CAMBRIDGE SYSTEMATICS

Massachusetts Freight Plan

TECHNICAL MEMORANDUM #1

Background Review

prepared for

Massachusetts Department of Transportation

prepared by

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with

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December 2016

technical memorandum

BACKGROUND REVIEW

prepared for

Massachusetts Department of Transportation

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Think Forward

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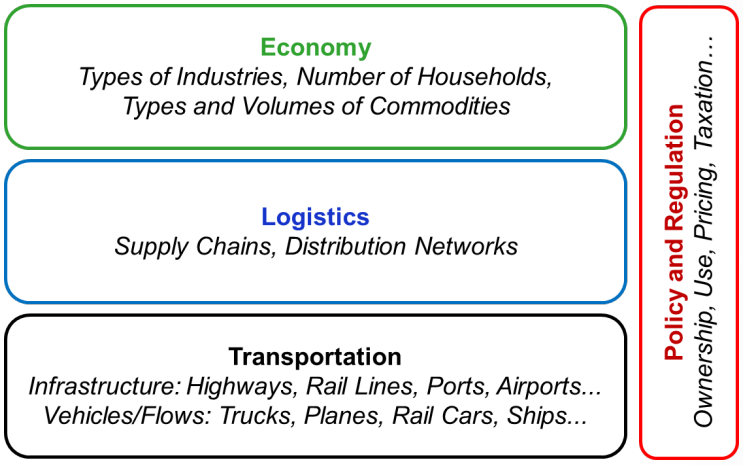
The objective of this memorandum is to synthesize the recent freight-related studies and reports at the State, regional, national, and international level into freight issues, trends, and common themes as a foundation for the *Massachusetts Statewide Freight Plan*.

Introduction

Planning for freight requires understanding how the economy, logistics, transportation, and policy and regulation interact to support economic development at multiple levels. Figure 1 illustrates the core of each of these elements.

FIGURE 1 THE STRUCTURE OF THE FREIGHT SYSTEM



Source: Cambridge Systematics, Inc.

To build this understanding, we reviewed more than 30 documents from other New England states, regional and federal agencies, and national and international think tanks and consultants. We worked to draw the essential elements from each of these documents, synthesize them, and summarize them.

The remainder of this memorandum describes the elements of the freight system in the following order:

- Section 2 describes the economy;
- Section 3 describes logistics;
- Section 4 describes transportation;
- Section 5 describes policy and regulation; and
- Section 6 summarizes the studies and makes recommendations for the *2017 Massachusetts Freight Plan*.
- Appendix A includes a summary of key points made in each document.

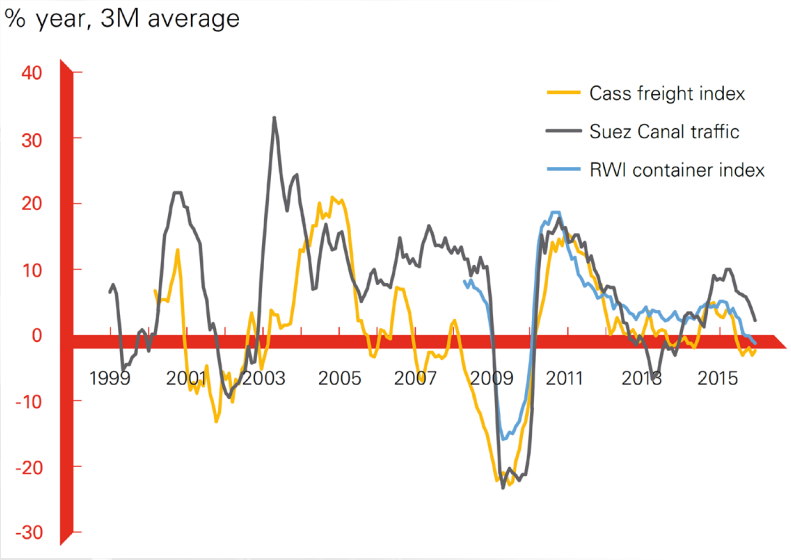
The Economy

Global Economy

(Adapted from HSBC Trade Forecast Global, 2015; EY Trading Places, 2011.)

World trade has recovered since the financial crisis in 2007. Figure 2 illustrates the steep decline in freight movements in the 2007 economic recession through the Cass freight index (an index that gauges cumulative freight volume and expenditures), Suez Canal traffic, and the Leibniz-Institut für Wirtschaftsforschung (RWI) container index (an index that shows the short-term trends in container shipping as an indicator of global trade). All three follow a similar trend: a steep decline in activity from 2007 through 2010, followed by the global recovery, and a gradual decline from 2011 through present day. The decline from 2011 is due to cyclical and structural changes. Cyclically, major world economies are expected to grow and the pace of investments are expected to increase gradually over the next few years. Structurally, the share of services in the global economy has been rising, which is not captured by the indicators. In addition, as global supply chains mature, trade will become more resilient to disruptions and can recover faster. So the medium- and long-term prospects for trade still are positive.

FIGURE 2 WORLDWIDE TRENDS IN FREIGHT INDICATORS



Source: Oxford Economics/Haver Analytics.

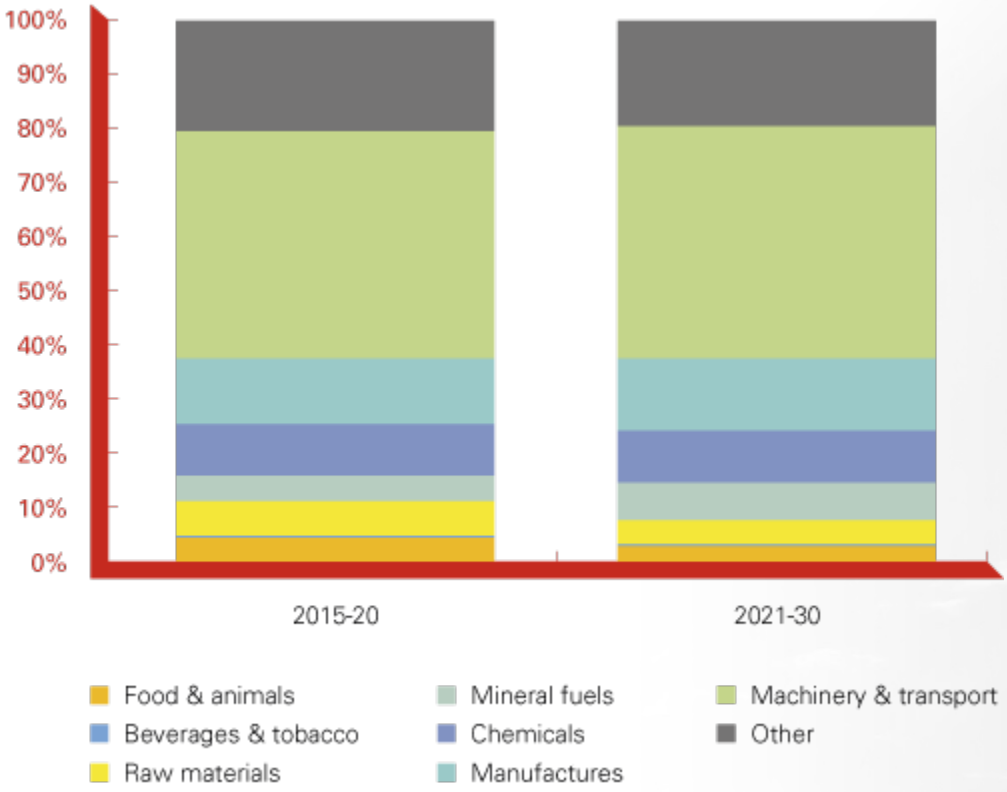
Cass freight index: An index that uses January 1990 as its base month to gauge cumulative freight shipments each month in terms of volume of shipment and expenditure of freight shipment. Cass Information System processes the index to indicate national shipping levels. It covers more than 400 company and manufacturer types and over 1,200 different divisions. (Cass Freight Index.)

Suez Canal traffic: Shows traffic through the Suez Canal.

Institute of Shipping Economics and Logistics/ Leibniz-Institut für Wirtschaftsforschung (ISL/RWI) container index: the container index shows short-term trends in international trade. Because containers have become the most important means of transporting processed products, global container throughput and international trade are highly correlated. (RWI/ISL-Container Throughput Index.) The index is based on data from over 60 ports covering around 60 percent of world container throughput.

From 2021 to 2030, Asia is expected to lead the growth in world merchandise exports, while US trade will grow by around six percent per year during the same time period. Figure 3 illustrates that the biggest contribution to this growth will be from **machinery and transport equipment sector** (i.e., industrial equipment, aerospace and defense, transport equipment excluding cars, household electrical appliances, and information and communication technology equipment) followed **by other manufactured goods** (i.e., textiles, lumber and wood, printing and packaging, rubber and plastics, medical and pharmaceutical, and other durable goods). This trend can be partly attributed to the strong demand for consumer and capital goods from the growing middle class in Asia.

FIGURE 3 SECTOR CONTRIBUTION TO GROWTH IN WORLD TRADE



Source: Oxford Economics.

