Memorandum

To: City of Newton

Date: May 19, 2021

Project #: 10865.03

From: Randall C. Hart, Principal
Matthew Duranleau, EIT

Re: Riverside Redevelopment
Alternative Program Modification Traffic Generation and Analysis
Newton, Massachusetts

VHB, on behalf of Mark Development (The Proponent) has prepared a traffic generation and operational analysis memorandum to reflect potential minor changes to the development program. This memorandum outlines the impacts of converting Building 1 from research and development (R&D) space to general office space given market demand since the March 2021 Traffic Impact and Access Study (TIAS) was prepared and submitted to the City of Newton. Since the potential changes in program are relatively minor and have not been officially proposed, the March 2021 TIAS is not being updated. Instead, this supplemental memorandum has been prepared to provide traffic generation and operational analyses at key intersections with the potential revised program in mind.

The building program as proposed in the March 2021 TIAS includes a mix of research and development, residential, and retail space that includes approximately 1.025 million gross square feet (sf) spread out over 10 buildings. Two of the 10 buildings are proposed in the March 2021 TIAS to house R&D space. Based on discussions with the City of Newton and the dialogue surround the look-back metric for the Project, the Proponent is examining an alternative program scenario which still includes the 1.025 million sf of development. The revisions are in how the two R&D building may be tenanted, one as general office and the other as research and development, as opposed to both buildings containing strictly R&D uses. General office space generates peak hour trips at a higher rate than research and development space, so this evaluation is a sensitivity analysis to determine the impacts of providing general office space in Building 2.

Table 1 below presents the proposed building program as of March 2021 and the potential revised building program.

Table 1 Riverside Redevelopment Building Program

Land Use	Existing Site	March 2021 TIAS Building Program [a]	May 2021 Potential Building Program [b]
Hotel	194 rooms	n/a	**n/a**
Office [c]	n/a	n/a	**217,137 sf**
Research and Development [c]	n/a	363,401 sf	**146,440 sf**
Residential	n/a	550 units	**550 units**
Retail/Restaurant	n/a	22,442 sf	**22,442 sf**

Note: Total sf may vary slightly between March 2021 and May 2021 programs due to further refinement of useable space within each building. Overall size and dimensions of each building are not proposed to change under the potential revised building program.

a Building Program as outlined in March 2021 TIAS for the Riverside Station Development.

b Potential revised building program

c Does not include approximately 10,000 sf of office space for MBTA uses on-site today and included in the future development.

As shown in Table 1, the potential revised building program includes a mix of office and research and development space while the March 2021 building program assumes all research and development space. An analysis of the revised program is presented below.

Trip Generation Summary

To assess the changes that would be expected as a result of the program modifications, traffic generation projections have been prepared for the revised program. The rate at which any development generates traffic is dependent upon the size, location, and concentration of surrounding developments. As mentioned previously, the Project is comprised of a mix of office, residential, research and development, and retail use. The ITE *Trip Generation Manual*[1] categorizes these land uses and provides weekday daily, weekday morning peak hour, weekday evening peak hour, Saturday daily, and Saturday midday peak hour unadjusted vehicle trip generation estimates for each use. The trip generation estimates for the proposed uses were projected using Land Use Code (LUC) 221 (Mid-Rise Residential), LUC 710 (General Office Building), LUC 760 (Research and Development Center), and LUC 820 (Shopping Center).

The change in total site-generated vehicle trips with the building program is summarized below in Table 2 and a breakdown of the detailed trip generation analyses for the revised building program as requested by the City of Newton Planning Department is described in the following sections.

Table 2 Total Site-Generated Vehicle Trip Generation Comparison

			March 2021 TIAS Building Program		Potential Revised Building Program		
Time Period	**Direction**	**Existing Hotel / MBTA Trips [a]**	**Total Unadjusted Trips [b]**	**Total Net New Trips [c]**	**Total Unadjusted Trips [d]**	**Total Net New Trips [e]**	**Total Net New Trip Difference**
Weekday Morning	Enter	295	262	**157**	392	**270**	+113
Peak Hour	Exit	170	235	**119**	244	**122**	+3
	Total	465	497	**276**	636	**392**	+116
Weekday Evening	Enter	200	252	**89**	274	**108**	+19
Peak Hour	Exit	270	334	**187**	444	**287**	+100
	Total	470	586	**276**	718	**395**	+119
Saturday Midday	Enter	255	259	**122**	295	**154**	+32
Peak Hour	Exit	120	256	**127**	283	**148**	+21
	Total	375	515	**249**	578	**302**	+53

a Based on empirical counts conducted by VHB; from Table 3-4 in the March 2021 Riverside Redevelopment TIAS.
b Unadjusted trip generation estimates based on ITE Trip Generation Manual; from Table 3-5 in the March 2021 Riverside Redevelopment TIAS (does not included MBTA-generated or trips).
c Total Net New trip generation estimate including credits for mode share, internal capture, pass-by, and existing trips; from Table 3-7 in the March 2021 Riverside Redevelopment TIAS.
d Unadjusted trip generation estimates based on ITE Trip Generation Manual; as described in Table 4 in this memorandum (does not include MBTA-generated trips).
e Total Net New trip generation estimate for entire building program and including credits for mode share, internal capture, pass-by, and existing trips; as described in Table 6 in this memorandum.

