Traffic and Parking Analysis
The Residences at Johnson Farm
Sudbury, Massachusetts

Submitted to:
Sudbury Zoning Board of Appeals

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1.0 Introduction

Moss Development, Inc. is proposing to develop a 35.44-acre site at 189 Landham Road in Sudbury, Massachusetts. The proposed project, known as The Residences at Johnson Farm, consists of 120 rental apartments to be permitted through the Chapter 40B Comprehensive Permit process. The building program will include ten 3-story buildings and a rental office. A total of 180 parking spaces will be provided, 158 surface spaces in parking lots and 22 garage spaces located in seven garage structures throughout the development. Access to the site would be provided by a single driveway on Landham Road, located opposite Brookside Farm Drive, approximately one half mile south of Route 20. The site plan is shown in Figure 1.

Tetra Tech (TT) has prepared an evaluation of

- parking adequacy,
- potential traffic impacts, and
- safety at the site driveway.

This report summarizes the results of these evaluations.

2.0 Parking

The project includes 180 parking spaces for 120 apartment units. Sudbury Zoning Bylaw (Article IX) requires two parking spaces per dwelling unit or for this project a total of 240 parking spaces. It is our opinion, based on the analysis presented below, that 180 parking spaces will suffice for the intended site development and that 240 parking spaces for this project would be excessive. It is the applicant's desire not to construct parking spaces which would reduce green areas and not be utilized.

As half of the 120 apartment units are one bedroom units and the other half are two bedroom units (a total of 180 bedrooms), it is anticipated that many of the apartment units will be occupied by single individuals owning one vehicle. The proposed site plan provides one parking space per bedroom or 1.5 parking spaces per unit. In order to confirm that these parking ratios will accommodate the parking demand generated by 120 apartment units, parking surveys were conducted at two nearby residential developments and national parking ratios were reviewed.

2.1 Local Parking Surveys

Parking surveys were conducted at two locations in the vicinity of the proposed project including developments in Framingham and Marlborough. Windsor Green, located in Framingham on Edgell Road, is a 187-unit condominium complex approximately 2.3 miles southwest of the proposed site. According to the Town of Framingham Assessor's data base, Windsor Green contains 375 bedrooms in 187 units reflecting an average of approximately 2 bedrooms per unit. The site includes 336 parking spaces.

Avalon Orchards is a 156-unit apartment complex located along Route 20 in Marlborough and was developed under 40B regulations. As this property is comprised of apartments, the number of bedrooms could not be determined from the Town of Marlborough Assessor's data base. At this location, a total of 305 parking spaces are provided including 271 surface parking spaces and 34 garaged spaces.

Parking surveys at both locations were conducted on Thursday, May 26, 2011 from 4:00 a.m. to 5:00 a.m. This time period was chosen to coincide with the peak parking demand time for each location which according to *Parking Generation, 3rd Edition* (Institute of Transportation Engineers, 2004) is between 12:00 a.m. and 5:00 a.m. Table 1 summarizes for each survey location the number of units, bedrooms, on-site parking spaces, parking demand (parked vehicles) and calculated parking ratios.

As seen in the table, both locations have parking ratios of less than 1.5 vehicles per unit. It is also likely that the Avalon Orchards' vehicle per unit ratio is higher than it should be as it was assumed during the count that all 34 existing garages were occupied by vehicles. It is more likely that many of these garages are used for storage, and if even half of the garages were used for storage, the parking rate would drop from 1.45 vehicles per unit to 1.33 vehicles per unit.

Table 1 Parking Survey Summary

Location	Units	Bedrooms	Parking Spaces	Parked Vehicles	Parking Utilization Per Unit	Parking Utilization per Bedroom
Windsor Green	187 units	375	336	240	1.28	0.64
Avalon Orchards	156 units	Unknown	305[1]	226[2]	1.45[2]	Unknown

[1] Includes 271 spaces plus 34 garages
[2] Conservatively assumes all 34 garages are occupied.

At Windsor Green the parking ratio is even less at 1.28 vehicles/unit. At this location, where a bedroom count was available, the data indicates that the site has a vehicle per bedroom ratio of 0.64, considerably less than the 1.0 parking spaces per bedroom which is provided for the proposed project on Landham Road.

2.2 National Parking Data

Parking Generation, 3rd Edition (Institute of Transportation Engineers, 2004) provides parking ratios for various land uses including apartment buildings. These ratios are based on parking surveys conducted at numerous locations throughout the United States. For land use code 221 – Low/Mid-Rise Apartments, parking demand ratios are reported for both urban and suburban settings. The average parking ratio for 19 suburban apartment complexes (with an average of 320 units) was measured at 1.20 vehicles per unit. The parking supply proposed for the Residences at Johnson Farm project will exceed this national rate by providing 1.50 parking spaces per unit.

2.3 Conclusion

The proposed site plan depicts 180 parking spaces to be provided on the site, which equates to a parking supply ratio of 1.5 spaces per unit or 1.0 space per bedroom. Based on the observed peak parking demands at the nearby residential developments and reported in *Parking Generation*, this parking supply is expected to be more than adequate. Local measurements at similar facilities indicate a maximum parking ratio of 1.45 vehicles per unit and 0.64 vehicles per bedroom. Both of these values are lower than the 1.5 vehicles per unit ratio and 1.0 vehicle per bedroom ratio which are proposed at the site. Additionally, the site's parking supply ratio exceeds the parking demand ratio reported in *Parking Generation*.

3.0 Traffic Impact Analysis

The traffic impact analysis for this project will be focused on three intersections located on Landham Road in Sudbury, Massachusetts. These intersections include Landham Road at Route 20, Pelham Island Road and Brookside Farm Lane/Site Driveway. Impact analysis includes the evaluation of existing traffic conditions, future conditions without the proposed project, and a future condition with the proposed project in place. The impact of the additional trips on the study intersections which result from the proposed project will be evaluated through capacity analyses.

3.1 Existing Conditions

Evaluation of the transportation impacts associated with the proposed development requires an understanding of the existing transportation system in the study area including roadway geometrics, traffic control, peak hour traffic volumes, and traffic accidents. A summary of this information is provided below.

3.1.1 Roadway and Intersection Descriptions

Route 20. In Sudbury, Route 20 is an east-west rural minor arterial under the jurisdiction of the Massachusetts Department of Transportation (MassDOT). It is has a total pavement section of approximately 30 feet which includes a 13 foot wide travel lane and a two foot wide shoulder in each direction. A five foot wide bituminous sidewalk, located on the north side of Route 20, is separated from the travel way by a five foot wide grass strip and a bituminous curb. In the vicinity of Landham road, the post speed limit is 30 miles per hour.

Landham Road. Landham Road is part of a north-south corridor which connects Route 20 in Sudbury to Route 135 south of Framingham center. In Framingham, Landham Road is renamed Elm Street and then continues as Concord Road south of Route 126 to Route 135.

Lanham Road in Sudbury is a rural minor collector under local jurisdiction. It consists of an 11 foot travel lane and two foot shoulder in each direction. North of Pelham Island Road, a bituminous sidewalk on its west side is separated from the travel way by a grass strip. It has a posted speed limit of 35 miles per hour.

A speed survey conducted on Landham Road, just north of the project site from April 27, 2011 to April 29, 2011 indicates that the average travel speed is approximately 37 miles per hour in both directions. The speed at which 85 percent of all measured vehicles traveled at or below is 40 miles per hour in the southbound direction and 43 miles per hour in the northbound direction. The speed survey data is provided in Appendix A.

Pelham Island Road. Pelham Island Road has an east-west orientation between Landham Road in Sudbury to its intersection with the south side of Route 20, just west of Wayland Center. It functions as a local road and is under local jurisdiction. In the vicinity of Landham Road, Pelham

Island Road is approximately 24 feet wide accommodating two travel lanes. No curbing or sidewalks are provided on Pelham Island Road. The posted speed limit is 30 miles per hour.

Pelham Island Road in Wayland passes through a National Wildlife Refuge and travels along the north side of Heard Pond. Occasional flooding of Heard Pond results in the closure of Pelham Island Road. Pelham Island Road in Wayland has a curving alignment, poor pavement and a one lane temporary bridge over the Sudbury River.

Route 20/Landham Road. Landham Road forms a T-intersection with the south side of Route 20 approximately one half mile north of the project site. A gas station driveway and residential driveway form minor approaches to the intersection. The gas station is located in the southwest corner of the intersection and its driveway intersects the intersection at the entrance to the eastbound channelized right turn lane. The residential driveway intersects the north side of Route 20, opposite the Landham Road southbound lane.

