BOSTON REGION METROPOLITAN PLANNING ORGANIZATION
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TECHNICAL MEMORANDUM

DATE: **December 16, 2021**
TO: **Boston Region Metropolitan Planning Organization**
FROM: **Bill Kuttner, Central Transportation Planning Staff**
RE: **Hazardous Cargoes on Core Area Roadways**

1 THE CHALLENGE OF HAZARDOUS CARGOES

1.1 Introduction

Planning and study efforts concerning the transportation of hazardous cargo (HC) pose analytical and policy challenges unique to this class of commodities. While trucks carrying non-hazardous cargoes have almost complete access to the roadway network, HC trucks are restricted from parts of the network. Also, crashes involving these trucks can be much more serious when flammable materials are involved. For these reasons, HC movements are a public policy issue. Therefore, the Boston Region Metropolitan Organization’s (MPO) freight program aims to develop better data to understand the movement of HC vehicles on the region’s roadways.

The first part of this study defines hazardous cargoes and discusses the three circumstances that make analyzing and policymaking for HC challenging:

- Elevated seriousness of HC crashes
- HC prohibitions from important sections of the roadway network
- Difficulty of developing HC traffic data

The second section presents HC traffic volumes developed in recent years. HC trucks have been counted as part of earlier area studies. This study pulls together the existing counts and supplements them where appropriate. The study concludes with a brief discussion of the planning implications of the study findings.

This study does not make recommendations. It is intended as a resource to help understand the issues and circumstances concerning HC movements. Preparation of the study depended upon the numerous earlier efforts that explicitly counted HC traffic. Hopefully, the process of identifying these vehicles within regional traffic flows will continue.

Civil Rights, nondiscrimination, and accessibility information is on the last page.

1.2 Hazardous Cargoes and the Seriousness of Crashes

Cargoes and Placards

Many trucks will display a square diamond placard that indicates the type of commodities being carried. The color of the placard indicates the general nature of the contents, often supplemented by a number, which refers to a specific type of commodity. This information is valuable for any work crews tasked with cleaning up crash debris.

A red placard indicates that the contents are a hazardous cargo, in most cases a flammable liquid such as gasoline or home heating oil. Figure 1 shows examples of common HC placards. The first placard is the most specific, indicating that the truck hauls gasoline, commodity 1203. The other two placard designs are more generic. The placard simply marked “Dangerous” is sometimes displayed on box trucks transporting medical waste.

The HC placard symbol is usually stenciled on liquid HC tanks because even after all the liquid contents have been delivered combustible fumes may remain in the tank. Figure 2 shows HC semi-trailers with stenciled HC placards. The first trailer carries gasoline and the second carries liquefied natural gas, primarily methane, commodity 1972.

Figure 3 shows a pair of single-unit trucks displaying HC placards. The first truck is a type often seen delivering home heating oil in residential neighborhoods. The signage on the truck indicates that it delivers diesel fuel, which is often supplied to heavy equipment at construction sites. Heating oil and diesel fuel are heavier fuels than gasoline, but these fuels are still sufficiently volatile that the HC symbol is stenciled on the tank. Links to emergency response data for all hazardous material codes can be found in the National Oceanic and Atmospheric Administration’s database of hazardous materials at this website: UN/NA Datasheets | CAMEO Chemicals | NOAA.

Figure 1
Hazardous Cargo Placards

Source: United States Department of Transportation.

Figure 2
Hazardous Cargo Semi-Trailers

Source: Central Transportation Planning Staff.

Figure 3
Single-Unit Hazardous Cargo Trucks

Source: Central Transportation Planning Staff.

The second truck in Figure 3 is distributing a variety of industrial gases to commercial customers. Visible in the figure are two pairs of changeable placards: one red and one green placard are above the cab facing the direction of travel, and an identical pair appear on the side of the truck. The red placards read, “Flammable Gas,” and the green placards read, "Non-Flammable Gas." If all HC containers have been removed, the red placards can be closed and the HC route restrictions do not apply.

Crash Severity and HC Tunnel Prohibitions

A crash involving an HC truck has the potential to be far more severe than a crash of a similar vehicle that is not carrying hazardous material. All gasoline- or diesel-powered vehicles carry some fuel which can ignite in a crash, and some non-hazardous cargoes are also combustible. Responding to vehicle fires is always a challenge, especially in tunnels.

The intense heat of flames naturally rises, and if a fire is not in a tunnel, firefighters can safely approach the flames from the side and apply water or foam as appropriate. If, however, a fire takes place in a tunnel, the smoke and heat leaves through the tunnel portals. Firefighters liken this to approaching a fire by way of the chimney.

The burning of a vehicle’s own fuel in a tunnel can be managed with some difficulty. When a truck’s entire cargo is fuel, the task is impossible. Fire suppression and emergency egress systems adequate to allow HC in tunnels is not considered practical in the United States. Even if evacuation of stranded motorists were feasible, allowing a fire to burn itself out is not an option because the heat can severely damage tunnel structures, both steel and concrete.

Tunnels also pose difficulties if a crash involves a truck carrying hazardous medical waste. Building tunnels without full-sized breakdown lanes is often considered a reasonable design economy. Truck crashes in a tunnel without a breakdown lane can result in a lane closure or full tunnel closure during cleanup, and with a truck carrying medical waste the cleanup process and associated closure can take longer.

1.3 Hazardous Cargo Network Restrictions

The Core Area Tunnel System

The Interstate Highway System was envisioned in the 1950s as the backbone of a nationwide roadway freight network. Nationwide heavy vehicle and roadway standards date from this era and have gradually evolved in the ensuing decades. Lifecycle reconstruction of limited-access highways, both interstate and non-interstate, has incorporated the newer standards and selectively increased capacity as necessary.

The Central Artery/Third Harbor Tunnel Project (CA/T) in the 1990s reconstructed several miles of Interstate 93 (I-93) in and near downtown Boston, and important sections were built underground. Also, Interstate 90 (I-90) was extended from its junction with I-93 eastward under Boston Harbor to Logan Airport and East Boston. Parts of the core area express highway system were already underground and did not allow travel by HC trucks. Completion of the CA/T project extended significantly the core area roadways prohibiting HC.

Taken altogether, the CA/T project greatly improved the flow of local and regional non-hazardous truck movements. The much smaller number of HC trucks use alternate routes to avoid tunnels. Some of these routes are signed for HC cargoes, and some have time-of-day restrictions.

Figure 4 is a simplified map of selected roadways in Boston's urban core area. The limited-access highways are shown, notably I-93, I-90, and US 1. The parts of these highways with HC prohibitions are highlighted in red, as are the Sumner and Callahan Tunnels, which connect downtown Boston with East Boston. HC prohibitions were extended to the Tobin Bridge after the approach lanes in Charlestown were relocated underground.