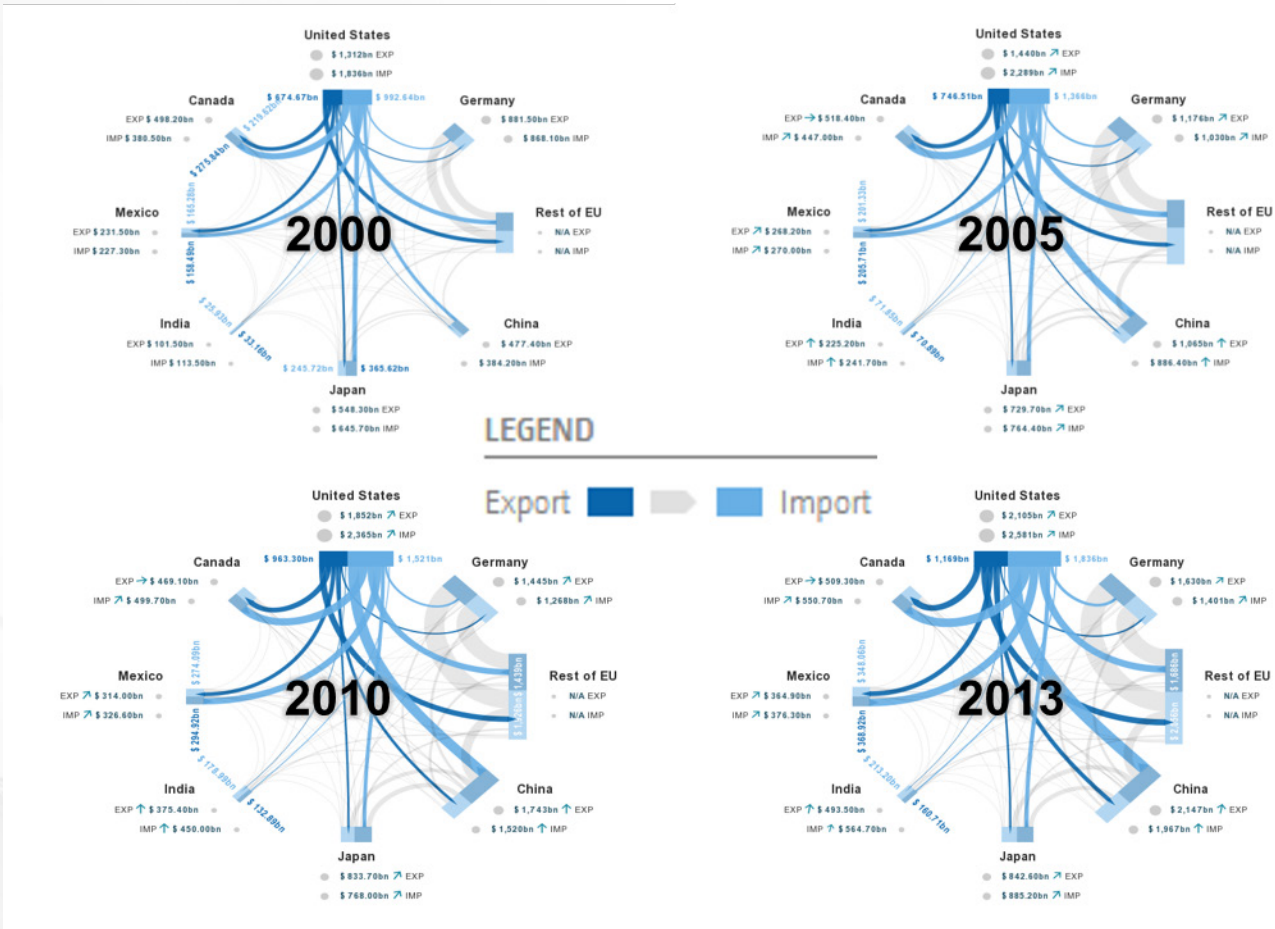
US Economy

US Trading Partners

(Adapted from HSBC Trade Forecast Global, 2015; EY Trading Places, 2011.)

Beyond traditionally established trade ties with neighboring countries (e.g. Canada and Mexico) and advanced economies (e.g., European Union), the trade volume with Asia will grow significantly, especially with China, India, and southeast Asian countries. China is and will remain the top source of imports to the US. It will surpass Mexico as the second largest export market of US in 2030. A trade flow chart for the US and its key partners is provided in Figure 4.

FIGURE 4 US TRADE FLOWS WITH KEY TRADING PARTNERS: TOTAL



Note: Exports/imports to/from countries in billion US$ (current prices); total exports/imports in billion US$ (constant prices, 2010).

Source: Visualization from iz.ged-project.de; data from UN Comtrade, OECD/European Commission.

US Exports and Imports

(Adapted from HSBC Trade Forecast US, 2015.)

Similar to the global trend, growth in US merchandise exports will be driven primarily by **machinery and transport equipment**, **other manufactured goods** (including medical equipment), and **chemicals** (including pharmaceuticals). These exports have seen steady growth in the past decade. Continuing investment in Research and Development (R&D) will enable the US to retain its competitive advantage in these high value-added products (e.g. high-technology and research-intensive goods).

In the US, the domestic demand is growing with slow yet steady gains in the labor market. The major drivers will be **industrial machinery and transport equipment** sector and **consumer goods** (e.g. household appliances, information and communication technology equipment, and apparel).

Figures 5 and 6 show how US trade with key trading partners of machinery and transport equipment (5) and chemicals (6) has grown over time.