Each leg of the intersection consists of one approach lane and departure lane. A landscaped median island divides Landham Road at the intersection. The eastbound Route 20 and northbound Landham Road approaches have channelized right turns, thus triangular shaped channelizing islands are present on both sides of the median. The Landham Road channelized island is of a sufficient size to allow approximately five vehicles to stack in the left turn lane before blocking the channelized right turn lane. The Landham Road left turn lane is under STOP sign control and the channelized right turn lane is under YIELD sign control.

The gas station driveway approach is problematic as vehicles exiting the driveway conflict with vehicles either turning right or left onto Landham Road from Route 20. Additionally, there is no pedestrian continuity at this intersection as crosswalks are not provided on any approach. Thus, the sidewalk on west side of Landham Road has no connection to the sidewalk on the north side of Route 20.

Landham Road/Brookside Farm Lane. Brookside Farm Lane is a cul-du-sac roadway, recently constructed to serve nine single family homes. It forms a T intersection with the west side of Landham Road approximately 2,500 feet south of Route 20. Each approach to the intersection consists of one travel lane. A sidewalk is located on the west side of Landham Road and a crosswalk is provided on the Landham Road southbound approach to the intersection. Land uses in the vicinity of the intersection are residential. The proposed site driveway will form the forth approach to this existing three legged intersection.

Landham Road/Pelham Island Road. Approximately 1,000 feet south of Brookside Farm Lane, Pelham Island Road intersects the west side of Landham Road. The T-shaped intersection is STOP signed controlled. A residential driveway intersects Landham Road opposite Pelham Island Road. The three major approaches to the intersection each consist of one travel lane. A church and private homes are located in the vicinity of the intersection.

Sidewalks are located on both sides of Landham Road south of Pelham Island Road and only on the west side north of Pelham Island Road. No sidewalks are provided on Pelham Island Road and no crosswalks were noted at the intersection.

3.1.2 Traffic Volumes

Both weekday daily and peak hour traffic counts were conducted to determine existing traffic conditions in the study area. The counts were taken during the weekday morning and afternoon commuter peak periods to coincide with the peak demand periods of site traffic. Specifically, the daily and peak period (7:00 a.m. to 9:00 a.m. and 4:00 p.m. to 6:00 p.m.) traffic counts were obtained on Wednesday, April 27, 2011. Daily traffic volumes were measured using Automatic Traffic Recorders (ATRs) for a 5 day period on Landham Road south of Stagecoach Drive. The daily and peak period traffic count data is provided in Appendix B.

MassDOT collects data to determine seasonal adjustments for roadways within the state. The 2010 Weekday Seasonal Factors (provided in Appendix B) provided show that April traffic volumes on arterial and collector roadways are approximately seven percent higher average annual volumes. For this study traffic volumes were not adjusted (decreased) to reflect average annual conditions, resulting in a conservative analysis.

The intersection turning movement counts at the study intersections indicate that traffic peaks approximately from 7:30 a.m. to 8:30 in the morning and from 5:00 p.m. to 6:00 p.m. in the afternoon. In order to provide a conservative analysis, the peak hours for each individual intersection were used for the traffic operations analysis.

Peak hour traffic volumes for the existing Landham Road/Brookside Farm Lane intersection were estimated based on the volumes at the Landham Road/Pelham Island Road and using standard trip rates for the nine homes on Brookside Farm Lane. The peak hour traffic volumes are shown on Figure 2.

The daily traffic volume data indicates that Landham Road carries approximately 10,700 vehicles per day (24 hours), of which 900 vehicles (8 percent) occur during the morning peak hour and 1,000 vehicles (9 percent) occur during the afternoon peak hour.

3.2 Future Conditions

This study considers future conditions for a five-year planning horizon, consistent with State requirements for the preparation of traffic impact studies. Traffic volumes for the future analysis year are a combination of existing volumes, background traffic growth and any specific development project-related traffic. The 2016 No-Build scenario is first considered, which provides an analysis of future conditions without the proposed project in place. Finally, the 2016 Build scenario is considered, which provides an analysis of future conditions with the project in place.

3.2.1 No-Build Traffic Volumes

Future (2016) no-build traffic volumes are a combination of existing (2011) traffic and traffic from background growth. Projections of No-Build traffic volumes consider traffic growth within the study area and changes in traffic patterns associated with any proposed roadway improvements.

Background traffic growth is independent of the proposed development. Background traffic growth is related to land development in the immediate area as well as population, economic development and changes in travel patterns in the region. Background growth generally considers two factors: specific land developments in the immediate area and a general traffic growth rate. MassDOT historic traffic counts along the I-495 corridor indicate a decrease in traffic volumes since 2005. However, to provide a conservative analysis of traffic conditions in the future, a conservative annual growth rate of one percent is assumed.

According to the Town of Sudbury Planning and Community Development, there are several proposed projects in Town that may affect traffic at the three study area intersections. These projects along with their size, location and status are listed in Table 2. Table 2 also provides the source for each project's trip assignment to the study area roadways and intersections.

Table 2 Off-Site Development

Name	Location	Type – more specific	Size	Status	Source for traffic
Mahoney Farm	Nobscot Road	Residential	39 units	Construction	VHB
Maple Meadows	Maple Avenue	Residential	23 units	Construction	Conley Associates
Villages at Old County Road	Old County Road	Residential	37 units	Construction	Gillon Associates
Grouse Hill	Old Framingham Road	Residential	46 units	Construction	McMahon Associates
Sudbury Village	Route 20	Residential	66 units	Construction	Abend Associates
Landham Crossing	Route 20	Residential	32 units	Permitting	MDM
The Coolidge	Route 20	Residential	64 units	Permitting	Vanasse and Associates
Wayland Town Center	Route 20	Mixed	400,000 s.f.	Permitted	MDM

Applying the one percent annual growth rate to the 2011 existing traffic volumes for five years and adding trips generated by the background development projects listed in Table 2 resulted in the 2016 No-Build traffic networks. The resulting 2016 No-Build weekday peak hour traffic volumes are presented in Figure 3 for the weekday morning and afternoon peak hours.

3.2.2 Roadway Improvements

Two roadways improvements are proposed within the study area including improvements to the Route 20/Landham Road intersection and modification of the Route 20/Brookside Farm Lane intersection to include the proposed Site Driveway.

Route 20/Landham Road. The MassDOT and town of Sudbury are in the processes of evaluating improvements to the Route 20/Landham Road intersection as part of a corridor study being conducted for Route 20 between Wayside Inn Road to the west and Goodman Hill Road to the east. A copy of the *Draft Route 20 Corridor Study* (VHB, April 2011) was obtained from the Sudbury Department of Public Works. Town staff indicated that although the study is a draft, no significant changes are anticipated between the draft and the final document.

The study presents several alternatives to increase capacity and safety at the intersection including roundabouts (single and double lanes) and traffic signalization with various lane arrangements. The study includes capacity analyses of the various options which were conducted for 2020 and based on existing (2011) traffic volumes increased by 0.8 percent per

year for nine years. Traffic generated by potential off-site developments as listed in Table 2 above was not included in the study's projected 2020 volumes.

The single lane roundabout option was eliminated due to capacity constraints and the two lane roundabout was eliminated due to impacts to abutter properties. The options which included traffic signalization of the intersection consist of the following:

Traffic Signal and 3-Lane Cross-Section

- Eastbound: Through lane and a new exclusive right turn lane
- Westbound: Through lane and a new exclusive left turn lane
- Landham Road: Tighter westerly corner radius to position the gas station driveway outside the intersection

The report indicates that this option is consistent with past recommendations made by Central Transportation Planning Staff (CTPS) for the intersection. Although providing sufficient capacity, this option may result in long queues on the Route 20 westbound approach which is not acceptable to MassDOT.

Town staff has indicated that the 3-lane option is their preferred option.

Traffic Signal and 4-Lane Cross-Section

- Eastbound: Through lane and new shared through/right lane
- Westbound: Through lane and a new exclusive left turn lane
- Landham Road: Tighter westerly corner radius to position the gas station driveway outside the intersection

The 4-lane option is the recommended option of the consultant that prepared the corridor study.

Traffic Signal and 5-Lane Cross-Section

- Eastbound: Through lane and new shared through/right lane
- Westbound: Through lane, a new through lane and new exclusive left turn lane
- Landham Road: Tighter westerly corner radius to position the gas station driveway outside the intersection

The study indicates that due to right of way impacts, this option should not be considered further.

MassDOT officials have indicated that the 5-lane option is their preferred option.

