to 5.8 and 3.3 seconds, respectively, to effectively lower the delay on the Forest Ridge Road from that calculated using HCM 6 methodology. Similarly, during the weekday PM peak hour, the Applicant has reduced the critical headway for vehicles turning left from Main Street onto Forest Ridge Road from 4.19 to 4.12 seconds. As no delay study was conducted for the left-turn from Main Street onto Forest Ridge Road, the critical headway

on this movement should not be reduced. In addition, the delay study was only conducted during the weekday PM peak period from 4:00 PM – 5:00 PM. No delay study was conducted during the weekday morning peak period to determine a baseline delay; therefore the critical headways should not be adjusted for the weekday morning peak period.

There is only a summary page provided in the appendix for the delay study that was conducted. Although the turning movements exiting Forest Ridge Road in the delay study appear to match the volumes collected as part of the turning movement counts, the count sheets indicate that the turning movement counts and delay study were conducted on different days (October 10 and October 30, 2024). If the delay data is to be used to adjust the critical headway in the weekday PM peak hour, the Applicant should provide the detailed delay study data that demonstrates the delay experienced by each vehicle passing through the intersection and provide details on how the delay study was conducted.

GPI notes that although many drivers may choose to take shorter gaps in traffic during periods of heavy congestion to avoid excessive delays, it is not necessarily a desirable or safe condition to do so. Therefore, the critical headway should be adjusted with caution and in special circumstances, and a reduced headway should not be used for the design of improvements at an intersection.”

Response: The critical headway for the westbound left turn into Forest Ridge Road was not measured nor adjusted in the analysis.

The delay study was performed using a traffic count board with delay study template and a video of the intersection on the day of the turning movement counts from October 2024. The detailed delay data for the PM peak hour is included in the **Attachments**. The TIAS utilized the more congested delay study from the PM peak period for the morning which is appropriate. Subsequently, a delay study was performed during the weekday morning peak hour (see **Attachments**) which confirms that the results included in the TIAS remain conservative and that the vehicles during the am peak hour in fact utilize lower gaps without safety issues.

The use of the delay study was to understand the actual delays and gaps being used on the Forest Ridge Road approach to Main Street. The data indicates that the intersection operates with moderate delay (LOS C) for left turn and minimal delay (LOS A) for right turns during the peak hours. A review of the crash history at the Main Street intersection with Forest Ridge Road indicates that the intersection, experienced a crash rate well below the District 4 averages and the intersection is not listed as high crash (HSIP) locations; therefore, the gaps being used by drivers are appropriate and not causing a safety problem.

ATTACHMENTS

- Seasonal/Yearly Growth Data
- Sensitivity Analysis
 - 1% Yearly Growth
 - 0.92 Peak Hour Factor
- Sight Distance Calculations
- Traffic Volume Data/Calculations
- Signal Warrant Analysis
- Revised Capacity Analysis
- Delay Study

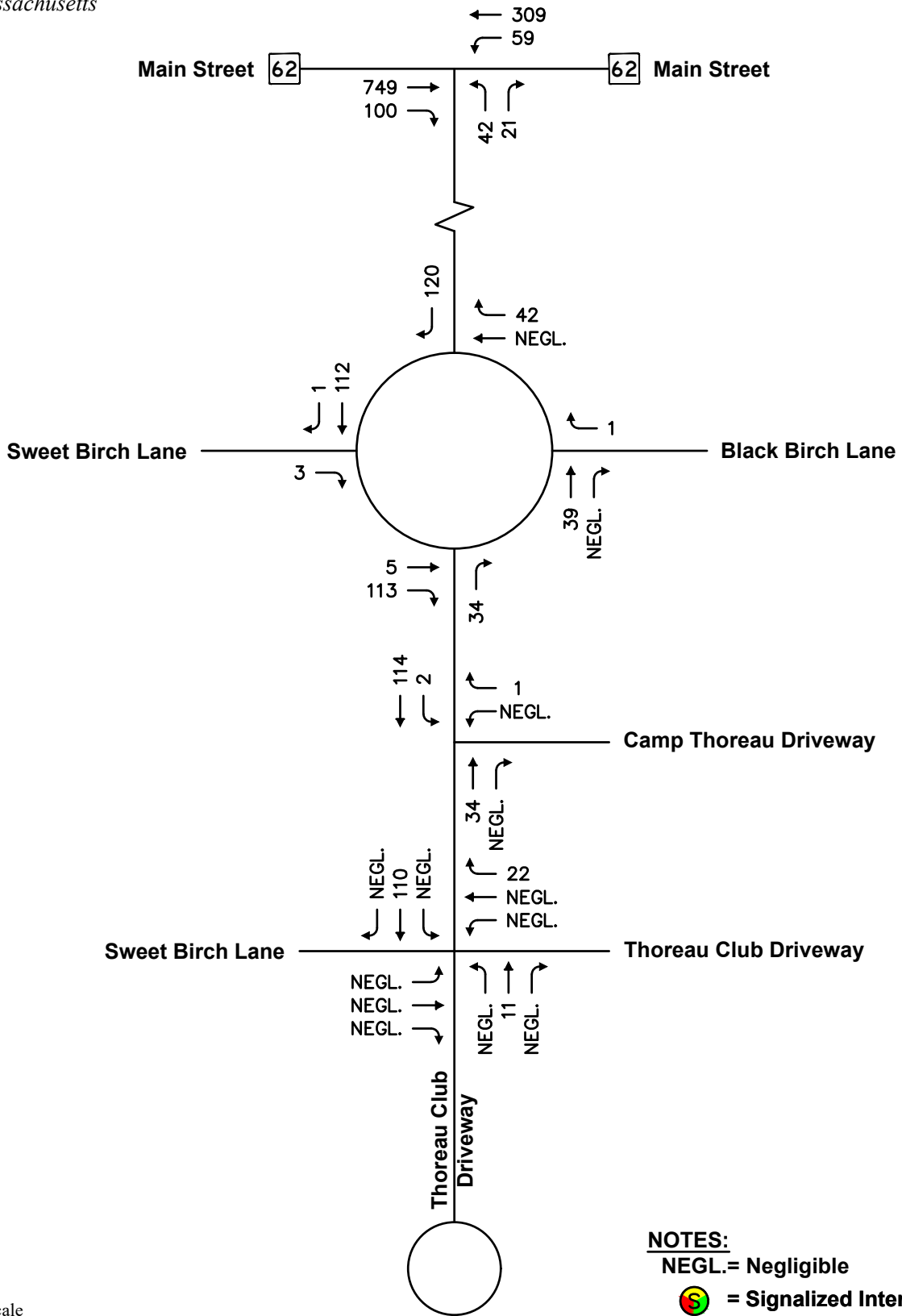
□ Seasonal/Yearly Growth Data

SECTION I - CONTINUOUS COUNTING STATION MONTHLY AVERAGE DAILY TRAFFIC

STATION 403 - CONCORD - RTE.2 - 0.2 km EAST OF CONCORD ROTARY													
YR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
10	41,546	41,883	46,472	50,492	45,910	46,524	43,534	39,595	40,709	46,285	43,576	44,350	44,240
	-6%	-4%	-6%	-12%	0%	-1%	0%	9%	10%	-2%	-1%	-5%	-2%
11	39,037	40,138	43,732	44,191	45,777	46,145	43,496	43,117	44,740	45,508	43,282	42,043	43,434
	6%	5%	-2%	0%	0%	-1%	-7%	4%	0%	-1%	-1%	-1%	0%
12	41,311	42,111	43,069	44,294	45,759	45,640	40,408	44,775	44,720	44,904	42,980	41,701	43,473
	1%	-7%	-2%	-3%	-3%	-1%	4%	-3%	-1%	0%	-1%	3%	-1%
13	41,792	39,095	42,007	42,993	44,222	44,984	41,995	43,310	44,422	45,062	42,684	42,773	42,945
	-6%	-6%	2%	2%	3%	2%	4%	1%	-1%	2%	2%	12%	1%
15	39,457	36,908	42,703	44,051	45,401	45,790	43,572	43,700	43,992	46,043	43,701	47,747	43,589
	6%	15%	4%	1%	3%	4%	3%	6%	3%	2%	4%	-9%	3%
16	41,896	42,396	44,580	44,670	46,737	47,669	45,004	46,441	45,499	47,080	45,357	43,312	45,053
	3%	1%	1%	1%	2%	2%	2%	1%	4%	4%	3%	-1%	2%
17	43,250	43,008	45,196	45,139	47,491	48,619	45,789	46,860	47,255	48,955	46,715	42,828	45,855
	0%	3%	0%	4%	1%	1%	-3%	-2%	-5%	-1%	-9%	5%	0%
18	43,289	44,164	45,201	46,965	48,147	49,054	44,492	45,928	44,882	48,454	42,446	45,171	45,683
	-4%	-4%	-4%	18%	-7%	-5%	-2%	0%	1%	-2%	6%	-5%	-1%
23	41,584	42,298	43,456	55,261	44,743	46,752	43,638	45,699	45,234	47,363	44,928	42,884	45,320
	1%	1%	3%	-18%	6%	1%	2%	0%	4%	2%	7%	8%	1%
24	41,896	42,854	44,818	45,484	47,311	47,214	44,635	45,921	47,074	48,331	47,894	46,263	45,808
Seasonal Adjustment Factor (to average month)	1.07	1.08	1.01	0.97	0.97	0.95	1.02	1.00	0.99	0.95	1.01	1.02	Growth 0.36%