1 Trip Generation Manual, 10th Edition, Institute of Transportation Engineers, Washington, D.C., 2017.

As shown in Table 2, the potential revised building program as compared to the previous building program will result in 116 additional new vehicle trips (+113 entering / +3 exiting) during the weekday morning peak hour, 119 additional new vehicle trips (+19 entering / +100 exiting) during the weekday evening peak hour, and 53 additional new vehicle trips (+32 entering / +21 exiting) during the Saturday midday peak hour.

Project-Generated Trips

Estimating future conditions volumes for the Site involved a review of the existing development on those parcels, along with the additional trip generation expected from the Project development.

Existing Site-Generated Traffic

The planned development parcels currently are occupied by the Hotel Indigo, which features 194 hotel rooms and an on-site restaurant, and a commuter park and ride, kiss and ride, and pick-up / drop-off loop for the MBTA Riverside Station featuring approximately 960 parking spaces. The vehicular Site trip generation for the weekday morning and weekday evening peak hours under existing conditions was estimated based on turning movement counts conducted at the two Site driveways. Table 3 summarizes the Project-related trips for the existing uses on Site.

Table 3 Existing Site Trip Generation

	Hotel	MBTA Station	Total Vehicle Trips
Weekday Morning Peak Hour			
Enter	45	250	**295**
Exit	45	125	**170**
Total	90	375	**465**
Weekday Evening Peak Hour			
Enter	50	150	**200**
Exit	35	235	**270**
Total	85	385	**470**
Saturday Midday Peak Hour [c]			
Enter	30	225	**255**
Exit	25	95	**120**
Total	55	320	**375**

Based on turning movement counts conducted by VHB in June 2018, October 2018, and September 2019.

As shown in Table 3, the Site under existing conditions currently generates approximately 465 vehicular trips (295 entering / 170 exiting) during the weekday morning peak hour, 470 vehicular trips (200 entering / 270 exiting) during the weekday evening peak hour, and 375 vehicular trips (255 entering / 120 exiting) during the Saturday midday peak hour. It should be noted that the existing Site also contains the Riverside MBTA maintenance yard and supporting facilities, but it was assumed that the maintenance yard generated negligible trips during the weekday morning, weekday evening, and Saturday midday peak hours.

It is expected that the existing MBTA Station-generated vehicular trips will continue to be generated by the Site under future conditions. A parking garage with approximately 960 parking spaces for commuters and a pick-up / drop-off loop near the station entrance will be provided on Site to accommodate the commuters that use the Riverside MBTA Station today.

Unadjusted Project-Generated Traffic

The proposed development will consist of a mixture of residential, office, office R&D, and supporting retail uses. Specifically, the Site is proposed to include approximately 550 residential units, 217,137 sf of general office, 146,440 sf of office R&D, 22,442 sf of supporting restaurant/retail uses, and 2,171 parking spaces on-Site to accommodate the proposed development and the commuters using the Riverside MBTA Station.

Traffic associated with the residential units was estimated using ITE LUC 221 (Mid-Rise Residential), traffic associated with the R&D space was estimated using ITE LUC 760 (Research & Development Office), traffic associated with the office space was estimated using ITE LUC 710 (General Office Building), and traffic associated with the retail uses was estimated with ITE LUC 820 (Shopping Center). As noted previously, traffic associated with the MBTA station was estimated based on the observed existing Site-generated vehicular trips.

Approximately 10,000 sf of office space will also be built and be dedicated office/operational space for the MBTA. This space will replace existing MBTA office space that is currently housed within the rail yard, which are proposed to be eliminated in the future. While this small portion of office space will not be considered a new use and will replace existing office on-site, to present a conservative analysis all of the proposed MBTA office space on-site was analyzed as a new use and no existing trip credits were applied.

It should be noted that the retail uses are expected to be smaller, Main Street style businesses catering to the residential and office space on-Site and the adjacent neighborhoods as opposed to large big-box style retail stores. Potential uses will may include eating establishments, coffee shops, pharmacies, convenience stores, or gallery uses. The service style retail that would serve the uses on site are not expected to draw heavily from the community like a shopping center would. While these do not fit the exact description of a traditional ITE "Shopping Center", retail traffic was estimated using this land use code, which results in an overly conservative analysis.

The unadjusted new vehicle trip estimates are presented in Table 4 and trip generation worksheets are included in the Attachments.

