



BOSTON REGION METROPOLITAN PLANNING ORGANIZATION

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MEMORANDUM

DATE October 4, 2012
TO City of Quincy
FROM Chen-Yuan Wang, MPO Staff
Mark Abbott, MPO Staff
Steven Andrews, MPO Staff
RE Safety and Operations Analyses at Selected Boston Region MPO Intersections, FFY 2012: Southern Artery (Route 3A) at Sea Street/Coddington Street and at McGrath Highway/Field Street in Quincy

Introduction

The two intersections are located in close proximity to each other, with highly correlated traffic flows, and therefore were examined together in this study. They are high-crash and congested locations, and both are on MassDOT's 2007–09 list of high-crash intersection locations.¹ In the three-year period, the intersection of Southern Artery at Sea Street/Coddington Street had 76 crashes (16 of them had caused personal injuries), and the intersection of Southern Artery at McGrath Highway/Field Street had 71 crashes (21 of them had caused personal injuries).

In addition to the high number of crashes, the two intersections were selected for their congested conditions during peak hours, the regional significance of Southern Artery, and their proximity to a major rapid transit station. Furthermore, the two intersections are expected to be impacted by a series of recently planned Quincy Center developments and transportation improvement projects.

This memorandum summarizes safety and operations analyses and proposes improvement strategies for the two intersections. It contains the following sections:

- Existing Conditions
- Issues and Concerns
- Crash Data Analysis
- Intersection Capacity Analysis
- Improvement Alternatives
- Future Conditions Analysis
- Improvement Recommendations

¹ MassDOT's 2007 Top Crash Locations Report, 2008 Top Crash Locations Report, and 2009 Top Crash Locations Report.

The memorandum also includes technical appendices that contain methods and data applied in the study and detailed reports of the intersection capacity analyses.

Existing Conditions

The two intersections are located about a quarter mile northeast of Quincy Center. They are only about 500 feet apart and are surrounded by commercial developments, except for the areas north of Sea Street and Coddington Street, where the Quincy High School playing field and a major cemetery are situated. All the roadways connected to the two intersections are under the City's jurisdiction. All of them function as an urban principal or minor arterial with regional significance, except Field Street, located at the second intersection (McGrath Highway/Field Street), which is a local street.

Southern Artery is the major street that connects the two intersections. It is an urban principal arterial about two miles in length running from Quincy Avenue near the Braintree border to slightly west of Furnace Brook Parkway. Its entire length is designated as state Route 3A, except for its westernmost section of about half a mile from Quincy Avenue to Washington Street (designated as Route 53). Route 3A serves the coastal communities south of Boston and runs parallel to Route 3, the only major freeway in the South Shore area. As Route 3 is usually very congested during peak traffic periods, especially in the vicinity of the Braintree Split (the interchange of Interstate 93 and Route 3), commuters frequently use the Southern Artery as one of their alternative routes for commuting between Boston and the South Shore communities.

Sea Street, an urban minor arterial, runs from its intersection with Coddington Street and Seat Street to Nut Island, serving the neighborhoods along Quincy Bay. About 2,000 feet east of the intersection, Sea Street intersects Quincy Shore Drive, a popular route connecting to Boston and points north via Neponset Bridge. For this reason, it carries a high volume of regional traffic in the section between the study intersection and Quincy Shore Drive.

Coddington Street is a short section of roadway, about half a mile long, running from The Southern Artery (at Sea Street) to Quincy Center and the MBTA (Massachusetts Bay Transportation Authority)'s Quincy Center Station. Although Coddington Street is categorized as an urban principal arterial, it carries much less traffic than Sea Street. Most of the traffic from Route 3A (Southern Artery) heading south to Quincy Center or to the MBTA station usually diverts to Washington Street before this intersection.

McGrath Highway (also known as Mayor Thomas J. McGrath Highway), running from the Southern Artery at Field Street to Washington Street near Quincy Center, is part of the recently constructed Quincy Center Concourse. The Concourse, located on Mayor Hannon Parkway, Revere Road, and McGrath Highway, is a four-lane urban boulevard running from Granite Street, through the southern part of Quincy Center, to Southern Artery. It was created to improve east-west travel across the city, to relieve congestion

at Quincy Center, and to promote economic development along the corridor and at Quincy Center. The significance of the Concourse is increasing because it is near a large-scale downtown redevelopment project that is currently being prepared for implementation by the City.²

The new downtown master plan envisions a mixed-use redevelopment for the area bounded by the MBTA station, Burgin Parkway, Mayor Hannon Parkway, Revere Road, Chestnut Street, Temple Street, and Washington Street. The plan includes the development of a major open space at the northern end of the redevelopment district, to be called Adams Green Park in order to celebrate the historic significance of the city.

The Adams Green project will transform the streets around Quincy Town Hall, City Hall, the Church of the Presidents (United First Parish Church), and the historic burial ground into a lively green civic common. It will close off the section of Hancock Street between Washington Street and Temple Street to vehicular traffic and integrate the section into the park to enhance pedestrian connections to the Quincy Center MBTA station. Thereby, it will also alter the traffic patterns in Quincy Center.

Figure 1 shows the locations of the two intersections, the adjacent roadways, the Concourse, and the proposed Quincy downtown redevelopment area. Based on the traffic forecasts of the proposed developments, the traffic flow from the Concourse, via Southern Artery between the two intersections, to Sea Street north of Southern Artery, or vice versa, is expected to increase gradually in the next 10 years.

Figure 2 shows the two intersections' existing layout and the adjacent developments and land uses. Both intersections are signalized. Their traffic signals are interconnected, but operate independently at present.

At the Sea Street/Coddington Street intersection, the Southern Artery northbound approach has four lanes: a shared left-turn/through lane, an exclusive through lane, and two channelized exclusive right-turn lanes. The channelized right-turn lanes have a storage length of about 200 feet and are signal-controlled. The Southern Artery southbound approach has two lanes: a shared left-turn/through lane and a shared through/right-turn lane. The Coddington Street eastbound approach has two lanes: one left-turn/through lane and one through/right-turn lane. The Sea Street westbound approach has three lanes: an exclusive left-turn lane, a shared left-turn/through lane, and a shared through/right-turn lane. However, due to the high proportion of left-turning traffic, the shared left-turn/through lane operates like an exclusive left-turn lane. The shared through/right-turn lane is short (about 225 feet in length) and directs its right-turning traffic to a channelized lane about 75 feet before the approach's stop line.

² Adams Green Transportation Improvements Functional Design Report, Howard/Stein-Hudson Associates, Inc., April 2012.

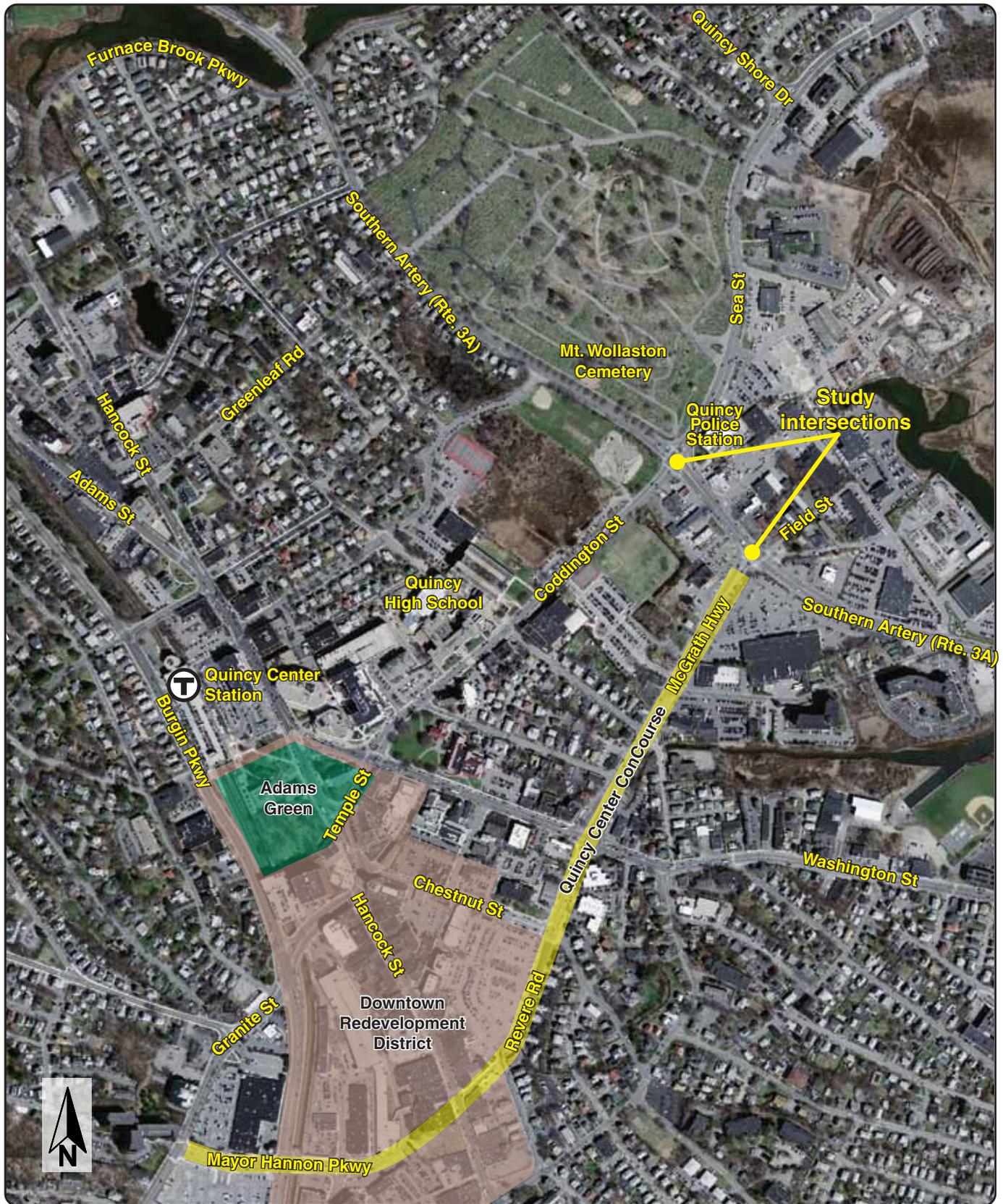
No on-street parking is allowed on any of the approaches at the intersection. There are sidewalks on both sides of all approaches, and crosswalks across all of the approaches. The two right-turn channelized islands are used as pedestrian refuge areas between crosswalks. Pedestrian signal push buttons are located at all the corners of the intersection and at the two channelized islands facing the crosswalks. The intersection traffic signal provides an exclusive pedestrian signal phase of 24 seconds, when any of the buttons is activated. The pedestrian signal is not equipped with a countdown or accessible (audible) function.

Curb-cut ramps are installed at both ends of most of the crosswalks. However, there are no curb-cut ramps at the ends of the crosswalk between the two traffic islands on Sea Street, and there are no curb-cut ramps at the westbound traffic island for the crosswalks across the westbound right-turn lane and across Southern Artery. None of the ramps are equipped with tactile warning strips. Most of them are too narrow and some of them are too steep. These appear not to be in compliance with ADA (Americans with Disabilities Act) standards. Pedestrians using the crosswalks approaching the two traffic islands run the risk of walking into mast arm poles or pedestrian signal poles.

With multiple travel lanes on Southern Artery and Sea Street, the intersection is relatively wide. Traffic signal heads, pedestrian signals, and route/destination guide signs appear to have been added to the intersection over the years and lack consistency and integration. These many signs and indications within the intersection can be confusing for drivers. Figure 3 shows various route and destination signs and signal indications within the intersection of Southern Artery at Sea Street/Coddington Street.

There is a mast arm for each approach of the intersection. Generally, a traffic signal head should be placed over its intended travel lane and preferably be suspended from a mast arm. At this intersection, only the signal head of the leftmost lane is hung from the mast arm on each approach. The signal head for the lane next to the inside lane is mounted on the mast arm pole, which is too low, not over its lane, and difficult for drivers to see when they are approaching the intersection. Figure 4 shows two signals—one mounted on a mast arm and one on the mast arm pole—at the intersection of Southern Artery at Sea Street/Coddington Street. The mast arms were probably installed when the intersection had a layout smaller than the existing one, and the mast arms are probably not strong enough to hold more than one signal head.

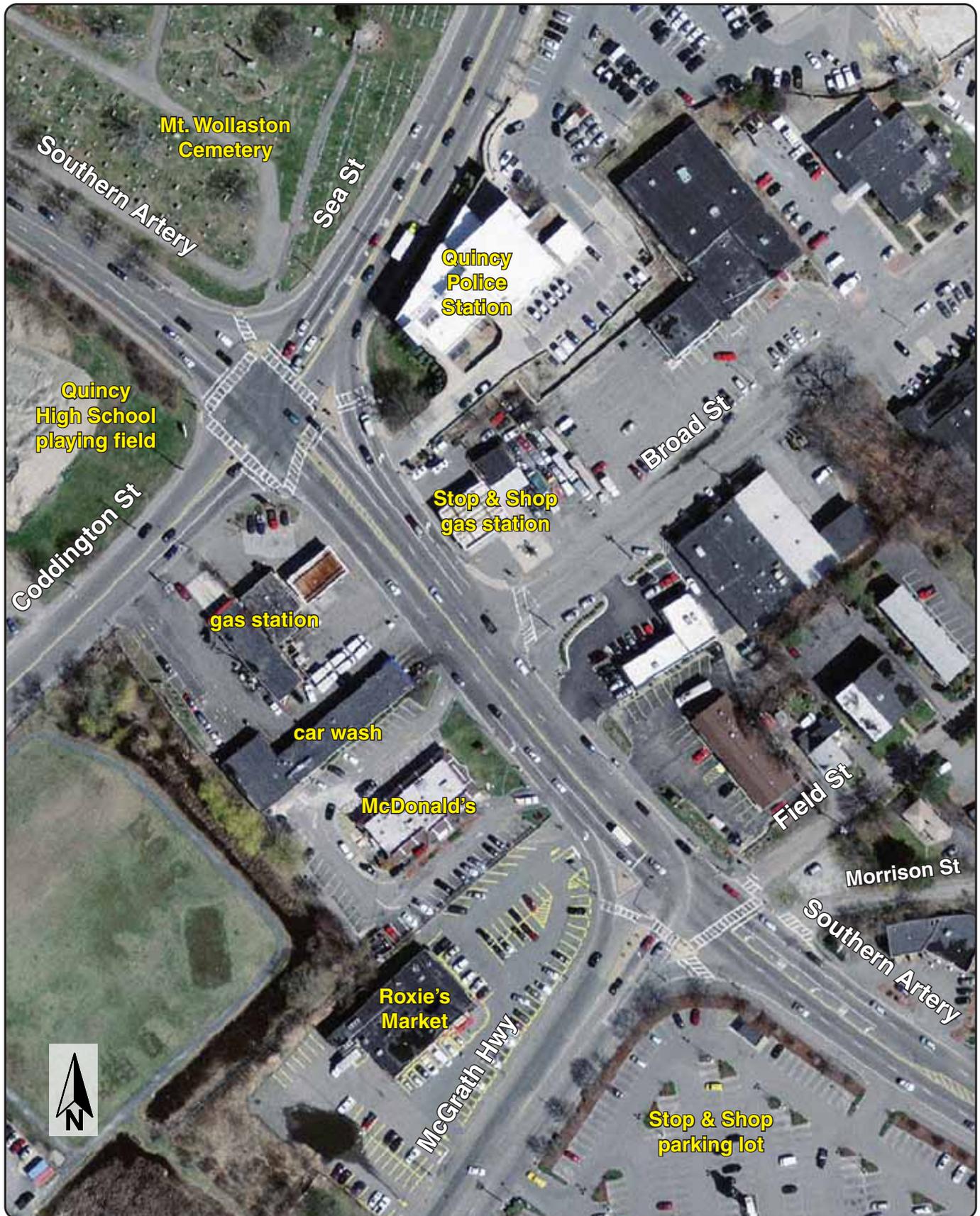
At the McGrath Highway/Field Street intersection, the Southern Artery northbound approach has three lanes: an exclusive left-turn lane about 225 feet long, an exclusive through lane, and a shared through/right-turn lane. The Southern Artery southbound approach has three lanes: a shared left-turn/through lane, an exclusive through lane, and an exclusive channelized right-turn lane. The McGrath Highway eastbound approach has three lanes: an exclusive left-turn lane, a shared left-turn/through lane, and a channelized exclusive right-turn lane about 200 feet long. The Field Street westbound approach has only one lane, which is shared by all movements. In addition, a private road, Morrison Street, joins Southern Artery at the northeast corner of the



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FIGURE 1
Intersection Locations, Adjacent Roadways,
and Quincy Center Developments

*Safety and Operations
 Analyses at
 Selected Intersections*



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FIGURE 2
Intersection Layout

*Safety and Operations
Analyses at
Selected Intersections*

intersection (see Figure 2). It carries very little traffic, and therefore does not usually affect the intersection's traffic operations during peak hours.

No on-street parking is allowed on any of the approaches at the intersection. There are sidewalks on both sides of all approaches except the Field Street approach, and crosswalks across all of the approaches except the Southern Artery southbound approach. The City reconstructed the crosswalks across McGrath Highway about a year ago. Curb-cut ramps with sufficient width are installed at both ends of all the crosswalks, including those at the two traffic islands. The ramps also are equipped with warning tactile strips.

Pedestrian crossings at this intersection are operated concurrently with traffic flows. The crossing on Southern Artery is concurrent with the McGrath Highway traffic phase, and the crossing on McGrath Highway is concurrent with the Southern Artery approach. The pedestrian signals for the crossing on Southern Artery are equipped with a countdown feature.

The surrounding areas are a mix of commercial developments, institutional land use, and open space. The commercial developments are located mainly on Southern Artery south of the intersection of Southern Artery at Sea Street/Coddington Street. There are many driveways on Southern Artery between the two intersections. Broad Street, located between the two intersections, is a local road that serves some commercial and office buildings. Although Southern Artery is striped with double yellow center lines, left turns from Broad Street are not clearly prohibited. Drivers do make the turns at times, but crash data collected for this study do not indicate that there are a high number of crashes at this location.

Pedestrian activity is at medium to high levels at the two intersections. Based on the peak-period counts that staff performed in April 2012, the two intersections carried about 25 to 45 pedestrians per hour during the two peak hours (one in the AM and one in the PM). The counts also indicated that there were about three to five bicycles at each of the two intersections during both the AM peak hour and during the PM peak hour. The percentage of heavy vehicles is moderate, at 1% to 2% of the total entry traffic at the two intersections, during peak hours.

Massachusetts Bay Transportation Authority bus Route 214 (Germantown – Quincy Center) and Route 216 (Houghs Neck – Quincy Center) runs on Sea Street and Coddington Street through the intersections: six outbound and six inbound trips during the AM peak hour and four inbound and four outbound trips during the PM peak hour. There are no bus stops immediately adjacent to either of the two intersections.

FIGURE 3
Various Route/Destination Signs and Signal Indications within the Intersection:
Southern Artery at Sea Street/Coddington Street



FIGURE 4
A Signal Head Mounted on a Mast Arm Pole:
Southern Artery at Sea Street/Coddington Street



Issues and Concerns

Based on field observations and the available crash and traffic data, the issues and concerns for the intersection can be summarized as:

- High number of crashes and high crash rate at the two intersections
- Traffic congestion at the two intersections during the peak hours, especially in the PM peak hour
- Extensive traffic queues and delays on Sea Street and on the Southern Artery southbound approach at the Coddington Street/Sea Street intersection in the PM peak hour
- Substandard crosswalks, some of which lack wheelchair curb-cuts, at the Coddington Street/Sea Street intersection
- Improper route/destination signs located in the middle of the Coddington Street/Sea Street intersection
- Unfitting signal indications at the Coddington Street/Sea Street intersection
- No bicycle travel accommodation at either intersection
- No accessible pedestrian signals at either intersection
- Dense commercial section between the two intersection, with multiple driveway entry and exit points

Crash Data Analysis

Based on MassDOT's Registry of Motor Vehicles Division crash data for 2005 to 2009, Table 1, a summary of MassDOT crash data for 2005 through 2009 for the intersection of Southern Artery at Sea Street/Coddington Street, shows that, on average, about 29 crashes occurred at the intersection of Southern Artery at Sea Street and Coddington Street each year. Slightly over 20% of the crashes resulted in personal injuries, and nearly 80% of the total crashes involved property damage only or unknown severity of injuries. None of the crashes caused a fatality. The crash types consist of about 35% rear-end collisions, 34% angle collisions, 19% sideswipe collisions, 5% single-vehicle collisions, and 2% head-on collisions. One crash involved a pedestrian, and one crash involved a bicyclist. About 35% of the total crashes occurred during peak periods. About 26% of the total crashes happened when the roadway pavement was wet or icy. Approximately 22% of the crashes occurred in dark conditions (dawn, dusk, and nighttime).

Crash rates are another effective metric for examining the relative safety of a particular location.³ Based on the 2005 to 2009 crash data and the recently-collected traffic

³ Crash rates are calculated based on crash frequency (crashes per year) and vehicle exposure (traffic volumes or miles traveled). Crash rates are expressed as "crashes

volume data, the calculated crash rate for this intersection is was 2.31 crashes per million entering vehicles (see Appendix A for the calculation). This crash rate is about three times the average rate for signalized intersections in MassDOT Highway Division District 6 (in which the intersections are located), reported by MassDOT to be 0.77 crashes per million entering vehicles.⁴

Staff also collected crash reports from the Quincy Police Department (QPD) for 42 reported crashes that occurred during the period April 2009 to April 2012. From the reports, staff constructed a collision diagram for the intersection (see Figure B-1, in Appendix B). The collision diagram shows that many rear-end crashes occurred on the Southern Artery northbound approach. More significant is that seven rear-end collisions occurred in the right-turn bay to Sea Street from Southern Artery in the three-year period. The right-turn bay is controlled by a stop light and right-turn-on-red is prohibited. A few drivers failed to stop at the red light, and ran into the vehicles that had done so. In addition, the signal indication for the right turns can be confusing. The right-turn movement is overlapped with the westbound left-turn movement. It shows a red ball and a green arrow simultaneously during the overlapped phase. Drivers who are not familiar with the operation can be confused and don't know if they should stop or should go. Hesitation at the approach could cause them to be rear ended.

Although most of the crashes on the northbound approach were related to the congested conditions on the multiple travel lanes, some were related to police vehicles exiting from the adjacent police station. An emergency exit driveway from the station is located near the northeast corner of the intersection about 30 feet from the northbound stop line. When a police vehicle exited and crossed four to six lanes of traffic in an emergency, vehicles on the approach near the intersection had little time and space to respond. This operation affects not only the northbound traffic, but also the southbound traffic. The rear-end collision involved two southbound vehicles on the approach related to a police car's heading to McGrath Highway from the driveway, and there was one crash on the approach related to a police vehicle turning into the driveway.

Another significant collision type was angle collisions between vehicles turning left from Southern Artery southbound with vehicles passing through the intersection heading northbound on Southern Artery. There were seven such crashes in the three-year

per million entering vehicles” for intersection locations and as “crashes per million miles traveled” for roadway segments.

⁴ The average crash rates calculated by the MassDOT Highway Division are based on a database that contains intersection crash rates submitted to MassDOT as part of the review process for an Environmental Impact Report or Functional Design Report. The most recent average crash rates, which are updated on a nearly annual basis, are based on all entries in the database, not just those entries made within the past year. The average crash rate for District 6 was calculated on July 7, 2011.

period. The left-turn movement is operated under a protected/permissive phase, as it shares a lane with the through movement. Such settings can be confusing to some left-turning drivers because they may think that they have the right-of-way when the green ball is on (even though the green left-turn arrow is off) and proceed without yielding to the opposite through traffic. However, a review of the crash reports indicated that most of the crashes were caused by aggressive driving by the left-turning drivers during congested traffic conditions. In contrast, there was only one crash that involved a vehicle turning left from the Southern Artery northbound approach with a vehicle heading south on Southern Artery, as there were many fewer left turns in the northbound approach than in the southbound approach.

Two crashes involved a bicyclist. Both were in part due to improper driving on the bicyclist's part. One occurred at the northbound right-turn bay. In this crash, the bicyclist started to ride his bicycle on the crosswalk across the right-turn bay when the light for the right turns was red. Soon the light turned green and a vehicle clipped the bicyclist. The other crash occurred on Southern Artery north of the intersection, when a bicyclist rode the wrong way on the northbound side heading south and a vehicle heading north hit the bicyclist with its mirror.

