Needham, Massachusetts

Gould Street – Industrial 1 and Reservoir Street – Industrial Districts

Contract No. 16GEN0110D

December 2015

Traffic Impact Study

BETA
315 Norwood Park South
2nd Floor
Norwood, Massachusetts 02062
781.255.1982
www.BETA-Inc.com

Gould Street – Industrial 1 and Reservoir Street – Industrial Districts

Needham, Massachusetts

Contract No. 16GEN0110D

TRAFFIC IMPACT STUDY

Prepared by: BETA GROUP, INC.

Prepared for: Town of Needham Economic Development/Planning Department

December 2015

TABLE OF CONTENTS

List of Tables

List of Figures

List of Appendices (Separate Document)

1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

BETA Group, Inc. (BETA) has prepared this Traffic Impact Study (TIS) to determine the individual and combined traffic impacts of a future build out of the development of two industrial districts in Needham, Massachusetts that abut the Route 128/Highland Avenue Interchange (Exit 19B). The two industrial districts are separated by Route 128. Gould Street – Industrial 1 is located, on the westerly side of Route 128, and Reservoir Street – Industrial District is located on the easterly side of Route 128.

1.2 PROJECT LOCATION

The following signalized and unsignalized intersections are included in the study area and correlate to the locus map shown in Figure 1:

Signalized Intersections
- Highland Avenue/Gould Street

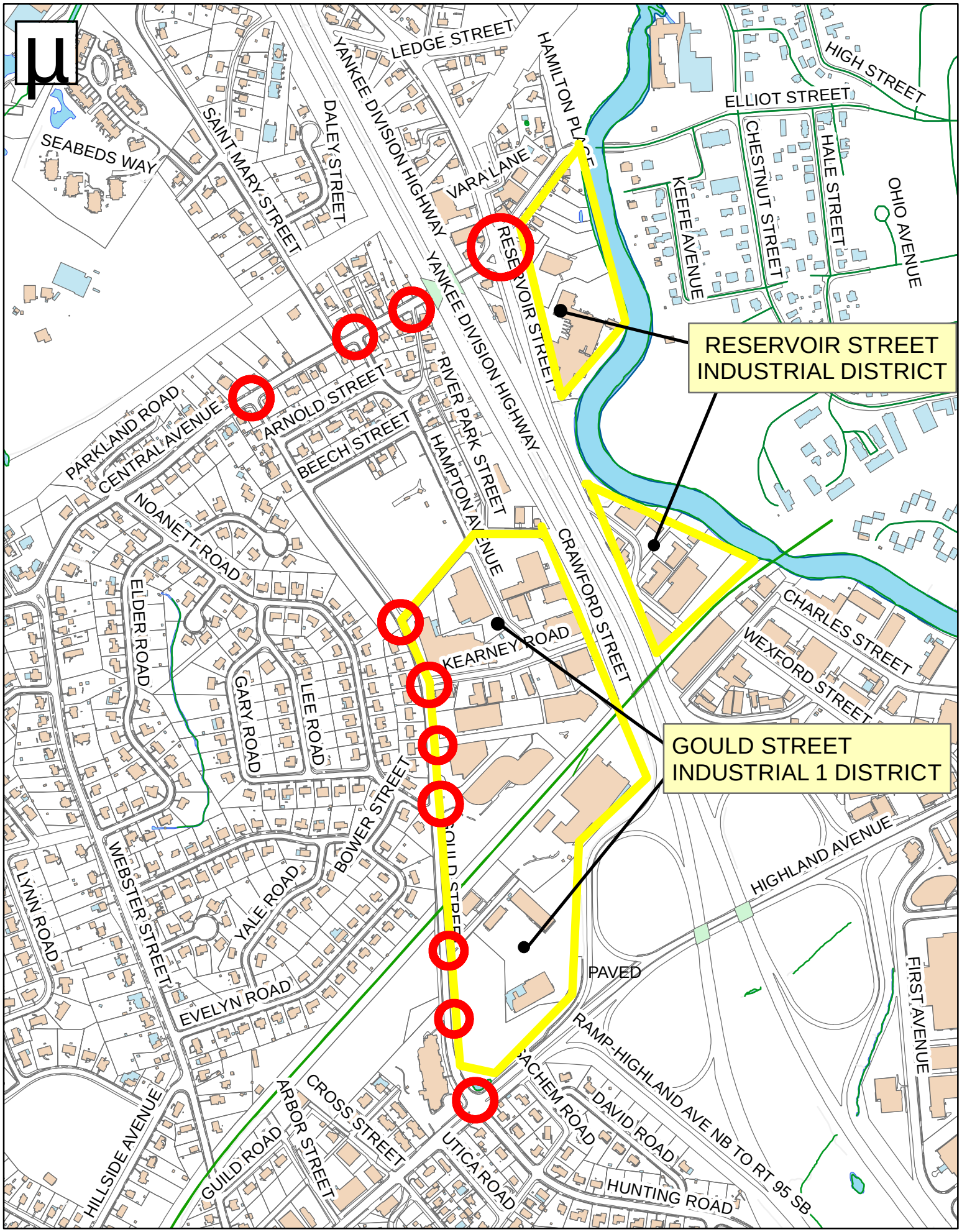
Unsignalized Intersections
- Central Avenue/Reservoir Street
- Central Avenue/River Park Street
- Central Avenue/Hampton Avenue
- Gould Street/Central Avenue
- Gould Street/Ellis Street
- Gould Street/Kearney Road
- Gould Street/Station Street
- Gould Street/Noanett Road
- Gould Street/TV Place
- Gould Street/Muzi Motors Driveway/Wingate Driveway

1.3 ANALYSIS CRITERIA

The following scenarios were evaluated for both the morning (AM) and afternoon (PM) commuting peak periods:

1. 2015 Existing Traffic Volumes with Existing Geometry
2. 2025 Future No-Build Volumes with Existing Geometry
3. 2025 Future Traffic Volumes with only Gould Street –Industrial 1 implemented
4. 2025 Future Traffic Volumes with only Reservoir Street-Industrial District implemented.
5. 2025 Future Traffic Volumes with both industrial districts implemented

A proposed ten-year (2025) project horizon has been established for the study to evaluate the impact of the proposed build out to the adjacent intersections and roadways.



= STUDY INTERSECTIONS

FIGURE 1: LOCUS MAP
Needham, MA
Not to scale

1.4 DATA RESOURCES

The Town provided to BETA available traffic data from the following studies and resources:

- *Future Land Use Mix Gould St. and Reservoir St. Industrial Zones,* Town of Needham. August 25, 2015
- *Build out Analysis Gould St. Industrial 1 and Reservoir St. Industrial Districts – Needham, Massachusetts.* Town of Needham. June 25, 2015
- *Response to Traffic Review Comments – Needham Mews Residential Community*. Vanasse & Associates, Inc. October 2, 2013
- *Traffic Impact and Access Study. Proposed Wingate Senior Living Needham, Massachusetts.* Vanasse & Associates, Inc. June 2014
- *Traffic & Parking Evaluation. North Hill Life Care Facility Needham, Massachusetts.* Vanasse Hangen Brustlin, Inc. June 2011

In addition, BETA referenced traffic data from the following studies and resources:

- *Supplemental Draft Environmental Impact Report –Center 128. Epsilon Associates,* Tetra Tech, etc., for the Executive Office of Energy and Environmental Affairs - MEPA Office. August 31, 2015.
- *Functional Design Report for the I-95/I-93 Transportation Improvement Project (Bridge V).* McMahon Transportation Engineers & Planners. August 2010.

2.0 EXISTING CONDITIONS

2.1 ROADWAYS

CENTRAL AVENUE

Central Avenue runs in a west to east direction in the project area and varies in width from approximately 28-38 feet in the project area. The roadway provides one lane of travel in each direction with approximately 5' or wider shoulders on either side and is separated by a double yellow centerline. A bituminous sidewalk is provided along the both sides of the roadway.

GOULD STREET

Gould Street runs in a north to south direction in the project area and varies in width from approximately 25-28 feet. The roadway provides one lane of travel in each direction with approximately 2' shoulders on either side and is separated by a double yellow centerline. A bituminous sidewalk is provided along the westerly side of the roadway.

2.2 INTERSECTIONS

CENTRAL AVENUE AT RESERVOIR STREET

Reservoir Street intersects Central Avenue in the north/south direction to form a four-legged unsignalized intersection. Both Reservoir Street approaches to Central Avenue are stop controlled. The Reservoir Street southbound approach to the intersection consists of one lane in each direction, is approximately 38 feet wide with no sidewalks and no pavement markings. The Reservoir Street northbound approach to the intersection is approximately 40 feet wide with one lane in each direction separated by a double yellow centerline. A channelized right-turn is provided from Central Avenue eastbound onto Reservoir Street southbound. Sidewalks are not provided along Reservoir Street. Marked crosswalks are provided along both Reservoir Street approaches and from the southeast to the northwest corner of the intersection.

CENTRAL AVENUE AT RIVER PARK STREET

River Park Street intersects Central Avenue from the south to form a three-legged T-type intersection. River Park Street is approximately 14 feet wide approaching the intersection with one lane in each direction and widens to approximately 24 feet at the intersection. Sidewalks and pavement marking are not provided along River Park Street.

CENTRAL AVENUE AT HAMPTON AVENUE

Hampton Avenue intersects Central Avenue from the south to form a three-legged T-type intersection. Hampton Avenue is approximately 24 feet wide approaching the intersection with one lane in each direction and sidewalks provided on both sides. Hampton Avenue is under stop control. Pavement markings are not provided along Hampton Avenue.

GOULD STREET AT CENTRAL AVENUE

Gould Street intersects Central Avenue from the south opposite a residential driveway to form a four-legged intersection. Gould Street is under stop control. Gould Street is approximately 25 feet wide approaching the intersection with one lane in each direction separated by a double yellow centerline. A marked crosswalk is provided across Gould Street at the intersection. Sidewalks are provided at the intersection.

GOULD STREET AT ELLIS STREET

Ellis Street intersects Gould Street from the east to form a three-legged T-type intersection. Stop control is not provided at the intersection. Ellis Street is approximately 25 feet wide approaching the intersection with one lane in each direction separated by a double yellow centerline. Sidewalks are not provided along Ellis Street at the intersection. A parking lot is located along the eastern side of Gould Street and southern side of Ellis Street at the intersection.

GOULD STREET AT KEARNEY ROAD

Kearney Road intersects Gould Street from the east to form a three-legged T-type intersection. Stop control is not provided at the intersection. Kearney Road is approximately 28 feet wide approaching the intersection. Pavement markings and sidewalks are not provided on Kearney Road. Parking lots are located on along the eastern side of Gould Street and both sides of Kearney Road at the intersection.

GOULD STREET/STATION STREET

Station Street intersects Gould Street from the east to form a three-legged T-type intersection. Stop control is not provided at the intersection. Station Street is approximately 20 feet wide approaching the intersection due to landscaped areas. The roadway widens to approximately 24 feet past the intersection. Pavement markings and sidewalks are not provided on Station Street. Parking is located on along the eastern side of Gould Street and both sides of Station Street at the intersection.