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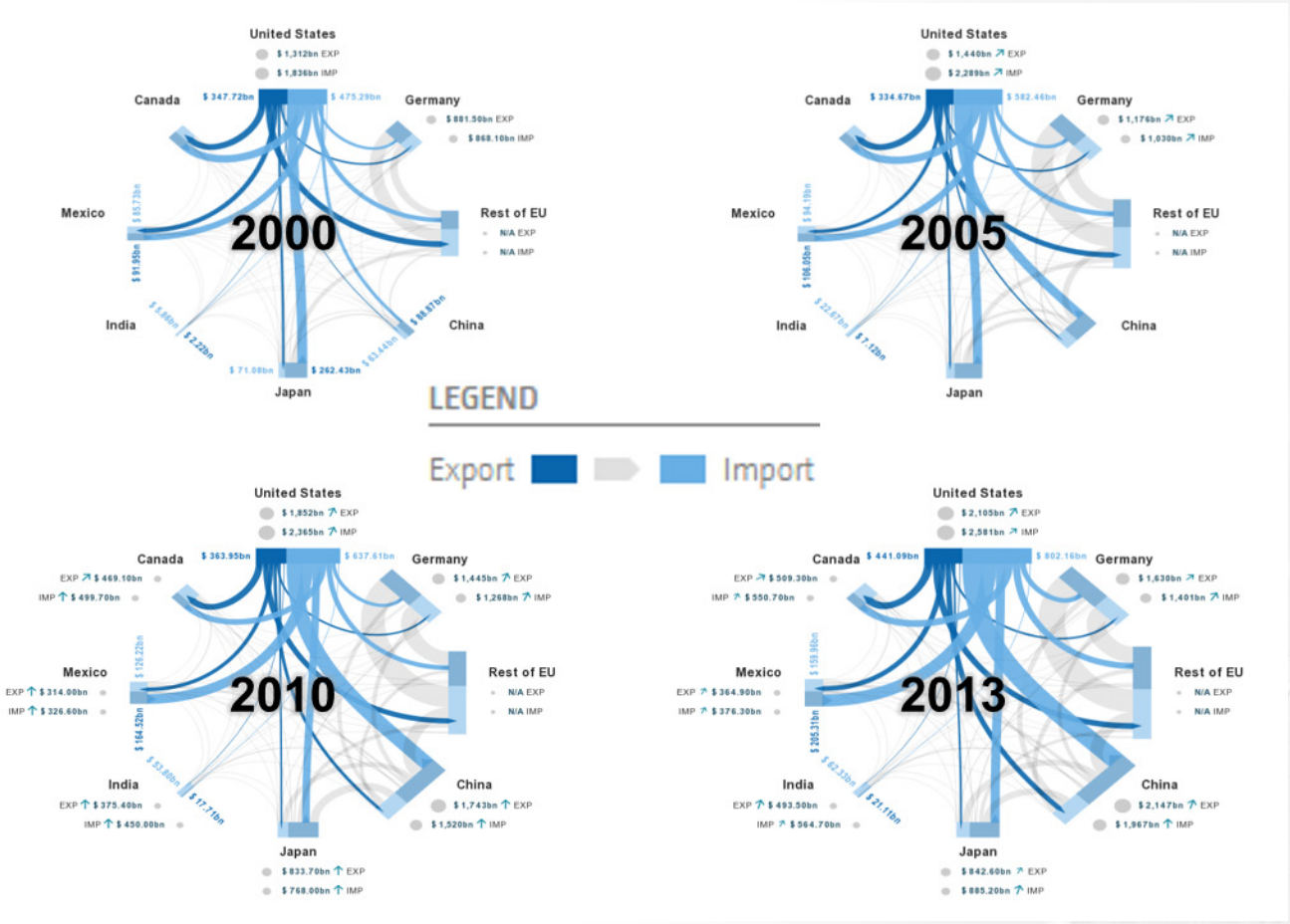
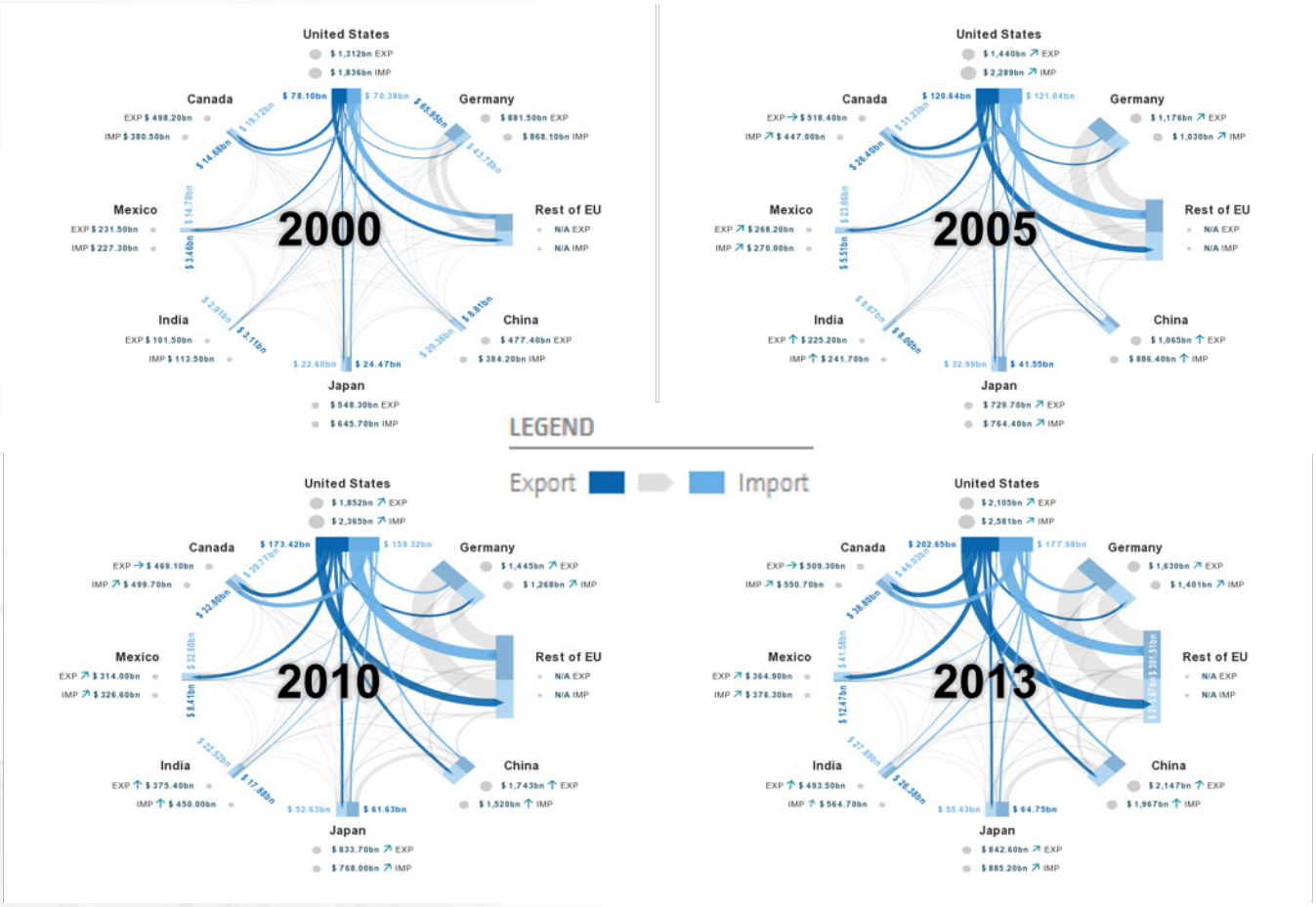
FIGURE 5 US TRADE FLOWS WITH KEY TRADING PARTNERS: MACHINERY AND TRANSPORT EQUIPMENT



Note: Exports/imports to/from countries in billion US$ (current prices); total exports/imports in billion US$ (constant prices, 2010).

Source: Visualization from iz.ged-project.de; data from UN Comtrade, OECD/European Commission.

FIGURE 6 US TRADE FLOWS WITH KEY TRADING PARTNERS: CHEMICALS



Note: Exports/imports to/from countries in billion US$ (current prices); total exports/imports in billion US$ (constant prices, 2010).

Source: Visualization from iz.ged-project.de; data from UN Comtrade, OECD/European Commission.

Regional and State Economy

Northeast Regional Economy

(Adapted from Northeast Rail Operations Study, 2007.)

For the Northeast region, like the entire country, the economy is shifting from manufacturing to a service and information economy, with the size of employment in service sector twice as large as manufacturing employment in 2004. As a result, the composition of freight and the logistics patterns have also changed. **Commodities are increasingly becoming low-weight and high-value and require just-in-time logistics practices. Trucks and air transportation are preferred for these commodities because they offer more flexibility and responsiveness.**

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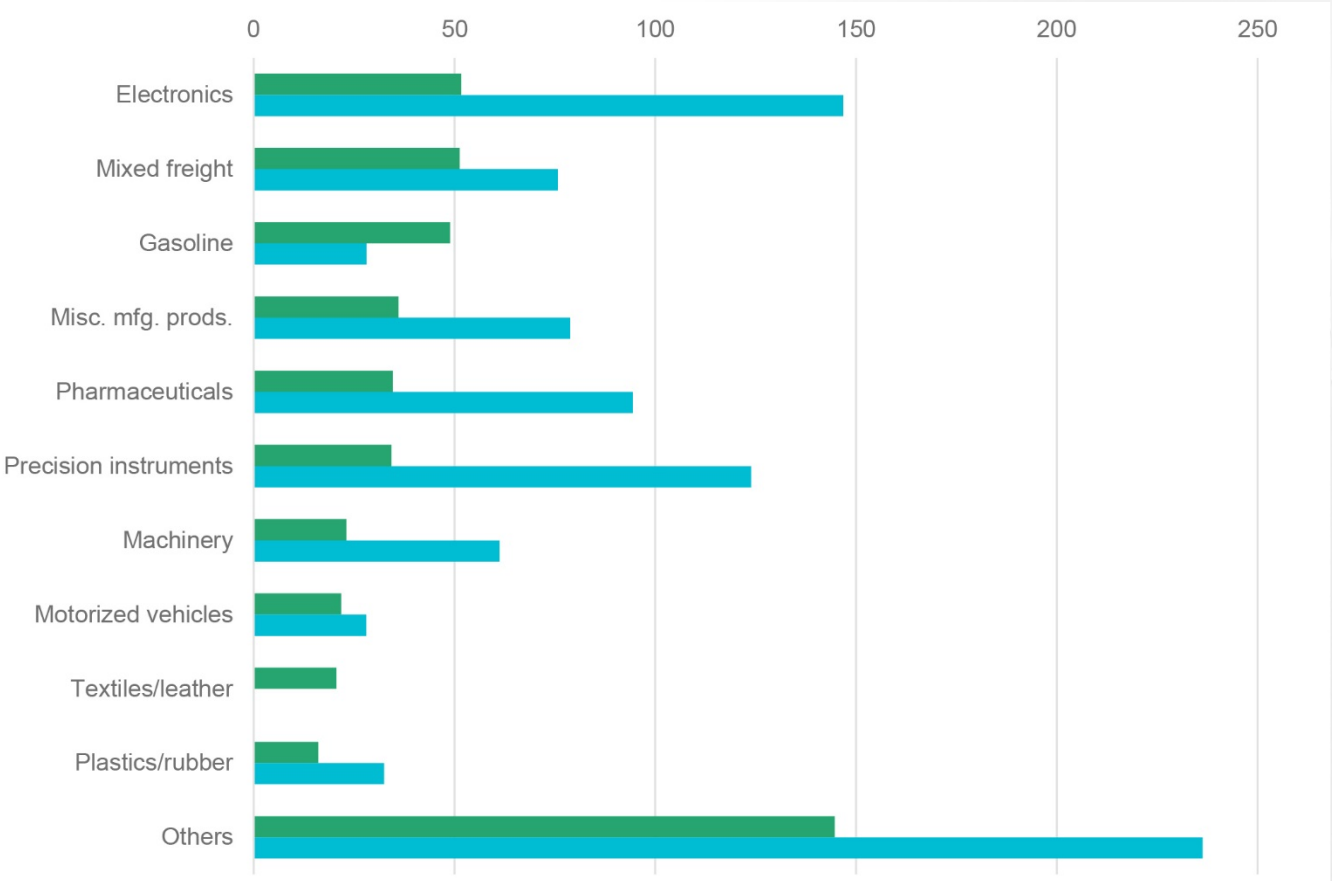
Massachusetts Economy

The Commonwealth mirrors the national and regional trend away from manufacturing towards a service economy. A manufacturing shift towards high-value, low-weight products is projected in the 2010 *Massachusetts Freight Plan*. In the most recent Federal Highway Administration (FHWA) Freight Analysis Framework (FAF) data, the highest value trade commodity from Massachusetts was electronics. Figure 7 illustrates the top commodities by value. Half of the top ten commodities by value are high value-added products, including those that drive national exports like machinery, pharmaceuticals, and motorized vehicles. In 2045, the proportion of high value-added commodities increases to more than 60 percent of top ten commodities by value.

