

Hunts Point Terminal Market: The Demand for Waterborne Transportation as a Part of the Outbound-Distribution System

Final Report

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Hunts Point Terminal Market: The Demand for Waterborne Transportation as a Part of the Outbound-Distribution System

Final Report

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Notice

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Key Words

Hunts Point Terminal Market, outbound-waterborne transportation, produce market, wholesale-produce market, retail-produce market, food distribution, produce distribution supply chain

Abstract

The goal of the study is to explore an alternative to the primary use of trucks for outbound delivery or pickup of food products in the New York Metropolitan Area from Hunts Point Terminal Market (HPTM). The alternative proposed is the use of waterborne transportation, e.g., barges or freight ferries, as part of the food outbound-distribution system. The study's objective is to quantify the potential demand for waterborne services from which vehicle mile savings will be determined. The waterborne vessel will be loaded with food products at HPTM and moved (self-propelled or pulled) to a strategically located predetermined site in the New York Metropolitan Area. Customers will pick up their preordered food products from this site. After the waterborne vessel is discharged, it will travel back to HPTM for the next day's operations.

Findings: An outbound, waterborne-transportation system moving produce from HPTM to its consumers will significantly reduce the surface transportation traffic and emissions in New York State east of the Hudson River. However, to obtain a reliable outbound, waterborne-operation system, a few major challenges a need to be overcome, such as trust between wholesalers, scale of produce delivered, schedule, and local delivery. Other challenges include community objections, service quality and customer relations, and the loss of toll revenues for City agencies.

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Acronyms and Abbreviations

3PWDP:	Third Party Waterborne Delivery Provider
CO ₂ :	Carbon Dioxide
HPTM:	Hunts Point Terminal Market
IFSTTAR:	French Institute of Science and Technology for Transport, Development and Networks
ITT:	International Transportation and Trade
MARAD:	Maritime Administration
N ₂ O:	Nitrogen Dioxide
NYMTC:	New York Metropolitan Transportation Council
DOT:	New York State Department of Transportation
NYSERDA:	New York State Energy Research and Development Authority
SFT:	See, Feel and Touch
USC:	University of Southern California
UTRC:	Region 2 University Transportation Research Center at City College of New York
NYCEDC:	New York City Economic Development Corporation
NYCDOT:	New York City Department of Transportation

Summary

S.1 Team Members

The project was carried out by a research team from UTRC, led by researchers from the State University of New York at Maritime College and the City College of New York. The research team includes: Shmuel (Sam) Yahalom, Ph.D., Distinguished Service Professor in the departments of Global Business and Transportation and International Transportation and Trade (ITT); Camille Kamga, Ph.D., Director of UTRC and Assistant Professor of Civil Engineering at the City College of New York; Captain Eric Johansson, Professor of Marine Transportation; and Changqian Guan, Ph.D., Professor of Supply Chain Management and Logistics. The research team was assisted by graduate and undergraduate students pursuing degrees in Global Business and Transportation, ITT, and Transportation Engineering.

S.2 Background

New York City roads and highways leading to the City are congested, in part, due to trucks delivering food products. Some of the deliveries are to the HPTM located at the Hunts Point Peninsula. HPTM is the largest fresh food distribution center in the United States. It is the source of 60%¹ of food distribution in the New York Metropolitan Area.

The daily food distribution in the New York Metropolitan Area is primarily by truck to and from HPTM. The number of daily truck movements, which includes the delivery and pickup of food products, at HPTM is reported to be 15,000 of which 12,000 are outbound. These trucks increase traffic congestion, pollution, and wear and tear of the roads. In turn, this increases the cost of living in the City, commute time, medical problems and costs, and reduced productivity to name a few negative impacts.

¹ Deputy Mayor Steel and NYCEDC Announce Hunts Point Terminal Produce Market Commits to Stay in the Bronx Until At Least 2021, Press Release, December 31, 2013, <http://www.nycedc.com/press-release/deputy-mayor-steel-and-nycedc-announce-hunts-point-terminal-produce-market-commits>

S.3 Objective and Scope of Project

The goal of the study is to explore an alternative to the primary use of trucks for outbound delivery or pickup of food products from HPTM in the metropolitan area. *The alternative proposed is the use of waterborne transportation, e.g., barges or freight ferries, as part of the food outbound-distribution system. The study's objective is to quantify the potential demand for waterborne services from which vehicle mile savings will be determined.* The waterborne vessel will be loaded with food products at HPTM and moved (self-propelled or pulled) to a strategically located predetermined site in the metropolitan area. Customers will pick up their preordered food products from this site. After the waterborne vessel is discharged, it will travel back to HPTM for the next day's operations.

S.4 Findings

An outbound, waterborne-transportation system moving produce from HPTM to its consumers will significantly reduce the surface transportation traffic and emissions in New York City east of the Hudson River.

A fully operating waterborne system functioning east of the Hudson, completely replacing the present surface transportation system, would have a net-effect estimate of:

- savings of 39,500 miles per day (10.3 million per year)
- emissions reduction of 37,300 pounds of carbon dioxide (CO₂) per day (9.7 million pounds a year)
- savings of 2,076 gallons a day (540,000 gallons per year and \$1.35 million at \$2.50 per gallon)
- savings of 1,000 to 1,500 hours of driving per day

S.5 Challenges

To obtain a reliable outbound, waterborne-operation system, a few major challenges need to be overcome, such as lack of trust between wholesalers, scale of products delivered, schedule, and local delivery. Other challenges include community objections, service quality and customer relations, and the loss of toll revenues for the City agencies. The key conclusions are highlighted as follows:

- The present operation system is minimal **trust** among HPTM wholesalers. Without trust, there is no collaboration in pooling resources together in order to establish the proposed operation.
- The present operation is dominated by small individual trucks with **on-demand** delivery schedules (24/7). The retailers have grown accustomed to and depend on this schedule. Altering the schedule might present a problem. Another question that arises is: Will the outbound-distribution system work with a one-hour pickup time?

- The present operation includes produce rejection with immediate and unconditional return to the wholesalers. This implies the return of produce to HPTM by the deliverer.
- The present delivery includes a door-to-door service from the wholesaler or broker to the retailer. Modifying the “last mile” operation might be a challenge for some wholesalers, retailers, and brokers.
- At the present time, the retailer can order on the spot. This ordering alternative will not be available in a waterborne operation. It might be supplemented with a vehicle delivery.
- The waterborne operation needs to obtain high-volume shipments to make the operation economically viable.
- The new friendly landing sites for vessel discharge might raise concerns for the surrounding communities (Not-In-My Back-Yard) because of increased traffic, noise, emissions, and other factors.
- The waterborne operation’s inability to closely monitor service quality and customer relations between wholesaler and retailer creates a concern for some wholesalers.
- The toll revenue reduction from fewer bridge crossings might find objection from agencies who depend on those revenues.
- The definition, role, and function of the Third-Party Waterborne Delivery Provider (3PWDP) proposed in the study are a concern to some wholesalers.
- The Coast Guard might require compliance with security regulations and public access permits at the landing sites.

S.6 Recommendations

An outbound, waterborne-distribution system is a challenge to develop but the benefits to NYC could have very visible benefits, such as reducing traffic congestion, pollution, wear and tear of roads and bridges, as well as using the marine highway that is underutilized at this time. Indirectly an outbound-waterborne distribution will also reduce the cost of living, commute time, and medical problems and costs; in other words, an increase in productivity could be expected.

Adopting and implementing an outbound-waterborne distribution requires stakeholders’ cooperation and support. There are many stakeholders including wholesalers, retailers, and government officials at various local and State levels. A waterborne outbound food distribution should be an important undertaking by authorities in populated areas with rich waterway alternatives. The challenges and complexities could be overcome with government leadership.

The implementation of an outbound, waterborne-distribution system should be gradual, starting in Brooklyn. Brooklyn has the appropriate facilities in place for this type of operation and, after the Bronx, it is the largest consumer of produce from HPTM. These two factors make Brooklyn the most appropriate candidate to start the operation.

Once the waterborne operation is fully operational, it will reduce the number of vehicles from the main roads and mitigate all associated externalities, which are mostly negative. However, there will be an increase in traffic in areas near the offloading location. The actual amount of traffic increase from pier to retail business will be determined by the quantity of produce delivered, type of truck, and time of day.

The conclusions and recommendations for this preliminary study of the potential demand for waterborne outbound-produce distribution from HPTM indicate that there are severe multiple challenges in developing an outbound-produce distribution from HPTM to New York Metropolitan Area sites east of the Hudson. Thus, it is difficult to envision them resolved in the near future.

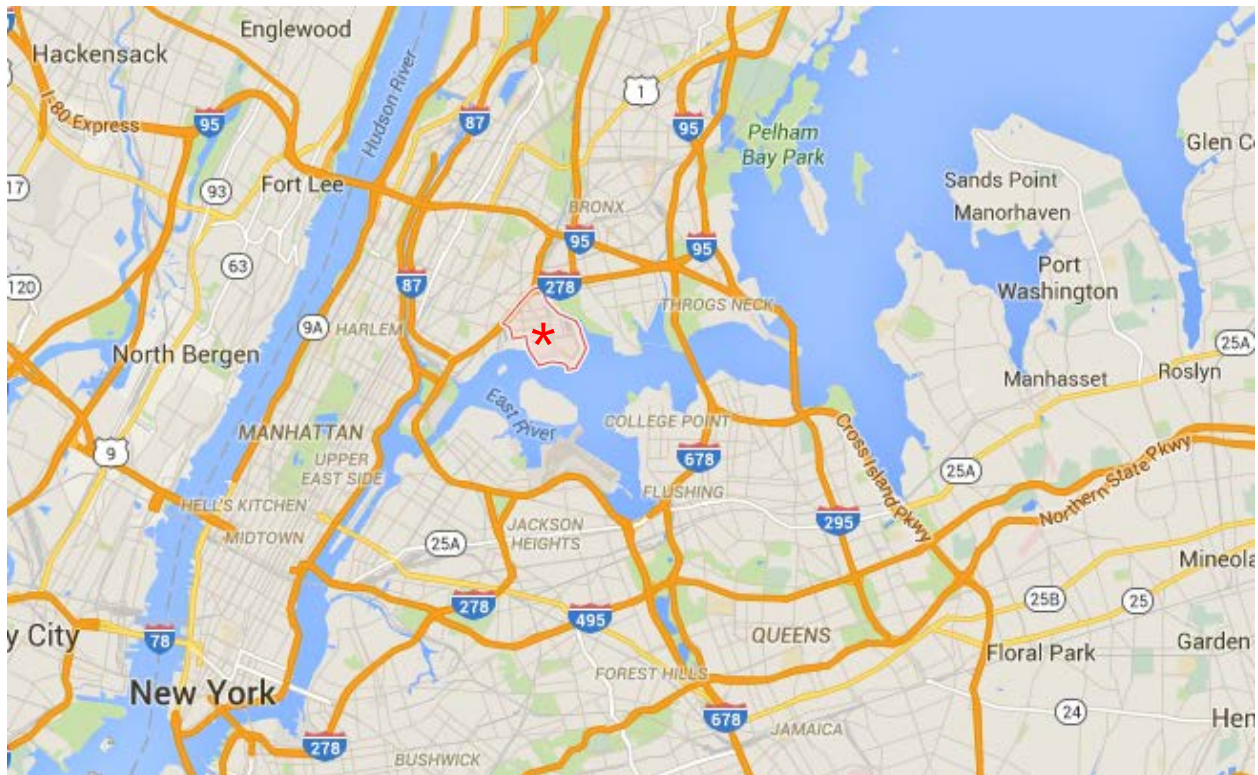
1 Background

Hunts Point Food Distribution Center, also referred to as Hunts Point Terminal Market, is the center or hub for food distribution for the New York Metropolitan Area. Hunts Point Peninsula is located in southeastern Bronx, adjoining the East River at the mouth of the Bronx River (Figure 1) and a few major highways. The Bruckner Expressway (I-287) borders Hunts Point and the Cross Bronx (I-95) and Sheridan Expressway (I-895) are nearby. Hunts Point has both deep water (50 feet) access on the East River and shallow water access on the Bronx River. The HPTM is the source of food for the regional transportation network and the pass-through traffic to and from New England. Hunts Point Peninsula is also home to over 40,000 residents (see Box 1 for more on Hunts Point Peninsula profile).²

² Hunt's Point, New York Daily Photo, January 9, 2009, file:///C:/Users/sy/Documents/PROJECTS%20-%20ACTIVE/Hunts%20Point/Hunt%E2%80%99s%20Point%20%20%20New%20York%20Daily%20Photo.htm

Figure 1. Hunts Point location

Source: Google map



HPTM is a cooperative owned by stockholders and has a long-term lease with the City of New York. The City extended the contract with HPTM to 2021 expecting to keep the 3000 direct jobs in the market. Furthermore, “Mayor de Blasio just announced an investment of \$150 million over 12 years to modernize the buildings and facilities, activate underutilized space, and provide space for dozens of small businesses to set up shop at the distribution center.”³

³ “Mayor de Blasio Announces \$150 Million Investment in Hunts Point Food Distribution Center”, NYCEDC, March 06, 2015, <https://www.nycedc.com/blog-entry/mayor-de-blasio-announces-150-million-investment-hunts-point-food-distribution-center>

The HPTM distribution center (Box 2 for HPTM profile and Figure 2 for HPTM’s map) is a vital part of the food supply chain in the New York Metropolitan Area. Distributors, brokers, firms (restaurants, caterers, grocery stores, and others) and firms’ agents arrive at the food distribution center to select and pick up food daily. Some food is ordered in advance; therefore, it is only picked up. The food is hauled away by vehicles including: minivans, pickup trucks, vans, trucks (2 axles to 6 axles), or other commercial vehicles, many of which are refrigerated. Two types of truck trips are made to and from HPTM:

- The inbound-truck trip is for delivering food products to the distribution center (56% from west of the Hudson River and 44% from east of the Hudson River).⁴
- The outbound truck trip is for hauling food products from the distribution center to grocery stores, restaurants, and other food venues (17% to west of the Hudson River and 79% to east of the Hudson River).⁵
- The outbound truck trips are 80% of total truck trips generated by HPTM.⁶ This implies that from the total 15,000 daily truck trips, 12,000 are outbound.

Box 1. Hunts Point Peninsula Food Distribution Profile

Business profile (Hunts Point Anaerobic): over 670 public and private wholesalers, distributors and processing businesses for produce, meat, and fish.

Size (Hunts Point Peninsula): approximately 690 acres.

Food Distribution Center (Hunts Point Peninsula): 329 acres.

- Employs (Deputy Mayor): 13,000 people.
- Sales (Deputy Mayor): over \$3 billion annually.

Sources:

- Deputy Mayor Steel and NYCEDC Announce Hunts Point Terminal Produce Market Commits to Stay in the Bronx Until At Least 2021, Press Release, December 31, 2013, <http://www.nycedc.com/press-release/deputy-mayor-steel-and-nycedc-announce-hunts-point-terminal-produce-market-commits>
- Hunts Point Peninsula, (Last update 1/28/2014) <http://www.nycedc.com/project/hunts-point-peninsula> (accessed 5/13/14)
- Hunts Point Anaerobic Digestion Feasibility Study, NYCEDC, R-W-Beck an SAIC Company, July 2010, Page 2-5, http://www.nycedc.com/sites/default/files/filemanager/Projects/Hunts_Point_Peninsula/HuntsPointAnaerobicDigestionFeasibilityStudy.pdf

⁴ Hunts Point – Sheridan Land Use and Transportation Study, NYCDOT, NYCEDC, NYCPLANNING, and Department of Housing and Development, Dec 2013, Page 24. http://www.nyc.gov/html/dcp/pdf/sheridan_hunt/final_full_report.pdf

⁵ Hunts Point – Sheridan, Page 24.

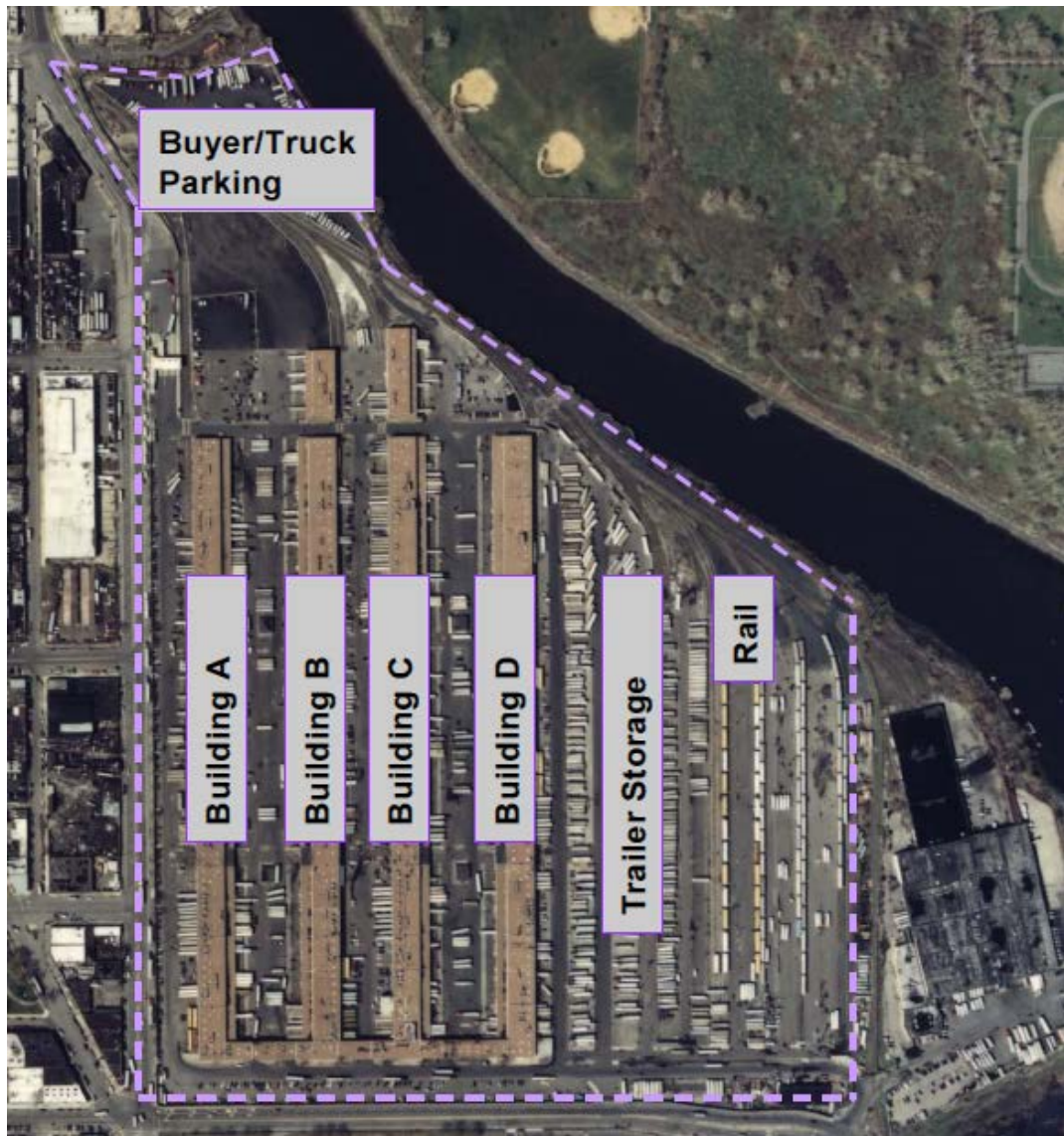
⁶ Hunts Point – Sheridan, Page 24.

As noted above, consumer demand for the distribution center's goods is handled by approximately 12,000 outbound trucks per day, including some from as far as Baltimore and Boston. Traffic flow is constant, occurring 24 hours a day, especially during the early-morning hours. There are times during the daily operating cycle when the roads leading to and from the distribution center and the terminal itself are congested.⁷ Congestion results in air pollution, noise pollution, excess road wear and tear, an increase of public spending on health and infrastructure maintenance, and other negative externalities.

⁷ Hunt Point Truck Study, URS/Goodkind & O'Dea, Inc., 2004, Page 15., HuntsPointTruckStudy_URS.pdf, https://www.dot.ny.gov/regional-offices/region11/projects/project-repository/bese/pdf/hp_p1.pdf

Figure 2. Map of HPTM

Source: New York City Economic Development Corporation



Box 2. Hunts Point Terminal Market

Profile

Facility

Landlord: New York City Economic Development Corporation
Terminal size (Hunts Point): 113 acres
Number of buildings: 4
Number of vendors (Tarleton): 42
Amount of interior space (Hunts Point): 1,000,000 square feet (60% refrigerated)
Additional number of store units: 270 (1,500 square feet each)
Number of pallets held (Zalman): 50,000
Number of employees (Hunts Point): 10,000
Receiving hours (Hunts Point): 24 hours a day
Selling hours (Hunts Point): Sun 9PM, Mon-Thus 10PM, closes Fri 3PM.