GOULD STREET AT NOANETT ROAD/BUSINESS DRIVEWAY

Noanett Road intersects Gould Street from the west at a skewed angle and a business driveway intersects Gould Street from the east to form a slightly skewed four-legged unsignalized intersection. Both intersecting roads approaching Gould Street are stop controlled. Noanett is approximately 26 feet wide with sidewalks on both sides of the street and no pavement markings. The business driveway 23 foot wide access and 23 foot wide egress is divided by an approximate 10 foot wide landscaped median. Sidewalks are provided on both sides of the driveway approach.

GOULD STREET/TV PLACE

TV Place intersects Gould Street at a skewed angle from the northeast to form a three-legged T-type intersection. TV Place is approximately 33 feet wide approaching the intersection and widens to over 60 feet at the intersection. Stop control is not provided at the intersection. Sidewalks are not provided along TV Place at the intersection.

GOULD STREET AT MUZI MOTORS DRIVEWAY/WINGATE DRIVEWAY

The Wingate driveway intersects Gould Street from the west and the Muzi Motors driveway intersects Gould Street from the east to form a four-legged unsignalized intersection. Stop control pavement markings are provided on the Wingate driveway approach. The Wingate driveway consists of one lane in each direction and is approximately 24 feet wide. The Muzi Motors driveway is approximately 33 feet wide and consists of three lanes. One left turn and one right turn lane exiting and one entering lane. A sidewalk is provided along the northern side of the driveway. Gould Street runs in a north/south direction.

HIGHLAND AVENUE AT GOULD STREET/HUNTING ROAD

Gould Street intersects Highland Avenue from the north and Hunting Road intersects Highland Avenue from the south to form a four-legged signalized intersection. Highland Avenue runs in the east/west direction. The Highland Avenue eastbound and westbound approaches to the intersection consist of two 12-foot travel lanes and one 10-foot left-turn lane. The Hunting Road approach consists of an 11-foot wide shared left-turn/through lane and one 11-foot wide exclusive right-turn lane. The Gould Street approach consists of a 10-foot wide exclusive left turn lane and one 11-foot lane. Sidewalks are provided on all approaches to the intersection. Crosswalks are provided on all legs of the intersections except for the westbound approach.

2.3 CRASH DATA

Crash data for key project intersections were obtained from MassDOT Highway Division for the three most recent years available, 2011-2013. A summary of the intersection crash data is shown in Table 1. Complete crash data and crash rate worksheets are included in the Appendix.

The number of crashes which occurred at the eight study intersections range between 0 and 25 crashes per intersection over the three year period reviewed. Zero crashes were reported at four of the intersections during the latest 3-year period. The intersections are Gould Street at Kearney Road, Gould Street at the Muzi Drive, Gould Street at Station Street, and Central Avenue at Hampton Avenue. The crash rates for the study intersections, expressed in crashes per Million Entering Vehicles (MEV), range between 0.00 and 0.72 MEV. The average crash rate for signalized intersections within MassDOT District 6, is 0.76 and statewide is 0.80. The average crash rate for unsignalized intersections within MassDOT District 6 is 0.58 MEV, and the statewide average is 0.60 MEV. As shown in Table 1, all signalized and unsignalized intersections have a crash rate which is lower than both the District and statewide averages.

Table 1: MassDOT Crash Data Summary

MassDOT Crash Data Summary*										
		Collision Type					Collision Severity			
	Total	Angle	Rear-End	Side-swipe	Head-On	Single Vehicle	Property Damage	Non-Fatal Injury	Fatality	Other/ Unknown
Highland Avenue at Gould Street (Signalized)									Crash Rate =	0.72 MEV
2011	11	2	5	4	-	-	9	-	-	2
2012	6	1	2	1	-	2	5	-	-	1
2013	8	5	3	-	-	-	7	1	-	-
Total	25	8	10	5	0	2	21	1	0	3
Gould Street at TV Place									Crash Rate =	0.21MEV
2011	0	-	-	-	-	-	-	-	-	-
2012	1	1	-	-	-	-	1	-	-	-
2013	1	-	-	-	-	1	1	-	-	-
Total	2	1	0	0	0	1	2	0	0	0
Gould Street at Noanett Road									Crash Rate =	0.20 MEV
2011	1	-	1	-	-	-	1	-	-	-
2012	0	-	-	-	-	-	-	-	-	-
2013	1	1	-	-	-	-	1	-	-	-
Total	2	1	1	0	0	0	2	0	0	0
Gould Street at Ellis Street									Crash Rate =	0.17 MEV
2011	1	-	1	-	-	-	1	-	-	-
2012	0	-	-	-	-	-	-	-	-	-
2013	0	-	-	-	-	-	-	-	-	-
Total	1	0	1	0	0	0	1	0	0	0
Central Avenue at Gould Street									Crash Rate =	0.45 MEV
2011	4	3	1	-	-	-	3	-	-	1
2012	3	2	-	-	1	-	2	1	-	-
2013	1	1	-	-	-	-	-	1	-	-
Total	8	6	1	0	1	0	5	2	0	1
Central Avenue at River Park Street									Crash Rate =	0.06 MEV
2011	0	-	-	-	-	-	-	-	-	-
2012	1	-	1	-	-	-	1	-	-	-
2013	0	-	-	-	-	-	-	-	-	-
Total	1	0	1	0	0	0	1	0	0	0
Central Avenue at Reservoir Street									Crash Rate =	0.18 MEV
2011	1	-	-	1	-	-	1	-	-	-
2012	1	1	-	-	-	-	1	-	-	-
2013	1	1	-	-	-	-	1	-	-	-
Total	3	2	0	1	0	0	3	0	0	0
No crashes occurred at the intersections of Gould Street at Kearney Road, Gould Street at Station Street, Gould Street at Muzi Drive, and Central Avenue at Hampton Avenue within the most recent three years.										
Average Statewide Crash Rate = 0.80 (Signalized), 0.60 (Unsignalized) Average District 6 Crash Rate = 0.76 (Signalized), 0.58 (Unsignalized) * 2011 - 2013 Source: Massachusetts Department of Transportation MEV = Million Entering Vehicles										

2.4 EXISTING TRAFFIC VOLUMES

To assess existing traffic conditions, manual turning movement counts (TMC's) were collected in June, October, and December 2015 from 7:00-9:00AM and from 4:00-6:00PM. A review of the data indicated that the weekday morning peak hour occurred between 8:00-9:00AM and the weekday evening peak occurred between 5:00-6:00PM. The 2015 existing weekday morning and evening peak hour traffic volumes are provided in Figure 2 and the supplemental data can be found in the Appendix.

Automatic Traffic Recorder (ATR) counts were collected on Central Avenue/Elliot Street for a 96-hour period from Wednesday, June 3rd through Saturday, June 6th, 2015. The ATR count locations are listed below:

- Central Avenue, between St. Mary's Street and Gould Street
- Elliot Street, west of Chestnut Street

These counts were used to confirm the daily traffic volumes along the project area roadways. ATR data has been summarized in Table 2 below

Table 2: ATR Data Summary

Location	Daily	Weekday AM Peak Hour			Weekday PM Peak Hour		
	Weekday	Volume	K Factor	Dir. Dist	Volume	K Factor	Dir. Dist
Elliot Street Between St Mary's and Gould	15,200	1,147	8%	EB 74%	1,327	9%	WB 60%
Elliot Street West of Chestnut	14,100	1,026	7%	EB 67%	1,182	8%	WB 64%

SEASONAL ADJUSTMENT

Once peak hours were determined, the traffic volumes were examined to evaluate the need for seasonal adjustment. A review of historical traffic growth data maintained by the MassDOT Highway Division indicated that the average month traffic volumes in June, October, and December are higher than the average-month traffic volume. Therefore, to maintain a more conservative analysis, the volume data was not adjusted.

Count Dates: Wednesday, October 21, 2015
Wednesday, December 9, 2015

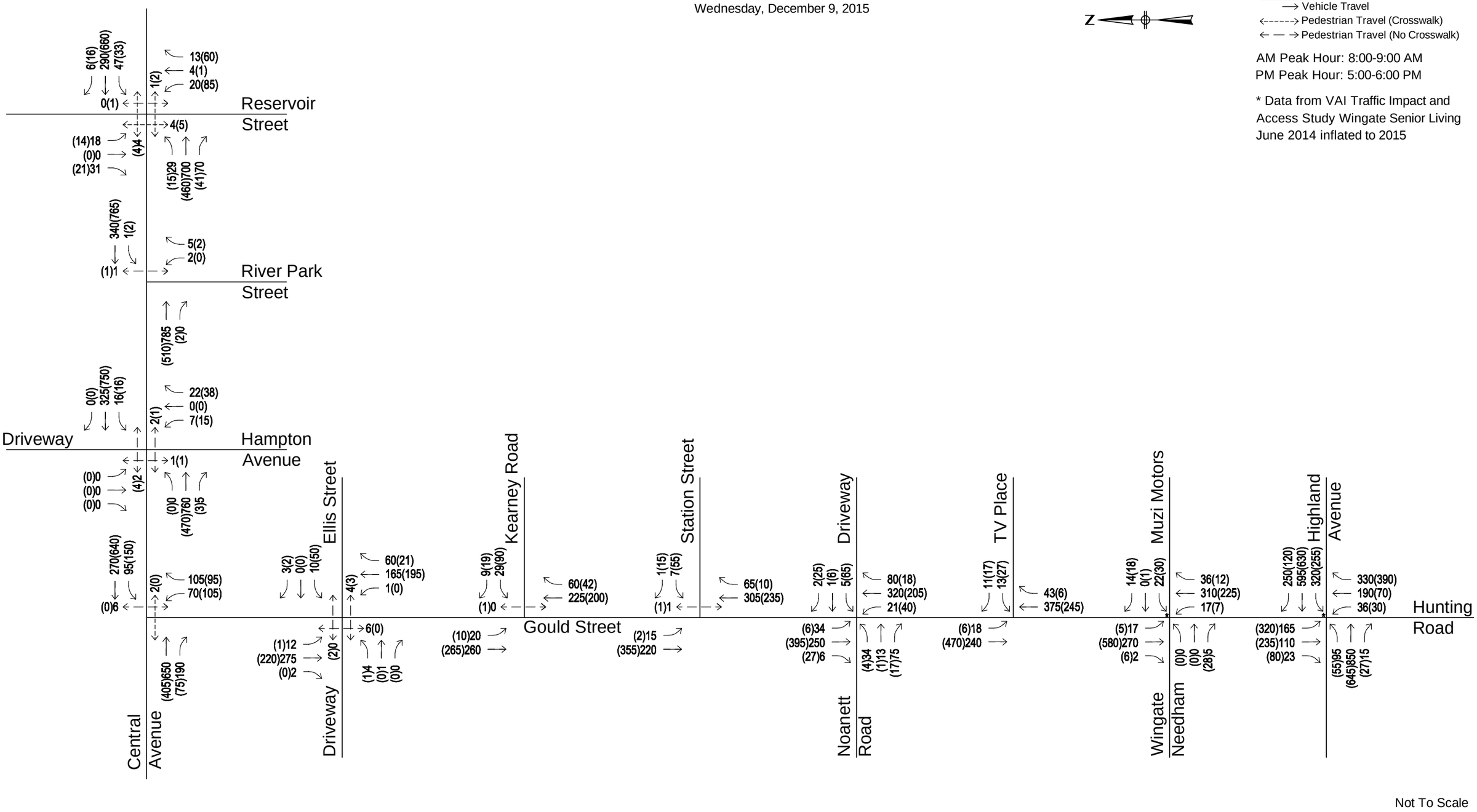
N

Legend:

⟶ Vehicle Travel
<------> Pedestrian Travel (Crosswalk)
← — → Pedestrian Travel (No Crosswalk)

AM Peak Hour: 8:00-9:00 AM
PM Peak Hour: 5:00-6:00 PM

* Data from VAI Traffic Impact and Access Study Wingate Senior Living June 2014 inflated to 2015



Not To Scale

BETA
www.BETA-Inc.com

TRAFFIC IMPACT STUDY GOULD AND RESERVOIR INDUSTRIAL DISTRICT
Needham, MA

Figure 2
Study Area Intersection
AM(PM) Peak Hour Volumes
2015 Existing

O:\5100s\5178 - Needham - Gould St Traffic\Drawing Files\Miscellaneous\5178 TMC.dwg Dec 18,2015 8:32am

2.5 Existing Level-Of-Service Analysis

In order to evaluate existing traffic conditions, a capacity (level of service) analysis was performed. This analysis was performed using methods of the Highway Capacity Manual published by the Transportation Research Board. For intersections, six levels of service, "A"-"F", have been established with "A" representing very good operation and "F" representing very poor operation. For signalized intersections, level of service is defined in terms of total delay and is computed for individual intersection turning movements. Delay is a measure of driver discomfort, frustration, fuel consumption, and lost travel time.