FIGURE 7 TOP 10 MASSACHUSETTS COMMODITIES BY VALUE ($ BILLION)



	Others	Plastics/rubber	Textiles/leather	Motorized vehicles	Machinery	Precision instruments	Pharmaceuticals	Misc. mfg. prods.	Gasoline	Mixed freight	Electronics
2015 Value	144,656	16,070	20,583	21,820	23,097	34,264	34,628	36,074	48,917	51,249	51,701
2045 Value	236,326	32,463	0	27,970	61,248	123,879	94,372	78,740	28,086	75,749	146,783

Note: In 2045, Textiles/Leather is projected to rank 12th in terms of commodity value; Chemical Products will rank 10th (it is projected to grow by 116%), and Other Foodstuffs will rank 11th.

Source: Cambridge Systematics using Federal Highway Administration Freight Analysis Framework data.

The major industrial sectors in the state as documented in *Opportunities for All: The Baker-Polito Strategy and Plan for Making Massachusetts Great Everywhere* are listed below, of which many are aligned with the fastest growing sectors for global trade in the next decade. **Massachusetts is well positioned to benefit from the recovery in foreign demand and the expansion of US exports**.

- **Statewide clusters,** including established, emerging, and traditional clusters:
  - **Top established clusters statewide**: education, financial services, information technology, clean energy, tourism, and the life sciences.
  - **Emerging clusters**: digital health care, big data, autonomous vehicles, flexible electronics, and revolutionary fibers and textiles.
  - **Traditional industries**: transportation services, agriculture, retail, and restaurants.
- **Regional clusters**: aerospace in the Pioneer Valley, plastics in the Merrimack Valley and Berkshires, food production in Franklin County, digital health care in Springfield, and marine technology in the South Coast and on the North Shore.
- **Regional cluster development opportunities**: flexible electronics in Amherst and Lowell, nano-manufacturing, medical devices and robotics in Lowell, big data and cybersecurity in Amherst, digital health care and life science in Worcester and marine technology in Dartmouth.

Logistics

Potential Shifts back from Global to Regional Supply

(Adapted from MassDOT Freight Plan, 2010 and EY Trading Places, 2011.)

There has been a trend towards more international supply chains and vertical specialization due to the low costs of logistics and transportation and foreign manufacturing. However, as an optimal level of production efficiency is reached, there is likely to be a slowdown in the pace of the global outsourcing. In addition, some firms started to gauge the benefits and costs of outsourcing critical components or essential stages of production far away from home markets, especially following major disruptions in global supply chains due to events like the Tohoku earthquake in Japan in 2011. The need for certainty of the risk-averse firms in developed economies could drive a more regional focus on developing production capacity close to key regional markets. Further, **E-commerce will have a significant influence over the future shape of these supply chains.**

Massachusetts Logistics

Massachusetts' Position within Supply Chain

(Adapted from MassDOT Freight Plan, 2010.)

While there are some regional variations, Massachusetts produces many highly profitable products and sits relatively high in the value chain. The State thus needs to import energy products (e.g., petroleum and coal); intermediate goods (e.g., rubber, plastics, wood products, and metal products) that help turn commodities such as iron and steel into finished products like electronics and machinery; and food products to support local consumption. **More research is needed to study where each type of industries sources, makes, stages and sells materials, parts, and finished products.**

Massachusetts' Changing Logistics Patterns

(Adapted from Northeast Rail Operations Study, 2007, Ports of Massachusetts Strategic Plan, 2013, MassDOT Freight Plan, 2010.)

While the western regions of Massachusetts are still relatively more involved with traditional manufacturing, and thus require freight transportation to move bulk commodities, the shifts towards just-in-time manufacturing and supply chain logistics for service and time-sensitive industries, especially in the eastern regions, have raised the standards on travel time and reliability to a higher level and highlighted the importance of integrated multi-modal transportation infrastructure. **In particular, the *2017 Massachusetts Freight Plan* should pay special attention to access to air and freight ports.**

Trends for Air: International passenger aircraft belly freight has been identified in the 2010 *Massachusetts Freight Plan* as the fastest growing segment of the cargo market at Logan airport. FAF data also forecasts a substantial increase of modal share of freight (in value term) by air from 2015 to 2045 (as illustrated in Figure 8). **Air freight flows into and out of all Massachusetts airports should be reestablished for the *2017 Massachusetts Freight Plan*.**

FIGURE 8 AIR FREIGHT COMMODITY VALUE: 2015 VS. 2045

Source: Cambridge Systematics using Federal Highway Administration Freight Analysis Framework data.

Trends for Sea: As a result of congestion and bottlenecks at West Coast ports, international container ships are increasingly using all-water routes via Panama and Suez Canals to connect Asian-based manufacturers and exporters with major consumer markets on the US East Cost. The expansion of the Panama Canal allows larger vessels to pass, further boosting the trend. East Coast ports accessible to neo-panamax vessels (e.g., 10k – 14.5k twenty foot equivalent units (TEUs)) are listed in Figure 9.

With the expansion of the Panama Canal, Boston is becoming a port for larger vessels (e.g., 8-10k twenty foot equivalent units (TEU)). The modernization of Conley Terminal will enable the port to handle ships up to 12k TEUs. Even with these improvements, ensuring truck access to New York/New Jersey ports will remain critical as they are likely to remain the primary North Atlantic ports-of-call for many Asian as well as South American and African markets. Because of this, **the *2017 Massachusetts Freight Plan* should at least briefly discuss short-sea shipping as an alternative to trucking on the I-95 (M-95) corridor**.

FIGURE 9 STANDARD LARGE CONTAINER SHIPS ACCOMMODATED AT EAST COAST PORTS

Source: Adapted from Dr. Jean-Paul Rodrigue, Hofstra University. Note: Boston will be able to handle neo-panamax ships once the Conley Terminal upgrades and the Boston Harbor Deep Draft Navigation Improvement Project have been completed.

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Transportation

The *2010 Freight Plan* profiles the transportation infrastructure of the overall Massachusetts freight system. The *2010 Rail Plan* and the *2013 Ports of Massachusetts Strategic Plan* discuss specifically freight rail and seaports. The *2010 Airport System Plan* does not have much discussion on air freight.

Trucking and Highway System

The majority of freight in the state (as well as the region) travels by truck, thus an efficient and viable highway network is critical to the economical movement of goods. According to the *2010 Freight Plan* "Massachusetts currently has a 7,058-mile system of Interstate highways, state highways, and arterial roadways that connect all major cities and freight facilities. The highway system in eastern Massachusetts is focused on serving the Boston metropolitan area with two major east-west routes (I-90 and Route 2), three major routes from the north (I-95, I-93, and Route 3) and three major routes from the south (I-95, Route 3, and Route 24)." Massachusetts also has a network of supporting facilities (e.g. distribution centers, warehouses, truck terminals, etc.) located along major roadways that are close to but outside of the largest urban centers in Boston, Worcester, and Springfield areas.

Freight Rail System

Rail accounts for less than five percent of overall market share in the region, but is critical as it transports and distributes several major commodities, including transportation equipment, paper, and wood products. Machinery, including transportation equipment, is one of the fastest growing commodities in global trade. According to the *2010 Rail Plan*, about 40 percent of the rail network in Massachusetts is owned by the Massachusetts Bay Transit Authority (MBTA) and MassDOT. Also, about 40 percent of track is used for both freight and passenger operations. Ownership and operation of the Commonwealth's rail network is shared between private and public entities. **Because MassDOT has purchased several rail lines since the last *Freight Plan* and *Rail Plan*, the *2017 Massachusetts Freight Plan* should touch on the mechanisms by which MassDOT buys lines. It also should coordinate with the current *Rail Plan* to determine future freight rail trends in Massachusetts.**

Marine Transportation and Seaports

Massachusetts has five major seaports - Boston, Gloucester, Salem, New Bedford, and Fall River. Freight cargo volumes have decreased from 2007 to 2011 largely due to the economic recession. However, as the economy recovers, cargo volumes are expected to increase. **The *2017 Massachusetts Freight Plan* should address trends in Massachusetts seaport data.**

Air Freight System

According to the *2010 Freight Plan*, all major air freight activities in Massachusetts are handled at Boston's Logan Airport. Based on the latest FAF data, goods moved by air account for about 0.2 percent of all freight movements in Massachusetts on a tonnage basis but nearly seven percent by value. As stated in the *2010 Freight Plan*, air cargo is a "critical factor related to international passenger air service as it can play an important role in the profitability of international flights and the number of direct international flights is a key determinant of why companies ship through different airports." **Air freight flows into and out of all Massachusetts airports should be reestablished for the *2017 Massachusetts Freight Plan*.**

Freight Programs and Projects

Programs or projects that are planned or proposed, or have been completely recently are listed below.