There were no crashes involving pedestrians in the police crash reports. However, the MassDOT crash data show that there was a crash in 2007 involving a pedestrian and a crash in 2005 involving a bicyclist.

Based on the MassDOT crash data, Table 2 shows that the intersection of Southern Artery at McGrath Highway/Field Street had an average of 20 crashes each year from 2005 to 2009. Most of the crashes (61%) involved property damage only. The crash types consisted of 36% rear-end collisions, 38% angle collisions, 10% sideswipe collisions, 10% single-vehicle collisions, 4% head-on collisions, and 2% unknown. About a quarter of the crashes occurred during a weekday peak period. About 20% of the crashes occurred on wet or icy pavement. Nearly 30% of the crashes occurred in dark conditions. There were six crashes involving a pedestrian and two crashes involving a bicyclist in the five-year period.

The calculated crash rate at the intersection was 1.47 crashes per million entering vehicles (see Appendix A for the calculation). It is lower than the intersection of Southern Artery at Sea Street/Coddington Street (2.31 crashes per million entering vehicles), but is higher than the average crash rate of District 6 signalized intersections (0.77 crashes per million entering vehicles).

The QPD provided 17 crash reports for this intersection for the three-year period between April 2009 and April 2012 for this study. Based on the reports, staff constructed a collision diagram for analysis (see Figure B-2, in Appendix B for the collision diagram). It should be noted that among the 17 reported crashes, 4 occurred at or near the Stop & Shop driveway on McGrath Highway rather than at the intersection.

In general, there are no prevailing collision patterns at this intersection. There were four crashes related to vehicles turning left from McGrath Highway onto Southern Artery. Two of them involved a left-turn vehicle from McGrath Highway colliding with a vehicle headed south on Southern Artery. Crash reports do not indicate that the crashes are related to signal timing (one crash was due to glare from sunlight and the other was in large part due to an aggressive maneuver). One involved a vehicle turning left from McGrath Highway colliding with a vehicle headed north on Southern Artery. Both operators claimed that they had a green light. The other crash involved a vehicle on the outside lane of McGrath Highway that turned left at too sharp an angle and hit a vehicle on the inside lane.

There were two crashes involving a vehicle turning left from Southern Artery onto McGrath Highway colliding with a vehicle heading south on Southern Artery. Crash reports indicate that both crashes relate to the turning vehicle's driver in choosing an unsafe traffic gap on Southern Artery. The Southern Artery northbound left turns are currently operated under a permissive operation. Since the approach has an exclusive lane for the left turns, it would be safer to operate the movement under a protected or a protected/permissive phase.

On Southern Artery, one crash occurred at the driveway of McDonald's and another one occurred just before the driveway of Roxie's Market. It is difficult for vehicles to get in and out of the driveways during peak hours, when right-turning traffic on the Southern Artery southbound approach is heavy.

There were no crashes involving pedestrians in the 2009–12 crash reports. The MassDOT 2005–09 crash data show that there were six crashes involving a pedestrian and two crashes involving a bicyclist in the five-year early period. As mentioned, the City reconstructed the pedestrian facilities and replaced mast arms and signal heads at this intersection about two years ago. It is possible that the replacement of traffic equipment has improved the safety of the users at this intersection, especially the pedestrians.

TABLE 1
Summary of MassDOT Crash Data 2005–09:
Southern Artery at Sea Street/Coddington Street, Quincy

Statistics Period		2005	2006	2007	2008	2009	5-Yr. Total	Annual Avg.
Total number of crashes		23	28	31	31	31	144	28.8
Severity	Property damage only	12	20	23	23	24	102	20.4
	Non-fatal injury	5	7	6	7	6	31	6.2
	Fatality	0	0	0	0	0	0	0.0
	Not reported/unknown	6	1	2	1	1	11	2.2
Collision type	Single vehicle	1	0	1	3	2	7	1.4
	Rear-end	10	7	9	8	16	50	10.0
	Angle	5	15	11	12	6	49	9.8
	Sideswipe, same direction	4	3	8	5	5	25	5.0
	Sideswipe, opposite direction	1	1	0	1	0	3	0.6
	Head-on	0	1	1	1	0	3	0.6
	Rear-to-rear	0	0	0	0	1	1	0.2
	Not reported/unknown	2	1	1	1	1	6	1.2
Involved pedestrian(s)		0	0	1	0	0	1	0.2
Involved cyclist(s)		1	0	0	0	0	1	0.2
Occurred during weekday peak periods		7	7	12	12	13	51	10.2
Wet or icy pavement conditions		6	7	9	9	7	38	7.6
Dark conditions (lit or unlit)		3	8	5	8	8	32	6.4

TABLE 2
Summary of MassDOT Crash Data 2005–09:
Southern Artery at McGrath Highway/Field Street, Quincy

Statistics Period		2005	2006	2007	2008	2009	5-Yr. Total	Annual Avg.
Total number of crashes		24	22	15	21	18	100	20.0
Severity	Property damage only	15	12	8	16	10	61	12.2
	Non-fatal injury	5	9	5	5	8	32	6.4
	Fatality	0	0	0	0	0	0	0.0
	Not reported/unknown	4	1	2	0	0	7	1.4
Collision type	Single vehicle	1	1	2	3	3	10	2.0
	Rear-end	11	7	4	9	5	36	7.2
	Angle	11	11	3	6	7	38	7.6
	Sideswipe, same direction	1	0	2	1	2	6	1.2
	Sideswipe, opposite direction	0	1	1	1	1	4	0.8
	Head-on	0	1	2	1	0	4	0.8
	Not reported/unknown	0	1	1	0	0	2	0.4
Involved pedestrian(s)		0	1	2	1	2	6	1.2
Involved cyclist(s)		0	0	1	1	0	2	0.4
Occurred during weekday peak periods		7	7	4	3	5	26	5.2
Wet or icy pavement conditions		4	3	4	5	5	21	4.2
Dark conditions (lit or unlit)		6	7	3	4	7	27	5.4

Intersection Capacity Analysis

Staff collected turning- movement counts at the two intersections on two individual midweek days in April 2012. The data were recorded in 15-minute intervals during peak traffic periods in the morning, from 7:00 to 9:00, and in the evening, from 4:00 to 6:00. Meanwhile, 24-hour automatic traffic recorder (ATR) counts at locations near the two intersections for three consecutive midweek days were collected by the MassDOT Highway Division in the week beginning March 11, 2012 (see Appendix C for the ATR counts, summarized by hours of the day). Based on the 24-hour traffic counts, the turning- movement counts at the two intersections were adjusted and balanced.

Figure 5 shows the estimated vehicular turning-movement counts and the observed bicycle movements and pedestrian crossings in the AM peak hour (7:30–8:30) at the two intersections. In the AM peak hour, the intersection of Southern Artery at Sea Street/Coddington Street carried about 4,000 vehicles, five bicycles, and 25 pedestrians. The intersection of Southern Artery at McGrath Highway/Field Street carried about 3,120 vehicles, three bicycles, and 40 pedestrians.

Figure 6 shows the estimated vehicular turning-movement counts and the observed bicycles movements and pedestrian crossings in the PM peak hour (5:00–6:00) at the two intersections. In the AM peak hour, the intersection of Southern Artery at Sea Street/Coddington Street carried about 4,000 vehicles, three bicycles, and 45 pedestrians. The intersection of Southern Artery at McGrath Highway/Field Street carried about 3,350 vehicles, two bicycles, and 35 pedestrians.

Based on the turning-movement counts and the signal timings measured on the site, staff analyzed the intersection capacity by using an intersection capacity analysis program, Synchro.⁵ Both intersections were modeled as actuated and uncoordinated signals. The first intersection has a cycle length of about 150 seconds in both peak periods; it consists of a lead/lag left-turn protected/permissive phase on the Southern Artery approaches, a split phase on the Sea Street/Coddington Street approach, and an on-call 24-second exclusive pedestrian phase. The second intersection has a cycle length of 100 seconds in the AM peak period and 90 seconds in the PM peak period; it consists of a permissive phase for all movements on Southern Artery and a split phase on McGrath Highway/Field Street. Pedestrian phases are operated concurrently with the Southern Artery approach or the McGrath Highway northbound approach.

The Synchro analyses indicate that the intersection of Southern Artery at Sea Street/Coddington Street operates at an acceptable level of service (LOS) D in the AM peak hour; it operates at a less desirable LOS E in the PM peak hour, with the

⁵ Synchro Version 8 was used for these analyses. This software is developed and distributed by Trafficware Ltd. It can perform capacity analysis and traffic simulation (when combined with SimTraffic) for an individual intersection or a series of intersections.

southbound and westbound approaches enduring extensive delays. The intersection of Southern Artery at McGrath Highway/Field Street operates at LOS B during both peak hours. The AM and PM peak-hour analyses for the existing conditions are summarized in Table 3.

The analyses show that the estimated 95th percentile queues on Southern Artery between the two intersections would not spill back into each other.⁶ In general, the analyses are consistent with field observations for both peak hours. Detailed HCM (Highway Capacity Manual) signalized intersection capacity analysis reports for both intersections are included in Appendix D.

Improvement Alternatives

The two intersections are located in a built-up commercial area and each has a fairly large layout, especially the intersection at Sea Street/Coddington Street. Because the area is so built up, staff developed four improvement alternatives that do not involve major geometry modifications. They are analyzed below, progressing from simple to more involved options.

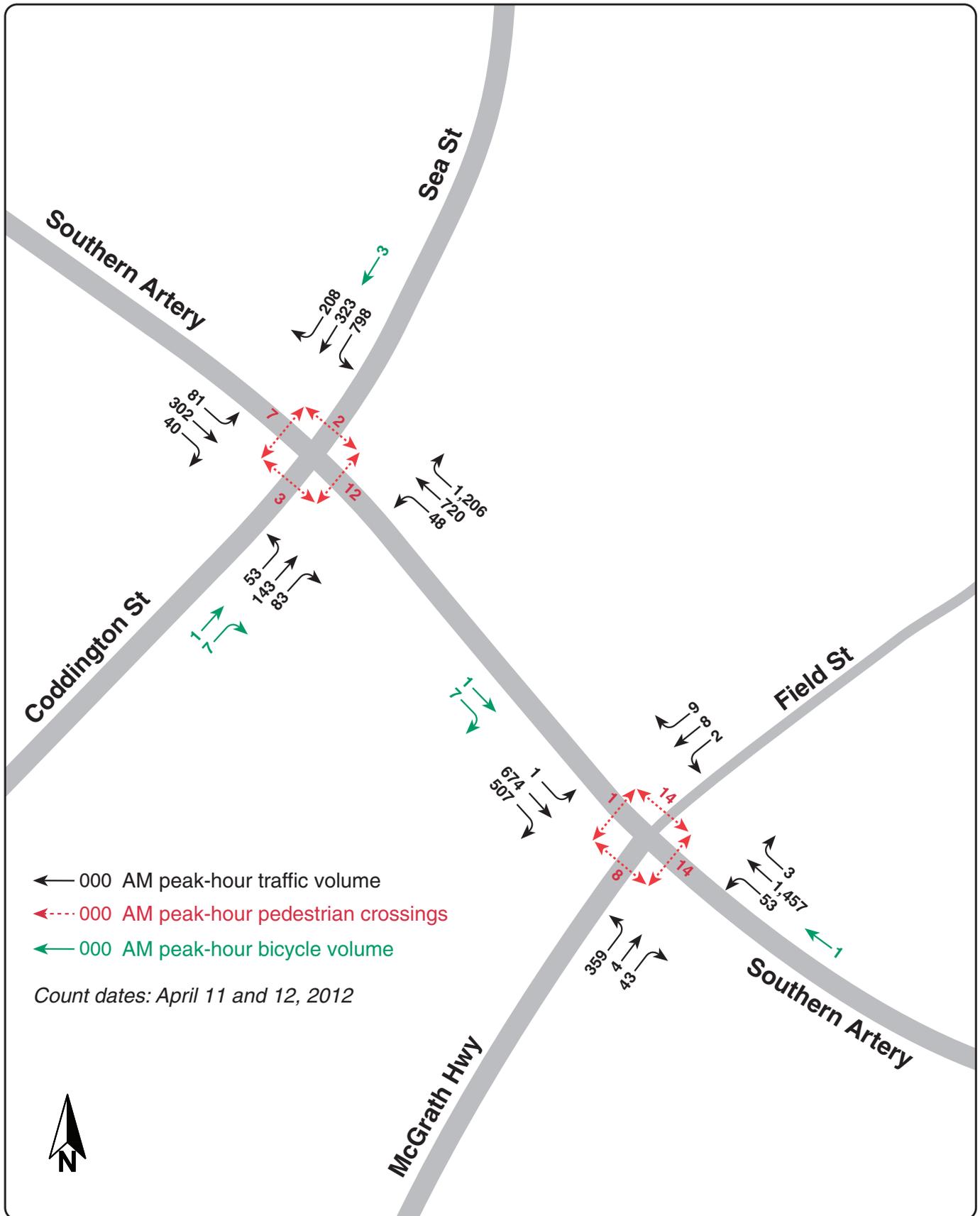
Alternative 1: Signal Timing Optimization

- Retain the existing geometry at both intersections
- Retain the existing signal phasing at the intersection of Southern Artery at Sea Street/Coddington Street
- Add a protected/permitted phase for the Southern Artery northbound left turns for the intersection of Southern Artery at McGrath Highway/Field Street
- Optimize the signal timings and phasing at both intersections

Alternative 2: Signal Coordination

- Retain the existing geometry at both intersections
- Use the same signal phasing as in Alternative 1
- Coordinate the signals for Southern Artery northbound in the AM peak hour and southbound in PM peak hour

⁶ The 95th-percentile queue is defined to be the queue length (25 feet per vehicle) that has only a 5% probability of being exceeded during the analysis time period. It is a useful parameter for determining the appropriate length of turn pockets, but it is not typical of what an average driver would experience. It can be regarded as the potential maximum queue length under the input traffic conditions.



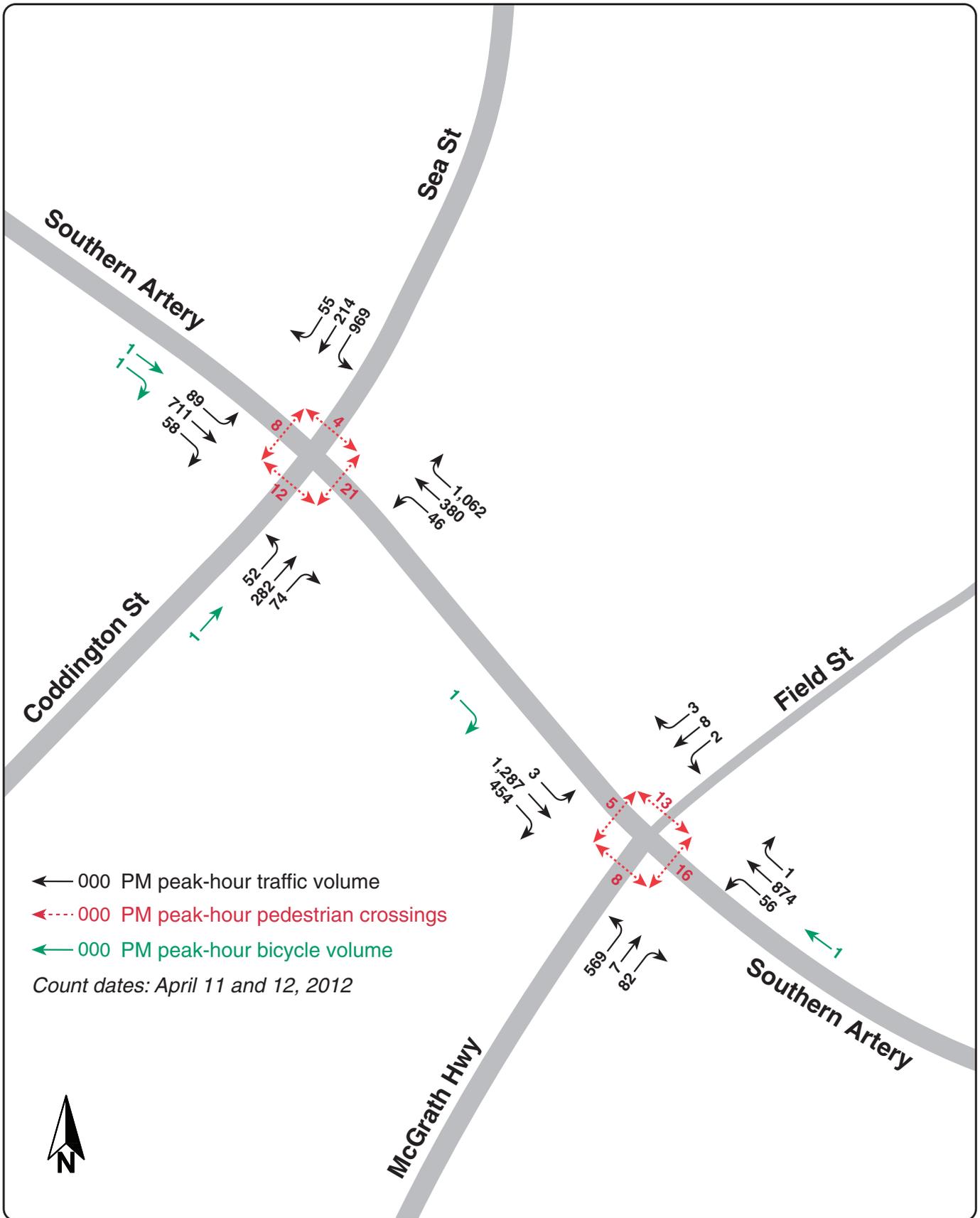


TABLE 3
Intersection Analysis – 2012 Existing Conditions

Intersection/ Approach	Lane	AM Peak Hour			PM Peak Hour		
		LOS	Delay ¹	Q ³	LOS	Delay ¹	Q ³
<i>Southern Artery at Sea St./Coddington St.</i>							
Southern Artery – SB	LTR	C	33.8	255	F	87.1	#623
Southern Artery – NB	LT	D	37.3	#476	D	37.1	248
	R	B	14.4	294	B	16.9	232
Coddington St. – EB	LTR	D	53.8	178	E	61.2	#269
Sea St. – WB	L	E	77.9	#778	F	130.8	#856
	LTR	E	61.1	#658	D	51.7	#516
Overall		D	41.0	-	E	59.1	-
<i>Southern Artery at McGrath Highway/Field</i>							
Southern Artery – SB	LT	A	8.7	166	B	15.9	410
	R	A	8.5	45	A	9.8	59
Southern Artery – NB	L	A	7.5	38	B	16.1	#89
McGrath Highway – EB	L	C	27.6	191	C	30.7	#294
	LT	C	27.1	188	C	30.0	#289
	R	C	22.5	29	C	20.3	40
Field St – WB	LTR	C	34.7	29	D	38.3	24
	TR	B	14.3	482	B	11.0	224
Overall		B	13.8	-	B	16.5	-

¹ Delay in seconds per vehicle.

² V/C is the volume-to-capacity ratio.

³ 95th percentile queue in feet.

95th percentile volume exceeds capacity, queue may be longer.

Alternative 3: Modifying Left-Turn Lanes on the Southern Artery Approaches at the Intersection of Southern Artery at Sea Street/Coddington Street

- Retain the existing geometry at the intersection of Southern Artery at McGrath Highway/Field Street.
- Use same signal phasing as in Alternative 1 at the intersection of Southern Artery at McGrath Highway/Field Street.
- Convert the shared left-turn/through lane on the Southern Artery northbound approach to a dedicated left-turn lane at the intersection of Southern Artery at Sea Street/Coddington Street.
- Add a dedicated left-turn lane to the Southern Artery southbound approach at the intersection of Southern Artery at Sea Street/Coddington Street. Provide the new left-turn lane with protected/permissive phasing.
- Optimize the signal timings.

Alternative 4: Adding a Left-Turn Lane on the Southern Artery Southbound Approach at the intersection of Southern Artery at Sea Street/Coddington Street

- Retain the existing geometry at the intersection of Southern Artery at McGrath Highway/Field Street
- Use same signal phasing as in Alternative 1 at the intersection of Southern Artery at McGrath Highway/Field Street
- Add a dedicate left-turn lane to the Southern Artery southbound approach at the intersection of Southern Artery at Sea Street/Coddington Street
- Provide the new left-turn lane with protected/permissive phasing
- Optimize the signal timings

In summary, Alternative 1 was developed to examine both signals to find out if they could be optimized under the existing intersection layout and signal sequencing. Alternative 2 was developed to assess whether signal coordination could improve the traffic operations at the two intersections. Alternative 3 was developed to reduce conflicts between left turns and opposite through traffic on Southern Artery. Alternative 4 was developed to improve both the safety and capacity of Southern Artery.

Due to the anticipated developments in the downtown area, the four improvement alternatives were also examined using projected future traffic conditions. The future year used in the analyses was 2022, a 10-year horizon commonly used for intersection operations analysis. Staff developed the projection based on historical traffic counts in

the area and information gathered from the functional design report of Adam Green Transportation Improvements.⁷

Figures 7 and 8 show the year 2022 projected vehicular turning movements, bicycle movements, and pedestrian crossings at the two intersections in the AM and PM peak hours, respectively. Overall, traffic at the intersection of Southern Artery at Sea Street/Coddington Street is projected to grow by 6.5% in the AM peak hour and 9.0% in the PM peak hour. Traffic at the intersection of Southern Artery at McGrath Highway/Field Street is projected to grow by 9.0% in the AM peak hour and 11.5% in the PM peak hour. Traffic on McGrath Highway is expected to grow by 15.0% to 20.0% in the peak hours.

Future Conditions Analysis

A future no-build alternative was also analyzed, using the projected traffic conditions. It was developed to examine the impact of the traffic growth using the existing layout and signal timings as the baseline for evaluating the various proposed alternatives. Tables 4 and 5 summarize the intersection capacity analyses for the no-build scenario and the four alternatives using the projected 2022 traffic conditions for the AM peak hour. Tables 6 and 7 summarize the 2022 PM peak-hour analyses for the various alternatives. Detailed HCM signalized intersection capacity analysis reports for the 2022 no-build scenario and Alternatives 1 to 4 are included in Appendices E to I. The analysis results for the various alternatives are discussed below.

2022 No-Build Scenario

The 2022 analyses show that traffic operations in the AM peak hour at the intersection of Southern Artery at Sea Street/Coddington Street would remain at LOS D, with minor delay increases on all approaches except the Sea Street approach. That approach would deteriorate from LOS E to LOS F, with a noticeable delay increase. In the PM peak hour, traffic operations at the intersection would deteriorate from LOS E to LOS F, with noticeable delay increases on almost all of the approaches.

At the intersection of Southern Artery at McGrath Highway/Field Street, traffic operations in the AM peak hour would remain at LOS B, with minor delay increases on all of the approaches. Traffic operations in the PM peak hour would deteriorate from LOS B to LOS C, with noticeable delay increases on almost all of the approaches. Although this intersection has higher projected traffic growth than the other intersection, it would still operate at an acceptable LOS of C or better.

⁷ Howard/Stein-Hudson Associates Inc., Adams Green Transportation Improvements Functional Design Report, April 2012.

Alternative 1: Signal Timing Optimization

The analyses show that traffic operations in the peak hours at the intersection of Southern Artery at Sea Street/Coddington Street could be improved somewhat by signal timing optimization. Traffic operations in the PM peak hour would improve from LOS F to LOS E, with a reduction of overall delay by about 10 seconds per vehicle. Synchro optimization indicates that a slightly shorter cycle length, 145 seconds (which is less than the existing 150 seconds), including the exclusive on-call pedestrian phase with the current phasing sequence, would work for both the AM and PM peak hours.

At the intersection of Southern Artery at McGrath Highway/Field Street, traffic operations in both peak hours would maintain at the acceptable LOS of C or better, with either a minor delay increase or decrease on each approach. This alternative proposes to add a left-turn protected/permissive phase on the Southern Artery northbound approach that would reduce the conflicts between the left turns and their opposite through traffic on Southern Artery and would improve safety for drivers, pedestrians, and bicyclists at the intersection. The analyses show that the additional phase would not worsen the overall intersection traffic operations.