A delay and level of service (LOS) analysis was performed for the existing intersections using Synchro (version 8) computer software. The evaluation criteria for unsignalized and signalized intersections are defined as shown in Table 3.

Table 3: Level of Service Criteria

LOS	Signalized Control Delay (Sec/Veh)	Unsignalized Control Delay (Sec/Veh)	General Description
A	<= 10	<= 10	Free flow
B	>10 and <=20	>10 and <=15	Stable flow (slight delays)
C	>20 and <=35	>15 and <=25	Stable flow (acceptable delays)
D	>35 and <=55	>25 and <=35	Approaching unstable flow (tolerable delay)
E	>55 and <=80	>35 and <=50	Unstable flow (intolerable delay)
F	>80	>50	Forced flow (jammed)

Results of the existing capacity analysis are provided in Table 4. Complete analyses results are provided in the Appendix.

Table 4: Existing Level of Service Summary

INTERSECTIONS	AM Peak Hour			PM Peak Hour		
	2015 Existing			2015 Existing		
	LOS	Delay (s/veh)	95%ile Queue	LOS	Delay (s/veh)	95%ile Queue
Central Avenue at Reservoir Street [UNSIGNALIZED]						
Central - EB	A	8	2.5	A	9	2.5
Central - WB	A	10	5	A	9	2.5
Reservoir - NB	E	36	27.5	F	*	437.5
Reservoir - SB	C	23	22.5	D	32	22.5
Central Avenue at River Park Street [UNSIGNALIZED]						
Central - WB	A	10	0	A	9	0
River Park - NB	C	18	2.5	B	12	0
Central Avenue at Hampton Avenue [UNSIGNALIZED]						
Central - WB	A	10	2.5	A	9	2.5
Hampton - NB	C	19	10	C	20	25
Central Avenue at Gould Street [UNSIGNALIZED]						
Central - WB	B	11	12.5	A	9	15
Gould - NB	F	114	242.5	F	*	482.5
Gould Street at Ellis Street [UNSIGNALIZED]						
Driveway - EB	B	14	2.5	B	14	0
Ellis - WB	B	14	2.5	C	15	15
Gould - NB	A	8	0	A	0	0
Gould - SB	A	8	0	A	8	0
Gould Street at Kearney Road [UNSIGNALIZED]						
Kearney - WB	B	14	10	C	16	32.5
Gould - SB	A	8	2.5	A	8	0
Gould Street at Station Street [UNSIGNALIZED]						
Station - WB	B	13	2.5	C	16	20
Gould - SB	A	8	0	A	8	0
Gould Street at Noanett Street [UNSIGNALIZED]						
Noanett - EB	C	17	37.5	C	16	5
Driveway - WB	C	20	5	D	33	70
Gould - NB	A	8	2.5	A	9	2.5
Gould - SB	A	8	2.5	A	8	0
Gould Street at TV Place [UNSIGNALIZED]						
TV - WB	B	13	7.5	C	16	20
Gould - SB	A	8	2.5	A	8	0
Gould Street at Muzi Drive/Wingate Drive [UNSIGNALIZED]						
Wingate - EB	B	10	0	B	14	7.5
Muzi - WB	A	15	7.5	C	20	17.5
Gould - NB	A	8	0	A	9	0
Gould - SB	A	8	2.5	A	8	0
Highland Avenue at Gould Street/Hunting Road [SIGNALIZED]						
Highland - EBL	E	64	#170	E	58	#127
Highland - EBTR			#540			#376
Highland - WBL	D	43	#445	D	38	310
Highland - WBTR			356			328
Hunting - NBTL	D	45	#317	D	41	#164
Hunting - NBR			224			334
Gould - SBL	D	44	208	D	41	361
Gould - SBLTR			204			#464
OVERALL	D	50	-	D	44	-

95th percentile volume exceeds capacity, queue may be longer. Queue shown is maximum after 2 cycles.
* Delay exceeds 300 seconds

As shown in the previous table, most intersection movements currently operate at LOS D or better. However, the following movements operate at LOS E or F:

- Reservoir Street northbound at Central Avenue (PM) – LOS F with significant queuing
- Reservoir Street northbound at Central Avenue (AM) – LOS E
- Gould Street northbound at Central Avenue (AM & PM) - LOS F with significant queuing
- Highland Avenue eastbound at Gould Street/Hunting Road (AM & PM) – LOS E

3.0 Future No-Build Conditions

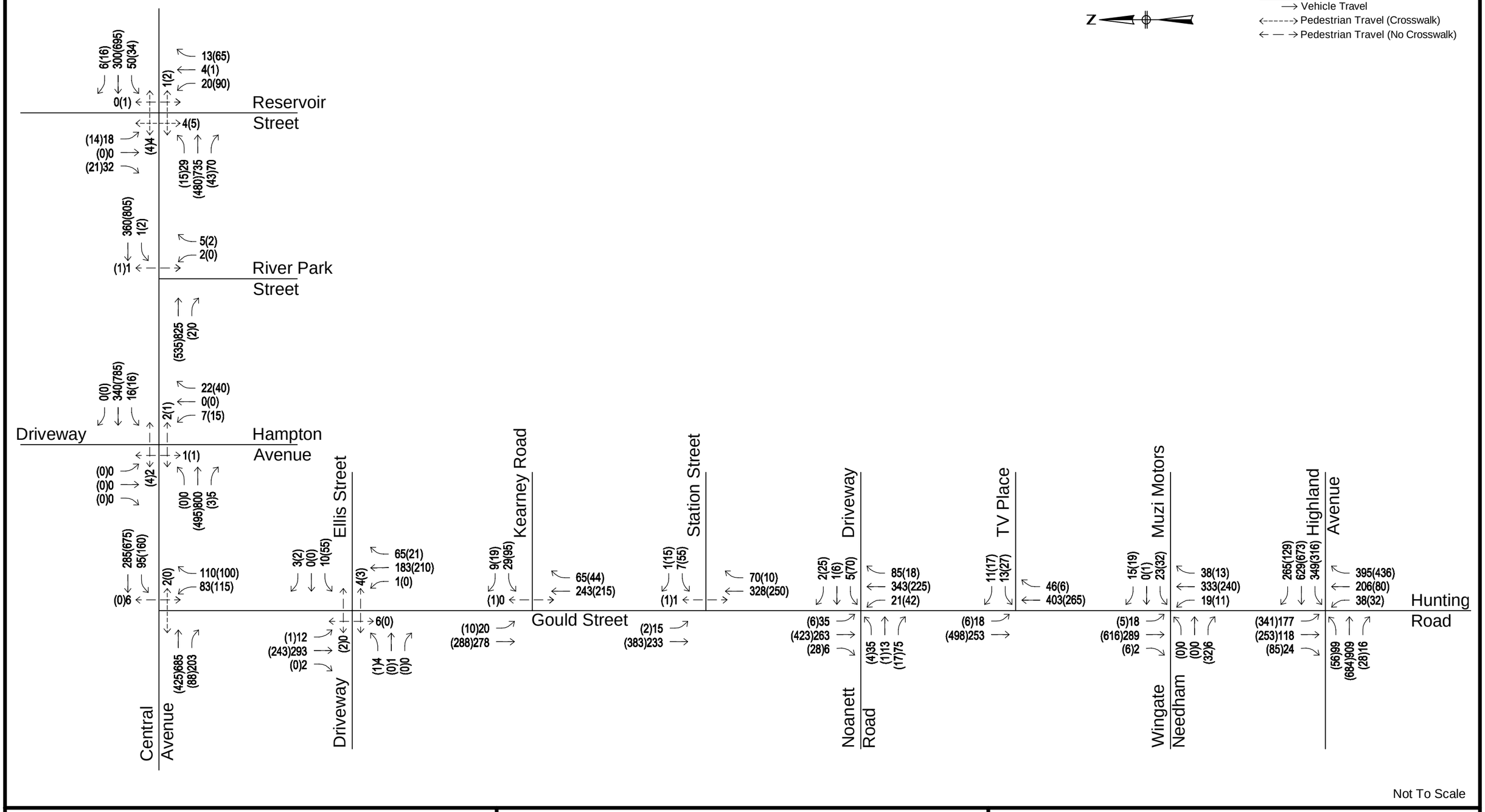
To examine the "No-Build" scenario, a level of service analysis was performed for the study intersections with projected (2025) volumes under existing geometry and traffic control and without any additional Industrial District growth.

3.1 No-Build Background Growth and Developments

Based on discussions with the Town of Needham, the Town Is not anticipating to experience any significant amount of traffic growth along the adjacent street network. However, to be conservative, a background growth rate of 0.5% per year over a 10-year horizon was used to generate the No-Build conditions. In addition, the trips associated with the following proposed projects have been added to the 2025 No-Build traffic volumes: Needham Mews Residential Community, Wingate Senior Living, and Center 128. Projected 2025 No-Build AM and PM peak hour traffic volumes are shown in Figure 3.

3.2 No-Build Level-Of-Service Analysis

A delay and level of service analysis was performed for the No-Build conditions at the study intersections. Results of the No-Build capacity analysis are provided below in Table 5. Complete analyses results are provided in the Appendix.



