Traffic Impact, Access & Parking Study

Proposed "Cushing Village" Mixed Use Redevelopment

Cushing Square
Belmont, Massachusetts

Prepared For
Smith Legacy Partners Series, LLC
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Introduction

TEC, Inc. has prepared this Traffic Impact and Access Study (TIAS) in support of the proposed Cushing Village mixed-use development located at 102 to 112 Trapelo Road and 493 to 527 Common Street in Belmont, Massachusetts. The site currently contains a vacant 6,200 square foot (SF) CVS/pharmacy, a 2,430 SF Starbucks restaurant with 30 seats, approximately 12,065 SF of specialty retail and restaurant space, the foundation of a former 3,590 SF retail building, and a municipal parking lot containing 50 parking spaces. The project proponent, Smith Legacy Partners, LLC, is proposing to demolish the existing land uses on the site and construct a mixed-use development to contain a 2,000 SF Starbucks, a 5,000 SF quality restaurant, a 3,300 SF health and fitness club, approximately 27,200 SF of retail space, and approximately 118 apartment units. TEC evaluated the traffic operations for the immediate intersections surrounding the site under existing conditions (2010), future No-Build conditions (2017), as well as the conditions following the introduction of new traffic generated by the proposed development.

Study Area Intersections

The study area for this TIAS included the following intersections:

1. Trapelo Road / Common Street / Cushing Avenue (Cushing Square)
2. Trapelo Road / Starbuck's Driveway / *future Northerly Site Driveway*
3. Trapelo Road / Williston Road
4. Common Street / Horne Road
5. Williston Road / Horne Road
6. Horne Road / Poplar Street
7. Common Street / Belmont Street

Existing Traffic Volumes

Traffic counts were conducted at the study area intersections on June 15, 2010 during the weekday morning (7:00 to 9:00 AM) and weekday evening (4:00 to 6:00 PM) peak period and on June 12, 2010 during the Saturday Midday (11:00 AM to 2:00 PM) peak period. Public schools were still in session at the time of these counts. Based on historic traffic volume counts provided by the Massachusetts Department of Transportation (MassDOT), traffic volumes in the month of June are typically higher than average month conditions. Therefore, the raw unadjusted traffic volumes were used to represent a conservative (worse than expected) analysis scenario.

No-Build Traffic Volumes

The 2010 Existing traffic volumes were projected to 2017 No-Build conditions in accordance with MassDOT standards for completion of a traffic study. No-Build traffic volumes were calculated by applying a 1.0 percent compounded annual growth rate to the 2010 Existing traffic volumes and adding traffic to be generated by other development projects proposed to be completed within the 5-year design horizon.

Site-Generated Traffic

TEC estimated the traffic to be generated by the proposed mixed-use development project based on rates contained in the Institute of Transportation Engineers (ITE) publication *Trip Generation, Eighth Edition*. The proposed project is estimated to generate approximately 65 *new* trips during the weekday morning peak hour, 147 *new* trips during the weekday evening peak hour, and 178 *new* trips during the Saturday midday peak hour.

Redistributed Traffic Volumes

As part of the proposed mixed-use development project, the existing Starbucks will be relocated along Trapelo Road. Additionally, the Horne Road connection to Common Street will be discontinued as part of this project except for emergency access. The existing driveways on Trapelo Road and Common Street will also be closed as part of the project. TEC has redistributed existing traffic volumes associated with these changes to the site and driveway layout.

Build Traffic Volumes

The 2017 Build traffic-volume networks were calculated by adding the site-generated traffic volumes and the redistributed existing traffic resulting from closing the municipal parking lot, Horne Road and the existing driveways to the 2017 No-Build traffic-volume networks.

Capacity and Queuing Analysis

The results of the capacity and queue analysis indicate that several movements at the intersection of Trapelo Road / Common Street / Cushing Avenue are anticipated to operate at level of service (LOS) E or F under 2017 No-Build and Build conditions. The additional traffic generated by the proposed mixed-use development is expected to have a limited impact on the operations of this intersection, increasing the overall intersection delay by less than 3 seconds per vehicle.

All movements at all other study area intersections are anticipated to operate at acceptable levels of service (LOS D or better) under all analysis scenarios.

Parking Analysis

There are currently a total of 187 on-street parking spaces in the immediate area surrounding the site, as well as 50 off-street parking spaces in a municipal parking lot on Williston Road. The Trapelo Road Improvement project will result in the net loss of 10 on-street parking spaces near Cushing Square. The proposed Cushing Village project will result in the loss of an additional 4 on-street parking spaces and 50 off-street parking spaces in the municipal parking lot.

Based on the Town of Belmont Zoning By-laws, a total of 157 parking spaces are required on the Cushing Village site to accommodate the proposed land uses, plus an additional 54 parking spaces to replace those being removed by the proposed development. Therefore, a total of 211 parking spaces are required on the Cushing Village site to satisfy zoning requirements. The applicant

proposes to construct a parking garage under the proposed mixed-use building, which will contain 212 parking spaces. An additional 22 parking spaces will be provided in surface lots on the site, providing a total of 234 parking spaces on the site. Therefore, the available parking on site will exceed zoning requirements without seeking parking relief.

TEC conducted a parking occupancy count to assess the utilization of existing on-street and off-street parking spaces. Additionally, the parking demand of the proposed land uses on the site was estimated using parking demand generation rates contained in the ITE *Parking Generation* report. Combining the parking demand of the existing and proposed land uses in the area, a peak parking demand of 369 parking spaces is anticipated in the area under Build conditions. Approximately 173 on-street parking spaces will be provided in the area, and 234 off-street spaces will be provided on the site, resulting in a total area parking supply of 407 spaces. Therefore, the peak parking demand can be accommodated by the proposed parking supply in the surrounding area.

Mitigation/Recommendations

Common Street / Belmont Street

The following measures are recommended to be implemented by the applicant to mitigate the impacts of the proposed mixed-use development and improve the safety of the Common Street / Belmont Street intersection:

- The foundation for the strain pole on the northwest corner should be reconstructed and the strain pole reset. This may require installation of a new span wire.
- The Common Street northbound approach should be restriped to provide a short exclusive left-turn lane and a shared through/right-turn lane to provide better alignment with the receiving lane on the opposite leg.
- The crosswalks should be relocated to cross Belmont Street and Common Street perpendicular to the roadway to reduce the length of the crossing. This will require reconstructing the wheelchair ramps, which should consist of perpendicular ramps with detectable warning devices to comply with current Americans with Disabilities Act (ADA) standards.
- The "Flashing Don't Walk" phase should be extended to 18 seconds to allow a pedestrian walking at 3.5 feet per second to cross the entire roadway during the "Flashing Don't Walk" phase.
- The signal heads should be upgraded to solid HAND/PERSON indications and the push-buttons should be upgraded with plunger-type (mushroom cap) buttons to comply with current MUTCD standards. The signal heads should be properly aligned to face a pedestrian standing on the ramp at the opposite side of the street
- The "NO TURN ON RED ARROW" sign for the Common Street northbound approach should be relocated and mounted on a sign post near the STOP-line.
- Extend the proposed Trapelo Road Improvements widen the sidewalk along Belmont Street the site frontage to improve pedestrian safety and access.

Additionally, emergency vehicle pre-emption will be installed at signalized intersections along the Trapelo Road corridor as part of the Trapelo Road / Belmont Street Corridor Improvements Project. In order to improve emergency vehicle response to the site and the surrounding area, it is recommended that the Town also install emergency vehicle pre-emption at the intersection of Common Street / Belmont Street.

Horne Road / Williston Road

There is currently a right-turn restriction sign posted on the Williston Road southbound approach to Horne Road that restricts right turns during certain time periods. Due to the closure of Horne Road's connection to Common Street, it is recommended that this sign be removed to allow right turns from Williston Road onto Horne Road during all time periods. In addition, a DEAD END (W14-1) sign should be posted on Horner Road just east of Williston Road to alert drivers that Horne Road is no longer a through street.

Sidewalks are provided along both sides of Horne Road and Williston Road in the vicinity of this intersection. However, there are no crosswalks at the intersection, nor are wheelchair ramps provided on any corner of the intersection. In order to improve the safety and accessibility of the intersection, it is recommended that crosswalks be striped on all legs of the intersection and that perpendicular wheelchair ramps be installed on all corners equipped with detectable warning devices to meet current ADA standards.

Horne Road / Poplar Street

There is currently no traffic control provided at the intersection of Horne Road and Poplar Street. It is recommended that a STOP-sign be installed and a STOP-line be striped on the Horne Road westbound approach to Poplar Street.

Sidewalks are provided along both sides of Horne Road and Poplar Street in the vicinity of the intersection. However, no crosswalks or wheelchair ramps are provided. It is recommended that the Town stripe crosswalks on the Horne Road and Poplar Street north legs of the intersection and that wheelchair ramps be constructed to connect the sidewalks to the crosswalks in compliance with current ADA standards. Pedestrian warning signs should be provided on the Poplar Street and Horne Road approaches to the intersection.

Trapelo Road / Williston Road

The STOP-sign for the Williston Road northbound approach is mounted high on the side of a light pole on the southeast corner of the intersection. It is recommended that this sign be relocated and post-mounted near the STOP-line on Williston Road.

Introduction

Purpose of Study

TEC, Inc. has prepared this Traffic Impact, Access, and Parking Study (TIAS) in support of the proposed Cushing Village mixed-use development located at 102 to 112 Trapelo Road and 493 to 527 Common Street in Belmont, Massachusetts. The site currently contains a vacant 6,200 square foot (SF) CVS/pharmacy, a 2,430 SF Starbucks Coffee Shop with 30 seats, approximately 12,065 SF of specialty retail and restaurant space, the foundation of a former 3,590 SF retail building, and a municipal parking lot containing 50 parking spaces. The project proponent, Smith Legacy Partners, LLC, is proposing to demolish the existing land uses on the site and construct a mixed-use development to contain approximately 27,200 SF of general retail space, a 2,000 SF Starbucks, a 5,000 SF quality restaurant, a 3,300 SF health and fitness club, and approximately 118 apartment units. TEC evaluated the traffic operations for the immediate intersections surrounding the site under existing conditions (2010), future No-Build conditions (2017), as well as the conditions following the introduction of new traffic generated by the proposed development.

This study reports existing traffic operating parameters on key roadways and intersections within the study area, as well as the anticipated future conditions as traffic volumes increase due to background growth, specific nearby projects in the planning stages, and the specific volumes generated by the site's redevelopment. To remain consistent with other traffic studies, TEC has coordinated with the Town of Belmont to further identify future projects and plans relating to traffic increases.

Project Area Description

The site is located on the southwest corner of the intersection of Trapelo Road and Common Street (Cushing Square) and occupies 102 to 112 Trapelo Road and 493 to 527 Common Street. Access to the existing Starbucks is provided via a full-access/egress driveway on Trapelo Road, as well as to an adjacent municipal parking lot via a full-access/egress driveway on Williston Road. Access to the existing specialty retail and restaurant buildings is provided via two-way access on Trapelo Road between Starbucks and the retail building, a driveway on Common Street, and a driveway on Horne Road. Access to the existing CVS/pharmacy is provided via two driveways on Common Street, one driveway on Horne Road, and one driveway on Belmont Street. The site contains a vacant 6,200 SF CVS/pharmacy, a 2,430 SF Starbucks, approximately 12,170 SF of specialty retail and restaurant space, the foundation of a former 3,590 SF retail building, and a municipal parking lot containing 50 parking spaces.

Study Methodology

This study was prepared using standard guidelines for the preparation of traffic impact studies. It examines the existing conditions of the project area, including intersection geometry and traffic control. It examines a 5-year design horizon from the date of predicted project permitting (year 2017) for traffic volume projections, which include an evaluation of the no-build conditions and build conditions. These conditions are compared to determine what, if any, off-site mitigation is necessary to provide reasonable traffic operations in the area after the development is complete.

I. Existing Conditions

A comprehensive field inventory of existing traffic conditions on the study area roadways was conducted by TEC staff in July 2010. The field investigations consisted of an inventory of existing roadway geometrics, traffic volumes, and operating characteristics. The study area was selected to contain the major roadways providing local access to the project site. The study area intersections are listed below.

Study Area Intersections

The following intersections were included in the study area for this project:

1. Trapelo Road / Common Street / Cushing Avenue (Cushing Square)
2. Trapelo Road / Starbuck's Driveway / *future Northerly Site Driveway*
3. Trapelo Road / Williston Road
4. Common Street / Horne Road
5. Williston Road / Horne Road
6. Horne Road / Poplar Street
7. Common Street / Belmont Street

The study area intersections are shown graphically in Figure 1.

Geometry

Intersection geometry and lane usage were obtained from a field inventory conducted by TEC. The field investigation consisted of an inventory of existing roadway geometrics, traffic volumes, and operating characteristics. A description of existing roadway and intersection inventory is provided below.

Roadways

Trapelo Road

Trapelo Road is a two lane east-west local highway maintained by the Town of Belmont and classified as an urban principal arterial roadway. This roadway provides a local connection between Belmont Street and Watertown/Cambridge to the east and Interstate-95 (I-95) and Waltham to the west. In the vicinity of the project site, Trapelo Road has a 75-foot layout with adjacent on-street parking lanes, and sidewalks along each edge. The roadway was originally constructed in the early 1900s to contain a single lane in each direction with electric trolley tracks in the center of the roadway. The tracks were paved over in the 1950s when the trolley service was replaced by trackless electric trolleys. Eliminating the tracks resulted in a roadway containing two 21-foot travel lanes that are striped as two 10.5-foot lanes at some signalized intersections along the corridor. Drivers who were familiar with the area utilized the 21-foot wide travel lane as two lanes, but generally drove

staggered rather than side by side. Drivers unfamiliar with the area were often confused by the wide travel lanes. As a result, the Town of Belmont restriped Trapelo Road between Waverly Square and Belmont Street to contain a 12-foot travel lane in each direction with 9-foot shoulders and 8-foot parking lanes. Improvements are proposed along Trapelo Road as part of the Trapelo Road / Belmont Street Corridor Improvements Project and are discussed further in the *Planned Roadway Improvements* section of this report. Land uses surrounding the site include commercial, retail, and residential. There are no posted speed limits within the study area; however, it is an assumed 30 miles per hour (mph) zone because it is a thickly-settled arterial roadway. The Massachusetts Bay Transit Authority (MBTA) provides electric trackless trolley service along the corridor via Line #73 that terminates at Waverly Square. There is an intermodal transfer station at Waverly Square where it meets the MBTA commuter rail line from Fitchburg to Boston, and the MBTA bus line #554 that runs along Lexington Street.

Common Street

Common Street is a two lane north-south local highway maintained by the Town of Belmont and is classified as an urban collector roadway north of Belmont Street and as an urban minor arterial south of Belmont Street. This roadway provides a local connection between Mount Auburn Street (in Watertown) to the south and Concord Avenue to the north. Generally, one lane runs in each direction and varies in width between 12 and 16 feet with adjacent on-street parking in the vicinity of the site. Sidewalks are provided along both sides of the roadway for pedestrian access. Land uses include commercial, retail and residential uses where the site is located. There are no posted speed limits within the study area; however, it is an assumed 30 miles per hour (mph) zone because it is a thickly-settled arterial roadway. At the time of the traffic counts presented in this TIAS, Common Street was under minor construction with full access for traffic in both directions.

Intersections

Trapelo Road at Common Street / Cushing Avenue (Cushing Square)

Common Street and Cushing Avenue intersect Trapelo Road to form a five-legged, four-way, fully-actuated signalized intersection. The Trapelo Road eastbound and westbound approaches both consist of two general-purpose travel lanes with adjacent on-street parking lanes on both sides of the roadway. Directional flow along Trapelo Road is separated by a marked centerline. The Common Street northbound approach consists of a single general-purpose travel lane that was observed and operates as a shared left-turn/through lane and an exclusive right-turn lane. The Common Street southbound approach consists of an exclusive left-turn lane, a through lane, and a channelized right-turn lane operating under YIELD control. Adjacent on-street parking lanes are present on both sides of the roadway. Directional flow along Common Street is separated by short raised concrete medians at the intersection and a marked centerline. Cushing Avenue provides a one-way approach exiting the intersection to the northeast with an adjacent on-street parking lane on the easterly edge of pavement. Crosswalks with pedestrian signals and push-buttons are provided on all five legs of the intersection. Additionally, a crosswalk without signals and push-buttons is provided from the channelization island on the Common Street southbound approach to the sidewalk on the northwest corner of the intersection.