Alternative 2: Signal Coordination

Signal coordination between the two intersections is a possibility. However, it comes with high impacts to the LOS of the side streets. Sea Street, Coddington Street, and McGrath Highway traffic delays and queues increase as a result of the coordination.

Although the coordination is not favored in terms of the overall traffic operation, it could expedite traffic flow on certain approaches. In the AM peak hour, the coordination would allow most traffic from the Southern Artery northbound approach and the McGrath Highway westbound approach to travel freely through the intersections. In the PM peak hour, some traffic from the Southern Artery southbound approach and Sea Street could pass through the intersections without stopping. The Analyses indicate that a half signal cycle at the McGrath Highway intersection would operate efficiently for the coordination system in the AM peak hour.

One significant reason for keeping the two intersections interconnected and ready for coordination is to prevent queuing traffic spilling over to each other should spillback begin to occur. The City should regularly monitor the queuing conditions in the section and coordinated the two signals if necessary.

Alternative 3: Modifying Left-Turn Lanes on the Southern Artery Approaches at the Intersection of Southern Artery at Sea Street/Coddington Street

Converting the northbound left-turn/through shared lane to a dedicated left-turn lane and adding a southbound left-turn lane (by using the northbound inside departure lane) on Southern Artery would significantly improve traffic operations at the intersection in

the PM peak hour. However, it would cause serious deterioration of traffic operations at the intersection in the AM peak hour, when the northbound through traffic is heavy. Being reduced to one-lane capacity, the northbound through movement operations would deteriorate from LOS D to LOS F, with delay increasing to more than four minutes per vehicle. Its traffic queue would likely spill back through the intersection of Southern Artery at /McGrath Highway/Field Street and would also block the right turns to Sea Street.

Alternative 4: Adding a Left-Turn Lane on the Southern Artery Southbound Approach at the Intersection of Southern Artery at Sea Street/Coddington Street

This alternative would maintain the same LOS (D) as Alternatives 1 and 2 in the AM peak hour, with similar delays at the approaches. However, it would significantly improve the PM peak hour traffic operations, to LOS E from LOS F (in the 2022 no-build scenario), with a reduction of about half a minute average delay per vehicle. Meanwhile, it would potentially reduce the conflicts between the southbound left turns and their opposite through traffic and improve traffic safety on Southern Artery.

The lane addition would likely require some land takings on the Southern Artery southbound approach. Based on the estimation of 95th-percentile queues in both peak hours, a storage length of 150 feet should be sufficient for the projected left turns. The MassDOT Roadway Inventory File indicates that the roadway currently has a surface width of 46 feet and a right-of-way width of 70 feet. It appears that it would be necessary to take an area about 10 feet wide and 200 feet long from the Quincy High School playing field to add a lane.

In summary, the above analyses indicate that Alternative 4 is the preferred option, as it would significantly improve the PM traffic operations at the intersection of Southern Artery at Sea Street/Coddington Street and improve traffic safety on the Southern Artery approaches. If the southbound left-turn lane cannot be added because of land taking issues, Alternative 1 or Alternative 2 could be implemented to partially accommodate future traffic growth. Alternative 3 is not recommended, as it would cause significant deterioration of traffic operations at both intersections in the AM peak period.

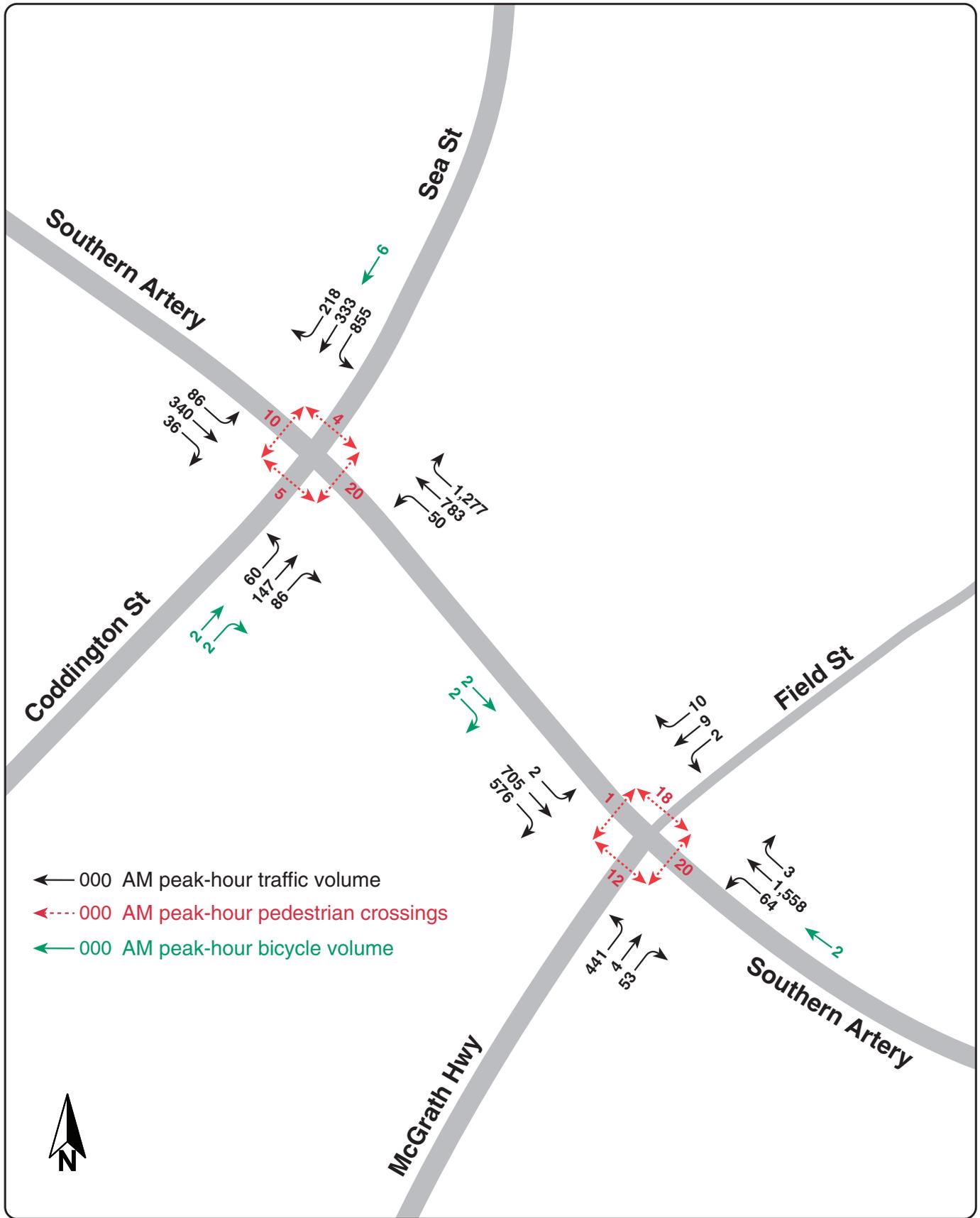
Improvement Recommendations

Staff performed a series of safety and operations analyses to identify geometry design and operational deficiencies at these two intersections. In general, the analyses found that the congestion and most of the crashes were caused by heavy peak-period traffic and significant commercial and commuting activities in the vicinity.

In addition, staff tested four improvement alternatives for the two intersections using the projected traffic conditions for the year 2022. Staff developed the projections based on

historical traffic counts in the area and the information related to the Quincy Center development and transportation improvement projects. The four alternatives are:

- Signal timing optimization
- Signal coordination
- Modifying left-turn lanes on the Southern Artery approaches at the intersection of Southern Artery at Sea Street/Coddington Street
- Adding a left-turn lane on the Southern Artery southbound approach at the intersection of Southern Artery at Sea Street/Coddington Street.



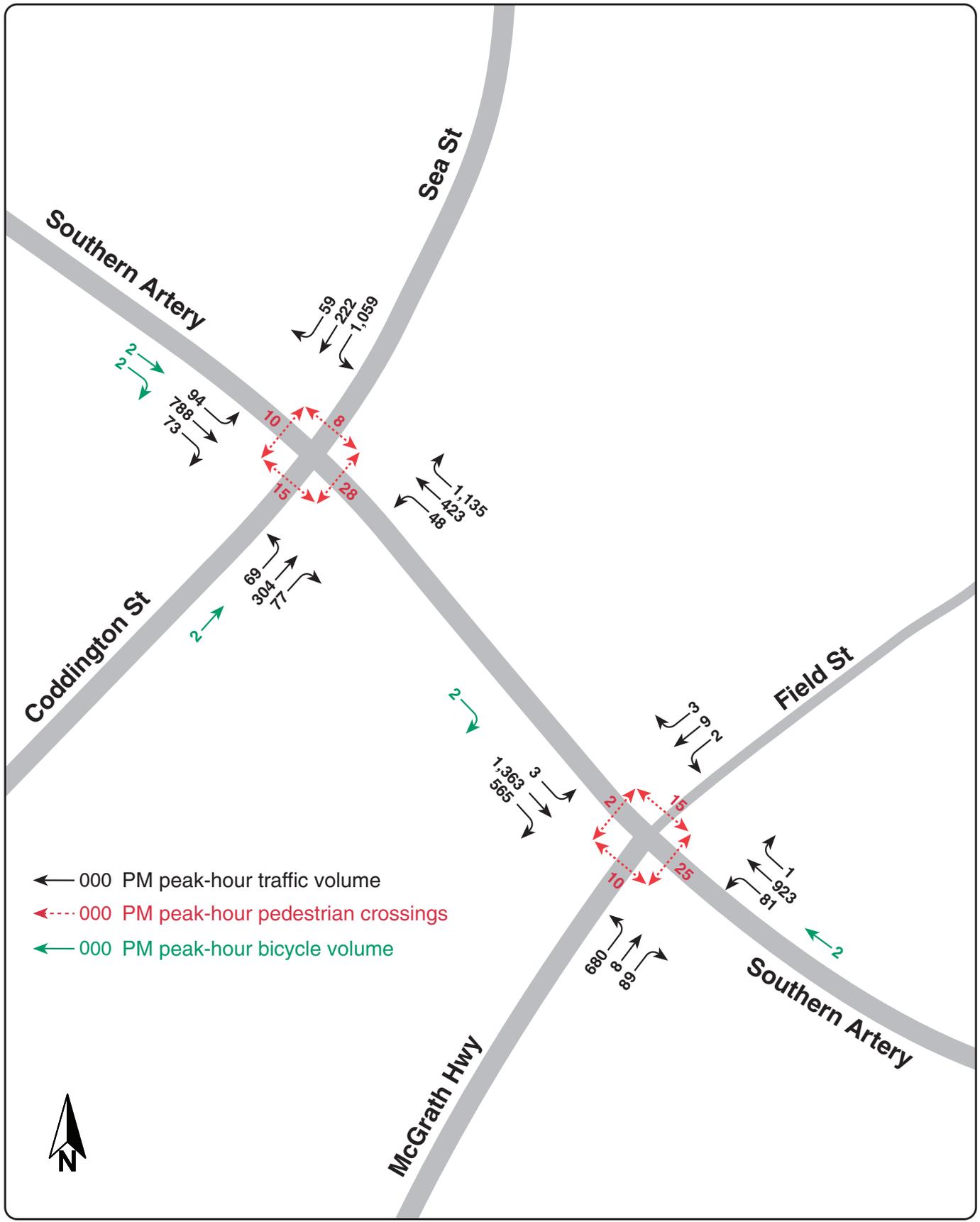


FIGURE 8
Vehicle and Bicycle Volumes and Pedestrian Crossings
2022 PM Peak Hour

TABLE 4
Intersection Capacity Analysis – 2022 AM Peak Hour:
No-Build Scenario and Alternatives 1 and 2

Intersection/ Approach	Lane	2022 No-Build			2022 Alternative 1			2022 Alternative 2		
		LOS	Delay ¹	Q ³	LOS	Delay ¹	Q ³	LOS	Delay ¹	Q ³
<i>Southern Artery at Sea St./Coddington St.</i>										
Southern Artery – SB	LTR	D	37.4	#313	D	45.8	#326	D	35.4	288
Southern Artery – NB	LT	D	42.1	#442	D	54.4	#570	C	33.4	#532
	R	B	16.0	331	B	14.7	302	A	9.6	139
Coddington St. – EB	LTR	E	55.2	187	E	65.0	#231	F	92.1	#241
Sea St. – WB	L	F	97.7	#831	E	62.2	#759	F	101.1	#792
	LTR	F	81.7	#718	D	51.3	#643	F	84.8	#671
Overall		D	49.5	-	D	42.5	-	D	49.3	-
<i>Southern Artery at McGrath Highway/Field SSt.</i>										
Southern Artery – SB	LT	A	9.4	176	A	9.1	170	B	15.8	115
	R	A	9.5	47	A	9.0	51	D	50.2	129
Southern Artery – NB	L	A	8.2	45	A	7.9	45	A	8.6	38
	TR	B	17.2	546	B	17.5	#577	C	20.1	#576
McGrath Highway – EB	L	C	31.4	230	C	32.1	186	C	31.2	158
	LT	C	31.8	234	C	32.8	189	C	31.7	161
	R	C	23.6	32	C	22.1	28	C	22.3	24
Field St – WB	LTR	D	37.8	31	C	33.5	27	C	33.4	24
Overall		B	16.2	-	B	16.3	-	C	25.6	-

¹ Delay in seconds per vehicle.

² V/C is the volume-to-capacity ratio.

³ 95th percentile queues in feet.

95th percentile volume exceeds capacity, queue may be longer.

TABLE 5
Intersection Capacity Analysis – 2022 AM Peak Hour:
No-Build Scenario and Alternatives 3 and 4

Intersection/ Approach	Lane	2022 No-Build			2022 Alternative 3			2022 Alternative 4		
		LOS	Delay ¹	Q ³	LOS	Delay ¹	Q ³	LOS	Delay ¹	Q ³
<i>Southern Artery at Sea St./Coddington St.</i>										
Southern Artery – SB	L				F	88.9	#187	E	61.1	152
	TR	D	37.4	#313	D	45.5	241	C	29.4	193
Southern Artery – NB	L	D	42.1	#442	C	24.5	64	E	62.0	606
	T				F	257.9	#1718			
	R	B	16.0	331	B	16.6	308	C	21.1	414
Coddington St. – EB	LTR	E	55.2	187	E	78.6	#254	E	77.6	#254
Sea St. – WB	L	F	97.7	#831	F	254.0	#968	F	86.5	#830
	LTR	F	81.7	#718	F	240.0	#851	E	71.0	#709
Overall		D	49.5	-	F	151.4	-	D	52.6	-
<i>Southern Artery at McGrath Highway/Field SSt.</i>										
Southern Artery – SB	LT	A	9.4	176						
	R	A	9.5	47						
Southern Artery – NB	L	A	8.2	45						
	TR	B	17.2	546						
McGrath Highway – EB	L	C	31.4	230	<i>Same as Alt. 1</i>			<i>Same as Alt. 1</i>		
	LT	C	31.8	234						
	R	C	23.6	32						
Field St – WB	LTR	D	37.8	31						
Overall		B	16.2	-						

¹ Delay in seconds per vehicle.

² V/C is the volume-to-capacity ratio.

³ 95th percentile queues in feet.

95th percentile volume exceeds capacity, queue may be longer.

TABLE 6
Intersection Capacity Analysis – 2022 PM Peak Hour:
No-Build Scenario and Alternatives 1 and 2

Intersection/ Approach	Lane	2022 No-Build			2022 Alternative 1			2022 Alternative 2		
		LOS	Delay ¹	Q ³	LOS	Delay ¹	Q ³	LOS	Delay ¹	Q ³
<i>Southern Artery at Sea St./Coddington St.</i>										
Southern Artery – SB	LTR	F	162.5	#738	F	110.0	#703	D	54.0	#654
Southern Artery – NB	LT	D	44.9	#309	D	37.7	275	C	27.6	233
	R	B	19.8	260	B	16.4	240	B	11.5	288
Coddington St. – EB	LTR	E	60.8	#317	F	107.3	#367	F	115.6	#394
Sea St. – WB	L	F	184.8	#954	F	174.0	#952	F	273.2	#1013
	LTR	E	66.5	#580	E	62.5	#575	F	118.3	#626
Overall		F	86.8	-	E	76.4	-	F	85.1	-
<i>Southern Artery at McGrath Highway/Field SSt.</i>										
Southern Artery – SB	LT	B	16.7	452	C	28.5	#570	B	18.6	#287
	R	B	11.0	89	B	15.0	151	B	18.2	102
Southern Artery – NB	L	E	65.1	#140	B	17.8	#42	C	22.0	#71
	TR	B	11.5	241	B	11.1	228	B	14.2	323
McGrath Highway – EB	L	D	49.3	#382	D	54.8	#405	E	73.7	#495
	LT	D	46.4	#372	D	51.5	#395	E	70.2	#481
	R	C	24.0	49	C	24.4	52	D	41.4	81
Field St – WB	LTR	D	46.4	25	D	46.3	25	E	70.0	34
Overall		C	21.6	-	C	26.4	-	C	28.1	-

¹ Delay in seconds per vehicle.

² V/C is the volume-to-capacity ratio.

³ 95th percentile queues in feet.

95th percentile volume exceeds capacity, queue may be longer.

TABLE 7
Intersection Capacity Analysis – 2022 AM Peak Hour:
No-Build Scenario and Alternatives 3 and 4

Intersection/ Approach	Lane	2022 No-Build			2022 Alternative 3			2022 Alternative 4		
		LOS	Delay ¹	Q ³	LOS	Delay ¹	Q ³	LOS	Delay ¹	Q ³
<i>Southern Artery at Sea St./Coddington St.</i>										
Southern Artery – SB	L	F	162.5	#738	F	105.4	#326	D	40.2	118
	TR				E	67.1		D	47.3	516
Southern Artery – NB	L	D	44.9	#309	D	43.6	#570	E	69.0	#368
	T				E	72.7				
	R	B	19.8	260	C	21.8	302	C	22.1	318
Coddington St. – EB	LTR	E	60.8	#317	F	144.1	#231	F	117.2	#388
Sea St. – WB	L	F	184.8	#954	F	107.5	#759	F	104.1	#928
	LTR	E	66.5	#580	D	47.1	#643	D	46.0	510
Overall		F	86.8	-	E	65.5	-	E	56.8	-
<i>Southern Artery at McGrath Highway/Field St.</i>										
Southern Artery – SB	LT	B	16.7	452						
	R	B	11.0	89						
Southern Artery – NB	L	E	65.1	#140						
	TR	B	11.5	241						
McGrath Highway – EB	L	D	49.3	#382	<i>Same as Alt. 1</i>			<i>Same as Alt. 1</i>		
	LT	D	46.4	#372						
	R	C	24.0	49						
Field St – WB	LTR	D	46.4	25						
Overall		C	21.6	-						

¹ Delay in seconds per vehicle.

² V/C is the volume-to-capacity ratio.

³ 95th percentile queues in feet.

95th percentile volume exceeds capacity, queue may be longer.

Analysis of the alternatives indicates that Alternative 4 is the preferred option, as it would significantly improve the PM traffic operations at the intersection of Southern Artery at Sea Street/Coddington Street and improve safety for all users at the intersection. If a southbound left-turn lane cannot be added because of land taking issues, Alternative 1 or Alternative 2 could be implemented to partially accommodate future traffic growth. Alternative 3 is not recommended, as it would cause deterioration of traffic operations at both intersections in the AM peak period.

Also, for the short term, staff propose the following measures to improve operations and safety for all users at the two intersections and the adjacent roadways. They are mostly low-cost measures that could be implemented in a relatively short time:

- Retime traffic signals at the two intersections (Alternative 1). The retiming includes adding a protected/permissive phase for the Southern Artery northbound left turns at the intersection of Southern Artery at McGrath Highway/Field Street.⁸
- Continue monitoring traffic queues on Southern Artery between the two intersections. If the queues affect traffic operations at either of the intersections, signal coordination of the two intersections (Alternative 2) should be implemented.
- Remove the red ball indication and display only the right-turn arrow indication during the overlapping phase for the right turns at the intersection of Southern Artery at Sea Street/Coddington Street.
- Relocate all the route and destination guide signs from the middle of the intersection of Southern Artery at Sea Street/Coddington Street to appropriate roadside locations, about 100 to 200 feet before the intersection.
- Realign the crosswalks connected to the two traffic islands at the intersection of Southern Artery at Sea Street/Coddington Street so that they do not run into the poles⁹ on the islands; and install ADA (Americans with Disabilities Act) compliant curb-cut ramps on traffic islands that have connecting crosswalks and that currently lack ramps.
- Install a “Turning Vehicles Yield to Pedestrians” regulatory sign (R10-15 (see Figure 9) about 50 feet before the crosswalk on the right-turn bays of the intersection of Southern Artery at McGrath Highway/Field Street.
- Ensure that pavement markings such as crosswalks, stop lines, yellow center lines, and white shoulder lines are well maintained and clearly visible to delineate the travel path of vehicles at the two intersections.

⁸ The addition would require replacing the existing signal head for the lane with a four- or five-section signal head, including a flashing yellow indication.

⁹ Some poles on the traffic islands are for the route/destination guide signs. They should be removed when the signs are relocated.

FIGURE 9
“Turning Vehicles Yield to Pedestrians” Sign



* A fluorescent yellow-green background color may be used instead of yellow for this sign.

Source: Federal Highway Administration, *Manual on Uniform Traffic Control Devices*, 2009 Edition.

There are a number of driveways on Southern Artery between and near the two intersections. In order to reduce potential crashes on Southern Artery and enhance the continuity of pedestrian flow, a few access management measures should be considered by the City and the nearby businesses. These measures include:

- Clearly define a right-in-only entry and a right-out-only exit driveway for the gas station at the southwest corner of the intersection of Southern Artery at McGrath Highway/Field Street.
- Make the Maxie’s Market driveway a right-in-only entry. It would prevent the dangerous left-turn exits from the driveway. The market also has a driveway on McGrath Highway, which could provide access to destinations in all directions.
- Close off the driveway for the commercial building at the southeast corner of the intersection of Southern Artery at Broad Street. All vehicles entering or exiting from the building can use Broad Street. Another option would be to narrow the driveway and make it a right-in-only entry, if the close-off is not favored.
- Relocate Morrison Street away from the functional area of the intersection of Southern Artery at McGrath Highway/Field Street. The area southeast of the intersection has a significant possibility of being redeveloped in the near future. At that time, Morrison Street should be relocated to at least 150 feet from the intersection.

For the long term, staff propose the following measures to further improve operations and safety at the two intersections and the adjacent roadways:

- Implement Alternative 4: adding a left-turn lane on the Southern Artery southbound approach at the intersection of Southern Artery at Sea Street/Coddington Street.

- Reconstruct the intersection of Southern Artery at Sea Street/Coddington Street. The reconstruction should include the following items.
 - Install new mast arms and signal heads on all approaches.
 - Reconstruct all of the crosswalk curb-cut ramps at the intersection to comply with ADA standards.
 - Install new accessible pedestrian signals with countdown features.
 - Incorporate a preemption function for the signal for police vehicles exiting from the police station.¹⁰
- Install an exclusive bicycle lane on both directions of Coddington Street and designate the outside lane of all of the approaches of the two intersections as a shared (with motor vehicles) bicycle lane. The bicycle lanes on Coddington Street should connect to the planned bicycle lanes in the new roadways surrounding the Adams Green Park.

The reconstruction of the intersection would be a much needed safety improvement for the intersection; even if the addition of the southbound left-turn lane is not feasible due to land taking issues, safety would be increased. At this preliminary planning stage, the reconstruction (without adding the lane) is estimated to be roughly \$750,000 to \$1,000,000.

CW/cw

¹⁰ The preemption plan should include the installation of an emergency-vehicle exiting flashing beacon at the police station driveway with an “Emergency Signal Ahead” (W11-12P) supplemental plaque placed about 200 feet before the driveway. The preemption should be designed to clear the vehicles near the driveway and stop vehicles at all approaches.