TABLE 1 FREIGHT PROGRAM AND PROJECTS

Project Name	Project Description	Progress
Double-Stack Corridor Improvements (New England Rail Initiatives, 2010)	The State has partnered with the freight railroads to increase track clearances between New York State and the major intermodal terminals in Worcester and Ayer to allow high-cube double-stacking intermodal container traffic, which increasingly are the industry standard for moving both international and domestic containers and this project will enable long-distance movement.	Ongoing
Worcester Terminal Improvements (New England Rail Initiatives, 2010)	CSX invested $100 million in a project to expand the Worcester Franklin Street Terminal, in order to support increased volumes anticipated from the improved double-stack corridor.	Completed in 2012 (telegram.com)
Freight Rail-based Economic Development (Auburn/Oxford Freight Rail Pilot Study, 2015)	Auburn, Oxford, and their local metropolitan planning organization (MPO) teamed with the Providence and Worcester Railroad to study the potential and feasibility for rail-oriented industrial and commercial development in each town. The document models an effective public-private partnership between local governments and industry.	Plan/Proposed
286K Weight-On-Rail Capacity Improvements (MassDOT Freight Plan, 2010)	Improvement of weight capacity (286,000 pound) on selected railroads to increase competitiveness, including Worcester to Ayer, Pioneer Valley Railroad (PVRR) Westfield to Holyoke, New England Central Railroad (NECR) from the Vermont border to the Connecticut border, CSX from Framingham to Taunton and from Taunton to New Bedford and Fall River. The project was identified in the *2010 Freight Plan* as high return on investment (ROI) project.	Plan/Proposed
New Bedford North Terminal Expansion (MassDOT Freight Plan, 2010)	This North Terminal Expansion project with associated port improvements (dredging, bridge clearance) is estimated to cost $55 million with 7,370 tons of cargo annually per $1 million in investment. It is identified in the *2010 Freight Plan* as high ROI project. Supporting projects, such as transload facility in the region, navigational dredging projects, and highway access improvements to New Bedford, might be necessary to achieve the marine cargo shipping market gains estimated.	Plan/Proposed (SouthCoast Today.com)
Boston Harbor Deep Draft Dredging (MassDOT Freight Plan, 2010)	The project will deepen the port to 50 feet and potentially attract larger post-panamax ships. The Panama Canal expansion project completed in June 2016. Identified in the *2010 Freight Plan* as high ROI project.	Expected to commence construction in 2017 (joc.com)

Project Name	Project Description	Progress
South Boston Port Access Improvements (MassDOT Freight Plan, 2010)	This project will improve roadway connecting to and from the Port of Boston in South Boston including the Conley Haul Road, Cypher Street, E Street, and the Massport Haul Road, to provide more efficient truck routes as well as increased safety for auto, pedestrian, and bike travel in the dense urban areas. It is Identified in the *2010 Freight Plan* as high ROI project.	Plan/Proposed
Boston's Smart City Challenge Proposal (Smart City Challenge – Mobility Innovation Lab, 2016)	Two projects are proposed that are related to urban delivery and logistics. They focus on the final delivery part of freight transport. (1) Micro navigation: build micro navigation systems for way-finding for the last 30 feet where GPS cannot direct to a precise destination. This will be of great utility for any future autonomous vehicles or delivery devices. (2) Zoning by hour: experiment with programmable markings in streets to allow streets whose purpose adjusts by time, day and season, as demand requires. Build for vehicle to infrastructure (V2I) for connected and automated vehicle navigation in partnership with Google Sidewalk Labs, Massachusetts Institute of Technology SENSEable City Lab, and Waze.	Plan/Proposed

Policies/Regulations

Existing Policy/Regulations

- **Truck parking and rest areas**: New, stricter federal regulations of hours of service by truck drivers took effect in 2013 to reduce fatigue and improve safety. (FMCSA, 2013.)
- **FAST Act Freight Apportionment**: Under the Fixing America's Surface Transportation (FAST) Act passed in December 2015, states will receive apportionments from 2016 through 2020 for six programs including the new National Highway Freight Program (NHFP), to improve the condition and performance of the national freight network and to support investment in freight-related surface transportation projects.

Policy Recommendations by Plans/Studies

The following recommendations are suggested by existing plans/studies. **These recommendations should be reviewed to determine whether they have already been implemented. If so, what the results are; and if not, whether they are still relevant and meaningful, or require adaptation.**

- **Truck parking and rest areas**: The number of large commercial truck parking facilities on or near the express highway system in Massachusetts needs to be increased. (Boston Regional Metropolitan Planning Organization. CTPS Proposed Freight Planning Action Plan for the Boston Region MPO, 2013 and Boston Regional Metropolitan Planning Organization. Rest Locations for Long-Distance Truck Drivers in Massachusetts.) The stops should fill in gaps on the northwest arc of I-495. Public rest-areas should be improved. All commercial and public stops should include new technology.
- **Land Use Development:** Recommendations made by the *2010 Freight Plan* include a freight-intensive land use policy, statewide inventory of possible distribution center and freight village sites, development and preservation of freight-intensive land uses, and pre-review of freight-intensive development under the Massachusetts Environmental Policy Act (MEPA).
- **Funding and Financing:** Recommendations made by the *2010 Freight Plan* include greater consideration of freight in transportation funding decisions, strategic multimodal investments, increased use of public-private partnerships, an Industrial Rail Access Program (IRAP), and improved approaches to competitive Federal funding programs.
- **Freight Planning and Policies:** Recommendations made by the *2010 Freight Plan* include engaging in effective multimodal transportation planning and development and developing a proactive truck parking program to enhance freight flows.
- **Freight Performance Measures**: The *1999 Needs Assessment* establishes the concept of performance measures for freight at the statewide level, and *weMove Massachusetts* established the need for performance measures in capital planning. The *2017 Massachusetts Freight Plan* should explore freight performance measures and how they could be applied by MassDOT. The 2016 white paper on *Freight Performance Measurement* should be used as a reference. (I-95 Corridor Coalition, Freight Performance Measurement: Measuring the Performance of Supply Chains across Multistate Jurisdictions, 2016.)

Policy Issues and Constraints by Plans/Studies

- **Freight rail double-stacking**: The state has partnered with the freight railroads to increase track clearances between New York State and the major intermodal terminals in Worcester and Ayer so as to take advantage of the cost efficiencies of that intermodal container service. (MassDOT Freight Plan, 2010 and New England Rail Initiatives, 2010.) However, as of 2016, track clearance information for specific bridges from MassDOT's Highways Division indicates that **there are nine bridges over the Haverhill Main Line with clearances of less than the minimum level (20'8'').** (MVPC Regional Transportation Plan, 2016 (Appendix A Freight). **The *2017 Massachusetts Freight Plan* should check on the status of this effort.**

- **Freight rail ownership and coordination**: Freight and passenger railroads share railroad infrastructure throughout the region, which, coupled with complicated and over-lapping arrangements and agreements made among various stakeholders, have contributed many operational and institutional constraints. (Northeast Rail Operations Study, 2007.) In addition, growing public ownership of the rail network requires an updated rail policy and communication framework.

- **Limited funding**: There is limited funding for capital investments in railroads, which makes it even more important to conduct careful evaluation in order to make targeted capacity improvement. (Northeast Rail Operations Study, 2007.)

- **Air freight**: Logan Airport has a very small land area for an airport with its level of activity, and the land must be shared by passenger, freight, and airline support facilities. Long term growth in air freight may eventually necessitate adding or expanding regional air freight facilities. Massport-operated Worcester airport may be an option to direct some future air freight growth. (CTPS Proposed Freight Planning Action Plan for the Boston Region MPO, 2013.)

Summary

In summary, the global and local economies are strong and becoming more service oriented, global trade in machinery and chemicals is growing, and sea shipping is changing to accommodate the new capacity through the Panama Canal and perhaps through a newly opened Northwest Passage. Massachusetts is primed to take advantage of these changes with opportunities to export high value commodities. The major takeaways from our research for each element of the freight system are listed below.

The Economy

- Growth in global and US merchandise exports will be driven primarily by machinery and transport equipment, other manufactured goods (including medical equipment), and chemicals (including pharmaceuticals).
- The major drivers for growing imports will be industrial machinery and transport equipment sector and consumer goods (e.g. household appliances, information and communication technology equipment, and apparel).
- The top US trading partners for exports include Canada, Mexico, and China and for imports include China, Canada, Mexico, Japan, and India.
- Commodities are increasingly becoming low-weight and high-value and require just-in-time logistics practices. Truck and air transportation are preferred for these commodities because they offer more flexibility and responsiveness. In the most recent Freight Analysis Framework data, the highest value trade commodity from Massachusetts was electronics.
- The Commonwealth is well positioned to benefit from the recovery in foreign demand and the expansion of US exports.

Logistics

- There is a potential shift back toward regional sourcing as risk-averse firms account for global uncertainties.
- E-commerce will have a significant influence over the future shape of these supply chains.

Transportation

- Most freight is transported by truck but some important commodities (transportation equipment) are shipped by rail.
- As commodities are growing lighter and more expensive, air freight is becoming more important.

