

Memorandum

TO: Yevgeniy Galinski and Gerry Bogacz, NYMTC

FROM: Christopher Lamm and Ben Eskin, Cambridge Systematics

DATE: June 15, 2022 (revised June 20, 2022)

RE: Task 3: Describe the Impacts of Changing Business Models and Development Pressures on Freight-Related and Industrial Land Uses

INTRODUCTION

NYMTC has initiated a Regional Freight Land Use Study to assess the current mix of land uses related to goods movement in the region, assess recent and projected future trends that affect the region's supply and use of land to support freight-generating economic activity, and develop a "typology" that categorizes freight land uses in the region and describes key features and trends affecting each category. This study will fulfill a recommendation of the Regional Freight Element of *Plan 2045*, NYMTC's Federal Fiscal Years 2018-2045 Regional Transportation Plan.

The study is reviewing the impacts of:

- Changing business models in response to technological development, logistics trends, and customer demands; and
- Local, regional, and national development pressures; on freight-related and industrial land use in the multi-state region.

The memorandum contains two sections:

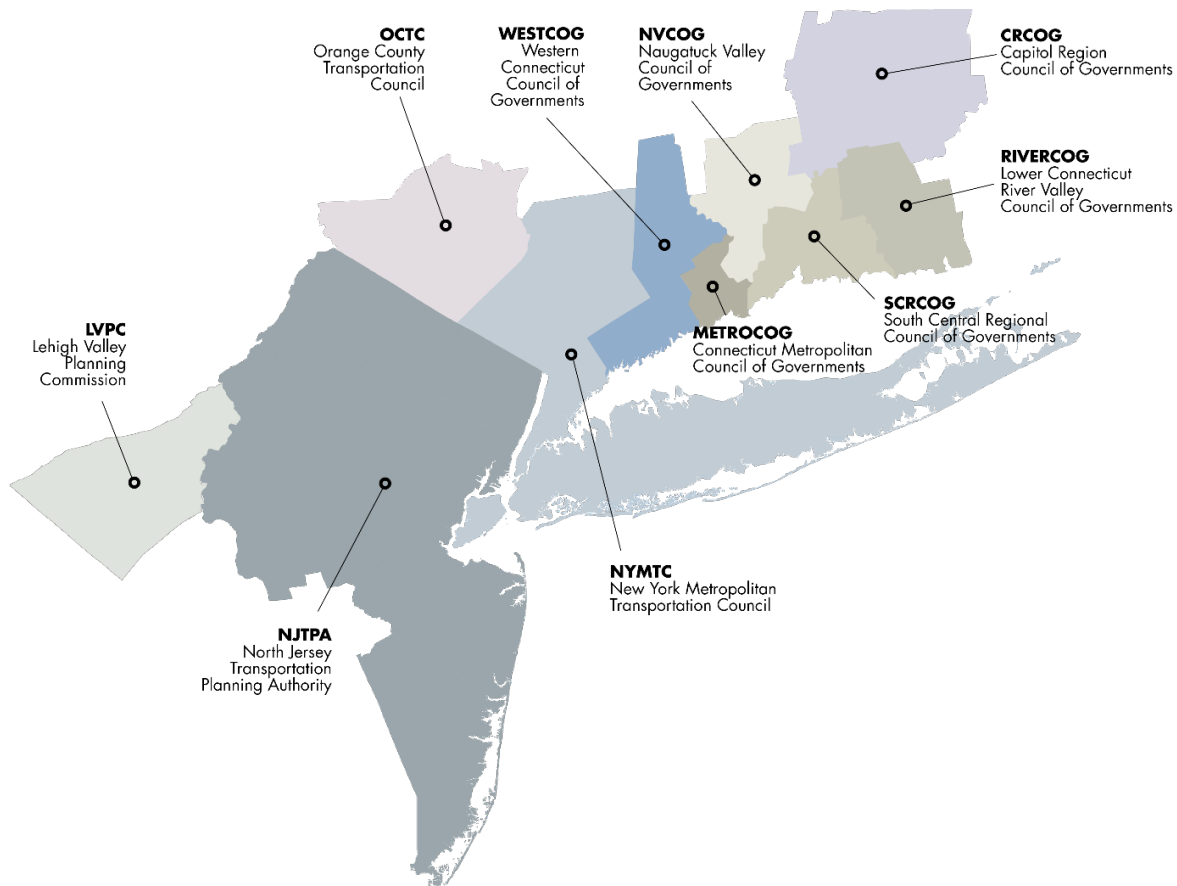
1. **Scan of Key Trends** - identifies and describes a selection of trends that are having a material impact, or likely to have significant material impacts on the locations, intensity, and types of land uses that support the movement of goods.
2. **Scenario Analysis** develops potential future scenarios associated with the potential for a selection of the key trends to develop, accelerate, or change over time. The analysis attempts to quantify the effects, where possible, though most of the analysis is qualitative. Where the trends' effects on freight land use are likely to affect certain portions of the Study Area, or certain land use categories, maps of those areas are provided in Appendix A.

The region under study consists of the planning areas of the ten metropolitan planning organizations and councils of government in New York, New Jersey, Connecticut, and Pennsylvania. These together comprise the Metropolitan Area Planning (MAP) Forum as shown in Figure 1.

This memorandum describes the potential impacts of key freight and economic trends on freight-related land uses in the region covered by the study. It builds on the work completed by NYMTC and other MAP Forum member organizations as described in the Task 2 memo of this study: Literature Review.

The analysis provided here was also enhanced with feedback received from a technical advisory group survey conducted during the study. Details of the survey are in Appendix A¹.

Figure 1 Multi-State Region Study Area



¹ Various experts including municipal planners, industrial and commercial real estate professionals, freight industry representatives, and transportation planners representing various parts of the Study Area were invited to participate as technical advisors via a virtual survey format. A summary of the input received from the focus group is provided in Appendix A.

Source: NYMTC.org

SCAN OF KEY TRENDS

One of the objectives of the study is to provide a scan and discussion of trends within the freight sector that are having a material impact or are likely to have significant material impacts on the locations, intensity, and types of land use that support the movement of goods. Taking into account the literature review completed in TASK 2 of this study. The scan identified nine key trends. The nine trends, described in greater detail in this section, include:

1. Growth in e-commerce demand;
2. Fulfillment center automation and multi-story facilities;
3. Distributed manufacturing;
4. Autonomous delivery vehicles;
5. Climate change and risks to freight facilities and potential land availability for freight use;
6. Population growth and distribution within and surrounding the region;
7. Retail center repurposing to support e-commerce growth;
8. Supply chain fluidity and resilience; and
9. Clean freight (using alternative fuels and electric charging)

Please note that the numbering of trends in this section is strictly for organizational purposes and does not imply that these trends are more or less important.

TREND 1: GROWTH IN E-COMMERCE DEMAND

Over the past 30 years, the Internet became an indispensable tool for communications, business, education, and entertainment. Improvements in cost, speed, availability, and reliability of connections over time made the Internet an attractive platform for selling physical goods. E-commerce is a term that is typically used to refer to commercial transactions made using the Internet. Recent years have seen rapid growth in e-commerce sales volumes. The following changes in supply chains, logistics, and transportation enabled or resulted from this growth:

- Larger vessels made it cheaper to ship goods from overseas
- Ports expanded to handle the increased volumes
- Truck fleets added capacity and sophisticated routing systems to make deliveries more quickly

- Information technology systems were developed to improve inventory management, track the movement of products within the supply chain, and manage the fulfillment of customer orders
- Networks of fulfillment centers have been built to place inventories proximate to consumer markets, facilitating two-day or same-day delivery

COVID-19 pandemic public health measures of social distancing and working from home contributed to a leap in e-commerce sales and in corresponding volumes of freight.

Approximately 10 years ago, in late 2011, e-commerce sales in the United States totaled approximately \$50.2 billion. This represented about 4.9% of total retail sales in the U.S. By the 1st quarter of 2020, on the eve of the COVID-19 pandemic's spread through the U.S., e-commerce sales totaled \$154.6 billion, and represented 11.4% of total retail sales. As Figures 2 and 3 show, e-commerce sales increased by 32% (to \$203.8 billion, and nearly 16% of total retail sales) in the second quarter of 2020, when the pandemic was spreading across the U.S.

E-commerce companies offered a safe way to purchase goods and services at a time when many stores, offices, and other business establishments were closed or operating under restrictions. When some of the early emergency public health measures lapsed later in 2020, and many brick-and-mortar retail stores resumed operation, E-commerce sales reduced slightly. Online sales growth resumed throughout 2021. However, its share of total retail decreased, suggesting that while e-commerce sales have increased, so too have brick-and-mortar retail sales.

