Proposed Mixed-Use Development
Ayer Road

Harvard, MA

July 29, 2022

Prepared by:

BAYSIDE ENGINEERING

600 Unicorn Park Drive
Woburn, MA 01801
781-932-3201
www.baysideengineering.com

Prepared for:

Yvonne Chern

TRAFFIC IMPACT AND ACCESS STUDY

Proposed Mixed-Use Development
203 Ayer Road
Harvard, Massachusetts

Prepared for:

Yvonne Chern

July 29, 2022

Prepared by:

Bayside Engineering
600 Unicorn Park Drive
Woburn, MA 01801

TABLE OF CONTENTS

TABLES

FIGURES

SECTION 1: EXECUTIVE SUMMARY

Bayside Engineering has prepared this study to assess the traffic impact and to evaluate the access requirements of a proposed mixed-use development to be located at 203 Ayer Road in Harvard, Massachusetts.

This report identifies existing traffic operating parameters on key roadways and intersections within the study area, evaluates the anticipated traffic volume increases as a result of the proposed project, analyzes the project's traffic-related impacts, determines the projects access/egress requirements and identifies appropriate mitigating measures designed to minimize the traffic-related impacts created by the project. The following provides a summary of the study findings.

PROJECT DESCRIPTION

The site is located on the north side of Ayer Road (Route 110), south of Gebo Lane. The site is abutted by Ayer Road to the east, commercial development to the south and wooded land to the north and west. Currently, the site consists of vacant, undeveloped land.

The project will consist of the construction of three commercial buildings. Initially, an approximately 30,000 square foot (sf) recreation center will be built. The recreation center will include:

- 16 badminton play courts
- Approximately 6,768 sf Non-recreational court uses, mostly ancillary uses that will include:
  a) One (1) residential apartment for the facility manager (approximately 900 sf)
  b) Fitness Area (approximately 390 sf)
  c) Kitchenette (approximately 165 sf)
  d) Common Space Areas (approximately 4,323 sf)
  e) Lockers, bathrooms, showers (approximately 990 sf)

Additionally, two (2) eight-thousand square foot commercial buildings are proposed. No tenants are identified at this time.

Access will be provided by way of a single, full movement driveway to Ayer Road. The driveway approach will consist of an exclusive left-turn lane and an exclusive right-turn lane. There will be 170 parking spaces provided on site. Figure 1 shows the site location in relation to the surrounding area.

Figure 1
Site Location Map

STUDY METHODOLOGY

This study has been prepared in three stages. The first stage involved an assessment of existing conditions within the study area and included an inventory of roadway geometrics, pedestrian and bicycle facilities and public transportation services. Existing traffic counts were performed at the study area intersections.

In the second stage of the study, future traffic conditions were projected and analyzed. Specific travel demand forecasts for the project were assessed along with future traffic demands due to expected traffic growth independent of the proposed project. In accordance with Massachusetts Department of Transportation (MassDOT) guidelines, the year 2029 was selected as the basis for modeling future transportation impacts of the proposed development to reflect the opening year conditions and a seven-year planning horizon.

The third stage of the study presents and evaluates measures to address traffic issues, if any, and necessary improvements to accommodate the development.

STUDY AREA

Roadway geometry and traffic control information was collected for the following locations:

- Ayer Road and Lancaster County Road
- Ayer Road and Gebo Lane
- Ayer Road and 202 Ayer Road Driveway
- Ayer Road and Route 2 Westbound Ramps

EXISTING CONDITIONS

Evaluation of existing conditions within the study area includes a description of roadway geometrics, traffic constraints, land uses at the intersections, and quantification of traffic volumes.

Existing Traffic Volumes

To establish base traffic conditions within the study area, manual turning movement and vehicle classification counts were obtained in April 2022. Data from the MassDOT was reviewed to determine the monthly variations of the traffic volumes. Based upon available data, April volumes were found to be slightly lower than average month conditions. To be conservative, the April volumes were adjusted upward by a factor of 1.079 to reflect average month conditions.

Due to the Covid-19 pandemic, traffic volumes typically continue to be less than normal (pre-COVID, 2019 conditions). To account for this, data from a previous TMC conducted in July 2019 for the Ayer Road improvement project were compared to the counts conducted in April 2022. Using these counts, COVID adjustments factors were calculated for morning and afternoon traffic. This data showed that April 2022 traffic volumes for the Harvard area are the generally the same during the weekday morning peak hour and approximately 12 percent lower than normal during the weekday afternoon peak hour. The 2022 weekday evening peak hour traffic counts performed for this study were increased by a factor of 1.136 to represent pre-COVID conditions. The same adjustment was used for the Saturday midday peak hour.

Ayer Road, south of Gebo Lane was recorded to carry approximately 15,900 vehicles per day (vpd) on a weekday. During the weekday morning peak hour, approximately 1,252 vehicles per hour (vph) were recorded and during the weekday evening peak hour, 1,322 vph were recorded. On a Saturday, Ayer Road, south of Gebo Lane was recorded to carry approximately 11,100 vpd). During the Saturday midday peak hour, approximately 1,055 vph were recorded.

Vehicle Speeds

Existing speed data for Ayer Road was also collected. The average speed of vehicles travelling northbound and southbound on Ayer Road, south of Gebo Lane was found to be 34.1 mph to 36.2 mph, respectively. The 85th percentile speed was found to be 39 mph for northbound vehicles and 40 mph for southbound vehicles. The 85th percentile speed is the speed at which sight distances are evaluated.

Motor Vehicle Crash Data

Motor vehicle crash data for the study area intersections were obtained from the MassDOT Crash Portal for 2015 through the end of 2021. The motor vehicle crash data was reviewed to determine crash trends in the study area. Thirty-three (33) crashes were reported at the study area intersections. Of the thirty-three (33) crashes, three (3) crashes were reported at the intersection of Ayer Road and the Route 2 Westbound Ramps, three (3) crashes were reported at the driveway of 202 Ayer Road, twelve (12) crashes were reported at the intersection of Ayer Road and Gebo Lane, and fifteen (15) crashes were reported at the intersection of Ayer Road and Lancaster County Road. No fatalities were reported.

Planned Roadway Improvements

Current proposed improvements that will impact traffic conditions within the study area include the reconstruction of Ayer Road to provide a consistent roadway width, including 11-foot travel lanes and 4-foot shoulders, the removal of the eastern end of Lancaster County Road, between the Post Office Driveway and its intersection with Ayer Road, the closure of the existing Post Office Exit Driveway onto Ayer Road, and the installation of an exclusive left turn lane on the northbound approach of Ayer Road at Gebo Lane. These improvements will be reflected in this analysis (future No-Build and Build conditions) to keep the analysis consistent with the planned future conditions. Construction of a 10-foot shared use path along the west side of Ayer Road with a 3-5-foot grass buffer and granite curbing to provide pedestrian and bicycle accommodations is also included. Currently this project is proposed to be programmed to be split between the 2026/2027 TIP year.

PROBABLE IMPACTS OF THE PROJECT

No-Build Traffic Volumes

To determine the impact of site-generated traffic volumes on the roadway network under future conditions, baseline traffic volumes in the study area were projected to the year 2029. Traffic volumes on the roadway network at that time, in the absence of the proposed project, would include existing traffic, new traffic due to general background traffic growth, and traffic related to specific developments by others expected to be completed by 2029. A one (1.0) percent compounded growth rate was used to develop future No-Build conditions based on communications with representatives from the Central Transportation Planning Staff (CTPS). Conversations with the Town of Harvard indicated that there are several small projects identified along the Ayer Road corridor which could generate traffic, but is believed that the growth rate will encompass the traffic from these projects.

Build Traffic Volumes

Site generated traffic was based on trip-generation data published by the ITE *Trip Generation* manual[1] and empirical trip generation data from a similar recreational facility. The proposed development is expected to consist of the 30,000 sf recreation center and two (2) eight-thousand square foot retail/office buildings. Trip generation data from a similar badminton club and data for Land Use Code (LUC) 710 – General Office Building was reviewed.

On a typical weekday, the proposed development is expected to generate 856 daily vehicle trips. During the weekday morning peak hour, 63 vehicle trips (35 vehicles entering and 28 vehicles exiting) are expected. During the weekday evening peak hour, 146 vehicle trips (68 vehicles entering and 78 vehicles exiting) are expected. On a typical Saturday, the proposed development is expected to generate 896 daily vehicle trips. During the Saturday midday peak hour, 118 vehicle trips (66 vehicles entering and 52 vehicles exiting) are expected.

Trip Distribution

The trip distribution is expected to be regionally oriented. A gravity model was developed based on Harvard Journey-to-Work data from the U.S. Census to determine the expected trip distribution.

[1] *Trip Generation,* Eleventh Edition; Institute of Transportation Engineers; Washington, DC; 2021.

TRAFFIC OPERATIONS ANALYSIS

To assess the impacts of the proposed project on the roadway network, traffic operations analyses were performed at the study area intersections under 2022 Existing, 2029 No-Build and 2029 Build conditions. These analyses indicate that the proposed project will generally not result in an impact on traffic operations at the study area intersections over No-Build conditions.

The critical movements at the unsignalized intersection of Ayer Road and Gebo Lane currently operate at level of service (LOS) B or better during the weekday morning, weekday evening and Saturday midday peak hours. Under future No-build conditions (without the project but with the planned improvements), the critical movements are projected to operate at LOS D or better during the weekday morning, weekday evening and Saturday midday peak hours. With the project generated traffic, the critical movements are projected to continue to operate at LOS D or better during the weekday morning, weekday evening and Saturday midday peak hours.

Right-turn movements from the proposed site driveway are projected to operate at LOS C during the weekday morning peak hour, at LOS B during the weekday evening peak hour and at LOS B during the Saturday midday peak hour. Left-turn movements from the proposed site driveway are projected to operate at LOS F during the weekday morning and weekday evening peak hours and at LOS E during the Saturday midday peak hour. The volume to capacity (v/c) ratio for this movement is well below 1.0 indicating adequate capacity for the left-turn movements. The projected 95th percentile queue (the vehicle queue that can be expected five (5) percent of the time during the peak hour) is one (1) vehicle.

RECOMMENDATIONS

The final phase of the analysis process is to identify the mitigation measures necessary to minimize the impact of the project on the transportation system. The capacity analyses performed for 2022 Existing and 2029 future No-Build and Build conditions indicate that the proposed project will not result in a significant impact on traffic operations at the study area intersections. The addition of the site generated traffic will marginally increase projected delays.

Site Access

The proposed site access intersection analyses indicate that the right-turn movements at the intersection will operate at good levels of service with minimal delay for existing and site-generated traffic during the peak hours. Left-turn movements are projected to operate at LOS F during the weekday morning and weekday evening peak hours and at LOS E during the Saturday midday peak hour. The volume to capacity (v/c) ratio for this movement is well below 1.0 indicating adequate capacity for the left-turn movements. The volume of traffic generated by the project is not high enough to warrant signalization. The proposed site access should provide one entering and two exiting lanes be placed under STOP-sign control.

There are no other improvements warranted for this project as the capacity analyses indicate that there is no change in level of service at the study area intersections with the addition of the project related traffic. To maintain sight lines, it is recommended that any landscaping and proposed site signage be set back to not impede sight lines.

Transportation Demand Management

A Transportation Demand Management (TDM) plan should be implemented for the commercial component of the project. The goal of a TDM plan is to reduce the project's overall traffic impact by implementing measures geared toward affecting a change in driver behavior, and to be successful, they must rely on incentives or disincentives to cause drivers to shift travel patterns. TDM programs are designed to maximize the capability of the existing transportation infrastructure by increasing the number of persons in a vehicle, providing alternate modes of travel, or influencing the time of, or need to, travel.

The project proponent is committed to promoting several measures that contribute toward the reduction of vehicular traffic to and from the site. The following describes the TDM program:

- A Transportation Coordinator (TC) will be assigned the responsibilities of coordinating the TDM program.
- The TC will also promote alternative transportation modes by posting local commuter rail and bus schedules and encouraging employees to use public transportation.
- The TC will also promote ridesharing via carpools for employees. The project proponent will recommend that employees interested in car-pooling provide their contact information.
- Designate two (2) carpool/vanpool parking spaces as close as possible to the front.
- Site amenities should also be provided to discourage off-site trips. These measures may include providing a break room, direct deposit of paychecks, allowing for telecommuting or flex work opportunities.
- Bicycle racks will also be located throughout the site to encourage the use of bicycles.

CONCLUSION

Review of the proposed project and the access plan shows that in relation to roadway capacity, traffic safety, and traffic impacts upon the surrounding roadway network, the proposed project will meet safety standards and have a minimal impact on existing traffic conditions. Project-related increases are in the range of 11 to 72 bi-directional vehicles during the peak hours entering or exiting the study area on Ayer Road. This is equivalent to approximately one additional vehicle every two (2) minutes or less per direction on average during the peak hours.