Not To Scale

BETA
www.BETA-Inc.com

TRAFFIC IMPACT STUDY GOULD AND RESERVOIR INDUSTRIAL DISTRICT
Needham, MA

Figure 3
Study Area Intersection
AM(PM) Peak Hour Volumes
2025 No-Build

Table 5: No-Build Level of Service Summary

INTERSECTIONS	AM Peak Hour 2025 No-Build			PM Peak Hour 2025 No-Build		
	LOS	Delay (s/veh)	95%ile Queue	LOS	Delay (s/veh)	95%ile Queue
Central Avenue at Reservoir Street [UNSIGNALIZED]						
Central - EB	A	8	2.5	A	9	2.5
Central - WB	A	10	5	A	9	2.5
Reservoir - NB	E	40	30	F	*	522.5
Reservoir - SB	C	24	25	E	37	27.5
Central Avenue at River Park Street [UNSIGNALIZED]						
Central - WB	A	10	0	A	9	0
River Park - NB	C	19	2.5	B	12	0
Central Avenue at Hampton Avenue [UNSIGNALIZED]						
Central - WB	A	10	2.5	A	9	2.5
Hampton - NB	C	20	12.5	C	21	27.5
Central Avenue at Gould Street [UNSIGNALIZED]						
Central - WB	B	11	12.5	A	9	17.5
Gould - NB	F	202	342.5	F	*	600
Gould Street at Ellis Street [UNSIGNALIZED]						
Driveway - EB	C	15	2.5	B	14	0
Ellis - WB	B	14	5	C	16	17.5
Gould - NB	A	8	0	A	0	0
Gould - SB	A	8	0	A	8	0
Gould Street at Kearney Road [UNSIGNALIZED]						
Kearney - WB	B	15	10	C	22	47.5
Gould - SB	A	8	2.5	A	8	0
Gould Street at Station Street [UNSIGNALIZED]						
Station - WB	B	14	2.5	C	16	22.5
Gould - SB	A	8	0	A	8	0
Gould Street at Noanett Street [UNSIGNALIZED]						
Noanett - EB	C	18	42.5	C	17	7.5
Driveway - WB	C	21	5	E	43	95
Gould - NB	A	8	2.5	A	9	5
Gould - SB	A	8	2.5	A	8	0
Gould Street at TV Place [UNSIGNALIZED]						
TV - WB	C	17	7.5	C	18	15
Gould - SB	A	9	2.5	A	8	0
Gould Street at Muzi Drive/Wingate Drive [UNSIGNALIZED]						
Wingate - EB	B	10	0	B	14	7.5
Muzi - WB	C	16	7.5	C	23	22.5
Gould - NB	A	8	2.5	A	9	0
Gould - SB	A	8	2.5	A	8	0
Highland Avenue at Gould Street/Hunting Road [SIGNALIZED]						
Highland - EBL	F	83	#182	E	64	#132
Highland - EBTR			#597			#425
Highland - WBL	D	48	#505	D	42	#425
Highland - WBTR			386			360
Hunting - NBTL	D	47	#354	D	45	#188
Hunting - NBR			307			411
Gould - SBL	D	47	220	D	48	387
Gould - SBLTR			217			#516
OVERALL	E	59	-	D	49	-

95th percentile volume exceeds capacity, queue may be longer. Queue shown is maximum after 2 cycles.
* Delay exceeds 300 seconds

As shown in the previous table, most intersection movements would continue to operate at LOS D or better. However, the following movements would continue to operate at or degrade to a LOS E or F from the existing conditions:

- Reservoir Street northbound at Central Avenue (PM) – LOS F with significant queuing
- Reservoir Street northbound at Central Avenue (AM) – LOS E
- Gould Street northbound at Central Avenue (AM & PM) - LOS F with significant queuing
- Highland Avenue eastbound at Gould Street/Hunting Road (AM) – LOS F
- Highland Avenue eastbound at Gould Street/Hunting Road (PM) – LOS E

4.0 Future Build Conditions

To examine the "Build" conditions, the following three scenarios were considered:

- 2025 Future Traffic Volumes with only Gould Street –Industrial 1 implemented
- 2025 Future Traffic Volumes with only Reservoir Street-Industrial District implemented.
- 2025 Future Traffic Volumes with both industrial districts implemented

The level-of-service analyses were performed for the study intersections using the projected (2025) No-Build volumes and adding trips associated with each of the development scenarios under existing geometry and traffic control.

4.1 Trip Generation

Based on discussions with the Town and references developed by the Town of Needham, the following Institute of Transportation Engineers (ITE) Land Use Codes (LUC) were used to generate trips for the Build scenarios as well as the following land use ratios per LUC provided by the Town:

- LUC 150 – Warehousing (40%)
- LUC 714 – Corporate Headquarters Building (30%)
- LUC 760 – Research and Development Center (30%)

The same land use ratios and codes noted above apply to each of the Build scenarios, however, the Build scenario square footage varies per scenario and is outlined in the table below. The combined total Residential District additional build out square footage used in the report was 667,286 SF and the Gould District square footage is 2,201,830 SF for a total of 2,869,116 SF. Table 6 summarizes the trip generation for each of the Build scenarios.

Table 6: Trip Generation Summary

	Reservoir District				Gould District				Reservoir District and Gould District			
Land Use	Warehouse	Corporate HQ	R&D	Total	Warehouse	Corporate HQ	R&D	Total	Warehouse	Corporate HQ	R&D	Total
Square Footage	266,914 sf	200,186 sf	200,186 sf	667,286 sf	880,732 sf	660,549 sf	660,549 sf	2,201,830 sf	1,147,646 sf	860,735 sf	860,735 sf	2,869,116 sf
AM Peak Hour Trips												
Entering	63	275	198	536	211	901	638	1,750	274	1,176	836	2,286
Exiting	18	20	40	78	55	68	132	255	73	88	172	333
Total Trips	81	295	238	614	266	969	770	2,005	347	1,264	1,008	2,619
PM Peak Hour Trips												
Entering	22	28	25	75	72	92	85	249	94	120	110	324
Exiting	64	255	143	462	212	826	468	1,506	276	1,081	611	1,968
Total Trips	86	283	168	537	284	918	553	1,755	370	1,201	721	2,292

It should be noted that the Gould District trip generation was divided into three parts. The three parts of the Gould District are the section north of the old rail tracks, TV Place, and the Muzi Motors property which are all currently physically divided. The peak hour trip generation calculations for each of the three development scenarios are provided in the Appendix.

4.2 Trip Distribution, Assignment & Build Volumes

The distribution of site-generated trips were assigned to and from the Gould and Reservoir Industrial Districts via the local roadway network based on existing traffic patterns. Those trips were added to the 2025 No-Build volumes to develop the AM and PM peak hour traffic volumes for the Build scenarios.

Reservoir Industrial District Trip Assignment

The assignment of AM and PM peak hour trips for the Reservoir Industrial District is presented in Figures 4 and 5, respectively. The Reservoir District peak hour trips were added to the 2025 No-Build volumes to generate the 2025 Build Reservoir development volumes as shown in Figure 6.

Gould Industrial District Trip Assignment

The assignment of AM and PM peak hour trips for the Gould Industrial District is presented in Figures 7 and 8, respectively. The Gould District peak hour trips were added to the 2025 No-Build volumes to generate the 2025 Build Gould development volumes as shown in Figure 9.

Combined Reservoir Industrial District & Gould Industrial District Trip Assignment

The assignment of the combined project site generated AM and PM trips are presented in Figures 10 and 11, respectively. The combined peak hour trips were added to the 2025 No-Build volumes to generate the 2025 Build Reservoir and Gould Industrial development volumes as shown in Figure 12.

4.3 Build Level-Of-Service Analysis

A delay and LOS analysis was performed for the three Build condition scenarios under existing geometry and traffic control. Results of the Build capacity analyses are provided below in Table 7. Complete analyses results are provided in the Appendix.

RESERVOIR INDUSTRIAL DISTRICT ANALYSIS RESULTS

As shown in Table 7, most intersection movements would continue to operate at LOS D or better with the Reservoir District build out. Most notably the following movements would experience a significant increase in queuing and delays:

- Reservoir Street northbound & southbound at Central Avenue (AM & PM) – LOS F with significant queuing northbound
- Gould Street northbound at Central Avenue (AM & PM) - LOS F with significant queuing

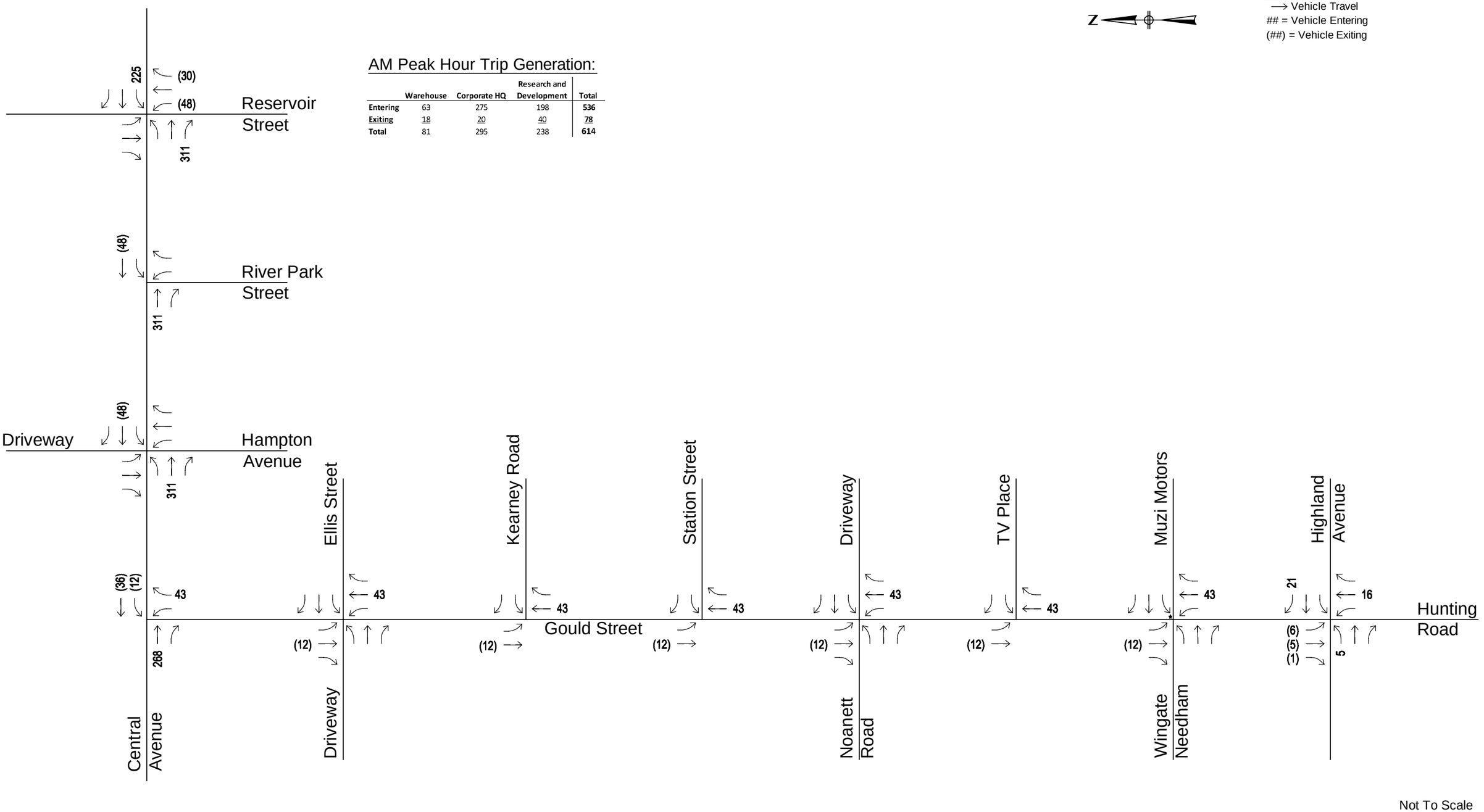
GOULD INDUSTRIAL DISTRICT ANALYSIS RESULTS

As can be seen in Table 7, the majority of intersection movements degrade in LOS as a result of the Gould District build out. Gould Street would continue to operate at LOS A or B, however, all of the side street with the exception of Wingate driveway, would operate at LOS E or F. This is a result of the lack of gaps in traffic along Gould Street combined with the increase in traffic from both Industrial Districts.