Figure 2 Value of E-Commerce Retail Sales by Quarter, 2011-2021

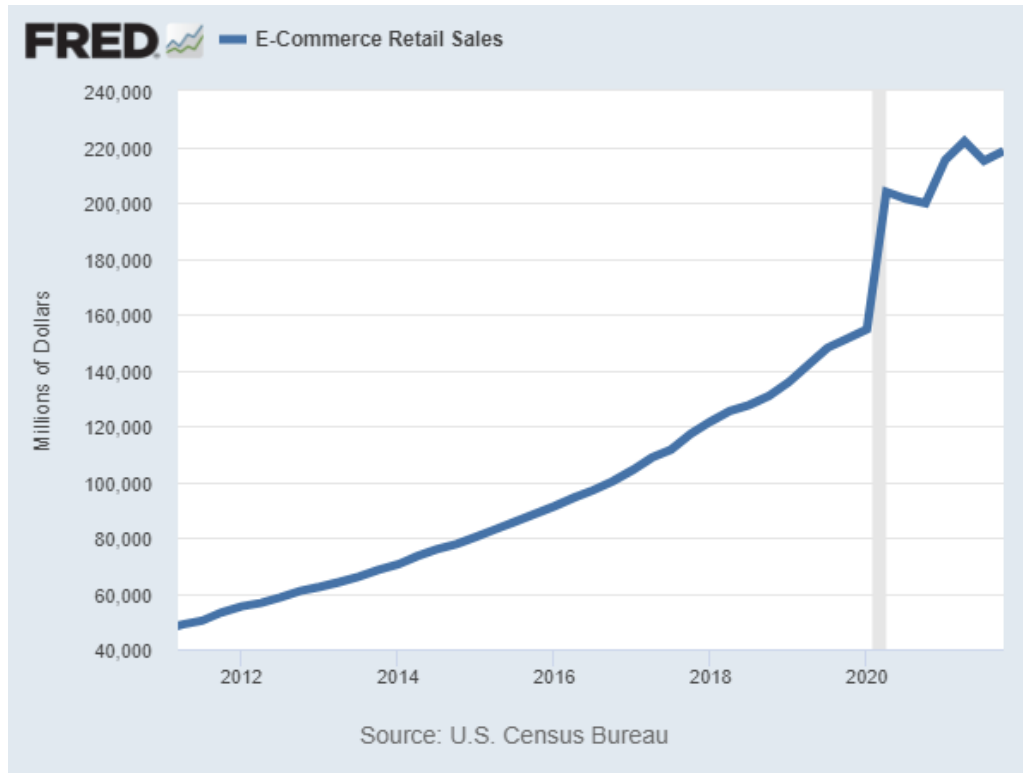
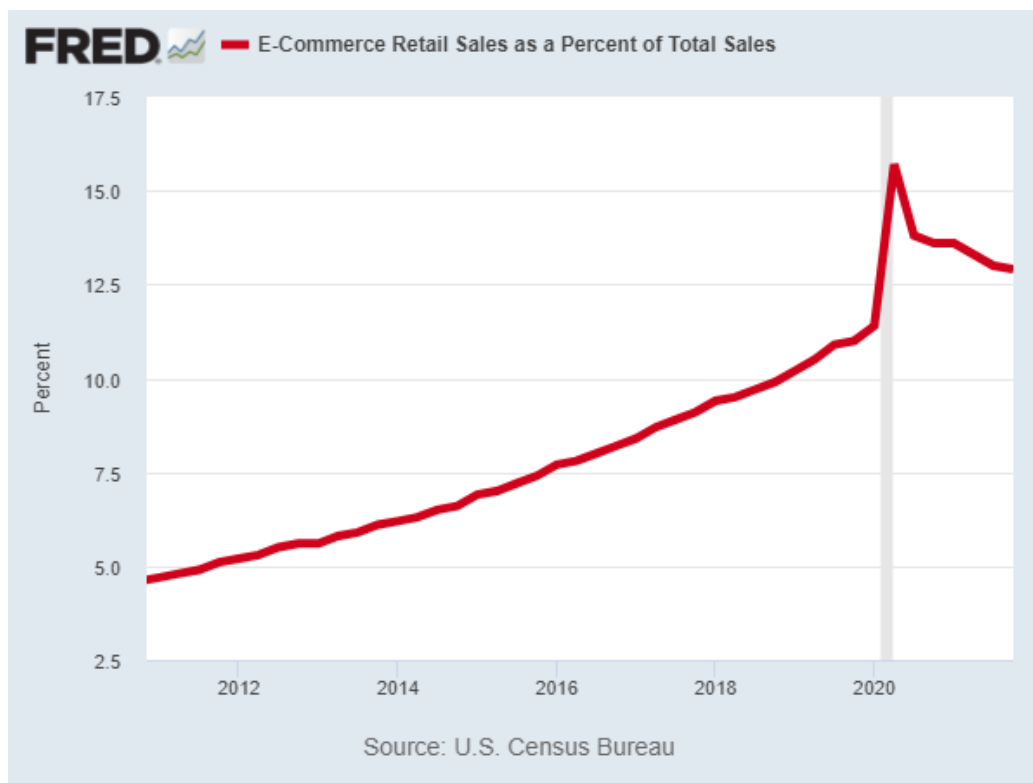


Figure 3 E-Commerce Sales as a Percent of Total Retail Sales by Quarter, 2011-2021



The growth in e-commerce demand (combined with faster delivery trend prompted by the

industry) is having significant repercussions on warehouse location decisions. There is a notable shift away from the practice of using a small number of large facilities located a long distance from the urban areas they serve, toward using more numerous, smaller industrial spaces located closer to the consumers. For the NYMTC planning area, this has resulted in many new facilities in the outer boroughs of New York. For example, Fresh Direct and Jet.com both opened new fulfillment centers in the Bronx in 2018. Similarly, Amazon opened new fulfillment centers in Staten Island and Brooklyn, (with more on the way). One result of this trend is greater truck volumes on regional roadways as well as increased volumes on local roadways, both from trucks and smaller delivery vehicles.

Impacts on Freight and Logistics

- E-commerce emphasizes time-definite delivery and quick order fulfillment to meet consumers' demands for same-day, next-day, or "as soon as possible" delivery. This places pressure on warehouse and fulfillment center operations to be as quick and efficient as possible, and for the transportation system to perform reliably. (Higher costs in/near urban cores are justified by better access/service to consumers)
- Some e-commerce retailers and/or integrated carriers are implementing tiered distribution networks to facilitate supply chain velocity. The tiers consist of large distribution centers to distribute products to various regions, and then a series of secondary distribution centers, fulfillment centers (where customer orders are packed), and last-mile delivery sorting centers.
- More food (groceries, prepared meals, restaurant meals) is being ordered online. While not traditionally "freight," these services represent a segment of e-commerce in which goods (meals) are delivered to a consumer's doorstep.
- In many cases, an e-commerce order requests the delivery of a shipment to the consumer's doorstep. This transaction introduces a delivery vehicle that makes a tour in the consumer's neighborhood. However, that delivery vehicle may replace dozens (or more) personal automobile trips to retail stores.
- A growing segment of the e-commerce market is the "order online for in-store pickup," in which consumers place orders online and pick them up in person from a retail location. This model of e-commerce changes some of the upstream logistics (i.e., moving individual customer orders from warehouse to store versus a truckload of products that are stocked in the store for sale).
- Change in business plans collectively to include (or increase the share of sales via) e-commerce is driving increasing investments in freight and logistics assets.

Impacts on Land Use

- Growth in e-commerce demand is fueling demand for warehousing, distribution center, and fulfillment center space.

- The tiered distribution system is creating demand for industrial real estate (and changing the profile of demand for commercial/retail real estate) at all levels, including large distribution centers (over 500,000 square feet), and smaller last-mile sorting and dispatching centers and micro-warehouses (many under 50,000 square feet).
- The value of being in and near large consumer markets is making urban infill, brownfields redevelopment, and other urban sites, (which have historically been at a cost disadvantage,) much more marketable. The proximity to consumers and ability to meet same-day delivery expectations is worth the higher land and development cost in the current market environment.
- Establishing and managing loading areas/curb utilization in urban core areas and town center commercial districts for deliveries is increasingly important.

TREND 2: MULTI-STORY AND AUTOMATED DISTRIBUTION CENTERS

Automation

E-commerce fulfillment centers differ from traditional brick-and-mortar retail (or wholesale) distribution centers in the requirement for greater labor input. This is due to smaller order sizes and more varied SKU content typical of online consumer purchases. Over time e-commerce companies have increased levels of automation within the fulfillment centers. Automation is being used to increase order throughput while controlling labor and warehousing costs.

Automated fulfillment centers can increase throughput per square foot (and thus per acre) by as much as three times. Aisles between storage racks can be narrower and the height of the racks taller, due to the use of automated handling equipment. This allows more products to be handled and stored horizontally and vertically, and it pushes facility ceiling heights well above 40 feet. Combinations of material handling and optical equipment enable greater precision in picking and packing of inventory, which enables the management of larger volumes and greater varieties of products.

Growth in the e-commerce market share of overall retail sales is expected to contribute to greater levels of fulfillment center automation. Companies are likely to continue to turn to these technologies to control costs and improve operations.

Multi-Story

A multi-story distribution center is a facility that consists of several floors above ground. While multi-story facilities are not new, the modern versions are likely to feature vehicle ramp access to each floor. The primary benefit is that capacity per acre is tripled versus traditional one-story facilities. These designs are adapted to the smaller sites and costlier land characteristics of urban infill.

Vertical designs are more expensive. Construction of a new multi-story building can be at

least twice the cost of renovating an existing facility, according to one estimate,² and the approach has its doubters. Vertical buildings work best in dense, high cost and high-demand markets with large populations all of which fit the metropolitan New York profile.

Figure 4 55 Bay Street, a Multi-Story Fulfillment Center in Brooklyn



Source: JLL

Impacts on Freight and Logistics

- Multi-story and automated distribution center facilities are more productive on a tons-per-acre basis and can reduce operating costs.
- With more freight stored per acre, these facilities are also likely to generate more truck trips (inbound and outbound) than single-story, non-automated facilities.
- The concentration of facilities within a single building footprint increases operational risks due to man-made and natural disasters.