Cushing Village Redevelopment - Belmont, Massachusetts

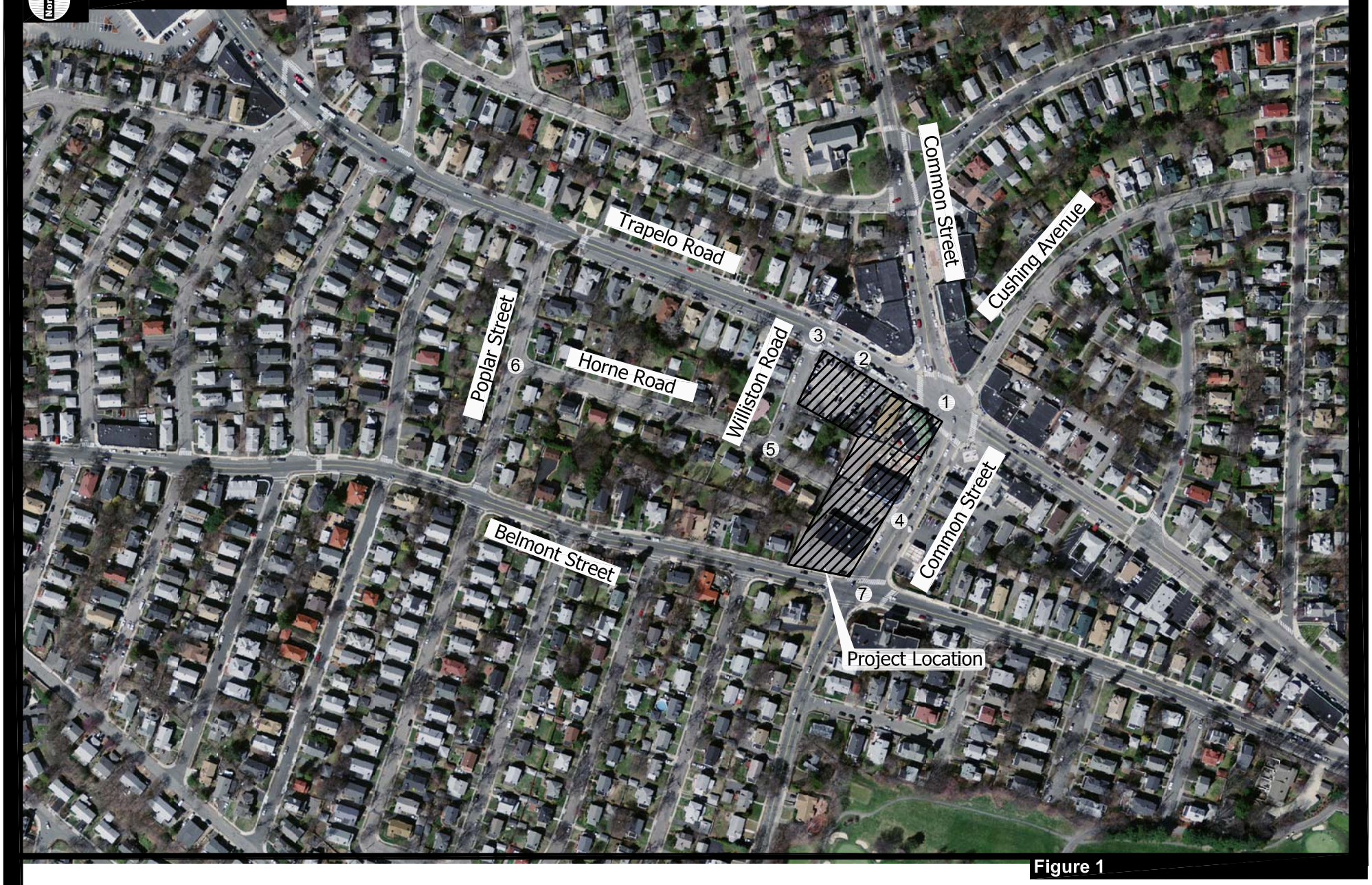

Figure 1

Project Location Map

TEC, Inc.

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Improvements are proposed at the intersection of Trapelo Road, Common Street, and Cushing Avenue as part of the Trapelo Road / Belmont Street Corridor Improvements Project. This project includes the following improvement measures:

- Removing the raised median island on the Common Street northbound and southbound approaches.
- Narrowing the Common Street southbound channelized right-turn lane by increasing the size of the channelization island.
- Extending the curb between the Common Street northerly and Cushing Avenue legs of the intersection.
- Increasing sidewalk widths in order to reduce the length of crosswalks.
- Relocating the bus stop on the northeast corner and replacing it with a loading zone.
- Restriping Trapelo Road approaches to provide an exclusive left-turn lane and a shared through/right-turn lane on each approach.
- Eliminating on-street parking along the easterly side of the Common Street northbound approach and restriping to provide an exclusive left-turn lane and a shared through/right-turn lane.
- Modifying the signal phasing to provide protected left-turn phases on all approaches and to allow the Common Street northbound and southbound through movements to operate concurrently.

A copy of the roadway improvement plans for the proposed Trapelo Road / Belmont Street Corridor Improvements Project is provided in Appendix M.

Trapelo Road at Williston Road

Williston Road intersects Trapelo Road from the south to form this T-type unsignalized intersection. The Williston Road northbound approach operates under STOP-sign control, while the Trapelo Road approaches are free-flowing. The Trapelo Road eastbound approach consists of a single general-purpose travel lane that tapers to a 20-foot travel lane in advance of the Common Street intersection downstream. The Trapelo Road westbound approach consists of a single general-purpose travel lane, but was observed to be operating as two lanes in advance of a lane merge to the west. Adjacent on-street parking lanes are present along each edge of pavement on Trapelo Road. Directional flow along Trapelo Road is separated by a marked centerline. The Williston Road northbound approach consists of a single general-purpose travel lane with an adjacent on-street parking lane along the westerly side, leaving approximately 18-feet for two-way traffic flow. Directional flow along Williston Road is unmarked. Sidewalks are present along both sides of each approach. A crosswalk is across the Williston Road leg of the intersection.

Improvements are proposed at the Trapelo Road and Williston Road intersection as part of the Trapelo Road / Belmont Street Corridor Improvements Project. These improvements include constructing a raised median island on Trapelo Road to narrow the roadway width. Additionally, curb extensions will be constructed on the southeast and southwest corners of the intersection to further narrow the roadway, providing a single travel lane in each direction on Trapelo Road. The proposed improvements are depicted graphically on the roadway improvement plans include in Appendix M.

Common Street at Horne Road

Horne Road intersects Common Street from the west to form a T-type unsignalized intersection. The Horne Road eastbound approach operates under STOP-sign control, while the Common Street approaches are free-flowing. The Horne Road eastbound approach consists of a single general-

purpose travel lane with an adjacent on-street parking along the northerly edge of pavement. Directional flow along Horne Road is separated is unmarked. The Common Street northbound approach consists of a single general-purpose travel lane that narrows as it passes through the intersection. The Common Street southbound approach consists of a single general-purpose travel lane that widens as it passes through the intersection. On-street parking is provided on both sides of Common Street in the vicinity of the intersection. Directional flow along Common Street is separated by a marked centerline. Sidewalks are present along both sides of each approach. A crosswalk is provided across the Horne Road leg of the intersection.

Horne Road at Williston Road

Williston Road intersects Horne Road from the north to form a T-type unsignalized intersection. The Williston Road southbound approach operates under STOP-sign control, while the Horne Road approaches are free-flowing. Right-turn movements from Williston Road onto Horne Road are restricted from 7:00 to 9:00 AM and from 4:00 to 6:00 PM. The Horne Road eastbound and westbound approaches consist of single general-purpose travel lanes. The Williston Road southbound approach consists of a single general-purpose travel lane with on-street parking provided the westerly side of the roadway only. Directional flow along all three approaches is unmarked. Sidewalks are provided along both sides of Horne Road and Williston Road in the vicinity of the intersection.

Poplar Street at Horne Road

Horne Road intersects Poplar Street from the east to form a T-type unsignalized intersection. There is currently no traffic control on any of the approaches to this intersection. Due to the geometry, however, drivers approaching the intersection along Horne Road westbound typically stop and yield to Poplar Street traffic. The Horne Road westbound approach consists on a single general-purpose travel lane. The Poplar Street northbound and southbound approaches both consist of single general-purpose travel lanes. On-street parking is allowed on both sides of each approach. Sidewalks are also provided along both sides of Horne Road and Poplar Street in the vicinity of the intersection.

Common Street at Belmont Street

Common Street intersects Belmont Street to form a four-way, fully-actuated signalized intersection. The Belmont Street eastbound approach consists of a single general-purpose travel lane. The Belmont Street westbound approach consists of a single general-purpose travel lane that widens to a 22-foot travel lane approximately 125 feet in advance of the intersection, which was observed operate as a shared left-turn/through lane and a right-turn lane. Directional flow along Belmont Street is separated by a marked centerline. The Common Street northbound and southbound approaches each provide a single general-purpose travel lane that widens in advance of the intersection, providing adequate width for two lanes of traffic. The Common Street approaches are slightly offset, resulting in poor alignment of the through lanes. Directional flow along Common Street is separated by a marked centerline. An adjacent on-street parking lane is provided along the westerly side of Common Street north of the intersection. Sidewalks are provided along both sides of all four approaches. Crosswalks with pedestrian signals and push-buttons are provided across all four legs of the intersection.

Improvements are proposed at the intersection of Common Street and Belmont Street as part of the Trapelo Road / Belmont Street Corridor Improvements Project, and include restriping the Common Street southbound approach to provide an exclusive left-turn lane and a shared through/right-turn lane. This improvement will provide better alignment of the through lanes on the Common Street

approaches to the intersection. The improvements are graphically depicted on the roadway improvement plans included in Appendix M.

Existing Traffic Volumes

In order to establish existing traffic-volume conditions within the study area, manual turning movement counts (TMC's) were conducted at the study area intersections on Tuesday June 15, 2010 during the weekday morning (7:00 to 9:00 AM) and weekday evening (4:00 to 6:00 PM) peak period and on Saturday June 12, 2010 during the Saturday Midday (11:00 AM to 2:00 PM) peak period. Public schools were still in session at the time that these counts were conducted. The weekday morning and evening peak periods are consistent with typical peak commuter traffic periods. These periods represent the most critical traffic volume conditions in the study area and were conducted during an annual period when public schools were in session. A detailed summary of the turning movement counts, partitioned into 15-minute intervals, is provided within Appendix A.

Automatic Traffic Recorder (ATR) counts were conducted concurrently with the TMCs on Saturday June 12 to Tuesday June 15, 2010 along Trapelo Road and Horne Road and subsequent to the TMCs on Tuesday June 29 to Thursday July 1, 2010 along Common Street to gather daily traffic data for the study area roadways during a continuous 72-hour time period. A summary of the weekday and Saturday ATR traffic data is presented in Tables 1 and 2, respectively. A detailed summary of the ATR counts partitioned into 15-minute intervals is provided within Appendix B.

Table 1 - Existing Weekday Traffic Volume Summary[a]

Location	Weekday 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
Trapelo Road (west of Common Street)	16,170	1,260	7.8	64.1% EB	1,360	8.4	55.3% WB
Horne Road (west of Common Street)	640	55	8.6	79.2% EB	65	10.2	53.1% WB
Common Street (south of Trapelo Road)	6,730	435	6.5	61.7% SB	590	8.8	52.5% 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.
EB = eastbound, WB = westbound, NB = northbound, SB = southbound

Table 2 - Existing Saturday Traffic Volume Summary[a]

Location	Weekday Traffic Volume[b]	Weekday Morning Peak Hour		
		Traffic Volume[c]	K Factor[d]	Directional Distribution[e]
Trapelo Road (west of Common Street)	12,790	1,085	8.5	50.3% EB
Horne Road (west of Common Street)	530	70	13.2	50.0% --
Common Street (south of Trapelo Road)	6,500	555	8.5	54.6% 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.
EB = eastbound, NB = northbound

As no TMC's were conducted at the existing Starbuck's driveway along Trapelo Road, TEC utilized standard trip rates contained in the Institute of Transportation Engineers (ITE) publication *Trip Generation, 8th Edition*, for Land Use Code (LUC) LUC 936 - Coffee/Donut Shop without Drive-Through Window, to estimate the trips generated by the Starbucks at this driveway.

Seasonal Adjustment

In accordance with MassDOT standards, traffic-volumes are typically adjusted to average-month conditions. Based on a review of historic traffic-volume counts collected by MassDOT at permanent count stations along Interstate 95 / Route 128 in Woburn[1] and Lexington[2], traffic-volumes in June are slightly higher than average-month conditions. Therefore, the unadjusted June 2010 traffic counts were utilized to reflect a conservative (worse case) analysis scenario. The compiled seasonal adjustment data is provided in Attachment C. The resulting 2010 Existing weekday morning, weekday evening, and Saturday midday peak-hour traffic-volume networks are illustrated in Figure 2.

[1] MassDOT Permanent Count Station 4049 – Woburn – Interstate 95 / Route 128 – south of Interstate 93
[2] MassDOT Permanent Count Station 4118 – Lexington – Interstate 95 / Route 128 – north of Route 2A

Not to Scale

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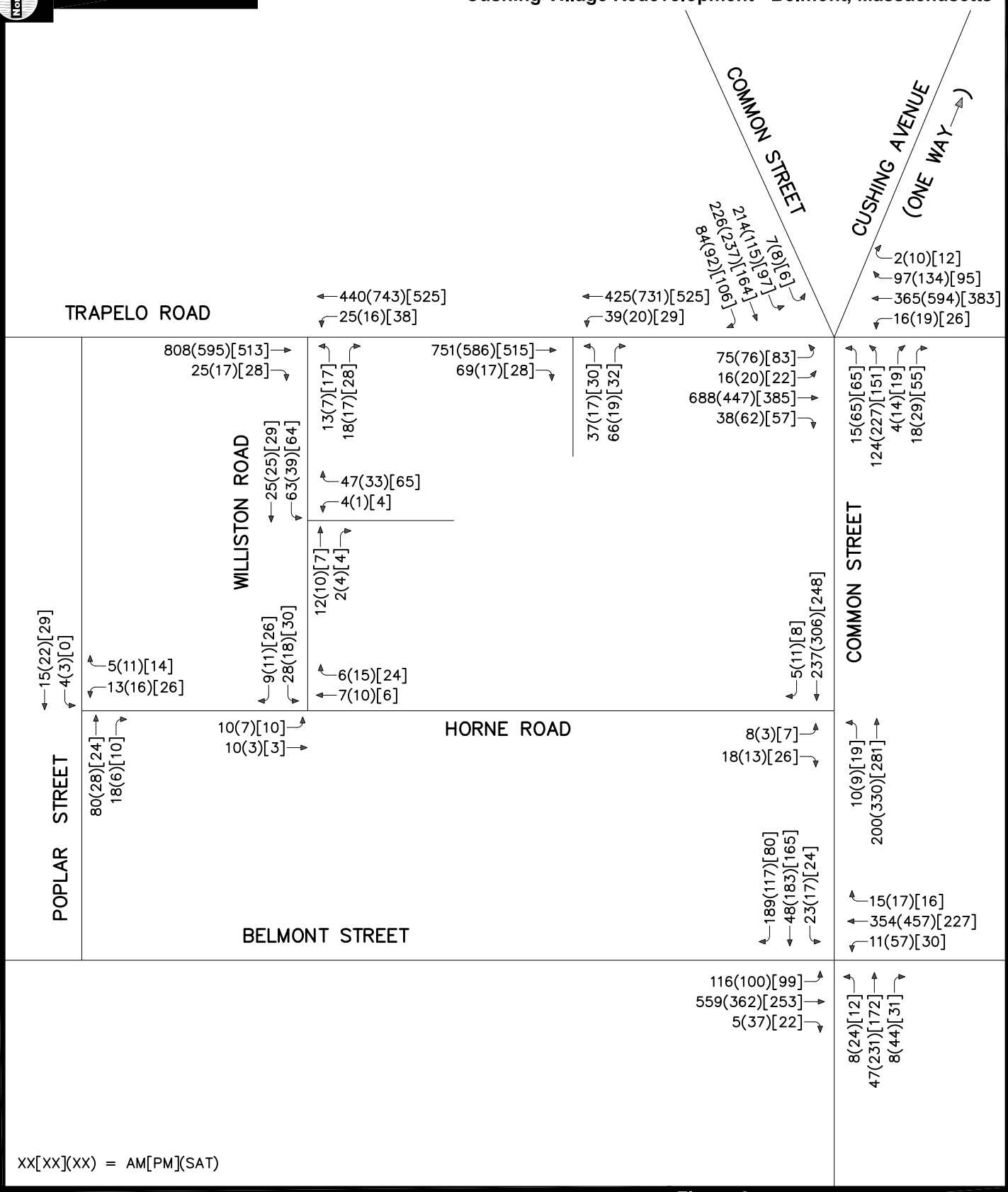

Figure 2

**2010 Existing Conditions
Weekday Morning,
Weekday Evening, and
Saturday Midday
Peak Hour Traffic Volumes**

TEC, Inc.

Public Transportation

Public transportation within the study area is provided by the Massachusetts Bay Transportation Authority (MBTA). There are currently two MBTA bus routes (Bus Routes #73 and #554) that traverse through the study area intersections. Bus route and schedule data are included in Appendix D and a summary of the routes are provided below:

- *MBTA Route 73 – Waverly Square to Harvard Square via Trapelo Road* – Electronic trolley service is provided along Trapelo Road and Belmont Street in Belmont), and along Belmont Road and Mount Auburn Street in Cambridge. This bus operates from 5:02 AM to 1:20 AM on weekdays with approximately 5-40 minute headways and from roughly 5:03 AM to 1:19 AM on Saturdays with approximately 10-45 minute headways. This bus does operate on Sundays.
- *MBTA Route 554 – Waverly Square to Downtown Boston* – Service is provided along Federal Street and Lincoln Street in Boston, along Washington Street, Elm Street, River Street, and Lexington Street in Newton, Moody Street, Elm Street, Lexington Street, Beaver Street, Forest Street, Trapelo Road, Waverly Oaks Road (Route 60), and Warren Street in Waltham, along Belmont Street in Watertown, and along Lexington Street in Belmont. This bus operates from 5:51 AM to 8:15 PM on weekdays with approximately 24-66 minute headways and from 6:30 AM to 7:48 PM on Saturdays with approximately 45 minute headways.

Bus stops for MBTA Bus Route #73 are located within the study area on the eastbound approach of Trapelo Road at the existing Starbucks driveway and along the Trapelo Road westbound approach at Common Street. The MBTA also provides commuter rail service to Waverly Square via the Fitchburg/South Acton line, which may be accessed from the site via Bus Route #73. Waverly Square Commuter Rail Station is located approximately 0.9 miles west of Cushing Square.

Crash Data Analysis

Collision data for the study area intersections was compiled and analyzed for the most recent consecutive four year period (2007-2010) on file from MassDOT. The motor vehicle crash data was reviewed to determine crash trends in the study area. A summary of the vehicle crash data and rates is provided in Table 3 on the following page. None of the study area intersections are listed on MassDOT's Top 200 Crash Locations.

Crash Rate Worksheets

In addition to examining the number of collisions at the intersections, a crash rate was calculated to compare occurrence of collisions to the volume of traffic passing through the intersection. The crash rate per million entering vehicles (MEV) was calculated using the evening peak hour volumes from the TMCs and a calculated K-factor obtained from ATR counts. The crash rates at each of the study area intersections were compared to the statewide and district-wide averages published by MassDOT in July 2011 to determine the significance of the collision occurrence. The statewide average for signalized intersections is 0.81 and the District 4 average for signalized intersections is 0.78. The statewide average for unsignalized intersections is 0.61 and the District 4 average for unsignalized intersections is 0.59. A compilation of the MEV rate calculation worksheets and detailed crash data are provided in Appendix E.