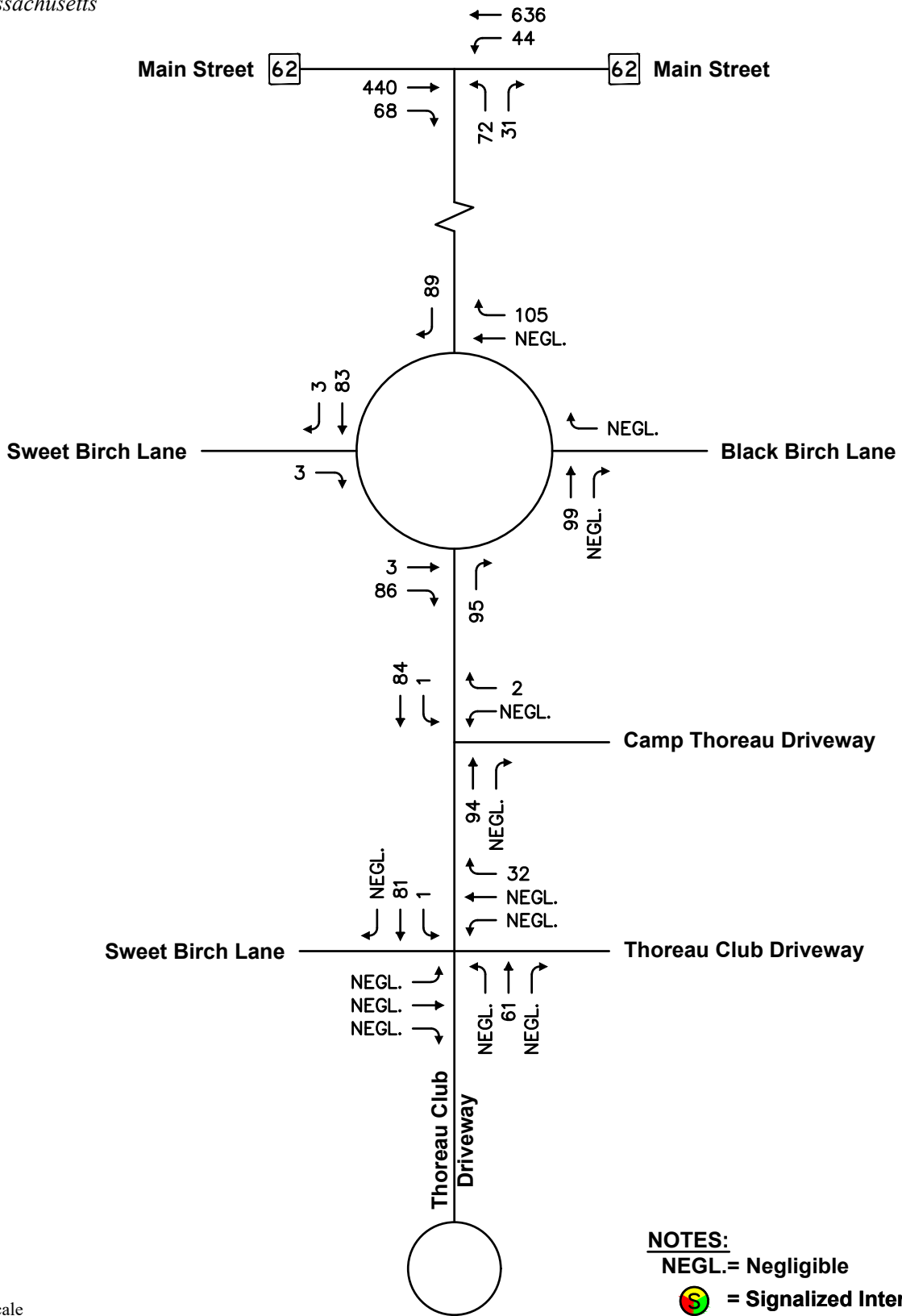
□ Sensitivity Analysis

1% Yearly Growth



North

Scale: Not to Scale



North

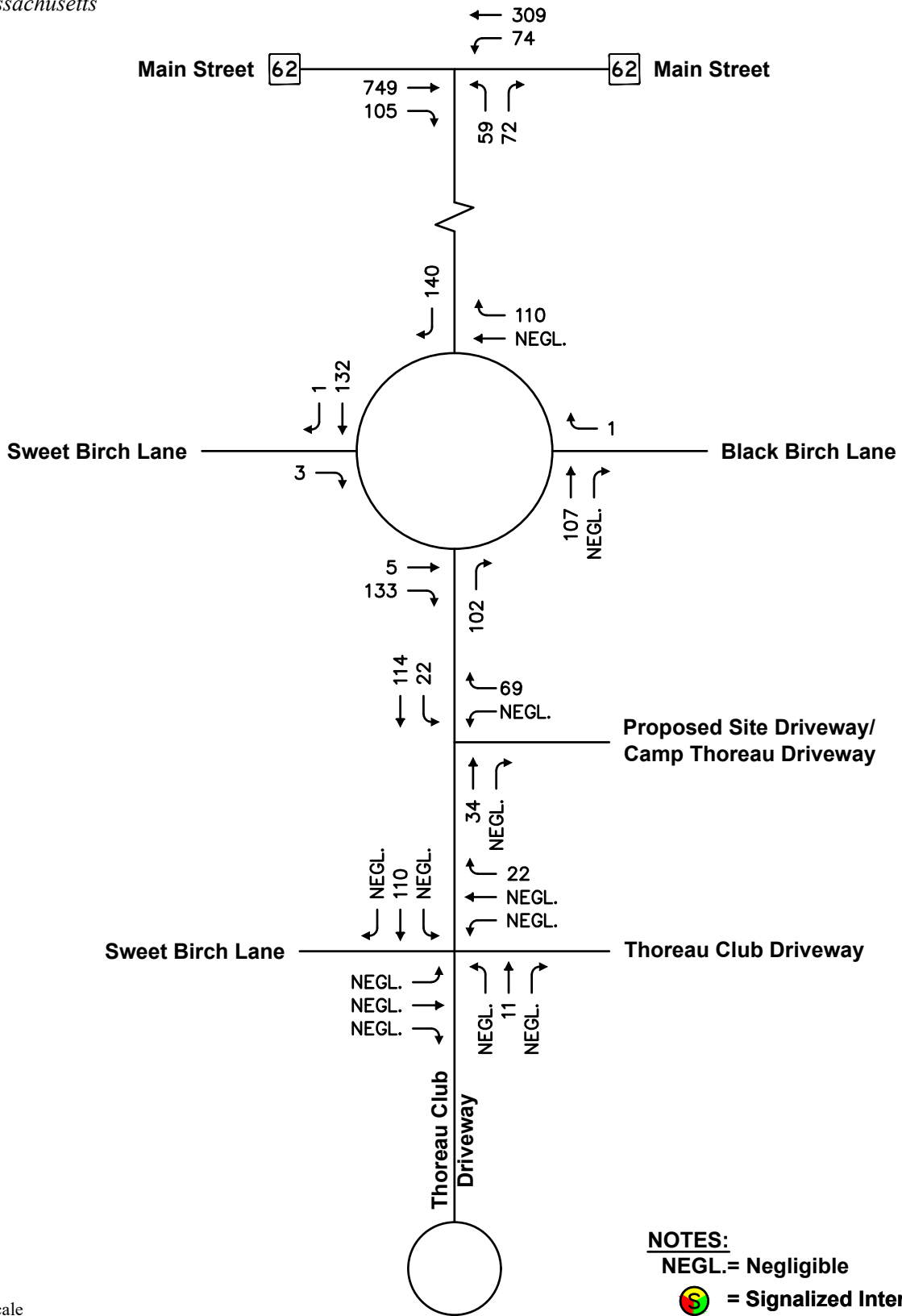
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NOTES:

NEGL. = Negligible

 = Signalized Intersection

Attachment

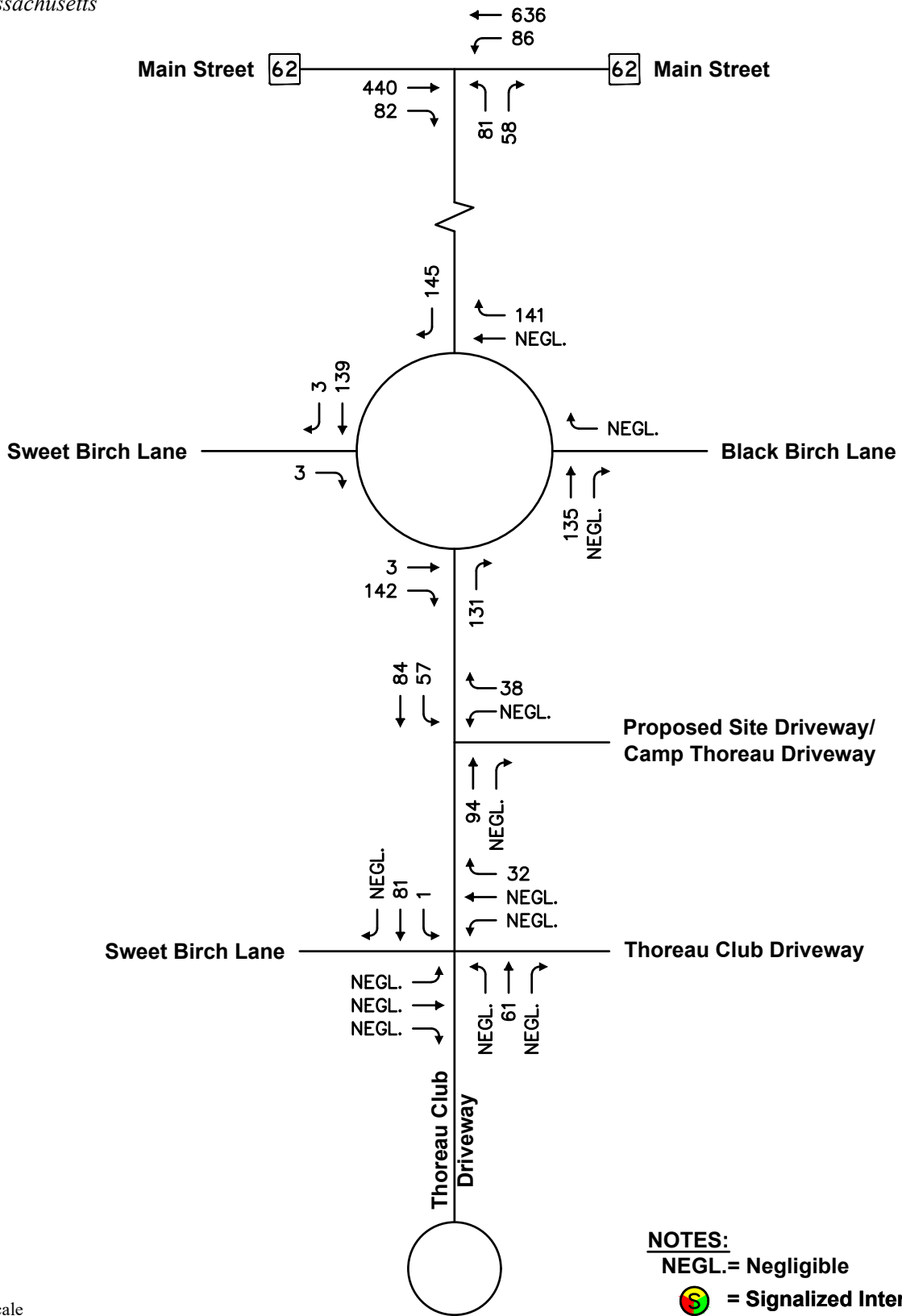


NOTES:
 NEGL.= Negligible
 = Signalized Intersection



Scale: Not to Scale

Attachment



North

Scale: Not to Scale

NOTES:

NEGL.= Negligible

 = Signalized Intersection

Attachment

HCM 6th TWSC
1: Forest Ridge Road & Main Street

2031 No-Build Conditions - 1% Growth
Weekday Morning Peak Hour Volumes

Intersection

Int Delay, s/veh	1.6					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	749	100	59	309	42	21
Future Vol, veh/h	749	100	59	309	42	21
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	94	94	94	94	94	94
Heavy Vehicles, %	2	1	9	6	3	10
Mvmt Flow	797	106	63	329	45	22

Major/Minor	Major1	Major2	Minor1		
Conflicting Flow All	0	0	903	0	1305 850
Stage 1	-	-	-	-	850 -
Stage 2	-	-	-	-	455 -
Critical Hdwy	-	-	4.19	-	5.8 3.4
Critical Hdwy Stg 1	-	-	-	-	5.43 -
Critical Hdwy Stg 2	-	-	-	-	5.43 -
Follow-up Hdwy	-	-	2.281	-	3.527 3.39
Pot Cap-1 Maneuver	-	-	725	-	221 691
Stage 1	-	-	-	-	417 -
Stage 2	-	-	-	-	637 -
Platoon blocked, %	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	725	-	198 691
Mov Cap-2 Maneuver	-	-	-	-	198 -
Stage 1	-	-	-	-	417 -
Stage 2	-	-	-	-	569 -













Approach	EB	WB	NB
HCM Control Delay, s	0	1.7	22.4
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	198	691	-	-	725	-
HCM Lane V/C Ratio	0.226	0.032	-	-	0.087	-
HCM Control Delay (s)	28.4	10.4	-	-	10.4	0
HCM Lane LOS	D	B	-	-	B	A
HCM 95th %tile Q(veh)	0.8	0.1	-	-	0.3	-

Volume

2031 No-Build Conditions - 1% Growth

2: Thoreau Club Driveway/Forest Ridge Road & Sweet Birch Lane/Black Birch Lane Peak Hour Volumes

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Traffic Volume (vph)	3	0	0	0	0	1	0	34	0	0	120	1
Future Volume (vph)	3	0	0	0	0	1	0	34	0	0	120	1
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Adj. Flow (vph)	3	0	0	0	0	1	0	37	0	0	130	1
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	3	0	0	1	0	0	37	0	0	131	0
Intersection Summary												

HCM 6th TWSC
 1: Forest Ridge Road & Main Street

2031 No-Build Conditions - 1% Growth
 Weekday Evening Peak Hour Volumes

Intersection

Int Delay, s/veh	2.1					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	440	68	44	636	72	31
Future Vol, veh/h	440	68	44	636	72	31
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	98	98	98	98	98	98
Heavy Vehicles, %	1	2	2	4	3	0
Mvmt Flow	449	69	45	649	73	32

Major/Minor	Major1	Major2	Minor1		
Conflicting Flow All	0	0	518	0	1223
Stage 1	-	-	-	-	484
Stage 2	-	-	-	-	739
Critical Hdwy	-	-	4.12	-	5.8
Critical Hdwy Stg 1	-	-	-	-	5.43
Critical Hdwy Stg 2	-	-	-	-	5.43
Follow-up Hdwy	-	-	2.218	-	3.527
Pot Cap-1 Maneuver	-	-	1048	-	244
Stage 1	-	-	-	-	618
Stage 2	-	-	-	-	471
Platoon blocked, %	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	1048	-	228
Mov Cap-2 Maneuver	-	-	-	-	228
Stage 1	-	-	-	-	618
Stage 2	-	-	-	-	439













Approach	EB	WB	NB
HCM Control Delay, s	0	0.6	22.4
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	228	867	-	-	1048	-
HCM Lane V/C Ratio	0.322	0.036	-	-	0.043	-
HCM Control Delay (s)	28.1	9.3	-	-	8.6	0
HCM Lane LOS	D	A	-	-	A	A
HCM 95th %tile Q(veh)	1.3	0.1	-	-	0.1	-

Volume

2031 No-Build Conditions - 1% Growth

2: Thoreau Club Driveway/Forest Ridge Road & Sweet Birch Lane/Black Birch Lane

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Traffic Volume (vph)	3	0	0	0	0	0	0	95	0	0	89	3
Future Volume (vph)	3	0	0	0	0	0	0	95	0	0	89	3
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Adj. Flow (vph)	5	0	0	0	0	0	0	146	0	0	137	5
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	5	0	0	0	0	0	146	0	0	142	0
Intersection Summary												

HCM 6th TWSC
1: Forest Ridge Road & Main Street

2031 Build Condition - 1% Growth
Weekday Morning Peak Hour Volumes

Intersection						
Int Delay, s/veh	2.6					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	749	105	74	309	59	72
Future Vol, veh/h	749	105	74	309	59	72
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	94	94	94	94	94	94
Heavy Vehicles, %	2	1	9	6	3	10
Mvmt Flow	797	112	79	329	63	77

Major/Minor	Major1	Major2	Minor1		
Conflicting Flow All	0	0	909	0	1340 853
Stage 1	-	-	-	-	853 -
Stage 2	-	-	-	-	487 -
Critical Hdwy	-	-	4.19	-	5.8 3.4
Critical Hdwy Stg 1	-	-	-	-	5.43 -
Critical Hdwy Stg 2	-	-	-	-	5.43 -
Follow-up Hdwy	-	-	2.281	-	3.527 3.39
Pot Cap-1 Maneuver	-	-	721	-	212 690
Stage 1	-	-	-	-	416 -
Stage 2	-	-	-	-	616 -
Platoon blocked, %	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	721	-	184 690
Mov Cap-2 Maneuver	-	-	-	-	184 -
Stage 1	-	-	-	-	416 -
Stage 2	-	-	-	-	533 -













Approach	EB	WB	NB
HCM Control Delay, s	0	2	21.5
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	184	690	-	-	721	-
HCM Lane V/C Ratio	0.341	0.111	-	-	0.109	-
HCM Control Delay (s)	34.4	10.9	-	-	10.6	0
HCM Lane LOS	D	B	-	-	B	A
HCM 95th %tile Q(veh)	1.4	0.4	-	-	0.4	-

Volume

2031 Build Condition - 1% Growth

2: Thoreau Club Driveway/Forest Ridge Road & Sweet Birch Lane/Black Birch Lane

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Traffic Volume (vph)	3	0	0	0	0	1	0	102	0	0	140	1
Future Volume (vph)	3	0	0	0	0	1	0	102	0	0	140	1
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Adj. Flow (vph)	3	0	0	0	0	1	0	111	0	0	152	1
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	3	0	0	1	0	0	111	0	0	153	0
Intersection Summary												

HCM 6th TWSC
1: Forest Ridge Road & Main Street

2031 Build Condition - 1% Growth
Weekday Evening Peak Hour Volumes

Intersection

Int Delay, s/veh 3.2

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	440	82	86	636	81	58
Future Vol, veh/h	440	82	86	636	81	58
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	98	98	98	98	98	98
Heavy Vehicles, %	1	2	2	4	3	0
Mvmt Flow	449	84	88	649	83	59

Major/Minor	Major1	Major2	Minor1
Conflicting Flow All	0	0	533
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	-	4.12
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	-	2.218
Pot Cap-1 Maneuver	-	-	1035
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	-	-	1035
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-













Approach	EB	WB	NB
HCM Control Delay, s	0	1	26.2
HCM LOS			D

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	189	864	-	-	1035	-
HCM Lane V/C Ratio	0.437	0.068	-	-	0.085	-
HCM Control Delay (s)	38.1	9.5	-	-	8.8	0
HCM Lane LOS	E	A	-	-	A	A
HCM 95th %tile Q(veh)	2	0.2	-	-	0.3	-

Volume

2031 Build Condition - 1% Growth

2: Thoreau Club Driveway/Forest Ridge Road & Sweet Birch Lane/Black Birch Lane

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Traffic Volume (vph)	3	0	0	0	0	0	0	131	0	0	145	3
Future Volume (vph)	3	0	0	0	0	0	0	131	0	0	145	3
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Adj. Flow (vph)	5	0	0	0	0	0	0	202	0	0	223	5
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	5	0	0	0	0	0	202	0	0	228	0
Intersection Summary												

0.92 Peak Hour Factor

Forest Ridge Road
 South of Main Street
 Concord, MA

MDM TRANSPORTATION CONSULTANTS, INC.
Planners & Engineers

28 Lord Road, Suite 280
 Marlborough, MA 01752

Site Code: 00001229

Start Time	26-Oct-23 Thu	Southbound		Hour Totals		Northbound		Hour Totals		Combined Totals	
		Morning	Afternoon	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon
12:00		0	16			0	25				
12:15		0	11			0	25				
12:30		0	12			0	21				
12:45		0	16	0	55	0	18	0	89	0	144
01:00		0	5			0	16				
01:15		0	5			0	16				
01:30		0	8			0	13				
01:45		0	15	0	33	0	9	0	54	0	87
02:00		0	8			0	8				
02:15		0	10			0	14				
02:30		0	19			0	17				
02:45		0	14	0	51	0	16	0	55	0	106
03:00		0	15			0	30				
03:15		0	14			0	18				
03:30		0	18			0	20				
03:45		0	21	0	68	0	9	0	77	0	145
04:00		0	34			0	27				
04:15		0	14			0	13				
04:30		0	23			0	13				
04:45		3	24	3	95	0	11	0	64	3	159
05:00		4	21			0	15				
05:15		6	12			0	33				
05:30		8	13			0	16				
05:45		4	23	22	69	1	17	1	81	23	150
06:00		3	22			3	32				
06:15		6	20			1	41				
06:30		5	12			16	14				
06:45		12	13	26	67	5	12	25	99	51	166
07:00		13	5			11	12				
07:15		21	11			6	11				
07:30		18	16			11	13				
07:45		11	8	63	40	5	25	33	61	96	101
08:00		31	11			15	12				
08:15		27	5			19	18				
08:30		28	5			14	4				
08:45		34	2	120	23	16	15	64	49	184	72
09:00		37	2			14	8				
09:15		31	0			17	5				
09:30		22	2			19	3				
09:45		18	0	108	4	20	7	70	23	178	27
10:00		25	1			23	1				
10:15		19	0			10	0				
10:30		17	0			36	0				
10:45		15	0	76	1	20	0	89	1	165	2
11:00		12	0			13	0				
11:15		10	0			16	0				
11:30		8	0			25	1				
11:45		17	0	47	0	30	0	84	1	131	1
Total		465	506			366	654			831	1160
Percent		47.9%	52.1%			35.9%	64.1%			41.7%	58.3%
Total		465	506			366	654			831	1160
Percent		47.9%	52.1%			35.9%	64.1%			41.7%	58.3%
Combined Total		971				1020				1991	

