New York City
Arterial Goods Movement Study

Rennselaer Polytechnic Institute,
Polytechnic University,
and
Cornell University

Region II University Transportation Research Center
and
Region 11 New York State Department of Transportation

March 5, 2003

New York City
Freight Arterials Study

What Impact Will Future Freight Transportation Needs Have on the New York City Interstates and Truck Routes

FINAL REPORT

prepared for the

Region II University Transportation Research Center

and

Region 11, New York State Department of Transportation

George List, Donald Geoffroy, Jeffrey Wojtowicz, Laura Koniezny and Chanda Durnford
Rensselaer Polytechnic Institute

John Falcocchio, Jose Ulerio, and Ali Afshar
Polytechnic University

Arnim Meyburg
Cornell University

March 5, 2003

Acknowledgement

The authors would like to acknowledge the help received from many people in the course of this research project. First and foremost is Peter King from Region 11, NYSDOT, who has contributed guidance and counsel that have been absolutely essential in understanding the purpose, scope, and context of the study, and ensuring that its focus, analysis, and findings can be most meaningful to the broadest possible audience. Supporting Peter have been Richard Hansen and Victor Teglasi, also from Region 11. Also critical have been Howard Mann and Kuo-Ann Chow from NYMTC and Alice Cheng of the New York City Economic Development Corporation, who have helped us with supporting information and guidance in the context of the Regional Freight Study, the modeling of the urban network, and the Cross Harbor Major Investment Study. Last, but certainly not least, we have to thank the people at Rensselaer who were invaluable in bringing the final report to closure, Marcia Hartnett and Jessica Josselyn.

Table of Contents

New York City Arterial Goods Movement Study

What Impact Will Future Freight Transportation Needs Have on the NYC Interstate and Truck Route System?

Tables and Figures

Chapter 1 Introduction

Chapter 2 Setting the Context

Tables

Figures

Chapter 3 Evidence of Needs & Existing Problems

Tables

Figures

Chapter 4 <u>Methodology</u>

Table

Figures

Chapter 5 <u>Year 2025</u>

Tables

Figures

Chapter 1 - Introduction

As the world economy grows and comparative economic advantage takes on greater significance at both the national and regional level, efficient and effective freight transportation systems become increasingly important. Local economies are immersed in the global economy and regions that are strategically placed geographically and well connected logistically can attract new economic development and enhance existing business activity.

Since the mid-1970s, better support for freight transportation has been a concern in the New York Metropolitan area. Studies of specific ideas have produced a wealth of information about the options available, but a comprehensive plan is still needed.

More than forty freight studies have examined the options for the New York region. One of the most recent has focused on developing a comprehensive plan for freight [1-4]. The other has considered the merits of building a new rail tunnel under the Hudson [5]. It seems, at last, that a consensus-based freight plan for the region may be emerging.

Truck information, though, is still sparse. The New York Metropolitan Transportation Council (NYMTC)-sponsored Best Practices Model (BPM) development effort created a current year truck trip table and a methodology for forecasting truck trips in the future [6,7], but a comprehensive plan for truck traffic is still lacking. Efforts underway as part of the Regional Freight Plan Project [1, 2, 4] are progressing in that direction for a comprehensive, multi-modal plan. The Cross Harbor MIS provides a more focused analysis on freight flows that could use a new cross harbor tunnel [8].

In an effort to begin meeting the need for a comprehensive plan, a team comprised of Rensselaer Polytechnic Institute, Cornell University, and Polytechnic University was selected by the Region II University Transportation Research Center to assist Region 11, NYSDOT focus its freight-related planning actions. This report describes the results of that effort. The analysis of the Transportation Improvement Program (TIP) for New York City concluded that a more accurate reflection of freight needs for network enhancement was needed. The TIP is the list of projects approved for funding with federal monies by the Metropolitan Planning Organization, in this instance NYMTC. The City's principle arterials have been the major focus of this study, especially in the boroughs of Kings (Brooklyn), Queens, and the Bronx. The main question of the study has been: where would strategic investments in capacity, geometric improvements, and support services, such as Intelligent Transportation Systems (ITS), and changes in regulations affecting trucks and commercial vans have the greatest beneficial impacts on freight mobility and economic development.

Conceptually, the study involved a supply-demand analysis of the City's multi-modal freight transportation system and in the analysis of freight demand, be on present and the future, the system's ability to meet those demands.

The questions of greatest interest are: how should the city deal with freight delays? How can the impacts of traffic congestion on freight activities be ameliorated? How can the high cost of freight transportation be reduced? What actions will mitigate the fact that trucks can block narrow streets and contribute to congestion? Are current capital investment and TIP plans logically coupled to the fact that trucks accelerate pavement and bridge deterioration and maybe have special geometric, operational, capacity and access requirements?

To do this, the project team has:

- Researched stakeholder needs;
- Reviewed previous studies on truck, rail, and other freight modes;
- Located the freight-related problem spots on the arterial system (congestion, spillback, etc.);
- Determined the degree to which the TIP contains projects that will correct or mitigate those problem spots;
- Determined what the conditions will be in the future for freight flows;
- Identified potential solutions to the future problems (i.e., develop scenarios that would help solve current and anticipated problems);
- Outlined several solution scenarios and evaluated benefits and costs; and
- Developed consensus-based support among freight stakeholders for the proposed solutions.

In addition, through meetings with the freight stakeholder groups and the project's Technical Advisory Committee, the team also identified the need to assess the impacts of current truck regulations on truck mobility; and explore the issues related to allowing commercial vans on the parkways.

This report presents the results of these efforts, identifying where enhancements would have major value to freight logistics and potential economic development.

The document is organized as follows. Chapter 2 describes the existing multi-modal freight transportation system, so the reader has a clear sense of the context in which the study has been conducted. Chapter 3 presents the opinions of the stakeholders that are major players in the goods transport marketplace. Chapter 4 describes the model that was created to develop the comprehensive highway freight plan. It checks the validity of the datasets used by the model by comparing predictions of current conditions with field observations. Chapter 5 presents the analysis of multiple scenarios for the year 2025 while Chapter 6 focuses on non-capital enhancement options, like the use of parkways by commercial vans, which have been suggested as freight mobility enhancements. Chapter 7 presents conclusions and recommendations based on these findings.

Several appendices follow the main report. Appendix A provides supporting material for Figures 2.3 through 2.8 in Chapter 2. Appendix B provides a table in support of Figure 3.8. Appendix C provides a list of the previous studies described briefly in Chapter 3. Appendix D contains a detailed description of the findings from the 1999 NYMTC Shipper Survey. Appendix E gives a mathematical description of the model used in the network analyses. Appendix F presents the network data employed. Appendix G presents the capital cost estimates used by the model.

Finally, Appendix H contains maps of the network flows for the Year 2000 and Year 2025 model analyses.

REFERENCES

[1] Cambridge Systematics, Inc., *NYMTC Regional Freight Plan, Task 5-Preliminary Identification of Improvements and Solutions*, January 2002.

[2] Cambridge Systematics, Inc., *NYMTC Regional Freight Plan Project, Alternative Packages for Analysis*, NYMTC Freight Forum Meeting, City University of New York, February, 2002.

[3] New York Metropolitan Transportation Council, Summary, NYNMTC Regional Freight Forum Meeting, February 13, 2002.
http://webservices.camsys,com/nymtcfreight/documents/02_13_02_mtg_summary.htm.

[4] Mann, Howard, *Regional Freight Plan Project*, Presentation to NYMTC Freight Forum, February 13, 2002.

[5] Edwards and Kelcey Engineers, Inc., *Cross Harbor Freight Movement Major Investment Study*, *Final Report*, prepared for NYC Economic Development Corporation, May, 2002.

[6] Vovsha, P., E. Petersen, and R. Donnelly. "Micro-Simulation in Travel Demand Modeling: Lessons Learned From the New York 'Best Practice' Model", *Proceedings of the 81st Annual Meeting, Transportation Research Board*, Washington, DC January 13-17, 2002.

[7] Parsons Brinckerhoff Quade & Douglas, Inc. *Transportation Models and Data Initiative, Technical Memorandum, No. 1.2.2, Final Model Structure and Framework*, prepared for NYMTC, New York, NY, June 1997.

[8] Edwards & Kelcey, *Task 11 Draft Technical Memorandum: Performance Evaluation of Alternatives,* prepared for the Cross Harbor Freight Movement: Major Investment Study, sponsored by the New York City Economic Development Corporation, April 2000.

Chapter 2 – Setting the Context

Deciding what enhancements to recommend is possible only if it is done in the context of the region's current multi-modal transportation system as well as plans for its enhancement. This chapter provides a general description of that network and emphasizes its freight sub-network.

2.1 THE HIGHWAY NETWORK AND THE FREIGHT SUB-NETWORK

New York City's highway network is immense. The network dataset maintained by NYMTC has more than 40,000 links or 23,500 centerline miles (not lane miles). A macroscopic view of that network is provided in Figure 2.1

The official truck sub-network consists of routes designated by the City for truck use. More than 1,000 miles of truck routes exist within the study area. These routes break down into "through routes" and "local routes." Through routes are for all trips while local routes are only for the last leg of a trip or the first, e.g., to reach a shipper or consignee. A truck on a local route without a nearby pickup or delivery can receive a summons. Table 2.1 shows the miles of truck route by type and jurisdiction. Through routes comprise 395 of these miles and the local routes the remaining 616 miles. A map of these routes is shown in Figure 2.2.

Table 2.1 New York City Truck Route System

Type of Roads	Truck Route System		
	New York City DOT (miles)	New York State DOT (miles)	Total (miles)
Through Truck Routes	228	167	395
Local Truck Routes	593	23	616
Total	821	190	1011

Source: New York City Truck Route Network and State Highway Network

Bridges and tunnels are important in New York City because of its island nature. The truck network contains four major toll bridges: the Throgs Neck, the Whitestone, the Triborough, and the Verrazano Narrows; three major free bridges: the Williamsburg, Manhattan, and Queensboro bridges; and two tolled tunnels (the Queens Midtown Tunnel and the Brooklyn Battery Tunnel).

2.1.1 EZ Pass

Trucks can use EZ Pass tags on all of the toll bridges which aids in reducing delays. Very importantly, as of March 2001, the Port Authority implemented time-of-day varying tolls on five facilities: the George Washington Bridge, the Lincoln Tunnel, the Holland Tunnel, the Goethals Bridge, and the Outerbridge Crossing. This encourages truck (and auto) use off-peak especially on major through routes.

Figure 2.3 shows the location of major truck terminals and warehousing facilities in the study area. In addition, Figure 2.4 shows the major stations and distributions centers for the three major carriers: United States Postal Service (USPS), Federal Express (FedEx), and United Parcel Service (UPS). Tables 2.2 and 2.3 provide information on the name and location of these facilities. These are all major generators of truck movements which mainly use local routes for deliveries.

2.1.2 Parkways

It is interesting to note that approximately 280 lane miles of the limited access highway system in New York City are Parkways. While this is advantageous from the perspective of auto users, it is a handicap for commercial vehicles. The Parkway system is closed to commercial vehicles, i.e., vans, pick up trucks, panel trucks, etc. If light commercial trucks were allowed to use the Parkways, this would be roughly equivalent to an 88 % increase in the lane miles of limited access highways that could be used by commercial vehicles (with the understanding that opening parkways to additional traffic may have considerable congestion implications).

2.2 RAIL, WATER, AND AIR NETWORKS

Rail and water are used to a limited extent and air cargo is a major source of generated truck trips.

2.2.1 Rail Network

The rail network is limited in scope, supporting shippers and consignees in Brooklyn, Queens and the Bronx. Inbound commodities are grain and coal. A significant outbound commodity is garbage. Figure 2.5 shows the rail freight network, rail yards, and intermodal terminals. It is at least at the present time, important to note that this is a small portion of the overall New York metropolitan area rail network and the network west of the Hudson is far more extensive. Of the 74 major freight trains that operate in the study area each weekday, only four of them operate east of the Hudson. Those four originate in Albany. That is to say that rail shipments destined to the east side of the Hudson are carried on trains that originate in Albany and cross the Hudson 150 miles north of the City. No crossings exist further south except for the tunnels on Amtrak, which are only used for passenger and express mail services and a car float operation across New York Harbor from New Jersey to South Brooklyn.

2.2.2 Water Network

The water network consists of the Hudson River, East River, Long Island Sound, and New York Harbor. Figure 2.6 shows the locations of the major marine terminals, most of which are in New Jersey.

The Port Authority of New York and New Jersey (the Port Authority) concentrates its port activities in New Jersey. Its major facility, Port Elizabeth, competes with the ports of Halifax, Baltimore, Norfolk, Savannah, Charleston, and Jacksonville. It handles containers, grain, and coal. As vessel drafts increase toward 50-feet, Port Elizabeth faces challenges. Significant dredging would be required to accommodate such ships. At other places in the harbor, deep water next to shore is easier to create and maintain. As a result, the Port Authority has been working with New York City's Economic Development Corporation to explore expansion of the marine terminals on Staten Island (Howland Hook) and in Brooklyn (Red Hook, Erie Basin, Sunset Park, and Inland Terminals). Plans for renovation and expansion are being formed [1]. The major impediments are limited space for docks and storage and difficult landside access. Except in a few cases, the water network is tied into the truck network, but direct ship to rail transfer is being encouraged.

2.2.3 Air Network

The air network contains three airports, JFK (John F. Kennedy Airport), LaGuardia, and Newark. Figure 2.7 shows their locations. New York in general is one of the 10 major air cargo hubs in the world. JFK handles the most traffic (1.7 million tons of cargo in 1999, mostly international) while Newark handles a bit less (1.0 million tons, a mix of domestic and international) [2]. For the most part, LaGuardia handles domestic mail. To reach JFK, trucks use the Van Wyck Expressway (VWE) as well as Linden and Conduit Boulevards, which are heavily congested. Other impediments include height restrictions Brooklyn-Queens Expressway (BQE) and the disconnect that exists between the Triborough Bridge and the BQE (i.e., no trucks are allowed on the intervening section of the Grand Central Parkway). Several studies have proposed use of the Belt Parkway by courier vans to get to JFK, but so far, access has not been granted. In comparison, getting to Newark Airport is much easier, although height restrictions still exist in the tunnels.

2.3 FREIGHT FLOW PATTERNS

Freight flows within the City are complex. In spite of the perception that the truck is dominant, many modes are involved. The use of rail, water, and other modes tends to be for specific commodities and/or locations. It is true that truck tends to always be involved, because most shippers and consignees do not have direct access to other modes (e.g. rail or water). Rail, water, and air provide direct service only to a few locations and customers. Consequently, the first and last legs of most trips tend to be by truck. The perspective one has also tends to be affected by whether one focuses on tonnage or value. The shipments handled by air and truck tend to be low tonnage and high value, while those handled by rail and water tend to involve higher tonnage and lower value.

2.3.1 How Freight is Carried

Table 2.4 shows the amount of freight that moved into and out of New York City in 1995 broken down by rail, truck, air, and water. Additional assessments of freight, especially trucks can be found in [5,6,7,8]. Some of the main observations are that:

- Trucks carry the largest share of the tonnage, into or out of the study area.
- Truck tonnage inbound is predominantly destined to Brooklyn (50%), Manhattan (25%), and Queens (15%).
- Truck tonnage outbound originates mainly in Queens (32%), Brooklyn (28%), and Manhattan (25%).
- Water is the second most important carrier by tonnage.
- Water carries almost as much tonnage as truck inbound.
- Water carries less than one third as much as truck outbound.
- Water tonnage inbound is destined to Manhattan.
- Water tonnage outbound originates in Brooklyn.
- Rail carries less than one percent of the tonnage in either direction.
- Rail tonnage inbound is twice the outbound.
- Rail destinations are in the Bronx.
- Rail origins are in Brooklyn.
- Air carries less than one percent of the tonnage in either direction, but its value is high.
- Air cargo flows are balanced inbound and outbound.
- Air cargo is handled by Queens since JFK and LGA are located there.

Although each mode plays an important role in freight; air, rail, and water are more concentrated in specific boroughs, while trucks are ubiquitous. Moreover, trucks are almost always involved in the first and last legs of the journey. In that regard, nearly all freight moves by truck to some degree.

