massDOT
Massachusetts Department of Transportation

CAPE COD CANAL
TRANSPORTATION STUDY

Prepared by:
Stantec

CONTENTS

EXHIBITS

TABLES

Existing Environmental and Traffic Conditions

This chapter provides a review of existing conditions in the study area including roadway and multimodal facilities, natural and social environmental resources, and socio-economic conditions. These data informed the design constraints and provide a basis for the evaluation criteria. Next, existing and future traffic volumes in the study area were modeled to create a future (2040) 'no build' alternative which serves as the baseline for the comparison of future transportation improvements.

2.1 EXISTING ENVIRONMENTAL CONDITIONS

A survey of existing conditions and trends in the study area shapes a broad understanding of the transportation systems and important environmental resources that any transportation initiative should, if possible, avoid disrupting.

The Cape Cod Canal study area is home to abundant natural, cultural, and recreational resources. This includes unique ecological systems and habitats, including wetlands and

waterways, and valuable cultural assets such as park systems, archaeological sites, and historic landmarks and districts.

Federal, state, and local laws and regulations—including the federal Clean Water and Endangered Species Acts, the state Wetlands Protection Act (WPA), and municipal wetland ordinances—protect natural wetland, water, and wildlife resources from impact. Similarly, cultural resources such as historic sites and open space receive protection under laws such as the National Historic Preservation Act and Section 4(f) of the DOT Act of 1966.

2.1.1 Wetland, Floodplain, and Surface Waterbodies

Based on information gathered from the MassGIS database, wetland resources in the study area (Exhibit 2-1) include extensive coastal resources both north and south of the Canal, wetlands bordering the Herring River, and scattered wetlands north of Buttermilk Bay. Additional open water wetlands include the Cape Cod Canal, Great Herring Pond, Buttermilk Bay, and smaller waterbodies.

The wetland resources at the east end of the Canal represent the largest extent of wetlands in the study area. Floodplains, as designated by the Federal Emergency Management Agency

Exhibit 2-1 Wetlands and Surface Waterbodies

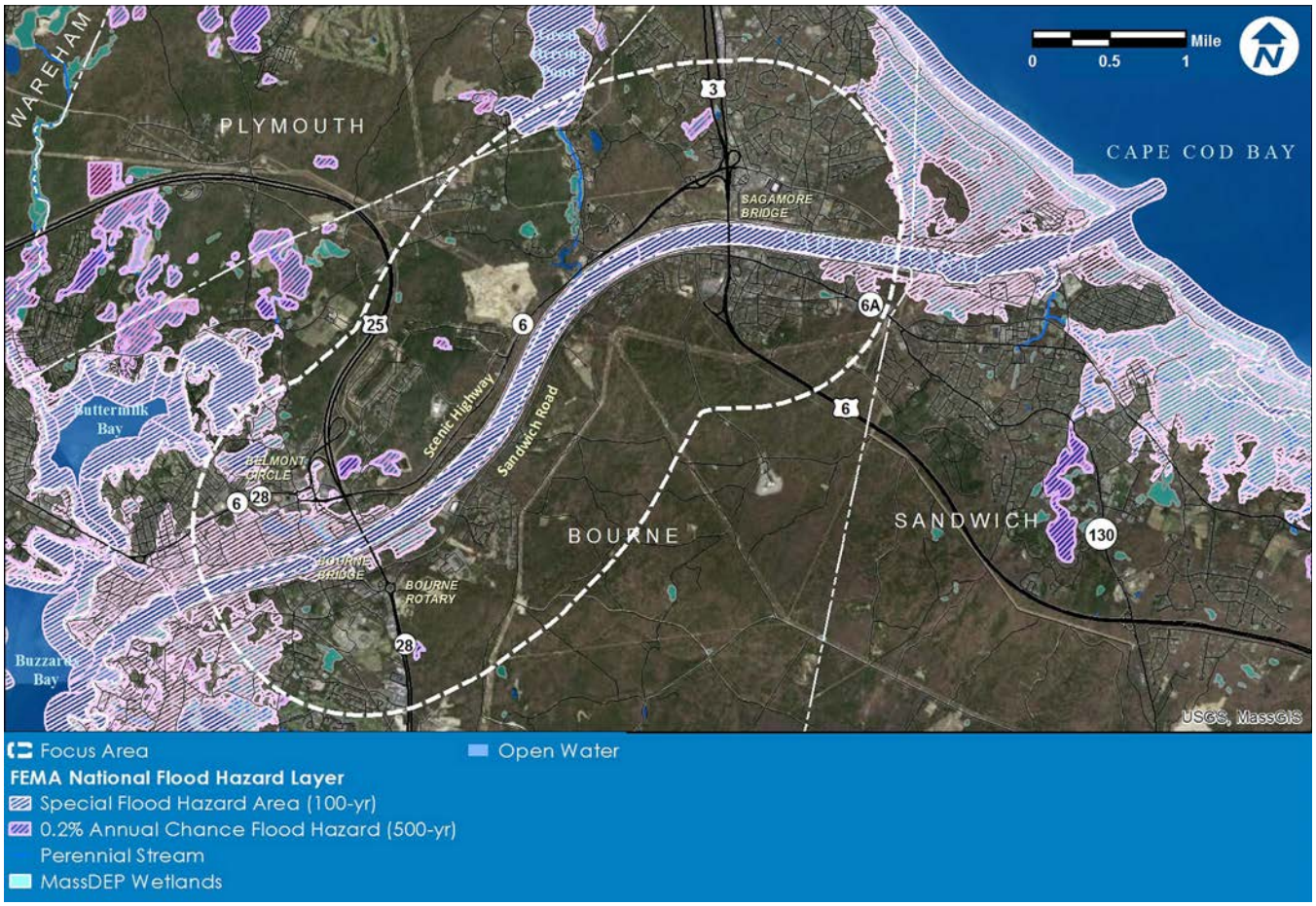


Exhibit 2-2 FEMA Floodplains

(FEMA), exist both north and south of the Canal in nearly the same areas as the wetlands (Exhibit 2-2). The one exception comprises areas in Bourne designated as 100-year floodplains that extend north of the Canal beyond Main Street to the Buzzards Bay Bypass. Areas immediately south of the Canal in Bourne are also designated as 100 year floodplains.

2.1.2 Aquifers and Public Water Supply Wells

An aquifer is an underground layer of rock containing water that can easily move within the layer. Wells provide access to this water for personal uses such as drinking, cooking, and showering, as well as for agricultural use. Exhibit 2-3 (next page) identifies state-designed buffers around drinking-water supply wells (known as Zone II areas and Interim Wellhead Protection Areas (IWPA)).

Protection of aquifers is particularly important because the study area sits atop a designated "sole-source aquifer" that includes all of Barnstable County, the towns of Plymouth and Wareham, and portions of Kingston, Plympton, and Carver.

Under the federal Safe Drinking Water Act, an aquifer qualifies as "sole source" if it provides at least 50% of the drinking water for

Exhibit 2-3 Aquifers and Public Water Supply Wells

its service area and there are no reasonably available alternative drinking water sources should the aquifer become contaminated.

2.1.3 Fisheries and Shellfish Growing Areas

Commercial fishing and shellfishing are key economic activities on Cape Cod and important parts of its history and culture. While there are eight commercial fishing harbors on the Cape only the East Canal Entrance Harbor is within the study area (Exhibit 2-4). Fish species commonly landed by commercial fishermen on Cape Cod include black sea bass, striped bass, bluefin tuna, bluefish, cod, dogfish, flounder, monkfish, and skate. Shellfish (mollusks and crustaceans) species commonly landed include lobster, mussels, sea scallops, bay scallops, and conch.

Shellfishing also occurs in the Cape Cod Canal, Buttermilk Bay, and Buzzards Bay. Shellfishing areas are regularly evaluated through sanitary surveys to confirm whether or not harvested shellfish are safe for human consumption. Based on the sanitary survey shellfish areas are assigned one of five categories.

1. **Approved:** Open to shellfish harvesting for direct human consumption.

2. **Conditionally Approved**: Closed some of the time due to rainfall or seasonally poor water quality or other predictable events.

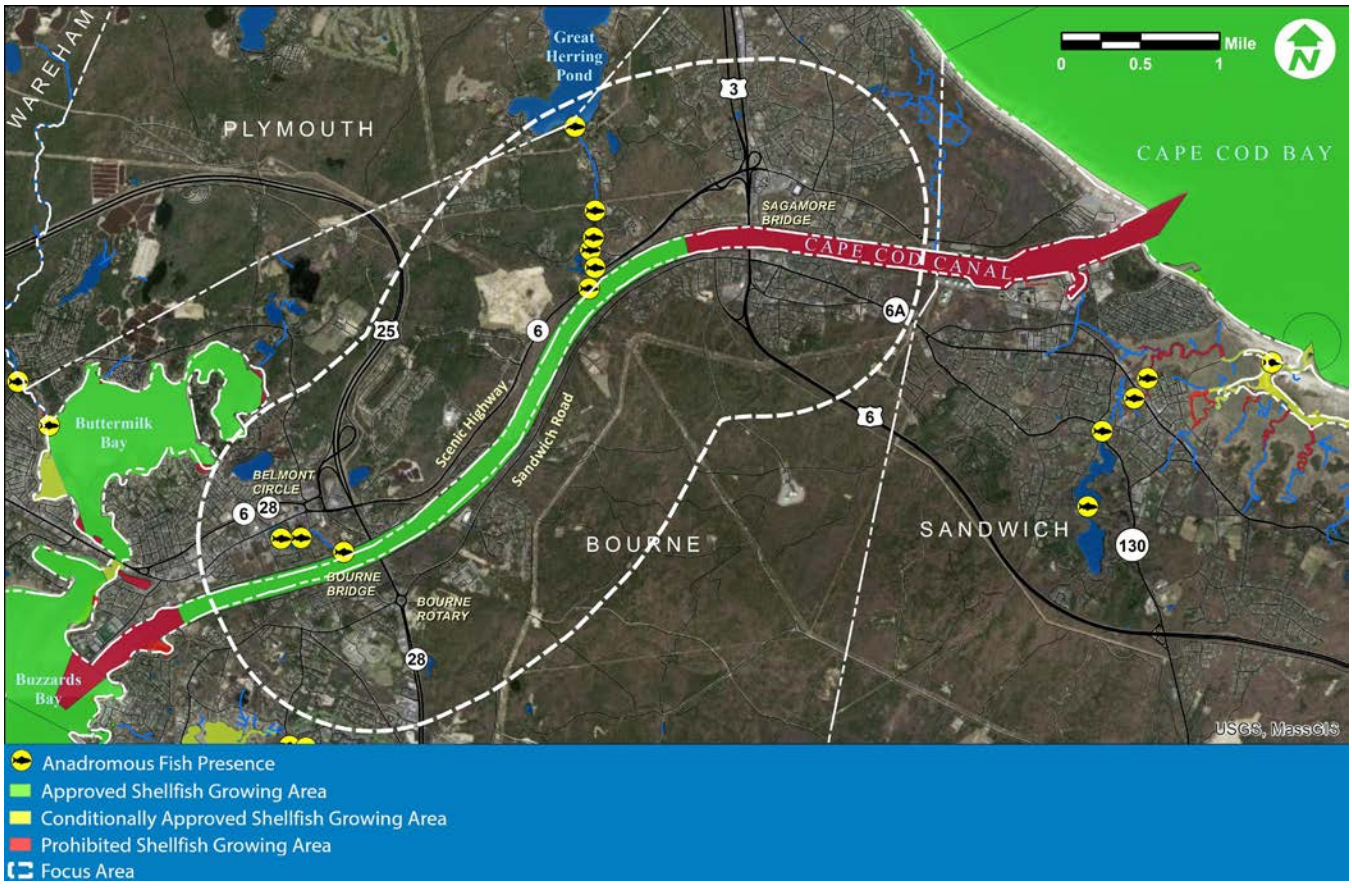
3. **Restricted:** Contains a limited degree of contamination at all times. When open, shellfish can be relayed to a less contaminated area or harvested for depuration.

4. **Conditionally Restricted:** Contains a limited degree of contamination at all times. Subject to intermittent pollution events and may close due poor water quality from rainfall events or season.

5. **Prohibited:** Closed to the harvest of shellfish under all conditions.

As shown on Exhibit 2-4, shellfishing is approved in most of Buzzards Bay and Buttermilk Bay and the central portion of the Canal. Shellfishing is prohibited at both the eastern and western ends of the Canal.

Exhibit 2-4 Fisheries and Shellfish Growing Areas



(top to bottom)
Fishing on Cape Cod Canal

Roseate Tern – federally listed endangered species

Diamondback Terrapin – state listed threatened species

Recreational fishing and shellfishing are also important parts of the Cape's history and culture. Chartering a fishing boat for the day or fishing from the banks of the Canal for striped bass and sea bass is a popular activity for residents and visitors alike.

The Canal area is also home to several anadromous fish species, including alewife and blueback herring. These fish spend most of their lives in the ocean but migrate up the Herring River or Mill Creek to lay their eggs in Great Herring Pond or Shawme Lake.

2.1.6 Rare, Threatened, and Endangered Species

Extensive areas both north and south of the Canal contain rare-species habitat (Exhibit 2-5). Specifically, the Massachusetts Natural Heritage and Endangered Species Program (MNHESP) has designated these areas as either Estimated Habitats of Rare Wildlife or Priority Habitats of Rare Species.

The MNHESP provided a list of state-designated rare, threatened, or endangered species in the study area (see Appendix B). These species include a wide variety of turtles, reptiles, birds, butterflies, moths, mussels, and plants. Numerous certified and potential vernal pools also exist throughout the study area.

Any proposed work within rare species habitats will require coordination with MNHESP, generally as part of the WPA Notice of Intent process, to ensure there is no significant impact to these rare species (known as a "take"), requiring the development of a Conservation Management Plan.

The federally-listed species known to occur in the study area include the piping plover, roseate tern, and red knot (all bird species), the red bellied cooter turtle, the sandplain gerardia (flower), the northeastern red tiger beetle, and the northern long-eared bat.

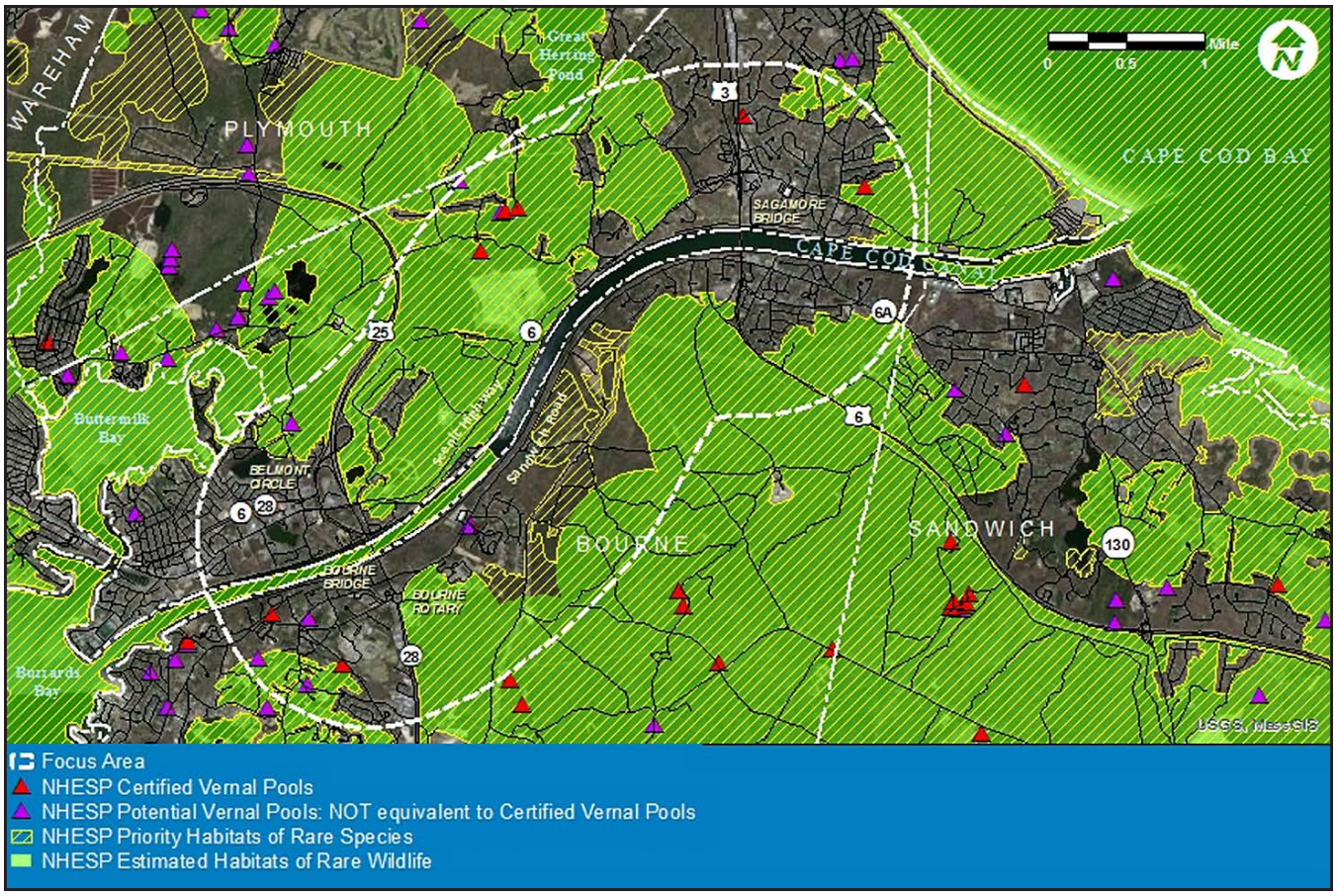


Exhibit 2-5 Rare, Threatened, and Endangered Species

Exhibit 2-6 Areas of Critical Environmental Concern

2.1.7 Areas of Critical Environmental Concern

The study area contains two state-designated Areas of Critical Environmental Concern (ACECs): the Bourne Back River and the Herring River (Exhibit 2-6). ACECs are places in Massachusetts that receive special recognition because of the quality, uniqueness, and significance of their natural and cultural resources. These areas are identified and nominated at the community level, then are reviewed and designated by the state's Secretary of Energy and Environmental Affairs (EEA). The ACEC program is administered by the Department of Environmental Protection on behalf of the EEA Secretary.

The 1,850-acre **Bourne Back River ACEC** in Bourne was designated an ACEC in 1989. It contains outstanding natural resources including marshes, tidal flats, and freshwater wetlands. Because these resources occur within an unaltered and undeveloped area, they function at their maximum capacity as habitats, nurseries, spawning grounds, and in the case of barrier beaches, storm-protection barriers. The estuarine/saltmarsh ecosystem, including headwater wetland areas, supports a wide variety of shellfish, finfish, amphibians, reptiles, birds, and mammals within an extraordinary spectrum of habitat types. The area contains at least three known state-listed rare and endangered species, including osprey, spotted turtle, and diamondback terrapin.

The **Herring River ACEC** in Bourne and Sandwich received ACEC designation in 1990. At 4,450 acres, it contains eleven lakes and ponds (the largest, Great Herring Pond, is 376 acres), numerous freshwater wetlands, productive cranberry bogs, and more than 250 acres of protected open space. The area contains one of the most important anadromous fish runs along the Southeastern Massachusetts coast and Great Herring Pond supports a regionally important freshwater recreational fishery. The area lies within the Plymouth-Carver Sole Source Aquifer and is critical to public water supply. At least three known state-listed rare and endangered species, including the box turtle and spotted turtle, are present.

2.1.8 Oil and Hazardous Materials Sites

Oil and hazardous-material release sites exist in the study area, including active Massachusetts Department of Environmental Protection (MassDEP) Chapter 21E sites, sites with an approved Activity and Use Limitation (AUL, as shown on Exhibit 2-7), and Superfund sites.

MassDEP Chapter 21E sites are sites that have been reported to MassDEP and have been issued a tier classification for the presence of oil and/or hazardous materials. The study area

contains sites classified as either Tier ID or Tier II. A site is classified as Tier ID if the responsible party has not met MassDEP reporting requirements. A site is classified as a Tier II site when the hazardous releases do not pose an imminent hazard, involve groundwater contamination, or threaten drinking water supplies.

AULs provide notice that oil and/or hazardous material contamination remains at the location after a cleanup. The AUL is a legal document that identifies activities and uses that may and may not occur on the property, as well as the owner's obligation and maintenance conditions that must be followed to ensure the safe use of the property.

Exhibit 2-7 also identifies the transfer stations in Bourne and Sandwich and the Superfund site at Joint Base Cape Cod, which is described in more detail below.

Superfund sites are locations contaminated with hazardous substances and pollutants that have designated by the U.S. Environmental Protection Agency for cleanup.

The Otis Air National Guard Base (ANGB)/Joint Base Cape Cod (JBCC) is a federal facility that was placed on the National

Exhibit 2-7 Oil and Hazardous Materials Sites

Priorities List as a Superfund site in 1989. The site covers more than 20,000 acres in the towns of Bourne, Falmouth, Mashpee, and Sandwich. The site contains multiple plumes of contaminated groundwater that are undergoing active remediation to protect the Cape's federally-designated sole source aquifer (source of drinking water for 200,000 year-round and 500,000 seasonal residents). Contamination sources include fuel spills, training, disposal, and other past activities at Otis ANGB/JBCC.

Two environmental cleanup programs at the JBCC address groundwater contamination and its sources. One program under the Superfund program is managed by the U.S. Air Force and focuses on contamination found primarily at Otis ANGB on the southern portion of the JBCC. The other, managed by the U.S. Army, addresses contamination from Camp Edwards, the northern portion of the base, under the Safe Drinking Water Act. Both of these programs operate under oversight of the U.S. Environmental Protection Agency and the MassDEP.

2.1.9 Upper Cape Water Supply Reserve

The Upper Cape Water Supply Reserve (Reserve) is the northern 15,000 acres of JBCC (Exhibit 2-8). The Reserve, owned by the Commonwealth, serves two purposes:

1. It is New England's largest military training center serving soldiers from the Massachusetts Army National Guard and numerous other military branches. The Reserve provides facilities for soldiers to practice maneuvering exercises, bivouacking, and using the small arms ranges.

2. It serves as a drinking water and wildlife protection area. The Reserve is the largest piece of undeveloped land on Cape Cod which serves as a drinking water source for Upper Cape Cod, and is home to 37 state-listed species living in a variety of habitats throughout the base.

The Reserve was created by the Massachusetts legislature through Chapter 47 of the Acts of 2002. This Act transferred the care, custody, and control of the Reserve (northern 15,000 acres of JBCC) from the Special Military Reservation Commission to the Division of Fisheries and Wildlife of the Massachusetts Department of Fish and Game. The Reserve is designated as public open space, subject to legal protection under both Article 97 of the Massachusetts Constitution and federal Section 4(f) of the DOT Act. Both laws recognize the high value this property provides to the community and requires substantial justification to develop these sites, including converting them to transportation uses.

Exhibit 2-8 Upper Cape Water Reserve

Chapter 47 of the Acts of 2002 also created an Environmental Management Commission (EMC) whose purpose is to ensure the permanent protection of the drinking water supply and wildlife habitat of the Reserve. The Reserve's enacting legislation requires that the Massachusetts National Guard comply with all environmental decisions and orders of the EMC. The EMC includes representatives from the Massachusetts Department of Fish and Game, the Department of Environmental Protection (MassDEP) and the Department of Conservation and Recreation. The Reserve is designated as public conservation land dedicated to three primary purposes:

1. Water supply and wildlife habitat protection,
2. The development and construction of public water supply systems, and,
3. The use and training of the military forces of the commonwealth; provided that such military use and training is compatible with the natural resource purposes of water supply and wildlife habitat protection.

The EMC oversees compliance with, and enforcement of, 19 Environmental Performance Standards. The Environmental

Performance Standards are specifically created through the Massachusetts Environmental Policy Act (MEPA) process to protect the resources in the Reserve. The 19 standards pertain to rare species and habitat management, hazardous materials, solid waste, and pest and fire management. The goal is to ensure the protection of the groundwater and habitat during conduct of compatible military training and civilian use activities, such as hunting.

2.1.4 Cultural, Historical, and Archaeological Resources

There are many important cultural resources in the study area (Exhibit 2-9). Bourne, Plymouth, Sandwich, and Wareham are rich in historic resources and open space properties. The key historic sites and districts in the study area include the Bourne and Sagamore Bridges, the Old Kings Highway Regional Historic District in Sandwich, and the Jarvesville, Town Hall Square, and Spring Hill National Historic Districts in Sandwich. Several public buildings in Bourne are individually listed on the National Register of Historic Places including Bourne High School, Jonathan Bourne Public Library, and Bourne Town Hall.

Exhibit 2-9 Historic Districts and Individual Historic Properties

Overall, cultural resources are categorized as historic, archaeological, and/or cultural/ethnographic:

- Historic resources include above-ground man-made resources such as buildings, structures, objects, districts, landscapes, and sites that meet the criteria for listing in the National Register of Historic Places.
- Archaeological resources are buried pre-colonial Native American and historic-period sites.
- Cultural/ethnographic resources are above and below-ground areas of cultural sensitivity and importance to the Mashpee Wampanoag Tribe and the Wampanoag Tribe of Gay Head (Aquinnah).

The study area, including Bourne, Plymouth, Sandwich, and Wareham, is rich in above-ground historic resources (Table 2-2):

- The Bourne Bridge and the Sagamore Bridge have been identified by the Massachusetts Historical Commission (MHC) as eligible for individual listing in the National Register of Historic Places (NRHP).
- The Cape Cod Canal area may also qualify for listing on the NRHP. The identified area contains 18 structures that add to the district's historical integrity.
- The eastern end of the Canal, and the land just south of it in Sandwich, is in the Old King's Highway Regional Historic District, listed in the State Register of Historic Places.
- All inventoried historic structures and districts in Sandwich are listed in the State Register of Historic Places, with some potentially eligible as NRHP districts.
- North and south of the Cape Cod Canal, in Bourne, are many buildings and districts that are listed, eligible for listing, or potentially eligible for listing in the NRHP (Table 2-1).
- In Plymouth, the Indian Cemetery on the south shore of Great Herring Pond is potentially eligible for the NRHP as a contributing resource to the MHC-inventoried Cedarville District (PLY.G).

The focus area is also rich in archaeological and cultural resources. For thousands of years, the river, marsh, and coastal resources on Cape Cod made the area a prime location for Native American settlements. This is demonstrated through both archaeological finds made during the Canal's construction and oral tradition among the Wampanoag tribes. Archaeological surveys previously undertaken as part of cultural resource management projects in the focus area have identified dozens

Table 2-1 Historic Status of Resources Inventoried by the Massachusetts Historic Commission

SR LISTED	NAME	NR (INDIVIDUAL PROPERTIES)	NR-ELIGIBLE PER MHC	POTENTIALLY NR-ELIGIBLE (DISTRICT)	POTENTIALLY NR-ELIGIBLE PROPERTIES	SR-LISTED
CAPE COD CANAL						
BOU.918	Bourne Bridge		*			
BOU.919	Sagamore Bridge		*			
BOU.AF	Cape Cod Canal			*		
SDW.Z	Cape Cod Canal			*		*
NORTH OF CANAL						
BOU.388	Mass. Army NG Armory		*			
BOU.C	Head of the Bay				1	
BOU.I	Bournedale	1			3	
BOU.J	Main Street Commercial Area				2	
BOU.O	North Sagamore				3	
BOU.P	Savery Avenue					
BOU.U	Sagamore Beach				3	
BOU.AE	Bourne Town Hall	1				*
PLY.G	Cedarville			*		
SDW.AA	Sagamore Hill Gun Battery			*		*
SOUTH OF CANAL						
BOU.A	Keene St - Sandwich Rd Area	3		*	6	
BOU.B	Cape Cod Air Station - Otis AFB					
BOU.AG	Aptucxet Trading Post			*		
BOU.AH	Shore Road North				1	
BOU.AJ	County Road North					
BOU.V	South Sagamore			*	8	
SDW.906	Route 6 Bridge					*
SDW.907	Route 6 Bridge					*
SDW.F	Shawme Road			*		*
SDW.G	Route 6A West					*
SDW.I	Main Street					*
SDW.R	Old Kings Highway Regional HD					*

MHC = Massachusetts Historical Commission; NR = National Register of Historic Places; SR = State Register of Historic Places

of archaeological sites. Areas of cultural importance to the Wampanoag tribes are present in numerous locations in the focus area.

Due to sensitivity of the location of archaeological sites and other areas culturally important to Tribal culture, this study does not identify their locations. Both the National Historic Preservation Act and the Archaeological Resources Protection Act mandate that Federal agencies only disclose archaeological site locations if no harm, theft, or destruction of cultural resources will result from disclosure.

In addition to these sites, historic-period Euro-American sites are also likely present in the study area given colonial settlement on the Cape in the early 17th century.

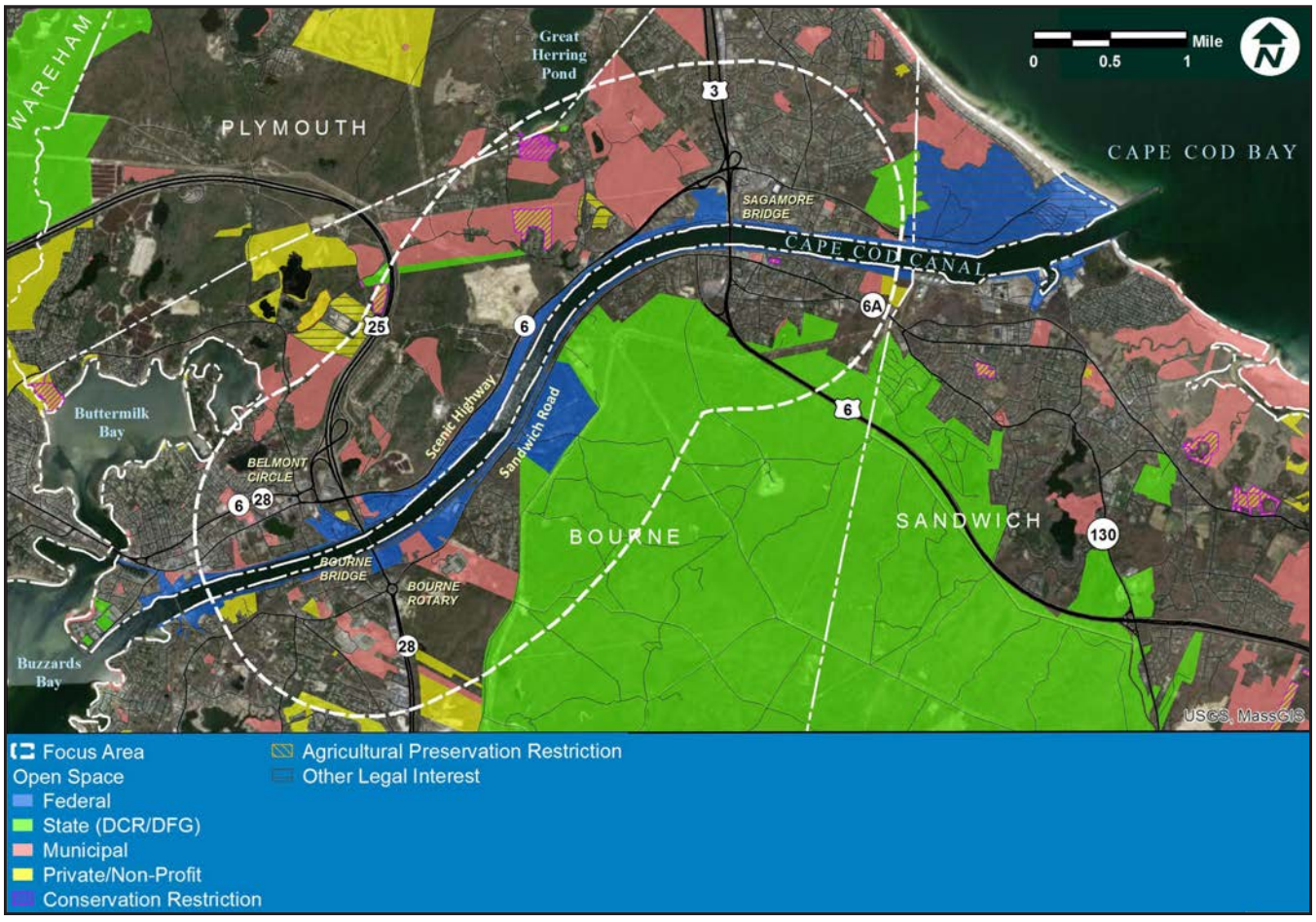
Appendix C, the Cape Cod Transportation Study—Cultural Resources Identification and Evaluation, includes a detailed description of the cultural resources in the study area.

2.1.5 Protected Open Space

Numerous properties in the study area are designated as protected open space (Exhibit 2-10). Examples of these publicly- and privately-owned properties include the Scusset Beach State Reservation, Shawme-Crowell State Forest, Upper Cape Water Supply Reserve, Cape Cod Canal Recreation Area, Gallo Skating Rink, Bourne Scenic Park, Carter Beal Conservation Area, Sacrifice Woods Rock, and the Nightingale Pond Recreation Area.

These open space properties serve a wide variety of purposes, including watershed protection, wildlife habitat, conservation, and recreation. Their owners include the federal government (U.S. Army Corps of Engineers), the Commonwealth of Massachusetts (Division of Fisheries & Wildlife, the Department of Conservation and Recreation), Barnstable County, municipalities, water districts, and private conservation or wildlife trusts.

Exhibit 2-10 Protected Open Space



While varying levels of legal protection safeguard these resources, the publicly-owned properties receive protection under both Article 97 of the Massachusetts Constitution and Section 4(f) of the DOT Act. Both laws recognize the high value these properties provide to the community and require substantial justification to convert them to other uses, including transportation uses.

2.1.6 Utilities

Important utility corridors cross the study area. These include an electrical utility corridor which transmits electricity through transmission towers from the Canal Generating Plant in Sandwich northwest across the Canal and east to Cape Cod customers (Exhibit 2-11). Natural gas enters Cape Cod within a pipe network that crosses the Canal attached to the Canal bridges. Natural gas compressor stations are located close to both the Sagamore and Bourne Bridges.

These electrical transmission towers and gas lines and compressor stations represent a substantial constraint when considering future work on the Canal bridges.

