BOSTON REGION METROPOLITAN PLANNING ORGANIZATION
Jamey Tesler, MassDOT Secretary and CEO and MPO Chair
Tegin L. Teich, Executive Director, MPO Staff

TECHNICAL MEMORANDUM

DATE: **December 15, 2022**
TO: **Chris Dilorio, Town of Hull**
FROM: **Julie Dombroski, Boston Region MPO Staff**
Seth Asante, Boston Region MPO Staff
RE: **Safety and Operations Analyses at Selected Intersections, FFY 2022—George Washington Boulevard at Rockland Circle in Hull**

This memorandum summarizes the analyses and improvement strategies for the intersection of George Washington Boulevard and Rockland Circle, an extension of Rockland House Road, in Hull.

This memorandum contains the following sections:

1. Study Background
2. Existing Conditions
3. Issues and Concerns
4. Crash Data Analysis
5. Existing Conditions Analysis
6. Proposed Short-term Improvements
7. Long-term Improvement Alternatives
8. Recommendations

The memorandum also includes technical appendices that contain data and methods applied in the study.

1 STUDY BACKGROUND

The purpose of the "Safety and Operations Analyses at Selected Intersections" studies is to examine safety, operations, and mobility issues at major intersections in the Boston Region Metropolitan Planning Organization's (MPO) planning area. These studies focus on arterial highways where:

- many crashes occur,
- congestion during peak traffic periods may be heavy, or
- improvements are needed for people walking, biking, and riding transit.

For more than 10 years, the MPO has been conducting these planning studies with municipalities in the region. The communities find the studies beneficial, as they provide an opportunity to begin looking at the needs of problematic locations at the conceptual level before municipalities commit funds for design and engineering. Eventually, if a project qualifies for federal funds, the study's

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documentation will also be useful to the Massachusetts Department of Transportation (MassDOT) and its project-development process.

These studies support the MPO's visions and goals, which include increasing transportation safety, maintaining the transportation system, advancing mobility, and reducing congestion.

2 EXISTING CONDITIONS

The study intersection is located southeast of Nantasket Beach and Paragon Boardwalk, in the Town of Hull. There are numerous safety concerns at the intersection of George Washington Boulevard at Rockland Street for people who walk and bike.

Land adjacent to the intersection is zoned Single-Family-C and Commercial-Rec-B. Single-Family-C is a residential zoning use classified by detached single-family dwellings, requiring a minimum of 12,000 square feet. for subdividing lots. The area south of Rockland Circle is zoned Single-Family-C. Commercial-Rec-B is a multi-use zoning designation classified by multi-family residences, hotels, motels, inns, marinas, restaurants, convenience stores, and places of amusement. The area north of Rockland Circle is zoned Commercial-Rec-B.

At the northeast corner of the study intersection is a parcel of land owned by the Department of Conservation and Recreation (DCR). DCR owns and operates a parking lot on this parcel. The lot has an ingress/egress off Rockland Circle. At the north end of the parking lot there is an egress-only gate, where vehicles can exit directly onto George Washington Boulevard. The lot is most frequently used during summer months, when the Town sees an influx of visitors to nearby Nantasket Beach. A private developer has proposed a 100-space parking lot to be located on the parcel adjacent to the DCR lot (see Appendix E for site plan). East of those parcels contains a condominium complex.

At the southeast corner of the intersection is a small parking area also owned by DCR. East of that parking area is an open parcel.

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FIGURE 1
Study Area

Safety and Operations at Selected Intersections
Town of Hull

An important connection between Hull and the neighboring community of Hingham to the south, George Washington Boulevard is a minor arterial under the jurisdiction of MassDOT. It is a four-lane roadway (two lanes in each direction) that connects with Hingham at the Cpl. A. Roger Borland Memorial Bridge over the Weir River. Traffic on George Washington Boulevard can get busy during peak hours between the months of October through May, but the roadway is significantly busier in the summer months. The section of George Washington Boulevard in the study area has a speed limit of 35 miles per hour (MPH).

Rockland Circle is a local road under the Town of Hull's jurisdiction. It is a two-lane roadway (one lane in each direction) that splits into two legs about 300 feet east of the intersection. The northern leg ends at Park Avenue about 460 feet northeast of the split. The southern leg of Rockland Circle intersects Park Avenue about 515 feet east of the split. It then continues east to Nantasket Avenue, where it ends. The section of roadway between Park Avenue and Nantasket Avenue is known as Rockland House Road. Rockland Circle has a speed limit of 30 MPH.

The intersection of George Washington Boulevard at Rockland Circle is signalized. The signal has a semi-actuated operation. Southbound movements have an exclusive phase, followed by a shared phase with the northbound movements, and finally an exclusive phase for westbound movements The southbound approach on George Washington Boulevard widens from two lanes to three, to accommodate for the exclusive left-turn movement onto Rockland Circle. The other two lanes are for through movements only. The northbound approach maintains two lanes—one for through movements and one for through and right-turn movements. The westbound approach maintains one lane for all movements (left and right turns). There are no crosswalks or pedestrian signals at the study intersection. Alert pedestrians can cross concurrently with green phases, an allowed pedestrian activity.

The MBTA contracts with Joseph's Transportation to operate bus service in Hull. This service is advertised as bus Route 714, the 700-route series indicating that the service is provided by a private bus operator.

There are 14 weekday bus operations in each direction between Hingham Center and Point Pemberton at the end of the Hull's peninsula. At Hingham Center bus 714 connects with the more frequent MBTA bus Route 220, which provides service on Route 3A through Weymouth to the Quincy Center Red Line station.

On the basic travel route, buses enter Hull on highway Route 228 and travel directly up the peninsula to Point Pemberton. Nine trips operate on this route on Saturdays and Sundays. However, only four inbound and six outbound weekday trips use the basic route in each direction. Instead, most of the weekday bus operations use one or more of three possible route variants:

- Three inbound and four outbound buses travel on George Washington Boulevard.
- Five inbound and three outbound buses make a loop via Rockland Circle to serve the community health center.
- Four inbound and two outbound buses make a loop on request to serve the Nantasket Junction commuter rail station.

Bus Route 714 is a flag stop service. Riders may signal drivers that they wish to be picked up or dropped off at any point along the route. Drivers will stop at or near requested locations if it is considered safe.

There is a five-foot-wide asphalt path along the southbound barrel of George Washington Boulevard between the curb and the guardrail. People walking along the northbound barrel north of Rockland Circle must either walk in the DCR parking lot or along a landscaped strip between the parking lot and the roadway. Aerial photos show wear in the grass on this strip suggesting some amount of use by pedestrians. Underbrush abuts the northbound barrel for much of the distance south of Rockland Circle. A six-and-a-half-foot sidewalk exists on the northern side of Rockland Circle between Park Avenue and the study intersection.

3 ISSUES AND CONCERNS

Based on MPO staff's field observations, discussions with town officers, and analyses of crash data and existing operations, major issues and concerns at the intersection include the following:

- *Lack of pedestrian accommodations*
  Currently there is no pedestrian phase nor are there crosswalks on any leg of the intersection.
- *Lack of bicycle accommodations*
  There are no dedicated lanes or wide shoulders to accommodate people biking on either George Washington Boulevard or Rockland Circle.
- *Pedestrian accessibility and safety concerns*
  Existing pedestrian infrastructure is inadequate, in poor condition, and does not meet ADA standards. Existing sidewalks along George Washington Boulevard and Rockland Circle range between five and six feet wide, which makes some portions too narrow and difficult to navigate.
- *Inadequate signal displays*
  All but one of the approaches of the intersection currently have basic three-section signals, with no backplates and no retroreflective borders. There is a four-section signal for the outside lane of the northbound approach for through-right movements. Vegetation behind this signal head might make it difficult to see in any season but winter. Signals for the westbound right and left movements and southbound through movements are mounted on a mast arm. All other signal heads are post-mounted.
- *Traffic congestion during summer months*

The Town of Hull sees significant volumes of non-local traffic during the summer, mostly due to Nantasket Beach visitors. The number of people walking and biking at this intersection during those months also increases.

- *Issues with DCR lot*
  The parking lot operated by DCR poses issues for people walking across its wide ingress/egress apron on Rockland Circle. The egress at the northern end of the lot also poses issues. High speeds of people driving on George Washington Boulevard and those attempting to travel southbound after exiting the lot could create dangerous conditions
- *Stormwater drainage on George Washington Boulevard*
  Town officials noted that there are drainage issues on George Washington Boulevard southbound, just south of the intersection. Specific design recommendations about stormwater mitigation are outside of the scope of this study but should be addressed in the design process should the Town move forward with pursuing a project at this location.

4 CRASH DATA ANALYSIS

Crash data analysis is essential to identify safety and operational problems at an intersection. Analyzing data on the frequency of crashes, types and patterns of collisions, and the circumstances under which crashes occur, such as the time of day and roadway surface conditions, also helps to develop improvement strategies.

4.1 Crash Statistics

MPO staff used the most recent six-year crash reports (January 2015–December 2020) for this study. In total, there were 13 crashes in the recent five-year period in the study area.

The predominant crash types were rear-end crashes (six total) and single vehicle crashes (four total). The remaining three crashes were one sideswipe by a vehicle traveling in the same direction, one sideswipe by a vehicle traveling in the opposite direction, and one head-on collision. Table 1 summarizes the 13 crashes in terms of severity, collision type, pedestrian or bicycle involvement, time of the day, and weather and pavement conditions. Two crashes caused personal injuries with no fatalities.

Most of the crashes (nine) did not occur during peak travel periods (7:00 AM–10:00 AM and 3:00 PM–6:00 PM). This fact supports the observations that this intersection is not affected by daily peak-period traffic volumes. About a quarter of the collisions occurred during dark conditions. Street lighting at the intersection is minimal—there are two light posts at the intersection, and little streetlighting on George Washington Boulevard and Rockland Circle heading towards the intersection.

Table 1
Crash Data Summary Table
George Washington Boulevard at Rockland Circle, Town of Hull
Police Crash Reports 2015-20

Statistics Period		2015	2016	2017	2018	2019	2020	6-Yr. Total	Annual Avg.
Total number of crashes		3	3	3	1	2	1	13	2.2
Severity	Property damage only	3	3	1	1	2	1	11	1.8
	Non-fatal injury	0	0	2	0	0	0	2	0.3
	Fatality	0	0	0	0	0	0	0	0.0
	Not reported/unknown	0	0	0	0	0	0	0	0.0
Collision type	Single vehicle	1	1	1	1	0	0	4	0.7
	Rear-end	2	1	1	0	1	1	6	1.0
	Angle	0	0	0	0	0	0	0	0.0
	Sideswipe, same direction	0	0	0	0	1	0	1	0.2
	Sideswipe, opposite direction	0	1	0	0	0	0	1	0.2
	Head-on	0	0	1	0	0	0	1	0.2
	Rear-to-rear	0	0	0	0	0	0	0	0.0
	Not reported/unknown	0	0	0	0	0	0	0	0.0
Involved pedestrian(s)		0	0	0	0	0	0	0	0.0
Involved cyclist(s)		0	0	0	0	0	0	0	0.0
Occurred during weekday peak periods*		2	1	0	0	1	0	4	0.7
Wet or icy pavement conditions		3	0	0	0	0	0	3	0.5
Dark conditions (lit or unlit)		1	0	1	1	0	1	4	0.7

* Peak periods are defined as 7:00a–10:00a and 3:30p-6:30p.

4.2 Collision Diagram and Crash Pattern Analysis

Based on the police reports on crashes, staff constructed a collision diagram (Figure 2) that shows the locations and patterns of all the crashes at George Washington Boulevard and Rockland Circle.