2.3.2 More about Truck Trips

Two major classes of truck movements are apparent. About 48% of the truck trips originate west of the City or to the north and are destined to warehouses, manufacturing plants, airports, ports, and rail terminals [3]. These shipments tend to be carried in large trucks. Many of these trips use the northern east-west corridor (George Washington Bridge – Cross Bronx Expressway). A smaller number use the southern east-west corridor (the Staten Island Expressway, the Verrazano Narrows Bridge, and the Gowanus Expressway). 39% originate in warehouses and distribution centers near the Hudson and are destined to retail stores, offices, and manufacturing plants in the City. These trips use smaller trucks, some of which are especially designed to pass through the Lincoln and Holland tunnels [3].

2.4 USE OF THE HIGHWAY NETWORK

The highway network is generally congested throughout the day. More capacity is needed but at the same time, greater use of transit (passenger) and rail (freight) would be beneficial as well so that more effective use could be made of the highway capacity that is available (e.g., through ITS). The time periods which are of the most interest for truck movements are during the midday, followed closely by the AM and PM peaks (with the notable exception of Hunts Point, the produce distribution center, where truck traffic is at its peak in the very early hours of the morning (e.g., 2-4am), and the Fulton Fish Market on a smaller scale).

2.4.1 Overall Perspective

Figure 2.8 gives an overall picture of the network flows. The highest AADT (Average Annual Daily Traffic) values range from 100,000 to over 200,000 vehicles per day (vpd). Two facilities have AADT values greater than 200,000 vpd. One is the George Washington Bridge with 292,000 vpd: the heaviest used facility in the study area. The other is the Long Island Expressway (LIE) with 213,000 vpd. The LIE provides truck access to all of Long Island.

2.4.2 Heavily Used Segments

NYSDOT maintains an extensive report of AADT (Annual Average Daily Traffic) values for highway facilities in the state [4]. For some of these locations, truck traffic information is also available. Tables 2.5 and 2.6 give a sense of the "typical" conditions that exist in the network, especially truck percentages, based on about 20 of these locations. (These two tables also appear in Chapter 3.) Just to put the locations in perspective, the highest AADT values per lane per day for these locations are:

- Van Wyck Expressway: highest volume section = 28,830 vehicles per lane, per day
- Cross Bronx Expressway: highest volume section = 27,442 vehicles per lane, per day
- Long Island Expressway: 26,462 vehicles per lane, per day
- Major Deegan Expressway: 21,875 vehicles per lane, per day
- West Shore Expressway: 20,474 vehicles per lane, per day
- Prospect Expressway: 16,921 vehicles per lane, per day
- Nassau Expressway: 14,592 vehicles per lane, per day
- Clearview Expressway: 5,594 vehicles per lane, per day

Even assuming the traffic is uniform for 24 hours (unreasonable), the per hour per lane volume for the top three locations is 1,102 vehicles per hour. That is high. It is half of a typical capacity. The implication is that facilities such as the Cross Bronx, Van Wyck, Long Island Expressway, and Major Deegan Expressway must be at or near capacity during the peak hour. This is confirmed by the peak hour observations at these facilities where the flow rates are as follows:

- Major Deegan Expressway: (7,072)/3 lanes = 2,357 vehicles per lane
- Cross Bronx Expressway: (6,012)/3 lanes = 2,004 vehicles per lane
- Van Wyck Expressway: (5,223)/3lanes = 1,741 vehicles per lane
- Long Island Expressway: (4,919)/3lanes = 1,640 vehicles per lane

These values are hovering around typical capacities (2200 passenger cars per hour per lane) especially when the percentage of trucks is taken into account. If we use a truck equivalency factor of 2.5 (one truck is the same as 2.5 passenger cars, which is reasonable), the passenger car equivalent volumes per lane per hour are:

- Major Deegan Expressway: 2,534 passenger cars per lane
- Cross Bronx Expressway: 2,291 passenger cars per lane
- Van Wyck Expressway: 1,907 passenger cars per lane
- Long Island Expressway: 1,790 passenger cars per lane

Except for the last example, perhaps, these may be the capacities of those facilities. (It may also be true for the LIE. It depends on other factors, including the highway geometry.)

For two of the surface arterials, the AADT values, again per lane for comparison purposes, are:

- Northern Boulevard = 9,912 vehicles per lane, per day
- Hillside Avenue = 6,502 vehicles per lane, per day

These represent per hour flow rates (across 24 hours) of 413 and 271 vehicles per hour respectively. A fully saturated signal with a 50% green split would reach capacity at 850 vehicles per hour. Consequently if it is assumed that the arterial is truly busy for 10 to 12 hours per day, the 9,912 value becomes 826-991 vehicles per lane per hour and the 6,502 becomes 542-650. These are considerable values.

Based on actual peak hour observations, the vehicle per lane per hour flow rates are:

- Northern Boulevard = (1,721)/2 = 861 passenger cars per lane, per hour
- Hillside Avenue = (1,210)/2 = 605 passenger cars per lane, per hour

The value for Northern Boulevard is clearly close to the 850 passenger cars per hour limit discussed earlier. The value for Hillside Avenue may also be at or near capacity depending on the geometry, signal timing, and other factors.

2.4.3 Truck Volumes

Information about truck volumes is limited. That is one of the reasons why modeling is needed; to estimate what the truck flows are as well as to plan the future. About 50 sites are monitored across the City to varying degrees of specificity.

The Cross Bronx Expressway carries 18-24,000 trucks per day. These flows are balanced all day (eastbound versus westbound) except between Crotona Avenue and the Sheridan Expressway. At that location in the AM peak, the NB volume is twice as large as the SB volume (1164 versus 575, the specific cause for this is not known).

The Van Wyck Expressway carries 12-16,000 trucks per day. As with the Cross Bronx, the flows are balanced with the exception of the segment between Jewel Avenue and the LIE. For that segment, the all-day flow northbound (6,310) is much smaller than it is southbound (10,539). A similar directional pattern exists at that location in the AM peak.

The LIE clearly carries 22,000 trucks per day. For the segment where we have data (Kissena Avenue to 164th Street), the truck volume is evenly split by direction.

The Major Deegan Expressway carries about 9,000 trucks per day. Of these, 60% are northbound and 40% are southbound. The truck percentage is 5% in the peak hours.

For the other expressways, the truck volumes are smaller. The West Shore Expressway in Staten Island carries 6,000 trucks per day while the Prospect Expressway carries 2,500. On the two surface arterials where data are available, the daily truck volumes range from 450 to 960 trucks per day. The volumes are evenly split by direction with a very small peak hourly truck volume (39 to 45).

2.5 SUMMARY

Based on the above discussion, one can conclude that the existing transportation system is not only multi-modal and complex but also discontinuous and operating at capacity. The ability to accommodate the movement of freight is quite limited. Any plan to improve the efficiency and effectiveness of freight movement in the metropolitan area needs to consider options to increase capacity, system connectivity and intermodal capacity.

REFERENCES

[1] New York City Economic Development Corporation, *Strategic Plan for the Redevelopment of the Port of New York*, New York, NY, 1999.

[2] Port Authority of New York and New Jersey, *Air Cargo Volumes,* New York, NY, 1999.

[3] Port Authority of New York and New Jersey, *Regional Truck Freight Network Strategies Plan*, New York, NY, 1997.

[4] New York State Department of Transportation, *Traffic Count Information,* Albany, NY, 2002 (http://www.dot.state.ny.us/tech_serv/high/tvwebpag.html).

[5] List, G.F., and Turnquist, M.A., *Estimating Truck Travel Patterns in Urban Areas,* Transportation Research Record 1430, pp.1-9, January 1994.

[6] Edwards & Kelcey, *Task 11 Draft Technical Memorandum: Performance Evaluation of Alternatives,* prepared for the Cross Harbor Freight Movement: Major Investment Study, sponsored by the New York City Economic Development Corporation, April 2000.

[7] Cambridge Systematics, Inc., *NYMTC Regional Freight Plan" Task 2 – Description of Freight Transportation System in the Region,* prepared for New York Metropolitan Transportation Council, July 2001.

[8] Cambridge Systematics, Inc., *NYMTC Regional Freight Plan" Task 4 – Definition and Assessments of Needs*, prepared for New York Metropolitan Transportation Council, November 2001.

Chapter 3 – Evidence of Needs & Existing Problems

Since the goal of the project is to determine what network enhancements might facilitate truck flows, it is important to see what others think those problems might be. Three main sources of that information are available: data kept by the agencies responsible for the facilities, like the PANYNJ and NYSDOT, findings from prior studies, and comments from the carriers and other stakeholders. (These are primary sources: [24,25,26]).

3.1 EVIDENCE FROM AGENCY DATA

It makes sense to start with the agency data. Nominally, these organizations are responsible for understanding the needs of the highway users and seeing that those needs are met. To say that they understand or can second-guess all needs is a strong statement. Maintaining a highway network and keeping ahead of its growing traffic volumes is always a challenge. New York City is no exception. What makes it difficult is that the City's user population and employment is highly diversified, the network is more extensive than that of many states, and it experiences intense use.

A review of these agency documents shows five kinds of issues related to truck use: congestion levels, geometrics, pavement conditions, clearances, connectivity, and access.

3.1.1 Delays

NYSDOT uses a mathematical model to calculate delay and gauge the congestion on the highway network. The model, known as the Congestion Needs Analysis Model (CNAM) [1], uses the Bureau of Public Roads formula to estimate travel time, which is given as:

$$T = T_0 [1 + 0.15 (V/C)^4]$$

where:

T = congested travel-time, minutes per mile
T_0 = free flow travel-time, minutes per mile
V = traffic volume, vehicle per hour per lane
C = practical capacity in vehicles per hour per lane (1500 vphpl for freeway lanes)

Delays by link can be estimated from this formula. Delay is defined to be the difference between the time needed to traverse the segment at the free-flow speed (i.e., T_0) and the time required under peak period conditions (T). This delay is experienced by every vehicle on the link.

To establish a basis of comparison for future truck volumes, we selected the set of highway segments shown in Table 3.1. For each of these, delay data were available. The table shows the number of lanes, daily traffic volume, daily truck volume, daily truck percentage, AM peak hour traffic volume, the percentage of averaged daily traffic that this volume represents, the truck volume, and percentage of the AM peak hour traffic that is trucks. The data are for 1998-1999 conditions.

Figure 3.1 shows the segments of the truck network that experience delay during the AM peak period. As is obvious, all of the major links into and out of the City (George Washington Bridge and Cross Bronx Expressway/I-95, Long Island Expressway/I-495, Staten Island Expressway/I-278, and the Lincoln and Holland Tunnels) have significant delays. In addition, the Gowanus, Brooklyn-Queens, Van Wyck, and Bruckner Expressways have significant delays.

In a corresponding fashion, Table 3.2 and Figure 3.2 show delays on the truck network during the PM peak. Many of the congested segments are the same as the AM peak. The Cross Bronx Expressway segment from I-95 to Pelham Parkway is the one exception. It carries more trucks in the PM peak than the AM peak hour.

3.1.2 Congestion

Highway congestion is a concept that is closely related to delay. It's common for transportation agencies to track the congestion conditions on urban networks. In a simple sense, highways with significant amounts of delay are "congested". Rothenberg [2] defines congestion as "a condition in which the number of vehicles attempting to use a roadway at any given time exceeds the ability of the roadway to carry the load at generally acceptable service levels."

Arnold [3] further indicates that:

> "the concept of levels of service (LOS) is well established in highway capacity analysis procedures[4]. The levels range from LOS A, which represents free-flowing traffic, to LOS F, which represents forced flow or stop-and-go traffic. Urban roadways are typically considered satisfactory if operating at LOS D, which represents high-density but stable flow. Small increases in traffic at this level will often cause operational problems. Flow in the next level, LOS E, is said to be at capacity and on the verge of breaking down. Accordingly, it is generally agreed that congestion begins to occur when traffic is operating at LOS D. Since these levels of service have been quantitatively defined by certain traffic characteristics, although different for different kinds of roadways, the use of LOS D provides a way of measuring congestion."

NYSDOT defines congestion as being level of service equal to low D or worse [5]. Congestion maps of New York City are readily available on the web. Figure 3.3 shows a recent congestion map for the Bronx while Figures 3.4, 3.5, 3.6, and 3.7 show congested facilities in Brooklyn, Queens, Manhattan, and Staten Island respectively. It's common for these facilities to see significant traffic volumes for 16-18 hours per day.

3.1.3 Pavement Conditions

NYSDOT's highway sufficiency datasets indicate that pavement conditions are a third major problem, after delay and congestion. Surface condition is one of two determining factors. The other is pavement roughness.

Figure 3.8 shows the pavement conditions in the study area. (Appendix B contains a table corresponding to Figure 3.8. The data include the parkways of the New York State Highways on the National Highway System.) The pavement conditions are determined by trained pavement experts conducting "windshield surveys", supplemented by photographic and linguistic scales that ensure consistency between regions and repeatability over time. The rating categories are:

Rating	Condition Description
9-10	Excellent
7-8	Good
6	Fair
1-5	Poor

According to Table 3.3, in 2001, 69.8% of the pavements on the New York State Highways in the study area were conditions good or excellent [6]. This is on par with the rest of the state. Moreover, the 30.1% of miles in fair or poor condition is less in the study than it is statewide. However, it is important to note that over 30% the network is poor or fair, which means there is significant need of either major or minor rehabilitation.

Table 3.3 State Highway Pavement Conditions

Pavement Condition Rating	% of in NYC	% of in NY State
Excellent	9.8	9.4
Good	60.0	58.4
Fair	27.3	25.9
Poor	2.8	6.2

Source: NYSDOT, Pavement Condition of New York's Highways: 2001

Pavement condition is only part of the story, however. The other part is pavement roughness. The Federal Highway Administration noted in Chapter 3 of its 1999 Conditions and Performance Report [7] that: "Pavement condition affects travel cost including vehicle operation, delay and crash expenses. Poor road surfaces cause additional wear or even damage to vehicle suspensions, wheels, and tires. Delay occurs when vehicles slow for potholes or very rough pavement. In heavy traffic, such slowing can create significant queuing and subsequent delay. Unexpected changes in the surface condition can lead to crashes and inadequate road surfaces may reduce road friction, which affects the stopping ability and maneuverability of vehicles."

Pavement roughness is measured in inches per mile or mm per kilometer. (See the International Roughness Index (IRI)). The ratio represents the amount of vertical rise in pavement that a vehicle axle experiences per unit of horizontal travel. For example, if a mile of pavement has two bumps, each of which pushes the axle up 2-inches, then that mile of pavement has a roughness of 4-inches/mile. A highway is "very smooth" if it has a roughness of 0-60 inches per mile; it is smooth at between 61-120 inches per mile; fair between 121-170; rough between 171-220; and very rough at greater than 220 (inches per mile).

There are several ways to measure pavement roughness but one of the most common involves using the Mays Ride Meter. “This device determines the smoothness of the roadway by measuring the displacement between the axle housing and the body of the host vehicle” [8].

FHWA has defines “acceptable ride quality”. In order to be rated "acceptable" pavement performance must have an IRI value of less than or equal to 170 inches per mile [9].

As seen in Table 3.4, over 60% of the system’s pavement, nearly 1000 lane miles is rough or very rough with IRI values greater than 170 inches per mile. As indicates, 37.7% of the pavement on the principal arterials in the study area is very rough. This is almost four times the state average. In fact, 64% of the lane miles are rough or very rough compared to 19.6% statewide. This means almost two-thirds of the network has an unacceptable ride quality as defined by the FHWA. As noted above, these rough and very rough pavements, cause additional wear or even damage to vehicle suspensions, wheels, and tires and can lead to crashes.

Table 3.4 Pavement Roughness: State Highway Interstate & Principal Arterials

Pavement Roughness		New York City		New York State	
Roughness Category	In. per Mile	Lane Miles	Percent of Lane Miles	Lane Miles	Percent of Lane Miles
Very Smooth	0-60	0	0	1,140	6.5
Smooth	61-120	105	6.8	9,412	53.9
Fair	121-170	446	29.2	3,480	20.0
Rough	171-220	401	26.3	1,770	10.1
Very Rough	>220	576	37.7	1,660	9.5

Source: NYSDOT, Pavement Condition of New York’s Highways: 2001

3.1.4 Physical Restrictions

Physical restrictions limit facility use by certain types of trucks. Height, length, and width limitations are the most common. The main detrimental affect of these restrictions is increased truck mileage. More circuitous routes must be used. Decreased safety can also be an issue if the paths that must be followed involve routes with higher accident rates.