Table 3 – Crash Data Summary

		Location					
		Trapelo Rd & Common St	Trapelo Rd & Williston Rd	Common St & Belmont St	Common St & Horne Rd	Horne Rd & Poplar St	Horne Rd & Williston Rd
Year:	2007	4	1	1	0	0	0
	2008	1	3	1	0	0	0
	2009	5	1	5	0	0	0
	2010	1	1	0	0	0	0
	TOTAL	**11**	**6**	**7**	**0**	**0**	**0**
Annual Average:		*2.75*	*1.50*	*1.75*	*0.00*	*0.00*	*0.00*
Crash Rate (MEV):		*0.29*	*0.25*	*0.26*	*0.00*	*0.00*	*0.00*
Type:	Angle	2	4	2	0	0	0
	Rear - End	1	2	1	0	0	0
	Single Vehicle	0	0	3	0	0	0
	Sideswipe	6	0	1	0	0	0
	Head-on	0	0	0	0	0	0
	Ped/Bike	2	0	0	0	0	0
	Not Reported	0	0	0	0	0	0
	TOTAL	**11**	**6**	**7**	**0**	**0**	**0**
Severity:	Property Damage	8	5	6	0	0	0
	Non-Fatal Injury	3	1	1	0	0	0
	Not Reported	0	0	0	0	0	0
	TOTAL	**11**	**6**	**7**	**0**	**0**	**0**
Time Of Day	7 AM-9 AM	0	0	1	0	0	0
	10 AM-3 PM	6	5	5	0	0	0
	4 PM-6 PM	3	1	1	0	0	0
	All Other Times	2	0	0	0	0	0
	TOTAL	**11**	**6**	**7**	**0**	**0**	**0**

The Trapelo Road / Common Street intersection experienced eleven collisions during the four-year study period. The majority of these collisions (6 of 11) were side-swipe collisions which are likely due to driver confusion over the number and usage of lanes resulting from wide shoulders and parking lanes in the vicinity of the intersection and a lack of signage. Improvements are proposed at this intersection as part of the Trapelo Road/Belmont Street Corridor Improvements Project, which include restriping the intersection and may reduce collisions of this type.

The remaining intersections experienced fewer than three collisions per year over the four-year study period. All of the study area intersections experienced crash rates lower than the statewide and district-wide averages, indicating the no safety trend exists.

II. Future Conditions

Traffic volumes in the study area were projected to the year 2017, which reflects a five-year planning horizon from the planned date of project submission for permitting. The traffic conditions for the year 2017 under No-Build conditions were developed to document the operating conditions independent of the proposed project, including all existing traffic, new traffic resulting from background growth, and traffic from specific development projects, if any, in the vicinity of the project corridor. Anticipated site-generated traffic volumes for the proposed mixed-use development were superimposed upon the No-Build traffic network to reflect the Build conditions with the project.

Planned Roadway Improvements

TEC contacted officials from the Town of Belmont and MassDOT to determine whether there are any roadway improvement projects that are planned to be completed within the five-year design horizon. Improvements are proposed along Trapelo Road as part of the Trapelo Road / Belmont Street Corridor Improvements Project (#640688). This project is intended to provide a roadway width that is consistent with the number of lanes of traffic along the corridor, provide bicycle accommodations, upgrade traffic signal equipment, provide fire preemption along the corridor, and improve access for pedestrians and the handicapped. Construction of the Trapelo Road / Belmont Street Corridor Improvements Project is scheduled to begin in spring of 2013. The following is a summary of the improvement measures that are proposed at the study area intersections. A plan depicting these improvement measures is provided in Appendix M.

Trapelo Road / Common Street / Cushing Avenue

- The raised median island on the Common Street northbound and southbound approaches will be removed.
- The width of the Common Street southbound channelized right-turn lane will be reduced by increasing the size of the channelization island.
- The curb between the Common Street northerly and Cushing Avenue legs of the intersection will be extended.
- The sidewalk widths will be increased in order to reduce the length of crosswalks.
- The bus stop on the northeast corner will be relocated and replaced with a loading zone.
- The Trapelo Road approaches will be restriped to provide an exclusive left-turn lane and a shared through/right-turn lane on each approach.
- On-street parking along the easterly side of the Common Street northbound approach will be eliminated and Common Street will be restriped to provide an exclusive left-turn lane and a shared through/right-turn lane.
- The signal phasing will be modified to provide protected left-turn phases on all approaches and to allow the Common Street northbound and southbound through movements to operate concurrently.

Trapelo Road / Williston Road

Improvements at this intersection include constructing a raised median island on Trapelo Road to narrow the roadway width. Additionally, curb extensions will be constructed on the southeast and southwest corners of the intersection to further narrow the roadway, providing a single travel lane in each direction on Trapelo Road.

Belmont Street / Common Street

Improvements at this intersection include restriping the Common Street southbound approach to provide an exclusive left-turn lane and a shared through/right-turn lane. This improvement will provide better alignment of the through lanes on the Common Street approaches to the intersection.

Background Traffic Growth

Traffic growth is a function of the expected land development in the immediate area and the surrounding region. Several methods can be used to estimate this growth. Traffic engineers frequently employ an annual percentage increase in traffic growth, which is applied to all traffic volumes under study. The drawback to such a procedure is that some turning volumes may actually 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 procedure 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 considered.

General Background Growth

Traffic volume data compiled by MassDOT from permanent count stations and other interim counts were researched in order to determine traffic growth trends. However, traffic volume data was not collected consistently in the immediate vicinity of the site. Therefore traffic volume data from surrounding towns was reviewed, which indicated that traffic volumes in the region have been decreasing at an average rate of 2.6 percent per year. Traffic volume counts collected at the intersection of Trapelo Road and Common Street in 2005 were obtained from the Functional Design Report prepared for the Trapelo Road/Belmont Street Corridor Improvements Project and compared to turning movement counts collected by TEC in 2010. These counts indicated a growth rate of -1.3 percent per year in the immediate study area. For a conservative analysis, a 1.0 percent compounded annual growth rate was used to account for general background traffic growth and development by others not yet identified. See Appendix F for traffic growth rate calculations.

Specific Development by Others

TEC coordinated with the Town of Belmont Community Development Department, Divisions of Planning and Engineering, to identify nearby private development projects that are either in the planning process or were recently approved by the Planning Board. After discussions with Town officials and review of recently approved projects, TEC was informed that there are currently no proposed or approved projects in the vicinity of the site.

Re-Occupancy of Vacant Space

At the time that the turning movement counts were collected, the existing site contained a vacant 6,200 SF CVS/pharmacy and 3,930 SF of vacant specialty retail space, which could be reoccupied in the future by similar land uses without further project permitting. Therefore, traffic volumes associated with the re-occupancy of existing vacant space on the site were included in the 2017 No-Build traffic volume networks. Trips generated by re-occupancy of the existing space were estimated based on standard trip rates obtained from the ITE publication *Trip Generation, 8th Edition* for LUC 814 – Specialty Retail and for LUC 880 – Pharmacy/Drugstore without Drive Through Window. The resulting re-occupancy trips generated for the weekday morning, weekday evening, and Saturday midday peak hours are illustrated in Figure G-2. Trip generation calculations for the re-occupancy of existing vacant space are provided in Appendix G.

No-Build Traffic Volumes

The 2017 No-Build weekday morning, weekday evening and Saturday midday peak-hour traffic-volume networks were developed by applying the 1.0 percent per year compounded annual background traffic growth rate to the 2010 Existing peak-hour traffic volumes for 7 years and adding traffic generated by the re-occupancy of existing vacant space on the site. The 2017 No-Build weekday morning, weekday evening and Saturday midday peak-hour traffic-volume networks are illustrated in Figure 3.

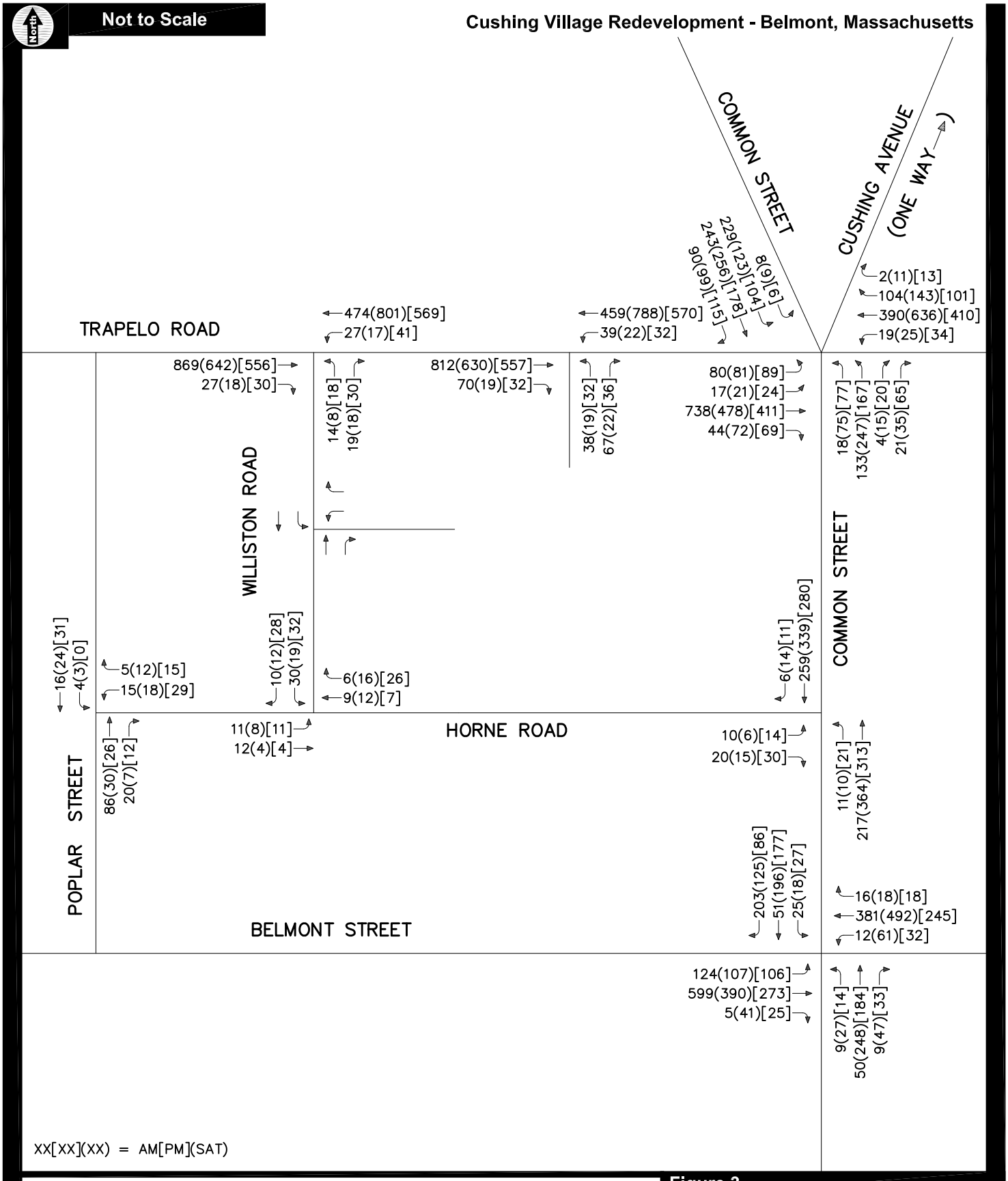

Figure 3

**2017 No-Build Conditions
Weekday Morning,
Weekday Evening, and
Saturday Midday
Peak Hour Traffic Volumes**

TEC, Inc.

Site Generated Traffic

The proposed mixed-use development project consists of demolishing the existing buildings on the site and constructing approximately 118 apartment units, a 3,300 health and fitness club, a 5,000 SF quality restaurant, a 2,000 SF Starbucks, and 27,200 SF of general retail space. The trips generated by the proposed mixed-use development were estimated using standard trip rates published in the ITE publication, *Trip Generation, 8th Edition* for LUC 220 - Apartments, LUC 492 – Health and Fitness Center, LUC 931 – Quality Restaurant, LUC 936 – Coffee/Donut Shop without Drive Thru Window, and LUC 820 - Shopping Center, respectively. Table 4 provides a summary of the resulting trip generation.

Table 4 – Proposed Trip Generation Summary

Time Period	Health Club LUC 492	Shopping Center LUC 820	Apartments LUC 220	Quality Restaurant LUC 931	Starbucks LUC 936	Total Trips
Weekday Daily	109	2,604	785	450	1,733	**5,681**
Weekday Morning						
IN	2	38	12	2	119	**173**
OUT	3	24	48	2	115	**192**
TOTAL	5	62	60	4	234	**365**
Weekday Evening						
IN	7	118	47	25	41	**238**
OUT	5	121	26	12	41	**205**
TOTAL	12	239	73	37	82	**443**
Saturday Daily	69	3,613	754	439	1,683	**6,558**
Saturday Midday						
IN	4	171	31	32	63	**301**
OUT	5	158	30	22	69	**284**
TOTAL	9	329	61	54	132	**585**

[a]*ITE Trip Generation*, Eighth Edition, Institute of Transportation Engineers, 2008.

It is reasonable to expect that some trips to the site will be shared between multiple land uses. For example, someone living within the apartments may choose to shop at the retail or eat at the restaurant on site. Therefore, a reduction in the overall trips experienced at the site driveways can be anticipated as a result of multi-use trips that include stops at more than one use on the site. Based on information contained in the ITE Trip Generation Handbook, multi-use trips are anticipated to account for 16 percent of the total site-generated traffic during the weekday morning peak period, 23 percent of the total site-generated traffic during the weekday evening peak period, and 26 percent of the total site-generated traffic during the Saturday midday peak period. The multi-use trip generation worksheets are included in Appendix H.

Not all of the trips generated by the proposed mixed-use development will be new to the roadway network. Many of the trips generated by the proposed development are already present in the existing traffic flow passing by the site. For example, some vehicles which are already on the roadways may decide to visit the site on their way to another destination. Once they complete their visit to the site, they continue on toward their ultimate destination. These vehicle trips are known as "pass-by" trips and are subtracted from the total trips to calculate the total primary (or "new") trips that affect the volume of traffic within the study area away from the site. Based on rates contained in ITE Trip Generation Handbook, 2nd Edition, approximately 50 percent of traffic generated by the

Starbucks, 44 percent of traffic generated by restaurants, and 26 to 34 percent of traffic generated by retail represents pass-by traffic.

In addition to pass-by trips, the existing land uses on the site are currently generating trips that will be removed from the roadway network as part of the redevelopment of the site. Table 5 provides a summary of the trips generated by the existing land uses on the site.

The availability of public transportation for access to the site may result in a reduction in the trips generated by passenger vehicles traveling to and from the site. The proposed mixed-use project is located in close proximity to two MBTA bus stops along Trapelo Road and within one mile of the Waverly Commuter Rail Station to the west along Trapelo Road. However, to provide a conservative (worst-case) analysis scenario, no credit was taken for transit trips generated by the project.

The estimated net increase in trip generation for the proposed mixed-use development is summarized in Table 5 and the detailed trip generation worksheets are provided in Appendix H. As shown Table 5, the proposed mixed-use development is estimated to generate approximately 65 *new* trips during the weekday morning peak hour, 147 *new* trips during the weekday evening peak hour, and 178 *new* trips during the Saturday midday peak hour.

Table 5 - Trip Generation – Total Additional Trips

Time Period	Total Trips			Multi-Use Trips	Pass-by Trips[c]	New Primary Trips[d]
	Proposed[a]	Re-Occupied[b]	Net Increase			
Weekday Daily	5,681	2,649	**3,032**	1,758	-6	**1,280**
Weekday Morning						
IN	173	125	**48**	29	1	**18**
OUT	192	115	**77**	29	1	**47**
TOTAL	365	240	**125**	58	2	**65**
Weekday Evening						
IN	238	78	**160**	52	17	**91**
OUT	205	80	**125**	52	17	**56**
TOTAL	443	158	**285**	104	34	**147**
Saturday Daily	6,558	2,730	**3,828**	1,692	196	**1,940**
Saturday Midday						
IN	301	115	**186**	75	11	**100**
OUT	284	120	**164**	75	11	**78**
TOTAL	585	235	**350**	150	22	**178**

[a] From Table 3.
[b] ITE LUC 880 (Pharmacy/Drugstore without Drive-Thru Window) for 6,200 SF, ITE LUC 936 (Coffee/Donut Shop without Drive-Through Window) for 1,800 SF, and ITE LUC 814 (Specialty Retail) for 12,065 SF, which assumes re-occupancy of vacant space on the site.
[c] 44 percent of restaurant trips; 26 percent of retail trips during all periods except weekday evening peak hour; 34 percent of retail trips during weekday peak hour.
[d] Net Increase in trips minus multi-use trips and pass-by trips.

Site Access

Access to the site is currently provided at a total of nine driveways:

- One driveway to the CVS/pharmacy on Belmont Street west of Common Street
- Two driveways to the CVS/pharmacy on Common Street
- One driveway to the CVS/pharmacy on Horne Road
- One driveway to the existing Laundromat and bank on Horne Road
- One driveway on Common Street south of Trapelo Road to the specialty retail building on the northeast corner of the site
- One driveway on Trapelo Road west of Common Street to the specialty retail building on the northeast corner of the site
- One driveway to the Starbucks on Trapelo Road west of Common Street
- One driveway to the municipal parking lot on Williston Road.

As part of the proposed mixed-use development project, all of the existing driveways to the site will be closed or relocated. The existing Horne Road connection to Common Street will be closed except for emergency access. Access to the site will be provided via a driveway at the current Horne Road intersection with Common Street and via a new driveway on Trapelo Road west of Common Street. The Common Street driveway will provide full access and egress, while the Trapelo Road driveway will provide full access and right-out only egress.