APPENDIX A

Intersection Crash Rate

Calculation Worksheet 1

Southern Artery at Sea Street/Coddington Street, Quincy

Calculation Worksheet 2

Southern Artery at McGrath Highway/Field Street, Quincy

APPENDIX B

Intersection Collision Diagram

Figure B-1

Southern Artery at Sea Street/Coddington Street, Quincy

Figure B-2

Southern Artery at McGrath Highway/Field Street, Quincy

Table B-1

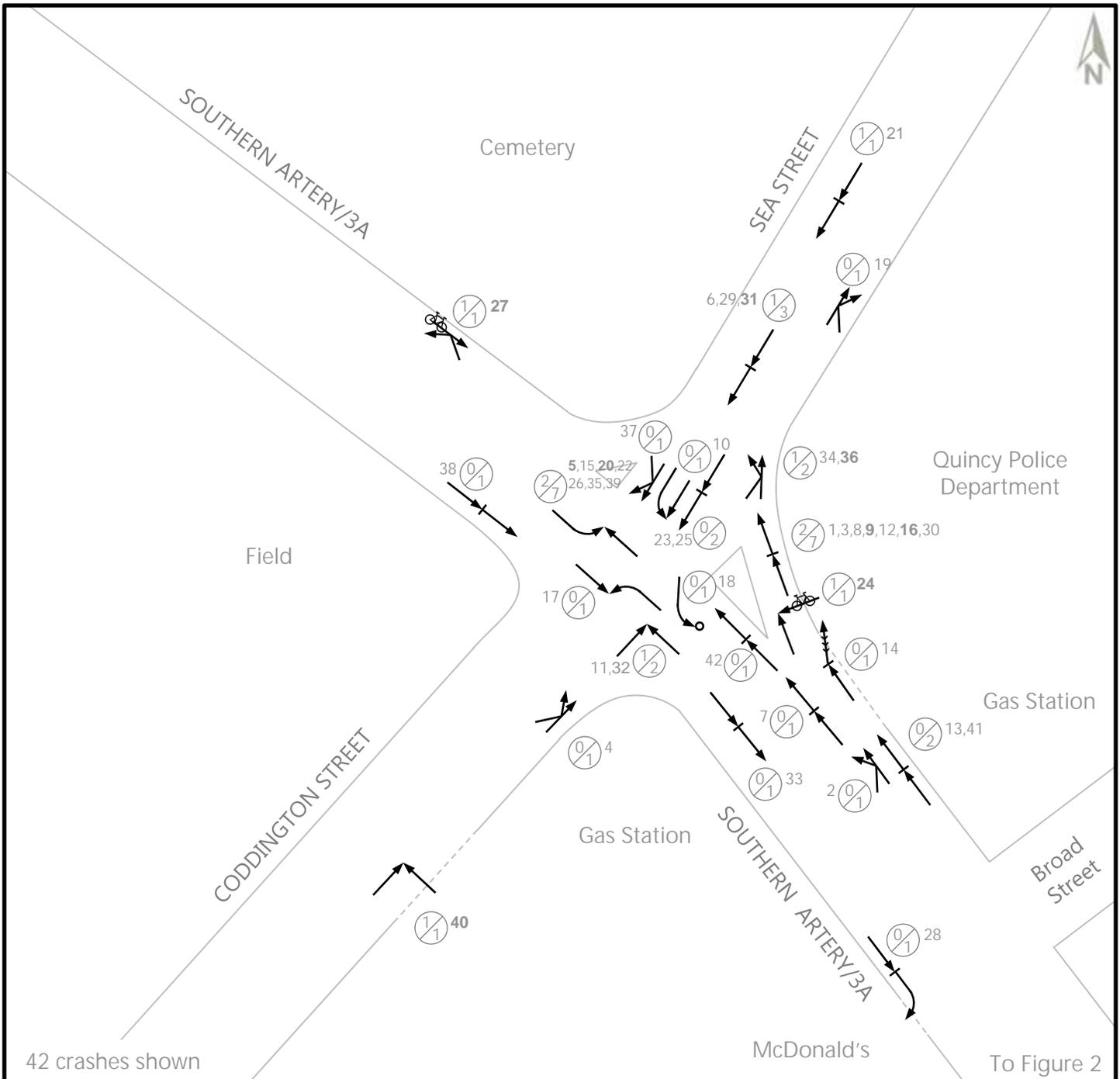
Summary of Crash Reports April 2009–April 2012
Southern Artery at Sea Street/Coddington Street, Quincy

Table B-2

Summary of Crash Reports April 2009–April 2012
Southern Artery at McGrath Highway/Field Street, Quincy

FIGURE B-1

Collision Diagram: Southern Artery/Route 3A at Sea Street, Quincy: April 2009 – April 2012



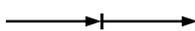
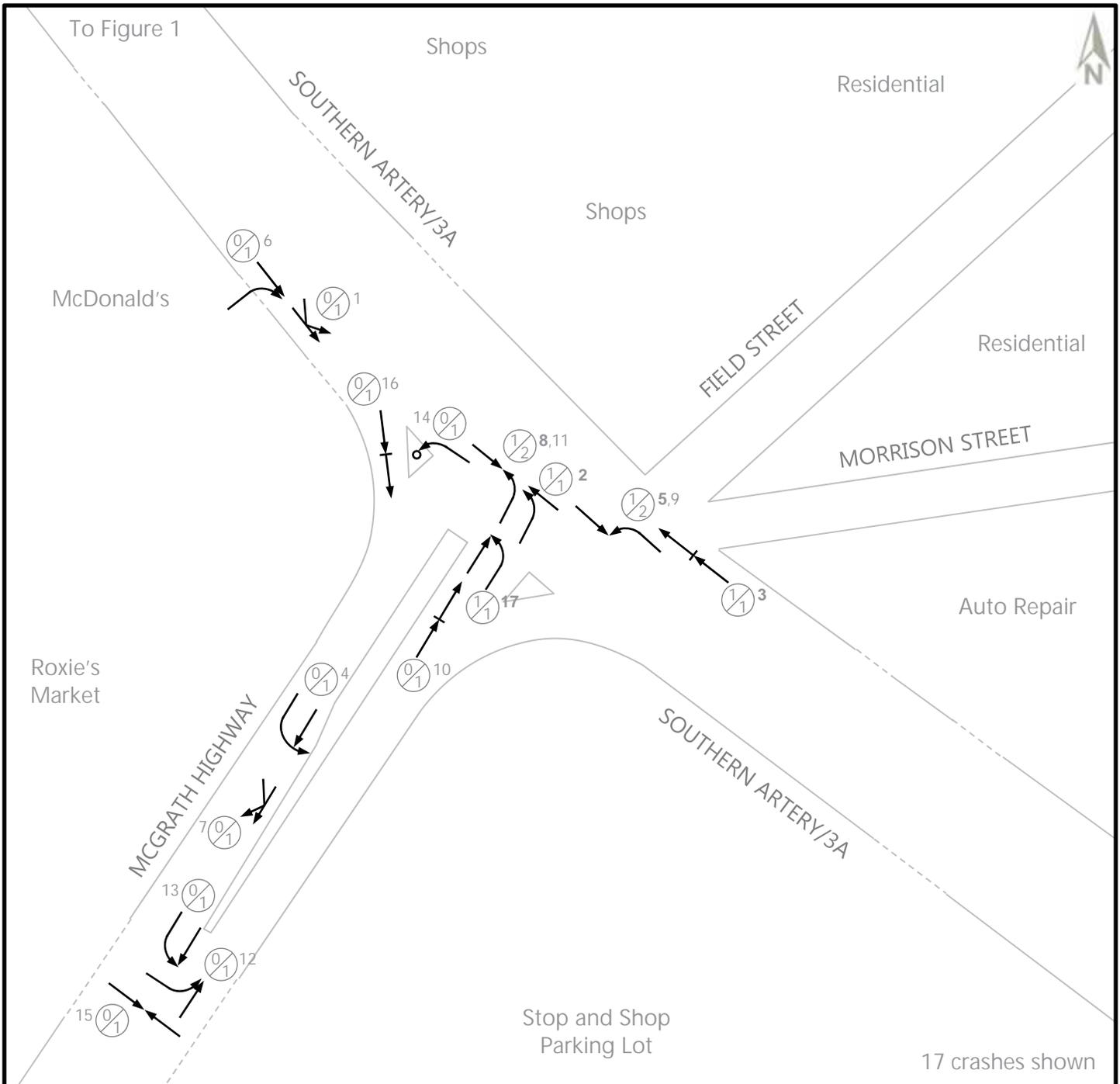
SYMBOLS	TYPES OF CRASH	SEVERITY
<ul style="list-style-type: none">  Moving Vehicle  Backing Vehicle  Non-Involved Vehicle  Parked Vehicle  Fixed Object  Pedestrian  Bicycle  Animal 	<ul style="list-style-type: none">  Head-On  Angle  Turning Move  Rear-End  Sideswipe  Out-of-Control 	<div style="text-align: center;">  </div> <p>#1 Injury Accident(s)</p> <p>#2 Total Number of Accidents</p> <p>#3,4,... Accident ID Number</p>

FIGURE B-2

Collision Diagram: Southern Artery/Route 3A at McGrath Highway, Quincy: April 2009 – April 2012



17 crashes shown

SYMBOLS	TYPES OF CRASH	SEVERITY
<ul style="list-style-type: none">  Moving Vehicle  Backing Vehicle  Non-Involved Vehicle  Parked Vehicle  Fixed Object  Pedestrian  Bicycle  Animal 	<ul style="list-style-type: none">  Head-On  Angle  Turning Move  Rear-End  Sideswipe  Out-of-Control 	<div style="text-align: center;">  </div> <p>#1 Injury Accident(s)</p> <p>#2 Total Number of Accidents</p> <p>#3,4,... Accident ID Number</p>

Crash Severity	Number of		Total Non-			Nonmotorist		Contributing Factor(s)
	Vehicles	fatal	Injuries	Manner of Collision	Road Surface	Light Conditions	Weather Condition	
Property damage only	2	0	0	Rear-end	Dry	Dark - lighted roadway	Clear	Followed too closely
Property damage only	2	0	0	Sideswipe, same dir.	Dry	Dawn	Clear	Failed to yield right-of-way
Property damage only	3	0	0	Rear-end	Dry	Dark - lighted roadway	Clear	No improper driving
Property damage only	2	0	0	Sideswipe, same dir.	Dry	Daylight	Clear	Inattention
Non-fatal injury	2	1	1	Angle	Wet	Dark - lighted roadway	Rain	No improper driving
Property damage only	3	0	0	Rear-end	Dry	Dark - lighted roadway	Clear	No improper driving
Property damage only	2	0	0	Rear-end	Dry	Dark - lighted roadway	Clear	Inattention
Property damage only	2	0	0	Rear-end	Dry	Daylight	Cloudy	Unknown
Non-fatal injury	2	1	1	Rear-end	Wet	Dark - lighted roadway	Rain	Unknown
Property damage only	2	0	0	Single vehicle crash	Dry	Daylight	Clear/Cloudy	Failed to yield right-of-way
Property damage only	2	0	0	Angle	Wet	Daylight	Clear	Disregarded traffic signs, signals, road marking
Property damage only	2	0	0	Rear-end	Dry	Daylight	Clear	Unknown
Property damage only	3	0	0	Rear-end	Snow	Daylight	Clear	Operating vehicle in erratic, reckless, careless,
Property damage only	2	0	0	Rear-end	Wet	Daylight	Cloudy/Rain	Failed to yield right-of-way/Unknown
Property damage only	2	0	0	Angle	Wet	Dark - lighted roadway	Rain	Unknown
Non-fatal injury	2	1	1	Rear-end	Wet	Daylight	Clear/Rain	No improper driving
Property damage only	2	0	0	Angle	Dry	Daylight	Cloudy	Failed to yield right-of-way
Property damage only	1	0	0	Single vehicle crash	Dry	Dark - lighted roadway	Clear	Unknown/No improper driving
Property damage only	2	0	0	Sideswipe, same dir.	Unknown	Unknown	Unknown	Unknown/No improper driving
Non-fatal injury	2	1	1	Angle	Unknown	Unknown	Unknown	Unspecified improper action/No improper driving
Non-fatal injury	2	1	1	Rear-end	Dry	Dark - lighted roadway	Clear	Distracted/Unspecified improper action
Property damage only	2	0	0	Angle	Dry	Dark - lighted roadway	Cloudy	Failed to yield right-of-way
Property damage only	2	0	0	Rear-end	Dry	Daylight	Clear	No improper driving
Non-fatal injury	1	1	1	Angle	Dry	Daylight	Cloudy	No improper driving
Property damage only	2	0	0	Rear-end	Dry	Dark - lighted roadway	Clear	No improper driving
Property damage only	2	0	0	Rear-end	Dry	Daylight	Clear	Inattention/Distracted
Non-fatal injury	1	1	1	Angle	Wet	Daylight	Rain	Swerving or avoiding unfavorable conditions/Unknown
Property damage only	2	0	0	Rear-end	Dry	Daylight	Cloudy/Rain	Unknown
Property damage only	2	0	0	Rear-end	Wet	Dusk	Rain	Made an improper turn
Property damage only	2	0	0	Rear-end	Wet	Daylight	Cloudy/Rain	No improper driving
Non-fatal injury	3	2	2	Rear-end	Wet	Daylight	Rain	No improper driving
Non-fatal injury	3	3	3	Angle	Dry	Dark - lighted roadway	Clear	Inattention/Unknown
Property damage only	2	0	0	Rear-end	Dry	Daylight	Clear	Operating vehicle in erratic, reckless, careless,
Property damage only	2	0	0	Sideswipe, same dir.	Unknown	Unknown	Clear	Unknown
Property damage only	2	0	0	Angle	Wet	Dark - lighted roadway	Unknown	Unknown
Non-fatal injury	2	1	1	Angle	Dry	Dark - lighted roadway	Rain	Failed to yield right-of-way
Property damage only	2	0	0	Sideswipe, same dir.	Wet	Daylight	Clear	Unspecified improper action
Property damage only	2	0	0	Rear-end	Dry	Daylight	Cloudy/Rain	No improper driving
Property damage only	2	0	0	Angle	Unknown	Unknown	Clear	Unspecified improper action/Unknown
Non-fatal injury	2	1	1	Angle	Dry	Unknown	Unknown	Unknown
Property damage only	2	0	0	Angle	Dry	Daylight	Clear	Unspecified improper action/Unknown
Property damage only	2	0	0	Rear-end	Dry	Daylight	Clear	No improper driving
Property damage only	2	0	0	Rear-end	Dry	Daylight	Cloudy	No improper driving

Crash Severity	Number of		Manner of Collision	Road Surface	Light Conditions	Weather Condition	Nonmotorist	
	Vehicles	fatal Non-fatal Injuries					Type	Contributing Factor(s)
Property damage only	2	0	Angle	Wet	Daylight	Rain/Cloudy		Failed to yield right-of-way
Non-fatal injury	2	3	Angle	Wet	Dark - lighted roadway	Rain		Unknown
Non-fatal injury	2	1	Rear-end	Wet	Daylight	Clear		Unknown
Property damage only	2	0	Angle	Dry	Dark - lighted roadway	Clear		Made an improper turn
Non-fatal injury	2	1	Angle	Dry	Dark - lighted roadway	Clear		Exceeded authorized speed limit
Property damage only	2	0	Angle	Dry	Daylight	Cloudy		Failed to yield right-of-way
Property damage only	2	0	Sideswipe, same dir.	Dry	Daylight	Clear		Failed to yield right-of-way
Non-fatal injury	2	1	Angle	Dry	Daylight	Clear		Unknown
Property damage only	2	0	Angle	Dry	Daylight	Cloudy		Failed to yield right-of-way/Unspecified improper
Property damage only	2	0	Rear-end	Dry	Daylight	Clear		Unknown
Property damage only	2	0	Angle	Dry	Daylight	Clear		Failed to yield right-of-way
Property damage only	2	0	Angle	Dry	Daylight	Cloudy/Rain		Failed to yield right-of-way
Property damage only	2	0	Angle	Wet	Daylight	Clear		Made an improper turn
Property damage only	2	0	Angle	Dry	Daylight	Clear		No improper driving
Property damage only	3	0	Single vehicle crash	Wet	Dark - lighted roadway	Cloudy/Rain		Unknown
Property damage only	2	0	Head on	Dry	Daylight	Cloudy		Unknown
Property damage only	2	0	Rear-end	Dry	Daylight	Clear		Unknown
Non-fatal injury	2	1	Angle	Dry	Dark - lighted roadway	Clear/Cloudy		Failure to keep in proper lane or running off road

APPENDIX C

**Average Daily Traffic (ADT) Summary
March 12-15, 2012**

bing Maps

My Notes

TDC PROJECT #
S12-016
QUINCY

On the go? Use m.bing.com to find maps, directions, businesses, and more



Mass Highway Department
 WEEKLY SUMMARY FOR LANE 1
 Starting: 3/12/2012

STA. 1 NB

Site Reference: 000000010102
 Site ID: 120160000866
 Location: RTE. 3A BTWN RUSSEL PRAK& CODDINGTON STS
 Direction: NORTH

File: 10102.prn
 City: QUINCY
 County: DIR VOL

TIME	MON 12	TUE 13	WED 14	THU 15	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		36	48	47		43			43	131
02:00		22	29	23		24			24	74
03:00		14	14	14		14			14	42
04:00		18	30	22		23			23	70
05:00		49	41	43		44			44	133
06:00		161	169	158		162			162	488
07:00		458	422	472		450			450	1352
08:00		837	751	720		769			769	2308
09:00		762	708	719		729			729	2189
10:00		442	429	474		448			448	1345
11:00		455	489			472			472	944
12:00		457	429			443			443	886
13:00	462	528	439			476			476	1429
14:00	451	462	447			453			453	1360
15:00	529	477	515			507			507	1521
16:00	504	499	464			489			489	1467
17:00	520	530	505			518			518	1555
18:00	505	536	510			517			517	1551
19:00	407	419	416			414			414	1242
20:00	372	384	311			355			355	1067
21:00	233	285	279			265			265	797
22:00	197	215	214			208			208	626
23:00	154	164	146			154			154	464
24:00	68	81	72			73			73	221
TOTALS	4402	8291	7877	2692	0	8050	0	0	8050	23262
% AVG WKDY	54.6	102.9	97.8	33.4						
% AVG WEEK	54.6	102.9	97.8	33.4						
AM Times		08:00	08:00	08:00		08:00			08:00	
AM Peaks		837	751	720		769			769	
PM Times	15:00	18:00	15:00			17:00			17:00	
PM Peaks	529	536	515			518			518	

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NB 8050
 SB 7982

 COMB AWD 16032
 FAC .96(.98)
 COMB ADT 15,100

Mass Highway Department
 WEEKLY SUMMARY FOR LANE 2
 Starting: 3/12/2012

Page: 2

STA. 15B

Site Reference: 000000010102
 Site ID: 120160000866
 Location: RTE. 3A BTWN RUSSEL PRAK& CODDINGTON STS
 Direction: SOUTH

File: 10102.prn
 City: QUINCY
 County: DIR VOL

TIME	MON 12	TUE 13	WED 14	THU 15	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		43	47	36		42			42	126
02:00		17	36	23		25			25	76
03:00		25	28	27		26			26	80
04:00		21	13	13		15			15	47
05:00		29	33	30		30			30	92
06:00		76	80	87		81			81	243
07:00		157	164	144		155			155	465
08:00		383	347	312		347			347	1042
09:00		384	384	396		388			388	1164
10:00		339	352	378		356			356	1069
11:00		339	485			412			412	824
12:00		453	421			437			437	874
13:00	463	595	453			503			503	1511
14:00	482	490	512			494			494	1484
15:00	613	568	601			594			594	1782
16:00	699	626	642			655			655	1967
17:00	736	753	741			743			743	2230
18:00	883	850	802			845			845	2535
19:00	667	702	612			660			660	1981
20:00	408	434	419			420			420	1261
21:00	292	326	282			300			300	900
22:00	200	207	198			201			201	605
23:00	145	166	136			149			149	447
24:00	102	102	110			104			104	314

TOTALS 5690 8085 7898 1446 0 7982 0 0 7982 23119

% AVG WKDY 71.2 101.2 98.9 18.1
 % AVG WEEK 71.2 101.2 98.9 18.1

AM Times 12:00 11:00 09:00 12:00 12:00
 AM Peaks 453 485 396 437 437

PM Times 18:00 18:00 18:00 18:00 18:00
 PM Peaks 883 850 802 845 845

Mass Highway Department
 WEEKLY SUMMARY FOR LANE 1
 Starting: 4/23/2012

STA. 2 NB

Site Reference: 000000000201

Site ID: 000000000527

Location: RTE. 3A, BTWN CODDINGTON/SEA ST & McGRATH

Direction:

File: V-201.prn

City: QUINCY

County: VOL N.B.

TIME	MON 23	TUE 24	WED 25	THU 26	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		105	141	136		127			127	382
02:00		67	82	91		80			80	240
03:00		30	48	42		40			40	120
04:00		46	55	46		49			49	147
05:00		164	146	145		151			151	455
06:00		610	629	594		611			611	1833
07:00		1490	1483	1480		1484			1484	4453
08:00		1990	1901	1966		1952			1952	5857
09:00		1708	1726	1619		1684			1684	5053
10:00		1333	1252	1329		1304			1304	3914
11:00		1121	1121	1130		1124			1124	3372
12:00		1154	1195			1174			1174	2349
13:00	1145	1209	1214			1189			1189	3568
14:00	1194	1190	1246			1210			1210	3630
15:00	1472	1244	1392			1369			1369	4108
16:00	1750	1403	1374			1509			1509	4527
17:00	1628	1410	1414			1484			1484	4452
18:00	1732	1526	1537			1598			1598	4795
19:00	1330	1270	1309			1303			1303	3909
20:00	960	1050	1064			1024			1024	3074
21:00	719	786	723			742			742	2228
22:00	584	614	523			573			573	1721
23:00	397	449	493			446			446	1339
24:00	195	258	295			249			249	748
<hr/>										
TOTALS	13106	22227	22363	8578	0	22476	0	0	22476	66274
<hr/>										
% AVG WKDY	58.3	98.8	99.4	38.1						
% AVG WEEK	58.3	98.8	99.4	38.1						
<hr/>										
AM Times		08:00	08:00	08:00		08:00			08:00	
AM Peaks		1990	1901	1966		1952			1952	
<hr/>										
PM Times	16:00	18:00	18:00			18:00			18:00	
PM Peaks	1750	1526	1537			1598			1598	

43

NB 22476

SB 18696

COMB AWD 41172

FAZ .92 (.98)

COMB ADT 37,100

Mass Highway Department
 WEEKLY SUMMARY FOR LANE 1
 Starting: 4/23/2012

Page: 1

STA. 2 SB

Site Reference: 000000000202

Site ID: 000000000732

Location: RTE. 3A, BTWN CODDINGTON/SEA ST& McGRATH

Direction: SOUTH

File: V-202.prn

City: QUINCY

County: VOL S.B.