Two examples are the Lincoln and Holland Tunnels. They both have significant height, length, and width limitations. Trucks have to use the George Washington Bridge or the Verrazano Narrows Bridge instead.

Another example is the Brooklyn-Queens Expressways (BQE). These deficiencies force trucks to use other routes involving the George Washington Bridge, the Major Deegan Expressway, the Cross Bronx Expressway, the Whitestone Expressway, and the Van Wyck Expressway.

Signs are posted per law to indicate the overhead clearances of bridges and elevated structures that have less than 14-feet of legal clearance. (Legal clearance is one foot less than measured clearance. The one-foot difference allows for vertical movement of the truck.) Table 3.5 lists the locations that are posted. Many truck route violations are caused by height restriction violations. In some instances, residential streets are the alternate routes. That disturbs the neighborhoods and can cause damage to private properties, street-beds and sidewalks as well as negatively affecting health and air quality.

Figure 3.9 shows the places where the measured height is less than 14 feet. Most are on the Gowanus Expressway and the BQE. Given their location, freight carriers compensate by using smaller trucks (which means more trucks) or they use a different route (e.g., the George Washington Bridge and Cross Bronx).

3.1.5 Connectivity

Connectivity is another problem that is evident. This is not connectivity from a network point of view. The network is comprehensive and ubiquitous. Rather, it relates to the fact that there are links that autos can use but which trucks are prohibited. A good example is the gap between the Triborough Bridge and the BQE. The Grand Central Parkway connects these two facilities, but trucks are not allowed to use the parkway. There is a clearance problem, which is being examined, but the prohibition will have to be removed as well. A second example lies along the southern shore of Long Island. Trucks are prohibited from using the Shore Parkway, which means that for courier vans, etc., to reach JFK from the Verrazano Narrows Bridge, they have to use the Gowanus, the LIE, and the Van Wyck. What could be a 15 mile trip is presently a 23 mile journey. This suggests the need for better truck access across southern Brooklyn.

3.1.6 Access to Freight Complexes

This issue relates to how trucks have to travel from the freeways and major arterials to the main freight complexes within the city. Places such as Hunts Point Market, Maspeth Avenue, Red Hook, the Brooklyn waterfront, and Harlem River Yard generate considerable truck activity which may contribute to localized congestion.

For example, almost 1,000 trucks per day use residential streets to get from the Bruckner and Cross Bronx Expressways to Hunts Point Market. In addition, the trucks often get lost because the guide signs are hard to find or non-existent. This use of local streets has a negative impact on the homes near the terminals and warehouses.

In the case of Red Hook Terminal, trucks coming from the Gowanus Expressway often use the residential portions of Columbia and Van Brunt streets instead of Hamilton Avenue, which goes though an industrial area.

Related to these access problems are issues such as:

- outdated roadway geometry (turning radii, sight distances),
- zoning policies (conflicts with commercial traffic because of proximity to residential areas),
- parking policies (lack of on-street parking along truck routes, time limitations for loading and unloading), and
- roadway lighting (especially for underpasses).

Moreover, the understandable concentration of business activities during normal working hours produces a need to deliver goods and supplies during those hours. This encourages freight carriers to make pickups and deliveries during the daytime, adding to the already heavy flows. This also means there is a high level of dock and street activity in the mornings accompanied by average dwell times of 30 minutes or more[7].

3.2. EVIDENCE FROM PRIOR STUDIES

More than 40 recent studies have touched on issues regarding truck traffic within the City. Appendix C provides a brief description of each one. Taken as a whole, the studies give an insightful picture of where problems exist within the City and what people think should be done to fix them. This list summarizes the recommendations those studies provide:

- *Have trucks operate off-peak* (*e.g., at night*). The Bi-State Carrier Conference of Port Truckers, which handles most of the Port Authority of New York and New Jersey truck traffic, estimate that congestion cuts into truck productivity by at least 30%. Large economic losses result from the long queues at terminal entrances. This problem leads to proposals for changes in delivery hours in the region . A recent time-of-day toll change at the Hudson River crossings helps encourage that behavior change. Toll pricing incentives should also be time- and direction- specific (so that they draw carriers out of the peak-direction flows as well as the peak-period flows.) The program should be coupled with a traffic management program that addresses through-truck traffic in the region [11].

- *Create a new truck route in Brooklyn*. As shown in Figure 3.10, develop an alternative to Van Brunt Street, using the railroad spurs west of Imlay Street between Bowne and Verona streets. Moreover, as shown in Figure 3.11, remove Columbia and Clinton streets from the designated truck route network and replace them with a north/south pairing of Court and Smith streets from Hamilton Avenue to Percival Street [12].

- *Allow small commercial vehicles to use the Belt, Cross Island and Grand Central parkways during the off-peak periods* (10AM - 4PM and 7PM - 7AM, Monday - Friday). Conduct a pilot study to determine the impacts of allowing these vehicles on the parkways and determine the relative merits of sign regulations versus permits, and to identify enforcement issues [12].

- *Improve the city's local truck route network to facilitate the freight movement and patterns in neighborhoods with easier access to the main truck routes and bridges*. Presently, NYC Department of Transportation is moving ahead with a project to reevaluate the existing truck route network. It is expected that the outcome of the study would suggest areas for extension and improvements of through and local truck system. [13]

- *Add a third lane at the interchange of the Van Wyck Expressway, Jackie Robinson Parkway and the Grand Central Parkway* [14]. This would allow three continuous lanes through the interchange and enhance traffic flow.

- *Provide signage for the truck routes* and directions to the through routes so that trucks do not use the local streets [15, 16]. Provide informational and directional signs on all expressways and on the roadways leading to the entrances for major terminals and warehouses.

- *On Ocean Parkway, Prospect Expressway, and NY Route 27, use the existing trolley tunnel under the intersection for through traffic* [14]. This would allow easier east/west movement and reduce congestion at the traffic signals. In addition, implement new signals that can accommodate increased levels of traffic.

- *Improve the interchanges at Cross Bay Boulevard, Linden Boulevard, Belt Parkway, Conduit Avenue, and Nassau Expressway*. This includes sign and guard rail replacements. Install U-turn facilities, restripe the crosswalks, and redesign the landscaping to reduce driver confusion and increase pedestrian safety [14].

- *Improve the signal timing and traffic controls* on all roadways that lead to the entrances of major traffic generators to reduce unnecessary delays.

- *Take advantage of today's metering and enforcement technology*. Make use of in-vehicle parking devices (IVPDs). Provide them free-of-charge to trucking firms. Establish a time-dependent fee structure that does not involve charges between 4PM and 10 AM and has a graduated rate between 10AM and 4PM [13].

- *Use ITS technology to manage commercial parking spaces (*e.g., by appointment or pricing) in the highly congested New York central business district [17] (for example: time of day parking pricing at Times Square).

- *Remove curb parking along sections of Linden Boulevard* to facilitate truck movement to and from warehouses adjacent JFK airport [18].

- *Review curb regulations in areas of heavy truck activity*, with a view of expanding truck loading zones, and creating additional on-street parking for trucks [10].

- *Issue E-Z Passes to all commercial vehicles that regularly conduct business in the metropolitan area*, and give them a further discounted rate it they choose to come in between 11PM and 7AM. Offer a lesser discount during the same time period to commercial vehicles that do not have an E-Z Pass. This could be accomplished through toll incentives and cooperation between the trucking companies, warehouses, business, and traffic management and enforcement agencies in the region. The recommendation may have implications for reducing congestion, accidents, pollution, travel time and frustration for both commuters and delivery/service operators [13].

- *Use ITS technology to provide drivers with up to date information on traffic conditions*. Variable Message Signs should be provided on all major highways at critical decision points allowing drivers to bypass congestion hot spots. For example, the I-95 Corridor Coalition is funding the Fleet Forward operation test, which is providing real-time traffic information to improve motor carrier operational efficiency and safety [17].

- *Increase the use of rail to move freight across the Hudson River*. It has been reported in 1998 that more than 32,000 trucks per day crossed the Hudson River at George Washington Bridge, Lincoln and Holland Tunnels [19]. In addition, an average of 8,500 trucks per day crossed Verrazano-Narrows Bridge. It is estimated that trucks crossing the Hudson River have the following destinations: 43% Long Island; 21% Manhattan; 13% New England; 8% Staten Island; 7% Bronx; and 6% Westchester [20]. The use of rail would reduce truck traffic on these Hudson River crossings, and reduce congestion on the Cross-Bronx and Long Island Expressways. This could be abetted by extended rail freight service to places such as the proposed Long Island Intermodal Facility at the Pilgrim State Hospital Site in Deer Park, in Suffolk County.

- *Promote rail service east of the Hudson River* by revitalizing the Oak Point Link, the intermodal facility at Harlem River Yard, restoration of the Staten Island Railway, and Arlington Yard.

- *Increase the railcar clearances along the Hudson River Line* so that double-stack and TOFC cars can reach the Bronx from Albany.

- *Create an intermodal terminal and a bulk transfer facility at Harlem River Yard*.

- *Find a way whereby rail freight traffic is less in conflict with the busy commuter lines*.

- *Provide a new rail freight yard in Brooklyn* (65th Street Rail yard). Give it access to the Long Island Rail Road and car float connections to New Jersey [21].

- *Provide information systems that facilitate the handling of intermodal traffic* [17] This could be provided by stakeholders that have an interest in goods movement such as the Port Authority, by third-party service providers who can derive an income from providing such services (as with truck permitting services).

- *Ensure there is better coordination between the port- and land-sides improvement projects* [17].

3.3 STAKEHOLDER INPUTS

Stakeholder input is always important in planning studies. It is sometimes difficult to get, it is often difficult to determine who the stakeholders really are and to reach them, but when the input can be obtained, it is invaluable. It is the clearest picture of what is really needed. These things are particularly true in freight related studies. Freight carriers have special needs that are not easily identified or understood unless one talks to them directly. Doing so helps ensure that the needs of the freight carrier community are met and that the solutions identified are relevant. A

1996 survey conducted by NYMTC was helpful in this regard. The study team also met with some key freight carriers and terminal operators.

3.3.1 1996 NYMTC Survey

In March 1996, while inventorying truck terminals and warehouse facilities in the study area, NYMTC interviewed a number of local carriers. The interviewees were asked to identify problem locations on the highway network. Appendix D shows areas of the highway network that they suggested had problems. Sub-standard infrastructure was their main concern. They indicated that the facilities in the City were incompatible with today's truck dimensions and truck volumes. They identified the need for greater vertical clearances, wider lanes, larger turning radii, better lighting, better signage, more curb space for truck parking in commercial zones, larger loading areas and better enforcement of street regulations allocating curb space for commercial purposes. From an operating standpoint, they also asked for better parking enforcement (e.g., ticketing for double parking).

From a borough-by-borough perspective, the problems are as follows:

a. The Bronx: On the Cross Bronx Expressway, congestion is a problem, along with poor roadway surface conditions, narrow lane widths, and restrictive turning radii. On Boston Road, East Tremont Avenue, and the West Farm Road entrance to Route 895, congestion is an impediment along with poor roadway signage, and interference from repair and construction activity.

b. Queens: The main concerns relate to accessing the freight terminals and delivery points. For example, access to the Maspeth Avenue area (via 48th Street and 56th Road) is restricted by congestion. Congestion, inadequate traffic enforcement, and restrictive turning radii are also problems. On Steinway Street, 19th Avenue, 37th Avenue, 5th Street, 22nd Street, and 37th Street, similar problems exist. Rockaway Boulevard in Jamaica suffers from insufficient truck parking spaces. Restrictive turning radii and congested conditions impede access to the 59th Street Bridge from the LIE.

c. Manhattan: Every gateway to Manhattan has problems. On the access ramps to the George Washington Bridge, the Lincoln and Holland Tunnels, the Brooklyn Battery Tunnel, the Williamsburg Bridge, and the Midtown Tunnel, the problems are height restrictions, narrow lane widths, restrictive turning radii, and poor lighting and signage. (Note that large trucks are not permitted in Manhattan.)

d. Brooklyn: For the BQE and the East River Bridges into Manhattan, the problems are height restrictions, narrow lane widths, and congestion. Cherry Street, Meeker Avenue, Gardner Avenue, Vandervoort Avenue, and Lombardy Street have problems with roadway surface condition and traffic enforcement.

e. Staten Island: "High tolls" on the bridges are the main problem. Congestion is also a problem on the Staten Island Expressway.

3.3.2 JFK Stakeholders

On April 4, 2000, members of the project team met with some large stakeholders from JFK (John F. Kennedy International Airport) [18]. Included were industry leaders, freight carrier representatives, and facility operators. They stated that getting to and from the airport was a major problem as well as getting around within it. They said that while air cargo worldwide will triple by 2017, activity at JFK would only double. In part, this is because the present infrastructure problems are not being addressed.

The primary focus of their comments was that the City and the State had not provided sufficient attention to the future of freight at JFK. Passenger-related concerns were receiving significantly more attention and, if left unattended, the goods movement infrastructure needs would jeopardize the airport's ability to compete. These needs were:

- Better accessibility to places in the metropolitan area and beyond (as far away as Chicago and Miami);
- More capacity on critical access links like the Van Wyck Expressway, the Cross-Bronx Expressway, and the George Washington Bridge; and
- Direct access to the airport from the Verrazano Narrows Bridge (e.g., across Brooklyn).

There were real concerns that air freight at JFK would be "dead" in 50 years if these needs were not addressed.

Improvements they specifically requested were:

- Provide a new north-south route to the airport by extending the Clearview Expressway.
- Make further capacity improvements to the Van Wyck.
- Open the Belt Parkway and other parkways to commercial vans.
- Create a new access to JFK from the Verrazano Bridge by using the LIRR right-of-way from Bay Bridge to Linden Boulevard, and then onto the Belt Parkway/ Nassau Expressway.
- Eliminate or restrict parking on the major city truck routes such as Linden Boulevard.

3.3.3 Hunts Point Economic Development Corporation

On August 21, 2000, the project team members met with the Hunts Point Economic Development Corporation (HP-EDC) [16]. Hunts Point is the major food distribution center for New York City. Over 10,000 trucks deliver products to Hunts Point each day; using local streets for the last leg of the trip because no other options exist. Safety is a major concern, especially for the residents near Hunts Point, who have to protect their children from the heavy truck flows.

The HP-EDC suggested several ways in which truck flows to and from their terminal could be improved and the area made safer while encouraging economic growth:

- Create a Hunts Point Truck Transportation Loop separate from the local streets.

- Develop a Hunts Point Color Coded Signage Plan. The signs should be highly visible and easy to follow for drivers unfamiliar with Hunts Point.
- Develop streetscaping along Hunts Point Avenue. This would increase safety for pedestrians and drivers and improve the quality of life. It would beatify the main roadway in the neighborhood.

3.3.4 United Parcel Service

On November 10, 2000, members of the project team met with UPS (United Parcel Service) [19]. UPS is the world's largest package delivery company. UPS manages three hubs within the City. Several projects were suggested that would enhance the network:

- *Increase the use of parking lots*: UPS would like to see the number of cars on the street reduced by encouraging automobiles to park in available parking lots and garages. This would free up local street curb space for goods movement. The parking regulations should be modified to facilitate goods movement by allowing more curb space for truck or van parking. In addition there should be more effective enforcement of the existing parking regulations.
- *Issue special permits* to UPS and similar freight operators that would prevent or minimize the towing and ticketing of vehicles.
- *Develop "special use" arrangements* for certain facilities. Two examples were cited. The first would allow UPS trucks to use the bus lanes in Lincoln Tunnel to access Newark at the end of the AM peak. The other would allow their courier vans to use the Southern State Parkway to reach JFK.
- *Explore high-speed ferries* for goods movement.
- *Implement ITS on the arterials*. This would give UPS real-time information about the condition of the roadways and help them make better routing decisions.
- *Improve incident management*. Implementing an advanced incident management system would allow accidents and incidents to be cleared away faster.
- *Provide reserved parking locations* during certain seasons. For example, during the Christmas season, allow UPS to keep a trailer outside of FAO Schwarz instead of running multiple trucks to the location each day. This would require a special permit from NYCDOT. If provided, it would reduce truck traffic, reduce congestion, and expedite service.