SECTION 2: EXISTING TRAFFIC CONDITIONS

STUDY AREA

Roadway geometry and traffic control information was collected for the following intersections:

- Ayer Road and Lancaster County Road
- Ayer Road and Gebo Lane
- Ayer Road and 202 Ayer Road Driveway
- Ayer Road and Route 2 Westbound Ramps

FIELD SURVEY

A comprehensive field inventory of the proposed site was conducted in April 2022. The inventory included collection of existing roadway geometrics, traffic volumes, and safety data for the existing study area intersections and site access driveway locations. Traffic volumes were measured by means of automatic traffic recorder (ATR) counts and substantiated by manual turning movement counts (TMCs) conducted at the study area intersections.

GEOMETRICS

Primary study area roadways are described below.

<u>Roadways</u>

Ayer Road (Route 110)

Ayer Road is Rural Principal Arterial roadway which runs in a general north/south direction in the study area. Ayer Road is under the jurisdiction of the Town of Harvard. Ayer Road provides one travel lane in each direction separated by a double-yellow centerline. The posted speed limit on Ayer Road is 40 mph in the vicinity of the site. Illumination is provided by luminaires mounted on telephone poles within the study area. Land use along Ayer Road in the study area consists primarily commercial properties.

Intersections

Ayer Road and Lancaster County Road

This unsignalized intersection is under the jurisdiction of the Town of Harvard. Ayer Road forms the north and south legs and Lancaster County Road forms the west leg of the intersection and intersects Ayer Road at an approximately 70^{o} angle.. The Ayer Road approaches each consist of single lanes permitting left or right-turn movements. The Lancaster County Road approach consists of a single lane permitting left or right-turns. No sidewalks are present at the intersection. Lancaster County Road operates under STOP-sign control. Land use at the intersection consists primarily of wooded land.

Ayer Road and Gebo Lane

This unsignalized intersection is under the jurisdiction of the Town of Harvard. Ayer Road forms the north and south legs and Gebo Lane forms the west leg of the intersection and intersects Ayer Road at an approximately 60^{o} angle. The Ayer Road approaches each consist of single lanes permitting left or right-turn movements. The Gebo Lane approach consists of a single lane permitting left or right-turns. No sidewalks are present at the intersection. Gebo Lane operates under STOP-sign control. Land use at the intersection consists primarily of wooded land and commercial properties.

Ayer Road and 202 Ayer Road Driveway

This unsignalized intersection is under the jurisdiction of the Town of Harvard. Ayer Road forms the north and south legs and the existing driveway to No. 202 Ayer Road forms the east leg of this three-legged unsignalized intersection. The Ayer Road approaches to the intersection consist of a single lane permitting left or right-turn movements. The driveway approach consists of a single lane and operates under STOP control. No sidewalks are present at the intersection. Land use at the intersection consists of the existing site and commercial properties.

Route 2 Ramps and Ayer Road

This unsignalized intersection is under the jurisdiction of the MassDOT. Ayer Road forms the north and south legs with the ramps to and from Route 2 (eastbound and westbound). The Ayer Road approaches each consist of two lanes permitting right-turns. Ayer Road though the interchange with Route 2 is median divided, prohibiting left-turns. The Route 2 off-ramps consist of single lanes permitting right-turns only and are under STOP-sign control. No sidewalks are present on Ayer Road in the vicinity of the off-ramps, however, there is a sidewalk on the east side of Ayer Road over Route 2. There are no pedestrian accommodations at any of the ramp intersections with Ayer Road. Land use at the intersections consists primarily of residential and commercial properties.

TRAFFIC VOLUMES

Existing Traffic Volumes

To establish base traffic conditions within the study area, manual turning movement and vehicle classification counts were obtained in April 2022. Peak-period turning movement counts (TMC) were conducted on Thursday, April 7, 2022 during the weekday morning and evening peak periods (7:00 to 9:00 AM and 4:00 to 6:30 PM). Peak-period Saturday midday turning movement counts were conducted on Saturday, April 9, 2022 during the midday peak period (10:30 AM to 1:30 PM). Counts were performed at the following intersections:

- Ayer Road and Lancaster County Road
- Ayer Road and Gebo Lane
- Ayer Road and 202 Ayer Road Driveway
- Ayer Road and Route 2 Westbound Ramps

Daily traffic counts were conducted on Ayer Road for a two-day period using automatic traffic recorders (ATR) on Wednesday April 6, 2022 and Thursday, April 7, 2022.

Analysis of the peak-period traffic counts indicated that the weekday morning commuter peak hour generally occurs between 7:15 and 8:15 AM and the weekday evening commuter peak hour generally occurs between 4:00 and 5:00 PM. The Saturday midday peak hour was found to occur between 10:45 and 11:45 AM. The traffic count worksheets are provided in the Appendix.

Seasonal Adjustment

To establish base traffic conditions within the study area, manual turning movement and vehicle classification counts were obtained in April 2022. Data from the MassDOT was reviewed to determine the monthly variations of the traffic volumes. Based upon available data, April volumes were found to be slightly lower than average month conditions. To be conservative, the April volumes were adjusted upward by a factor of 1.079 to reflect average month conditions.

Due to the Covid-19 pandemic, traffic volumes typically continue to be less than normal (pre-COVID, 2019 conditions). To account for this, data from a previous TMC conducted in July 2019 for the Ayer Road improvement project were compared to the counts conducted in April 2022. Using these counts, COVID adjustments factors were calculated for morning and afternoon traffic. This data showed that April 2022 traffic volumes for the Harvard area are the generally the same during the weekday morning peak hour and approximately 12 percent lower than normal during the weekday afternoon peak hour. The 2022 weekday evening peak hour traffic counts performed for this study were increased by a factor of 1.136 to represent pre-COVID conditions. The same adjustment was used for the Saturday midday peak hour.

The 2022 existing weekday daily and peak-hour traffic volumes for average-month conditions are summarized below in Table 1. The 2022 existing Saturday daily and peak-hour traffic volumes for average-month conditions are summarized below in Table 2. The 2022 Existing weekday morning, weekday evening and Saturday midday peak hour traffic flow networks are shown graphically on Figures 2, 3 and 4, respectively. The seasonal worksheets are provided in the Appendix.

TABLE 1
EXISTING WEEKDAY TRAFFIC-VOLUME SUMMARY[a]

Location	Daily Traffic Volume[b]	Weekday Morning Peak Hour			Weekday Evening Peak Hour		
		Traffic Volume[c]	K Factor[d]	Directional Distribution[e]	Traffic Volume	K Factor	Directional Distribution
Ayer Road, south of Gebo Lane	15,900	1,252	7.9	51.5% SB	1,322	8.3	54.2% NB

[a]Two-way traffic volume.
[b]Daily traffic expressed in vehicles per day.
[c]Expressed in vehicles per hour.
[d]Percent of daily traffic volumes which occurs during the peak hour.
[e]Percent of peak-hour volume in the predominant direction of travel.
NB = northbound; SB = southbound; EB = eastbound; WB = westbound.

TABLE 2
EXISTING SATURDAY TRAFFIC-VOLUME SUMMARY[a]

Location	Saturday Traffic Volume[b]	Saturday Morning Peak Hour		
		Traffic Volume[c]	K Factor[d]	Directional Distribution[e]
Ayer Road, south of Gebo Lane	11,100	1,055	9.5	50.0% NB

[a]Two-way traffic volume.
[b]Daily traffic expressed in vehicles per day.
[c]Expressed in vehicles per hour.
[d]Percent of daily traffic volumes which occurs during the peak hour.
[e]Percent of peak-hour volume in the predominant direction of travel.
NB = northbound; SB = southbound; EB = eastbound; WB = westbound

Ayer Road, south of Gebo Lane was recorded to carry approximately 15,900 vehicles per day (vpd) on a weekday. During the weekday morning peak hour, approximately 1,252 vehicles per hour (vph) were recorded and during the weekday evening peak hour, 1,322 vph were recorded. On a Saturday, Ayer Road, south of Gebo Lane was recorded to carry approximately 11,100 vpd). During the Saturday midday peak hour, approximately 1,055 vph were recorded.

VEHICLE SPEEDS

Existing speed data for Ayer Road was also collected using the ATR over the four-day period from April 6, 2022 through April 9, 2022. The speed data is summarized in Table 3.

TABLE 3
OBSERVED VEHICLE SPEEDS

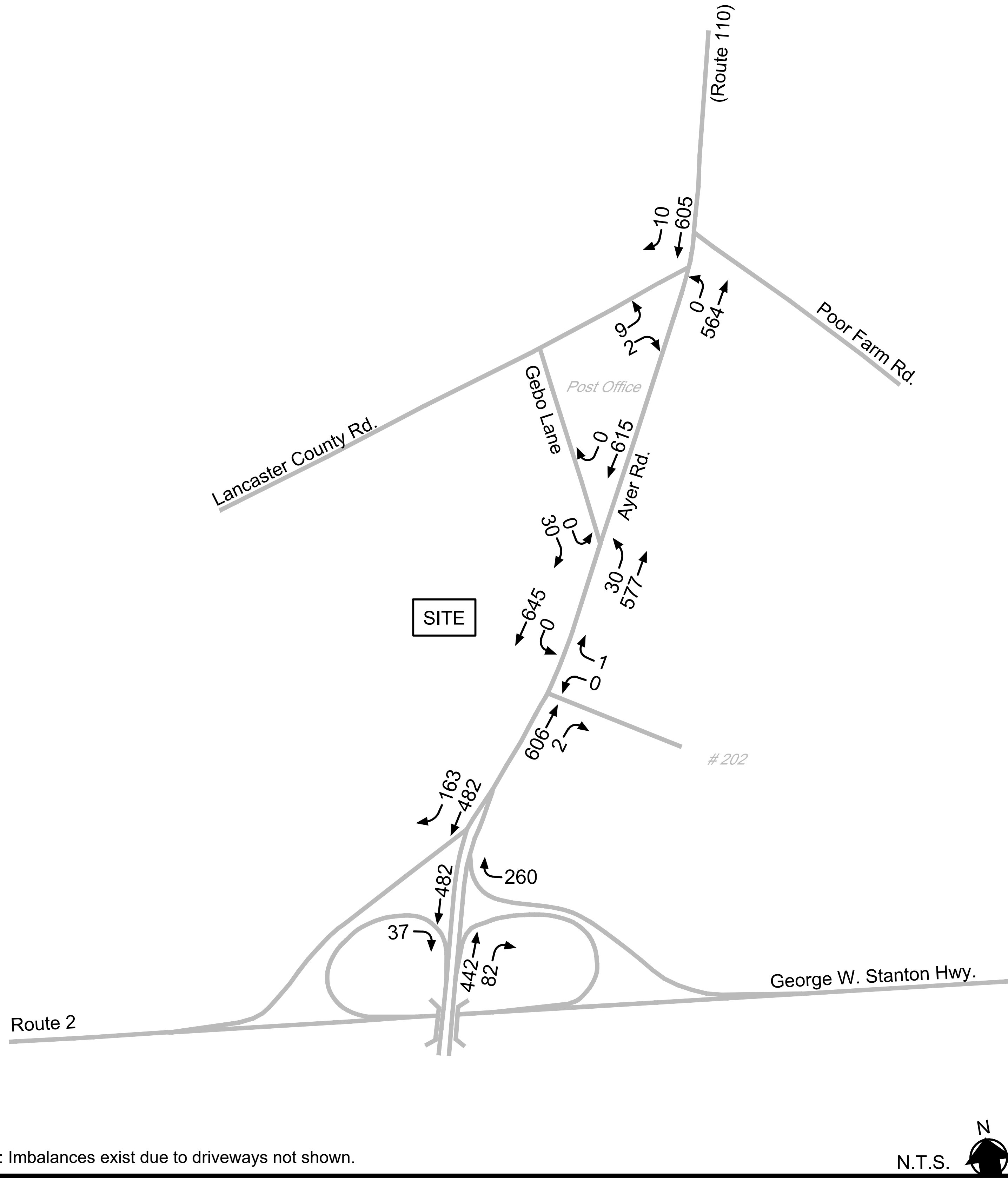
Location	Posted Speed Limit (mph)	Direction	Average Observed Speed[a] (mph)	85th Percentile Speed (mph)
Ayer Road, south of Gebo Lane	40	NB	34.1	39
	40	SB	36.2	40

[a]Based on speed data compiled on April 6 through 9, 2022.

As shown in Table 3, the average speed of vehicles travelling northbound and southbound on Ayer Road, south of Gebo Lane was found to be 34.1 mph to 36.2 mph, respectively. The 85th percentile speed was found to be 39 mph for northbound vehicles and 40 mph for southbound vehicles. The 85th percentile speed is the speed at which sight distances are evaluated.