Critical Urban Freight Corridors

Figure 4 also highlights in blue a set of surface roadways. Most of these have been designated as Critical Urban Freight Corridors (CUFC) and a few are classified as intermodal connectors. The CUFCs, intermodal connectors, and interstate highways have been designated by federal legislation as parts of the National Highway Freight Network (NHFN).

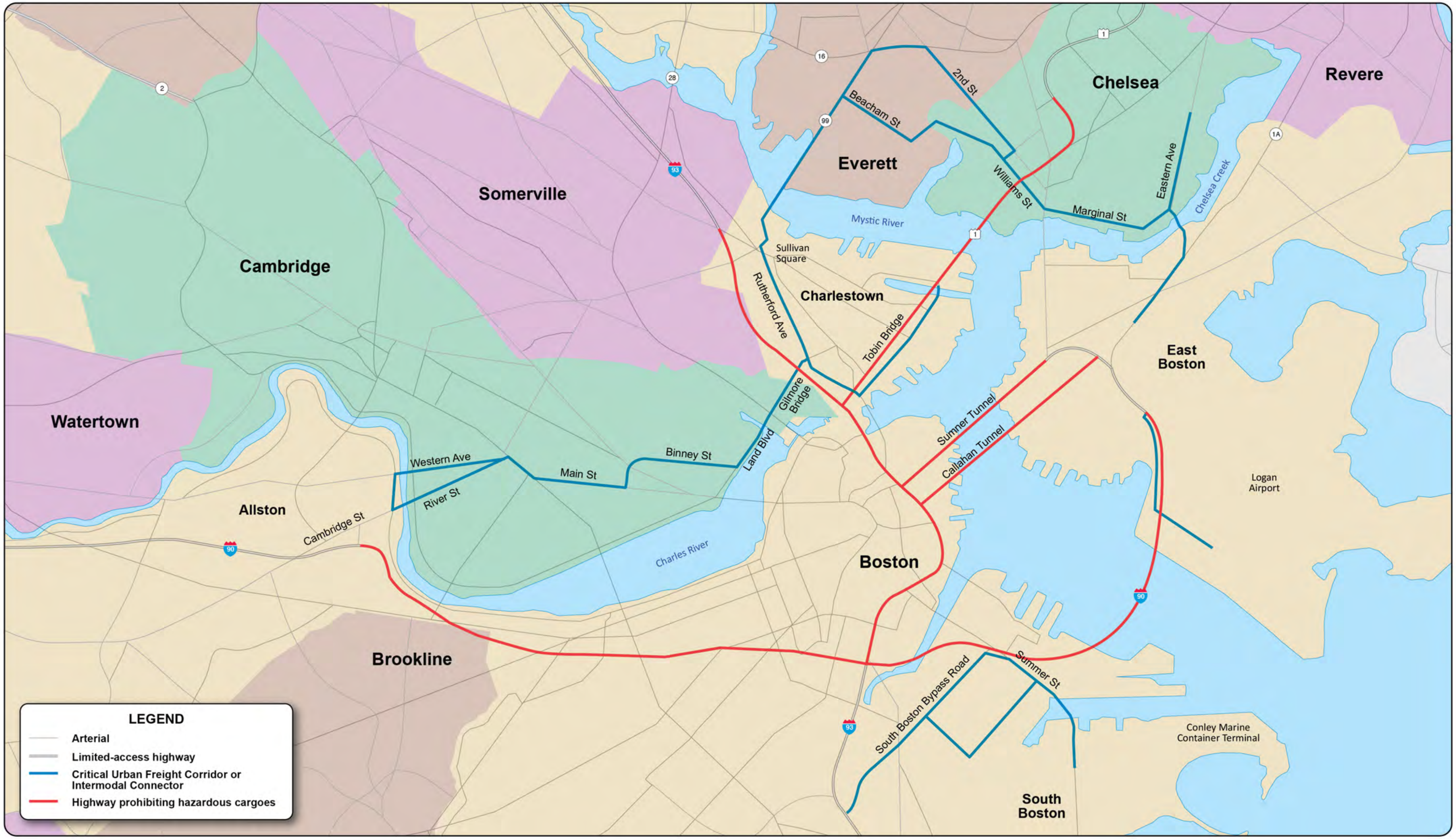

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Figure 4
Hazardous Cargo-Restricted Highways, Critical Urban Freight Corridors, and Intermodal Connectors