Exhibit 2-11 Utilities

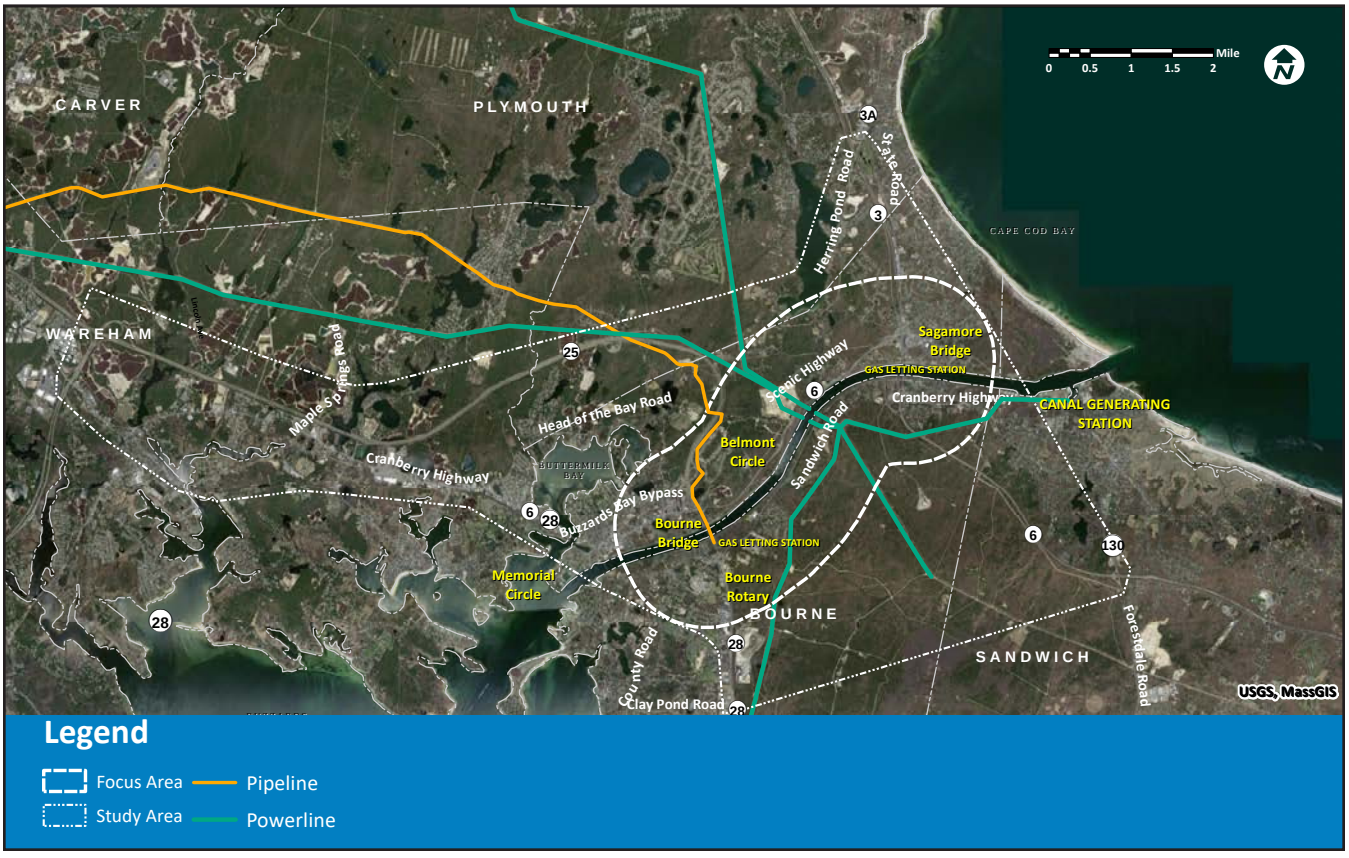


Exhibit 2-12 Environmental Justice Populations

2.1.7 Environmental Justice Populations

Environmental Justice (EJ) refers to an effort to ensure the fair distribution of environmental benefits and burdens created by any action of the federal government. President Clinton issued Executive Order 12898—Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations in 1994. It directs all federal agencies to identify and address the disproportionately high and adverse human health or environmental effects of their actions on minority and low-income populations, to the greatest extent practicable and permitted by law.

At the state level, the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) ensures that state agencies, divisions, and other entities (including MassDOT) identify and address EJ populations in their projects or other actions. The EEA's Environmental Justice Policy was updated in 2017.

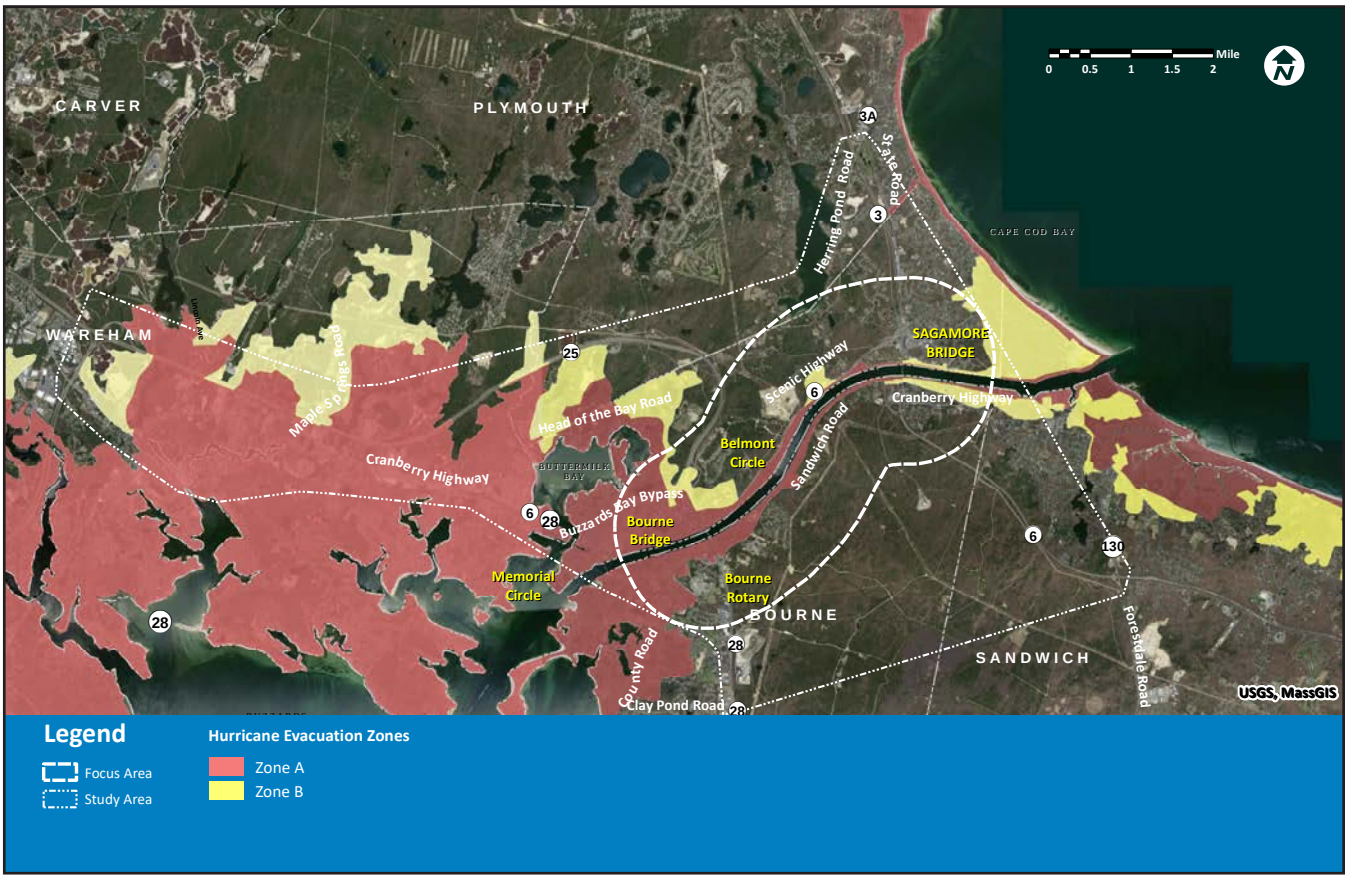
EJ populations are identified according to three criteria: minority (non-white) status, income, and English isolation, which is a metric of English language fluency. Minority status is determined at the block group level with U.S. Census data, and English isolation and income are determined at the state level

with American Community Survey (ACS) data. The thresholds that determine EJ status are:

- 25% of households within the census block have a median household income at or below the statewide median income for Massachusetts (2016: $75,297); or
- 25% or more of residents are minority (defined as those who identify themselves as Latino/Hispanic, Black/African American, Asian, Indigenous people, and people who otherwise identify as non-white); or
- 25% or more have English isolation (defined as those that do not have an adult over 14 years old that speaks only English or English very well).

According to the data from the 2010 US Census, the only environmental justice populations in the study area are in Wareham (Exhibit 2-12). The Village of Onset in Wareham and areas west of Onset contain high minority populations (higher than the state average). Other areas in Wareham, including areas surrounding Main Street and west of the I-495/I-195 Interchange, contain areas of low-income populations.

Exhibit 2-13 MEMA Hurricane Evacuation Zones



The study team also reviewed the recommendations within the National Cooperative Highway Research Program Report No. 532 (NCHRP 532), titled Effective Methods for Environmental Justice Assessment. This report emphasized that beyond considering low-income and minority populations, it is appropriate to consider other demographic characteristics such as race, national origin, age, disability, and English-speaking ability.

2.1.8 MEMA Evacuation Zones

The Massachusetts Emergency Management Agency (MEMA) is the state agency responsible for coordinating the planning and response of federal, state, local, voluntary, and private resources during emergencies or disasters, including hurricanes, flooding events, winter storms, nuclear or terrorist events or other natural and man-made disasters.

MEMA has established statewide evacuation zone maps in Massachusetts. On Cape Cod, the evacuation of residents, workers, and visitors may be necessary during a hurricane or tropical storm due to risk of storm surge. A storm surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tide. The destructive power of a storm surge and large battering waves is often the greatest threat to life and property during a storm, and can result in loss of life, destroyed buildings, beach and dune erosion, and road and bridge damage along the coast.

Evacuation zones A and B exist within the study area (Exhibit 2-13). These zones include areas that, depending on predicted inundation, may flood first from storm surge during a tropical storm or hurricane. Areas in Zone A would flood before areas in Zone B.

The reliability of multimodal travel across the Canal would be critical during an evacuation, this includes ensuring the accessibility of the Canal bridges and all roadway approaches to the bridges.

2.2 LAND USE AND DEVELOPMENT

This section includes a discussion of existing land uses within the study area.

2.2.1 Land Uses within the Study Area

The study area is characterized by a wide variety of land uses (Exhibit 2-14). Along Route 25, land uses include forested areas, interspersed with cranberry bogs, and residential development (particularly on the south side of Route 25). Land use shifts to

Exhibit 2-14 Land Uses in the Study Area

more high-density residential and commercial development in the Buzzard's Bay section of Bourne.

Located west of Route 28 (south of the Bourne Bridge) are medium- to low-density residential developments and commercial properties. The Bourne Back River ACEC, described in Section 2.1.5, is west of Route 28 and Waterhouse Road. East of Route 28, from Bourne to Route 6 in Sandwich, land use is predominantly protected open space, identified as the Upper Cape Water Supply Reserve (described in Section 2.1.7).

East and west of Route 3, in the northeast portion of the study area, land uses include medium-density residential development with dispersed pockets of municipally-owned open space. Great Herring Pond, a 376-acre pond in Plymouth, is the largest of multiple ponds found west of Route 3. To the east, from Route 3 to the Sagamore Beach in Sandwich, the landscape is characterized by medium-density single- and multi-family residential developments. Further east (and north of the Canal), land use transitions to open space including the Scusset Beach State Reservation (owned by the U.S. Army Corps of Engineers) and a large expanse of wetland marshes.

East of Route 6, south of the Canal, land uses in Bourne and Sandwich include the 624 acre Shawme-Crowell State Forest. The Massachusetts Department of Conservation and Recreation (DCR) owns and manages this state forest, which is protected open space. East of the state forest, development between Route 130 and Route 6A in Sandwich consists of high- to low-density residential uses.

Along Route 6A, land use in Sandwich includes high-density residential development and commercial properties, particularly west of this corridor. Further east of Route 6A in Sandwich, land use is characterized by concentrations of dense residential development with extensive areas of municipally managed wetland resource areas.

2.2.2 Joint Base Cape Cod

Joint Base Cape Cod (JBCC) is a nearly 21,000-acre full scale, joint-use base home to five military commands training for missions at home and overseas, conducting airborne search and rescue missions, and intelligence command and control. Numerous important military training and operating facilities exist at JBCC including:

Tactical Training Base (TTB) Kelley replicates a forward operating base soldiers occupy when deployed overseas.

102nd Intelligence Wing provides world-wide precision intelligence and command and control along with trained and experienced Airmen for expeditionary combat support and homeland security.

U.S. Coast Guard Base Cape Cod serves as the single Deputy Commandant for Mission Support (DCMS) touch point for the support of Coast Guard operations within the 1st Coast Guard District.

Air Station Cape Cod (ASCC), with its three helicopters and four jets, is the only Coast Guard Aviation facility in the northeast. ASCC is responsible for the waters from New Jersey to the Canadian border and maintains the ability to launch a helicopter and/or jet within 30 minutes of a call, 365 days-a-year, 24 hours-a-day, and in nearly any weather condition.

Camp Edwards is the primary military training facility for the National Guard and Army Reserve for soldiers throughout New England. The primary mission of Camp Edwards is to prepare soldiers for combat missions overseas as well as missions to serve and protect the United States.

Upper Cape Water Supply Reserve The 15,000 acres of the northern portion of JBCC is designated as the Upper Cape Water Supply Reserve which, as described in Section 2.1.7 is the largest piece of protected, undeveloped land on Cape Cod providing drinking water and wildlife protection and is used jointly for training by the Massachusetts Army and Air National Guard and the U.S. Coast Guard.

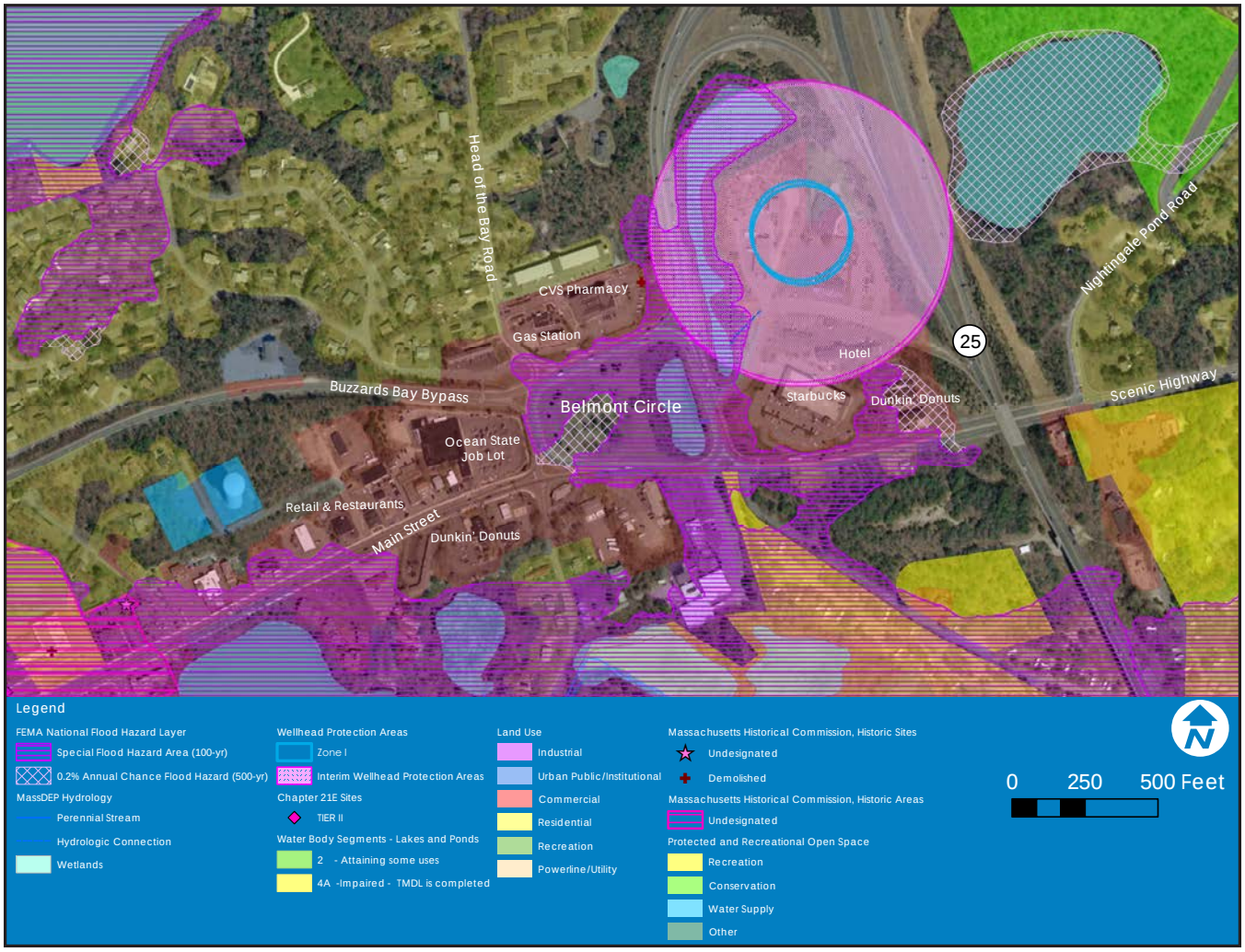
2.2.3 Belmont Circle and Bourne Rotary

As Belmont Circle and the Bourne Rotary are two of the most critical intersections in the study area, this section provides information on the existing land uses and environmental resource found at these locations. The existing traffic conditions at these locations are provided in Section 2.5.10.

Belmont Circle

This section describes the existing land uses and environmental resources at Belmont Circle and the adjacent Scenic Highway at Nightingale Pond Road intersection.

Exhibit 2-15 Existing Land Uses and Environmental Resources - Belmont Circle



Land Uses and Environmental Resources

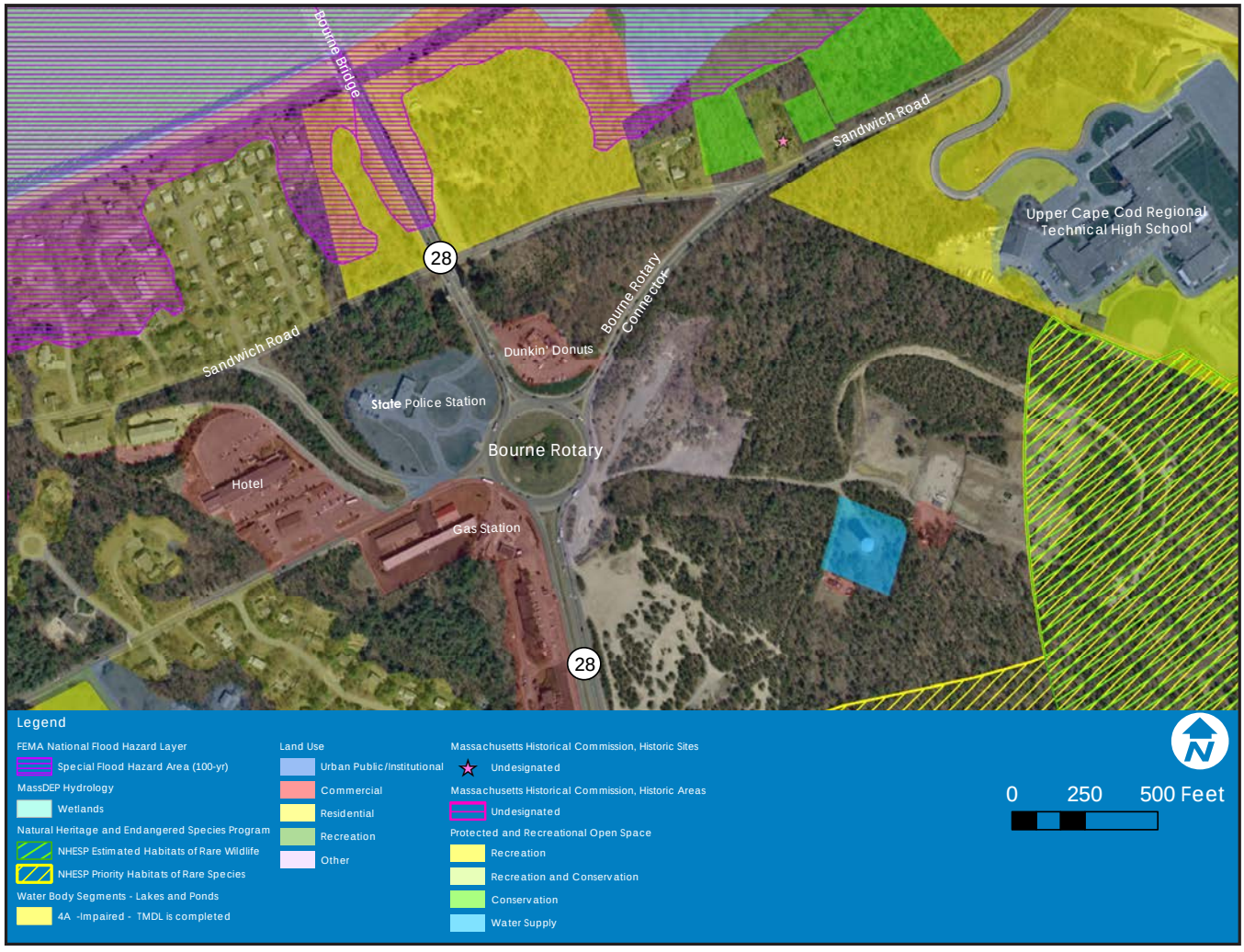
Land uses adjacent to Belmont Circle include numerous retail and restaurant business, such as CVS pharmacy, Starbucks, Mobil Gas, and Ocean State Job Lot, have direct access to Belmont Circle. West of Belmont Circle, Main Street includes numerous retail and restaurant establishments in Bourne's business district and Bourne town hall and police station.

Natural resources in the Belmont Circle area include a one-acre wetland on the east side of the Circle infield. The 100-year floodplain extends from the Canal north to Main Street and the entire Belmont Circle area (see Exhibit 2-15).

Bourne Rotary

This section describes the existing land uses and environmental resources in the Bourne Rotary area.

Exhibit 2-16 Existing Land Uses and Environmental Resources - Bourne Rotary



Land Uses and Environmental Resources

Land uses adjacent to the Bourne Rotary include Dunkin' Donuts and a Cumberland Farms Convenience store and gas station. A Massachusetts State Police barracks is adjacent to the northwest side of the Rotary.

Several schools are in the Bourne Rotary area. The entrance to the Upper Cape Cod Regional Technical High School is 0.4 miles to the east of the Rotary on Sandwich Road. The entrance to the Bourne Middle and High School and the James Pebbles Elementary School are 0.4 miles west of the Rotary on Trowbridge Road.

Traveling east on Sandwich Road from the Rotary for ¼-mile leads to the entrance of the Upper Cape Cod Regional Technical High School. Several restaurants and retail businesses, including Dunkin Donuts and Gulf Oil have direct access to the rotary. Undeveloped land exists east and south of the rotary. No wetland or floodplain areas exist in the Bourne Rotary area (see Exhibit 2-16).

2.3 SOCIO-ECONOMIC CONDITIONS

The socio-economic conditions in Barnstable, Dukes (Martha's Vineyard and nearby islands), and Nantucket counties were evaluated using data from sources including the U.S. Census, the U.S. Department of Labor, the Massachusetts Department of Revenue, and the Nielsen Company. Because the study area includes portions of Wareham and Plymouth, this report also includes certain socioeconomic data for these towns.

This evaluation documents existing conditions and recent trends for population, household makeup, income, employment, and journey to work data.

2.3.1 Population

Socio-economic conditions in Barnstable County (Cape Cod) are in transition. After several decades of rapid population and employment growth, the county has experienced a population decline since 2000. The demographics of this population is also shifting to a higher percentage of senior citizens and a lower percentage of working adults and school-age children.

Table 2-2 Historical Population Change in Barnstable County

	1960	1970	1980	1990	2000	2010	2017	2018
Population	70,286	96,656	147,925	186,605	222,230	215,888	213,444	213,413
% Change from previous period		37.52	53.04	26.15	19.09	-2.85	-1.13	-0.01

Source: US Census Bureau

The population of Barnstable County grew rapidly between 1960 and 2000. Table 2-2 shows growth from approximately 70,000 to more than 220,000 residents during this 40-year period, a 214% increase. However, this growth faltered in the period 2000-2010, with the county experiencing a population decline of 2.85%. The population lost an additional 1.13% from 2010 to 2017. Forecasts for Barnstable County[1] project modest population growth of 2.53% between 2010 and 2019.

By comparison, the population of Plymouth County grew 4.9% between 2000 and 2010 and an additional 3.9% between 2010 and 2017. The population of Plymouth County is forecast to grow an additional 1.7% between 2017 and 2019. The population of Massachusetts as a whole grew 3.1% in the ten years from 2000 to 2010 and an additional 4.5% between 2010 and 2016.

Nantucket and Dukes counties have also experienced significant increases in population since1960. Between 1960 and 2016, Nantucket County's population increased approximately 209% from 3,559 to 11,008 persons. In the same period, Dukes County's population rose approximately 196%, from 5,829 to 17,246 persons. Neither experienced a more recent decline like the one in Barnstable County.

Table 2-3 Change in Age Cohorts 2000–2017, Barnstable County

	2000	2017	% CHANGE
Total population	222,230	213444	-3.95
Under 5 years	10,599	7,764	-26.8
5 to 9 years	12,811	8,670	-32.3
10 to 14 years	14,208	9,579	-32.6
15 to 19 years	11,725	10,375	-11.51
20 to 24 years	7,735	11,002	42.2
25 to 34 years	21,595	18,962	-12.2
35 to 44 years	33,982	18,558	-45.4
45 to 54 years	32,802	27,220	-17.0
55 to 64 years	25,508	37,546	47.2
65 to 74 years	26,357	36,218	37.4
75 to 84 years	11,075	18,794	69.7
85 years and over	6,447	8756	35.8

Source: US Census Bureau, American Community Survey, 2017

Barnstable County has also experienced changes in the age groups (or cohorts) that make up its population (Table 2-3). Between 2000 and 2017, the population of Barnstable County remained relatively stable (decreasing by 3.95%) however, the county experienced considerable change in age cohorts.

1 The Nielsen Company, Site Reports, 2014 data.

Specifically, the population of pre-school and school-age children (residents ages 1 19) dropped significantly, as did the number of working-age adults aged 25 to 54. Conversely, the county experienced a considerable increase in older residents (residents older than 55).

While the drop in the number of prime working-age adults (and their children) is partially due to the natural aging of the large baby boomer generation, the extent of these changes is also likely due, in part, to the increasing cost of Cape Cod residential real estate and limited growth opportunities for local employment. At the same time, 19% of persons who own second homes on Cape Cod have reported their intention to convert these homes to their primary residences over the next 20 years[2]. This would result in the conversion of approximately 11,000 second homes on Cape Cod to primary residences. While this trend may increase the year-round population of Cape Cod, without changes to local zoning or housing stock, it would decrease the stock of rental homes available for visitors.

Any discussion of Barnstable County's population must acknowledge its seasonality. During the summer tourist season, the population of the county nearly doubles, increasing by approximately 200,000 people due to the influx of seasonal residents, employees, and visitors[3]. This substantial increase in the summertime population (with related increases in vehicle trips) places tremendous pressure on the transportation system in the Cape Cod Canal area.

2.3.2 Housing Units

A housing unit is defined as a house, an apartment, a mobile home, a group of rooms, or a single room that is occupied (or if vacant, is intended for occupancy) as separate living quarters.

Table 2-4 Housing Units (2005–2015), Barnstable, Dukes, and Nantucket Counties and the Commonwealth of Massachusetts

COUNTY/COMMONWEALTH	2005	2010	2015	% INCREASE, 2000–2015
Barnstable	153,798	160,281	162,118	4.22
Dukes	15,896	17,188	17,614	8.13
Nantucket	10,296	11,618	11,951	12.84
Massachusetts	2,688,014	2,808,254	2,845,699	4.46

Source: US Census Bureau, American Community Survey

2 UMass Donahue Institute, Cape Cod Second Homeowners, Technical Report of 2017 Survey Findings, Cape Cod Commission, June 2017.
3 Cape Cod Commission, 2015. Calculations based on the UMass Donahue Institute Second Home Owner Survey 2008 and 2010 U.S. Census.

According to U.S. Census Bureau, the number of housing units in Barnstable County increased slightly between 2005 and 2010 and again between 2010 and 2015 (Table 2-4). In the five years ending in 2010, the county experienced a 4.2% increase in housing units; from 2010 to 2015, the increase was only 1%. Dukes and Nantucket counties experienced stronger growth in housing units from 2000 to 2015 (8.13% and 12.84%, respectively). In comparison, the Commonwealth of Massachusetts experienced a more modest 4.5% increase in housing unit growth between 2005 and 2015. Overall, the rate of housing construction in Barnstable County between 2005 and 2015 has kept pace with the construction rate in Massachusetts as a whole, although it slowed considerably from 2010 to 2015.

As a major summer tourist destination, Barnstable County has traditionally had a large percentage of housing units serving as seasonal housing, i.e. second homes. Currently, approximately 38% (62,000 of the 162,000) of the housing units in Barnstable County are seasonal units[4]. The percentage of housing units serving as seasonal units has been increasing since the 2007-2009 recession and is forecast to continue to increase in the future.

2.3.3 Median Household Income

The U.S. Census Bureau defines a household as all the people who occupy a housing unit as their usual place of residence. The occupants may be a single family, one person living alone, two or more families living together, or any other group of related or unrelated persons who share living arrangements. "Median household income" refers to the income earned by a given household where half of the households in an area earn more and half earn less.

According to the American Community Survey (ACS), the median household income for Barnstable County in 2017 was $68,048,

Table 2-5 Median Household Income, 2017

	BARNSTABLE COUNTY	DUKES COUNTY	NANTUCKET COUNTY	MASSACHUSETTS
Median Household Income	$68,048	$67,535	$91,942	$74,167

Source: American Community Survey, 2017

Table 2-6 Per Capita Income, 2017

	BARNSTABLE COUNTY	DUKES COUNTY	NANTUCKET COUNTY	MASSACHUSETTS
Per Capita Income	$40,886	$42,956	$47,924	$39,913

Source: U.S. Census Bureau American Community Survey, 2017 (http://www.census.gov/quickfacts/table/PST045215/25,25007,25001,25019)

4 Regional Housing Market Analysis and 10-year Forecast of Housing Supply and Demand for Barnstable County, Massachusetts, September, 2017, Cape Cod Commission.

roughly 8% less than the statewide median of $74,167 (Table 2-5). The median household income for Barnstable County was also 26% less than the Nantucket County and 0.7% more than Dukes County. Overall, the median household income in Barnstable County is below the state median income but approximately the same as most Massachusetts counties other than Middlesex and Norfolk County.

Table 2-6 compares per capita incomes for Barnstable, Dukes, and Nantucket counties and the Commonwealth of Massachusetts. "Per capita income" is the average income for every person in a particular household group, including those living in group quarters. It is derived by dividing the aggregate income of a particular group by the total population in that group.

According to 2017 American Community Survey data, per capita incomes for Barnstable County were slightly higher (2.4%) than that of Massachusetts as a whole. The per capita income for Nantucket County was approximately 14.6% higher than Barnstable County. Based on a comparison of median household income (Table 2-5) and per capital income (Table 2-6), a greater percentage of households statewide have multiple employed residents, resulting in a higher total household income.

2.3.4 Employment

Historically, Cape Cod and the Islands (Barnstable, Dukes, and Nantucket counties) have experienced considerable seasonal variation in employment, related to their long standing economic dependence on tourism and seasonal service industries.

Table 2-7 Monthly 2017 Labor Force and Unemployment Data, Barnstable County

MONTH	LABOR FORCE	EMPLOYED	UNEMPLOYED	MONTHLY UNEMPLOYMENT RATE[1]	
				BARNSTABLE COUNTY	MASSACHUSETTS[2]
January	105,866	97,764	8,102	7.7%	4.5%
February	105,480	97,515	7,965	7.6%	4.4%
March	106,188	99,071	7,117	6.7%	4.1%
April	107,514	102,239	5,275	4.9%	3.6%
May	110,992	106,293	4,699	4.2%	3.7%
June	120,469	115,937	4,532	3.8%	4.0%
July	126,272	121,981	4,291	3.4%	4.0%
August	125,602	121,616	3,986	3.2%	3.6%
September	114,309	110,471	3,838	3.4%	3.5%
October	111,049	107,483	3,566	3.2%	3.1%
November	108,557	104,167	4,390	4.0%	3.0%
December	107,563	102,507	5,056	4.7%	3.1%
Annual	**112,489**	**107,254**	**5,235**	**4.7%**	**3.7%**

[1] U.S. Bureau of Labor Statistics Unemployment rates by county and state, not seasonally adjusted, Massachusetts, 2017

[2] Massachusetts Department of Unemployment Assistance; U.S. Bureau of Labor Statistics, not seasonally adjusted, 2017 (http://lmi2.detma.org/lmi/lmi_lur_b.asp?A=04&GA=000001&T-F=3&Y=2017&Sopt=&Dopt=TEXT)

Tables 2-7 and 2-8 demonstrate this trend in 2017 by charting unemployment rates in January (historically when unemployment on the Cape and Islands peaks) through August (historically when unemployment rates are lowest). Data for September through December and the annualized data for 2017 are also provided.

U.S. Bureau of Labor Statistics data for 2017 shows that, at 7.7%, Barnstable County's January unemployment rate was more than double its 3.2% August rate. The data also demonstrate that Barnstable County experienced higher rates of unemployment compared to the state from January to May, which coincides with Cape Cod's tourist off-season.