MOTOR VEHICLE CRASH DATA

Motor vehicle crash data for the study area intersections were obtained from the MassDOT Crash Portal for 2015 through the end of 2021. The motor vehicle crash data was reviewed to determine crash trends in the study area. Thirty-three (33) crashes were reported at the study area intersections. Of the thirty-three (33) crashes, three (3) crashes were reported at the intersection of Ayer Road and the Route 2 Westbound Ramps, three (3) crashes were reported at the driveway of 202 Ayer Road, twelve (12) crashes were reported at the intersection of Ayer Road and Gebo Lane, and fifteen (15) crashes were reported at the intersection of Ayer Road and Lancaster County Road. No fatalities were reported. The crash data is summarized in Table 4 and included in the Appendix.



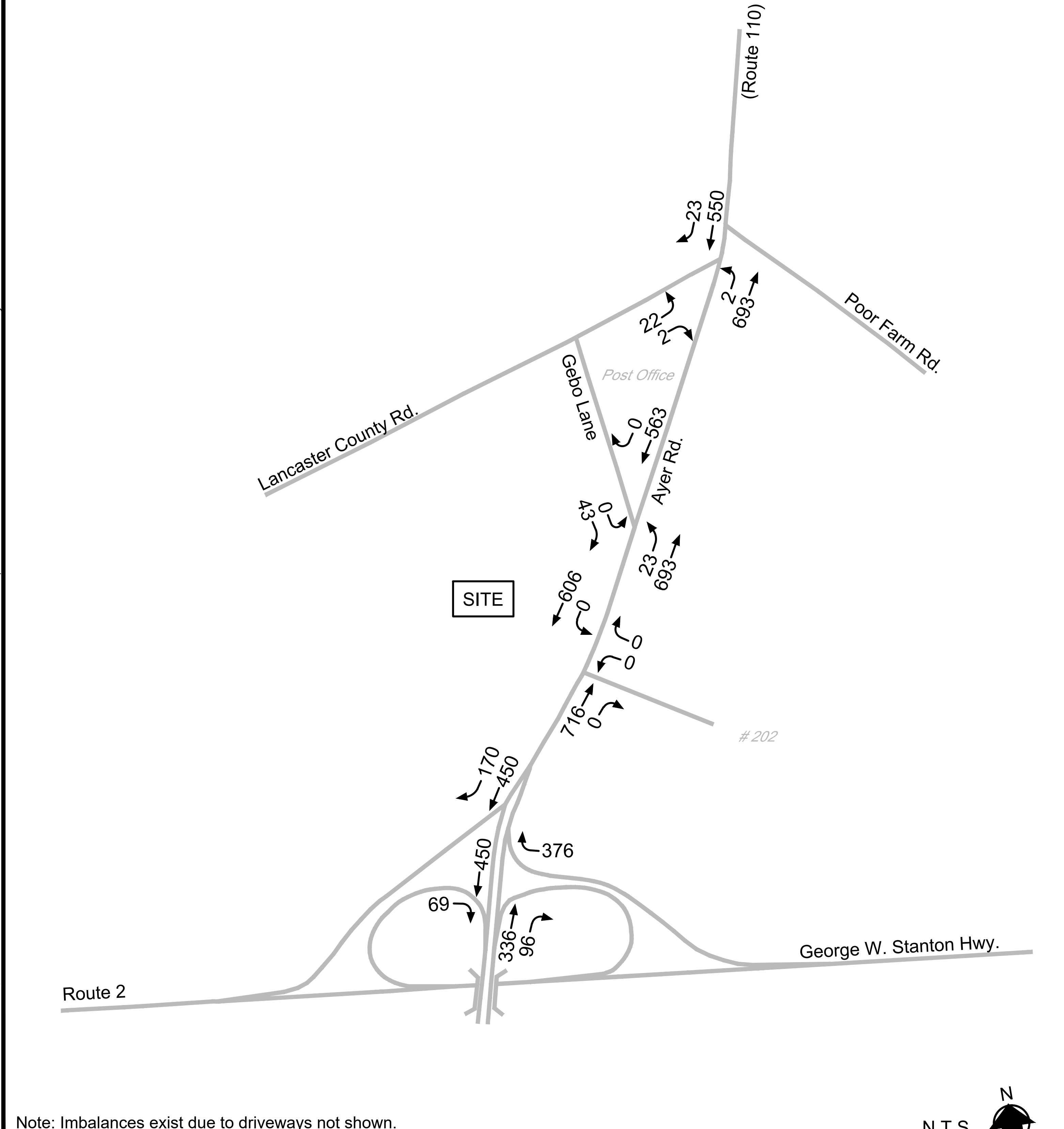
Note: Imbalances exist due to driveways not shown.

BAYSIDE ENGINEERING
600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com

Proposed Mixed-Use Development
Harvard, MA

Figure 2

2022 Existing Weekday Morning Peak Hour Traffic Volumes



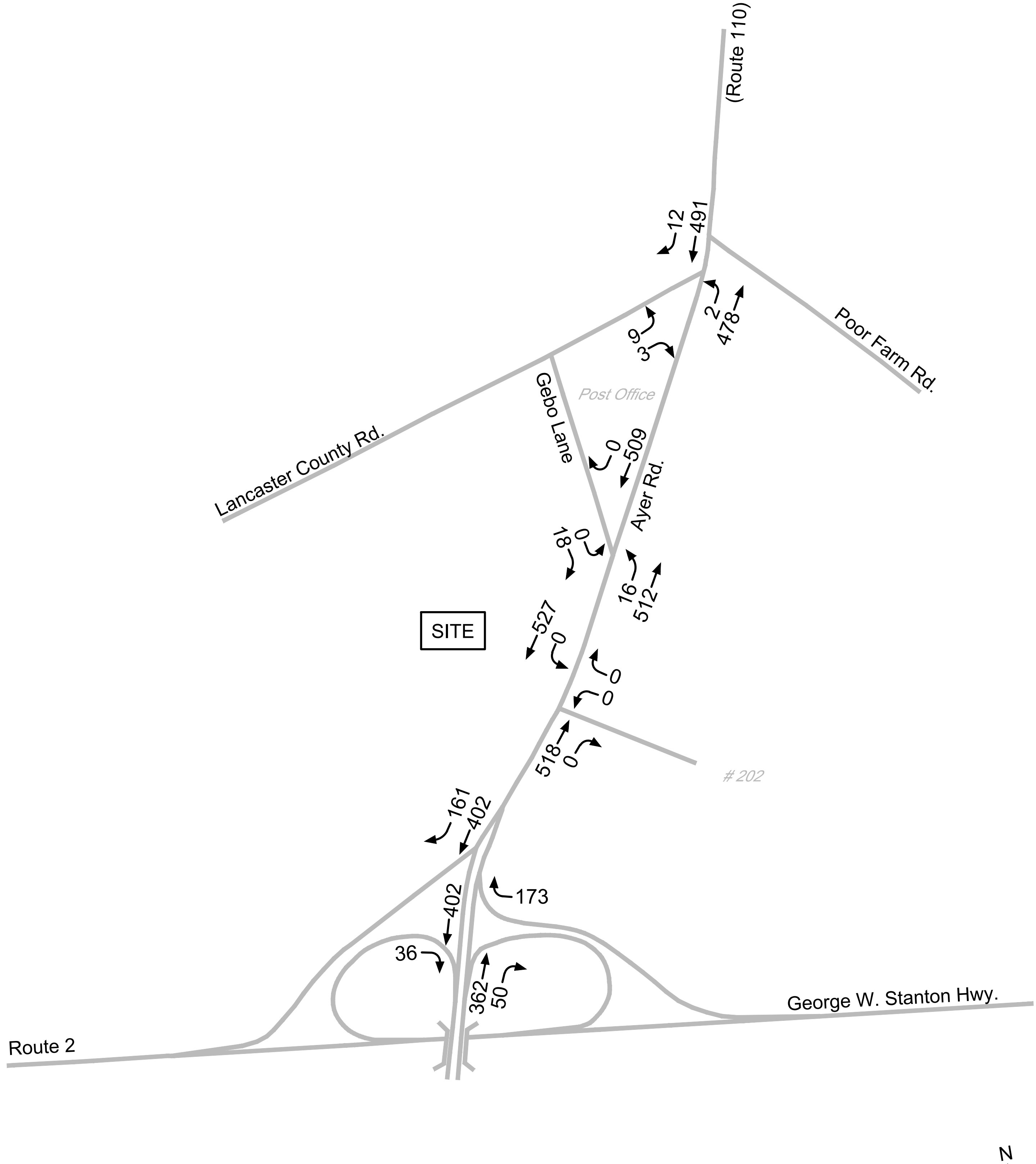
BAYSIDE ENGINEERING

600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com

Proposed Mixed-Use Development
Harvard, MA

Figure 3

2022 Existing
Weekday Evening
Peak Hour Traffic Volumes



Note: Imbalances exist due to driveways not shown.

N.T.S.

BAYSIDE ENGINEERING
600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com

Proposed Mixed-Use Development
Harvard, MA

Figure 4

2022 Existing
Saturday Midday
Peak Hour Traffic Volumes

TABLE 4
MOTOR VEHICLE CRASH DATA SUMMARY[a]

Scenario	Ayer Road and Route 2 WB Ramps	202 Ayer Road Driveway	Ayer Road and Gebo Lane	Ayer Road and Lancaster County Road
Year:				
2015	0	1	2	2
2016	1	0	1	4
2017	0	1	2	2
2018	0	1	4	0
2019	1	0	1	3
2020	1	0	1	2
2021	0	0	1	2
Total	3	3	12	15
Average:	0.43	0.43	1.71	2.14
Crash Rate:	0.06	0.07	0.29	0.38
Significance:	No	No	No	No
Type:				
Angle	0	2	0	2
Rear-End	3	0	1	6
Head-On	0	0	8	1
Sideswipe	0	0	0	2
Single Vehicle Crash	0	1	2	4
Front-To-Rear	0	0	1	0
Unknown	0	0	0	0
Total	3	3	12	15
Time of Day:				
Weekday (7:00 to 9:00 AM)	0	0	0	3
Weekday (4:00 to 6:00 PM)	2	1	4	3
Remainder of Day	1	2	8	9
Total	3	3	12	15
Pavement Conditions:				
Dry	2	3	12	8
Wet	1	0	0	5
Snow/Ice	0	0	0	1
Other	0	0	0	0
Unknown	0	0	0	1
Total	3	3	12	15
Severity:				
Property Damage Only	2	2	7	10
Personal Injury	1	1	5	4
Fatal Accident	0	0	0	0
Unknown	0	0	0	1
Total	3	3	12	15

[a]Source: MassDOT Impact Crash Portal.
[b]Average crashes over analysis period.
[c]Crash rate per million entering vehicles (mev).
[d]Signalized intersections in MassDOT District 3 are significant if rate >0.89 crashes per million vehicles, and unsignalized intersections are significant if rate >0.62 crashes per million vehicles.

PUBLIC TRANSPORTATION

There are no public transportation services located within the Town of Harvard near the site.

PLANNED ROADWAY IMRPOVEMENTS

The Town of Harvard and MassDOT were contacted regarding roadway improvements planned for the study area intersections. Improvements are currently planned for Ayer Road as identified in the Ayer Road Corridor Improvement Project designed by TEC, Inc for MassDOT and the Town of Harvard.

The current proposed improvements that will impact traffic conditions within the study area include:

- Reconstruction of Ayer Road to provide a consistent roadway width, including 11-foot travel lanes and 4-foot shoulders.
- Construction of a 10-foot shared use path along the west side of Ayer Road with a 3-5-foot grass buffer and granite curbing to provide pedestrian and bicycle accommodations.
- Removal of the eastern end of Lancaster County Road, between the Post Office Driveway and its intersection with Ayer Road.
- Closure of the existing Post Office Exit Driveway onto Ayer Road. Installation of an exclusive left turn lane on the northbound approach of Ayer Road at Gebo Lane.
- Construction of Americans with Disabilities Act (ADA) / Architectural Access Board (AAB) compliant accessible ramps at the shared use path crossings at the intersections of Ayer Road with Gebo Lane and Old Mill Road.
- Installation of six new mid-block pedestrian crossings with ADA/AAB compliant accessible ramps and flashing beacons, such as Rectangular Rapid Flashing Beacons (RRFB), at the 196/200 Ayer Road commercial driveway, Poor Farm Road, South Shaker Road, the Blomfelt Land conservation area, Myrick Lane, and at the Harvard-Ayer Town Line.
- Installation of new Manual on Uniform Traffic Control Devices (MUTCD) compliant regulatory and warning signs and pavement markings throughout the project limits.
- Complete stormwater drainage system modifications within the project limits to accommodate the geometric modifications and curb ramp construction.

Currently the project is proposed to be programmed to be split between the 2026/2027 TIP year.

SECTION 3:
FUTURE NO-BUILD AND BUILD TRAFFIC CONDITIONS

To determine the impact of site-generated traffic volumes on the roadway network under future conditions, baseline traffic volumes in the study area were projected to the year 2029. Traffic volumes on the roadway network at that time, in the absence of the proposed project, would include existing traffic, new traffic due to general background traffic growth, and traffic related to specific developments by others expected to be completed by 2029. Consideration of these factors resulted in the development of 2029 No-Build traffic volumes. Anticipated site-generated traffic volumes were then superimposed upon these No-Build traffic flow networks to develop the 2029 Build conditions.