Freight Planning Support: Federal Fiscal Year 2021

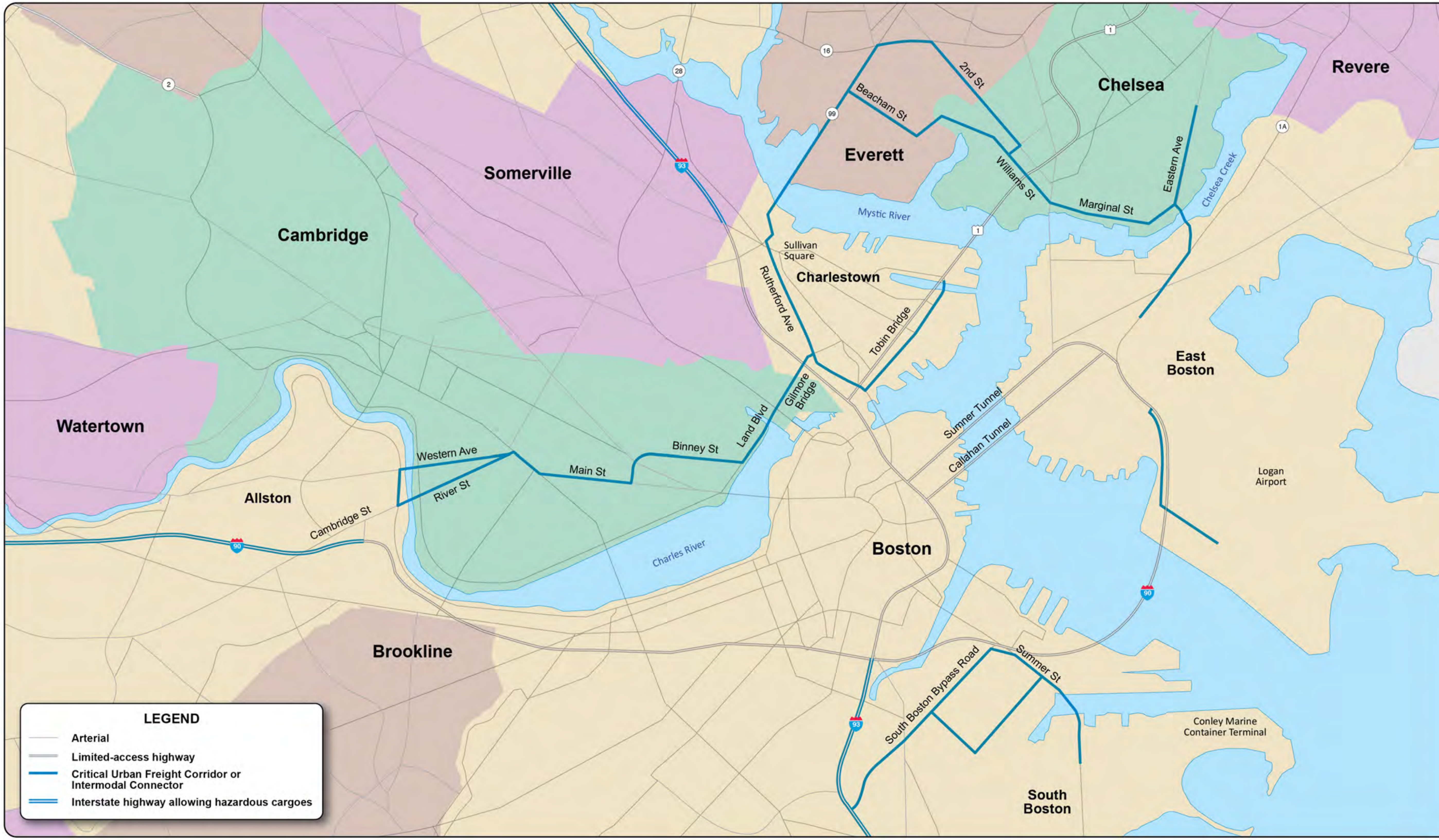

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Figure 5
National Highway Freight Network Sections Allowing Hazardous Cargoes

Freight Planning Support: Federal Fiscal Year 2021

The NHFN was created as part of a multi-year federal surface transportation funding authorization. Initially the NHFN included only parts of the Interstate Highway System and intermodal connectors. The current authorization, the Fixing America's Surface Transportation (FAST) Act, expanded the NHFN to include the entire Interstate Highway System, plus state-designated CUFCs and Critical Rural Freight Corridors. The FAST Act includes funds specifically designated for maintenance and improvement of the NHFN.

The FAST Act stipulated that the CUFCs be recommended by the state departments of transportation. The Massachusetts Department of Transportation (MassDOT) divided the CUFC mileage allocated to Massachusetts between the states' various metropolitan planning organizations and requested that the MPOs identify appropriate roadways as CUFCs.

The board of the Boston Region MPO recommended a set of corridors located throughout the Boston region.[1] The CUFC subsystem north of Boston Harbor and the Charles River, highlighted in Figure 4, was proposed largely because it provides a logical alternative path for HC movements prohibited from the extensive tunnel system. Also, extensive industrial and commercial activity has developed and evolved in the vicinity of local waterfronts, and the CUFC designation was mandated to support freight transportation needs along such corridors.

Figure 5 is a simplified version of the map showing the core area roadway network available to a driver or dispatcher charged with planning an HC delivery or pick up. All the roadways on this graphic are available for HC transport. The NHFN roadways allowing HC movements are highlighted in blue. The NHFN is shown here to inform infrastructure planning and should not be thought of primarily as HC routes.

Most of the roadways shown in Figure 5 are classified as arterials, which are designed to higher standards and are usually the routes of choice for trucks and heavy vehicles traveling in the core area if use of an express highway is not an option. Interspersed between the arterials is a dense complex of streets. Delivery of heating oil to residences and small businesses is commonplace throughout the urban core area during much of the year, and HC vehicles can appear almost anywhere in the roadway system despite their comparatively small numbers.

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[1] Boston Region Metropolitan Planning Organization (website), *Proposed Critical Urban Freight Corridors*, May 2017. Accessed 30 October 2020. https://www.bostonmpo.org/data/calendar/pdfs/2017/MPO_0525_Draft_Critical_Urban_Freight_Corridors.pdf.

1.4 Observing Hazardous Cargo Vehicles

The third challenging circumstance concerning HC is the difficulty of developing HC traffic data. Traffic engineering practice requires some understanding of the distribution of vehicle sizes in traffic. The capacity of a roadway or intersection depends to some degree of the composition of various size vehicles in the traffic flows.

Traditional tube-based counting systems and newer machine-vision-based systems can provide reasonably reliable counts of vehicles by size. Even better vehicle-size information is available for tolled facilities because they operate constantly and tolls are often based on the number of axles on a vehicle. Unfortunately, the presence of an HC placard is not reported, leaving visual observation of traffic as the only reliable way of estimating the number of HC vehicles on a roadway. The data obtained for capacity analysis will include HC vehicles, but they are simply included in one of the truck-size classes.

Another data collection issue is that many capacity analyses focus on traffic during the AM and PM peaks. Manual turning movement counts are often performed to support capacity analyses. But, these are usually confined to peak periods and HC trucks are rarely identified in the count. Even if counting HC trucks were added as a subtask of a turning movement count project, HC traffic during the important midday period would be ignored if the study focused only on the peak periods.

Both weekday truck traffic and private vehicles that make up commuter traffic start out strong during the AM peak period. Commuter traffic then subsides until the daytime workforce begins to crowd the roadways to return home during the PM peak period. Trucks traffic, however, continues strong through the late morning and early afternoon, later subsiding as traffic builds in the PM peak. This temporal travel pattern is seen consistently for both HC trucks and trucks carrying non-hazardous cargoes.

It has been a consistent practice in MPO-supported freight studies to count trucks through much of the midday in order to develop data and conclusions about truck travel patterns. It has also been a practice to count subgroups of trucks in order to better understand the logistic activities supported by various parts of the roadway network. Given the importance of HC-placarded vehicles for travel demand model development, economic activity, and public safety policy, they have been counted as a truck subgroup for virtually all MPO-supported freight studies. The HC traffic findings of prior MPO studies have been combined and, together with selected additional counts, are presented in the second part of this memorandum.

2 HAZARDOUS CARGO VOLUMES ON CORE AREA ROADWAYS

2.1 Data Development Efforts

The first Boston Region MPO freight program study examined truck volumes and flow patterns in the extensive Everett-Chelsea industrial area.[2] Trucks by type, including single-unit and semi-trailer HC vehicles, were counted at cordon points around the study area. A subsequent study focused on the South Boston Waterfront and applied the same cordon approach.[3] With few HC vehicles in this area, single-unit and semi-trailer HC vehicles were counted together to permit more detail in other counting categories.