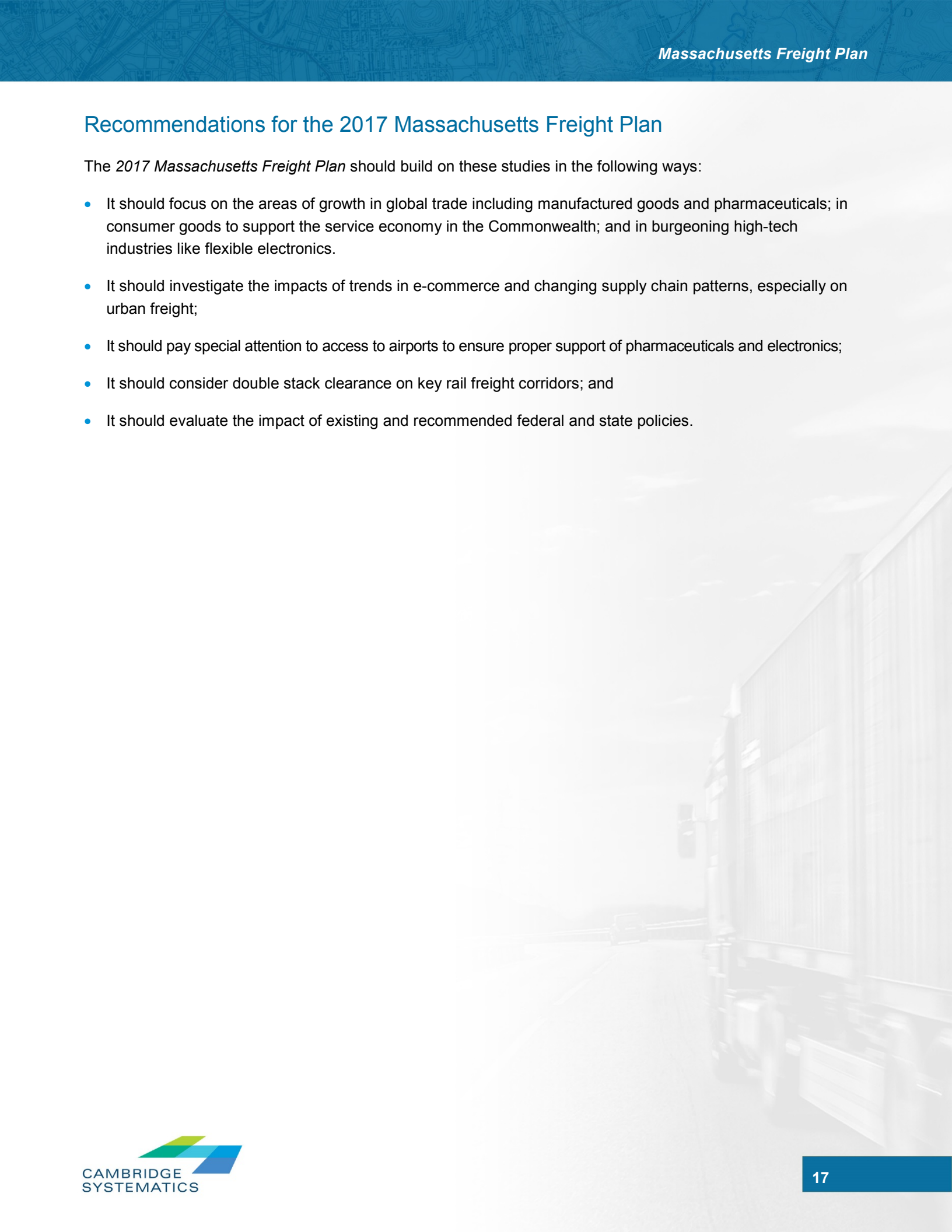
Policies/Regulations

- These recommendations should be reviewed to determine whether they have already been implemented. If so, what the results are; and if not, whether they are still relevant and meaningful, or require adaptation.
- As of 2016, track clearance information for specific bridges from MassDOT's Highways Division indicates that there are nine bridges over the Haverhill Main Line with clearances of less than the minimum level (20'8'').

Recommendations for the 2017 Massachusetts Freight Plan

The *2017 Massachusetts Freight Plan* should build on these studies in the following ways:

- It should focus on the areas of growth in global trade including manufactured goods and pharmaceuticals; in consumer goods to support the service economy in the Commonwealth; and in burgeoning high-tech industries like flexible electronics.
- It should investigate the impacts of trends in e-commerce and changing supply chain patterns, especially on urban freight;
- It should pay special attention to access to airports to ensure proper support of pharmaceuticals and electronics;
- It should consider double stack clearance on key rail freight corridors; and
- It should evaluate the impact of existing and recommended federal and state policies.



Appendix A

TABLE 2 BACKGROUND SUMMARIES AND TAKEAWAYS

Document Name	Geography	Agency	Summary and Key Trends / Highlights/Takeaways	Needs for Update
2011 Trading Places – the Emergence of New Patterns of International Trade	Global	EY, Oxford Economics	The report discusses the new patterns of world trade following the financial crisis, including changes in geography/market, supply, and trade sectors, etc. • **Commodities/Sectors**: Globally, machinery and transport equipment as well as other manufactured goods such as textiles, lumber and rubber will account for the largest share of exports from 2010 to 2020. For the US, similarly, exports of machinery and transport equipment are expected to account for about one-third of the expansion in US exports between 2010 and 2020. More than half of the forecast growth in this sector will be accounted for by exports in the industrial machinery subsector. But the rate of growth in exports of communication technologies (ICT) equipment will outpace the projected growth in industrial machinery. • **Trade Flows**: US trade with China and India will see the strongest growth from 2010 to 2020, both in terms of export and import. Asia Pacific region as a whole will also grow quickly as a trading partner.	The report was done in 2011, so some forecasts may be a bit dated. Additional research is needed to verify the trends and the impacts on US and Massachusetts

Document Name	Geography	Agency	Summary and Key Trends / Highlights/Takeaways	Needs for Update
2015 Trade Forecast Report United States	Global/US	HSBC, Oxford Economics	Two-way trade flows between the US and Asia will grow in importance relative to slower-growing but more established trade ties with industrialized economies. **Exports** • **Machinery and transport** equipment are set to play the biggest role in driving long-term growth in US merchandise exports, contributing close to 45% of the projected increase from 2020 to 2030; **chemical sector (in particular pharmaceuticals)** will be another major contributor to growth in US exports, which accounts for 13% of the forecast increase. • Canada will remain to be the largest US export market, followed by Mexico; by the end of 2030, China will surpass Mexico as the second largest export market of US. **Imports** • The sector composition of US imports closely mirrors that of exports; industrial machinery and transport equipment will be major drivers of merchandize imports, consumer goods including household appliances, ICT equipment and clothing and apparel will be other major contributors from 2020 to 2030. • In terms of trading partners, China is and will remain the top source of imports to US market; followed by Canada, Mexico and Japan; India will overtake Germany as the fifth source of US imports by 2030. **Drivers of Recovery** • **Mineral fuels and chemicals sectors** will have the fastest growth to lead the export recovery. • Other categories where export growth is expected to strengthen significantly over the next few years include **machinery and 'other manufactures'** – a broad category that includes cyclical sectors such as metals, but also scientific instruments.	

Document Name	Geography	Agency	Summary and Key Trends / Highlights/Takeaways	Needs for Update
2015 OECD Transport Outlook Summary (full report for purchase)	Global	OECD	• Growth in world road and rail freight volumes to 2050 ranges from 230% to 420% depending on freight intensity of future GDP growth; growing service sector shares in advanced economies or increasing production and trade of lighter weight goods like electronic devices reduces actual tonnages shipped. • Trade related international freight is projected to grow by a factor of 4.3 by 2050; future growth is driven by changes in the product composition of trade and by growth in the average hauling distance caused by changes in the geographical composition of trade; 85% of total international freight volume is carried by sea. • Increasing international trade will set unprecedented challenges to the transport system, particularly around ports. Port volumes are projected to increase nearly fourfold by 2050.	
2015 Global Trends in International Trade and the Laws that Underpin Them	Global	Holman Fenwick Willan LLP	The paper discusses some of the main global trends that are shaping the current landscape in international trade. • US has enjoyed rapid growth and the economy is expected to remain strong. • Weakness in the Eurozone and several commodity-exporting emerging economies could slow the growth and dampen US exports, but growing domestic demand and a strong dollar should encourage US imports. • US' main export partners are Canada, Mexico, and China; other strong trading relationships include those with Japan and European countries like Germany and the UK. • Factors ranging from climate change to economic development will rapidly alter global trading patterns in the future (e.g. melting ice could open up the Northwest Passage – passing over Canada and Alaska – to more large commercial vessels). • The growth of e-commerce sector will drive the development of international trade patterns and relationships over the coming years.	