Peak Hour Factor Calculations

Location: Forest Ridge Road
South of Main Street
Concord, MA

Date: October 26, 2023

Morning

SB	NB	Total
31	15	46
27	19	46
28	14	42
34	16	50
		184
	PHF	0.92

Evening

SB	NB	Total
34	27	61
14	13	27
23	13	36
24	11	<u>35</u>
		159
	PHF	0.65

Peak 15-minute period

HCM 6th TWSC
1: Forest Ridge Road & Main Street

2031 No-Build Condition - 0.92 Sensitivity
Weekday Morning Peak Hour Volumes

Intersection						
Int Delay, s/veh	1.6					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	725	96	57	299	40	21
Future Vol, veh/h	725	96	57	299	40	21
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	1	9	6	3	10
Mvmt Flow	788	104	62	325	43	23

Major/Minor	Major1	Major2	Minor1		
Conflicting Flow All	0	0	892	0	1289 840
Stage 1	-	-	-	-	840 -
Stage 2	-	-	-	-	449 -
Critical Hdwy	-	-	4.19	-	5.8 3.4
Critical Hdwy Stg 1	-	-	-	-	5.43 -
Critical Hdwy Stg 2	-	-	-	-	5.43 -
Follow-up Hdwy	-	-	2.281	-	3.527 3.39
Pot Cap-1 Maneuver	-	-	732	-	225 695
Stage 1	-	-	-	-	422 -
Stage 2	-	-	-	-	641 -
Platoon blocked, %	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	732	-	202 695
Mov Cap-2 Maneuver	-	-	-	-	202 -
Stage 1	-	-	-	-	422 -
Stage 2	-	-	-	-	575 -

Approach	EB	WB	NB
HCM Control Delay, s	0	1.7	21.7
HCM LOS			C













Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	202	695	-	-	732	-
HCM Lane V/C Ratio	0.215	0.033	-	-	0.085	-
HCM Control Delay (s)	27.6	10.4	-	-	10.4	0
HCM Lane LOS	D	B	-	-	B	A
HCM 95th %tile Q(veh)	0.8	0.1	-	-	0.3	-

Intersection				
Intersection Delay, s/veh	3.2			
Intersection LOS	A			
Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	3	1	37	127
Demand Flow Rate, veh/h	3	1	37	128
Vehicles Circulating, veh/h	127	40	3	0
Vehicles Exiting, veh/h	1	0	127	41
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	3.0	2.7	2.8	3.4
Approach LOS	A	A	A	A
Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	3	1	37	128
Cap Entry Lane, veh/h	1212	1325	1376	1380
Entry HV Adj Factor	1.000	1.000	1.000	0.990
Flow Entry, veh/h	3	1	37	127
Cap Entry, veh/h	1212	1325	1376	1366
V/C Ratio	0.002	0.001	0.027	0.093
Control Delay, s/veh	3.0	2.7	2.8	3.4
LOS	A	A	A	A
95th %tile Queue, veh	0	0	0	0

Volume

2031 No-Build Condition - 0.92 Sensitivity

2: Thoreau Club Driveway/Forest Ridge Road & Sweet Birch Lane/Black Birch Lane Peak Hour Volumes

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Traffic Volume (vph)	3	0	0	0	0	1	0	34	0	0	116	1
Future Volume (vph)	3	0	0	0	0	1	0	34	0	0	116	1
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Adj. Flow (vph)	3	0	0	0	0	1	0	37	0	0	126	1
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	3	0	0	1	0	0	37	0	0	127	0

Intersection Summary

HCM 6th TWSC
1: Forest Ridge Road & Main Street

2031 No-Build Condition - 0.92 Sensitivity
Weekday Evening Peak Hour Volumes

Intersection

Int Delay, s/veh 2.2

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	426	65	42	616	69	30
Future Vol, veh/h	426	65	42	616	69	30
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	1	2	2	4	3	0
Mvmt Flow	463	71	46	670	75	33

Major/Minor	Major1	Major2	Minor1
Conflicting Flow All	0	0	534
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	-	4.12
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	-	2.218
Pot Cap-1 Maneuver	-	-	1034
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	-	-	1034
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.6	24
HCM LOS			C













Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	216	860	-	-	1034	-
HCM Lane V/C Ratio	0.347	0.038	-	-	0.044	-
HCM Control Delay (s)	30.3	9.4	-	-	8.6	0
HCM Lane LOS	D	A	-	-	A	A
HCM 95th %tile Q(veh)	1.5	0.1	-	-	0.1	-

Intersection				
Intersection Delay, s/veh	3.2			
Intersection LOS	A			
Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	3	0	103	93
Demand Flow Rate, veh/h	3	0	103	93
Vehicles Circulating, veh/h	90	106	3	0
Vehicles Exiting, veh/h	3	0	90	106
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	2.9	0.0	3.2	3.1
Approach LOS	A	-	A	A
Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	3	0	103	93
Cap Entry Lane, veh/h	1259	1238	1376	1380
Entry HV Adj Factor	1.000	1.000	1.000	1.000
Flow Entry, veh/h	3	0	103	93
Cap Entry, veh/h	1259	1238	1376	1380
V/C Ratio	0.002	0.000	0.075	0.067
Control Delay, s/veh	2.9	2.9	3.2	3.1
LOS	A	A	A	A
95th %tile Queue, veh	0	0	0	0

Volume

2031 No-Build Condition - 0.92 Sensitivity

2: Thoreau Club Driveway/Forest Ridge Road & Sweet Birch Lane/Black Birch Lane

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Traffic Volume (vph)	3	0	0	0	0	0	0	95	0	0	83	3
Future Volume (vph)	3	0	0	0	0	0	0	95	0	0	83	3
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Adj. Flow (vph)	3	0	0	0	0	0	0	103	0	0	90	3
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	3	0	0	0	0	0	103	0	0	93	0
Intersection Summary												

HCM 6th TWSC
1: Forest Ridge Road & Main Street

2031 Build Condition - 0.92 Sensitivity
Weekday Morning Peak Hour Volumes

Intersection

Int Delay, s/veh	2.6					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	725	101	72	299	57	72
Future Vol, veh/h	725	101	72	299	57	72
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	1	9	6	3	10
Mvmt Flow	788	110	78	325	62	78

Major/Minor	Major1	Major2	Minor1		
Conflicting Flow All	0	0	898	0	1324
Stage 1	-	-	-	-	843
Stage 2	-	-	-	-	481
Critical Hdwy	-	-	4.19	-	5.8
Critical Hdwy Stg 1	-	-	-	-	5.43
Critical Hdwy Stg 2	-	-	-	-	5.43
Follow-up Hdwy	-	-	2.281	-	3.527
Pot Cap-1 Maneuver	-	-	728	-	216
Stage 1	-	-	-	-	420
Stage 2	-	-	-	-	620
Platoon blocked, %	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	728	-	188
Mov Cap-2 Maneuver	-	-	-	-	188
Stage 1	-	-	-	-	420
Stage 2	-	-	-	-	539

Approach	EB	WB	NB
HCM Control Delay, s	0	2	20.7
HCM LOS			C













Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	188	694	-	-	728	-
HCM Lane V/C Ratio	0.33	0.113	-	-	0.108	-
HCM Control Delay (s)	33.3	10.8	-	-	10.5	0
HCM Lane LOS	D	B	-	-	B	A
HCM 95th %tile Q(veh)	1.4	0.4	-	-	0.4	-

Intersection				
Intersection Delay, s/veh	3.4			
Intersection LOS	A			
Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	3	1	111	144
Demand Flow Rate, veh/h	3	1	111	145
Vehicles Circulating, veh/h	144	114	3	0
Vehicles Exiting, veh/h	1	0	144	115
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	3.0	2.9	3.3	3.5
Approach LOS	A	A	A	A
Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	3	1	111	145
Cap Entry Lane, veh/h	1191	1228	1376	1380
Entry HV Adj Factor	1.000	1.000	1.000	0.990
Flow Entry, veh/h	3	1	111	144
Cap Entry, veh/h	1191	1228	1376	1366
V/C Ratio	0.003	0.001	0.081	0.105
Control Delay, s/veh	3.0	2.9	3.3	3.5
LOS	A	A	A	A
95th %tile Queue, veh	0	0	0	0

Volume

2031 Build Condition - 0.92 Sensitivity

2: Thoreau Club Driveway/Forest Ridge Road & Sweet Birch Lane/Black Birch Lane

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Traffic Volume (vph)	3	0	0	0	0	1	0	102	0	0	132	1
Future Volume (vph)	3	0	0	0	0	1	0	102	0	0	132	1
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Adj. Flow (vph)	3	0	0	0	0	1	0	111	0	0	143	1
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	3	0	0	1	0	0	111	0	0	144	0
Intersection Summary												

HCM 6th TWSC
 1: Forest Ridge Road & Main Street

2031 Build Condition - 0.92 Sensitivity
 Weekday Evening Peak Hour Volumes

Intersection						
Int Delay, s/veh	3.4					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	426	79	84	616	78	57
Future Vol, veh/h	426	79	84	616	78	57
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	1	2	2	4	3	0
Mvmt Flow	463	86	91	670	85	62

Major/Minor	Major1	Major2	Minor1		
Conflicting Flow All	0	0	549	0	1358 506
Stage 1	-	-	-	-	506 -
Stage 2	-	-	-	-	852 -
Critical Hdwy	-	-	4.12	-	5.8 3.3
Critical Hdwy Stg 1	-	-	-	-	5.43 -
Critical Hdwy Stg 2	-	-	-	-	5.43 -
Follow-up Hdwy	-	-	2.218	-	3.527 3.3
Pot Cap-1 Maneuver	-	-	1021	-	207 857
Stage 1	-	-	-	-	603 -
Stage 2	-	-	-	-	416 -
Platoon blocked, %	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	1021	-	178 857
Mov Cap-2 Maneuver	-	-	-	-	178 -
Stage 1	-	-	-	-	603 -
Stage 2	-	-	-	-	357 -