The design of the intersection is being funded by the town of Sudbury and construction funding will be through the MassDOT. The project has not been vetted through the MassDOT Project Development process yet and thus has not been placed on the Transportation Improvement Program (TIP) by the Metropolitan Planning Organization (MPO). However, Town staff has indicated that although the option for the improvements has not been agreed upon by the town and MassDOT, it is likely that the traffic signal and some additional lanes will be constructed within the next five years.

As only a draft of the corridor study has been submitted to the town and consensus has not been reached on the preferred design, the future configuration of the Route 20/Landham Road intersection is presently unknown. However, it appears likely that a minimum the intersection will be improved with a traffic signal, a new westbound left-turn lane, a new eastbound right-turn lane and a tighter westerly corner (the town's preference). Therefore, the future peak hour capacity analyses conducted for this study at the Route 20/Landham Road intersection will consider both the existing configuration and the minimum expected capacity enhancements (traffic signalization, a westbound left-turn lane and an eastbound right-turn lane).

Route 20/Brookside Farm Lane/Site Driveway. The site driveway will intersect Landham Road opposite Brookside Farm Lane. Although an off-set intersection was considered, the safest alignment is one where opposing streets have a common centerline. The proposed two lane driveway will be under STOP sign control.

3.2.3 Trip Generation

Trip generation for the proposed project was determined by applying trip rates obtained from the Institute of Transportation Engineers (ITE) publication *Trip Generation*, 7th Edition, 2008 for Land Use Code 220 – Apartments. The ITE rates are based on empirical studies conducted at residential apartment facilities across the nation.

Table 3 presents the trip generation estimates for the proposed project. A trip is defined as a one-way movement to or from the site. As noted in Table 3, the project is anticipated to generate 850 trips for an average weekday, with 63 trips occurring in the morning peak hour (13 enter and 50 exit) and 84 trips in the afternoon peak hour (54 enter and 29 exit).

Table 3 Total Trip Generation Summary

Time Period	Weekday	AM Peak Hour	PM Peak Hour
Vehicle Trips[1]			
Enter	425	13	54
Exit	425	50	29
Total	**850**	**63**	**84**

[1] Based on ITE Land Use Code 220 – Apartments (120 units)

3.2.4 Trip Distribution

The trip distribution pertains to the arrival/departure directions for vehicle traffic generated by the project. Distribution of site-generated traffic demand during weekday peak hours will be influenced primarily by work locations of the residents. Therefore, the distribution and assignment of project generated vehicle trips to the study roadways and intersections was derived by analyzing the 2000 U.S. Census Journey to Work data for Sudbury residents. This analysis is provided in Appendix C.

The projected trip distribution is shown in Table 4.

Table 4 Trip Distribution

Direction-Route	Distribution (%)
Route 20, east of Landham Road	23%
Route 20, west of Landham Road	34%
Landham Road, south of Pelham Island Road	40%
Pelham Island Road	3%
Total	100%

The assumed trip assignment patterns are shown in Figure 4. The weekday morning and afternoon project trips assignments to the study area roadway network are depicted in Figure 5.

3.2.5 Build Traffic Volumes

The projected site-generated trips illustrated in Figure 5 were combined with the No-Build traffic volumes presented in Figure 3 to estimate the Build Volumes. The Build traffic volumes for the weekday morning and afternoon peak hours are illustrated on Figure 6.

Table 5 provides a summary of the total entering volumes for both 2016 peak hours. The project will increase traffic at the Route 20/Landham Road intersection by approximately 36 trips during the morning peak hour (approximately one vehicle every two minutes) and by approximately 48 trips during the afternoon peak our (approximately one vehicle per minute). These volumes represent a less than 2 percent increase over no-build levels.

Table 5 Traffic Volume Comparison

	AM				PM			
Intersection	No-Build	Project Trips	Build	Change	No-Build	Project Trips	Build	Change
Route 20/Landham Road	2,405	36	2,441	1.5%	2,670	48	2,718	1.8%
Landham Rd./Brookside Farm Ln./Site Dr.	995	63	1,057	6.3%	1,199	84	1,282	7.0%
Landham Road/Pelham Island Road	1,051	27	1,078	2.6%	1,264	36	1,300	2.8%

3.3 Intersection Capacity Analysis

3.3.1 Level of Service

Level of service (LOS) is a term used to describe the quality of the traffic flow on a roadway facility at a particular point in time. It is an aggregate measure of travel delay, travel speed, congestion, driver discomfort, convenience, and safety based on a comparison of roadway system capacity to roadway system travel demand. Operating levels of service are reported on a scale of A to F, with A representing the best operating conditions with little or no delay to motorists, and F representing the worst operating conditions with long delays and traffic demands exceeding roadway capacity.

Roadway operating levels of service are calculated following procedures defined in the *2000 Highway Capacity Manual*, published by the Transportation Research Board. For signalized and unsignalized intersections, the operating level of service is based on travel delays. Delays can be measured in the field but generally are calculated as a function of traffic volume; peaking

characteristic of traffic flow; percentage of heavy vehicles in the traffic stream; type of traffic control; number of travel lanes and lane use; intersection approach grades; pedestrian activity; and signal timing, phasing, and progression where applicable. The specific criteria applied from the *Highway Capacity Manual (2000)* are summarized in Table 6.

For unsignalized intersections, it is assumed that through movements on the main street have the right-of-way and are not delayed by side street traffic. Thus, the total delay values in Table 6 for unsignalized intersections apply only to the minor street intersection approaches or to left turns from the major street into the minor street which must yield to oncoming traffic.

SYNCRHO 6 software was used to analyze the study intersections.

Table 6 Intersection Level of Service Criteria

	Average Delay per Vehicle (Seconds)	
Level of Service	**Signalized Intersections**	**Unsignalized Intersections**
A	≤10.0	≤10.0
B	10.1 to 20.0	10.1 to 15.0
C	20.1 to 35.0	15.1 to 25.0
D	35.1 to 55.0	25.1 to 35.0
E	55.1 to 80.0	35.1 to 50.0
F	>80.0	>50.0

Source: *Highway Capacity Manual*, Transportation Research Board, National Research Council, Washington, DC, 2000.

3.3.2 Intersection Operating Conditions

The procedures described above were used to determine the peak hour operating levels of service at the study area intersections for the 2011 existing, 2016 no-build and 2016 build conditions. The results of the analyses are presented in Table 7 and the analysis worksheets are contained in Appendix D.

Overall delay for motorists existing from Brookside Farm Lane will increase by approximately one second during the morning peak hour and by three seconds during the afternoon peak hour as a result of the proposed project. However, no change in level of service will occur. Vehicles entering and existing Brookside Farm Lane will continue to operate at LOS A and LOS C, respectively during both peak hours.

As shown in Table 7, the level of service will not change at any of the study intersections as a result of traffic generated by the proposed project. The Route 20/Landham Road intersection will continue to operate at LOS F conditions in 2016 during peak hours with or without the project. Should the intersection be improved by installation of a traffic signal and at a minimum a westbound left-turn lane and eastbound right-turn lane, the intersection would operate at LOS D conditions with or without the proposed development.

Table 8 provides further detail on how the proposed project would affect future peak hour traffic operations at the Route 20/Landham Road intersection assuming the intersection is under traffic signal control and the Route 20 turn lanes have been installed. The table summarizes by lane-group the level of service, delay, volume-to-capacity ratio and 50th percentile and 95th percentile queues. The project would add approximately 2 to 4 vehicles to the Landham Road queue

during the morning peak hour, 1 to 2 vehicles to the Landham Road queue during the afternoon peak hour and 1 to 2 vehicles to the Route 20 exclusive turn lanes during the afternoon peak hour. The project's 36 morning peak hour trips and 48 afternoon peak hour trips would utilize approximately two percent of the available capacity at the signalized intersection.