Trip Distribution & Assignment

Directional distribution of trips to and from the proposed development is a function of population densities, areas of employment, shopping opportunities, recreational activity, and prevailing traffic conditions on area roadways. Another factor taken into account was current traffic patterns evident in the turning movement counts mentioned previously. The resulting trip distribution for each of the study time periods is shown in Table 6. Traffic networks illustrating this distribution and assignment are shown in Figures 4 through 9 for the weekday morning, weekday evening and Saturday midday peak hours, respectively. Distribution and assignment calculations can be found in Appendix H based on existing traffic volumes.

Table 6 - Trip Distribution Summary

Direction	Weekday AM	Weekday PM	Saturday Midday
Trapelo Road to/from West	25%	23%	28%
Trapelo Road to/from East	15%	20%	20%
Common Street to/from North	15%	15%	15%
Common Street to/from South	5%	10%	10%
Belmont Street to/from West	25%	17%	17%
Belmont Street to/from East	15%	15%	10%
Total	100%	100%	100%

Not to Scale

Cushing Village Redevelopment - Belmont, Massachusetts

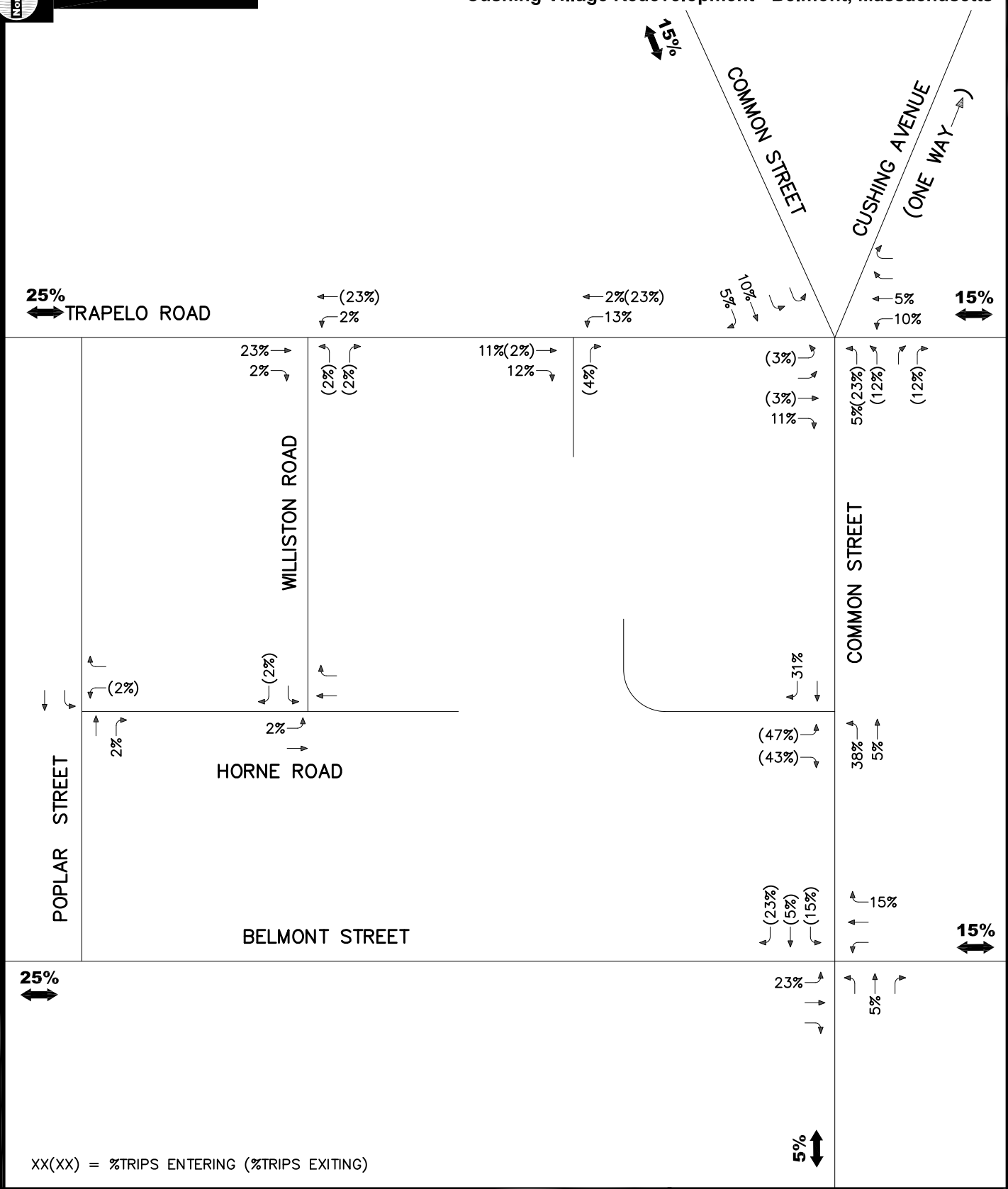

Figure 4

Primary Trip Distribution
Weekday Morning
Peak Hour Traffic Volumes

Not to Scale

Cushing Village Redevelopment - Belmont, Massachusetts

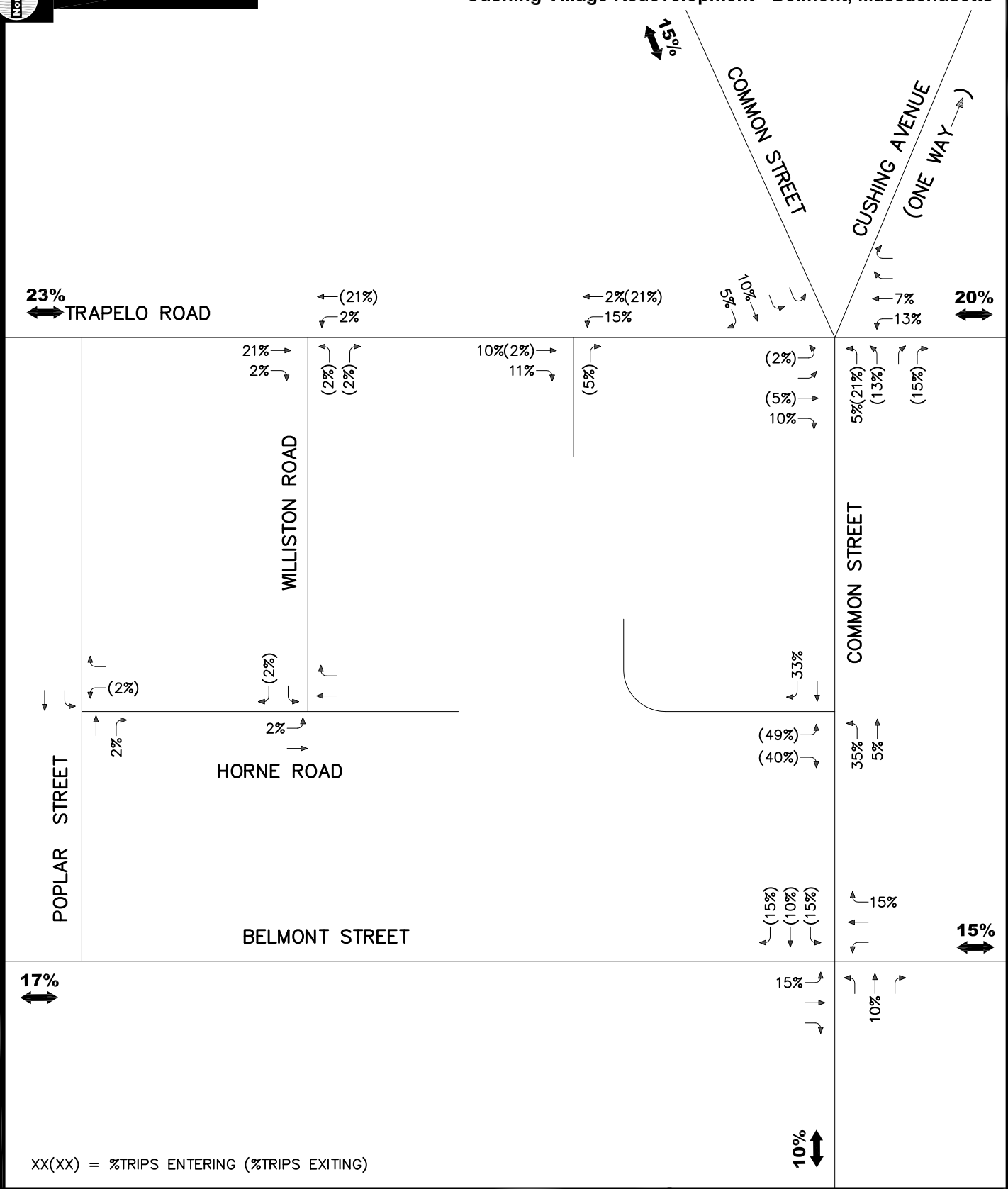

Figure 5

Primary Trip Distribution
Weekday Evening
Peak Hour Traffic Volumes

TEC, Inc.

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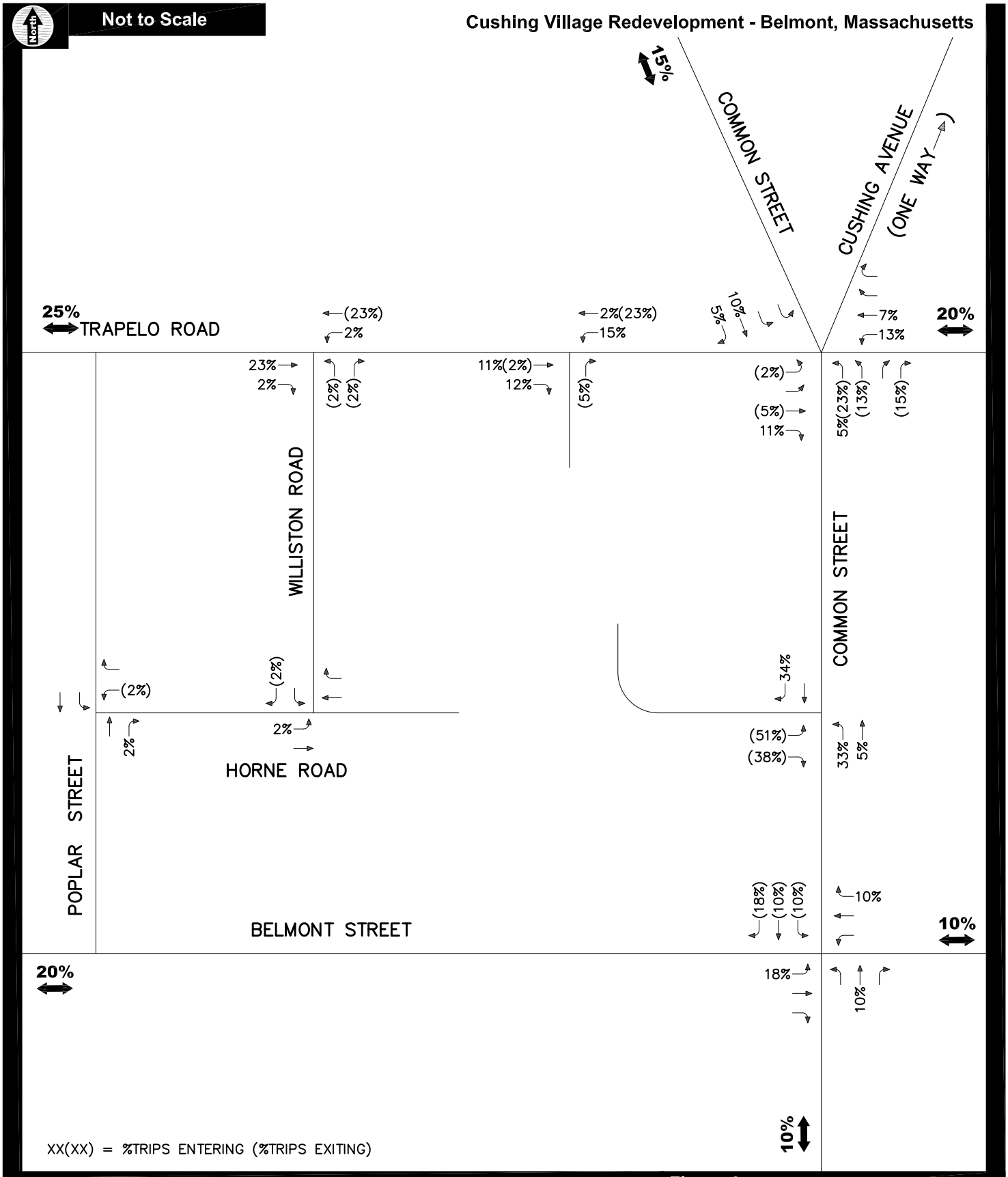


Figure 6

Primary Trip Distribution
Saturday Midday
Peak Hour Traffic Volumes

TEC, Inc.

Not to Scale

Cushing Village Redevelopment - Belmont, Massachusetts

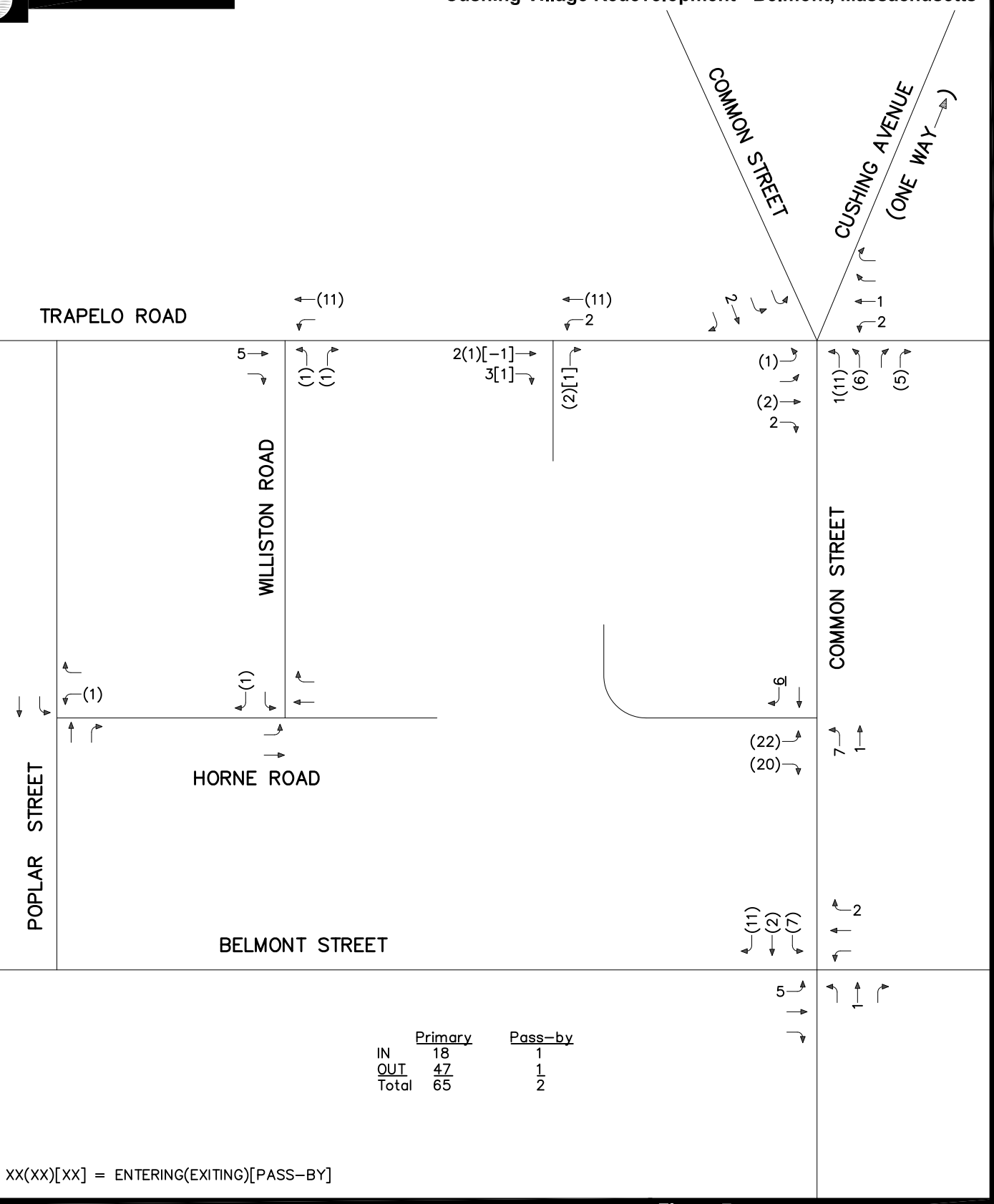


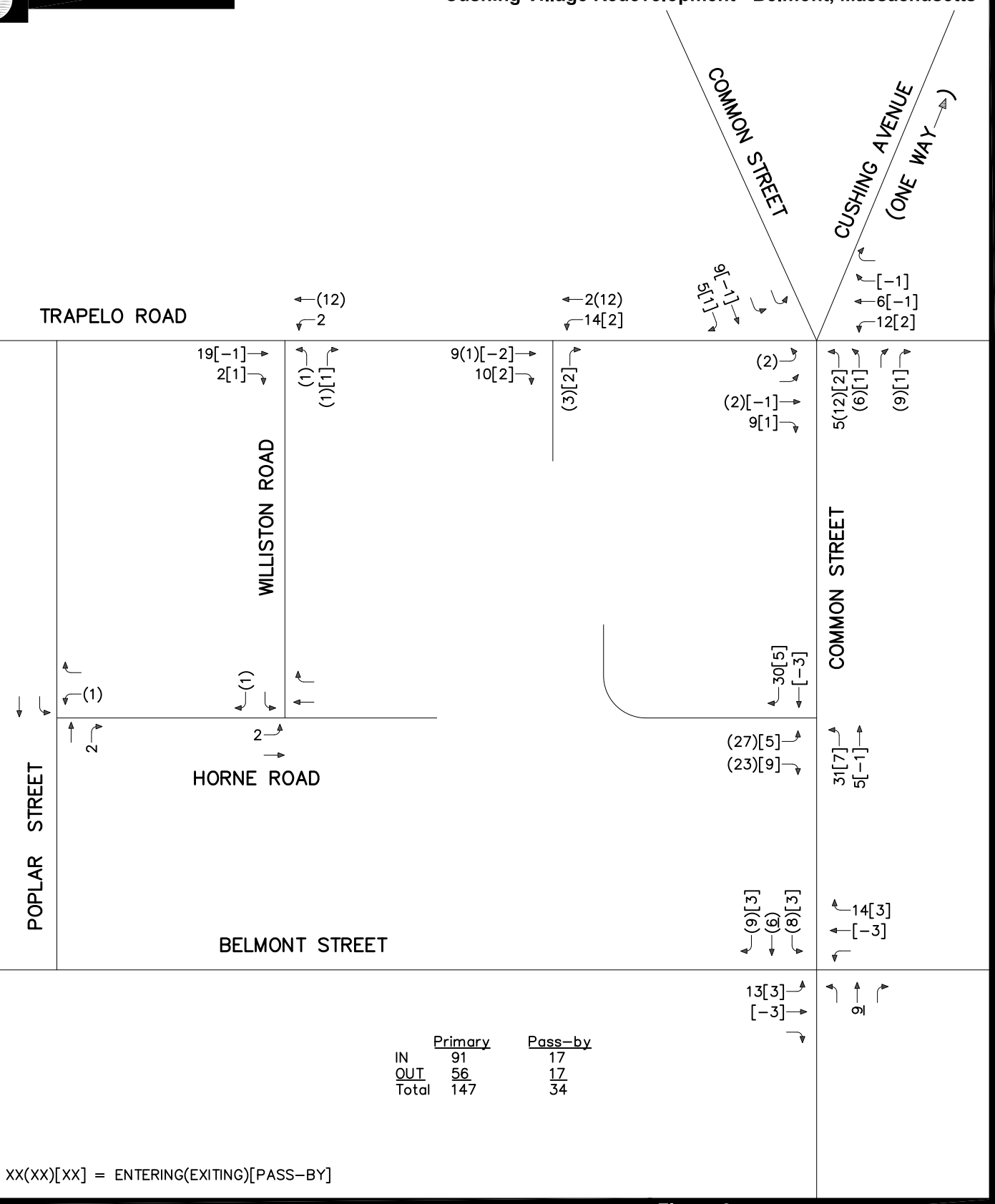
Figure 7

Site Generated Trip Assignment
Weekday Morning
Peak Hour Traffic Volumes

TEC, Inc.