Financials

Annual rent paid by merchants (Zalman): \$4.5M
Annual sale (Hunts Point): \$2.4 Billion
Average salary of employees in 2006 (USDA): \$56,130

Operations

Produce source (Hunts Point, Tarleton): 49 states and 55 countries
Annual produce sold (USDA): 3.3 billion pounds
Number of packages of fruit and vegetables handled a year (Hunts Point): 210 million
Number of pallets of fruit and vegetables handled a year (Freight Rate): 9.6 million
Number of buyers (USDA, DiNapoli): 5,500 (in 2008) Repeat Customers (day/week) (Hunts Point – Sheridan): 86%
Inbound-delivery method (Hunts Point): plane, boat, rail, tractor trailer
Rail cars (USDA, DiNapoli): 3,200 a year
Tractor trailers visits (Tarleton): 120,000 annually
Number of vehicles (Tarleton, Zalman): 50,000 per day
Trucks (USDA, DiNapoli): 200,000 a year
Truck trips a day: 15,000 of which 12,000 are outbound trips
Vehicles (USDA, DiNapoli): 1.4 million a year
Overnight buyers with small trucks and vans (Tarleton): 1,000,000
Vehicle distribution (Hunts Point – Sheridan): 50% box vehicles, 31% vans and 19% tractor trailers

Customers

Number of restaurants in NYC (Hunts Point, Tarleton): 23,000
Population served (Hunts Point, USDA): 22 million (in 50-mile radius)
Customers reached (Tarleton): 30 million daily
The number of charities that receive food (Hunts Point): 250

Sources:

- DiNapoli, Thomas P., An Economic Snapshot of the Hunts Point Food Distribution Center, Office of the State Controller, December 2008, <https://www.osc.state.ny.us/reports/economic/huntspoint08.pdf>
- <http://urbanomnibus.net/2013/09/the-past-and-future-of-the-hunts-point-produce-market/>
- Freight Rate Modernization: Improving the Freight Rail & Transfer Facility at the Hunts Point Terminal Produce Market in the South Bronx, NY, NYCEDC, Page 5, (Accessed 5/21/2014), <https://www.dot.ny.gov/recovery/sponsors/tiger/repository/NYCEDC%20HPTPM%20Application.pdf>
- Hunts Point Produce Market, July 20, 2014, <http://www.huntspointproducemkt.com/about-us/>
- Hunts Point – Sheridan Land Use and Transportation Study, NYCDOT, NYCEDC, NYCPLANNING, and Department of Housing and Development, Dec 2013, Page 24. http://www.nyc.gov/html/dcp/pdf/sheridan_hunt/final_full_report.pdf
- Tarleton, Jonathan, The Past and Future of the Hunts Point Produce Market, The Architectural League's Urban Omnibus, The Culture of Citymaking, Sept. 17, 2013.
- USDA Daily report, <http://www.terminalmarkets.com/huntspoint.htm>
- Zalman, Jonathan, A Perishable Business, Narratively, Sept. 11, 2013. <http://narrative.ly/survivors/a-perishable-business/>

The latest New York Metropolitan Transportation Council (NYMTC) study, which includes a freight traffic assessment from 2004,⁸ indicates that trucks are the dominant mode of transportation to and from the Bronx in the year 2000 (87% inbound and 96% outbound). The study also indicates that “the commodity category ‘food and kindred products’ is the Bronx’s second-leading commodity class by weight (representing 22% of tonnage) and its leading commodity class by value (representing 18% of value). The category ‘farm products’ ranks fourth in tonnage (7%) and fifth in value (5%).”⁹ For the same study data of produce and meat market vehicle traffic see Box 3.

Box 3. Produce and Meat Market Vehicle Traffic (highlights)

The Hunts Point Truck Study collected data on the number of trucks arriving and departing the Produce and Meat Market over a 24-hour period. The key findings were:

- **Produce Market** – 1,921 inbound-truck moves (1,304 with two-axes/six-tires, 617 with more than three-axes);
- **Meat Market** – 715 inbound-truck moves; and
- **Combined** – 2,636 inbound-truck moves. Assuming each inbound move has a corresponding outbound move, the Produce and Meat markets generate 5,272 truck moves per day – around 41 percent of total truck moves for the Hunts Point Peninsula.

The Hunts Point Truck Study also performed time-of-day and origin-to-destination surveys for a sample of Produce and Meat Market truck traffic. ..., both markets show distinctive time-of-day patterns for truck traffic:

- For the Produce Market, most trucks arrive between midnight and 8:00 a.m.; most trucks depart between 4:00 a.m. and 1:00 p.m.
- For the Meat Market, arrival and departure patterns show a similar reliance on overnight trucking, with even less midday and evening travel. Most trucks arrive between 2:00 a.m. and 10:00 a.m.; most trucks depart between 6:00 a.m. and 11:00 a.m.
- Overall, this produces a pattern of trucking activity that is highest between 4:00 a.m. and 10:00 a.m., peaking between 5:00 a.m. and 9:00 a.m.

Source: Hunts Point Waterborne Freight Assessment, Prepared for New York Metropolitan Transportation Council (NYMTC) by Cambridge Systematics, Sept. 23, 2004, page 16.

⁸ Hunts Point Waterborne Freight Assessment, Prepared for New York Metropolitan Transportation Council (NYMTC) by Cambridge Systematics, Sept. 23, 2004, page 12.

⁹ Hunts Point Waterborne Freight Assessment, page 12.

Even though the NYMTC study is outdated it demonstrates the distribution of traffic by mode and the hours of operation (Box 3 and Figure 3). There is a large likelihood that the hours of operation remain similar with an increase in the number of trucks.

A Hunts Point truck study from 2004¹⁰ indicates that the peak arrival hours at the meat and produce markets were from 3:00 a.m. to 7:00 a.m. (44.4% of all the freight traffic). The peak single hour was 5:00 a.m. to 6:00 a.m. (15% of the traffic). The peak departure hours were 6:00 a.m. to 10:00 a.m. (47.3% of traffic). The single peak departure hour was 8:00 a.m. to 9:00 a.m. (15.3% of traffic). Drivers (38.4%) indicated that they come to the market a minimum of five days a week.

¹⁰ Hunt Point Truck Study, URS/Goodkind & O'Dea, Inc., 2004, pages 6 and 14., HuntsPointTruckStudy_URS.pdf, https://www.dot.ny.gov/regional-offices/region11/projects/project-repository/bese/pdf/hp_p1.pdf

Figure 3. Map of Produce Market, Meat Market, and Fish Market

Source: New York City Economic Development Corporation

New York City Terminal Produce
Market Cooperative
105 acres, 48 cooperator firms

Hunts Point Cooperative Market
(meat market)
37 acres, 37 cooperator firms

Fulton Fish Market at Hunts Point
33 acres, 31 cooperator firms



The large HPTM distribution center does not have simple and quick access. The geographical layout of the New York Metropolitan Area of highways, bridges, and tunnels along rivers and creeks complicates the surface transportation delivery. Delivery takes more miles to drive and more time to deliver. As a result, at times of peak demand, vehicles spend excessive time waiting and idling on the road wasting fuel and emitting CO₂ and other gases.

1.1 Problem Statement

The goal of the study is to explore an alternative to the primary use of trucks for outbound delivery or pickup of food products in the New York Metropolitan Area from HPTM. The alternative considered is the use of waterborne transportation, e.g., barges or freight ferries, as part of the food outbound-distribution system. The study's objective is to quantify the potential demand for waterborne services from which vehicle mile savings will be determined.

In general, the vision is a waterborne distribution via waterborne vessel in addition to the truck distribution system. The expectation is for the waterborne system to develop and grow so that it can eventually replace the existing surface transportation system. The development of the waterborne alternative is directly linked to the surface transportation congestion level in the New York Metropolitan Area; the higher the congestion, the larger the incentive of all stakeholders to seek a waterborne alternative.

In the waterborne-distribution system, the vessel will be loaded with food products at HPTM and moved (self-propelled or pulled) to strategically located predetermined sites in the Metropolitan Area. Retailers will pick up their preordered food products from these sites. After the waterborne vessel is discharged, it will travel back to HPTM for the next day's operations.

The waterborne-distribution system could save a very large number of truck miles and truck trips per day, thereby reducing fuel consumption, congestion, wear-and-tear on the roadways, and pollution.

This objective is also consistent with and reinforced by the marine highway initiative and other initiatives proposed in the long-term plan for Hunts Point, titled Hunts Point Lifeline, which states:

There are several ways in which Hunts Point can be integrated into a Marine Highway. Besides existing routes, the Maritime Administration (MARAD) periodically publishes a Call for Projects that allows local and state agencies to propose new Marine Highways. These projects receive administrative and monetary support, as well as preferential status for any future federal assistance that might be available. ... MARAD designed six proposals as “initiatives.” These proposals are defined as having enough promise to warrant continued support from the DOT and MARAD, but not enough to warrant project status and federal funding. Hunts Point is well situated for integration into two of the eight MARAD/DOT projects, and one of its six initiatives.¹¹

¹¹ Hunts Point Lifeline, Rebuild by Design, PennDesign / OLIN, April 6, 2014, pages 125-126.

2 Literature Review

The literature review includes various issues associated with wholesale produce distribution in general and HPTM in particular. A large amount of the literature review associated with HPTM is embedded in the section of discussion itself and therefore will not be in this section. The focus of the literature review is to seek information on wholesale outbound-produce distribution via waterborne means in the United States and globally. In the process, the literature review identifies wholesale outbound-produce distribution via vehicle transportation as well. Thus, the literature review is divided into a few categories.

2.1 General

The wholesale distribution system requires various rules associated with the type of product stored and distributed. Thompson and Kader (1996) describe the key factors required for storage and transport of produce. These rules drive the food storage handling and storage system and therefore the transportation system. The authors indicate, “The consumer will receive quality produce only if each operation in the handling chain minimizes abuse caused by mechanical damage, improper temperature, and relative humidity, moisture loss, ethylene damage, odor contamination, and excessive storage time.” Furthermore, “Large wholesale distribution facilities, whether independently owned or integrated with a retail chain, strive to receive only the amount of produce that can be shipped the following day.” To understand the distribution constraints, the paper identifies three categories of storage temperature for each fruit and vegetable (see produce storage temperatures in Appendix 1).¹²

In answering the question, “What are financially profitable methods of distribution linking dispersed rural producers to concentrated urban markets?” Rogoff (2014) describes generic and general characteristics and the importance of logistics and supply chain in food distribution. The study also provides distribution models and the role of different functionaries in achieving the distribution goals.¹³

¹² James F. Thompson and Adel A. Kader, “Wholesale Distribution Center Storage,” University of California, Davis, reference to Thompson, J., A.A. Kader, and K. Sylva. 1996, “Compatibility chart for fruits and vegetables in short-term transport and storage. Nat. Res. Pub. no. 21560, University of California, Division of Agriculture and Natural Resources, Oakland, CA.” <http://www.ba.ars.usda.gov/hb66/wholesale.pdf>

¹³ Jonah Rogoff, Improving Systems of Distribution and Logistics for Regional Food Hubs, October 2014. https://dusp.mit.edu/sites/dusp.mit.edu/files/attachments/project/Food%20Hub%20Report%2010_12_14.pdf

Another study that discusses freight ferries “explores the feasibility of freight ferries as a potential intra-regional waterborne alternative for truck freight movements across the Hudson River/New York Harbor.”¹⁴ The study did not address food products, but it mentions undefined niche markets.

2.2 Hunts Point Terminal Market (HPTM)

References associated with HPTM are used throughout the study. Some of the references are repeated in the literature review below.

The role of HPTM in the food supply, its characteristics, and performance information for the New York Metropolitan Area are discussed in various reports and studies. These reports and studies were also the source of information used in the introduction and food distribution sections of this article. DiNapoli (2008) addresses the economic impact of Hunts Point on food distribution. Freight rates are raised by NYCEDC (2014). HP (2014) provides some basic statistics of the facility. New York City Department of Housing and Development (2013) discusses the land use of HP Peninsula and future plans. Tarleton (2013) address the future of HPTM. Zalman (2013) talks about the perishable business.

The NYC Plan for the next 30 years highlights in general a few of food distribution characteristics the role of HPTM in the food supply (PlaNYC, 2013). The NYC plan assumes that vehicles will be used for outbound distribution.

2.2.1 A profile of some HPTM wholesalers

HPTM is home to 42 wholesalers. Among them are a few large companies that account for the majority of the businesses. The large companies include A&J Produce Corporation, Katzman Produce, Fierman, Armata, and D’Arrigo. There are about five medium size ones which include Armarte, Fierman, Rubin, Nigel Brothers, and Top Banana. All the firms occupy four large buildings (Appendix 1). Some use additional refrigerated tractor-trailer trucks for additional storage space in the HPTM yard in front of their facilities. The large companies have a fleet of delivery trucks (box and tractor-trailer trucks) of which some are refrigerated. Below are short profiles of two of the large wholesalers.

¹⁴ Allison L. C. de Cerreño, et.al., Bi-State Domestic Freight Ferries Study, Rudin Center for Transportation Policy & Management, September 2006, <https://wagner.nyu.edu/files/rudincenter/domesticFreightFerries.pdf>

2.2.1.1 A&J Produce Corp and Katzman Produce

A&J Produce Corporation (Box 4) and Katzman Produce (Box 5) are two of the largest fresh produce distributors at HPTM. They have a wide range of customers with market coverage of the Greater New York Area and beyond, including Connecticut, Massachusetts, Maryland, New Jersey, and Pennsylvania. Their customers cover the full spectrum of buyers such as big supermarkets, food distributors, big and small restaurants, bodegas, and others.

2.2.2 A profile of supply chain time operation

The retailers or their agents spend time along the supply chain when picking up produce. This includes driving to HPTM, searching for produce, negotiating the purchase, loading vehicles, driving to the retailer, and unloading the produce at the retailers before driving back. The time it takes to complete the tasks along the supply chain is not consistent; there is a large variance in certain areas such as road-trip time. However, in the interviews with retailers and agents, the answer to the question of time traveled to HPTM or back ranged from 30 minutes to 90 minutes, where a large number of individuals indicated more than an hour. The answer to time spent in HPTM ranged from two to seven hours with the majority at four hours. The agents who served multiple retailers (average of four) indicated that the total round trip could be five to seven hours with an extra hour for Manhattan. Furthermore, the time spent in HPTM for different agents also depended on the scale of their operation.

Box 4. A&J Produce Corp.

Number of employees at HPTM: 40

Company truck fleet: 6 – 7 box trucks and 10 – 12 tractor-trailer trucks.

Types of customers: big, medium, and small supermarkets; food distributors; and all sizes of restaurants.

Number of customers: Approx. 150

Commercial relationship with customers: 50/50 split, 50% orders received from brokers and 50% from end users.

Methods of customers placing orders: by phone and email.

Inbound Cargo: from 48 states as well as internationally, including: Europe, Mexico, Central and South America.

Mode of transportation for Inbound: Truck and intermodal rail (rail reefer cars direct to HPTM).

Outbound volume: 10 box-trucks/day and 20 tractor-trailer trucks/day, and about 2,000 pallets/week.

Truck turn-around time at HPTM: 30 – 45 minutes

Truck round-trip time: 5 – 6 hours to Manhattan and 6 – 7 hours for outer boroughs.

Operational pattern: inbound trucks lining up at the gate starting at 8 p.m., 9 – 10 p.m. for off-loading operations at HPTM. Outbound trucks arriving around 3 a.m. and leaving HP around 4 a.m. The overwhelming majority is one-way traffic, and a very small portion is two-way traffic.

Inventory Turnover: 2 days for wet produce (fresh) and 5 days for other food products.

Source: interview

2.3 Other U.S. Wholesale Produce Markets

A wholesale produce market with an outbound truck-delivery system is common to major U.S. cities. A sample of cities include:

- The Philadelphia Wholesale Produce Market¹⁵
- The New England Produce Center, located in Chelsea, Massachusetts, which also reports prices on line daily¹⁶
- The San Francisco Wholesale Produce Market, located at the Bay Area¹⁷
- Maryland Food Center Authority located in Jessup, Maryland¹⁸
- Quality Service Information Produce located in Los Angeles, California¹⁹
- Chicago International Produce Market is home to 22 companies²⁰
- Wholesale Produce located in Minneapolis, Minnesota²¹

¹⁵ <http://www.pwpm.net/>

¹⁶ <http://www.terminalmarkets.com/neweng.htm>

¹⁷ <http://www.sfproduce.org/home.html>

¹⁸ <http://www.mfca.info/>

¹⁹ <https://www.qsiproduce.com/>

²⁰ <http://www.chicagoproducemarket.com/>

²¹ <http://wholesaleproduce.cc/contact-wholesale-produce/>

Box 5. Katzman Produce

Number of employees at HPTM: N/A

Company truck fleet: 25

Types of customers: big, medium, and small supermarkets (Shop Rite, Whole Food, etc.); food distributors; and all sizes of restaurants.

Number of customers: N/A, there are 350 zip codes.

Commercial relationship with customers: 50/50 split, 50% orders received from brokers and 50% from end users.

Methods of customers placing orders: by phone and email.

Inbound Cargo: from 48 states and Europe, Mexico, Central and South America. There are substantial inbound intermodal volumes, about 50 refrigerated boxes/week, directly to HPTM.

Modes of transportation for inbound: Truck and intermodal rail (rail-refrigerated cars direct to HPTM, approximately 50 refrigerated boxes/week).

Outbound volume: 60 trucks/week, 14 pallets per/box-truck and 20 pallets for tractor-trailer trucks.

Truck turn-around time at HPTM: 30 – 45 minutes.

Truck round-trip time: 5 – 6 hours to Manhattan on the high end and 6 – 7 hours for outer boroughs.

Operational pattern: inbound trucks lining up at the gate starting at 8 p.m., 9 – 10 p.m. for off-loading operations at HPTM. Outbound trucks arriving around 3 a.m. and leaving HPTM around 4 a.m. The overwhelming majority is one-way traffic, and a very small portion is two-way traffic.

Inventory Turnover: 2 days for wet produce (fresh) and 3 days for other food products.

Source: Interview

2.4 Global Wholesale Produce Markets

Globally key wholesale produce distribution centers that use an outbound truck-delivery system include:

- Mexico City's Central Wholesale Produce Market. "Spread over an area of 304 hectares, deals in just about everything from fruit and vegetables, flowers, birds and meat, fish and seafood to dairy products, groceries, sweets, seeds, cereals, tinned products, raw materials and cleaning products—and countless more! In all, it generates more than eight billion dollars annually and supplies the daily needs of 20 million people. It is the country's largest business center, second only to the Mexican Stock Market."

²² <http://www.citymayors.com/development/mexico-market.html>

- Shanghai Yu Hua Fruits Co., Ltd.²³
- A detailed study by Fredoun Ahmadi-Esfahani and Christofer Locke, (1998)²⁴ describes the five main distribution centers in China (Beijing, Nanjing, Guangzhou, Shenzhen and Shanghai). All the centers have a truck outbound-distribution system.
- A short description of the Japanese wholesale sector includes the Tsukiji Market²⁵ and others.^{26,27}

The literature reviewed indicates that the only inbound food-product study for the New York Metropolitan Area using waterways was completed in 2004. The literature review also indicated that there has not been a study of outbound food distribution for HPTM, and demonstrated that the distribution of outbound food is predominantly by motor vehicle, usually by truck.

In conclusion, the extensive literature review and discussions with numerous executives from the wholesale produce distribution system indicates that the outbound distribution of produce is by vehicle, mostly truck and there is no waterborne outbound-distribution system.

²³ <http://www.yuhuafruits.com/en/default/>

²⁴ Fredoun Z. Ahmadi-Esfahani and Christopher G. Locke, Wholesale food markets with 'Chinese characteristics', Food Policy, Vol. 23, No. 1, pp. 89–103, 1998, http://202.116.197.15/cadalcanton/Fulltext/21377_2014319_101821_295.pdf

²⁵ https://en.wikipedia.org/wiki/Tsukiji_fish_market

²⁶ https://www.jetro.go.jp/ext_images/en/reports/market/pdf/2005_01_1.pdf

²⁷ https://books.google.com/books?id=_Vxcb0_zODQC&pg=PA34&lpg=PA34&dq=wholesale+produce+markets+distribution+tokyo&source=bl&ots=UcF4n4TBTm&sig=tTDWnRft1muwS-XcyVQgPNVMwLw&hl=en&sa=X&ved=0ahUKEwjAvOOdlOzMAhUQVFIKHXXyACAQ6AEIRDAE#v=onepage&q=wholesale%20produce%20markets%20distribution%20tokyo&f=false

3 Research Methodology

The research methodology included data collection and data analysis. Since data of outbound distribution is not available, the research team used a survey and interviews to collect data. Most of the data was collected via interviews.

The research team focused on zip codes. Zip code distribution is the smallest unit of location available in the public domain in the U.S. Therefore, delivery by zip code enabled researchers to determine demand in relation to outbound distribution by location and its proximity to the waterfronts.

The statistical analysis of the data provides an estimated demand of the services by zip code. The number of zip codes in the data collected is very large but it does not include all the zip codes to which produce is delivered. Estimates are used to establish a distribution pattern, which becomes the foundation for food distribution and cluster building for east of the Hudson River in order to determine the direct and indirect impact of a waterborne distribution on the region. Thus, the fact that there are a larger number of zip codes than the surveys and interviews reported might also imply that there is a larger demand per cluster than estimated in this research.

For the amount of data needed to validate the results, the well-established method of “sample size calculator”²⁸ was used. The sample size needed to obtain a confidence level of 95% at a confidence interval of 5% for a population of 5,500 is 359 (a large or unknown population requires a sample size of 384). The number of buyers’ zip code locations generated for the outbound-distribution data provided a total of 448 zip code distributions (sample size), well above the 359 needed. For the purpose of this study it is more than enough to identify potential demand for waterborne service.

The data obtained identifies the relative share of produce shipped to each zip code. The relative share is used to determine weekly demand from the total demand for HPTM produce by zip code. The locations with large produce amounts are considered for waterborne distribution if close to the waterfront.

²⁸ The Survey System, Creative Research System, <http://www.surveysystem.com/sscalc.htm#one>, for more details of sample size calculations also see, How to Determine Sample Size, Determining Sample Size, Six Sigma, <https://www.isixsigma.com/tools-templates/sampling-data/how-determine-sample-size-determining-sample-size/>

4 Food Distribution

The consumption of food is the most important component of human existence. The annual food consumption in the U.S. is almost one ton per person (Box 6). The food supply that flows into New York City is more than 5.7 million tons annually.²⁹

Box 6. Food Consumption in the U.S.