MassDOT requested the CUFC recommendations as the South Boston Waterfront study was nearing completion. The completed Everett-Chelsea and Waterfront truck-flow analyses clearly indicated roadways appropriate for CUFC designation in those areas. Review of earlier pilot studies and consideration of the need for alternate HC routes informed the final set of core area CUFCs that were recommended to MassDOT.

After the CUFC system was finalized, subsequent freight program studies have examined other CUFC sections in detail. A key link for HC vehicles to get around the HC-restricted tunnel system is where Route 99 crosses the Mystic River between Everett and Charlestown.[4] This CUFC section and its key connections were studied in 2019. Selected nighttime counts were also undertaken as part of this study.

South Boston Bypass Road was built in the 1990s as a commercial-vehicle-only facility to support construction of the Ted Williams Tunnel, and today it connects the I-93 Southeast Expressway with industrial and commercial activities in the South Boston Waterfront area. Traffic flow issues where these two NHFN facilities meet were studied in 2020.[5] This is the only core area location where HC vehicles have been counted directly on the main barrels of a limited-access highway.

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[2] Boston Region Metropolitan Organization (website), *Freight Planning Support, FFY 2014: Improving Truck Travel in the Everett-Chelsea Industrial Area,* January 2016. Accessed 24 February 2021. https://www.bostonmpo.org/truck-travel-everett-chelsea

[3] Boston Region Metropolitan Organization (website), *Trucks in the South Boston Waterfront*, April 2017. Accessed 24 February 2021. https://www.bostonmpo.org/trucks-south-boston-waterfront

[4] Boston Region Metropolitan Organization (website), *Review of Critical Urban Freight Corridors: Crossing Mystic River*, October 2019. Accessed 24 February 2021. https://www.bostonmpo.org/freight-corridors-mystic

[5] Boston Region Metropolitan Organization (website), *Trucks at the Southampton Street Bottleneck,* December 2020. Accessed 24 February 2021. https://www.bostonmpo.org/trucks-southampton-street

Truck counts with HC vehicles broken out have also been performed in Allston and Braintree in support of other planning studies. Similar counts in support of regional travel demand model development were also undertaken on Route 2 near Alewife Station and on the complex of ramps entering and exiting I-90 at Interchange 17 in Newton Corner.

2.2 Core Area Hazardous Cargo Volumes

Depicting Hazardous Cargo Volumes

Figure 6 shows selected HC vehicle counts graphically on a map similar to the map in Figure 5. The limited-access highways that have tunnel segments prohibiting HC (the red corridors in Figure 4) have been completely removed from Figure 6. This is the core area roadway network available to a driver of a HC placarded truck. The above-ground Rose Kennedy Greenway, available to HC vehicles in certain circumstances, is shown snaking through downtown Boston.

The vehicle flows on these roadways are all two-way, which sometimes requires combining reciprocal one-way flows from two separate express highway ramps. The schematic format of Figure 6 indicates the general location of these vehicle flows rather than specific ramps. For example, consider the 80 HC vehicles on US 1 in Chelsea. HC vehicles are not allowed south of this point and these 80 vehicles are either traveling southbound and exiting at Carter Street or entering northbound US 1 from the nearby 6th Street on-ramp. The connection from US 1 shown for this location happens to approximate Carter Street and, for purposes of graphic simplicity, 6th Street is not shown.

Details about the traffic volumes shown in Figure 6 are provided in Table 1. Table 1 lists the locations of the 29 HC count locations in descending order based on the total number of HC trucks observed at each location. Table 1 also provides the breakdown between semi-trailer and single-unit vehicles for those locations where this distinction was observed. All the counts were conducted during the daytime between 6:00 AM and 6:00 PM.

Table 2 shows core area HC vehicles counts on minor roadways that are not shown in Figure 6. Table 3 shows results from counts at several locations outside of the urban core. All the HC data developed in the studies mentioned above are summarized in these three tables.