Table 4 Project Trip Generation – New Unadjusted Vehicle Trips

	Residential [a]	R&D [b]	Office [c]	Retail [c]	Total New Unadjusted Vehicle Trips [d]
Weekday Daily					
Enter	1,498	851	1,125	1,088	**4,562**
Exit	1,498	851	1,125	1,088	**4,562**
Total	2,296	1,702	2,250	2,176	**9,124**
Weekday Morning Peak Hour					
Enter	47	46	198	101	**392**
Exit	135	15	32	62	**244**
Total	182	61	230	163	**636**
Weekday Evening Peak Hour					
Enter	139	11	38	86	**274**
Exit	89	61	200	94	**444**
Total	228	72	238	180	**718**
Saturday Daily					
Enter	1,045	148	240	1,765	**3,198**
Exit	1,045	148	240	1,765	**3,198**
Total	2,090	296	480	3,530	**6,396**
Saturday Midday Peak Hour					
Enter	116	18	62	99	**295**
Exit	121	18	53	91	**283**
Total	237	36	115	190	**578**

a Based on ITE LUC 221 (Mid-Rise Residential) for 550 residential units.
b Based on ITE LUC 760 (Research and Development) for 217,137 sf
c Based on ITE LUC 760 (Research and Development) for 146,440 sf
d Based on ITE LUC 820 (Shopping Center) for 22,442 sf
e Sum of unadjusted residential, R&D, office, and retail trips.
Note: MBTA Station generated trips are already generated under existing conditions and therefore are not included as "new" trips to the Site.

Person Trips

The unadjusted vehicle trips are converted into person trips by applying the average vehicle occupancy (AVO) of 1.18 for residential, office, and R&D trips and of 1.82 for retail trips, as outlined by the U.S. Department of Transportation[2]. The unadjusted vehicle trips were converted into person trips in order to apply internal capture credits and applicable mode share credits, as described below. Applying these credits to person trips allows for estimates to be made for the total number of Project-generated transit users, walkers, and bicyclists in addition to the total number of Project-generated vehicles.

[2] Summary of Travel Trends: 2017 National Household Travel Survey, US Department of Transportation, Federal Highway Administration, Washington D.C., 2017

Internal Capture Trips

Since the proposed development is a mixed-use project, the trip generation characteristics of the Project Site will be different from a single-use project. Some of the traffic to be generated by the proposed development will be contained on-site as "internal" or "shared vehicle" trips. For example, workers at the R&D space on-site may patron the retail shops after work, or residents who live in the development may also work in the R&D on-site. While these shared trips represent new traffic to the individual uses, they would not show up as new vehicle trips on the surrounding roadway network.

As described in the ITE Trip Generation Handbook[3] "because of the complementary nature of these land uses, some trips are made among the on-site uses. This capture of trips internal to the Project Site has the net effect of reducing vehicle trip generation between the overall Project Site and the external street system (compared to the total number of trips generated by comparable land uses developed individually on stand-alone sites) an internal capture rate can generally be defined as the percentage of total person trips generated by a site that are made entirely within the site. The trip origin, destination, and travel path are all within the site."

Based on the methodology outlined in the ITE Trip Generation Handbook, internal capture rates were applied to the gross person trips. Internal capture worksheets are included in the Attachments to this memorandum.

Mode Share

The Project is conveniently located at the Riverside MBTA Station, providing direct access to both the MBTA Green Line and several MBTA bus routes, local shuttles, etc. and making it a true Transit Oriented Development. It is expected that a portion of the employees that will work on-site will use the Green Line or the bus to travel to and from the Project Site. It is also expected that a portion of the residents living on the Project Site will use the MBTA buses and Green Line to travel to and from the Project Site.

Mode share data was reviewed from the US Census Bureau's 2015-2019 American Community Survey[4] (the most recent five-years of data that is currently available) to determine the potential mode shares for the residential component of the Project Site. Based on that data, approximately 77-percent of all Newton residents that commute to work travel via private vehicle, 15-percent commute via public transit, and 8-percent commute via walking or bicycling. For the office/laboratory component of the Project Site, the most recent mode share data was reviewed from the US Census Bureau Journey to Work data. Based on the 2010 US Census data, approximately 88-percent of all workers that work in the City of Newton commute via private vehicle, 7-percent commute via public transit, and 5-percent commute via walking or biking. While the residential and office transit share may be higher at the Project Site location adjacent to a transit station than in other places in the City of Newton, the local census data for the entire City was used for the residential and office/R&D uses in order to provide an analysis of the study area based on local data.

In general, retail uses are expected to generate fewer transit trips than residential, and office uses, as the main trip generator of retail uses are customers, not commuters. The mode shares for the retail component of the Project Site are based on the *2017 National Household Travel Survey* which estimates that, nationwide, the mode share for all trips generated for the purpose of shopping or running errands was approximately 88.5 percent by private vehicle, 1.8 percent by public transit, 8.1 percent by walking, and 1.7 percent by other modes of transportation, including bicycle. While that data was collected nationally and is not specific to Massachusetts, it is assumed that the retail on-site in Newton will generate trips at a similar pattern to those across the nation.

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3 Trip Generation Handbook, 3rd Edition, Institute of Transportation Engineers, Washington, D.C., 2017.

4 US Census Bureau, 2014-2018 American Community Survey, City of Newton

A summary of the projected mode shares by land use is provided below in Table 5.