Table 7 Intersection Level of Service Summary

Location	Peak Hour	2011 Existing LOS[1]	2011 Existing Delay[2]	2011 Existing v/c[3]	2016 No-Build LOS[1]	2016 No-Build Delay[2]	2016 No-Build v/c[3]	2021 Build LOS[1]	2021 Build Delay[2]	2021 Build v/c[3]
Route 20/Landham Road - Signalized	AM	-	-	-	C	31.2	0.95	C	34.4	0.97
	PM	-	-	-	D	40.6	0.97	D	44.6	1.01
Route 20/Landham Road - Unsignalized										
Route 20 WB	AM	A	4.4	0.18	A	5.5	0.22	A	5.7	0.23
	PM	A	8.8	0.37	B	12.9	0.47	B	13.7	0.49
Landham Road NB	AM	F	*	**	F	*	**	F	*	**
	PM	F	*	**	F	*	**	F	*	**
Gas Station Driveway	AM	D	26.0	0.07	D	29.9	0.09	D	30.2	0.09
	PM	D	25.5	0.11	D	32.2	0.15	D	33.0	0.15
Landham Road/Brookside Farm Lane/Site Driveway										
Site Driveway EB	AM	-	-	-	-	-	-	C	21.7	0.20
	PM	-	-	-	-	-	-	D	31.0	0.19
Brookside Farm Lane WB	AM	C	17.0	0.04	C	18.6	0.05	C	19.9	0.05
	PM	C	18.6	0.02	C	22.1	0.02	C	25.0	0.02
Landham Road NB	AM	-	-	-	-	-	-	A	0.2	0.01
	PM	-	-	-	-	-	-	A	0.8	0.03
Landham Road SB	AM	A	0.1	0.00	A	0.1	0.00	A	0.1	0.00
	PM	A	0.1	0.01	A	0.1	0.01	A	0.1	0.01
Landham Road/Pelham Island Road										
Pelham Island Road WB	AM	C	19.6	0.14	C	21.8	0.16	C	22.7	0.17
	PM	D	27.5	0.26	E	37.5	0.36	E	40.3	0.38
Landham Road SB	AM	A	0.2	0.01	A	0.2	0.01	A	0.3	0.01
	PM	A	0.5	0.02	A	0.6	0.02	A	0.6	0.02

[1] Level of service
[2] Average delay in seconds per vehicle
[3] Volume-to-capacity ratio
*Calculated delay is greater than 120 seconds
*Calculated v/c ratio is greater than 2.0.

Table 8 Route 20/Landham Road Detailed Signalized Capacity Analysis Results

	2016 No-Build					2016 Build				
Lane Group	**LOS[1]**	**Delay[2]**	**v/c[3]**	**50%**	**95%**	**LOS[1]**	**Delay[2]**	**v/c[3]**	**50%[4]**	**95%[4]**
Morning Peak Hour										
Route 20 Eastbound Through	D	44.6	0.99	23*	37*	D	47.9	1.00	23*	37*
Route 20 Eastbound Right	A	2.3	0.23	1	1	A	2.3	0.23	1	1
Route 20 Westbound Left	C	34.6	0.78	2	7*	D	38.9	0.81	2	7*
Route 20 Westbound Through	A	7.8	0.47	7	10	A	8.2	0.48	7	10
Landham Road Northbound Left/Right	D	47.8	0.90	10	19*	D	54.3	0.94	12	22*
Overall Intersection	**C**	**31.2**	**0.95**			**C**	**34.4**	**0.97**		
Afternoon Peak Hour										
Route 20 Eastbound Through	E	55.8	1.00	19	31*	E	55.8	1.00	19	31*
Route 20 Eastbound Right	A	5.3	0.27	2	3	A	5.4	0.28	2	4
Route 20 Westbound Left	E	64.0	0.98	8	17*	E	77.5	1.03	9*	18*
Route 20 Westbound Through	B	13.1	0.75	14	21	B	13.1	0.75	14	21
Landham Road Northbound Left/Right	E	67.2	1.00	13	24*	E	77.0	1.03	15*	25*
Overall Intersection	**D**	**40.6**	**0.97**			**D**	**44.6**	**1.01**		

[1] Level of service
[2] Average delay in seconds per vehicle
[3] Volume-to-capacity ratio
[4] Queue is in number of vehicles.
*Queue may be longer

4.0 Safety

Existing accident data obtained for the two study area intersections and sight lines at the proposed site driveway were evaluated as a part of a safety study conducted for the proposed project.

4.1 Accident History at Study Intersections

MassDOT accident data for the most recent three years available (2006, 2007 and 2008) were reviewed for the study area intersections. The accident data is provided in Appendix E and summarized in Table 9. Crash rate calculations are also provided in Appendix E. As indicated in Table 9, the intersection of Route 20/Landham Road had approximately seven accidents per year. Of the 22 accidents reported at this intersection during the three-year period, half were rear-end collisions. The crash rate for the intersection, calculated in accordance with MassDOT methodology, is 0.77 accidents per million entering vehicles, higher than both the MassDOT state-wide average of 0.62 accidents per million entering vehicles and the MassDOT District 3 average of 0.68 accidents per million entering vehicles for unsignalized intersections. Improvements are being evaluated for this intersection by the Town of Sudbury and MassDOT.

Table 9 Study Area Accident Summary (2006 - 2008)

Route 20/Landham Road					
Year		**Time**		**Severity**	
2006	4	7:00 AM to 9:00 AM	7	Property	18
2007	10	9:00 AM to 4:00 PM	7	Personal Injury	4
2008	8	4:00 PM to 6:00 PM	3	Fatality	0
Total	**22**	6:00 PM to 7:00 AM	5	Other	0
		Total	**22**	**Total**	**22**
Type		**Weather**		**Crash Rates[1]**	
Angle	6	Clear	14	Statewide Rate	0.62
Rear-end	11	Cloudy	2	District 3 Rate	0.68
Sideswipe	3	Rain	5	**Crash Rate**	**0.77**
Single Vehicle Crash	1	Snow	1		
Unknown-Other	1	**Total**	**22**		
Total	**22**				
Route 20/Pelham Island Road					
Year		**Time**		**Severity**	
2006	2	7:00 AM to 9:00 AM	0	Property	2
2007	1	9:00 AM to 4:00 PM	3	Personal Injury	1
2008	0	4:00 PM to 6:00 PM	0	Fatality	0
Total	**3**	6:00 PM to 7:00 AM	0	Other	0
		Total	**3**	**Total**	**3**
Type		**Weather**		**Crash Rates[1]**	
Angle	1	Clear	3	Statewide Rate	0.62
Rear-end	1	**Total**	**3**	District 3 Rate	0.68
Single Vehicle Crash	1			**Crash Rate**	**0.22**
Total	**3**				

[1] Accident rates per million entering vehicles (MEV) calculated.

4.2 Sight Distance Analysis at Site Driveway

Stopping sight distance and intersection sight distance analyses were conducted at the proposed intersection of Landham Road/Site Driveway in accordance with the methodology contained in *A Policy on Geometric Design of Highways and Streets*, 5th Edition, 2004, American Association of State and Highway Transportation Officials (AASHTO).

4.2.1 Stopping Sight Distance

Definition. Stopping sight distance (SSD) is the length of roadway ahead which is visible to the driver. The minimum sight distance available on a roadway should be sufficiently long enough to enable a vehicle to stop before reaching a stationary object in its path. SSD includes the length of roadway traveled during the perception and reaction time of a driver to an object in a road, and the distance traveled during braking. Stopping sight distance criteria are defined by AASHTO based on design speeds, anticipated driver behavior and vehicle performance, as well as physical roadway conditions.

Measurement Criteria. Per AASHTO guidelines, the stopping sight lines are measured with an eye height 3.5 feet above the road surface. The distance at which a 2-foot tall object located in the road is visible is measured for each approach to the proposed Site Driveway. It was assumed for the measurements that the proposed Site Driveway will be located directly opposite Brookside Farm Lane.

AASHTO Recommendation. Table 10 provides for each major road approach to the Site Driveway the recommended stopping sight distance based on the 85 percentile travel speed. The 85 percentile travel speed on Landham Road, in the vicinity of the site was measured for three weekdays between Wednesday, April 27, 2011 and Friday, April 28, 2011. The data, provided in Appendix A, indicates that the speed at which 85 percent of all measured vehicles traveled at or below is 40 miles per hour in the southbound direction and 43 miles per hour in the northbound direction.

Conclusions. Table 10 summarizes the results of the stopping sight distance analysis. SSD is adequately provided at the site driveway.

Table 10 Stopping Sight Distance (SSD)

Intersection	85th percentile speed (mph)	AASHTO Recommended SSD (feet)	Measured SSD (feet)	Sufficient SSD?
Site Driveway				
From the south	43	335	465	YES
From the north	40	300	600	YES

4.2.2 Intersection Sight Distance

Definition. Intersection sight distance (ISD) is the length of roadway which is visible to a driver stopped on a minor road approach to an intersection. The intersection sight distance should be

sufficiently long for vehicles on the site driveway to depart from the driveway and enter Landham Road.

Measurement Criteria. Per AASHTO guidelines, the intersection sight lines are measured on the minor approach with an eye height 3.5 feet above the road surface and 14.5 feet from the edge of traveled way on the major street. The distance at which a 4.35 foot tall vehicle is visible is measured for each approach to the study intersection. It was assumed for the measurements that the proposed Site Driveway will be located directly opposite Brookside Farm Lane.