Impacts on Land Use

- Taller buildings may be inconsistent with local zoning and development regulations in some communities.
- Conserving land by placing loading bays for trucks, truck parking, and circulation space above ground level at multi-story facilities.
- Create more space for commercial and industrial uses without using more land.

TREND 3: DISTRIBUTED MANUFACTURING

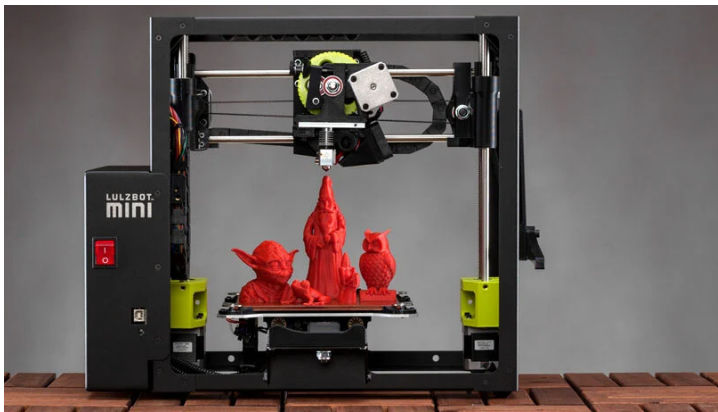
Distributed manufacturing refers to the potential for three-dimensional (3D) printing to permit the production of goods near the points of demand, leading to many small factories situated in and serving local markets. This contrasts with the long-standing imperative for factories to

² “Last Mile Delivery and the Rise of the Urban Warehouse”, NAIOP, 3/17

achieve economies of scale through mass production and to locate large plants in limited locations where the availability of raw materials, affordable skilled labor, vendors, or other factors make the production of products most efficient.

3D printing is a type of additive manufacturing (AM) by which products are formed by layering materials, as opposed to subtractive (cutting away) or formative (molding) techniques (AM and 3D are terms used interchangeably, although technically the latter is a category of the former). The 3D production machinery is loosely referred to as “printers” and does include inkjet printers used with ceramics and concrete, although they are just one of a half dozen types. Similarly, raw materials may be referred to metaphorically as “inks”; the actual materials include plastics, metals, and even food in various forms. Fused Deposition Modeling of plastics is the most common and probably best-known production method, utilizing melted filaments extruded through a nozzle.

Figure 5 3D Printer Producing Figurines



Source: pcmag.com, 2021

Impacts on Freight and Logistics

- Although 3D printing remains a niche in the overall manufacturing picture, it is growing, and with that growth comes increased demand for the transportation of “inks” to feed 3D processes. These materials include plastics, resins, various synthetic powders, and metals. The type of handling required for these types of commodities is different from finished goods. Generally, the weight of the materials will be greater when shipped in bulk form. And there is a probability that some of the commodities will need to be transported under hazardous materials regulations.

- The “inks” are commodities that are generally conducive to rail transportation, in large quantities. Rail could be used to move ink materials long distances, with trucks or other modes used to distribute smaller shipments to end users.

Impacts on Land Use

- Distributed manufacturing could potentially facilitate the establishment of more (and potentially smaller) manufacturing facilities throughout the region.
- Alternatively, or in addition, future 3D printing locations could be in the home, commercial buildings, industrial buildings, and almost anywhere, thus reducing the need for consolidated manufacturing.
- Larger-scale 3D printing facilities or ink suppliers could seek (i.e., generate higher demand for) rail-served industrial sites.
- Potential sites for both manufacturers and suppliers will need to satisfy higher safety and environmental requirements versus other types of land use.

TREND 4: AUTONOMOUS DELIVERY VEHICLES

Recent developments in autonomous and connected driving technology have sparked significant discussion and experimentation with autonomous delivery vehicles. Proponents highlight potential cost savings and increased safety. Opponents on the other hand point to congested areas, which represent a significant challenge for both autonomous and connected vehicles. The interaction of trucks, cars, cyclists, and pedestrians – all moving in different directions at different times for different purposes – presents automated vehicles with a significant amount of variability and unpredictability.

While progress is being made to solve technical challenges, deployment of this technology will require land use and operational adaptations.

For the multi-state region specifically, one could envision a scenario in which a driverless vehicle operating in conjunction with a delivery employee, or a delivery “robot,” such as the food delivery bots operating in Washington, DC and shown in Figure 6, and parcel delivery bots being tested elsewhere, could circumvent some of the delays caused by the perennial lack of suitable street parking in front of many residences. The vehicle could stop to allow the employee to disembark with the package(s), drive around the area while the employee delivers the packages and return to pick up the employee once the transaction had been completed – subsequently moving on to the next location. For the long haul over the road operations may see widespread adoption of truck platooning where several trucks are being controlled by artificial intelligence or by a human driver. From a freight and land use perspective, there may be impacts on the layout and configuration of shipping and receiving facilities and also impacts on roads and roadside facilities.

Figure 6 Delivery Robot in Washington, DC



Source: Washington Post

Autonomous aerial drones represent another opportunity for driverless deliveries of goods, however, regulatory and operational issues, particularly in dense urban contexts, have stifled the development of aerial drones for widespread last-mile delivery applications.

Impacts on Freight and Logistics

- Should autonomous vehicles be used for widespread delivery applications, they could help to reduce fuel, labor, and equipment costs for deliveries;
- With continued and substantial development in the artificial intelligence used to control them, autonomous vehicles could potentially improve safety;
- Depending upon the technology used, autonomous vehicles (such as the robot shown in Figure 6) could reduce the need for curb space relative to delivery trucks. Because these robots operate on sidewalks shared with pedestrians, their impact on pedestrian safety and the operation of sidewalks and crosswalks needs to be evaluated.
- For long-haul over-the-road applications, truck platooning may only be economically viable in circumstances where large shipments are common and the facilities are large enough for vehicle staging and maneuvering. Truck platoons in urban commercial districts will face significant operating constraints.

Impacts on Land Use

- Autonomous vehicles used for last-mile deliveries and/or long-haul freight operations could reduce the need for truck parking and rest area space if human pilots or companions are not required.
- Autonomous delivery vehicles could lead to development regulations that require off-street loading areas or other accommodations for the autonomous vehicle/technology.
- Autonomous delivery vehicles could lead to the reconfiguration or enlargement of industrial facilities to accommodate space needed for vehicle staging and maneuvering.

- Should truck platooning technology become widely adopted for long-distance transport, it could lower shipping costs versus rail to the extent that trucks will further reduce the attractiveness of rail-served industrial sites and rail transport, in general.

TREND 5: CLIMATE CHANGE

Superstorm Sandy in 2012 and the heavy rains associated with the remnants of Hurricane Ida in 2021 demonstrated the severe economic and social burdens that extreme weather can inflict upon the region's freight infrastructure and economy. Rising sea levels may inundate some low-lying areas and exacerbate storm surges. Climate change could increase the severity and frequency of extreme precipitation and temperature events.

Impacts on Freight and Logistics

- Freight movement contributes to greenhouse gas emissions, which is a contributing cause of global climate change.
- Extreme weather can disrupt the movement of freight and compromise some of the region's transportation infrastructure. Such disruptions can affect the availability of various goods, decrease the reliability of the transportation system, and increase the cost of transporting freight.

Impacts on Land Use

- 7% of the region's industrial land is in low-lying coastal areas or river valleys prone to flooding, which is not an insignificant proportion.
- In areas prone to flooding and/or rising seas, flood protections may be needed, or some facilities may need to be relocated to less-vulnerable areas. In the latter event, there may be increased demand for the development of freight-generating and freight-handling facilities in areas that are less vulnerable to flooding.

TREND 6: POPULATION GROWTH AND DISTRIBUTION

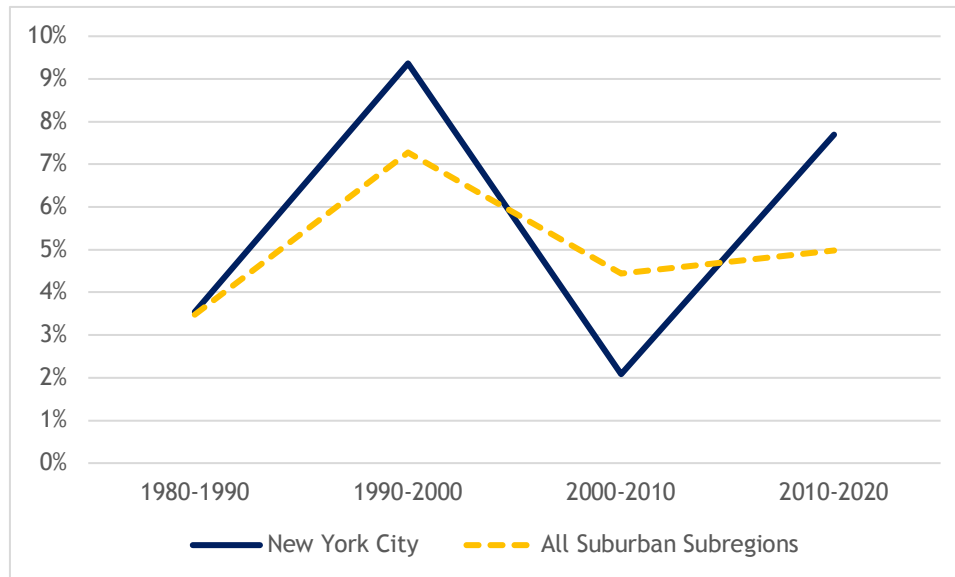
. Between 2010 and 2020, population growth in the multi-state New York City metropolitan region had been greatest in the urban core areas (New York City; Hudson County, NJ; etc.), reversing the trend of suburban sprawl that had occurred through the second half of the 20th century.