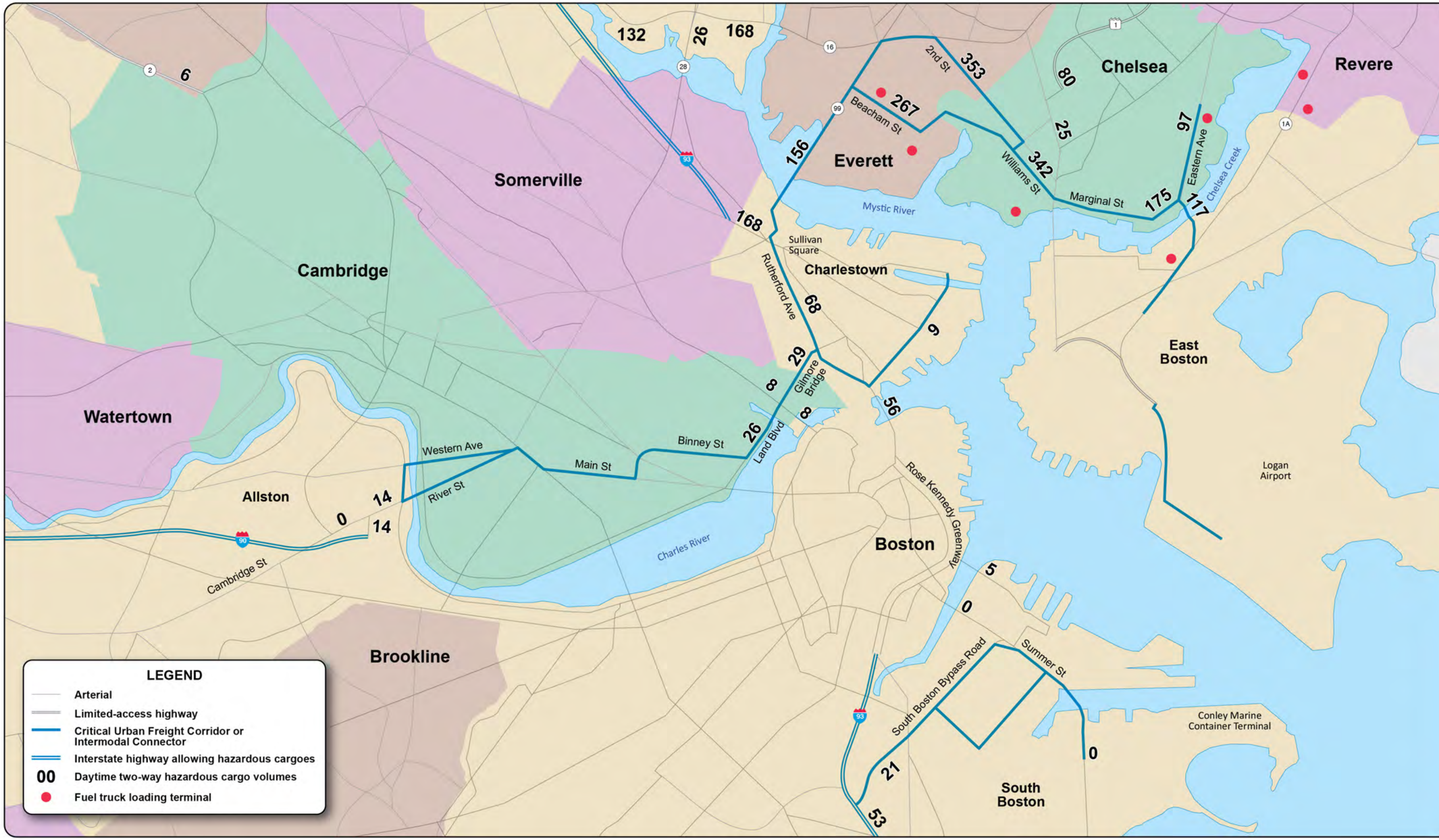

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Figure 6
Daytime Two-Way Hazardous Cargo Volumes

Freight Planning Support: Federal Fiscal Year 2021

Table 1
Two-Way HC-Placarded Vehicle Counts Appearing in Figure 6
Daytime (6:00 AM to 6:00 PM)

Area	Location	Total HC	Semi-Trailer	Single-Unit
Everett	Second Street at Route 16	353	262	91
Chelsea	Williams Street under Tobin Bridge approach	342	230	112
Everett	Beacham Street at Route 99	267	247	20
Chelsea	Marginal Street	175	137	38
Medford	Route 16 east of Route 28	168	96	72
Charlestown	Sullivan Square: Maffa/Mystic connecting roads	168	144	24
Charlestown	Route 99 over Mystic River	156	114	42
Medford	Route 16 west of Route 28	132	82	50
Chelsea	Chelsea Creek Bridge	117	88	29
Chelsea	Eastern Avenue	97	69	28
Chelsea	US 1 at Carter Street/6th Street ramps	80	68	12
Charlestown	Rutherford Avenue north of Gilmore Bridge	68	17	51
Charlestown	Charlestown Bridge	56	15	41
S. Boston	I-93 south of Southampton Street ramp	53	na	na
Cambridge	Gilmore Bridge	31	10	21
Cambridge	Land Boulevard at O'Brien Highway	26	10	16
Medford	Route 28 south of Route 16	26	8	18
Chelsea	Everett Avenue under Tobin Bridge approach	25	4	21
S. Boston	South Boston Bypass Road	21	0	21
Allston	Cambridge Street west of Soldiers' Field Road	14	8	6
Allston	I-90 ramps to/from Cambridge Street	14	8	6
Charlestown	Chelsea Street	9	1	8
Cambridge	O'Brien Highway at Gilmore Bridge	8	0	8
Cambridge	Charles River Dam	8	0	8
Cambridge	Route 2 west of Alewife	6	4	2
S. Boston	Seaport Boulevard at Fort Point Channel	5	na	na
Allston	Cambridge Street west of I-90 ramps	0	0	0
S. Boston	Summer Street at Fort Point Channel	0	0	0
S. Boston	Summer Street at First Street	0	0	0

HC = hazardous cargo. na = not available.
Source: Central Transportation Planning Staff.

Table 2
Other Core Area HC-Placarded Vehicle Counts Not Shown in Figure 6
Daytime (6:00 AM to 6:00 PM)

Area	Location	Total HC	Semi-Trailer	Single-Unit
Everett	Vine Street at Route 16	15	0	15
Chelsea	Arlington Street at 6th Street	4	2	2
Chelsea	Second Street at Tobin Bridge	6	0	6
Chelsea	Central Avenue at Eastern Avenue	3	0	3
Everett	Vale Street at Route 16	3	0	3
Everett	Boston Street at Route 16	3	0	3
S. Boston	Congress Street and Fort Point Channel	2	na	na
S. Boston	A Street at West Second Street	2	na	na
S. Boston	West Second Street at A Street	2	na	na
Everett	Spring Street at Route 16	0	0	0
Everett	Everett Avenue at Route 16	0	0	0
Chelsea	Carter Street under US 1 viaduct	0	0	0
Chelsea	Spruce Street at 6th Street	0	0	0

HC = hazardous cargo. na = not available.
Source: Central Transportation Planning Staff.

Table 3
Non-Core Area Daytime HC-Placarded Vehicle Counts

Area	Location	Total HC	Semi-Trailer	Single-Unit
Stoneham	I-93 at Medford city line	352	na	na
Braintree	Union Street east of Route 3	111	na	na
Newton	Newton Corner ramps to/from I-90 west	20	4	16
Newton	Newton Corner ramps to/from I-90 east	0	0	0

HC = hazardous cargo. na = not available.
Source: Central Transportation Planning Staff.

Hazardous Cargo Trip Generation

If vehicle classification information is not available, trucks are sometimes assumed to be some percent of total traffic for purposes of simulating traffic flow. This can be a reasonable modeling assumption because warehouses, manufacturers, and their suppliers and customers are scattered throughout the region. Trucks and their travel paths will cover the region, though more densely in some parts of the network than others.

This is not the situation for HC trucks. Customers, whether residential, commercial, or industrial, may be scattered throughout the region. However, trip tours serving these customers will probably begin at one of a handful of large fuel terminals. Because almost all HC tours begin at a key regional terminal, the greatest concentration of HC vehicles will be in the vicinity of an origin terminal. As one looks at traffic farther away from the origin terminal, the numbers of HC vehicles will be fewer. Throughout most of the Boston region, HC vehicles represent a very small amount of traffic.

In other parts of the US there are pipelines for refined petroleum products that connect refineries with markets. In the Boston area, however, the various grades of gasoline, diesel fuel, aviation fuel, and heating oil arrive by ship. There are terminals in Everett, Chelsea, East Boston, and Revere with wharves on the Mystic River and Chelsea Creek. There is also a wharf for liquefied natural gas (LNG) on the Mystic River in Everett. Ethanol, a corn-based gasoline additive, is also delivered by barge at the petroleum terminals and then blended into gasoline. Locations of fuel truck loading points are highlighted in Figure 6.

Most of the aviation fuel is stored in the port area and moved to Logan Airport by pipeline. Most LNG arriving by ship is returned to a gas state and enters the regional gas pipeline distribution system. Heating oil, diesel fuel, and gasoline are also stored in the port area and distributed to customers throughout the region by truck.