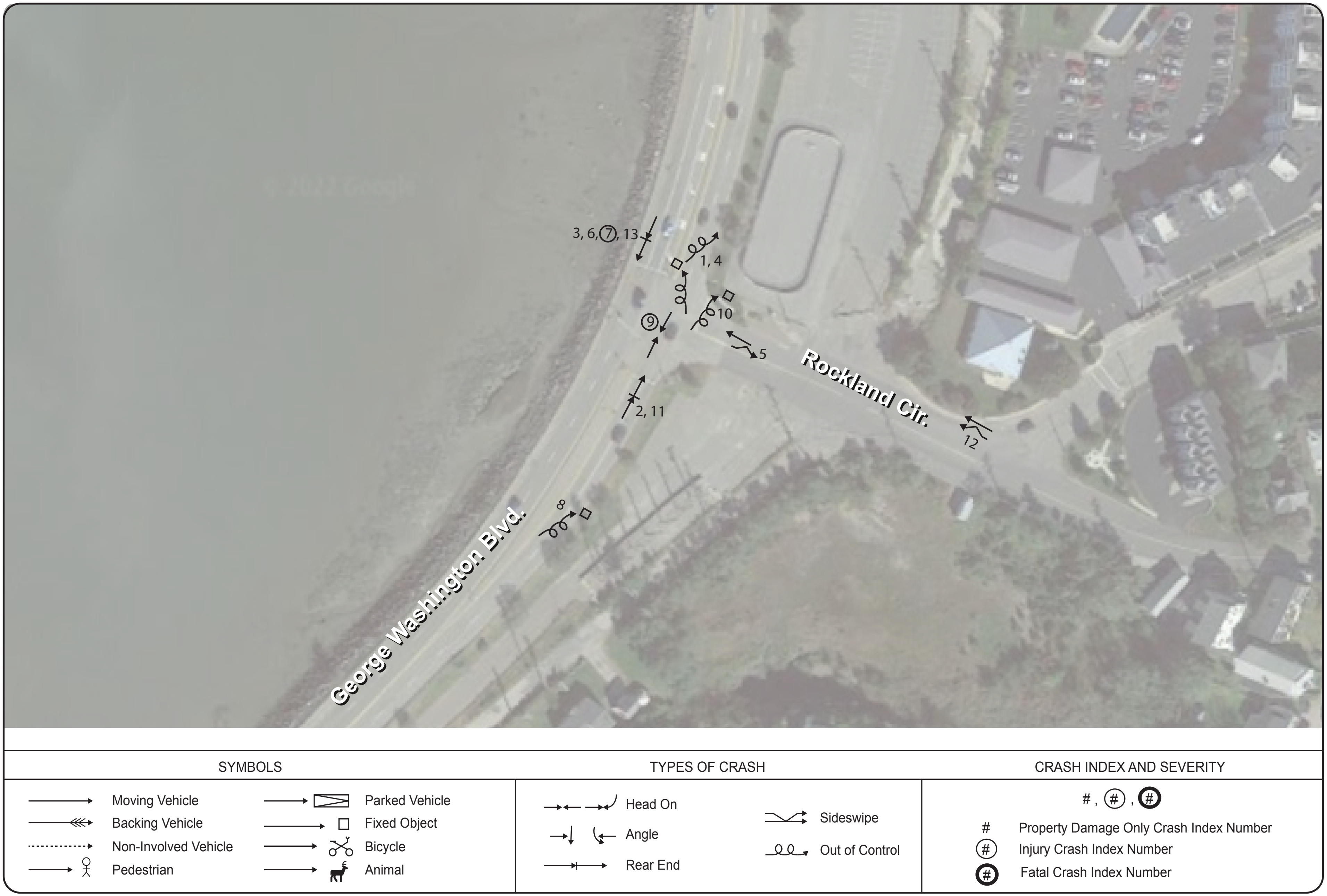

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FIGURE 2
Collision Diagram: George Washington Boulevard at Rockland Circle
Police Crash Reports 2015-20

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5 EXISTING CONDITIONS ANALYSIS

To examine the existing conditions, MPO staff requested MassDOT's assistance in collecting Automatic Traffic Recorder (ATR) counts on the approaching roadways and intersection turning movement counts (TMCs) for this study.

The ATR counts were performed during the week of March 8-14, 2022. The TMCs were collected Thursday, March 12, 2022.

5.1 Daily Traffic Volumes

Based on the data, staff estimated the average weekday traffic volumes at roadway sections near the study intersections as follows:

- George Washington Boulevard, north of Rockland Circle—9,100 vehicles, with a split of 5,100 (56 percent) northbound vehicles and 4,000 (44 percent) southbound vehicles
- George Washington Boulevard, south of Rockland Circle—11,300 vehicles, with a split of 5,600 (49 percent) northbound vehicles and 5,700 (51 percent) southbound vehicles
- Rockland Circle, east of George Washington Boulevard—1,800 vehicles, with a split of 1,000 (55 percent) eastbound vehicles and 800 (45 percent) westbound vehicles

5.2 Turning Movement Counts

MassDOT collected turning movement counts at the study intersections on Thursday, March 10, 2022, during the morning peak period (7:00 AM–10:00 AM) and the evening peak period (3:00 PM–6:00 PM), and on Saturday, March 12, 2022, during the midday peak period (10:00 AM–2:00 PM).

Due to the seasonal nature of traffic patterns in the study area, staff adjusted TMC data using a 2019 MassDOT seasonal adjustment factor of 0.95 for an urban (U4-U7) roadway.

Figure 3 summarizes the adjusted 2022 AM and PM peak-hour traffic turning volumes by approach at the study intersection.

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FIGURE 3
Weekday Peak-Hour Traffic Volumes
George Washington Boulevard at Rockland Circle in Hull

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5.3 Intersection Capacity Analysis

Based on the 2022 AM and PM peak-hour turning movements, staff conducted the intersection capacity analysis for the two study intersections by using the Synchro traffic analysis and simulation program.

Staff conducted traffic operations analyses consistent with the Highway Capacity Manual (HCM) methodologies. HCM methodology demonstrates driving conditions at signalized and unsignalized intersections in terms of level-of-service (LOS) ratings from A through F. LOS A represents the best operating conditions (little to no delay), while LOS F represents the worst operating conditions (very long delay). LOS E represents operating conditions at capacity (limit of acceptable delay).

Table 2 summarizes the estimated LOS, average delay, and volume to capacity ratio (V/C) for all the approaches at the intersection in the AM and PM peak hours. The estimation is based on a total cycle length of 95 seconds that consist of 70 seconds total for both George Washington Boulevard approaches, including 24-second exclusive southbound left-turn movement. The remaining 25 seconds are used for the Rockland Circle approach split (20-second green, plus 3-second yellow and 2-second all-red).

Table 2
Summary of Intersection Capacity Analyses
Adjusted 2022 AM and PM Peak-Hour Traffic Conditions

Analysis Period	AM	AM	AM	PM	PM	PM
Approach	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**
George Washington Boulevard northbound	A	8	0.18	A	8.4	0.32
George Washington Boulevard southbound	A	2.7	0.21	A	2.6	0.19
Rockland Circle westbound	C	31.9	0.33	C	31.3	0.27
Intersection Average	A	7	-	A	7.1	-

Notes: All movements share a single lane on all approaches.
AM Peak Hour = 7:30 AM–-8:30 AM. PM Peak Hour = 3:45 PM–4:45 PM.
Delay = Average delay per vehicle (seconds).
LOS = Level of service. V/C = Volume-to-capacity ratio.

6 PROPOSED SHORT-TERM IMPROVEMENTS

Based on the above analyses, MPO staff developed a series of short- and long-term improvements to address safety and operational problems at the intersections. The proposed short-term improvements generally can be implemented within two years at a relatively low cost (usually less than $30,000). The proposed short-term improvements are summarized below, from the lowest to the highest cost:

- Retime the traffic signal at the intersection.
- Repaint faded pavement markings on all approaches and consider painting lane markings on all approaches.
- Examine the feasibility of installing backplates with retroreflective borders on existing signal heads.
- Examine the feasibility of upgrading street lighting around the intersection. A quarter of crashes at the intersection occurred in the dark.
- Install jersey barrier(s) at northern DCR lot egress to prevent or discourage exiting onto George Washington Boulevard.

7 LONG-TERM IMPROVEMENT ALTERNATIVES

Long-term improvements would require intensive planning and design and more significant funding. Based on the goals of maximizing safety and operational benefits for all transportation modes and minimizing construction impacts, staff assessed two alternatives.

Staff also analyzed traffic operations for the alternatives and the base case (no-build scenario) under the projected 2030 traffic conditions. For comparison purposes, the analysis includes a future year no-build scenario that contains only signal retiming with no geometry modifications and no signal system upgrade.

Key elements of the no-build scenario and the two alternatives are summarized below.

7.1 No-Build Scenario

The no-build alternative assumes that the intersection would remain the same as the existing conditions. The only improvement included in this no-build scenario is to retime the signal.

7.2 Alternative One

Alternative One proposes to modify the intersection layout and upgrade the signal system for adding a protected pedestrian crossing. Figure 4 shows the conceptual plan of the alternative. Key elements of the alternative include the following:

- Reducing turning radii at all corners
- Installing a crosswalk across the northern leg of George Washington Boulevard
- Installing a six-foot sidewalk on the northern side of Rockland Circle to provide connectivity to Park Avenue and Nantasket Avenue
- Installing a crosswalk across the DCR lot and proposed parking lot entrances and exits
- Installing ADA-compliant wheelchair ramps at each end of the crosswalk

- Upgrading the signal system to include accessible count-down pedestrian signals, and new signal indications[1]

7.3 Alternative Two

Alternative Two proposes to modify the intersection layout and control and remove the signal system. Two options are available in Alternative 2:

- Option 1: Two-way stop control intersection
- Option 2: Roundabout

Figure 5 shows the conceptual plans of both options. Key elements of Options 1 and 2 include the following:

- Reducing existing lanes on George Washington Boulevard from four lanes to two create extra space for people walking and biking.
- Installing a 10-foot-wide asphalt-paved, shared-use path to replace the existing sidewalk along the western side of George Washington Boulevard
- Reducing the travel lane widths on George Washington Boulevard from 12 feet to 11 feet
- Installing a crosswalk across the northern leg of George Washington Boulevard
- Installing a six-foot sidewalk on the northern side of Rockland Circle to provide connectivity to Park Avenue and Nantasket Avenue
- Installing a crosswalk across the DCR lot and proposed parking lot entrances and exits
- Installing ADA-compliant wheelchair ramps at each end of the crosswalk

Appendix B contains Synchro intersection capacity analysis reports that detail input volumes, lane configurations, signal-timing settings, and analysis results of the 2030 AM and PM peak hour traffic conditions.

[1] Based on feedback from MassDOT, a signal warrant analysis was conducted for the intersection, and none of the warrants were met. The signal warrant analysis can be found in Appendix F.