AASHTO Recommendation. Table 11 provides for each major road approach to the site driveway the minimum and recommended ISD based on the 85 percentile travel speeds (40/43 miles per hour). These distances are for a vehicle stopped on a minor approach and turning left into the major street.

Conclusions. Table 11 summarizes the results of the Intersection Sight Distance (ISD) analysis. ISD is adequately provided at the proposed Site Driveway.

Table 11 Intersection Sight Distance (ISD) - Left Turn From Stop

Intersection	85th percentile speed (mph)	Approx. Grade at Stopped Vehicle's Rear Wheels	AASHTO Minimum ISD (feet)	AASHTO Recom-mended ISD (feet)	Measured ISD	Meets AASHTO Minimum ISD?	Meets AASHTO Recom-mended ISD
Site Driveway							
To the south	43	0	335	474	850	Yes	Yes
To the north	40	0	300	441	1,215	Yes	Yes

5.0 Conclusion

Parking. The parking analysis performed for this project indicates that the proposed 180 parking spaces will provide sufficient parking for 120 apartment units. Parking observations at similar facilities in Marlborough and Framingham indicate maximum parking ratios of 1.45 vehicles per unit and 0.64 vehicles per bedroom. Both of these values are lower than the 1.5 vehicles per unit ratio and 1.0 vehicle per bedroom ratio which are proposed at the site. The *Parking Generation* manual indicates that a parking ratio of 1.20 spaces per apartment unit would be adequate.

Intersection Operations. The project will add less than one new trip a minute to the Landham Road intersections with Route 20 and Pelham Island Road during the weekday peak hours and will not cause a change in overall level of service at this intersection.

The town, in conjunction with MassDOT, is considering traffic improvements to Route 20/Landham Road intersection. However, it is unknown when these improvements will be construction. Therefore, the intersection of Route 20/Landham Road was analyzed under its present unsignalized configuration as well as with improvements. For this study, it is assumed that, at a minimum, these improvements will include traffic signalization, a westbound left-turn land and eastbound right-turn lane. In both cases (unsignalized, signalized with additional lanes), the overall level of services remained the same with or without project generated trips.

At the Route 20/Brookside Farm Lane/Site Driveway intersection, the project will generate approximately 65 and 85 new trips during the morning and afternoon peak hours, respectively. No changes in level of service are anticipated.

Safety. The existing conditions evaluation shows that the Route 20/Landham Road intersection has a higher than statewide average for crashes at an unsignalized intersection. Although improvements are not required as a result of the proposed project, the town and MassDOT are currently reviewing improvement options for this location that may improve safety.

The sight distance analyses conducted at the site driveway indicates that adequate stopping and intersection sight lines are available.

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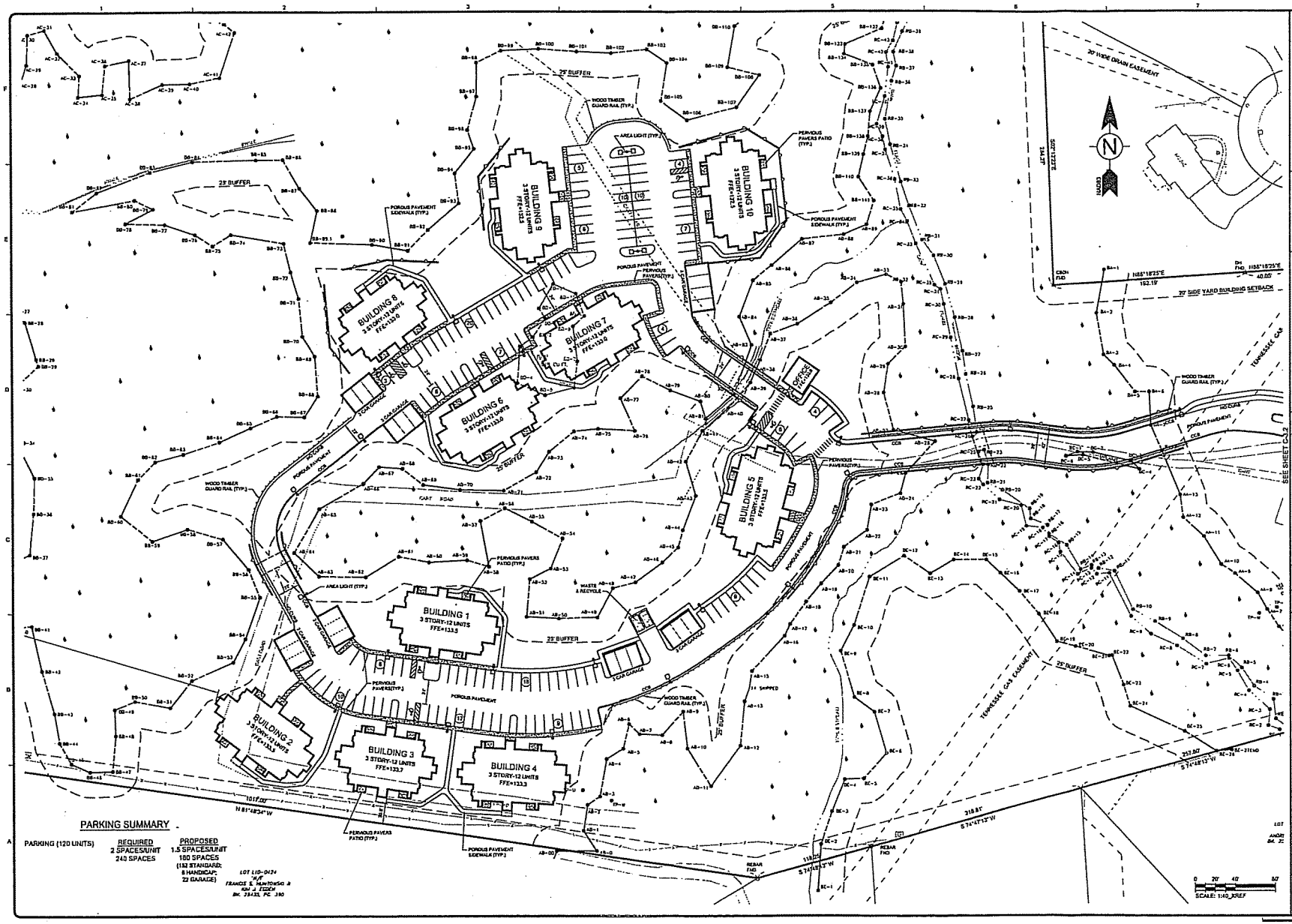


PARKING SUMMARY

	REQUIRED	PROPOSED
PARKING (120 UNITS)	2 SPACES/UNIT 240 SPACES	1.5 SPACES/UNIT 180 SPACES (152 STANDARD; 6 HANDICAP; 22 GARAGE)

LOT L10-0124
"M.F."
FRANCIS & HUNTINGTON R
KAY J TRUST
BK 28433, PG 380

TETRA TECH
www.tetratech.com
One Grant Street
Framingham, MA 01701
PHONE: (508) 903-2000 FAX: (508) 903-2001