In 2010 the average American consumed almost 1 ton of food per year (1,996.3 pounds). From this total, 44.5% comes from vegetables (415.4 pounds), fruit (273.2 pounds), meat (110 pounds), poultry (73.6 pounds), and fish (16.1 pounds), and works out to be 2.43 pounds of food per person per day.

Source: <http://www.ask.com/food/many-pounds-food-average-adult-eat-day-3f49d34cd3d872cd> (accessed 5/12/16)

Outbound-food distribution, that is, from a warehouse to a customer, takes a large amount of logistics and supply chain resources. The daily quantities of food moved are very large, and they find their way to every store, food cart, food-delivery service, restaurant, hospital, school, airline, on-line grocery retailer, and university in the New York Metropolitan Area and beyond

The number of food establishments in the New York Metropolitan Area alone is in the thousands (Box 7), and the outbound food distribution to the area is exclusively via surface transportation modes. Both businesses that demand food products and distributors are large and small. The small retailers have little storage space, and therefore demand and expect just-in-time delivery.

Box 7. The Number of Food Establishments in NYC (Est.)

Restaurants bars and cafes (2014) 23,705* of which fast food (2014) are 7,151**

Sources:

** <http://www.wsj.com/articles/new-york-city-restaurants-multiply-despite-high-profile-closures-1412816142> (accessed 5/12/16).*

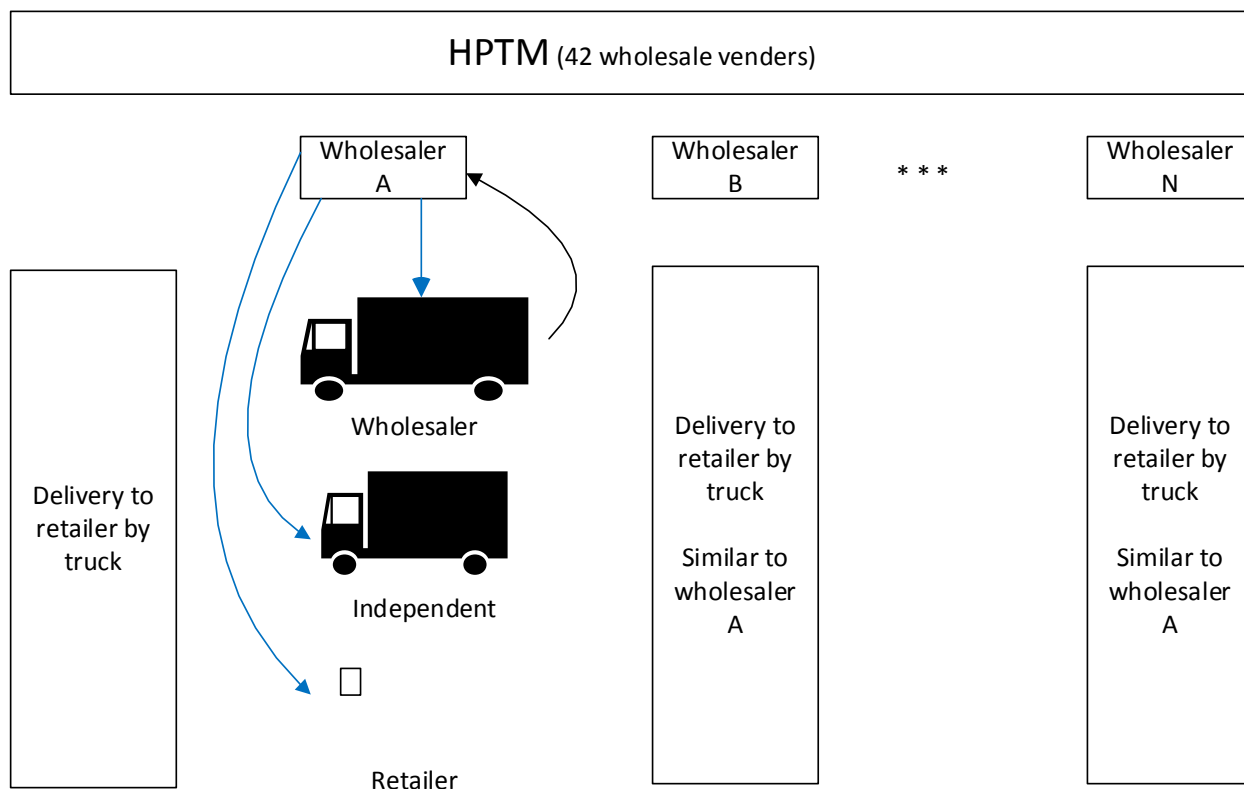
*** <https://labor.ny.gov/workerprotection/laborstandards/pdfs/5-20-statistics.pdf> (accessed 5/12/16).*

²⁹ PlaNYC, A Stronger, More Resilient New York, June 11, 2013, Ch, 13, Page. 222.
http://s-media.nyc.gov/agencies/sirr/SIRR_singles_Hi_res.pdf

The outbound food wholesalers are divided into three general categories: large, medium, and small. Some large firms' warehouses are also located in New Jersey, Connecticut, and Upstate New York. There are retailers who come directly to HPTM to purchase food products regularly:

- The large wholesalers have in-house distribution facilities and vehicles, including refrigerated vehicles. The food products are shipped inbound directly to their distribution facilities mostly via surface transportation modes. The food products are shipped outbound to retailers from the wholesalers' own distribution facilities. These large firms supply at least 95% of the produce from their warehouses and rarely use a facility such as HPTM, unless they are short an item. Wholesalers that are classified as large include: Sysco, White Rose, General Trading and Performance Food Group.
- Like the large wholesalers, intermediate wholesalers have in-house distribution facilities and vehicles. The intermediate wholesalers get the products shipped inbound directly to their distribution facilities, some of which are in HPTM. The outbound distribution is with their own vehicles (Figure 4). However, the intermediate wholesalers that are not located in HPTM use HPTM produce for outbound distribution regularly, as well. Each wholesaler decides what and how much to stock, relying on HPTM to make up the differences. Wholesalers that might be generally classified as intermediate include: Restaurant Depot, P Kings, Baldor, A&J Produce, Katzman, Fierman, Armata, and D'Arrigo.
- The small distribution firms, also called third-party distributors or brokers, depend exclusively on HPTM, probably at a rate of at least 95%. They obtain orders from their customers and fill the orders with food products from HPTM. They also visit large wholesalers to fill some orders in no specific pattern, some regularly, others if/when HPTM is short on produce. There are many firms in this category.

Figure 4. Contemporary supply chain delivery



- There is a class of small retailers that come to HPTM to purchase food products regularly for their own establishments. Anyone can come into the market to buy wholesale for an annual membership gate fee of \$25. The small retailers do not use brokers. They are either very small or they might prefer to See, Feel, and Touch (SFT) the food products themselves before purchasing. The SFT phenomenon itself is very important for retailers in the food business in general and for some of those who visit HPTM in particular. According to a Katzman representative about 50% of the customers are SFT oriented.

Furthermore, there is also an additional class of small stores “that lack sufficient access to full-line grocers ... These areas often are served by smaller stores that provide only basic staples and lack nutritious, affordable fresh food.”³⁰

The borderlines between the categories are hard to identify. The difficulties are rooted in incomplete information and the lack of an established methodology to determine comparison units of measure for delivery (quantity, dollar value, frequency, other).

³⁰ PlaNYC, Page, 223.

As indicated, HPTM serves the intermediate and small stores in the form of direct buying and/or direct outbound distribution (Box 8).

The distribution of the food products, inbound and outbound, uses surface transportation modes almost exclusively. “Approximately 95% of the City’s food travels into New York City by truck, via a limited number of access points (mainly bridges). In fact, nearly 30% of the truck traffic over the George Washington Bridge on any given day is believed to be carrying food. Every day, almost 13,000 trucks travel into and out of the Hunts Point Food Distribution Center alone ...”³¹

Box 8. Hunts Point’s share in New York City’s small stores food supply

When it comes to smaller stores, restaurants and other retail outlets, many rely heavily on the markets in Hunts Point—especially the public wholesale markets. In fact, about **60 percent** of the City’s produce and about **half** of the City’s meat and fish pass through Hunts Point for sale and distribution to retailers and consumers.

Source: PlaNYC, A Stronger, More Resilient New York, June 11, 2013, Ch. 13, Pages, 222. http://s-media.nyc.gov/agencies/sirr/SIRR_singles_Hi_res.pdf

The large HPTM wholesalers own their own vehicles that are used for distribution. Altogether, the wholesalers own about 100 trucks (box and tractor-trailers trucks). They use these trucks and occasionally rent additional ones as needed.

³¹ PlaNYC Page, 223.

5 Produce Handling

The data collected provides the foundation for determining HPTM's outbound distribution. The number of packages of fruit and vegetables handled in a year is 210 million (Hunts Point, 2014).

5.1 Packing

A package is the smallest unit of fruits and vegetables sold. A package is an undefined unit that could be a box, carton, or bag. A number of packages make up pallets or skids. A pallet for groceries is usually a wooden or plastic flat base of 48" x 40." There are other dimensions as well. Each product pallet has a different number of boxes and therefore a different weight. For example, a pallet can be loaded with 80 packages (cartons) of 18 pounds Vine-Ripe Tomatoes "place packed" for a total weight of 1,700 to 2,200 pounds. If loaded single layer, it can carry 70 cartons for a total weight of 1,500 pounds. Loaded low layers of 70 cartons weigh between 1,800 and 2,000 pounds.³² A pallet of Cherry Tomatoes of 12 1-pint loose can hold 112 cartons weighing 1,700 to 1,800 pounds and 12 1-pint clamshells can hold 112 cartons at a weight of 1,100 pounds.³³ A pallet of apples can hold 7 boxes per layer, which are stacked 7 high for a total of 49 boxes. A typical box of apples weighs 40 pounds. A pallet of apples can also hold 5 boxes per layer which are stacked 12 high or a total of 60 boxes.³⁴ A typical banana pallet holds 48 boxes of 40 pounds each.³⁵ There are also banana pallets that hold 24 boxes.

The dimensions of pallets stacked with boxes are not uniform (see Figures 5, 6, 7, and 8). The stacking height and weight depend on the product and transport conditions. The packing and stacking range is very large. A package could weigh anywhere between 8 and 50 pounds with figures averaging in the middle for many produce items.³⁶ Furthermore, each produce of the nearly 100 items sold in HPTM has specific transport and storage temperature requirements. Thus, shipping produce must take all this into consideration.

³² Fresh Pac, Vine-Ripe Tomatoes, <http://freshpac.com/?projects=vine-ripe-tomatoes> (Accessed 9/10/16).

³³ Fresh Pac, Cherry Tomatoes, <http://freshpac.com/?projects=cherry-tomatoes> (Accessed 9/10/16).

³⁴ Hudson Produce, Fresh Apples, <http://www.hudsonproduce.com/pallet/washington-apple-pallet.html>, (Accessed 9/10/16).

³⁵ Banacol, <http://www.banacol.com/Products/159/2/Banana>, (Accessed 9/10/16).

³⁶ Lesley Sykes, Wholesale Packing Resource Guide, New Jersey Sustainable Farming, Tuft University, November 2010, https://www.carolinafarmstewards.org/wp-content/uploads/2015/05/Wholesale_Packing_Resource_Guide-1.pdf

Figure 5. Stacked tomatoes

Source: https://commons.wikimedia.org/wiki/File:Boxes_of_Nissin_Cup_Noodles_on_pallets_at_Costco,_SSF_ECR.JPG



Figure 6: Pallet of apples

Source: <https://www.pinterest.com/pin/558868634982735368/>



Figure 7. Banana stacks and warehouse

Source: http://www.silverdollarsales.com/index.php?p=1_2_Banana-Boxes



Figure 8. Truck loading

Source: <http://www.ediblegeography.com/spaces-of-banana-control/>



Produce pallets range from 9 boxes (packages) to 112 per pallet. The number of boxes depends on the product, stacking heights, number of layers and stacking configuration (Box 9). Every produce box has different dimensions; some products are in bags, not boxes (potatoes, onions, etc.).

Produce	Boxes per pallet
Banana	54
Tomatoes	40
Apples	54
Grapes	72 or 80
Strawberry	112
Avocado	100

In order to determine the number of outbound pallets from HPTM, we assume 50 boxes per pallet because many products stacked with this amount per pallet (for a sample of loaded pallets see figures). Forty boxes per pallet from the ratio of packages to pallets is explained in the next section.

6 Retailers Demand Requirements and Scheduling

There is limited detailed information in the literature about HPTM outbound-produce distribution from wholesalers to retailers. Thus, the study resorted to obtaining this information from interviews with HPTM buyers, some of which are retailers, wholesale brokers, and third-party buyers. The interviews were used to develop an industry outbound-distribution profile and determine challenges.

In general, the input via interviews indicates a very complex and competitive industry. The industry operation is dominated by wholesalers attempting to maximize the wishes of their customers, that is, retailers. Retailers' requests are multifaceted at every step of the way. The interviews also highlighted a host of daily food-distribution issues.

HPTM wholesalers' customers (retailers) have specific requirements for delivery derived from their operation and retail business model. The retailers' demand drives the operation. A typical retailer has the following characteristics:

- Small size, following its own business model
- Location in high-density population
- Deals with expensive real estate
- Limited amount of space, using HPTM as its warehouse, therefore, placing small orders at a high frequency (some orders daily or twice a day, others a few times a week)
- A mix of produce items for sale at prime quality condition and the lowest price
- Rejection of produce possible for no apparent logical reason
- Third-party broker delivery used, for which retailer pays
- Time sensitivity and expectation of on-demand delivery
- Spot order — no advance order

6.1 Retailers Delivery Scheduling

Scheduling is a complex undertaking, probably the most challenging one. At the present time, the retailers are in command of the delivery schedule. The retailers expect on-time delivery. Some retailers ask for delivery at 2 or 3 a.m., others require delivery at 6 or 7 a.m. or any time in between. There are retailers that require delivery in the evening hours as well. In short, retailers require delivery that fits their firms' schedule, day or night, within a given window of time. There is no uniformity. Furthermore, there are retailers that also order a second delivery for the same day. The delivery between wholesaler and retailer is carried out either by wholesaler, third-party distributor, or the retailer itself, that is, they are usually able to accommodate retailers' schedules (Figure 4).

6.2 Third-Party Broker

The business model of 70 to 80% of the retailers is to use a third-party broker for ordering and/or delivering produce. In the present service environment, a retailer expects from a third-party broker the following:

- Buy the produce for the retailer
- Check the produce, SFT
- Pickup an order
- Deliver the produce to the retailer in good condition, otherwise it will be rejected and returned (A typical retailer does not have a vehicle designated for pickup or delivery)
- Deliver the produce to the retailer on-time (just-in-time), in a situation where each retailer could have a different schedule
- Return of the produce if the retailer rejects the produce which happens 5 to 10% of the time. A third-party broker with too many returns could lose its contract with a retailer
- Competitive pricing for the service
- Payment: the retailer has an arrangement that either the retailer pays directly to the third-party broker or the retailer pays directly to the HPTM wholesaler

In order for the third-party broker to stay in business in the present distribution environment, it has to accommodate its customers and be competitive in pricing its services. This is more easily attained by a large third-party broker through consolidation services for a few retailers. A small third-party broker must find a way to consolidate various orders from various retailers for delivery to the same area and have a good communication system between the drivers, the office, and the retailers. Juggling these requirements for a large or small third-party broker is challenging. In addition, the third-party broker frequently hauls back with an empty truck to HPTM to return rejected produce.

7 HPTM Outbound Distribution

HPTM outbound-produce distribution includes six states. The states and their relative share of the outbound moves are counted in packages (boxes, bags, cartons, etc.). According to HPTM the total annual outbound distribution is 210 million packages,³⁷ which is an average of 67 packages per truck trip for the 12,000 outbound truck trips per day (Table 1). A different source indicates that the number of pallets of fruit and vegetables handled a year is 9.6 million³⁸ or 3.1 pallets per truck (Table 1). According to NYCEDC the annual HPTM distribution is 4.5 billion pounds.³⁹ The number of packages and pallets also indicates that there is an average of 22 packages per pallet. Obviously, the outbound majority is in small parcels in small vehicles and not by pallet. In order to reconcile the difference in the number of packages per pallet, the average of 40 and 50 packages per pallet is used, reflecting a closer approximation of amounts moved.

Table 1. Load per truck trip

	Annual	Week	Day (5-day week)	Load per outbound truck trip (12,000 truck trips a day)
Packages	210,000,000	4,038,462	807,692	67.3 (packages)
Pallets	9,600,000	184,615	36,923	3.1 (pallets)
Packages/pallets	21.9			

The number of outbound packages by zip code is estimated in Table 2.⁴⁰ New Jersey's share of the food distribution is very large, 64.5% of the average weekly number of packages that are distributed to 125 zip codes (33% of all zip codes),⁴¹ Fierman alone indicated that more than 100 trucks go to New Jersey daily. New York City's share of average weekly packages is 17% and 52% by zip code area of the annual 2010 figure.

³⁷ Hunts Point, 2014.

³⁸ Freight Rate Modernization.

³⁹ #78 Food Supply Study, <https://www.nycedc.com/podcast/78-food-supply-study>

⁴⁰ The estimates are based on the data collected from the HPTM wholesalers and buyers and extrapolating from the 2010 annual number of packages handled by HPTM.

⁴¹ This is not a surprise due to the proximity of the high-density region of NJ to HPTM (see appendix 5).

Table 2. Produce outbound by box share and by zip code distribution

STATE	Weekly average number of packages	Relative share	Number of zip codes	Relative share
Connecticut	354,595	8.8%	23	6%
Massachusetts	146,193	3.6%	11	3%
Maryland	199,795	4.9%	7	2%
New Jersey	2,605,237	64.5%	125	33%
New York	681,496	16.9%	200	52%
Pennsylvania	51,144	1.3%	15	4%
Totals	4,038,462		381	

We also note that the total weekly number of packages of produce distributed to NYC from all sources, not only from HPTM, includes large wholesalers not located in HPTM. Thus, total weekly produce distribution to NYC is about 1.136 million packages (about 60% of NYC produce or 681,500 packages come from HPTM⁴²).

The weekly outbound average package distribution was further analyzed, focusing on New York State (NYS), specifically NYS counties. Table 3 reveals that the dominating county for outbound-produce distribution from HPTM is the Bronx (24%). This is no surprise due to its location with respect to HPTM. Brooklyn had a 19% share and Queens 18%. Following these boroughs is Nassau with 11%. The total outbound produce delivered to all NYC boroughs out of NYS is 71%. Within NYC the Bronx share is 33%, Brooklyn 28%, Queens 25%, Manhattan 13%, and Staten Island's 1%.

⁴² PlaNYC (2013).

Table 3. Weekly produce package distribution by NYS counties

County	Weekly average observed	% from NYS	Weekly average estimated*	% from NYC
Albany	8,278	4%	26,398	
Bronx	50,309	24%	160,433	33%
Brooklyn	41,587	19%	132,619	28%
Manhattan	19,244	9%	61,368	13%
Nassau	22,921	11%	73,094	
Queens	37,850	18%	120,702	25%
Rockland	7,353	3%	23,448	
Staten Island	1,910	1%	6,091	1%
Suffolk	8,236	4%	26,264	
Westchester	13,827	6%	44,094	
Other	2,190	1%	6,984	
Total NYC	150,900	71%	481,214	100%
Total NYS	13,705		681,496	

* Estimate was extrapolated using 210 million packages a year reported before (Hunts Point, 2014)

The outbound distribution of produce from HPTM to a location based on zip code number varies by the location. NYS HPTM produce distribution is dominated by zip code 10462 (East Bronx/Park Chester) with an outbound distribution of 23% from all NYS produce or an observed 48,930 packages a week (Table 4), or an estimated 156,000 a week when using the HPTM report (Hunts Point, 2014). The next zip code area with a large distribution is 11219 (Borough Park in Brooklyn) with 18% (observed 37,861 packages a week and an annual estimate of over 120,000). Other destinations generate a much smaller distribution where the smallest ones were observed with a few dozen packages a week.

Table 4. Weekly package distribution by zip code (observed)

County	Town	Zip	Weekly	%	Estimate*	
A. Leading distribution by zip code						
Bronx	East Bronx	10462	48,930	22.9%	156,035	
Brooklyn	Borough Park	11219	37,861	17.7%	120,738	
Manhattan	Rockefeller Center	10111	14,937	7.0%	47,632	
Albany	Schenectady	12306	8,255	3.9%	26,326	
Queens	Ridgewood	11385	6,811	3.2%	21,721	
Subtotal			116,794	54.7%	372,452	
B. Remaining distribution by zip code						
Number of zip codes	Weekly average (range)		Weekly	% Range		Estimate*
3	4,266	4,642	13,186	2.00%	2.17%	42,050
7	2,455	3,810	21,585	1.15%	1.78%	68,834
14	1,000	2,000	21,886	0.50%	0.89%	69,793
171	-	1,000	40,254	0.00%	0.50%	128,367
Subtotal			96,911			309,044
Total			213,705			681,496

* Estimate was extrapolated using 210 million packages a year (Hunts Point, 2014).

The outbound-produce distribution demonstrates the extent of HPTM's importance for the region. The data obtained is the foundation for a cluster development that is the basis for offering a waterborne alternative.

8 Cluster Development Analysis

Using the HPTM outbound-distribution findings, a cluster for outbound distribution by zip code was developed in order to determine potential waterfront sites for waterborne delivery. The analysis focuses on NYS zip codes. The cluster figures are obtained by extrapolating an estimated weekly distribution from the observed figures. Clustering is expected to provide a number of potential waterfront pickup sites. However, in addition to the number of packages as an input, there are various ways of determining a cluster depending on assumptions of customers' preference, location, and site characteristics.