Table 2-8 Labor Force and Unemployment Data by Municipality, August 2017 Cape Cod and the Islands

CITY/TOWN	LABOR FORCE	EMPLOYED	UNEMPLOYED	UNEMPLOYMENT RATE
BARNSTABLE COUNTY				
Barnstable	26,726	26,726	909	3.4%
Bourne	11,927	11,466	461	3.9%
Brewster	5,797	5,651	146	2.5%
Chatham	3,292	3,210	82	2.5%
Dennis	7,386	7,148	238	3.2%
Eastham	2,864	2,798	66	2.3%
Falmouth	17,328	16,746	582	3.4%
Harwich	6,791	6,595	196	2.9%
Mashpee	8,824	8,540	284	3.2%
Orleans	3,207	3,137	70	2.2%
Provincetown	2,162	2,106	56	2.6%
Sandwich	12,754	12,375	379	3.0%
Truro	1,333	1,303	30	2.3%
Wellfleet	1,811	1,771	40	2.2%
Yarmouth	13,400	12,953	447	3.3%
DUKES COUNTY				
Aquinnah	275	272	3	1.1%
Chilmark	632	619	13	2.1%
Edgartown	3,076	3,003	73	2.4%
Gosnold	53	52	1	1.9%
Oaks Bluffs	3,335	3,256	79	2.4%
Tisbury	2,917	2,830	87	3.0%
West Tisbury	2,070	2,023	47	2.3%
NANTUCKET COUNTY				
Nantucket	9,532	9,369	163	1.7%
Cape & Islands (total)	**147,492**	**143,040**	**4,452**	**3.0%**
PLYMOUTH COUNTY (SELECT MUNICIPALITIES)				
Plymouth	31,612	30,472	1,140	3.6%
Wareham	14,175	13,608	567	4.0%

Source: MA DUA, US DOL, Local Area Unemployment Statistics (LAUS), not adjusted for seasonality. Tables drawn from http://lmi2.detma.org/lmi/lmi_lur_a.asp.

Conversely, during the peak tourist season, from June to September, Barnstable County experienced lower unemployment rates than Massachusetts as a whole. The 2017 labor force data show that the size of the labor force in the county grows and shrinks in response to seasonal demand, from a July peak of 126,272 persons to a February low of 105,480 persons, a 20% difference. Dukes and Nantucket counties experience even larger percentage increases from peak summer rates to their winter low.

Table 2-8 presents labor force and unemployment data by municipality for the Cape and Islands during August 2017. August is historically the month when unemployment rates in the region are the lowest. As the study area encompasses parts of Wareham and Plymouth, labor force and unemployment data are also provided for these towns.

The highest rates of unemployment in August 2017 were reported in the towns of Wareham (4.0%), Bourne (3.9%), and Plymouth (3.6%), each of which was equal or higher than the statewide rate of 3.6%. Unemployment for all the other towns on Cape Cod and the Islands was lower than the statewide rate. Improving transportation mobility on- and off-Cape Cod may increase year-round employment on Cape Cod, reducing the seasonal variability in the unemployment rates.

2.3.5 Journey to Work

This section describes the different methods that commuters in Barnstable County use for getting to work. According to 2010 and 2017 American Community Survey 5-Year Estimates, the largest share of workers in Barnstable County (81.1%) drove alone to work in 2017, a decrease of 0.6% since 2010. The second most common means of traveling to work was by carpool. Taken together, nearly 90% of commuters use private automobiles to

Table 2-9 Mode of Commuter Transportation to Work in Barnstable County (2010-2017)

MODE OF TRANSPORTATION TO WORK	2010	2017
Drove Alone	81.7%	81.1%
Carpool	7.1%	7.2%
Work at Home	5.6%	6.3%
Walk	2.9%	2.5%
Public Transit (excluding taxi cab)	1.2%	1.3%
Other (includes bicycle travel)	1.4%	1.6%

Source: US Census Bureau, 2006-2010 and 2013-2017 American Community Survey 5-year estimates Dataset: ACS 5-year Estimates, 2006-2010 (https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_17_5YR_S0801&prodType=table) and 2013-2017 (https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_17_5YR_S0801&prodType=table)

travel to work, accounting for the most important component of commuter transportation in Barnstable County (Table 2-9).

Crossing the two roadway bridges over the Canal represents an important part of the daily commute for many residents in Barnstable and nearby counties. U.S. Census data from 2010, shown in Table 2-10, indicate that 13,277 of Barnstable County residents (approximately 12% of working residents) crossed the Canal bridges to off-Cape workplaces. These data also show that residents from all 15 Barnstable County towns commuted off-Cape to work, ranging from 3,133 commuters from Bourne to 20 off-Cape commuters from Truro. Not surprisingly, the closer one lives to mainland Massachusetts the more likely one is to work off-Cape. A little less than one-third (32.4%) of all working Bourne residents commute to jobs off Cape (the highest percentage of any town on the Cape), followed by 19.6% of Sandwich workers, 13% of Falmouth workers and 12.9% of Mashpee workers. Note that portions of both Bourne and Sandwich are north of the Cape Cod Canal. Dennis, Eastham, Barnstable follow with 9.1%, 9.1% and 8.8% of resident workers commuting off-Cape, respectively. Outer-Cape towns such as Provincetown, Truro, and Wellfleet had the lowest percentages of commuters who travel to jobs off-Cape. Table 2-10 illustrates the distribution of off-Cape commuting from Barnstable County by town.

Table 2-10 Barnstable County Labor Force Commuting Off-Cape to Work (2010)

		PLACE OF WORK		
TOWN OF RESIDENCE	ALL WORKERS	ON-CAPE	OFF-CAPE	PERCENT WORKING OFF-CAPE
Barnstable	24,034	21,922	2,112	8.8%
Bourne	9,675	6,542	3,133	32.4%
Brewster	5,112	4,833	279	5.5%
Chatham	3,120	2,873	247	7.9%
Dennis	7,328	6,663	665	9.1%
Eastham	2,524	2,294	230	9.1%
Falmouth	16,595	14,443	2,152	13%
Harwich	5,743	5,488	255	4.4%
Mashpee	7,382	6,432	950	12.9%
Orleans	2,772	2,597	175	6.3%
Provincetown	1,745	1,665	80	4.6%
Sandwich	10,594	8,520	2,074	19.6%
Truro	1,312	1,292	20	1.5%
Wellfleet	1,460	1,405	55	3.8%
Yarmouth	10,896	10,046	850	7.8%
Barnstable County (Total)	**110,292**	**97,015**	**13,277**	**12%**

Source: US Census Bureau, 2010

Similarly, a substantial number of workers (9,030) travel from mainland Massachusetts to workplaces on Cape Cod. Overall, 22,307 commuters cross one of the Canal bridges twice a day during their work commute.

2.4 PUBLIC HEALTH CONDITIONS

The prevalence of health problems in Barnstable County was determined using data from the Massachusetts Department of Public Health (DPH).

The leading causes of death in Barnstable County mirror those statewide and include heart disease (25.1%), cancer (24.6%), and stroke (5.9%). Health problems include asthma, heart disease, diabetes, and depression. The data highlight factors that increase the risk of health-related problems, such as obesity and smoking. Finally, suicide and opioid overdose data are provided. The data sets vary; some data track Barnstable County only and some describe Cape Cod and the Islands.

Table 2-11 compares mortality and hospitalization rates in Barnstable County and Massachusetts for asthma, heart disease, and diabetes. It demonstrates that the mortality and hospitalization rates in Barnstable County were lower than statewide rates except for the asthma-specific mortality rate, which was the same.

The Department of Public Health's Behavioral Risk Factor Surveillance System (BRFSS) collects data on general health

Table 2-11 Mortality and Hospitalization Rates in Barnstable County

	MORTALITY[1]		HOSPITALIZATION[1]	
	BARNSTABLE COUNTY	MASSACHUSETTS	BARNSTABLE COUNTY	MASSACHUSETTS
Asthma[2]	0.6	0.6	88.5	155.5
Heart Disease[3]	192.1	201.6	1,244.6	1,536.8
Diabetes[4]	11.4	13.2	352.8	488.5

1 Adjusted by age per 100,000 persons to minimize effects of differences in age and population distributions.
2 Mortality rates based on average of 2008-2010 data, hospitalization based inpatient rate from 2007-2009
3 Mortality rates based on average of 2008-2010, hospitalization rates based on 2007-2009
4 Mortality rates based on 2010, hospitalization based on inpatient rate from 2009

Source: Mass Community Health Information Profile from Massachusetts Executive Office of Health and Human Services website (http://www.mass.gov/eohhs/researcher/community-health/masschip).

Table 2-12 Population with Sad, Blue, or Depressed Feelings

	CAPE COD AND THE ISLANDS	MASSACHUSETTS
15+ days of sad, blue, or depressed in the past 30 days among adults	5.1%	7.2%

Source: MassCHIP from Massachusetts Executive Office of Health and Human Services BRFSS Special Reports: General Health Status for Cape and Islands 2002-2007

Table 2-13 Population with Health Risk Factors in Barnstable County

	BARNSTABLE COUNTY	MASSACHUSETTS
Obesity	15.8%	19.4%
Smoking	12.8%	15.0%

Source: MassCHIP from Massachusetts Executive Office of Health and Human Services BRFSS Special Reports: Risk Factors and Health Behaviors for Cape and Islands 2006-2009

Table 2-14 Suicide Rate in Barnstable County

	BARNSTABLE COUNTY	MASSACHUSETTS
Suicide Rate[1]	12.1	8.7

[1] Age-adjusted rate per 100,000 persons

Source: MDPH Bureau of Communicable Diseases, 2014

status and asks respondents to report the number of days that they had felt sad, blue, or depressed in the previous 30 days. Fewer Cape and Island residents reported these feelings for 15 or more days in the previous month than residents statewide (Table 2-12).

The BRFSS also reports health-risk factors in adult populations in Massachusetts including obesity and smoking. Table 2-13 provides a comparison of these health risk factors for Barnstable County and Massachusetts and demonstrates that the rates of these conditions for Barnstable County were less than the average statewide rates.

Table 2-14 shows the increase in opioid-related deaths in Massachusetts from 2000 to 2015 (up more than 360%, from 355 to 1,658), with a particularly sharp rise since 2013. Opioidrelated deaths rose even more dramatically in Barnstable County, which experienced a 450% increase from 2000 to 2015.

Two other health issues of note are suicide and Lyme disease. Table 2-14 shows a substantially higher age-adjusted suicide rate on Cape Cod and the Islands than for the entire state. Additionally, since 2000, Barnstable County's suicide rate has nearly doubled, from 6.2 to 12.1 suicides per 100,000 persons.

Overall, hospitalizations and mortality rates from common health problems in Barnstable County is lower than statewide rates. The percent of health-risk factors is also lower in Barnstable County than it is for the state.

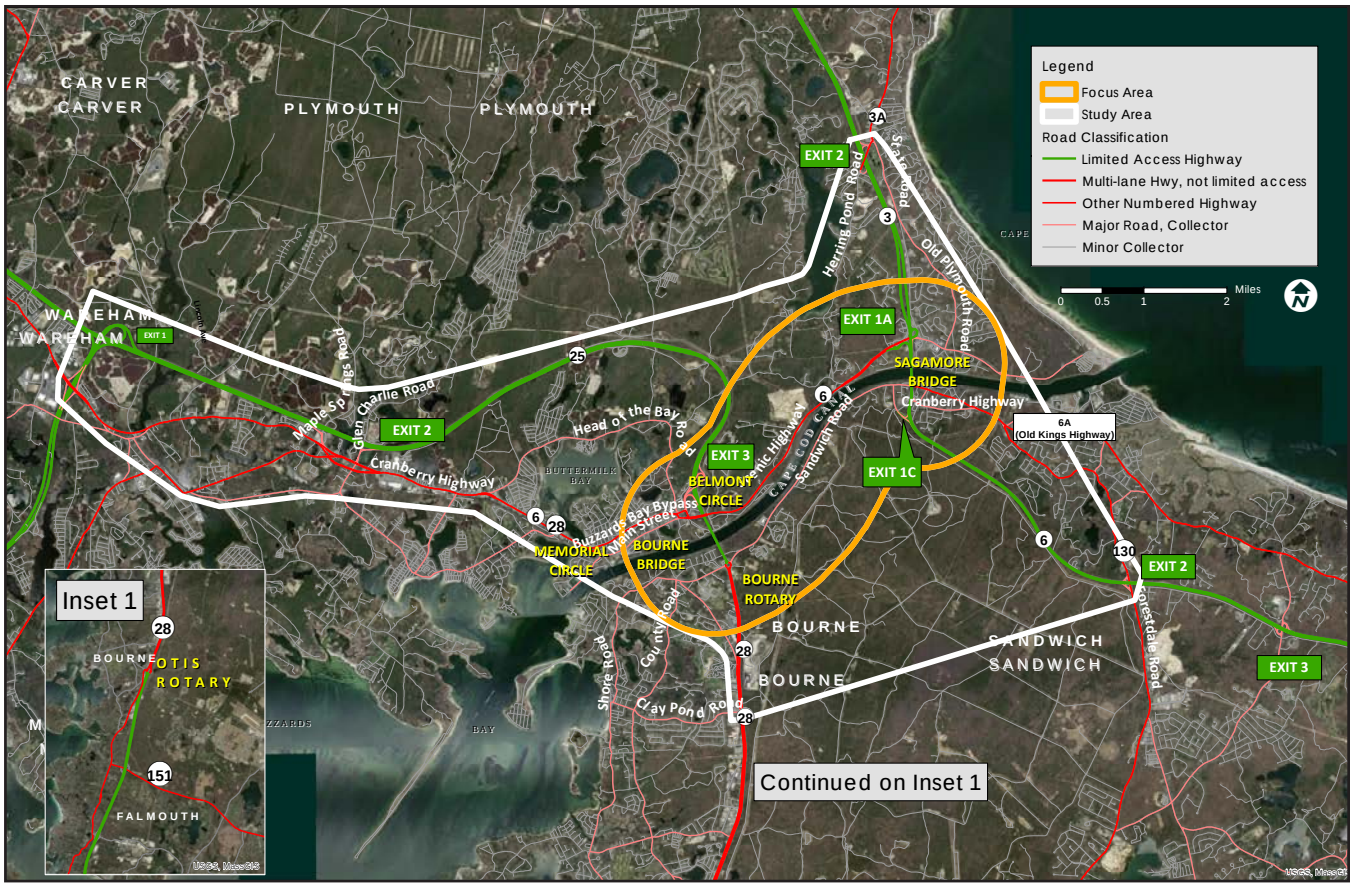


Exhibit 2-17 **Major Roadways in the Study Area**

2.5 TRANSPORTATION CONDITIONS

This section describes existing transportation facilities and traffic conditions in the study area. The major roadways and intersections in the study area are shown on Exhibit 2-17.

2.5.1 Major Highways in the Study Area

(top to bottom)
Sagamore Bridge
Bourne Bridge

Major highway corridors in the study area include the Route 3/ Sagamore Bridge/Route 6 corridor along the eastern side of the study area and the Route 25/Bourne Bridge/Route 28 corridor along the western side. These two bridges provide the only roadway access to Cape Cod (Exhibit 2-17). These highways are all under MassDOT jurisdiction.

Route 6 (Scenic Highway) and Sandwich Road connect these two corridors on the north and south sides of the Canal, respectively.

Route 3/Sagamore Bridge/Route 6 Corridor

Route 3, a principal arterial roadway, provides the main highway connection from Boston and other points north to Cape Cod. From the "Braintree Split" (the I-93/Route 3 Interchange in Braintree) south to the Sagamore Bridge, Route 3 generally has

two 12-foot wide travel lanes in each direction with an eight-foot shoulder separated by a grassed median. This configuration continues into the study area from the north at the Route 3/Route 3A Interchange (Exit 2) in Bourne.

Approximately two miles south of the Route 3 Exit 2 at Herring Pond Road interchange, Route 3 passes through the "Sagamore Flyover" (Exit 1A, the interchange of Route 3 with Route 6/Scenic Highway). Approaching this interchange from the north, one of the two travel lanes in Route 3 southbound is dropped to allow travelers from Scenic Highway to merge onto Route 3 at Exit 1A, reinstating the second travel lane. This lane-drop on Route 3 southbound was a required – but less desirable - feature in the design of the 2006 reconstruction of the Sagamore Rotary as a highway interchange because of the need to immediately tie into the two-lane Sagamore Bridge.

South of the Sagamore Rotary the highway designation changes to Route 6 and immediately crosses the Canal on the Sagamore Bridge. The cross section of the Sagamore Bridge includes two 10-foot travel lanes in each direction with no roadway shoulder. A 5-foot wide sidewalk is present on the east side of the bridge. The sidewalk is separated from the roadway by a 12-inch high granite curb.

The roadway geometry in this area, including the dropping of a travel lane on Route 3 southbound and the narrow travel lanes with no roadway shoulder on the Sagamore Bridge, contributes to congestion and delays on Route 3, especially during peak travel periods.

Immediately south of the Sagamore Bridge, Route 6 Exit 1C provides access to Sandwich Road for eastbound travelers via the Mid-Cape Connector and to Cranberry Highway for westbound travelers. The geometry of Route 6 Exit 1C westbound (at Cranberry Highway) is substandard and not in compliance with current MassDOT highway design standards. The deficiencies of Exit 1C include short acceleration and deceleration lanes, and steep grades approaching the Sagamore Bridge. High traffic volumes are common at the Exit 1entrance ramp to Route 6 westbound because travelers often use Route 6A to Cranberry Highway to bypass congestion on Route 6 westbound.

Route 6 eastbound maintains the same roadway cross section as Route 3 (two 12-foot travel lanes in each direction). Route 6 continues southeast for approximately 3.3 miles to the Route 6/ Route 130 Interchange in Sandwich, the southeast point of the study area.

Route 25, Wareham

Route 25/Bourne Bridge/Route 28 Corridor

The Route 25/Bourne Bridge/Route 28 corridor provides access to Cape Cod from the south and west. The northwest corner of the study area begins at the I 495/I-195/Route 25 Interchange in Wareham. Route 25, a principal arterial roadway, provides three 12-foot travel lanes with an eight-foot shoulder in each direction separated by a 90 foot grassed median. From the I-495/I-195 Interchange, Route 25 travels southeast 2.4 miles to the partial interchange with Maple Springs Road and another 0.5 miles to the partial interchange at Glen Charlie Road in Wareham. Together, these two interchanges provide access in all directions and are designated as Exit 2.

Route 25 continues south/southeast for six more miles to the Route 25/Route 6 (Scenic Highway) Interchange in Bourne. Belmont Circle, immediately to the west, can be reached through this interchange. At this point the highway designation changes to Route 28, and the highway immediately crosses the Canal on the Bourne Bridge. The cross section of the bridge is substandard, featuring two 10-foot travel lanes in each direction with no roadway shoulder. A five-foot wide sidewalk is present on the west side of the bridge. The sidewalk is separated from the roadway by a 12-inch high granite curb. Continuing south from the bridge is the Bourne Rotary, which handles traffic from several roadways, including Route 28, Sandwich Road, and Trowbridge Road.

Route 28 is a principal arterial roadway. Within the study area, it comprises two 12 foot travel lanes in each direction with a 10-foot shoulder separated by a 70-foot forested median. Route 28 provides at-grade access to roadways to the west and has turn around ramps every 0.5 miles. Route 28 continues south of the Bourne Rotary for approximately 6.75 miles to the southwest corner of the study area at the Route 151 intersection in Bourne.

2.5.2 Local Roadways/Highways and Principal Intersections in the Study Area

The following describes the main local highways/roadways and principal intersections in the study area (Exhibit 2-17).

Scenic Highway (Route 6)

Local Roadways/Highways

Route 6 (Scenic Highway, Buzzards Bay Bypass, Cranberry Highway)

Route 6 (Scenic Highway) is a principal arterial roadway under MassDOT jurisdiction that extends along the north side of the Canal from Route 3 at the Sagamore Interchange and continues to the west approximately 3.5 miles to Belmont Circle in Bourne. Scenic Highway provides a connection between the

Sagamore Bridge and the Bourne Bridge. Traveling west from the Sagamore Bridge for approximately one-mile, the roadway is approximately 84 feet wide consisting of two 12-foot travel lanes in each direction with a 16-foot wide median and 10-foot wide shoulders. No marked bicycles lanes or sidewalks are present. West of Bournedale Road, Scenic Highway narrows to approximately 48 feet wide, consisting of two 11-foot wide travel lanes in each direction with no median. Four-foot-wide shoulders are present on the south side of the roadway. No marked bicycle lanes or sidewalks are present. On the west side of Belmont Circle, Route 6 continues west for approximately one mile as Buzzards Bay Bypass. Traveling west, the bypass has two 11-foot wide westbound travel lanes and a single 11-foot wide eastbound lane. No marked bicycle lanes or sidewalks are present. Prior to the St. Margaret's Street intersection, the roadway shifts to two 11-foot wide travel lanes in each direction to Memorial Circle, where it turns northwest and becomes Cranberry Highway.

Cranberry Highway continues northeast for 2.5 miles, entering Wareham at the Cohasset Narrow Bridge. This portion of Cranberry Highway has a cross section of four 11-foot-wide travel lanes, but it drops to a single lane in each direction for one more mile until it reaches the Route 25 interchange at Glen Charlie Road in Wareham. No marked bicycle lanes or sidewalks are present.

Sandwich Road

Sandwich Road, a principal arterial roadway owned by the Town of Bourne, extends east-west for approximately 4.7 miles, parallel to the south side of the Canal, from the Route 6A/Route 130 intersection to the Sandwich Road/Trowbridge Road/County Road intersection. Sandwich Road is generally 22 to 24 feet wide, consisting of one 11- or 12-foot-wide lane in each direction with little or no shoulder. No marked bicycle lanes or sidewalks are present. Sandwich Road passes underneath Route 6 at the Sagamore Bridge and provides access to Route 6 eastbound via the Mid-Cape Connector in Bourne and Route 3 via Cranberry Highway. At its western end, Sandwich Road provides access to either Routes 25 or 28 via the Bourne Rotary. An unsignalized left-turn lane is provided as one approaches the Upper Cape Cod Regional Technical School from the east, 0.4 miles east of the Bourne Rotary.

Route 6A (Old Kings Highway)

Route 6A, a minor arterial, is a municipal roadway owned by the towns of Bourne and Sandwich. Route 6A extends approximately 1.3 miles from the Route 130/Sandwich Road intersection to

Sandwich Road at Technical High School

Route 6A, Sandwich

Tupper Road in Sandwich at the eastern edge of the study area. Route 6A is generally 22-feet wide, consisting of two 11-foot travel lanes with no shoulder. This section of Route 6A passes through primarily residential areas containing numerous historic structures within the Old Kings Highway Regional Historic District (Exhibit 2-9). While Route 6A is a designated bicycle route, no marked bicycle lanes or roadway shoulders are present. Sidewalks are present along either one or both sides of Route 6A from the Route 130 intersection to Crowell Lane.

Route 130 (Main Street)

Route 130, Sandwich

Route 130 (Main Street), a major collector roadway, is a municipal roadway owned by the town of Sandwich. Route 130 extends approximately 2.9 miles from the Route 6A/Sandwich Road intersection to Route 6 at Exit 2 in Sandwich at the eastern edge of the study area. Route 130 is generally 22-feet wide, consisting of two 11-foot travel lanes with no shoulder. Like Route 6A, this section of Route 130 passes through primarily residential areas containing numerous historic structures within the Old Kings Highway Regional Historic District. Sidewalks are generally present along either one or both sides of Route 130. Other land uses along Route 130 include the Henry Wing School and the Sandwich Landfill.

Route 151


Route 151, Falmouth

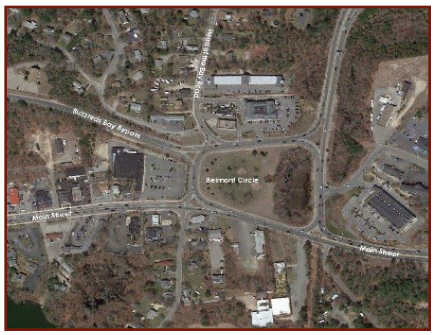
Route 151 is a major collector roadway that extends approximately 6.6 miles from the Route 28/Great Neck Road intersection in Mashpee east to the Otis Rotary. Route 151 is owned by the towns of Falmouth and Mashpee. Route 151 is generally 22-feet wide, consisting of two 11-foot travel lanes with a four foot shoulder on both sides of the roadway. Land uses along Route 151 include the Barnstable County Fairgrounds and Mashpee Commons retail center. Sidewalks are not present. A 10 foot wide bike trail runs alongside a portion of the north side of Route 151. The trail extends 0.75 miles from Old Barnstable Road to Job's Fishing Road.

Principal Intersections (Gateway Intersections)

The principal intersections in the study area are Belmont Circle, Bourne Rotary, and Route 6 Exit 1C. Because these intersections lead motorists directly to and from Cape Cod via the Bourne and Sagamore Bridges. For this reason, for this study they are known as the 'Gateway Intersections'. Because each of these gateway intersections suffers from substandard design features and high peak period traffic volumes, they are a main driver of traffic congestion in the study area.

Belmont Circle

Belmont Circle is a rotary north of the Cape Cod Canal immediately west of the Route 25 approach to the Bourne Bridge in Bourne. The roadway approaches to Belmont Circle include Scenic Highway, Main Street, Buzzards Bay Bypass, Head of the Bay Road, and the ramps to Route 25. The entrance ramp to Route 25 eastbound leads directly to the Bourne Bridge. Upon entering the bridge, the roadway designation changes to Route 28 and continues southeast to other Cape Cod destinations in Bourne, Falmouth, Mashpee, and Chatham. Route 28 also provides access to the Massachusetts Steamship Authority's Woods Hole ferry terminal which provides access to the islands of Martha's Vineyard and Nantucket.



Belmont Circle, Bourne

East of Belmont Circle, Main Street becomes Scenic Highway at the Nightingale Pond Road intersection. Scenic Highway provides direct access to Route 3 at the Sagamore Interchange, 3.4 miles to the east.

To avoid traffic congestion on Route 25 eastbound while heading toward the Bourne Bridge, travelers often leave Route 25 at Exit 2 (Glen Chen Charlie Road) to access Route 6 eastbound in Wareham towards Main Street and Belmont Circle in Bourne. A strong traveler preference for Main Street eastbound rather than the parallel route of the Buzzards Bay Bypass has been observed. This traffic diversion contributes to additional traffic volumes in Belmont Circle.

The roadway approaches to Belmont Circle generally consist of a single 11 foot lane in each direction. Scenic Highway features two 11-foot lanes in each direction. The rotary itself generally features three 12-foot lanes. The Main Street approach has parking on both sides of the road. No marked bicycle lanes or sidewalks are present.

Several restaurants and retail businesses, including CVS pharmacy, Ocean State Job Lot, the Way-Ho restaurant, and Mobil Gas have driveways directly from the Circle. Traveling west on Main Street from Belmont Circle leads directly to the Bourne business district.

Bourne Rotary, Bourne

Bourne Rotary

The Bourne Rotary is immediately south of the Bourne Bridge. The roadway approaches to the Bourne Rotary include Route 28 (on both the north and south sides of the Rotary), Trowbridge Road, and the Bourne Rotary Connector. Sandwich Road provides a roadway connection north of the rotary between Trowbridge Road (via Veterans Way) and the Bourne Rotary Connector.

Sandwich Roads provides a connection to Route 6 (via the Mid Cape Connector) 3.0 miles to the east.

Route 28 north of the Bourne Rotary leads directly to the Bourne Bridge. Upon exiting the bridge, the roadway designation changes to Route 25 and continues northwest to other destination in southeastern Massachusetts and Rhode Island.

The roadway cross section along Route 28 approach from the north includes two 10 foot travel lanes in each direction with no roadway shoulder. A five-foot wide sidewalk exists on the west side of the Bourne Bridge. In 2017, MassDOT extended this sidewalk to the south around the front of the State Police barracks to Veterans Way. Other than this sidewalk at the State Police barracks, no other sidewalks or marked bicycle lanes are present. The cross section of the Route 28 approach from the south consists of two 12 foot travel lanes in each direction with a 10-foot shoulder separated by a 70-foot forested median. The Trowbridge Road approach to the rotary consists of a single 12-foot lane in each direction. Finally, the Bourne Rotary Connector approach to the rotary consists of a single 16-foot lane in each direction.

Route 6 Exit 1C Westbound

Route 6 Exit 1C

Route 6 Exit 1C includes westbound-only exit and entrance ramps to and from Cranberry Highway in Bourne. The highway ramps are immediately south of the Sagamore Bridge. The Christmas Tree Shop retail store is adjacent to the Exit 1C entrance ramp. At approximately 200 feet, these exit- and entrance-ramps are substandard in length. MassDOT Highway Design standards recommend 600-foot exit ramps and 1,000-foot entrance ramps.

The roadway geometry at the Route 6 Exit 1C entrance ramp, including the substandard acceleration lane and steep grades on the Sagamore Bridge approach, contributes to congestion and delays on Route 6 westbound, especially during peak travel periods.

Automatic Traffic Recorders (ATRs) *are pneumatic tubes placed across a roadway that record the number and type of all vehicles that pass over them.*

Turning Movement Counts (TMCs) *are conducted at intersections to determine how many and what types of vehicles approach an intersection and what direction they head to.*

Exhibit 2-18 Location of Automatic Traffic Recorders and Turning Movement Counts

2.5.3 Traffic Counting Methods

The study team collected traffic data in the study area using methods that include Automatic Traffic Recorders (ATRs), Turning Movement Counts (TMCs), and BlueTOAD™ origin-destination study.

Traffic data along highways, local roadways and numerous intersections was collected using a combination of all three methods. Traffic counts were collected using ATRs at 57 locations and conducted TMCs at 37 locations in or close to the study area (Exhibit 2-18). These data identified average daily traffic (ADT), peak-hour volumes, and the turning movements of vehicles in the study area.

Traffic data is presented for two different time periods, the peak period and the peak hour. Traffic data is collected during the peak period, typically a two-hour period. This data is used to identify the one-hour period with the highest traffic volume. The subsequent traffic analysis uses the peak hour traffic volumes to evaluate capacity and Level of Service (LOS).

Automatic Traffic Recorders and Turning Movement Counts

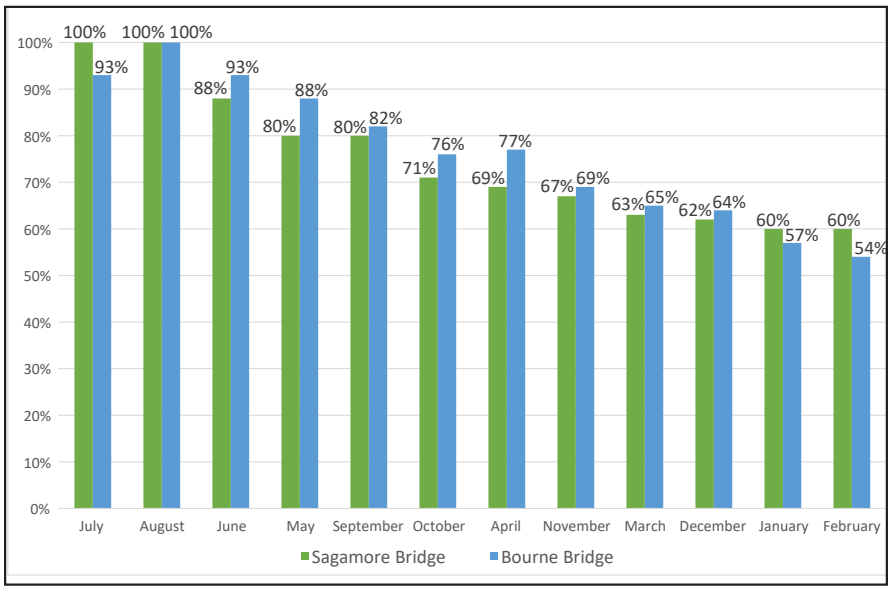
Automatic Traffic Recorders (ATRs) comprise pneumatic tubes laid across a roadway perpendicular to the line of travel. As vehicles pass over the tube, a recording device stores the number of vehicles that pass over during certain time intervals. Turning Movement Counts are important to traffic analysis because they provide the data necessary to analyze delay and queuing at an intersection. These data allow traffic engineers to assign a LOS for that location (as described in Section 2.5.5).

Turning Movement Counts (TMCs) were conducted at roadway intersections, including signalized and stop-controlled intersections, roundabouts, and rotaries. Turning Movement Counts determine how many and what type of vehicles approach an intersection and what direction they head to (left, right, or through). This count is taken for all roadway approaches. The TMCs were conducted by hand counts and they include pedestrian and bicycle traffic.

The study team collected traffic data during a summer period and a non summer period in 2014. The summer period data collection occurred August 10–17 and the non summer collection took place October 19–26, as these months were found to be representative of these periods.

The summer and non-summer collection periods reflect the reality of Cape Cod traffic patterns: as a major summer tourist destination, it has far higher traffic volumes in the summer than in the non-summer periods. For example, as shown on Exhibit 2-19, the average traffic volumes crossing the Canal Bridges during February are only 54% (Bourne Bridge) to 60% (Sagamore Bridge) of the volumes crossing these bridges during August.

Exhibit 2-19 Seasonal Traffic Volumes Differences on Canal Bridges



Traffic data was collected for summer Saturday peak period, a period of high traffic demand because vacation rentals on the Cape generally begin and end on Saturday. Summer Saturdays are a period of high bi-directional volumes with traffic traveling both to and leaving from Cape Cod. Based on the traffic data collected during these two-hour travel periods, the peak one-hour period is identified. The data from this peak hour was used to inform the study's traffic analysis.

The time periods examined were:

- AM summer weekday (7:00 AM – 9:00 AM)
- PM summer weekday (4:00 PM – 6:00 PM)
- Saturday summer (10:00 AM - 12:00 PM)
- AM non-summer weekday (7:00 AM – 9:00 AM)
- PM non-summer weekday (4:00 PM – 6:00 PM)
- Saturday non-summer (10:00 AM - 12:00 PM)

A BlueTOAD™ unit performs detailed origin-destination studies by detecting the unique Bluetooth number of phones, navigation, and other GPS-based devices as they enter and exit a Study Area.

A BlueTOAD™ unit

2.5.4 BlueTOAD™ Origin-Destination Study

The study area presents two sets of unique decision locations not found in most transportation studies. These are the access control represented by the two highway bridge crossings of the Cape Cod Canal and the multiple exit-entrance choices afforded by study area rotaries.

Understanding travel routing in the study area requires an understanding of the travel patterns of vehicles using the roadway network. That emerges from origin-and-destination data collected from vehicles as they enter and exit the roadway. A seven-day origin-destination study was conducted using BlueTOAD™ units and ATRs to gain an understanding of the origins and destinations of traffic in the study area. For example, the BlueTOAD™ study allowed for a better understanding of which roads a vehicle used to travel from Route 25 eastbound in Wareham to Route 6 eastbound in Sandwich.