TIME	MON 23	TUE 24	WED 25	THU 26	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		126	147	159		144			144	432
02:00		77	82	82		80			80	241
03:00		27	55	47		43			43	129
04:00		43	47	46		45			45	136
05:00		77	82	81		80			80	240
06:00		221	203	192		205			205	616
07:00		562	528	552		547			547	1642
08:00		1023	998	968		996			996	2989
09:00		1071	1168	1082		1107			1107	3321
10:00		952	920	928		933			933	2800
11:00		983	1028	963		991			991	2974
12:00		1015	1045			1030			1030	2060
13:00	1019	1119	1113			1083			1083	3251
14:00	1078	1138	1063			1093			1093	3279
15:00	1286	1244	1408			1312			1312	3938
16:00	1376	1506	1479			1453			1453	4361
17:00	1519	1573	1579			1557			1557	4671
18:00	1632	1627	1644			1634			1634	4903
19:00	1360	1520	1496			1458			1458	4376
20:00	844	1079	1192			1038			1038	3115
21:00	675	730	762			722			722	2167
22:00	426	536	530			497			497	1492
23:00	319	387	413			373			373	1119
24:00	218	268	339			275			275	825
TOTALS	11752	18904	19321	5100	0	18696	0	0	18696	55077
% AVG WKDY	62.8	101.1	103.3	27.2						
% AVG WEEK	62.8	101.1	103.3	27.2						
AM Times		09:00	09:00	09:00		09:00			09:00	
AM Peaks		1071	1168	1082		1107			1107	
PM Times	18:00	18:00	18:00			18:00			18:00	
PM Peaks	1632	1627	1644			1634			1634	

Mass Highway Department
 WEEKLY SUMMARY FOR LANE 1
 Starting: 3/12/2012

STA. 3 NB

Site Reference: 000000030102
 Site ID: 120160000456
 Location: RTE. 3A, BTWN MCGRATH HWY & BRACKETT ST.
 Direction: NORTH

File: 30102.prn
 City: QUINCY
 County: DIR VOL

TIME	MON 12	TUE 13	WED 14	THU 15	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		56	76	63		65			65	195
02:00		39	56	55		50			50	150
03:00		39	32	31		34			34	102
04:00		48	45	46		46			46	139
05:00		138	131	120		129			129	389
06:00		499	500	492		497			497	1491
07:00		1173	1168	1114		1151			1151	3455
08:00		1504	1458	1500		1487			1487	4462
09:00		1354	1235	1312		1300			1300	3901
10:00		925	946	924		931			931	2795
11:00		745	751	771		755			755	2267
12:00		761	678			719			719	1439
13:00	813	810	754			792			792	2377
14:00	814	716	717			749			749	2247
15:00	920	824	818			854			854	2562
16:00	928	862	790			860			860	2580
17:00	941	970	871			927			927	2782
18:00	915	907	837			886			886	2659
19:00	741	823	766			776			776	2330
20:00	557	650	543			583			583	1750
21:00	447	483	453			461			461	1383
22:00	379	411	374			388			388	1164
23:00	288	279	262			276			276	829
24:00	136	171	151			152			152	458
TOTALS	7879	15187	14412	6428	0	14868	0	0	14868	43906
% AVG WKDY	52.9	102.1	96.9	43.2						
% AVG WEEK	52.9	102.1	96.9	43.2						
AM Times		08:00	08:00	08:00		08:00			08:00	
AM Peaks		1504	1458	1500		1487			1487	
PM Times	17:00	17:00	17:00			17:00			17:00	
PM Peaks	941	970	871			927			927	

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NB 14868
 SB 13541

 COMB AWD 28409
 FAC .96 (.98)
 COMB ADT 26,700

Mass Highway Department
 WEEKLY SUMMARY FOR LANE 2
 Starting: 3/12/2012

Page: 2

STA. 35B

Site Reference: 000000030102
 Site ID: 120160000456
 Location: RTE. 3A, BTWN MCGRATH HWY & BRACKETT ST.
 Direction: SOUTH

File: 30102.prn
 City: QUINCY
 County: DIR VOL

TIME	MON 12	TUE 13	WED 14	THU 15	FRI .	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		124	184	144		150			150	452
02:00		79	101	86		88			88	266
03:00		48	57	62		55			55	167
04:00		43	36	29		36			36	108
05:00		46	43	58		49			49	147
06:00		111	107	129		115			115	347
07:00		285	306	291		294			294	882
08:00		583	540	554		559			559	1677
09:00		617	656	694		655			655	1967
10:00		563	574	546		561			561	1683
11:00		605	656	595		618			618	1856
12:00		726	703			714			714	1429
13:00	792	869	808			823			823	2469
14:00	774	858	808			813			813	2440
15:00	985	924	944			951			951	2853
16:00	1095	1068	1026			1063			1063	3189
17:00	1119	1159	1172			1150			1150	3450
18:00	1366	1219	1220			1268			1268	3805
19:00	1229	1185	1052			1155			1155	3466
20:00	860	886	759			835			835	2505
21:00	551	643	551			581			581	1745
22:00	411	472	448			443			443	1331
23:00	307	340	325			324			324	972
24:00	225	248	250			241			241	723
TOTALS	9714	13701	13326	3188	0	13541	0	0	13541	39929
% AVG WKDY	71.7	101.1	98.4	23.5						
% AVG WEEK	71.7	101.1	98.4	23.5						
AM Times		12:00	12:00	09:00		12:00			12:00	
AM Peaks		726	703	694		714			714	
PM Times	18:00	18:00	18:00			18:00			18:00	
PM Peaks	1366	1219	1220			1268			1268	

Mass Highway Department
 WEEKLY SUMMARY FOR LANE 1
 Starting: 4/23/2012

Page: 1

STA. 4 EB

Site Reference: 000000040304
 Site ID: 000000000854
 Location: SEA ST., EAST OF RTE. 3A
 Direction:

File: V-40304.prn
 City: QUINCY
 County: DIR VOL E&W

TIME	MON 23	TUE 24	WED 25	THU 26	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		103	104	108		105			105	315
02:00		60	23	23		35			35	106
03:00		33	12	12		19			19	57
04:00		33	5	6		14			14	44
05:00		85	10	9		34			34	104
06:00		253	94	84		143			143	431
07:00		530	367	370		422			422	1267
08:00		991	797	738		842			842	2526
09:00		979	934	956		956			956	2869
10:00		786	822	766		791			791	2374
11:00		868	836	620		774			774	2324
12:00		772	893			832			832	1665
13:00	889	874	925			896			896	2688
14:00	1005	918	899			940			940	2822
15:00	1015	948	947			970			970	2910
16:00	1121	1124	1103			1116			1116	3348
17:00	1138	1165	1151			1151			1151	3454
18:00	1151	1134	1154			1146			1146	3439
19:00	971	1017	1027			1005			1005	3015
20:00	738	838	875			817			817	2451
21:00	604	686	694			661			661	1984
22:00	448	536	554			512			512	1538
23:00	353	407	397			385			385	1157
24:00	182	250	237			223			223	669
TOTALS	9615	15390	14860	3692	0	14789	0	0	14789	43557
% AVG WKDY	65	104	100.4	24.9						
% AVG WEEK	65	104	100.4	24.9						
AM Times		08:00	09:00	09:00		09:00			09:00	
AM Peaks		991	934	956		956			956	
PM Times	18:00	17:00	18:00			17:00			17:00	
PM Peaks	1151	1165	1154			1151			1151	

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EB 14789
 WB 24252
 COMB AWD 39041
 FAC .92(.98)
 COMB ADT 35,200

Mass Highway Department
 WEEKLY SUMMARY FOR LANE 2
 Starting: 4/23/2012

Page: 2

STA. 4WB

Site Reference: 000000040304
 Site ID: 000000000854
 Location: SEA ST., EAST OF RTE. 3A
 Direction:

File: V-40304.prn
 City: QUINCY
 County: DIR VOL E&W

TIME	MON 23	TUE 24	WED 25	THU 26	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		106	166	288		186			186	560
02:00		59	102	160		107			107	321
03:00		32	74	96		67			67	202
04:00		45	81	63		63			63	189
05:00		108	166	164		146			146	438
06:00		477	646	694		605			605	1817
07:00		1276	1468	1734		1492			1492	4478
08:00		1695	1796	2674		2055			2055	6165
09:00		1394	1503	2378		1758			1758	5275
10:00		1165	1139	1903		1402			1402	4207
11:00		965	1064	1745		1258			1258	3774
12:00		1101	1008			1054			1054	2109
13:00	911	1047	992			983			983	2950
14:00	955	1047	1740			1247			1247	3742
15:00	1234	1102	2268			1534			1534	4604
16:00	1262	1279	2204			1581			1581	4745
17:00	1374	1314	2237			1641			1641	4925
18:00	1296	1360	2224			1626			1626	4880
19:00	1275	1384	2294			1651			1651	4953
20:00	913	1067	1940			1306			1306	3920
21:00	703	788	1327			939			939	2818
22:00	492	541	998			677			677	2031
23:00	330	402	779			503			503	1511
24:00	225	286	603			371			371	1114
TOTALS	10970	20040	28819	11899	0	24252	0	0	24252	71728
% AVG WKDY	45.2	82.6	118.8	49						
% AVG WEEK	45.2	82.6	118.8	49						
AM Times		08:00	08:00	08:00		08:00			08:00	
AM Peaks		1695	1796	2674		2055			2055	
PM Times	17:00	19:00	19:00			19:00			19:00	
PM Peaks	1374	1384	2294			1651			1651	

Mass Highway Department
 WEEKLY SUMMARY FOR LANE 1
 Starting: 3/12/2012

STA. 5 EB

Site Reference: 000000050304
 Site ID: 120160000733
 Location: CODDINGTON ST. BTWB RTE. 3A & NEWCOMB ST
 Direction: EAST

File: 50304.prn
 City: QUINCY
 County: DIR VOL

TIME	MON 12	TUE 13	WED 14	THU 15	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		34	33	40		35			35	107
02:00		21	32	33		28			28	86
03:00		10	9	11		10			10	30
04:00		13	11	8		10			10	32
05:00		13	18	7		12			12	38
06:00		51	50	46		49			49	147
07:00		102	101	107		103			103	310
08:00		278	172	158		202			202	608
09:00		183	194	199		192			192	576
10:00		246	232	246		241			241	724
11:00		247	392			319			319	639
12:00	238	318	253			269			269	809
13:00	326	346	300			324			324	972
14:00	327	300	261			296			296	888
15:00	384	310	348			347			347	1042
16:00	348	381	396			375			375	1125
17:00	406	395	382			394			394	1183
18:00	435	434	421			430			430	1290
19:00	396	371	386			384			384	1153
20:00	299	308	298			301			301	905
21:00	255	264	218			245			245	737
22:00	179	190	195			188			188	564
23:00	92	117	83			97			97	292
24:00	67	67	65			66			66	199

TOTALS	3752	4999	4850	855	0	4917	0	0	4917	14456
% AVG WKDY	76.3	101.6	98.6	17.3						
% AVG WEEK	76.3	101.6	98.6	17.3						
AM Times	12:00	12:00	11:00	10:00		11:00			11:00	
AM Peaks	238	318	392	246		319			319	
PM Times	18:00	18:00	18:00			18:00			18:00	
PM Peaks	435	434	421			430			430	

u3

EB 4917
 WB 4570

 COMB AWD 9487
 FAC .96 (.98)
 COMB ADT 8,900

Mass Highway Department
 WEEKLY SUMMARY FOR LANE 2
 Starting: 3/12/2012

Page: 2

STA. SWB

Site Reference: 000000050304
 Site ID: 120160000733
 Location: CODDINGTON ST. BTWB RTE. 3A & NEWCOMB ST
 Direction: WEST

File: 50304.prn
 City: QUINCY
 County: DIR VOL

TIME	MON 12	TUE 13	WED 14	THU 15	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		29	31	39		33			33	99
02:00		15	18	15		16			16	48
03:00		6	3	10		6			6	19
04:00		12	13	11		12			12	36
05:00		33	32	20		28			28	85
06:00		87	91	81		86			86	259
07:00		197	222	200		206			206	619
08:00		435	334	315		361			361	1084
09:00		398	400	376		391			391	1174
10:00		296	293	308		299			299	897
11:00		214	351			282			282	565
12:00	235	245	229			236			236	709
13:00	275	283	230			262			262	788
14:00	240	309	248			265			265	797
15:00	298	319	308			308			308	925
16:00	313	306	272			297			297	891
17:00	290	269	304			287			287	863
18:00	246	298	285			276			276	829
19:00	344	305	282			310			310	931
20:00	198	257	215			223			223	670
21:00	158	147	159			154			154	464
22:00	130	133	96			119			119	359
23:00	67	74	60			67			67	201
24:00	40	45	53			46			46	138
TOTALS	2834	4712	4529	1375	0	4570	0	0	4570	13450
% AVG WKDY	62	103.1	99.1	30						
% AVG WEEK	62	103.1	99.1	30						
AM Times	12:00	08:00	09:00	09:00		09:00			09:00	
AM Peaks	235	435	400	376		391			391	
PM Times	19:00	15:00	15:00			19:00			19:00	
PM Peaks	344	319	308			310			310	

Mass Highway Department
 WEEKLY SUMMARY FOR LANE 1
 Starting: 3/12/2012

STA. 6 EB

Site Reference: 000000000603
 Site ID: 120160000876
 Location: MCGRATH HWY, BTWN BRACKETT ST. & RTE. 3A
 Direction: EAST

File: 603.prn
 City: QUINCY
 County: VOL

TIME	MON 12	TUE 13	WED 14	THU 15	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		47	56	62		55			55	165
02:00		37	40	46		41			41	123
03:00		25	26	21		24			24	72
04:00		13	26	12		17			17	51
05:00		23	21	31		25			25	75
06:00		70	63	81		71			71	214
07:00		223	211	205		213			213	639
08:00		354	378	351		361			361	1083
09:00		387	378	370		378			378	1135
10:00		416	402	416		411			411	1234
11:00		471	459	449		459			459	1379
12:00		496	517			506			506	1013
13:00	551	573	543			555			555	1667
14:00	597	536	578			570			570	1711
15:00	587	562	548			565			565	1697
16:00	631	582	600			604			604	1813
17:00	685	702	709			698			698	2096
18:00	670	662	703			678			678	2035
19:00	601	599	577			592			592	1777
20:00	479	460	436			458			458	1375
21:00	370	353	361			361			361	1084
22:00	229	297	291			272			272	817
23:00	188	183	172			181			181	543
24:00	99	133	127			119			119	359

TOTALS	5687	8204	8222	2044	0	8214	0	0	8214	24157
% AVG WKDY	69.2	99.8	100	24.8						
% AVG WEEK	69.2	99.8	100	24.8						
AM Times		12:00	12:00	11:00		12:00			12:00	
AM Peaks		496	517	449		506			506	
PM Times	17:00	17:00	17:00			17:00			17:00	
PM Peaks	685	702	709			698			698	

u5

EB 8214
 WB 7856

 COMB AWD 16070
 FAC 1.96 (.98)
 COMB ADT 15,100

Mass Highway Department
 WEEKLY SUMMARY FOR LANE 1
 Starting: 3/12/2012

Page: 1

STA. 6WB

Site Reference: 000000000604
 Site ID: 120160000885
 Location: MCGRATH HWY, BTWN BRACKETT ST. & RTE. 3A
 Direction: WEST

File: 604.prn
 City: QUINCY
 County: VOL

TIME	MON 12	TUE 13	WED 14	THU 15	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		47	58	49		51			51	154
02:00		36	33	42		37			37	111
03:00		20	16	24		20			20	60
04:00		25	29	24		26			26	78
05:00		35	33	28		32			32	96
06:00		83	85	101		89			89	269
07:00		195	195	188		192			192	578
08:00		451	454	454		453			453	1359
09:00		551	555	574		560			560	1680
10:00		434	439	417		430			430	1290
11:00		433	477	401		437			437	1311
12:00		480	474			477			477	954
13:00	547	575	507			543			543	1629
14:00	519	563	531			537			537	1613
15:00	644	545	580			589			589	1769
16:00	593	565	613			590			590	1771
17:00	565	560	592			572			572	1717
18:00	543	555	548			548			548	1646
19:00	584	577	575			578			578	1736
20:00	397	442	345			394			394	1184
21:00	308	284	243			278			278	835
22:00	174	213	189			192			192	576
23:00	135	148	125			136			136	408
24:00	84	108	94			95			95	286
TOTALS	5093	7925	7790	2302	0	7856	0	0	7856	23110
% AVG WKDY	64.8	100.8	99.1	29.3						
% AVG WEEK	64.8	100.8	99.1	29.3						
AM Times		09:00	09:00	09:00		09:00			09:00	
AM Peaks		551	555	574		560			560	
PM Times	15:00	19:00	16:00			16:00			16:00	
PM Peaks	644	577	613			590			590	

APPENDIX D

AM/PM Peak-Hour Intersection Capacity Analysis Existing Conditions

Southern Artery at Sea Street/Coddington Street, Quincy

Southern Artery at McGrath Highway/Field Street, Quincy

HCM Signalized Intersection Capacity Analysis
 1: Coddington St & Southern Artery

8/13/2012



Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↕↕			↕↕	↕↕		↕↕		↕	↕↕	
Volume (vph)	81	302	40	48	720	1206	53	143	83	798	323	208
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	11	11	11	11	12	12	11	11	11
Total Lost time (s)		5.0			5.0	5.0		5.0		5.0	5.0	
Lane Util. Factor		0.95			0.95	0.88		0.95		0.91	0.91	
Frbp, ped/bikes		1.00			1.00	1.00		0.99		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00		1.00		1.00	1.00	
Frt		0.99			1.00	0.85		0.96		1.00	0.96	
Flt Protected		0.99			1.00	1.00		0.99		0.95	0.98	
Satd. Flow (prot)		3451			3410	2694		3127		1542	3056	
Flt Permitted		0.57			0.89	1.00		0.99		0.95	0.98	
Satd. Flow (perm)		1983			3029	2694		3127		1542	3056	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	85	318	42	51	758	1269	56	151	87	840	340	219
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	17	0
Lane Group Flow (vph)	0	445	0	0	809	1269	0	294	0	470	912	0
Confl. Peds. (#/hr)	3		2	2		3	7		12	12		7
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	8%	8%	8%	3%	3%	3%
Turn Type	pm+pt	NA		pm+pt	NA	pt+ov	Split	NA		Split	NA	
Protected Phases	1	6		5	2	2 8	4	4		8	8	
Permitted Phases	6			2								
Actuated Green, G (s)		39.9			39.9	75.6		15.0		35.7	35.7	
Effective Green, g (s)		39.9			39.9	75.6		15.0		35.7	35.7	
Actuated g/C Ratio		0.34			0.34	0.65		0.13		0.31	0.31	
Clearance Time (s)		5.0			5.0			5.0		5.0	5.0	
Vehicle Extension (s)		2.0			2.0			2.0		2.0	2.0	
Lane Grp Cap (vph)		683			1044	1759		405		475	942	
v/s Ratio Prot						0.47		c0.09		c0.30	0.30	
v/s Ratio Perm		0.22			c0.27							
v/c Ratio		0.65			0.77	0.72		0.73		0.99	0.97	
Uniform Delay, d1		32.1			33.9	13.2		48.4		39.9	39.5	
Progression Factor		1.00			1.00	1.00		1.00		1.00	1.00	
Incremental Delay, d2		1.7			3.3	1.3		5.4		38.0	21.6	
Delay (s)		33.8			37.3	14.4		53.8		77.9	61.1	
Level of Service		C			D	B		D		E	E	
Approach Delay (s)		33.8			23.3			53.8			66.8	
Approach LOS		C			C			D			E	

Intersection Summary

HCM Average Control Delay	41.0	HCM Level of Service	D
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	115.8	Sum of lost time (s)	25.2
Intersection Capacity Utilization	84.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Queues

1: Coddington St & Southern Artery

8/13/2012



Lane Group	SET	NWT	NWR	NET	SWL	SWT
Lane Group Flow (vph)	445	809	1269	294	470	929
v/c Ratio	0.64	0.76	0.68	0.71	0.98	0.96
Control Delay	39.1	40.8	11.2	59.1	76.1	59.1
Queue Delay	0.0	0.0	0.4	0.0	0.0	0.0
Total Delay	39.1	40.8	11.6	59.1	76.1	59.1
Queue Length 50th (ft)	121	234	170	99	325	312
Queue Length 95th (ft)	255	#476	294	178	#778	#658
Internal Link Dist (ft)	586	527		193		192
Turn Bay Length (ft)			225			
Base Capacity (vph)	709	1082	1885	587	482	972
Starvation Cap Reductn	0	0	218	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.63	0.75	0.76	0.50	0.98	0.96

Intersection Summary

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

HCM Signalized Intersection Capacity Analysis
 2: McGrath Highway/Field St & Southern Artery

8/13/2012



Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↕↕	↗	↖	↕↕		↖	↗	↗		↕↕	
Volume (vph)	1	674	507	53	1457	3	359	4	43	2	8	9
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	12	12	12	12
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0	5.0	5.0		5.0	
Lane Util. Factor		0.95	1.00	1.00	0.95		0.95	0.95	1.00		1.00	
Frbp, ped/bikes		1.00	0.98	1.00	1.00		1.00	1.00	0.97		0.99	
Flpb, ped/bikes		1.00	1.00	1.00	1.00		1.00	1.00	1.00		1.00	
Frnt		1.00	0.85	1.00	1.00		1.00	1.00	0.85		0.94	
Flt Protected		1.00	1.00	0.95	1.00		0.95	0.95	1.00		0.99	
Satd. Flow (prot)		3388	1491	1722	3454		1609	1615	1525		1481	
Flt Permitted		0.95	1.00	0.35	1.00		0.95	0.95	1.00		0.99	
Satd. Flow (perm)		3231	1491	638	3454		1609	1615	1525		1481	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	1	709	534	56	1534	3	378	4	45	2	8	9
RTOR Reduction (vph)	0	0	235	0	0	0	0	0	36	0	9	0
Lane Group Flow (vph)	0	710	299	56	1537	0	193	189	9	0	10	0
Confl. Peds. (#/hr)	14		8	8		14	1		14	14		1
Heavy Vehicles (%)	3%	3%	3%	1%	1%	1%	3%	3%	3%	2%	20%	20%
Turn Type	Perm	NA	Perm	Perm	NA		Split	NA	Perm	Split	NA	
Protected Phases		6			2		4	4		8	8	
Permitted Phases	6		6	2				4	4			
Actuated Green, G (s)		39.1	39.1	39.1	39.1		13.9	13.9	13.9		1.8	
Effective Green, g (s)		39.1	39.1	39.1	39.1		13.9	13.9	13.9		1.8	
Actuated g/C Ratio		0.56	0.56	0.56	0.56		0.20	0.20	0.20		0.03	
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0	5.0	5.0		5.0	
Vehicle Extension (s)		2.0	2.0	2.0	2.0		2.0	2.0	2.0		2.0	
Lane Grp Cap (vph)		1810	835	357	1935		320	322	304		38	
v/s Ratio Prot					c0.45		c0.12	0.12			c0.01	
v/s Ratio Perm		0.22	0.20	0.09					0.01			
v/c Ratio		0.39	0.36	0.16	0.79		0.60	0.59	0.03		0.27	
Uniform Delay, d1		8.7	8.4	7.4	12.2		25.4	25.3	22.5		33.4	
Progression Factor		1.00	1.00	1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2		0.1	0.1	0.1	2.2		2.2	1.8	0.0		1.4	
Delay (s)		8.7	8.5	7.5	14.3		27.6	27.1	22.5		34.7	
Level of Service		A	A	A	B		C	C	C		C	
Approach Delay (s)		8.6			14.1			26.9			34.7	
Approach LOS		A			B			C			C	

Intersection Summary		
HCM Average Control Delay	13.8	HCM Level of Service B
HCM Volume to Capacity ratio	0.73	
Actuated Cycle Length (s)	69.8	Sum of lost time (s) 15.0
Intersection Capacity Utilization	90.1%	ICU Level of Service E
Analysis Period (min)	15	

c Critical Lane Group

Queues

2: McGrath Highway/Field St & Southern Artery

8/13/2012



Lane Group	SET	SER	NWL	NWT	NEL	NET	NER	SWT
Lane Group Flow (vph)	710	534	56	1537	193	189	45	19
v/c Ratio	0.38	0.49	0.15	0.77	0.58	0.57	0.13	0.12
Control Delay	9.4	2.7	10.0	15.3	36.4	35.9	11.0	31.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	9.4	2.7	10.0	15.3	36.4	35.9	11.0	31.8
Queue Length 50th (ft)	56	0	7	171	62	61	0	3
Queue Length 95th (ft)	166	45	38	482	191	188	29	29
Internal Link Dist (ft)	527			292		558		61
Turn Bay Length (ft)		175	200				100	
Base Capacity (vph)	2674	1326	528	2858	595	597	589	183
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.27	0.40	0.11	0.54	0.32	0.32	0.08	0.10

Intersection Summary

HCM Signalized Intersection Capacity Analysis
 1: Coddington Street/Sea Street & Southern Artery

8/14/2012



Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↕↕			↕↕	↕↕		↕↕		↕	↕↕	
Volume (vph)	89	711	58	46	380	1062	52	282	74	969	214	55
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	11	11	11	11	12	12	11	11	11
Total Lost time (s)		5.0			5.0	5.0		5.0		5.0	5.0	
Lane Util. Factor		0.95			0.95	0.88		0.95		0.91	0.91	
Frbp, ped/bikes		1.00			1.00	1.00		0.99		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00		1.00		1.00	1.00	
Frt		0.99			1.00	0.85		0.97		1.00	0.99	
Flt Protected		0.99			0.99	1.00		0.99		0.95	0.97	
Satd. Flow (prot)		3514			3436	2720		3389		1572	3167	
Flt Permitted		0.75			0.63	1.00		0.99		0.95	0.97	
Satd. Flow (perm)		2638			2169	2720		3389		1572	3167	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	94	748	61	48	400	1118	55	297	78	1020	225	58
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	4	0
Lane Group Flow (vph)	0	903	0	0	448	1118	0	430	0	510	789	0
Confl. Peds. (#/hr)	4		12	12		4	8		21	21		8
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	2%	2%	2%	1%	1%	1%
Turn Type	pm+pt	NA		pm+pt	NA	pt+ov	Split	NA		Split	NA	
Protected Phases	1	6		5	2	2 8	4	4		8	8	
Permitted Phases	6			2								
Actuated Green, G (s)		40.6			40.6	76.1		19.1		35.5	35.5	
Effective Green, g (s)		40.6			40.6	76.1		19.1		35.5	35.5	
Actuated g/C Ratio		0.33			0.33	0.61		0.15		0.28	0.28	
Clearance Time (s)		5.0			5.0			5.0		5.0	5.0	
Vehicle Extension (s)		2.0			2.0			2.0		2.0	2.0	
Lane Grp Cap (vph)		859			706	1660		519		448	902	
v/s Ratio Prot						0.41		c0.13		c0.32	0.25	
v/s Ratio Perm		c0.34			0.21							
v/c Ratio		1.05			0.63	0.67		0.83		1.14	1.07dl	
Uniform Delay, d1		42.1			35.7	16.1		51.2		44.6	42.5	
Progression Factor		1.00			1.00	1.00		1.00		1.00	1.00	
Incremental Delay, d2		45.1			1.4	0.9		10.0		86.2	9.2	
Delay (s)		87.1			37.1	16.9		61.2		130.8	51.7	
Level of Service		F			D	B		E		F	D	
Approach Delay (s)		87.1			22.7			61.2			82.6	
Approach LOS		F			C			E			F	

Intersection Summary

HCM Average Control Delay	59.1	HCM Level of Service	E
HCM Volume to Capacity ratio	1.04		
Actuated Cycle Length (s)	124.7	Sum of lost time (s)	29.5
Intersection Capacity Utilization	91.5%	ICU Level of Service	F
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.

c Critical Lane Group

Queues

1: Coddington Street/Sea Street & Southern Artery

8/14/2012



Lane Group	SET	NWT	NWR	NET	SWL	SWT
Lane Group Flow (vph)	903	448	1118	430	510	793
v/c Ratio	1.04	0.63	0.65	0.82	1.13	1.07dl
Control Delay	83.5	42.3	11.7	65.5	123.7	54.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	83.5	42.3	11.7	65.5	123.7	54.5
Queue Length 50th (ft)	~490	183	187	194	~612	376
Queue Length 95th (ft)	#623	248	232	#269	#856	#516
Internal Link Dist (ft)	586	527		193		192
Turn Bay Length (ft)			225			
Base Capacity (vph)	866	712	1725	584	452	914
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	1.04	0.63	0.65	0.74	1.13	0.87

Intersection Summary

- ~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
- # 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
- dl Defacto Left Lane. Recode with 1 though lane as a left lane.