The cluster analysis focuses on waterfront location proximity to a zip code. Since most counties have large waterfronts, a cluster could include a number of zip codes. Delivery to a cluster in various locations provides flexibility of delivery if the waterborne asset is small, such as a barge. Large waterborne assets provide economics of scale in loading a waterborne asset, but less flexibility in unloading and location choice for delivery. The discussion addresses both. However, cluster discussions exclude the Bronx because of the HPTM location, and since it is most efficient for the locals to pick up their produce by vehicle.

There are few operating waterfront sites that the cluster analysis considers. Some have the required landing piers, including Brooklyn, for instance, Navy Yard Basin, Red Hook, Atlantic Basin and Erie Basin. However, other sites could be developed to accommodate a waterborne outbound distribution, including, for example, a site in Flushing Bay or Bowery Bay for northern Queens and Newtown Creek between Pulaski Bridge and Brooklyn Queens Expressway for southern Queens and north Brooklyn. In Manhattan a possible site would be along the East River at 90th Street, 60th Street to 62nd Street, 34th Street, Pier 35 to Pier 42, or further south at Pier 11.

Most of the sites identified are not ready or equipped for a waterborne produce delivery operation. However, the centrally located Erie Basin could accommodate all of Brooklyn (Figure 9). For example, the potential demand of the three closest zip code areas⁴³ to the basin is estimated at 485 packages a week (about two pallets a day in a five-day week, assuming 50 packages per pallet). The next eight zip codes⁴⁴ together with the first three (11 zip codes) have a potential estimated demand of almost 122,000 packages

⁴³ Zip codes: 11231, 11215 and 11232.

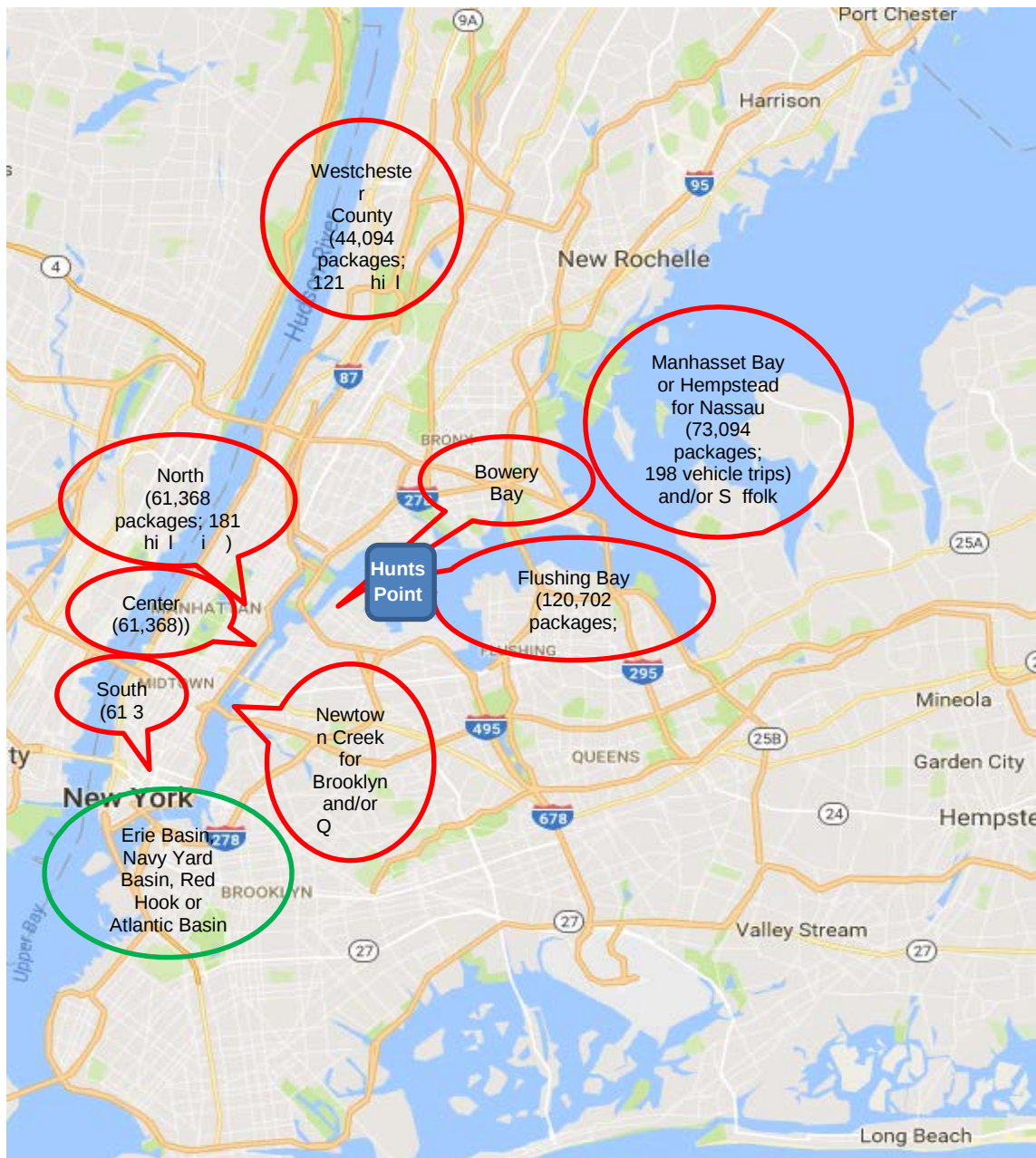
⁴⁴ Zip codes: 11201, 11217, 11238, 11225, 11226, 11218, 11219, and 11232.

a week (about 488 pallets a day assuming 50 packages per pallet or 610 pallets a day assuming 40 packages per pallet). As the area increases so does the demand of the basin services.

Brooklyn's estimated demand is almost 133,000 packages a week (530 pallets a day in a five-day week, assuming 50 packages per pallet) or, as indicated earlier, 27 semitrailers of 40 feet (Table 3), or 53 box trucks of 20 feet with 50 packages per pallet, or 66 box trucks with 40 packages per pallet (Table 5). With their similar demand, the same can be estimated for Red Hook, Atlantic Basin, or the Brooklyn Navy Yard Basin.

Figure 9. Potential cluster locations

Source: Figures by authors



Code: estimated number of packages a week, Green = ready to go, Red = need development

In Queens, a centrally located area for a potential waterborne pickup site is Flushing Bay, which includes Flushing Creek (Figure 9). At this time, these sites do not have landing facilities for waterborne transport. However, the potential demand for such a facility is 121,000 packages a week, which works out to be 24,000 packages a day (five-day week) or 483 pallets a day (five-day week). These figures are equivalent to 48 box trucks (20 feet in length) trips a day assuming 50 packages per pallet or 60 box truck (20 feet in length) trips a day assuming 40 packages per pallet (Table 5).

Table 5. NYC potential demand for waterborne produce pickup at the pier

County	Weekly packages (estimated average)	Packages per day (5-day week)	Number of pallets a day at 50 packages per pallet (number of 20-foot box trucks**)	Number of pallets a day at 40 packages per pallet (number of 20-foot box trucks**)
Bronx*	160,433	32,087	642 (64)	802 (80)
Brooklyn	132,619	26,524	530 (53)	663 (66)
Manhattan	61,368	12,274	245 (25)	307 (31)
Queens	120,702	24,140	483 (48)	604 (60)
Staten Island	6,091	1,218	24 (2)	30 (3)
Total NYC	481,214	96,243	1,925 (192)	2,406 (241)

* The Bronx is not considered for waterborne alternatives.

** This is the equivalent of the number of box trucks.

Manhattan generates a total estimated demand of 12 equivalent units of 40-foot semitrailer trucks a day (Table 3). But, it is more likely that the service will be via smaller trucks such as 20-foot box trucks trips, e.g., 25 to 31 trips (Table 5). Manhattan could benefit from two or three landing sites in the north, center, and south of the east side of the island. Manhattan does not have operating sites ready to go. However, they could be developed in the north at the vicinity of 90th Street (Ferry Terminal), in the center at the vicinity between 60th and 62nd Streets, and in the south at the vicinity between the piers 35 and 42. Landing sites in Manhattan will need to be developed or modified depending on location.

Similar to Manhattan, Nassau and Suffolk counties could benefit from a waterborne delivery. Developing a site in Manhasset Bay or Hempstead Bay where the produce is delivered. If all produce is delivered by 40-foot semitrailers trucks, the number of trips per day would be 20. However, as mention previously the number of trips would substantially increase with smaller box trucks.

Based on the above estimates, a Westchester waterborne system is estimated to remove nine 40-foot truck trips per day and Rockland waterborne system is estimated to remove five 40-foot truck trips per day. Both require identifying waterfront sites for development.

In summary, since Brooklyn and Queens are the two largest boroughs for the distribution of produce from HPTM, the introduction of the first waterborne operation site should be in Brooklyn. This strategic decision could follow with a site in Queens. These two boroughs have the largest impact on both road traffic reduction and testing the success of the waterborne alternative. A sample of a potential pier or terminal to pick up the produce is the design for the “food exchange” (Appendix 8).

Even though some NYC locations are geographically distant from the waterfront, their geographical distance to the waterfront is shorter than to HPTM. Therefore, their travel time, depending on time of day, from the waterfront to their business, compared to the back and forth from HPTM, is shorter. Finally, the pickup cost (tolls, fuel, wear-and-tear, employee cost, etc.) is much less with at a waterfront pickup site. Thus, a waterfront site has cost, time, and distance advantages.

9 Outbound: Estimated Number of Truck Trips

Outbound distribution from HPTM is associated with retailer order size, frequency of delivery, and location. These factors determine the vehicle's size for the delivery. A large number of retailers' orders are from various states. Travel patterns for distant states are expected to be at a lesser frequency than for the local and immediate states such as New York, New Jersey and Connecticut regions close to HPTM. The data gathered via observation and interviews revealed that in general the further the distance from HPTM, the larger the vehicle used with less frequency. The shorter the distance, the smaller the vehicle with more frequency. The delivery to distant states (Massachusetts, Maryland, and Pennsylvania) and distant locations within the immediate states from HPTM is assumed to be by larger trucks as well.

The 12,000 outbound vehicle trips per day are distributed between six states, based on the driver's market-survey ratio of 80% of outbound truck traffic from HPTM.⁴⁵ The outbound traffic from HPTM is moved by a variety of vehicle sizes. The potential distribution between vehicle classes is as follows:⁴⁶

- The box truck dominates by moving 50%⁴⁷ of the produce. This vehicle class provides a very large variety of truck choices (2- or 3-axle/6-tire single unit) and therefore loading choices as well.
- The small vehicle size moved 31%⁴⁸ of the produce. In this class (vans, pickup trucks, etc., also identified as 2-axle/4-tire single unit), even though there is a variety of vehicles, the common denominator is that all carry a small load.
- The tractor-trailer truck moved 19%⁴⁹ of the produce. This vehicle class has several large-truck choices (3-, 4-, or 5-axle/single trailer) that carry in each trip a larger amount of produce.



⁴⁵ Hunts Point – Sheridan, page 24.

⁴⁶ Note, the determination of the distribution between the three categories of vehicle sizes is based on 15,000 truck trips a day to six states and hundreds of zip code numbers within the states. Since there is no other data addressing vehicle size distribution for close distances to HPTM, this study uses the data as indicated in the report.

⁴⁷ Hunts Point – Sheridan, page 24.

⁴⁸ Hunts Point – Sheridan, page 24.

⁴⁹ Hunts Point – Sheridan, page 24.

For example, a semitrailer⁵⁰ pulling a 28-foot trailer can move 14 pallets (one layer), a 40-foot trailer can move 20 pallets (one layer), and a 53-foot trailer can move 26 pallets (one layer). Therefore, the equivalence of 663 pallets of 40 packages per pallet hauled by 40-foot trailers is equal to 33 trucks trips a day. Obviously, an across-the-board use of 20-foot box trucks doubles the number of truck trips per day from 33 to 66. This also holds true for vans and other vehicles.

The daily outbound distribution by state of the 12,000 vehicles is estimated by using the relative share of retailer orders by state (Table 6). Table 6 estimates show the large share of New Jersey (64.5%), followed by New York and Connecticut.

Table 6. Vehicle daily outbound distribution by state

State	Relative retailer order (%)	Relative share of vehicle trips by state
Connecticut	8.8%	1,054
Massachusetts	3.6%	434
Maryland	4.9%	594
New Jersey	64.5%	7,741
New York	16.9%	2,025
Pennsylvania	1.3%	152
Totals	100%	12,000

The focus of the study is on New York State, more specifically on the eastern region of the Hudson River. Table 6 shows New York State's relative share of daily vehicle trips for a total of 2,025 vehicles, of which 1,856 (Table 7, Column 2) travel from HPTM to east of the Hudson River counties and boroughs, which works out to be 15.5% of total truck trips. Obviously, since the actual figure is not known, this figure is a starting point, or an indicator of the number of outbound vehicles from HPTM to retailers.

⁵⁰ Semitrailer trucks are 28 to 53 feet long.

Table 7. Estimated daily outbound vehicle distribution for New York State east of the Hudson River

County/ Borough	% of NYS (1)	Relative share by county (2)	Tractor trailer share (3)	Van Share (4)	Box truck share (5)
			19%	31%	50%
Bronx	23.5%	477	91	148	238
Brooklyn	19.5%	394	75	122	197
Manhattan	9.0%	182	35	57	91
Nassau	10.7%	217	41	67	109
Queens	17.7%	359	68	111	179
Staten Island	0.9%	18	3	6	9
Suffolk	3.9%	78	15	24	39
Westchester	6.5%	131	25	41	66
Totals	91.7%	1,856	262	428	690

A large number of counties and boroughs are close to HPTM; therefore, there is a small probability for the distribution to be reliable, as indicated in Table 7 (Columns, 3, 4, and 5), because it ignores the distance from HPTM to the retailers and the most likely type of vehicle that would be used. That is, the actual distribution is most likely skewed towards smaller vehicles, not the general distribution obtained from the drivers' market survey.

A few scenarios are developed to capture various possible distribution alternatives, using various assumptions, primarily the role of tractor-trailer services to the New York City boroughs east of the Hudson, as follows:

1. The outbound traffic from HPTM to the Bronx retailers, due to their close proximity to HPTM, is only by box trucks and van.
2. Outbound deliveries for long distances from HPTM are primarily by tractor trailer. All distant states that qualify include Albany, NY, southern NJ, and eastern Connecticut.
3. Tractor trailers come in different sizes. For the purpose of the analysis, the 40-foot trailer is used.
4. A tractor trailer 40 feet in length can potentially load 20 pallets or the equivalent in packages. It will load with a minimum of 16 pallets. It is uneconomical to use fewer pallets or equivalents for long-distance trips.
5. An average boxcar is 20 feet in size. It can potentially load 10 pallets. Its operational high load is eight pallets and low load three pallets or the equivalent. It is most likely to load six pallets or the equivalent.

6. A van takes a maximum of two pallets. Its high load is 1.5 pallets. It is most likely loaded with an equivalent of one pallet or less. Vans are frequently loaded with packages, not pallets.

Using these assumptions a few scenarios were developed to provide alternatives for vehicle use to accommodate retailers' demand for produce in the region east of the Hudson River.

9.1 Scenario I: East of Hudson River estimated daily outbound-vehicle distribution based on driver's market survey

The estimated daily distribution, based on the driver's market survey, east of the Hudson River is simple to obtain. Table 7 is an extrapolation of the data for the relative share distribution for each borough and county. The vehicle class share of the outbound distribution is identified in Table 7. For example, the 31% of small vehicle size (van) delivery to Brooklyn is 122 van trips (394 x 31%).

Scenario I (Table 7) overstates some of the vehicle trip categories and understates others. For example, the Bronx outbound distribution includes 91 tractor-trailer deliveries, where in reality there are probably no tractor-trailer deliveries in the Bronx from HPTM. This assertion is because all these deliveries are local, a short distance from HPTM and can be accommodated on demand. Similarly, the probability of the number of tractor-trailer deliveries in other boroughs, as indicated in Table 7, is also inflated. In contrast for example, the deliveries to Massachusetts and Maryland probably do not include vans; they most likely use tractor trailers and some box trucks. Thus, the overall distribution between the vehicles in this scenario needs to be modified.

9.2 Scenario II: East of Hudson River estimated daily outbound-vehicle distribution based on pallets assuming high-density vehicle pallet loading

The daily demand for produce for retailers east of the Hudson River region is the foundation of vehicle-demand estimates in this scenario. The daily average retailers' demand for produce generates 3,123 pallets of 40 packages per pallet (Table 8, Column 1). Applying the drivers' market-survey distribution for vehicles to the pallet demand distribution among vehicle types, we note that the 3,123 pallets will be distributed as follows: 593 pallets for tractor trailers, 968 pallets for vans, and 1,562 pallets for box trucks (Table 8, Section A).

Table 8. High-density daily estimated distribution by pallets and vehicle trips

County/ Borough	Demand for pallets per day (40 packages per pallet) (1)	Pallets by vehicle type (Section A)			Number of vehicle trips (Section B)			Total vehicles by County/ Borough
		Tractor trailer (share)	Van (share)	Box Truck (share)	Tractor trailer (pallets/ truck)	Van (pallets/ van)	Box truck (pallets/ truck)	
		19%	31%	50%	16.00 (2)	1.50 (3)	8.00 (4)	
Bronx	802	152	249	401	10	166	50	225
Brooklyn	663	126	206	332	8	137	41	186
Manhattan	307	58	95	153	4	63	19	86
Nassau	365	69	113	183	4	76	23	103
Queens	604	115	187	302	7	125	38	170
Staten Island	30	6	9	15	0	6	2	9
Suffolk	131	25	41	66	2	27	8	37
Westchester	220	42	68	110	3	46	14	62
Totals	3,123	593	968	1,562	37	645	195	878
Distribution		19%	31%	50%	4%	74%	22%	

Applying the high-density assumptions (4, 5, and 6) outlined above for the loading potential of each vehicle type (Table 8, Section B, Columns: 2, 3, and 4), we note that the total potential number of vehicle trips needed to deliver the produce east of the Hudson River is 878 per day. This scenario assumes optimal utilization of space on board vehicles. However, the scenario's shortcomings are generally associated with the tractor-trailer trips; especially the Bronx (assumption 1). The likelihood of having a tractor trailer delivered in the Bronx is highly improbable (0%). But Table 8 (Section B, Column 2) indicates 10 tractor-trailer trips to the area.

9.3 Scenario III: East of Hudson River estimates for daily outbound-vehicle distribution based on pallets and modified vehicle size

In this scenario, a few assumptions are applied. The assumptions are designed to align the figures with the observations and discussions with third-party produce delivery groups from the HPTM facility to retailers. The figures are the research team's assessment. Thus, these figures can be modified with new data.

The tractor trailers' share in the distribution is modified. For example, the likelihood of a tractor-trailer delivery of produce in the Bronx, where HPTM is located, is zero. For instance, Table 9 denotes in Section A in the Tractor Trailer (share) section that for the Bronx, the percentage of tractor-trailer deliveries is 0%. Thus, similar to the Bronx, the modifications of tractor-trailer delivery in the east of the Hudson region are based on the assumptions of likelihood from interviews. The results are reported in Table 9 below the Bronx. Section B modified the figures of the number of truck trips accordingly. The figures in Section B use 16 pallets per tractor trailer and the low end of the above assumption number five for box trucks (three pallets) and assumption number six for vans (one pallet).

Table 9. Modified estimated vehicle size distribution by pallets and vehicle trips

County/ Borough	Demand for pallets per day (40 pack- ages per pallet)	Pallets per Vehicle Type (Section A)				Number of Vehicle Trips (Section B)			Total Vehicles by County/ Borough
		Tractor trailer (share)		Van (share)	Box- truck (share)	Tractor trailer (pallets/ truck)	Van (pallets/van)	Box truck (pallets/ truck)	
		% of tractor- trailer	19%	31%	50%	16.00	1.00	3.00	
Bronx	802	0%	0	343	459	0	343	153	496
Brooklyn	663	25%	32	242	390	2	242	130	373
Manhattan	307	0%	0	117	189	0	117	63	181
Nassau	365	46%	32	128	206	2	128	69	198
Queens	604	28%	32	219	353	2	219	118	338
Staten Island	30	0%	0	11	19	0	11	6	18
Suffolk	131	64%	16	44	71	1	44	24	69
Westchester	220	38%	16	78	126	1	78	42	121
Totals	3,123		128	1,182	1,813	8	1,182	604	1,794
Distribution			4.1%	37.8%	58.0%	0.4%	65.9%	33.7%	

Table 9 provides pallet and daily vehicle distribution between the three vehicle types with a total of 128 pallets to 8 tractor trailers (average of 16 pallets per truck), 1,182 pallets to 1,182 vans (one pallet per van), and 1,813 pallets to 604 boxcars (average three pallets per box truck). The redistribution of the tractor-trailer pallets (Table 9, Section A) to the other vehicles in Section A is based on the vehicles' relative share without tractor trailers.

The box-truck vehicles come in a large variety of sizes, from 10 feet to 28 feet. The potential number of pallets or equivalent packages transported range accordingly, since the distribution between box-truck sizes outbound from HPTM is not known. Table 9 estimates daily-truck distributions by assuming a few alternatives for box-trucks pallets per truck. Applying a few alternatives for the number of pallets per truck for box trucks in table 9 (assuming that van trips and tractor-trailers trips do not change) generates Table 10's section labeled, Table 9 Number of Vehicles.

9.4 Scenarios summary

A summary of the total number of vehicle scenarios (Table 10) of the different alternatives provides the number of vehicles distributed to each county and borough east of the Hudson. Table 10 provides a few additional alternatives, namely, under the subtitle, Table 9 Number of Vehicles. In this section, there are three alternatives where a box truck carries 3.5 pallets, 3.0 pallets, or 2.5 pallets. The three alternatives provide a range of potential outcomes of the number of vehicles per day. Table 10 summary is used for comparisons between the alternatives. Each alternative has its shortcomings. However, Table 9 is the most reliable with additional alternatives, as indicated in Table 10.