Other options, some of which have been explored with NYCDOT, are helping to improve the City's air quality and traffic conditions:

- *Minimize vehicle miles of travel*: UPS sends trucks to specific areas where they remain all day delivering and picking up. The trucks leave full and return full.
- *Use efficient truck routing patterns*.
- *Use special vehicles*: UPS has developed special vehicles that fit within the geometric envelope of restrictive facilities like the Lincoln Tunnel.
- *Reduce the fleet size*: UPS has reduced its fleet size by 142 vehicles to mitigate parking and environmental concerns. However, this makes the towing problem even more severe

because the loss of one vehicle then has more impact on missed deliveries. If one vehicle is towed it affects more customers than would be the case with smaller trucks.

- *Use alternate fuel vehicles*. At the time of this study, UPS had 33 CNG vehicles in its fleet and mechanics on site trained to properly service these vehicles.

3.4. TRUCK NEEDS VERSUS THE TIP (TRANSPORTATION IMPROVEMENT PROGRAM)

A major question emerges from all of these inputs. Does the region's TIP (Transportation Improvement Program) [20] address these freight related needs? The TIP is a federally mandated document that describes the network investment/enhancement strategy for a given urban area. Each year it is updated to show the list of projects that are planned for the next five years. It must be consistent with the region's long- and short-range land use and transportation plans. The TIP is developed by the MPO (Metropolitan Planning Organization) in cooperation with state and local officials, regional and local service providers, and other stakeholders. In the case of the City, the New York Metropolitan Transportation Council (NYMTC) is the MPO.

Table 3.6 shows the TIP projects for the study area that are located on the truck route network. These improvements vary from renovation (e.g., resurfacing) to reconstruction.

One important way to see if freight-related needs are being met is to juxtapose the current TIP projects against the locations where the people have said attention should be focused (e.g., in the reports, from the stakeholder meetings, from the project Advisory Committee's comments). In Figures 3.10 - 3.14 provide a simultaneous plot of the TIP projects identified in Table 3.6 and the places where the terminal and warehouse operators interviewed by NYMTC said there were problems. It is easy to see that the two are not the same. To some degree, this is because the TIP projects are for 2000-2004 while the NYMTC survey dates from 1996. On the other hand, if it were true that the inputs from the NYMTC respondents had been factored into the long-run TIP planning, the two plots should overlap, which they do not. (It is also important to note that the TIP only reflects federally funded projects. Projects that are being funded 100% by NYCDOT funds would not be included on the TIP. Keeping an all-inclusive inventory of all highway improvement projects is a significant challenge for a metropolitan area as large and complex as is NYC.)

Bronx. Figure 3.12 shows the juxtaposition of TIP projects and freight needs for the Bronx. The TIP projects (Table 3.6) are mainly focused on the rehabilitation of major bridges and highway crossings along Cross Bronx, Major Deegan, Bruckner, Sheridan, Throgs Neck, and Whitestone Expressways. There are also improvements at the Bruckner/Sheridan interchange and the Bruckner/Cross Bronx interchange. Resurfacing is slated for the Bruckner, the Sheridan, the Throgs Neck, and the Whitestone Expressways. There is no indication of TIP projects for the Boston Road, East Tremont Avenue, or West Farm Road, which are places where truck-related problems were also identified.

Brooklyn: Figure 3.13 shows the juxtaposition of TIP projects and freight needs for Brooklyn. All the TIP projects are focused on infrastructure improvements and bridge rehabilitation. The projects are concentrated along the Gowanus Expressway and Brooklyn-Queens Expressway where most of the warehouse operators concerns were expressed. Table 3.6 does not indicate any improvement on Manhattan or Williamsburg Bridges, which were cited as areas of concern in Table 3.5.

Manhattan. Figure 3.14 shows the juxtaposition of TIP projects and freight needs for Manhattan. The main emphasis is on bridge rehabilitation, highway improvements, and ITS projects. None of the capacity, etc. improvements called for by the NYMTC survey are included (e.g., for the tunnels and major bridge crossings).

Queens. Figure 3.15 shows the juxtaposition of TIP projects and freight needs for Queens. As can be seen, there is bridge and roadway rehabilitation along the Brooklyn-Queens Expressway, the Long Island Expressway, the Van Wyck Expressway, and the Whitestone Expressway. Resurfacing is underway for Clearview Expressway, the Nassau Expressway, and Van Wyck Expressway. Improvements are also in progress at the Clearview/Long Island Expressway interchange and the Brooklyn-Queens Expressway/Long Island Expressway interchange. Also, the Kew Gardens Interchange on the Van Wyck Expressway is having improvements. This location is one of the major bottlenecks in the City [10]. Roadway improvements are also underway on Queens Boulevard, Springfield Boulevard, Hillside Avenue, and Jamaica Avenue. Access deficiencies to the Maspeth area may be addressed through the Kosciuszko Bridge EIS. Access to the 59th Street Bridge from LIE will remain circuitous. Other needs such as for geometric improvement and traffic control measures are not generally included in the current TIP.

Staten Island: Figure 3.16 shows Staten Island's TIP projects and problem locations. The TIP projects are located along the Staten Island, West Shore, and Dr. M.L. King Expressways and include projects ranging from resurfacing to infrastructure improvements. There is no TIP project to improve the congestion problem on Richmond Terrace.

3.5 SUMMARY

Several common, recurrent themes are evident from the material presented in this chapter.(They are reinforced elsewhere in other studies: [24,27,28,29]). The first is that the current system is congested. Many of the city's main arterials are under capacity; experience significant delays, and are congested. It is imperative that network improvements continue to take place and that "best practice" ways are found to meet the mobility needs of all the user constituencies, including freight.

The second is that pavement conditions on both the major arterials and the local arterials, while having shown improvement, remain an ongoing problem.

A third conclusion is that the network has significant physical constraints, especially low clearances and tight turning geometry, that results in more circuitous routings being employed and/or smaller vehicles being used. In either instance, the number of truck-miles required to accomplish the "transport work" is larger, and the resources requirements are greater, including fuel consumed, labor hours required, air pollutants generated, etc.

There is a continued reliance on local streets for some trips. Good examples are Hunts Point Market, Harlem River Yard, the Maspeth Avenue terminal area, and the air cargo activity surrounding JFK airport. This reliance on local streets needs to be reduced and alternate facilities constructed to allow truck access to these facilities directly from the major freeways where feasible.

A final point is that there does not seem to be a close correspondence between freight-related needs and the projects that presently appear on the TIP. The NYMTC stakeholder survey, the inputs from the JFK user group, the Hunts Point market representatives, and UPS make it clear that there are freight-related needs not being met by the present TIP. Better integration of freight stakeholders' interests into the capital program process needs to be found. It is also important that a comprehensive inventory of all highway improvement projects be maintained including those not federally funded, which would not normally be listed on the TIP.

REFERENCES

[1] Corridor Management Group (NYSDOT). *Congestion Need Analysis Model Manual, A Technical Tool for Congestion Management System*, Long Island City, New York, 1998.

[2] Rothenberg, M. J., "Urban Congestion in the United States: What Does the Future Hold?", ITE Journal, 55 (7), July 1985, pp. 22-39.

[3] Arnold, E.D., "Congestion on Virginia's Highways," Working Paper VTRC 88-R24, Virginia Transportation Research Council, Charlottesville, VA, April 1988 (http://ntl.bts.gov/DOCS/arnold.html).

[4] Transportation Research Board, *Highway Capacity Manual*, Special Report 209, Transportation Research Board, National Research Council, Washington, D.C., 2000.

[5] New York State Department of Transportation, *NYSDOT Highway Design Manual,* Chapter 2, Design Criteria, Albany, NY, 2002 (http://www.dot.state.ny.us/cmb/consult/hdmfiles/hdm.html).

[6] Bennett, R. *Pavement Condition of New York's Highways: 2001*, Prepared for NYSDOT, March 2002.

[7] 1999 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance Report, Federal Highway Administration (http://www.fhwa.dot.gov/policy/1999cpr/report.htm).

[8] Budras, Joseph, A Synopsis on the Current Equipment Used for Measuring Pavement Smoothness, Federal Highway Administration (http://www.fhwa.dot.gov/pavement/rough.htm).

[9] Federal Highway Administration, *Conditions and Performance Report,* Chapter 3, System Conditions, Washington, D.C., 1999.

[10] Morris, A., *Goods Movement in the New York Metropolitan Area*, Baruch College, 1998.

[11] New York City Economic Development Corporation, *Strategic Plan for the Redevelopment of the Port of New York*, New York, NY, 1999.

[12] New York City Department of City Planning, *Potential for Small Commercial Vehicles on Selected Parkways*, New York, NY, 1994.

[13] New York City Department of City Planning, *Off-Peak Delivery and Service Study*, New York, NY, 1999.

[14] New York City Department of City Planning, *Citywide Congestion Bottleneck Study*, New York, NY, 1999.

[15] New York City Department of City Planning, *Industrial Areas Transportation Study, Phase II, Red Hook Community*, New York, NY, 1995.

[16] Meeting with Hunts Point Economic Development Corporation, August 21, 2000.

[17] U.S. Department of Transportation, Office of the Secretary of Intermodalism, *ITS/Intermodal Freight operational Test Project*, Washington, DC, 1999.

[18] Meeting with freight industry of JFK, April 4, 2000.

[19] New York Metropolitan Transportation Committee, *Regional Transportation Statistical Report*, New York, NY, 1998.

[20] Port Authority of New York and New Jersey, *Regional Truck Freight Network Strategies Plan*, New York, NY, 1997.

[21] New York City Economic Development Corporation, *Intermodal Goods Movement Study: NYC Rail Freight Access*, New York, NY, 1997.

[22] Meeting with United Parcel Service, November 10, 2000.

[23] New York Metropolitan Transportation Committee, Transportation Improvement Program, New York, NY, 2002 (http://www.nymtc.org/downloadablepgs/tip/tip.html).

[24] Edwards & Kelcey, *Cross Harbor Freight Movement Major Investment Study, Final Report,* prepared for the New York City Economic Development Corporation, May, 2002.

[25] Cambridge Ststematics, Inc., NYMTC Regional Freight Plan: Task 4- Definition and Assessments of Needs, prepared for New York Metropolitan Transportation Council, November, 2001.

[26] New York Metropolitan Transportation Council, *Mobility for the Millennium*, New York, NY, September, 1999.

[27] Cambridge Systematics, Inc., NYMTC Regional Freight Plan: Task 5 – Preliminary Identification of Improvements and Solutions, prepared for New York Metropolitan Transportation Council, January 2002.

[28] Center for an Urban Future, *On a Wing and a Prayer: Highway Gridlock, Antiquated Cargo Facilities Keep New York's Airports Grounded*, October, 2000.

Chapter 4 – Methodology

To identify network enhancements that can produce significant benefits, one has to first understand the existing conditions. Chapter 2 presents the current status of the multimodal network and Chapter 3 presents input about problems and solutions to those problems, but those solutions are not examined in a comprehensive fashion. In addition, since a treatment applied in one location can produce unexpected effects in another, a system level analysis with a model needs to be undertaken. (Appendix E contains a mathematical description of the model.)

One can extrapolate from individual analyses to predict system-level effects if an integrative logic is applied, but identifying that logic is challenging. Working from individual analyses is appealing because the analytical focus is largely on "small-scale" problems. A complex system-wide analysis can be avoided. The problem is that system level impacts are hard to capture.

Working "top-down" from a comprehensive perspective is the other option. The tradeoff is that the analytical work is typically more complex and a network model is often needed to track the interactions. This model is also used to show how supply and demand interact. It can be used to predict how trucks will route themselves across the network, how those routings will be sensitive to changes in the network, and how those routings change as traffic increases. The model can predict future conditions so that performance differences between and among scenarios can be examined for alternative strategies. The downside is that the model can become the focus of the whole effort. The analyst can be lured into placing more credibility in the model's predictions than field observations or input from stakeholders. The detail can also get lost.

The project team elected to use the "top-down" approach and work with a model. Moreover, since no off-the-shelf model was available, the project team developed one. It can be used to study the entire metropolitan area. Yet it can also focus on corridor and local issues. This chapter describes the model's development, its calibration for existing conditions, and its predictions of present network performance.

4.1 MODEL DESCRIPTION

The model is derived from the BPM (best practices model) development effort sponsored by NYMTC. The new model's main capabilities are twofold: it can perform a capacity constrained assignment of the truck flows to the network and it can add capacity, at a cost, to minimize the total generalized cost of assigning the flows to the network. It uses the BPM model's network dataset, baseline flows (for the year 2000 flows), and employment forecasts (to develop the model's year 2025 trip table).

Two figures help explain how the model functions. The first is Figure 4.1. It shows how the inputs for the Year 2000 and Year 2025 scenarios are developed. The Year 2000 inputs are obtained by combining the Year 2000 BPM truck trip table with the existing highway network dataset. The Year 2025 datasets are obtained by combining one of two Year 2025 truck trip tables with one of five Year 2025 networks. The Year 2025 truck trip tables are derived from the Year 2000 BPM truck trip table, the NYMTC county employment forecasts, and assumptions about intermodal diversions. (See Chapter 5 for a discussion about these scenarios.) The Year 2025 networks are derived from the existing highway network dataset, the projects listed on the TIP, and ideas for network enhancements (from the stakeholder inputs).

The second helpful illustration is Figure 4.2. The model assigns truck flows to the BPM network so that an equilibrium assignment is achieved. To achieve this result, the truck traffic is assigned incrementally. Equilibrium is a condition in which, for every origin-destination pair, all of the traffic going from the origin to the destination experiences the exact same travel time regardless of the path employed. Sheffi's book [1] provides a thorough treatment of the subject. A more basic discussion can be found in Morlok [2].

As Figure 4-.2shows, a small amount of traffic is assigned to the network at each iteration for every OD (origin-destination) pair. The path that is used is selected because it has minimum cost. The sequence in which the OD pairs are considered is random and changes with each iteration. Figure 4.2 shows a network with four nodes and four links. Three OD pairs have traffic: AD, CB, and DA. In the first iteration, traffic for DA is assigned first. The path is via node C (DCA). CB is assigned next, using the path via node A. AD is assigned next using the path via node B. That is the end of the first iteration. In the second iteration, traffic for AD is assigned first (it is the only one shown) and the path via node C is employed (ACD). Either CB or DA would be selected next and the process would continue. Via this process, a close approximation to an equilibrium assignment is achieved.

The assignment is also capacity constrained. That is, the model works within the limits of the capacities of the links (to accommodate truck traffic) or it adds capacity to the links where it needs to so that all the truck flows can be assigned.

The definition of capacity being employed is different than is normally used, so a bit of discussion is appropriate. Capacity is defined as being the link's ability to accommodate truck traffic across an average 24-hour period. These values account for the vagaries of the highway network and its traffic flows (total, not just trucks). Effectively, these values reflect the network's ability to accommodate daily truck traffic. The values are derived from 1) actual observations (e.g., classification counts), 2) an AADT value and an assumed truck percentage by functional class, or 3) the total number of lanes, an estimate of the AADT per lane by functional class, and an assumed truck percentage by functional class. The model can assign up to this amount of traffic to the link without incurring a capacity-related cost. To assign more traffic it must increase these all-day truck flow limits at a pre-specified cost-per-unit-"capacity" (depending on functional class). The result is a least-total-generalized-cost solution. In Year 2025 where significant traffic growth has occurred, this is a critical feature.

4.2 EXISTING CONDITIONS

From field observations, no clear picture of the existing truck flows is available. The network is not instrumented well enough to do that. Truck data is available for only about 200 links. In contrast, the NYMTC network dataset has about 40,500 links. So, about 0.5% of the network is instrumented or an observation exists for every 200 links. (Appendix F describes the data employed by the model.)

However, the network model is capable of developing a picture of the network flows. The network model has about 410 origin/destination zones, 27,100 nodes, and 40,500 links (that expand to 65,250 one-way arcs). The exact numbers depend on the scenario. To this network, the Year 2000 truck trip table is applied. It contains 19,100 non-zero flows (origin-to-destination volumes) that represent 765 thousand trips per day (two-axle, six-tire and larger trucks). When assigned to the network, these trips result in 574,000 truck-hours of travel and 21.2 million truck miles (about 45 minutes and 28 truck-miles per trip).