Reservoir Street at Central Avenue would operate at a LOS E and F during this scenario, but with less significant queuing than the Reservoir Street build out.

COMBINED RESERVOIR INDUSTRIAL DISTRICT & GOULD INDUSTRIAL DISTRICT ANALYSIS RESULTS

The combined build out analysis results show compounded significant queuing and delay on all side street approaches to Gould Street as well as the side street approaches to Central Avenue. In addition, the Hunting Road northbound approach to Highland Avenue would experience substantial queuing and delay during the AM peak period and the Gould Street approach to Highland Avenue would experience substantial queuing and delay during the PM peak period.



Not To Scale

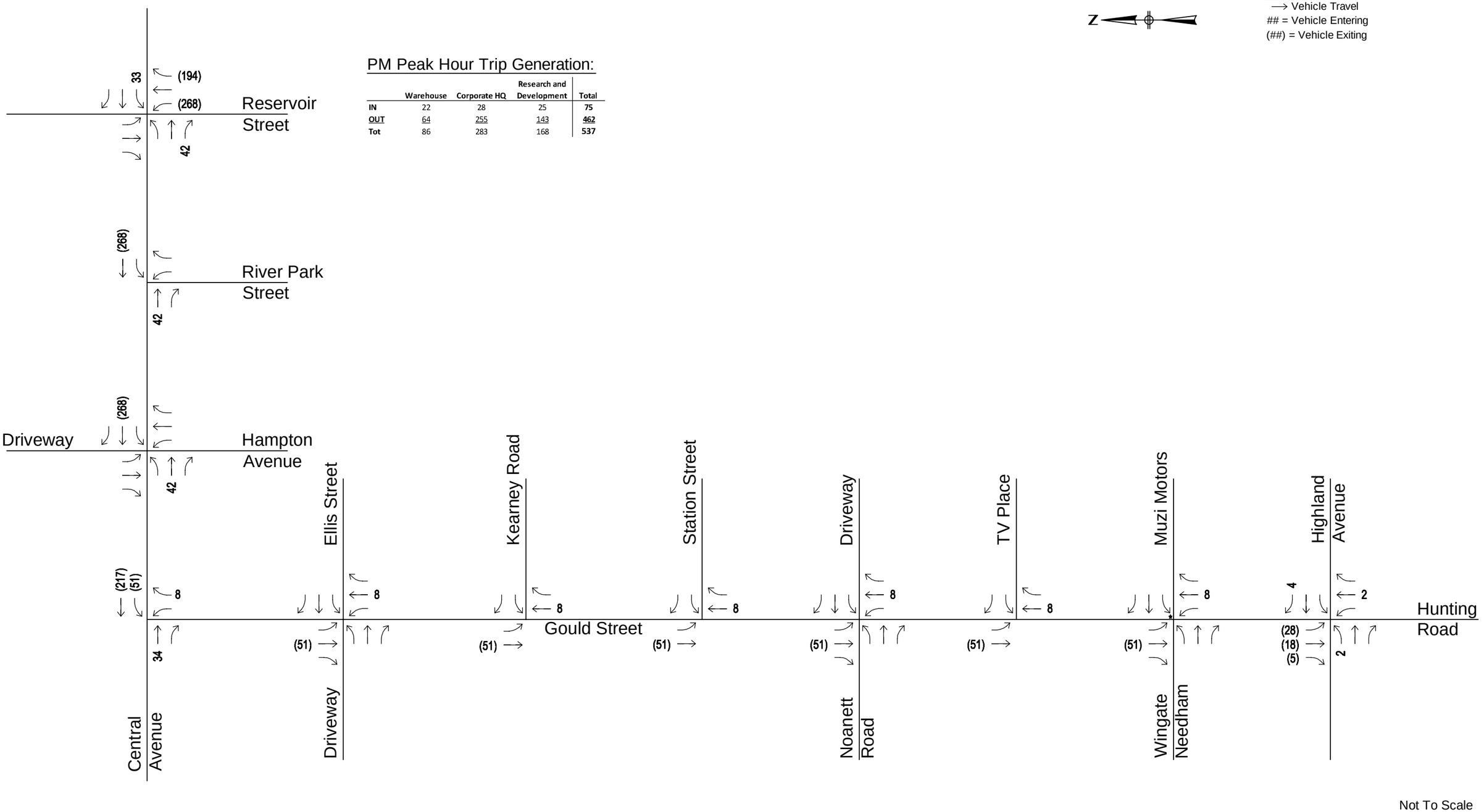
Warehouse	Corporate HQ	Research and Development	Total
Entering	63	275	198	536
Exiting	18	20	40	78
Total	81	295	238	614

BETA
www.BETA-Inc.com

TRAFFIC IMPACT STUDY GOULD AND RESERVOIR INDUSTRIAL DISTRICT
Needham, MA

Figure 4
Reservoir Industrial District
AM Peak Hour Trip Assignment

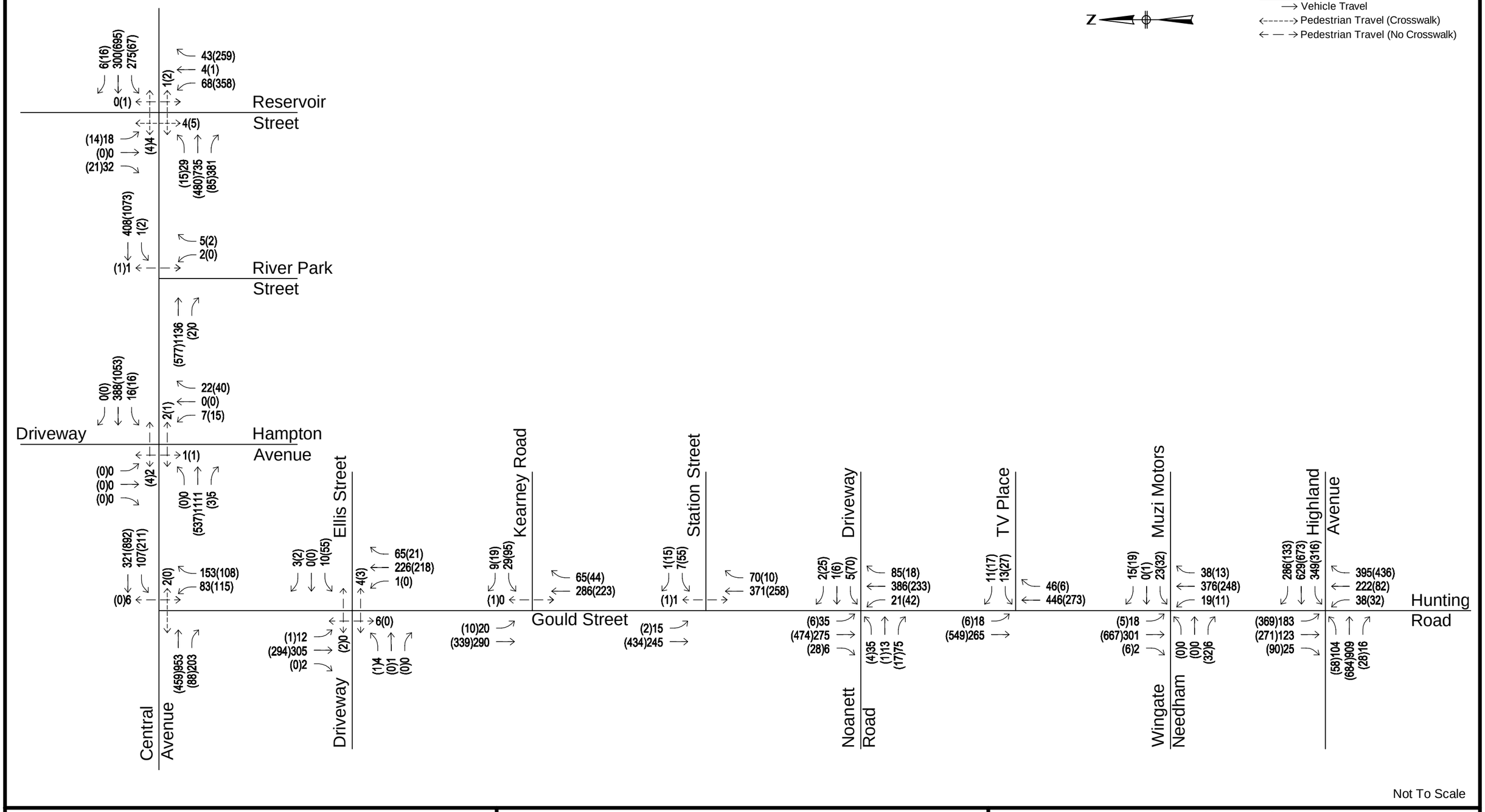
O:\5100s\5178 - Needham - Gould St Traffic\Drawing Files\Miscellaneous\5178 TMC.dwg Dec 18,2015 8:33am