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FIGURE 4
Proposed Long-Term Improvement Alternative 1
George Washington Boulevard at Rockland Circle

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FIGURE 5
Proposed Long-Term Improvement Alternative 2, Option 1
George Washington Boulevard at Rockland Circle

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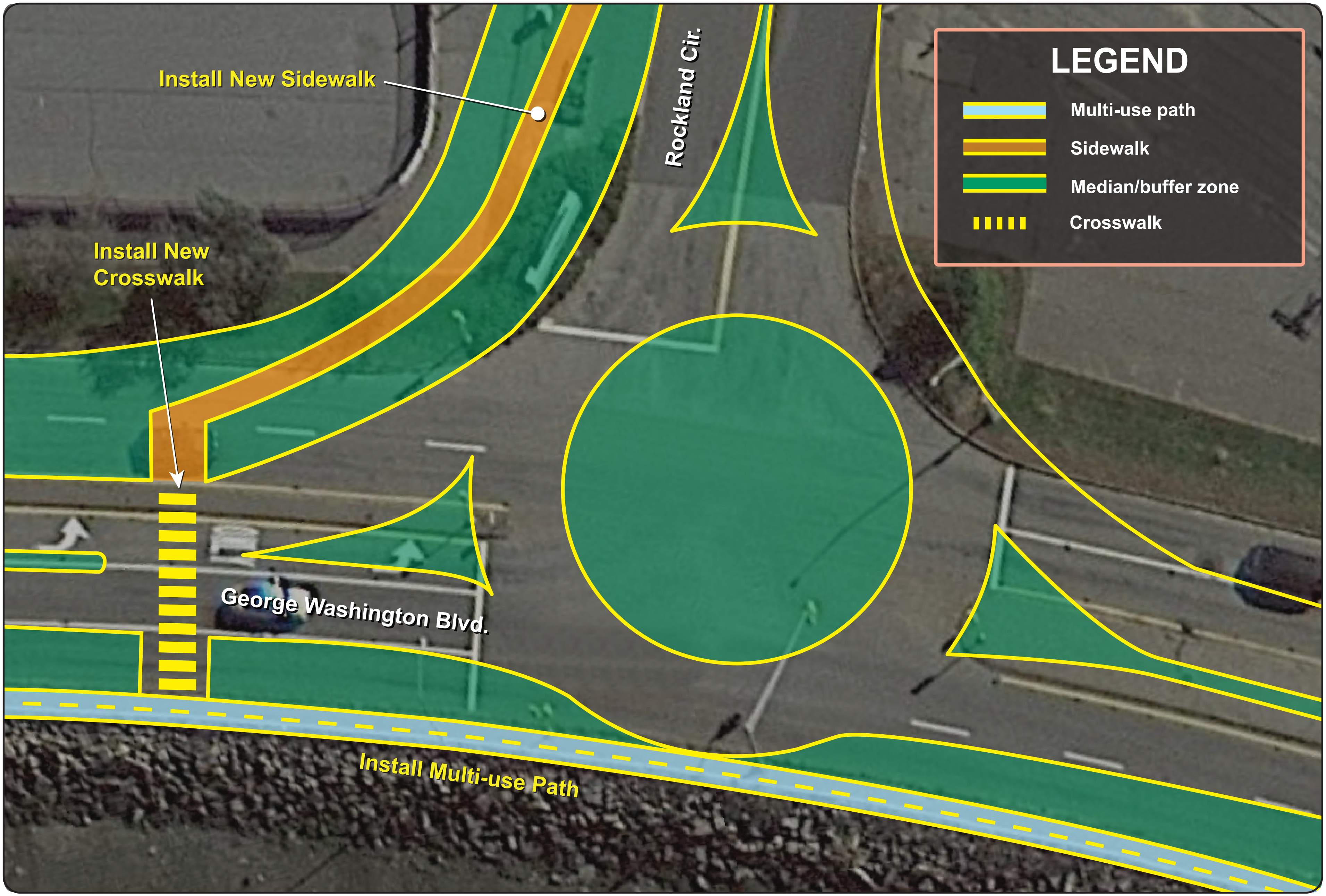

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FIGURE 6
Proposed Long-Term Improvement Alternative 2, Option 2
George Washington Boulevard at Rockland Circle

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8 RESILIENCY CONSIDERATIONS

Hull is one of many Massachusetts coastal communities vulnerable to sea level rise and coastal flooding. Over the years, Hull has conducted several climate vulnerability and adaptations studies to learn more about the issues and help prevent and reduce damage to assets. George Washington Boulevard is one of the three routes that connect Hull to mainland Massachusetts and serves the town economically and for emergency evacuation purposes. The intersection of George Washington Boulevard and Rockland Circle are among the high-risk transportation infrastructure in Hull due to the many low-lying areas (elevations less than 10 feet NAVD88) on the corridor. A study conducted for Hull indicated that the roadway is at risk of flooding from waves overtopping the DCR seawalls and flowing over Nantasket Avenue.

Due to the threats from climate change and sea-level rise, MPO staff recommend that the long-term improvements be considered along with climate change resiliency efforts to preserve and protect investments. Such efforts should include a regional approach to the problems, comprising of South Shore communities and state agencies to address the resiliency of George Washington Boulevard and Rockland Circle. Some of the adaptation measures to be considered include but not limited to beach nourishment (green infrastructure), repairing sea walls, reinforcing bulkheads, revetments, and flood protection barriers.

9 RECOMMENDATIONS

This study performed a series of safety and operations analyses, identified issues and concerns, and proposed short- and long-term improvements at the intersection. The proposed short-term improvements would enhance safety and operations for the intersection under the existing conditions. These improvements should be implemented as soon as resources are available from highway maintenance or local Chapter 90 funding.

The assessed long-term improvements, such as installing sidewalks, crosswalks, and bicycle accommodations and renovating the signal system to include pedestrian signals, would significantly address the safety and operational problems at the intersection. Alternative Two allows for a shorter pedestrian crossing distance due to lane reductions and adjustments and provides a safe refuge for bicyclists on the 10 foot wide multi-use path.

Regardless of future intersection control, staff recommend that a multi-use path along George Washington Boulevard and accommodations for people to cross the roadway are included in any future design considerations, as it would greatly benefit connectivity between Hull and its neighbors, as well as provide safe access for non-driving residents and visitors.

The Town of Hull has jurisdiction of the intersection and roadways in the study area and is responsible for renovation of the intersection to improve safety, mobility, connectivity, and operations. George Washington Boulevard and its adjacent areas have the potential to better accommodate seasonal traffic volumes, as well as better serve pedestrian and bicycle travel through the town and surrounding destinations. Improving safety and operations at this intersection is one essential component in successfully developing the Nantasket Beach area and the Town of Hull into a destination accessible by all modes of transportation.

This study gives the Town of Hull an opportunity to address the needs of users of the intersection and to plan for design and engineering. The next steps would be to further assess this intersection and advance the project through the planning process. These steps will depend upon cooperation among MassDOT, the Town of Hull, and the MPO. The first steps are for the Town of Hull staff to engage in MassDOT's project notification and review process and complete a project initiation form. After completing the initial steps, the Town and MassDOT can start preliminary design and engineering to place the project in the MPO's Transportation Improvement Program (TIP). Should the project receive TIP funding, Intersection Control Evaluation (ICE) would be required prior to preliminary design work.[2]

Project development is a process that takes transportation improvements from concept to construction and is influenced by factors such as financial limitations and agency programmatic commitments. (See Appendix D for an overview of this process.)

This study supports the MPO's visions and goals, which include increasing transportation safety, maintaining the transportation system, advancing mobility and access, reducing congestion, and expanding the opportunities for walking and bicycling, while making these activities safer. If implemented, the improvements proposed in this report would modernize the roadway and significantly improve safety and mobility of all users.

Appendices

[2] More information about the ICE procedure can be found here: https://www.mass.gov/info-details/massdot-intersection-control-evaluation-ice

The Boston Region Metropolitan Planning Organization (MPO) operates its programs, services, and activities in compliance with federal nondiscrimination laws including Title VI of the Civil Rights Act of 1964 (Title VI), the Civil Rights Restoration Act of 1987, and related statutes and regulations. Title VI prohibits discrimination in federally assisted programs and requires that no person in the United States of America shall, on the grounds of race, color, or national origin (including limited English proficiency), be excluded from participation in, denied the benefits of, or be otherwise subjected to discrimination under any program or activity that receives federal assistance. Related federal nondiscrimination laws administered by the Federal Highway Administration, Federal Transit Administration, or both, prohibit discrimination on the basis of age, sex, and disability. The Boston Region MPO considers these protected populations in its Title VI Programs, consistent with federal interpretation and administration. In addition, the Boston Region MPO provides meaningful access to its programs, services, and activities to individuals with limited English proficiency, in compliance with U.S. Department of Transportation policy and guidance on federal Executive Order 13166.

The Boston Region MPO also complies with the Massachusetts Public Accommodation Law, M.G.L. c 272 sections 92a, 98, 98a, which prohibits making any distinction, discrimination, or restriction in admission to, or treatment in a place of public accommodation based on race, color, religious creed, national origin, sex, sexual orientation, disability, or ancestry. Likewise, the Boston Region MPO complies with the Governor's Executive Order 526, section 4, which requires that all programs, activities, and services provided, performed, licensed, chartered, funded, regulated, or contracted for by the state shall be conducted without unlawful discrimination based on race, color, age, gender, ethnicity, sexual orientation, gender identity or expression, religion, creed, ancestry, national origin, disability, veteran's status (including Vietnam-era veterans), or background.

A complaint form and additional information can be obtained by contacting the MPO or at http://www.bostonmpo.org/mpo_non_discrimination.

To request this information in a different language or in an accessible format, please contact

Title VI Specialist
Boston Region MPO
10 Park Plaza, Suite 2150
Boston, MA 02116
civilrights@ctps.org

By Telephone:
857.702.3700 (voice)

For people with hearing or speaking difficulties, connect through the state MassRelay service:

- **Relay Using TTY or Hearing Carry-over:** 800.439.2370
- **Relay Using Voice Carry-over:** 866.887.6619
- **Relay Using Text to Speech:** 866.645.9870

For more information, including numbers for Spanish speakers, visit https://www.mass.gov/massrelay.

APPENDIX A

Intersection Capacity Analyses
2022 Adjusted AM & PM Peak Hours

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	31	22	280	24	20	512
Future Volume (vph)	31	22	280	24	20	512
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		6.0		4.0	4.0
Lane Util. Factor	1.00		0.95		1.00	0.95
Frt	0.94		0.99		1.00	1.00
Flt Protected	0.97		1.00		0.95	1.00
Satd. Flow (prot)	1708		3366		1752	3505
Flt Permitted	0.97		1.00		0.54	1.00
Satd. Flow (perm)	1708		3366		1005	3505
Peak-hour factor, PHF	0.63	0.63	0.88	0.88	0.93	0.93
Adj. Flow (vph)	49	35	318	27	22	551
RTOR Reduction (vph)	31	0	5	0	0	0
Lane Group Flow (vph)	53	0	340	0	22	551
Heavy Vehicles (%)	2%	2%	6%	6%	3%	3%
Turn Type	Prot		NA		D.P+P	NA
Protected Phases	3		2		1	1 2
Permitted Phases					2	
Actuated Green, G (s)	6.9		40.5		50.8	54.8
Effective Green, g (s)	6.9		40.5		50.8	54.8
Actuated g/C Ratio	0.09		0.56		0.70	0.75
Clearance Time (s)	5.0		6.0		4.0	
Vehicle Extension (s)	3.0		3.0		3.0	
Lane Grp Cap (vph)	162		1875		808	2642
v/s Ratio Prot	c0.03		0.10		0.00	c0.16
v/s Ratio Perm					0.02	
v/c Ratio	0.33		0.18		0.03	0.21
Uniform Delay, d1	30.7		7.9		3.3	2.6
Progression Factor	1.00		1.00		1.00	1.00
Incremental Delay, d2	1.2		0.0		0.0	0.0
Delay (s)	31.9		8.0		3.4	2.7
Level of Service	C		A		A	A
Approach Delay (s)	31.9		8.0			2.7
Approach LOS	C		A			A

Intersection Summary			
HCM 2000 Control Delay	7.0	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.24		
Actuated Cycle Length (s)	72.7	Sum of lost time (s)	15.0
Intersection Capacity Utilization	49.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	31	21	464	74	33	423
Future Volume (vph)	31	21	464	74	33	423
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		6.0		4.0	4.0
Lane Util. Factor	1.00		0.95		1.00	0.95
Frt	0.95		0.98		1.00	1.00
Flt Protected	0.97		1.00		0.95	1.00
Satd. Flow (prot)	1710		3501		1770	3539
Flt Permitted	0.97		1.00		0.40	1.00
Satd. Flow (perm)	1710		3501		745	3539
Peak-hour factor, PHF	0.77	0.77	0.85	0.85	0.83	0.83
Adj. Flow (vph)	40	27	546	87	40	510
RTOR Reduction (vph)	25	0	10	0	0	0
Lane Group Flow (vph)	42	0	623	0	40	510
Heavy Vehicles (%)	2%	2%	1%	1%	2%	2%
Turn Type	Prot		NA		D.P+P	NA
Protected Phases	3		2		1	1 2
Permitted Phases					2	
Actuated Green, G (s)	6.6		40.4		50.2	54.2
Effective Green, g (s)	6.6		40.4		50.2	54.2
Actuated g/C Ratio	0.09		0.56		0.70	0.75
Clearance Time (s)	5.0		6.0		4.0	
Vehicle Extension (s)	3.0		3.0		3.0	
Lane Grp Cap (vph)	157		1969		660	2671
v/s Ratio Prot	c0.02		c0.18		0.01	c0.14
v/s Ratio Perm					0.03	
v/c Ratio	0.27		0.32		0.06	0.19
Uniform Delay, d1	30.4		8.4		3.3	2.5
Progression Factor	1.00		1.00		1.00	1.00
Incremental Delay, d2	0.9		0.1		0.0	0.0
Delay (s)	31.3		8.4		3.4	2.6
Level of Service	C		A		A	A
Approach Delay (s)	31.3		8.4			2.6
Approach LOS	C		A			A