Figure 7 shows HC vehicles at port-area terminals taking on liquid cargoes at industry characteristic loading racks. The first photo shows semi-trailers being loaded with either gasoline or diesel fuel. The closer loading rack lanes in this photo are used to load heating oil. The second photo shows a single-unit tank truck being loaded with heating oil as indicated by the sign above the lane. Note that the driver stands atop the tank to operate the filling pipe. Most HC vehicle tours begin at terminals similar to these.

Figure 7
Petroleum Products Terminals and Loading Racks

Source: Central Transportation Planning Staff.

Core Area Hazardous Cargo Trip Flows: Magnitudes

The HC vehicle data in Figure 6 illustrates the significance of the port-area fuel terminals. The HC vehicle counts undertaken in earlier studies showed that the roadways in the Everett and Chelsea industrial areas have by far the greatest number of HC trips. The large HC volumes shown on Second Street and Beacham Street include trucks from seven marine fuel terminals in the port area.

At the western end of the northern CUFC system, only 14 HC vehicles were observed entering or leaving I-90. All of these vehicles were using Cambridge Street to connect with the River Street/Western Avenue one-way pair in Cambridge. These vehicles may have traveled all the way from the port area or may have come from the port area and made an intermediate stop, or may have traveled to or from some location unassociated with the port.

A value of zero appears on Cambridge Street west of the I-90 ramps. Despite their importance in formulating roadway policy, the numbers of HC vehicles are comparatively small, and it is entirely possible that no HC vehicles might be observed as part of an otherwise thorough truck analysis. Small numbers are commonplace when studying HC traffic.

These two estimates, zero and fourteen, were derived by counting for six hours: 1½ hours between 6:00 AM and 9:00 AM, 1½ hours between 9:00 AM and noon, 1½ hours between noon and 3:00 PM, and 1½ hours between 3:00 PM and 6:00 PM. Seven HC vehicles were observed accessing I-90 during these six hours, and none were observed traveling only on Cambridge Street. Multiplying the six-hour counts by two gives the 12-hour daytime estimates of 14 and zero shown in Figure 6.

All the HC count locations in Table 1 are roadways classed as arterial or higher, many of which are part of the NHFN. No HC vehicles were observed on the CUFC Summer Street in South Boston. But this roadway was designated a CUFC because it is used by large numbers of trucks that do not carry hazardous cargo, notably trucks hauling ocean-shipping containers to and from the nearby Conley Marine Container Terminal.

Roadways classed lower than arterial were counted as part of the Everett-Chelsea and South Boston Waterfront cordon-based studies, and HC volumes from these counts are summarized in Table 2. Another notable zero HC value is seen in Table 3. A study of trucks at interchange 17 at Newton Corner outside the map area found no HC vehicles entering or leaving I-90 to or from the east.

Core Area Hazardous Cargo Trip Flows: The Port Area

There are three locations where fuel trucks can be loaded near the northern reaches of Chelsea Creek: one on Eastern Avenue in Chelsea, and two on Route 1A in Revere. Some trucks travel on Eastern Avenue or Route 1A to or from the north to serve their customers, but many reach their customers on a travel path that extends west through Everett.

Figure 6 shows 97 HC vehicles on Eastern Avenue, most of which began or ended a trip at the fuel terminal and traveled on Marginal Street. Similarly, most of the 117 HC vehicles that crossed Chelsea Creek began or ended a trip at one of the fuel terminals in East Boston or Revere. Most of these trucks also traveled on Marginal Street, which at this location was used by 175 HC vehicles during the 12 daytime hours.

Marginal Street becomes Williams Street and 342 HC vehicles were counted at the point where Williams Street passes under the US 1 Tobin Bridge approach. There are two fuel terminals on lower Chelsea Creek generating HC trips and these account for much of the increased HC volume seen under Tobin Bridge.

There are two more fuel terminals in Everett supplied from the Mystic River waterfront. Altogether, at the time of the Everett-Chelsea study in 2015 the port area terminals generated about 620 HC trips that reached their markets via Beacham and Second Streets. While this area represents the largest single concentration of HC vehicles in the region, HC vehicles only represented 13 percent of total trucks in this area. Indeed, these streets were designated as CUFCs because of large total truck volumes, especially trucks carrying food products.

Core Area Hazardous Cargo Trip Flows: CUFCs in the Distribution System

The northern part of the CUFC system appears in Figure 6 as a path connecting Chelsea Creek at its eastern end to the Allston I-90 ramps in the west. These interconnected sections of roadway all share special standing for federal highway funding, but they do not really function as a path. The hundreds of HC vehicles on the roadways in the port area serve customers throughout the region and connect with Route 16, US 1, I-93, or any suitable arterial or express highway that will get them to their customer.

The largest HC vehicle flow in Figure 6 is represented by the 353 trucks seen on Second Street in Everett. All these vehicles were turning to or from Route 16 to the west, the CUFC segment. Some of these trucks may have been following the

CUFC on Route 99, but more were using Route 16 to serve points farther west or north.

The 267 trucks serving fuel terminals near Beacham Street used the Route 99 CUFC in both directions. At the time of the Everett-Chelsea study the intersection of Beacham Street and Route 99 was very problematic for large vehicles. The intersection was reconstructed in 2019 with larger clearances, and preliminary truck counts show that some truck traffic in this area has shifted from Second Street to Beacham Street.

Two key paths that leave the port area are Routes 16 and 99. Figure 6 shows 168 HC vehicles on Route 16 and 156 on Route 99 west of the port area. Together, these 324 HC vehicles are greatly exceeded by the 620 that were counted in 2015 coming out of Beacham and Second Streets, vehicles flows that could be expected to be similar. Breaking these numbers into the semi-trailer and single-unit components shows that the single-unit flows are roughly in balance and that the higher 2015 counts result primarily from semi-trailers carrying gasoline or diesel fuel.

The counts on Route 16 and at Chelsea Creek were done in 2021 and reflect the traffic reduction during the COVID-19 pandemic and associated reduction in fuel use. Another cause of this imbalance is that some trucks connecting with Route 99 at the expanded intersection with Beacham Street are using Route 16 to travel to or from points to the east. HC vehicles traveling in this direction were not counted extensively for this study, but limited recent counts suggest that there might be 70 daytime HC vehicles using this path.

Route 99 meets Rutherford Avenue at Sullivan Square, an important local nexus. Trucks can travel on the Rutherford Avenue CUFC section, travel in Somerville, or connect conveniently with I-93. Most of the 168 daytime HC vehicles that entered or exited Sullivan Square from the north connected with Route 99. South of Sullivan Square, HC vehicles continued to disperse with 56 traveling in downtown Boston, 29 traveling in Cambridge on Gilmore Bridge, and 26 on Land Boulevard in Cambridge.