BETA
www.BETA-Inc.com

TRAFFIC IMPACT STUDY GOULD AND RESERVOIR INDUSTRIAL DISTRICT
Needham, MA

Figure 5
Reservoir Industrial District
PM Peak Hour Trip Assignment

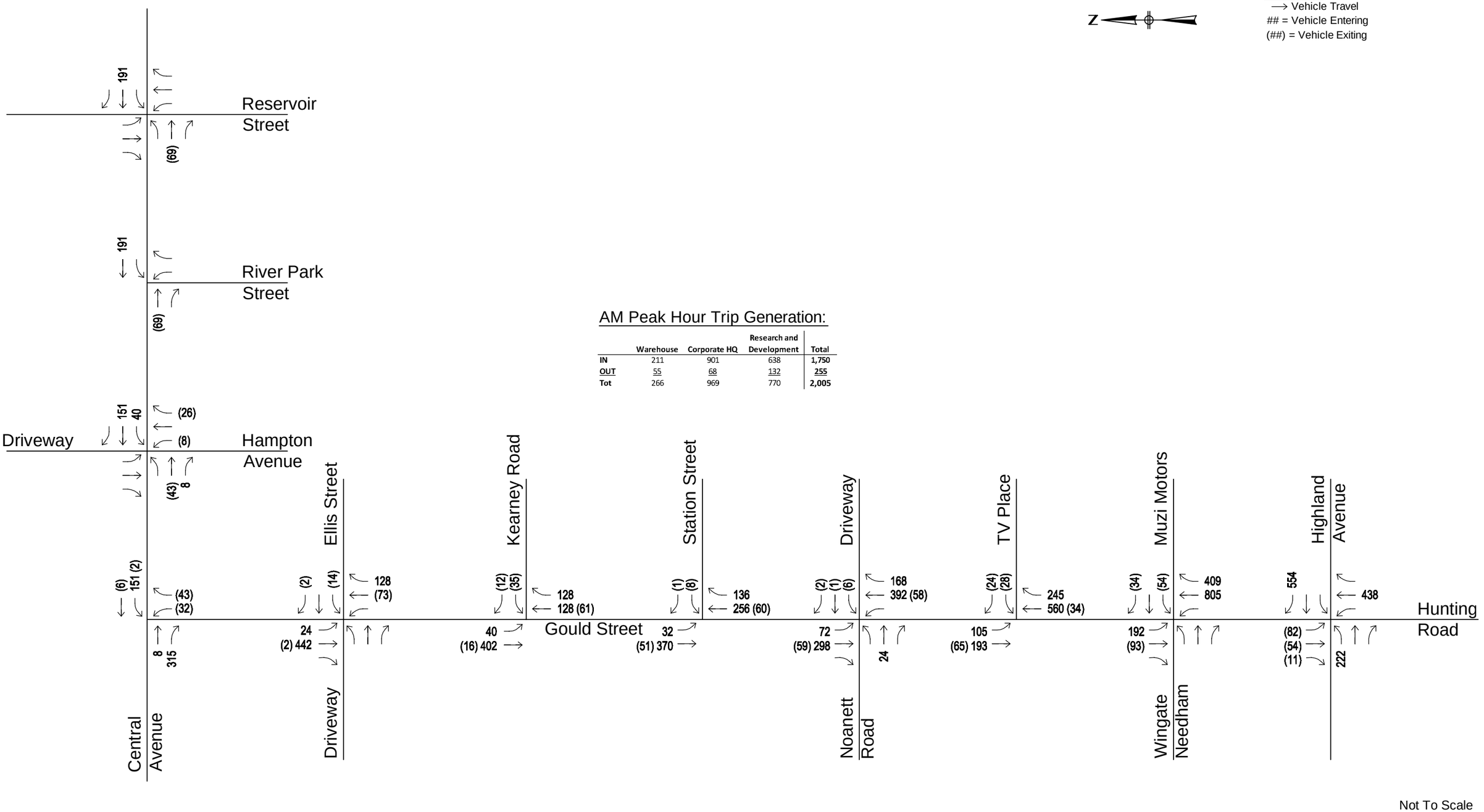


Not To Scale

BETA
www.BETA-Inc.com

TRAFFIC IMPACT STUDY GOULD AND RESERVOIR INDUSTRIAL DISTRICT
Needham, MA

Figure 6
Study Area Intersection
AM(PM) Peak Hour Volumes
2025 Build (Reservoir Only)



AM Peak Hour Trip Generation:

	Warehouse	Corporate HQ	Research and Development	Total
IN	211	901	638	**1,750**
OUT	55	68	132	**255**
Tot	266	969	770	**2,005**

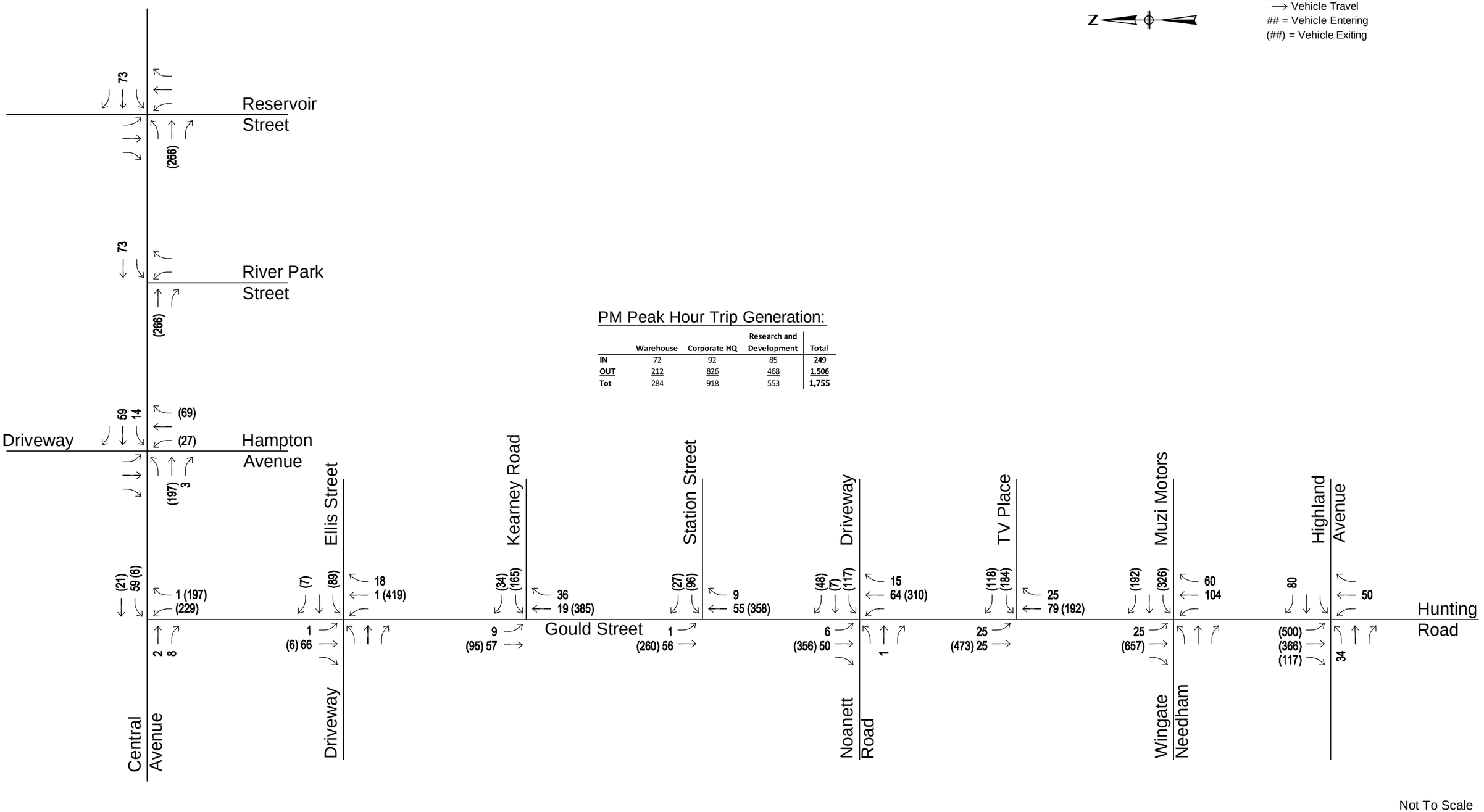
Not To Scale

BETA
www.BETA-Inc.com

TRAFFIC IMPACT STUDY GOULD AND RESERVOIR INDUSTRIAL DISTRICT
Needham, MA

Figure 7
Gould Industrial District
AM Peak Hour Trip Assignment

O:\5100s\5178 - Needham - Gould St Traffic\Drawing Files\Miscellaneous\5178 TMC.dwg Dec 18,2015 8:34am



PM Peak Hour Trip Generation:

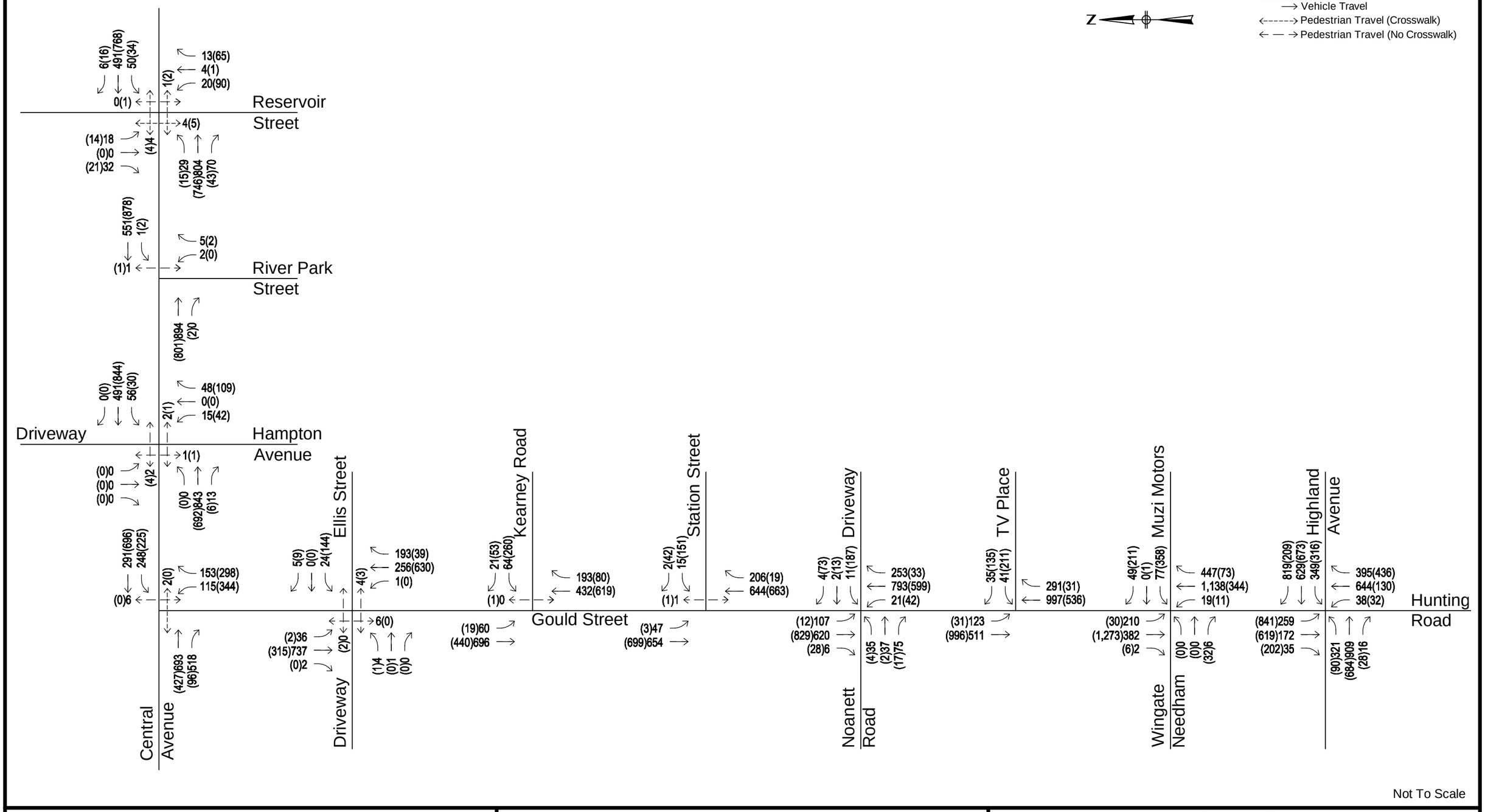
	Warehouse	Corporate HQ	Research and Development	Total
IN	72	92	85	**249**
OUT	212	826	468	**1,506**
Tot	284	918	553	**1,755**