Table 5 Project Mode Share

Use	Vehicle	Transit	Walk/Bike
Residential [a]	77%	15%	8%
Office / R&D [b]	88%	7%	5%
Retail [c]	88%	2%	10%

a Based on 2019 American Community Survey 5-year estimates for the City of Newton (US Census Bureau).
b Based on 2010 Journey to Work data for workers who work in the City of Newton (US Census Bureau)
c Based on 2017 National Household Travel Survey, Table 9b (US Department of Transportation)

The mode shares discussed above were applied to the net-new person trips to generate the adjusted Project trips by mode. The local average vehicle occupancy, based US Census data for each primary use, was then applied to the vehicle mode to reflect the number of vehicle trips generated by the Project Site.

Pass-By Trips

While the ITE rates provide estimates for all the traffic associated with each land use, not all of the traffic generated by the Project will be new to the area roadways. A portion of the vehicle-trips generated by the retail land use will likely be drawn from the traffic volume on roadways adjacent to the Project Site. For example, someone traveling on Grove Street may choose to deviate from their original travel path to visit the Project Site retail, before heading back to continue to their final destination. For this evaluation, ITE pass-by rates for LUC 820 (Shopping Center) were utilized for the retail trip generation and applied to existing trips on Grove Street. Specifically, 34-percent and 26-percent of the retail trip generation was assumed to be drawn from the surrounding roadway network during the weekday evening and Saturday midday peak hours, respectively, as outlined in the ITE Trip Generation Handbook. For all other time periods studied, a 25-percent pass-by rate was assumed.

Project-Generated Trips

As described in the previous sections, internal capture credit, mode share credit, and pass-by credit for the retail portion of the Project was applied to the unadjusted new vehicle trips presented in Table 4 to develop the net new trips expected to be generated by the Project Site. Table 6 presents the Project-generated net new vehicle peak hour trips by mode while Tables 7, 8, and 9 present the Project-generated net new peak hour vehicle trips, transit trips, and walk/bike trips by mode, respectively. Trip generation calculations to develop the net new project-generated peak-hour trips by mode are included in the Attachments for reference.

Table 6 Net New Project-Generated Peak-hour Trips by Mode

	Net New Vehicle Trips [a]	Net New Transit Trips	Net New Walk/Bike Trips
Weekday Morning Peak Hour			
Enter	270	31	35
Exit	122	28	24
Total	392	59	59
Weekday Evening Peak Hour			
Enter	108	24	25
Exit	287	36	33
Total	395	60	58
Saturday Midday Peak Hour			
Enter	154	23	26
Exit	148	25	26
Total	302	48	52

a Net vehicle trips not including pass-by trips associated with the retail portion.

Note: MBTA Station generated trips are already generated on-site under existing conditions and therefore are not included as "new" trips to the Project Site. Similarly, trips generated by the existing hotel are already generated on-site and therefore have been subtracted from the net new vehicle trips.

Table 7 below summarizes the Project-generated net new peak hour vehicle trips by use.

Table 7 Project-Generated Peak-hour Vehicle Trips by Use

	Residential [a]	R&D [b]	Office [c]	Retail [d]	Total Net Vehicle Trips [e]	Existing Hotel Trips [f]	Total Net New Vehicle Trips [g]	Pass-By [h]	Existing MBTA Trips [i]	Total Site-Generated Vehicle Trips [j]
Weekday Morning										
Enter	37	40	174	64	**315**	-45	**270**	16	250	**581**
Exit	104	10	21	32	**167**	-45	**122**	16	125	**308**
Total	141	50	195	96	**482**	-90	**392**	32	375	**889**
Weekday Evening										
Enter	77	9	31	41	**158**	-50	**108**	21	150	**329**
Exit	57	53	174	38	**322**	-35	**287**	21	235	**578**
Total	134	62	205	79	**480**	-85	**395**	42	385	**907**
Saturday Midday										
Enter	62	15	52	55	**184**	-30	**154**	17	225	**426**
Exit	80	13	39	41	**173**	-25	**148**	17	95	**285**
Total	142	28	91	96	**357**	-55	**302**	34	320	**711**

a Residential vehicle trips with internal capture and mode share credits applied.
b R&D vehicle trips with internal capture and mode share credits applied.
c Office vehicle trips with internal capture and mode share credits applied.
d Retail vehicle trips with internal capture, mode share, and pass-by credits applied.
e Sum of columns a through d.
f Existing Hotel trips based on traffic counts conducted by VHB in October 2018.
g Sum of columns e and f.
h Pass-by Credits of 25% and 34% applied to weekday morning and weekday evening peak hour retail trip generation, respectively.
i MBTA Station trips based on traffic counts conducted by VHB in June 2018.
j Sum of columns e, h, and i.