Table 10. Total number of vehicles per day: scenarios summary

County/ Borough	Table 7 Number of Vehicles	Table 8 Number of Vehicles	Table 9 Number of Vehicles		
			3.5 Pallets per Box Truck	3 Pallets per Box Truck	2.5 Pallets per Box Truck
Bronx	477	225	474	496	527
Brooklyn	394	186	355	373	399
Manhattan	182	86	172	181	193
Nassau	217	103	189	198	212
Queens	359	170	321	338	362
Staten Island	18	9	17	18	19
Suffolk	78	37	65	69	73
Westchester	131	62	115	121	130
Total number of vehicles	1,856	878	1,708	1,794	1,915

The range in the number of packages and vehicles for each county or borough is large, as demonstrated in Figure 9.

As indicated in Table 10 the range in the number of vehicles and their distribution by county or borough is from a low of 878 to a high of 1,915. Due to the assumption and analysis highlighted above, the scenario alternative named, 3 Pallets per Box Truck (from Table 9 and used in Table 10 with 1,794 vehicles) is used going forward in this article as the estimate foundation for the number of vehicle trips and emissions.

10 Outbound: Estimated Number of Vehicle Miles and their Emissions

The number of outbound truck trips from HPTM to the boroughs differs by location, and more specifically, by zip code. The proposed waterborne-operation system delivers the produce to the cluster site in the boroughs (Figure 9). Since the pickup of produce is from the local designated pier, the truck trip to and from HPTM is saved or unnecessary. The study identified five waterborne-cluster sites east of the Hudson (Nassau and Suffolk Counties are in the same waterborne cluster). The surface transportation round-trip distance from HPTM to the waterborne drop-off sites is reported in Table 11 (column 1). Using the data from Table 10 (scenario in column 4) and Table 11 (column 1), we obtain total daily miles and their distribution between the three types of vehicles in Table 11, columns 3 to 6. For example, there are 373 vehicle trips per day (Table 9, last column for Brooklyn, which is confirmed in Table 10) from and to Brooklyn at 40 miles round trip (Table 11, column 1) for a total of 14,920 miles a day (Table 11, column 3). The distribution between the vehicles (Table 11, columns 4 to 6) is from Table 9. The five sites exclude the Bronx and Staten Island.

Table 11. Estimated HPTM outbound number of miles per day by vehicle type

County/ borough cluster locations	Average round-trip miles to/from HPTM (1)	Vehicles (3 pallets per box truck scenario) (2)	Total miles (3)	Tractor- trailer ratio (4)	Van ratio (5)	Box- truck ratio (6)
				0.4%	65.9%	33.7%
Brooklyn	40	373	14,920	60	9,832	5,028
Manhattan	20	181	3,620	14	2,386	1,220
Nassau*	40	198	7,920	32	5,219	2,669
Queens	20	338	6,760	27	4,455	2,278
Suffolk*	40	69	2,760	11	1,819	930
Westchester	50	121	6,050	24	3,987	2,039
Totals		1,280	42,030	168	27,698	14,164

* These two are in the same cluster.

A fully implemented, waterborne operation would move in excess of 91,500 packages a day (2,291 pallets) from HPTM to the five waterborne cluster sites (excluding the Bronx and Staten Island). This total is estimated to reduce vehicle traffic by over 42,000 miles a day (Table 11, column 3), which is an average of 33 round-trip miles per vehicle. Using Table 9 (Section B, last row) the distribution between the three types of vehicles is obtained and shown in Table 11. The majority of the reduction in vehicle trips is by van, which is estimated at about 27,700 miles per day, followed by box truck with over 14,000 miles per day (Table 11). Obviously, a lower rate of waterborne operations would reduce the number of vehicle miles per day accordingly.

The highway driving miles traveled per day east of the Hudson to the five boroughs and counties considered in this study are estimated to burn 3,575 gallons of fuel per day (Table 12). This figure uses the average mpg (miles per gallon) for a van using 13 mpg, box truck using 10 mpg and tractor trailer using six mpg (see Table 12, sources). At the present, fuel costs are about \$2.50 per gallon, thereby making the estimated daily cost about \$8,900.

Table 12. Estimated surface transportation potential fuel (gallons) savings per day of a fully implemented waterborne system

County/ Borough	Tractor-trailer average mpg	Van average mpg	Box-truck average mpg	Totals
	6*	13**	10***	
Brooklyn	10	756	503	1,269
Manhattan	2	184	122	308
Nassau	5	401	267	674
Queens	5	343	228	575
Suffolk	2	140	93	235
Westchester	4	307	204	515
Totals	28	2,131	1,416	3,575

Source:

* “The study found that in the U.S., average tractor-trailer fuel consumption rates for the entire fleet are approximately 39 L/100 km (6 mpg).” <https://www.google.com/webhp?sourceid=chrome-instant&ion=1&ie=UTF-8&rct=j#q=Tractor+trailer+fuel+consumption>

** *Fuel Consumption* of 2014 vans, passenger type, U.S. Department of Energy, https://www.fueleconomy.gov/feg/byclass/Vans__Passenger_Type2014.shtml

*** *U-Haul trucks and gas mileage* <http://blog.upack.com/posts/what-is-the-gas-mileage-of-a-u-haul-rental-truck>

The fully implemented waterborne system requires new local trips from the retailer to the pier. The number of miles associated with these trips is hard to estimate. But they probably range from one to three miles per trip. Assuming an average of two miles per road trip, it adds up to 2,560 miles (1,280 x 2) (Table 11). Thus, a fully operating waterborne system would have a net estimated savings of 39,470 miles per day and 3,357 gallons per day (Table 13).

Table 13. Fuel consumption emission per day

	Tractor Trailer	Van	Box truck	Totals
1. Vehicle ratio (Table 11)	0.004	0.659	0.337	1.00
2. Net miles per day	158	26,011	13,301	39,470
3. Fuel consumption per day (gallons)	26	2,001	1,330	3,357
4. Emissions per gallon (pounds of CO₂)	22.38	19.64	19.64	
5. Emissions per day (pounds of CO ₂)	589	39,296	26,124	66,009
6. Distribution between vehicles (from row 5)	0.9%	59.5%	39.6%	100%

Fuel burning emits 19.64 pounds of carbon dioxide (CO₂) per gallon of gasoline that does not contain ethanol and 22.38 pounds of CO₂ from burning a gallon of diesel fuel.⁵¹ Therefore, the estimated net savings of 39,500 miles driven per day will reduce emissions by more than an estimated 66,000 pounds of CO₂ per day (Table 13, row 5).

A tugboat waterborne operating system generates its own demand for diesel fuel. The fuel consumption of a tugboat is measured in gallons per hour. A tugboat of 2,200 horsepower (HP), the size that will operate this proposed system, burns between 83 and 100 gallons per hour (an average of 91.5 gallons per hour). The amounts burned depend on the barge weight (loaded or unloaded), speed, and current. The amount of fuel a tugboat burns also depends on whether the tug stays with the barge or not. In general, this range of fuel consumption for tugboats cruising at 6 knots is common practice in planning or estimating fuel consumption. There are other sources that state tugboat use 85 gallons per hour.⁵² However, in this study, a conservative average of 91.5 gallon per hour is used because the round trip is heavy on one leg and light

⁵¹ *How much carbon dioxide is produced by burning gasoline and diesel fuel?* EIA, U.S. Energy Information Administration, (Accessed 1/1/17).

⁵² Kwame Agyei, 1999 Tugboat Fuel Consumption in Seattle Area, Working Together for Clean Air, Seattle, WA kwamea@pscleanair.org, page 10, <https://www3.epa.gov/ttnchie1/conference/ei11/poster/gyei.pdf>

on the return. We assume that the tug does not stay with the barge during the discharge and load of the barge. The barge energy source during these times is electrical from a shore source.

Table 14 highlights the daily tugboat diesel fuel consumption of a fully operating system to five counties and boroughs, indicating an estimated total of 1,281 gallons of fuel per day. This figure is 35.8% (1,281/3,575) of the fuel consumption by the surface transportation. Fuel burning by tug emits 28,700 (1,281 x 22.38) pounds of CO₂ per day. Thus, the total net fuel savings and emissions reduction per day are 2,076 gallons (3,357-1,281) and 37,300 pounds of CO₂, (66,009 – 28,669), respectively. These figures reduce fuel consumption by 38% and emissions by 43%, respectively.

Table 14. Distance from HPTM to the landing sites and tugboat fuel consumption

County/ Borough	HPTM to pier (nautical miles)	Trip time one way in hours (operating speed, 6 nm)	Average fuel consumption round trip (91.5 gallons/hour)
Brooklyn	13	2	366
Manhattan	6	1	183
Nassau/Suffolk	8	1	183
Queens	3	0.5	91.5
Westchester	15	2.5	457.5
Totals			1,281

In short, on an annual basis of 260 working days, the fuel savings adds up to 540,000 gallons (over \$1.35 million at \$2.50 a gallon) and CO₂ emissions savings comes to 9.7 million pounds.

Other pollutants, such as carbon monoxide (CO) and hydrocarbons, are converted to CO₂ relatively quickly in the atmosphere.⁵³ However, “It is more difficult to estimate vehicle emissions of methane (CH₄), nitrogen oxide (N₂O), and hydrofluorocarbons (HFCs) than CO₂. Emissions of CH₄ and N₂O are dependent on the design of the engine and emission control system, rather than fuel consumption per mile.”⁵⁴ Nonetheless, given N₂O emissions of 0.13 pounds per gallon,⁵⁵ we note that the total savings of 2,076 miles per day also translate into the estimated reduction of 270 pounds (2,076 x 0.13) of N₂O per day. Furthermore, the recent regulations for tugboats and other waterborne vessels that requires the use of tier 3 and 4 engines are designed to further reduce emissions and noise.

The total of 1,280 vehicle trip savings per day (Table 11) also reduces the total number of hours a vehicle is on the road. With an estimated hour plus per vehicle, this time saving on the road adds up to close to 1,500 hours a day or 390,000 hours a year of 260 working days.

Obviously, these figures are gross numbers. The figures assume regular travel times and other regular traffic patterns, and they provide a gross estimate of the emissions, fuel consumption, and road time. Therefore, this analysis should be used as a general indicator of savings for the waterborne operations.

⁵³ Greenhouse Gas Emissions from a Typical Passenger Vehicle, EPA, Office of Transportation and Air Quality, EPA-420-F-14-040a, May 2014, page 1, <https://www.epa.gov/sites/production/files/2016-02/documents/420f14040a.pdf>

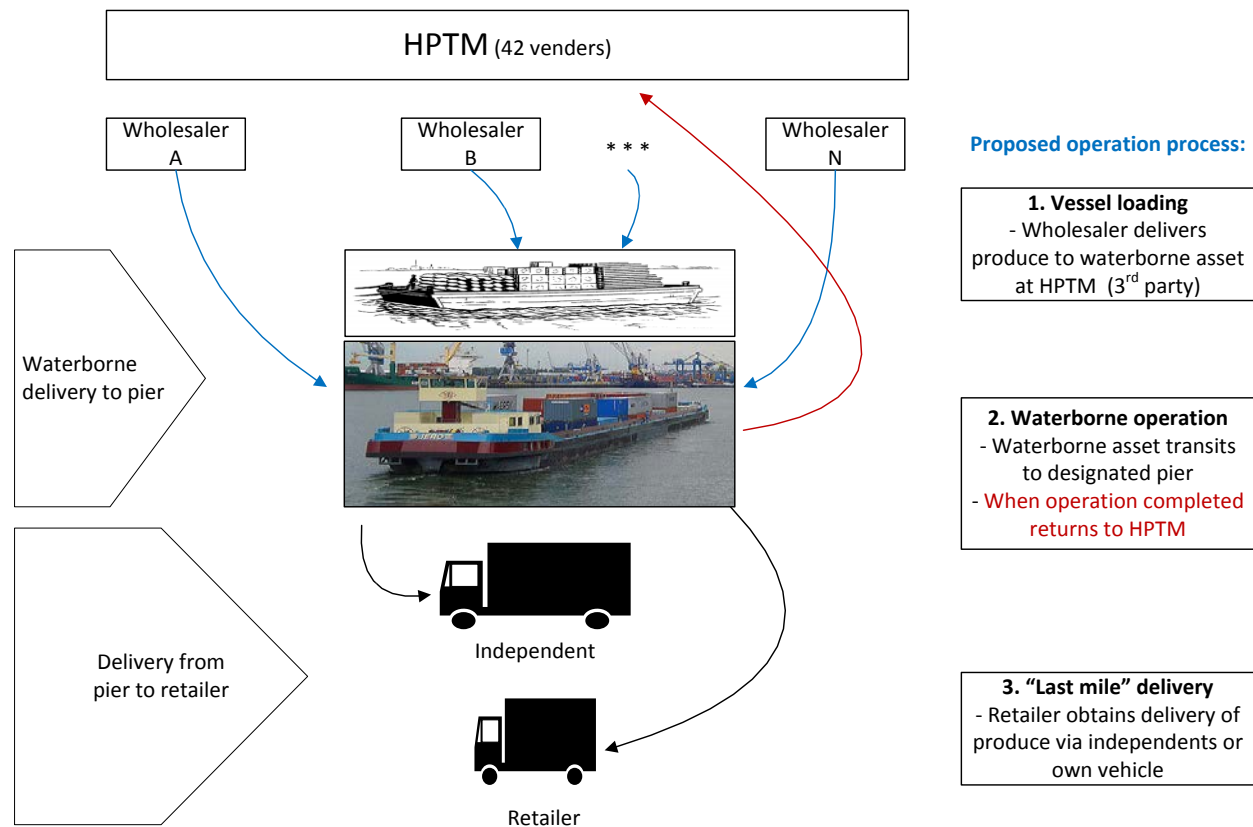
⁵⁴ Greenhouse Gas Emissions from a Typical Passenger Vehicle, EPA, Office of Transportation and Air Quality, EPA-420-F-14-040a, May 2014, page 3, <https://www.epa.gov/sites/production/files/2016-02/documents/420f14040a.pdf>

⁵⁵ Chris Kent, Basics of Toxicology, John Wiley and Sons, Inc., 1998, page 187, https://books.google.com/books?id=VEUIWz4vQsC&pg=PA187&dq=%22Nitrogen+dioxide%22+per+gallon&hl=en&sa=X&ved=0ahUKEwjRn66P85nSAhUs54MKHVbD_YQ6AEIHDAA#v=onepage&q=%22Nitrogen%20dioxide%22%20per%20gallon&f=false

11 Waterborne Operation: Proposed

The proposed overall waterborne-operation system is straight forward. Using a barge as an example, the barge is loaded at HPTM and hauled to its discharge site. The produce loading is for all participating HPTM wholesalers. After the discharge at a pier, the barge is hauled back to HPTM for the next round or day operation (Figure 10).

Figure 10. Proposed supply chain operation



This operation model (Figure 10) requires that a large number of operating pieces and agreements come together in order to be a success. Since there is no such operation system, it should be carefully planned from beginning to end. Thus, the proposed waterborne, outbound-distribution system faces many challenges, in addition to some of the operation challenges mentioned previously.

11.1 General Outline of Waterborne-Operation Issues

In order for a waterborne operation to come to fruition and succeed, various issues need to be addressed.

The important issues include (some of the issues will be discussed in detail below):

- A dedicated party to load and discharge, such as an HPTM vender or an independent third-party operator [see for example, Third-Party Waterborne Delivery Provider (3PWDP)].
- Comply with temperature requirement per product during loading and transit.
- Segregate products as required.
- Have a waterborne crew dedicated to this operation. The crew is on waterborne asset and tugboat.
- Schedule waterborne asset duration for load and discharge.
- Determine an optimal departure schedule from origin and destination.
- Fix a schedule for departure from HPTM and return to HPTM. This schedule requires the tugboat operator commitment as well.
- Determine transit time to discharge location including the consideration of the river's current.
- Develop a maintenance schedule and contingency plans during maintenance.
- Prepare a security awareness and security plan.
- Train the crews for loading, discharge, and transit
- Prepare contingency plans for weather impacts that might disturb operations (emergency, snow, storms, ice, etc.).
- Develop a chain of responsibility.

These waterborne issues and others need to be addressed before, during, and after the system is implemented. However, even though some of the issues are beyond the scope of the research, a number of issues are addressed below starting with the outbound, waterborne-distribution system itself. The objective of the following is to highlight important challenges that may be encounter when developing the system.

12 Outbound, Waterborne-Distribution System and Challenges

As indicated before there is little information about the HPTM outbound distribution. The available data indicates a complex and competitive outbound-distribution industry. The industry is dominated by wholesalers attempting to accommodate retailers' wishes. Thus, the daily complexities and challenges will not diminish with an introduction to an outbound, waterborne-distribution system; if fact, they might get worse.

The many challenges can be divided into present challenges and outbound via waterborne-distribution challenges. Many of the present challenges such as produce segregation, temperature control, timing of delivery, wholesalers working together, etc., are also challenges for the waterborne-distribution system. However, in addition, there are new and very specific waterborne challenges derived from all the aspects of the waterborne operation itself.

Planning and executing a waterborne-operation plan are complex. In order for a waterborne operation to be economically viable it should carry a sufficient amount of produce in order to take advantage of the economies of scale that a waterborne system is designed to provide. A viable waterborne-operation system will, for instance, reduce the number of trucks on the road, reduce the HPTM wholesalers' transport cost, and encourage wholesalers' participation in an outbound-waterborne distribution. All of which are critical for the economies of scale imbedded in a waterborne, outbound-delivery system.

The challenges of the outbound-waterborne distribution from HPTM are divided into categories, such as retailers' demand requirements and delivery schedule, waterborne hardware and vessel design requirements, new system supply chain management (waterborne vessel loading priority and schedule, produce storage requirements, routing), landing sites' locations and designs, operations finance, community concerns, and others. Overcoming the challenge these concerns present is not a small task. The following discusses some of the important issues and their challenges.

12.1 New System Supply Chain Operations and Management

The proposed outbound-waterborne distribution from HPTM has to address various operation and management issues. The issues addressed below start with the technical aspects, followed by operations and other matters.

12.1.1 Waterborne Hardware and Vessel Design

A waterborne operation requires waterborne hardware and an infrastructure for friendly landing sites. Each of the waterborne assets and landing sites around the city generated from the demand analysis have different characteristics and requirements in order to provide the service. The hardware outlined below is for the general waterborne assets and landing sites.

12.1.1.1 Hardware: waterborne assets

- Waterborne vessel size and design by destination, including different temperature control storage facilities (generators) to accommodate produce temperature requirement.
- Safety facilities and instruments on board, during docking and undocking.
- Inspections, licensing, and certification by the appropriate authorities.
- Tugboat size and operating characteristics for equipment support.

12.1.1.2 Hardware: landing site

- Designated pier(s) for operations in both origin and destination.
- The origin pier needs to be long enough to accommodate more than one barge.
- Piers (origin & destination) need to have appropriate equipment to facilitate the operations.
- Pier should maintain required dredging status.
- Parking and access to waterborne vessel at destination.

12.1.1.3 Vessel Type and Design

The use of an outbound, waterborne system for distribution of food products would also be a part of the Marine Highway System, which has long been promoted by the MARAD. Once built, it will be local with a very specific purpose. Furthermore, an optimal towing method will be a part of the waterborne asset planning as well as berthing.

There are a few types of vessels that could be used for outbound distribution of products, such as barge, Articulated Tug Barge, Refrigerated Cargo Carrier, and others. Specifically designed vessels will be required.

A barge can come in different designs and dimensions. In general, it is a floating platform with a shallow flat bottom, usually not self-propelled (Figure 11), depending on external power, such as a tugboat, which also tows the barge into position at the loading dock. The barge's shallow bottom allows it to function in low-draft waters such as canals and creeks, and its floating platform can be designed to have a number of floors, refrigerated goods, or roll-on, roll-off vehicles. There are various towing methods, and the newest and most efficient towing methodology is the tug-barge combination, that is, the articulated tug barge (Figure 12). A barge that needs power on board gets it from the tugboat or from a generator on board. A barge is very safe, efficient, and reliable. It can carry a large amount of weight; therefore, when used to transport produce from HPTM, it will remove a large number of vehicles off the road.