A BlueTOAD™ unit records the unique Bluetooth number of GPS-enabled devices (cell phones, navigation, and car radios), then records where these devices pass by the BlueTOAD™ units installed throughout the study area. This technology collects information on approximately 10% to 15% of the total traffic

Exhibit 2-20 Location of BlueTOAD™ Units

volume, a level of sampling considered sufficient to estimate origins and destinations for all traffic.

Exhibit 2-20 shows the location of BlueTOAD™ devices throughout the study area for two one-week recording periods: in July 2014 during the peak season and in October 2014 during the non-peak season. Each deployment coincided with ATR data collection. The study team applied the percentages determined by the BlueTOAD™ data to the coinciding traffic counts from ATRs and TMCs, yielding the origins and destinations of all vehicles entering and exiting the study-area roadway network.

2.5.5 Transportation Analysis Methodology

The analyses of study area highway operations primarily used Highway Capacity Manual Software (HCS) and other methodologies based on the Highway Capacity Manual (HCM) to calculate levels of service and other measures of effectiveness of roadway operations for major highways. Synchro™ Version 8 was used to analyze signalized and unsignalized intersection operations and SimTraffic software was used to produce simulations. Belmont Circle, the Bourne Rotary, and other traffic circles in the study area were simulated using VISSIM™ software and analyzed using SIDRA™ 5.1 software. These traffic analysis

techniques are accepted by the Federal Highway Administration (FHWA) and state Departments of Transportation nationwide, including MassDOT.

Level of Service (LOS), identified in the Highway Capacity Manual (2016 edition), is a commonly accepted measure of the efficiency for peak-hour traffic operating conditions. Level of Service accounts for such factors as automobile and truck volumes, roadway capacity, speeds, grades, traffic control devices, the progression of vehicular traffic flow along an arterial roadway, roadway types, roadway widths and geometric layouts, as well as anticipated delays. LOS range from A, the optimal free-flow condition, to F, where traffic demands are beyond roadway capacity or create excessive delays (Table 2-15).

Table 2-15 Level of Service (LOS) Criteria[1]

FREEWAY FACILITIES	
LEVEL OF SERVICE	DENSITY (PC/MI/LN)
A	< 11
B	> 11 – 18
C	> 18 – 26
D	> 26 – 35
E	> 35 – 45
F	> 45 or any component v_d/c ratio > 1.00

SIGNALIZED INTERSECTIONS		
CONTROL DELAY (S/VEH)	LOS BY VOLUME-TO-CAPACITY RATIO[A]	
	<1.0	>1.0
< 10	A	F
> 10 – 20	B	F
> 20 – 35	C	F
> 35 – 55	D	F
> 55 – 80	E	F
> 80	F	F

UNSIGNALIZED INTERSECTIONS		
CONTROL DELAY (S/VEH)	LOS BY VOLUME-TO-CAPACITY RATIO[A]	
	<1.0	>1.0
0-10	A	F
> 10 – 15	B	F
> 15 – 25	C	F
> 25 – 35	D	F
> 35 – 50	E	F
> 50	F	F

Note: For approach-based and intersection-wide assessments, LOS is defined solely by control delay.
Note: The LOS criteria apply to each lane on a given approach and to each approach on the minor street. LOS is not calculated for major-street approaches or for the intersection.

Transportation Research Board, Highway Capacity Manual, Sixth Edition: A Guide for Multimodal Mobility Analysis, 2016

Roadways or intersections operating at LOS F are typically judged 'undesirable'. LOS E has generally become a threshold between acceptable and undesirable traffic operations in urban areas.

Traffic operations are defined by the performance of several components characterized by either uninterrupted flow (highway sections and ramp junctions) or interrupted flow (unsignalized intersections with roadway ramps and arterials or yield-controlled movements at the rotary). In recognition of the distinctly different nature of traffic flow and driver's expectations for these types of traffic facilities, LOS is based on density for highway sections and ramps and average delay at intersections. This concept and the typical characteristics of various components that comprise the roadway network in the study area are explained further in the following paragraphs.

Highway segments or **links** have limited access between interchanges. In these areas, with no ramps, LOS reflects vehicle density per lane, a measure of the spacing between vehicles and the ability of a driver to travel at a desired speed without being delayed by other vehicles on the road. Other measures of effectiveness used to assess operations for links include density in passenger cars per mile per lane (pc/mi/ln) and average passenger car speed in miles per hour.

Ramp junctions are locations where traffic either merges with or diverges from the mainline traffic stream. **Merge movements** occur where vehicles entering the highway from an on-ramp must blend with or merge into the mainline flow. **Diverge movements** occur as a vehicle maneuvers out of the mainline flow and onto an exit ramp. As with links, LOS for merge and diverge sections is a function of the density in the lanes. The main traffic demands are the volumes of merge or diverge traffic and mainline traffic value. A **weave** area occurs as vehicles attempting to enter and where entry and exit points occur close to each other.

VISSIM™ vs. HCM

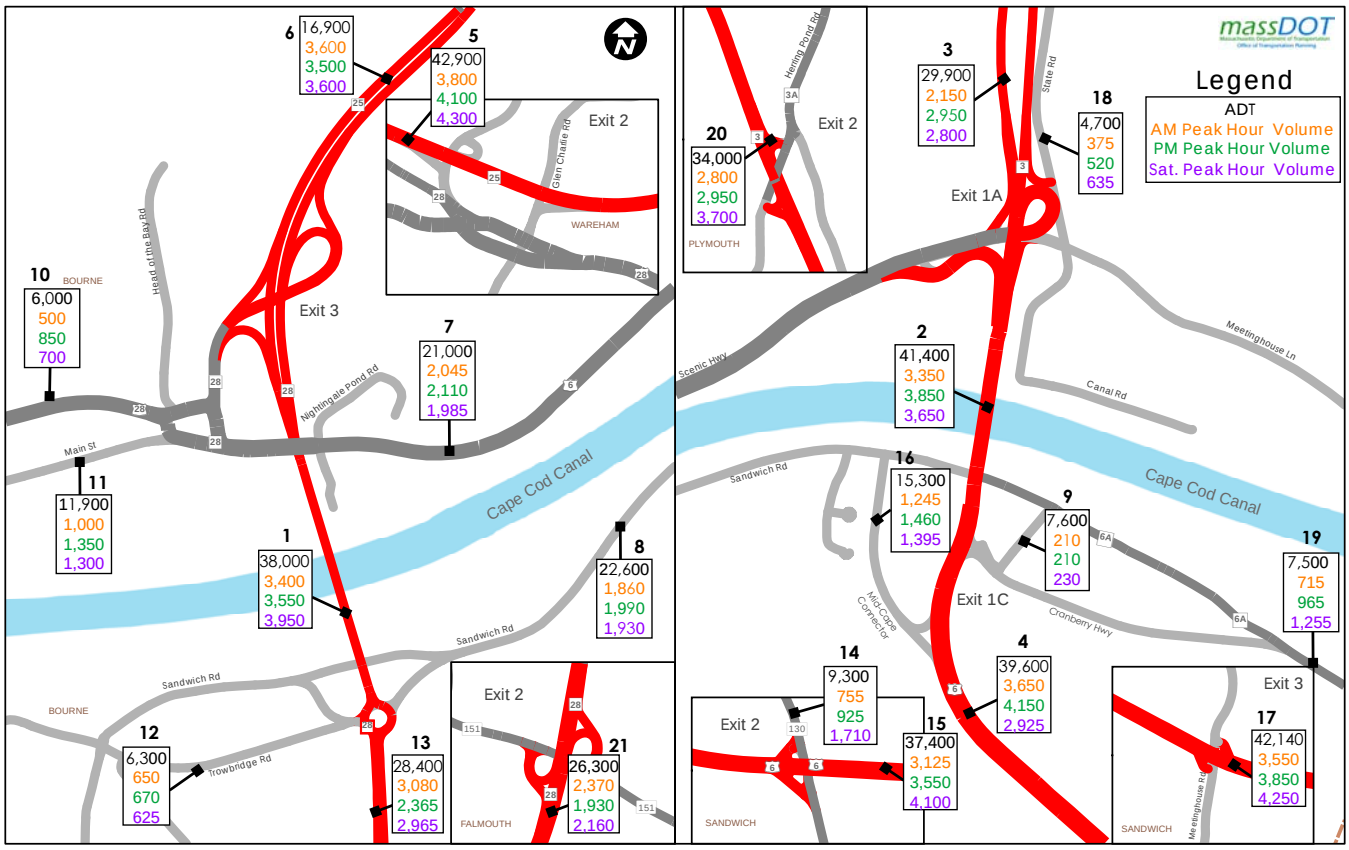
While HCM software determines LOS along highways and at intersections, LOS is not an effective measure of performance at rotaries or other unconventional intersections. To understand how traffic operates in Belmont Circle and the Bourne Rotary (and other rotaries in the study area), VISSIM™ was used to analyze and simulate existing conditions. This highly customizable software can reproduce and predict uncommon roadway conditions more effectively than other industry-standard traffic software.

Therefore, to understand how traffic operates in Belmont Circle and the Bourne Rotary, VISSIM™ software was used to analyze and simulate existing and future conditions. Traffic conditions within these rotaries are described in terms of the VISSIM™ model's output, including queues, vehicle delays, and travel time. The results from the simulation (average delay) are then used to determine LOS based on the criteria in the HCM.

2.5.6 Existing Average Daily Traffic and Peak-Hour Traffic Volumes

Exhibits 2-21 and 2-22 present summer and non-summer Average Daily Traffic (ADT) and the AM, PM, and summer peak-hour traffic volumes at select locations in the study area. Table 2-16 offers a summary of peak-hour traffic volumes for the AM, PM and Saturday periods for both summer and non-summer traffic. The morning peak is 7:00–9:00 AM; the afternoon peak is 4:00–6:00 PM; and the Saturday peak is 10:00 am–12:00 PM.

Exhibit 2-21 Existing Non-Summer Average Daily and Peak Hour Traffic Volumes (AM/PM/Saturday)



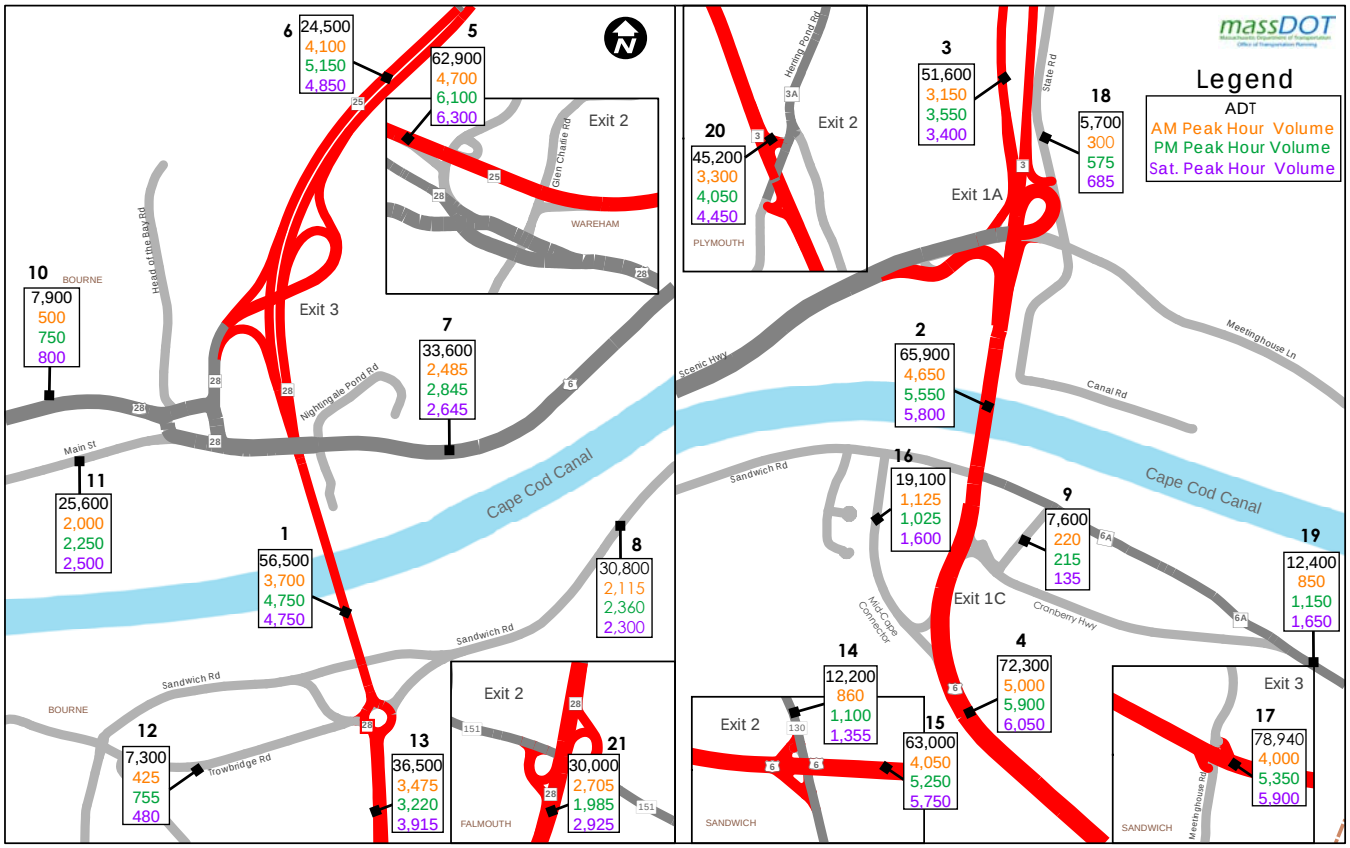


Exhibit 2-22 Existing Summer Average Daily and Peak Hour Traffic Volumes (AM/PM/Saturday)

There are substantial seasonal differences in traffic volumes in the study area because Cape Cod is a major summer tourist destination. For example, daily traffic volumes on the Bourne and Sagamore Bridge are 49% and 59% higher in the summer, respectively, compared to non-summer periods. Daily traffic volumes are 45% higher on Route 25 and 83% higher on Route 6 during the summer (Table 2-17).

Certain count locations were excluded from the table as they were outside of the focus area or did not contribute meaningfully to the study. These locations are:

- Herring Pond Road South of Black Pond Road
- Route 130/Main Street North of Pickerel Cove Road
- Bournedale Road over Route 25
- Route 130 South of Kiahs Way
- Shore Road West of County Road
- Driveway from Cranberry Highway to the Christmas Tree Shop
- Quaker Meeting House Road North of Route 6

Table 2-16 Existing Average Daily Traffic Volumes and Peak Hour Traffic Volumes

EXHIBIT LOCATION (2-21 / 2-22)	ATR COUNTING STATIONS	SUMMER 2014				NON-SUMMER 2014			
		AM	PM	SAT	ADJUSTED ADT[1]	AM	PM	SAT	ADJUSTED ADT[1]
1	Bourne Bridge	3,700	4,750	4,750	56,500	3,400	3,550	3,950	38,000
2	Sagamore Bridge	4,650	5,550	5,800	65,900	3,350	3,850	3,650	41,400
3	Route 3 between Exits 1A and 2	3,150	3,550	3,400	51,600	2,150	2,950	2,800	29,900
4	Route 6 between Exits 1 and 2	5,000	5,900	6,050	72,300	3,650	4,150	2,925	39,600
5	Route 25 West of Exit 2	4,700	6,100	6,300	62,900	3,800	4,100	4,300	42,900
6	Route 25 East of Exit 2	4,100	5,150	4,850	24,500	3,550	3,500	3,600	16,900
7	Route 6 (Scenic Hwy) East of Nightingale Rd	2,485	2,845	2,645	33,600	2,045	2,110	1,985	21,000
8	Sandwich Rd East of Bourne Rotary Connector	2,115	2,360	2,300	30,800	1,860	1,990	1,930	22,600
9	Adams St South of Sandwich Rd	220	215	135	7,600	210	210	230	7,600
10	Buzzards Bay Bypass	500	750	800	7,900	500	850	700	6,000
11	Main St West of Perry Ave	2,000	2,250	2,500	25,600	1,000	1,350	1,300	11,900
12	Trowbridge Rd West of Veterans Way	425	755	480	7,300	650	670	625	6,300
13	Route 28 South of Bourne Rotary	3,475	3,220	3,915	36,500	3,080	2,365	2,965	28,400
14	Route 130 North of Route 6	860	1,100	1,355	12,200	755	925	1,710	9,300
15	Route 6 between Exit 2 and 3	4,050	5,250	5,750	63,000	3,125	3,550	4,100	37,400
16	Mid-Cape Connector South of Sandwich Rd	1,125	1,025	1,600	19,100	1,245	1,460	1,395	15,300
17	Route 6 East of Exit 3	4,000	5,350	5,900	78,940	3,550	3,850	4,250	42,140
18	State Rd North of Ramp to Route 3 NB	300	575	685	5700	375	520	635	4,700
19	Route 6A East of Cranberry Hwy	850	1,150	1,650	12,400	715	965	1,255	7,500
20	Route 3 between Exits 2 and 3	3,300	4,050	4,450	45,200	2,800	2,950	3,700	34,000
21	Route 28 South of Exit 2 (Route 151)	2,705	1,985	2,925	30,000	2,370	1,930	2,160	26,300
22	Route 3 NB Off Ramp to Herring Pond Rd	100	200	100	1,800	100	200	150	1,400
23	Route 3 SB Off Ramp to Herring Pond Rd	250	500	800	4,600	400	450	800	2,100
24	Route 3 SB Off Ramp to Scenic Highway	250	300	300	3,400	350	350	450	3,500
25	Route 6 EB Off Ramp to Mid-Cape Connector	450	600	500	5,900	450	500	250	4,700
26	Route 6 EB Off Ramp to Quaker Meeting House Rd	350	200	200	1,300	100	150	150	1,300
27	Route 6 EB Off Ramp to Route 130	450	250	450	7,000	450	650	400	5,600
28	Route 6 WB Off Ramp to Cranberry Hwy	450	500	450	5,500	450	550	400	2,500
29	Route 6 WB Off Ramp to Meetinghouse Lane EB	300	450	300	4,700	250	350	300	3,300

[1] Average Daily Traffic (ADT)

Table 2-16 continues on the next page.

Table 2-16 Existing Average Daily Traffic Volumes and Peak Hour Traffic Volumes

EXHIBIT LOCATION (2-21 / 2-22)	ATR COUNTING STATIONS	SUMMER 2014				NON-SUMMER 2014			
		AM	PM	SAT	ADJUSTED ADT[1]	AM	PM	SAT	ADJUSTED ADT[1]
30	Route 6 WB Off Ramp to Quaker Meetinghouse Rd	100	200	200	1,000	200	350	200	2,500
31	Route 6 WB Off Ramp to Route 130	200	250	300	2,200	250	300	750	2,400
32	Route 6 WB Off Ramp to Scenic Hwy WB	800	1,100	1,000	11,800	700	800	550	7,500
33	Route 25 EB Off Ramp to Belmont Circle	600	750	700	9,000	500	500	400	4,700
34	Route 25 EB Off Ramp to Maple Springs Rd	350	850	1200	7,300	300	650	500	5,100
35	Route 28 NB Off Ramp to Route 151	100	290	185		150	245	200	2,300
36	Route 28 SB Off Ramp to Route 151	355	745	580		400	600	550	5,600
37	Route 130 On Ramp to Route 6 EB	200	200	150	2300	300	200	100	2,000
38	Route 130 On Ramp to Route 6 WB	500	500	300	9,400	550	450	350	4,700
39	Route 130 South of Route 6	1,620	1,900	1,685	24,500	1,655	1,805	1,690	16,900
40	Route 151 On Ramp to Route 28 NB	520	550	565		620	500	600	5,800
41	Route 151 On Ramp to Route 28 SB	245	220	220		280	200	250	2,400
42	Belmont Circle On Ramp to Bourne Bridge	700	700	1,000	8,600	750	700	1,000	7,000
43	Belmont Circle On Ramp to Route 25 WB	1,000	1,050	800	12,100	850	800	850	7,900
44	Bourne Bridge Off Ramp to Belmont Circle	500	700	400	7,200	450	650	600	5,900
45	Scenic Hwy EB On Ramp to Sagamore Bridge	650	750	950	9400	650	550	400	5,400
46	Scenic Hwy WB On Ramp to Sagamore Bridge	285	280	700	3600	275	230	350	2,700
47	Sandwich Rd West of Jillian Drive	1,925	2,295	2,305	31,200	1,845	1,960	1,855	24,300
48	Sandwich Rd East of Adams St	770	1,225	1,430	11,700	1,010	1,220	1,065	8,900
49	Cranberry Hwy On Ramp to Route 6 WB	450	550	800	6,500	400	550	750	5,100
50	Mid Cape Connector On Ramp to Route 6 EB	800	1,000	1,100	12,500	700	800	900	8,400
51	Herring Pond Rd On Ramp to Route 3 NB	350	350	450	4,400	600	300	400	4,000
52	Herring Pond Rd On Ramp to Route 3 SB	350	150	100	2,500	250	150	150	3,800
53	Quaker Meeting House Rd On Ramp to 6 EB	350	200	200	2,700	400	200	200	2,500
54	Quaker Meeting House Rd On Ramp to Route 6 WB	100	100	50	1,000	150	100	100	1,000
55	Glen Charlie Rd On Ramp to Route 25 EB	150	250	250	2,200	350	150	150	1,600
56	Maple Springs Rd On Ramp to Route 25 WB	600	700	700	6,900	600	400	500	4,600

[1] Average Daily Traffic (ADT)

Table 2-17 Comparison of Non-Summer and Summer Daily Traffic Volumes

ATR COUNTING STATIONS	ADJUSTED ADT[1]		PERCENT INCREASE
	NON-SUMMER	SUMMER	
Bourne Bridge	38,000	56,500	49
Sagamore Bridge	41,400	65,900	59
Route 3 between Exits 1A and 2	29,900	46,500	56
Route 6 Between Exits 1 and 2	39,600	72,300	83
Route 25 west of Exit 2	42,900	62,900	47
Route 25 east of Exit 2	16,900	24,500	45
Route 6A East of Tupper Road	7,500	12,400	65
Route 6 (Scenic Hwy) east of Nightingale Rd	21,000	33,600	60
Sandwich Rd East of Bourne Rotary Connector	22,600	30,800	36
Main Street, Bourne West of Perry Avenue	11,900	25,600	115

[1] Average Daily Traffic (ADT)

2.5.7 Existing (2014) Turning Movements

Turning movement counts (TMC) quantify the movement of vehicles traveling through intersections, including signalized, stop-controlled, and rotaries. TMCs are important to traffic analysis because they provide the data necessary to analyze delay and queuing at an intersection. These data allow for the assignment of LOS for that location. Exhibits 2-23 to 2-28 present vehicle turning movements at intersections in the study area for the various summer and non-summer peak periods. Individual results are provided for the AM, PM, and Saturday peak periods. Certain TMC locations were excluded as they were outside of the focus area or did not contribute meaningfully to the study.

Text continues on page 2-55.

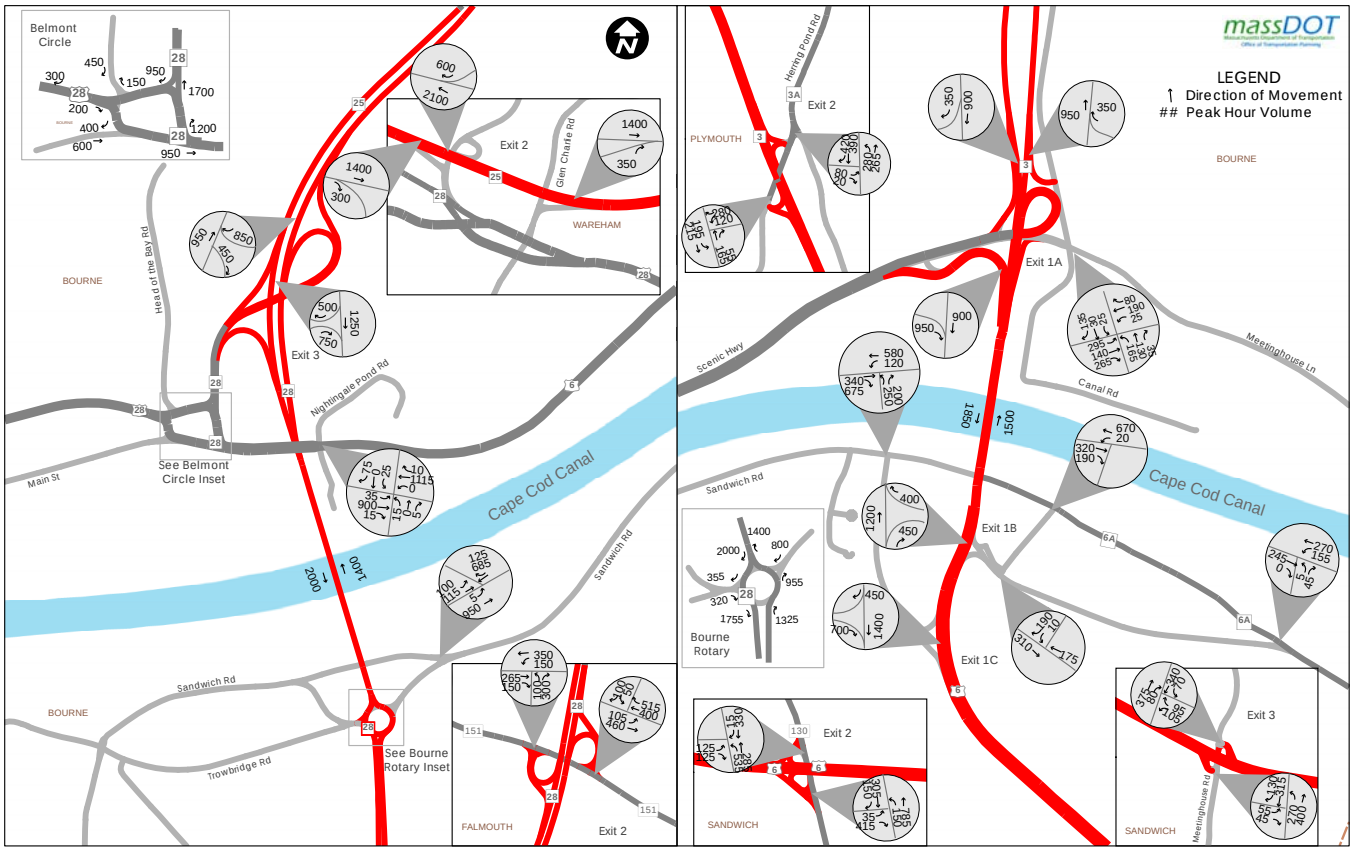
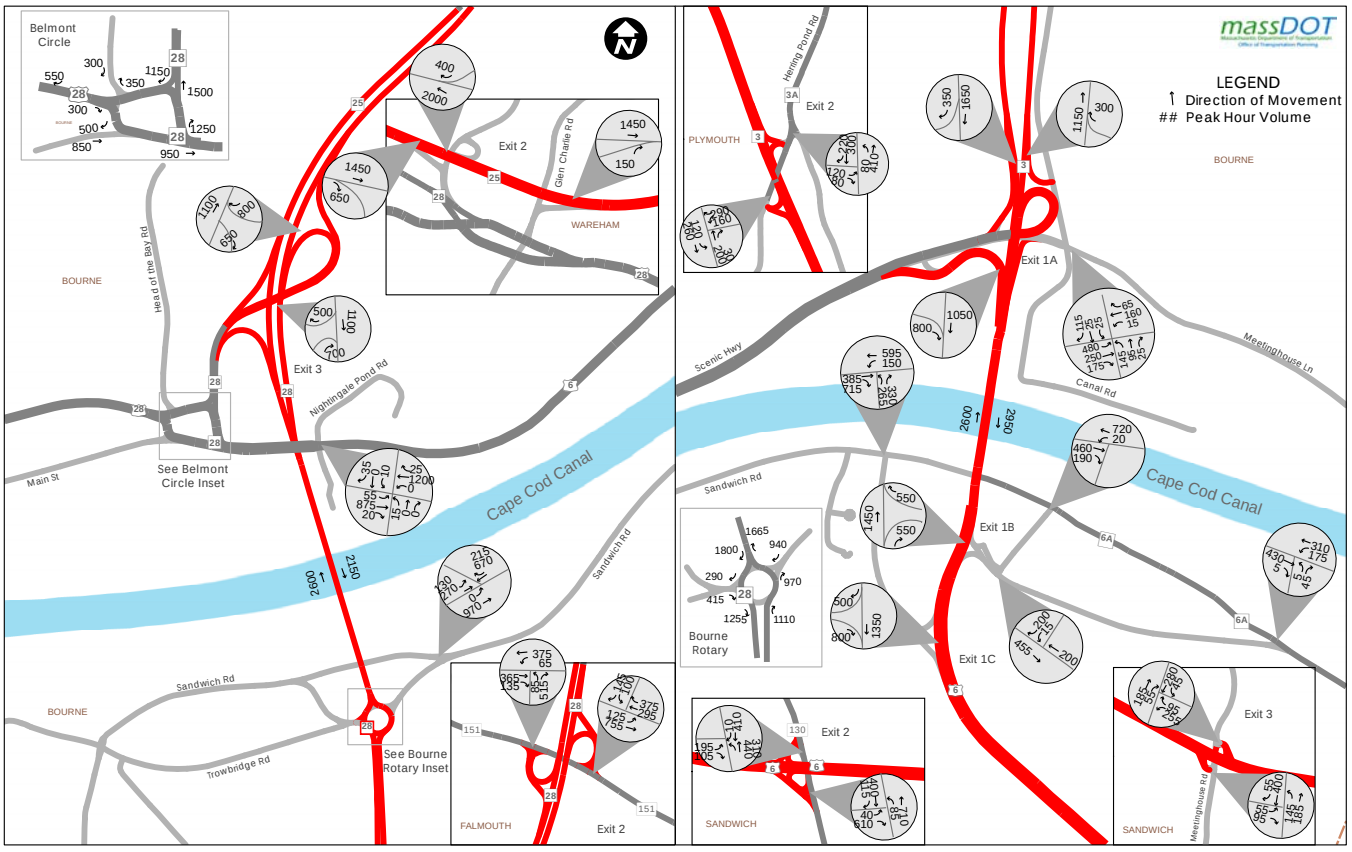


Exhibit 2-23 Existing Non-Summer AM Turning Movements

Exhibit 2-24 Existing Non-Summer Weekday PM Turning Movements



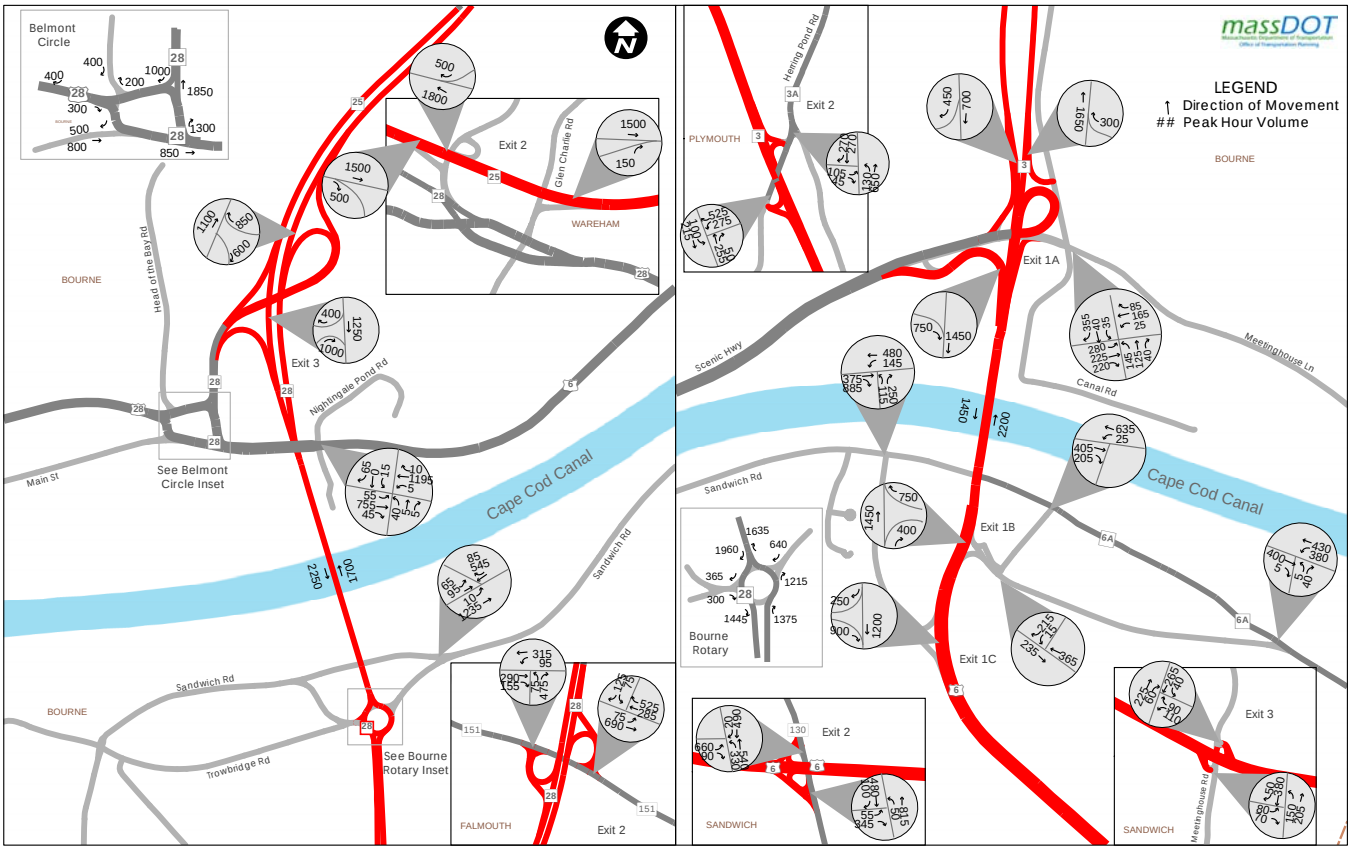
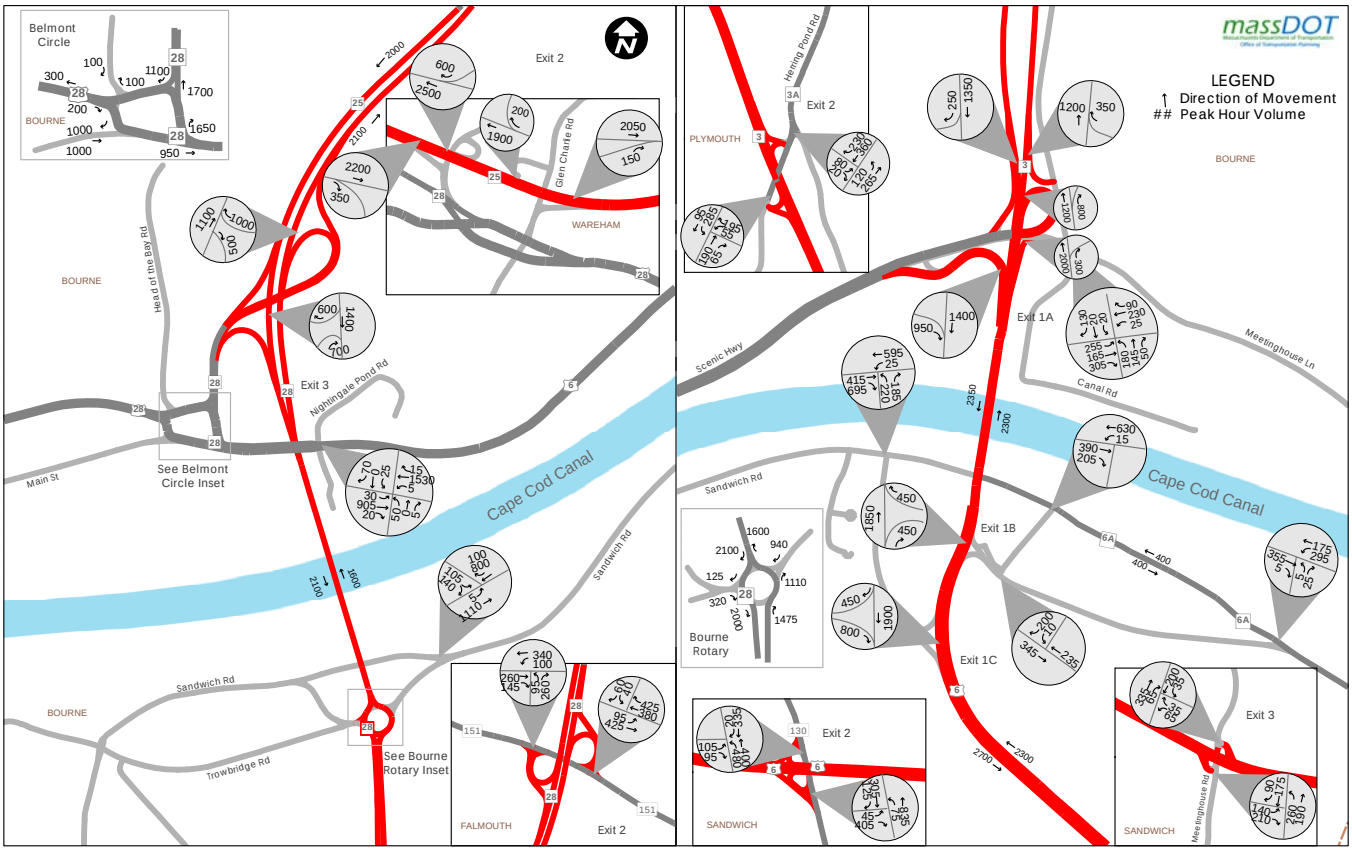