HCM Signalized Intersection Capacity Analysis
 2: McGrath Highway/Field Street & Southern Artery

8/14/2012



Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↕↕	↗	↖	↕↕		↗	↖	↗		↕↕	
Volume (vph)	3	1287	454	56	874	1	569	7	82	2	8	3
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	12	12	12	12
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0	5.0	5.0		5.0	
Lane Util. Factor		0.95	1.00	1.00	0.95		0.95	0.95	1.00		1.00	
Frbp, ped/bikes		1.00	0.98	1.00	1.00		1.00	1.00	0.97		0.97	
Flpb, ped/bikes		1.00	1.00	1.00	1.00		1.00	1.00	1.00		1.00	
Frt		1.00	0.85	1.00	1.00		1.00	1.00	0.85		0.97	
Flt Protected		1.00	1.00	0.95	1.00		0.95	0.95	1.00		0.99	
Satd. Flow (prot)		3455	1520	1726	3454		1641	1647	1552		1760	
Flt Permitted		0.95	1.00	0.11	1.00		0.95	0.95	1.00		0.99	
Satd. Flow (perm)		3295	1520	197	3454		1641	1647	1552		1760	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	3	1355	478	59	920	1	599	7	86	2	8	3
RTOR Reduction (vph)	0	0	209	0	0	0	0	0	57	0	3	0
Lane Group Flow (vph)	0	1358	269	59	921	0	305	301	29	0	10	0
Confl. Peds. (#/hr)	13		8	8		13	5		16	16		5
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm	NA	Perm	Perm	NA		Split	NA	Perm	Split	NA	
Protected Phases		6			2		4	4		8	8	
Permitted Phases	6		6	2			4	4				
Actuated Green, G (s)		36.9	36.9	36.9	36.9		17.6	17.6	17.6		1.0	
Effective Green, g (s)		36.9	36.9	36.9	36.9		17.6	17.6	17.6		1.0	
Actuated g/C Ratio		0.52	0.52	0.52	0.52		0.25	0.25	0.25		0.01	
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0	5.0	5.0		5.0	
Vehicle Extension (s)		2.0	2.0	2.0	2.0		2.0	2.0	2.0		2.0	
Lane Grp Cap (vph)		1725	796	103	1808		410	411	387		25	
v/s Ratio Prot					0.27		c0.19	0.18			c0.01	
v/s Ratio Perm		c0.41	0.18	0.30					0.02			
v/c Ratio		0.79	0.34	0.57	0.51		0.74	0.73	0.07		0.40	
Uniform Delay, d1		13.6	9.7	11.4	10.9		24.4	24.3	20.2		34.5	
Progression Factor		1.00	1.00	1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2		2.3	0.1	4.7	0.1		6.3	5.7	0.0		3.8	
Delay (s)		15.9	9.8	16.1	11.0		30.7	30.0	20.3		38.3	
Level of Service		B	A	B	B		C	C	C		D	
Approach Delay (s)		14.3			11.3			29.1			38.3	
Approach LOS		B			B			C			D	

Intersection Summary			
HCM Average Control Delay	16.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	70.5	Sum of lost time (s)	15.0
Intersection Capacity Utilization	77.5%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Queues

2: McGrath Highway/Field Street & Southern Artery

8/14/2012



Lane Group	SET	SER	NWL	NWT	NEL	NET	NER	SWT
Lane Group Flow (vph)	1358	478	59	921	305	301	86	13
v/c Ratio	0.75	0.46	0.55	0.48	0.71	0.70	0.19	0.07
Control Delay	15.5	3.2	35.7	10.9	35.5	34.9	9.0	32.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	15.5	3.2	35.7	10.9	35.5	34.9	9.0	32.9
Queue Length 50th (ft)	200	7	14	108	118	117	3	4
Queue Length 95th (ft)	410	59	#89	224	#294	#289	40	24
Internal Link Dist (ft)	527			292		558		61
Turn Bay Length (ft)		175	200				100	
Base Capacity (vph)	2364	1214	141	2478	580	582	595	204
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.57	0.39	0.42	0.37	0.53	0.52	0.14	0.06

Intersection Summary

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

APPENDIX E

AM/PM Peak-Hour Intersection Capacity Analysis 2022 No-Build Scenario

Southern Artery at Sea Street/Coddington Street, Quincy

Southern Artery at McGrath Highway/Field Street, Quincy

HCM Signalized Intersection Capacity Analysis
 1: Coddington St & Southern Artery

8/15/2012



Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↔↔			↔↔	↔↔		↔↔		↔	↔↔	
Volume (vph)	86	340	36	50	783	1277	60	147	86	855	333	218
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	11	11	11	11	12	12	11	11	11
Total Lost time (s)		5.0			5.0	5.0		5.0		5.0	5.0	
Lane Util. Factor		0.95			0.95	0.88		0.95		0.91	0.91	
Frbp, ped/bikes		1.00			1.00	1.00		0.99		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00		1.00		1.00	1.00	
Frnt		0.99			1.00	0.85		0.96		1.00	0.97	
Flt Protected		0.99			1.00	1.00		0.99		0.95	0.98	
Satd. Flow (prot)		3461			3411	2694		3127		1542	3056	
Flt Permitted		0.54			0.86	1.00		0.99		0.95	0.98	
Satd. Flow (perm)		1891			2955	2694		3127		1542	3056	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	91	358	38	53	824	1344	63	155	91	900	351	229
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	16	0
Lane Group Flow (vph)	0	487	0	0	877	1344	0	309	0	495	969	0
Confl. Peds. (#/hr)	3		2	2		3	7		12	12		7
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	8%	8%	8%	3%	3%	3%
Turn Type	pm+pt	NA		pm+pt	NA	pt+ov	Split	NA		Split	NA	
Protected Phases	1	6		5	2	2 8	4	4		8	8	
Permitted Phases	6			2								
Actuated Green, G (s)		40.7			40.7	76.3		15.5		35.6	35.6	
Effective Green, g (s)		40.7			40.7	76.3		15.5		35.6	35.6	
Actuated g/C Ratio		0.35			0.35	0.65		0.13		0.30	0.30	
Clearance Time (s)		5.0			5.0			5.0		5.0	5.0	
Vehicle Extension (s)		2.0			2.0			2.0		2.0	2.0	
Lane Grp Cap (vph)		658			1028	1757		414		469	930	
v/s Ratio Prot						0.50		c0.10		c0.32	0.32	
v/s Ratio Perm		0.26			c0.30							
v/c Ratio		0.90dl			0.85	0.76		0.75		1.06	1.04	
Uniform Delay, d1		33.5			35.4	14.1		48.9		40.7	40.7	
Progression Factor		1.00			1.00	1.00		1.00		1.00	1.00	
Incremental Delay, d2		3.9			6.7	1.8		6.3		57.0	41.0	
Delay (s)		37.4			42.1	16.0		55.2		97.7	81.7	
Level of Service		D			D	B		E		F	F	
Approach Delay (s)		37.4			26.3			55.2			87.0	
Approach LOS		D			C			E			F	

Intersection Summary

HCM Average Control Delay	49.5	HCM Level of Service	D
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	117.0	Sum of lost time (s)	25.2
Intersection Capacity Utilization	89.2%	ICU Level of Service	E
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.

c Critical Lane Group

Queues

1: Coddington St & Southern Artery

8/15/2012



Lane Group	SET	NWT	NWR	NET	SWL	SWT
Lane Group Flow (vph)	487	877	1344	309	495	985
v/c Ratio	0.90dl	0.84	0.72	0.73	1.04	1.03
Control Delay	42.9	45.0	12.5	60.1	92.2	75.5
Queue Delay	0.0	0.0	0.6	0.0	0.0	0.0
Total Delay	42.9	45.0	13.2	60.1	92.2	75.5
Queue Length 50th (ft)	140	267	197	105	353	343
Queue Length 95th (ft)	#313	#553	331	187	#831	#718
Internal Link Dist (ft)	586	527		193		192
Turn Bay Length (ft)			225			
Base Capacity (vph)	667	1043	1861	580	476	959
Starvation Cap Reductn	0	0	206	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.73	0.84	0.81	0.53	1.04	1.03

Intersection Summary

- # 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
- dl Defacto Left Lane. Recode with 1 though lane as a left lane.

HCM Signalized Intersection Capacity Analysis
 2: McGrath Highway/Field St & Southern Artery

8/15/2012



Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↕↕	↗	↖	↕↕		↖	↕	↗		↕↕	
Volume (vph)	2	705	576	64	1558	3	441	4	53	2	9	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	12	12	12	12
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0	5.0	5.0		5.0	
Lane Util. Factor		0.95	1.00	1.00	0.95		0.95	0.95	1.00		1.00	
Frbp, ped/bikes		1.00	0.98	1.00	1.00		1.00	1.00	0.97		0.99	
Flpb, ped/bikes		1.00	1.00	1.00	1.00		1.00	1.00	1.00		1.00	
Frnt		1.00	0.85	1.00	1.00		1.00	1.00	0.85		0.93	
Flt Protected		1.00	1.00	0.95	1.00		0.95	0.95	1.00		1.00	
Satd. Flow (prot)		3388	1491	1722	3454		1609	1615	1524		1472	
Flt Permitted		0.95	1.00	0.33	1.00		0.95	0.95	1.00		1.00	
Satd. Flow (perm)		3223	1491	604	3454		1609	1615	1524		1472	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	2	742	606	67	1640	3	464	4	56	2	9	11
RTOR Reduction (vph)	0	0	265	0	0	0	0	0	43	0	11	0
Lane Group Flow (vph)	0	744	341	67	1643	0	232	236	13	0	11	0
Confl. Peds. (#/hr)	14		8	8		14	1		14	14		1
Heavy Vehicles (%)	3%	3%	3%	1%	1%	1%	3%	3%	3%	2%	20%	20%
Turn Type	Perm	NA	Perm	Perm	NA		Split	NA	Perm	Split	NA	
Protected Phases		6			2		4	4		8	8	
Permitted Phases	6		6	2				4	4			
Actuated Green, G (s)		42.5	42.5	42.5	42.5		16.1	16.1	16.1		1.9	
Effective Green, g (s)		42.5	42.5	42.5	42.5		16.1	16.1	16.1		1.9	
Actuated g/C Ratio		0.56	0.56	0.56	0.56		0.21	0.21	0.21		0.03	
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0	5.0	5.0		5.0	
Vehicle Extension (s)		2.0	2.0	2.0	2.0		2.0	2.0	2.0		2.0	
Lane Grp Cap (vph)		1814	839	340	1944		343	344	325		37	
v/s Ratio Prot					c0.48		0.14	c0.15			c0.01	
v/s Ratio Perm		0.23	0.23	0.11					0.01			
v/c Ratio		0.41	0.41	0.20	0.85		0.68	0.69	0.04		0.30	
Uniform Delay, d1		9.4	9.4	8.1	13.8		27.3	27.4	23.6		36.2	
Progression Factor		1.00	1.00	1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2		0.1	0.1	0.1	3.4		4.1	4.5	0.0		1.7	
Delay (s)		9.4	9.5	8.2	17.2		31.4	31.8	23.6		37.8	
Level of Service		A	A	A	B		C	C	C		D	
Approach Delay (s)		9.4			16.8			30.8			37.8	
Approach LOS		A			B			C			D	

Intersection Summary

HCM Average Control Delay	16.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	75.5	Sum of lost time (s)	15.0
Intersection Capacity Utilization	97.2%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Queues

2: McGrath Highway/Field St & Southern Artery

8/15/2012



Lane Group	SET	SER	NWL	NWT	NEL	NET	NER	SWT
Lane Group Flow (vph)	744	606	67	1643	232	236	56	22
v/c Ratio	0.40	0.54	0.19	0.82	0.65	0.66	0.15	0.15
Control Delay	10.1	3.0	11.0	17.9	39.5	39.9	10.5	32.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	10.1	3.0	11.0	17.9	39.5	39.9	10.5	32.0
Queue Length 50th (ft)	71	0	11	231	90	92	0	4
Queue Length 95th (ft)	176	47	45	546	230	234	32	31
Internal Link Dist (ft)	527			292		558		61
Turn Bay Length (ft)		175	200				100	
Base Capacity (vph)	2546	1305	476	2730	539	541	544	167
Starvation Cap Reductn	0	12	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.29	0.47	0.14	0.60	0.43	0.44	0.10	0.13

Intersection Summary

HCM Signalized Intersection Capacity Analysis
 1: Coddington Street/Sea Street & Southern Artery

8/15/2012



Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↔↔			↔↔	↔↔		↔↔		↔	↔↔	
Volume (vph)	94	788	73	48	423	1135	69	304	77	1059	222	59
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	11	11	11	11	12	12	11	11	11
Total Lost time (s)		5.0			5.0	5.0		5.0		5.0	5.0	
Lane Util. Factor		0.95			0.95	0.88		0.95		0.91	0.91	
Frbp, ped/bikes		1.00			1.00	1.00		0.99		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00		1.00		1.00	1.00	
Frt		0.99			1.00	0.85		0.97		1.00	0.99	
Flt Protected		1.00			0.99	1.00		0.99		0.95	0.97	
Satd. Flow (prot)		3509			3437	2720		3394		1572	3165	
Flt Permitted		0.72			0.58	1.00		0.99		0.95	0.97	
Satd. Flow (perm)		2535			1987	2720		3394		1572	3165	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	99	829	77	51	445	1195	73	320	81	1115	234	62
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	4	0
Lane Group Flow (vph)	0	1005	0	0	496	1195	0	474	0	557	850	0
Confl. Peds. (#/hr)	4		12	12		4	8		21	21		8
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	2%	2%	2%	1%	1%	1%
Turn Type	pm+pt	NA		pm+pt	NA	pt+ov	Split	NA		Split	NA	
Protected Phases	1	6		5	2	2 8	4	4		8	8	
Permitted Phases	6			2								
Actuated Green, G (s)		40.4			40.4	75.7		21.2		35.3	35.3	
Effective Green, g (s)		40.4			40.4	75.7		21.2		35.3	35.3	
Actuated g/C Ratio		0.32			0.32	0.60		0.17		0.28	0.28	
Clearance Time (s)		5.0			5.0			5.0		5.0	5.0	
Vehicle Extension (s)		2.0			2.0			2.0		2.0	2.0	
Lane Grp Cap (vph)		809			634	1626		568		438	883	
v/s Ratio Prot						0.44		c0.14		c0.35	0.27	
v/s Ratio Perm		c0.40			0.25							
v/c Ratio		1.24			0.88dl	0.73		0.83		1.27	1.20dl	
Uniform Delay, d1		43.1			39.1	18.3		51.0		45.6	45.0	
Progression Factor		1.00			1.00	1.00		1.00		1.00	1.00	
Incremental Delay, d2		119.4			5.8	1.5		9.8		139.2	21.5	
Delay (s)		162.5			44.9	19.8		60.8		184.8	66.5	
Level of Service		F			D	B		E		F	E	
Approach Delay (s)		162.5			27.1			60.8			113.2	
Approach LOS		F			C			E			F	

Intersection Summary

HCM Average Control Delay	86.8	HCM Level of Service	F
HCM Volume to Capacity ratio	1.16		
Actuated Cycle Length (s)	126.6	Sum of lost time (s)	29.7
Intersection Capacity Utilization	99.2%	ICU Level of Service	F
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
 c Critical Lane Group

Queues

1: Coddington Street/Sea Street & Southern Artery

8/15/2012



Lane Group	SET	NWT	NWR	NET	SWL	SWT
Lane Group Flow (vph)	1005	496	1195	474	557	854
v/c Ratio	1.23	0.88dl	0.71	0.83	1.26	1.20dl
Control Delay	151.8	49.9	13.4	64.9	171.1	66.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	151.8	49.9	13.4	64.9	171.1	66.0
Queue Length 50th (ft)	~602	215	210	217	~706	~440
Queue Length 95th (ft)	#738	#309	260	#315	#954	#580
Internal Link Dist (ft)	586	527		193		192
Turn Bay Length (ft)			225			
Base Capacity (vph)	816	639	1691	573	443	895
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	1.23	0.78	0.71	0.83	1.26	0.95

Intersection Summary

- ~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
- # 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
- dl Defacto Left Lane. Recode with 1 though lane as a left lane.

HCM Signalized Intersection Capacity Analysis
 2: McGrath Highway/Field Street & Southern Artery

8/15/2012



Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↕↕	↗	↖	↕↕		↖	↕	↗		↕↕	
Volume (vph)	3	1363	565	81	923	1	680	8	89	2	9	3
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	12	12	12	12
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0	5.0	5.0		5.0	
Lane Util. Factor		0.95	1.00	1.00	0.95		0.95	0.95	1.00		1.00	
Frbp, ped/bikes		1.00	0.98	1.00	1.00		1.00	1.00	0.97		0.97	
Flpb, ped/bikes		1.00	1.00	1.00	1.00		1.00	1.00	1.00		1.00	
Frt		1.00	0.85	1.00	1.00		1.00	1.00	0.85		0.97	
Flt Protected		1.00	1.00	0.95	1.00		0.95	0.95	1.00		0.99	
Satd. Flow (prot)		3455	1521	1728	3454		1641	1647	1547		1766	
Flt Permitted		0.95	1.00	0.10	1.00		0.95	0.95	1.00		0.99	
Satd. Flow (perm)		3295	1521	177	3454		1641	1647	1547		1766	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	3	1435	595	85	972	1	716	8	94	2	9	3
RTOR Reduction (vph)	0	0	229	0	0	0	0	0	52	0	3	0
Lane Group Flow (vph)	0	1438	366	85	973	0	365	359	42	0	11	0
Confl. Peds. (#/hr)	13		8	8		13	5		16	16		5
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm	NA	Perm	Perm	NA		Split	NA	Perm	Split	NA	
Protected Phases		6			2		4	4		8	8	
Permitted Phases	6		6	2				4	4			
Actuated Green, G (s)		46.2	46.2	46.2	46.2		20.9	20.9	20.9		1.1	
Effective Green, g (s)		46.2	46.2	46.2	46.2		20.9	20.9	20.9		1.1	
Actuated g/C Ratio		0.56	0.56	0.56	0.56		0.25	0.25	0.25		0.01	
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0	5.0	5.0		5.0	
Vehicle Extension (s)		2.0	2.0	2.0	2.0		2.0	2.0	2.0		2.0	
Lane Grp Cap (vph)		1830	845	98	1918		412	414	389			23
v/s Ratio Prot					0.28		c0.22	0.22				c0.01
v/s Ratio Perm		0.44	0.24	c0.48					0.03			
v/c Ratio		0.79	0.43	0.87	0.51		0.89	0.87	0.11			0.48
Uniform Delay, d1		14.6	10.8	15.9	11.5		30.0	29.8	24.0			40.8
Progression Factor		1.00	1.00	1.00	1.00		1.00	1.00	1.00			1.00
Incremental Delay, d2		2.1	0.1	49.2	0.1		19.3	16.6	0.0			5.6
Delay (s)		16.7	11.0	65.1	11.5		49.3	46.4	24.0			46.4
Level of Service		B	B	E	B		D	D	C			D
Approach Delay (s)		15.0			15.8			45.1				46.4
Approach LOS		B			B			D				D

Intersection Summary

HCM Average Control Delay	21.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	83.2	Sum of lost time (s)	15.0
Intersection Capacity Utilization	101.4%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Queues

2: McGrath Highway/Field Street & Southern Artery

8/15/2012



Lane Group	SET	SER	NWL	NWT	NEL	NET	NER	SWT
Lane Group Flow (vph)	1438	595	85	973	365	359	94	14
v/c Ratio	0.75	0.54	0.83	0.48	0.84	0.83	0.21	0.10
Control Delay	16.4	3.9	74.8	11.4	47.6	45.9	11.0	33.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	16.5	3.9	74.8	11.4	47.6	45.9	11.0	33.8
Queue Length 50th (ft)	242	16	30	128	171	167	9	5
Queue Length 95th (ft)	452	89	#140	241	#382	#372	49	25
Internal Link Dist (ft)	527			292		558		61
Turn Bay Length (ft)		175	200				100	
Base Capacity (vph)	1924	1101	103	2017	458	459	481	163
Starvation Cap Reductn	2	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.75	0.54	0.83	0.48	0.80	0.78	0.20	0.09

Intersection Summary

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

APPENDIX F

AM/PM Peak-Hour Intersection Capacity Analysis 2022 Alternative 1

Southern Artery at Sea Street/Coddington Street, Quincy

Southern Artery at McGrath Highway/Field Street, Quincy

HCM Signalized Intersection Capacity Analysis

1: Coddington St & Southern Artery

8/15/2012



Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↔			↔	↔		↔		↔	↔	
Volume (vph)	86	340	36	50	783	1277	60	147	86	855	333	218
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	11	11	11	11	12	12	11	11	11
Total Lost time (s)		5.0			5.0	5.0		5.0		5.0	5.0	
Lane Util. Factor		0.95			0.95	0.88		0.95		0.91	0.91	
Frb, ped/bikes		1.00			1.00	1.00		0.99		1.00	1.00	
Ftp, ped/bikes		1.00			1.00	1.00		1.00		1.00	1.00	
Frt		0.99			1.00	0.85		0.96		1.00	0.97	
Flt Protected		0.99			1.00	1.00		0.99		0.95	0.98	
Satd. Flow (prot)		3461			3411	2694		3124		1542	3056	
Flt Permitted		0.52			0.84	1.00		0.99		0.95	0.98	
Satd. Flow (perm)		1826			2886	2694		3124		1542	3056	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	91	358	38	53	824	1344	63	155	91	900	351	229
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	17	0
Lane Group Flow (vph)	0	487	0	0	877	1344	0	309	0	495	968	0
Confl. Peds. (#/hr)	3		2	2		3	7		12	12		7
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	8%	8%	8%	3%	3%	3%
Turn Type	pm+pt	NA		pm+pt	NA	pt+ov	Split	NA		Split	NA	
Protected Phases	1	6		5	2	2 8	4	4		8	8	
Permitted Phases	6			2								
Actuated Green, G (s)		40.4			40.4	82.8		14.9		42.4	42.4	
Effective Green, g (s)		40.4			40.4	82.8		14.9		42.4	42.4	
Actuated g/C Ratio		0.33			0.33	0.67		0.12		0.34	0.34	
Clearance Time (s)		5.0			5.0			5.0		5.0	5.0	
Vehicle Extension (s)		2.0			2.0			2.0		2.0	2.0	
Lane Grp Cap (vph)		599			946	1811		378		531	1052	
v/s Ratio Prot						0.50		c0.10		c0.32	0.32	
v/s Ratio Perm		0.27			c0.30							
v/c Ratio		1.08dl			0.93	0.74		0.82		0.93	0.92	
Uniform Delay, d1		37.9			40.0	13.2		52.8		39.0	38.8	
Progression Factor		1.00			1.00	1.00		1.00		1.00	1.00	
Incremental Delay, d2		7.9			14.4	1.5		12.2		23.2	12.5	
Delay (s)		45.8			54.4	14.7		65.0		62.2	51.3	
Level of Service		D			D	B		E		E	D	
Approach Delay (s)		45.8			30.4			65.0			54.9	
Approach LOS		D			C			E			D	

Intersection Summary

HCM Average Control Delay	42.5	HCM Level of Service	D
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	123.2	Sum of lost time (s)	25.5
Intersection Capacity Utilization	89.2%	ICU Level of Service	E
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.

c Critical Lane Group

Queues

1: Coddington St & Southern Artery

8/15/2012



Lane Group	SET	NWT	NWR	NET	SWL	SWT
Lane Group Flow (vph)	487	877	1344	309	495	985
v/c Ratio	1.08dl	0.91	0.70	0.80	0.92	0.91
Control Delay	50.0	54.6	10.7	69.7	63.0	50.7
Queue Delay	0.0	0.0	0.7	0.0	0.0	0.0
Total Delay	50.0	54.6	11.4	69.7	63.0	50.7
Queue Length 50th (ft)	160	304	201	114	356	345
Queue Length 95th (ft)	#326	#570	302	#231	#759	#643
Internal Link Dist (ft)	586	527		193		192
Turn Bay Length (ft)			225			
Base Capacity (vph)	608	960	1909	389	538	1084
Starvation Cap Reductn	0	0	248	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.80	0.91	0.81	0.79	0.92	0.91

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

dl Defacto Left Lane. Recode with 1 though lane as a left lane.