Figure 7 shows the population growth for each decade since 1980.

The 2020 Census revealed that the population of New York City had increased nearly 8 percent (or nearly 630,000 people) between 2010 and 2020, which is more than 3 times the growth observed during the previous decade. The population of Hudson County, New Jersey, a very urban and densely populated county, increased by 14.3% to nearly 725,000 people between 2010 and 2020. At the same time, the population of suburban and rural

portions of the Study Area increased by about 5%.

Figure 7 Population Growth by Decade, NYC and Suburban/Rural Subregions, 1980-2020



Source: U.S. Census Bureau

Since 2020, during the COVID-19 pandemic, however, Census estimates show a shift in population growth toward suburban and rural areas, and to locations outside the region altogether. Recent evidence suggests that the population of New York City may be rebounding.³ Whether estimations between decennial Census years are accurate, and/or whether estimated trends persist throughout the remainder of the decade, remain to be seen.⁴ The long-term outlook may be influenced by:

- Long-term work-from-home status for many office-based jobs;
- International immigration, which has boosted population growth in this region in the past, has decreased in recent years.⁵

³ <https://www.bloomberg.com/graphics/2022-manhattan-real-estate-moving-data/#:~:text=More%20People%20Are%20Moving%20to%20Manhattan%20Than%20Before%20the%20Pandemic&text=New%20York%20City%20is%20making,many%20NYC%20neighborhoods%20has%20reversed>.

⁴ "Population Estimates For New York City and Boroughs as of July 1, 202" available from: <https://www1.nyc.gov/assets/planning/download/pdf/planning-level/nyc-population/new-population/current-population-estimates-2021.pdf> (accessed April 13, 2022).

⁵ [https://www.census.gov/library/stories/2021/12/net-international-migration-at-lowest-levels-in-decades.html#:~:text=Net%20international%20migration%20\(NIM\)%20added,2021%20population%20estimates%20released%20today](https://www.census.gov/library/stories/2021/12/net-international-migration-at-lowest-levels-in-decades.html#:~:text=Net%20international%20migration%20(NIM)%20added,2021%20population%20estimates%20released%20today).

- The cost of living is often cited as a reason for the region's long ongoing domestic migration outflow.⁶

Impacts on Freight and Logistics

- Population size is closely related to the size of the economy and demand for freight.
- Demand for freight will dictate the sizing and quantity of logistics assets such as ports, airports, railway terminals, warehouses, and transportation equipment.
- Population growth in other parts of the country could also impact freight flows in this region, as the region is a major international trade gateway for goods traveling to and from other parts of the country.

Impacts on Land Use

- More freight demand supports the demand for industrial and commercial real estate to serve the distribution needs of that freight.
- If population growth is focused in one portion of the region versus another, freight demand (and the facilities needed to distribute that freight) will shift to places where the increased demand is best served. If the population shifts to suburban and rural areas (a "sprawl" scenario), more demand for freight facilities in suburban and rural areas would likely follow, leading to a "freight sprawl".. Population growth in the urban core would support more development of distribution facilities in and near the urban core. These trends would impact not only locations of development, but also the volume of freight traffic on the highways, streets, and rail lines that provide access to these areas.

TREND 7: RETAIL CENTER REPURPOSING

As described in the Trend 1 discussion on e-commerce demand, there is increased importance on distribution staging closer to end markets, with an emphasis on delivery more than storage. The demand for close-in facilities is met with urban infill - which simply means development or redevelopment in areas that are mainly built out - and it represents a major shift from practices of the past decades.

This is leading to several responsive strategies, such as repurposing existing facilities, such as to change the allocation of space used for e-commerce fulfillment versus showroom and/or stockroom space, and companies leasing out portions of underutilized space. Redevelopment and/or repurposing is possible for properties such as shopping malls, and

⁶ <https://statchatva.org/2016/04/18/age-and-migration-nyc/>; https://www.nytimes.com/interactive/2014/08/13/upshot/where-people-in-each-state-were-born.html#New_York; <https://www.aeaweb.org/articles?id=10.1257/jep.25.3.173>.

vacant big-box stores (also known as “dark stores”).

Impacts on Freight and Logistics

- Establishes fulfillment centers close to population centers where land for new construction may be limited
- Enables the decrease of time needed for final mile delivery
- Enables use of non-traditional transportation equipment in e-commerce last mile delivery such as cargo bikes and electric scooters.

Impacts on Land Use

- At the facility level, a former retail store repurposed for e-commerce fulfillment would generate more inbound/outbound truck/delivery vehicle trips than personal auto trips.
- Personal auto and transit trips during employee shift changes (not for shoppers arriving/departing throughout the day) would have to be accommodated.
- Some retail stores are becoming partial fulfillment centers (portion of sq footage for fulfillment, but still open as a retail storefront)
- This repurposing activity may or may not require zoning changes, depending upon the activity and the local zoning regulations.

TREND 8: SUPPLY CHAIN FLUIDITY AND RESILIENCE

Recent growth in demand for consumer products and other goods, combined with the challenges of producing, transporting, and processing shipments of those goods in a COVID-19 environment, has presented many challenges to logistics companies, carriers, and shippers. These challenges have led many companies to reevaluate their sourcing decisions to mitigate the risk of disruption.

The initial effects of the pandemic were impacting supply chains as early as late 2019 when the virus was spreading through parts of China. By 2019, Chinese manufacturing accounted for 29% of global manufacturing.⁷ The pandemic disrupted the production and operations of logistics systems and ports in China, thus affecting supply chains that stretch across the globe.

As the pandemic spread throughout the world in early 2020, new challenges arose. Mandated “lockdowns” in many countries, and social distancing measures in the U.S. led to widespread shutdowns or slow-downs affecting every industry, including manufacturing,

⁷ <https://www.statista.com/chart/20858/top-10-countries-by-share-of-global-manufacturing-output/>

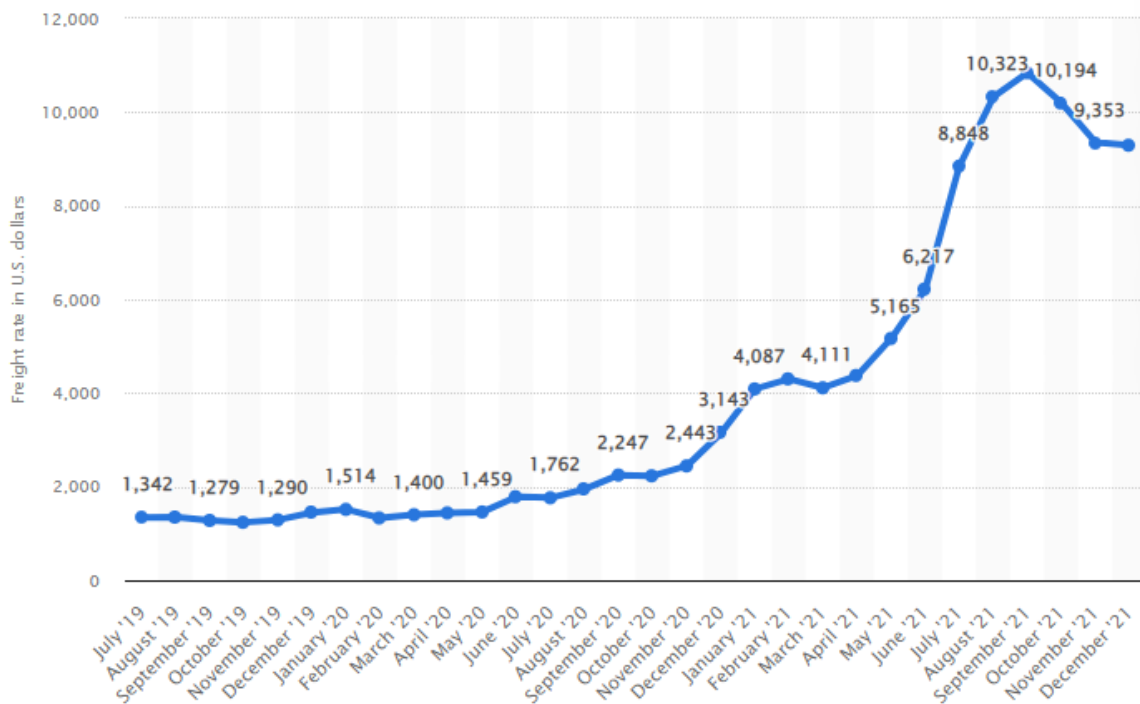
warehousing, and transportation. As consumer demand increased during the pandemic, meeting the challenges of manufacturing, transporting, distributing, and delivering goods with depleted workforces and limited capacity was a daunting task.