Exhibit 2-26 Existing Non-Summer Saturday Turning Movements

Exhibit 2-25 Existing Summer Weekday AM Turning Movements



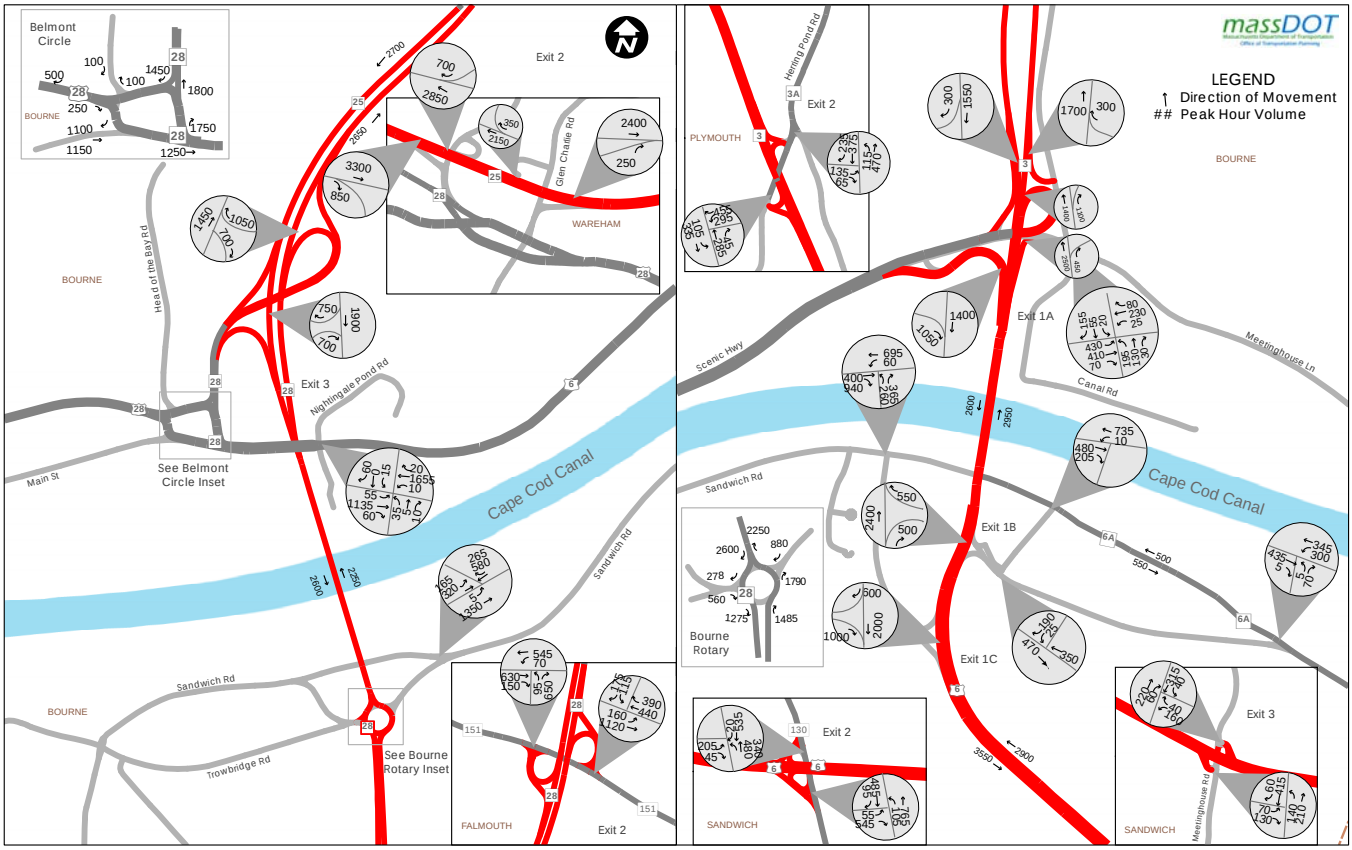
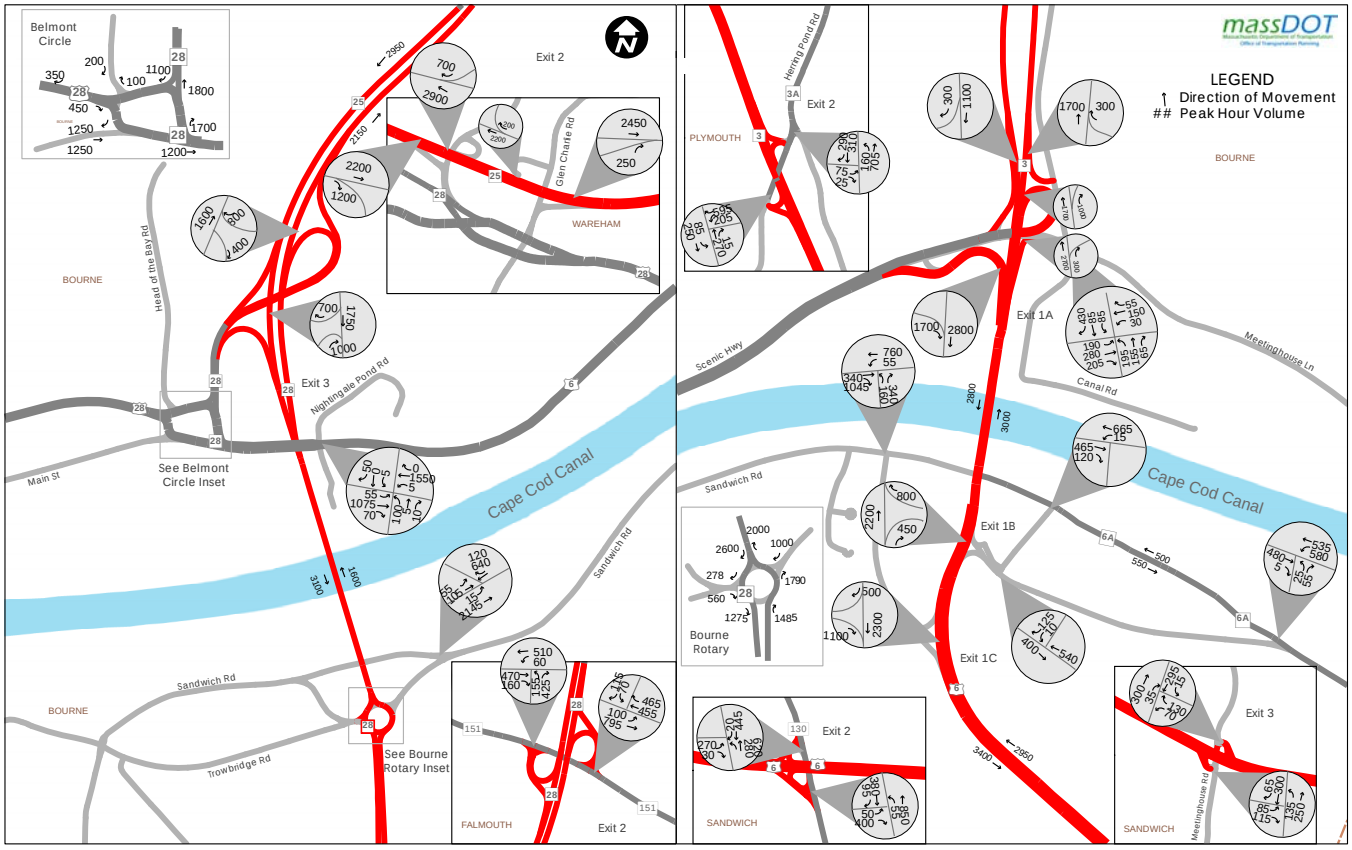


Exhibit 2-27 Existing Summer Weekday PM Turning Movements

Exhibit 2-28 Existing Summer Saturday Turning Movements



2.5.8 Existing (2014) Peak-Hour Levels of Service

Based on the traffic volume counts, peak-hour LOS was analyzed at 50 locations throughout the study area, including six signalized intersections, 15 unsignalized intersections, two rotaries, seven highway links, and 20 highway ramps for the AM and PM weekday peak-periods as well as Saturday mid-day peak hour.

All signalized and stop-controlled intersections were analyzed using Synchro™ Version 8 software and simulated using SimTraffic software. Freeway operations, such as merge, diverge, weave and link analysis were calculated using Highway Capacity Software (HCS) 2010. Finally, Belmont Circle and the Bourne Rotary were simulated using VISSIM™ software and analyzed using SIDRA™ Version 5.1. SIDRA™ provides the overall LOS for the rotaries and traffic circles. The results of this analysis are shown in Tables 2-18 and 2-19. Exhibits 2-29 and 2-30 (freeways) and Exhibits 2-31 through 2-36 (intersections) present the results graphically.

Text continues on page 2-62.

Table 2-18 Existing Levels of Service for Freeway Sections

	SUMMER AM	NON-SUMMER AM	SUMMER PM	NON-SUMMER PM	SUMMER WEEKEND	NON-SUMMER WEEKEND
HIGHWAY LINKS						
Bourne Bridge (NB)	B	B	C	B	C	B
Bourne Bridge (SB)	C	C	C	B	C	C
Route 25 East Of Exit 2 (EB)	A	A	B	A	B	A
Route 25 East Of Exit 2 (WB)	B	A	B	A	B	A
Route 25 West Of Exit 2 (EB)	B	A	B	A	B	A
Route 25 West Of Exit 2 (WB)	B	A	B	A	B	B
Route 3 Between Exits 1A and 2 (NB)	B	A	B	A	B	B
Route 3 Between Exits 1A and 2 (SB)	B	A	B	B	B	A
Route 6 EB Between Exits 1 & 2 (EB)	C	C	D	C	D	C
Route 6 WB Between Exits 1 & 2 (WB)	C	B	D	C	C	B
Sagamore Bridge (NB)	C	B	D	C	D	B
Sagamore Bridge (SB)	C	B	C	B	C	B
HIGHWAY ON-RAMPS						
Belmont Circle to Route 25 WB	B	B	B	B	B	B
Cranberry Highway to Rte. 6 WB (Exit 1C)	C	B	D	B	D	C
Route 130 to Route 6 EB	C	B	C	B	D	B
Glen Charlie to Rte. 25 EB	B	A	B	A	B	A

Notes:
LOS E or LOS F locations are **bold**

Table 2-18 continues on the next page.

Table 2-18 Existing Levels of Service for Freeway Sections

	SUMMER AM	NON-SUMMER AM	SUMMER PM	NON-SUMMER PM	SUMMER WEEKEND	NON-SUMMER WEEKEND
HIGHWAY ON-RAMPS (CONTINUED)						
Route 130 to Rte. 6 WB	C	B	D	B	C	B
Quaker Meeting House Road to Route 6 EB	C	C	C	B	D	B
Herring Pond Road to Route 3 NB	B	B	B	B	C	B
Herring Pond Road to Route 3 SB	B	B	B	B	B	B
Mid Cape Connector to Route 6 EB	C	C	D	C	D	C
Quaker Meeting House Road to Route 6 WB	C	B	C	B	C	C
Scenic Hwy to Route 6 EB/ Bridge	C	B	C	B	C	B
Belmont Circle to Route 25 (Bourne Bridge)	C	C	C	B	C	C
HIGHWAY OFF-RAMPS						
Route 25 EB to Maple Springs Road	B	B	C	B	C	B
Route 6 EB to Route 130	D	C	D	C	**E**	C
Route 6 WB to Route 130	C	B	D	B	D	C
Route 6 EB to Mid-Cape Connector	C	B	C	B	D	B
Route 6 EB to Quaker Meeting House Road	C	C	C	B	D	B
Route 6 WB to Quaker Meetinghouse Road	C	B	D	C	D	C
Route 6 WB (Exit 1) to Cranberry Hwy	C	B	D	C	D	C
Route 25 EB to Belmont Circle	B	B	B	A	B	A
Route 3 NB to Herring Pond Road	B	A	B	B	B	B
Route 3 SB to Herring Pond Road	B	B	C	B	C	B
Bourne Bridge to Belmont Circle	A	A	B	B	B	B
Route 3 SB to Scenic Highway	B	B	B	B	B	B
Route 6 WB (Sagamore Bridge NB) to 6 WB/ Scenic Hwy	C	B	C	B	D	C
Route 6 WB (Sagamore Bridge NB) to Meeting House Road	C	B	D	C	D	C

Notes:
LOS E or LOS F locations are **bold**

Table 2-19 Existing Levels of Service at Selected Intersections

	SUMMER AM	NON-SUMMER AM	SUMMER PM	NON-SUMMER PM	SUMMER WEEKEND	NON-SUMMER WEEKEND
SIGNALIZED INTERSECTIONS						
Scenic Hwy at Church Lane	B	C	B	C	C	D
Meetinghouse Lane, State Rd, and Canal Rd	C	C	**F**	D	C	F
Scenic Highway at Nightingale Pond Rd/Andy Olivia Dr	A	A	A	A	B	A
Route 6 EB Off Ramp (Exit 2) at Route 130	B	B	B	A	B	A
UNSIGNALIZED INTERSECTIONS						
Sandwich Rd at Bourne Rotary Connector	**F**	**F**	**F**	**F**	**F**	**F**
Sandwich Rd at High School Drive	**F**	**F**	**F**	**F**	**F**	**F**
Sandwich Rd at Harbor Lights Rd	**F**	**E**	**F**	**F**	**F**	**F**
Sandwich Rd at Jarvis Drive	C	**F**	A	**E**	B	C
County Road, Sandwich Road, and Trowbridge Road	C	C	F	**E**	C	C
Route 28 NB Off-ramp at Route 151	C	D	**F**	**E**	**E**	C
Route 28 SB Off-ramp at Route 151	C	D	**F**	D	**F**	C
Sandwich Rd, Cranberry Hwy, and Regency Drive	E	C	**F**	**E**	**F**	C
Old Kings Hwy at Main Street	B	B	C	C	D	B
Route 6A at Main Street	A	A	A	A	A	A
Maple Springs Rd at Route 25 EB	B	A	D	B	F	B
Route 130 at Cotuit Rd	**F**	**E**	**F**	**F**	**F**	**F**
Herring Pond Rd at State Rd	D	**E**	**F**	**F**	**F**	**F**
Belmont Circle	**F**	**F**	**F**	**F**	**F**	**F**
Bourne Rotary	**F**	**F**	**F**	**F**	**F**	**F**
Route 6 EB Off Ramp (Exit 3) Quaker Meeting House Rd	D	**E**	D	D	D	C
Route 3 SB Off Ramp at Exit 2/Herring Pond Rd	D	D	**F**	D	**E**	D
Route 130 (Main St) at Tupper Rd	B	D	D	C	**E**	**E**

Notes:
LOS E or LOS F locations are **bold**

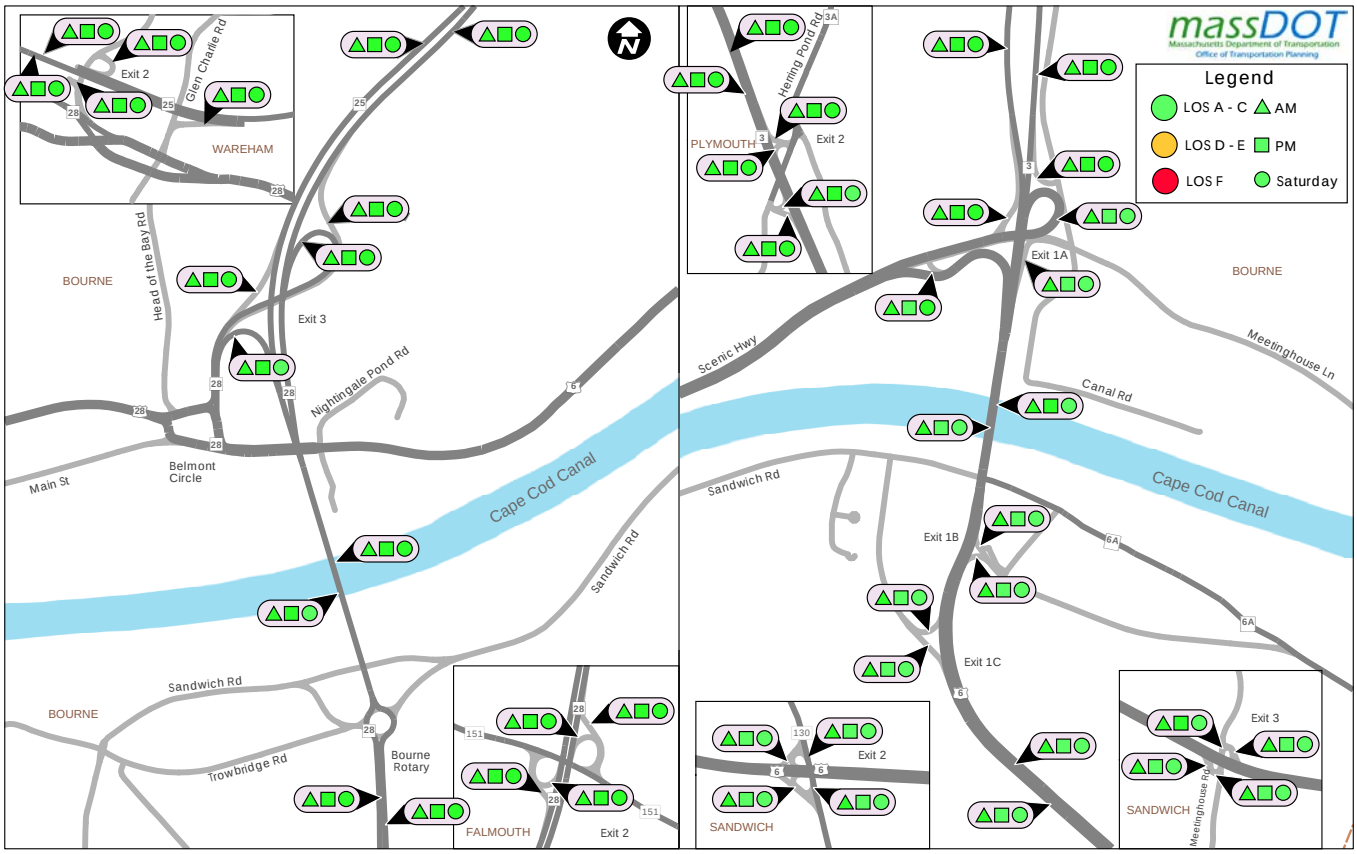
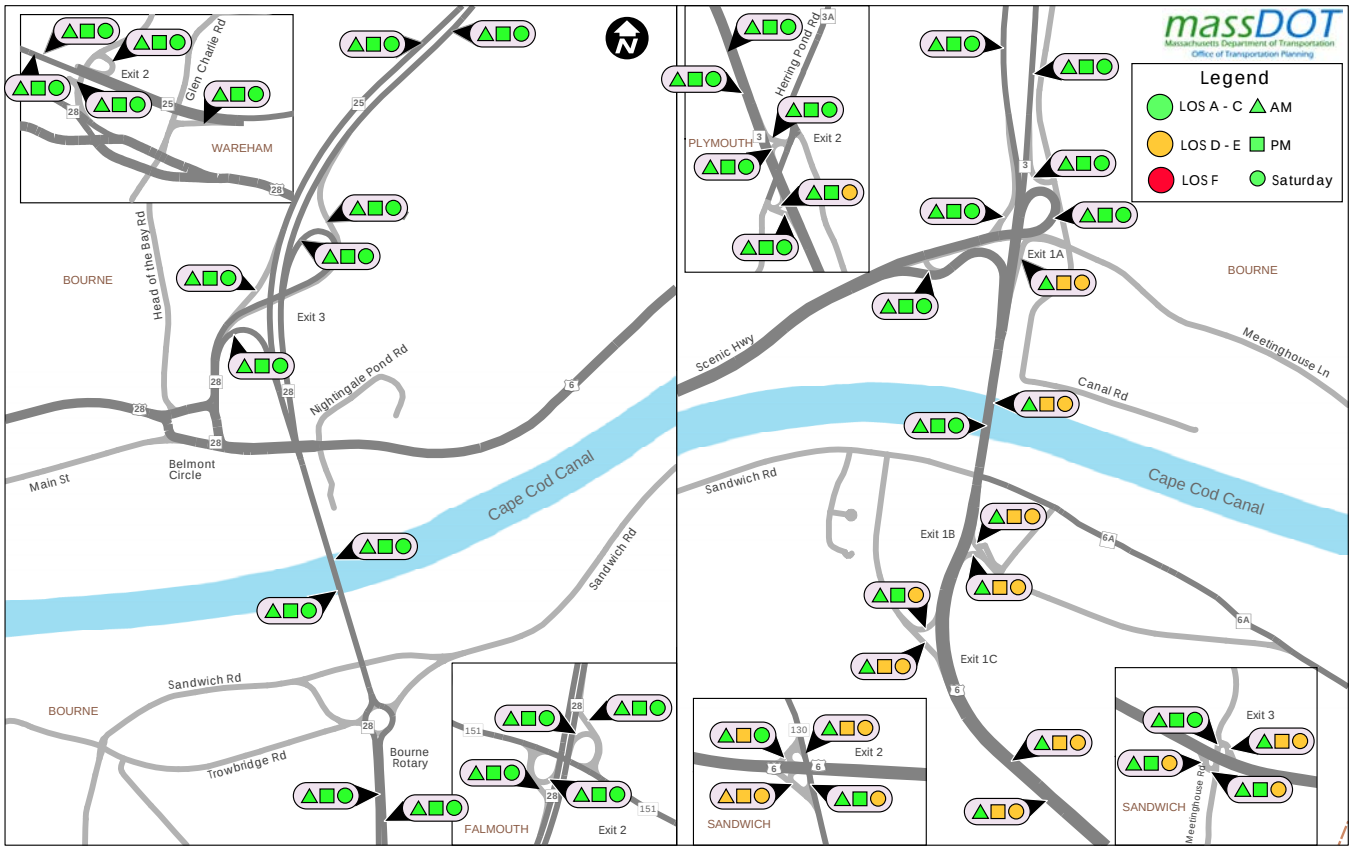


Exhibit 2-29 Existing Non-Summer Levels of Service - AM/PM/Saturday Peak Hour (Freeway)

Exhibit 2-30 Existing Summer Levels of Service - AM/PM/Saturday Peak Hour (Freeway)



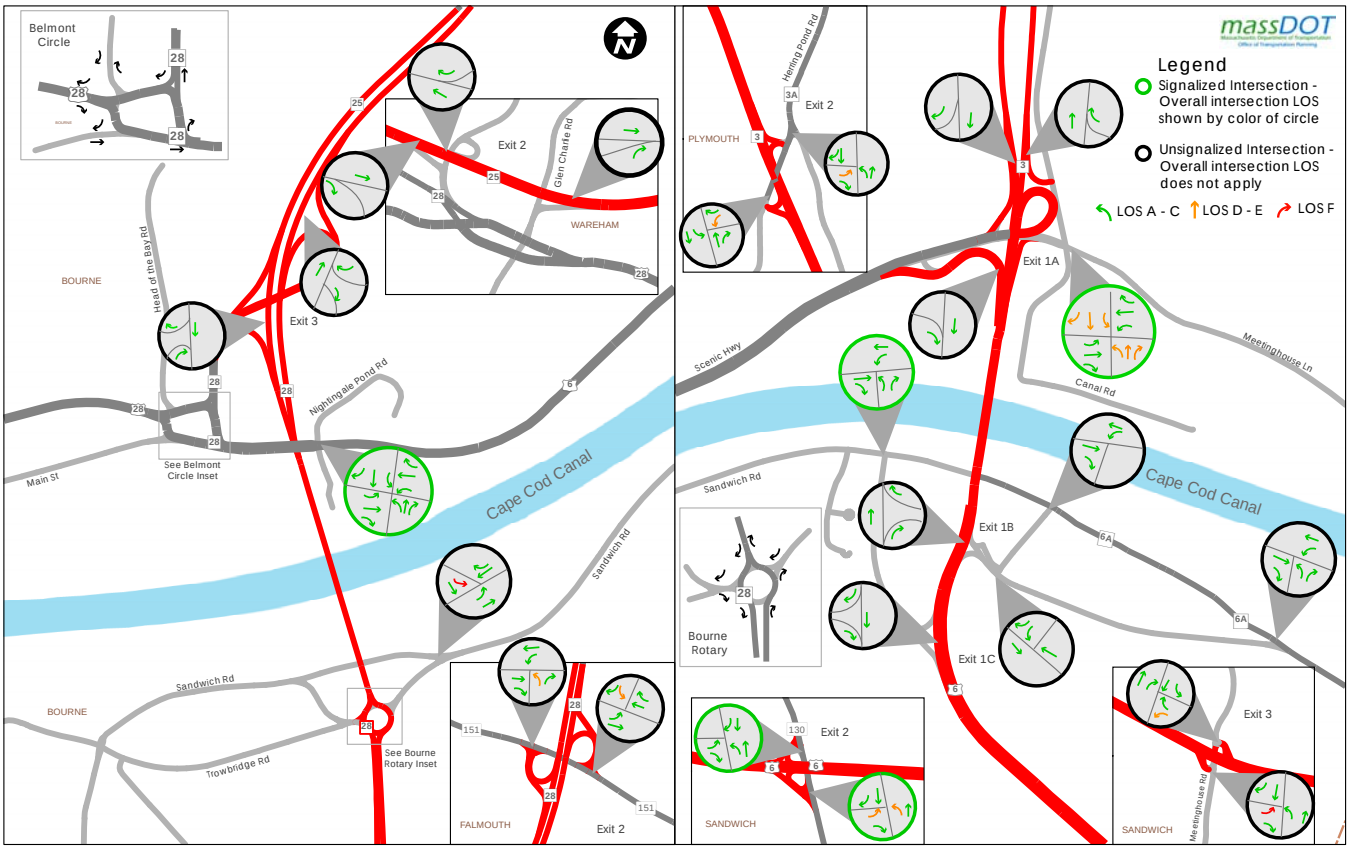
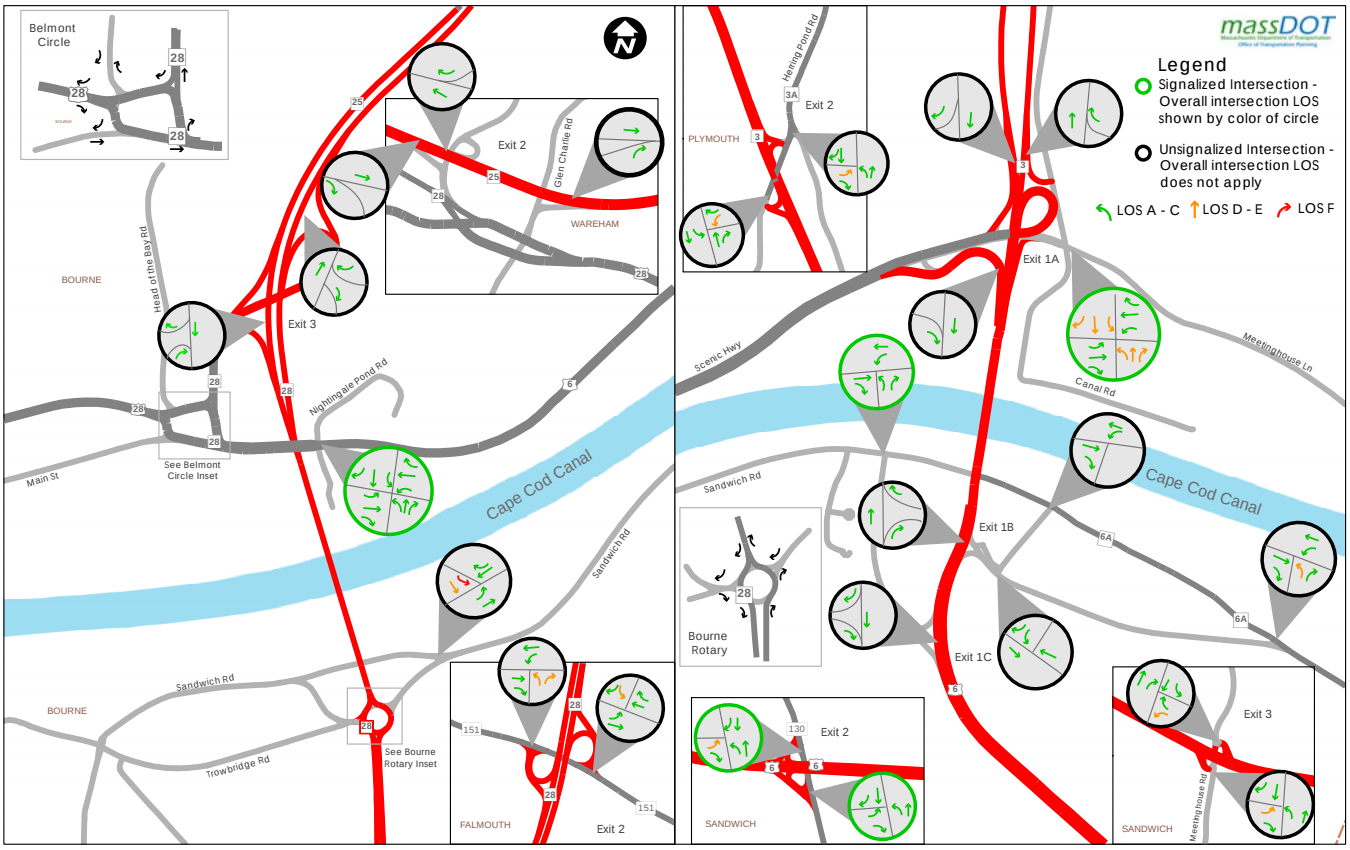


Exhibit 2-31 Existing Non-Summer Weekday AM Levels of Service (Intersections)

Exhibit 2-32 Existing Non-Summer Weekday PM Levels of Service (Intersections)