Figure 4.3 shows a map of the model's prediction of average daily truck flows. The widths of the lines correspond to the volumes involved. The legend at bottom right gives a sense of how large the flows are. The widths of the lines are directional. East and north flows are plotted to the right of the link centerline. South and west flows are plotted to the left of the link's centerline. So flow imbalances can show if they exist. (None are evident at this scale.)

There are predictably heavy flows on the New Jersey Turnpike, the George Washington Bridge, the Cross Bronx Expressway, the Connecticut Turnpike, the Long Island Expressway, and many other major arterials in the City. (There appears to be good correspondence between the flow pattern for existing truck tips, developed by the project team and the one shown in Figure 4.4, developed for the Regional Freight Plan Project [3].

4.3 MODEL VALIDATION

Of course, concluding that Figure 4.3 is valid implies that the model is able to predict the truck flows. How do we know this is so? What evidence exists?

Fortunately, the 200 highway links that are monitored in the NYC area are ones that have heavy truck traffic, such as major bridges, tunnels, and expressways. Hence, it is possible to check and see that a model intended to predict truck flows is in fact doing so credibly. The trip matrix developed for the BPM was created based on these data. That means it is possible to check the validity of the new model developed for this project based on those data.

Figure 4.5 shows the correspondence between the field observations and model's predictions of link volumes. The field observations are on the horizontal axis while the model's predicted values are on the vertical axis. As can be seen, the model does quite well, except for a few outliers (points A through I). The model overestimates the volumes in general, which is better than having it underestimate them. Most likely, the trucks are using a routing logic that is more complex than that which the model assumes, so the model's predictions tend to be more concentrated than is true in real life.

As the scatter plot in Figure 4.5 suggests, the flow pattern in Figure 4.3 matches instinctive expectations about truck flow patterns. The New Jersey Turnpike is very busy, as is the George Washington Bridge, the Cross Bronx Expressway, and the Long Island Expressway. Flows in the metropolitan area are diffuse and complex with a lot of activity concentrated on major facilities such as the BQE, the Gowanus, the LIE, and the Van Wyck. This picture is a very useful benchmark. It can be used to compare the changes in flows that occur in future years from traffic growth and network enhancements.

The validation issue can also be raised on a "critical link" basis. To gain a sense of the improvements in network performance being created by the enhancement scenarios (i.e., discussed in Chapter 5 for Year 2025), a few "critical links" have been identified. Their location in the highway network is shown in Figure 4.6. The list includes four major bridges: the George Washington Bridge, the Verazzano Narrows Bridge, the Goethals, and the Triborough Bridge. It also includes major freeways (the BQE, the Cross Bronx Expressway, and the LIE) as well as major arterials (Linden Boulevard, Atlantic Avenue, Hunts Point Avenue, Northern Boulevard, Rockaway Boulevard.

Table 4.1 presents observed and predicted daily truck volumes for a few of the critical links in the network. The observed values that are in clear cells, like the George Washington Bridge, are actual truck volume observations. Those that are shaded are deduced from AADT observations and an assumption about the percent trucks. There are a couple of links, like Linden Boulevard, where the correspondence is not what it ought to be, but for the most part, the correspondence is quite good. The deviations are due to limitations in the model (limitations that could be removed with more model development and sophistication). The first is that the model does not dispatch trucks the way companies do with whole-day itineraries in mind. It routes them from origins to destinations. The second is that the path choice algorithm is not as sophisticated as those used by the truck companies and the truck drivers in that it is based strictly on minimizing generalized cost and not other factors related to geometric constraints, getting set for delivery, likelihood of incidents, etc.

Table 4.1 Observed vs. Predicted Flows for Critical Links

Location	Trucks/day Observed	Trucks/day Predicted
Triborough Bridge, west of Astoria Blvd	6489	3068
	6489	4052
George Washington Bridge	14342	11037
	14342	11626
Verazzano Narrows Bridge	4712	6178
	4712	5652
Linden Blvd, east of New Truck Route connection	506	2332
	506	1978
Atlantic Avenue, west of the Van Wyck Expressway	1034	1077
	1034	1041
BQE, south of the LIE on the Kosciusko Bridge	5748	7127
	6354	6870
Cross Bronx Expressway, west of the Sheridan Expresswa	7952	6834
	7683	7683
Goethals Bridge	3751	4509
	3751	4537
Hunts Point Avenue, south of the Bruckner Expressway	1652	1724
	1652	1328
LIE, west of the Van Wyck Expressway	5958	6439
	5958	6547
Northern Boulevard, east of the BQE	1725	2034
	1725	2054
Rockaway Blvd, east of the juncture with Nassau Blvd	1988	1520
	1988	1416
Tappan Zee Bridge	5958	4892
	5958	4600
Van Wyck Expressway, south of Conduit Avenue	4976	2091
	4976	2661

A scatterplot of the data from Table 4.1 is shown in Figure 4.7. Two observations stand out. The first is that the trend is clearly being matched. The second is that the model is under-predicting the volumes for the link with the largest volumes (the George Washington Bridge). The under-prediction is again due to the "simplicity" of the model, its path choice routine does not take into account all the factors used by the truck drivers and the trucking companies.

Since the model has an ability to add capacity where needed to ensure that the truck flows can be accommodated, it is important to see whether major investments were needed to accommodate the Year 2000 flows. Two major variables are reported out by the model from every run. The first is the flow, by direction, on each of the network links. The second is the amount of capacity added to each link.

It is important to remember that the definition of "capacity" being used is not the classic notion of vehicles per hour past a given point, by direction, but rather the facility's ability to handle truck traffic across an average day. That is, the portion of the AADT (Average Annual Daily Traffic) by direction that can "easily" be truck traffic. For example, assume a given link has an AADT of 100,000 vpd (vehicles per day). Further, assume the flows are directionally balanced with 50% of the traffic being in the "forward" direction (say A node => B node) and 50% in the "reverse" direction (B node => A node). Finally, assume 7% of the traffic is trucks, which is common for the freeways in the City. Then, the "capacity" value used by the model for this link would be 3500 trucks per day (3500 = 100,000 * 0.5 * 0.07).

That having been said, if the model wants to increase those limits significantly to accommodate the Year 2000 flows, then something about the model is not right. The capacities might be under-specified or the flows might be too large. If the model wants to add a lot of capacity to some links and none to others, then the OD trip table might be incorrectly specified (too much traffic on some OD pairs and not enough on others). The routing algorithm might also be bad if it tends to route too much traffic over some links and not enough over others.

Figure 4.8 shows the capacity (XCap) added to the network above that which was specified in the initial conditions. As can be seen almost no capacity has been added. The implication is that the flows and the capacity specifications on the network are compatible. The existing flows fit within the capacities assumed, which further validates the fact that the model is set to represent existing conditions. Only in New Jersey are there places where capacity has been added. The study team only checked the major and critical links in New Jersey for coding errors. Most likely, the functional class is incorrectly specified.

4.4 CONCLUSIONS

This chapter has served three purposes. Section 4.1 presented an overview of the network model, Section 4.2 showed the model's predictions of existing truck flows, and Section 4.3 demonstrates that those flows are consistent with field observations. It is now possible to examine the model's predictions of truck flows in the future and use the model to assess where capacity enhancements will be needed to accommodate those flows.

REFERENCES

[1] Sheffi, Y. *Urban Transportation Networks: Equilibrium Analysis with Mathematical Programming Methods.* Prentice-Hall, Inc., Englewood Cliffs, NJ, 1985.

[2] Morlok, E. K. *Introduction to Transportation Engineering and Planning*. McGraw-Hill, Inc. New York, NY, 1978.

[3] Cambridge Systematics, Inc., *NYMTC Regional Freight Plan" Task 2 – Description of Freight Transportation System in the Region,* prepared for New York Metropolitan Transportation Council, July 2001.

Chapter 5 – Year 2025

The main purpose of the project was to discern what network enhancements would be helpful in accommodating future truck flows. This chapter addresses that issue. It is assumed that the region's economy will continue to grow, despite the events of 9-11, and that truck volumes will increase. So the questions to be addressed are: what enhancements are needed, where are they needed and how large an enhancement is required?

2025 has been chosen as the "horizon year" because many other highway investment studies are focusing on that year as well. Section 5.1 provides a discussion about the scenarios that will be examined while Section 5.2 describes the truck traffic projections that were prepared. Section 5.3 presents results for the various scenarios that were investigated while Section 5.4 discusses trends in those results. Tables and figures that illustrate general trends are contained within the body of the chapter. Additional exhibits can be found in Appendix H.

It is important to note that the project only *demonstrates* how such analyses might be conducted and gives a *sense* of the results that might be obtained. A comprehensive examination of all the options that might be pursued has not been done. Much work is needed to determine exactly what enhancements should be pursued. However, the study does provide a well documented analysis and sense of direction.

5.1 FUTURE SCENARIOS

The main challenge in doing the analysis is to decide how the highway network might be enhanced. Many possibilities exist, based on the stakeholder inputs and the Transportation Improvement Program (TIP). The challenge is to cluster these into logical scenarios.

Working in conjunction with NYSDOT Region 11 staff, the study team developed five scenarios. They range from least to most aggressive and with the background of various strategies and tactical planning efforts [1,2,3,4,5,6,7], have been examined in conjunction with corresponding Year 2025 truck flows. In each scenario, the objective was to see how well the network would perform given the assumed enhancements and how much additional "capacity" still had to be added to accommodate the flows at current (base line) levels of service.

The five scenarios are as follows:

- ***S1***: This scenario includes the projects already on the Transportation Improvement Plan (TIP) [5] and projects that are programmed for construction (no build).

- ***S2***: This scenario adds the following enhancements to S1:
  - Cross-harbor rail tunnel (from Brooklyn to either Staten Island or New Jersey) [1]
  - Additional intermodal facilities at Maspeth, Fresh Pond, and the Pilgrim site [7]
  - Full interchange at 39th Street on the Gowanus Expressway
  - Direct connection to Hunts Point from the Bruckner Expressway
  - Direct connection to the Harlem River Yard from the Bruckner Expressway
  - Connection from 65th Street Yard to the Gowanus Expressway

- ***S3***: This scenario adds two enhancements to S2 that have seen a significant amount of consideration and discussion:
  - A three-link truckway network in Brooklyn. The first link follows the LIRR Bay Ridge Line from the Verazzano Narrows Bridge to Linden Boulevard. The second continues east to the Nassau Expressway. The third continues north to the LIE.
  - Physical improvements and operational changes that allow the Grand Central Parkway from the Triborough Bridge to the BQE to be used by trucks.
- ***S4***: This scenario adds two "blue sky" enhancements to S3. These ideas have surfaced in discussions with one or more stakeholders and other transportation agencies:
  - A truckway from the LIE across the Hell Gate Bridge to Harlem River Yard with a further connection to the Bruckner Expressway
  - Extension of the Clearview Expressway to the Belt Parkway and a change in operational practice to allow trucks to use a short section of the Belt Parkway.
- ***S5***: This scenario adds to S4 a truck tunnel under the Hudson River, parallel to the rail tunnel.

5.2 YEAR 2025 TRAFFIC PROJECTIONS

The second critical task is to develop truck trip matrices for the horizon year. The study team decided to advance the NYMTC Year 2000 truck trip to 2025 based on employment projections. A number of previous studies have found that employment is a good predictor of area-wide (zonal) truck trip originations and terminations.

Figure 5.1 shows how the employment levels are expected to grow from 1990 to 2020. From about 11 million in 1990, it is expected to rise to about 13.6 million in 2020. NYMTC created these projections as part of the BPM (best practices model) project. The largest increases will be in the Mid-Hudson region, New Jersey, and Connecticut. In New York City, specifically, employment is expected to increase from 3.9M (million) to 4.2M in 2010 and 4.5M in 2020.

The growth rates are steady at 4%-6% from 1995 to 2020, which makes extrapolation to 2025 straightforward. Two ways to create the 2025 estimates were explored. The first used a linear growth rate based on the change from 1995 to 2020. The second used a constant, compounded percentage growth rate based on the same end years. The differences in the projections were small. Since a compounded growth-based methodology is more common, the results from that process were selected for use.

Table 5.1 presents the employment trends in a numerical format for the region. The values through 2020 are from the BPM project while the 2025 values were developed by the study team. The Mid-Hudson Region includes Dutchess, Orange, Putnam, Rockland, Sullivan, Ulster, and Westchester counties. The New Jersey subregion includes Bergen, Essex, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Passaic, Somerset, Sussex, Union, and Warren counties. The Connecticut area includes Fairfield, Litchfield, and New Haven counties. These data, at the more disaggregate county level, were used to develop the 2025 truck trip table.

Table 5.1 Employment Trends for the Region

County	1995	2000	2005	2010	2015	2020	2025
Bronx	250.6	258.7	266.0	278.4	292.0	303.3	315.1
Kings	559.1	557.6	554.4	568.4	585.3	611.8	622.9
New York	2276.9	2378.3	2491.5	2580.4	2638.4	2701.4	2795.4
Queens	598.8	613.8	635.8	663.7	698.2	731.8	761.8
Richmond	101.1	105.6	109.2	114.0	120.1	125.8	131.4
New York City	3786.5	3914.0	4056.9	4204.9	4334.0	4474.1	4626.6
Long Island	1310.7	1357.3	1428.9	1516.5	1602.9	1705.0	1799.4
Mid-Hudson	965.8	1019.1	1069.6	1120.9	1171.5	1230.9	1293.4
New Jersey	3419.4	3568.3	3753.7	3955.9	4156.5	4318.0	4529.3
Connecticut	1000.2	1038.6	1096.5	1150.9	1204.8	1250.7	1308.3
Region	10482.6	10897.3	11405.6	11949.1	12469.7	12978.7	13557.0

Based on these data, two truck trip matrices were developed for 2025. One assumes the rail tunnel under the Hudson exists. The other assumes no tunnel. This means that the development of the trip matrix was a two-step process. First, the Year 2000 truck trip table was factored forward to 2025 based on growth in employment in the origin and destination counties. Then the rail diversions were taken into account.

To factor the trip table forward to 2025, it was assumed that the truck traffic between origin O and destination D would grow in proportion to multiplication of the employment growth in the origin county times the employment growth in the destination county. That is, if T_{2000}^{OD} is the number of trips for a given OD pair in Year 2000 and T_{2025}^{OD} is the number of trips in Year 2025, then T_{2025}^{OD} is given by:

$$T_{2025}^{OD} = T_{2000}^{OD}\left(\frac{E_{2025}^{O}}{E_{2000}^{O}}\right)\left(\frac{E_{2025}^{D}}{E_{2000}^{D}}\right) \qquad (5\text{-}1)$$

For example, if T_{2000}^{OD} is 100 truck trips per day and the first employment ratio for the origin is 1.08 (8% increase) and the ratio for the destination D is 1.10 (10%) growth, then T_{2025}^{OD} would be 119 (or 118.8) = 100*1.08*1.10.

To adjust for increased intermodal activity, certain percentages of the trips to NYC and Long Island were diverted to one or more intermodal terminals. Two trip tables were prepared, one with and one without the cross-harbor rail tunnel.

Table 5.2 shows the diversion percentages that were assumed for the condition without the rail tunnel. It was assumed that two intermodal facilities would be in use: 65th Street Yard and Harlem River Yard. For these two facilities, diversion percentages were developed for the counties in New York City and Long Island. For example, the table shows that 5% of the traffic to and from Manhattan (New York County) was assumed to be diverted to 65th Street Yard and

5% to Harlem River Yard. In the case of Queens, those same values were 10%. Thus, for Queens, 10% of the inbound trips had their origins changed to 65th Street Yard. Another 10% had their origin shifted to Harlem River Yard. (These diversion percentages are consistent with the cross-harbor MIS study.) Similarly, 10% of the trips outbound from Queens had their destination changed to 65th Street and another 10% had the destination shifted to Harlem River Yard.