MARK	DATE	DESCRIPTION	BY
1	8-8-11	COMPREHENSIVE PERMIT FILING	

Client: Madison Place Sudbury LLC
Proj. Loc.: Sudbury, MA

The Residences at Johnston Farm
Landham Road, Sudbury

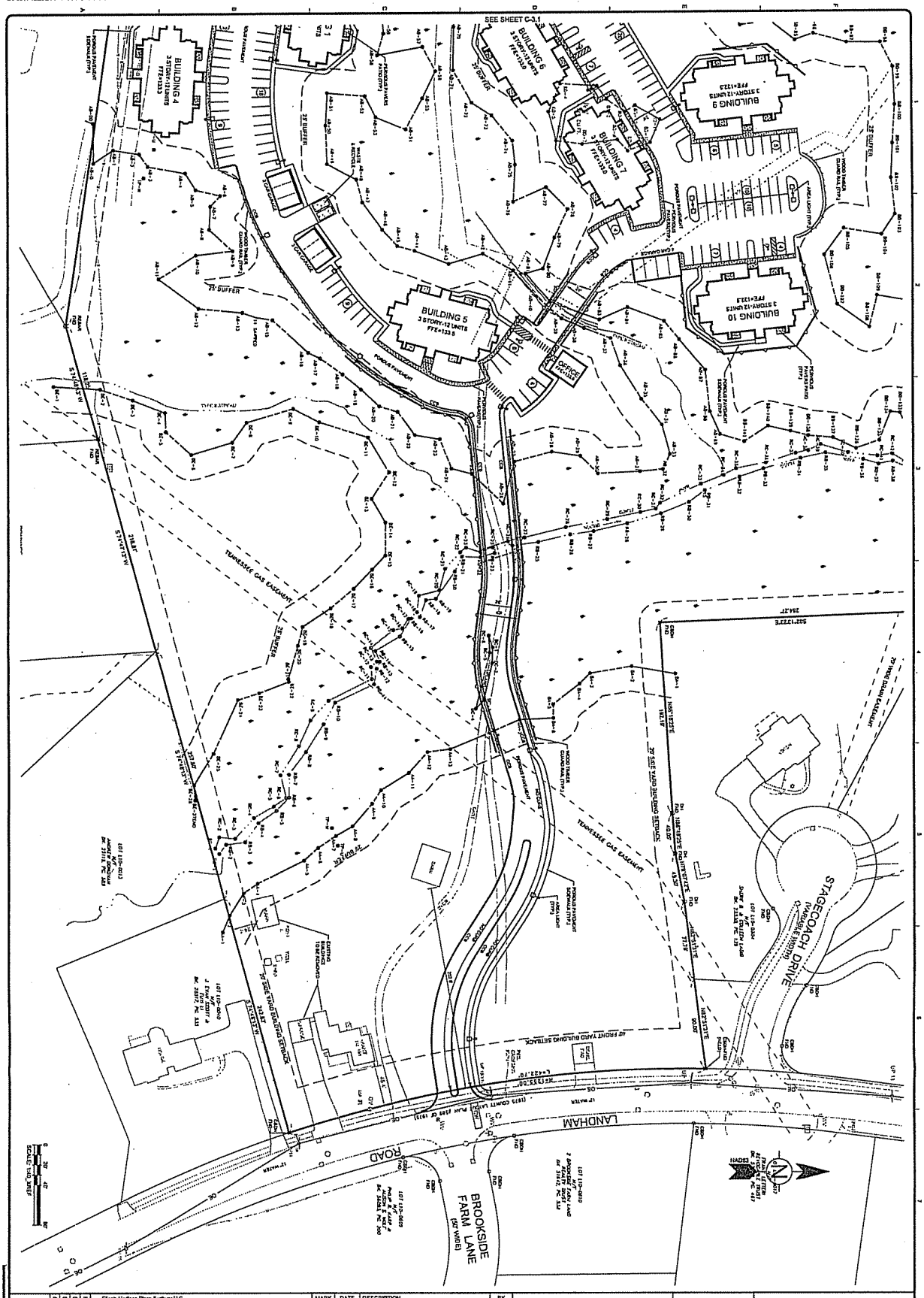
Layout Plan

Project No.: 127-14331-11001
Designed By: G.K.O.
Drawn By: J.L.P.
Checked By:

1A

Bar Measures 1 Inch

8/5/2011 12:29:31 PM - P:\143311\27-14331-11001\CAD\SHEET FILES\C-3.2 LAYOUT PLAN.DWG - PAPPAS, JUD



MARK	DATE	DESCRIPTION	BY
1	8-8-11	COMPREHENSIVE PERMIT FILING	

Client: Madison Place Sudbury LLC
Proj. Loc.: Sudbury, MA

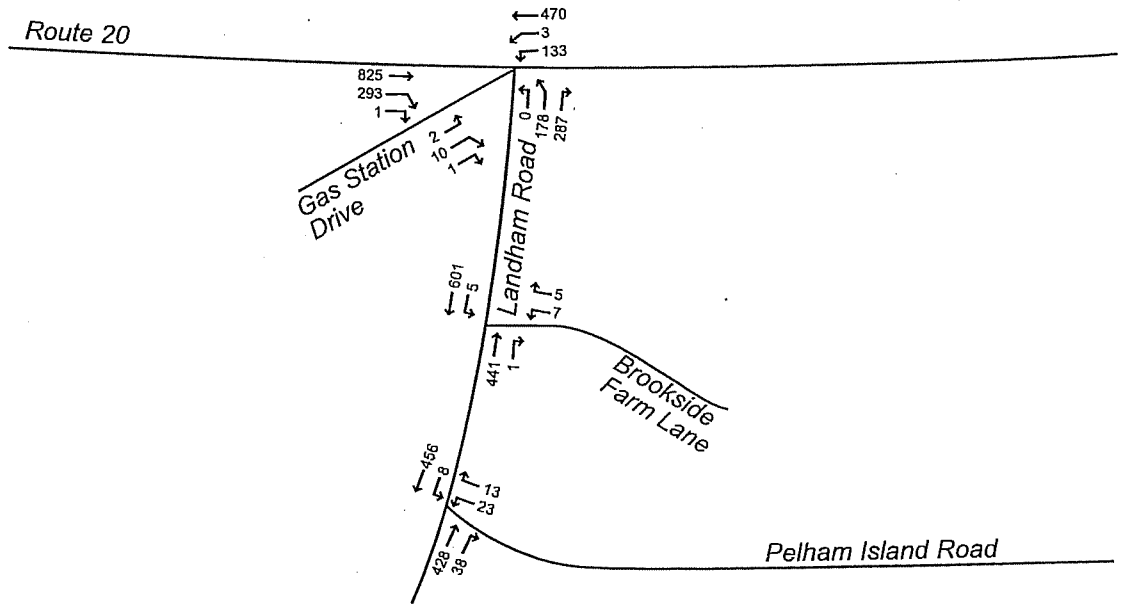
The Residences at Johnson Farm
Landham Road, Sudbury

Layout Plan

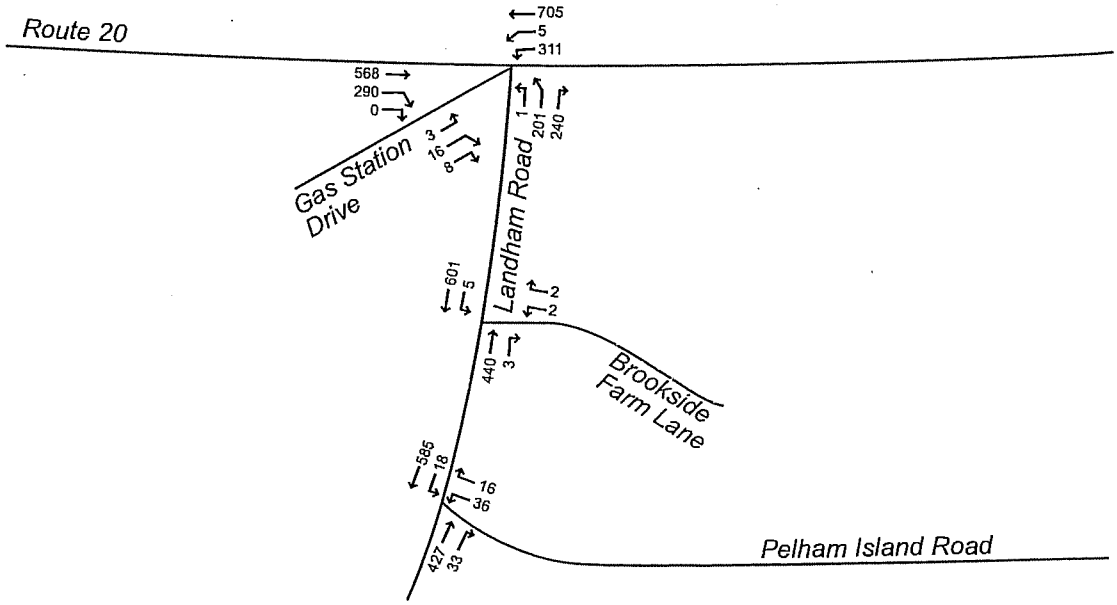
Project No.: 143-11001
Designed By: EAS
Drawn By: JLP
Checked By:

1B

TETRA TECH
www.tetratech.com
One Grant Street
Framingham, MA 01701
PHONE: (508) 903-2000 FAX: (508) 903-2001