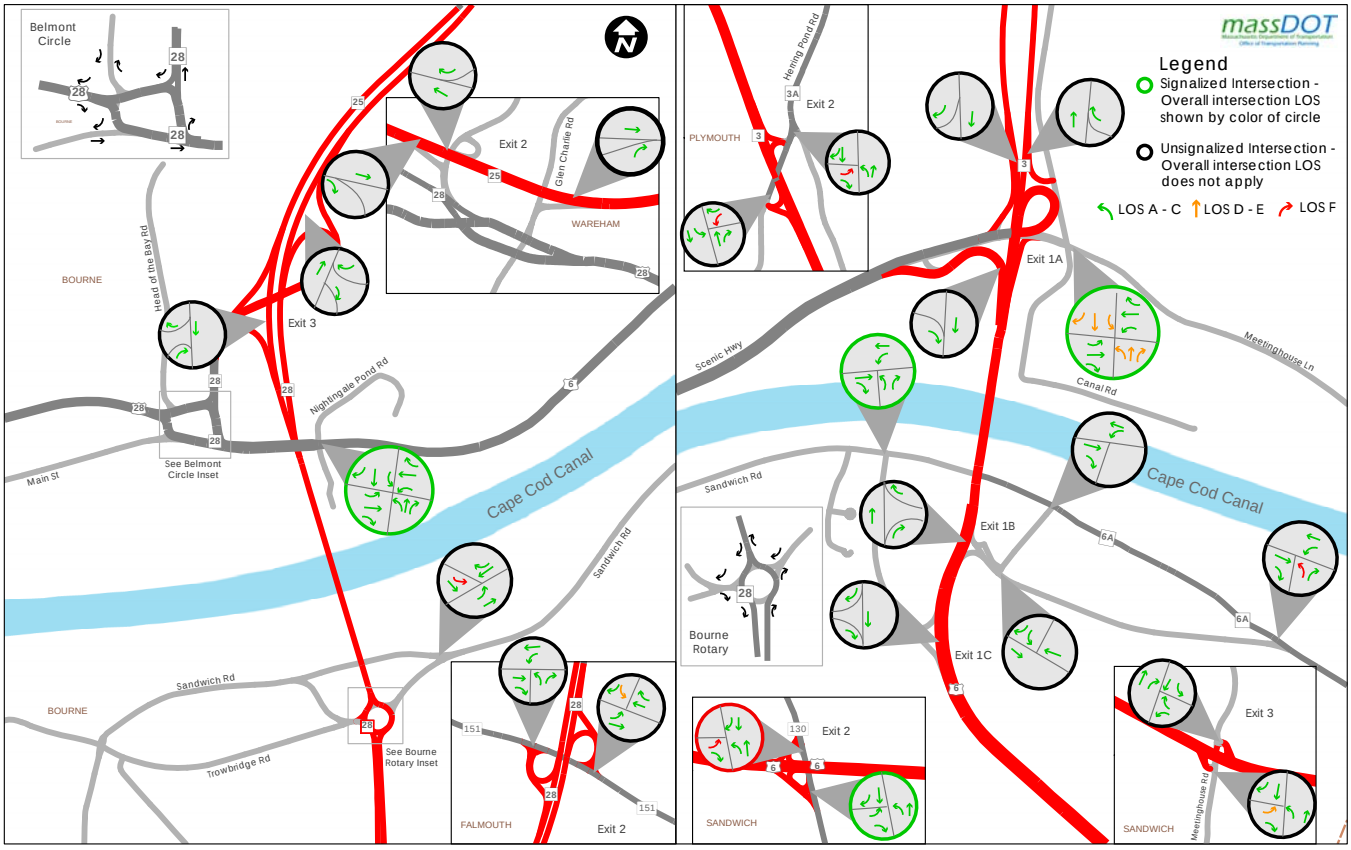
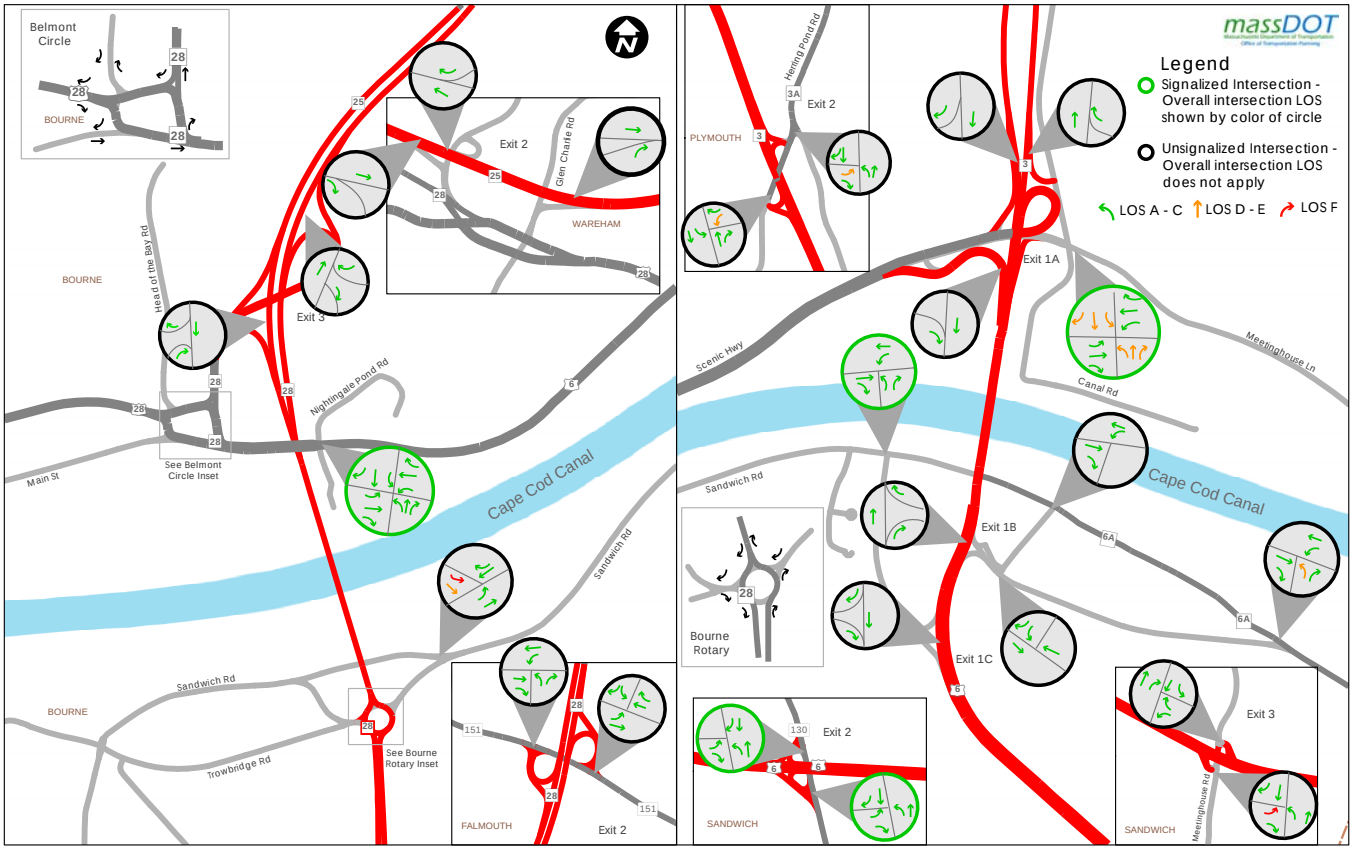


Exhibit 2-34 *Existing Non-Summer Saturday Levels of Service (Intersections)*

Exhibit 2-33 *Existing Summer Weekday AM Levels of Service (Intersections)*



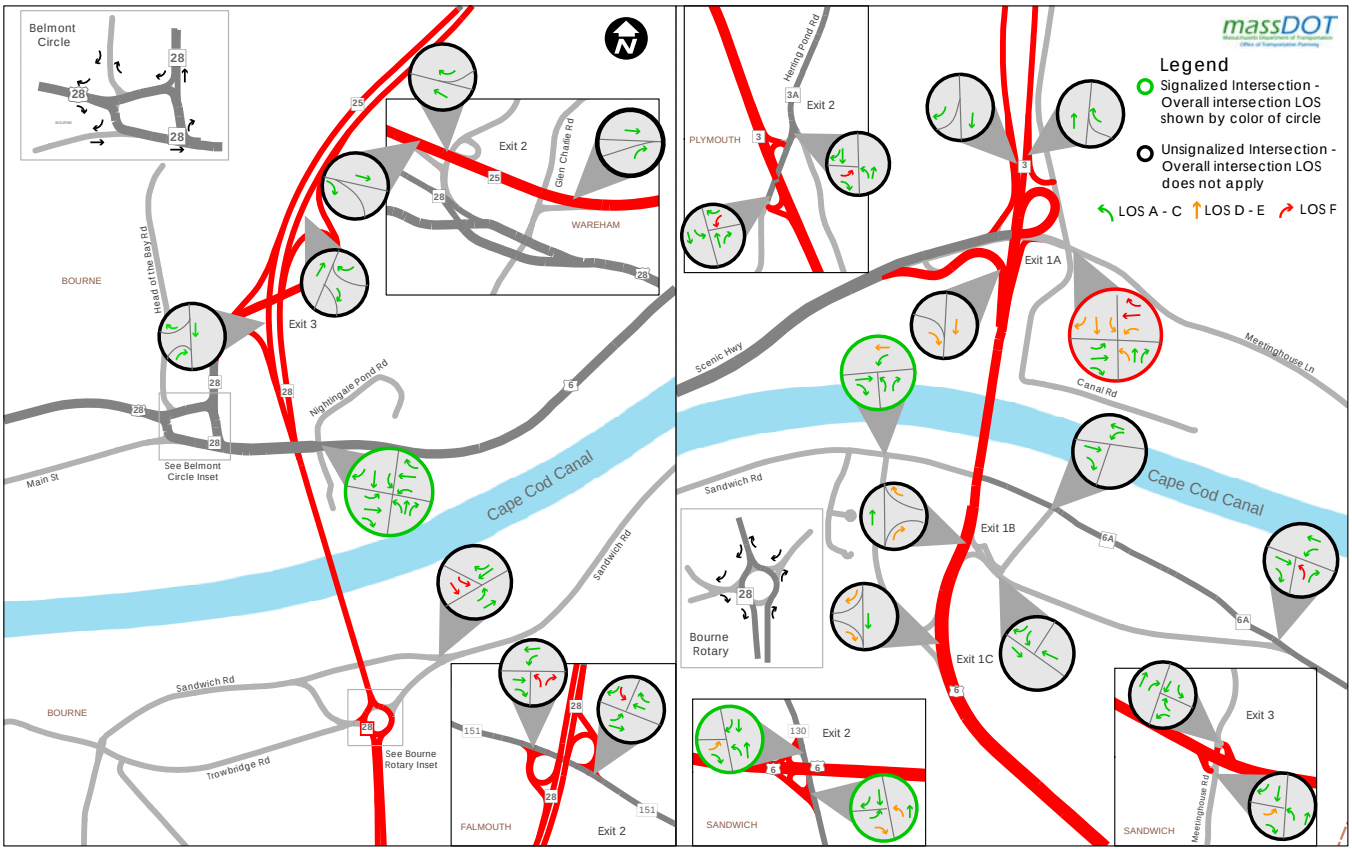
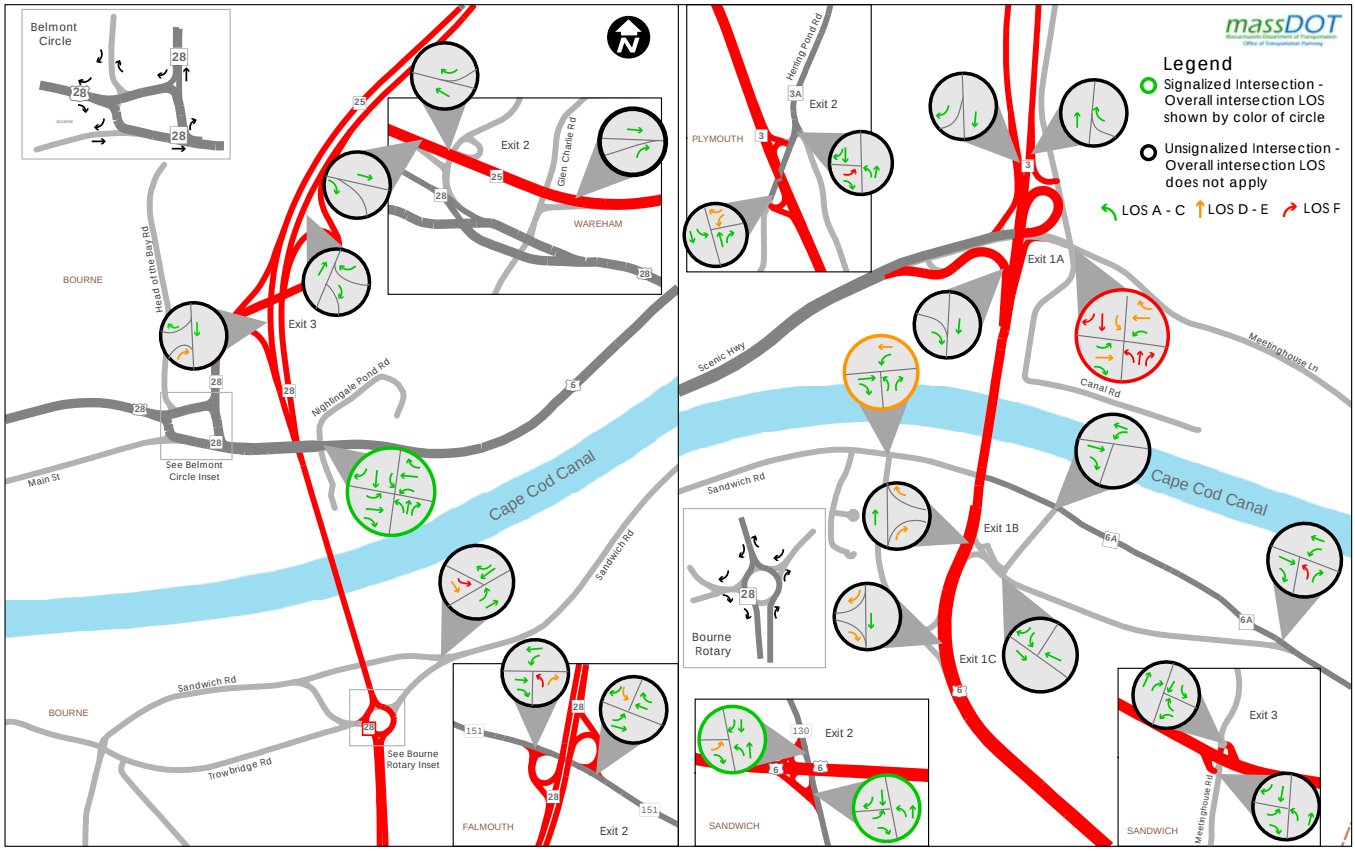


Exhibit 2-35 Existing Summer Weekday PM Levels of Service (Intersections)

Exhibit 2-36 Existing Summer Saturday Levels of Service (Intersections)



The analysis found that most freeway sections operate within a range of LOS A to LOS C during most peak periods. But certain freeway sections experience a lower level of operations (LOS D), especially during summer peak periods, including Route 6 at the Sagamore bridge, Route 6 between Exits 1 and 2, Route 6 at Cranberry Highway, and Route 6 at Route 130. However, as shown on Table 2-18 and Exhibits 2-31 through 2-36 show, far more intersections in the study area operate at an unacceptable LOS E or F during at least one peak hour than operate acceptably.

The most problematic of these locations are intersections that lead directly to the Canal bridges (known as 'gateway intersections') such as Belmont Circle and Bourne Rotary Route 6 Exit 1C is also considered a gateway intersection for this study but is not listed here because, as a highway entrance ramp, it was evaluated for delays and queues, rather than LOS. Other problematic intersections in the study area include Route 130 at Cotuit Road, Herring Pond Road at State Road, and Sandwich Road at its intersections with Adams Street, Bourne Rotary Connector, Technical High School Drive, and Harbor Lights Drive.

2.5.9 Origin-Destination Analysis Findings

The traffic data collected in the study area, including data through Automatic Traffic Recorders (ATRs) and Turning Movement Counts (TMCs), is used in conjunction with data from the BlueTOAD™ study to understand the travel patterns within the study area.

A major finding of the BlueTOAD™ origin-destination analysis was the substantial amount of travel between the Route 3/Route 6 corridor and the Route 25/Route 28 corridor. For example, as shown on Exhibit 2-37, during summer Saturdays when visitors are traveling to Cape Cod, 59% of vehicles on Route 25 exit the highway at Belmont Circle and travel east on Scenic Highway to Route 6. Similarly, on summer Sundays when visitors are leaving Cape Cod, 48% of vehicles exit Route 3 at the Sagamore interchange and travel west on Scenic Highway to Route 25, via Belmont Circle. These movements put tremendous pressure on the 'gateway intersections' adjacent to the Canal such as Route 6 Exit 1C, Belmont Circle, and the Bourne Rotary and lead to high levels of congestion during the peak hours.

2.5.10 Existing Traffic Conditions at Belmont Circle and Bourne Rotary

Traffic conditions at Belmont Circle and Bourne Rotary were simulated using VISSIM™ software and analyzed using SIDRA™ 5.1 software. As noted in Section 2.5.3, while HCM (Highway Capacity Manual) software was used to determines LOS along highways and intersections in the study area, traffic analysis

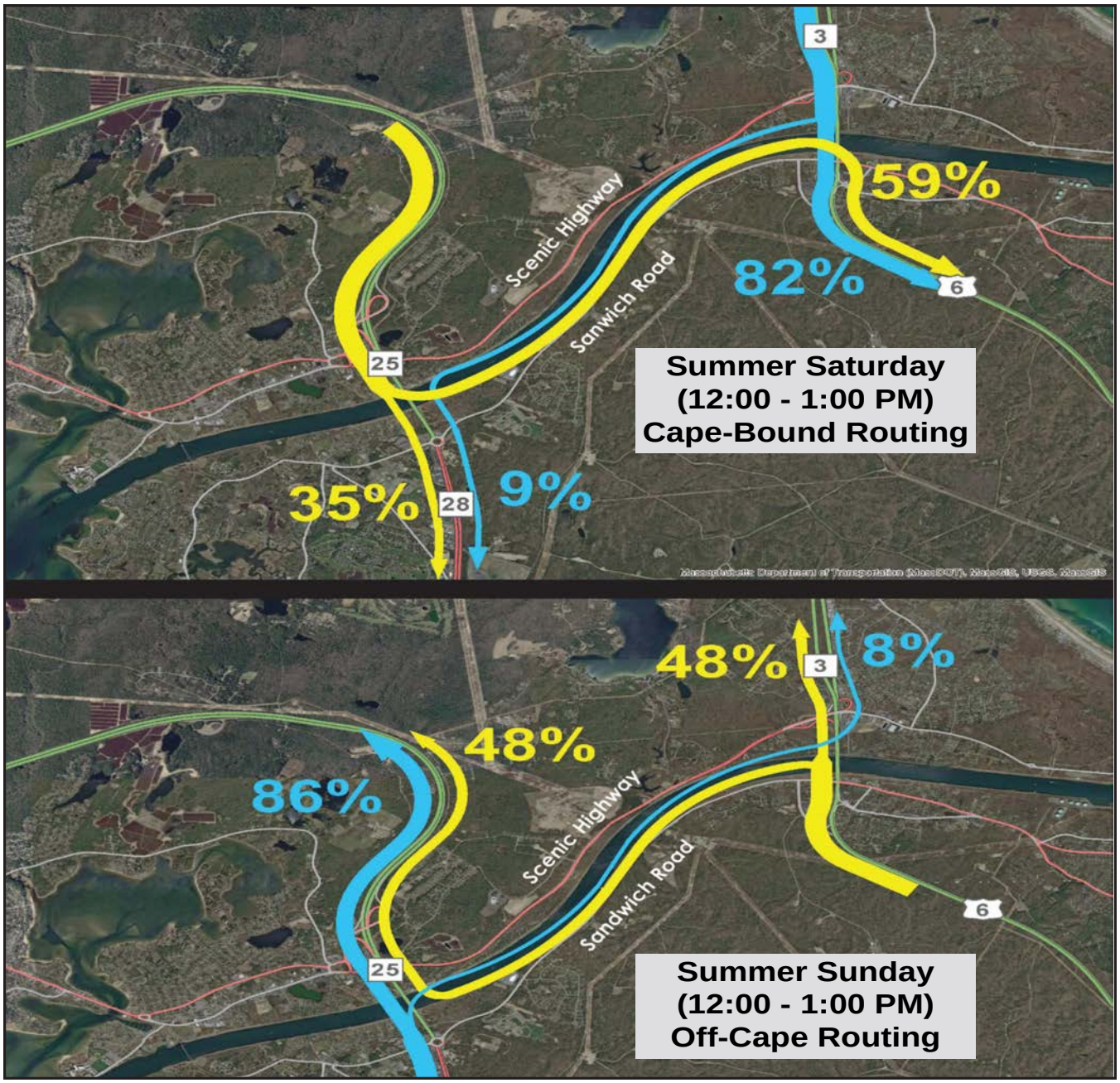


Exhibit 2-37 Routing of Traffic Between Highway Corridors

using VISSIM™ and SIDRA™ 5.1 are preferred by MassDOT for the analysis of rotaries, roundabouts, and other unconventional intersections.

Therefore, to understand how traffic operates in Belmont Circle and Bourne Rotary, VISSIM™ software was used to analyze and simulate existing conditions. Traffic conditions within these rotaries are described in terms of the VISSIM™ model's output, including queues, vehicle delays, and travel time. The results from the simulation (average delay) are then used to determine LOS based on the criteria in the HCM.

Belmont Circle and Bourne Rotary, located immediately north and south of the Bourne Bridge, respectively, play a key role in traffic operations in the study area. The high frequency of cross-corridor travel noted in Section 2.5.9 often results in traffic volumes that exceed the capacity of Belmont Circle and Bourne Rotary. This results in significant queues and delays at their approaches.

Further, the proximity of these rotaries to each other can result in queues at one location negatively affecting traffic operations at the other. For example, congestion at the Bourne Rotary often results in queues on Route 28 southbound that extend over the Bourne Bridge beyond the Route 25 southbound entrance ramp from Belmont Circle. This, in turn, can exacerbate traffic congestion at Belmont Circle as vehicles cannot enter Route 25 because of the lengthy queues from Bourne Rotary.

Tables 2-20 and 2-21 and Exhibit 2-38 provide vehicle delay and queue lengths at Belmont Circle and Bourne Rotary, respectively, for the existing (2014) non-summer weekday PM and summer Saturday peak periods.

Table 2-20 Belmont Circle - Existing (2014) Queue Lengths and Average Delay

	AVERAGE VEHICLE DELAY (SEC./MIN.)		MAX. QUEUE LENGTHS (FEET/MILES)	
STREET NAME/APPROACH	NON-SUMMER PM	SUMMER SATURDAY	NON-SUMMER PM	SUMMER SATURDAY
Route 25 Exit 3 Off-Ramps (westbound)	5	4	515	510
Head of Bay Road (southbound)	15	83 (1.4)	270	570)
Buzzards Bay Bypass (eastbound)	3	19	100	335
Main Street (eastbound)	13	82 (1.4)	530	5,755 (1.1)
Scenic Highway (westbound)	7	125 (2.1)	380	10,605 (2.0)

Notes:
Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.

Table 2-21 Bourne Rotary - Existing (2014) Queue Lengths and Average Delay

	AVERAGE VEHICLE DELAY (SEC./MIN.)		MAX. QUEUE LENGTHS (FEET/MILES)	
STREET NAME/APPROACH	NON-SUMMER PM	SUMMER SATURDAY	NON-SUMMER PM	SUMMER SATURDAY
Route 25 (southbound)	19	280 (4.7)	650	8,885 (1.7)
Trowbridge Road (eastbound) EB	75	30	840	335
Route 28 (northbound)	14	301 (5.0)	340	4,135 (0.8)
Bourne Rotary Connector (westbound)	20	27	1,530	1,475

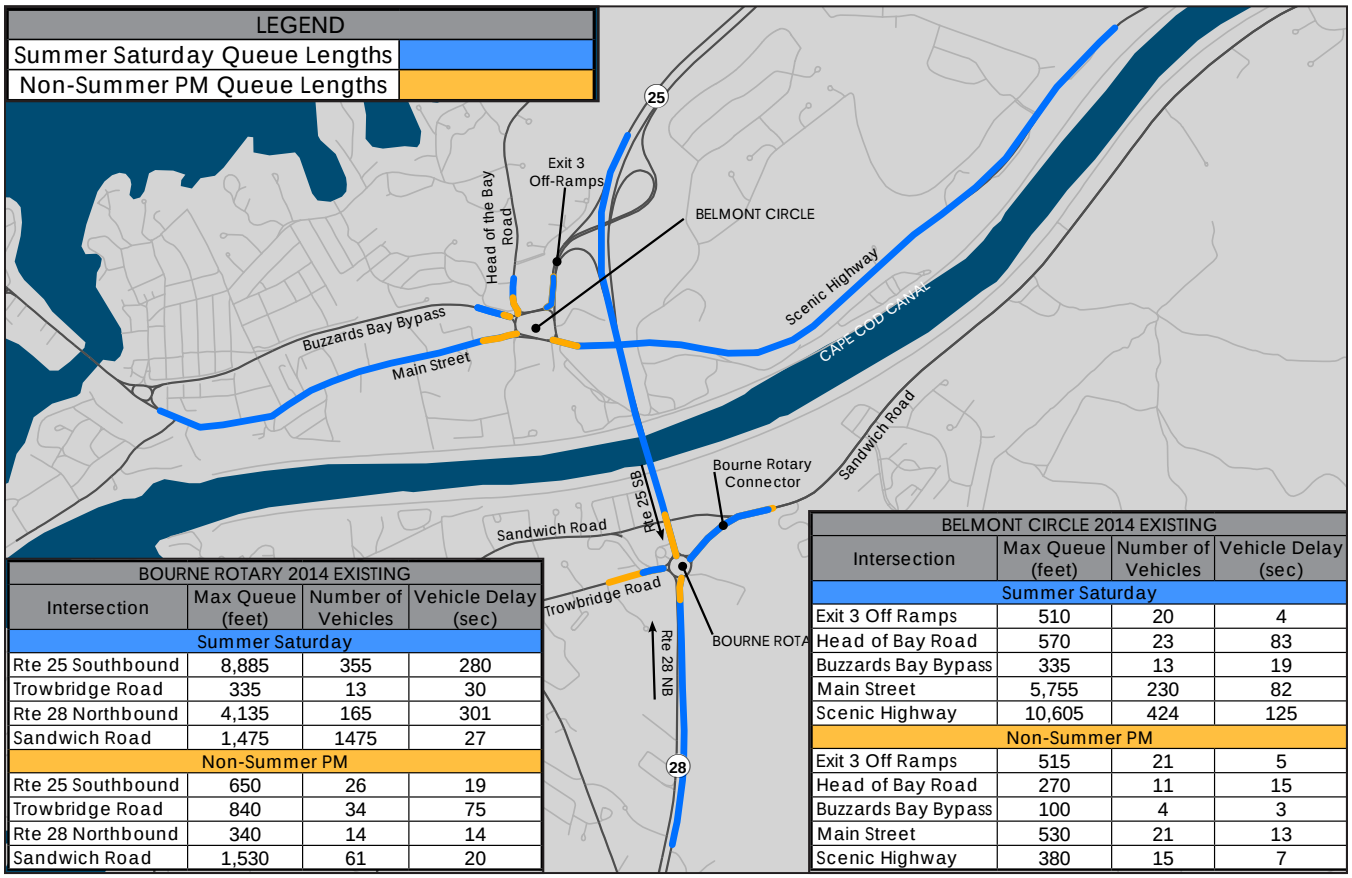
Notes:
Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.

Belmont Circle

The VISSIM™ analysis quantified average vehicle delays and the maximum queue length for the five approaches to Belmont Circle including Scenic Highway, Main Street, Buzzards Bay Bypass, Head of the Bay Road, and the Route 25 ramps. As shown on Table 2-20 and Exhibit 2-38, the approaches with the greatest average delay and maximum queue lengths include those from Scenic Highway and the Route 25 ramps to Belmont Circle.

While the average delay during the non-summer weekday are relatively minor (3 to 15 seconds), the average delay during summer Saturday peak periods can extend from 4 to 125 seconds (2.1 minutes). The maximum queues of note include the Main Street (eastbound) approach to Belmont Circle which can extend 530 to 5,755 feet (1.1 miles) during the non-summer weekday and summer Saturday peak hours, respectively. The maximum queues on the Scenic Highway (westbound) approach to Belmont Circle can extend 10,605 feet (2.0 miles) during the summer Saturday peak hour.

Exhibit 2-38 Belmont Circle and Bourne Rotary Queue Lengths



BOURNE ROTARY 2014 EXISTING

Intersection	Max Queue (feet)	Number of Vehicles	Vehicle Delay (sec)
Summer Saturday			
Rte 25 Southbound	8,885	355	280
Trowbridge Road	335	13	30
Rte 28 Northbound	4,135	165	301
Sandwich Road	1,475	1475	27
Non-Summer PM			
Rte 25 Southbound	650	26	19
Trowbridge Road	840	34	75
Rte 28 Northbound	340	14	14
Sandwich Road	1,530	61	20

BELMONT CIRCLE 2014 EXISTING

Intersection	Max Queue (feet)	Number of Vehicles	Vehicle Delay (sec)
Summer Saturday			
Exit 3 Off Ramps	510	20	4
Head of Bay Road	570	23	83
Buzzards Bay Bypass	335	13	19
Main Street	5,755	230	82
Scenic Highway	10,605	424	125
Non-Summer PM			
Exit 3 Off Ramps	515	21	5
Head of Bay Road	270	11	15
Buzzards Bay Bypass	100	4	3
Main Street	530	21	13
Scenic Highway	380	15	7

Bourne Rotary

The VISSIM™ analysis quantified average vehicle delays and the maximum queue length for the four approaches to the Bourne Rotary, including Route 28 (north and south end), Trowbridge Road, and Sandwich Road. As shown on Table 2-21 and Exhibit 2-38, the approaches with the greatest average delay and maximum queue lengths include those from Route 28 southbound and Route 28 northbound.

While the average delay during the non-summer weekdays are modest (14 to 75 seconds), the average delay during summer Saturdays can extend from 27 to 301 seconds (5.0 minutes). The queues of note include the Route 25 (southbound) approach to the Bourne Rotary which can extend 650 to 8,885 feet (1.7 miles) during the non-summer weekday PM and summer Saturday peak hours, respectively. The queues on the Route 28 (northbound) approach to Bourne Rotary can extend 340 to 4,135 feet (0.8 miles) during the non-summer weekday PM and summer Saturday peak periods, respectively.

2.5.11 Crashes

Crash data was collected for the years 2012–2014 (the most recent three-year period available at the time data was collected)

Exhibit 2-39 Crashes in the Study Area

from all study area intersections analyzed for LOS. These data were used to create diagrams that portray crashes by type and by frequency (provided in Appendix D). Analysis of these diagrams—that is, the types of crashes and where they took place—helped the study team understand why crashes may be occurring at certain locations. Table 2-22 summarizes crash data for the study area. Exhibit 2-39 shows the location crashes in the study area.

Crash rates were calculated for each study area intersection and compared to the average crash rate for MassDOT' s District 5, which includes Cape Cod and Southeastern Massachusetts.

Table 2-22 Crashes in Study Area, 2012–2014

TOWN	NAME OF LOCATION	MAP NUMBER	HSIP LOCATION[1] (Y/N)	2012	2013	2014	TOTAL (2012-2014)	EPDO[2]	CRASH RATE[3]
Plymouth	Herring Pond Road at State Road	1	N	5	3	13	9	13	**0.42**
Plymouth	Route 3 SB Exit 2 Off/On Ramps at Herring Pond Rd	13	N	1	3	4	8	12	**0.52**
Bourne	Belmont Circle	2	Y	26	29	32	87	127	**1.40**
Bourne	Scenic Highway at Nightingale Pond Road/Olivia Drive	3	N	11	9	3	23	27	0.61
Bourne	Scenic Highway at Church Lane	14	N	2	2	1	5	9	0.16
Bourne	Scenic Highway/Meetinghouse Lane at State Road	10	N	4	8	7	19	25	**0.82**
Bourne	Bourne Rotary	4	Y	31	38	45	114	150	**2.12**
Bourne	Sandwich Road at Bourne Rotary Connector	5	N	5	3	1	9	15	0.25
Bourne	Sandwich Road at High School Drive	6	Y	3	1	3	7	9	0.27
Bourne	Sandwich Road at Harbor Lights Road	7	N	0	1	0	1	3	0.04
Bourne	Sandwich Road at Jarvis Drive	15	N	0	0	0	0	0	0.00
Bourne	Sandwich Road at Adams Street[4]	16	Y	8	10	11	29	42	**1.66**
Bourne	Sandwich Road at Cranberry Highway/Regency	8	N	3	7	2	12	26	**0.58**
Sandwich	Route 130 (Main Street)/Route 6A/ Tupper Road	9	Y	6	3	3	12	24	0.59
Sandwich	Route 6A at Main Street	17	N	0	0	1	1	3	1.02
Sandwich	Old Kings Highway at Main Street	18	N	1	1	0	2	4	0.16
Sandwich	Route 6 Eastbound (Exit 2) Ramps at Route 130	19	N	0	2	3	5	9	**0.20**
Sandwich	Route 130 at Cotuit Road	11	N	6	1	1	8	18	**0.34**
Falmouth	Route 28 Southbound Off/On Ramps at Route 151	12	N	3	4	2	9	15	**0.34**
Falmouth	Route 28 Northbound Off/On Ramps at Route 151	12	N	5	3	2	10	22	**0.34**

[1] Highway Safety Improvement Program (HSIP) – Crash cluster in which the total number of 'equivalent property damage only' crashes in the cluster are within the top 5% of all clusters in that region.
[2] Equivalent Property Damage Only (EPDO) – crash analysis method that weights factors related to the societal costs of fatal, injury, or property damage-only crashes.
[3] **Bold** text indicates accident rate exceeds District 5 average crash of 0.76 and 0.58 per million entering vehicles for signalized and unsignalized intersections, respectively.
[4] Adams Street converted to one-way (southbound) travel only in 2015.

District 5 had an average crash rate of 0.76 crashes (signalized intersections) and 0.58 crashes (unsignalized intersections) for every million vehicles who traveled through the intersection.[5]

Eight locations within the study area rank as high-crash locations under the Highway Safety Improvement Program (HSIP). This MassDOT designation identifies crash clusters that rank within the top five percent of their respective regional planning agency's crash locations. This criterion reflects a combination of factors, including crash incidence and severity, based on an equivalent property damage only (EPDO) index that assigns points based on the type of accident. Property-damage-only crashes earn 1 point on this scale; injury crashes earn 5 points; and fatal crashes earn 10 points.

The locations in the study area with the highest crash rates include Belmont Circle, Bourne Rotary, and the intersections of Route 6A at Route 130 and Scenic Highway at Meetinghouse Lane.

2.6 MULTIMODAL TRANSPORTATION

This section describes other modes of transportation used by people in the study area, including walking, bicycling, buses, trains, ferries, and airplanes. These other transportation modes provide safe ways to travel and encourage healthy non motorized travel. These facilities function as critical transportation modes for non drivers.

The varied elements of a multimodal transportation system work best when they work together. For example, one may bike to a transit facility to catch a bus to work or drive to a downtown area then walk to various shops.

This section provides details on these transportation modes and gaps identified in connecting these transportation modes.