The turnaround time for an Asia-to-America-and-back journey, therefore, extended from four weeks to seven weeks, eight weeks, or more in some cases.⁸ In effect, the capacity of the ocean liner industry was limited due to the delays, at a time when demand was rebounding and soaring. This, along with the uneven growth between imports and exports through 2020 and 2021, led to record-high shipping container costs (topping \$15,000 from China to the West Coast in the Fall of 2020 and \$20,000 in the Fall of 2021).⁹ Figure 8 shows the global container shipping rates from July 2019-December 2021.

Figure 8 Global Container Freight Rate Index, July 2019-December 2021

⁸ <https://www.bloomberg.com/graphics/2021-congestion-at-americas-busiest-port-strains-global-supply-chain/>

⁹ <https://www.washingtonpost.com/business/interactive/2021/supply-chain-issues/>



Source: [Statista.com](https://www.statista.com)

The global supply chain disruptions have led many logistics managers to consider the merits of diversifying production locations by seeking additional production capacity in other Asian countries, and/or bringing more production back to the United States (a.k.a., “onshoring”) or to Mexico or Central America (a.k.a., “nearshoring”) to reduce exposure to disruption risks. Such decisions may take years to implement. Production capacity would have to be expanded in the new production locations, and transportation capacity may need to be reallocated to improve service to/from those locations. And in some cases, it may be simpler to build up inventory reserves than to relocate production facilities to mitigate supply risks.¹⁰

If and when the pandemic becomes a distant memory, quarter-over-quarter cost and profit could once more be the most important driving factor, and that could pressure production to relocate offshore to China or other low-cost locations once again. Apart from the pandemic, other issues such as rising labor costs in China, transit times, global politics and trade relationship issues, and other considerations may also come to bear.¹¹ It is therefore uncertain as to whether considerations of diversifying production and mitigating risk in the

¹⁰ <https://www.mckinsey.com/business-functions/operations/our-insights/how-covid-19-is-reshaping-supply-chains>

¹¹ <https://link.springer.com/article/10.1057/s42214-020-00075-5>

wake of the COVID-19 disruptions are short-term topics of interesting discussion or long-term trends that could reshape global supply chains.

Impacts on Freight and Logistics

- Sudden fluctuations in cargo volumes can produce either significant shipment delays and cost increases or on the opposite end price wars and asset underutilization.
- Supply chain uncertainty could facilitate more nearshoring or onshoring, and/or redundancy (offshore + near/onshore). Such changes will lead to a reconfiguration of shipping routes and associated investment and divestment.
- Diversified production locations can mitigate transportation risk, but also introduces challenges, such as country trade relationships, and transportation service options from those other countries to the U.S.

Impacts on Land Use

- Onshoring production could increase demand for manufacturing facilities to be redeveloped or expanded in the United States.
- As some companies have opted to increase inventories during this period of supply chain disruption, the demand for warehousing space increases. This could lead to more warehouse development.

TREND 9: CLEAN FREIGHT FUELING/CHARGING

Diesel emissions impact the natural environment through greenhouse gases and the human environment through ground-level ozone and particulate matter. The timing and extent of the transition from medium-duty and heavy-duty trucks to electric or other alternative fuel sources will be influenced by the relative costs of acquiring, fueling, and maintaining alternative fuel source vehicles.

The map in Figure 9 below illustrates highway corridors throughout the multi-state New York City metropolitan region prioritized for the needed expansion of alternative fueling and/or electric charging capacity. The map is a product of the recently completed Regional Clean Freight Corridors Study.

Figure 9 Population Growth by Decade, NYC and Suburban/Rural

be expanded. There may be increased interest in unused sites next to commercial or industrial-zoned land close to roadway interchanges.

SCENARIO ANALYSIS

The series of scenarios listed in this section describe the potential impacts of the trends listed above and changing business models on freight-related and industrial land uses. This document summarizes a high-level or “sketch planning” scenario assessment, which lays out, quantitatively where possible, and qualitatively elsewhere, projected changes in freight land use demand and development patterns based upon each key trend’s likely effects.

Each scenario is likely to impact several factors, including freight transportation mode choice, facility location (e.g., brick-and-mortar retail outlet, warehouse, distribution center, factory/production site), building specifications (e.g., size, design), supporting freight services, operations, economic effects and employment, land use regulations and zoning, and other factors.

Working with NYMTC staff and the Study Steering Committee, five of the nine trends profiled in the previous section were selected for scenario analysis:

- Growth in E-Commerce Demand (repurposing of retail buildings was merged with this trend for this assessment);
- Distributed manufacturing;
- Climate change adaptation;
- Population growth and distribution; and
- Clean freight fueling and charging.

The scenarios were presented to a group of technical advisors via a virtual focus group activity. The technical advisors included municipal planners who are responsible for enforcing land use regulations at the local level, commercial and industrial real estate representatives, freight industry representatives, and transportation planners. Technical advisors were asked to review each of the scenarios presented below and provide feedback on the anticipated outcomes, potential effects on freight land use, and/or any scenarios or impacts that the analysis may have missed.

The feedback received from the technical advisors was widely varied. On every set of scenarios, there was disagreement regarding the most likely outcome(s). This result suggests that there is a lot of uncertainty regarding the impacts of the COVID-19 pandemic long term, the health of the regional and global economy, and whether contemporary trends are likely to persist far into the future.

GROWTH IN E-COMMERCE DEMAND SCENARIOS

E-commerce has increased its share of retail sales in the past decade, from 5% of retail sales in 2012 to 13% in 2021, impacting supply chains by increasing demand for warehousing and fulfillment center development. This increased demand could further current industrial real estate trends: new industrial buildings could be constructed on industrial and agricultural lands, older industrial buildings could be modernized or redeveloped, and/or commercial spaces could be repurposed to facilitate e-commerce logistics.

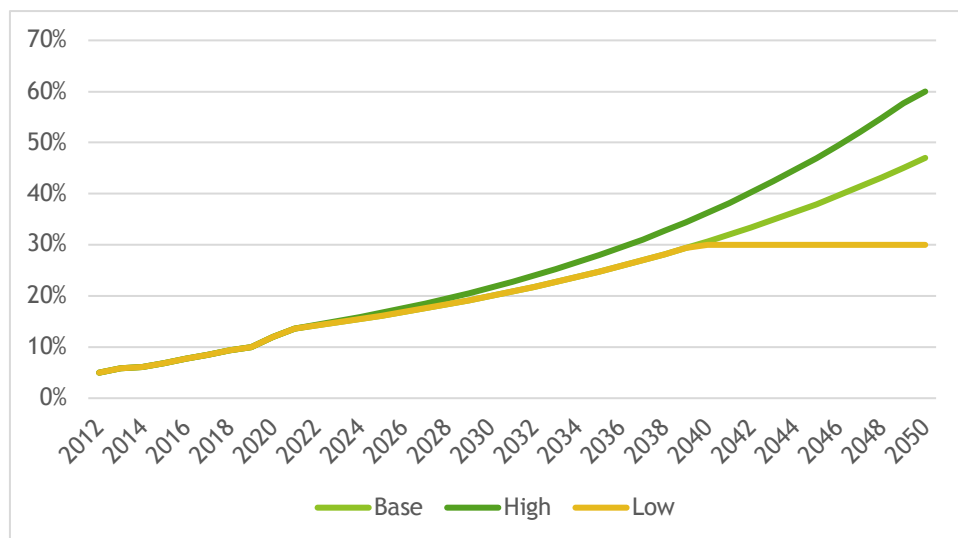
The map below illustrates the current distribution of industrial, agricultural, and commercial land uses across the Metropolitan Area Planning (MAP) Forum region in New York, New Jersey, Connecticut, and Pennsylvania.

Potential e-commerce future demand scenarios include:

1. Low-growth Scenario: E-commerce sales increase by 350% and represent 30% of total retail sales by 2050, and the corresponding requirement for warehousing space to stage, fulfill, and ship orders increases by 250%.
2. High-Growth Scenario: E-commerce sales increase by 900% and represent nearly 60% of total retail sales by 2050, and the corresponding requirement for warehousing space to stage, fulfill, and ship orders increases by 650%.

Figure 10 shows a range of potential e-commerce demand growth scenarios. The low-growth scenario assumes e-commerce achieves 30% retail sales share by 2040 and then remains capped at 30% of retail sales thereafter. This scenario assumes that a sizable proportion of retail sales will continue to be made in brick-and-mortar stores due to consumer preference, economic, public policy, or other reasons. The high growth scenario assumes a continued robust rate of growth in e-commerce market share, achieving 60% of retail sales by 2050.