Not to Scale

Cushing Village Redevelopment - Belmont, Massachusetts



	Primary	Pass−by
IN	91	17
OUT	56	17
Total	147	34

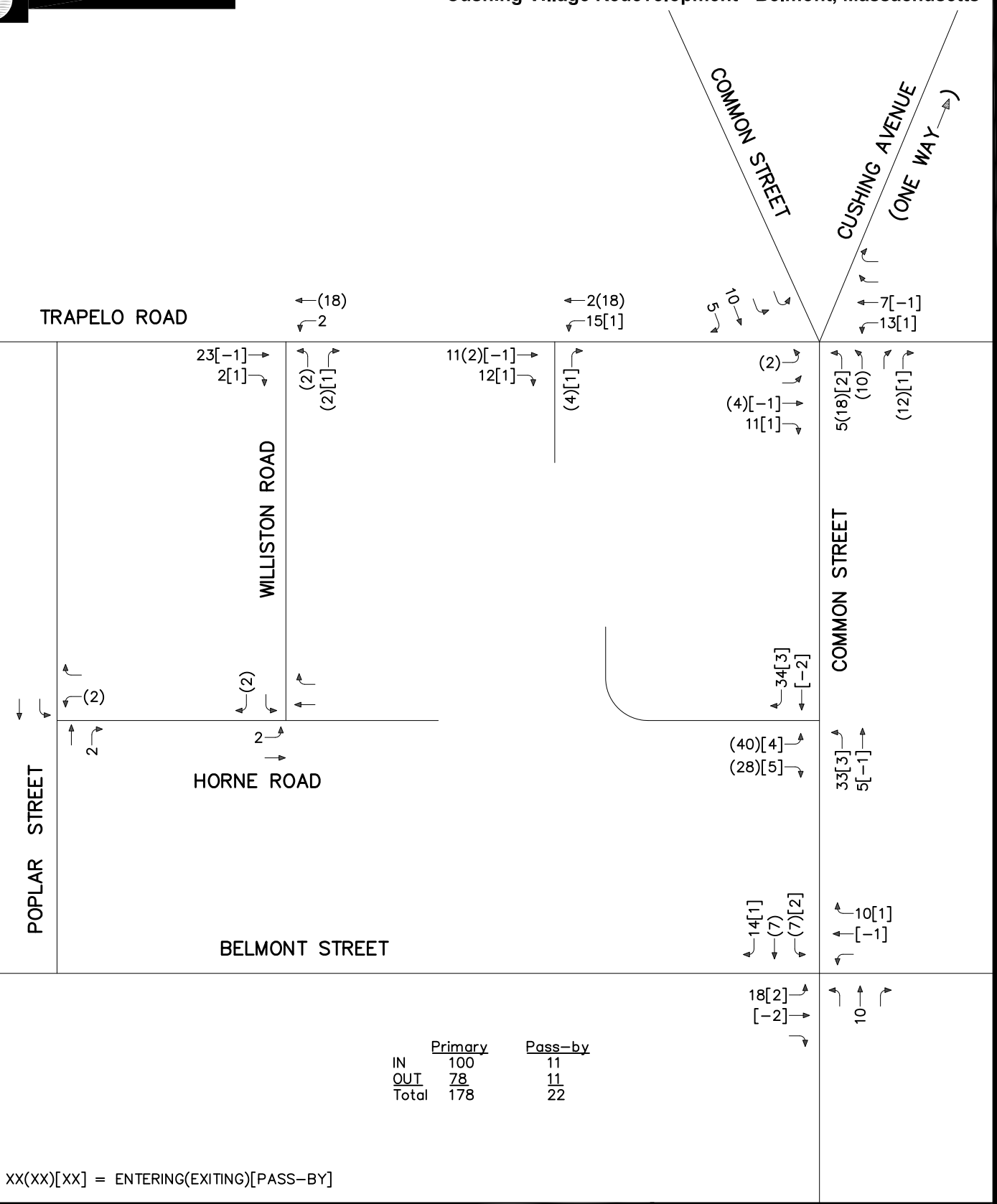
Figure 8

Site Generated Trip Assignment
Weekday Evening
Peak Hour Traffic Volumes

TEC, Inc.

Not to Scale

Cushing Village Redevelopment - Belmont, Massachusetts



	Primary	Pass-by
IN	100	11
OUT	78	11
Total	178	22

XX(XX)[XX] = ENTERING(EXITING)[PASS-BY]

Figure 9

Site Generated Trip Assignment
Saturday Midday
Peak Hour Traffic Volumes

TEC, Inc.

Redistributed Traffic Volumes

As part of the proposed mixed-use development project, the existing municipal parking lot on Williston Road will be closed. The traffic currently parking in this lot is anticipated to utilize on-site parking spaces and on-street parking spaces on the study area roadways. In order to provide a conservative (worst case) analysis scenario of the site driveway operations, TEC has assumed that all traffic currently parking in the municipal lot will utilize on-site parking spaces. TEC has redistributed traffic that is currently parking in the municipal lot to the site driveways. The resultant redistribution of existing traffic to and from the municipal parking lot is shown in Figure I-1 of Appendix I.

As part of the proposed mixed-use development project, the existing Horne Road connection to Common Street will be closed except for emergency access. All traffic currently using Horne Road to access Common Street will utilize either Williston Road or Poplar Street. The redistribution of existing traffic volumes associated with closing Horne Road is shown in Figure I-2 of Appendix I.

There are a total of seven site driveways along Trapelo Road, Common Street, Belmont Street, and Horne Road that will be closed as part of the proposed redevelopment project. New driveways will be constructed on Trapelo Road west of Common Street and at the current intersection of Horne Road and Common Street. TEC has redistributed the existing site-generated traffic to the proposed site driveways as shown in Figure I-3 of Appendix I. The site-generated traffic associated with re-occupancy of the existing vacant CVS pharmacy and retail space was also redistributed to the proposed site driveways as shown in Figure 1-4 of Appendix I.

There is an existing Starbucks on the site that has a driveway on Trapelo Road between Williston Road and Common Street that accesses a 13-stall parking lot. The Starbucks will be reconstructed on the site just west of the proposed Trapelo Road site driveway. Based on the location of the Starbucks on the site, the majority of Starbucks patrons are anticipated to park in the proposed surface parking lot on Trapelo Road. The existing Starbucks driveway provides full access and full egress, while the proposed site driveway on Trapelo Road will be limited to full access and right-out-only egress. As such, all traffic exiting Starbucks toward Trapelo Road west will be required to exit the Common Street driveway onto Common Street and turn left at the signalized intersection of Trapelo Road / Common Street to access Trapelo Road west. In addition, traffic exiting the Starbucks toward Common Street south is anticipated to divert to the Common Street driveway. The redistribution of existing traffic associated with the relocation of the Starbucks and reconfiguration of the driveways is shown in Figure I-5 of Appendix I.

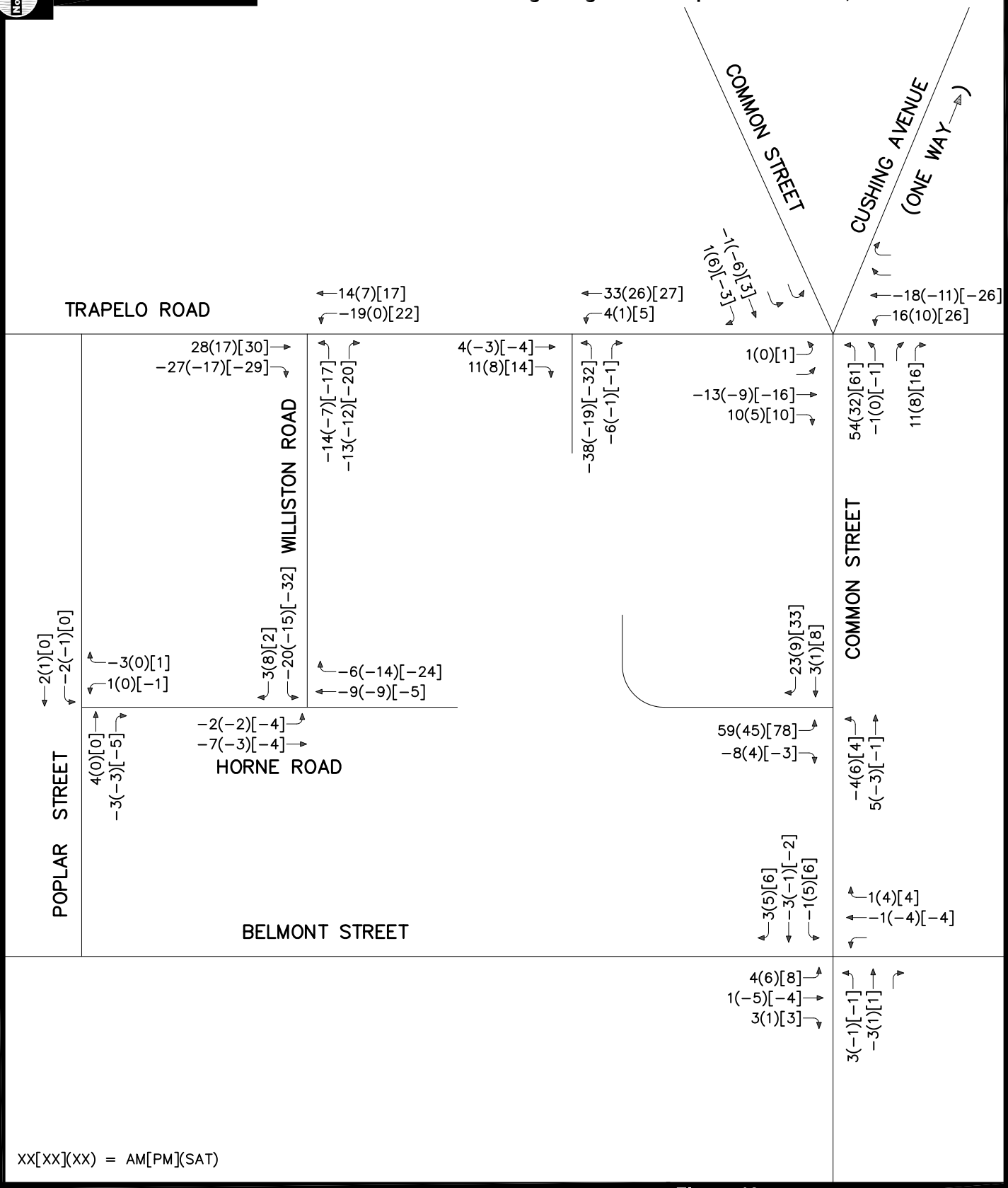
The Net Redistributed Trips traffic volume networks were obtained by combining the trips associated with closing the municipal parking lot, discontinuing the Horne Road connection to Common Street, reconstructing the Starbucks, and removing existing driveways. The resulting Net Redistributed Trips traffic-volume networks are shown in Figure 10.

Future Traffic Volumes

The 2017 Build condition traffic volume network consists of the 2017 No-Build traffic volumes with the addition of the anticipated site-generated traffic and redistributed existing traffic resulting from closing the municipal parking lot, Horne Road and the existing driveways. The 2017 Build weekday morning, weekday evening, and Saturday midday peak-hour traffic-volume networks are illustrated in Figure 11.

Not to Scale

Cushing Village Redevelopment - Belmont, Massachusetts



XX[XX](XX) = AM[PM](SAT)

Figure 10

**NET Trip Redistribution
Weekday Morning,
Weekday Evening, and
Saturday Midday
Peak Hour Traffic Volumes**

TEC, Inc.

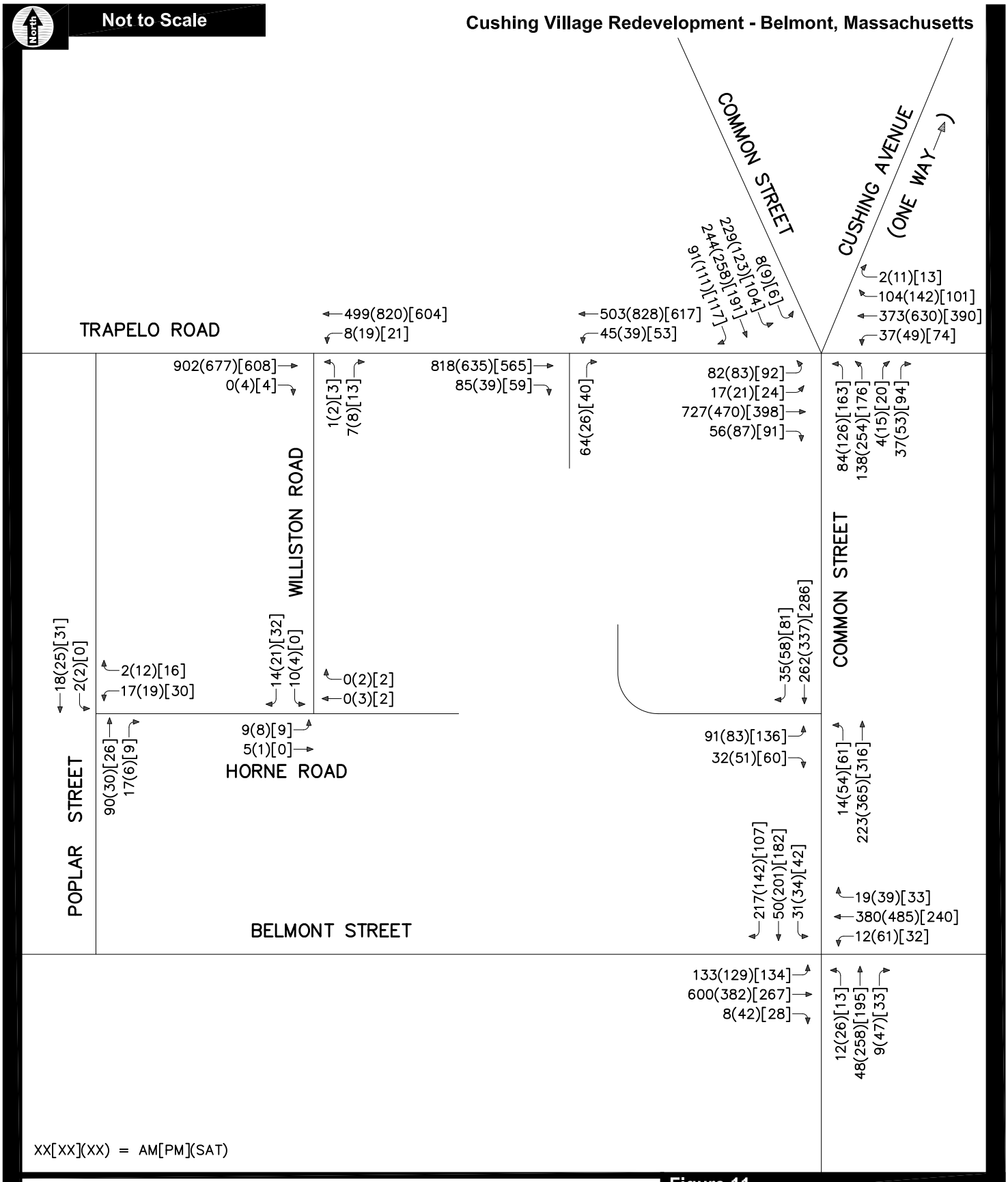


Figure 11

**2017 Build Conditions
Weekday Morning,
Weekday Evening, and
Saturday Midday
Peak Hour Traffic Volumes**

TEC, Inc.