FUTURE 2029 NO-BUILD TRAFFIC VOLUMES

Traffic growth on area roadways is a function of the expected land development in the immediate area as well as the surrounding region. Several methods can be used to estimate this growth. A procedure frequently employed estimates an annual percentage increase in traffic growth and applies that percentage to all traffic volumes under study. The drawback to such a procedure is that some turning volumes may grow at either a higher or a lower rate at particular intersections.

An alternative procedure identifies the location and type of planned development, estimates the traffic to be generated, and assigns it to the area roadway network. This produces a more realistic estimate of growth for local traffic. However, the drawback of this procedure is that the potential growth in population and development external to the study area would not be accounted for in the traffic projections.

To provide a conservative analysis framework, both procedures were used.

Background Traffic Growth

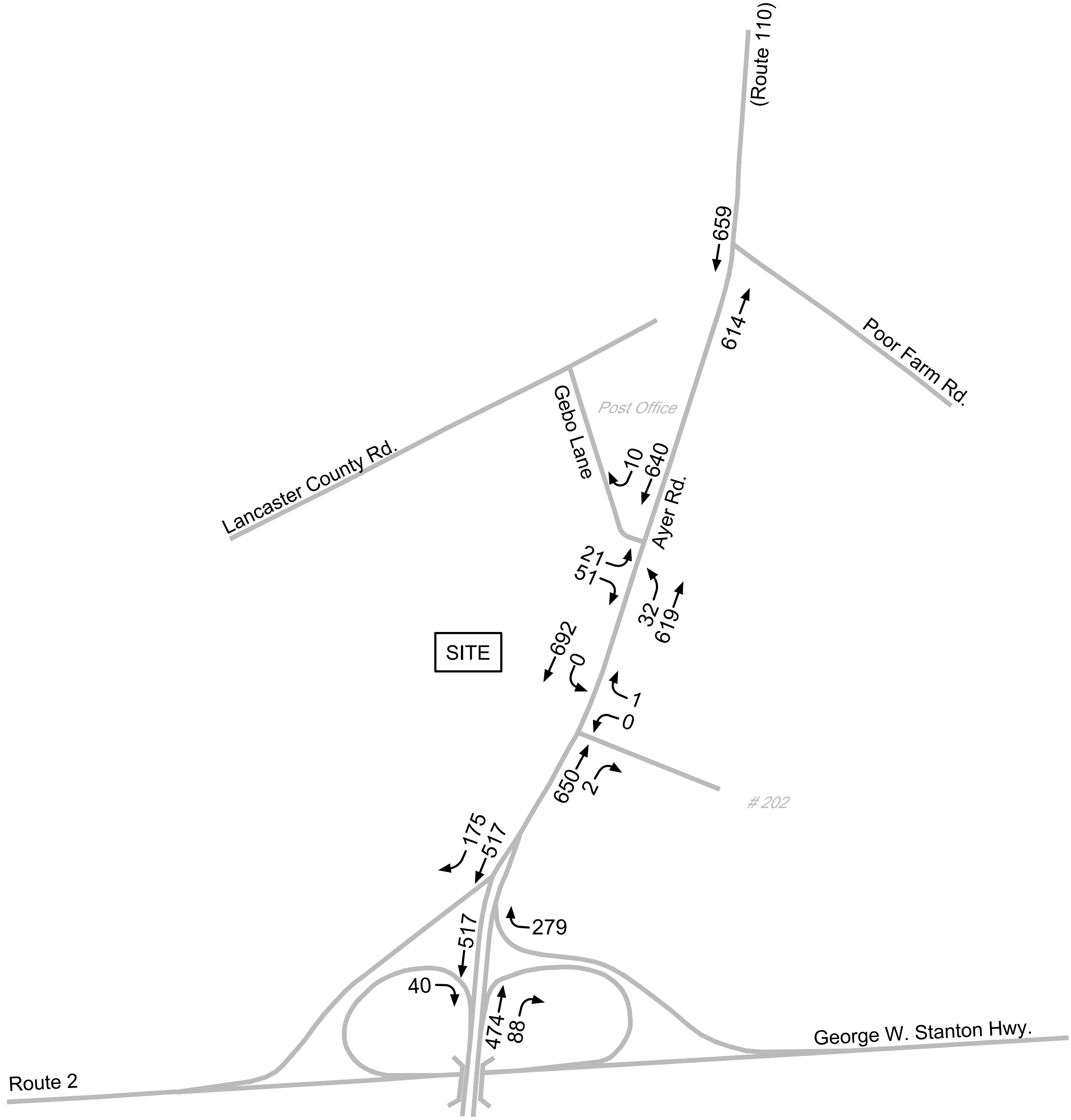
To determine the impact of site-generated traffic volumes generated by the project on the roadway network, under future conditions, baseline traffic volumes in the study area were projected to the year 2029. Traffic volumes on the roadway network at that time, in absence of the proposed project, would include existing traffic, new traffic due to general background traffic growth, and traffic related to specific developments by others expected to be completed by 2029. Communications with the Central Transportation Planning Staff (CTPS) indicate that overall growth in this area is currently at 0.21 Percent. Therefore, a one (1.0) percent compounded growth rate was used to develop future No-Build conditions.

Specific Development by Others

Traffic volumes generated by the specific local developments by others were included in the 2029 No-Build condition. Conversations with the Town of Harvard indicated that there are several small projects identified along the Ayer Road corridor which could generate traffic, but is believed that the growth rate will encompass the traffic from these projects.

No-Build Condition Traffic Volumes

The 2029 No-Build weekday morning and weekday evening peak-hour traffic volumes were developed by applying a compounded one (1.0) percent annual growth rate to the 2022 Existing peak-hour traffic volumes and adding traffic from any identified background projects. Traffic was also re-assigned as a result of the proposed closure of Lancaster County Road and the proposed circulation changes for the Post Office building. Figures 5 through 7 show the projected 2029 No-Build peak hour traffic volumes for the respective weekday morning, weekday evening and Saturday midday peak-hours.



Note: Imbalances exist due to driveways not shown.

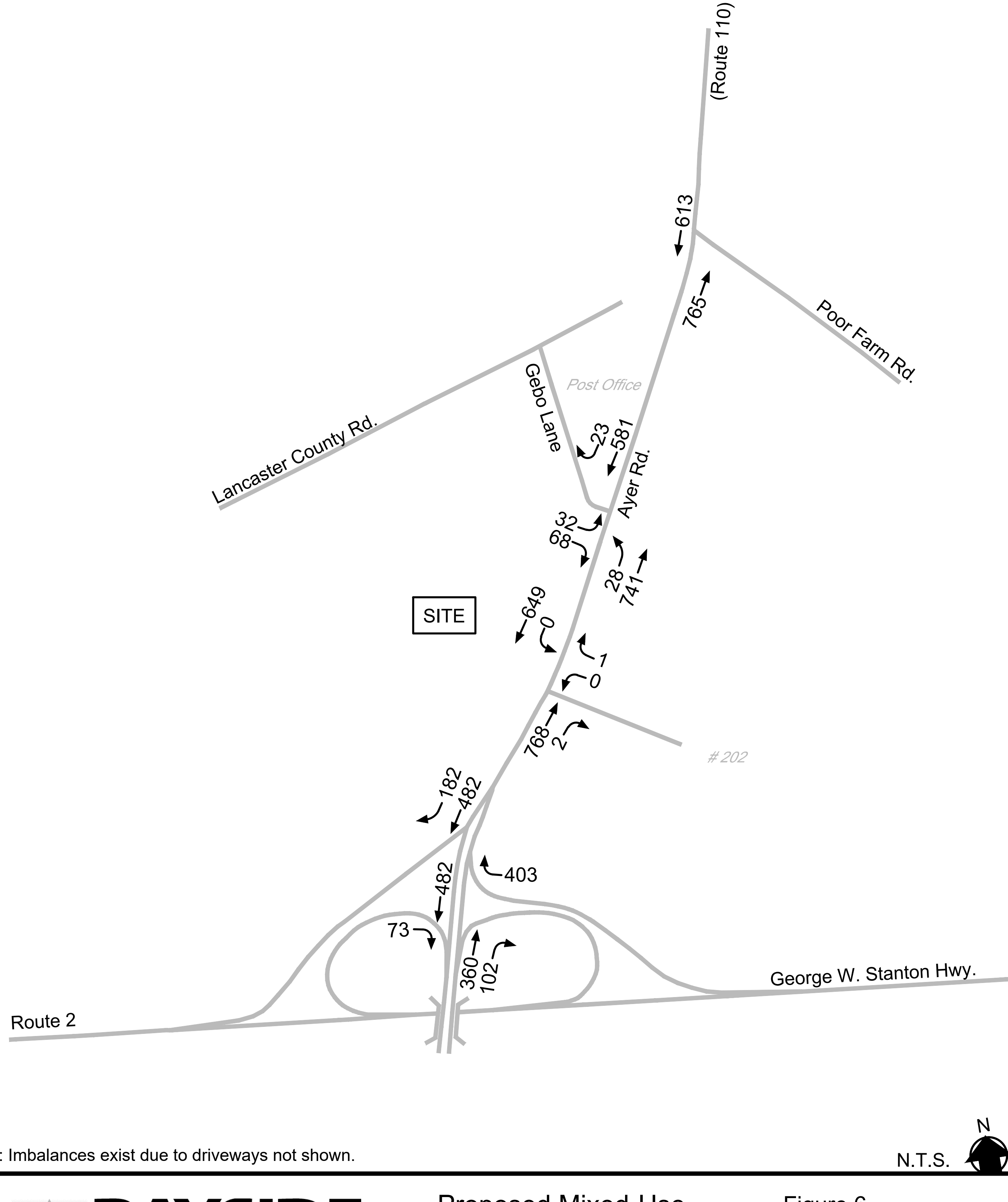
N.T.S.

Proposed Mixed-Use Development
Harvard, MA

Figure 5

2029 No-Build
Weekday Morning
Peak Hour Traffic Volumes

BAYSIDE ENGINEERING
600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com



Note: Imbalances exist due to driveways not shown.

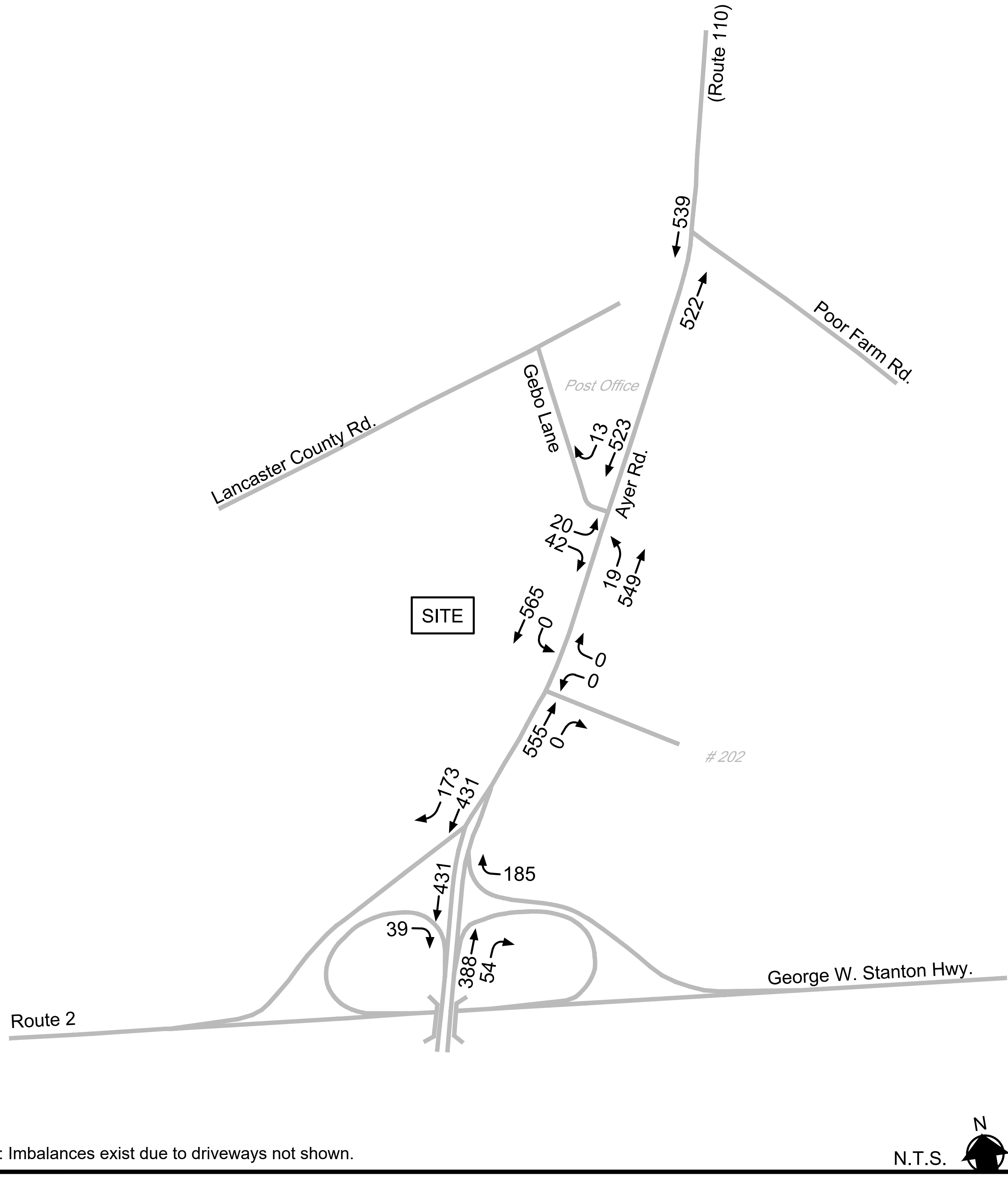
N.T.S.