Intersection Summary			
HCM 2000 Control Delay	7.1	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.29		
Actuated Cycle Length (s)	71.8	Sum of lost time (s)	15.0
Intersection Capacity Utilization	49.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

APPENDIX B

Intersection Capacity Analyses
No Build and Alternative Scenarios
2030 AM & PM Peak Hours

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	31	22	280	24	20	512
Future Volume (vph)	31	22	280	24	20	512
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12
Grade (%)	0%		0%			0%
Storage Length (ft)	0	0		0	270	
Storage Lanes	1	0		0	1	
Taper Length (ft)	25				25	
Lane Util. Factor	1.00	1.00	0.95	0.95	1.00	0.95
Ped Bike Factor						
Frt	0.944		0.988			
Flt Protected	0.972				0.950	
Satd. Flow (prot)	1709	0	3365	0	1752	3505
Flt Permitted	0.972				0.545	
Satd. Flow (perm)	1709	0	3365	0	1005	3505
Right Turn on Red		Yes		Yes		
Satd. Flow (RTOR)	35		20			
Link Speed (mph)	30		30			30
Link Distance (ft)	857		702			753
Travel Time (s)	19.5		16.0			17.1
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor	0.63	0.63	0.88	0.88	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	6%	6%	3%	3%
Bus Blockages (#/hr)	0	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)	0%		0%			0%
Adj. Flow (vph)	49	35	318	27	22	551
Shared Lane Traffic (%)						
Lane Group Flow (vph)	84	0	345	0	22	551
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Right	Left	Left
Median Width(ft)	12		12			12
Link Offset(ft)	0		0			0
Crosswalk Width(ft)	16		16			16
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15	9		9	15	
Turn Type	Prot		NA		D.P+P	NA
Protected Phases	3		2		1	1 2
Permitted Phases					2	
Detector Phase	3		2		1	1 2
Switch Phase						
Minimum Initial (s)	8.0		40.0		8.0	
Minimum Split (s)	13.0		46.0		12.0	
Total Split (s)	14.0		49.0		12.0	
Total Split (%)	18.7%		65.3%		16.0%	

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Yellow Time (s)	3.0		4.0		3.0	
All-Red Time (s)	2.0		2.0		1.0	
Lost Time Adjust (s)	0.0		0.0		0.0	
Total Lost Time (s)	5.0		6.0		4.0	
Lead/Lag			Lag		Lead	
Lead-Lag Optimize?			Yes		Yes	
Recall Mode	None		None		None	
Act Effct Green (s)	8.4		40.3		50.4	55.4
Actuated g/C Ratio	0.12		0.59		0.73	0.81
v/c Ratio	0.35		0.17		0.03	0.20
Control Delay	23.6		7.2		2.5	2.5
Queue Delay	0.0		0.0		0.0	0.0
Total Delay	23.6		7.2		2.5	2.5
LOS	C		A		A	A
Approach Delay	23.6		7.2			2.5
Approach LOS	C		A			A
Queue Length 50th (ft)	20		33		2	26
Queue Length 95th (ft)	35		52		6	41
Internal Link Dist (ft)	777		622			673
Turn Bay Length (ft)					270	
Base Capacity (vph)	255		2126		823	2925
Starvation Cap Reductn	0		0		0	0
Spillback Cap Reductn	0		0		0	0
Storage Cap Reductn	0		0		0	0
Reduced v/c Ratio	0.33		0.16		0.03	0.19

Intersection Summary	
Area Type: Other	
Cycle Length: 75	
Actuated Cycle Length: 68.8	
Natural Cycle: 75	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.35	
Intersection Signal Delay: 5.9	Intersection LOS: A
Intersection Capacity Utilization 49.2%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 3:

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	31	21	464	74	33	423
Future Volume (vph)	31	21	464	74	33	423
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12
Grade (%)	0%		0%			0%
Storage Length (ft)	0	0		0	270	
Storage Lanes	1	0		0	1	
Taper Length (ft)	25				25	
Lane Util. Factor	1.00	1.00	0.95	0.95	1.00	0.95
Ped Bike Factor						
Frt	0.946		0.979			
Flt Protected	0.971				0.950	
Satd. Flow (prot)	1711	0	3499	0	1770	3539
Flt Permitted	0.971				0.409	
Satd. Flow (perm)	1711	0	3499	0	762	3539
Right Turn on Red		Yes		Yes		
Satd. Flow (RTOR)	27		41			
Link Speed (mph)	30		30			30
Link Distance (ft)	857		702			753
Travel Time (s)	19.5		16.0			17.1
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor	0.77	0.77	0.85	0.85	0.83	0.83
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	1%	1%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)	0%		0%			0%
Adj. Flow (vph)	40	27	546	87	40	510
Shared Lane Traffic (%)						
Lane Group Flow (vph)	67	0	633	0	40	510
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Right	Left	Left
Median Width(ft)	12		12			12
Link Offset(ft)	0		0			0
Crosswalk Width(ft)	16		16			16
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15	9		9	15	
Turn Type	Prot		NA		D.P+P	NA
Protected Phases	3		2		1	1 2
Permitted Phases					2	
Detector Phase	3		2		1	1 2
Switch Phase						
Minimum Initial (s)	8.0		40.0		8.0	
Minimum Split (s)	13.0		46.0		12.0	
Total Split (s)	13.0		50.0		12.0	
Total Split (%)	17.3%		66.7%		16.0%	

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Yellow Time (s)	3.0		4.0		3.0	
All-Red Time (s)	2.0		2.0		1.0	
Lost Time Adjust (s)	0.0		0.0		0.0	
Total Lost Time (s)	5.0		6.0		4.0	
Lead/Lag			Lag		Lead	
Lead-Lag Optimize?			Yes		Yes	
Recall Mode	None		None		None	
Act Effct Green (s)	8.1		40.4		50.5	56.3
Actuated g/C Ratio	0.12		0.61		0.77	0.86
v/c Ratio	0.29		0.29		0.06	0.17
Control Delay	23.1		6.9		2.3	1.9
Queue Delay	0.0		0.0		0.0	0.0
Total Delay	23.1		6.9		2.3	1.9
LOS	C		A		A	A
Approach Delay	23.1		6.9			1.9
Approach LOS	C		A			A
Queue Length 50th (ft)	16		65		3	24
Queue Length 95th (ft)	42		87		8	31
Internal Link Dist (ft)	777		622			673
Turn Bay Length (ft)					270	
Base Capacity (vph)	233		2375		708	3150
Starvation Cap Reductn	0		0		0	0
Spillback Cap Reductn	0		0		0	0
Storage Cap Reductn	0		0		0	0
Reduced v/c Ratio	0.29		0.27		0.06	0.16

Intersection Summary	
Area Type: Other	
Cycle Length: 75	
Actuated Cycle Length: 65.8	
Natural Cycle: 75	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.29	
Intersection Signal Delay: 5.6	Intersection LOS: A
Intersection Capacity Utilization 49.2%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 3:

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT	Ø9
Lane Configurations							
Traffic Volume (vph)	31	21	464	74	33	423	
Future Volume (vph)	31	21	464	74	33	423	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	
Lane Width (ft)	11	11	11	11	11	11	
Grade (%)	0%		0%			0%	
Storage Length (ft)	0	0		0	270		
Storage Lanes	1	0		0	1		
Taper Length (ft)	25				25		
Lane Util. Factor	1.00	1.00	0.95	0.95	1.00	0.95	
Ped Bike Factor							
Frt	0.946		0.979				
Flt Protected	0.971				0.950		
Satd. Flow (prot)	1654	0	3383	0	1711	3421	
Flt Permitted	0.971				0.405		
Satd. Flow (perm)	1654	0	3383	0	729	3421	
Right Turn on Red		Yes		Yes			
Satd. Flow (RTOR)	27		23				
Link Speed (mph)	30		30			30	
Link Distance (ft)	857		702			753	
Travel Time (s)	19.5		16.0			17.1	
Confl. Peds. (#/hr)							
Confl. Bikes (#/hr)							
Peak Hour Factor	0.77	0.77	0.85	0.85	0.83	0.83	
Growth Factor	100%	100%	100%	100%	100%	100%	
Heavy Vehicles (%)	2%	2%	1%	1%	2%	2%	
Bus Blockages (#/hr)	0	0	0	0	0	0	
Parking (#/hr)							
Mid-Block Traffic (%)	0%		0%			0%	
Adj. Flow (vph)	40	27	546	87	40	510	
Shared Lane Traffic (%)							
Lane Group Flow (vph)	67	0	633	0	40	510	
Enter Blocked Intersection	No	No	No	No	No	No	
Lane Alignment	Left	Right	Left	Right	Left	Left	
Median Width(ft)	11		11			11	
Link Offset(ft)	0		0			0	
Crosswalk Width(ft)	16		16			16	
Two way Left Turn Lane							
Headway Factor	1.04	1.04	1.04	1.04	1.04	1.04	
Turning Speed (mph)	15	9		9	15		
Turn Type	Prot		NA		D.P+P	NA	
Protected Phases	3		2		1	1 2	9
Permitted Phases					2		
Detector Phase	3		2		1	1 2	
Switch Phase							
Minimum Initial (s)	8.0		40.0		8.0		7.0
Minimum Split (s)	13.0		46.0		12.0		24.0
Total Split (s)	13.0		50.0		12.0		24.0
Total Split (%)	13.1%		50.5%		12.1%		24%

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT	Ø9
Yellow Time (s)	3.0		4.0		3.0		2.0
All-Red Time (s)	2.0		2.0		1.0		1.0
Lost Time Adjust (s)	0.0		0.0		0.0		
Total Lost Time (s)	5.0		6.0		4.0		
Lead/Lag			Lag		Lead		
Lead-Lag Optimize?			Yes		Yes		
Recall Mode	None		None		None		None
Act Effct Green (s)	8.1		40.3		50.3	55.3	
Actuated g/C Ratio	0.12		0.59		0.74	0.81	
v/c Ratio	0.31		0.32		0.06	0.18	
Control Delay	23.8		8.0		2.4	2.3	
Queue Delay	0.0		0.0		0.0	0.0	
Total Delay	23.8		8.0		2.4	2.3	
LOS	C		A		A	A	
Approach Delay	23.8		8.0			2.3	
Approach LOS	C		A			A	
Queue Length 50th (ft)	16		67		3	24	
Queue Length 95th (ft)	42		90		8	32	
Internal Link Dist (ft)	777		622			673	
Turn Bay Length (ft)					270		
Base Capacity (vph)	218		2198		652	2919	
Starvation Cap Reductn	0		0		0	0	
Spillback Cap Reductn	0		0		0	0	
Storage Cap Reductn	0		0		0	0	
Reduced v/c Ratio	0.31		0.29		0.06	0.17	

Intersection Summary	
Area Type: Other	
Cycle Length: 99	
Actuated Cycle Length: 68.4	
Natural Cycle: 95	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.32	
Intersection Signal Delay: 6.4	Intersection LOS: A
Intersection Capacity Utilization 49.2%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 1:

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT	Ø9
Lane Configurations							
Traffic Volume (vph)	31	22	280	24	20	512	
Future Volume (vph)	31	22	280	24	20	512	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	
Lane Width (ft)	11	11	11	11	11	11	
Grade (%)	0%		0%			0%	
Storage Length (ft)	0	0		0	270		
Storage Lanes	1	0		0	1		
Taper Length (ft)	25				25		
Lane Util. Factor	1.00	1.00	0.95	0.95	1.00	0.95	
Ped Bike Factor							
Frt	0.944		0.988				
Flt Protected	0.972				0.950		
Satd. Flow (prot)	1652	0	3253	0	1694	3388	
Flt Permitted	0.972				0.545		
Satd. Flow (perm)	1652	0	3253	0	972	3388	
Right Turn on Red		Yes		Yes			
Satd. Flow (RTOR)	29		11				
Link Speed (mph)	30		30			30	
Link Distance (ft)	857		702			753	
Travel Time (s)	19.5		16.0			17.1	
Confl. Peds. (#/hr)							
Confl. Bikes (#/hr)							
Peak Hour Factor	0.63	0.63	0.88	0.88	0.93	0.93	
Growth Factor	100%	100%	100%	100%	100%	100%	
Heavy Vehicles (%)	2%	2%	6%	6%	3%	3%	
Bus Blockages (#/hr)	0	0	0	0	0	0	
Parking (#/hr)							
Mid-Block Traffic (%)	0%		0%			0%	
Adj. Flow (vph)	49	35	318	27	22	551	
Shared Lane Traffic (%)							
Lane Group Flow (vph)	84	0	345	0	22	551	
Enter Blocked Intersection	No	No	No	No	No	No	
Lane Alignment	Left	Right	Left	Right	Left	Left	
Median Width(ft)	11		11			11	
Link Offset(ft)	0		0			0	
Crosswalk Width(ft)	16		16			16	
Two way Left Turn Lane							
Headway Factor	1.04	1.04	1.04	1.04	1.04	1.04	
Turning Speed (mph)	15	9		9	15		
Turn Type	Prot		NA		D.P+P	NA	
Protected Phases	3		2		1	1 2	9
Permitted Phases					2		
Detector Phase	3		2		1	1 2	
Switch Phase							
Minimum Initial (s)	8.0		40.0		8.0		7.0
Minimum Split (s)	13.0		46.0		12.0		24.0
Total Split (s)	15.0		48.5		12.0		24.0
Total Split (%)	15.1%		48.7%		12.1%		24%

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT	Ø9
Yellow Time (s)	3.0		4.0		3.0		2.0
All-Red Time (s)	2.0		2.0		1.0		1.0
Lost Time Adjust (s)	0.0		0.0		0.0		
Total Lost Time (s)	5.0		6.0		4.0		
Lead/Lag			Lag		Lead		
Lead-Lag Optimize?			Yes		Yes		
Recall Mode	None		None		None		None
Act Effct Green (s)	8.6		40.3		50.4	55.3	
Actuated g/C Ratio	0.12		0.58		0.73	0.80	
v/c Ratio	0.36		0.18		0.03	0.20	
Control Delay	25.6		7.6		2.5	2.6	
Queue Delay	0.0		0.0		0.0	0.0	
Total Delay	25.6		7.6		2.5	2.6	
LOS	C		A		A	A	
Approach Delay	25.6		7.6			2.6	
Approach LOS	C		A			A	
Queue Length 50th (ft)	23		34		2	26	
Queue Length 95th (ft)	38		55		6	45	
Internal Link Dist (ft)	777		622			673	
Turn Bay Length (ft)					270		
Base Capacity (vph)	265		2022		793	2794	
Starvation Cap Reductn	0		0		0	0	
Spillback Cap Reductn	0		0		0	0	
Storage Cap Reductn	0		0		0	0	
Reduced v/c Ratio	0.32		0.17		0.03	0.20	

Intersection Summary	
Area Type: Other	
Cycle Length: 99.5	
Actuated Cycle Length: 69	
Natural Cycle: 95	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.36	
Intersection Signal Delay: 6.2	Intersection LOS: A
Intersection Capacity Utilization 49.2%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 1:

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	31	22	475	75	433	33
Future Volume (vph)	31	22	475	75	433	33
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12
Grade (%)	0%		0%			0%
Storage Length (ft)	0	0		0	0	
Storage Lanes	1	0		0	0	
Taper Length (ft)	25				25	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor						
Frt	0.944		0.981			
Flt Protected	0.972					0.956
Satd. Flow (prot)	1709	0	1827	0	0	1781
Flt Permitted	0.972					0.295
Satd. Flow (perm)	1709	0	1827	0	0	550
Right Turn on Red		Yes		Yes		
Satd. Flow (RTOR)	24		16			
Link Speed (mph)	30		30			30
Link Distance (ft)	488		355			430
Travel Time (s)	11.1		8.1			9.8
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)	0%		0%			0%
Adj. Flow (vph)	34	24	516	82	471	36
Shared Lane Traffic (%)						
Lane Group Flow (vph)	58	0	598	0	0	507
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Right	Left	Left
Median Width(ft)	12		0			0
Link Offset(ft)	0		0			0
Crosswalk Width(ft)	16		16			16
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15	9		9	15	
Number of Detectors	1		2		1	2
Detector Template	Left		Thru		Left	Thru
Leading Detector (ft)	20		100		20	100
Trailing Detector (ft)	0		0		0	0
Turn Type	Prot		NA		D.P+P	NA
Protected Phases	3		2		1	1 2
Permitted Phases					2	
Detector Phase	3		2		1	1 2
Switch Phase						

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Minimum Initial (s)	8.0		40.0		7.5	
Minimum Split (s)	13.0		46.0		12.0	
Total Split (s)	13.0		46.0		16.0	
Total Split (%)	17.3%		61.3%		21.3%	
Yellow Time (s)	3.0		4.0		3.0	
All-Red Time (s)	2.0		2.0		1.0	
Lost Time Adjust (s)	0.0		0.0			
Total Lost Time (s)	5.0		6.0			
Lead/Lag			Lag		Lead	
Lead-Lag Optimize?			Yes		Yes	
Recall Mode	Max		Max		Max	
Act Effct Green (s)	8.0		40.0			54.0
Actuated g/C Ratio	0.11		0.53			0.72
v/c Ratio	0.29		0.61			0.86
Control Delay	24.8		15.1			23.1
Queue Delay	0.0		0.0			0.0
Total Delay	24.8		15.1			23.1
LOS	C		B			C
Approach Delay	24.8		15.1			23.1
Approach LOS	C		B			C
Queue Length 50th (ft)	15		173			56
Queue Length 95th (ft)	48		273			#138
Internal Link Dist (ft)	408		275			350
Turn Bay Length (ft)						
Base Capacity (vph)	203		981			592
Starvation Cap Reductn	0		0			0
Spillback Cap Reductn	0		0			0
Storage Cap Reductn	0		0			0
Reduced v/c Ratio	0.29		0.61			0.86

Intersection Summary	
Area Type: Other	
Cycle Length: 75	
Actuated Cycle Length: 75	
Offset: 0 (0%), Referenced to phase 2:NBSB and 6:, Start of Green	
Natural Cycle: 75	
Control Type: Pretimed	
Maximum v/c Ratio: 0.86	
Intersection Signal Delay: 19.1	Intersection LOS: B
Intersection Capacity Utilization 78.2%	ICU Level of Service D
Analysis Period (min) 15	

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3:

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	31	23	286	25	523	20
Future Volume (vph)	31	23	286	25	523	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12
Grade (%)	0%		0%			0%
Storage Length (ft)	0	0		0	0	
Storage Lanes	1	0		0	0	
Taper Length (ft)	25				25	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor						
Frt	0.943		0.989			
Flt Protected	0.972					0.954
Satd. Flow (prot)	1707	0	1842	0	0	1777
Flt Permitted	0.972					0.494
Satd. Flow (perm)	1707	0	1842	0	0	920
Right Turn on Red		Yes		Yes		
Satd. Flow (RTOR)	25		9			
Link Speed (mph)	30		30			30
Link Distance (ft)	488		355			430
Travel Time (s)	11.1		8.1			9.8
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)	0%		0%			0%
Adj. Flow (vph)	34	25	311	27	568	22
Shared Lane Traffic (%)						
Lane Group Flow (vph)	59	0	338	0	0	590
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Right	Left	Left
Median Width(ft)	12		0			0
Link Offset(ft)	0		0			0
Crosswalk Width(ft)	16		16			16
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15	9		9	15	
Number of Detectors	1		2		1	2
Detector Template	Left		Thru		Left	Thru
Leading Detector (ft)	20		100		20	100
Trailing Detector (ft)	0		0		0	0
Turn Type	Prot		NA		D.P+P	NA
Protected Phases	3		2		1	1 2
Permitted Phases					2	
Detector Phase	3		2		1	1 2
Switch Phase						

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Minimum Initial (s)	8.0		40.0		7.5	
Minimum Split (s)	13.0		46.0		12.0	
Total Split (s)	13.0		46.0		16.0	
Total Split (%)	17.3%		61.3%		21.3%	
Yellow Time (s)	3.0		4.0		3.0	
All-Red Time (s)	2.0		2.0		1.0	
Lost Time Adjust (s)	0.0		0.0			
Total Lost Time (s)	5.0		6.0			
Lead/Lag			Lag		Lead	
Lead-Lag Optimize?			Yes		Yes	
Recall Mode	Max		Max		Max	
Act Effct Green (s)	8.0		40.0			54.0
Actuated g/C Ratio	0.11		0.53			0.72
v/c Ratio	0.29		0.34			0.74
Control Delay	24.6		10.9			9.9
Queue Delay	0.0		0.0			0.0
Total Delay	24.6		10.9			9.9
LOS	C		B			A
Approach Delay	24.6		10.9			9.9
Approach LOS	C		B			A
Queue Length 50th (ft)	15		81			68
Queue Length 95th (ft)	48		133			107
Internal Link Dist (ft)	408		275			350
Turn Bay Length (ft)						
Base Capacity (vph)	204		986			799
Starvation Cap Reductn	0		0			0
Spillback Cap Reductn	0		0			0
Storage Cap Reductn	0		0			0
Reduced v/c Ratio	0.29		0.34			0.74

Intersection Summary

Area Type: Other
Cycle Length: 75
Actuated Cycle Length: 75
Offset: 0 (0%), Referenced to phase 2:NBSB and 6:, Start of Green
Natural Cycle: 75
Control Type: Pretimed
Maximum v/c Ratio: 0.74
Intersection Signal Delay: 11.1 Intersection LOS: B
Intersection Capacity Utilization 82.5% ICU Level of Service E
Analysis Period (min) 15

Splits and Phases: 3:

Intersection	
Intersection Delay, s/veh	6.3
Intersection LOS	A

Approach	WB	NB	SB
Entry Lanes	1	1	1
Conflicting Circle Lanes	1	1	1
Adj Approach Flow, veh/h	60	338	590
Demand Flow Rate, veh/h	62	345	601
Vehicles Circulating, veh/h	317	22	36
Vehicles Exiting, veh/h	50	615	342
Ped Vol Crossing Leg, #/h	0	0	0
Ped Cap Adj	1.000	1.000	1.000
Approach Delay, s/veh	4.3	4.9	7.3
Approach LOS	A	A	A

Lane	Left	Left	Left
Designated Moves	LR	TR	LT
Assumed Moves	LR	TR	LT
RT Channelized			
Lane Util	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976
Entry Flow, veh/h	62	345	601
Cap Entry Lane, veh/h	999	1349	1330
Entry HV Adj Factor	0.968	0.979	0.981
Flow Entry, veh/h	60	338	590
Cap Entry, veh/h	966	1321	1305
V/C Ratio	0.062	0.256	0.452
Control Delay, s/veh	4.3	4.9	7.3
LOS	A	A	A
95th %tile Queue, veh	0	1	2