HCM Signalized Intersection Capacity Analysis
 2: McGrath Highway/Field St & Southern Artery

8/15/2012



Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↕↕	↗	↖	↕↕		↖	↗	↗		↕↕	
Volume (vph)	2	705	576	64	1558	3	441	4	53	2	9	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	12	12	12	12
Total Lost time (s)		5.0	5.0	3.5	5.0		5.0	5.0	5.0		5.0	
Lane Util. Factor		0.95	1.00	1.00	0.95		0.95	0.95	1.00		1.00	
Frbp, ped/bikes		1.00	0.98	1.00	1.00		1.00	1.00	0.97		0.99	
Flpb, ped/bikes		1.00	1.00	1.00	1.00		1.00	1.00	1.00		1.00	
Frt		1.00	0.85	1.00	1.00		1.00	1.00	0.85		0.93	
Flt Protected		1.00	1.00	0.95	1.00		0.95	0.95	1.00		1.00	
Satd. Flow (prot)		3388	1490	1727	3454		1609	1615	1525		1474	
Flt Permitted		0.95	1.00	0.28	1.00		0.95	0.95	1.00		1.00	
Satd. Flow (perm)		3222	1490	512	3454		1609	1615	1525		1474	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	2	742	606	67	1640	3	464	4	56	2	9	11
RTOR Reduction (vph)	0	0	318	0	0	0	0	0	45	0	11	0
Lane Group Flow (vph)	0	744	288	67	1643	0	232	236	11	0	11	0
Confl. Peds. (#/hr)	14		8	8		14	1		14	14		1
Heavy Vehicles (%)	3%	3%	3%	1%	1%	1%	3%	3%	3%	2%	20%	20%
Turn Type	Perm	NA	Perm	pm+pt	NA		Split	NA	Perm	Split	NA	
Protected Phases		6		5	2		4	4		8	8	
Permitted Phases	6		6	2				4	4			
Actuated Green, G (s)		33.3	33.3	39.2	39.2		13.7	13.7	13.7		2.1	
Effective Green, g (s)		33.3	33.3	39.2	39.2		13.7	13.7	13.7		2.1	
Actuated g/C Ratio		0.48	0.48	0.56	0.56		0.20	0.20	0.20		0.03	
Clearance Time (s)		5.0	5.0	3.5	5.0		5.0	5.0	5.0		5.0	
Vehicle Extension (s)		2.0	2.0	3.0	2.0		2.0	2.0	2.0		2.0	
Lane Grp Cap (vph)		1533	709	328	1934		315	316	298		44	
v/s Ratio Prot				0.01	c0.48		0.14	c0.15			c0.01	
v/s Ratio Perm		0.23	0.19	0.11					0.01			
v/c Ratio		0.49	0.41	0.20	0.85		0.74	0.75	0.04		0.26	
Uniform Delay, d1		12.5	11.9	7.7	12.9		26.5	26.5	22.8		33.2	
Progression Factor		1.00	1.00	1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2		0.1	0.1	0.3	3.6		7.5	8.2	0.0		1.1	
Delay (s)		12.6	12.1	8.0	16.5		34.0	34.7	22.8		34.3	
Level of Service		B	B	A	B		C	C	C		C	
Approach Delay (s)		12.4			16.1			33.1			34.3	
Approach LOS		B			B			C			C	

Intersection Summary

HCM Average Control Delay	17.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	97.2%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Queues

2: McGrath Highway/Field St & Southern Artery

8/15/2012



Lane Group	SET	SER	NWL	NWT	NEL	NET	NER	SWT
Lane Group Flow (vph)	744	606	67	1643	232	236	56	22
v/c Ratio	0.45	0.57	0.17	0.83	0.69	0.70	0.15	0.14
Control Delay	14.6	4.2	9.3	19.2	36.9	37.3	8.6	25.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	14.6	4.2	9.3	19.2	36.9	37.3	8.6	25.8
Queue Length 50th (ft)	89	0	8	198	85	87	0	4
Queue Length 95th (ft)	208	64	36	#577	186	189	28	27
Internal Link Dist (ft)	527			292		558		61
Turn Bay Length (ft)		175	200				100	
Base Capacity (vph)	1663	1061	393	2138	485	486	498	174
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.45	0.57	0.17	0.77	0.48	0.49	0.11	0.13

Intersection Summary

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

HCM Signalized Intersection Capacity Analysis

1: Coddington Street/Sea Street & Southern Artery

8/15/2012



Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↕↕			↕↕	↕↕		↕↕		↕	↕↕	
Volume (vph)	94	788	73	48	423	1135	69	304	77	1059	222	59
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	11	11	11	11	12	12	11	11	11
Total Lost time (s)		5.0			5.0	5.0		5.0		5.0	5.0	
Lane Util. Factor		0.95			0.95	0.88		0.95		0.91	0.91	
Frbp, ped/bikes		1.00			1.00	1.00		0.99		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00		1.00		1.00	1.00	
Frnt		0.99			1.00	0.85		0.97		1.00	0.99	
Flt Protected		1.00			0.99	1.00		0.99		0.95	0.97	
Satd. Flow (prot)		3509			3437	2720		3388		1572	3165	
Flt Permitted		0.73			0.60	1.00		0.99		0.95	0.97	
Satd. Flow (perm)		2582			2084	2720		3388		1572	3165	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	99	829	77	51	445	1195	73	320	81	1115	234	62
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	4	0
Lane Group Flow (vph)	0	1005	0	0	496	1195	0	474	0	557	850	0
Confl. Peds. (#/hr)	4		12	12		4	8		21	21		8
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	2%	2%	2%	1%	1%	1%
Turn Type	pm+pt	NA		pm+pt	NA	pt+ov	Split	NA		Split	NA	
Protected Phases	1	6		5	2	2 8	4	4		8	8	
Permitted Phases	6			2								
Actuated Green, G (s)		44.4			44.4	80.7		17.2		36.3	36.3	
Effective Green, g (s)		44.4			44.4	80.7		17.2		36.3	36.3	
Actuated g/C Ratio		0.35			0.35	0.63		0.13		0.28	0.28	
Clearance Time (s)		5.0			5.0			5.0		5.0	5.0	
Vehicle Extension (s)		2.0			2.0			2.0		2.0	2.0	
Lane Grp Cap (vph)		898			725	1720		457		447	900	
v/s Ratio Prot						0.44		c0.14		c0.35	0.27	
v/s Ratio Perm		c0.39			0.24							
v/c Ratio		1.12			0.68	0.69		1.04		1.25	1.17dl	
Uniform Delay, d1		41.6			35.6	15.4		55.2		45.6	44.7	
Progression Factor		1.00			1.00	1.00		1.00		1.00	1.00	
Incremental Delay, d2		68.4			2.1	1.0		52.1		128.3	17.8	
Delay (s)		110.0			37.7	16.4		107.3		174.0	62.5	
Level of Service		F			D	B		F		F	E	
Approach Delay (s)		110.0			22.6			107.3			106.5	
Approach LOS		F			C			F			F	

Intersection Summary

HCM Average Control Delay	76.4	HCM Level of Service	E
HCM Volume to Capacity ratio	1.15		
Actuated Cycle Length (s)	127.6	Sum of lost time (s)	29.7
Intersection Capacity Utilization	99.2%	ICU Level of Service	F
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.

c Critical Lane Group

Queues

1: Coddington Street/Sea Street & Southern Artery

8/15/2012



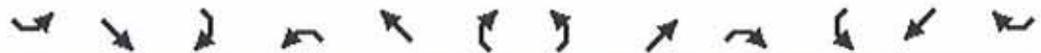
Lane Group	SET	NWT	NWR	NET	SWL	SWT
Lane Group Flow (vph)	1005	496	1195	474	557	854
v/c Ratio	1.11	0.68	0.67	1.03	1.23	1.17dl
Control Delay	103.1	42.5	11.1	104.1	161.8	62.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	103.1	42.5	11.1	104.1	161.8	62.7
Queue Length 50th (ft)	~566	204	194	~253	~703	~435
Queue Length 95th (ft)	#703	275	240	#367	#952	#575
Internal Link Dist (ft)	586	527		193		192
Turn Bay Length (ft)			225			
Base Capacity (vph)	907	732	1786	459	452	913
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	1.11	0.68	0.67	1.03	1.23	0.94

Intersection Summary

- ~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
- # 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
- dl Defacto Left Lane. Recode with 1 though lane as a left lane.

HCM Signalized Intersection Capacity Analysis
 2: McGrath Highway/Field Street & Southern Artery

8/15/2012



Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↕↕	↗	↖	↕↕		↖	↕	↗		↕↕	
Volume (vph)	3	1363	565	81	923	1	680	8	89	2	9	3
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	12	12	12	12
Total Lost time (s)		5.0	5.0	3.5	5.0		5.0	5.0	5.0		5.0	
Lane Util. Factor		0.95	1.00	1.00	0.95		0.95	0.95	1.00		1.00	
Frbp, ped/bikes		1.00	0.98	1.00	1.00		1.00	1.00	0.97		0.97	
Flpb, ped/bikes		1.00	1.00	1.00	1.00		1.00	1.00	1.00		1.00	
Frt		1.00	0.85	1.00	1.00		1.00	1.00	0.85		0.97	
Flt Protected		1.00	1.00	0.95	1.00		0.95	0.95	1.00		0.99	
Satd. Flow (prot)		3455	1520	1728	3454		1641	1647	1547		1766	
Flt Permitted		0.95	1.00	0.09	1.00		0.95	0.95	1.00		0.99	
Satd. Flow (perm)		3294	1520	169	3454		1641	1647	1547		1766	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	3	1435	595	85	972	1	716	8	94	2	9	3
RTOR Reduction (vph)	0	0	237	0	0	0	0	0	51	0	3	0
Lane Group Flow (vph)	0	1438	358	85	973	0	365	359	43	0	11	0
Confl. Peds. (#/hr)	13		8	8		13	5		16	16		5
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm	NA	Perm	pm+pt	NA		Split	NA	Perm	Split	NA	
Protected Phases		6		5	2		4	4		8	8	
Permitted Phases	6		6	2				4	4			
Actuated Green, G (s)		39.6	39.6	46.6	46.6		20.2	20.2	20.2		1.1	
Effective Green, g (s)		39.6	39.6	46.6	46.6		20.2	20.2	20.2		1.1	
Actuated g/C Ratio		0.48	0.48	0.56	0.56		0.24	0.24	0.24		0.01	
Clearance Time (s)		5.0	5.0	3.5	5.0		5.0	5.0	5.0		5.0	
Vehicle Extension (s)		2.0	2.0	3.0	2.0		2.0	2.0	2.0		2.0	
Lane Grp Cap (vph)		1573	726	161	1942		400	401	377		23	
v/s Ratio Prot				0.02	c0.28		c0.22	0.22			c0.01	
v/s Ratio Perm		c0.44	0.24	0.28					0.03			
v/c Ratio		0.91	0.49	0.53	0.50		0.91	0.90	0.11		0.48	
Uniform Delay, d1		20.1	14.8	14.7	11.1		30.5	30.3	24.4		40.6	
Progression Factor		1.00	1.00	1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2		8.4	0.2	3.1	0.1		24.3	21.2	0.0		5.6	
Delay (s)		28.5	15.0	17.8	11.1		54.8	51.5	24.4		46.3	
Level of Service		C	B	B	B		D	D	C		D	
Approach Delay (s)		24.5			11.7			49.9			46.3	
Approach LOS		C			B			D			D	

Intersection Summary			
HCM Average Control Delay	26.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	82.9	Sum of lost time (s)	20.0
Intersection Capacity Utilization	101.4%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Queues

2: McGrath Highway/Field Street & Southern Artery

8/15/2012



Lane Group	SET	SER	NWL	NWT	NEL	NET	NER	SWT
Lane Group Flow (vph)	1438	595	85	973	365	359	94	14
v/c Ratio	0.86	0.60	0.44	0.48	0.86	0.84	0.21	0.10
Control Delay	24.9	6.6	14.3	10.6	51.1	49.2	12.1	33.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	24.9	6.6	14.3	10.6	51.1	49.2	12.1	33.8
Queue Length 50th (ft)	298	35	14	118	177	174	10	5
Queue Length 95th (ft)	#570	151	42	228	#405	#395	52	25
Internal Link Dist (ft)	527			292		558		61
Turn Bay Length (ft)		175	200				100	
Base Capacity (vph)	1703	1004	193	2142	424	425	449	165
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.84	0.59	0.44	0.45	0.86	0.84	0.21	0.08

Intersection Summary

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

APPENDIX G

AM/PM Peak-Hour Intersection Capacity Analysis 2022 Alternative 2

Southern Artery at Sea Street/Coddington Street, Quincy

Southern Artery at McGrath Highway/Field Street, Quincy

HCM Signalized Intersection Capacity Analysis
 1: Coddington St/Sea Street & Southern Artery

9/11/2012



Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR	
Lane Configurations		↔↔			↔↔	↔↔		↔↔		↔	↔↔		
Volume (vph)	86	340	36	50	783	1277	60	147	86	855	333	218	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	
Lane Width	12	12	12	11	11	11	11	12	12	11	11	11	
Total Lost time (s)		5.0			5.0	5.0		5.0		5.0	5.0		
Lane Util. Factor		0.95			0.95	0.88		0.95		0.91	0.91		
Frbp, ped/bikes		1.00			1.00	1.00		0.99		1.00	1.00		
Flpb, ped/bikes		1.00			1.00	1.00		1.00		1.00	1.00		
Frt		0.99			1.00	0.85		0.96		1.00	0.97		
Flt Protected		0.99			1.00	1.00		0.99		0.95	0.98		
Satd. Flow (prot)		3461			3411	2694		3121		1542	3056		
Flt Permitted		0.55			0.87	1.00		0.99		0.95	0.98		
Satd. Flow (perm)		1936			2965	2694		3121		1542	3056		
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	
Adj. Flow (vph)	91	358	38	53	824	1344	63	155	91	900	351	229	
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	19	0	
Lane Group Flow (vph)	0	487	0	0	877	1344	0	309	0	495	966	0	
Confl. Peds. (#/hr)	3		2	2		3	7		12	12		7	
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	8%	8%	8%	3%	3%	3%	
Turn Type	pm+pt	NA		pm+pt	NA	pt+ov	Split	NA		Split	NA		
Protected Phases	1	6		5	2	2 8	4	4		8	8		
Permitted Phases	6			2									
Actuated Green, G (s)		55.5			55.5	98.6		15.0		43.1	43.1		
Effective Green, g (s)		55.5			55.5	98.6		15.0		43.1	43.1		
Actuated g/C Ratio		0.40			0.40	0.70		0.11		0.31	0.31		
Clearance Time (s)		5.0			5.0			5.0		5.0	5.0		
Vehicle Extension (s)		2.0			2.0			2.0		2.0	2.0		
Lane Grp Cap (vph)		767			1175	1897		334		475	941		
v/s Ratio Prot						0.50		c0.10		c0.32	0.32		
v/s Ratio Perm		0.25			c0.30								
v/c Ratio		0.63			0.75	0.71		0.93		1.04	1.03		
Uniform Delay, d1		34.1			36.2	12.2		61.9		48.4	48.4		
Progression Factor		1.00			0.88	0.73		1.00		1.00	1.00		
Incremental Delay, d2		1.3			1.6	0.7		30.1		52.7	36.4		
Delay (s)		35.4			33.4	9.6		92.1		101.1	84.8		
Level of Service		D			C	A		F		F	F		
Approach Delay (s)		35.4			19.0			92.1			90.3		
Approach LOS		D			B			F			F		
Intersection Summary													
HCM Average Control Delay		49.3			HCM Level of Service						D		
HCM Volume to Capacity ratio		0.88											
Actuated Cycle Length (s)		140.0			Sum of lost time (s)					26.4			
Intersection Capacity Utilization		89.2%			ICU Level of Service					E			
Analysis Period (min)		15											

c Critical Lane Group

Queues

1: Coddington St/Sea Street & Southern Artery

9/11/2012



Lane Group	SET	NWT	NWR	NET	SWL	SWT
Lane Group Flow (vph)	487	877	1344	309	495	985
v/c Ratio	0.61	0.72	0.68	0.93	1.04	1.03
Control Delay	39.1	35.2	6.9	94.8	99.6	82.0
Queue Delay	0.0	0.0	0.4	0.0	0.0	0.0
Total Delay	39.1	35.2	7.2	94.8	99.6	82.0
Queue Length 50th (ft)	156	276	174	148	~547	~527
Queue Length 95th (ft)	288	#532	139	#241	#792	#671
Internal Link Dist (ft)	586	527		193		192
Turn Bay Length (ft)			225			
Base Capacity (vph)	793	1215	1990	335	475	959
Starvation Cap Reductn	0	0	206	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.61	0.72	0.75	0.92	1.04	1.03

Intersection Summary

- ~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
- # 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis
 2: McGrath Highway/Field St & Southern Artery

9/11/2012



Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↕↕	↗	↖	↕↕		↗	↖	↗		↕↕	
Volume (vph)	2	705	576	64	1558	3	441	4	53	2	9	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	12	12	12	12
Total Lost time (s)		5.0	5.0	3.5	5.0		5.0	5.0	5.0		5.0	
Lane Util. Factor		0.95	1.00	1.00	0.95		0.95	0.95	1.00		1.00	
Frbp, ped/bikes		1.00	0.98	1.00	1.00		1.00	1.00	0.97		0.99	
Flpb, ped/bikes		1.00	1.00	1.00	1.00		1.00	1.00	1.00		1.00	
Frnt		1.00	0.85	1.00	1.00		1.00	1.00	0.85		0.93	
Flt Protected		1.00	1.00	0.95	1.00		0.95	0.95	1.00		1.00	
Satd. Flow (prot)		3388	1489	1727	3454		1609	1615	1525		1475	
Flt Permitted		0.95	1.00	0.27	1.00		0.95	0.95	1.00		1.00	
Satd. Flow (perm)		3221	1489	489	3454		1609	1615	1525		1475	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	2	742	606	67	1640	3	464	4	56	2	9	11
RTOR Reduction (vph)	0	0	338	0	0	0	0	0	44	0	11	0
Lane Group Flow (vph)	0	744	268	67	1643	0	232	236	12	0	11	0
Confl. Peds. (#/hr)	14		8	8		14	1		14	14		1
Heavy Vehicles (%)	3%	3%	3%	1%	1%	1%	3%	3%	3%	2%	20%	20%
Turn Type	Perm	NA	Perm	pm+pt	NA		Split	NA	Perm	Split	NA	
Protected Phases		6		5	2		4	4		8	8	
Permitted Phases	6		6	2				4	4			
Actuated Green, G (s)		31.0	31.0	38.0	38.0		14.4	14.4	14.4		2.6	
Effective Green, g (s)		31.0	31.0	38.0	38.0		14.4	14.4	14.4		2.6	
Actuated g/C Ratio		0.44	0.44	0.54	0.54		0.21	0.21	0.21		0.04	
Clearance Time (s)		5.0	5.0	3.5	5.0		5.0	5.0	5.0		5.0	
Vehicle Extension (s)		2.0	2.0	3.0	2.0		2.0	2.0	2.0		2.0	
Lane Grp Cap (vph)		1426	659	327	1875		331	332	314		55	
v/s Ratio Prot				0.01	c0.48		0.14	c0.15			c0.01	
v/s Ratio Perm		0.23	0.18	0.10					0.01			
v/c Ratio		0.52	0.41	0.20	0.88		0.70	0.71	0.04		0.21	
Uniform Delay, d1		14.1	13.3	8.3	14.0		25.8	25.9	22.2		32.7	
Progression Factor		1.11	3.78	1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2		0.1	0.1	0.3	6.1		5.4	5.9	0.0		0.7	
Delay (s)		15.8	50.2	8.6	20.1		31.2	31.7	22.3		33.4	
Level of Service		B	D	A	C		C	C	C		C	
Approach Delay (s)		31.2			19.6			30.5			33.4	
Approach LOS		C			B			C			C	

Intersection Summary		
HCM Average Control Delay	25.6	HCM Level of Service C
HCM Volume to Capacity ratio	0.80	
Actuated Cycle Length (s)	70.0	Sum of lost time (s) 15.0
Intersection Capacity Utilization	97.2%	ICU Level of Service F
Analysis Period (min)	15	

c Critical Lane Group

Queues

2: McGrath Highway/Field St & Southern Artery

9/11/2012



Lane Group	SET	SER	NWL	NWT	NEL	NET	NER	SWT
Lane Group Flow (vph)	744	606	67	1643	232	236	56	22
v/c Ratio	0.46	0.58	0.17	0.81	0.70	0.71	0.16	0.16
Control Delay	16.4	6.6	10.0	20.3	37.0	37.5	7.4	23.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	16.4	6.6	10.0	20.3	37.0	37.5	7.4	23.5
Queue Length 50th (ft)	187	126	8	212	97	100	0	5
Queue Length 95th (ft)	m155	m129	38	#576	158	161	24	24
Internal Link Dist (ft)	527			292		558		61
Turn Bay Length (ft)		175	200				100	
Base Capacity (vph)	1630	1051	400	2026	437	438	455	158
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.46	0.58	0.17	0.81	0.53	0.54	0.12	0.14

Intersection Summary

- # 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
- m Volume for 95th percentile queue is metered by upstream signal.