Document Name	Geography	Agency	Summary and Key Trends / Highlights/Takeaways	Needs for Update
2013 Scenario Planning for Freight Transportation Infrastructure Investment	US	NCHRP	The report discusses a variety of factors, trends, and uncertainties that may affect the US freight transportation system over the next 30 to 50 years. It then introduces the Scenario Planning Methodology and provides an example of how it can support the making of flexible, adaptive, and responsive strategy for freight transportation system planning and investment. • **Driving forces affecting US freight transportation system are analyzed to provide the basis of scenario planning.** The driving forces provide a useful framework to think about the future of freight in Massachusetts. • **Application of scenario planning methodology on freight to inform planning and decision making.** Four Future Freight Flows (FFF) scenarios were developed out of different combinations of driving forces – Global Market Place, One World Order, Millions of Market, and Naftástique. Workshops were held subsequently across the US to discuss about respective investment strategies under the four scenarios and to inform planning and decision making. • **Investment strategies are determined for different scenarios.** Various infrastructure investments proposed for the different scenarios are generalized into three types – Gateway, Corridor, and Connector Investments.	

Document Name	Geography	Agency	Summary and Key Trends / Highlights/Takeaways	Needs for Update
2007 Northeast Rail Operations Study Phase I Final Report	Regional	I-95 Corridor Coalition	This report investigated the regional rail transportation network in New York State, New England, and Atlantic Canada as a system, and identified the trends that are impacting the efficiency of the system. The report was finished in 2007, so there's a need to revisit some of the trends documented. • As the region's economy shifts from manufacturing to service industries, the composition of freight and the logistics patterns have changed (e.g. just-in-time logistics practices). • The rail system in the Northeast region is seeing increasing capacity constraints due to loss of physical capacity and rising demand for both passenger and freight movements. • Freight and passenger railroads share railroad infrastructure throughout the region, which, coupled with complicated and overlapping arrangements and agreements made among various stakeholders, have contributed to many operational and institutional constraints. • Capacity and congestion issues at the west coast ports are causing shippers to use east coast ports directly via Panama Canal and Suez Canal. In light of the growing trade with Asian countries, it is important to ensure sufficient capacity and rail-port connectivity are in place. • Rail accounts for less than 10 percent of overall market share in the region, but is critical as it transports and distributes several major commodities, including transportation equipment, paper and wood products, which are also the fastest growing commodities in global trade. • Physical, operational and institutional challenges exist and hinder the ability of the rail system to absorb new growth in freight demands; regional and shortline railroads which are more common in this region are particularly affected. There is limited funding for large-scale capital investments in all railroads, in particular shortline and regional railroads. This makes it even more important to conduct careful evaluation in order to make targeted capacity improvement.	

Document Name	Geography	Agency	Summary and Key Trends / Highlights/Takeaways	Needs for Update
2016 Freight Performance Measurement: Measuring the Performance of Supply Chains across Multistate Jurisdictions	Regional	I-95 Corridor Coalition	This white paper documents the case studies conducted to demonstrate the feasibility of using performance measures and metrics to assess high-level performance of various types of supply chains of different lengths and modes. The evaluation results are then used to inform freight transportation policy and target strategic investments. Some of the key metrics include travel time, travel-time reliability, and cost.	
2010 New England Rail Initiatives	Regional	CSX Transportation	This report examined three rail initiatives as a result of the strategic investments of the Commonwealth and CSX Transportation: double-deck corridor improvements, Worcester terminal improvements, and commuter rail improvements. Benefits of those initiatives are assessed, including: • Job creation; • Reduction in highway maintenance from the diversion of trucks; and • Logistics savings from using lower cost intermodal rail service instead of trucks.	
Neighboring States' Freight/Rail Plans	New Hampshire, Connecticut, Vermont, New York/New Jersey	Respective State DOTs	Common observations of the region with regard to freight include: • Through traffic and inbound traffic account for a significant portion, reflecting the more important role of service sectors in the region's economy; • Trucks are the major modal choice of freight; and • Limited funding sources are a common constraint.	

Document Name	Geography	Agency	Summary and Key Trends / Highlights/Takeaways	Needs for Update
2010 MassDOT Freight Plan	Massachusetts	MassDOT	The *2010 Freight Plan* summarizes Transearch and FAF data on freight volumes, routing, mode choice, and commodities. It identifies key issues in shipping by sea, rail, and road. It makes policy recommendations that include **land use development, funding and financing, and freight planning and policies.** • The document models investment scenarios, computing that a northern tier and central western rail improvements have a high expected ROI. • The document calls out international flights at Logan Airport and belly freight as key drivers of freight flows from the Boston Area, which produces lightweight, valuable, time-sensitive products. As international flights have increased since 2010, an assessment of belly freight growth to Europe and Asia should be a part of the 2017 Freight Plan.	Demographic and economic analysis in the document dates from 2007 in many cases. This places some onus on the 2017 Freight Plan to discuss both the recession and the recovery that has occurred since. Trends should all go back at least 10 years.
1999 Identification of Massachusetts Freight Issues and Priorities	Massachusetts	Massachusetts Highway Department	The document summarizes issues relating to freight identified through interviews with industry. It ultimately prioritizes them by level-of-importance. High-importance issues include administrative coordination (simplified by the MassDOT merger, consistency of Federal, State, and local hazmat regulations, consistency of regulations and enforcement, double-stacked rail clearance (partially resolved), improved signage, OS/OW permitting (both resolved and currently being updated) and simplified communication between industry and government.	• While some of these issues have been addressed or affected by organizational changes, it might be informative to explore how effective industry currently finds communication with MassDOT and coordination between agencies. • The 2017 Freight Plan should note the current OS/OW system upgrade.

Document Name	Geography	Agency	Summary and Key Trends / Highlights/Takeaways	Needs for Update
2010 MassDOT Rail Plan	Massachusetts	MassDOT	The 2010 Rail Plan set the goals of: (1) maintaining the Commonwealth's rail system; (2) expand the rail system and its capacity to accommodate growth in freight and passenger demand; (3) provide a rail system that is environmentally and financially sustainable; (4) improve intermodal connectivity for both passenger and freight facilities and coordination between system users; (5) improve the rail system to support sustainable economic growth throughout the state and enable Massachusetts to compete in a rapidly changing global economy; and (6) enhance the safety and security of the rail system.	
2007 Massachusetts Rail Trends and Opportunities	Massachusetts	Massachusetts Executive Office of Transportation and Public Works	The 2007 Rail Trends Report covers much of the same ground (in a prior year) as the 2010 Rail Plan and the *2010 Freight Plan*. The document places special emphasis on defining the Executive Office of Transportation (EOT's) place among the several public agencies that own railroads in Massachusetts – the MBTA, Turnpike Authority, Massport, and the Massachusetts Water Resources Authority (MWRA) owned railroads at the time. Though EOT, MBTA, and MBTA were merged into MassDOT, the Rail and Transit Division still owns railroad separately from the MBTA, and the MWRA and Massport still own track independently. • The document has a better flow diagram than the *2010 Freight Plan*. There's explanatory value in mapping the MA-specific flows instead of flows in general. In this case, it's very clear how important the CSX corridor from Chicago to Boston is. • The document's primary MA-specific trends and issues are: Growing public ownership of the rail network, needs for an updated rail policy and communication framework, railroad rationalization, operational concerns (shared-use corridors, grade crossing safety, whistle-blowing laws), network capacity (including weight rating and vertical clearance), and funding.	Especially as MassDOT's purchase of freight railroad is a major trend since the last Freight Plan and Rail Plan, the 2017 Freight Plan should touch on the mechanisms by which MassDOT buys lines and makes them available to shippers.

Document Name	Geography	Agency	Summary and Key Trends / Highlights/Takeaways	Needs for Update
2013 Ports of Massachusetts Strategic Plan	Massachusetts	MassDOT	The Ports of MA have the most recent report on trends in commercial shipping, and note the expansion of the Panama Canal and availability of "neo-panamax" container ships as important points of emphasis over the current period (the Panama Canal expansion opened in August, 2016). Boston is unlikely to be a port-of-call for neo-panamax ships, but the industry's decision to consolidate neo-panamax shipping in one or two Eastern Seaboard locations may change the way goods move through (mostly to) the region. The report also notes that a manufacturing shift to India and Southeast Asia may lead to more shipping through the Suez Canal, from which the Northeast is more convenient than ports in the Southeastern US. The report discusses "short-sea shipping" and "hub-and-spoke" approaches. Each has smaller ships distributing goods from hubs up and down the coast. Short-sea shipping, however, would be a scheduled service, while hub-and-spoke would be a series of one-time operations tied to specific large ships (to distribute their load, specifically). Short-sea shipping generally becomes cost-competitive with trucking when endpoints are more than 400 miles apart (Boston-Philadelphia). The document cites the US Marine Administration's Marine Highway (AMH) Program as an impetus for the development of these concepts – Boston is on the M-95 corridor between Florida and Maine.	• Ports of MA lists recommended projects with a timeline. Not all of these are freight projects, but those that are should be revisited. • The 2017 Freight Plan should address Massachusetts' and Boston's role in a neo-panamax shipping environment in which international shipping is consolidated at one or two East Coast Ports. • The 2017 Freight Plan should at least briefly discuss short-sea shipping as an alternative to trucking on the I-95 (M-95) corridor.