Approach	EB	WB	NB
HCM Control Delay, s	0	1.1	28.5
HCM LOS			D













Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	178	857	-	-	1021	-
HCM Lane V/C Ratio	0.476	0.072	-	-	0.089	-
HCM Control Delay (s)	42.4	9.5	-	-	8.9	0
HCM Lane LOS	E	A	-	-	A	A
HCM 95th %tile Q(veh)	2.3	0.2	-	-	0.3	-

Intersection				
Intersection Delay, s/veh	3.5			
Intersection LOS	A			
Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	3	0	142	154
Demand Flow Rate, veh/h	3	0	142	154
Vehicles Circulating, veh/h	151	145	3	0
Vehicles Exiting, veh/h	3	0	151	145
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	3.1	0.0	3.4	3.5
Approach LOS	A	-	A	A
Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	3	0	142	154
Cap Entry Lane, veh/h	1183	1190	1376	1380
Entry HV Adj Factor	1.000	1.000	1.000	1.000
Flow Entry, veh/h	3	0	142	154
Cap Entry, veh/h	1183	1190	1376	1380
V/C Ratio	0.003	0.000	0.103	0.112
Control Delay, s/veh	3.1	3.0	3.4	3.5
LOS	A	A	A	A
95th %tile Queue, veh	0	0	0	0

Volume

2031 Build Condition - 0.92 Sensitivity

2: Thoreau Club Driveway/Forest Ridge Road & Sweet Birch Lane/Black Birch Lane

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Traffic Volume (vph)	3	0	0	0	0	0	0	131	0	0	139	3
Future Volume (vph)	3	0	0	0	0	0	0	131	0	0	139	3
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Adj. Flow (vph)	3	0	0	0	0	0	0	142	0	0	151	3
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	3	0	0	0	0	0	142	0	0	154	0
Intersection Summary												

□ Sight Distance Calculations

Stopping Sight Distance - Regulatory

Existing Thoreau Club Driveway

		SPEED (MPH)	BRAKE REACTION DISTANCE (FT)	BRAKING DISTANCE (FT)	CALCULATED STOPPING SIGHT DISTANCE (FT)
Direction 1	NB	25	91.875	59.9	151.8
Direction 2	SB	25	91.875	59.9	151.8

<u>INPUTS</u>	<u>Direction 1</u>	<u>Direction 2</u>
Travel Direction	NB	SB
Speed	25	25
Grade	0	0
t	2.5	2.5
a	11.2	11.2

Stopping Sight Distance (SSD) - Source: AASHTO

SSD = Reaction Distance + Brake Distance

Reaction Distance = $1.47 \times t \times V$

Brake Distance = $V^2 / (30 \times ((a/32.2)+G))$

Where:
t = reaction time (sec)
V = travel speed (mph)
G= roadway grade
a - deceleration rate (ft/sec²)

Intersection Sight Distance Calculations

Source: *A Policy on Geometric Design of Highways and Street, 7th Edition*; AASHTO; 2018.

Passenger Car

$$ISD = 1.47 * V * t$$

V = speed

t = time gap

t = 7.5 s for a passenger car for Left Turn from a Stop

t = 6.5 s for a passenger car for Right Turn from a Stop

Thoreau Club Driveway

Looking North (left-turn from a stop)	ISD = 1.47*	Average Speed 25	* 7.5 =	Ideal ISD 275.625	SAY 280 feet
Looking South (right-turn from a stop)	ISD = 1.47*	Average Speed 25	* 6.5 =	Ideal ISD 238.875	SAY 240 feet

□ Traffic Volume Data/Calculations

N/S: Forest Ridge Road
E/W: Main Street
Concord, MA

File Name : 1319_Forest_at_Main_2024_TMC_1236148_10-10-2024
Site Code : 1319
Start Date : 10/10/2024
Page No : 1

Groups Printed- Lights - Mediums - Articulated Trucks

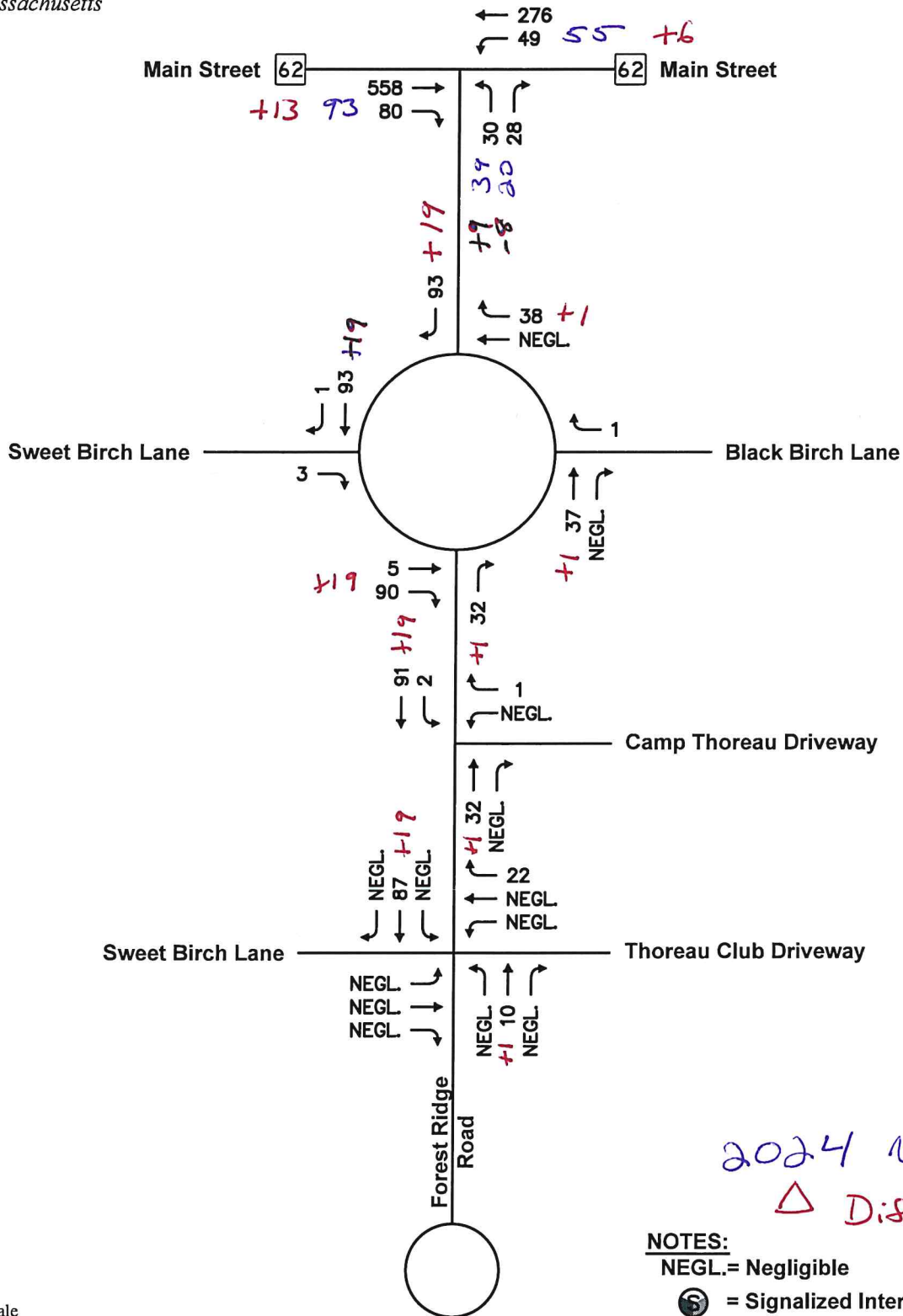
Start Time	Main Street From East				Forest Ridge Road From South				Main Street From West			Int. Total
	Thru	Left	U-Turn	App. Total	Right	Left	U-Turn	App. Total	Right	Thru	App. Total	
07:00 AM	40	4	0	44	6	9	0	15	7	152	159	218
07:15 AM	50	7	0	57	5	7	0	12	19	130	149	218
07:30 AM	40	4	0	44	0	8	0	8	6	155	161	213
07:45 AM	82	4	0	86	2	4	0	6	12	180	192	284
Total	212	19	0	231	13	28	0	41	44	617	661	933
08:00 AM	52	10	0	62	3	8	0	11	16	173	189	262
08:15 AM	67	19	0	86	2	8	0	10	33	172	205	301
08:30 AM	64	13	0	77	7	9	0	16	20	166	186	279
08:45 AM	90	13	0	103	8	14	0	22	24	139	163	288
Total	273	55	0	328	20	39	0	59	93	650	743	1130
04:00 PM	136	12	0	148	7	22	0	29	18	97	115	292
04:15 PM	129	12	0	141	12	10	0	22	29	77	106	269
04:30 PM	147	9	0	156	5	21	0	26	7	99	106	288
04:45 PM	143	8	0	151	5	14	0	19	9	113	122	292
Total	555	41	0	596	29	67	0	96	63	386	449	1141
05:00 PM	118	11	0	129	7	9	0	16	9	90	99	244
05:15 PM	153	9	0	162	8	15	0	23	4	87	91	276
05:30 PM	130	6	0	136	15	13	0	28	5	119	124	288
05:45 PM	139	7	0	146	7	10	0	17	14	105	119	282
Total	540	33	0	573	37	47	0	84	32	401	433	1090
Grand Total	1580	148	0	1728	99	181	0	280	232	2054	2286	4294
Apprch %	91.4	8.6	0		35.4	64.6	0		10.1	89.9		
Total %	36.8	3.4	0	40.2	2.3	4.2	0	6.5	5.4	47.8	53.2	
Lights	1515	144	0	1659	97	178	0	275	230	2002	2232	4166
% Lights	95.9	97.3	0	96	98	98.3	0	98.2	99.1	97.5	97.6	97
Mediums	60	4	0	64	2	2	0	4	2	44	46	114
% Mediums	3.8	2.7	0	3.7	2	1.1	0	1.4	0.9	2.1	2	2.7
Articulated Trucks	5	0	0	5	0	1	0	1	0	8	8	14
% Articulated Trucks	0.3	0	0	0.3	0	0.6	0	0.4	0	0.4	0.3	0.3