BAYSIDE ENGINEERING
600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com

Proposed Mixed-Use Development
Harvard, MA

Figure 6

2029 No-Build
Weekday Evening
Peak Hour Traffic Volumes



Note: Imbalances exist due to driveways not shown.

BAYSIDE ENGINEERING
600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com

Proposed Mixed-Use Development
Harvard, MA

Figure 7

2029 No-Build
Saturday Midday
Peak Hour Traffic Volumes

FUTURE 2029 BUILD CONDITIONS

Project Description

The project will consist of the construction of three commercial buildings. Initially, a 30,000 square foot (sf) recreation center will be built. The recreation center will include:

- 16 badminton play courts
- Approximately 6,768 sf Non-recreational court uses, mostly ancillary uses that will include:
  a) One (1) residential apartment for the facility manager (approximately 900 sf)
  b) Fitness Area (approximately 390 sf)
  c) Kitchenette (approximately 165 sf)
  d) Common Space Areas (approximately 4,323 sf)
  e) Lockers, bathrooms, showers (approximately 990 sf)

Additionally, two (2) eight-thousand square foot commercial buildings are proposed. No tenants are identified at this time. There will be 170 parking spaces provided on site. Access to the site will be provided by way of a single driveway to Ayer Road.

Site Traffic Generation

Site generated traffic was based on empirical trip-generation data as well as data published by the ITE *Trip Generation* manual[2]. The proposed development is expected to consist of a badminton club and two commercial buildings. Currently, the ITE does not have any data for badminton clubs. Therefore, an existing facility in Westborough was monitored for three (3) weekdays and a Saturday. The Westborough facility is very similar to the proposed facility, but is only eight (8) badminton courts. This data was applied to the proposed sixteen court badminton club and is shown in Table 5.

Trip generation data for Land Use Code (LUC) 220 – Multifamily Housing (Low-Rise) and ITE LUC 822 – Strip Retail Plaza (<40ksf) was reviewed. The trip generation for the project is summarized in Table 4. The trip generation worksheets are included in the Appendix.

---

[2]*Trip Generation,* Eleventh Edition; Institute of Transportation Engineers; Washington, DC; 2021.

TABLE 5
TRIP GENERATION SUMMARY

	Badminton Club Trips[a]	Commercial Trips[b]	Total Trips
Average Weekday Daily Traffic	620	236	856
Weekday Morning Peak Hour:			
Entering	4	31	35
Exiting	24	4	28
Total	28	35	63
Weekday Evening Peak Hour:			
Entering	62	6	68
Exiting	48	30	78
Total	110	36	146
Average Saturday Traffic	860	36	896
Saturday Middy Peak Hour:			
Entering	62	4	66
Exiting	48	4	52
Total	110	8	118

[a]Based on empirical data; 16 courts.
[b]Based on ITE LUC 710 – General Office Building; 16,000 sf.

On a typical weekday, the proposed development is expected to generate 856 daily vehicle trips. During the weekday morning peak hour, 63 vehicle trips (35 vehicles entering and 28 vehicles exiting) are expected. During the weekday evening peak hour, 146 vehicle trips (68 vehicles entering and 78 vehicles exiting) are expected. On a typical Saturday, the proposed development is expected to generate 896 daily vehicle trips. During the Saturday midday peak hour, 118 vehicle trips (66 vehicles entering and 52 vehicles exiting) are expected.

Trip Distribution

The directional distribution of the vehicular traffic approaching and departing the site is typically a function of population densities, the location of employment, existing travel patterns, similar uses, and the efficiency of the existing roadway system. A gravity model was developed based on Harvard Journey-to-Work data from the U.S. Census to determine the expected trip distribution. Table 6 summarizes the expected trip distribution. The trip distribution is shown graphically on Figure 8 and the gravity model is included in the Appendix.

TABLE 6
PROPOSED TRIP DISTRIBUTION

Route	Direction	Percent of Trips
Ayer Road	North	15
Gebo Lane	Northwest	1
Route 2	East	28
Route 2	West	40
Ayer Road	South	16
TOTALS		100

Future Traffic Volumes - Build Condition

The site-generated traffic was distributed within the study area according to the percentages summarized in Table 6. The site generated trips are shown on Figures 9, 10 and 11 for the respective weekday morning, weekday evening and Saturday midday peak hours. The site generated volumes were then superimposed onto the 2029 No-Build traffic volumes to represent the 2029 Build traffic-volume conditions. The anticipated 2029 Build weekday morning, weekday evening and Saturday midday peak-hour traffic volumes are graphically presented in Figures 12, 13 and 14. These volumes were used as the basis for all analysis as well as to identify potential mitigation measures to ameliorate the project's impacts.

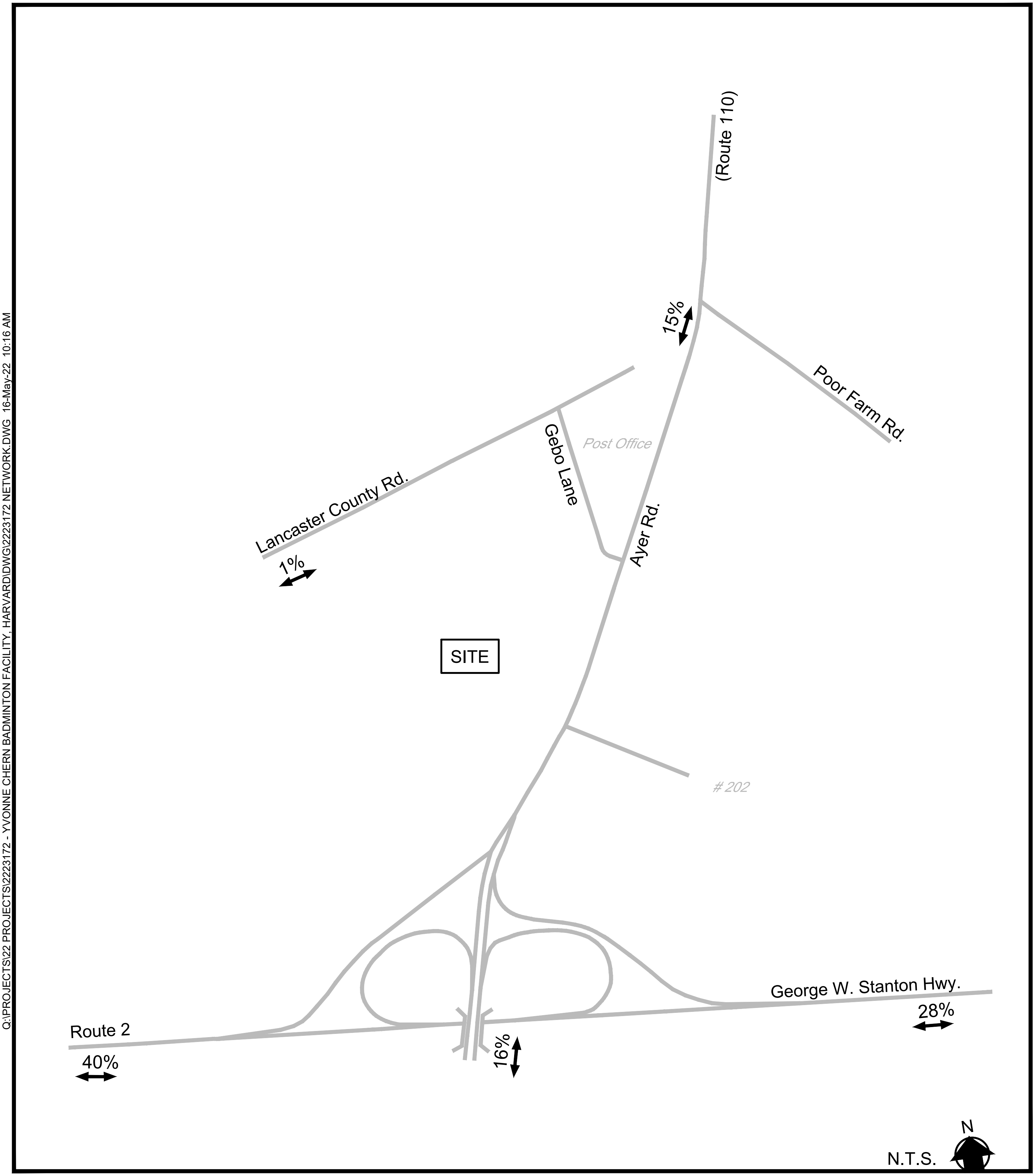
A summary of 2029 peak-hour projected traffic-volume changes in the site vicinity are shown in Table 7. These volumes are based on the expected increases from the site traffic generation.

TABLE 7
TRAFFIC-VOLUME INCREASES[a]

Location/Peak Hour	2029 No-Build	2029 Build	Volume Increase over No-Build
Ayer Road, north of Lancaster County Road			
Weekday Morning	1,273	1,284	11
Weekday Evening	1,378	1,401	23
Saturday Midday	1,061	1,078	17
Ayer Road, south of Route 2 Westbound Ramps			
Weekday Morning	1,119	1,150	31
Weekday Evening	1,017	1,089	72
Saturday Midday	912	964	52

[a]All volumes are vehicles per hour, total of both directions.

As shown in Table 7, project-related increases are in the range of 11 to 72 bi-directional vehicles during the peak hours entering or exiting the study area on Ayer Road. This is equivalent to approximately one additional vehicle every two (2) minutes or less per direction on average during the peak hours.



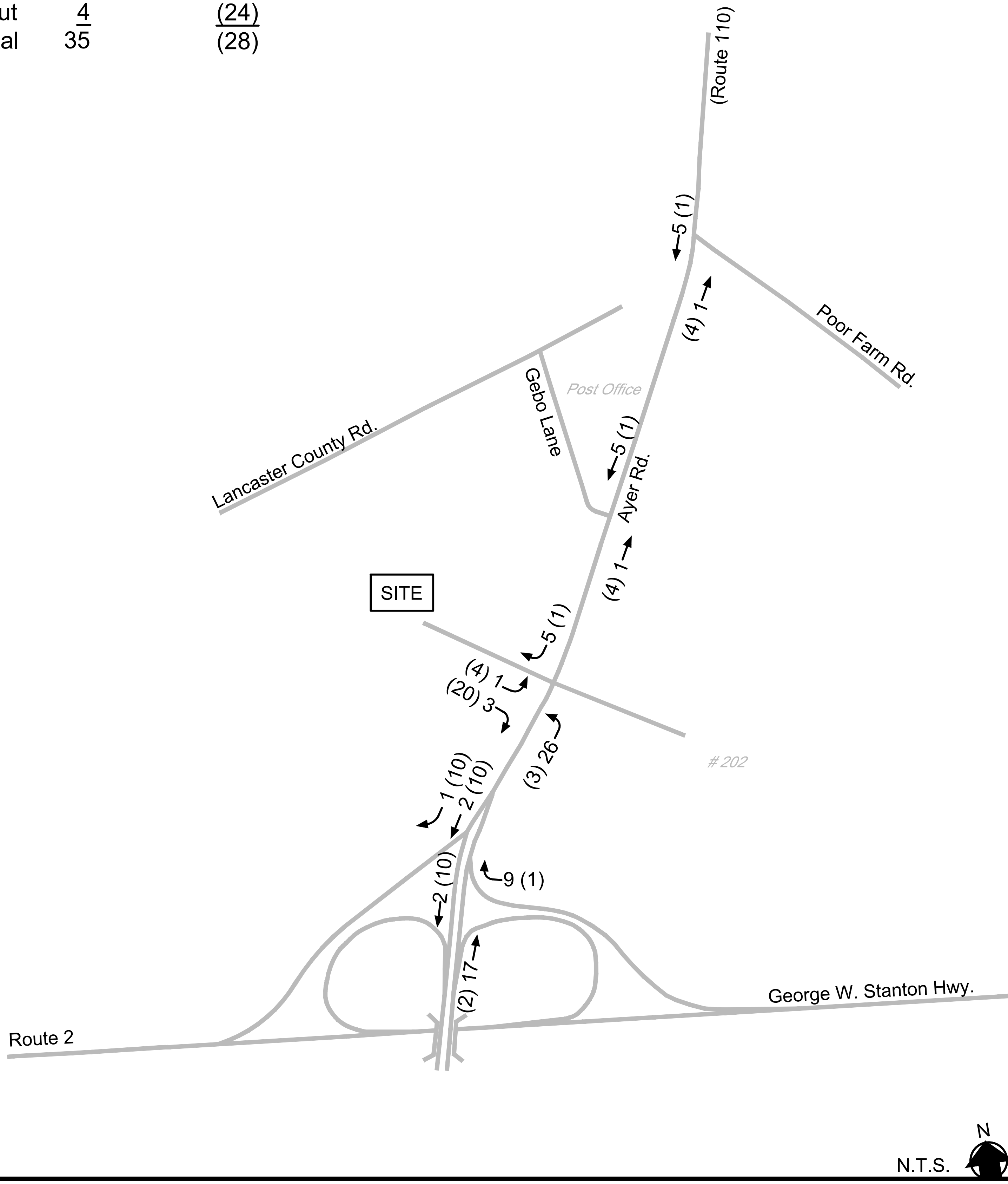
BAYSIDE ENGINEERING
600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com