Fewer HC vehicles were observed on roadways south of Boston Harbor. All trucks were counted on the main barrels of I-93 just south of the ramps that connect with South Boston Bypass Road, and 53 of these had visible HC placards. There are several opportunities at this point for HC vehicles to exit prior to entering the underground section of I-93 in downtown Boston, and South Boston Bypass Road was used by 21 of the HC vehicles.

The fewer number of HC vehicles south of Boston Harbor reflects the more modest needs of local distribution absent the presence of a major fuel terminal. HC vehicles serving multiple customers may be accessing the South Boston Waterfront area via any of several routes, but the origins of an HC vehicle tour will be one of the major fuel terminals.

Hazardous Cargo Trip Flows Outside the Core Area

In addition to the core area terminals described above, there is a major fuel terminal in Braintree on the Fore River. HC trips originating at this terminal access the regional express highway system via Union Street at Route 3. Table 3 shows 111 daytime HC vehicles at this location. Vehicles serving this terminal disperse through the region in the same manner as trucks from the Mystic River and Chelsea Creek terminals.

Table 3 shows 352 HC vehicles using I-93 at the Stoneham-Medford line north of the core area. This flow would include many of the 353 HC vehicles connecting between Second Street in Everett and Route 16, and also many of the 168 HC vehicles traveling between Sullivan Square and the north.

The 352 HC vehicles on I-93 contrasts with the six HC vehicles observed on Route 2 shown in Figure 6 at the western edge of Cambridge. I-93 north of Boston is a key regional access corridor for the port area, but the few HC vehicles observed on Route 2 are probably serving nearby customers. The limited-access section of Route 2 connects only with surface arterial roadways, some of which have general truck restrictions.

The I-90 ramps at Newton Corner were also counted. There were combined flows of 20 daytime HC vehicles at this location, as shown in Table 3. None of the 14 HC vehicles that accessed I-90 at Allston (as shown in Figure 6) used either of the Newton Corner ramps, so the total I-90 HC volume west of Newton Corner can be assumed to be about 34 vehicles, the sum of the two I-90 access flows.

Rose Kennedy Greenway Time-of-Day Restriction

Figure 6 shows that 56 HC vehicles cross the Charlestown Bridge during a typical 12-hour weekday daytime period. This number needs to be understood in the context of an HC time-of-day restriction, which applies to the Charlestown Bridge and the Rose Kennedy Greenway surface arterial system.

During the 14 hours beginning at 6:00 AM and ending at 8:00 PM, an HC-placarded vehicle may only use the Charlestown Bridge if its primary destination is in the city of Boston. During the 10 nighttime hours starting at 8:00 PM and ending at 6:00 AM there are no restrictions. The 56 HC vehicles were counted during the 12-hour 6:00 AM to 6:00 PM period, throughout which the time-or-day restriction is in force.

Of the 56 daytime HC vehicles, 15 were semi-trailers, which typically supply gasoline stations. The other 41 were single-unit trucks, which typically serve residences or construction sites. All 56 of these placarded trucks are assumed to have destinations in Boston.

To better understand the implications of the time-restriction policy, several nighttime counts were performed at the Charlestown Bridge. A total of 60 HC vehicles were counted crossing the Charlestown Bridge during the 12-hour period between 6:00 PM and 6:00 AM, almost all of which were during the 10-hour unrestricted period that begins at 8:00 PM. Usually, few trucks, regardless of cargo type, are seen during and shortly after the 3:00 PM to 6:00 PM evening peak period.

Of the 60 nighttime HC vehicles, 51 were semi-trailers and only nine were single-unit trucks, a reverse of the daytime size composition. The 51 HC semi-trailers counted on Charlestown Bridge during the unrestricted nighttime period were either passing through the downtown area and rejoining I-93 in the South Bay area, or they might have made a delivery at a Boston location where a late nighttime window was convenient for both the shipper and receiver. Most of the nine single-unit trucks crossing Charlestown Bridge during the unrestricted nighttime period were seen between 5:00 AM and 6:00 AM, a typical travel period for early customer deliveries.

It is only possible to speculate about the number of trucks that would use Charlestown Bridge during daytime hours if there were no time-of-day restriction. Truck dispatchers can work around the prohibition by either changing the trip schedule so that trucks travel at night or by specifying a different, unrestricted route. Some of the operators of the 60 HC vehicles counted at night would presumably choose to travel during daytime if allowed. Some of the 352 daytime HC trucks on I-93 in Stoneham (shown in Table 3) or the 31 HC trucks on Gilmore Bridge (shown in Figure 6) may have been using an unrestricted route in lieu of using the restricted Charlestown Bridge and Rose Kennedy Greenway.

Hazardous Cargo and Total Trucks as Percentages of Total Daytime Traffic

Developing useful comparisons of HC traffic between different roadways is difficult for three reasons:

- In-person counting is required to see HC placards.
- Both HC and other truck traffic is strong during midday periods, and extended counting efforts are necessary to understand truck flows.
- Many traffic studies focus on AM and PM peak hours, and the collection of midday traffic classification data is not always a priority.

Weekday traffic data that could be used to form useful truck traffic comparisons between Boston-area roadways were able to be developed for four locations noted in Table 1 and one location in Table 3. These data are summarized in Table 4 and include for the 12-hour daytime period total two-way traffic, total trucks (six or more wheels), and total trucks with HC placards.

The roadways listed in Table 4 are arranged in descending order of total vehicle volumes. The location with the second highest volume is I-93 in Stoneham north of the area depicted in Figure 6, and its HC count is from Table 3. The other four locations appear in Figure 6 and their HC counts are from Table 1. The total volumes in Table 4 vary widely as the list includes interstate highways and arterial streets.

Table 5 shows the percentages of total traffic that are trucks and HC vehicles. The percentages of total trucks for this small sample fall within a relatively narrow range: 4.0 percent for I-93 in South Boston to 6.7 percent for Route 99 crossing the Mystic River. As mentioned above, without any other truck information, a percentage similar to one of these might serve as a reasonable default value for simulating AM peak-hour traffic. For PM peak-hour traffic the assumed truck percent should be a couple percentage points lower.

The HC vehicle percentages in Table 5 are much smaller than the truck percentages but vary much more between locations. The lowest value is 0.03 percent on I-93 in South Boston, and the largest is 0.58 percent on Route 99 over the Mystic River.

The structure of the HC roadway network explains this wide range. As noted above, Route 99 is part of the closest route across the harbor that HC vehicles serving the port area fuel terminals are permitted to use. In contrast, the operators of the HC vehicles on I-93 in South Boston are aware that route options using I-93 and its connection with the Rose Kennedy Greenway are limited, and many will find paths on other routes. This section of I-93 being among the busiest highways in New England also keeps the HC percentage low.