As shown in Table 7, the Project is expected to generate a total of 889 vehicle trips (581 entering / 308 exiting) during the weekday morning peak hour, 907 vehicle trips (329 entering / 578 exiting) during the weekday evening peak hour, and 711 vehicle trips (426 entering / 285 exiting) during the Saturday midday peak hour. However, these totals include traffic already generated on-site by the hotel and the MBTA station and pass-by trips that will not be added as new trips to the roadway. After considering the existing traffic generation and the pass-by trips, the Project will result in an additional 392 vehicle trips (270 entering / 122 exiting) to the roadway network during the weekday morning peak hour, 395 vehicle trips (108 entering / 287 exiting) during the weekday evening peak hour, and 302 vehicle trips (154 entering / 148 exiting) during the Saturday midday peak hour.

Tables 8 and 9 below summarize the Project-generated net new peak hour transit and walk/bike trips by use.

Table 8 Project-Generated Peak-hour Transit Trips by Use

	Residential	R&D	Office	Retail	Total Transit Trips
Weekday Morning Peak Hour					
Enter	8	4	16	3	**31**
Exit	23	1	2	2	**28**
Total	31	5	18	5	**59**
Weekday Evening Peak Hour					
Enter	17	1	3	3	**24**
Exit	13	5	16	2	**36**
Total	30	6	19	5	**60**
Saturday Midday Peak Hour					
Enter	14	1	5	3	**23**
Exit	18	1	4	2	**25**
Total	32	2	9	5	**48**

Note: Based on transit mode shares presented in Table 5.

Table 9 Project-Generated Peak-hour Walk/Bike Trips by Use

	Residential	R&D	Office	Retail	Total Walk/Bike Trips
Weekday Morning Peak Hour					
Enter	4	3	11	17	**35**
Exit	12	1	1	10	**24**
Total	16	4	12	27	**59**
Weekday Evening Peak Hour					
Enter	9	1	2	13	**25**
Exit	7	3	11	12	**33**
Total	16	4	13	25	**58**
Saturday Midday Peak Hour					
Enter	7	1	3	15	**26**
Exit	10	1	3	12	**26**
Total	17	2	6	27	**52**

Note: Based on walk/bike mode shares presented in Table 5.

As shown in Tables 8 and 9, the Project is expected to generate approximately 59 new transit trips (31 entering / 28 exiting) and 59 walk/bike trips (35 entering / 24 exiting) during the weekday morning peak hour, 60 transit trips (24 entering / 36 exiting) and 58 walk/bike trips (25 entering / 33 exiting) during the weekday evening peak hour, and 48 transit trips (23 entering / 25 exiting) and 52 walk/bike trips (26 entering / 26 exiting) during the Saturday midday peak hour. As stated previously, the transit mode shares are based on the overall City of Newton census data.

Build Traffic Volumes

The project-related traffic volumes for the Build Condition are assigned to the study area roadway network based on the trip distribution patterns discussed in the TIAS. The assigned volumes are then added to the 2031 No-Build peak hour traffic volume networks to develop the 2031 Build Condition peak hour traffic volume networks.

Site-Generated volume networks and traffic volume networks for the 2031 Build Condition with Mitigation at key intersections for the weekday morning and weekday evening peak hours are included in the Attachments to this memorandum.

Traffic Operations

To demonstration future traffic operations at key internal and external locations with the revised program traffic volumes and the proposed mitigation in place, updated operational analyses have been performed for the following locations:

- Main Street at Grove Street Driveway/Garage Entrance
- Main Street at Road A
- Grove Street at Site Driveway (Signalized)
- Grove Street at Grove Street Extension (Signalized)
- Route 128/I-95 NB Off Ramp at Grove Street Extension/Main Street/Recreation Road (Signalized)
- Grove Street at Route 128/I-95 SB Off Ramp with Ashville Road (Roundabout)
- Grove Street at Woodland Grove Condominiums Driveway
- Recreation Road Extension at MBTA Yard Driveway

For this assessment, future Build year 2031 with mitigation were analyzed during the weekday morning peak hour and the weekday evening peak hour. Since the potential revised building program has the same overall square footage as the March 2021 program and only involves the change from all R&D to a mix of R&D and general office space, traffic operation analyses were only conducted during the weekday peak hours as office and R&D uses have less of an overall impact on the Saturday midday peak hour.

The signalized and unsignalized intersections were analyzed with Synchro 10 software and the roundabout intersection was analyzed with Sidra 8 software. To provide a comparison, the 2031 Build Conditions with mitigation analyses based on the updated building program have been compared against the 2031 No Build Conditions and the 2031 Build Conditions with mitigation as presented in the March 2021 TIAS.

Table 10 presents the capacity analyses for the signalized study area intersections and the capacity worksheets are included in the Attachments to this memorandum.