Proposed Mixed-Use Development
Harvard, MA

Figure 8

Trip Distribution

	Commercial	Badminton Club
In	31	(4)
Out	4	(24)
Total	35	(28)



Q:\PROJECTS\22 PROJECTS\2223172 - YVONNE CHERN BADMINTON FACILITY, HARVARD\DWG\2223172 NETWORK.DWG 16-May-22 10:16 AM

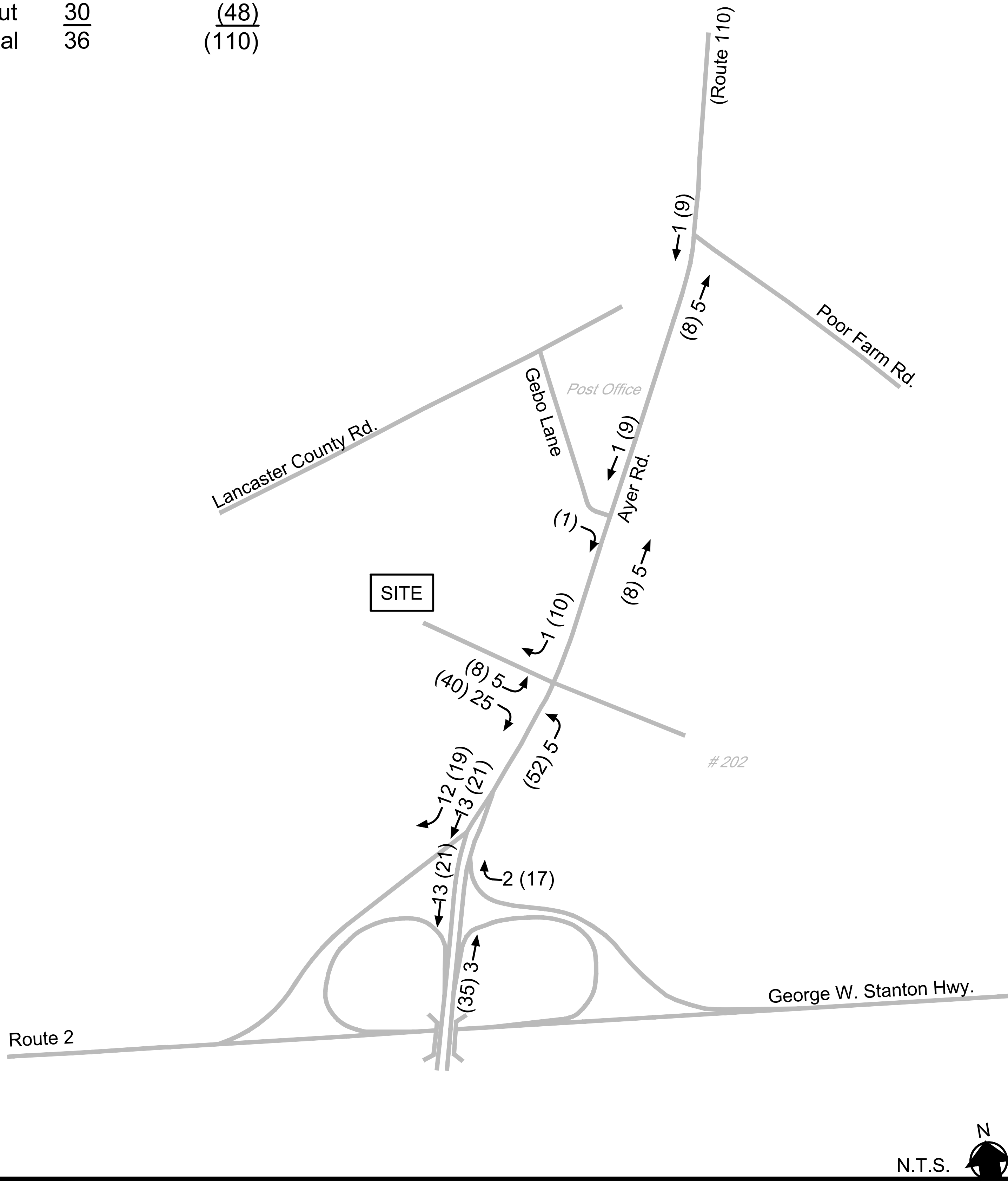
BAYSIDE ENGINEERING
600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com

Proposed Mixed-Use Development
Harvard, MA

Figure 9

Trip Generation
Weekday Morning
Peak Hour Traffic Volumes

	Commercial	Badminton Club
In	6	(62)
Out	30	(48)
Total	36	(110)



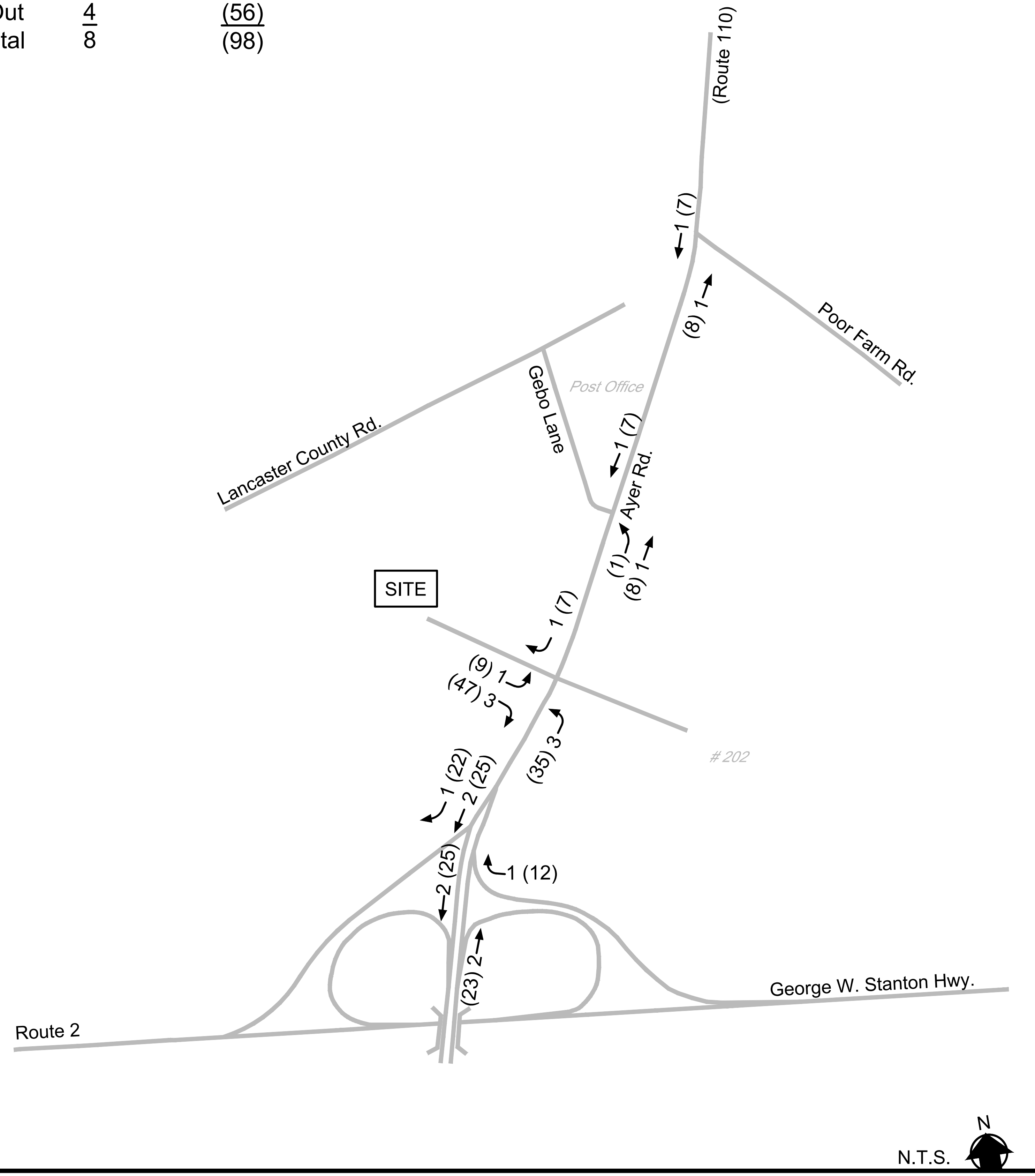
BAYSIDE ENGINEERING
600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com

Proposed Mixed-Use Development
Harvard, MA

Figure 10

Trip Generation
Weekday Evening
Peak Hour Traffic Volumes

	Commercial	Badminton Club
In	4	(42)
Out	4	(56)
Total	8	(98)



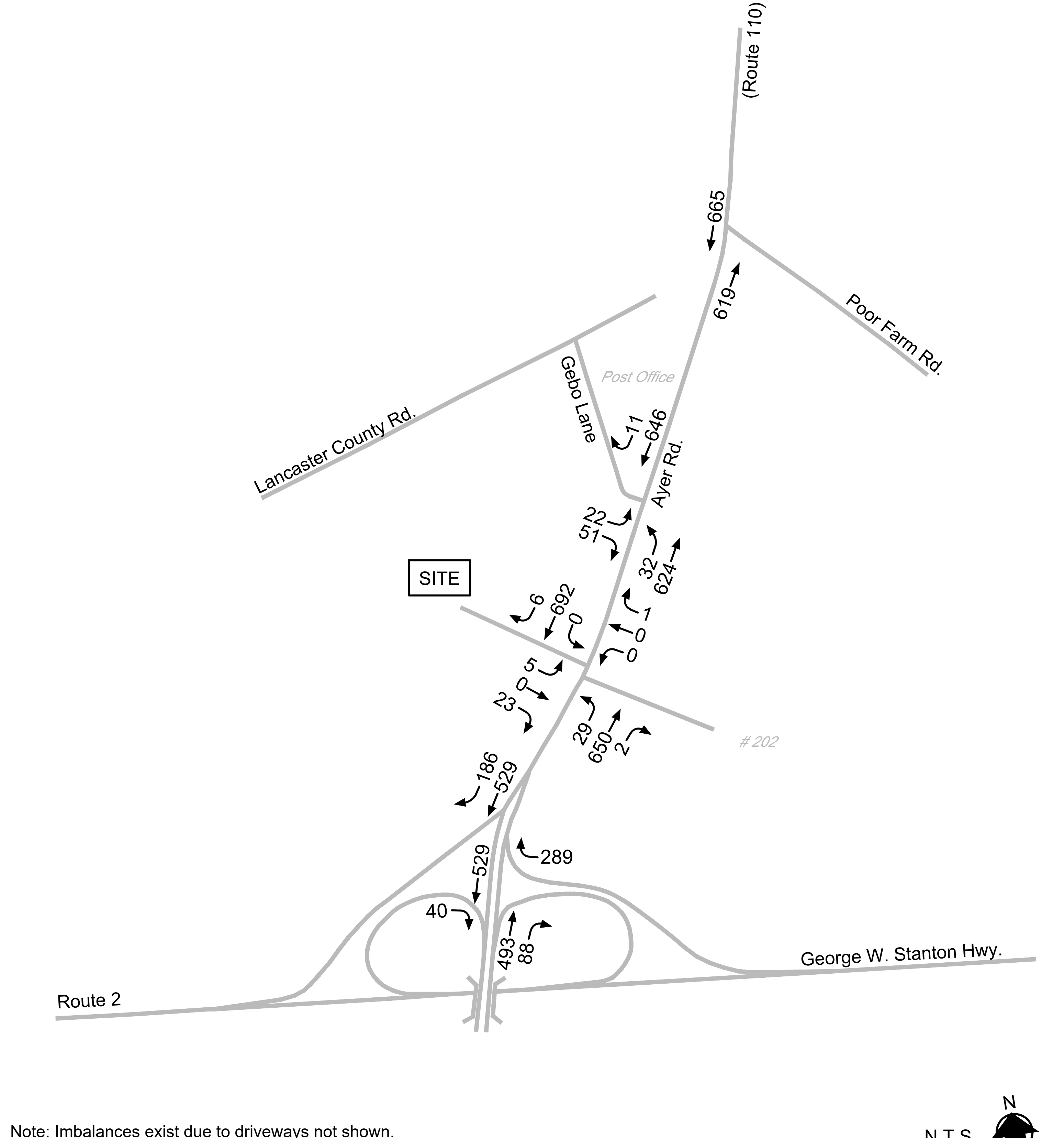
Q:\PROJECTS\22 PROJECTS\2223172 - YVONNE CHERN BADMINTON FACILITY, HARVARD\DWG\2223172 NETWORK.DWG 16-May-22 10:16 AM