Not To Scale

BETA
www.BETA-Inc.com

TRAFFIC IMPACT STUDY GOULD AND RESERVOIR INDUSTRIAL DISTRICT
Needham, MA

Figure 8
Gould Industrial District
PM Peak Hour Trip Assignment



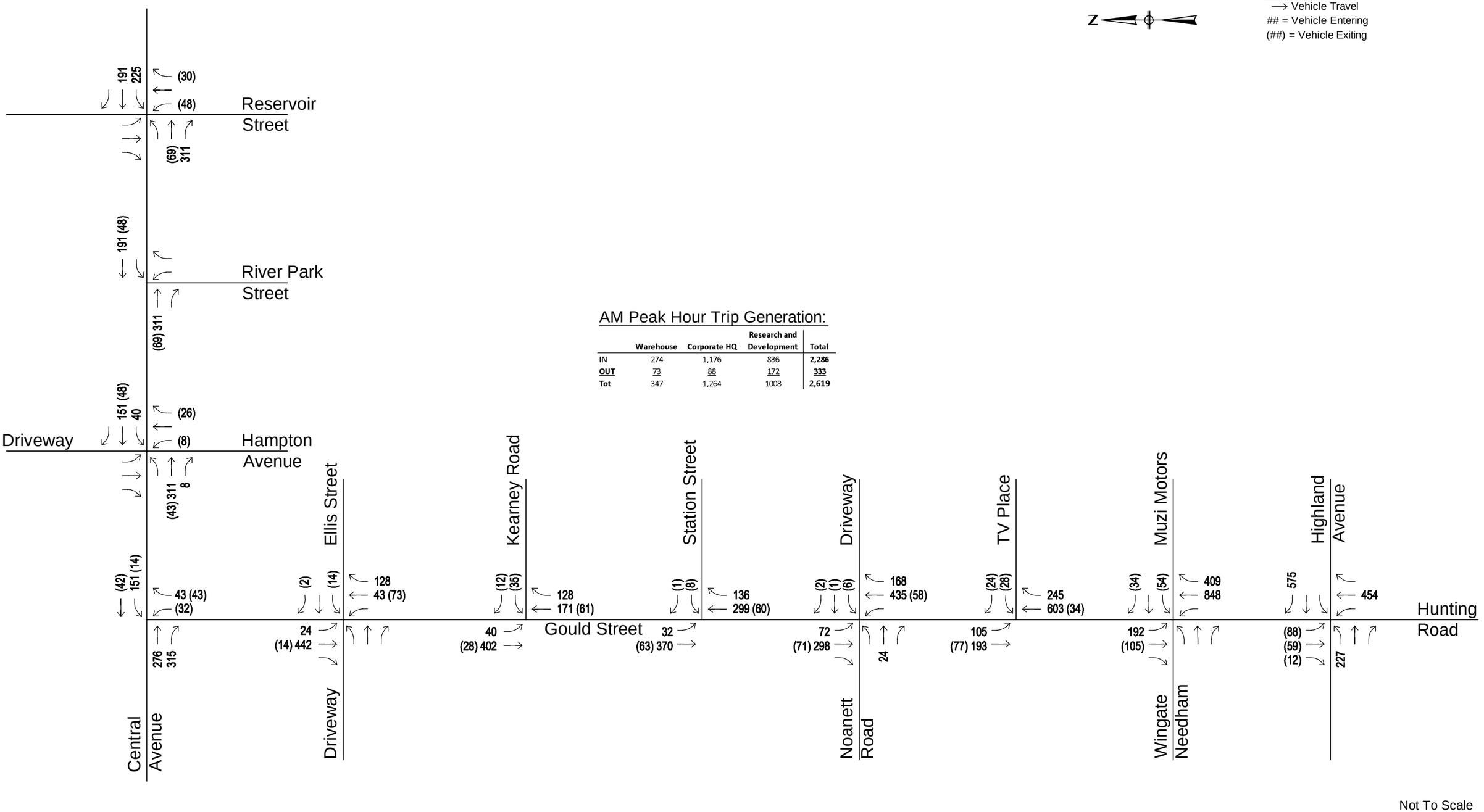
Not To Scale

BETA
www.BETA-Inc.com

TRAFFIC IMPACT STUDY GOULD AND RESERVOIR INDUSTRIAL DISTRICT
Needham, MA

Figure 9
Study Area Intersection
AM(PM) Peak Hour Volumes
2025 Build (Gould Only)

O:\5100s\5178 - Needham - Gould St Traffic\Drawing Files\Miscellaneous\5178 TMC.dwg Dec 18,2015 8:34am



AM Peak Hour Trip Generation:

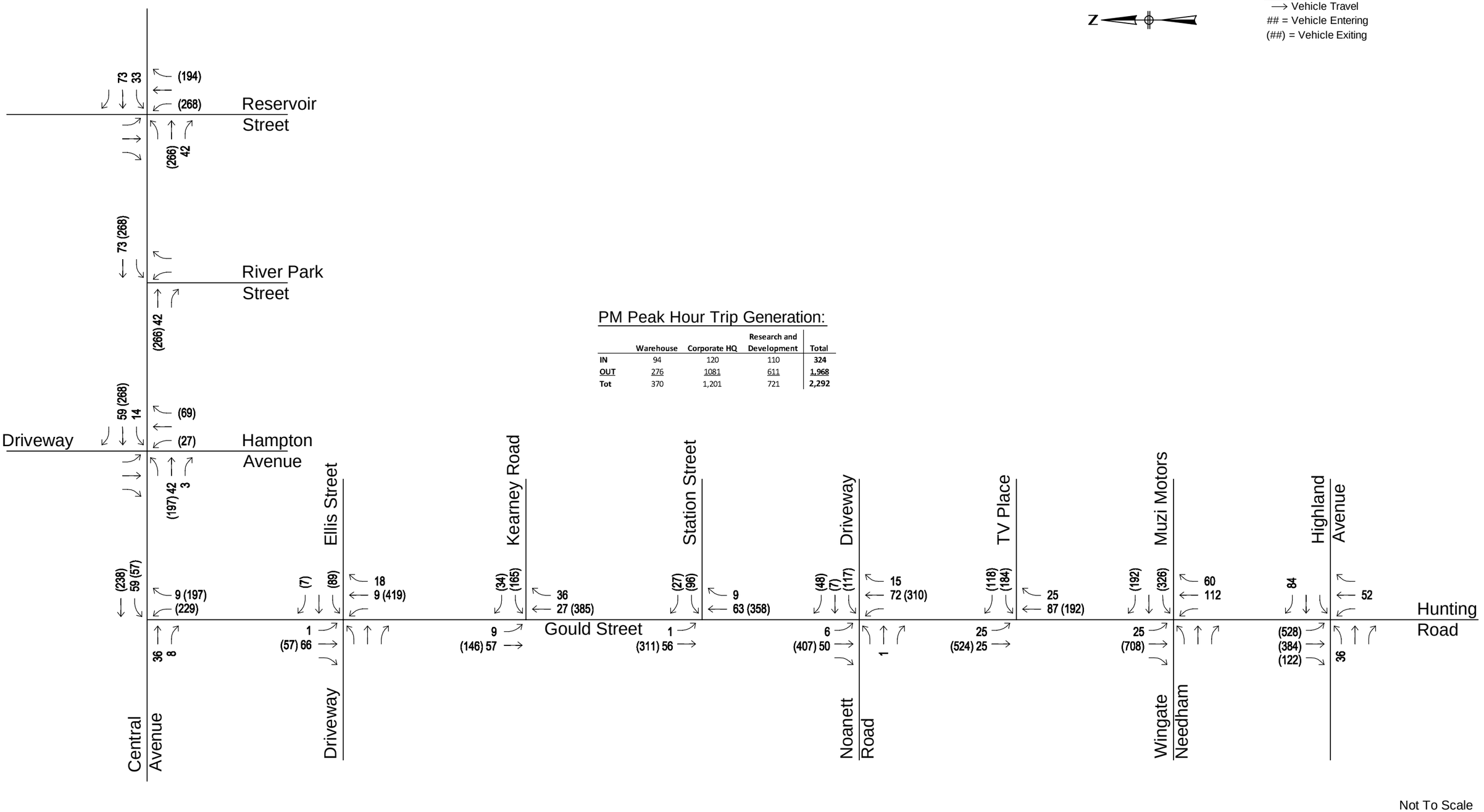
	Warehouse	Corporate HQ	Research and Development	Total
IN	274	1,176	836	**2,286**
OUT	73	88	172	**333**
Tot	347	1,264	1008	**2,619**

Not To Scale

BETA
www.BETA-Inc.com

TRAFFIC IMPACT STUDY GOULD AND RESERVOIR INDUSTRIAL DISTRICT
Needham, MA

Figure 10
Both Industrial Districts
AM Peak Hour Trip Assignment



PM Peak Hour Trip Generation:

	Warehouse	Corporate HQ	Research and Development	Total
IN	94	120	110	**324**
OUT	276	1081	611	**1,968**
Tot	370	1,201	721	**2,292**

Not To Scale

BETA
www.BETA-Inc.com

TRAFFIC IMPACT STUDY GOULD AND RESERVOIR INDUSTRIAL DISTRICT
Needham, MA

Figure 11
Both Industrial Districts
PM Peak Hour Trip Assignment

O:\5100s\5178 - Needham - Gould St Traffic\Drawing Files\Miscellaneous\5178 TMC.dwg Dec 18,2015 8:34am

Legend:
⟶ Vehicle Travel
<------> Pedestrian Travel (Crosswalk)
← — → Pedestrian Travel (No Crosswalk)

N

Reservoir Street
River Park Street
Gould Street
Hunting Road
Driveway
Hampton Avenue
Central Avenue
Ellis Street
Driveway
Kearney Road
Station Street
Noanett Road
Driveway
TV Place
Wingate
Muzi Motors
Needham
Highland Avenue

6(16) 491(768) 275(67) 0(1) 43(259) 4(1) 68(358) 1(2) 4(5)
(14)18 (0)0 (21)32 (4)4 (15)29 (746)804 (85)381
599(1,146) 1(2) (1)1 5(2) 2(0)
(843)1,205 (2)0
0(0) 539(1,112) 56(30) 2(1) 48(109) 0(0) 15(42)
(0)0 (0)0 (0)0 (4)2 1(1) (0)0 (734)1,154 (6)13
327(913) 260(276) (0)6 2(0) 196(306) 115(344)
(461)961 (96)518
5(9) 0(0) 24(144) (2)36 (366)749 (0)2 4(3) 193(39) 299(638) 1(0) 6(0) (1)4 (0)1 (0)0
21(53) 64(260) (1)0 193(80) 475(627)
(19)60 (491)708
2(42) 15(151) (1)1 206(19) 687(671)
(3)47 (750)666
4(73) 2(13) 11(187) (12)107 (880)632 (28)6 253(33) 836(607) 21(42) (4)35 (2)37 (17)75
35(135) 41(211) (31)123 (1,047)523 291(31) 1,040(544)
49(211) 0(1) 77(358) (30)210 (1,324)394 (6)2 447(73) 1,181(352) 19(11) (0)0 (0)0 (32)6
840(213) 629(673) 349(316) (869)265 (637)177 (207)36 395(436) 660(132) 38(32) (92)326 (684)909 (28)16

Not To Scale

BETA
www.BETA-Inc.com

TRAFFIC IMPACT STUDY GOULD AND RESERVOIR INDUSTRIAL DISTRICT
Needham, MA

Figure 12
Study Area Intersection
AM(PM) Peak Hour Volumes
2025 Build (Gould & Reservoir)