N/S: Forest Ridge Road
E/W: W Main Street
Concord, MA

File Name : 1391_West_Main_at_Forest_Ridge_TMC 8Hr
Site Code : 1391
Start Date : 10/10/2024
Page No : 1

Groups Printed- Lights - Mediums - Articulated Trucks

Start Time	West Main Street From East				Forest Ridge Road From South				West Main Street From West				Int. Total
	Thru	Left	Peds	App. Total	Right	Left	Peds	App. Total	Right	Thru	Peds	App. Total	
09:00 AM	89	14	0	103	4	12	0	16	20	134	0	154	273
09:15 AM	98	25	0	123	11	11	0	22	29	139	0	168	313
09:30 AM	58	1	0	59	4	20	0	24	9	104	0	113	196
09:45 AM	91	5	0	96	7	10	0	17	14	109	0	123	236
Total	336	45	0	381	26	53	0	79	72	486	0	558	1018
10:00 AM	77	13	0	90	8	10	0	18	13	90	0	103	211
10:15 AM	70	5	0	75	5	13	0	18	13	101	0	114	207
10:30 AM	102	7	0	109	9	30	0	39	12	102	0	114	262
10:45 AM	77	8	0	85	16	12	0	28	10	93	0	103	216
Total	326	33	0	359	38	65	0	103	48	386	0	434	896
11:00 AM	93	4	0	97	11	14	0	25	11	72	0	83	205
11:15 AM	75	7	0	82	9	19	0	28	13	101	0	114	224
11:30 AM	94	7	0	101	10	18	0	28	8	93	0	101	230
11:45 AM	101	3	0	104	8	12	0	20	7	100	0	107	231
Total	363	21	0	384	38	63	0	101	39	366	0	405	890
12:00 PM	122	4	0	126	10	13	0	23	12	96	0	108	257
12:15 PM	103	10	0	113	8	17	0	25	12	85	0	97	235
12:30 PM	77	4	0	81	11	15	0	26	10	106	0	116	223
12:45 PM	99	5	0	104	15	7	0	22	10	94	0	104	230
Total	401	23	0	424	44	52	0	96	44	381	0	425	945
01:00 PM	109	5	0	114	5	10	0	15	4	89	0	93	222
01:15 PM	97	5	0	102	5	6	0	11	11	110	0	121	234
01:30 PM	102	4	0	106	6	9	0	15	11	90	0	101	222
01:45 PM	100	9	0	109	6	5	0	11	3	92	0	95	215
Total	408	23	0	431	22	30	0	52	29	381	0	410	893
02:00 PM	92	5	0	97	6	7	0	13	4	106	0	110	220
02:15 PM	103	10	0	113	9	3	0	12	10	108	0	118	243
02:30 PM	94	9	0	103	6	8	0	14	4	90	0	94	211
02:45 PM	118	6	0	124	13	13	0	26	14	85	0	99	249
Total	407	30	0	437	34	31	0	65	32	389	0	421	923
03:00 PM	120	4	0	124	14	13	0	27	9	74	0	83	234
03:15 PM	106	6	0	112	9	8	0	17	12	94	0	106	235
03:30 PM	108	7	0	115	7	5	0	12	17	100	0	117	244
03:45 PM	159	14	0	173	9	15	0	24	20	83	0	103	300
Total	493	31	0	524	39	41	0	80	58	351	0	409	1013
Grand Total	2734	206	0	2940	241	335	0	576	322	2740	0	3062	6578
Aprch %	93	7	0		41.8	58.2	0		10.5	89.5	0		
Total %	41.6	3.1	0	44.7	3.7	5.1	0	8.8	4.9	41.7	0	46.5	
Lights	2610	200	0	2810	233	330	0	563	316	2584	0	2900	6273
% Lights	95.5	97.1	0	95.6	96.7	98.5	0	97.7	98.1	94.3	0	94.7	95.4
Mediums	107	6	0	113	8	5	0	13	5	133	0	138	264
% Mediums	3.9	2.9	0	3.8	3.3	1.5	0	2.3	1.6	4.9	0	4.5	4
Articulated Trucks	17	0	0	17	0	0	0	0	1	23	0	24	41
% Articulated Trucks	0.6	0	0	0.6	0	0	0	0	0.3	0.8	0	0.8	0.6



North
 Scale: Not to Scale

Figure 3

2023 Baseline Conditions
 Weekday Morning Peak Hour Volumes

Calc Sheet

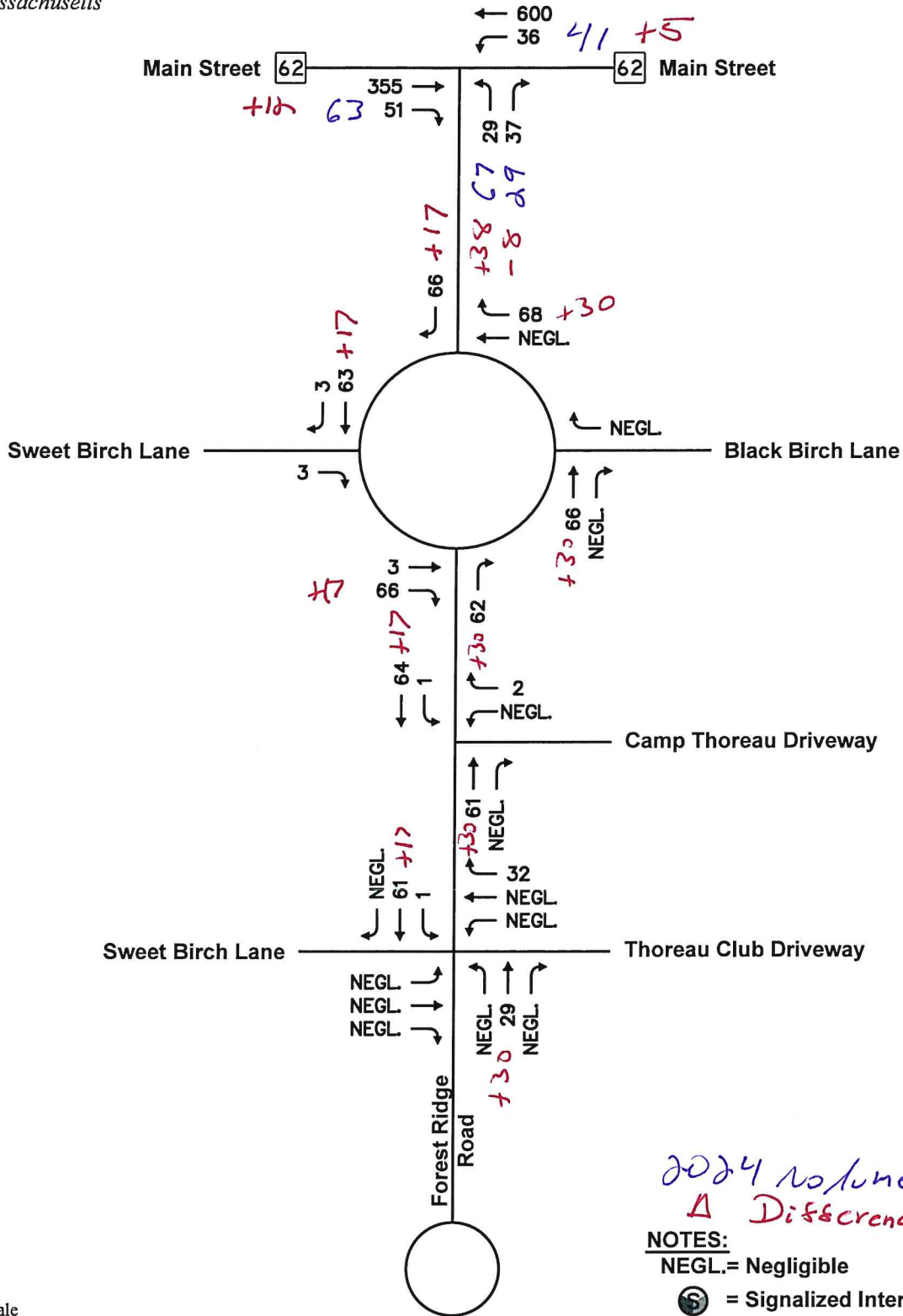


Figure 4

2023 Baseline Conditions
 Weekday Evening Peak Hour Volumes

Calc Sheet

□ Signal Warrant Analysis

MUTCD TRAFFIC SIGNAL WARRANT ANALYSIS

INTERSECTION : Main Street at Forest Ridge Road

Project Name	1391 Concord
Scenario	Baseline 2024 + Site Trips
Comments	-

	Street Name	Direction	No. of Lanes
Major Street 1	Main Street	EB	1
Major Street 2	Main Street	WB	1
Minor Street 1	Forest Ridge Road	NB	1
Minor Street 2	n/a		

Left Turn Only

Operating Speed on Major Roadway	<40	MPH
---	-----	-----

Distance to nearest traffic signal (ft)	>1000
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Time Period	Main Street EB Approach Volume	Main Street WB Approach Volume	Total Major St. Volume	Left Turn Only Forest Ridge Road NB Approach Volume	n/a Approach Volume	Higher Minor St. Volume	Warrant 1			
							CONDITION A Minimum Volume Threshold Met Maj. 500 / Min. 150	CONDITION B Minimum Volume Threshold Met Maj. 750 / Min. 75	80% CONDITION A Minimum Volume Threshold Met Maj. 400 / Min. 120	80% CONDITION B Minimum Volume Threshold Met Maj. 600 / Min. 60
6:00-7:00 AM	360	132	492	26		26	NO	NO	NO	NO
7:00-8:00 AM	636	243	879	48		48	NO	NO	NO	NO
8:00-9:00 AM	685	342	1027	37		37	NO	NO	NO	NO
9:00-10:00 AM	507	389	896	61		61	NO	NO	NO	YES
10:00-11:00 AM	418	369	787	71		71	NO	NO	NO	YES
11:00 AM-12:00 PM	409	396	805	67		67	NO	NO	NO	YES
12:00-1:00 PM	428	439	867	59		59	NO	NO	NO	NO
1:00 PM - 2:00 PM	412	446	858	36		36	NO	NO	NO	NO
2:00 PM - 3:00 PM	432	453	885	35		35	NO	NO	NO	NO
3:00 PM - 4:00 PM	400	556	956	45		45	NO	NO	NO	NO
4:00 PM - 5:00 PM	426	624	1050	74		74	NO	NO	NO	YES
5:00 PM - 6:00 PM	458	620	1078	55		55	NO	NO	NO	NO
6:00 PM - 7:00 PM	362	526	888	67		67	NO	NO	NO	YES
7:00 PM - 8:00 PM	267	345	612	44		44	NO	NO	NO	NO
8:00 PM - 9:00 PM	187	264	451	33		33	NO	NO	NO	NO
Hours Met							0	0	0	5
Warrant Met							NO	NO	NO	NO