AM Peak Hour



PM Peak Hour

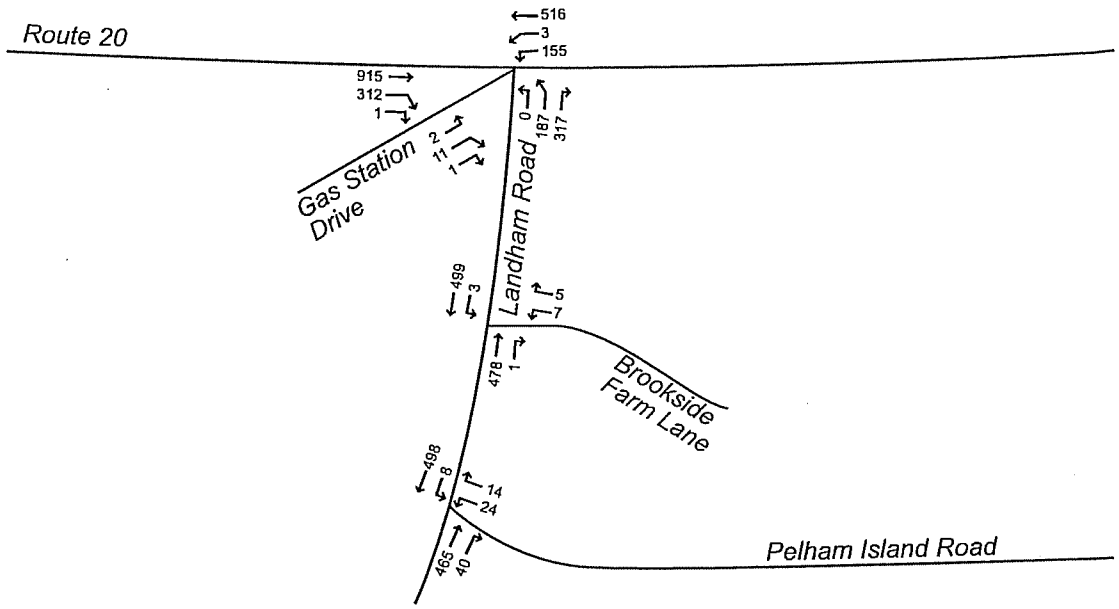
TETRATECH

One Grant Street
Framingham, MA 01701-9005
508.903.2000
www.tetratech.com

The Residence's at Johnson Farm
Sudbury, Massachusetts

2011 Existing Peak Hour Traffic Volumes

Figure 2



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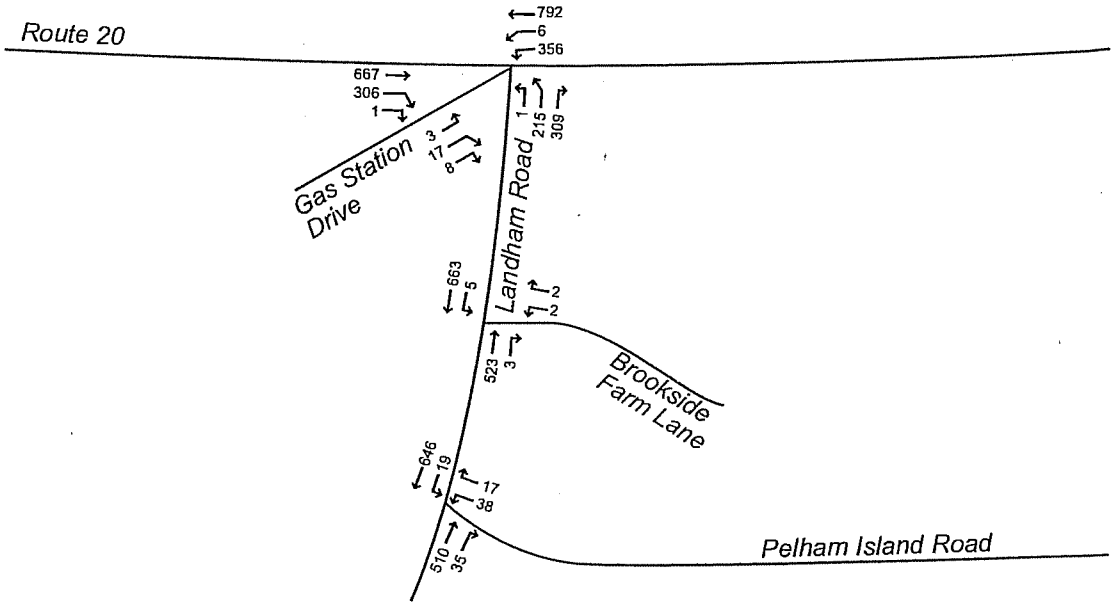

PM Peak Hour

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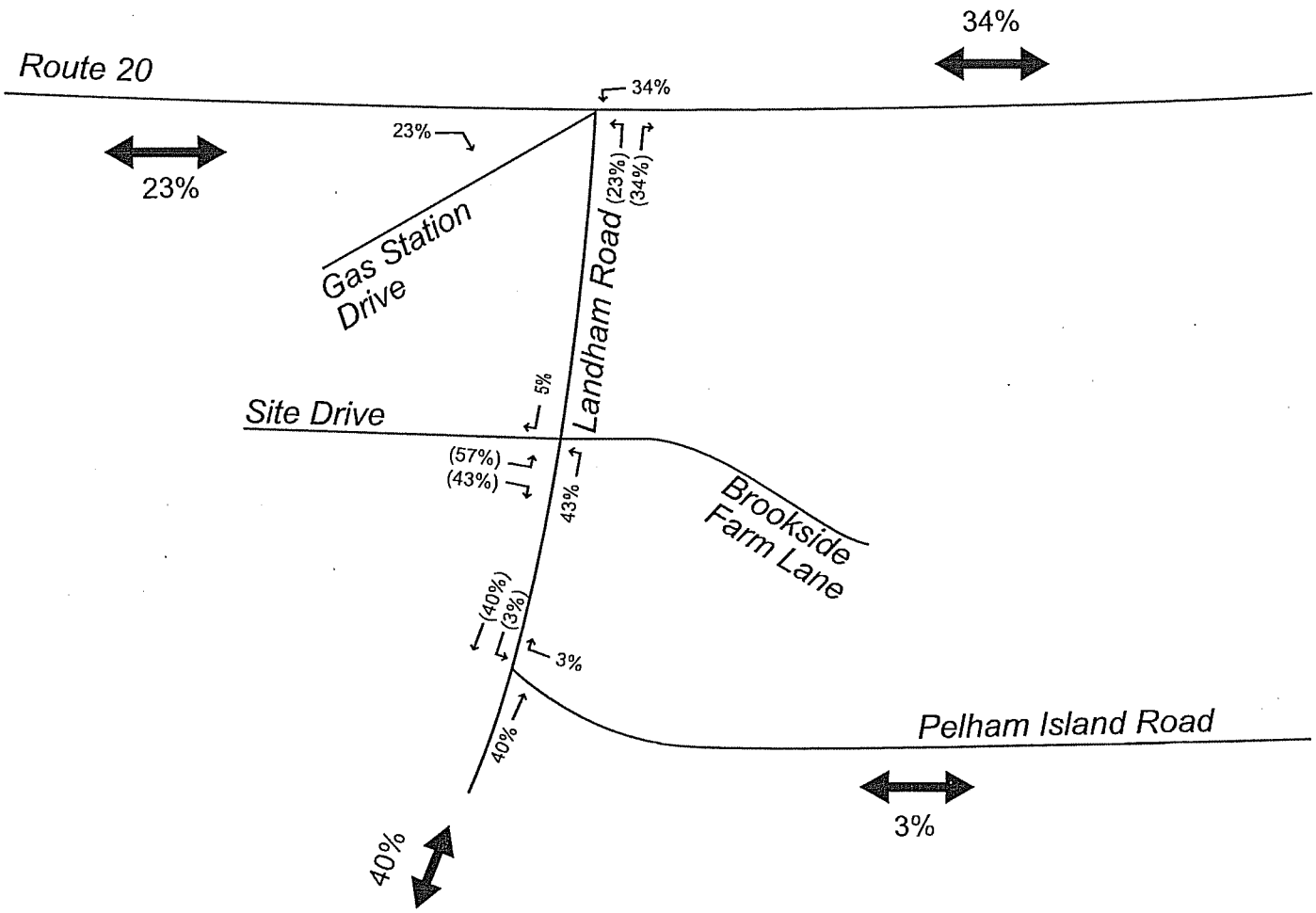
2016 No-Build Peak Hour
Traffic Volumes