2.6.1 Pedestrian Facilities

Pedestrian facilities in the focus area include sidewalks and recreational trails. Sidewalks are generally present in more densely developed residential and commercial areas but absent elsewhere (Exhibit 2-40). Many roads in the study area are narrow (20–22 feet) and lack sidewalks, presenting difficulties for pedestrians, particularly the elderly or those with disabilities. Sidewalks are especially important along bus routes to allow people to walk safely to/from bus stops. Sidewalks along major travel corridors in the focus area include those along the southern side of Scenic Highway from Nightingale Road

5 Known as 'crashes per million entering vehicles' (PMEV)

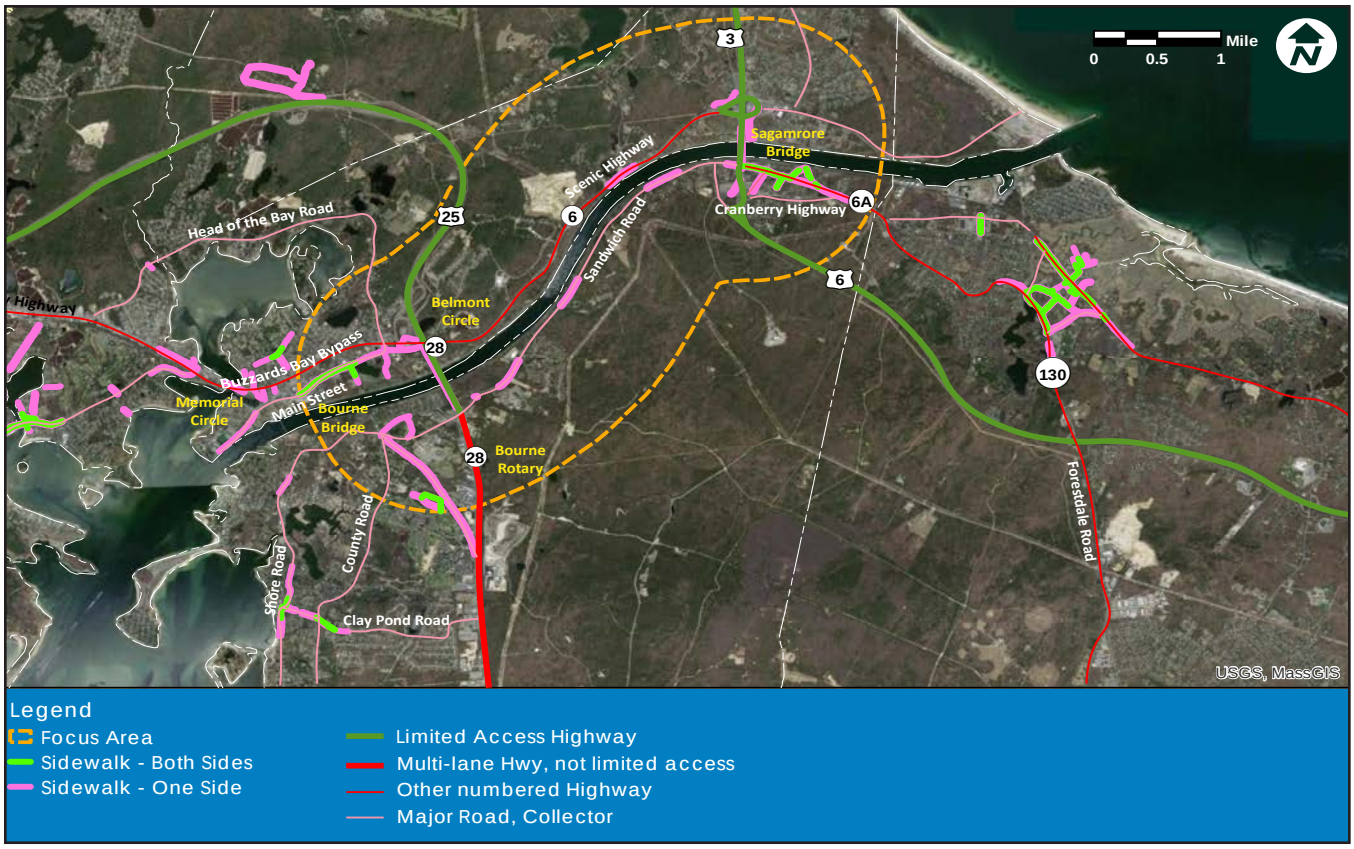


Exhibit 2-40 Pedestrian Facilities in the Focus Area

west along the southern edge of Belmont Circle and continuing through the Main Street business district in Bourne.

Sidewalks also exist on Trowbridge Road and the southern side of Sandwich Road from the Mid-Cape Connector to Route 6A and continuing along either one or both sides of Route 6A to Tory Lane. After a 1.5-mile gap, sidewalks continue Route 6A for 1.25 miles from Tupper Road (east end) to Crowell Lane. Both the Sagamore and Bourne bridges provide a single, narrow sidewalk, but several of the approach roadways to the bridges lack accessible sidewalk connections. For example, pedestrians can only reach the Bourne Bridge sidewalk from the north on an unmarked sidewalk at the end of the Bridge approach via the end of a shopping area entrance drive. To reach the sidewalk at the south end of the Bourne Bridge, a pedestrian would need to enter the Bourne Rotary, a high-volume traffic circle that lacks sidewalks.

For safety reasons, limited-access highways, including those in the study area such as Route 6, Route 3, and Route 25, prohibit pedestrian access and do not have sidewalks. Other roadways in the study area—such as Route 28, Route 151, Buzzards Bay Bypass, Sandwich Road, Tupper Road, Shore Road, County Road, and Scenic Highway (except in the immediate area of the Route 3 interchange)—also generally lack sidewalks.

Counts of pedestrians and bicyclists were conducted at intersections throughout the study area. Table 2-23 presents these counts the results of these counts for the non-summer weekday and summer Saturday peak periods. Higher pedestrian and bicycle activity occur in areas containing a greater concentration of retail or commercial establishments or near residential neighborhoods and schools. These areas include Route 6A in Sandwich and Trowbridge Road and Main Street in Bourne.

Gaps exist in the connections for pedestrian and bicycle access across the Canal and between the Cape Cod Canal service road (bike path) and local roadways in the study area. Exhibit 2-41 displays the desire route for pedestrians and bicyclists over the Canal at both the Bourne and Sagamore Bridges. At the approaches to both bridges gaps exists in the sidewalk system to allow pedestrians or bicyclists to cross the Canal. Sidewalks do not exist that would connect the south end of Sagamore Bridge to either Cranberry Highway or Sandwich Road. At the north end of the Bourne Bridge, lack of sidewalks limit pedestrian access to Belmont Circle.

While scattered pedestrian/bicycle connections exist between the Cape Cod Canal service road (bike path) and local roadways in the

Table 2-23 Pedestrian and Bicycle Counts at Select Intersections

INTERSECTION	BICYCLES						PEDESTRIANS					
	SUMMER			NON-SUMMER			SUMMER			NON-SUMMER		
	AM	PM	SAT	AM	PM	SAT	AM	PM	SAT	AM	PM	SAT
Route 130 at Route 6 EB On-Off Ramps	2	6	17	0	0	2	0	0	0	0	0	0
Route 6A at Route 130 and Tupper Road	0	7	6	0	0	0	0	2	0	2	1	1
Route 6A at Main Street	7	8	24	0	0	1	8	9	5	7	0	3
Cranberry Highway at Sandwich Road and Regency Road	1	3	11	0	0	1	1	7	9	3	4	2
Sandwich Road at Adams Street	0	1	2	0	0	0	0	4	1	0	0	3
Route 130 at Cotuit Road	1	6	11	0	0	1	0	0	2	0	0	0
Route 6 at Quaker Meetinghouse Road	0	3	2	0	0	0	0	0	10	0	0	0
Bourne Rotary	2	1	0	0	0	0	0	0	5	0	1	1
Trowbridge Road at Veterans Way	4	3	7	0	0	0	12	1	4	0	1	2
Trowbridge Road at Sandwich Road and County Road	5	2	25	0	0	5	0	2	0	0	0	6
Route 6 (Scenic Highway) at Nightingale Pond Road	2	2	3	0	1	0	0	22	8	0	0	0
Memorial Circle	2	5	25	0	2	11	1	2	3	0	1	0
Meetinghouse Lane at Canal St.	0	3	6	0	0	0	5	1	1	3	1	8
Tupper Road at Old King's Highway (Route 6A)	5	11	17	0	0	0	6	9	15	0	0	8
State Road at Route 3 NB Ramp and Homestead Road	0	0	7	0	0	0	1	0	2	0	0	0
Route 151 at Route 28 SB On-Off Ramps	5	4	17	0	0	1	0	0	0	0	0	0
Route 151 at Route 28 NB On-Off Ramps	5	3	14	0	0	1	0	0	0	0	0	0
Herring Pond Road at Route 3 NB On-Off Ramps	0	2	0	0	0	0	2	5	13	0	0	0

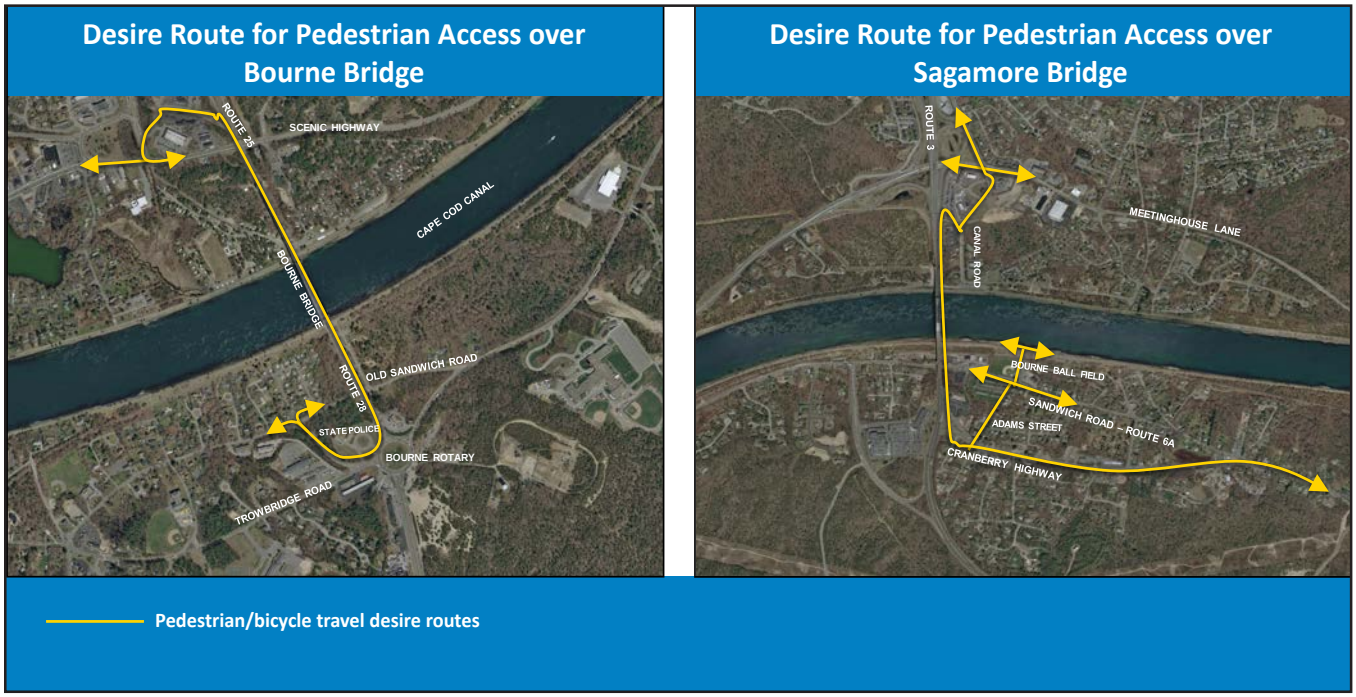


Exhibit 2-41 Pedestrian/Bicycle Travel Desire Routes over the Canal Bridges

focus area, there are notable gaps. Existing connections north of the Canal include Old Bridge Road, Herring River Recreation Center, Sagamore Recreation Area, Old Plymouth Road, and several along Scusset Beach Road. South of the Canal pedestrian connections to the Canal bike path include those at the Sandwich Marina Park, Sandwich Road, Bourne Recreation Area, and the Railroad Bridge Access parking lot. As shown on Exhibit 2-42, gaps in these connections exists west of the Bourne Bridge and east of the Sagamore Bridge.

2.6.2 Bicycle Facilities

Bicycle facilities in the study area include the Cape Cod Canal service roads (bike paths), owned and maintained by the U.S. Army Corps of Engineers. The service roads run on both the north and south sides of the Canal, and each is about 7 miles long. The service roads are very popular local resource for bicycle recreation and commuting. A daily count conducted by the Cape Cod Commission during July 2017 found 827 bicyclists using the Canal service road.

Lighting, benches and seating areas are provided along the path on both sides of the service road. While there are several accessible connections to the service roads from the local roadway network or parking lots, there are also notable areas that lack an accessible, ADA[6]-compliant connection to the service road.

6 Americans with Disabilities Act of 1990.

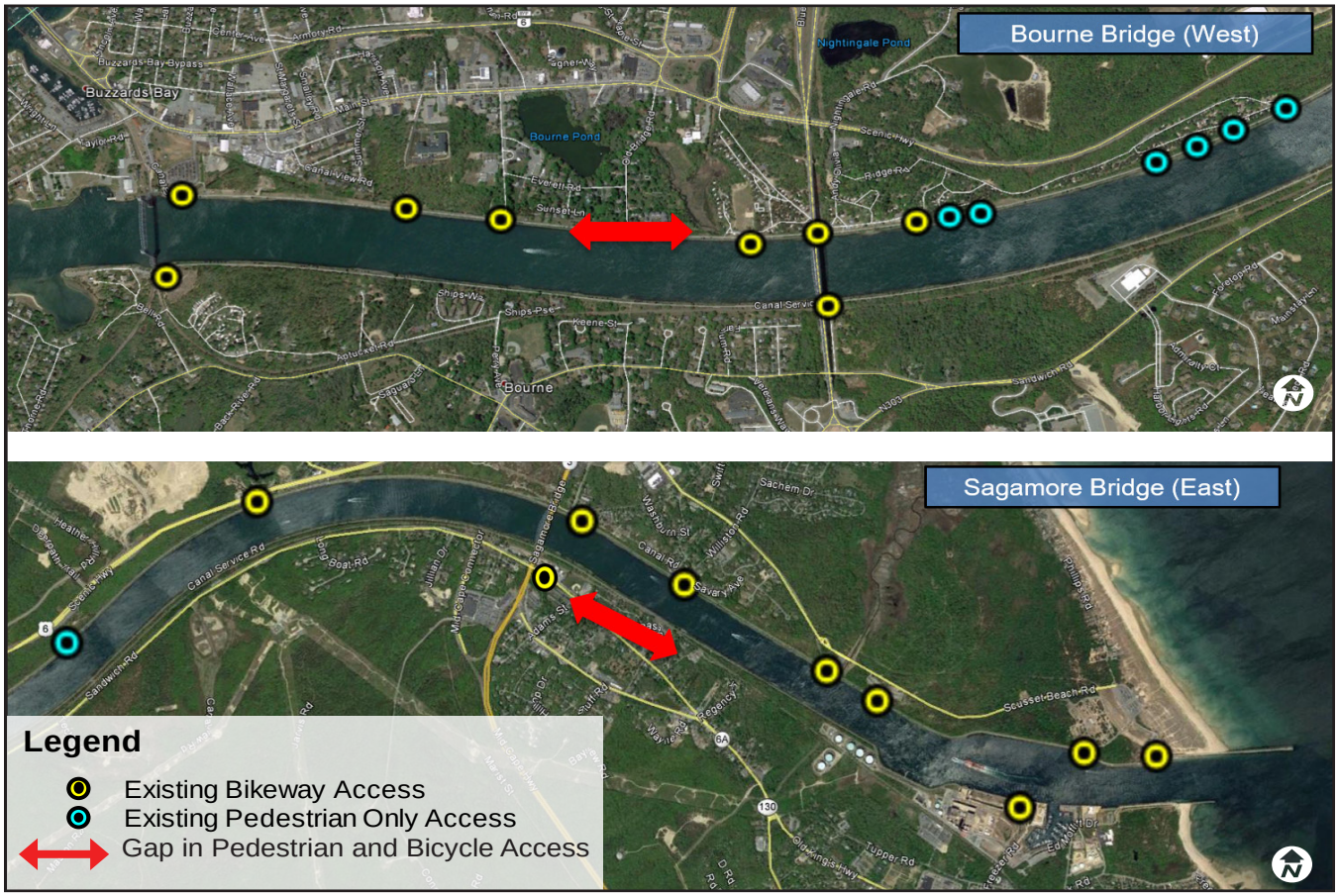


Exhibit 2-42 Gaps in Pedestrian/Bicycle Connections to Canal Bike Path

While somewhat outside of the study area, the Shining Sea Bike Path extends 10.6 miles from the Steamship Authority terminal in Woods Hole to County Road (Route 151) in Falmouth. An on-road bike route is designated on Route 6A in Sandwich.

Exhibit 2-43 shows the proximity of bicycle path and on-road bicycle routes to bus routes. Services provided by area transit organizations enhance bicycle access in the study area. The Cape Cod Regional Transit Authority (CCRTA) buses have racks for two bicycles, and the Steamship Authority (SSA) ferry service allows passengers to pay to take bicycles on the ferries.

Gaps between bicycle facilities and bus routes exist between the Canal service road (bike path) and the bus routes that cross the Canal bridges. Gaps also exist between the northern limit of the off-road Shining Sea bike path in Falmouth and bus routes along County Road and Shore Road in Bourne.

2.6.3 Transit Services

Cape Cod's unique shape allows access from multiple directions through a wide range of modes. For ground transportation, bus

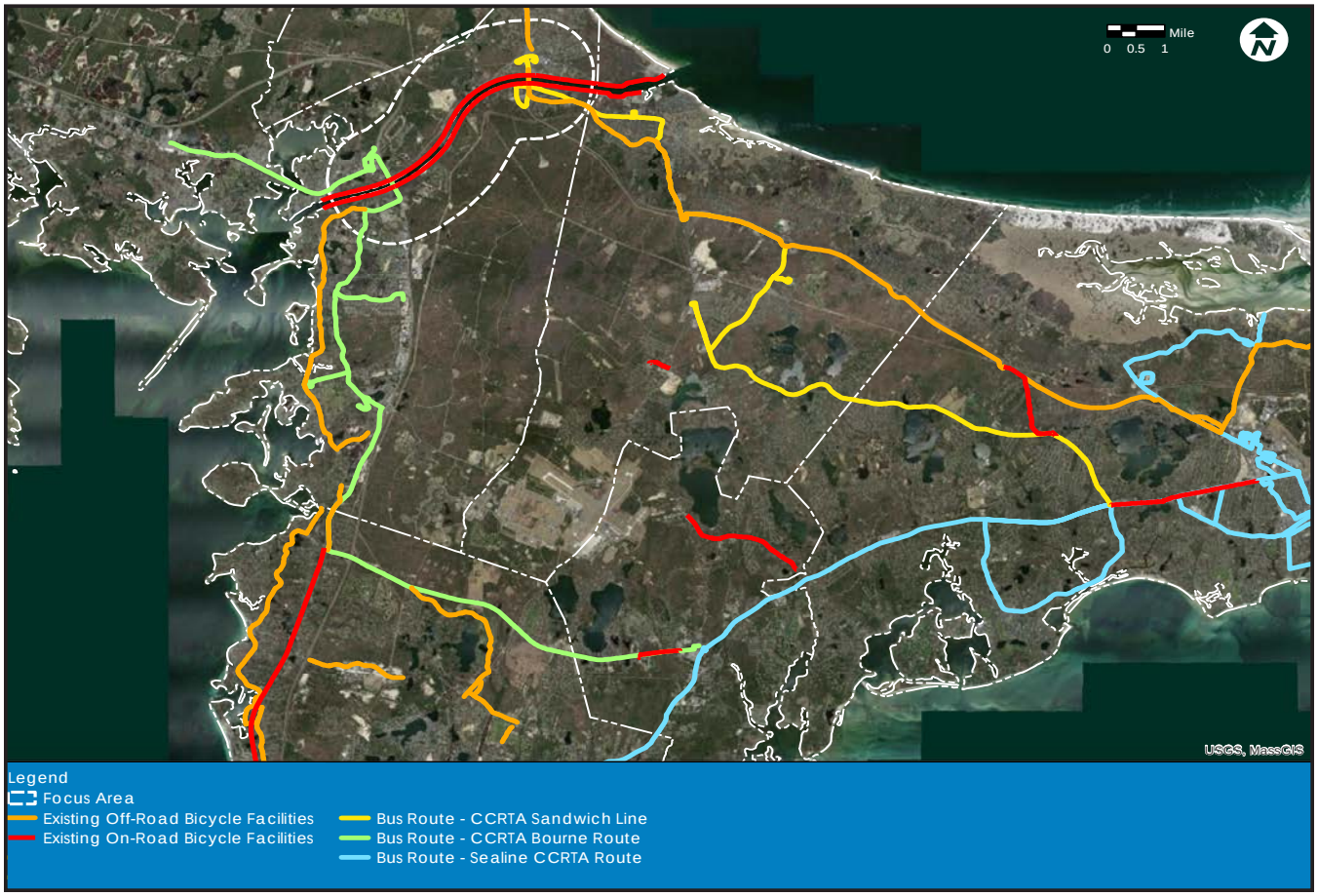


Exhibit 2-43 Bicycle Facilities and Bus Routes in the Study Area

CCRTA Map

and train service connect to places as far as Boston and New York City. Over water, ferry service connects the Cape to Nantucket, Martha's Vineyard, and Boston. Two municipal airports offer direct flights to Martha's Vineyard, Nantucket, Boston, New York City, and Washington D.C.

Multimodal transportation on Cape Cod centers on the Hyannis Transportation Center, built in 2002. The Center serves as a terminal for local and long-distance bus service and as a rail station for the seasonal MBTA Cape Flyer. The Center provides parking for 220 vehicles, and it has entrances from Route 28, Center Street, and Ridgewood Avenue in Hyannis. Proximity to Barnstable Municipal Airport and the Hyannis Ferry Dock (both less than one mile away) allows for quick transfers between transportation modes.

2.6.4 Bus Service

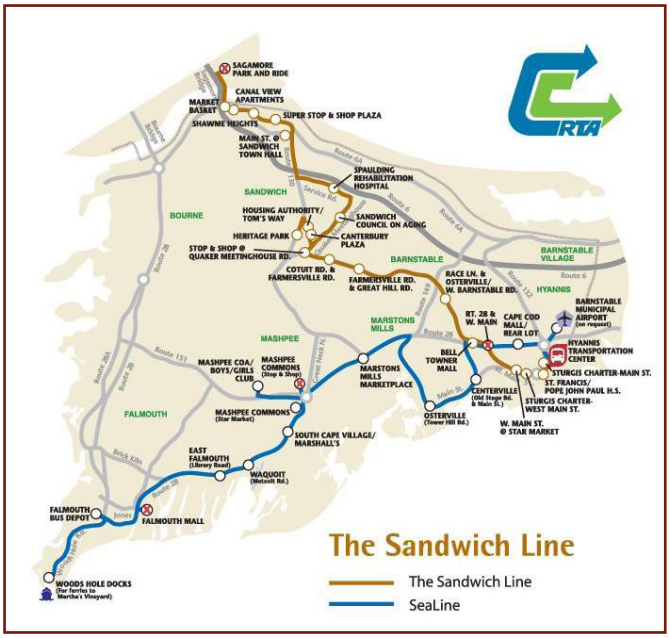
This section summarizes Cape Cod bus services. The Cape Cod Regional Transit Authority (CCRTA) serves as the primary transit provider within the study area. Other bus companies serving the area include the Greater Attleboro Taunton Regional Transit Authority (GATRA), Peter Pan Bus Company, and the Plymouth & Brockton Bus Company.

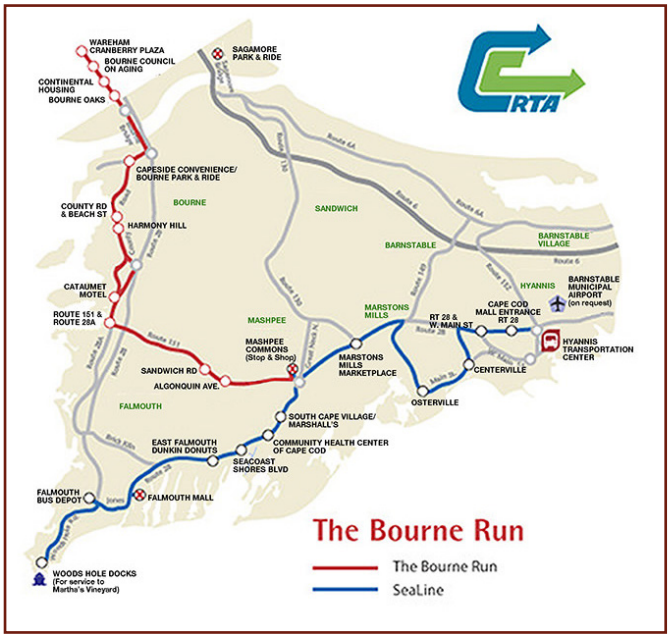
Cape Cod Regional Transit Authority (CCRTA)

A public transit authority, CCRTA provides bus service daily during the summer and weekdays and Saturdays during the off-season. Schedules and some stops also vary seasonally. The routes have designated stops, and passengers can request some stops on board. As described below, CCRTA operates six year-round fixed-route services covering every town on Cape Cod. These include the SeaLine, H2O Hyannis-Orleans (H2O Line), FLEX, Barnstable Villager, Sandwich Line and Bourne Run. Seasonal fixed-route services include the WOOSH Trolley, The Hyannis Area Trolley and the Provincetown/North Truro Shuttle. Access to these transit services is often limited by the lack of accessible sidewalks and bus shelters along CCRTA bus stops in the study area, particularly along Shore Road, County Road, and Route 6A.

CCRTA Fixed Routes

The SeaLine route runs from the Woods Hole docks in Falmouth to the Barnstable Municipal Airport with stops including the Hyannis Transportation Center. The SeaLine travels along Route 28 and deviates to Osterville and Centerville centers. Along Route 28, the SeaLine travels to Mashpee Commons, Falmouth Center, the Falmouth bus depot, and Woods Hole.





CCRTA Route Maps:
The Sandwich Line, left
The Bourne Run, right

The H2O line runs from the Hyannis Transportation Center to the Stop & Shop in Orleans. The bus travels to the Cape Cod Hospital and along Route 28 to the Stop & Shop and Star Market in Yarmouth, the Dennis Shopping Area, the Stop & Shop and Patriot Square in Dennis, the Harwich Chamber of Commerce, through Chatham and to the CVS and Stop & Shop in Orleans. From the H2O line, riders can connect to the FLEX bus that continues to Provincetown. The line also connects at the Hyannis Transportation Center with the SeaLine, the Barnstable Villager, intercity buses and in summer, with the Hyannis Trolley.

The FLEX travels from Route 28 in Harwich, over Queen Anne to Route 137, to Brewster on Route 6A, down Route 6 through the towns of Orleans, Eastham, Wellfleet, and Truro to Provincetown. The FLEX picks up and drops passengers off at designated stops and will deviate off its route for up to 0.75 miles. The FLEX line also offers transfer connections to the H2O line at various points in the towns of Harwich and Orleans.

The Barnstable Villager runs from downtown Hyannis at the Hyannis Transportation Center to the Courthouse Complex in Barnstable Village. The route passes through neighborhoods in the north and south of the Mid-Cape area. During the summer season, the route also serves Barnstable and Hyannis harbors. Passengers make connections to the H2O and SeaLine at the Hyannis Transportation Center.

The Bourne Run travels from the Walmart at Cranberry Plaza in Wareham through Bourne and Falmouth to Mashpee Commons. As shown below, the Bourne Run travels across the Bourne Bridge, through downtown Buzzards Bay, and along Routes 28A and 151 in Bourne, Falmouth and Mashpee. The Bourne

Run offers the only connection to Greater Attleboro Taunton Regional Transit Authority and the Onset/Wareham Link (OWL) fixed-route systems.

The Sandwich Line travels from the Sagamore Park and Ride across the Sagamore Bridge to the Hyannis Transportation Center through Sandwich (see figure on previous page). It passes through historical downtown Sandwich on Route 6A, travels on Race lane in Barnstable and then connects through Route 28 to Hyannis. This route offers transfer connections to the SeaLine, H2O and Barnstable Villager at the Hyannis Transportation Center.

The CCRTA's newest route, the Hyannis Loop, travels from the Hyannis Transportation Center to the Cape Cod Mall, Southwind Plaza, Festival mall, and other downtown locations. It connects the Hyannis Transportation Center with several other CCRTA fixed route services: the SeaLine, Villager, Sandwich Line, and H2O line. It also connects with Plymouth & Brockton and Peter Pan bus services. The Hyannis Loop travels from the Hyannis Transportation Center down Main Street, North Street, and West Main Street to Route 28 then connects to the Festival Mall and Super Stop & Shop via Pitchers Way. It then follows Attucks Lane to Independence Drive before following Route 28 and Barnstable Road back to the Hyannis Transportation Center.

CCRTA Seasonal Fixed Routes

Within Hyannis, Provincetown, and Falmouth, CCRTA runs seasonal trolleys to and from the ferry docks to help meet the demand for increased transit service from May through September. All trolleys run every hour or half-hour for ten or more hours a day.

In Hyannis, the Hyannis Area Trolley (HAT) operates seven days a week, from late June through Labor Day, including holidays. The HAT runs from the Hyannis Transportation Center to the Steamship Authority ferry docks and the Cape Cod Hospital before coming back to the Hyannis Transportation Center. The HAT route includes stops at the JFK Museum, Kennedy Memorial and Veterans Beach.

In Provincetown, CCRTA runs two shuttles. One route travels between MacMillan Pier in Provincetown to the National Park Service's Province Land Visitors Center, Race Point Beach, and the Provincetown Municipal Airport. The other route travels from MacMillan Pier to Beach Point in Provincetown to the North Truro and Horton's Campgrounds.

In Falmouth, the WHOOSH Trolley runs late June through early September daily from the Falmouth Mall to the Steamship

Authority docks. This line connects to the SeaLine fixed route service at the Falmouth bus depot, Falmouth Mall, and the Steamship Authority in Woods Hole.

Demand Response

CCRTA also provides demand-response services: Dial-A-Ride Transportation (DART); Americans with Disabilities Act (ADA) paratransit services, and Boston Hospital Transportation.

DART service, which operates as a door-to-door ride by appointment, is available to the public, with priority given to seniors and individuals with disabilities. DART service is available Monday through Saturday in all 15 Barnstable County towns, with limited service on Sunday. Vehicles used for DART services include 10- to 12-person vans and/or 15- to 18-person mini buses.

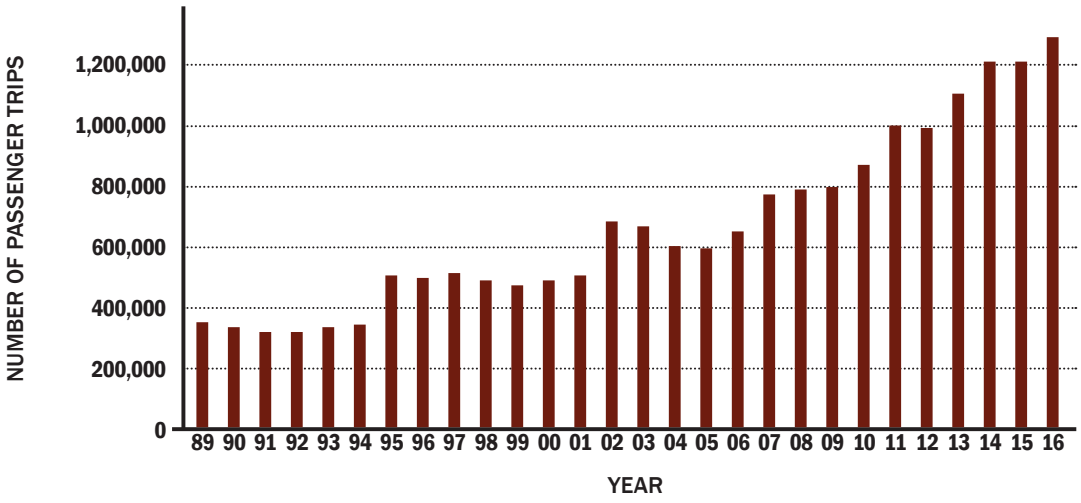
ADA Paratransit is a door-to-door shared-ride service for passengers who meet ADA eligibility requirements established by law in 1990. ADA Paratransit vehicles travel to destinations within 0.75-mile of fixed route bus services for any purpose.

The Boston Hospital Transportation (BHT) is another healthcare transit service. Services are provided from Wellfleet, Eastham, Orleans, Harwich, Barnstable, and Sagamore to 15 Boston-area medical facilities by appointment.

Annual CCRTA Ridership Counts

CCRTA systemwide ridership counts for the last 27 years show a considerable increase in public transit use throughout Cape Cod. Exhibit 2-44 shows that the CCRTA provided just over 357,000 passenger trips in 1989. By 2016, ridership had more than tripled, reaching nearly 1.3 million annual passenger trips.