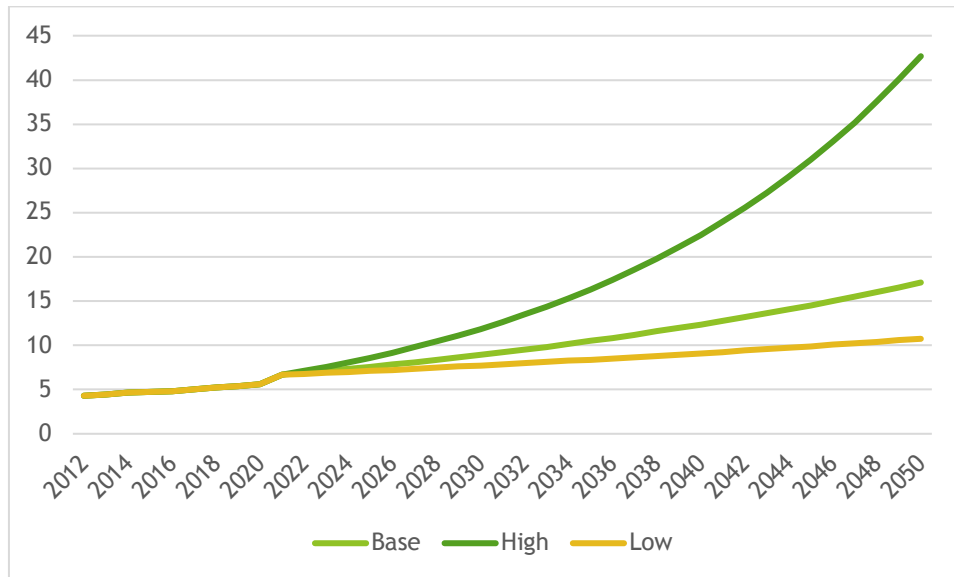
Figure 10 E-Commerce Growth Scenarios (E-Commerce as Percent of U.S. Retail Sales, 2012-2050)



To estimate total retail and total e-commerce sales in each scenario, the compounded annual growth rate (CAGR) in total U.S. retail sales between 2012 and 2019 was

calculated.¹² This pre-COVID rate of retail sales growth was assumed to be a “baseline” scenario upon which a “baseline” future could be estimated. The “high growth” scenario assumed that the increase in consumer sales observed during the COVID-19 era would continue for the foreseeable future. A doubling of the pre-COVID CAGR represents this very aggressive “high growth” scenario. A more pessimistic low-growth scenario assumes that the CAGR in total retail sales through 2050 averages half of the pre-COVID growth rate. Figure 11 shows the divergence of the estimated future retail sales based on these two outlooks.

Figure 11 Estimates of Total U.S. Retail Sales in High- and Low-Growth Scenarios Through 2050 (trillions of U.S. Dollars)

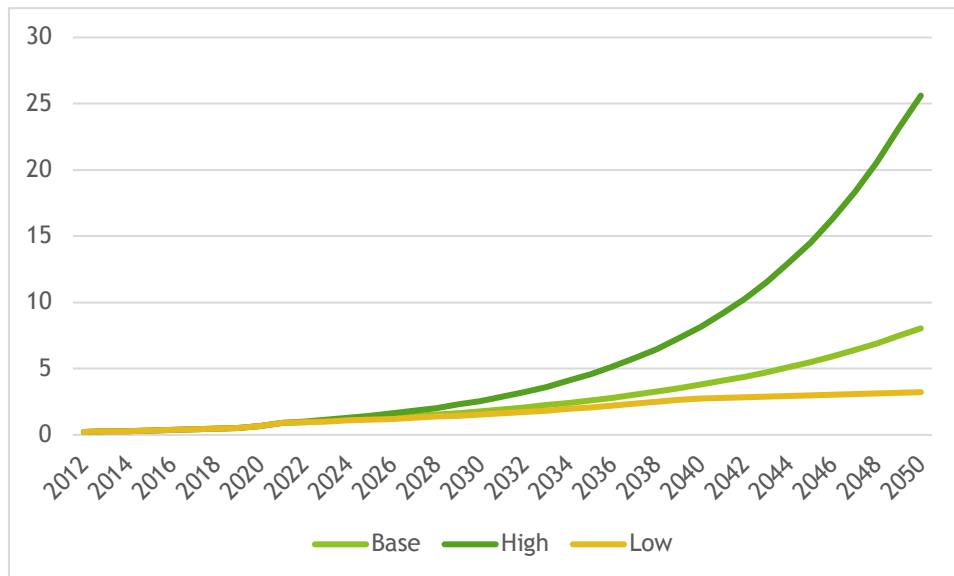


Combining the low-to-high retail sales estimates with the low-to-high market penetration assumptions for e-commerce as a percent of total retail sales produces an outlook of a low scenario, representing low retail sales growth and low market penetration for e-commerce (30%), and a high scenario, representing high retail sales growth and high market penetration for e-commerce (60%).

Figure 12 shows the range of potential e-commerce sales in the U.S. between these scenarios. In the low scenario, there would be \$3.2 trillion in e-commerce sales in the U.S. in 2050. In the high scenario, there would be \$25.6 trillion in e-commerce sales in the U.S. in 2050.

¹² Retail Trade, U.S. Census Bureau, available from: <https://www.census.gov/retail/index.html> (accessed March 22, 2022).

Figure 12 Estimated E-Commerce Sales in the U.S. through 2050, Low and High Scenarios (trillions of U.S. Dollars)



Growth in retail sales demand in the United States would generate demand for more warehousing and distribution center space to support the movement of goods from international trade gateways to retail stores and other outlets. The order fulfillment, distribution, and staging for delivery of e-commerce shipments require more space per dollar or ton of freight than traditional retail distribution. How much space may be required to accommodate the demand estimated in this analysis?

Prologis estimates that 1.2 million square feet of warehouse or distribution center space are required to support every \$1 billion of e-commerce sales.¹³ This ratio served as the basis for an estimation of the industrial space required to accommodate the estimated future e-commerce demand. Over time, it is reasonable to assume that productivity, defined in this case as throughput per square foot, may improve over the next 28 years. Thus, a 20% improvement in the Prologis ratio was assumed in the development of this estimation.

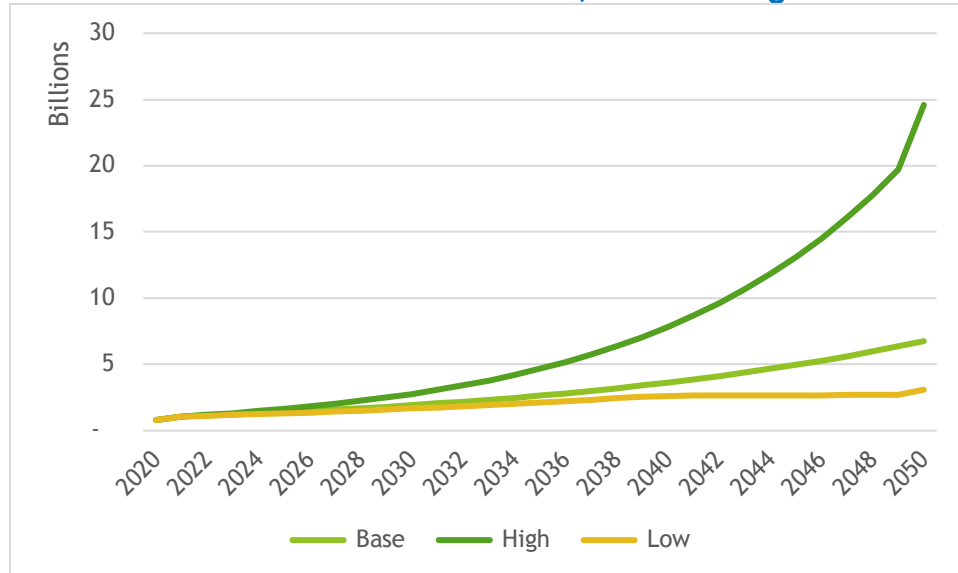
In the low scenario, 3.1 billion square feet of warehousing and distribution center space would be needed to accommodate the 2050 e-commerce sales estimate. In the high scenario, 24.6 billion square feet would be required. These estimates are national, and it is important to note that not all of this space would have to be built new. Some existing warehousing and distribution center space that serves traditional retail or other purposes

¹³ <https://www.cnbc.com/2020/07/09/us-may-need-another-1-billion-square-feet-of-warehouse-space-by-2025.html>

may shift into serving e-commerce logistics. In some cases, vacant or underutilized retail or office buildings are being repurposed to serve e-commerce logistics.