Figure 3



XX = Inbound
(XX) = Outbound

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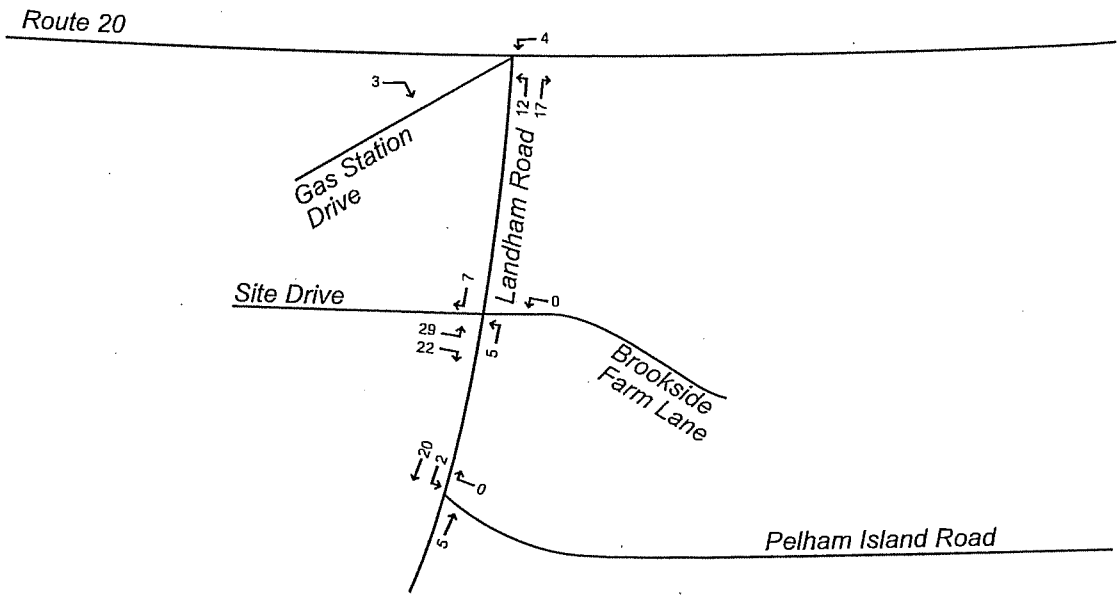
Project Trip Distribution Figure 4



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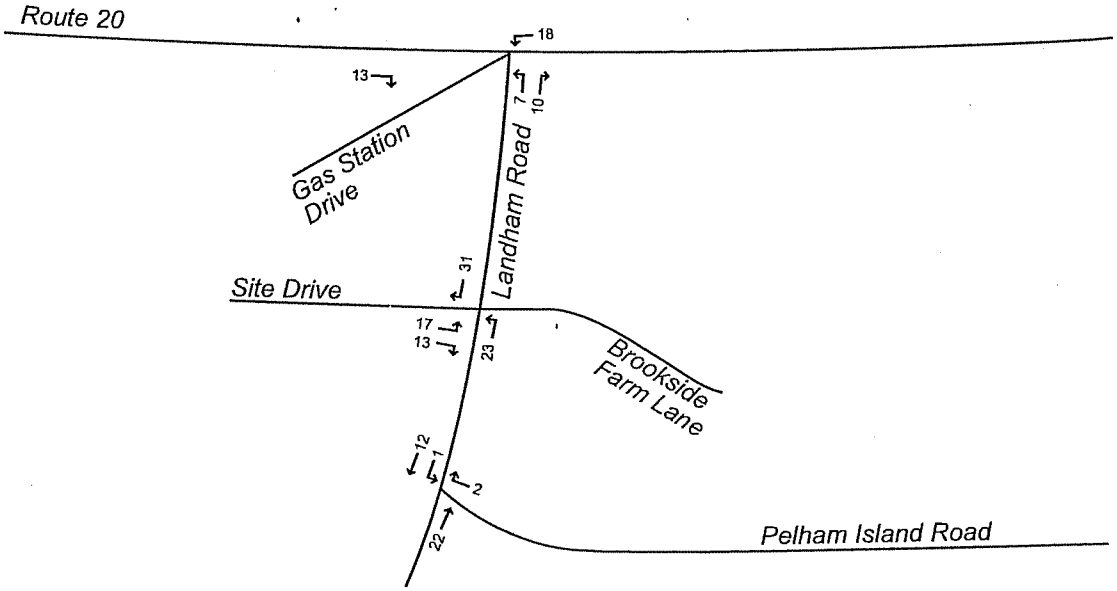

PM Peak Hour

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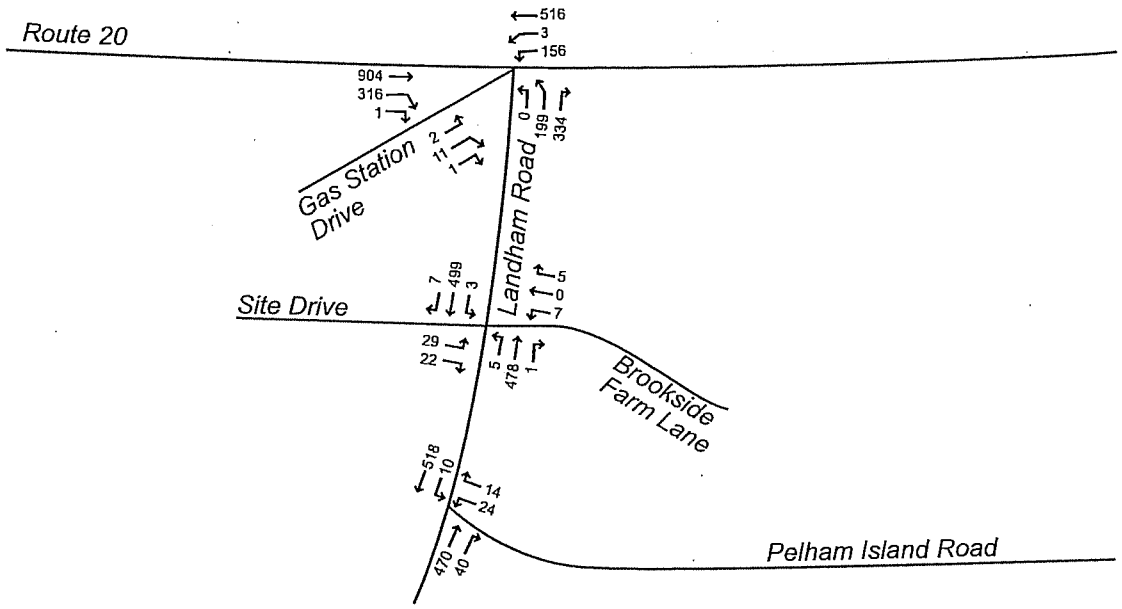
Project Trips

Figure 5



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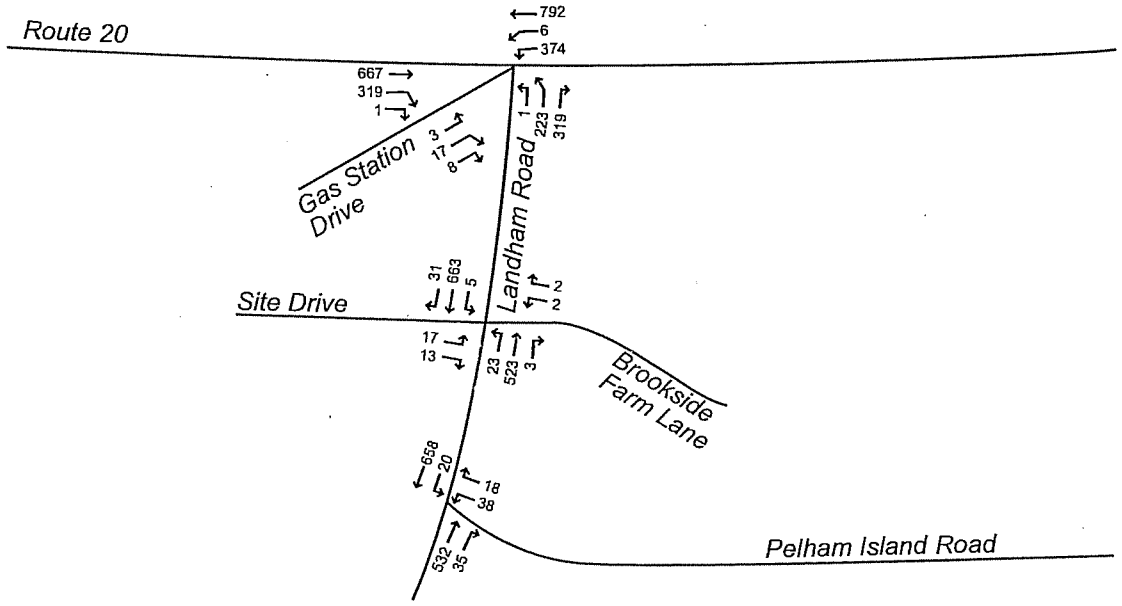

PM Peak Hour

TETRA TECH

One Grant Street
Framingham, MA 01701-9005
508.903.2000
www.tetratech.com

The Residence's at Johnson Farm
Sudbury, Massachusetts

2016 Build Peak Hour
Traffic Volumes

Figure 6