Table 4C-1. Warrant 1, Eight-Hour Vehicular Volume

Condition A—Minimum Vehicular Volume

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
		100% ^a	80% ^b	70% ^c	56% ^d	100% ^a	80% ^b	70% ^c	56% ^d
1	1	500	400	350	280	150	120	105	84
2 or more	1	600	480	420	336	150	120	105	84
2 or more	2 or more	600	480	420	336	200	160	140	112
1	2 or more	500	400	350	280	200	160	140	112

^a Basic minimum hourly volume
^b Used for combination of Conditions A and B after adequate trial of other remedial measures
^c May be used when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000
^d May be used for combination of Conditions A and B after adequate trial of other remedial measures when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000

Condition B—Interruption of Continuous Traffic

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
		100% ^a	80% ^b	70% ^c	56% ^d	100% ^a	80% ^b	70% ^c	56% ^d
1	1	750	600	525	420	75	60	53	42
2 or more	1	900	720	630	504	75	60	53	42
2 or more	2 or more	900	720	630	504	100	80	70	56
1	2 or more	750	600	525	420	100	80	70	56

^a Basic minimum hourly volume
^b Used for combination of Conditions A and B after adequate trial of other remedial measures
^c May be used when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000
^d May be used for combination of Conditions A and B after adequate trial of other remedial measures when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000

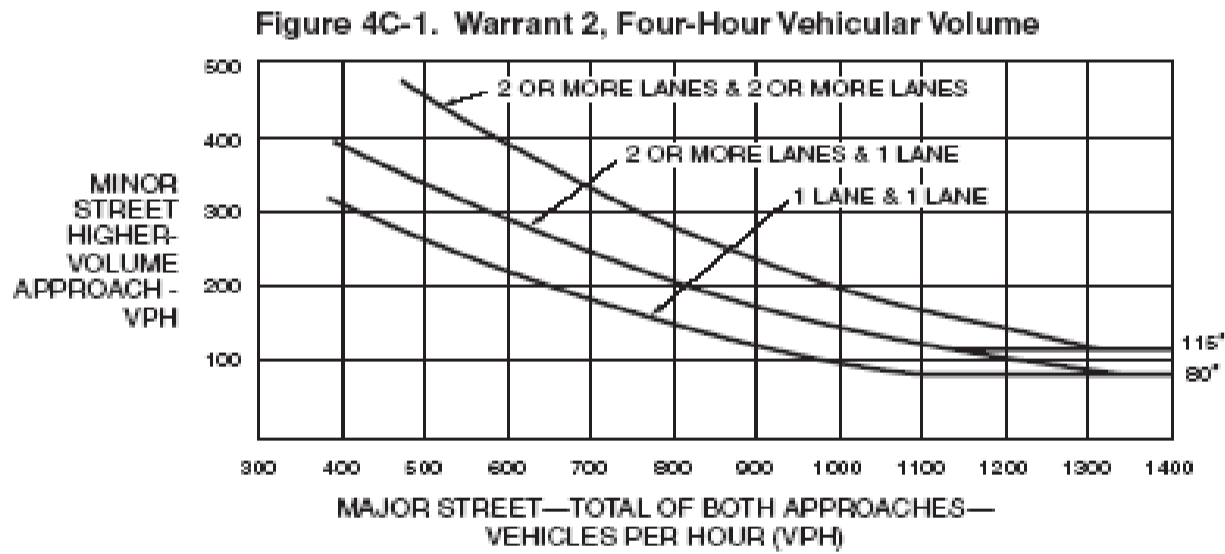
MUTCD Traffic Signal Warrant #2 Analysis

Project Name 1391 Concord
Date Baseline 2024 + Site Trips

	Street Name	Direction	
Major 1	Main Street	EB	1 Lane
Major 2	Main Street	WB	1 Lane
Minor 1	Forest Ridge Road	NB	1 Lane
Minor 2	n/a	0	

Node	Time Period	Main Street Major St. 1 Approach Volume	Main Street Major St. 2 Approach Volume	Total Major St. Volume	Left Turn Only			Warrant 2 Threshold Met
					Forest Ridge Road Minor St. 1 Approach Volume	n/a Minor St. 2 Approach Volume	Higher Minor St. Volume	
1	6:00-7:00 AM	360	132	492	26	0	26	NO
2	7:00-8:00 AM	636	243	879	48	0	48	NO
3	8:00-9:00 AM	685	342	1027	37	0	37	NO
4	9:00-10:00 AM	507	389	896	61	0	61	NO
5	10:00-11:00 AM	418	369	787	71	0	71	NO
6	11:00 AM-12:00 PM	409	396	805	67	0	67	NO
7	12:00-1:00 PM	428	439	867	59	0	59	NO
8	1:00 PM - 2:00 PM	412	446	858	36	0	36	NO
9	2:00 PM - 3:00 PM	432	453	885	35	0	35	NO
10	3:00 PM - 4:00 PM	400	556	956	45	0	45	NO
11	4:00 PM - 5:00 PM	426	624	1050	74	0	74	NO
12	5:00 PM - 6:00 PM	458	620	1078	55	0	55	NO
							Hours Met	0

Min Req = 80



	Street Name	Direction	
Major 1	Main Street	EB	1 Lane
Major 2	Main Street	WB	1 Lane
Minor 1	Forest Ridge Road	NB	1 Lane
Minor 2	n/a		

Node	Time Period	Main Street Major St. 1 Approach Volume	Main Street Major St. 2 Approach Volume	Total Major St. Volume	Left Turn Only			Warrant 3 Threshold Met
					Forest Ridge Road Minor St. 1 Approach Volume	n/a Minor St. 2 Approach Volume	Higher Minor St. Volume	
1	6:00-7:00 AM	360	132	492	26	0	26	NO
2	7:00-8:00 AM	636	243	879	48	0	48	NO
3	8:00-9:00 AM	685	342	1027	37	0	37	NO
4	9:00-10:00 AM	507	389	896	61	0	61	NO
5	10:00-11:00 AM	418	369	787	71	0	71	NO
6	11:00 AM-12:00 PM	409	396	805	67	0	67	NO
7	12:00-1:00 PM	428	439	867	59	0	59	NO
8	1:00 PM - 2:00 PM	412	446	858	36	0	36	NO
9	2:00 PM - 3:00 PM	432	453	885	35	0	35	NO
10	3:00 PM - 4:00 PM	400	556	956	45	0	45	NO
11	4:00 PM - 5:00 PM	426	624	1050	74	0	74	NO
12	5:00 PM - 6:00 PM	458	620	1078	55	0	55	NO
							Hours Met	0

Min Req = 100

Figure 4C-3. Warrant 3, Peak Hour



*Note: 150 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor-street approach with one lane.

1391 Signal Warrant Analysis Calculations

	Projected Hourly Trips																2024 TMC Plus Site Forest Ridge Road NB L Volume	
	ITE LUC 221 Residential Suburban No Transit			Residential			Exiting Trips Forest Ridge Road Residential Trips		Entering Trips Main Street Main Street		TMC 2024 Forest Ridge NB Left	2024 Baseline Main Street Main Street		2024 Design Year With Project Main Street Main Street Main Street				
	Total	Enter	Exit	Total	Enter	Exit	NB R	NB L	EB R	WB L		EB Approach	WB Approach	Total	EB Approach	WB Approach		Total
												Volume	Volume	Volume	Volume	Volume		Volume
6:00-7:00 AM	4.4%	1.0%	7.8%	47	5	42	32	11	1	4		359	128	487	360	132	492	
7:00-8:00 AM	8.6%	2.5%	14.7%	93	14	79	59	20	4	11	28	632	232	864	636	243	879	48
8:00-9:00 AM	7.8%	3.0%	12.5%	83	16	67	50	17	4	12	20	681	330	1011	685	342	1027	37
9:00-10:00 AM	4.5%	2.2%	6.9%	49	12	37	28	9	3	9	52	504	380	884	507	389	896	61
10:00-11:00 AM	3.7%	2.7%	4.6%	39	15	24	18	6	4	11	65	414	358	772	418	369	787	71
11:00 AM-12:00 PM	3.7%	3.4%	4.0%	40	18	22	17	6	5	14	61	404	382	786	409	396	805	67
12:00-1:00 PM	4.6%	4.3%	4.8%	49	23	26	20	7	6	17	52	422	422	844	428	439	867	59
1:00 PM - 2:00 PM	4.4%	4.4%	4.4%	47	23	24	18	6	6	17	30	406	429	835	412	446	858	36
2:00 PM - 3:00 PM	3.9%	4.1%	3.7%	42	22	20	15	5	6	17	30	426	436	862	432	453	885	35
3:00 PM - 4:00 PM	4.9%	5.9%	3.8%	52	32	20	15	5	8	24	40	392	532	924	400	556	956	45
4:00 PM - 5:00 PM	7.2%	9.2%	5.1%	77	50	27	20	7	13	38	67	413	586	999	426	624	1050	74
5:00 PM - 6:00 PM	9.4%	13.1%	5.8%	101	70	31	23	8	18	53	47	440	567	1007	458	620	1078	55
6:00 PM - 7:00 PM	9.0%	12.1%	6.0%	97	65	32	24	8	16	49		346	477	823	362	526	888	
7:00 PM - 8:00 PM	7.4%	9.4%	5.4%	80	51	29	22	7	13	38		254	307	561	267	345	612	
8:00 PM - 9:00 PM	5.4%	7.7%	3.1%	58	41	17	13	4	10	31		177	233	410	187	264	451	

□ Revised Capacity Analysis

HCM 6th TWSC
 1: Forest Ridge Road & Main Street

2024 Baseline Conditions - Revised
 Weekday Morning Peak Hour

Intersection						
Int Delay, s/veh	1.5					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	650	93	55	273	39	20
Future Vol, veh/h	650	93	55	273	39	20
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	94	94	94	94	94	94
Heavy Vehicles, %	2	1	9	6	3	10
Mvmt Flow	691	99	59	290	41	21