Table 4
Total Traffic, Trucks, and Hazardous Cargoes
Daytime (6:00 AM to 6:00 PM)

Area	Location	All Vehicles	Trucks	HC
S. Boston	I-93 south of Southampton Street ramp	154,600	6,200	53
Stoneham	I-93 at Medford city line	130,700	7,500	352
Chelsea	US 1 at Carter Street/6th Street ramps	64,700	3,300	80
Charlestown	Rutherford Avenue north of Gilmore Bridge	35,900	2,100	68
Charlestown	Route 99 over Mystic River	26,900	1,800	156

HC = hazardous cargo.
Source: Central Transportation Planning Staff.

Table 5
Percent of Daytime Traffic that is Trucks or Hazardous Cargoes
Daytime (6:00 AM to 6:00 PM)

Area	Location	Percent Trucks	Percent HC
S. Boston	I-93 south of Southampton Street ramp	4.0	0.03
Stoneham	I-93 at Medford city line	5.7	0.27
Chelsea	US 1 at Carter Street/6th Street ramps	5.1	0.12
Charlestown	Rutherford Avenue north of Gilmore Bridge	5.8	0.19
Charlestown	Route 99 over Mystic River	6.7	0.58

HC = hazardous cargo.
Source: Central Transportation Planning Staff.

The 0.12 percent of HC vehicles seen on US 1 in Chelsea reflects two influences. HC is not allowed on the Tobin Bridge, so US 1 will not attract any HC through traffic. It is, however, a convenient point for fuel trucks using the port area terminals to reach north shore communities.

The I-93 sections in South Boston and Stoneham have similar amounts of total traffic, but the HC percentages differ greatly: 0.03 percent in South Boston compared with 0.27 percent in Stoneham. As noted above, I-93 north of Boston provides a convenient route for fuel deliveries originating at the port area terminals.

The 68 HC vehicles on Rutherford Avenue north of Gilmore bridge represent 0.19 percent of total daytime traffic. The 56 trucks on Charlestown Bridge were 0.27 percent of total traffic. This value is not shown in Table 5 because it would certainly be higher if there were no HC restrictions. The 60 nighttime HC vehicles on Charlestown Bridge are a relatively high 0.39 percent of total traffic, reflecting the lower general traffic levels at night.

3 IMPLICATIONS FOR TRANSPORTATION PLANNING

HC Vehicles in the Travel Demand Model

The extreme range of HC vehicle percentages shown in Table 5 suggests that percent of total traffic or even percent of total truck traffic, will not be a reliable basis for estimating HC vehicles on roadways in the travel demand model. Admittedly, most of the HC vehicle counts presented in this memo are in some manner influenced by proximity to fuel terminals or HC prohibitions on roadways. Farther from the core area, there might be a more limited range of percentages and an average HC percentage for the suburban arterials that largely comprise the regional travel demand model might, with considerable effort, be estimated.

The analysis in this study suggests that a reasonable approximation of HC travel patterns might be developed by focusing on the actual numbers of HC vehicles observed at different places in the network at different times. Some characteristics of these travel patterns are already known and are supported by the field data presented in this study:

- Most HC trips tours begin at several major fuel terminal areas.
- HC vehicle operators respect the core area HC restrictions.
- HC vehicle counts diminish farther from the fuel terminals.
- Many regional roadways have very few HC vehicles.

Even though HC data is difficult to develop because of the need for counters to see the placards, the factors listed above suggest that estimating a useful HC component of the regional travel demand model might be feasible.

The importance of small numbers of HC vehicles is even more pronounced than suggested by Figure 6. Single-unit and semi-trailer HC vehicles are modeled separately because they have different impacts on traffic performance. Fortunately, they mostly serve different HC travel markets. They begin at the same major terminals, but the single-unit trucks make numerous customer deliveries. A semi-trailer tank truck may deliver a major portion of its contents to a single customer.

The numbers by HC vehicle size shown in Tables 1, 2, and 3 are further subdivided into six distinct vehicle flows: three in one direction by time period and three in the other direction by time period. The travel demand model time periods are as follows:

- AM peak between 6:00 AM and 9:00 AM
- Midday between 9:00 AM and 3:00 PM
- PM peak between 3:00 PM and 6:00 PM
- Nighttime between 6:00 PM and 6:00 AM

The daytime data in this study are available for the first three modeling time periods. Nighttime HC data has only been collected for Charlestown Bridge.

The HC traffic data organized for this study were gathered at a limited number of locations that were of specific interest for the study of truck travel or traffic congestion. With respect to the Boston Region MPO regional travel demand model's geographical extent, this sample is quite limited. It does, however, present a coherent picture of HC traffic and illustrates the explanatory power and potential value for model estimation of carefully acquired vehicle classification data.

Public Policy

Given that HC vehicles traveling throughout most of the region represents a small number of vehicles both in absolute numbers and as a percent of total traffic, it is reasonable to ask why these vehicles are modeled at all as separate classes. A practical example of this problem is the reliable data now available from tolling gantries on important regional limited-access highways. The gantries count heavy vehicles regardless of the presence of any HC placards. But, because there are so few HC vehicles, the gantry counts of all heavy vehicles can serve as acceptable approximations of the single-unit and semi-trailer truck classes even with the HC vehicles mixed in.

The seriousness of HC crashes is the reason that HC traffic is regulated differently than other heavy vehicles, but it is not necessarily a reason that these vehicles should be modeled separately. The prohibition of HC in tunnels makes perfect sense regardless of the number of HC vehicles that might use the tunnel if allowed. No counts, models, or industry surveys are required to formulate this policy.

Modeling HC vehicles as distinct groups with a reasonable level of accuracy makes sense for two reasons:

- Public officials and the public at large understandably have an elevated concern about this class of freight movements.
- The percentage of HC trucks among total traffic varies in a much wider range than the percentages of trucks carrying non-hazardous cargo.

Addressing public perceptions is important. It is very easy for concerns about trucks to be conflated with concerns about HC vehicles. If trucks are present on a surface roadway, HC vehicles will also be present. Counts and models cannot erase these concerns, but they can provide important context. Ultimately, most of the fuels delivered by these trucks will end up in the family car or in the home heating oil tank. The question is what is involved in getting it there.

The variation in HC traffic percentages results largely from the importance of the major fuel terminals. With numerous terminals and destinations, trucks carrying non-hazardous cargo appear statistically to be going everywhere. Measuring and modeling how the numbers of HC vehicles dissipate at greater distances from the terminals can clearly distinguish the transportation of these commodities from the much larger number of trucks carrying non-hazardous cargo.

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