Table 7: Build Level of Service Summary

INTERSECTIONS	AM Peak Hour									PM Peak Hour								
	2025 Build - Reservoir Only			2025 Build - Gould Only			2025 Build - Gould And Reservoi			2025 Build - Reservoir Only			2025 Build - Gould Only			2025 Build - Gould And Reservoi		
	LOS	Delay (s/veh)	95%ile Queue	LOS	Delay (s/veh)	95%ile Queue	LOS	Delay (s/veh)	95%ile Queue	LOS	Delay (s/veh)	95%ile Queue	LOS	Delay (s/veh)	95%ile Queue	LOS	Delay (s/veh)	95%ile Queue
Central Avenue at Reservoir Street [UNSIGNALIZED]																		
Central - EB	A	8	2.5	A	9	2.5	A	9	2.5	A	9	2.5	A	10	2.5	A	10	2.5
Central - WB	B	12	42.5	B	10	5	B	13	45	A	9	5	A	10	2.5	A	10	7.5
Reservoir - NB	F	*	312.5	F	64	42.5	F	*	420	F	*	1775	F	*	372.5	F	*	1957.5
Reservoir - SB	F	124	82.5	E	40	35	F	*	157.5	F	91	52.5	F	68	42.5	F	*	122.5
Central Avenue at River Park Street [UNSIGNALIZED]																		
Central - WB	B	11	0	B	10	0	B	12	0	A	9	0	A	10	0	A	10	0
River Park - NB	D	28	2.5	C	23	2.5	E	37	7.5	B	13	0	C	15	0	C	16	0
Central Avenue at Hampton Avenue [UNSIGNALIZED]																		
Central - WB	B	31	2.5	B	10	7.5	B	12	10	A	9	2.5	A	9	2.5	A	10	2.5
Hampton - NB	D	12	15	D	29	32.5	F	77	90	D	27	27.5	F	71	145	F	199	240
Central Avenue at Gould Street [UNSIGNALIZED]																		
Central - WB	B	13	20	C	19	72.5	E	36	145	A	10	22.5	A	10	25	B	10	32.5
Gould - NB	F	*	515	F	*	812.5	F	*	1325	F	*	650	F	*	1972.5	F	*	2187.5
Gould Street at Ellis Street [UNSIGNALIZED]																		
Driveway - EB	B	15	0	D	33	2.5	E	48	7.5	B	13	0	C	23	0	D	26	0
Ellis - WB	B	14	2.5	D	33	17.5	F	65	47.5	B	15	12.5	F	67	142.5	F	88	165
Gould - NB	A	8	0	A	9	0	A	10	0	A	0	0	A	0	0	A	0	0
Gould - SB	A	8	0	A	9	2.5	A	9	2.5	A	8	0	A	9	0	A	9	0
Gould Street at Kearney Road [UNSIGNALIZED]																		
Kearney - WB	B	14	7.5	F	58	80	F	179	165	C	19	35	F	*	642.5	F	*	682.5
Gould - SB	A	8	2.5	A	9	5	A	10	7.5	A	8	0	A	9	2.5	A	9	2.5
Gould Street at Station Street [UNSIGNALIZED]																		
Station - WB	B	14	2.5	E	45	15	F	59	40	C	16	17.5	F	243	320	F	297	347.5
Gould - SB	A	8	0	B	10	5	B	10	5	A	8	0	A	9	0	A	9	0
Gould Street at Noanett Street [UNSIGNALIZED]																		
Noanett - EB	C	18	35	F	*	397.5	F	*	522.5	B	14	5	E	38	17.5	E	42	17.5
Driveway - WB	C	20	2.5	†	†	†	†	†	†	D	25	42.5	F	*	772.5	F	*	795
Gould - NB	A	8	2.5	A	9	2.5	A	9	2.5	A	9	2.5	B	10	5	B	11	5
Gould - SB	A	9	2.5	B	12	17.5	B	12	20	A	8	0	A	9	0	A	9	0
Gould Street at TV Place [UNSIGNALIZED]																		
TV - WB	B	15	5	F	*	182.5	F	*	302.5	C	15	10	F	*	877.5	F	*	910
Gould - SB	A	9	2.5	C	15	27.5	E	38	75	A	8	0	A	9	2.5	A	9	2.5
Gould Street at Muzi Drive/Wingate Drive [UNSIGNALIZED]																		
Wingate - EB	B	10	0	B	11	0	B	11	0	B	14	7.5	D	31	17.5	D	33	20
Muzi - WB	C	16	7.5	F	*	305	F	*	322.5	C	22	17.5	F	*	1180	F	*	1195
Gould - NB	A	8	2.5	A	8	2.5	A	8	2.5	A	9	0	B	13	2.5	B	13	2.5
Gould - SB	A	8	2.5	D	30	35	A	39	132.5	A	8	0	A	8	2.5	A	8	1.5
Highland Avenue at Gould Street/Hunting Road [SIGNALIZED]																		
Highland - EBL	F	87	#195	F	261	#664	F	264	#669	E	66	#146	F	87	#226	F	89	#229
Higland - EBTR			#608			#608			#597			#448			#448			#448
Highland - WBL	D	53	#530	F	91	#530	F	80	#505	D	40	#420	D	40	#420	D	40	#420
Highland - WBTR			415			#805			#772			342			379			381
Hunting - NBTL	D	49	#382	F	*	#1220	F	*	#1275	D	44	#194	E	61	#301	E	62	#306
Hunting - NBR			299			339			352			411			442			442
Gould - SBL	D	47	223	E	59	#341	E	66	#372	D	52	#435	F	*	#1323	F	*	#1373
Gould - SBLTR			218			#336			#362			#563			#1621			#1673
OVERALL	E	62	-	F	210	-	F	221	-	D	50	-	F	210	-	F	223	-

95th percentile volume exceeds capacity, queue may be longer. Queue shown is maximum after 2 cycles.
* Delay exceeds 300 seconds
† Approach cannot be analyzed

5.0 Traffic Signal Warrant Analyses

In order to justify the installation of a traffic signal, one or more of the signal warrants in the Manual on Uniform Traffic Control Devices (MUTCD) must be met. If one or more of the warrants is met and the installation of a signal will improve the overall safety and operation of the intersection, then installation of a signal operation is justified.

Given the data collected as part of this study, two of the eight traffic signal warrants were examined in accordance with the procedures and criteria described in the MUTCD. The signal warrants evaluated are as follows:

Warrant 2, Four Hour Vehicular Volume

Vehicular volumes during each hour for any four (4) hours of an average day on the major street (total of both directions) and on the minor street in one direction (with higher volume) are plotted on a standard graph provided in the MUTCD. If the intersecting points fall above the respective curve in terms of number of approach lanes, the warrant is met.

Warrant 3, Peak Hour

Vehicular volumes during one (1) hour of any average weekday on the major street (total of both directions) and on the minor street in one direction (with higher volume) are plotted on a standard graph provided in the MUTCD. If the intersecting point falls above the respective curve in terms of number of approach lanes, the warrant is met.

5.1 Warrant Analysis Results

Signal warrant analyses were performed in accordance with the procedures and criteria described in the MUTCD. The results of this analysis, which were based on No-Build and the three Build scenarios volumes, are summarized in Table 8. Details pertaining to signal warrant analysis are included in the Appendix.

Table 8: Traffic Signal Warrant Analysis Summary

	No-Build		Build: Reservoir Only		Build: Gould Only		Build: Gould and Reservoir	
Intersection	Warrant 2: Four Hour	Warrant 3: Peak Hour	Warrant 2: Four Hour	Warrant 3: Peak Hour	Warrant 2: Four Hour	Warrant 3: Peak Hour	Warrant 2: Four Hour	Warrant 3: Peak Hour
Central at Reservoir	No	Yes	No	Yes	No	Yes	No	Yes
Central at River Park	No	No	No	No	No	No	No	No
Central at Hampton	No	No	No	No	No	Yes	No	Yes
Central at Gould	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Gould at Ellis	No	No	No	No	No	No	No	No
Gould at Kearney	No	No	No	No	No	Yes	No	Yes
Gould at Station	No	No	No	No	No	Yes	No	Yes
Gould at Noanett	No	No	No	No	No	Yes	No	Yes
Gould at TV	No	No	No	No	No	Yes	No	Yes
Gould at Muzi	No	No	No	No	No	Yes	No	Yes

As can be seen in the previous table, at least one traffic signal warrants is met for eight of the ten unsignalized intersections. MassDOT guidelines prefer an intersection satisfy an 8-hour signal warrant for the installation of a traffic signal. Meeting the 4-hour warrant criteria is a minimum requirement in many situations.

6.0 Proposed Future Mitigations & Cost Estimate

6.1 Reservoir Industrial District Only

As seen in the analysis results for the Reservoir Industrial District Only build out, the most significantly impacted intersections include Central Avenue at Reservoir Street and Central Avenue at Gould Street. Based on the signal warrant analysis, the intersection of Central Avenue at Gould Street would meet the 4-hour traffic signal warrant. The intersection of Central Avenue at Reservoir Street would meet the peak hour signal warrant in the future.

To mitigate the impact of the Reservoir Industrial district build out, the following mitigation would be recommended:

- Signalize the Central Avenue at Gould Street intersection. * ($250,000)
- Due to the anticipated increase in volume including truck traffic entering and exiting Reservoir Street, we would recommend the installation of a traffic signal at this location. Both Reservoir Street approaches to the intersection experience significant delay and queuing due to the lack of opportunity during peak periods to find sufficient gaps to enter Central Avenue. ($250,000)
- Coordinate both the Central Avenue at Reservoir Street and Central Avenue at Gould Street signals to manage queuing and efficiency along Central Avenue.
- An exclusive left-turn lane on Central Avenue southbound approach to Reservoir Street is not necessary during this scenario from an LOS perspective; however, it would provide benefits to safety and queuing in the Central Avenue westbound direction.
- Install an approximately 100’ long left turn lane on the Central Avenue westbound approach to Gould Street. ($120,000)
- Evaluate retiming the Highland Avenue at Gould Street/Hunting Road intersection traffic signal. This would cost approximately $15,000 to design for and implement.*

* The intersection of Central Avenue and Gould Street meets the 4-hour traffic signal warrant during the No-Build and signalization could be justified even without the Industrial District Build-Out. Traffic signal retiming evaluation would also be necessary during No-Build conditions.

6.2 GOULD INDUSTRIAL DISTRICT ONLY

During this build out, queuing along Central Avenue would occur from the Gould Street intersection and extend past Reservoir Street in the westbound direction. The coordination of both signals would be strongly recommended to manage queuing and efficiency along Central Avenue. This signalization would also provide necessary gaps in traffic for roadways along Gould Street.

In order to mitigate the impact of the build out of the Gould industrial districts, the following mitigation is recommended:

- Signalize and coordinate the intersections of Central Avenue at Reservoir Street and Central Avenue at Gould Street.* ($500,000)
- Install an approximate 100' left turn lane on the Central Avenue westbound approach to Gould Street. ($120,000)
- Install an approximate 100' right-turn lane on the Central Avenue eastbound approach to Gould Street. ($120,000)
- Consolidate and signalize the TV Place and Muzi Motors driveway intersections. Install a southbound left turn bay at the intersection. ($500,000)
- Evaluate the installation of an additional Gould Street southbound left-turn lane approaching Highland Avenue as well as another lane on the Hunting Road northbound approach to Highland Avenue. ($120,000)

* The intersection of Central Avenue and Gould Street meets the 4-hour traffic signal warrant during the No-Build and signalization could be justified even without the Industrial District Build-Out.

6.3 COMBINED RESERVOIR INDUSTRIAL DISTRICT & GOULD INDUSTRIAL DISTRICT

In addition to the Gould Industrial District only proposed mitigations, the following mitigation is recommended for the combined build out:

- Prohibit left turns exiting Hampton Street and River Park Street during peak hours.
- Additional widening to accommodate additional travel lanes and longer existing turn bays on the approaches would be necessary at the Highland Avenue and Gould Street/Hunting Road intersection. This would be necessary to accommodate the additional traffic at the intersection.