III. Traffic Operations Analysis

Measuring existing and future traffic volumes quantifies traffic flow within the study area. To assess quality of flow, roadway capacity and vehicle queue analyses were conducted under Existing, No-Build, and Build traffic-volume conditions. Capacity analyses provide an indication of how well the roadway facilities serve the traffic demands placed upon them, with vehicle queue analyses providing a secondary measure of the operational characteristics of an intersection or section of roadway under study. The No-Build and Build conditions for the year 2017 are examined in order to determine the impacts associated with the redevelopment.

Methodology

Levels of Service

A primary result of capacity analyses is the assignment of level-of-service to traffic facilities under various traffic-flow conditions.[3] The concept of level-of-service is defined as a qualitative measure describing operational conditions within a traffic stream and their perception by motorists and/or passengers. A level-of-service definition provides an index to quality of traffic flow in terms of such factors as speed, travel time, freedom to maneuver, traffic interruptions, comfort, convenience, and safety.

Six levels of service are defined for each type of facility. They are given letter designations from A to F, with level-of-service (LOS) A representing the best operating conditions and LOS F representing the worst.

Since the level of service of a traffic facility is a function of the traffic flows placed upon it, such a facility may operate at a wide range of levels of service, depending on the time of day, day of week, or period of year.

Unsignalized Intersections

The six levels of service for unsignalized intersections may be described as follows:

- *LOS A* represents a condition with little or no control delay to minor street traffic.
- *LOS B* represents a condition with short control delays to minor street traffic.
- *LOS C* represents a condition with average control delays to minor street traffic.
- *LOS D* represents a condition with long control delays to minor street traffic.
- *LOS E* represents operating conditions at or near capacity level, with very long control delays to minor street traffic.

[3]The capacity analysis methodology is based on the concepts and procedures presented in the *Highway Capacity Manual 2000*; Transportation Research Board; Washington, DC; 2000.

- *LOS F* represents a condition where minor street demand volume exceeds capacity of an approach lane, with long control delays resulting. This may be a result of very high through traffic on the major street even with low volume on the side street.

The levels of service of unsignalized intersections are determined by application of a procedure described in the 2000 Highway Capacity Manual. Level of service is measured in terms of average control delay. Mathematically, control delay is a function of the capacity and degree of saturation of the lane group and/or approach under study and is a quantification of motorist delay associated with traffic control devices such as traffic signals and STOP signs. Control delay includes the affects of initial deceleration delay approaching a STOP sign, stopped delay, queue move-up time, and final acceleration delay from a stopped condition. Definitions for level of service at unsignalized intersections are also given in the 2000 Highway Capacity Manual. Table 7 summarizes the relationship between level of service and average control delay.

Table 7 – Level-of-Service Criteria for Unsignalized Intersections[a]

Level of Service	Average Control Delay (seconds per vehicle)
A	≤ 10.0
B	10.1 to 15.0
C	15.1 to 25.0
D	25.1 to 35.0
E	35.1 to 50.0
F	>50.0

[a]Source: *Highway Capacity Manual 2000*; Transportation Research Board; Washington, DC; 2000; page 17-2.

Unsignalized Intersection Capacity Analysis Summary

Level-of-service analyses were conducted for 2010 Existing, 2017 No-Build, and 2017 Build conditions for the unsignalized intersections within the study area. The results of the unsignalized intersection capacity analyses are summarized in Table 8. The capacity analysis worksheets are provided in Appendix J.

Traffic exiting Williston Road onto Trapelo Road is anticipated to experience long delays during the weekday morning and evening peak hours under 2017 No-Build conditions. Relocation of the municipal parking lot as part of the project will significantly reduce delay for vehicles exiting Williston Road. Under 2017 Build conditions, all movements at the intersection of Trapelo Road / Williston Road are anticipated to operate at acceptable levels of service (LOS D or better) during all time periods. In addition, queues are not anticipated to exceed one vehicle the volume-to-capacity ratio will be below 1.00, indicating there will be adequate capacity to accommodate the anticipated traffic volumes.

All movements at all other unsignalized intersections within the study area are anticipated to operate at acceptable levels of service (LOS C or better) under all analysis scenarios.

Table 8 – Unsignalized Intersection Capacity and Queue Analysis Summary

	2010 Existing				2017 No-Build				2017 Build			
Intersection / Lane Group	V/C[a]	Delay[b]	LOS[c]	Queue[d]	V/C	Delay	LOS	Queue	V/C	Delay	LOS	Queue
Trapelo Road / Williston Road												
Weekday Morning												
Trapelo Road WB approach	0.04	1.8	A	<25	0.04	1.1	A	<25	0.01	0.3	A	<25
Williston Road NB approach	0.12	17.8	C	<25	0.29	39.8	E	28	0.54	20.4	C	<25
Weekday Evening												
Trapelo Road WB approach	0.02	0.7	A	<25	0.02	0.5	A	<25	0.02	0.6	A	<25
Williston Road NB approach	0.07	12.4	B	<25	0.26	37.6	E	25	0.07	27.2	D	<25
Saturday Midday												
Trapelo Road WB approach	0.04	1.9	A	<25	0.04	1.2	A	<25	0.02	0.6	A	<25
Williston Road NB approach	0.11	13.5	B	<25	0.22	23.2	C	<25	0.06	16.9	C	<25
Common Street / Horne Road / Site Driveway												
Weekday Morning												
Horne Road EB approach	0.05	10.1	B	<25	0.07	10.6	B	<25	0.25	13.3	B	<25
Common Street NB approach	0.01	0.5	A	<25	0.01	0.5	A	<25	0.01	0.6	A	<25
Weekday Evening												
Horne Road EB approach	0.04	10.0	A	<25	0.06	10.7	B	<25	0.31	15.2	C	33
Common Street NB approach	0.01	0.3	A	<25	0.01	0.3	A	<25	0.06	1.6	A	<25
Saturday Midday												
Horne Road EB approach	0.07	10.9	B	<25	0.10	11.1	B	<25	0.49	19.7	C	66
Common Street NB approach	0.02	0.6	A	<25	0.02	0.7	A	<25	0.06	1.8	A	<25
Horne Road / Williston Road												
Weekday Morning												
Horne Road EB approach	0.01	3.7	A	<25	0.01	3.6	A	<25	0.01	4.7	A	<25
Williston Road SB approach	0.05	8.9	A	<25	0.05	8.9	A	<25	0.03	8.6	A	<25
Weekday Evening												
Horne Road EB approach	0.01	5.1	A	<25	0.01	4.9	A	<25	0.01	6.4	A	<25
Williston Road SB approach	0.04	8.8	A	<25	0.04	8.8	A	<25	0.03	8.5	A	<25
Saturday Midday												
Horne Road EB approach	0.01	5.6	A	<25	0.01	5.4	A	<25	0.01	7.2	A	<25
Williston Road SB approach	0.08	8.9	A	<25	0.08	9.0	A	<25	0.04	8.5	A	<25

Table 8 Continued – Unsignalized Intersection Capacity and Queue Analysis Summary

	2010 Existing				2017 No-Build				2017 Build			
Intersection / Lane Group	V/C[a]	Delay[b]	LOS[c]	Queue[d]	V/C	Delay	LOS	Queue	V/C	Delay	LOS	Queue
Poplar Street / Horne Road												
Weekday Morning												
Horne Road WB approach	0.03	9.3	A	<25	0.03	9.3	A	<25	0.03	9.4	A	<25
Poplar Street SB approach	0.00	1.6	A	<25	0.00	1.5	A	<25	0.00	0.8	A	<25
Weekday Evening												
Horne Road WB approach	0.04	8.9	A	<25	0.05	8.9	A	<25	0.05	8.9	A	<25
Poplar Street SB approach	0.00	0.9	A	<25	0.00	0.8	A	<25	0.00	0.6	A	<25
Saturday Midday												
Horne Road WB approach	0.06	9.0	A	<25	0.06	9.0	A	<25	0.07	9.0	A	<25
Poplar Street SB approach	0.00	0.0	A	<25	0.00	0.0	A	<25	0.00	0.0	A	<25
Trapelo Road / Site Driveway												
Weekday Morning												
Trapelo Road WB approach	-	-	-	-	-	-	-	-	0.07	1.9	A	<25
Site Driveway NB approach	-	-	-	-	-	-	-	-	0.14	12.9	B	<25
Weekday Evening												
Trapelo Road WB approach	-	-	-	-	-	-	-	-	0.05	1.3	A	<25
Site Driveway NB approach	-	-	-	-	-	-	-	-	0.05	11.0	B	<25
Saturday Midday												
Trapelo Road WB approach	-	-	-	-	-	-	-	-	0.06	1.6	A	<25
Site Driveway NB approach	-	-	-	-	-	-	-	-	0.07	10.9	B	<25

[a] Volume-to-capacity ratio
[b] Delay expressed in seconds per vehicle (average)
[c] Level of service
[d] 95th Percentile Queue (in feet)

Signalized Intersections

The six Levels Of Service (LOS) for signalized intersections may be described as follows:

- *LOS A* describes operations with very low control delay; most vehicles do not stop at all.
- *LOS B* describes operations with relatively low control delay. However, more vehicles stop than LOS A.
- *LOS C* describes operations with higher control delays. Individual cycle failures may begin to appear. The number of vehicles stopping is significant at this level, although many still pass through the intersection without stopping.
- *LOS D* describes operations with control delay in the range where the influence of congestion becomes more noticeable. Many vehicles stop and individual cycle failures are noticeable, whereby motorists are not able to get through the signal on one cycle.
- *LOS E* describes operations with high control delay values. Individual cycle failures are frequent occurrences.
- *LOS F* describes operations with high control delay values that often occur with over-saturation. Poor progression and long cycle lengths may also be major contributing causes to such delay levels.

Level of service for signalized intersections is calculated using the operational analysis methodology of the 2000 Highway Capacity Manual. This method assesses the effects of signal type, timing, phasing, and progression; vehicle mix; and geometrics on delay. Level-of-service designations are based on the criterion of control or signal delay per vehicle. Control or signal delay can be related to driver discomfort, frustration, and fuel consumption, and includes initial deceleration delay approaching the traffic signal, queue move-up time, stopped delay and final acceleration delay. Table 9 summarizes the relationship between level of service and control delay. The tabulated control delay criterion may be applied in assigning level-of-service designations to individual lane groups, to individual intersection approaches, or to entire intersections.

Table 9 – Level-of-Service Criteria for Signalized Intersections[a]

Level of Service	Average Control (Signal) Delay (Seconds per Vehicle)
A	<10.0
B	10.1 to 20.0
C	20.1 to 35.0
D	35.1 to 55.0
E	55.1 to 80.0
F	>80.0

[a]Source: *Highway Capacity Manual 2000*; Transportation Research Board Washington, DC; 2000; page 16-2.

Signalized Intersection Capacity Analysis Summary

Table 10 below provides a summary of the results of the intersection capacity analysis for the two signalized intersections within the study area during each peak period. The 2017 No-Build and Build analysis reflect roadway improvements proposed at the Cushing Square intersection as part of the Trapelo Road Improvement Project.

Trapelo Road / Common Street / Cushing Avenue

Some movements at the intersection of Trapelo Road / Common Street / Cushing Avenue are anticipated to operate at LOS E or F under 2017 No-Build and Build conditions, primarily associated with the weekday east-west commuter travel on Trapelo Road. The analysis assesses operations following the completion of the pending MassDOT project. The additional traffic generated by the proposed mixed-use development will have a limited impact on the delays, with overall intersection delay increasing by less than 3 seconds per vehicle. The redistribution of traffic associated with the reconfiguration of the driveways will improve the overall operations of the intersection during the weekday morning and weekday evening peak hours.

Common Street / Belmont Street

All movements at the intersection of Common Street and Belmont Street are anticipated to operate at acceptable levels of service (LOS D or better) under all analysis scenarios. The additional traffic generated by the proposed mixed-use development in increases in overall intersection delay of less than 4 seconds per vehicle.

Table 10 – Signalized Intersection Capacity and Queue Analysis Summary

	2010 Existing				2017 No-Build				2017 Build			
Intersection / Lane Group	V/C[a]	Delay[b]	LOS[c]	Queue[d]	V/C	Delay	LOS	Queue	V/C	Delay	LOS	Queue
Trapelo Road / Common Street / Cushing Avenue												
Weekday Morning												
Trapelo Road EB approach	0.77	25.3	C	228/344	-	-	-	-	-	-	-	-
Trapelo Road EB LT	-	-	-	-	0.54	22.9	C	33/69	0.46	20.3	C	36/71
Trapelo Road EB TH / RT	-	-	-	-	1.11	95.6	F	525/996	1.10	94.4	F	698/1011
Trapelo Road WB approach	0.46	18.3	B	127/172	-	-	-	-	-	-	-	-
Trapelo Road WB LT	-	-	-	-	0.30	28.6	C	<25/<25	0.42	27.1	C	<25/33
Trapelo Road WB TH / RT	-	-	-	-	0.88	41.0	D	359/505	0.81	32.5	C	356/482
Common Street NB LT / TH	0.56	37.8	D	108/151	-	-	-	-	-	-	-	-
Common Street NB RT	0.03	32.4	C	<25/<25	-	-	-	-	-	-	-	-
Common Street NB LT	-	-	-	-	0.26	52.3	D	<25/37	0.54	48.3	D	76/117
Common Street NB TH / RT	-	-	-	-	0.53	40.0	D	131/173	0.66	45.9	D	152/195
Common Street SB LT	0.54	32.8	C	134/234	0.91	78.0	E	176/352	0.91	76.8	E	185/363
Common Street SB TH / RT	0.81	46.3	D	195/388	-	-	-	-	-	-	-	-
Common Street SB TH	-	-	-	-	0.50	31.3	C	133/253	0.69	43.7	D	178/275
Common Street SB RT	-	-	-	-	0.12	27.1	C	<25/61	0.16	34.6	C	26/67
Overall Intersection	**0.74**	**28.5**	**C**	**-**	**0.90**	**61.2**	**E**	**-**	**0.90**	**59.9**	**E**	**-**
Weekday Evening												
Trapelo Road EB approach	-	-	-	-	-	-	-	-	-	-	-	-
Trapelo Road EB LT	0.44	22.6	C	42/77	0.73	41.0	D	43/126	0.73	40.5	D	43/130
Trapelo Road EB TH / RT	0.80	32.3	C	321/473	0.79	31.2	C	401/633	0.83	35.0	D	415/662
Trapelo Road WB approach	0.94	52.4	D	290/434	-	-	-	-	-	-	-	-
Trapelo Road WB LT	-	-	-	-	0.13	21.7	C	<25/25	0.26	21.7	C	<25/41
Trapelo Road WB TH / RT	-	-	-	-	1.25	157.9	F	863/1112	1.24	153.5	F	850/1099
Common Street NB LT / TH	0.85	55.8	E	216/363	-	-	-	-	-	-	-	-
Common Street NB RT	0.07	32.8	C	<25/39	-	-	-	-	-	-	-	-
Common Street NB LT	-	-	-	-	0.51	52.0	D	63/109	0.71	59.1	E	109/185
Common Street NB TH / RT	-	-	-	-	0.82	54.6	D	248/371	0.86	59.2	E	267/396
Common Street SB LT	0.34	34.7	C	80/140	0.67	55.1	E	110/178	0.71	58.3	E	113/193
Common Street SB TH / RT	0.99	86.0	F	244/447	-	-	-	-	-	-	-	-
Common Street SB TH	-	-	-	-	0.69	43.3	D	203/328	0.76	49.2	D	209/303
Common Street SB RT	-	-	-	-	0.16	32.1	C	32/75	0.19	33.9	C	35/79
Overall Intersection	**0.93**	**50.7**	**D**	**-**	**1.05**	**80.5**	**F**	**-**	**1.07**	**79.7**	**E**	**-**

Table 10 Continued – Signalized Intersection Capacity and Queue Analysis Summary

Intersection / Lane Group	2010 Existing				2017 No-Build				2017 Build			
	V/C[a]	Delay[b]	LOS[c]	Queue[d]	V/C	Delay	LOS	Queue	V/C	Delay	LOS	Queue
Trapelo Road / Common Street / Cushing Avenue (continued)												
Saturday Midday												
Trapelo Road EB approach	0.69	24.5	C	143/218	-	-	-	-	-	-	-	-
Trapelo Road EB LT	-	-	-	-	0.59	22.2	C	40/73	0.59	23.1	C	43/75
Trapelo Road EB TH / RT	-	-	-	-	0.74	25.8	C	277/426	0.79	29.1	C	294/437
Trapelo Road WB approach	0.49	20.4	B	121/180	-	-	-	-	-	-	-	-
Trapelo Road WB LT	-	-	-	-	0.17	19.2	B	<25/27	0.38	19.9	B	26/50
Trapelo Road WB TH / RT	-	-	-	-	0.84	33.8	C	306/470	0.82	32.6	C	301/444
Common Street NB LT / TH	0.62	34.1	C	120/234	-	-	-	-	-	-	-	-
Common Street NB RT	0.10	27.6	C	<25/52	-	-	-	-	-	-	-	-
Common Street NB LT	-	-	-	-	0.48	41.7	D	51/106	0.71	46.3	D	111/239
Common Street NB TH / RT	-	-	-	-	0.65	36.7	D	155/267	0.75	40.4	D	177/338
Common Street SB LT	0.27	25.8	C	54/116	0.58	41.9	D	80/140	0.56	40.4	D	81/140
Common Street SB TH / RT	0.74	36.5	D	153/313	-	-	-	-	-	-	-	-
Common Street SB TH	-	-	-	-	0.51	31.3	C	122/196	0.65	37.2	D	133/212
Common Street SB RT	-	-	-	-	0.17	28.0	C	<25/62	0.21	30.6	C	26/68
Overall Intersection	**0.69**	**26.8**	**C**	**-**	**0.76**	**31.4**	**C**	**-**	**0.75**	**33.8**	**C**	**-**
Common Street / Belmont Street												
Weekday Morning												
Belmont Street EB approach	0.62	6.2	A	124/260	0.68	8.2	A	152/393	0.71	9.0	A	168/422
Belmont Street WB LT / TH	0.32	4.0	A	51/102	0.36	4.6	A	60/146	0.36	4.8	A	64/148
Belmont Street WB RT	0.01	3.0	A	<25/<25	0.01	3.4	A	<25/<25	0.02	3.5	A	<25/<25
Belmont Street NB LT / TH	0.46	27.5	C	57/57	0.61	31.5	C	63/63	0.70	37.1	D	66/66
Belmont Street NB RT	0.01	24.4	C	<25/<25	0.01	23.9	C	<25/<25	0.01	23.7	C	<25/<25
Common Street SB LT / TH	0.31	26.5	C	31/65	-	-	-	-	-	-	-	-
Common Street SB RT	0.15	25.3	C	<25/46	-	-	-	-	-	-	-	-
Common Street SB LT	-	-	-	-	0.16	25.0	C	<25/30	0.19	25.1	C	<25/36
Common Street SB TH / RT	-	-	-	-	0.54	28.6	C	45/111	0.53	28.4	C	45/112
Overall Intersection	**0.59**	**11.3**	**B**	**-**	**0.67**	**13.2**	**B**	**-**	**0.71**	**14.2**	**B**	**-**