Figure 11. Hopper Barge

Source: <http://products.damen.com/en/ranges/stan-hopper-barge/stan-hopper-barge-5208>

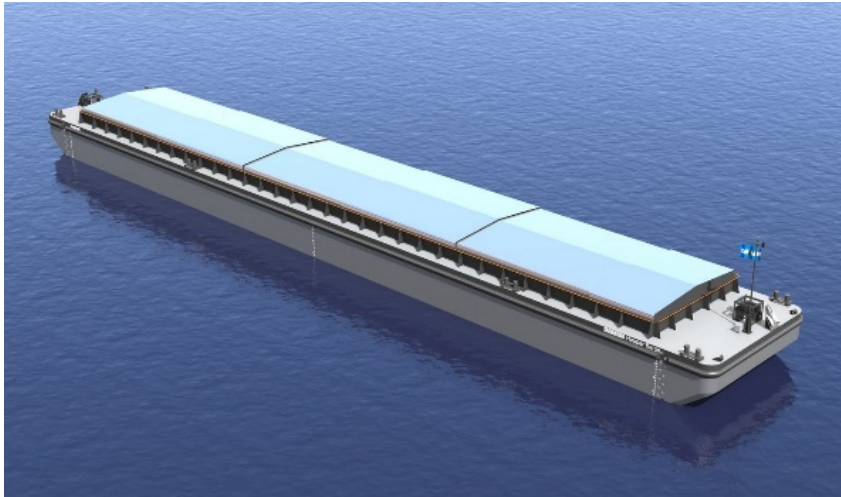
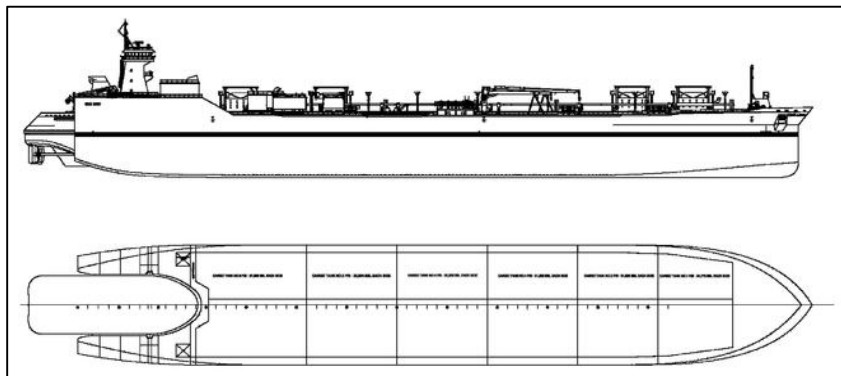


Figure 12: Articulated Tugboat Barge

Source: <http://www.nasdaq.com/markets/ipos/filing.ashx?filingid=5235571>



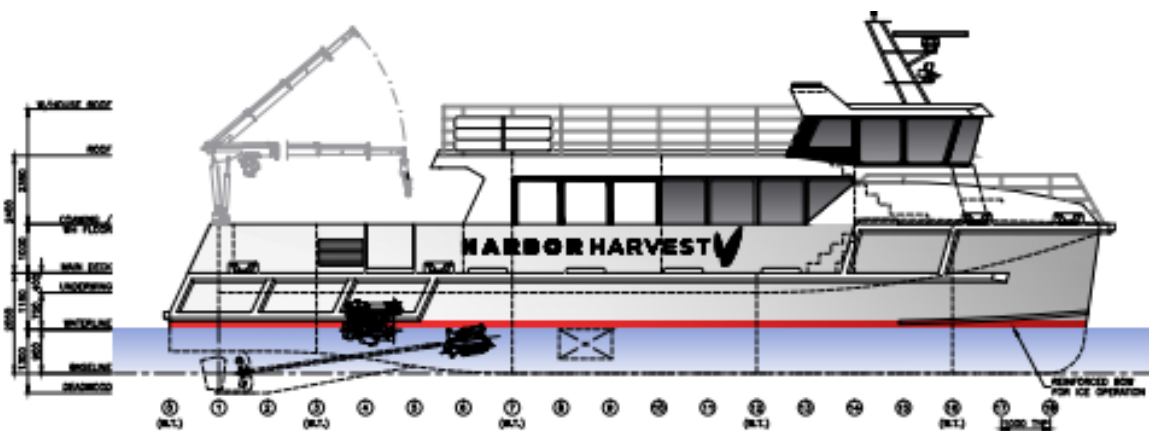
A different design is provided by Kunkel (2016), who describes the Harbor Harvest (Figure 13) and Amtech that specialize in the farm-to-market movement of agriculture and food service. The Amtech article describes the combination tug-barge:

...provide[s] an alternative transportation platform coupled with a vertical integration of retail space and support of the organic farm market located along the Connecticut/Long Island Gold Coast and Hudson River area. Using the same Catamaran design and Hybrid propulsion system, ... the future series of vessels to carry 9,000 pounds of protected refrigerated cargo and 3,000 pounds of deck cargo. Vessel speed is 15 knots and the Lithium battery component allows emission-free operation for approximately three voyage hours before charging is required. The vessel can be charged at a shore-side facility or while underway. ..., the vessel can deliver the required cargo in nearly half the time required along the congested land based routes.⁵⁶

The Harbor Harvest, at its present design, can carry 25 pallets, and larger vessels are planned.

Figure 13. Harbor Harvest

Source: [file:///C:/Users/Owner/Documents/Hunts%20point/Harbor%20Harvest%20GA%20-%20v01-3%20\(1\).pdf](file:///C:/Users/Owner/Documents/Hunts%20point/Harbor%20Harvest%20GA%20-%20v01-3%20(1).pdf)



⁵⁶ Robert Kunkel, *One Small Step towards Sustainable Coastal Shipping*, Marine News, March 2016, pages 28-31.

12.2 Waterborne Loading Operation at HPTM

An outbound-waterborne distribution for produce from HPTM to the various sites in NYC faces challenges and shortcomings derived from moving from a single wholesaler operation (Figure 4) to a shared operation between wholesalers (Figure 10), which requires consolidation. The consolidation of orders is clustered by delivery sites which could be based on zip code number or other methods. For example, the data indicates that there are a few clusters that could be considered for development in the New York City region as demonstrate in Figure 9 and Table 3.

The operation of the proposed waterborne system is also driven by controlling storage temperature⁵⁷ and by segregation at the consolidation stage. Temperature control and segregation start at the loading pier in HPTM and on board the vessel. Thus, an important question prior to loading is: should consolidation be by destination or by product? A choice of one over the other provides a different outcome in the stowage layout on board a waterborne asset and a different handling time for load and discharge in the pier of origin and destination.

In order to assure the success of a waterborne-delivery system and the economies of scale, a large system could provide, the participation and cooperation of a large number of HPTM wholesalers is required. Wholesalers' cooperation also implies sharing information of produce delivery destinations, including the quantities for each delivery between independent brokers. This type of information sharing is not the present norm among HPTM wholesalers. This level of cooperation among wholesalers requires trust, which at present is absent.

12.3 Wholesalers' Trust

The trust between HPTM wholesalers is limited and evident in their reluctance to share information or collaborate in the distribution of produce to the same location, even when it is occasional. Thus, the distrust needs to be resolved if an outbound, waterborne-distribution system is to be developed.

⁵⁷ Temperature control is a very important aspect of produce distribution. Appendix 2 outlines the produce storage temperature requirements.

To assure trust among HPTM wholesalers a 3PWDP will need to be a part of the new operation. Wholesalers' trust in the 3PWDP is key to start the operation and for it to be successful. Some wholesalers when interviewed were skeptical and wondered if success was possible. Therefore, measures of professional and impartial performance by the 3PWDP, an operation management company, should be incorporated into the operation from the start, in order to assure the wholesalers acceptance of the new 3PWDP operating system. Some of the trust-building methods to mitigate conflicts and other issues include:

- **Arbitration.** An arbitration system should follow a manual as well as protocol guidelines, which must be developed from or before the operations start. Thus, when there is a dispute, an arbitrator's involvement could diffuse and eliminate the difference or address any other issue that evolves.
- **Transparency.** In the effort to reduce tension and business operation disruption, transparency should be a high priority. Transparency, to the degree possible, between competing wholesalers and the 3PWDP should be emphasized and practices as one of the safeguards for success in addition to required, regular reports provided by the 3PWDP.

12.4 Outbound, Waterborne-Retail Delivery

The proposed distribution system with a waterborne segment (Figure 10) along the supply chain has a buffer which reduces the scheduling flexibility for delivery as perceived by the retailers.

The waterborne buffer (3PWDP) plays an important role in the distribution system by restricting the timing of each of the three parties along the supply chain:

- The wholesaler would be required to deliver the produce to the pier at HPTM for loading by a predetermined time.
- The 3PWDP would be required to:
 - o Complete loading by a predetermined time.
 - o Transit to the discharge location by a predetermined time.*
 - o Transit back to HPTM by a predetermined time.*(*The transit time is determined by distance, cruising speed, and the tide.)
- The retailer's pickup would be limited to a window of time at the pier between the vessel arrival from and its departure to HPTM.

The window of time for each party along the supply chain needs to be determined and thereby it is somewhat standardized. Standardizing scheduling of delivery might be resisted by the retailers.

The scheduling complexity could be an advantage and a disadvantage. The advantage is that large distribution firms would have the opportunity to utilize their fleet more efficiently because large firms have their own warehouses and fleet, taking advantage of their economics of size. Large firms are also independent of HPTM. For small firms, an outbound, waterborne-distribution system might force many out of the distribution industry altogether. Others will need to restructure to provide local services from the pier to the retailers' businesses. Furthermore, small distribution firms might have to resort to serve smaller firms at further distances, where the large firms do not want to serve.

12.5 “Last Mile”

A waterborne-distribution system once established and fully operational will reshape the transport of produce in the region. The emphasis is on the “last mile” instead of the route. Last mile in produce distribution refers to the trip from the waterborne, friendly landing site to the retailer's business site. The retailer or a designated agent could pick-up from the destination pier. A designated agent could be a newly formed delivery company specializing in pier pickup and delivery. Furthermore, developing friendly landing sites with community input is very important in order to minimize the Not-In-My-Back-Yard resistance.

It is likely that new local delivery companies will be formed. Local in this respect refers to within a district, borough, zip code, etc. The chances are slim that a produce retailer, depending on a third party to deliver its produce from HPTM, would pick-up produce from the pier. Thus, dependency of third party delivery will continue. But unforeseeable new arrangements are also possible. In either case or in the larger picture, it is expected that there will be a tradeoff, a reduction in congestion on the main arteries of the region for an increase in traffic to and from the waterborne piers. The increase in local traffic might trigger community objections as well.

12.6 Waterborne-Operation Finance

The financial aspect of a waterborne operation is complex. The outline below highlights the important issues that need to be addressed for a waterborne operation:

- The capital cost of building the waterborne asset(s).
- The operations cost of rent, labor (ILA or not), fuel, insurance, security, fees, dockage, wharf age, royalties, assessment, etc.
- The maintenance costs including downtime for inspection and repair.
- The charges for operating the system, such as computer systems, permits, etc.

- The government agencies' support (State, local, Coast Guard, Army Corps of Engineers, and others).
- The government agencies' regulations (State, local, Coast Guard, Army Corps of Engineers, and others).
- The training details, manuals, and schedules.
- The contract with the stakeholders.
- Potential support from government grants and/or subsidies.

In short, once the waterborne-operation alternative is fully functioning, it will, on the one hand, reduce the number of vehicles from the main roads and mitigate all the externalities (emissions, wear and tear of roadways, etc.) they generate. On the other hand, there will be an increase in traffic in areas near the waterborne piers. The actual amount of traffic increase from pier to retail business will be determined by the quantity of produce delivered, type of truck, and time of day.

13 Conclusions and Recommendations

The conclusions and recommendations for this preliminary study of the potential demand for waterborne, outbound-produce distribution from HPTM are divided into four sections. In general, there are severe multiple challenges in developing an outbound-produce distribution from HPTM to New York sites east of the Hudson. Thus, it is difficult to envision them resolved in the near future.

Findings: An outbound, waterborne-transportation system moving produce from HPTM to its consumers will significantly reduce the surface transportation traffic in New York east of the Hudson River and will reduce emissions as well.

A fully operating, waterborne system, completely replacing the present surface transportation system, would have a net effect, estimated east of the Hudson:

- savings of 39,500 miles per day (10.3 million per year)
- emissions reduction of 37,300 pounds of CO₂ per day (9.7 million pounds a year)
- savings of 2,076 gallons a day (540,000 gallons per year and \$1.35 million at \$2.50 per gallon)
- savings of 1,000 to 1,500 hours of driving per day

Challenges: In order to obtain a reliable outbound, waterborne-operation system, there is a need to overcome a few major challenges: trust, scale, schedule, and local delivery. There are some other challenges as well such as: community objections, service quality and customer relations, and the loss of toll revenues for the city agencies. The key conclusions are highlighted as follows:

- The present operation system lacks trust among HPTM wholesalers. Without trust, there is no collaboration in pooling resources together in order to establish the proposed operation.
- The present operation is dominated by small individual trucks on an on-demand delivery schedule (24/7). The retailers depend on this service and have gotten used to it—which might make change difficult. This raises another issue: Will the outbound-distribution system work with a one-hour pickup time?
- The present operation includes produce rejection with immediate and unconditional return to the wholesalers. This implies the return of produce to HPTM by the deliverer.
- The present delivery includes a door-to-door service from the wholesaler or broker to the retailer. Modifying the “last mile” operation might be a challenge for some wholesalers, retailers, and brokers.
- At the present time, the retailer can spot order. This ordering alternative will not be available in a waterborne operation—although it might be supplemented with a vehicle delivery.
- The waterborne operation needs to obtain high-volume shipments to make the operation economically viable. Otherwise, the operation will fail.

- The new friendly landing sites for vessel discharge might raise communities' concerns (Not-In-My Back-Yard) because of traffic increase, noise, emission, and others.
- The waterborne operations distance monitoring of the service quality and customer relations between wholesaler and retailer is diminished. The buffer it creates is a concern for some wholesalers.
- The toll-revenue reduction from fewer bridge crossings might produce objects from officials of agencies who depend on those toll revenues.
- The definition, role, and function of the 3PWDP proposed in the study are a concern to some.
- The Coast Guard might require compliance with security regulations and public access permits at the landing sites.

Recommendations: An outbound, waterborne-distribution system is a challenge to develop but the benefits to NYC could have very visible benefits: reducing congestion and pollution, reducing wear and tear of roads and bridges, and utilizing the marine highway that is underutilized at this time. Indirectly an outbound-waterborne distribution will also reduce the cost of living, commute time, medical problems and costs, that is, increase in productivity could be expected.

Adopting and implementing an outbound-waterborne distribution requires stakeholders' cooperation and support. There are many stakeholders including wholesalers, retailers, and government officials at various local and state levels. A waterborne, outbound-food distribution should be an important undertaking by authorities in populated areas with rich waterway alternatives. The challenges and complexities could be overcome with government leadership.

The implementation of an outbound, waterborne-distribution system should be gradual, starting in Brooklyn. Brooklyn has the appropriate facilities in place for this type of a waterborne operation and, after the Bronx, it is the largest consumer of produce from HPTM. These two considerations make Brooklyn the most appropriate candidate to start this operation.

Once the waterborne operation is fully operational, it will reduce the number of vehicles from the main roads and mitigate all associated externalities, which are mostly negative. However, there will be an increase in traffic in areas near the offloading location. The actual amount of traffic increase from pier to retail business will be determined by the quantity of produce delivered, type of truck, and time of day.

Future Research: Future research on the subject should address each of the challenges. In addition, research should consider (partial list):

- The use of the City Wide ferry sites for potential use for outbound-produce distribution.
- The inbound-waterborne delivery in conjunction with the outbound distribution.
- A regional analysis of the produce distribution and the role of waterborne assets.
- The role of tolls on produce delivery in the New York region.
- Industry research to identify target markets.

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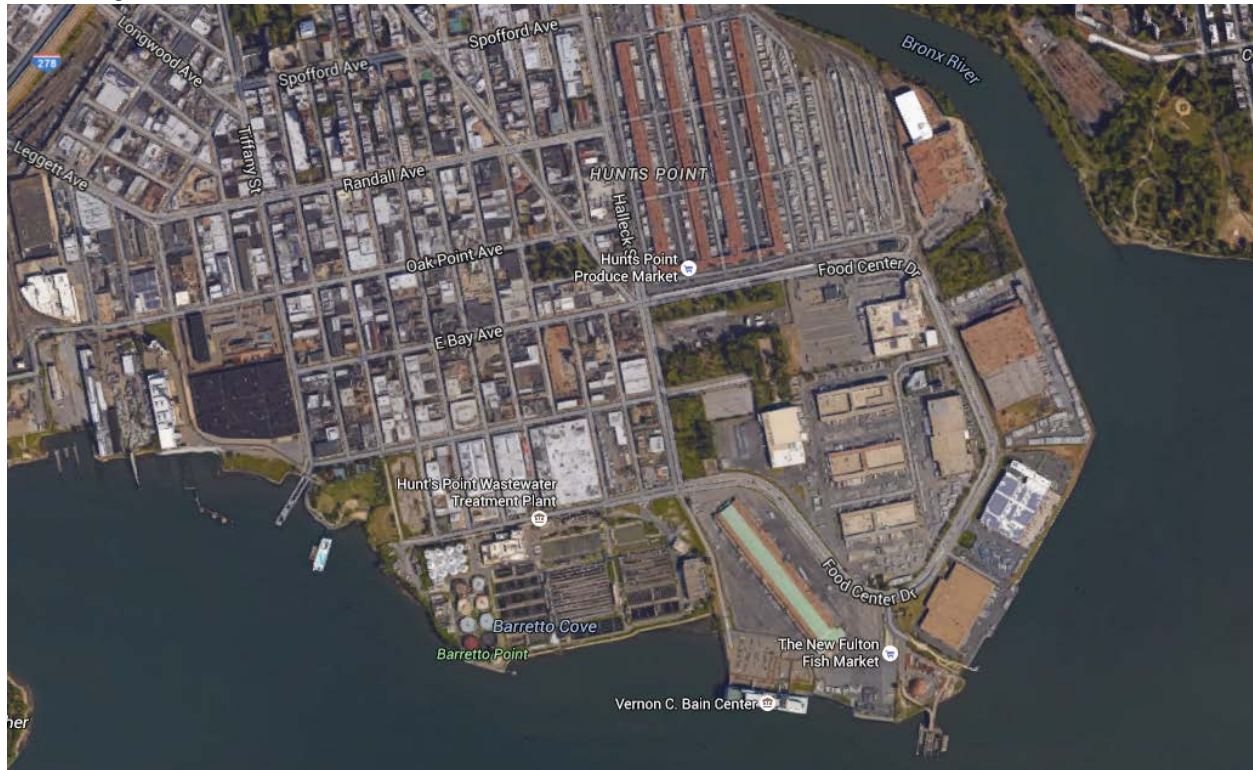
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Appendix A: HPTM Arial View

Source: Google earth



HPTM - Diagram of Wholesalers

Source: Huntspoint Terminal Market.html

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Appendix B: Produce Storage Temperature

Source: James F. Thompson and Adel A. Kader, "Wholesale Distribution Center Storage," University of California, Davis, reference to "Thompson, J., A.A. Kader, and K. Sylva. 1996, "Compatibility chart for fruits and vegetables in short-term transport and storage. Nat. Res. Pub. no. 21560, University of California, Division of Agriculture and Natural Resources, Oakland, CA." <http://www.ba.ars.usda.gov/hb66/wholesale.pdf>

Table 1. Compatible fresh fruits and vegetables during 7-day storage*

		Groups 1A and 1B		Group 2	Group 3
		0-2 °C; group 1A: 90-98% RH; group 1B: 85-95% RH		7-10 °C; 85-95% RH	13-18 °C; 85-95% RH
		Group 1A			
Vegetables	Alfalfa sprouts	Chinese cabbage†	Mint†	Basil†	Bitter melon
	Amaranth†	Chinese turnip	Mushroom	Beans, snap, green, wax	Boniato†
	Anise†	Collard†	Mustard greens†	Cactus leaves (nopales) †	Cassava
	Artichoke	Corn, sweet, baby	Parsley†	Calabaza	Dry onion
	Arugula†	Cut vegetables	Parsnip	Chayote†	Ginger
	Asparagus†	Daikon†	Radicchio	Cowpea (Southern pea)	Jicama
	Beans, fava, lima	Endive†-chicory	Radish	Cucumber†	Potato
	Bean sprouts	Escarole†	Rutabaga	Eggplant†	Pumpkin
	Beet	Fennel†	Rhubarb	Kiwano (horned melon)	Squash, winter (hard rind) †
	Belgian endive†	Garlic	Salsify	Long bean	Sweet potato†
	Bok choy†	Green onion†	Scorzonera	Malanga†	Taro (dasheen)
	Broccoli†	Herbs† (not basil)	Shallot†	Okra†	Tomato, ripe, partially ripe, & mature green
	Broccoli flower†	Horseradish	Snow pea†	Pepper, bell, chili	Yam†
	Brussels sprouts†	Jerusalem artichoke	Spinach†	Squash, summer (soft rind) †	
	Cabbage†	Kailan†	Sweet pea†	Tomatillo	
	Carrot†	Kale†	Swiss chard†	Winged bean	
	Cauliflower†	Kohlrabi	Turnip		
	Celeriac	Leek†	Turnip greens†		
	Celery†	Lettuce†	Water chestnut		
	Chard†		Watercress†		

		Group 1B			
Fruits and melons	Apple*	Elderberry	Prune*	Avocado, unripe*	Lime†
	Apricot*	Fig	Quince†	Babaco	Limequat
	Avocado, ripe†	Gooseberry	Raspberry	Cactus pear, tuna	Mandarin
	Barbados cherry	Grape	Strawberry	Calamondin	Mango, ripe†
	Blackberry	Kiwifruit†‡		Carambola	Olive
	Blueberry	Loganberry		Cranberry	Orange
	Boysenberry	Longan		Custard apple†	Passion fruit
	Caimito	Loquat		Durian, ripe†	Pepino
	Cantaloup†	Lychee		Feijoa	Pineapple
	Cashew apple	Nectarine		Granadilla†	Pummelo
	Cherry	Peach		Grapefruit†	Sugar apple
	Coconut	Pear (Asian & European)		Guava†	Tamarillo
	Currant	Persimmon†		Juan canary melon†	Tamarind
	Fresh-cut fruits†	Plum, ripe†		Kumquat	Tangelo
	Date	Plumcot, ripe†		Lemon†	Tangerine
	Dewberry	Pomegranate			Ugli fruit
					Rambutan

Source: Thompson et al. 1996

*Ethylene should be kept below 1 µL L⁻¹ (1 ppm) in the storage area.

†Sensitive to ethylene damage.

‡Produces significant ethylene.