BAYSIDE ENGINEERING
600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com

Proposed Mixed-Use
Development
Harvard, MA

Figure 11

Trip Generation
Weekday Evening
Peak Hour Traffic Volumes

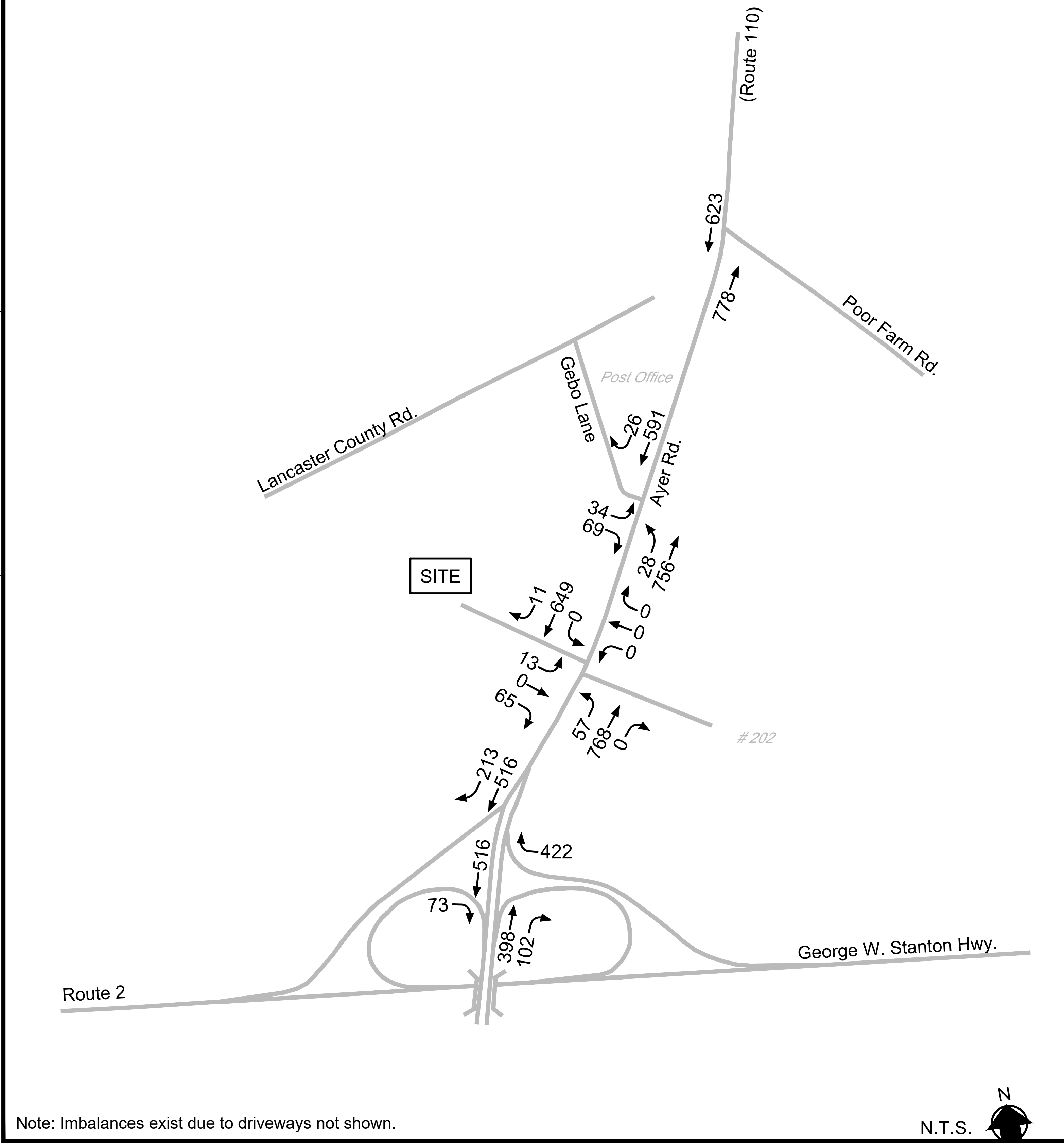


BAYSIDE ENGINEERING
600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com

Proposed Mixed-Use Development
Harvard, MA

Figure 12

2029 Build
Weekday Morning
Peak Hour Traffic Volumes



Note: Imbalances exist due to driveways not shown.

Q:\PROJECTS\22 PROJECTS\2223172 - YVONNE CHERN BADMINTON FACILITY, HARVARD\DWG\2223172 NETWORK.DWG 16-May-22 10:16 AM

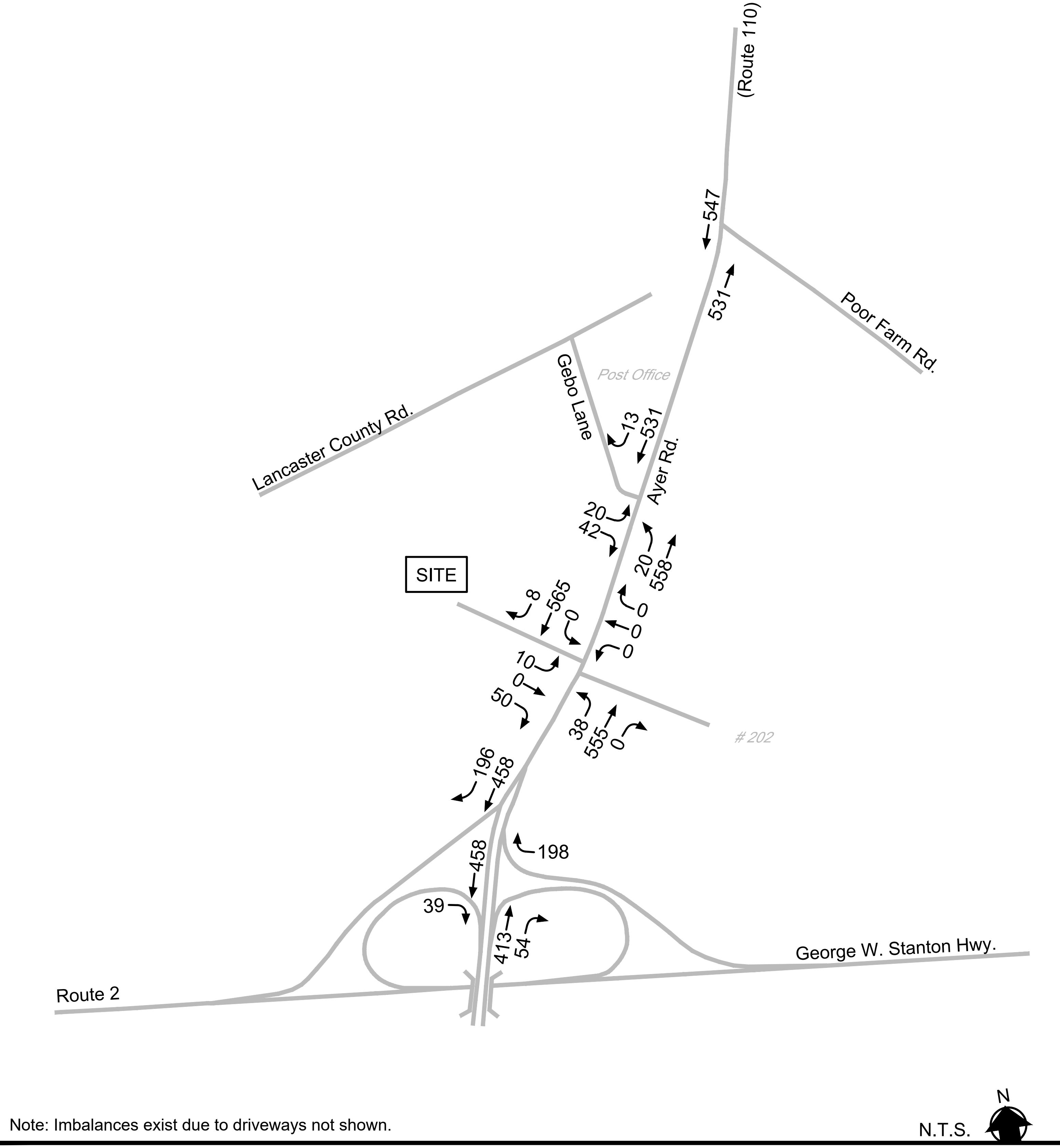
BAYSIDE ENGINEERING
600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com

Proposed Mixed-Use Development
Harvard, MA

Figure 13

2029 Build
Weekday Evening
Peak Hour Traffic Volumes

Q:\PROJECTS\22 PROJECTS\2223172 - YVONNE CHERN BADMINTON FACILITY, HARVARD\DWG\2223172 NETWORK.DWG 16-May-22 10:16 AM



Note: Imbalances exist due to driveways not shown.

BAYSIDE ENGINEERING
600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com

Proposed Mixed-Use Development
Harvard, MA

Figure 14

2029 Build
Saturday Midday
Peak Hour Traffic Volumes

SECTION 4: ANALYSIS

To assess intersection operations, capacity analyses were conducted for Existing, No-Build, and Build traffic-volume conditions. Capacity analyses provide an indication of how well the study area intersections serve existing and projected traffic volumes. Vehicle queue analyses provide a secondary measure of the operational characteristics of an intersection or section of roadway under study in terms of lane use and demand.

METHODOLOGY

Levels of Service

Level of service (LOS) is a quantitative measure used to describe the operation of an intersection or roadway segment. The level of service definition is described by the quality of traffic flow and is primarily defined in terms of traffic delays. The primary result of capacity analyses[3] is the assignment of a level of service to traffic intersections or roadway segments under various traffic-flow conditions. Six levels of service are defined for traffic intersections and roadway segments. Levels of service range from LOS A to LOS F. LOS A represents very good operating conditions and LOS F represents very poor operating conditions.

Signalized Intersections

Levels of service for signalized intersections are calculated using the methodology and procedures described in the 2010 *Highway Capacity Manual*[4]*(HCM)*. The methodology assesses the intersection based on type of signal operation, signal timing and phasing, progression, vehicle mix, and intersection geometrics. Level-of-service designations are based on the delay per vehicle. Table 8 summarizes the relationship between level of service and delay. The calculated delay values result in level-of-service designations which

[3]The capacity analysis methodology is based on procedures presented in the *Highway Capacity Manual;* Transportation Research Board; Washington, DC; 2010.

[4]*Highway Capacity Manual*; Transportation Research Board; Washington, DC; 2010.

are applied to individual lane groups, to individual intersection approaches, and to the entire intersection. In the 2010 HCM methodology, the critical lane group volume to capacity ratio is reported.

TABLE 8
LEVEL-OF-SERVICE CRITERIA FOR SIGNALIZED INTERSECTIONS[a]

Delay per Vehicle (Seconds)	Defined Level of Service v/c[b] < 1.0	Defined Level of Service v/c[b] > 1.0
$\leq$10.0	A	F
10.1 to 20.0	B	F
20.1 to 35.0	C	F
35.1 to 55.0	D	F
55.1 to 80.0	E	F
>80.0	F	F

[a]*Highway Capacity Manual*; Transportation Research Board; Broad, DC; 2010; page 18-6.
[b]Volume to capacity ratio.

Unsignalized Intersections

The level of service for an unsignalized intersection is determined by the methodology and procedures described in the 2010 HCM. The level of service for unsignalized intersections is measured in terms of average delay for the critical movements (typically side street turning movements or mainline turning movements). The delay for the critical movements is a function of the available capacity for the movement and the degree of saturation of the lane group containing the critical movement. The delay calculation includes the effects of initial deceleration delay approaching a STOP sign, stopped delay, queue move-up time, and final acceleration delay from a stopped condition. The definitions for level of service at unsignalized intersections are also provided in the 2010 *Highway Capacity Manual*. Table 9 summarizes the relationship between level of service and average control delay for the critical movements at unsignalized intersections.