Table 10 Signalized Intersection Capacity Analysis with Mitigation

	2031 No-Build Conditions					2031 Build Cond (March 2021 TIAS)					2031 Build Cond (Updated Program)				
				Vehicle Queues					Vehicle Queues					Vehicle Queues	
Location	**v/c[1]**	**Delay[2]**	**LOS[3]**	**50th[4]**	**95th[5]**	**v/c**	**Delay**	**LOS**	**50th**	**95th**	**v/c**	**Delay**	**LOS**	**50th**	**95th**
Grove Street at Grove Street Extension															
Weekday Morning															
Grove Street (from East) WB L						0.55	21	C	80	177	0.56	23	C	85	189
Grove Street (from East) WB R						0.08	8	A	7	26	0.08	9	A	8	29
Grove Street (from West) NB T	*Intersection Does Not Exist Under 2029 No Build Conditions*					0.59	21	C	96	208	0.64	22	C	117	247
Grove Street (from West) NB R						0.61	7	A	85	139	0.60	7	A	85	136
Grove Street Extension SB L						0.31	9	A	21	62	0.32	9	A	21	64
Grove Street Extension SB T						0.12	7	A	14	46	0.12	7	A	15	48
Overall							**13**	**B**				**14**	**B**		
Weekday Evening															
Grove Street (from East) WB L						0.77	23	C	156	310	0.77	23	C	158	312
Grove Street (from East) WB R						0.18	5	A	16	45	0.18	5	A	16	46
Grove Street (from West) NB T	*Intersection Does Not Exist Under 2029 No Build Conditions*					0.53	28	C	63	153	0.53	28	C	65	156
Grove Street (from West) NB R						0.17	3	A	17	29	0.17	3	A	17	29
Grove Street Extension SB L						0.37	15	B	36	102	0.37	15	B	36	103
Grove Street Extension SB T						0.28	14	B	47	128	0.32	14	B	56	150
Overall							**17**	**B**				**17**	**B**		
Grove Street at MBTA Riverside Driveway															
Weekday Morning															
Grove Street EB T	*Intersection Under Unsignalized Control Under 2029 No Build Conditions*					0.80	19	B	122	#360	0.80	19	B	122	#360
Grove Street WB T						0.35	8	A	33	89	0.35	8	A	33	89
Grove Street WB R						0.38	14	B	30	65	0.46	16	B	37	77
Riverside MBTA Driveway SB L						0.53	17	B	46	92	0.53	17	B	46	92
Riverside MBTA Driveway SB R						0.12	11	B	8	24	0.12	11	B	8	24
Overall							**16**	**B**				**16**	**B**		
Weekday Evening															
Grove Street EB T	*Intersection Under Unsignalized Control Under 2029 No Build Conditions*					0.40	9	A	47	118	0.41	10	A	49	128
Grove Street WB T						0.68	15	B	100	#294	0.70	16	B	104	#313
Grove Street WB R						0.52	16	B	48	96	0.51	15	B	50	97
Riverside MBTA Driveway SB L						0.59	17	B	61	116	0.61	17	B	66	123
Riverside MBTA Driveway SB R						0.13	11	B	10	28	0.12	10	B	10	27
Overall							**14**	**B**				**15**	**B**		

a volume-to-capacity ratio
b average delay in seconds per vehicle
c level of service
d 50th percentile queue length, measured in feet
e 95th percentile queue length, measured in feet
95th percentile volume exceeds capacity, queue may be longer

Table 10 Signalized Intersection Capacity Analysis with Mitigation (Cont.)

	2031 No-Build Conditions					2031 Build Cond (March 2021 TIAS)					2031 Build Cond (Updated Program)				
				Vehicle Queues					Vehicle Queues					Vehicle Queues	
Location	**v/c[1]**	**Delay[2]**	**LOS[3]**	**50th[4]**	**95th[5]**	**v/c**	**Delay**	**LOS**	**50th**	**95th**	**v/c**	**Delay**	**LOS**	**50th**	**95th**
I-95/Route 128 NB Off-Ramp / Site Main Street at Grove Street Extension / Recreation Road Extension															
Weekday Morning															
I-95 NB Off-Ramp EB LT	*Intersection Does Not Exist Under 2029 No Build Conditions*					0.64	24	C	97	218	0.67	25	C	112	244
I-95 NB Off-Ramp EB R						0.28	5	A	0	38	0.27	5	A	0	38
Site Main Street WB L						0.21	23	C	22	72	0.21	25	C	24	74
Site Main Street WB TR						0.44	27	C	52	141	0.45	28	C	55	144
Grove Street Extension LT						0.55	28	C	49	127	0.57	30	C	51	130
Grove Street Extension R						0.34	10	A	39	101	0.42	11	B	54	131
Recreation Road Ext. SB LTR						0.36	11	B	16	68	0.38	12	B	19	74
Overall							**18**	**B**				**19**	**B**		
Weekday Evening															
I-95 NB Off-Ramp EB LT	*Intersection Does Not Exist Under 2029 No Build Conditions*					0.76	35	C	170	#365	0.78	37	D	184	#378
I-95 NB Off-Ramp EB R						0.36	6	A	4	59	0.37	7	A	6	61
Site Main Street WB L						0.32	23	C	59	112	0.37	24	C	77	137
Site Main Street WB TR						0.65	30	C	140	236	0.71	32	C	169	275
Grove Street Extension LT						0.65	38	D	87	#184	0.67	41	D	93	#186
Grove Street Extension R						0.19	8	A	30	57	0.19	8	A	33	59
Recreation Road Ext. SB LTR						0.23	18	B	18	61	0.24	19	B	19	61
Overall							**26**	**C**				**27**	**C**		

a volume-to-capacity ratio
b average delay in seconds per vehicle
c level of service
d 50th percentile queue length, measured in feet
e 95th percentile queue length, measured in feet
95th percentile volume exceeds capacity, queue may be longer