Source: James F. Thompson and Adel A. Kader, "Wholesale Distribution Center Storage," University of California, Davis, reference to "Thompson, J., A.A. Kader, and K. Sylva. 1996, "Compatibility chart for fruits and vegetables in short-term transport and storage. Nat. Res. Pub. no. 21560, University of California, Division of Agriculture and Natural Resources, Oakland, CA." <http://www.ba.ars.usda.gov/hb66/wholesale.pdf>

Table 2. Compatible flowers, florist's foliage, and nursery items during 7-day storage[†]

Flowers	Group 1* 0-2 °C; 85-95% RH			Group 2 7-10 °C; 85-95% RH		Group 3 13-18°C; 85-95% RH
	Acacia	Gaillardia	Protea	Anemone		African violet
	Alstroemeria	Gardenia	Ranunculus	Bird of paradise		Anthurium
	Allium	Gerbera	Rose	Camellia		Ginger
	Aster	Gladiolus	Snapdragon	Eucharis		Heliconia
	Bouvardia	Gypsophila	Snowdrop	Gloriosa		Orchid, cattleya, vandal
	Buddleia	Heather	Squill	Godetia		Poinsettia
	Calendula	Hyacinth	Statice	Sweet-william		Bulbs, corms, rhizomes, tubers, & roots
	Candytuft	Iris	Stephanotis			Nursery stock
	Carnation	Laceflower	Stevia			
	Chrysanthemum	Lilac	Stock			
	Clarkia	Lily	Strawflower			
	Columbine	Lily-of-the-valley	Sweet pea			
	Coreopsis	Lupine	Tulip			
	Cornflower	Marigolds	Violet			
	Cosmos	Mignonette	Zinnia			
	Crocus	Narcissus	Cuttings & scions			
	Dahlia	Orchid, cymbidium				
	Daisy, English, Marguerite, Shasta	Ornithogalum				
	Delphinium	Poppy				
	Feverfew	Peony				
	Forget-me-not	Phlox				
	Foxglove	Primrose				
	Freesia					
Florist's foliage (greens)	Adiantum (maidenhair)	Gallax	Pittosporum	Chamaedorea		Dieffenbachia
	Asparagus (plumose)	Ground pine	Rhododendron	Cordylone		Staghorn fern
	Buxus (boxwood)	Hedera	Salal (lemon leaf)	Palm		
	Camellia	Ilex (holly)	Scotch-broom	Podocarpus		
	Cedar	Juniper	Smilax			
	Croton	Leatherleaf	Vaccinium (huckleberry)			
	Dracaena	Leucothoe	Woodwardia fern			
	Fern, dagger, wood	Magnolia				
	Eucalyptus	Mistletoe				
		Mountain-laurel				
		Myrtus (myrtle)				
		Philodendron				

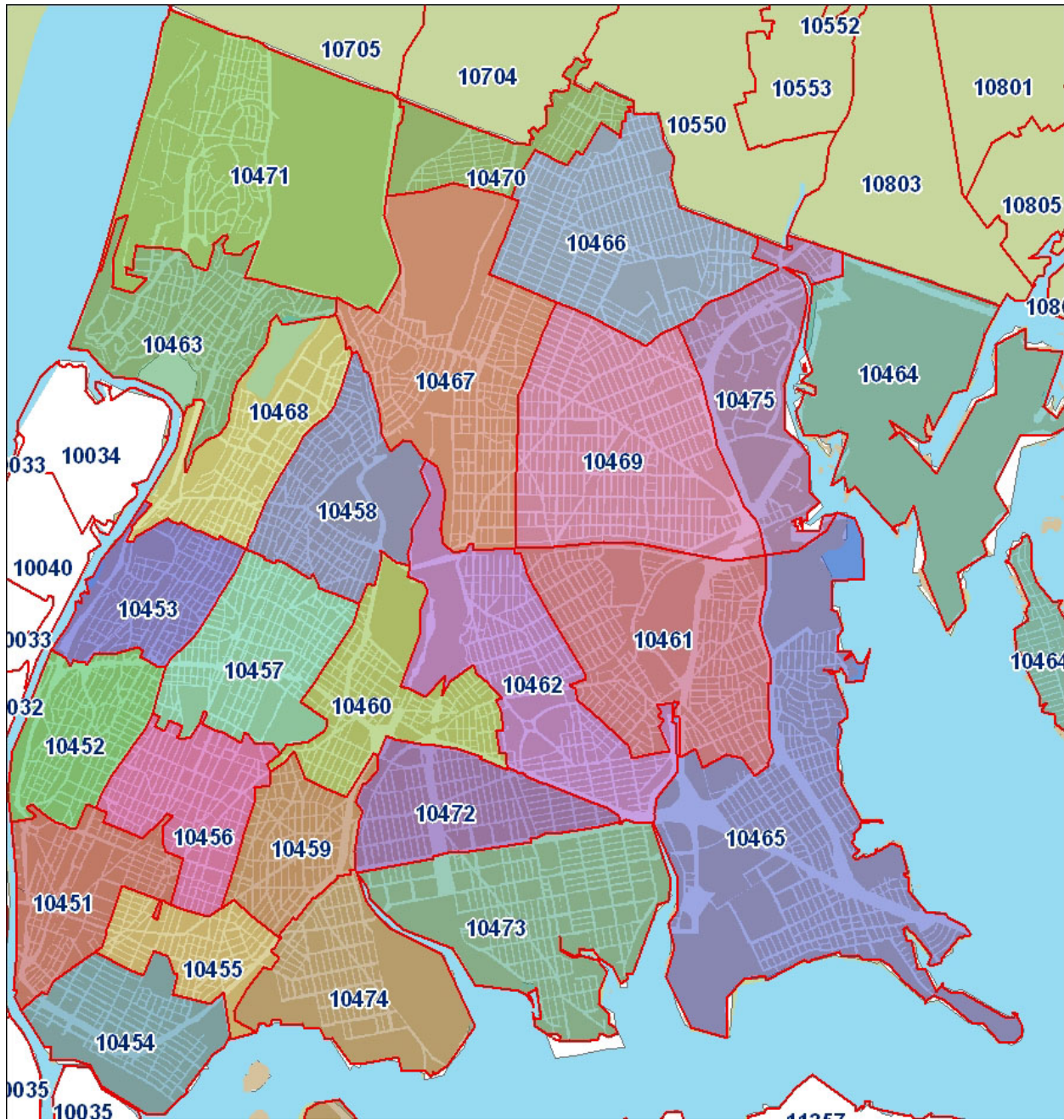
*Can be stored with group 1A vegetables in a mixed produce storage.

[†] Ethylene should be kept below 1 $\mu\text{L L}^{-1}$ (1 ppm) in the storage area.

Appendix C: Boroughs Maps

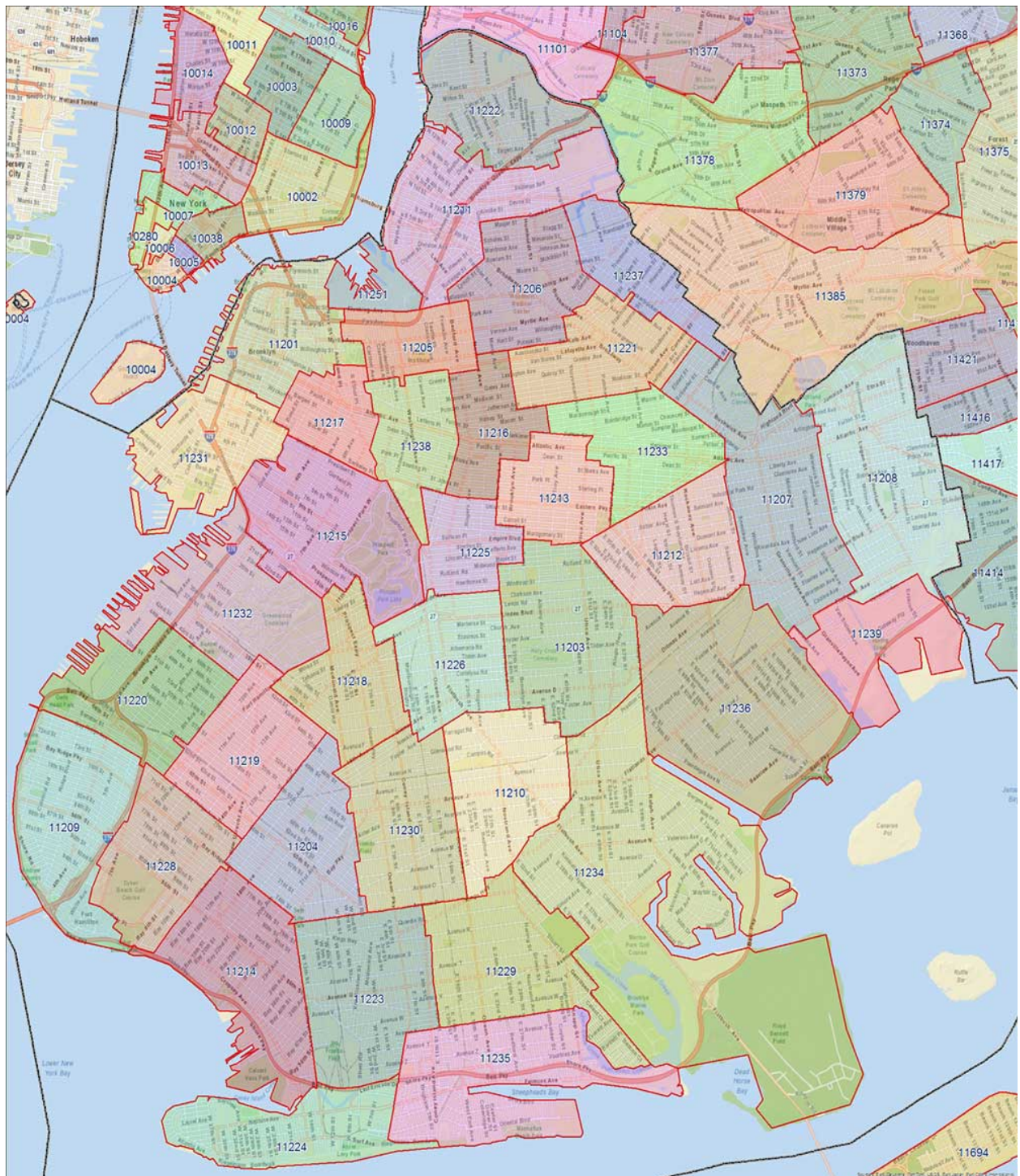
Bronx

Source: Bronx Zip Code Map, <https://unhp.org/crg/indy-maps-bxzip.html>



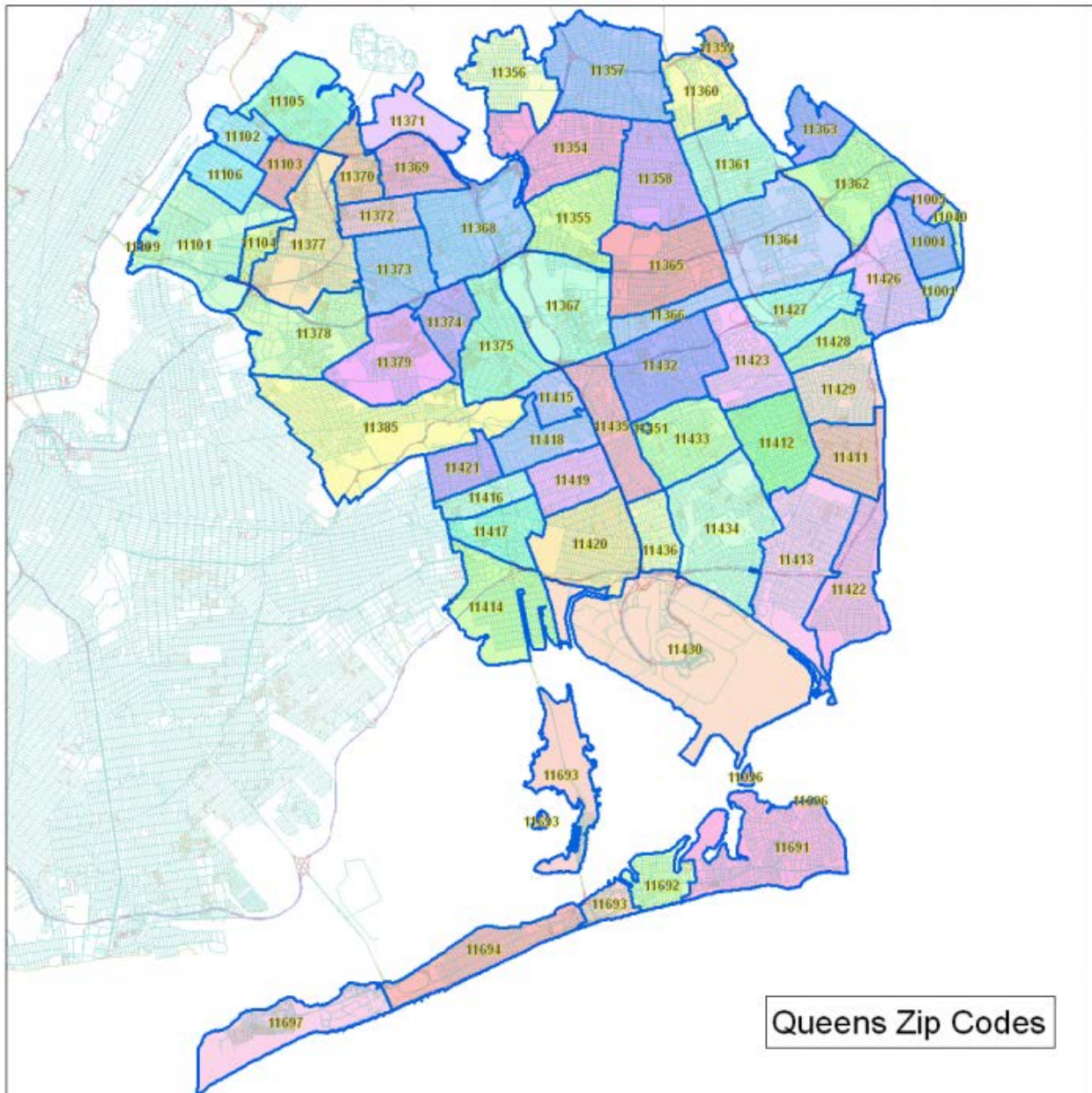
Brooklyn

Source: Brooklyn Zip Code Map, http://crg.unhp.org/view_map/brooklyn-zip-codes



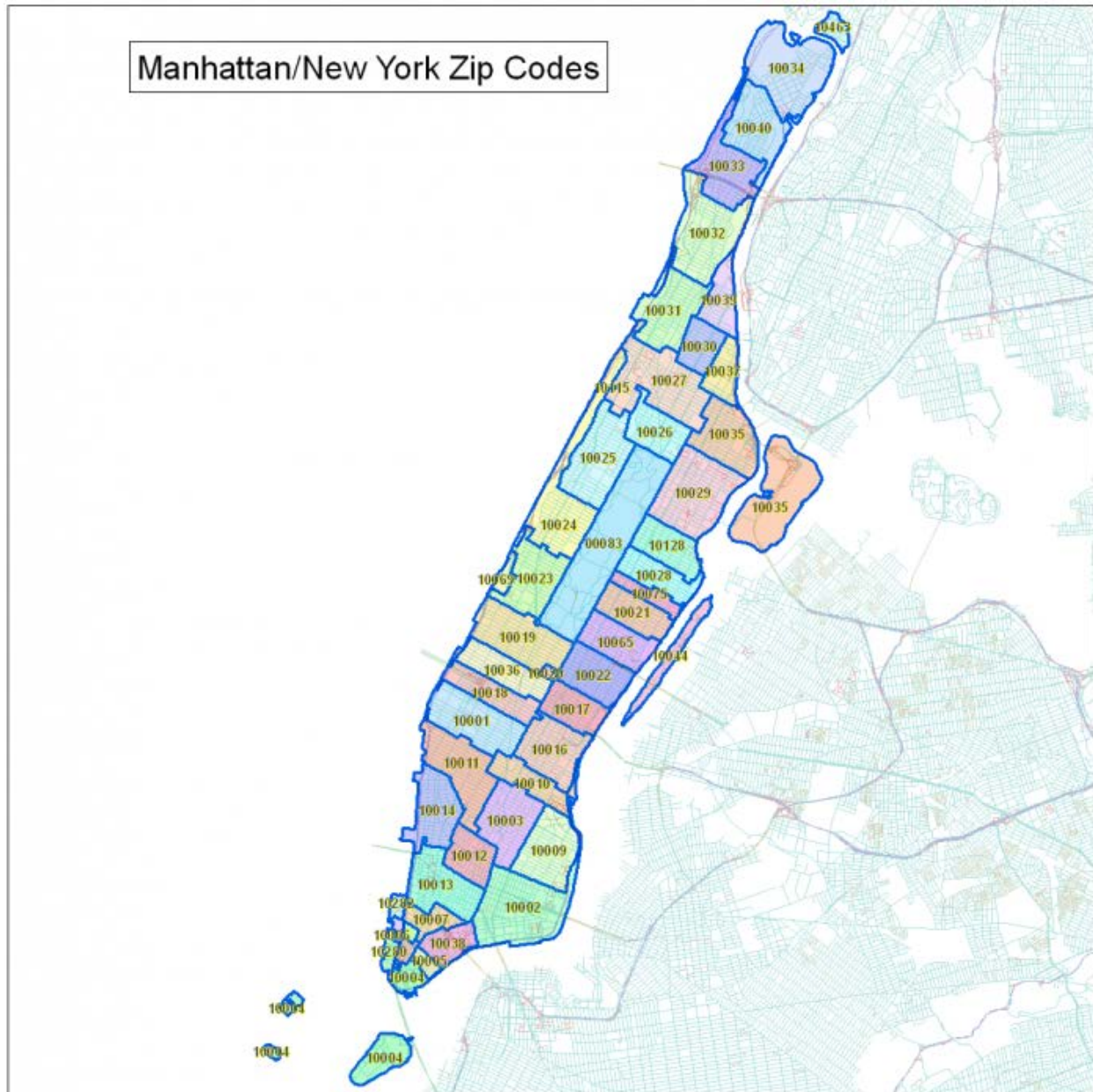
Queens

Source: Queens Zip Code Map, <http://map-world.us/queens-zip-code-map.html>



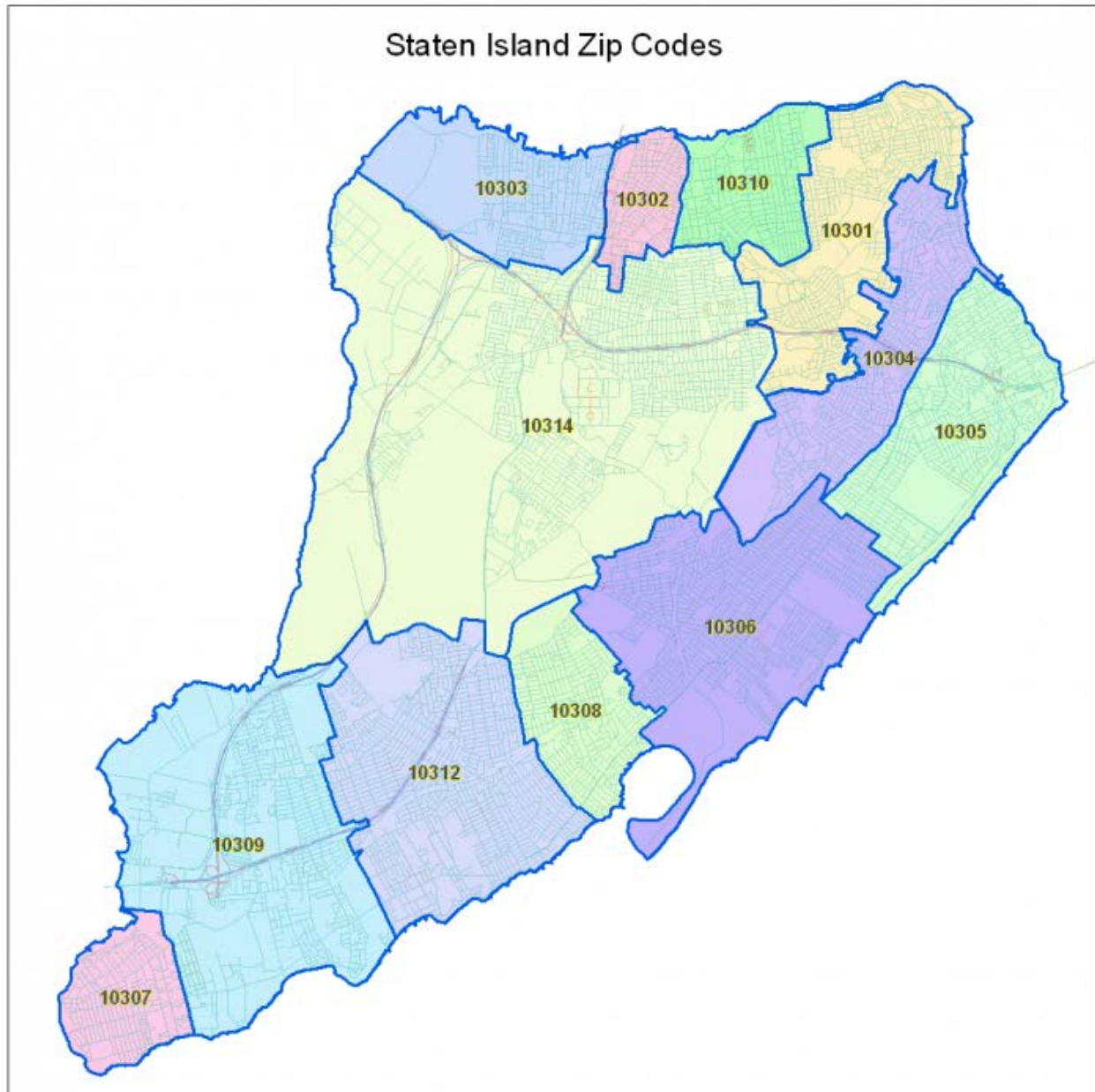
Manhattan

Source: Manhattan Zip Code Map, <http://map-world.us/manhattannew-york-zip-code-map.html>