Table 5.2 Intermodal Diversion Percentages Without the Cross-Harbor Rail Tunnel

Intermodal Facility	County					
	New York	Queens	Bronx	Brooklyn	Nassau	Suffolk
Maspeth	0	0	0	0	0	0
Fresh Pond	0	0	0	0	0	0
Pilgrim Site	0	0	0	0	0	0
65th Street	5	10	0	10	5	5
Harlem River Yard	5	10	10	0	5	5

Table 5.3 shows the intermodal diversion percentages that were assumed in the condition where the rail tunnel had been built. Overall, the total extent of diversion is higher. However, the use of 65th Street Yard and Harlem River Yard is much different than it was before. (The diversion percentages for the Pilgrim site are conservative since most of the freight traffic today originates and terminates in zones well west of that location.

Table 5.3 Intermodal Diversion Percentages with the Cross-Harbor Rail Tunnel

Intermodal Facility	County					
	New York	Queens	Bronx	Brooklyn	Nassau	Suffolk
Maspeth	0	10	5	5	5	0
Fresh Pond	0	5	0	5	5	0
Pilgrim Site	0	0	0	0	10	20
65th Street	0	0	0	10	0	0
Harlem River Yard	5	5	10	0	0	0

5.3 FINDINGS

This section presents the findings from the five scenarios. S1 is the scenario that reflects based on the TIP. It is used as a benchmark against which to compare the other scenarios. S2 through S5 represent progressively increasing levels of network enhancement.

5.3.1 Scenario S1

S1 is the scenario that incorporates all of the projects presently programmed for construction on the Transportation Improvement Program (TIP). This scenario is effectively the base case condition. It assumes that all of these programmed projects have been finished because none of them has an implementation schedule that extends to or beyond 2025.

To generate this scenario, all of the projects on the TIP were reviewed. Those that were presently programmed for construction were identified. They were placed into two categories: projects that would produce changes in the truck trip matrix and projects that would increase the “capacity” of a given facility. Examples of the former are the port development in Howland Hook, the upgrade to the Red Hook Container Barge facility, and the enhancement of Harlem River Yard. Examples of the latter are the twinning of the Goethals Bridge, the BQE reconstruction from Broadway to Queens Boulevard, and the Kosciusko Bridge replacement. For the former projects, the shifts in the truck trip table have been discussed in Section 5.2. For the latter projects, the study team developed a number that represented the percentage increase in truck "capacity" that would be produced by the project. These values reached as high as 60% in the case of the Goethals Bridge. For the most part, the values were in the 5-15% range. It was determined that some projects would not have a significant impact such as enhancements to the parkways where truck use is not allowed. Appendix H has a list of all these projects and their anticipated impacts. Plots of the capacity added by these TIP projects in each of the five boroughs can also be found in Appendix H.

The main finding in this scenario is that there are no dramatic changes. The volumes on the links all increase, reflecting the growth in traffic, but the flow map is unchanged. The main finding is that the projects on the TIP do not provide enough of a "capacity" increase to accommodate the increased volumes. Additional network capacity is needed on major links.

An overview of the truck flow pattern for S1 is shown in Figure 5.2. Plots of the volumes in each of the boroughs can be found in Appendix H. The overall results are similar to those for the Year 2000 case, but the volumes are significantly larger.

A sample of the comparisons between the S1 link volumes and the Year 2000 flows can be found in Table 5.4:

Substantial capacity investments are required beyond those provided by the TIP. Figure 5.3 presents an overview of those investments. Borough-specific maps can be found in Appendix H.

Table 5.4 Comparisons of S1 with the original Year 2000 condition

Location	VOLUMES (Trucks/Day) 2000	S1	Diff	
Triborough Bridge, west of Astoria Blvd	3068	4844	1776	NB / EB
	4052	6378	2326	SB / WB
George Washington Bridge	11037	16355	5318	NB / EB
	11626	17503	5877	SB / WB
Verazzano Narrows Bridge	6178	8951	2773	NB / EB
	5652	8318	2666	SB / WB
Linden Blvd, east of New Truck Route connection	2332	3477	1145	AB
	1978	3172	1194	BA
Atlantic Avenue, west of the Van Wyck Expressway	1077	1512	435	NB / EB
	1041	1631	590	SB / WB
BQE, south of the LIE on the Kosciusko Bridge	7127	9043	1916	NB / EB
	6870	9535	2665	SB / WB
Cross Bronx Expressway, west of the Sheridan Expressway	6834	8389	1555	NB / EB
	7683	9672	1989	SB / WB
Goethals Bridge	4509	7153	2644	NB / EB
	4537	6865	2328	SB / WB
Hunts Point Avenue, south of the Bruckner Expressway	1724	2508	784	AB
	1328	1868	540	BA
LIE, west of the Van Wyck Expressway	6439	9659	3220	NB / EB
	6547	9658	3111	SB / WB
Northern Boulevard, east of the BQE	2034	3161	1127	AB
	2054	3033	979	BA
Rockaway Blvd, east of the juncture with Nassau Blvd	1520	1990	470	AB
	1416	1990	574	BA
Tappan Zee Bridge	4892	7231	2339	NB / EB
	4600	7260	2660	SB / WB
Van Wyck Expressway, south of Conduit Avenue	2091	3297	1206	NB / EB
	2661	4467	1806	SB / WB

5.3.2 Scenario S2

Scenario S2 adds to S1 projects that are presently under serious consideration for funding. These ideas have been given significant stakeholder support. Most are in the midst of or have been through the MIS/EIS (Major Investment Study/Environmental Impact Statement) process and are progressing toward design. Perhaps the most significant of these is the Cross Harbor Rail Tunnel. Along with it are new intermodal facilities at Maspeth, Fresh Pond and the Pilgrim site: locations that would be potentially lucrative intermodal yards assuming the cross-harbor tunnel is constructed. Along with 65th Street Yard and Harlem River Yard, these facilities would represent a significant increase in intermodal handling capacity east of the Hudson River. The redistribution of truck trips caused by these projects was discussed in Section 5.2. By implementing these yards, truck demands on the arterial system would be impacted.

In addition, two new direct connections to the freeway network from major truck facilities are assumed. One is from Hunts Point Market to the Bruckner Expressway which is being studied. The other is from Harlem River Yard to the Bruckner Expressway. Appendix H has maps that locate these new network links. These spurs would relieve congestion on the local streets surrounding the intermodal yards, and would make the local communities safer by reducing truck traffic through residential areas.

Other notable projects in S2 are the construction of a full interchange on the Gowanus at 38th and 39th Streets. This would result in better access the South Brooklyn port facilities and reconstruction of the Highbridge interchange. A complete list of the enhancements in S2 can found in Appendix H.

The network flow differences between S1 and S2 are limited. There are locations that have considerable differences in volume, but the overall pattern is nearly identical to S1. The locations that have differences are located near the projects included in S2, such as the new intermodal facilities and the direct access spurs. Appendix H contains flow maps and capacity investment maps for the region and the individual boroughs. Appendix H also contains detailed maps of the changes near the S2 projects.

The changes near the new facilities can be illustrated using Hunts Point. Table 5.5 shows changes in volumes near Hunts Point Market.

Table 5.5 Comparisons of S1 with the original Year 2000 condition

HUNTS POINT AREA STREET	VOLUMES (Trucks/Day) S1	S2
HUNTS POINT AVE	2209	0
RANDELL AVE	2898	0
EDGEWATER RD	3930	1216
DIRECT CONNECTION TO HUNTS POINT	0	7821
TOTAL VOLUME	9037	9037

The truck volumes for the local streets drop substantially. The direct connections that are made available for these intermodal facilities not only benefit the local communities, but the trucking firms as well. Since it is possible for the trucks to move more freely, there is a potential for greater goods movement out of these intermodal facilities, which will benefit both trucking and rail companies.

5.3.3 Scenario S3

Scenario S3 adds to S2 network enhancements that have been proposed but are not yet clearly programmed for construction. Perhaps the most important are new truckways in Brooklyn, and a reconfiguration of the Grand Central Parkway (GCP) between the Triborough Bridge and the BQE, with concomitant lifting of truck prohibitions on that section of the GCP.

A "truckway" is a highway used "exclusively" by trucks. Boston presently has one truckway. The 'Haul Road' is in use by commercial vehicles during the major construction associated with the Central Artery/Tunnel project (the Big Dig). Many other areas of the country are in the planning and design stages of implementing such truckways as a way to alleviate congestion on the current arterial systems. These truckways are designed with the commercial vehicle in mind and are expected to improve traffic conditions. The places that are currently or have recently thought about truckways include:

- Duluth to Winnipeg (1996)
- Alameda Corridor, Los Angeles (1997)
- I-35 Truckways (especially in Texas) (1999)
- Chicago, truckways on railroad rights-of-way (1999)
- New Orleans, 15 miles along the Mississippi River (1999)
- Washington DC, northern suburbs (1999)
- New York, Brooklyn & Queens (1986 & 2002)

Congestion relief has been the preponderant reason. Facilitation of commerce has been another. Safety gains from the separation of truck and auto traffic have been cited as well. The I-35 Truckways in Texas are mainly for trucks, but will allow automobiles. The project is expected to begin early in 2003, and result in a 90-mile toll road that will eventually stretch between Dallas-Fort Worth and San Antonio. Other truckways in more congested areas will not allow automobiles to mix with the commercial traffic.

One challenge that each of the above cities has faced is where to put the truckway. In New York City, this problem has been remedied by the recommended joint use of railroad corridors.

The truckway network being proposed in S3 would have three sections. A picture of the network is shown in Figure 5.4. The first section would run from the Verazzano Narrows Bridge to Linden Boulevard along the LIRR Bay Ridge Line. The second would run from Linden Boulevard north to the LIE, again along the Bay Ridge Line, with an interchange at Atlantic Avenue. The third would run from the Bay Ridge Line at Linden Boulevard to the Nassau Expressway, along an alignment that parallels Linden Boulevard.

The other major enhancement in S3 is the reconstruction of the GCP between the Triborough Bridge and the BQE, bringing it up to interstate standards. The ban on trucks for this short section of the GCP can then be lifted, allowing trucks to remain on the GCP rather than exiting onto Astoria Boulevard and disturbing local activities.

The changes in S3 are substantial compared to S1. The truckways in Brooklyn produce major changes in truck volumes on the Gowanus Expressway, the BQE, and the western parts of the LIE. The opening of the GCP to trucks between the Triborough Bridge and the BQE removes substantial truck traffic from Astoria Boulevard. Freight to and from John F. Kennedy Airport (JFK) now has a more direct route as compared with current conditions and earlier scenarios.

However, this traffic is now crossing Staten Island and using the Verazzano Narrows to gain access to the truckway. When comparing the daily truck volume on the bridge with S1 data, there is an increase of between 1,500 and 2,000 trucks per day in each direction over the bridge. One other location with higher volumes is the Long Island Expressway where new ramps connect to the truckway. According to the model, between seven to eight thousand trucks will use the truckway each day therefore eliminating that many from other links within the network.

Figure 5.5 shows the overall flow pattern for S3. One can immediately notice the use of the truckways and the concomitant decreases in truck traffic on the Gowanus, BQE, and western sections of the LIE. One can also notice, in comparison with Figure 5.2, the increase in traffic across the Verazzano Narrows Bridge. Appendix H has more detailed maps for the boroughs and the section of the GCP between the Triborough Bridge and the BQE.

Changes in the truck volumes for a number of critical links are shown in Table 5.6. The "2000" column shows the model's predictions of the volumes for the existing conditions. Columns S1,

Table 5.6 Changes in Truck Volumes for Critical Links

	VOLUMES (Trucks/Day)							
Location	2000	S1	Diff	S2	Diff	S3	Diff	
Triborough Bridge, west of Astoria Blvd	3068	4844	1776	4779	-65	5958	1114	NB / EB
	4052	6378	2326	6402	24	7509	1131	SB / WB
George Washington Bridge	11037	16355	5318	15966	-389	14837	-1518	NB / EB
	11626	17503	5877	17252	-251	15681	-1822	SB / WB
Verazzano Narrows Bridge	6178	8951	2773	8873	-78	10170	1219	NB / EB
	5652	8318	2666	8189	-129	10313	1995	SB / WB
Linden Blvd, east of New Truck Route connection	2332	3477	1145	3393	-84	864	-2613	AB
	1978	3172	1194	2995	-177	657	-2515	BA
Atlantic Avenue, west of the Van Wyck Expressway	1077	1512	435	1489	-23	1327	-185	NB / EB
	1041	1631	590	1610	-21	1436	-195	SB / WB
BQE, south of the LIE on the Kosciusko Bridge	7127	9043	1916	8931	-112	7336	-1707	NB / EB
	6870	9535	2665	9460	-75	7152	-2383	SB / WB
Cross Bronx Expressway, west of the Sheridan Expressway	6834	8389	1555	8181	-208	8796	407	NB / EB
	7683	9672	1989	9466	-206	9901	229	SB / WB
Goethals Bridge	4509	7153	2644	7156	3	7610	457	NB / EB
	4537	6865	2328	6655	-210	8016	1151	SB / WB
Hunts Point Avenue, south of the Bruckner Expressway	1724	2508	784	978	-1530	885	-1623	AB
	1328	1868	540	616	-1252	603	-1265	BA
LIE, west of the Van Wyck Expressway	6439	9659	3220	9655	-4	9922	263	NB / EB
	6547	9658	3111	9490	-168	11702	2044	SB / WB
Northern Boulevard, east of the BQE	2034	3161	1127	3228	67	2821	-340	AB
	2054	3033	979	2971	-62	2775	-258	BA
Rockaway Blvd, east of the juncture with Nassau Blvd	1520	1990	470	1990	0	1990	0	AB
	1416	1990	574	1987	-3	1990	0	BA
Tappan Zee Bridge	4892	7231	2339	7114	-117	7076	-155	NB / EB
	4600	7260	2660	7121	-139	7061	-199	SB / WB
Van Wyck Expressway, south of Conduit Avenue	2091	3297	1206	3268	-29	3684	387	NB / EB
	2661	4467	1806	4432	-35	3993	-474	SB / WB
Truckway, Hunts Point to Bruckner	0	0		3953	3953	3885	3885	AB
	0	0		3868	3868	3906	3906	BA
Truckway, from 65th Street and Linden Boulevard	0	0		0		279	279	AB
	0	0		0		394	394	BA
Truckway, paralleling Linden Boulevard	0	0		0		7846	7846	AB
	0	0		0		6579	6579	BA
Truckway, Linden Boulevard to Atlantic Avenue	0	0		0		9588	9588	AB
	0	0		0		7569	7569	BA
Truckway, Atlantic Avenue to the LIE	0	0		0		9798	9798	AB
	0	0		0		7132	7132	BA

S2 and S3 show the predicted volumes for scenarios S1, S2, and S3 while the adjacent "Diff" columns show how those volumes change progressively from one scenario to the next. For example, the last entry in the table for the eastbound direction on the Triborough Bridge (1114) reflect the increase in volume that occurred from S2 to S3.

5.3.4 Scenario S4

Scenario S4 adds two more "blue sky" ideas to S3. These facilities ought to significantly decrease truck traffic on the more heavily congested facilities in Brooklyn and Queens.

The first is a truckway that follows the LIRR right of way north from the LIE (where the truckway in S3 ends), across the Hell Gate Bridge, to the Bruckner. A map of this truckway is shown in Figure 5.6.

Between the LIE and the Bruckner Expressway, there would be one interchange with the BQE. Additional interchanges do not seem necessary. A more problematic issue is the connection to the Bruckner Expressway. One option would be to have the truckway ramp around under the Hell Gate Bridge and end in the vicinity of Harlem River Yard. This is the idea shown in the map. It could be that other, better ways to tie the truckway to the Bruckner might be found if a more detailed engineering study was conducted.

With the truckway network extended north to the Bruckner Expressway, the volumes on the truckway network expand even further than before. On the S3 section of the truckway the daily truck volume increased to a maximum of approximately 12,000 trucks in each direction. The new section over the Hell Gate Bridge shows approximately 11,000 trucks per day in each direction. Truck traffic on the Triborough Bridge correspondingly decreases (see Table 5.7 below). Since the truckway does not terminate at the LIE, the volumes on the LIE remain similar to S3. Similar to the S3 case, truck volumes on the Verazzano Narrows Bridge increase. The model estimates an increase of about 1,500 trucks per day from S3 conditions which is an overall increase of between 3,000 – 3,750 trucks per day from S1. There are few facilities within the network which experience decrease in volume in 2025 compared with that of the year 2000 case. Most of the locations where this decrease exists is areas adjacent to the truckway. The model clearly shows that the continuation of the truckway over the Hell Gate Bridge would lower the truck volumes on the Triborough Bridge below current levels.