TABLE 9
LEVEL-OF-SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS[a]

Average Delay (seconds per vehicle)	Defined Level of Service $v/c^b < 1.0$	Defined Level of Service $v/c > 1.0$
≤ 10.0	A	F
10.1 to 15.0	B	F
15.1 to 25.0	C	F
25.1 to 35.0	D	F
35.1 to 50.0	E	F
>50.0	F	F

[a]*Highway Capacity Manual*; Transportation Research Board; Broad, DC; 2010; page 19-2
[b]Volume to capacity ratio.

The analytical methodologies used for the analysis of unsignalized intersections use conservative analysis parameters, such as high critical gaps. The critical gap is defined as the minimum time between successive main line vehicles for a side street vehicle to execute the appropriate turning maneuver. Actual field observations indicate that drivers at the study area intersections accept smaller gaps in traffic than those used in the analysis procedures and therefore experience less delay than calculated by the HCM methodology. **The analysis results from the HCM model overstate the actual delays experienced in the field.** It should be noted that the unsignalized intersections along heavily trafficked roadways operate at constrained levels and the resulting calculated results of the unsignalized intersection analyses should be considered highly conservative.

CAPACITY ANALYSIS RESULTS

Level-of-service analyses were conducted for 2022 Existing, 2029 No-Build, and 2029 Build conditions for the intersections within the study area. The results of the 2029 unsignalized analyses are summarized in Table 10. Detailed analysis sheets are presented in the Appendix.

Ayer Road and Lancaster County Road

Under 2022 Existing conditions, the critical movements at this unsignalized intersection (all movements from the Lancaster County Road) are modeled to operate at LOS D during the weekday morning peak hour, at LOS D during the weekday evening peak hour and at LOS C during the Saturday midday peak hour. Under future 2029 No-Build and Build conditions, Lancaster County Road will be terminated to the west and this intersection will no longer exist.

TABLE 10
UNSIGNALIZED LEVEL-OF-SERVICE ANALYSIS SUMMARY

Critical Movement/ Peak Hour	2022 Existing					2029 No-Build					2029 Build				
	Demand[a]	V/C[b]	Delay[c]	LOS[d]	Queue[e]	Demand	V/C	Delay	LOS	Queue	Demand	V/C	Delay	LOS	Queue
Ayer Road and Lancaster County Road															
All movements from Lancaster County Road:															
Weekday Morning	11	0.09	25.4	D	7.5	--	--	--	--	--	--	--	--	--	--
Weekday Evening	24	0.21	30.1	D	20.0	--	--	--	--	--	--	--	--	--	--
Saturday Midday	12	0.10	18.9	C	7.5	--	--	--	--	--	--	--	--	--	--
Ayer Road and Gebo Lane															
All movements from Gebo Lane:															
Weekday Morning	30	0.13	14.3	B	12.5	72	0.37	26.4	D	40.0	73	0.38	27.3	D	42.5
Weekday Evening	43	0.13	13.1	B	10.0	100	0.49	30.5	D	62.5	103	0.53	33.6	D	72.5
Saturday Midday	18	0.04	12.0	B	2.5	62	0.24	18.9	C	22.5	62	0.25	19.3	C	25.0
Ayer Road and 202 Ayer Road Driveway/Site Driveway															
All movements from 202 Ayer Road driveway:															
Weekday Morning	1	0.01	12.7	B	0.0	1	0.01	13.2	B	0.0	1	0.01	13.2	B	0.0
Weekday Evening	1	0.01	13.8	B	0.0	1	0.01	14.5	B	0.0	1	0.01	14.5	B	0.0
Saturday Midday	1	0.01	12.0	B	0.0	1	0.01	12.4	B	0.0	1	0.01	12.4	B	0.0
Left-turn movements from Site driveway:															
Weekday Morning	--	--	--	--	--	--	--	--	--	--	5	0.07	50.8	F	5
Weekday Evening	--	--	--	--	--	--	--	--	--	--	13	0.19	65.8	F	17.5
Saturday Midday	--	--	--	--	--	--	--	--	--	--	10	0.09	37.4	E	7.5
Right-turn movements from Site driveway:															
Weekday Morning	--	--	--	--	--	--	--	--	--	--	23	0.07	15.1	C	5
Weekday Evening	--	--	--	--	--	--	--	--	--	--	65	0.16	14.8	B	0
Saturday Midday	--	--	--	--	--	--	--	--	--	--	50	0.11	13.5	B	10
Ayer Road and Route 2 Westbound Ramps															
All movements from Route 2 WB Off-Ramp to Ayer Road NB:															
Weekday Morning	260	0.42	13.6	B	52.5	279	0.46	14.5	B	62.5	289	0.49	15.1	C	67.5
Weekday Evening	376	0.54	14.7	B	82.5	403	0.60	16.1	C	100.0	422	0.64	17.9	C	120.0
Saturday Midday	173	0.25	11.0	B	25.0	185	0.27	11.3	B	27.5	198	0.30	11.7	B	30.0
All movements from Route 2 WB Off-Ramp to Ayer Road SB:															
Weekday Morning	37	0.08	10.6	B	7.5	40	0.09	10.9	B	7.5	40	0.09	10.9	B	7.5
Weekday Evening	69	0.12	10.3	B	10.0	73	0.12	10.5	B	10.0	73	0.13	10.6	B	10.0
Saturday Midday	36	0.06	9.9	A	5.0	39	0.06	10.0	B	5.0	39	0.06	10.2	B	5.0

[a]Demand of critical movements in vehicles per hour.
[b]Volume-to-capacity ratio.
[c]Delay in seconds per vehicle.
[d]Level of service.
[e]95th percentile queue in feet.
Calculated delay and v/c not representative of actual conditions when v/c exceeds 1.0.

Ayer Road and Gebo Lane

Under 2022 Existing conditions, the critical movements at this unsignalized intersection (all movements from Gebo Lane) are modeled to operate at LOS B during the weekday morning, weekday evening and Saturday midday peak hours. Under future 2029 No-Build conditions, the critical movements are projected to operate at LOS D during the weekday morning and weekday evening peak hours and at LOS C during the Saturday midday peak hour. Under 2029 Build conditions, with the project, the critical movements are projected to continue to operate at LOS D during the weekday morning and weekday evening peak hours and at LOS C during the Saturday midday peak hour.

Ayer Road and 202 Ayer Road Driveway

Under 2022 Existing conditions, the critical movements at this unsignalized intersection (all movements from the 202 Ayer Road driveway) are modeled to operate at LOS B during the weekday morning, weekday evening and Saturday midday peak hours. Under future 2029 No-Build conditions, the critical movements are projected to continue to operate at LOS B during the weekday morning, weekday evening and Saturday midday peak hours. Under 2029 Build conditions, with the project, these critical movements are projected to continue to operate at LOS B during the weekday morning, weekday evening and Saturday midday peak hours. Right-turn movements from the proposed site driveway are projected to operate at LOS C during the weekday morning peak hour, at LOS B during the weekday evening peak hour and at LOS B during the Saturday midday peak hour. Left-turn movements from the proposed site driveway are projected to operate at LOS F during the weekday morning and weekday evening peak hours and at LOS E during the Saturday midday peak hour. The volume to capacity (v/c) ratio for this movement is well below 1.0 indicating adequate capacity for the left-turn movements. The projected 95th percentile queue (the vehicle queue that can be expected five (5) percent of the time during the peak hour) is one (1) vehicle.

Ayer Road and Route 2 Westbound Ramps

Under 2022 Existing conditions, the critical movements at this unsignalized intersection (right-turn movements from the Route 2 westbound off-ramp to Ayer Road northbound) are modeled to operate at LOS B during the weekday morning, weekday evening and Saturday midday peak hours. Under future 2029 No-Build conditions, the critical movements are projected to operate at LOS B during the weekday morning peak hour, at LOS C during the weekday evening peak hour and at LOS B during the Saturday midday peak hour. Under 2029 Build conditions, with the project, the critical movements are projected to operate at LOS C during the weekday morning peak hour, at LOS C during the weekday evening peak hour and at LOS B during the Saturday midday peak hour.

SIGHT DISTANCE

Sight distance measurements were performed at the proposed site driveway intersection with Ayer Road in accordance with Massachusetts Department of Transportation (MassDOT) and American Association of State Highway and Transportation Officials (AASHTO) standards. Stopping sight distance (SSD) measurements were performed. In brief, SSD is the distance required by a vehicle traveling at the design speed of a roadway, on wet pavement, to stop prior to striking an object in its travel path. Table 11 presents the measured SSD at the site access intersections. The sight distance calculations are included in the Appendix.

TABLE 11
SIGHT DISTANCE SUMMARY

	Required Minimum (Feet)[a]	Measured (Feet)
Site Access and Ayer Road		
Stopping Sight Distance:		
Ayer Road approaching from the north	281	400+
Ayer Road approaching from the south	324	400+

[a]Recommended minimum values obtained from *A Policy on Geometric Design of Highways and Streets*; American Association of State Highway and Transportation Officials (AASHTO); 2018 and based on observed 85th percentile speed, adjusted for grade.
[b]Recommended minimum value for vehicles turning right exiting a roadway under STOP-sign control.
[c]Recommended minimum value for vehicles turning left exiting a roadway under STOP-sign control.

As can be seen in Table 11, the SSD measurements performed at Ayer Road and the proposed site access intersection indicates that the intersection does meet the recommended minimum requirements based on the 85th percentile speeds. To maintain sight lines, it is recommended that any landscaping and proposed site signage be set back to not impede sight lines.

SECTION 5: RECOMMENDATIONS AND CONCLUSION

RECOMMENDATIONS

The final phase of the analysis process is to identify the mitigation measures necessary to minimize the impact of the project on the transportation system. The capacity analyses performed for 2022 Existing and 2029 future No-Build and Build conditions indicate that the proposed project will not result in a significant impact on traffic operations at the study area intersections. The addition of the site generated traffic will marginally increase projected delays.

Site Access

The proposed site access intersection analyses indicate that the right-turn movements at the intersection will operate at good levels of service with minimal delay for existing and site-generated traffic during the peak hours. Left-turn movements are projected to operate at LOS F during the weekday morning and weekday evening peak hours and at LOS E during the Saturday midday peak hour. The volume to capacity (v/c) ratio for this movement is well below 1.0 indicating adequate capacity for the left-turn movements. The volume of traffic generated by the project is not high enough to warrant signalization. The proposed site access should provide one entering and two exiting lanes be placed under STOP-sign control.

There are no other improvements warranted for this project as the capacity analyses indicate that there is no change in level of service at the study area intersections with the addition of the project related traffic. To maintain sight lines, it is recommended that any landscaping and proposed site signage be set back to not impede sight lines.

Transportation Demand Management

A Transportation Demand Management (TDM) plan should be implemented for the commercial component of the project. The goal of a TDM plan is to reduce the project's overall traffic impact by implementing measures geared toward affecting a change in driver behavior, and to be successful, they must rely on incentives or disincentives to cause drivers to shift travel patterns. TDM programs are designed to maximize the capability of the existing transportation infrastructure by increasing the number of persons in a vehicle, providing alternate modes of travel, or influencing the time of, or need to, travel.

TDM measures are generally directed at commuter travel. The day-to-day regularity of this type of trip and conditions at the workplace, in terms of employer practices such as on-site services, bicycle storage, and shuttle services, affect commuter choices and make this market the most suitable for identifying alternatives. TDM encompasses both alternatives to driving alone and the techniques or supporting strategies that encourage the use of these alternatives. TDM alternatives to driving alone include carpools and vanpools, public and private transit, and non-motorized travel, including bicycling and walking. TDM alternatives can also influence when trips are made. For example, alternative work hours (compressed work weeks, flex-time, and telecommuting) can affect what time of day trips are made, or if trips occur at all on certain days. TDM strategies are the supporting measures that encourage the use of alternatives to driving alone. TDM strategies typically include financial incentives, time incentives, provision of new or enhanced commuter services, dissemination of information, and marketing alternative services. TDM strategies include all the incentives and disincentives that increase the likelihood for people to change their travel behavior.

The project proponent is committed to promoting several measures that contribute toward the reduction of vehicular traffic to and from the site. The following describes the TDM program:

- A Transportation Coordinator (TC) will be assigned the responsibilities of coordinating the TDM program.
- The TC will also promote alternative transportation modes by posting local commuter rail and bus schedules and encouraging employees to use public transportation.
- The TC will also promote ridesharing via carpools for employees. The project proponent will recommend that employees interested in car-pooling provide their contact information.
- Designate two (2) carpool/vanpool parking spaces as close as possible to the front.
- Site amenities should also be provided to discourage off-site trips. These measures may include providing a break room, direct deposit of paychecks, allowing for telecommuting or flex work opportunities.
- Bicycle racks will also be located throughout the site to encourage the use of bicycles.

CONCLUSION

Review of the proposed project and the access plan shows that in relation to roadway capacity, traffic safety, and traffic impacts upon the surrounding roadway network, the proposed project will meet safety standards and have a minimal impact on existing traffic conditions. Project-related increases are in the range of 11 to 72 bi-directional vehicles during the peak hours entering or exiting the study area on Ayer Road. This is equivalent to approximately one additional vehicle every minute or less per direction on average during the peak hours.