As shown in Table 10, the revised building program results in negligible changes in operations in the 2031 Build Conditions with Mitigation to the signalized study area intersections. The overall delay at each intersection is not expected to increase by more than one second due to the revised building program. The three proposed signalized intersections are expected to operate at overall LOS C or better with all individual movements operating at LOS D or better. Maximum queues on the I-95/Route 128 NB Off-Ramp are not expected to exceed 400 feet, which minimizes the potential for the queue to spill back onto the mainline of the interstate. No queue is expected to exceed more than 375 feet on Grove Street, and therefore no queue will spill back to any upstream signalized intersections. The MBTA Driveway southbound approach to Grove Street is expected to operate at LOS B or better with no queue exceeding 125 feet under the 2031 Build Conditions with Mitigation.

Table 11 presents the capacity analyses for the unsignalized study area intersections and the capacity worksheets are included in the Attachments to this memorandum.

Table 11 Unsignalized Intersection Capacity Analysis with Mitigation

	2031 No-Build Conditions					2031 Build Cond (March 2021 TIAS)					2031 Build Cond (Updated Program)				
Location	**D[1]**	**v/c[2]**	**Delay[3]**	**LOS[4]**	**95th Q[5]**	**D**	**v/c**	**Delay**	**LOS**	**95th Q**	**D**	**v/c**	**Delay**	**LOS**	**95th Q**
Grove Street at Existing Hotel Driveway / Woodland Grove Condominiums Driveway															
Weekday Morning															
Grove Street EB L	40	0.04	9	A	3	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Grove Street WB L	1	0.00	11	B	0	1	0.00	9	A	0	1	0.00	9	A	0
Condo Driveway NB LTR	6	0.04	27	D	3	6	0.02	15	C	3	6	0.02	15	C	3
Existing Hotel Driveway SB LTR	45	0.23	27	D	23	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Weekday Evening															
Grove Street EB L	30	0.05	11	B	5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Grove Street WB L	1	0.00	9	A	0	1	0.00	8	A	0	1	0.00	8	A	0
Condo Driveway NB LTR	6	0.03	22	C	3	6	0.01	12	B	0	6	0.01	12	B	0
Existing Hotel Driveway SB LTR	35	0.33	50	E	33	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Site Main Street at Grove Street Driveway / Garage Driveway (All-Way Stop)															
Weekday Morning															
Site Main Street EB LTR						330	0.46	12	B	60	335	0.48	12	B	65
Site Main Street WB LTR						40	0.07	9	A	5	40	0.07	9	A	5
Grove Street Driveway NB LTR						155	0.24	10	A	23	185	0.30	10	B	30
Parking Garage Driveway SB LTR						160	0.24	10	A	23	155	0.24	10	A	23
Overall	*Intersection Does Not Exist under 2031 No Build Conditions*							**11**	**B**				**11**	**B**	
Weekday Evening															
Site Main Street EB LTR						305	0.47	12	B	63	320	0.49	13	B	68
Site Main Street WB LTR						55	0.10	10	A	8	55	0.10	10	A	8
Grove Street Driveway NB LTR						235	0.39	12	B	45	240	0.40	12	B	48
Parking Garage Driveway SB LTR						220	0.34	11	B	38	230	0.37	11	B	43
Overall								**12**	**B**				**12**	**B**	
Site Main Street at Road A / Buildings 2-3-4 Driveway West															
Weekday Morning															
Site Main Street EB L						200	0.18	9	A	18	285	0.26	9	A	25
Site Main Street WB L						1	0.00	8	A	0	1	0.00	8	A	0
Road A SB LR	*Intersection Does Not Exist under 2031 No Build Conditions*					110	0.26	15	C	25	115	0.32	19	C	35
Weekday Evening															
Site Main Street EB L						100	0.10	9	A	8	110	0.11	9	A	10
Site Main Street WB L						2	0.00	8	A	0	2	0.00	8	A	0
Road A SB LR						215	0.47	18	C	60	305	0.68	26	D	125
Site Main Street at Buildings 2-3-4 Driveway East															
Weekday Morning															
Building 2-3-4 Driveway NB LR	*Intersection Does Not Exist under 2031 No Build Conditions*					1	0.00	9	A	0	7	0.01	12	B	0
Weekday Evening															
Building 2-3-4 Driveway NB LR						2	0.00	8	A	0	3	0.01	12	B	0
Recreation Road Extension at MBTA Yard Driveway															
Weekday Morning															
MBTA Yard Driveway WB LR						5	0.01	11	B	0	5	0.01	12	B	0
Recreation Road Ext SB L	*Intersection Does Not Exist under 2031 No Build Conditions*					0	0.00	0	A	0	0	0.00	0	A	0
Weekday Evening															
MBTA Yard Driveway WB LR						5	0.01	12	B	0	225	0.01	12	B	0
Recreation Road Ext SB L						0	0.00	0	A	0	0	0.00	0	A	0