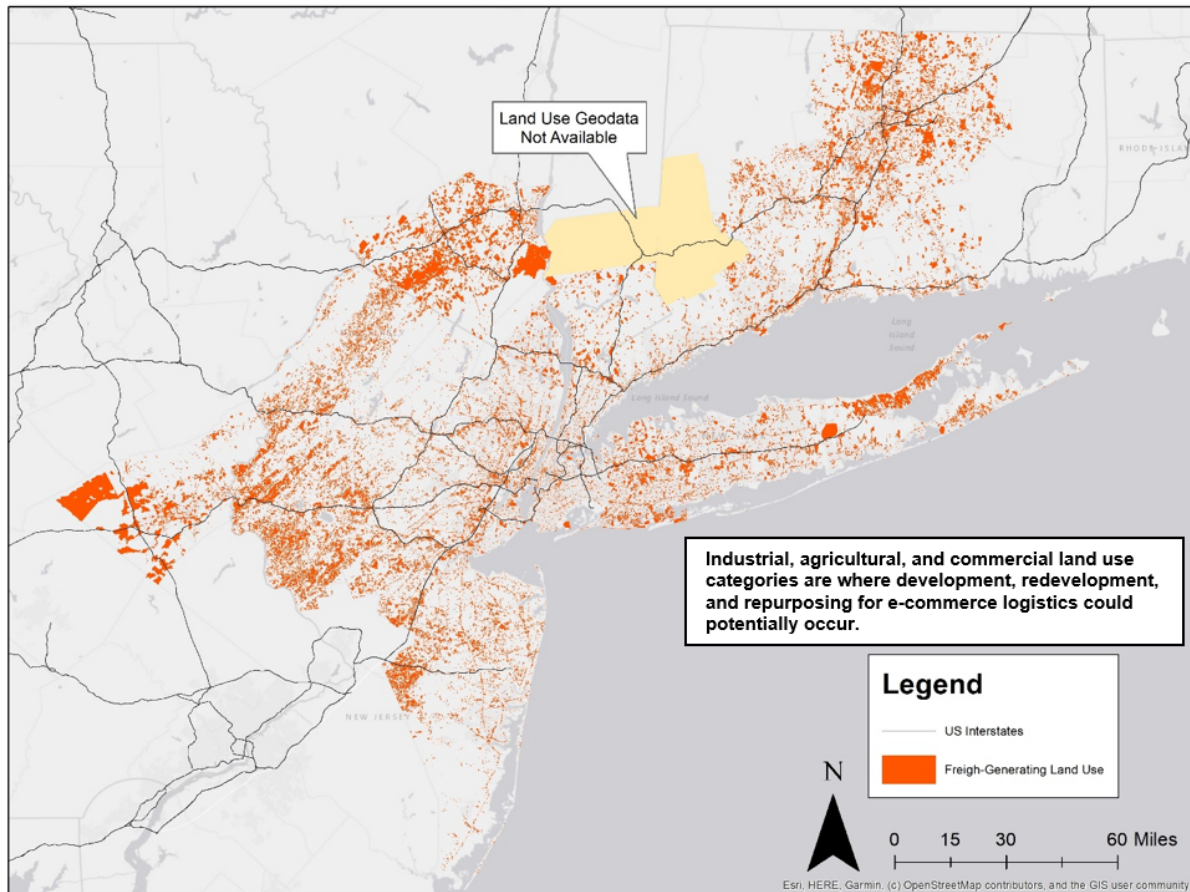
Figure 13 shows the estimated increase in square footage required to accommodate future e-commerce demand, nationally, in each scenario. Figure 14 shows industrial, agricultural, and retail lands where the development of new buildings and/or the repurposing of existing buildings to support e-commerce could occur within the Study Area.

Figure 13 Estimated Warehousing Square Footage Required to Support the Estimated E-Commerce Sales in 2050, Low and High Scenarios



As e-commerce grows to accommodate consumption trends, housing affordability presents an issue of concern, as the workforce needed to operate fulfillment centers may encounter difficulties finding housing in or near high-cost urban core communities. A workforce availability gap may emerge and/or grow over time, which could put strains on e-commerce companies, increase the cost of delivering goods, and/or affect the ratio of sales made via e-commerce versus traditional retail going forward.

Figure 14 Locations of Industrial, Agricultural, and Commercial Land Use, Categories Which Could be Most Impacted by E-Commerce Growth



DISTRIBUTED MANUFACTURING SCENARIOS

Distributed manufacturing (DM) refers to the potential for three-dimensional (3D) printing to permit efficient goods production near the points of demand, which would lead to the establishment of many small factories located in and serving many local markets. This would contrast with the historical need for factories to achieve economies of scale through mass production, and the location of fewer, larger plants located near raw materials and affordable skilled labor. As a result, shipments to the multi-state New York City metropolitan region of large volumes from some external sites in the U.S. or abroad might be replaced by local shipments from points of production inside the region.

Shipments to the Multi-state region market of large volumes from some external sites in the U.S. or abroad might be replaced by local shipments from points of production inside the region.

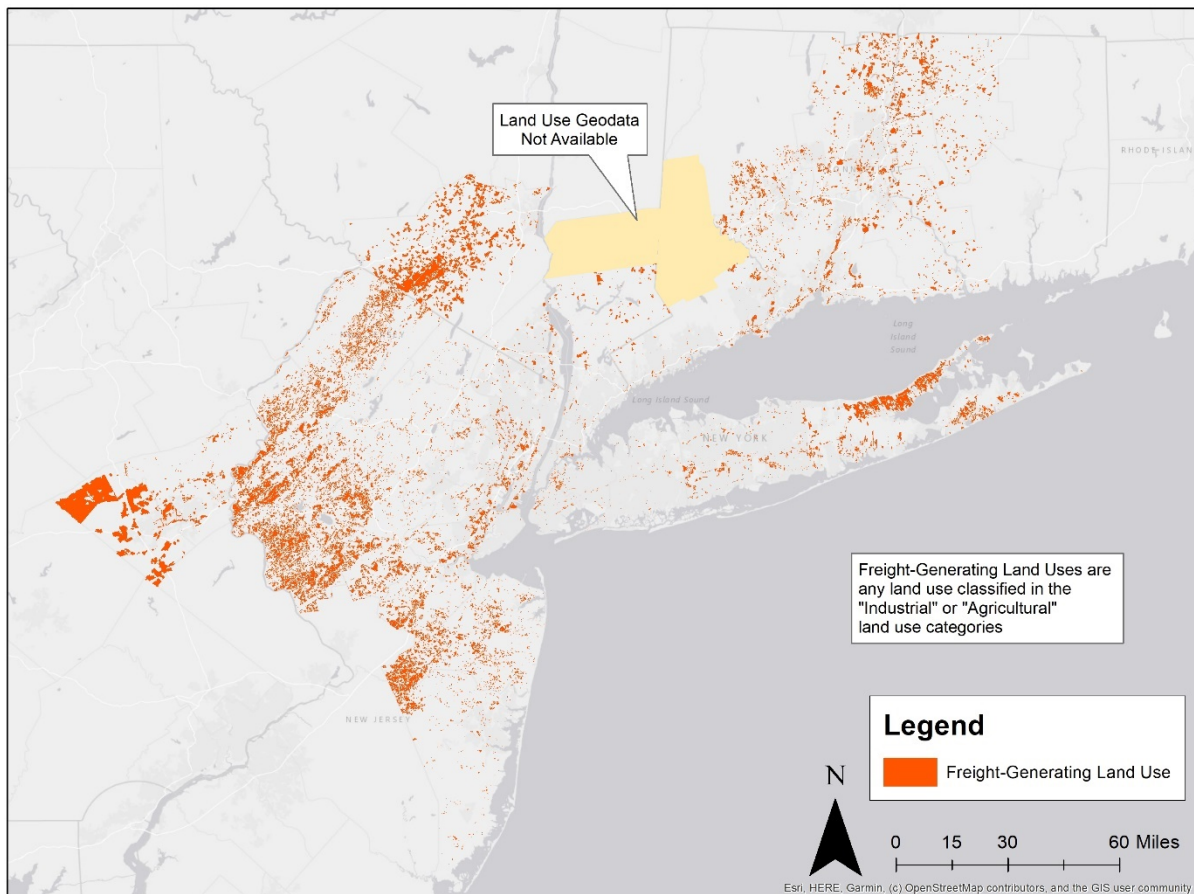
The future role of DM in the region could include one or more of the following potential scenarios:

1. DM could facilitate onshoring of production (i.e., relocating some manufacturing from overseas to the U.S.) of some goods, particularly replacement parts, healthcare

products, and construction materials. This activity could occur in industrial zones throughout the region.

2. Figure 15 shows the distribution of industrial zones and agricultural areas, many of which could potentially be developed for industrial use, throughout the Study Area. These areas are where impacts from Scenario 1 would most likely be observed.
3. DM could facilitate a cottage industry of "make-at-home" parts and goods (including consumers making their own, or entrepreneurs producing at a small scale) in industrial, commercial, residential, or other locations throughout the region;
4. DM could remain a "niche" activity with no measurable impact on production, logistics, and/or land use.

Figure 15 Locations of Industrial and Agricultural Land Use, Categories Which Could be Most Impacted by Distributed Manufacturing Scenario 1.



CLIMATE CHANGE ADAPTATION SCENARIOS

Superstorm Sandy in 2012 and the heavy rains associated with the remnants of Hurricane Ida in 2021 demonstrated the severe economic and social burdens that extreme weather can inflict upon the region's freight infrastructure and economy. Rising sea levels may

exacerbate storm surges and climate change could increase the severity and frequency of extreme precipitation and temperature events.

Approximately 9% of the freight-generating and freight-handling land and approximately 7% of freight-receiving land in the multi-state New York City metropolitan region is within a Special Flood Hazard Area, as defined by FEMA, as Table 1 shows.¹⁴

Table 1 Percent of Land Area by Freight Land Use Category at Greatest Risk for Flooding

Land Use Category	Special Flood Hazard Area
Freight-Generating Lands (<i>industrial, agricultural</i>)	9.1%
Freight-Handling Lands (<i>marine terminals, rail yards, transportation infrastructure</i>)	8.9%

Source: FEMA, analysis by Cambridge Systematics

Table 2 shows the percent of freight-generating land use area and freight-handling land use area in the Study Area that could be impacted by sea level rise. If seas were to rise by one foot, which is a commonly assumed rise in sea levels by 2050¹⁵, approximately 0.2% of freight-generating lands and 0.6% of freight-handling lands in the Study Area would be inundated. Sea level rise projections to 2100 vary substantially. Many experts anticipate a sea level rise of 3-5 feet by 2100, though others assume more or less.¹⁶ Assuming a five-foot rise in seas, about 1.2% of freight-generating lands and 2.9% of freight-handling lands would be impacted. While these appear to be small proportions of the region's freight lands, they contain thousands of acres of land and millions of square feet of warehousing, manufacturing, and transportation infrastructure.