Table 5.7 Changes in Truck Volumes on the Triborough Bridge

Triborough Bridge
Daily Truck Volumes by Direction

	2000	S1	S3	**S4**
NB	3068	4844	5958	**3211**
SB	4052	6378	7509	**2469**

The second new facility would be an extension of the Clearview Expressway. A picture of where this might be is shown in Figure 5.7. Since this is just an idea the location was approximated to produce a reasonable representation of how the model will perform in the S4 and S5 scenarios.

The logic behind this extension is to provide relief for the Van Wyck Expressway by providing an alternate route to and from JFK. To mitigate negative community impacts, the most reasonable plan would be to have the highway built as a tunnel. To make the connection to the Van Wyck Expressway most useful, it was necessary to make the terminus end of the tunnel at the Cross Island Parkway. The Cross Island Parkway becomes the Laurelton Parkway a short distance south of where the ramps connect to the Cross Island Parkway. Therefore, to make this connection work it would be necessary to reconstruct these short sections of the parkways to allow commercial vehicles.

When the model is run under the S4 condition, the volume on the Clearview Extension is much less than on the Van Wyck Expressway. In each direction, the maximum volume which utilizes the new sections of the Clearview range between 2400 -2600 trucks/day. However, the amount of trucks which utilize the route using the necessary Parkways is only between 1600–1750 trucks/day in each direction. Once these results were produced, an S4 model run was made without the extension just to see what effects would exist without the extension. The results are shown in Table 5.8.

Table 5.8 Changes in Truck Volumes due to the Clearview Expressway Extension

Location	With Extension	Without Extension	Difference (Trucks/Day)
Van Wyck NB south of LIE	3691	3764	73
Van Wyck SB south of LIE	2268	2253	-15
Van Wyck NB north of JFK	3176	3402	226
Van Wyck SB north of JFK	3875	3852	-23

It seems clear that extension of the Clearview Expressway does not significantly decrease the traffic on the Van Wyck. The model seems to be suggesting that the Clearview is a considerable distance east of the Van Wyck and provides little opportunity for traffic diversion. In addition, most of the traffic destined for JFK does not come from places that would be served by the extension, therefore it is out of the way for most traffic to utilize this new facility.

With these two "blue sky" ideas, the network begins to develop a truck flow pattern that is quite different from S1 through S3. A plot of the overall network flows is shown in Figure 5.8. Plots for the individual boroughs can be found in Appendix H.

5.3.5 Scenario S5

Scenario S5 adds one more "blue sky" idea to S4. It is a truck tunnel under the Hudson River that parallels the rail tunnel included in Scenario S2. (See Figure 5.9.) This idea was proposed at one juncture as part of the rail tunnel construction project, but presently has been set aside. The advantage is that it would provide relief for the bridges and tunnels that presently cross the Hudson. The idea explored by the project involved a tunnel running from the New Jersey Turnpike near Port Elizabeth to the beginning of the truckway in Brooklyn.

The connection could also be to Staten Island if need be. In scenarios S3 and S4, the Verazzano Narrows Bridge experienced large increases in daily truck volumes, but the creation of the truck tunnel would alleviate the traffic using many of the bridges and tunnels crossing the Hudson River. With the tunnel in operation, the Verazzano Narrows Bridge experiences the same conditions as scenario S3, and the tunnel accounts for between seven and eight thousand trucks per day in each direction. Since the tunnel creates a direct link from the NJTPK to Brooklyn, the truckway also experiences a substantial increase in volume. The section created in scenario S3 as volume as high as 16,000 trucks per day in each direction, and the section created in scenario S4 has volumes as high as 14,000 trucks per day in each direction.

A plot of the truck flows for the entire network is shown in Figure 5.10. Additional plots for the boroughs can be found in Appendix H. The main areas where major decreases in truck volumes occur are at the river crossings and highways in close proximity to the tunnel and the truckways.

5.4 OVERARCHING TRENDS

The findings from the analysis, especially for S4 and S5 show that the truckways would significantly reduce the amount of truck traffic on the adjacent highways. To facilitate the maximum performance from the truckway, exits would need to be strategically placed and geometric considerations would need to be met for commercial vehicles.

The fact that the volumes are significantly higher than in Year 2000 is evident in all five scenarios. Most notable of all the changes is the major decrease in S4 and S5, in the use of the Gowanus, BQE, LIE, GCP, and Triborough Bridge when the whole Brooklyn-Queens-Bronx truckway exists. Figures 5.11 and 5.12 show the facilities that have seen reductions in truck volumes and increases respectively. Additional plots for each of the boroughs can be found in Appendix H. The truck volumes have been shifted off facilities heavily used for other trips in the City onto facilities especially for trucks, so that the congestion on those other facilities is reduced and their operation is improved.

The facilities that experienced a decrease in truck volumes were the BQE, LIE, NJTPK, Van Wyck Expressway, and many of the Hudson River Crossings within the region. However, a few locations did see a negative impact as the scenarios progressed. The facilities that had increases in truck volumes are the Verrazano Narrows Bridge to the Truckway, and locations in the Bronx that are in the vicinity of Harlem River Yard at the north end of the Truckway.

A comprehensive comparison of the changes in truck volumes for critical network links is shown in Table 5.9.

Table 5.9 Trends in Truck Volumes among the Scenarios

Location	VOLUMES (Trucks/Day)											
	2000	S1	Diff	S2	Diff	S3	Diff	S4	Diff	S5	Diff	
Triborough Bridge, west of Astoria Blvd	3068	4844	1776	4779	-65	5958	1114	3211	-1633	3157	-1687	NB / EB
	4052	6378	2326	6402	24	7509	1131	2469	-3909	2250	-4128	SB / WB
George Washington Bridge	11037	16355	5318	15966	-389	14837	-1518	14014	-2341	12267	-4088	NB / EB
	11626	17503	5877	17252	-251	15681	-1822	14523	-2980	12928	-4575	SB / WB
Verazzano Narrows Bridge	6178	8951	2773	8873	-78	10170	1219	12279	3328	10625	1674	NB / EB
	5652	8318	2666	8189	-129	10313	1995	12529	4211	10928	2610	SB / WB
Linden Blvd, east of New Truck Route connection	2332	3477	1145	3393	-84	864	-2613	923	-2554	926	-2551	AB
	1978	3172	1194	2995	-177	657	-2515	683	-2489	686	-2486	BA
Atlantic Avenue, west of the Van Wyck Expressway	1077	1512	435	1489	-23	1327	-185	1369	-143	1376	-136	NB / EB
	1041	1631	590	1610	-21	1436	-195	1420	-211	1438	-193	SB / WB
BQE, south of the LIE on the Kosciusko Bridge	7127	9043	1916	8931	-112	7336	-1707	7092	-1951	6976	-2067	NB / EB
	6870	9535	2665	9460	-75	7152	-2383	7192	-2343	7052	-2483	SB / WB
Cross Bronx Expressway, west of the Sheridan Expressway	6834	8389	1555	8181	-208	8796	407	8768	379	8521	132	NB / EB
	7683	9672	1989	9466	-206	9901	229	9778	106	9435	-237	SB / WB
Goethals Bridge	4509	7153	2644	7156	3	7610	457	9155	2002	6891	-262	NB / EB
	4537	6865	2328	6655	-210	8016	1151	9279	2414	7604	739	SB / WB
Hunts Point Avenue, south of the Bruckner Expressway	1724	2508	784	978	-1530	885	-1623	1055	-1453	1074	-1434	AB
	1328	1868	540	616	-1252	603	-1265	952	-916	972	-896	BA
LIE, west of the Van Wyck Expressway	6439	9659	3220	9655	-4	9922	263	9486	-173	9421	-238	NB / EB
	6547	9658	3111	9490	-168	11702	2044	10681	1023	10693	1035	SB / WB
Northern Boulevard, east of the BQE	2034	3161	1127	3228	67	2821	-340	2643	-518	2681	-480	AB
	2054	3033	979	2971	-62	2775	-258	3596	563	3618	585	BA
Rockaway Blvd, east of the juncture with Nassau Blvd	1520	1990	470	1990	0	1990	0	1988	-2	1987	-3	AB
	1416	1990	574	1987	-3	1990	0	1986	-4	1963	-27	BA
Tappan Zee Bridge	4892	7231	2339	7114	-117	7076	-155	7112	-119	7104	-127	NB / EB
	4600	7260	2660	7121	-139	7061	-199	7104	-156	7032	-228	SB / WB
Van Wyck Expressway, south of Conduit Avenue	2091	3297	1206	3268	-29	3684	387	3265	-32	3312	15	NB / EB
	2661	4467	1806	4432	-35	3993	-474	3875	-592	3763	-704	SB / WB
Truckway, Hunts Point to Bruckner	0	0		3953	3953	3885	3885	3849	3849	3820	3820	AB
	0	0		3868	3868	3906	3906	3913	3913	3961	3961	BA
Truckway, from 65th Street and Linden Boulevard	0	0		0		279	279	8924	8924	12717	12717	AB
	0	0		0		394	394	9258	9258	13204	13204	BA
Truckway, paralleling Linden Boulevard	0	0		0		7846	7846	8259	8259	8636	8636	AB
	0	0		0		6579	6579	6713	6713	6891	6891	BA
Truckway, Linden Boulevard to Atlantic Avenue	0	0		0		9588	9588	12996	12996	16219	16219	AB
	0	0		0		7569	7569	11462	11462	14704	14704	BA
Truckway, Atlantic Avenue to the LIE	0	0		0		9798	9798	12996	12996	16818	16818	AB
	0	0		0		7132	7132	11462	11462	14791	14791	BA
Clearview Expressway Extension (Tunnel)	0	0		0		0		2629	2629	2598	2598	NB / EB
	0	0		0		0		2409	2409	2379	2379	SB / WB
Truckway, LIE to the Bruckner Expressway (Hell Gate)	0	0		0		0		8511	8511	11005	11005	NB / EB
	0	0		0		0		12285	12285	14407	14407	SB / WB
Truckway Tunnel under the Hudson River	0	0		0		0		0		7156	7156	AB
	0	0		0		0		0		8041	8041	BA

Scenarios S1 through S5 are only a few of the many possible improvement scenarios that exist. It would be possible to come up with new ideas or proposals, or to mix and match which items were put into each scenario. We also did a test of Scenario S3 to see what would happen if the cost of adding AADT (Average Annual Daily Traffic) "capacity" was a lot more expensive than originally assumed. The result was the flow pattern shown in Appendix H. A lot more facilities in the network see heavier use, so the average V/C (volume-to-capacity) ratio is much higher, and the total truck-miles and truck-hours are significantly higher since lengthier paths result from finding ways to make use of links that otherwise would be more lightly loaded. This same trend would occur in all the scenarios if they were all tested with the higher cost.

5.5 CONCLUDING REMARKS

After studying each of the scenarios, certain elements proved to contribute substantially to overall network performance. The projects that yielded the greatest improvement in network performance separate the commercial vehicles from the auto traffic. These projects include the truckways as well as the direct connections to facilities like Hunts Point, Maspeth, and Harlem River Yard.

The direct connections are concentrated at intermodal terminals and serve as a way to transport trucks from the rail facilities to a near by ramp on the interstate system. This way, trucks will not have to travel through local communities to arrive at their destination. Also, travel through many of the communities creates a challenge with the ambiguous signage in place. Direct connections will also allow for a route to and from the intermodal facility. From an industrial standpoint, the trucking community would not be the only beneficiary, but the rail community would also greatly benefit. The reason for this is that trucks would be able to gain better access to the intermodal facilities therefore, increasing the amount of freight that can be carried by the railroads in turn creating a larger revenue stream for both the trucking and rail communities.

As demonstrated in scenario S3, S4, and S5, the creation of truckways through Brooklyn and Queens proves to have a significant impact on reducing the truck vehicle miles of travel in the existing highway network. The truckways provide a route for trucks to take when traveling to one of the regions major freight facilities such as JFK Airport, Fresh Pond, Harlem River Yard, and other intermodal facilities.

The creation of the Clearview Extension does not show any substantial benefits to the network. Since there is a great deal of controversy with this project and the model runs suggest that this location does not divert a great deal of traffic off of the Van Wyck Expressway it is not recommended that this project receive priority.

REFERENCES

[1] Edwards & Kelcey, *Cross Harbor Freight Movement Major Investment Study, Final Report,* prepared for the New York City Economic Development Corporation, May, 2002.

[2] Cambridge Systematics, Inc., NYMTC Regional Freight Plan: Task 5 – Preliminary Identification of Improvements and Solutions, prepared for New York Metropolitan Transportation Council, January 2002.

[3] New York City Economic Development Corporation, *Strategic Plan for the Redevelopment of the Port of New York, Executive Briefing,* New York, NY, February, 1999.

[4] New York Metropolitan Transportation Council, *Mobility for the Millennium*, New York, NY, September, 1999.

[5] New York Metropolitan Transportation Council, *New York City Transportation Coordinating Committee portion of the NYMTC FFY 2002-04 Transportation Improvement Program,* New York, NY, July 2001.

[6] Center for an Urban Future, *On a Wing and a Prayer: Highway Gridlock, Antiquated Cargo Facilities Keep New York's Airports Grounded*, October, 2000.

[7] Parson, Brinckerhoff, Quade &n Douglas, Inc., *Pilgrim Intermodal Freight Transportation Center*, prepared for New York State Department of Transportation, Long Island Region, June 2001.

Chapter 6 – Non-Capital Enhancement Options

Responding to clear inputs from the stakeholders, two additional issues were investigated as part of the study:

- Geometric restrictions on truck use (e.g., 53 ft trailers)
- Commercial vehicles on parkways

Section 6.1 addressed the first issue while Section 6.2 addresses the second.

6.1 GEOMETRIC RESTRICTIONS ON TRUCK USE

Determining the combination of the length and width of tractor-trailer trucks and the highway network on which that truck is allowed to operate is a very complex issue that has been studied in depth by government agencies, i.e., Federal Highway Administration, Motor Carrier Administration, by advocates for larger and longer trailers and their opponents. A search of the World Wide Web using the key words Truck + Regulations yielded 203,000 references.

As evidence of the complex inter-relationships affected by this issue, the US Department of Transportation's "Comprehensive Truck Size and Weight Study" Summary Report [1] that was transmitted to Congress on August 31, 2000 identified the following 16 factors that affect determining truck size and weight.

- Enhances safety
- Promotes innovation
- Facilitates trade
- Ensures compliance
- Protects infrastructure
- Enhances competitiveness
- Promotes flexibility
- Recovers infrastructure costs
- Optimize system
- Effects uniformity
- Enhances logistics
- Streamlines procedures
- Reduces expenditures
- Reduces cost of freight
- Protects environment
- Conserves energy

The Purpose of the Study stated on the Internet site [1] "…was intended to provide decision makers with fact-based information regarding highly controversial and multifaceted truck size and weight issues."

This is an issue on which there are strongly held views. Those opposed to wider and longer trucks cite safety as a major concern.

The following is a quote from the Transportation Alternatives News Release [2] dated January 12, 1999 following a crash between a bicyclist and an 18-wheel tractor-trailer on January 12th in New York City, "How many bicyclists and pedestrian will be killed before New York City starts enforcing its own 55-foot truck law. Transportation Alternatives calls on the Police Department to enforce the monster truck laws and for the City Council to conduct an oversight hearing on why the law is not being enforced. Only a handful of officers perform truck enforcement while monster trucks are taking over city streets," said Susan Boyle, Bicycle Program Coordinator for Transportation Alternatives, a bicycle advocacy group.

On the other hand, Jonathan Bowles the writer of On a Wing and a Prayer [3] noted that, "The lack of highway options for trucks is also undercutting one of the airport's natural advantages: its network of experienced freight forwarders and custom brokers".

An in-depth study of the Truck Regulations in New York City is beyond the scope of this project but because of the far reaching implications of the current regulations on freight movement on the NYSDOT arterial network this study would not be complete without at least a review the current rules and regulations, existing studies and their impacts.