1 Demand
2 volume-to-capacity ratio
3 average total delay, in seconds per vehicle
4 level of service
5 95th percentile queue length, measured in feet

As shown in Table 11, the revised building program results in minimal changes in operations at most unsignalized study area intersections in the 2031 Build Conditions with Mitigation. However, at the intersection of Site Main Street at Road A / Buildings 2-3-4 Driveway West, the Road A stop-controlled southbound approach is expected to operate at LOS D under the revised building program as compared to LOS C under the March 2021 building program (with a modest 8 second increase in delay). However, the intersection is still expected to be able to handle the proposed volumes under the potential revised building program as the queue on this approach is not expected to exceed five vehicle lengths.

Table 12 presents the capacity analyses for the roundabout study area intersection and the capacity worksheets are included in the Attachments to this memorandum.

Table 12 Roundabout Intersection Capacity Analysis with Mitigation

	2031 No Build Conditions					2031 Build Cond (March 2021 TIAS)					2031 Build Cond (Updated Program)				
Location	**D[1]**	**v/c[2]**	**Delay[3]**	**LOS[4]**	**95th Q[5]**	**D**	**v/c**	**Delay**	**LOS**	**95th Q**	**D**	**v/c**	**Delay**	**LOS**	**95th Q**
Grove Street at I-95/Route 128 SB Ramps / Asheville Road															
Weekday Morning															
Grove Street EB LTR	*Intersection Unsignalized under 2031 No Build Conditions*					576	0.75	20	C	321	637	0.77	21	C	343
Grove Street WB LTR						380	0.38	7	A	50	413	0.38	7	A	50
I-95 SB Off-Ramp NB LTR						376	0.67	20	C	143	452	0.74	25	C	193
Asheville Road SB LTR						15	0.03	6	A	2	17	0.03	6	A	2
Overall								**16**	**C**				**18**	**C**	
Weekday Evening															
Grove Street EB LTR	*Intersection Unsignalized under 2031 No Build Conditions*					261	0.43	12	B	56	284	0.44	12	B	59
Grove Street WB LTR						730	0.76	17	C	212	832	0.79	19	C	251
I-95 SB Off-Ramp NB LTR						190	0.25	7	A	25	212	0.25	7	A	26
Asheville Road SB LTR						8	0.02	8	A	1	9	0.02	8	A	2
Overall								**14**	**B**				**16**	**C**	

Source: analyzed with Sidra 8 software.

a Demand
b volume-to-capacity ratio
c average total delay, in seconds per vehicle
d level of service
e 95th percentile queue length, measured in feet

As shown in Table 12, the revised building program results in negligible changes in operations in the 2031 Build Conditions with Mitigation to the study area intersection under roundabout control. While the overall LOS during the weekday evening peak period dropped from LOS C to LOS B due to the change in building program, the overall delay only decreased by two seconds as the intersection was on the cusp of LOS B/C under the March 2021 building program. No queue is expected to increase by more than two vehicle lengths with the potential revised building program.

Volume Monitoring Metric

Based on several rounds of discussions, the Proponent and the City of Newton have developed a metric that will be used in future traffic monitoring once the Project is fully open and operational. If the trip generated by the project exceed the agreed-upon metric, the Proponent has agreed to fund additional transportation demand management measures to lower the number of Site-generated trips below the metric.

The agreed-upon metric is based on 110-percent of the weekday evening peak hour Site-generated driveway trips. This includes the trips generated by the Site without the pass-by or existing hotel trips removed from the network. Table 13 below summarizes the metric based on the March 2021 building program and the potential revised program.

Table 13 Volume Monitoring Metric

	March 2021 Building Program	Potential Revised Building Program
Weekday Evening Peak Hour Site-Generated Driveway Trips [a]	403	522
Volume Monitoring Metric [b]	**443**	**574**

a Total trips generated by the Site without pass-by or existing hotel trips removed from the network (sum of columns e and h in Table 7 of this memorandum for the Potential Revised Building Program)

b 110-percent of the weekday evening peak hour Site-generated driveway trips

As shown in Table 13, based on the potential revised building program the volume monitoring metric would be 574 vehicles as compared to a metric of 43 vehicles based on the March 2021 building program.

Conclusion

VHB has developed a memorandum to supplement the trip generation and capacity analyses presented in the March 2021 TIAS to reflect potential minor changes to the development program. The building program as proposed in the March 2021 TIAS includes a mix of research and development, residential, and retail space that includes approximately 1.025 million gross square feet (sf) spread out over 10 buildings with two of the 10 buildings proposed to house R&D space. This memorandum outlined the change in trip generation and capacity analyses if one of the two R&D buildings was converted to general office space instead. As shown in the analyses presented in this memorandum, the slight change in building program would have a minimal impact on trip generation and overall operations at key study area intersections.