Document Name	Geography	Agency	Summary and Key Trends / Highlights/Takeaways	Needs for Update
2010 Massachusetts Statewide Airport System Plan (MSASP)	Massachusetts	MassDOT	The MSASP inventories the facilities of Massachusetts Airports. MassDOT does not directly own or manage any airports and does not oversee airports owned by Massport (Logan, Hanscom, and Worcester). For the rest, the document includes performance metrics relating to asset management and performance. • As freight primarily travels through Logan Airport, this document isn't of enormous use. In general, air freight flows into and out of all Massachusetts airports should be reestablished for the 2017 Freight Plan.	
2014 *we*Move Massachusetts: Planning for Performance	Massachusetts	MassDOT	*we*Move Massachusetts (WMM) sets the stage for MassDOT to adopt performance-based planning and asset management principles. Performance-based planning ties capital investments to quantitative outcomes, including modeled future condition of assets (e.g., bridges and pavement), traffic congestion and delay, and safety. This is in contrast to the prior approach of maintaining historic funding levels for programs over time. The performance-based principles in WMM were most recently applied in the 2017-2021 Capital Investment Plan (CIP), in which more funding than ever before was directly dedicated to the maintenance of bridges and pavement.	The 1999 Needs Assessment established the concept of performance measures for freight at the statewide level, and WMM established the need for performance measures in capital planning. The 2017 Freight Plan should therefore explore freight performance measures and how they could be applied by MassDOT.

Document Name	Geography	Agency	Summary and Key Trends / Highlights/Takeaways	Needs for Update
2015 Baker-Polito Economic Development Plan	Massachusetts	Massachusetts Executive Office of Housing and Economic Development	The Baker-Polito Report is the economic development plan required of all Massachusetts Governors. The document lays out key overarching goals and ties them to strategies and policy opportunities without directly proposing action or setting a timeline. The administration's agenda both recognizes the regional variations in the Massachusetts economy and identifies the innovation sector largely centers around Boston as a key driver for the Commonwealth. The report also calls for investment in infrastructure and Gateway Cities. • The Governor's administration strongly supports investment in the transportation system as a way to build the Massachusetts economy. • The administration prefers to recognize the regional nature of the Massachusetts economy, with different industries and concerns predominating in different areas of the Commonwealth. • The administration recognizes that innovation industries are both a current strength and a growth area.	
2015 Auburn/Oxford Freight Rail Pilot Study	MPO/Town	Town of Auburn, Town of Oxford, Providence and Worcester Railroad, and the Central Massachusetts Regional Planning Commission	Auburn, Oxford and their local metropolitan planning organization (MPO) teamed with the Providence and Worcester Railroad to study the potential and feasibility for rail-oriented industrial and commercial development in each town. The report profiles the regulatory environment in each case, generally identifying Oxford as a friendlier community due to its more permissive zoning and oversight. • The document models an effective public-private partnership between local governments and industry. • Local government and devolution of powers is a key point in all freight planning documents in Massachusetts when they discuss land use. The Baker-Polito Plan touches on it as well.	

TABLE 3 SUMMARY OF FREIGHT PLANS IN NEIGHBORING STATES

	New Hampshire State Rail Plan (2012)	Connecticut Statewide Freight Planning Program (2015, PowerPoint)	Vermont Freight Plan (2013)	A Comprehensive Goods Movement Action Program for the New York-New Jersey Metropolitan Region (2014)
Summary	The Plan identifies and evaluates issues and opportunities related to rail transportation in the State. It also profiles the freight rail system, active and abandoned freight lines, and intermodal freight connections.	This comprehensive statewide multimodal freight plan is under development.	The report includes an inventory of the State's freight transportation infrastructure, identification of emerging economic sectors, quantification of freight flows and description of freight system needs and deficiencies. It also provides a set of freight transportation performance measures to assess the condition of assets.	The document develops a shared vision and strategies amongst Port Authority of NY and NJ, NYSDOT, and NJDOT.
Modal Share by Tonnage/Value	**Existing (2009)** By Tonnage – Truck: 87% Rail: 7.3% Pipeline: 4.5% By Value – Truck: 91.9% Rail: 0.7% Air: 3.9% **Between 2009 and 2040**, air tonnage will have the fastest growth by over 300%; rail tonnage will grow by more than 250%, and truck tonnage will grow by about 170%.	**Existing (2012)** By Tonnage – Truck: 88% Rail: 6% to 8%	**Existing (2007)** By Tonnage – Truck: 80%	No discussion

CAMBRIDGE SYSTEMATICS

	New Hampshire State Rail Plan (2012)	Connecticut Statewide Freight Planning Program (2015, PowerPoint)	Vermont Freight Plan (2013)	A Comprehensive Goods Movement Action Program for the New York-New Jersey Metropolitan Region (2014)
Trade Flows and Commodities	As of 2009, through traffic accounts for 79% of total freight rail traffic. Surge in crude oil production can result in higher demand for shipment of crude oil to refineries (e.g. New Brunswick).	As of 2012, top commodities include gasoline and fuels, mixed freight, coal and petroleum, and machinery.	As of 2007, inbound and through traffic accounted for about one-third of all freight flows. This directional split is likely to be accentuated as service sector is taking a more pronounce role in the economy. "Secondary moves" (i.e. shipment of goods in retail and wholesale trade) make up the single largest commodity group; nonmetallic minerals are a key source of exports for Vermont.	No discussion.
Issues	Inadequate service levels (reliability, frequency, consistency) places NH businesses at a disadvantage. 800 miles of rail line have been abandoned, which could be used for other purposes.	Connecticut has 7 of the top 100 freight bottlenecks in the nation.	State's freight transportation system must adjust to serve the needs of an aging population and a state economy that depends more on services than production of natural resource based or manufactured commodities. Greater emphasis should be put on reliable and cost-effective connections between major distribution centers and population and business centers.	Eight million daily commuters consume most of the metro area's road and railway capacity. Dense development patterns and competing land uses push essential distribution and intermodal transfer facilities farther away from customers and consumers. Limited public funds are available for infrastructure maintenance and expansion.

	New Hampshire State Rail Plan (2012)	Connecticut Statewide Freight Planning Program (2015, PowerPoint)	Vermont Freight Plan (2013)	A Comprehensive Goods Movement Action Program for the New York-New Jersey Metropolitan Region (2014)
Recommendations	• Support grant funding for eliminating carload weight restrictions on the St. Lawrence and Atlantic Line. • Work with Maine and Massachusetts to raise the weight limits on MBTA owned lines that serve New Hampshire. • Coordinate with New England states to develop a region-wide approach to eliminating vertical constraint to New England main lines. • Advance plans for development of a freight intermodal facility in southern New Hampshire. • Provide technical support to identify and plan for freight distribution centers along rail lines. • Initiate program to provide financial support (in partnership with shippers/railroads) for infrastructure improvements that increase rail access.	Corridor Strategies are proposed. Specifically, the investment in the New Haven-Hartford-Springfield Corridor.	Six sets of policy, program and project packages were defined: • Freight policy: incorporate freight into VTrans planning, project development and service delivery. • Trade corridor: facilitate economic development in Vermont by improving transportation infrastructure and operations between Vermont and its trading partners. • Highway operations: improve access to major regional suppliers and markets for Vermont receivers. • Rail development: improve the rail infrastructure, operations and regulatory and institutional frameworks, so as to (1) keep rail freight viable, (2) support future growth in mid-length intermodal services, and (3) improve freight rail market share.	10 Action Packages (44% is funded): • Inside I-287: The First & Last Miles. • Airport Access: Delivering Priority Transportation. • Multimodal Rail: Realizing the Rail Renaissance. • GATES: Promoting the Region's Global Gateway. • I-95 Corridor: Serving the Northeast Megaregion. • Deploying Freight Technology for Smarter Operations. • Capital Resources for the Financial Capital. • Off-Peak: Capturing Available Capacity. • Regulatory Harmonization: Seamless Service Provision. • Freight Preservation: Preserving Access and Facilities for Essential Freight Services.

	New Hampshire State Rail Plan (2012)	Connecticut Statewide Freight Planning Program (2015, PowerPoint)	Vermont Freight Plan (2013)	A Comprehensive Goods Movement Action Program for the New York-New Jersey Metropolitan Region (2014)
Recommendations (continued)	• Initiate program to provide financial support (in partnership with shippers/railroads) for infrastructure improvements that increase rail access. • Participate in regional coordination efforts to plan and improve the New England railroad network. • Continue policy of acquiring abandoned rail lines with potential for future use.		• Air freight: expand air freight and cargo services available to Vermont shippers. • Freight transport performance measures: promote the use of performance measures that support informed and cost-effective investments	
Relevant Investment Strategies/ Scenarios	Improvement to the Conway Branch of the NH Northeast Railroad to meet the increase in demand - the line currently transports sand and gravel to Boston, MA. Investment in a distribution facilities via public-private partnership located in southern NH to provide rail option to transport freight from MA. Improve vertical clearance along Pan Am Railway to allow for higher rail capacity; need to be in conjunction with other regional improvements such as MA.	Completion of Hartford Line (New Haven to Springfield, MA).	The State of Vermont received an American Reinvestment and Recovery Act (ARRA) grant to fund track improvements along the New England Central Railroad line between St. Albans and the Massachusetts state line.	Each Action Package (above) has its own set of action plans and investments defined. See more details on page 7.