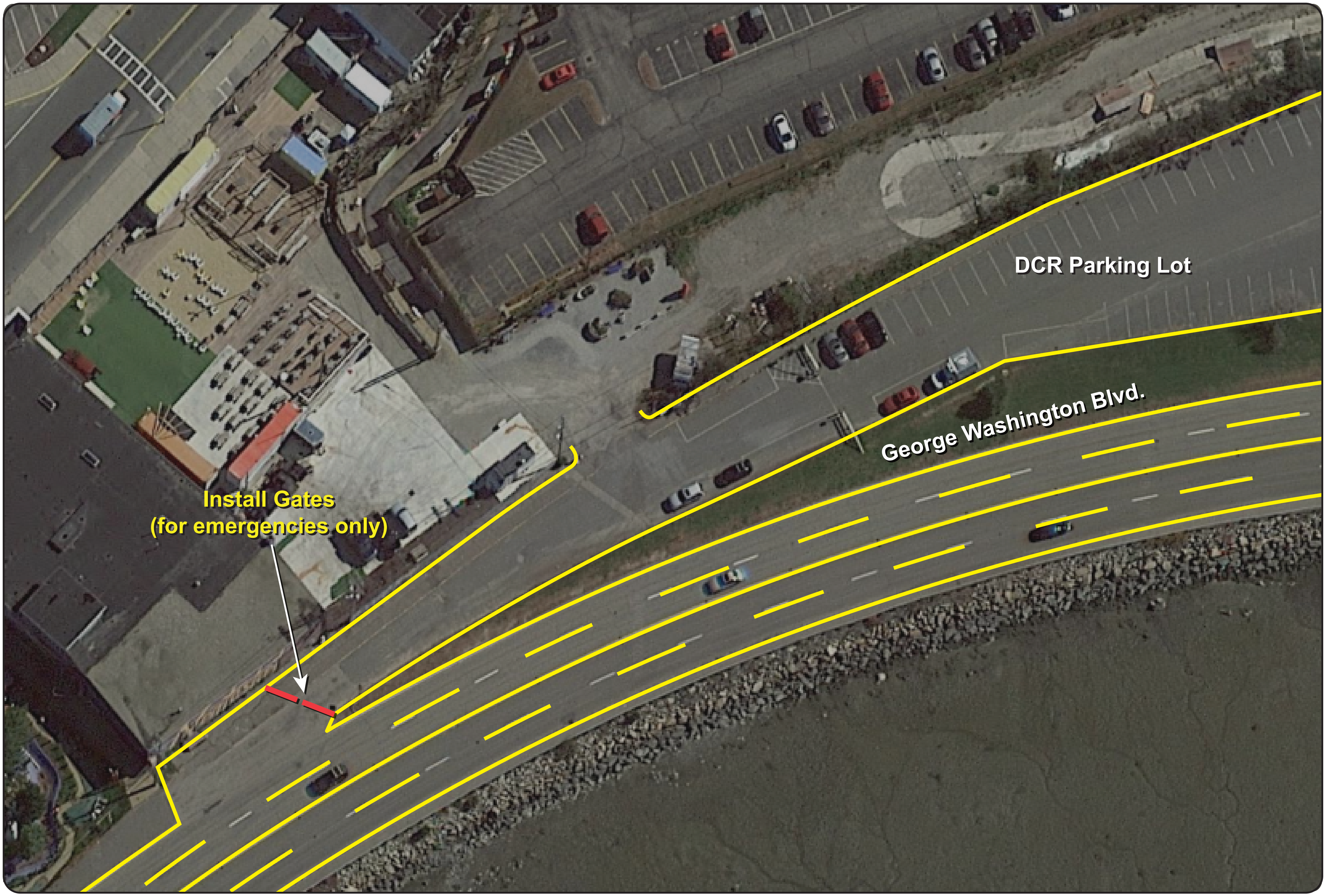
Intersection	
Intersection Delay, s/veh	6.3
Intersection LOS	A

Approach	WB	NB	SB
Entry Lanes	1	1	1
Conflicting Circle Lanes	1	1	1
Adj Approach Flow, veh/h	60	338	590
Demand Flow Rate, veh/h	62	345	601
Vehicles Circulating, veh/h	317	22	36
Vehicles Exiting, veh/h	50	615	342
Ped Vol Crossing Leg, #/h	0	0	0
Ped Cap Adj	1.000	1.000	1.000
Approach Delay, s/veh	4.3	4.9	7.3
Approach LOS	A	A	A

Lane	Left	Left	Left
Designated Moves	LR	TR	LT
Assumed Moves	LR	TR	LT
RT Channelized			
Lane Util	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976
Entry Flow, veh/h	62	345	601
Cap Entry Lane, veh/h	999	1349	1330
Entry HV Adj Factor	0.968	0.979	0.981
Flow Entry, veh/h	60	338	590
Cap Entry, veh/h	966	1321	1305
V/C Ratio	0.062	0.256	0.452
Control Delay, s/veh	4.3	4.9	7.3
LOS	A	A	A
95th %tile Queue, veh	0	1	2

APPENDIX C

DCR Lot Design Alternatives



BOSTON
REGION
MPO

APPENDIX C-1
Proposed DCR Lot Northern Exit Alternative 1
George Washington Boulevard

Safety and Operations at
Selected Intersections
Town of Hull

BOSTON
REGION
MPO

APPENDIX C-2
Proposed DCR Lot Northern Exit Alternative 2
George Washington Boulevard

Safety and Operations at Selected Intersections
Town of Hull

APPENDIX D
MassDOT Project Development Process

Overview of the Project Development Process

Transportation decision-making is complex and can be influenced by legislative mandates, environmental regulations, financial limitations, agency programmatic commitments, and partnering opportunities. Decision-makers and reviewing agencies, when consulted early and often throughout the project development process, can ensure that all participants understand the potential impact these factors can have on project implementation. Project development is the process that takes a transportation improvement from concept through construction.

The MassDOT Highway Division has developed a comprehensive project development process which is contained in Chapter 2 of the *MassDOT Highway Division's Project Development and Design Guide*. The eight-step process covers a range of activities extending from identification of a project need, through completion of a set of finished contract plans, to construction of the project. The sequence of decisions made through the project development process progressively narrows the project focus and, ultimately, leads to a project that addresses the identified needs. The descriptions provided below are focused on the process for a highway project, but the same basic process will need to be followed for non-highway projects as well.

1. Needs Identification

For each of the locations at which an improvement is to be implemented, MassDOT leads an effort to define the problem, establishes project goals and objectives, and defines the scope of the planning needed for implementation. To that end, it has to complete a Project Need Form (PNF), which states in general terms the deficiencies or needs related to the transportation facility or location. The PNF documents the problems and explains why corrective action is needed. For this study, the information defining the need for the project will be drawn primarily, perhaps exclusively, from the present report. Also, at this point in the process, MassDOT meets with potential participants, such as the Metropolitan Planning Organization (MPO) and community members, to allow for an informal review of the project.

The PNF is reviewed by the MassDOT Highway Division district office whose jurisdiction includes the location of the proposed project. MassDOT also sends the PNF to the MPO, for informational purposes. The outcome of this step determines whether the project requires further planning, whether it is already well supported by prior planning studies, and, therefore, whether it is ready to move forward into the design phase, or whether it should be dismissed from further consideration.

2. Planning

This phase will likely not be required for the implementation of the improvements proposed in this planning study, as this planning report should constitute the outcome of this step. However, in general, the purpose of this implementation step is for the project proponent to identify issues, impacts, and approvals that may need to be obtained, so that the subsequent design and permitting processes are understood.

The level of planning needed will vary widely, based on the complexity of the project. Typical tasks include: define the existing context, confirm project need, establish goals and objectives, initiate public outreach, define the project, collect data, develop and analyze alternatives, make recommendations, and provide documentation. Likely outcomes include consensus on the project definition to enable it to move forward into environmental documentation (if needed) and design, or a recommendation to delay the project or dismiss it from further consideration.

3. Project Initiation

At this point in the process, the proponent, MassDOT Highway Division, fills out a Project Initiation Form (PIF) for each improvement, which is reviewed by its Project Review Committee (PRC) and the MPO. The PRC is composed of the Chief Engineer, each District Highway Director, and representatives of the Project Management, Environmental, Planning, Right-of-Way, Traffic, and Bridge departments, and the MassDOT Federal Aid Program Office (FAPO). The PIF documents the project type and description, summarizes the project planning process, identifies likely funding and project management responsibility, and defines a plan for interagency and public participation. First the PRC reviews and evaluates the proposed project based on the MassDOT's statewide priorities and criteria. If the result is positive, MassDOT Highway Division moves the project forward to the design phase, and to programming review by the MPO. The PRC may provide a Project Management Plan to define roles and responsibilities for subsequent steps. The MPO review includes project evaluation based on the MPO's regional priorities and criteria. The MPO may assign project evaluation criteria score, a Transportation Improvement Program (TIP) year, a tentative project category, and a tentative funding category.

4. Environmental Permitting, Design, and Right-of-Way Process

This step has four distinct but closely integrated elements: public outreach, environmental documentation and permitting (if required), design, and right-of-way acquisition (if required). The outcome of this step is a fully designed and permitted project ready for construction. However, a project does not have to be fully designed in order for the MPO to program it in the TIP. The sections below provide more detailed information on the four elements of this step of the project development process.

Public Outreach

Continued public outreach in the design and environmental process is essential to maintain public support for the project and to seek meaningful input on the design elements. The public outreach is often in the form of required public hearings, but can also include less formal dialogues with those interested in and affected by a proposed project.

Environmental Documentation and Permitting

The project proponent, in coordination with the Environmental Services section of the MassDOT Highway Division, will be responsible for identifying and complying with all applicable federal, state, and local environmental laws and requirements. This includes determining the appropriate project category for both the Massachusetts Environmental Protection Act (MEPA) and the National Environmental Protection Act (NEPA). Environmental documentation and permitting is often completed in conjunction with the **Preliminary Design** phase described below.

Design

There are three major phases of design. The first is **Preliminary Design**, which is also referred to as the 25-percent submission. The major components of this phase include full survey of the project area, preparation of base plans, development of basic geometric layout, development of preliminary cost estimates, and submission of a functional design report. Preliminary Design, although not required to, is often completed in conjunction with the Environmental Documentation and Permitting. The next phase is **Final Design**, which is also referred to as the 75-percent and 100-percent submission. The major components of this phase include preparation of a subsurface exploratory plan (if required), coordination of utility relocations, development of traffic management plans through construction zones, development of final cost estimates, and refinement and finalization of the construction plans. Once Final Design is complete, a full set of **Plans, Specifications, and Estimates (PS&E)** is developed for the project.

Right-of-Way Acquisition
A separate set of Right-of-Way plans are required for any project that requires land acquisition or easements. The plans must identify the existing and proposed layout lines, easements, property lines, names of property owners, and the dimensions and areas of estimated takings and easements.

5. Programming (Identification of Funding)
Programming, which typically begins during the design phase, can actually occur at any time during the process, from planning to design. In this step, which is distinct from project initiation, the proponent requests that the MPO place the project in the region's Transportation Improvement Program (TIP). The proponent requesting the project's listing on the TIP can be the community or it can be one of the MPO member agencies (the Regional Planning Agency, MassDOT, and the Regional Transit Authority). The MPO then considers the project in terms of state and regional needs, evaluation criteria, and compliance with the regional Transportation Plan and decides whether to place it in the draft TIP for public review and then in the final TIP.

6. Procurement
Following project design and programming of a highway project, the MassDOT Highway Division publishes a request for proposals. It then reviews the bids and awards the contract to the qualified bidder with the lowest bid.

7. Construction
After a construction contract is awarded, MassDOT Highway Division and the contractor develop a public participation plan and a management plan for the construction process.

8. Project Assessment
The purpose of this step is to receive constituents' comments on the project development process and the project's design elements. MassDOT Highway Division can apply what is learned in this process to future projects.