Major/Minor	Major1	Major2	Minor1		
Conflicting Flow All	0	0	790	0	1149 741
Stage 1	-	-	-	-	741 -
Stage 2	-	-	-	-	408 -
Critical Hdwy	-	-	4.19	-	5.8 3.4
Critical Hdwy Stg 1	-	-	-	-	5.43 -
Critical Hdwy Stg 2	-	-	-	-	5.43 -
Follow-up Hdwy	-	-	2.281	-	3.527 3.39
Pot Cap-1 Maneuver	-	-	800	-	267 733
Stage 1	-	-	-	-	470 -
Stage 2	-	-	-	-	669 -
Platoon blocked, %	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	800	-	244 733
Mov Cap-2 Maneuver	-	-	-	-	244 -
Stage 1	-	-	-	-	470 -
Stage 2	-	-	-	-	610 -

Approach	EB	WB	NB
HCM Control Delay, s	0	1.7	18.5
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	244	733	-	-	800	-
HCM Lane V/C Ratio	0.17	0.029	-	-	0.073	-
HCM Control Delay (s)	22.8	10.1	-	-	9.9	0
HCM Lane LOS	C	B	-	-	A	A
HCM 95th %tile Q(veh)	0.6	0.1	-	-	0.2	-

HCM 6th TWSC
 1: Forest Ridge Road & Main Street

2031 No-Build Conditions - Revised
 Weekday Morning Peak Hour

Intersection						
Int Delay, s/veh	1.5					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	725	96	57	299	40	21
Future Vol, veh/h	725	96	57	299	40	21
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	94	94	94	94	94	94
Heavy Vehicles, %	2	1	9	6	3	10
Mvmt Flow	771	102	61	318	43	22

Major/Minor	Major1	Major2	Minor1		
Conflicting Flow All	0	0	873	0	1262 822
Stage 1	-	-	-	-	822 -
Stage 2	-	-	-	-	440 -
Critical Hdwy	-	-	4.19	-	5.8 3.4
Critical Hdwy Stg 1	-	-	-	-	5.43 -
Critical Hdwy Stg 2	-	-	-	-	5.43 -
Follow-up Hdwy	-	-	2.281	-	3.527 3.39
Pot Cap-1 Maneuver	-	-	744	-	233 702
Stage 1	-	-	-	-	430 -
Stage 2	-	-	-	-	647 -
Platoon blocked, %	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	744	-	210 702
Mov Cap-2 Maneuver	-	-	-	-	210 -
Stage 1	-	-	-	-	430 -
Stage 2	-	-	-	-	582 -

Approach	EB	WB	NB
HCM Control Delay, s	0	1.6	20.9
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	210	702	-	-	744	-
HCM Lane V/C Ratio	0.203	0.032	-	-	0.082	-
HCM Control Delay (s)	26.4	10.3	-	-	10.3	0
HCM Lane LOS	D	B	-	-	B	A
HCM 95th %tile Q(veh)	0.7	0.1	-	-	0.3	-

HCM 6th TWSC
 1: Forest Ridge Road & Main Street

2031 Build Conditions - Revised
 Weekday Morning Peak Hour

Intersection

Int Delay, s/veh	2.5					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	725	101	72	299	57	72
Future Vol, veh/h	725	101	72	299	57	72
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	94	94	94	94	94	94
Heavy Vehicles, %	2	1	9	6	3	10
Mvmt Flow	771	107	77	318	61	77

Major/Minor	Major1	Major2	Minor1		
Conflicting Flow All	0	0	878	0	1297
Stage 1	-	-	-	-	825
Stage 2	-	-	-	-	472
Critical Hdwy	-	-	4.19	-	5.8
Critical Hdwy Stg 1	-	-	-	-	5.43
Critical Hdwy Stg 2	-	-	-	-	5.43
Follow-up Hdwy	-	-	2.281	-	3.527
Pot Cap-1 Maneuver	-	-	741	-	223
Stage 1	-	-	-	-	429
Stage 2	-	-	-	-	626
Platoon blocked, %	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	741	-	195
Mov Cap-2 Maneuver	-	-	-	-	195
Stage 1	-	-	-	-	429
Stage 2	-	-	-	-	547

Approach	EB	WB	NB
HCM Control Delay, s	0	2	20
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	195	701	-	-	741	-
HCM Lane V/C Ratio	0.311	0.109	-	-	0.103	-
HCM Control Delay (s)	31.6	10.8	-	-	10.4	0
HCM Lane LOS	D	B	-	-	B	A
HCM 95th %tile Q(veh)	1.3	0.4	-	-	0.3	-

□ Delay Study

MDM Transportation Consultants, Inc.

28 Lord Road, Suite 280
Marlborough, MA, 01752

Forest Ridge Road
at Main Street
Concord, MA

File Name : 1391 Delay Study AM
Site Code : 00001391
Start Date : 10/10/2024
Page No : 1

L n.	No.	Delay	
1	1	5	
1	2	4	
1	3	1	
1	4	45	
1	5	35	
1	6	2	
1	7	3	
1	8	2	
1	9	2	
1	10	62	
1	11	6	
1	12	10	
1	13	8	
1	14	12	
1	15	49	
1	16	9	
1	17	27	
1	18	1	
1	19	8	
1	20	20	
1	21	13	
1	22	9	
1	23	11	
1	24	40	
1	25	5	
1	26	8	
1	27	5	
1	28	14	
1	29	7	
1	30	7	
1	31	2	
1	32	9	
1	33	34	
1	34	29	
1	35	27	
1	36	15	
1	37	2	
1	38	24	
1	39	27	
1	40	23	
1	41	3	
2	1	1	
2	2	2	
2	3	1	
2	4	3	
2	5	8	
2	6	17	
2	7	5	
2	8	10	
2	9	1	
2	10	1	
2	11	7	
2	12	1	
2	13	5	
2	14	9	
2	15	6	
2	16	1	

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L	No.	Delay	
n.			
2	17	19	
2	18	1	
2	19	5	

Summary Information:

8:01:00 AM - 9:00:00 AM	Left	Right
Total Vehicle Count:	41	19
Delayed Vehicle Count:	41	19
Through Vehicle Count:	0	0
Average Stopped Time:	15.24	5.421
Maximum Stopped Time:	62	19
Min. Secs. for Delay:	0	0
Average Queue:	0.18	0.029
Queue Density:	1.11	1.000
Maximum Queue:	3	1
Delay in Vehicle Hour:	0.18	0.03
Total Delay:	625	103

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L n.	No.	Delay	
1	1	10	
1	2	32	
1	3	13	
1	4	16	
1	5	3	
1	6	4	
1	7	5	
1	8	4	
1	9	18	
1	10	27	
1	11	46	
1	12	61	
1	13	63	
1	14	79	
1	15	85	
1	16	14	
1	17	18	
1	18	15	
1	19	18	
1	20	7	
1	21	15	
1	22	10	
1	23	6	
1	24	9	
1	25	30	
1	26	26	
1	27	26	
1	28	55	
1	29	43	
1	30	6	
1	31	8	
1	32	42	
1	33	11	
1	34	12	
1	35	24	
1	36	31	
1	37	25	
1	38	5	
1	39	27	
1	40	16	
1	41	37	
1	42	36	
1	43	14	
1	44	1	
1	45	16	
1	46	35	
1	47	22	
1	48	25	
1	49	33	
1	50	24	
1	51	11	
1	52	12	
1	53	9	
1	54	12	
1	55	17	
1	56	11	
1	57	15	

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File Name : 1391 Delay Study PM
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L n.	No.	Delay
1	58	6
1	59	5
1	60	46
1	61	55
1	62	9
1	63	6
1	64	42
1	65	29
1	66	6
1	67	6
2	1	10
2	2	2
2	3	3
2	4	8
2	5	1
2	6	2
2	7	5
2	8	3
2	9	1
2	10	2
2	11	2
2	12	1
2	13	7
2	14	8
2	15	2
2	16	7
2	17	3
2	18	2
2	19	2
2	20	3
2	21	1
2	22	2
2	23	1
2	24	4
2	25	12
2	26	2
2	27	6
2	28	13
2	29	8

Summary Information:

4:00:00 PM - 5:00:00 PM	Left Turn	Right Turn
Total Vehicle Count:	67	29
Delayed Vehicle Count:	67	29
Through Vehicle Count:	0	0
Average Stopped Time:	22.46	4.241
Maximum Stopped Time:	85	13
Min. Secs. for Delay:	0	0
Average Queue:	0.44	0.038
Queue Density:	1.50	1.017
Maximum Queue:	7	2
Delay in Vehicle Hour:	0.45	0.04
Total Delay:	1505	123

HCM 6th TWSC
1: Forest Ridge Road & Main Street

2024 Baseline Conditions - Calibrated
Weekday Morning Peak Hour

Intersection						
Int Delay, s/veh	1.2					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	650	93	55	273	39	20
Future Vol, veh/h	650	93	55	273	39	20
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	94	94	94	94	94	94
Heavy Vehicles, %	2	1	9	6	3	10
Mvmt Flow	691	99	59	290	41	21

Major/Minor	Major1	Major2	Minor1		
Conflicting Flow All	0	0	790	0	1149
Stage 1	-	-	-	-	741
Stage 2	-	-	-	-	408
Critical Hdwy	-	-	4.19	-	4.3
Critical Hdwy Stg 1	-	-	-	-	5.43
Critical Hdwy Stg 2	-	-	-	-	5.43
Follow-up Hdwy	-	-	2.281	-	3.527
Pot Cap-1 Maneuver	-	-	800	-	431
Stage 1	-	-	-	-	470
Stage 2	-	-	-	-	669
Platoon blocked, %	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	800	-	393
Mov Cap-2 Maneuver	-	-	-	-	393
Stage 1	-	-	-	-	470
Stage 2	-	-	-	-	610

Approach	EB	WB	NB
HCM Control Delay, s	0	1.7	13.5
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	393	733	-	-	800	-
HCM Lane V/C Ratio	0.106	0.029	-	-	0.073	-
HCM Control Delay (s)	15.2	10.1	-	-	9.9	0
HCM Lane LOS	C	B	-	-	A	A
HCM 95th %tile Q(veh)	0.4	0.1	-	-	0.2	-