HCM Signalized Intersection Capacity Analysis
 1: Coddington Street/Sea Street & Southern Artery

8/15/2012



Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↔↔			↔↔	↔↔		↔↔		↔	↔↔	
Volume (vph)	94	788	73	48	423	1135	69	304	77	1059	222	59
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	11	11	11	11	12	12	11	11	11
Total Lost time (s)		5.0			5.0	5.0		5.0		5.0	5.0	
Lane Util. Factor		0.95			0.95	0.88		0.95		0.91	0.91	
Frbp, ped/bikes		1.00			1.00	1.00		0.99		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00		1.00		1.00	1.00	
Frt		0.99			1.00	0.85		0.97		1.00	0.99	
Flt Protected		1.00			0.99	1.00		0.99		0.95	0.97	
Satd. Flow (prot)		3510			3437	2720		3388		1572	3165	
Flt Permitted		0.75			0.64	1.00		0.99		0.95	0.97	
Satd. Flow (perm)		2655			2206	2720		3388		1572	3165	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	99	829	77	51	445	1195	73	320	81	1115	234	62
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	4	0
Lane Group Flow (vph)	0	1005	0	0	496	1195	0	474	0	557	850	0
Confl. Peds. (#/hr)	4		12	12		4	8		21	21		8
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	2%	2%	2%	1%	1%	1%
Turn Type	pm+pt	NA		pm+pt	NA	pt+ov	Split	NA		Split	NA	
Protected Phases	1	6		5	2	2 8	4	4		8	8	
Permitted Phases	6			2								
Actuated Green, G (s)		56.7			56.7	90.7		18.7		34.0	34.0	
Effective Green, g (s)		56.7			56.7	90.7		18.7		34.0	34.0	
Actuated g/C Ratio		0.41			0.41	0.65		0.13		0.24	0.24	
Clearance Time (s)		5.0			5.0			5.0		5.0	5.0	
Vehicle Extension (s)		2.0			2.0			2.0		2.0	2.0	
Lane Grp Cap (vph)		1075			893	1762		453		382	769	
v/s Ratio Prot						0.44		c0.14		c0.35	0.27	
v/s Ratio Perm		c0.38			0.22							
v/c Ratio		0.93			0.56	0.68		1.05		1.46	1.39dl	
Uniform Delay, d1		39.9			32.0	15.5		60.6		53.0	53.0	
Progression Factor		1.00			0.85	0.70		1.00		1.00	1.00	
Incremental Delay, d2		14.2			0.3	0.7		54.9		220.2	65.3	
Delay (s)		54.0			27.6	11.5		115.6		273.2	118.3	
Level of Service		D			C	B		F		F	F	
Approach Delay (s)		54.0			16.2			115.6			179.5	
Approach LOS		D			B			F			F	

Intersection Summary

HCM Average Control Delay	85.1	HCM Level of Service	F
HCM Volume to Capacity ratio	1.12		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	30.6
Intersection Capacity Utilization	99.2%	ICU Level of Service	F
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
 c Critical Lane Group

Queues

1: Coddington Street/Sea Street & Southern Artery

8/15/2012



Lane Group	SET	NWT	NWR	NET	SWL	SWT
Lane Group Flow (vph)	1005	496	1195	474	557	854
v/c Ratio	0.91	0.54	0.66	1.05	1.46	1.39dl
Control Delay	52.9	30.1	7.8	112.6	258.1	113.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	52.9	30.1	7.8	112.6	258.1	113.6
Queue Length 50th (ft)	-518	168	202	-279	-760	-485
Queue Length 95th (ft)	#654	m233	288	#394	#1013	#626
Internal Link Dist (ft)	586	527		193		192
Turn Bay Length (ft)			225			
Base Capacity (vph)	1099	912	1824	452	382	772
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.91	0.54	0.66	1.05	1.46	1.11

Intersection Summary

- Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
- # 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
- m Volume for 95th percentile queue is metered by upstream signal.
- dl Defacto Left Lane. Recode with 1 though lane as a left lane.

HCM Signalized Intersection Capacity Analysis
 2: McGrath Highway/Field Street & Southern Artery

8/15/2012



Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↕↕	↗	↖	↕↕		↗	↖	↗		↕↕	
Volume (vph)	3	1363	565	81	923	1	680	8	89	2	9	3
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	12	12	12	12
Total Lost time (s)		5.0	5.0	4.0	5.0		5.0	5.0	5.0		5.0	
Lane Util. Factor		0.95	1.00	1.00	0.95		0.95	0.95	1.00		1.00	
Frbp, ped/bikes		1.00	0.98	1.00	1.00		1.00	1.00	0.95		0.98	
Flpb, ped/bikes		1.00	1.00	1.00	1.00		1.00	1.00	1.00		1.00	
Frt		1.00	0.85	1.00	1.00		1.00	1.00	0.85		0.97	
Flt Protected		1.00	1.00	0.95	1.00		0.95	0.95	1.00		0.99	
Satd. Flow (prot)		3455	1521	1728	3454		1641	1647	1524		1778	
Flt Permitted		0.95	1.00	0.08	1.00		0.95	0.95	1.00		0.99	
Satd. Flow (perm)		3294	1521	154	3454		1641	1647	1524		1778	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	3	1435	595	85	972	1	716	8	94	2	9	3
RTOR Reduction (vph)	0	0	148	0	0	0	0	0	35	0	3	0
Lane Group Flow (vph)	0	1438	447	85	973	0	365	359	59	0	11	0
Confl. Peds. (#/hr)	13		8	8		13	5		16	16		5
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm	NA	Perm	pm+pt	NA		Split	NA	Perm	Split	NA	
Protected Phases		6		5	2		4	4		8	8	
Permitted Phases	6		6	2				4	4			
Actuated Green, G (s)		77.6	77.6	87.9	87.9		34.5	34.5	34.5		2.6	
Effective Green, g (s)		77.6	77.6	87.9	87.9		34.5	34.5	34.5		2.6	
Actuated g/C Ratio		0.55	0.55	0.63	0.63		0.25	0.25	0.25		0.02	
Clearance Time (s)		5.0	5.0	4.0	5.0		5.0	5.0	5.0		5.0	
Vehicle Extension (s)		2.0	2.0	3.0	2.0		2.0	2.0	2.0		2.0	
Lane Grp Cap (vph)		1826	843	168	2169		404	406	376		33	
v/s Ratio Prot				0.02	c0.28		c0.22	0.22			c0.01	
v/s Ratio Perm		c0.44	0.29	0.30					0.04			
v/c Ratio		0.79	0.53	0.51	0.45		0.90	0.88	0.16		0.34	
Uniform Delay, d1		24.7	19.7	19.6	13.5		51.1	50.8	41.4		67.8	
Progression Factor		0.74	0.92	1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2		0.3	0.2	2.4	0.7		22.5	19.4	0.1		2.2	
Delay (s)		18.6	18.2	22.0	14.2		73.7	70.2	41.4		70.0	
Level of Service		B	B	C	B		E	E	D		E	
Approach Delay (s)		18.5			14.8			68.4			70.0	
Approach LOS		B			B			E			E	

Intersection Summary		
HCM Average Control Delay	28.1	HCM Level of Service C
HCM Volume to Capacity ratio	0.81	
Actuated Cycle Length (s)	140.0	Sum of lost time (s) 20.0
Intersection Capacity Utilization	101.4%	ICU Level of Service G
Analysis Period (min)	15	

c Critical Lane Group

Queues

2: McGrath Highway/Field Street & Southern Artery

8/15/2012



Lane Group	SET	SER	NWL	NWT	NEL	NET	NER	SWT
Lane Group Flow (vph)	1438	595	85	973	365	359	94	14
v/c Ratio	0.76	0.59	0.49	0.43	0.90	0.88	0.23	0.17
Control Delay	18.3	8.2	22.8	14.0	76.6	73.9	22.8	59.2
Queue Delay	0.8	0.7	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	19.1	8.9	22.8	14.0	76.6	73.9	22.8	59.2
Queue Length 50th (ft)	295	80	25	206	330	323	33	10
Queue Length 95th (ft)	m287	m102	#71	323	#495	#481	81	34
Internal Link Dist (ft)	527			292		558		61
Turn Bay Length (ft)		175	200				100	
Base Capacity (vph)	1896	1016	172	2242	445	447	447	93
Starvation Cap Reductn	193	164	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.84	0.70	0.49	0.43	0.82	0.80	0.21	0.15

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

m Volume for 95th percentile queue is metered by upstream signal.

APPENDIX H

AM/PM Peak-Hour Intersection Capacity Analysis 2022 Alternative 3

Southern Artery at Sea Street/Coddington Street, Quincy

HCM Signalized Intersection Capacity Analysis
1: Coddington St & Southern Artery

8/16/2012



Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	86	340	36	50	783	1277	60	147	86	855	333	218
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	11	11	11	11	12	12	11	11	11
Total Lost time (s)	4.0	5.0		4.0	5.0	5.0		5.0		5.0	5.0	
Lane Util. Factor	1.00	0.95		1.00	0.91	0.91		0.95		0.91	0.91	
Frbp, ped/bikes	1.00	1.00		1.00	1.00	1.00		0.99		1.00	0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00		1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.98	0.85		0.96		1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.99		0.95	0.98	
Satd. Flow (prot)	1769	3483		1710	1601	2786		3122		1542	3044	
Flt Permitted	0.16	1.00		0.51	1.00	1.00		0.99		0.95	0.98	
Satd. Flow (perm)	290	3483		914	1601	2786		3122		1542	3044	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	91	358	38	53	824	1344	63	155	91	900	351	229
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	18	0
Lane Group Flow (vph)	91	396	0	53	958	1210	0	309	0	495	967	0
Confl. Peds. (#/hr)	3		2	2		3	7		12	12		7
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	8%	8%	8%	3%	3%	3%
Turn Type	pm+pt	NA		pm+pt	NA	pt+ov	Split	NA		Split	NA	
Protected Phases	1	6		5	2	2 8	4	4		8	8	
Permitted Phases	6			2								
Actuated Green, G (s)	29.7	29.7		55.3	54.3	84.5		15.0		30.2	30.2	
Effective Green, g (s)	29.7	29.7		55.3	54.3	84.5		15.0		30.2	30.2	
Actuated g/C Ratio	0.22	0.22		0.42	0.41	0.63		0.11		0.23	0.23	
Clearance Time (s)	4.0	5.0		4.0	5.0			5.0		5.0	5.0	
Vehicle Extension (s)	3.0	2.0		3.0	2.0			2.0		2.0	2.0	
Lane Grp Cap (vph)	109	777		551	653	1769		352		350	691	
v/s Ratio Prot	c0.03	0.11		0.02	c0.60	0.43		c0.10		c0.32	0.32	
v/s Ratio Perm	0.16			0.02								
v/c Ratio	0.83	0.51		0.10	1.47	0.68		0.88		1.41	1.40	
Uniform Delay, d1	49.3	45.3		24.4	39.4	15.7		58.1		51.4	51.4	
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00		1.00	1.00	
Incremental Delay, d2	39.6	0.2		0.1	218.5	0.9		20.5		202.6	188.6	
Delay (s)	88.9	45.5		24.5	257.9	16.6		78.6		254.0	240.0	
Level of Service	F	D		C	F	B		E		F	F	
Approach Delay (s)		53.6			120.9			78.6			244.7	
Approach LOS		D			F			E			F	

Intersection Summary

HCM Average Control Delay	151.4	HCM Level of Service	F
HCM Volume to Capacity ratio	1.34		
Actuated Cycle Length (s)	133.1	Sum of lost time (s)	29.6
Intersection Capacity Utilization	113.8%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Queues

1: Coddington St & Southern Artery

8/16/2012



Lane Group	SEL	SET	NWL	NWT	NWR	NET	SWL	SWT
Lane Group Flow (vph)	91	396	53	958	1210	309	495	985
v/c Ratio	0.80	0.50	0.09	1.46	0.68	0.86	1.39	1.36
Control Delay	93.0	51.3	27.9	247.1	11.2	80.1	228.1	209.7
Queue Delay	0.0	0.0	0.0	27.1	0.0	0.0	0.0	0.0
Total Delay	93.0	51.3	27.9	274.2	11.2	80.1	228.1	209.7
Queue Length 50th (ft)	64	157	23	~1084	155	125	~542	~530
Queue Length 95th (ft)	#187	241	64	#1718	308	#254	#968	#851
Internal Link Dist (ft)		586		527		193		192
Turn Bay Length (ft)					225			
Base Capacity (vph)	114	1473	561	655	1786	362	357	723
Starvation Cap Reductn	0	0	0	26	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.80	0.27	0.09	1.52	0.68	0.85	1.39	1.36

Intersection Summary

- ~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
- # 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis
 1: Coddington Street/Sea Street & Southern Artery

8/16/2012



Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	94	788	73	48	423	1135	69	304	77	1059	222	59
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	11	11	11	11	12	12	11	11	11
Total Lost time (s)	5.0	5.0		5.0	5.0	5.0		5.0		5.0	5.0	
Lane Util. Factor	1.00	0.95		1.00	1.00	0.88		0.95		0.91	0.91	
Frbp, ped/bikes	1.00	1.00		1.00	1.00	1.00		0.99		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00		1.00		1.00	1.00	
Fr	1.00	0.99		1.00	1.00	0.85		0.97		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.99		0.95	0.97	
Satd. Flow (prot)	1787	3521		1727	1818	2720		3386		1572	3163	
Flt Permitted	0.11	1.00		0.11	1.00	1.00		0.99		0.95	0.97	
Satd. Flow (perm)	207	3521		200	1818	2720		3386		1572	3163	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	99	829	77	51	445	1195	73	320	81	1115	234	62
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	3	0
Lane Group Flow (vph)	99	906	0	51	445	1195	0	474	0	557	851	0
Confl. Peds. (#/hr)	4		12	12		4	8		21	21		8
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	2%	2%	2%	1%	1%	1%
Turn Type	pm+pt	NA		pm+pt	NA	pt+ov	Split	NA		Split	NA	
Protected Phases	1	6		5	2	2 8	4	4		8	8	
Permitted Phases	6			2								
Actuated Green, G (s)	41.3	37.3		39.5	36.4	81.8		17.1		45.4	45.4	
Effective Green, g (s)	41.3	37.3		39.5	36.4	81.8		17.1		45.4	45.4	
Actuated g/C Ratio	0.30	0.27		0.29	0.26	0.59		0.12		0.33	0.33	
Clearance Time (s)	5.0	5.0		5.0	5.0			5.0		5.0	5.0	
Vehicle Extension (s)	2.0	2.0		2.0	2.0			2.0		2.0	2.0	
Lane Grp Cap (vph)	108	954		92	481	1616		420		518	1043	
v/s Ratio Prot	c0.03	c0.26		0.01	0.24	0.44		c0.14		c0.35	0.27	
v/s Ratio Perm	0.25			0.15								
v/c Ratio	0.92	0.95		0.55	0.93	0.74		1.13		1.08	1.01dl	
Uniform Delay, d1	46.0	49.3		39.6	49.3	20.2		60.3		46.1	42.3	
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00		1.00	1.00	
Incremental Delay, d2	59.4	17.8		4.1	23.4	1.6		83.8		61.3	4.8	
Delay (s)	105.4	67.1		43.6	72.7	21.8		144.1		107.5	47.1	
Level of Service	F	E		D	E	C		F		F	D	
Approach Delay (s)		70.8			35.8			144.1			70.9	
Approach LOS		E			D			F			E	

Intersection Summary

HCM Average Control Delay	65.5	HCM Level of Service	E
HCM Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	137.7	Sum of lost time (s)	29.8
Intersection Capacity Utilization	86.8%	ICU Level of Service	E
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.

c Critical Lane Group

Queues

1: Coddington Street/Sea Street & Southern Artery

8/16/2012



Lane Group	SEL	SET	NWL	NWT	NWR	NET	SWL	SWT
Lane Group Flow (vph)	99	906	51	445	1195	474	557	854
v/c Ratio	0.91	0.93	0.49	0.94	0.74	1.11	1.06	1.01dl
Control Delay	106.9	65.8	53.5	78.8	15.2	129.0	98.9	49.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	106.9	65.8	53.5	78.8	15.2	129.0	98.9	49.1
Queue Length 50th (ft)	69	~496	35	~433	269	~284	~673	417
Queue Length 95th (ft)	#185	#632	#72	#659	329	#401	#928	#510
Internal Link Dist (ft)		586		527		193		192
Turn Bay Length (ft)					225			
Base Capacity (vph)	109	970	104	474	1620	428	527	1062
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.91	0.93	0.49	0.94	0.74	1.11	1.06	0.80

Intersection Summary

- ~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
- # 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
- dl Defacto Left Lane. Recode with 1 though lane as a left lane.

APPENDIX I

AM/PM Peak-Hour Intersection Capacity Analysis 2022 Alternative 4

Southern Artery at Sea Street/Coddington Street, Quincy

HCM Signalized Intersection Capacity Analysis
 1: Coddington St & Southern Artery

8/16/2012



Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↖	↗			↖	↗		↖		↖	↗	
Volume (vph)	86	340	36	50	783	1277	60	147	86	855	333	218
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	11	11	11	11	12	12	11	11	11
Total Lost time (s)	5.0	5.0			5.0	5.0		5.0		5.0	5.0	
Lane Util. Factor	1.00	0.95			0.95	0.88		0.95		0.91	0.91	
Frbp, ped/bikes	1.00	1.00			1.00	1.00		0.99		1.00	1.00	
Ftpb, ped/bikes	1.00	1.00			1.00	1.00		1.00		1.00	1.00	
Frt	1.00	0.99			1.00	0.85		0.96		1.00	0.97	
Flt Protected	0.95	1.00			1.00	1.00		0.99		0.95	0.98	
Satd. Flow (prot)	1770	3484			3411	2694		3123		1542	3056	
Flt Permitted	0.10	1.00			0.89	1.00		0.99		0.95	0.98	
Satd. Flow (perm)	182	3484			3044	2694		3123		1542	3056	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	91	358	38	53	824	1344	63	155	91	900	351	229
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	18	0
Lane Group Flow (vph)	91	396	0	0	877	1344	0	309	0	495	967	0
Confl. Peds. (#/hr)	3		2	2		3	7		12	12		7
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	8%	8%	8%	3%	3%	3%
Turn Type	pm+pt	NA		Perm	NA	pt+ov	Split	NA		Split	NA	
Protected Phases	1	6			2	2 8	4	4		8	8	
Permitted Phases	6			2								
Actuated Green, G (s)	49.4	49.4			40.4	82.7		15.0		42.3	42.3	
Effective Green, g (s)	49.4	49.4			40.4	82.7		15.0		42.3	42.3	
Actuated g/C Ratio	0.37	0.37			0.31	0.63		0.11		0.32	0.32	
Clearance Time (s)	5.0	5.0			5.0			5.0		5.0	5.0	
Vehicle Extension (s)	2.0	2.0			2.0			2.0		2.0	2.0	
Lane Grp Cap (vph)	116	1301			930	1684		354		493	977	
v/s Ratio Prot	c0.02	0.11				0.50		c0.10		c0.32	0.32	
v/s Ratio Perm	0.27				c0.29							
v/c Ratio	0.78	0.30			0.94	0.80		0.87		1.00	0.99	
Uniform Delay, d1	34.5	29.3			44.8	18.6		57.7		45.0	44.8	
Progression Factor	1.00	1.00			1.00	1.00		1.00		1.00	1.00	
Incremental Delay, d2	26.6	0.0			17.1	2.5		19.9		41.5	26.2	
Delay (s)	61.1	29.4			62.0	21.1		77.6		86.5	71.0	
Level of Service	E	C			E	C		E		F	E	
Approach Delay (s)		35.3			37.2			77.6			76.2	
Approach LOS		D			D			E			E	

Intersection Summary

HCM Average Control Delay	52.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	132.3	Sum of lost time (s)	30.6
Intersection Capacity Utilization	86.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Queues

1: Coddington St & Southern Artery

8/16/2012



Lane Group	SEL	SET	NWT	NWR	NET	SWL	SWT
Lane Group Flow (vph)	91	396	877	1344	309	495	985
v/c Ratio	0.77	0.30	0.93	0.79	0.86	0.99	0.98
Control Delay	72.7	30.8	61.4	15.6	80.1	82.2	66.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	72.7	30.8	61.4	15.6	80.1	82.2	66.0
Queue Length 50th (ft)	44	107	337	201	125	406	393
Queue Length 95th (ft)	#152	193	#606	414	#254	#830	#709
Internal Link Dist (ft)		586	527		193		192
Turn Bay Length (ft)				225			
Base Capacity (vph)	118	1319	941	1706	362	500	1009
Starvation Cap Reductn	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.77	0.30	0.93	0.79	0.85	0.99	0.98

Intersection Summary

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

HCM Signalized Intersection Capacity Analysis

1: Coddington Street/Sea Street & Southern Artery

8/16/2012



Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↘	↕			↕	↕		↕		↘	↕	
Volume (vph)	94	788	73	48	423	1135	69	304	77	1059	222	59
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	11	11	11	11	12	12	11	11	11
Total Lost time (s)	4.0	5.0			5.0	5.0		5.0		5.0	5.0	
Lane Util. Factor	1.00	0.95			0.95	0.88		0.95		0.91	0.91	
Frbp, ped/bikes	1.00	1.00			1.00	1.00		0.99		1.00	1.00	
Flpb, ped/bikes	1.00	1.00			1.00	1.00		1.00		1.00	1.00	
Frt	1.00	0.99			1.00	0.85		0.97		1.00	0.99	
Flt Protected	0.95	1.00			0.99	1.00		0.99		0.95	0.97	
Satd. Flow (prot)	1786	3522			3436	2720		3388		1572	3166	
Flt Permitted	0.28	1.00			0.61	1.00		0.99		0.95	0.97	
Satd. Flow (perm)	520	3522			2097	2720		3388		1572	3166	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	99	829	77	51	445	1195	73	320	81	1115	234	62
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	3	0
Lane Group Flow (vph)	99	906	0	0	496	1195	0	474	0	557	851	0
Confl. Peds. (#/hr)	4		12	12		4	8		21	21		8
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	2%	2%	2%	1%	1%	1%
Turn Type	pm+pt	NA		Perm	NA	pt+ov	Split	NA		Split	NA	
Protected Phases	1	6			2	2 8	4	4		8	8	
Permitted Phases	6			2								
Actuated Green, G (s)	43.3	43.3			35.3	80.7		18.1		45.4	45.4	
Effective Green, g (s)	43.3	43.3			35.3	80.7		18.1		45.4	45.4	
Actuated g/C Ratio	0.32	0.32			0.26	0.59		0.13		0.33	0.33	
Clearance Time (s)	4.0	5.0			5.0			5.0		5.0	5.0	
Vehicle Extension (s)	3.0	2.0			2.0			2.0		2.0	2.0	
Lane Grp Cap (vph)	202	1116			542	1607		449		522	1052	
v/s Ratio Prot	0.01	c0.26				0.44		c0.14		c0.35	0.27	
v/s Ratio Perm	0.14			c0.24								
v/c Ratio	0.49	0.81			0.92	0.74		1.06		1.07	1.01dl	
Uniform Delay, d1	38.3	42.9			49.2	20.4		59.2		45.6	41.6	
Progression Factor	1.00	1.00			1.00	1.00		1.00		1.00	1.00	
Incremental Delay, d2	1.9	4.4			19.8	1.7		57.9		58.5	4.4	
Delay (s)	40.2	47.3			69.0	22.1		117.2		104.1	46.0	
Level of Service	D	D			E	C		F		F	D	
Approach Delay (s)		46.6			35.8			117.2			69.0	
Approach LOS		D			D			F			E	

Intersection Summary

HCM Average Control Delay	56.8	HCM Level of Service	E
HCM Volume to Capacity ratio	1.02		
Actuated Cycle Length (s)	136.6	Sum of lost time (s)	34.8
Intersection Capacity Utilization	96.5%	ICU Level of Service	F
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.

c Critical Lane Group

Queues

1: Coddington Street/Sea Street & Southern Artery

8/16/2012



Lane Group	SEL	SET	NWT	NWR	NET	SWL	SWT
Lane Group Flow (vph)	99	906	496	1195	474	557	854
v/c Ratio	0.48	0.80	0.91	0.74	1.05	1.06	1.01dl
Control Delay	45.2	50.1	71.2	15.1	110.7	98.9	49.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	45.2	50.1	71.2	15.1	110.7	98.9	49.1
Queue Length 50th (ft)	69	427	246	260	-272	-673	417
Queue Length 95th (ft)	118	516	#368	318	#388	#928	510
Internal Link Dist (ft)		586	527		193		192
Turn Bay Length (ft)	150			225			
Base Capacity (vph)	208	1127	546	1620	453	527	1063
Starvation Cap Reductn	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.48	0.80	0.91	0.74	1.05	1.06	0.80

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

dl Defacto Left Lane. Recode with 1 though lane as a left lane.