Exhibit 2-44 Cape Cod Regional Transit Authority (CCRTA) Annual Ridership



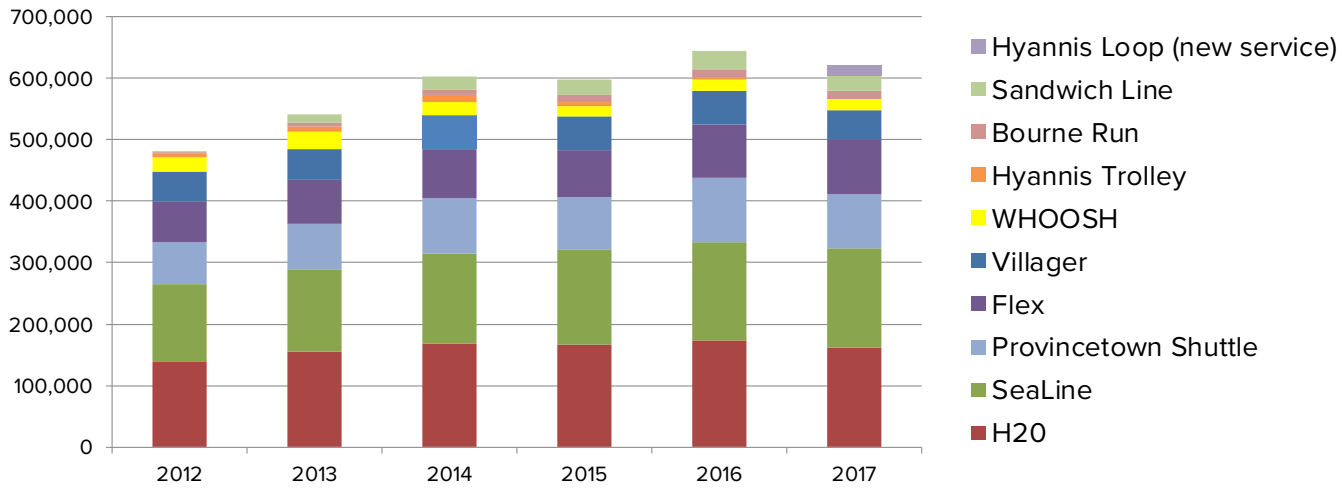


Exhibit 2-45 Cape Cod Regional Transit Authority (CCRTA) Fixed Route Ridership

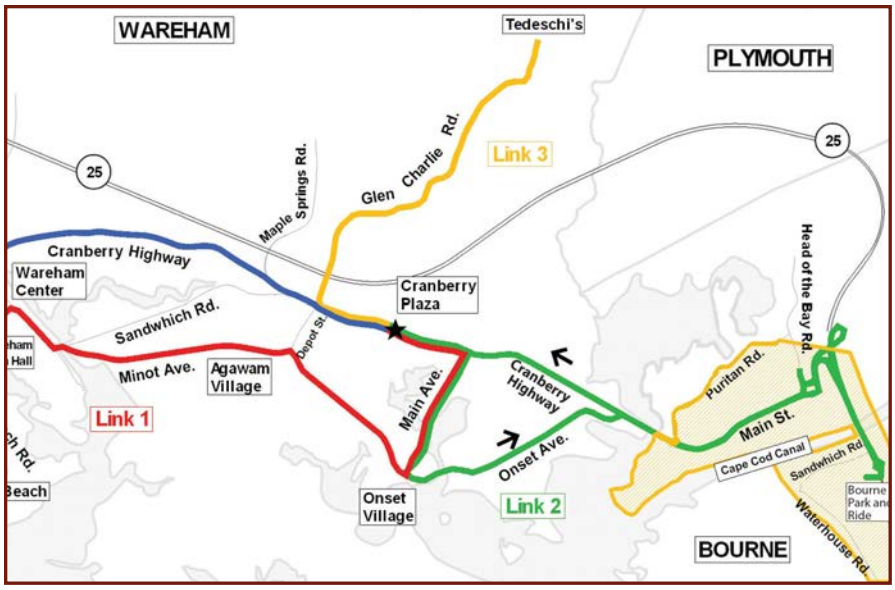
The annual CCRTA counts in Exhibit 2-44 represents trips by all CCRTA services— fixed-route and seasonal services, and demand-response, human service transportation and ADA passenger trips.

Exhibit 2-45 focuses on ridership for the CCRTA's fixed-routes for the period 2012–2017. This table shows that the routes with the highest ridership are the H2O and SeaLine, which travel the commercial corridor of Route 28. Both the Bourne Run and the Sandwich Line, introduced in 2012, experienced lower ridership than the more established fixed routes. Both lines experienced low ridership in 2012, their first year of operation; since then, however, annual ridership for the Sandwich Line shows a considerable increase. The Bourne Run has experienced slower ridership growth.

Greater Attleboro Taunton Regional Transit Authority (GATRA)

GATRA is a public authority that provides transit service through southern Norfolk County, Plymouth County, and the South Shore. The Wareham/Middleborough/Lakeville Train Connector bus route runs from the Lakeville MBTA commuter rail station/ Cape Flyer station to Onset Town Pier and connects to the CCRTA Bourne Run route at Cranberry Plaza in Wareham. The Plymouth Area Link has four lines that connect the Plymouth and Kingston MBTA commuter rail stations to the Plymouth & Brockton Bus in Plymouth at Route 3 (Exit 5). As shown in the route map, GATRA provides bus service in the study area in Wareham, Plymouth, and Bourne.

One shuttle links Wareham Center with Onset, while another shuttle connects with Marion and Mattapoisett.



(top to bottom)
GATRA Route Map

Plymouth & Brockton Bus Route, Provincetown to Logan Airport, Boston

Plymouth & Brockton Street Railway Co.

The Plymouth and Brockton Street Railway Co. ("Plymouth & Brockton Bus") is another privately-owned transportation company that runs four bus routes between Boston and Provincetown. One route runs from Hyannis to Boston's Logan International Airport via Barnstable, Sagamore, Plymouth, Rockland, and Boston. This route runs 16 times a day on weekdays with additional trips on the same route beginning and ending at South Station. These routes stop at Park and Ride lots on Route 6, providing daily service to Boston for commuters. On weekends the service runs 15 times a day. A second route connects from MacMillan Pier in Provincetown to New York City via New Bedford and Providence. An additional

line connects the outer Cape from Provincetown to the Hyannis Transportation Center via North Truro, Truro, Wellfleet, South Wellfleet, North Eastham, Eastham, Orleans, and Harwich. A separate route extends from Logan Airport in Boston to the Hyannis Transportation Center. Both the Provincetown-to-Hyannis line and the Hyannis-to-New York line run twice daily in both directions. Peak period congestion on the Route 6 – Route 3 corridor, particularly along the approaches to the Sagamore Bridge, can contribute to reduced reliability of these bus services.

Peter Pan Bus Line

Peter Pan Bus Line is a privately-owned transportation company that provides weekend service between Cape Cod and Boston a minimum of five times daily, with increased frequency on weekdays and during the summer. One route runs from Woods Hole to Logan Airport via Falmouth, Bourne, Buzzards Bay, Wareham, and Boston. A second route runs from the MacMillan Pier in Provincetown to New York City via Barnstable, Bourne, New Bedford, Fall River, and Providence. Peak period congestion on the Route 6 – Route 3 corridor, particularly along the approaches to the Sagamore Bridge, can contribute to reduced reliability of these bus services.

Other Transit Authorities

In addition to the transit services offered on Cape Cod, Nantucket and Martha's Vineyard each have their own transit system that runs year-round. The Nantucket Regional Transit Authority runs the WAVE with ten routes that originate near the Steamship Authority dock in Nantucket. The Martha's Vineyard Regional Transit Authority runs 13 routes throughout the island's six towns.

2.6.5 Rail

The MBTA provides summer weekend service to Cape Cod (Cape Flyer) through the Middleborough/Lakeville commuter rail line. The service runs from South Station in Boston to the Hyannis Transportation Center with stops in Braintree, Brockton, Middleborough/Lakeville, Wareham Village, and Buzzards Bay. The total trip from Boston to Hyannis takes approximately 2 hours and 20 minutes and costs $22 one way and $40 round trip. During its first season, 2013, the service had 16,586 passenger trips from May through October. For 2014 and 2015, the train serviced 12,625 and 13,278 passenger trips, respectively, from May through September. Passenger trips increased in 2016 to 14,499, an average of 9.2% more passenger trips than 2015.

Cape Flyer traveling over the Cape Cod Canal
Source: Debee Tlumacki for the Boston Globe

2.6.6 Ferry Service

Ferries provide year-round connections from Cape Cod to Nantucket and Martha's Vineyard via terminals at Woods Hole or Hyannis. Seasonally, ferries also run between Boston and Provincetown's MacMillan Pier. The Steamship Authority (SSA) operates year-round service and licenses private ferry operators to provide year round and seasonal ferry services from the mainland to the islands. SeaStreak, LLC, and Hyannis Harbor Tours, Inc. (Hy-Line) each has a license agreement with the SSA to operate ferry service. Both agreements were amended for the 2016 season, as described below.

The Steamship Authority terminal at Woods Hole

The SSA amended the SeaStreak license agreement to allow two daily round trips Monday through Thursday, and three daily round trips Friday through Sunday, during the summer. The trips run directly between New Bedford and Nantucket (in addition to the summer high-speed passenger service that SeaStreak provides between New Bedford and Martha's Vineyard). The crossing from New Bedford through Buzzards Bay, Vineyard Sound, and Nantucket Sound takes just under two hours.

Hy-Line Cruises also operated in 2016 under an amended license agreement with the SSA to provide ferry service from Hyannis Harbor to Nantucket and Oak Bluffs, Martha's Vineyard and between the islands. Under the amended agreement, Hy-Line will retire its 520-passenger ferry, the Brant Point, which provided one daily round trip on a seasonal basis between Hyannis and Oak Bluffs. It will substitute the Brant Point with a new high-speed passenger ferry (with a capacity of 300-350 passengers) running up to five daily round trips between Hyannis and Oak Bluffs on a seasonal basis. Hy-Line will also provide up to three daily round trips with the Lady Martha on a seasonal basis between Oak Bluffs and Nantucket (inter-island service) in addition to providing one morning daily trip from Hyannis to Oak Bluffs and an evening daily trip from Oak Bluffs to Hyannis.

Freedom Cruise Line, Inc. runs ferries between Harwich Port and Nantucket from Memorial Day weekend through September. During June and September, the ferries run one round trip a day; in July and August the ferries run three round trips per day.

Bay State Cruise Company runs a ferry and fast ferry service from Boston to MacMillan Pier in Provincetown from mid-May through mid-October. The fast ferry runs three round trips a day, with an additional early Monday morning service. The traditional ferry runs one round trip during the first three Saturdays in July.

The SSA itself runs ferries year-round from Woods Hole to Martha's Vineyard and from Hyannis to Nantucket. Off-season

ferries between Woods Hole and Vineyard Haven run 14 times a day. During the summer, ferries between Woods Hole and Vineyard Haven run nine to ten times a day with an additional four to five trips from Woods Hole to Oak Bluffs. The fare for adults is $8.50 one way and $17 round trip. The round-trip passage fare for vehicles ranges from $87 to $157 depending on the time of year and length of vehicle.

The SSA also runs a high-speed (60 minutes) passenger-only ferry from Hyannis to Nantucket. It runs four-round trips a day, April through mid-May and mid-October through December, and five round trips a day from late May through mid-October. The fare for adults is $36.50 one way and $69 round trip. Traditional ferry service also connects Hyannis to Nantucket. That ferry runs three round trips a day, mid-September through late May, and six round trips a day from late May through mid-September. The fare for adults is $8.50 one way and $17 round trip.

The SSA also runs ferries between Hyannis and Nantucket year-round. During the off season, September through May, the ferries run four round-trips per day. From June through August, they run six round-trips per day. All Steamship Authority ferries except the high-speed ferry carry passenger vehicles.

Steamship Authority Ferry Ridership

The number of passengers and automobiles transported by the SSA has increased significantly during a seven-year period, from 2011 to 2017 (Table 2-24). The only year-to-year decrease came between 2016 and 2017, when there was a slight decrease in the number of passengers and automobiles served. In comparison, the number of trucks carried on these routes decreased between 2011 to 2012, and subsequently increased each year between 2012 and 2017.

Table 2-24 shows that the SSA's vessels transported a total of 3,059,049 passengers, 481,425 automobiles, and 189,388 trucks of all sizes to and from the islands of Martha's Vineyard and Nantucket during 2017.

Table 2-25 presents a monthly summary of passengers transported on SSA vessels during 2016 and 2017. The lowest SSA passenger counts were experienced in the winter months

Table 2-24 Steamship Authority Ferry Ridership

	2011	2012	2013	2014	2015	2016	2017
Passengers	2,712,047	2,802,980	2,846,691	2,893,851	3,023,090	3,127,304	3,059,049
Automobiles	439,721	449,850	452,286	457,682	465,297	482,699	481,425
Trucks	154,380	153,757	162,148	166,577	172,861	182,099	189,388

Source: Massachusetts Steamship Authority

Table 2-25 Steamship Authority Ridership - Monthly Trends 2014 to 2015

	2016	2016	CHANGE
January	103,577	115,333	0.6%
February	104,494	103,861	-0.6%
March	130,505	120,872	-7.4%
April	185,330	199,140	7.5%
May	288,863	283,282	-1.9%
June	346,631	334,141	-3.6%
July	503,565	466,429	-7.4%
August	503,239	498,235	-1.0%
September	343,569	319,418	-7.0%
October	264,043	274,912	4.1%
November	179,606	183,154	2.0%
December	162,776	160,272	-1.5%
Total	**3,127,304**	**3,059,049**	**-2.2%**

Source: Massachusetts Steamship Authority

of January and February. The highest passenger counts, in both 2016 and 2017, were in July and August. There were significant decreases during March (-7.4%), July (-7.4%), and September (-7.0%). Though overall ridership decreased approximately 2% between 2016 and 2017, there was a significant increase during the month of April (+7.5%). There were also slight or moderate increases during several other months: January (+0.6%), October (+4.1%), and November (+2.0%).

Steamship Authority Capital Improvements (2015-2016)

The SSA completed several capital improvement projects in 2015, including the construction of a 1,900-space pervious-pavement parking lot on Landers Road in West Falmouth. This new lot allowed for the closure of two existing lots on Gilford Street in Falmouth, reducing traffic congestion in downtown Falmouth and creating a much more functional and efficient parking and shuttle bus operation for the SSA. The SSA also completed traffic-circulation improvements at its Vineyard Haven terminal.

The SSA christened a new ferry in June 2016. The M/V Woods Hole is a hybrid 235-foot vessel designed to carry up to 10 full-length tractor trailers trucks, 55 passenger vehicles, or some combination of both. The new boat can also carry 384 passengers, including a crew of nine. Finally, design and permitting for a multi-year, multi-phase reconstruction of the Woods Hole Terminal has been completed; construction of an initial phase is scheduled to start in early 2017.

Steamship Authority's New Bedford-to-Martha's Vineyard Freight Ferry Feasibility Study

In April 2016 the SSA completed a draft feasibility study of providing freight ferry service between New Bedford and Martha's Vineyard. As noted above, truckers destined to Martha's Vineyard currently cross one of the Canal highway bridges and make their way south through Falmouth to the SSA terminal at Woods Hole. The primary reason for considering freight ferry service from New Bedford is to divert trucking from the Woods Hole terminal, thereby reducing the number of trucks traversing Falmouth.

A prior 2000-2001 freight ferry pilot program was not financially successful, with collected revenues covering only 15% to 22% of the cost of the service. However, in 2015 the SSA decided to reexamine the issue and initiated a comprehensive study of potential freight service between New Bedford and Martha's Vineyard. The study examined numerous issues related to this potential service including whether it should be year-round or season and whether it should be financially self-supporting.

2.6.7 Airline Service

Barnstable Municipal Airport

The Barnstable Municipal Airport serves flights by two major airlines, Cape Air and JetBlue. Cape Air flies from Hyannis to Nantucket and Boston year-round up to 12 round-trip flights a day. From May through October the airline also flies from Hyannis to Martha's Vineyard. JetBlue Airlines flies one round trip a day between New York City and Hyannis seasonally.

The Martha's Vineyard Airport offers flights from four carriers: Cape Air, Delta, JetBlue, and American. These airlines fly direct to New York City, White Plains, Washington D.C., New Bedford, Boston, Nantucket, and Hyannis, though schedules vary seasonally. Tradewind Aviation also runs shuttle flights May through October to New York City and White Plains.

The same four airlines serve Nantucket Memorial Airport: Cape Air, Delta, JetBlue, and American. Flights from Nantucket to Hyannis, Martha's Vineyard, Boston, and New Bedford are available year-round, while White Plains flights run seasonally. Tradewind Aviation also runs shuttle flights, April through December, to New York City and White Plains.

The Provincetown Municipal Airport has flights through Cape Air year-round to Boston and June through September to White Plains.

2.6.8 Intelligent Transportation Systems

Intelligent Transportation Systems (ITS) refers to information technology applied to mitigate transportation congestion and improve traveler safety. These systems provide the public with the latest information on construction, traffic congestion, accidents, and weather via signs posted along the highway.

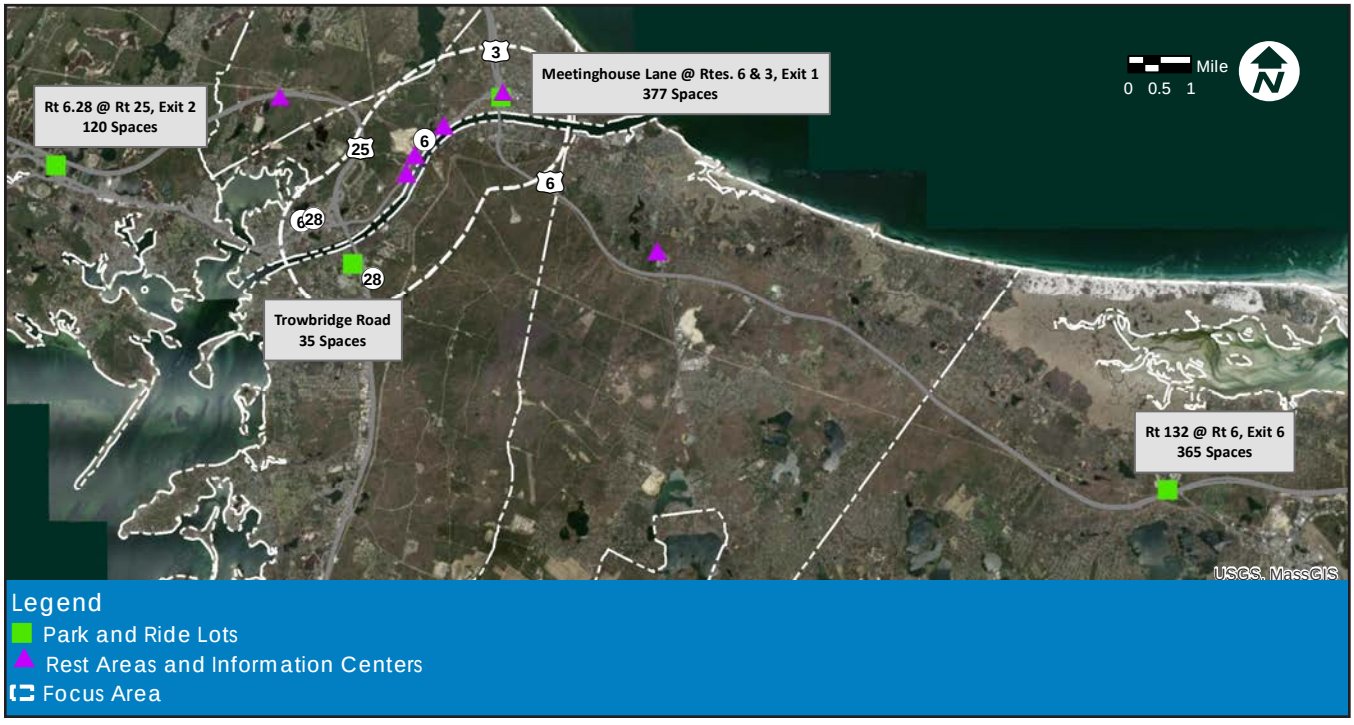
In April 2014 a "GO Time" real time traffic information system became operational along Route 6 on Cape Cod. This system anonymously tracks Bluetooth signals from vehicles to measure average vehicle speeds and travel times between points. Approaching Cape Cod and along Route 6 across the Cape, permanent federal highways signs with embedded digital displays show projected travel times to exits. MassDOT intends to continue to improve the ITS infrastructure on Cape Cod in the future.

Real time traffic information sign along Route 6 in Orleans

2.6.9 Park & Ride Lots

Park & Ride lots offer commuters and others the ability to carpool or use transit services on Cape Cod. Exhibit 2-46 shows the three Park & Ride lots within the study area and a fourth lot at Route 6 Exit 6. One is located at the Route 25 eastbound off-ramp at Exit 2 in Wareham. Operated by MassDOT, it has 120 spaces. Peter Pan Bus Lines operate a commuter bus service from Woods Hole to Logan Airport via South Station that stops at the Wareham lot twice on weekdays and once on weekends in each direction.

Exhibit 2-46 Rest Area and Park & Ride Lots in Study Area



A second Park & Ride lot in the study area, known as the Sagamore lot, is located north of the Cape Cod Canal at the southeast corner of the Route 3/Route 6 (Scenic Highway) interchange in Bourne. The lot is owned by MassDOT has a capacity of 377 vehicles. This lot is often at or near capacity year-round. The lot is serviced by the Plymouth & Brockton Bus Company, which runs buses from Hyannis to Boston, with stops including the Bourne Park & Ride lot.

The study team conducted a mid-week occupancy count at the Sagamore lot in October 2016. Their findings confirmed earlier counts, that the lot was 99% occupied. Finally, while outside the study area, a larger (365 spaces) Park & Ride lot is located at Route 6 Exit 6 in Barnstable. Based on this occupancy survey, it appears that the opportunity exists to either increase the number of parking spaces at existing park and ride lots or construct an additional park and ride lot along Route 6. Additional parking spaces, or a new parking lot located on-Cape would be preferable to reduce the need for vehicles to travel over the Sagamore Bridge.

2.6.10 Rest Areas

Rest areas provide locations for drivers to temporarily pull off major roads. They provide restroom facilities and tourist information. Exhibit 2-46 shows the rest areas within the study area. A tourist information center is located at the Park & Ride lot in the southeast corner of the Route 3/Route 6 (Scenic Highway) interchange, in Bourne. Another tourist information center is located between Exits 2 and 3 on Route 25 eastbound. In Sandwich, a small information center with parking sits north of Exit 2 off Route 6.

Along Route 6/Scenic Highway in Bourne there are two rest areas with parking and picnic tables and one at the Herring Run Recreation Center, owned and operated by the U.S. Army Corps of Engineers. This parking area also has paths that connect to the Cape Cod Canal Trail for recreational use.

2.7 SUMMARY OF EXISTING CONDITIONS

Chapter 2 provided a description of the existing natural and cultural conditions in the study area including the existing natural and cultural environmental resources, land uses, socio-economic conditions, public health and transportation.

Natural Environmental Resources

The study area features an abundance of natural environmental resources particularly coastal and inland wetlands north and

south of the Canal. Project area wetlands, floodplain, and waterbodies such as the Canal, Herring Pond, Buttermilk Bay are critical for supporting recreation, fishing, shellfishing, wildlife habitat, and flood control.

Rare species habitat is prevalent throughout the study area, particularly within Joint Base Cape Cod and the Shawme-Crowell State Forest. The rare species include a wide variety of turtles, reptiles, birds, butterflies, moths, mussels, and plants. Numerous certified and potential vernal pools also exist throughout the study area.

The study area also features two Areas of Critical Environmental Concern (ACEC); the Bourne Back River and the Herring River ACECs. Aquifers on Cape Cod are a particularly sensitive resource as they are part of a designated drinking water sole source aquifer.

Social Environmental Resources

The study area features numerous social environmental resources such as historic sites and open space.

Concerning historic resources, the study area, including Bourne, Plymouth, Sandwich, and Wareham, is rich in historic resources and open space properties. The historic sites include the Bourne and Sagamore Bridges, the Old Kings Highway Regional Historic District in Sandwich, and the Jarvesville, Town Hall Square, and Spring Hill National Historic Districts in Sandwich. Several public buildings are Bourne are individually listed on the National Register of Historic Places including the Bourne High School, the Jonathon Bourne Public Library, Bourne Town Hall.

There are many publicly- and privately-owned parcels which are protected as open space. These publicly- and privately-owned properties serve a wide variety of purposes, including watershed protection, wildlife habitat, conservation, recreation, public beaches, marinas, and camping. Open space properties in the study area include the Scusset Beach State Reservation, Shawme-Crowell State Forest, Upper Cape Water Supply Reserve, Cape Cod Canal Recreation Area, Gallo Skating Rink, Carter Beal Conservation Area, Sacrifice Woods Rock, and the Nightingale Pond Recreation Area.

The predominately-forested Joint Base Cape Cod dominates the central portion of the study area. The numerous historic and archaeological sites reflect the area's long and rich history. While these environmental resources contribute to the great appeal of Cape Cod, they also represent a constraint on future transportation improvement alternatives.

Socio-Economic Conditions and Public Health

Socio-economic conditions in Barnstable County (Cape Cod) are in transition. After several decades of rapid population and employment growth, the county has experienced a population decline since 2000. The demographics of this population is also shifting to a higher percentage of senior citizens and a lower percentage of working adults and school-age children. The unemployment rate in Barnstable County is similar to the rate in Massachusetts as a whole, but it fluctuates widely during the year, with a lower rate during the summer tourist season and a higher rate during the off season. The unemployment rate generally held steadier closer to the Canal area (and employment centers in Plymouth County and beyond).

The predominate health problems in Barnstable County include asthma, heart disease, diabetes, and depression. The method workers use to commute to work is an important issue in Barnstable County. Nearly 90% of commuters use private automobiles to travel to work. Crossing the two roadway bridges over the Canal represents an important part of the daily commute for many residents in Barnstable County. Nearly 34,000 commuters cross one of the Canal bridges each work day as part of their daily commute, including over 32% of workers in Bourne and 19% of workers in Sandwich.

Utilities

Important utility corridors cross the study area. These include an electrical utility corridor which transmits electricity through transmission towers from the Canal Generating Plant in Sandwich northwest across the Canal and east to Cape Cod customers. Natural gas enters Cape Cod within a pipe network that crosses the Canal attached to the Canal bridges. Natural gas compressor stations are located close to both the Sagamore and Bourne Bridges.

Joint Base Cape Cod

South of the Canal, Joint Base Cape Cod (JBCC) is a nearly 21,000-acre full scale, joint-use base home to five military commands training for missions at home and overseas, conducting airborne search and rescue missions, and intelligence command and control.

Multimodal Facilities

Cape Cod is well served by multimodal facilities including transit, air, bicycle and pedestrian facilities. Transit services on Cape Cod include public- and private-bus services and seasonal commuter rail. The Hyannis Transportation Center serves as an

important regional transportation hub. Barnstable Municipal Airport provides airline service to Nantucket, Boston, New York and beyond. The Massachusetts Steamship Authority provides a robust ferry service with regular ferries between Cape Cod and Nantucket and Martha's Vineyard. Seasonal ferry service is also provided between Provincetown and Boston.

Sidewalks are generally present for pedestrians in more densely developed residential and commercial areas but absent elsewhere. Sidewalks along major travel corridors in the focus area include those along the southern side of Scenic Highway from Nightingale Road west along the southern edge of Belmont Circle and continuing through the Main Street business district in Bourne.

Many other roads in the study area are narrow (20–22 feet) and lack sidewalks. This presents difficulties for pedestrians, particularly the elderly or those with disabilities. Major roadways in the study area, such as Route 28, Route 151, Route 130, Buzzards Bay Bypass, Sandwich Road, Tupper Road, Shore Road, County Road, and Scenic Highway (except in the immediate area of the Route 3 interchange) generally lack sidewalks.

Existing bicycle facilities in the study area include the USACE's Cape Cod Canal bike paths, which runs on both the north and south sides of the Canal. While somewhat outside of the study area, the Shining Sea Bike Path runs through Falmouth along an out-of-service Woods Hole Branch rail right-of-way. The path runs for 10.6 miles from the Steamship Authority terminal in Woods Hole to County Road (Route 151) in Falmouth. An on-road bike route is designated on Route 6A in Sandwich.

Traffic Study Findings

Existing traffic conditions during peak hours along highways in the focus area is often characterized by substantial traffic volumes and congestion (LOS D). There are also numerous roadway intersections that experience severe congestion (LOS E and F) during summer and non-summer peak hours. There are five HSIP high crash locations in focus area.

As described in Section 2.5.6, the highest daily and peak hour traffic volumes in the study area occur along the major highway corridors in the study area, including the Route 3/Sagamore Bridge/Route 6 corridor and the Route 25/Bourne Bridge/Route 28 corridor. Average daily traffic (ADT) on the bridges are generally 30% to 40% higher in the summer compared to the non-summer period. Traffic volumes range from 55,000 to 65,000 vehicles in the summer and 38,000 to 41,000 in the non-summer periods, with the Sagamore Bridge generally having the higher traffic volumes.

The roads connecting the bridge approaches (Scenic Highway north of the Canal and Sandwich Road south of the Canal) also experience high traffic volumes and congestion. This is the result of high traffic volumes within the focus area (not just travel through the focus area) and many travelers crossing from one of the travel corridor to the other.

Exacerbating this congestion is the inadequate capacity and sub-standard design at the intersections at the bridge approaches. These gateway intersections include Belmont Circle and Bourne Rotary (north and south of the Bourne Bridge) and Route 6 Exit 1C south of the Sagamore Bridge. These intersections and several others in the focus area experience extended queueing and poor LOS during the summer and non summer periods (see Sections 2.5.8 and 2.5.10). The roadway geometry on Route 3, including the dropping of a travel lane on Route 3 southbound and the narrow travel lanes with no roadway shoulder on the Sagamore Bridge, contributes to congestion and delays, especially during peak travel periods.

More frequent maintenance on the Canal bridges, with the resultant lane closures, also contributes to off-season traffic congestion. Congestion on the Canal bridges negatively effects the daily commute of the over 34,000 commuters who cross the Canal every work day.

2.8 ISSUES, CONSTRAINTS, AND OPPORTUNITIES

Based on the information gathered in Chapter 2, including existing natural and cultural environmental resources, socio-economic and demographic data, and the traffic study, a series of issues, constraints, and opportunities in the study area were identified (as listed below) which provide a framework for the alternatives development process described in Chapter 4.

Issues:

1. **Severe congestion at Gateway Intersections at Canal bridge approaches**

   Transportation conditions in the focus area are characterized by substantial congestion and delay, particularly during periods of high traffic volumes in the summer tourist season. Traffic conditions at the gateway intersections, including Belmont Circle, Bourne Rotary, the highway approaches to Route 6, and the Route 6 Exit 1C entrance ramp, are exacerbated by substandard roadway geometry. Peak period congestion also reduces the reliability of transit services.

This congestion may also negatively affect seasonal tourism as some people choose other, less congested vacation destinations.

Additionally, the roadway geometry on Route 3, including the dropping of a travel lane on Route 3 southbound and the narrow travel lanes with no roadway shoulder on the Sagamore Bridge, contributes to congestion and delays, especially during peak travel periods.

Peak period congestion in the Canal area affects the nearly 34,000 commuters who cross one of the Canal bridges each work day as part of their daily commute, including over 32% of workers in Bourne and 19% of workers in Sandwich.

2. **High Crash Rates in Study Area**

Eight locations within the study area rank as high-crash locations under the Highway Safety Improvement Program (HSIP). This MassDOT designation identifies crash clusters that rank within the top five percent of their respective regional planning agency's crash locations. The locations in the study area with the highest crash rates include Belmont Circle, Bourne Rotary, and the intersections of Route 6A at Route 130 and Scenic Highway at Meetinghouse Lane.

3. **Balancing visitor and resident needs**

It will be important to develop alternatives that improve regional travel while retaining the character of Cape Cod. Designing transportation improvements to accommodate the summertime peak period traffic levels would require very substantial infrastructure improvements, likely considered an 'over-build' not be in keeping with the type or scale of development desired on Cape Cod.

4. **Lack of population growth and aging population**

Peak period congestion, particularly at the Canal bridges, decreases the reliability of the transportation system. This inhibits the growth of Cape Cod businesses and may contribute to the stagnation of population growth. The population of Barnstable County has not grown since 2000 and has actually experienced a minor population decrease. Age cohorts in the county have also shifted since 2000 with a substantial decrease in the population of working-age adults and school-age children with a corresponding increase in senior citizens.

5. **Lack of bicycles and pedestrian accommodation and connections**

   The study area suffers from a lack of bicycle and pedestrian facilities and connections between the existing facilities. Other than the Canal bike path, there are few bicycle facilities in the study area. Accessible connections to the Canal path are often lacking. Sidewalks for pedestrians are also often absent outside of more densely developed residential and commercial areas in Bourne and Sandwich. This lack of sidewalks is especially problematic along bus routes in the study area.

Constraints:

1. **Extensive areas of sensitive environmental resources**

   The abundance of natural and social environmental resources in the study area. Natural environmental resources include coastal and inland wetlands north and south of the Canal; Herring Pond, Buttermilk Bay and other waterbodies; floodplains, and rare species.

   Areas of Critical Environmental Concern (ACEC), recreational, commercial fishing and shellfishing, and the numerous historic sites in the study area also represent a constraint on future transportation improvements. Aquifers on Cape Cod are a particularly sensitive resource as they are part of a designated sole source aquifer.

   Social environmental constraints include publicly- and privately-owned open space parcels, including the Scusset Beach State Reservation, Shawme-Crowell State Forest, Upper Cape Water Supply Reserve, Cape Cod Canal Recreation Area, Gallo Skating Rink, Carter Beal Conservation Area, Sacrifice Woods Rock, and the Nightingale Pond Recreation Area.

   Historic resources in the study area also represent a constrain to transportation improvements. The historic sites include the Bourne and Sagamore Bridges, the Old Kings Highway Regional Historic District in Sandwich, and the Jarvesville, Town Hall Square, and Spring Hill National Historic Districts in Sandwich.

2. **Developed residential and commercial area**

   Outside of areas of natural environmental resources, much of the study area contains dense residential and commercial development. This development along the region's major roadways represents a constraint of the expansion of these transportation facilities.

3. **Joint Base Cape Cod (JBCC, including the Upper Cape Water Reserve)**

   The 22,000 acres of JBCC, particularly the 15,000 acres of JBCC designated as the Upper Cape Water Reserve, represent a constraint on transportation improvements as use of this land for transportation purposes would require approval of the Massachusetts National Guard and the Massachusetts Legislature.

Opportunities:

1. **Collaboration between MassDOT and U.S. Army Corps of Engineers (USACE)**

   An opportunity for collaboration exists between MassDOT and the USACE to work together to exchange information to allow a more cost-effective and timely advancement of their agency and community transportation goals.

2. **Reduced Peak Period Congestion and Crash Rates**

   The opportunity exists to reduce peak period congestion and crash rates in the study area, reducing costs related to lost time commuting to work, school, shopping, etc. Reduced peak period congestion also increases the attractiveness of study area transit services by reducing travel times and improving reliability. Reducing crash rates would reduce the risk of property or injury for residents, workers, and visitors in the study area.

3. **Enhance multimodal accommodation**

   The opportunity exists to enhance multimodal transportation accommodation in the study area. While there is a robust transit network in the study area, including bus and ferry service, providing more accessible sidewalks and bicycle lanes, especially along bus routes, would encourage people to use other transportation modes. An additional multimodal facility (park and ride lot) on Route 6 in the study area could address demand for commuter car-pooling and bus travel.

4. **Improve employment opportunities**

   Improving transportation mobility on- and off-Cape Cod provides the opportunity to increase year-round employment on Cape Cod, reducing the seasonal variability in the unemployment rates.