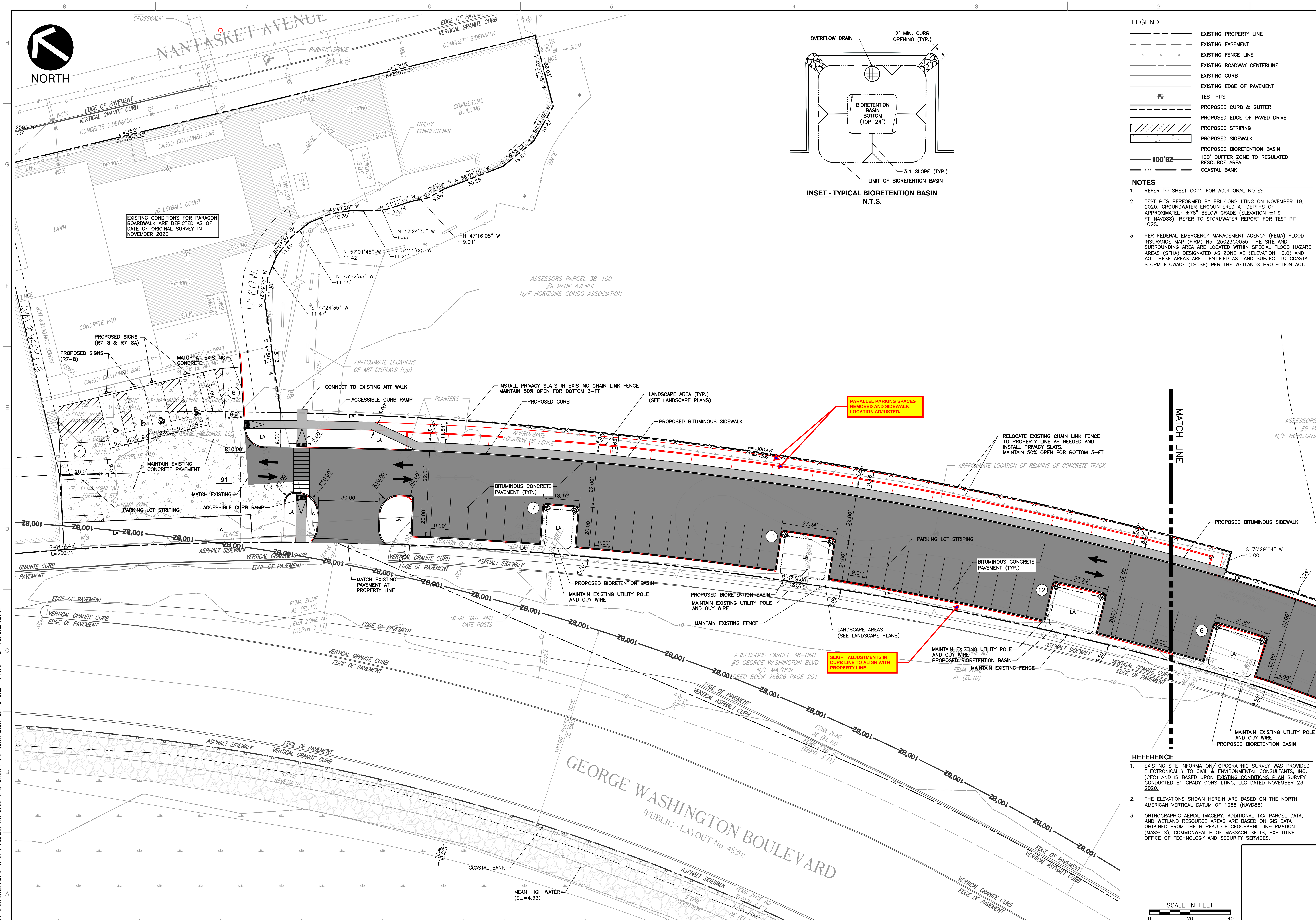
Project Development Schematic Timetable

Description	Schedule Influence	Typical Duration
Step I: Problem/Need/Opportunity Identification The proponent completes a Project Need Form (PNF). This form is then reviewed by the MassDOT District office which provides guidance to the proponent on the subsequent steps of the process.	The Project Need Form has been developed so that it can be prepared quickly by the proponent, including any supporting data that is readily available. The District office shall return comments to the proponent within one month of PNF submission.	1 to 3 months
Step II: Planning Project planning can range from agreement that the problem should be addressed through a clear solution to a detailed analysis of alternatives and their impacts.	For some projects, no planning beyond preparation of the Project Need Form is required. Some projects require a planning study centered on specific project issues associated with the proposed solution or a narrow family of alternatives. More complex projects will likely require a detailed alternatives analysis.	Project Planning Report: 3 to 24+ months
Step III: Project Initiation The proponent prepares and submits a Project Initiation Form (PIF) and a Transportation Evaluation Criteria (TEC) form in this step. The PIF and TEC are informally reviewed by the Metropolitan Planning Organization (MPO) and MassDOT District office, and formally reviewed by the PRC.	The PIF includes refinement of the preliminary information contained in the PNF. Additional information summarizing the results of the planning process, such as the Project Planning Report, are included with the PIF and TEC. The schedule is determined by PRC staff review (dependent on project complexity) and meeting schedule.	1 to 4 months
Step IV: Design, Environmental, and Right of Way The proponent completes the project design. Concurrently, the proponent completes necessary environmental permitting analyses and files applications for permits. Any right of way needed for the project is identified and the acquisition process begins.	The schedule for this step is dependent upon the size of the project and the complexity of the design, permitting, and right-of-way issues. Design review by the MassDOT district and appropriate sections is completed in this step.	3 to 48+ months
Step V: Programming The MPO considers the project in terms of its regional priorities and determines whether or not to include the project in the draft Regional Transportation Improvement Program (TIP) which is then made available for public comment. The TIP includes a project description and funding source.	The schedule for this step is subject to each MPO's programming cycle and meeting schedule. It is also possible that the MPO will not include a project in its Draft TIP based on its review and approval procedures.	3 to 12+ months
Step VI: Procurement The project is advertised for construction and a contract awarded.	Administration of competing projects can influence the advertising schedule.	1 to 12 months
Step VII: Construction The construction process is initiated including public notification and any anticipated public involvement. Construction continues to project completion.	The duration for this step is entirely dependent upon project complexity and phasing.	3 to 60+ months
Step VIII: Project Assessment The construction period is complete and project elements and processes are evaluated on a voluntary basis.	The duration for this step is dependent upon the proponent's approach to this step and any follow-up required.	1 month

Source: MassDOT Highway Division Project Development and Design Guide

APPENDIX E

189 Nantasket Ave. Proposed Site Plan Parking



LEGEND

- EXISTING PROPERTY LINE
- EXISTING EASEMENT
- EXISTING FENCE LINE
- EXISTING ROADWAY CENTERLINE
- EXISTING CURB
- EXISTING EDGE OF PAVEMENT
- TEST PITS
- PROPOSED CURB & GUTTER
- PROPOSED EDGE OF PAVED DRIVE
- PROPOSED STRIPING
- PROPOSED SIDEWALK
- PROPOSED BIORETENTION BASIN
- 100'BZ — 100' BUFFER ZONE TO REGULATED RESOURCE AREA
- COASTAL BANK

NOTES

1. REFER TO SHEET C001 FOR ADDITIONAL NOTES.
2. TEST PITS PERFORMED BY EBI CONSULTING ON NOVEMBER 19, 2020. GROUNDWATER ENCOUNTERED AT DEPTHS OF APPROXIMATELY ±78" BELOW GRADE (ELEVATION ±1.9 FT-NAVD88). REFER TO STORMWATER REPORT FOR TEST PIT LOGS.
3. PER FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA) FLOOD INSURANCE MAP (FIRM) No. 25023C0035, THE SITE AND SURROUNDING AREA ARE LOCATED WITHIN SPECIAL FLOOD HAZARD AREAS (SFHA) DESIGNATED AS ZONE AE (ELEVATION 10.0) AND AO. THESE AREAS ARE IDENTIFIED AS LAND SUBJECT TO COASTAL STORM FLOWAGE (LSCSF) PER THE WETLANDS PROTECTION ACT.

REFERENCE

1. EXISTING SITE INFORMATION/TOPOGRAPHIC SURVEY WAS PROVIDED ELECTRONICALLY TO CIVIL & ENVIRONMENTAL CONSULTANTS, INC. (CEC) AND IS BASED UPON EXISTING CONDITIONS PLAN SURVEY CONDUCTED BY GRADY CONSULTING, LLC DATED NOVEMBER 23, 2020.
2. THE ELEVATIONS SHOWN HEREIN ARE BASED ON THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)
3. ORTHOGRAPHIC AERIAL IMAGERY, ADDITIONAL TAX PARCEL DATA, AND WETLAND RESOURCE AREAS ARE BASED ON GIS DATA OBTAINED FROM THE BUREAU OF GEOGRAPHIC INFORMATION (MASSGIS), COMMONWEALTH OF MASSACHUSETTS, EXECUTIVE OFFICE OF TECHNOLOGY AND SECURITY SERVICES.

REVISION RECORD

NO	DATE	DESCRIPTION
1.	JAN 27, 2022	RESPONSE TO COMMENTS

Civil & Environmental Consultants, Inc.
31 Bellows Road · Raynham, MA 02767
Ph: 774.501.2176 · 866.312.2024 · Fax: 774.501.2669
www.cecinc.com

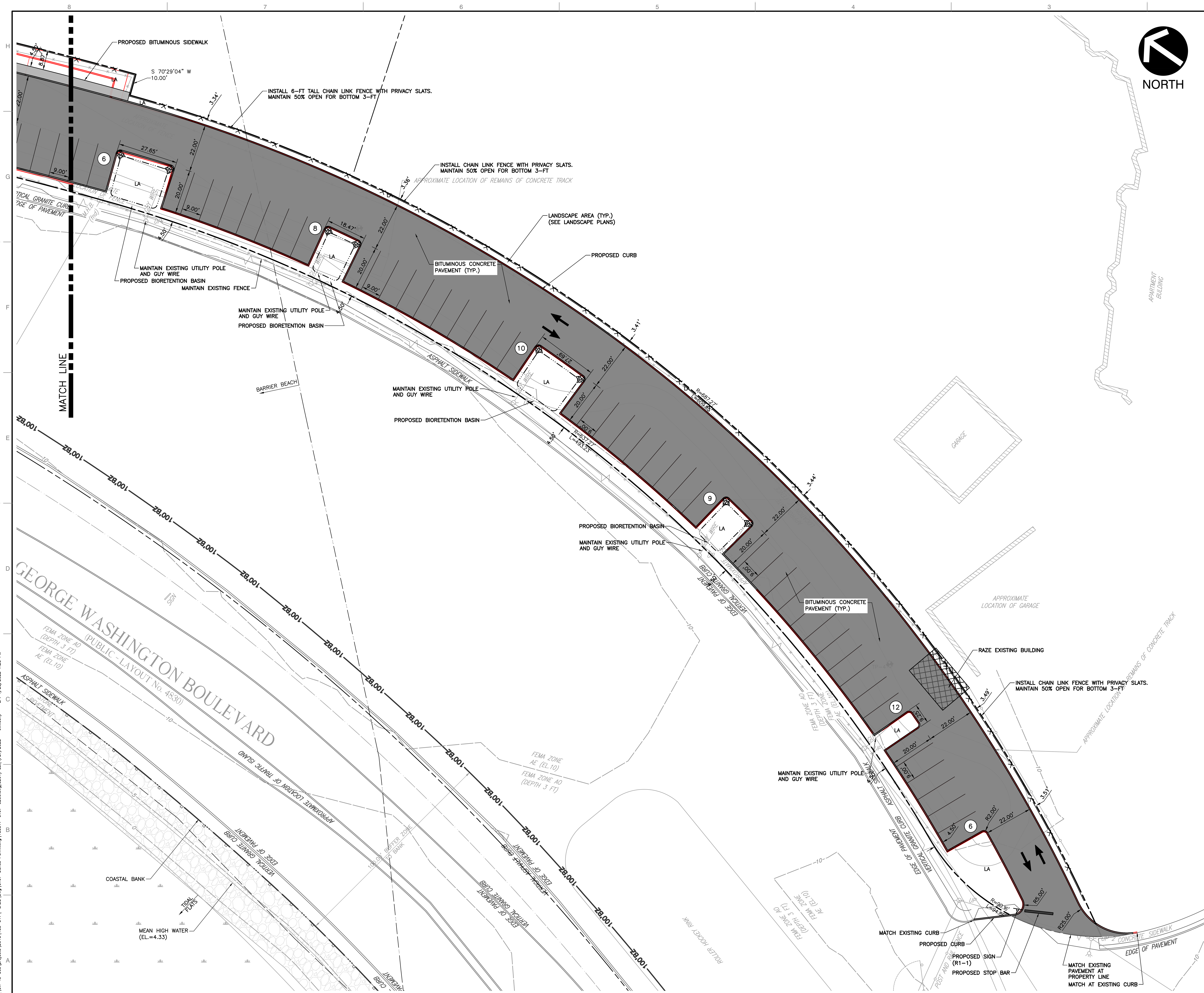
PARKING LOT DEVELOPMENT
189 NANTASKET AVENUE & 0 GEORGE WASHINGTON BOULEVARD
HULL, MASSACHUSETTS