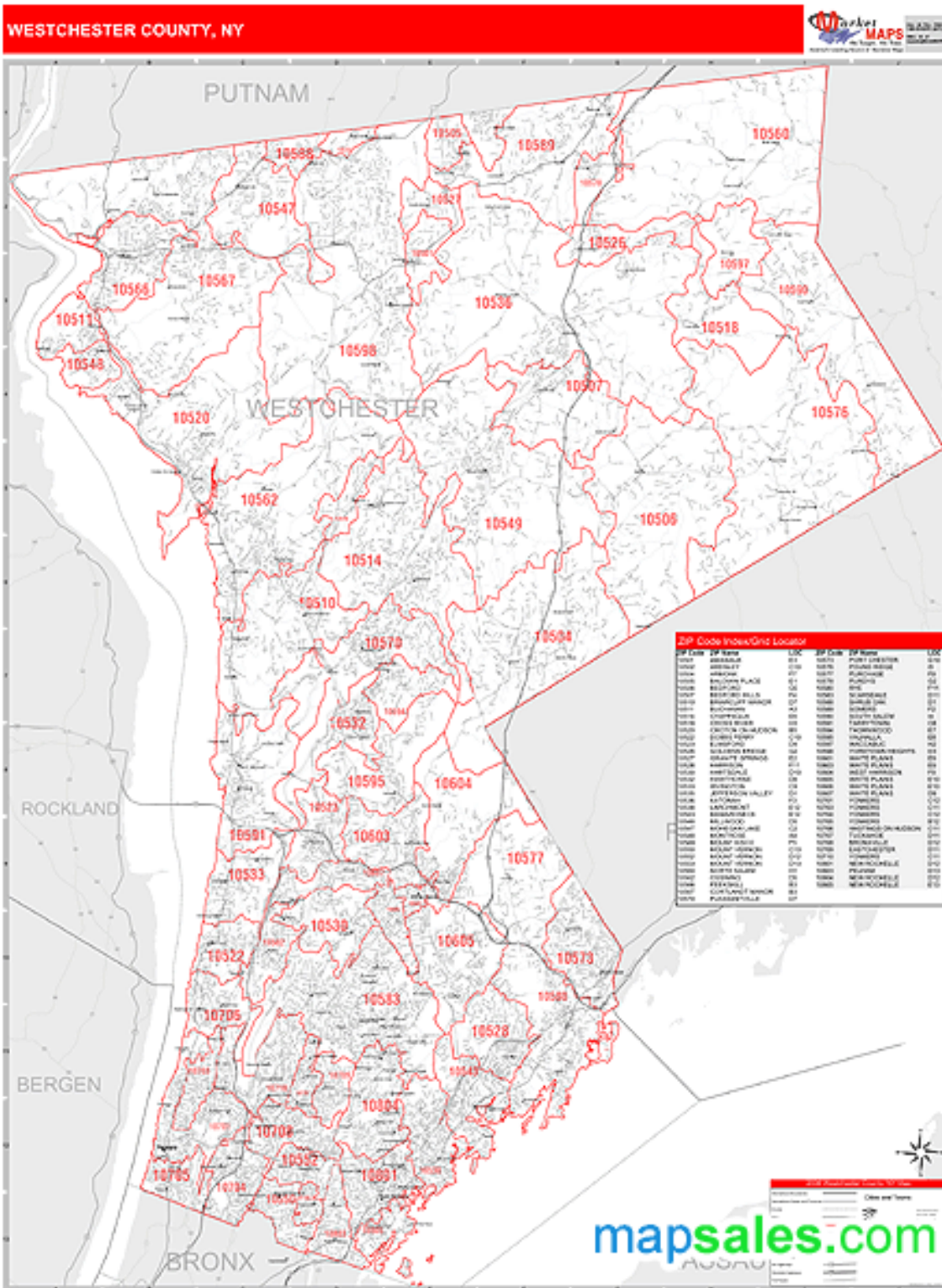
Staten Island

Source: Staten Island Zip Code Map, <http://turkeygrilldetroit.com/staten-island-zip-code-map.aspx>



Westchester

<http://huntspointcoopmkt.com/>



Appendix D: Boroughs Zip Codes

<https://www.health.ny.gov/statistics/cancer/registry/appendix/neighborhoods.htm>

Borough	Neighborhood	ZIP Codes
Bronx	Central Bronx	10453, 10457, 10460
	Bronx Park and Fordham	10458, 10467, 10468
	High Bridge and Morrisania	10451, 10452, 10456
	Hunts Point and Mott Haven	10454, 10455, 10459, 10474
	Kingsbridge and Riverdale	10463, 10471
	Northeast Bronx	10466, 10469, 10470, 10475
	Southeast Bronx	10461, 10462, 10464, 10465, 10472, 10473
Brooklyn	Central Brooklyn	11212, 11213, 11216, 11233, 11238
	Southwest Brooklyn	11209, 11214, 11228
	Borough Park	11204, 11218, 11219, 11230
	Canarsie and Flatlands	11234, 11236, 11239
	Southern Brooklyn	11223, 11224, 11229, 11235
	Northwest Brooklyn	11201, 11205, 11215, 11217, 11231
	Flatbush	11203, 11210, 11225, 11226
	East New York and New Lots	11207, 11208
	Greenpoint	11211, 11222
	Sunset Park	11220, 11232
	Bushwick and Williamsburg	11206, 11221, 11237
Manhattan	Central Harlem	10026, 10027, 10030, 10037, 10039
	Chelsea and Clinton	10001, 10011, 10018, 10019, 10020, 10036
	East Harlem	10029, 10035
	Gramercy Park and Murray Hill	10010, 10016, 10017, 10022
	Greenwich Village and Soho	10012, 10013, 10014
	Lower Manhattan	10004, 10005, 10006, 10007, 10038, 10280
	Lower East Side	10002, 10003, 10009
	Upper East Side	10021, 10028, 10044, 10065, 10075, 10128
	Upper West Side	10023, 10024, 10025
	Inwood and Washington Heights	10031, 10032, 10033, 10034, 10040
Queens	Northeast Queens	11361, 11362, 11363, 11364
	North Queens	11354, 11355, 11356, 11357, 11358, 11359, 11360
	Central Queens	11365, 11366, 11367
	Jamaica	11412, 11423, 11432, 11433, 11434, 11435, 11436

	Northwest Queens	11101, 11102, 11103, 11104, 11105, 11106
	West Central Queens	11374, 11375, 11379, 11385
	Rockaways	11691, 11692, 11693, 11694, 11695, 11697
	Southeast Queens	11004, 11005, 11411, 11413, 11422, 11426, 11427, 11428, 11429
	Southwest Queens	11414, 11415, 11416, 11417, 11418, 11419, 11420, 11421
	West Queens	11368, 11369, 11370, 11372, 11373, 11377, 11378
Staten Island	Port Richmond	10302, 10303, 10310
	South Shore	10306, 10307, 10308, 10309, 10312
	Stapleton and St. George	10301, 10304, 10305
	Mid-Island	10314

Appendix F: New Jersey's Weekly Produce Distribution by County

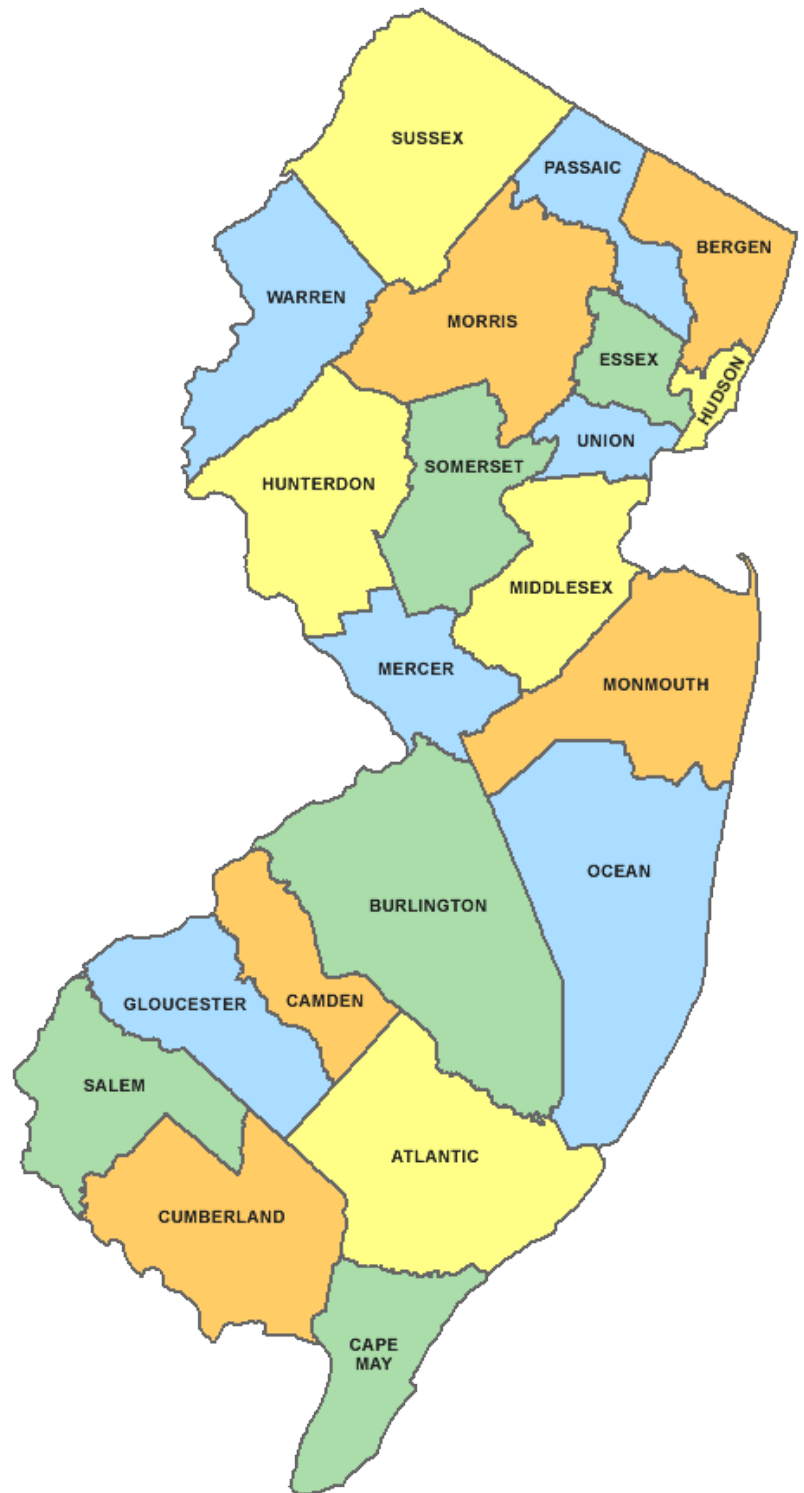
County	Weekly no. of packages	% of total
Bergen	947,000	36.35%
Union	489,774	18.80%
Essex	433,870	16.65%
Passaic	224,321	8.61%
Middlesex	178,617	6.86%
Hudson	105,269	4.04%
Ocean	63,734	2.45%
Monmouth	56,597	2.17%
Mercer	30,436	1.17%
Morris	24,082	0.92%
Somerset	12,305	0.47%
Gloucester	10,649	0.41%
Burlington	10,553	0.41%
Cumberland	10,185	0.39%
Sussex	7,385	0.28%
Atlantic	449	0.02%
Camden	12	0.00%
Total	2,605,237	100%

Note:

The produce distribution is primarily in the northern part of the state, with a very high population density and large cities.

The proximity to HPTM makes it very attractive as the main source for the purchase of produce as indicated in the table.

New Jersey does not have a produce market.



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Appendix G: Outbound, Waterborne-Distribution Services: Questions and Comments

The outbound, waterborne-alternative distribution for produce was a new concept for all the wholesalers. Their concerns touched on every aspect of their operation. Altogether, the following comments and questions were made:

About the concept and customers

- This is a new concept that we did not think about.
- It would be quite challenging to implement due to the diversity of customers.
- It would be interesting to see how the concept of waterborne operations looks and how it would meet the customer service requirements:
 - o Customer preferences
 - o Cost
 - o Schedule timing
 - o Service quality
 - o Customer relationships

About the operations

- What is the location in the outer boroughs?
- What is the transit time from HPTM?
- What is the frequency of service?
- How will we deal with returned shipments?
- Scheduling and timing: how will we overcome the time sensitivity of shipments?
- What is the barge capacity?
- How will we deal with the additional layer of operations since final pickup and delivery after shipments are offloaded from a barge?
- How will they overcome the complexity of the logistics involved with operations?

In general

- How will we compete against trucks with respect to flexibility, accessibility, and transit time?
- When it comes to barge loading and discharging, the first shipment loaded on barge may not be the first to be discharged off.
- Facing the critical time-sensitive issue for all distributors at HPTM, the simple question is whose shipment will get on the barge first and whose shipment will come off first.
- With trucking, the flexibility of pickup and delivery at a moment's notice is paramount for customers.

- Inbound shipments are more suitable to using water due to highly concentrated large volume (almost all shipments come via the George Washington Bridge) and single destination (HPTM). In addition, the high-toll cost through the George Washington Bridge provides cost incentive to switch to water for inbound shipment. However, cost is not the only factor in determining modal selection.
- The stringent market dynamics make it impossible to switch to water.
- Environmental concerns.

In short, based on the nature of the market and produce/shipment characteristics, HPTM resembles the just-in-time logistics: small volume and more frequent shipment/replenishment, no inventory at end user's premises, high-quality products, and zero defect. The truck is the most viable means for outbound distribution; switching to water for the time being does not seem viable in providing the competitive services trucks offer.

Appendix H: A Design of Waterfront Food Exchange for Barges



Source: Emerging New York Architects Competition Unveils the Winning Designs for the Harlem Edge Waterfront
Harlem – Inhabitant New York City

<http://inhabitat.com/nyc/emerging-new-york-architects-competition-unveils-the-winning-designs-for-the-harlem-edge-waterfront/harlem/?extend=1>

“... a literal food exchange, with food barges collecting produce from the onsite urban farm and distributing it to neighborhoods along the river. A boardwalk promenade creates a welcome path for the park for people ...”

Appendix I: Project Researchers

Shmuel (Sam) Yahalom, Ph.D.

Principal Investigator (PI)

Distinguished Service Professor of Economics and Transportation, Department of Global Business and Transportation, State University of New York – Maritime College

Shmuel (Sam) Yahalom, Ph.D., is a distinguished service professor of economics and transportation in the Department of Global Business and Transportation at the State University of New York – Maritime College. His area of research focuses on the maritime aspects of transportation. His research provided practical solutions to problems. Together with Changqian Guan, Ph.D., and Professor Johansson he completed (April 2014) a research project for New Jersey Department of Transportation addressing “Offshore Wind Development Research.” The projects, of which he was the PI, focused on determining the types of vessels and port characteristics needed to develop offshore wind farms in New Jersey. In an earlier project (March 2008) for NYCEDC, Yahalom (PI) together with the same team conducted the “Maritime Support Service Location Study.” This study identified New York City waterfront properties for maritime reserve use. The study also included a supplement for the Brooklyn Navy Yard determining the need for dry docks. Other studies for the Port Authority of New York and New Jersey (PA) include a three-phase study of “Intermodal Productivity and Goods Movement: Phase I - Crane Performance, Phase II – Land Access to Port and Terminal Gate Operations, and Phase III - Logistics Operations of Marine Container Terminal.”

Yahalom together with Guan researched for various agencies and groups including two studies for the Army Corps of Engineers in (2013) “Deep Draft Vessel Operating Costs” and in (2010) “Analysis of the Access Canals Development Needs.” Studies were carried out for New York Container Terminal (NYCT), Staten Island, NY, “Operational and Economic Analysis for a New Container Port Terminal” and Global Terminal, Bayonne, NJ, “Benefit-Cost Analysis and the Economic Impact Statement” for a TIGER IV submission for building the South Hudson Intermodal Facility. The analysis included a large part of emission reduction associated with the project. The grant was awarded to the terminal. Yahalom and Guan provided research also for NYCT and PA entitled “Economic Analysis of the Effect of the Recent PANYNJ Toll Increase on NYCT.” Yahalom and Guan were instrumental in providing analysis and simulation which secured a contract for barge transport of containerized waste material from New York City Marine Transfer Stations to a power station and/or a landfill.

Yahalom has a Ph.D. in Economics from the City University of New York – Graduate Center class of 1984. He is a senior faculty member in Maritime College since 1978. His primary interest in research, consulting and publications is maritime and ports. Yahalom frequently teams up with Guan and Captain Johansson to address various issues of research, consulting, and publishing. He is also an active member of University Transportation Research Center (Region II), Port Performance Task Force, Maritime Academic Council and others.

Camille Kamga, Ph.D.

Co-Principal Investigator (Co-PI)

Camille Kamga, Ph.D., will serve as the UTRC Principal Investigator of the proposed project. He is currently the director of the federally supported University Transportation Research Center (UTRC) and an Assistant Professor of Civil Engineering at the City College of New York (CCNY). A consortium of 19 major U.S. academic institutions, UTRC asserts a significant role in the region and nationally, conducting research and projects on surface transportation, carrying out training and educational programs and actively disseminating the results of its work. It is one of the few such centers in the U.S. with a concentration in public transportation operations, policy, and management. Kamga oversees the Center's activities and works closely with federal, regional, and state transportation planning and policy organizations. He also serves as member of the Board of Directors of the Intelligent Transportation Society of New York - a professional group providing education and outreach to foster the understanding of ITS applications and technologies. He holds a Ph.D. in Civil Engineering from the Graduate Center of the City University of New York, specializing in Intelligent Transportation Systems (ITS). He is the 2006 recipient of the National Pikarsky Award for Outstanding Dissertation in Science and Technology from the Council of University Transportation Center. His doctoral thesis was on the topic of "Estimation of Network Based Incident Delay in a Transportation Network Using Dynamic Traffic Assignment." In addition to his research and administrative duties, Kamga has participated in numerous transportation-related projects at UTRC. Kamga's research interests are in the modeling and of transportation network, analysis of very large transportation networks, and application of technology for transportation. Kamga is currently the principal investigator of many research projects sponsored by the New York State Department of Transportation, New York Metropolitan Transportation Council, New York State Energy and Research Development Authority, New Jersey Department of Transportation, and New York City Transit.

Changqian Guan, Ph.D.

Adjunct Professor of Supply Chain Management and Logistics, Global Business and Transportation Department

Changqian Guan, Ph.D., is a professor in Intermodal Freight Transportation. He was a faculty member of State University of New York Maritime College from 1998 – 2002. He has been a professor at the Department of Marine Transportation, U.S. Merchant Marine Academy. Previously he was a licensed merchant marine officer with several years of sea-going experience. He also worked in several international corporations of shipping maritime economics/logistics, intermodal freight transportation, and port/terminal operations in various management capacities. In addition, he worked at a marine container terminal as superintendent.

Guan's research, consulting, and teaching interests have been in maritime economics/logistics, intermodal freight system, port planning and terminal management. He has published papers and articles in academic journals, conferences, research reports and meetings and reviewed papers on various subjects of maritime shipping, intermodal freight, terminal management, and port development.

He has provided consulting and research services to the U.S. Army Corps of Engineers for an analysis in container vessel deployment patterns to determine infrastructure development priorities for East Coast ports with the anticipation of Panama Canal expansion in 2014; the NYCEDC for preserving the waterfront and the economic effectiveness of preserving the dry docks in the Brooklyn Navy Yard; Port of Charleston for a strategic analysis of global container shipping and port development concerns; Port Authority of New York and New Jersey for operational and economic analysis of vessel loading and discharging operations, yard operations, and gate operations; New York Container Terminal for an economic and financial analysis of developing Port Ivory; COVANTA Energy/TransRiver for a maritime plan of transporting containerized waste material by barge from Marine Transfer Stations in New York City to power plants or landfill. Other projects were for NYK Lines and Di Gregorio Lines.

Captain Eric Johansson

Co-Principal Investigator (Co-PI)

Professor in the Professional Education and Training Department

Captain Eric J. Johansson is a Professor with an M.S. in Transportation Science. He is a professor of professional education and training since 1994 in the State University of New York - Maritime College. He has many certificates and licenses and has received many awards.

He was also the Faculty Presiding Officer (2004–2008).

His research and consulting have been in Maritime Support Service Location Study, Phase II; New York State Department of State Division of Coastal Resources; Marine Technology Small Vessel Operations Cadet Observer; Towing Regulations, Lines of Communication; Hudson Transmission Project, Lower Hudson River Barge Traffic Study; Navigation Procedures Study; Governance Structures, Resources, and Procedures; International Safety Management (ISM) Development and Implementation.

Firms and associations that benefited from his research, consulting, and employment include: Circle Line Sightseeing, Donjon Marine, Bridgeport Port Jefferson Ferry, Moran Towing and Transportation, Association Port of NY/NJ Harbor Safety, Navigation & Operations Committee; Hudson Transmission Partners; Allied Transportation Corporation; Roehrig Maritime.

In addition, he is:

- Founder and Chair – Maritime College Towing Forum
- Chair – Energy Subcommittee Port of New York
- Chair – Towing Professors Group
- Executive Director – Maritime Industry Museum
- Executive Director – Tug and Barge Committee Port of NY/NJ
- Vice Chair - Towing Safety Advisory Committee
- Cochairman – Professional Advisory Committee, New York Harbor School
- Delegate – Port and Waterway Safety Assessment (PAWSA) Port of NY/NJ
- Member Steering Committee – Harbor Operations Committee Port of NY/NJ
- Member – NYC Waterfront Revitalization Program

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Joan McDonald, Commissioner