Table 10 Continued – Signalized Intersection Capacity and Queue Analysis Summary

Intersection / Lane Group	2010 Existing				2017 No-Build				2017 Build			
	V/C[a]	Delay[b]	LOS[c]	Queue[d]	V/C	Delay	LOS	Queue	V/C	Delay	LOS	Queue
Common Street / Belmont Street (continued)												
Weekday Evening												
Belmont Street EB approach	0.58	8.5	A	124/263	0.75	15.2	B	187/475	0.89	26.9	C	235/573
Belmont Street WB LT / TH	0.52	7.6	A	115/241	0.60	10.7	B	158/344	0.61	11.8	B	167/370
Belmont Street WB RT	0.02	4.8	A	<25/<25	0.02	6.2	A	<25/<25	0.04	6.9	A	<25/<25
Belmont Street NB LT / TH	0.67	28.3	C	122/182	0.70	29.0	C	138/201	0.68	27.6	C	143/206
Belmont Street NB RT	0.08	20.7	C	<25/29	0.08	19.7	B	<25/30	0.07	19.2	B	<25/30
Common Street SB LT / TH	0.56	25.3	C	87/149	-	-	-	-	-	-	-	-
Common Street SB RT	0.17	21.3	C	<25/49	-	-	-	-	-	-	-	-
Common Street SB LT	-	-	-	-	0.12	20.2	C	<25/<25	0.21	20.6	C	<25/36
Common Street SB TH / RT	-	-	-	-	0.75	31.2	C	142/229	0.76	31.5	C	155/247
Overall Intersection	**0.61**	**14.8**	**B**	**-**	**0.75**	**19.1**	**B**		**0.84**	**22.9**	**C**	**-**
Saturday Midday												
Belmont Street EB approach	0.55	8.9	A	54/145	0.58	10.6	B	76/208	0.61	12.0	B	100/239
Belmont Street WB LT / TH	0.35	7.5	A	33/91	0.37	8.6	A	45/126	0.34	9.1	A	52/128
Belmont Street WB RT	0.01	6.1	A	<25/<25	0.01	6.9	A	<25/<25	0.02	7.4	A	<25/<25
Belmont Street NB LT / TH	0.32	9.9	A	31/92	0.33	11.2	B	42/112	0.34	13.0	B	53/138
Belmont Street NB RT	0.03	8.6	A	<25/<25	0.03	9.8	A	<25/<25	0.04	11.3	B	<25/<25
Common Street SB LT / TH	0.40	10.4	B	35/97	-	-	-	-	-	-	-	-
Common Street SB RT	0.10	8.9	A	<25/28	-	-	-	-	-	-	-	-
Common Street SB LT	-	-	-	-	0.09	10.1	B	<25/<25	0.15	12.0	B	<25/38
Common Street SB TH / RT	-	-	-	-	0.52	12.8	B	60/146	0.57	15.5	B	81/190
Overall Intersection	**0.48**	**9.0**	**A**	**-**	**0.55**	**10.7**	**B**	**-**	**0.60**	**12.3**	**B**	**-**

[a] Volume-to-capacity ratio
[b] Delay expressed in seconds per vehicle (average)
[c] Level of service
[d] 50th / 95th Percentile Queue (in feet)
* Trapelo Road EB analyzed as an exclusive left-turn lane and shared through/right-turn lane due to de facto left-turn lane on this approach during the weekday evening peak period.

IV. Parking Analysis

As part of the Cushing Village mixed use development, existing and proposed parking demand needs were analyzed to determine if the project will negatively impact the existing parking supply in the vicinity of Cushing Square.

Existing Parking Supply

TEC inventoried the existing parking supply in the vicinity of Cushing Square on Thursday, June 17, 2010. The inventory included sections of on-street parking as well as the municipal lot located on the corner of Williston Road and Trapelo Road. The sections of on-street parking include:

1. Trapelo Road (between Poplar Street and Williston Road)
2. Trapelo Road (between Williston Road and Common Street)
3. Trapelo Road (between Common Street and Oak Avenue)
4. Common Street (between Trapelo Road and Payson Road)
5. Common Street (between Trapelo Road and Belmont Street)
6. Common Street (between Belmont Street and Sunset Road)
7. Belmont Street (between Common Street and Alden Road)
8. Belmont Street (between Common Street and Merrill Road)
9. Horne Road (between Poplar Street and Williston Road)
10. Horne Road (between Williston Road and Common Street)
11. Williston Road (between Horne Road and Trapelo Road)

The sections of on-street parking were broken up into different segments in order to determine the intensity of use in each segment. Figure 12 provides a graphical representation of each segment and the estimated available number of spaces in each segment. It should be noted that for areas where parking is allowed but spaces are not striped, TEC estimated the total number of spaces in each segment based on the number of vehicles that could theoretically fit assuming on an average length of parking space of 22 feet. For example, sections of Horne Road and Belmont Street do not provide sufficient striping to determine the total number of legal parking spaces provided.

Existing Parking Demand

TEC performed detailed parking counts on Thursday, June 17 and Saturday, June 19, 2010 to determine the parking demand at different time periods throughout the day. The counts on Thursday were performed between 7:00 AM and 6:00 PM with intermittent breaks during lower traffic periods. The counts on Saturday were performed between 11:00 AM and 1:00 PM. Table 11 presents the maximum and average occupancy for various time periods on both Thursday and Saturday. The detailed parking demand count sheets are included in Appendix K.

Table 11 – Existing Parking Demand Summary

Time		Weekday								Saturday	
		7-9AM		11AM-1PM		2-4PM		4-6PM		11AM-1PM	
Segment	Spaces Provided	% Occupancy									
		Avg[a]	Max[b]	Avg	Max	Avg	Max	Avg	Max	Avg	Max
Trapelo Road between Poplar Street and Williston Road	27	66%	78%	103%	107%	89%	96%	71%	85%	87%	93%
Trapelo Road between Williston Road & Common Street	11	68%	91%	85%	100%	78%	91%	80%	91%	99%	100%
Trapelo Road between Common Street & Oak Avenue	30	46%	63%	89%	93%	88%	93%	70%	77%	85%	90%
Common Street between Trapelo Road and Payson Road	26	84%	92%	65%	73%	66%	100%	84%	92%	90%	96%
Common Street between Trapelo Road & Belmont Street	16	12%	18%	60%	75%	28%	50%	28%	44%	40%	50%
Common Street between Belmont Street & Sunset Road[c]	12	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Belmont Street between Common Street and Alden Road	12	20%	50%	60%	83%	70%	83%	48%	58%	42%	50%
Belmont Street between Common Street & Merrill Road	15	52%	107%	94%	100%	45%	68%	48%	60%	12%	20%
Horne Road between Poplar Street and Williston Road	22	26%	36%	28%	32%	33%	41%	21%	27%	46%	50%
Horne Road between Williston Road & Common Street	11	10%	18%	33%	36%	26%	34%	14%	27%	46%	73%
Williston Road between Horne Road & Trapelo Road	5	28%	80%	90%	100%	69%	100%	35%	40%	73%	100%
Municipal Parking Lot on corner of Trapelo Rd & Williston Rd	50	42%	64%	66%	74%	47%	58%	34%	40%	48%	58%
Total	**237**	**43%**	**50%**	**67%**	**71%**	**56%**	**59%**	**48%**	**49%**	**59%**	**63%**

[a]Average percent occupancy
[b]Maximum percent occupancy
[c]Common Street was closed for construction during counts.

A total of 237 on and off-street public parking spaces are currently provided in the immediate area surrounding the site. These spaces experienced a maximum occupancy of 71 percent over the two-day study period, which represents 167 occupied parking spaces. Trapelo Road, between Williston Road and Common Street, saw consistent occupancy between 68 percent and 100 percent. The section of Common Street between Trapelo Road and Belmont Street experienced a maximum occupancy of 75 percent, with average occupancies ranging from 12 to 60 percent. Horne Road between Williston Road and Common Street experienced a maximum occupancy of 50 percent.

Proposed Alteration to Parking Facilities

As part of the Trapelo Road Roadway Improvement project, 6 parking spaces will be eliminated along the easterly side of Common Street between Trapelo Road and Belmont Street. The parking spaces along the westerly side of Common Street will also be reconfigured as part of the redevelopment project and the Trapelo Road improvement; however, it is anticipated that there will be no loss in on-street parking. As a result of closure of an existing driveway on Common Street between Trapelo Road and Horne Road, one additional parking space may be added on the westerly side of Common Street in this area. The closure of Horne Road's connection to Common Street as part of the proposed mixed-use development will result in a loss of 4 parking spaces along the northerly side of Horne Road. The Trapelo Road Roadway Improvement project will result in the loss of 5 parking spaces on the southerly side of Trapelo Road between Common Street and Williston Road. Therefore, the Trapelo Road improvement project will result in a net reduction in on-street parking of

10 spaces and the Cushing Village mixed-use development will result in a net reduction in on-street parking of 4 spaces in the vicinity of the site.

The proposed mixed-use development is also anticipated to result in changes to the existing off-street public parking supply. The 50-space municipal parking lot will be removed as part of the proposed project. Residents and business patrons currently using the municipal parking lot will be allowed to park in the public parking spaces to be provided on the site or in on-street parking spaces.

As a result of the Trapelo Road improvement project, the total on-street parking supply will be reduced by 10 parking spaces. As result of the proposed mixed-use development, the total on- and off-street public parking supply surrounding the site will be reduced by 54 parking spaces. The 50 off-street municipal parking spaces will be replaced in a structured parking lot on the site. Therefore, a total of 173 on-street and 50 off-street parking spaces will remain available for public use in the area surrounding the site. The peak parking demand in the study area was observed to be 167 parking spaces. Therefore, the peak parking demand can be accommodated by the remaining 223 public on-street and off-street parking spaces.

The proposed mixed-use development will provide a total of 234 off-street parking spaces on the site. Approximately 108 parking spaces will be designated as residential parking spaces to be provided in a below-ground parking lot. An additional 50 municipal parking spaces and 54 commercial parking spaces will be provided within a structured parking lot. A total of 19 parking spaces will be located in a surface parking lot on Trapelo Road between the proposed Winslow and Pomona buildings, which will likely service the retail land uses in these buildings. An additional 3 on-street parallel parking spaces will be provided on Williston Road, which will service the restaurant on the southeast corner of Trapelo Road / Williston Road. Figure 13 provides a graphical depiction of the proposed on- and off-street parking supply under Building conditions.

Proposed Parking Demand

TEC has estimated the potential parking demand generated by the proposed mixed-use development based on Town of Belmont Zoning Regulations and parking generation rates contained in the ITE *Parking Generation, 4th Edition*.

The Town of Belmont Zoning By-Laws contains off-street parking supply requirements for residential, restaurant, and retail land uses. For residential land uses within the Cushing Square Overlay District, the zoning ordinance requires that 1 space per residential unit be provided. For retail land uses on the first floor within the Cushing Square Overlay District, 1 space per 550 square feet is required. For restaurants within the Cushing Square Overlay District, 1 parking space for every four seats is required. When a development is located within 200 feet of public transportation, a 10 percent reduction in the off-street parking supply is allowed by the zoning regulations. The MBTA provides bus service along the Trapelo Road corridor with a stop at Cushing Square, which is within 200 feet of the site. Therefore, a 10 percent reduction in parking supply may be taken for the proposed mixed-use development. In addition, when a development is located within 250 feet of municipal parking garages or lots, a 20 percent reduction in the off-street parking supply is allowed by the zoning regulations. A 50-space municipal parking lot will be constructed on the site, reducing the parking requirement to serve the site by 20 percent.

In addition to those parking spaces required to serve the proposed land uses on the site, replacement of any parking spaces eliminated as part of a proposed development is required by the Special Permit regulations. The proposed mixed-use development will result in the elimination of 50 off-street parking spaces and 4 on-street parking spaces on Horne Road, and will therefore be required to replace 54 parking spaces. Table 12 summarizes the required off-street parking supply based on the zoning regulations assuming no shared use credits.

Table 12 – Town Zoning Parking Requirements

Land Use	*Required Rate*	*Units*	*Required Spaces*
Restaurant	1 Per 4 Seats	198 Seats	50
Retail - 1st Floor	1 Per 550 SF	30,500 SF	56
Residential	1.0 Per Unit	118 Units	118
Subtotal			**224**
20% Reduction for Proximity to Municipal Parking			-45
10% Reduction for Public Transportation			-22
Total Parking Required to Serve Project			**157**
Replacement Spaces			54
Total Parking - Required			**211**

As shown in Table 12, without the granting of Special Permit waivers, a total of 211 parking spaces are required by the zoning regulations to be provided on the site to accommodate the proposed land uses and parking displaced as part of the proposed mixed-use development.

The parking demand generated by the proposed mixed-use development was also estimated based on parking demand generation rates contained in the ITE *Parking Generation, 4th Edition.* The peak period demand for the proposed Starbucks was based on the parking supply at the existing Starbucks and supplemented with Time of Day Distribution data for LUC 936 (Coffee/Donut Shop without Drive-Through Window). The parking demand for the proposed 5,000 SF quality restaurant was estimated using data for LUC 931 (Quality Restaurant) where available and supplemented with data from LUC 932 (High-Turnover [Sit-Down] Restaurant). The parking demand for the proposed 27,200 SF retail space was based on LUC 820 (Shopping Center). The parking demand for the proposed 120 apartment units was based on LUC 221 (Low/Mid-Rise Apartments) for urban settings where available and supplemented with data from LUC 224 (Rental Townhouses). The 3,300 SF health club was estimated using data for LUC 492 (Health/Fitness Club). Detailed calculation sheets are included in Appendix L.

The ITE parking demand data obtained for the above land uses was collected at rural or suburban sites, with the exception of LUC 221 (Low/Mid-Rise Apartments), which did not account for nearby public transit. ITE estimates that for mixed-use developments within 0.25 miles of a public transit corridor, a reduction in parking supply of 10 percent can be anticipated. Therefore, a 10 percent reduction was applied to the parking demand generation estimates for the retail and restaurant uses. The ITE data for the apartments was obtained from urban sites that already included an adjustment for public transportation. Therefore, no reduction was applied to the parking demand generation estimate for the apartment units.

Based on the ITE data for the proposed land uses, a peak parking demand of 219 parking spaces is estimated for the proposed mixed-use development on a weekday and a peak parking demand of 234 spaces is estimated for a Saturday. A total of 234 parking spaces will be provided on the site with 173 on-street parking spaces in the vicinity that could potentially be used for trips accessing the redevelopment. Therefore, the peak parking demand can be accommodated by the proposed parking supply to be provided on the site and within the nearby on-street parking.

Not to Scale

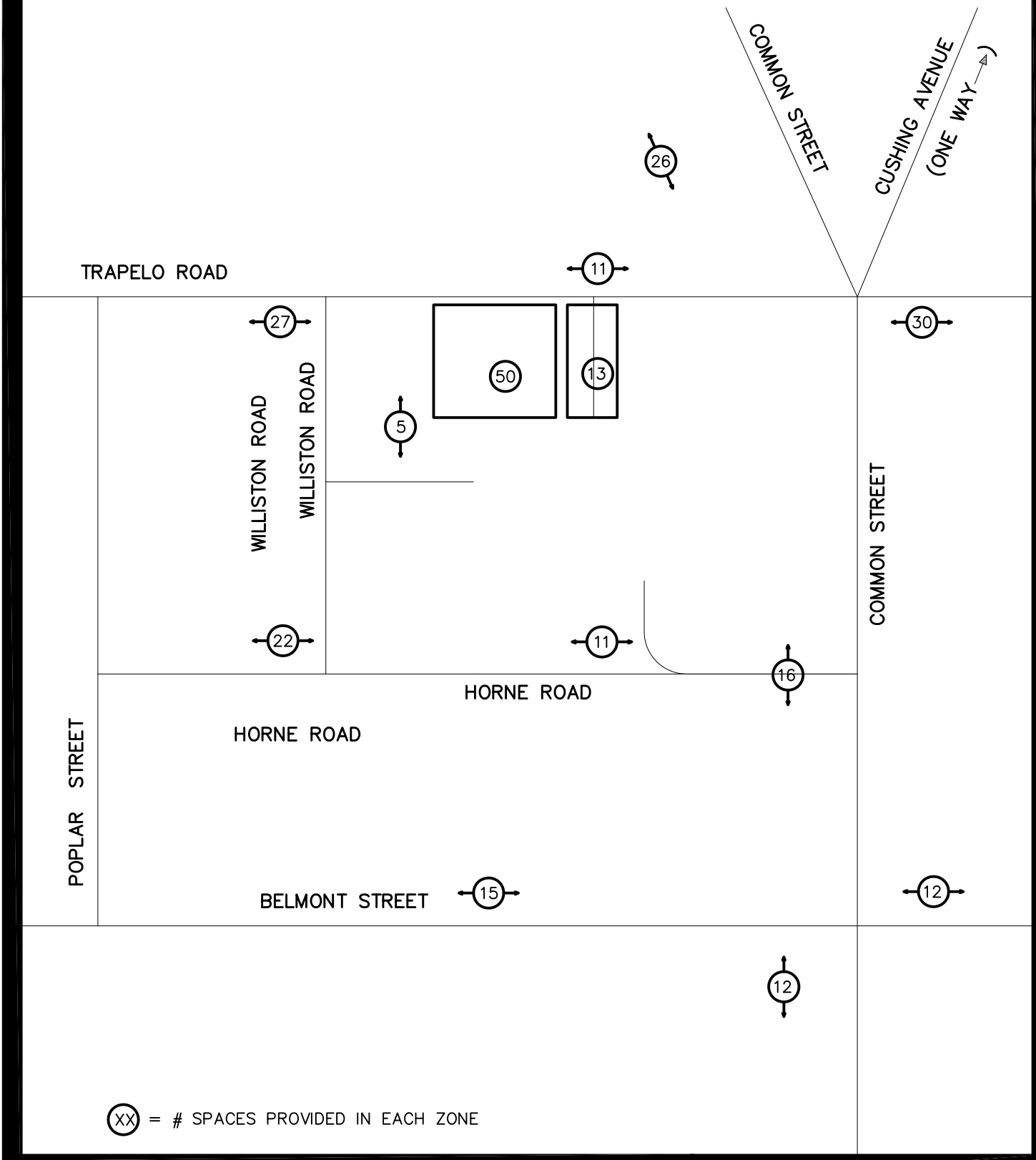


Figure 12

Existing Parking Supply

TEC, Inc.