SITE LAYOUT PLAN - NORTH

DATE:	OCTOBER 25, 2021
DRAWN BY:	EMW
DWG SCALE:	1"=20'
CHECKED BY:	KPS
PROJECT NO:	185-317
APPROVED BY:	KPS

DRAWING NO.: C200

SHEET 6 OF 14



LEGEND

- EXISTING PROPERTY LINE
- EXISTING EASEMENT
- EXISTING FENCE LINE
- EXISTING ROADWAY CENTERLINE
- EXISTING CURB
- EXISTING EDGE OF PAVEMENT
- TEST PITS
- PROPOSED CURB & GUTTER
- PROPOSED EDGE OF PAVED DRIVE
- PROPOSED STRIPING
- PROPOSED SIDEWALK
- PROPOSED BIORETENTION BASIN
- 100'BZ — 100' BUFFER ZONE TO REGULATED RESOURCE AREA
- COASTAL BANK

NOTES

1. REFER TO SHEET C001 FOR ADDITIONAL NOTES.
2. TEST PITS PERFORMED BY EBI CONSULTING ON NOVEMBER 19, 2020. GROUNDWATER ENCOUNTERED AT DEPTHS OF APPROXIMATELY ±78" BELOW GRADE (ELEVATION ±1.9 FT–NAVD88). REFER TO STORMWATER REPORT FOR TEST PIT LOGS.
3. PER FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA) FLOOD INSURANCE MAP (FIRM) No. 25023C0035, THE SITE AND SURROUNDING AREA ARE LOCATED WITHIN SPECIAL FLOOD HAZARD AREAS (SFHA) DESIGNATED AS ZONE AE (ELEVATION 10.0) AND AO. THESE AREAS ARE IDENTIFIED AS LAND SUBJECT TO COASTAL STORM FLOWAGE (LSCSF) PER THE WETLANDS PROTECTION ACT.

REFERENCE

1. EXISTING SITE INFORMATION/TOPOGRAPHIC SURVEY WAS PROVIDED ELECTRONICALLY TO CIVIL & ENVIRONMENTAL CONSULTANTS, INC. (CEC) AND IS BASED UPON EXISTING CONDITIONS PLAN SURVEY CONDUCTED BY GRADY CONSULTING, LLC DATED NOVEMBER 23, 2020.
2. THE ELEVATIONS SHOWN HEREIN ARE BASED ON THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)
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REVISION RECORD

NO	DATE	DESCRIPTION
1	JAN 27, 2022	RESPONSE TO COMMENTS

Civil & Environmental Consultants, Inc.
31 Bellows Road · Raynham, MA 02767
Ph: 774.501.2176 · 866.312.2024 · Fax: 774.501.2669
www.cecinc.com

PARKING LOT DEVELOPMENT
189 NANTASKET AVENUE & 0 GEORGE WASHINGTON BOULEVARD
HULL, MASSACHUSETTS

SITE LAYOUT PLAN - SOUTH

DATE:	OCTOBER 25, 2021	DRAWN BY:	EMW
DWG SCALE:	1"=20'	CHECKED BY:	KPS
PROJECT NO:	185-317	APPROVED BY:	KPS

DRAWING NO.: C201

APPENDIX F

HCS Signal Warrant Analysis

HCS Warrants Report

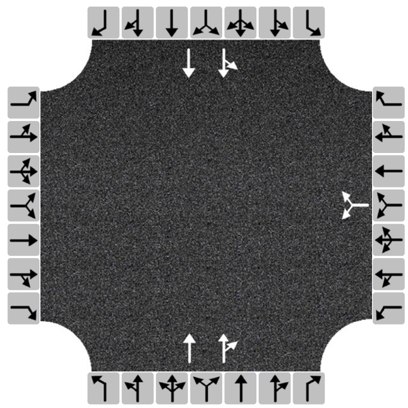
Project Information

Analyst	Julie Dombroski	Date	9/27/2022
Agency	CTPS	Analysis Year	2022
Jurisdiction		Time Period Analyzed	
Project Description			

General

Major Street Direction	North-South	Population < 10,000	No
Starting Time Interval	7	Coordinated Signal System	No
Median Type	Divided	Crashes (crashes/year)	2
Major Street Speed (mi/h)	35	Adequate Trials of Crash Exp. Alt.	No
Nearest Signal (ft)	1565		

Geometry and Traffic



Approach	Eastbound			Westbound			Northbound			Southbound		
Movement	L	T	R	L	T	R	L	T	R	L	T	R
Number of Lanes, N	0	0	0	0	0	0	0	2	0	0	2	0
Lane Usage					LR			TR			LT	
Vehicle Volumes Averages (veh/h)	0	0	0	30	0	28	0	288	40	23	384	0
Pedestrian Averages (peds/h)	0			0			0			0		
Gap Averages (gaps/h)	0			0			0			0		
Delay (s/veh)	0.0			31.2			7.5			2.6		
Delay (veh-hrs)	0.0			0.0			0.0			0.0		

School Crossing and Roadway Network

Number of Students in Highest Hour	0	Two or More Major Routes	No
Number of Adequate Gaps in Period	0	Weekend Counts	No
Number of Minutes in Period	0	5-year Growth Factor (%)	0

Railroad Crossing

Grade Crossing Approach	None	Rail Traffic (trains/day)	4
Highest Volume Hour with Trains	Unknown	High Occupancy Buses (%)	0
Distance to Stop Line (ft)	-	Tractor-Trailer Trucks (%)	10

Volume Summary

Hour	Major Volume	Minor Volume	Total Volume	Peds/h	Gaps/h	1A (100%)	1A (80%)	1B (100%)	1B (80%)	2 (100%)	3A (100%)	3B (80%)	4A (100%)	4B (80%)
07 - 08	539	40	579	0	0	No	No	No	No	No	No	No	No	No
08 - 09	747	61	808	0	0	No	No	No	Yes	No	No	No	No	No
09 - 10	676	100	776	0	0	No	No	No	No	No	No	No	No	No
10 - 11	659	61	720	0	0	No	No	No	No	No	No	No	No	No
11 - 12	658	52	710	0	0	No	No	No	No	No	No	No	No	No
12 - 13	709	63	772	0	0	No	No	No	No	No	No	No	No	No
13 - 14	728	61	789	0	0	No	No	No	Yes	No	No	No	No	No
14 - 15	758	57	815	0	0	No	No	No	No	No	No	No	No	No
15 - 16	821	54	875	0	0	No	No	No	No	No	No	No	No	No
16 - 17	865	62	927	0	0	No	No	No	Yes	No	No	No	No	No
17 - 18	874	50	924	0	0	No	No	No	No	No	No	No	No	No
18 - 19	806	46	852	0	0	No	No	No	No	No	No	No	No	No
Total	8840	707	9547	0	0	0	0	0	3	0	0	0	0	0

Warrants

Warrant 1: Eight-Hour Vehicular Volume	
A. Minimum Vehicular Volumes (Both major approaches --and-- higher minor approach) --or--	
B. Interruption of Continuous Traffic (Both major approaches --and-- higher minor approach) --or--	
80% Vehicular --and-- Interruption Volumes (Both major approaches --and-- higher minor approach)	
Warrant 2: Four-Hour Vehicular Volume	
Four-Hour Vehicular Volume (Both major approaches --and-- higher minor approach)	
Warrant 3: Peak Hour	
A. Peak-Hour Conditions (Minor delay -- and-- minor volume --and-- total volume) --or--	
B. Peak-Hour Vehicular Volumes (Both major approaches --and-- higher minor approach)	
Warrant 4: Pedestrian Volume	
A. Four Hour Volumes --or--	
B. One-Hour Volumes	
Warrant 5: School Crossing	
Gaps Same Period --and--	
Student Volumes	
Nearest Traffic Control Signal (optional)	✓
Warrant 6: Coordinated Signal System	
Degree of Platooning (Predominant direction or both directions)	
Warrant 7: Crash Experience	
A. Adequate trials of alternatives, observance and enforcement failed --and--	
B. Reported crashes susceptible to correction by signal (12-month period) --and--	
C. 80% Volumes for Warrants 1A, 1B, --or-- 4 are satisfied	
Warrant 8: Roadway Network	
A. Weekday Volume (Peak hour total --and-- projected warrants 1, 2, or 3) --or--	
B. Weekend Volume (Five hours total)	
Warrant 9: Grade Crossing	
A. Grade Crossing within 140 ft --and--	
B. Peak-Hour Vehicular Volumes	

APPENDIX G

Letter from the Town of Hull Comments and Concerns

TOWN OF HULL

Community Development and Planning
253 Atlantic Avenue
Hull, Massachusetts 02045

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12.6.22

Julie Dombroski
Transportation Planner
Central Transportation Planning Staff
Boston Region Metropolitan Planning Organization
10 Park Plaza, Suite 2150
Boston, MA 02116

Re: Safety and Operations Analyses at Selected Intersections, FFY 2022-George Washington Boulevard at Rockland Circle in Hull

Ms. Dombroski:

Thank you and the CTPS staff for your efforts in analyzing the intersection at George Washington Boulevard and Rockland Circle, and for the opportunity to comment on the draft Technical Memorandum. The report included many interesting ideas and options. It is understood that this process is still in the early stages of exploring what can be done at that intersection and that the options provided by CTPS could be substantially modified as work progresses. The Town supports the finding that the existing condition and the no-build scenario is not a recommended outcome. Clearly, the current condition doesn't meet the needs and goals of the town or the state in regards to the pedestrian infrastructure in an area that sees heavy pedestrian activity.

The following are the Town's comments on the proposed short and long term improvements outlined in the Technical Memorandum:

Proposed Short Term Improvements:

Install jersey barrier(s) at northern DCR lot egress to prevent or discourage exiting onto George Washington Boulevard.

The elimination of the north bound exit for the DCR lot would need additional study. Delivery access to the property at 189 Nantasket Avenue flows through this area and may be negatively impacted by a closure there. Also, boaters that trailer their boats and put in at Nantasket Pier often times park in this area as it is easy to access and park with a trailer.

Proposed Long Term Improvements:

Northern DCR lot: This intersection is not addressed in the long term improvements. Analysis of a potential new intersection at the northern end of the DCR lot that allows both north and south travel should be provided. Areas for limited trailer parking could be formalized and new pervious, green space installed.

Alternative 1: This shows the original vision for this intersection providing a formal and signalized crosswalk linking the existing sidewalk on Rockland Circle with the sidewalk on GWB. This design provides for basic needs that would improve ADA access, pedestrian movement and safety in this area.

Alternative 2: Construction of a Multi-use Path would be a great addition to the area, provide a safer condition for pedestrians and bicyclists and improve connectivity between Nantasket Beach, the Nantasket MBTA commuter rail station and Hingham Harbor. Concerns relate to the flow of vehicular traffic through the intersection. As we discussed in our meeting this is the main road in and out of Hull. The town and state needs to move emergency vehicles, equipment and snow plows through this intersection under often difficult environmental conditions. Also, this intersection needs to enable the movement of a substantial number of motorists during storm event evacuations, as well as, recreational traffic during the summer months. Additional barriers slowing southbound vehicles would exacerbate existing problems during these events. The reduction in the number of lanes out of town would have to be studied and data provided showing that this lane reduction would not negatively impact vehicular flow at the intersection. If possible, consider keeping two lanes moving out of town and eliminate one northbound lane to create space for the multi-use path.

Specifically for Options 1 and 2:

Option 1: Southbound traffic taking a left onto Rockland Circle could cause considerable backup on GWB. At minimum, a left turn lane should be considered here.

Option 2: Crosswalk should be signalized and possibly shifted further away from the intersection so a driver does not have to address multiple conflicts at the same time. Also, there would probably be space to provide more pedestrian protections with a center island big enough to stop and wait for traffic to pass in the event no signal is installed.

Again, the Town looks forward to working with you further on this project through the next stages of development. It is an intersection that the town feels needs to be addressed and find that the Technical Memorandum represents good initial progress in that direction. We sincerely appreciate all your efforts on this project and look forward to next steps.

Thank you,

Chris DiIorio

Cc: Rebecca Morgan
Philip Lemnios
Jennifer Constable