¹⁴ <https://www.fema.gov/about/reports-and-data/data-visualizations>

¹⁵ <https://www.noaa.gov/news-release/us-coastline-to-see-up-to-foot-of-sea-level-rise-by-2050>;
<https://www.globalchange.gov/browse/multimedia/projected-sea-level-rise-and-flooding-2050>;
<https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level>.

¹⁶ <https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level>;
<https://oceanservice.noaa.gov/hazards/sealevelrise/sealevelrise-tech-report.html>;
<https://earthobservatory.nasa.gov/images/148494/anticipating-future-sea-levels>;
<https://nca2014.globalchange.gov/report/our-changing-climate/sea-level-rise>;
<https://www.theatlantic.com/science/archive/2019/01/sea-level-rise-may-not-become-catastrophic-until-after-2100/579478/>;

Table 2 Percent of Land Area by Freight Land Use Category Affected by Sea Level Rise

Land Use Category	Sea Level Rise: 1 foot	Sea Level Rise: 5 feet
Freight-Generating Lands <i>(industrial, agricultural)</i>	0.2%	1.2%
Freight-Handling Lands <i>(marine terminals, rail yards, transportation infrastructure)</i>	0.6%	2.9%

Source: NOAA, analysis by Cambridge Systematics

In response to the risks associated with flood events and rising seas, there are two potential future scenarios regarding freight land use:

1. Industrial real estate developers, landowners, and others invest in constructing flood walls or other preventative measures to protect land and facilities that generate, receive, and/or handle freight. This increases development and real estate costs.
2. Freight-generating and freight-handling land uses are relocated to areas less prone to flooding or sea level rise. This could spur new development in parts of the region that may or may not have clusters of freight-generating or freight-handling facilities at present.

A third scenario, involving a combination of both approaches, is also a potential outcome.

POPULATION GROWTH AND DISTRIBUTION SCENARIOS

In general, freight demand, especially demand for consumer commodities (e.g., food, electronics, household goods, apparel, etc.) follows population growth. Since 2000, population growth in the multi-state New York City metropolitan region had been greatest in the urban core areas (New York City; Hudson County, NJ; etc.), reversing the trend of suburban sprawl that had occurred through the second half of the 20th century.

However, since 2020, during the COVID-19 pandemic, Census estimates show a shift in population growth toward suburban and rural areas, and to locations outside the

“WE’VE SEEN GIGANTIC LEASES, HIGH-DENSITY LEASES, SIGNED IN BROOKLYN, QUEENS AND MARKETS AROUND NEW YORK CITY. AND WHAT’S REMARKABLE ABOUT THOSE IS THERE ARE RENTS THAT ARE EQUAL TO OFFICE BUILDING RENTS, BECAUSE BEING CLOSE TO THAT CLUSTER, FOR THAT LAST MILE, IS SO CRITICAL.”

Craig Meyer, President of JLL’s Americas Industrial Division, in an interview with CNBC, available from:
<https://www.cnbc.com/2021/07/01/warehouse-demand-at-unprecedented-levels-in-cities-like-savannah-jll.html>

region altogether.¹⁷ There remains uncertainty and disagreement regarding the long-term effects of the pandemic and “work-from-home” corporate culture on population growth and distribution within the Study Area.

The precise impact of population trends on freight land use is difficult to determine, as forecasting warehousing demand based on population growth as a driver is quite difficult to accomplish. Population certainly is an important variable for last-mile distribution center and fulfillment center demand. However, a sizable portion of industrial real estate development is related to traffic coming in/out of the Port, manufacturing, and regional/national distribution that are affected by population growth, trade, economic, and other factors inside and far beyond the Study Area.

Three population growth scenarios have been developed, and the anticipated effects of each on freight land use are as follows:

1. **Centralized Population Growth:** The longer-term population growth trend (pre-pandemic) returns, and the urban core continues to see the most population growth. In this scenario, distribution centers may continue being developed in exurban and peripheral areas, many of which may serve regional or national distribution, and/or international trade gateways (ports, airports, etc.). The higher costs of acquiring, developing, or redeveloping land and brownfields may be justified by having access to the large consumer market and being able to offer same-day or next-day delivery service.
2. **Suburban Population Growth:** The pandemic-induced suburban and rural population growth trend continues with a corresponding increase in widely spread distribution and fulfillment centers to serve a more widely distributed consumer market. There may be less urban development, redevelopment, and brownfield redevelopment as a result.
3. **Stagnation/Out-Migration:** Population growth in the entire region stalls relative to other regions of the country, with less demand for and development of e-commerce fulfillment and last-mile distribution centers. Demand for facilities that serve mega-regional or national distribution and/or facilitate imports/exports from the region's international gateways to and from consumers in other regions of the country may increase.

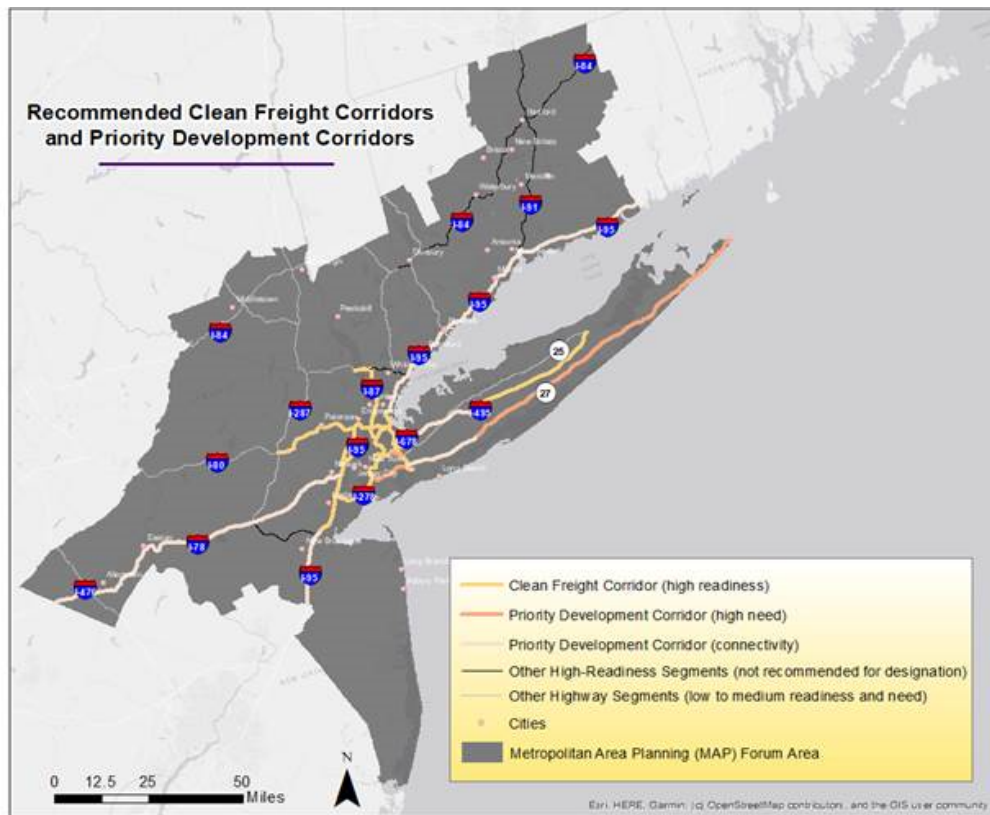
¹⁷ “Population Estimates For New York City and Boroughs as of July 1, 202” available from: <https://www1.nyc.gov/assets/planning/download/pdf/planning-level/nyc-population/new-population/current-population-estimates-2021.pdf> (accessed April 13, 2022).

CLEAN FREIGHT FUELING/CHARGING SCENARIOS

Diesel emissions impact the natural environment through greenhouse gases and the human environment through ground-level ozone and particulate matter. The timing and extent of the transition from medium-duty and heavy-duty trucks to electric or other alternative fuel sources will be influenced by the relative costs of acquiring, fueling, and maintaining alternative fuel source vehicles.

NYMTC recently completed the Clean Freight Corridors Planning Study which performed analysis and developed recommendations to advance high-efficiency, low-emission alternative transportation technologies in the region's freight fleet, including infrastructure for fast electric charging for heavy-duty trucks.¹⁸ Figure 16 below illustrates highway corridors throughout the multi-state New York City metropolitan region prioritized for the needed expansion of alternative fueling and/or electric charging capacity.

Figure 16 Recommended Clean Freight Corridors and Priority Development Corridors



Source: Clean Freight Corridors Study, NYMTC, 2022

¹⁸ <https://www.nymtc.org/Regional-Planning-Activities/Freight-Planning/Clean-Freight-Corridors-Study>.

Transitioning heavy-duty trucks to electric or other fuels could potentially move at a quicker pace than transitioning private automobiles. Many companies are tuned into the cost of converting their fleets and operating and maintaining them long-term, as well as available public incentive programs at their disposal.

Potential scenarios for the widespread adoption of heavy-duty electric or alternative fuel commercial vehicles in this region, and the land use impacts of that adoption include:

1. Limited Impact: Slow transition to electric (or other alternative fuels) occurs with a correspondingly low impact on freight land use.
2. High Impact: There is robust growth in electric or other alternative fuel adoption among truck fleets, requiring the addition of alternative fuel and charging capacity at existing truck stops, service plazas, and fueling stations. New facilities may be developed at or adjacent to major terminals (ports, air cargo hubs, industrial clusters) and/or on commercial properties located along major highway corridors.