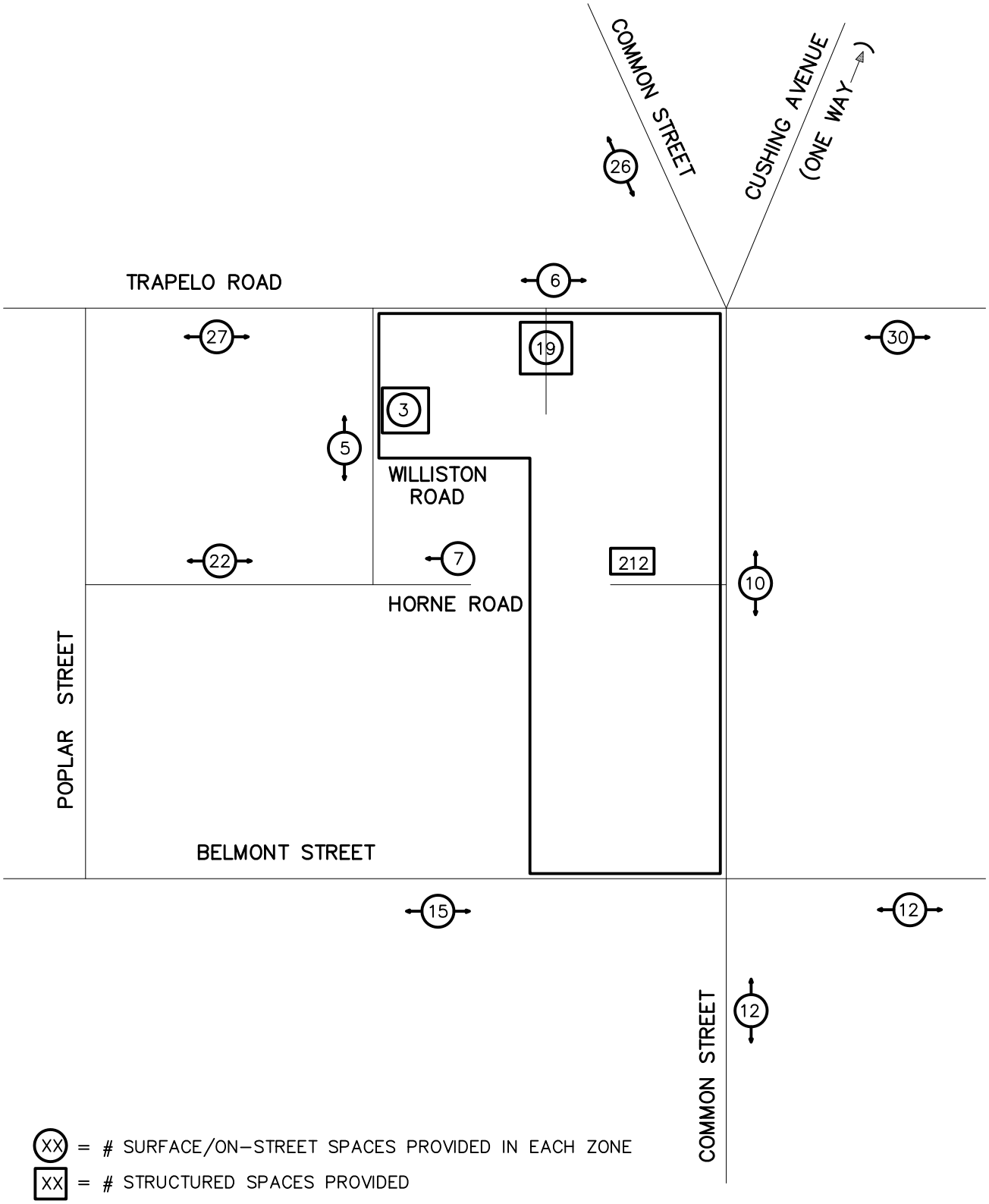


Figure 13

Build Parking Supply

As previously noted, the proposed mixed-use development project will result in the elimination of the 50-space municipal parking lot on Williston Road, which is currently being used by surrounding businesses and neighborhood residents for overnight parking. Additionally, another 10 on-street parking spaces will be eliminated as part of the Trapelo Road improvements and 4 on-street parking spaces will be eliminated as part of the Cushing Village mixed-use development. In order to determine whether the vehicles displaced as a result of the proposed project can be accommodate either on-site or on-street, the parking demand counts collected in the municipal lot and on-street were combined with the anticipated parking demand generated by the proposed mixed-use development. These calculations are included in Appendix L, and indicate that a peak parking demand of 359 parking spaces is anticipated in the area on a weekday and a peak parking demand of 369 parking spaces is anticipated in the area on a Saturday. Approximately 173 on-street parking spaces will be provided in the area, plus an additional 234 parking spaces provided on the site, resulting in a total area parking supply of 407 spaces. Therefore, the peak parking demand can be accommodated by the proposed parking supply in the surrounding area.

V. Mitigation/Conclusion

After having evaluated the operations and safety of the study area roadways, the next step is to identify measures to improve the intersections based on existing and future deficiencies. The following sections provide a summary of measures that are recommended in order to improve the existing and future operations and safety of the study area intersections.

Trapelo Road / Common Street / Cushing Avenue

As discussed in the *Analysis* section of this report, some movements at the Trapelo Road / Common Street / Cushing Avenue intersection are anticipated to experience long delays and queues under 2017 No-Build and Build conditions. The additional traffic generated by the proposed Cushing Village project is anticipated to have a limited impact on the operations of this intersection, increasing the overall intersection delay by less than 3 seconds per vehicle. The additional traffic from the proposed project does not compromise the integrity of the pending Trapelo Road / Belmont Street Corridor Improvements Project.

Common Street / Belmont Street

All movements at this intersection are anticipated to operate at acceptable levels of service under all analysis scenarios. Emergency vehicle pre-emption will be installed at signalized intersections along the Trapelo Road corridor as part of the Trapelo Road / Belmont Street Corridor Improvements Project. In order to improve emergency vehicle response to the site and the surrounding area, it is recommended that the Town also install emergency vehicle pre-emption at the intersection of Common Street / Belmont Street.

As part of the Trapelo Road / Belmont Street Corridor Improvements Project, the Common Street southbound approach to the intersection will be restriped to provide an exclusive left-turn lane and a shared through/right-turn lane. It is recommended that the Common Street northbound approach also be restriped to provide an exclusive left-turn lane and a shared through/right-turn lane in order to provide better alignment of the through lane with the receiving lane on the opposite leg.

Construction of the proposed mixed-use development may compromise the stability of the strain pole located on the northwest corner of the Common Street / Belmont Street intersection. Therefore, it is recommended that the foundation for this strain pole be reconstructed and the strain pole reset as part of the proposed mixed-use development project. This may require installation of a new span wire.

The crosswalks on the Common Street north and Belmont Street east legs of this intersection cross the legs at a diagonal, resulting in crosswalks that are longer than necessary. The current "Flashing Don't Walk" phase is not long enough to allow a pedestrian to cross the entire roadway on these crosswalks. Several of the pedestrian signal heads and push-buttons at the intersection do not meet

current Manual on Uniform Traffic Control Devices (MUTCD) standards. Some of the signal heads are not properly aligned to face a pedestrian waiting to cross the roadway and are missing backplates, making them difficult to see. The following measures are recommended to improve the safety of the intersection and are shown graphically in Figure 14:

- The crosswalks should be relocated to cross Belmont Street and Common Street perpendicular to the roadway to reduce the length of the crossing.
- This will require reconstructing the wheelchair ramps, which should consist of perpendicular ramps with detectable warning devices to comply with current Americans with Disabilities Act (ADA) standards.
- The "Flashing Don't Walk" phase should be extended to 18 seconds to allow a pedestrian walking at 3.5 feet per second to cross the entire roadway during the "Flashing Don't Walk" phase.
- The signal heads should be upgraded to solid HAND/PERSON indications with backplates and the push-buttons should be upgraded with plunger-type (mushroom cap) buttons to comply with current MUTCD standards. The signal heads should be properly aligned to face a pedestrian standing on the ramp at the opposite side of the street.

The existing sidewalk on the northerly side Belmont Street is narrow. The Town should consider extending the Trapelo Road improvement project to widen the sidewalk on the northerly side of Belmont Street along the site frontage.

There is a "NO TURN ON RED ARROW" sign for the Common Street northbound approach posted on the overhead span wire. A utility pole blocks the sign when approaching the intersection on Common Street northbound, and the height and location of this sign makes it difficult to see when sitting in a vehicle at the STOP-line. It is recommended that this sign be relocated to be mounted on a sign post near the STOP-line.

Horne Road / Williston Road

There is currently a right-turn restriction sign posted on the Williston Road southbound approach to Horne Road that restricts right turns during certain time periods. Due to the closure of Horne Road's connection to Common Street, it is recommended that this sign be removed to allow right turns from Williston Road onto Horne Road during all time periods. It is also recommended that DEAD END (W14-1) signs be posted on Horne Road east of Williston Road to indicate to drivers that Horne Road is no longer a through street.

Sidewalks are provided along both sides of Horne Road and Williston Road in the vicinity of this intersection; however, there are no crosswalks striped at the intersection, nor are wheelchair ramps provided on any corner of the intersection. In order to improve the safety and accessibility of the intersection, it is recommended that crosswalks be striped on all legs of the intersection and that perpendicular wheelchair ramps be installed on all corners equipped with detectable warning devices to meet current ADA standards.

Horne Road / Poplar Street

There is currently no traffic control provided at the intersection of Horne Road and Poplar Street. It is recommended that a STOP-sign be installed and a STOP-line be striped on the Horne Road westbound approach to Poplar Street.

Sidewalks are provided along both sides of Horne Road and Poplar Street in the vicinity of the intersection; however, no crosswalks or wheelchair ramps are provided. TEC recommends that the Town stripe crosswalks on the Horne Road and Poplar Street north legs of the intersection and construct wheelchair ramps to connect the sidewalks to the crosswalks in compliance with current

ADA standards. Pedestrian crossing warning signs should be provided on each approach to the crosswalks.

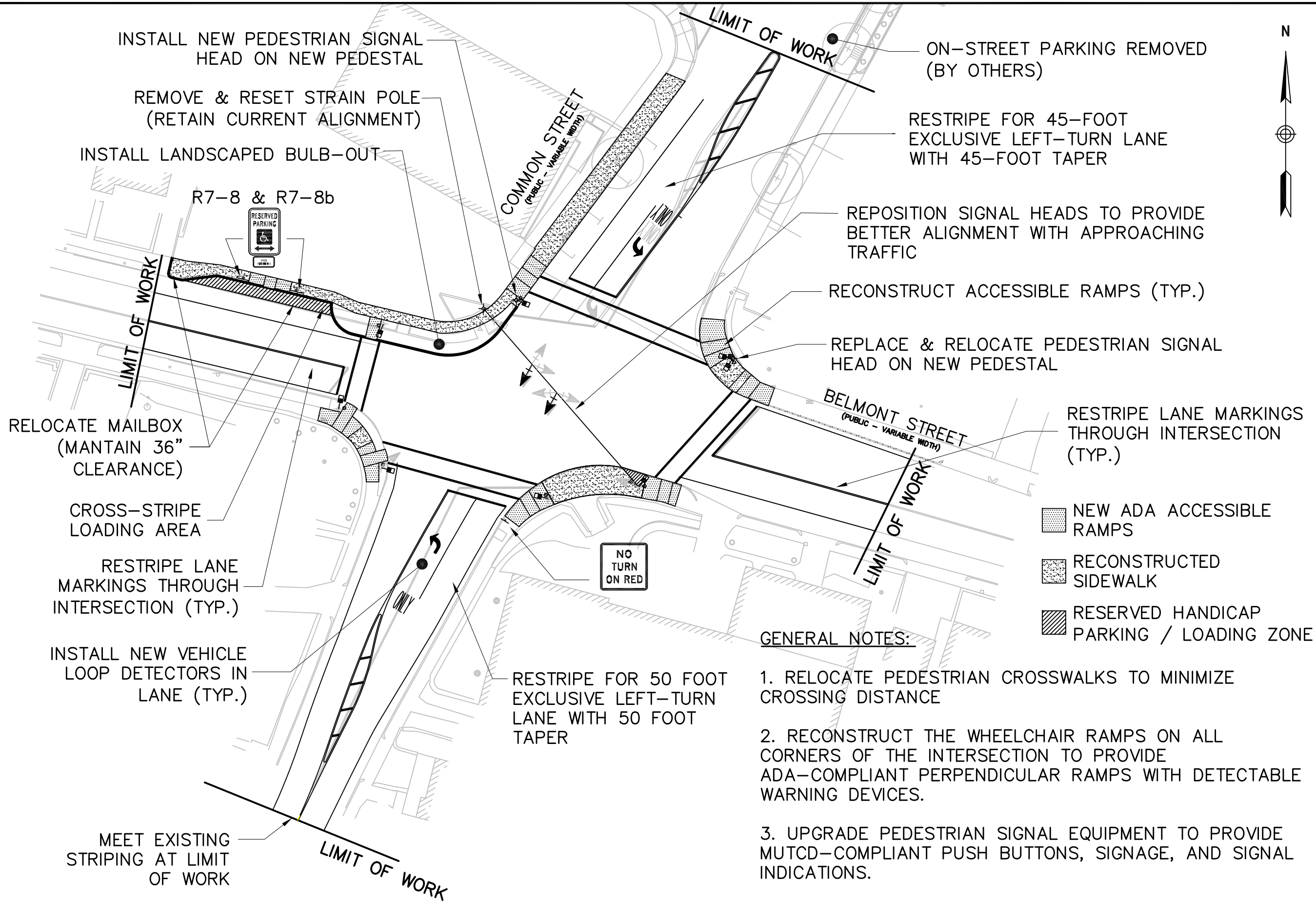
Trapelo Road / Williston Road

The STOP-sign for the Williston Road northbound approach is mounted high on the side of a mast arm pole on the southeast corner of the intersection. It is recommended that a new sign be post-mounted near the STOP-line on Williston Road.

Conclusions

- The proposed Cushing Village development contains a mix of complimentary land uses, which will reduce the total external vehicle trips and parking demand generated by the site by allowing for shared trips and parking between multiple uses.
- The project is anticipated to generate a total of approximately 65 new trips during the weekday morning peak hour, 147 new trips during the weekday evening peak hour, and 178 new trips during the Saturday midday peak hour.
- The proposed development is anticipated to result in increases in traffic volumes on study roadways leading beyond the study area of 3 to 45 trips during the peak hours. These increases represent one additional vehicle every one to twenty minutes during the peak hours.
- The proposed project will not adversely impact the integrity of the improvements proposed at the Cushing Square intersection as part of the Trapelo Road / Belmont Street Corridor Improvements Project.
- The additional traffic generated by the proposed Cushing Village will have a negligible impact on the operations of the study area intersections.
- There will be no perceived impact to the Horne Road neighborhood in terms of traffic or parking resulting from the proposed Cushing Village.

With implementation of the improvements identified in the previous section, the multi-modal traffic associated with the Cushing Village Redevelopment project can be safely and efficiently accommodated on the adjacent street system.



GENERAL NOTES:

1. RELOCATE PEDESTRIAN CROSSWALKS TO MINIMIZE CROSSING DISTANCE

2. RECONSTRUCT THE WHEELCHAIR RAMPS ON ALL CORNERS OF THE INTERSECTION TO PROVIDE ADA-COMPLIANT PERPENDICULAR RAMPS WITH DETECTABLE WARNING DEVICES.

3. UPGRADE PEDESTRIAN SIGNAL EQUIPMENT TO PROVIDE MUTCD-COMPLIANT PUSH BUTTONS, SIGNAGE, AND SIGNAL INDICATIONS.

4. ON-STREET PARKING ON COMMON STREET DESIGNED BY BSC GROUP AS PART OF TRAPELO ROAD / BELMONT STREET CORRIDOR IMPROVEMENT PROJECT

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DESIGNED BY	SWG
DRAWN BY	SWG
CHECKED BY	RLB
DATE	10/12/2012
SCALE	1" = 40'

PREPARED FOR
Smith Legacy Partners
6 Littlefield Road
Acton, MA 01720

REVISIONS

ISSUED FOR
Town Review

PROJECT TITLE
Cushing Village Mixed-Use Redevelopment

PROJECT LOCATION
Belmont, Massachusetts

DRAWING TITLE
Conceptual Sign, Marking, and Signal Plan

PROJECT NO.
T0376.01

TEC CAD FILE
T0376.01_Concept.dwg

DRAWING NO.
Figure 14

SHEET 1 OF 1

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