6.1.1 Current New York City Regulations

Section 4-15 of the New York City Traffic Rules specifies that a combination vehicle shall not be wider than 96 inches and that the overall length including tractor and trailer shall not exceed 55 feet. There is also a requirement that the trailer shall not exceed 48 feet in length. However, because there are no tractors less than 7 feet in length, the 55-foot over all length is the governing maximum. Therefore, if the distance from the front of the tractor to the king pin is 20 feet, the maximum length of the trailer allowed is 35 feet. Furthermore, there are specifically defined truck routes on which these trucks can go. The streets are listed in the Traffic Regulations and maps showing the Through Truck Routes, Local Truck Routes and Limited Truck Routes for the 5 Boroughs can be found at the following web site: (http://www.nyc.gov/html/dot/html/transportation_maps/frm_truck.html)

The currently approved tractor-trailer for use on the Interstate system in New York State has a 53-foot trailer that is 102 inches wide. This is also known as a Special Dimension Vehicle. This is 6 inches wider and several feet longer than the tractor-trailers allowed for use in the City.

Were the longer and wider trailers legal within the city, truck productivity could be improved. The difference is akin to the productivity boost the railroads gained by changing from single to double-stack container trains.

The reason relates to the way in which freight is presently transported by truck. Freight moves on pallets or in containers for easy and quick loading and unloading. Wooden pallets are typically 8-feet wide by 4-feet long and containers are typically 10, 20, and 40 feet long with a nominal width of 8 feet [4]. The exact exterior dimensions for one manufacturer of a 20 foot dry freight container is 19'-10 ½" long by 8'-0" wide [5].

The 102-inch wide limit on trailer width makes productivity much higher. In the case of a dry van (typical trailer), the extra three inches on each side makes it possible to build the trailer so that the interior width is at least 8-feet! 8-foot long pallets can now be stored widthwise across the trailer, or two 4-foot by 8-foot pallets can be stored side-by-side. Products such as plywood, hardboard, etc. that are manufactured in 8-foot lengths or widths, can be carried inside the trailer and fill the space. On open trailers, the same notions pertain with ample room for tie-downs. For containers similarly designed to have interior dimensions of 8-feet, they can now sit on the trailer without an overhang. Wasted space is eliminated and productivity is increased.

102" wide by 53" trailer allows far greater productivity in transporting combinations of containers and pallets than does the maximum size trailer presently allowed within the city. Up to a 50% decrease in truck traffic might be possible if it were legal to use the larger size trailer since fewer trucks would be needed.

To allow for the movement of the larger tractor-trailers through New York City the following routes were established on which the 53 foot trailers are allowed: I-95; I-678 from I-95 to I-295; I-295 from I-695 to I –495 via the Throgs Neck Bridge; and I-495 from I-295 to the Queens-Nassau County line. These routes are shown on Figure 6.1. It can be seen that this is a very limited system.

The existence of two tractor-trailer standards, one outside the City and one inside the City necessitates that freight haulers maintain two separate fleets, one fleet for deliveries to suburban warehouses (e.g., in NJ) that service the City and another for deliveries to locations in the city.

6.1.2 Vertical Clearances

This study identified 28 locations on the arterial system where the vertical clearance is less than 14 feet. These locations are listed in Table 6.1 and shown on Figure 6.2. Clearances below 14 feet are a potential restriction to larger trucks.

6.1.3 Other Jurisdictions

In addition to the New York City Department of Transportation, there are three other agencies that either control or have activities that impact the movement of truck freight in the City. These are the New York State Department of Transportation; the Triborough Bridge and Tunnel Authority (TBTA), an agency of the MTA; and the Port Authority of New York and New Jersey.

6.1.3.1 ***New York State Department of Transportation***

Since 1989 when the new City Charter was adopted, NYSDOT has not had operational authority over the state arterial system in the City. However many sections of Interstate Highway are owned by the state. Hence, NYSDOT does implement a very large bridge and pavement rehabilitation and reconstruction program. As part of this program, it has the capability to progress capital projects to install signing and intelligent transportation system technologies to facilitate the movement of truck freight and to remove bottlenecks such as low vertical clearances.

The Department does provide information on highways with truck restrictions. Clicking on the Department's web page (http://www.dot.state.ny.us/), then clicking on Frequently Asked Questions, the following is one of the questions concerning 53-foot trailers.

> *Where can I operate Special Dimension Vehicles (e.g. 53' trailers and STAA vehicle combinations such as twin 28' trailers, stinger-steered autocarriers, maxi-cubes, triple saddlemounts and vehicles with a total combination length greater than 65')?*
>
> These vehicles may operate on the Designated Truck Access Highway System which includes the National Network (a.k.a. Qualifying Highways) and Access Highways. A complete listing of the valid routes as well as information about the program can be obtained via the Department's website: (http://www.dot.state.ny.us/traffic/infodownl.html).

Clicking on that link directs one to a site where one can download information including the Department's Official Description of Designated Qualifying and Access Highways in New York State [6]. The following is an excerpt from the Manual:

> "Under the 1990 Onimbus Truck Safety Bill, New York authorized the use of 53 foot trailer combinations effective November 1990. Per § 385(3) (e) of the Vehicle & Traffic Law, the 53 foot trailer combinations are restricted to the Qualifying and Access Highway system. Because New York City felt that 53 foot trailers would be unable to maneuver effectively on City streets, a provision was included in the legislation that prohibited the vehicles within the City. However, in order to provide service to Long Island, one specific corridor consisting of the following interstate highways was approved for travel to Long Island. The New York City interstate routes approved for 53 foot trailers (see map on page 3) are as follows:
>
> - I 95 - between Bronx-Westchester County line and I 295
> - I 295 - between I 695 and I 495 via Throgs Neck Bridge
> - I 495 - between I 295 and Queens-Nassau County line"

Figure 6.3 presents the map that is shown on page 3 referenced above.

There is no listing on the site of locations with vertical clearance problems. Presumably, this implies that all Interstate Highways have 14 foot clearances or will have them soon.

6.1.3.2 ***Triborough Bridge and Tunnel Authority***

MTA Bridges and Tunnels (The Triborough Bridge and Tunnel Authority) has jurisdiction over the toll bridges and tunnels in New York City. They operate the following facilities.

- Triborough Bridge
- Throgs Neck Bridge
- Verrazano Narrows Bridge

- Bronx-Whitestone Bridge
- Henry Hudson Bridge
- Marine Parkway Gil Hodges Memorial Bridge
- Cross Bay Veterans Memorial Bridge
- Brooklyn Battery Tunnel
- Queens Midtown Tunnel

There is no indication on their web site that 53-foot trailers are not allowed on their bridges other than the Throgs Neck.

6.1.3.3 ***Port Authority of New York and New Jersey***

The Port Authority of New York and New Jersey operate the following commercial facilities in the New York City metropolitan area.

- George Washington Bridge (http://www.panynj.gov/tbt/gwframe.HTM)
- Goethals Bridge (http://www.panynj.gov/tbt/gbframe.HTM)
- Bayonne Bridge (http://www.panynj.gov/tbt/bbframe.HTM)
- Outerbridge Crossing (http://www.panynj.gov/tbt/ocframe.HTM)
- Lincoln Tunnel (http://www.panynj.gov/tbt/ltframe.HTM)
- Holland Tunnel (http://www.panynj.gov/tbt/htframe.HTM)

Except for the George Washington Bridge, which is part of I-95, none of the other facilities allow 53- foot trailers.

There is no indication on their web site that 53-foot trailers are not allowed on their facilities.

There is no central location where one can go to find all the regulations that pertain to trucks in New York City. Searching the Internet for Truck + Regulations + New + York + City yielded 28,200 references. As discussed above, there are four agencies that have separate truck regulations.

To illustrate the difficulty of finding information, an attempt was made to get information regarding the Triborough Bridge. First, one has to know the Triborough is part of the MTA. Then go to:http://www.mta.nyc.ny.us

Knowing that the Triborough is part of Bridges and Tunnels, click on About B&T yielding: http://www.mta.nyc.ny.us/bandt/html/btintro.htm

Then click on Triborough Bridge:
http://www.mta.nyc.ny.us/bandt/html/triboro.htm

Then click on Access Roads:
http://www.mta.nyc.ny.us/bandt/html/tribaccess.htm

This yields the following information.

Approach Roads to Triborough Bridge

Driving directions to reach the **Triborough Bridge** connecting the boroughs of Queens, Manhattan and the Bronx:

From Manhattan: Passenger cars (no commercial vehicles) may use the FDR Drive northbound or the southbound Harlem River Drive. All vehicles may use the local entrance to the bridge at 125th Street.

From Queens: Passenger cars (no commercial vehicles) may use the westbound Grand Central Parkway. All vehicles may use the local street Hoyt Avenue North entrance in Astoria.

From the Bronx: All vehicles may use the southbound Major Deegan Expressway (Route 87), Bruckner Expressway (Route 278), Bruckner Boulevard or the local street entrance at St. Ann's Place.

Nowhere in the Web site for the Triborough Bridge, is there an indication that the 102" wide by 53" long Special Dimension Vehicles are not allowed on the Triborough Bridge.

This process can be repeated for the other Bridges or for the facilities operated by the Port Authority of New York and New Jersey but at no time does the user have the assurances that one has found all the information necessary to know what and where the truck restrictions are in New York City.

6.1.4 Impact of the Restricted Truck Network

On June 19, 2001, representatives of the JFK Air Cargo Association and the Kennedy Airport Airline Managers Council (KAAMCO) Freight Committee submitted a letter to Alice Cheng of the New York City Economic Development Corporation. In their letter they made the point that the new cargo aircraft containers are eight (8) feet wide by ten (10) feet long. Because an 8-foot container cannot be placed in an 8-foot trailer, the 102-inch trailers are needed to carry these new containers. Furthermore, five containers can be carried in a 53-foot long trailer, not four, a 20% boost in productivity! The prohibition from allowing 53 foot, 102 inch wide trailers from operating on the Whitestone Bridge, Whitestone Expressway, Van Wyck Expressway, and the Nassau Expressway and in areas within a 5-mile radius of JFK is causing a problem for the freight industry at JFK. They indicated that the region's airports used to be responsible for 38% of all international cargo entering or leaving the United States. Currently that number is 23% and while there has been growth in air cargo at JFK it has not kept pace with national growth.

Jonathan Bowles [3] states that, “Continental Airlines, for example, doesn’t fly a single plane into Kennedy, but it sends much of the freight that comes into Newark-about 30 trucks a day-to JFK. But because no east-west highway to Kennedy through Brooklyn is open to commercial vehicles, trucks originating from Newark cannot take the most direct route to Kennedy, through Staten Island via the Verrazano Bridge and the Belt Parkway. Instead, most are forced to take a much longer route up the New Jersey Turnpike, across the George Washington Bridge, along the Cross Bronx Expressway and over the Whitestone Bridge, where they can finally get onto the crowded Van Wyck”.

6.1.5 Conclusions and Recommendations about Truck Dimensions

Based on this very brief review the following can be concluded:

- In their letter to Ms. Cheng, officials of the KAAMCO Cargo Committee and the JFK Air Cargo Association indicated that, “ In the past, the regions airports were responsible for 38 percent of all international cargo entering or leaving the United States, the same airports handle 23 percent of that traffic.” If we are to maintain our status as a major air cargo gateway we must consider that a portion of this decrease is due to poor access to commercial vehicles trying to serve JFK. Certainly, one of the biggest contributors to that problem is the restrictions on vehicles as it pertains to their length and width.”
- Jonathan Bowles [3] noted that, “ The lack of highway options for trucks is also under cutting one of the airport’s natural advantages: its network of experienced freight forwarders and custom brokers.” “ But because no east-west highway to Kennedy through Brooklyn is open to commercial vehicles, trucks originating from Newark cannot take the most direct route to Kennedy, through Staten Island via the Verrazano bridge and the Belt Parkway. Instead, most are forced to take a much longer route up the New Jersey Turnpike, across the George Washington Bridge, along the Cross- Bronx Expressway and over the Whitestone Bridge, where they finally get onto the crowded Van Wyck.”
- There is no central source of information on the truck restrictions and truck routes in New York City. Anyone trying to obtain information on this subject has to click down three or four levels in either New York State DOT’s or NYC DOT’s web page to find material related to the subject.

It is recommended that:

- A central clearinghouse be established where someone who desires information on bringing a truck into New York City can obtain all the information necessary regarding truck routes, truck restrictions, low vertical clearances and any other information that a driver might need to safely make a delivery in New York City in accordance with all the current rules.
- Serious consideration be given to expanding the routes on which the 53-foot long, 102-inch wide tractor-trailer can operate in New York City.

6.2 COMMERCIAL VEHICLES ON PARKWAYS

Approximately 280 lane miles of the limited access highway system in New York City are Parkways. The Parkway system is closed to vans, pick up trucks, panel trucks, and anything else registered as a commercial vehicle. If light commercial vehicles were allowed to use the Parkways, this would be roughly equivalent to an 88 % increase in the lane miles of limited access highways that could be used by commercial vehicles.

"Airlines, passengers and civic groups have been calling attention to the chronic congestion on the Van Wyck and the Belt Parkway-the main routes to Kennedy –for more than 20 years, but there have been no significant improvements." "Mounting traffic problems in Queens pose an even greater threat to the future of New York's air cargo industry, a sector of the city's economy that shouldn't be taken lightly-the cargo industry accounts for 44 percent of all the employment at Kennedy and 45 percent of the total wages earned at the airport. Because the Belt Parkway is closed to commercial traffic, the hundreds of trucks that drop off and pick up cargo shipments at Kennedy everyday are left with just one option, the crowded Van Wyck." [3]

Because of the congestion on the Van Wyck Expressway leading up to JFK, the participants at the Stakeholders Meetings suggested that small commercial vehicles, i.e., vans and pickup trucks, be allowed to operate on the Parkways. At their suggestion, the Study Team briefly reviewed the issue.

6.2.1 Possible Mitigating Solution

In January 2002, Jonathan Bowles of the Center for an Urban Future indicated that an option for reducing the congestion on the Van Wyck would be to "…open the Belt Parkway to a limited number of small commercial trucks, which would allow courier vans and small delivery trucks to use the Belt from the airport to Manhattan and Newark. This isn't a panacea, but it would provide much needed relief on the Van Wyck." The Port Authority has endorsed this plan and the New York State Department of Transportation (NYSDOT) is said to be supportive, but the city transportation officials have withheld their crucial support." [3]

The New York City Department of Transportation addressed this issue in their report, "Developing a Long Range Transportation Plan"[7]. The following is taken directly from that report:

> "Commercial vehicle trips have two characteristics in common.
>
> - They have a direct business-related purpose (other than normal commuting) that produces income for the vehicle owner or operator. As such, their volume is tangible evidence of the complex inter-relationship between economic activity and trip making. Some of these trips are generated by economic activity (a dress factory orders rolls of fabric to fill a hurry-up order for Macy's). Some produce economic activity (a sales presentation results in production orders that cause people to be hired and goods to be purchased from suppliers). And some fall into both categories (a service call to repair a broken air conditioner at a mainframe

computer installation is prompted by the need for the computer to process weekly payrolls for clients, and the repair requires the purchase of replacement parts).
- Because of their nature, it is not currently practical for these trips to be made by any mode other than motor vehicle. In most cases, public transportation is not a realistic option. If they are not made by motor vehicle, they cannot be made at all. And if they are not made, the economic activity that generates them or that they generate does not occur.

These two characteristics suggest that commercial trips may merit some degree of priority in allocating the use of highway lane space. This is especially true when there is not enough lane space for all trips that seek to use highways during a given period. Then it may be appropriate to displace trips that are not clearly commercial in order to free up space for those that are.

This concept represents a potential shift in the way street and arterial space is allocated. Roughly 47 percent of the city's limited access highways (i.e. all the parkways) are currently off-limits to vehicles bearing commercial license plates, and there is wide-spread sympathy for the periodic ground swells of public pressure to "ban trucks" from certain roadways during certain times of the day. The end result is to increase the time it takes to complete commercial vehicle trips. Since commercial trip costs are a direct function of trip times, higher transportation costs are added to the price of everything we buy and sell.

New York City's Transportation Plan should seriously evaluate a policy that assign priority for highway use to commercial vehicles during high demand periods. This would accelerate completion times for trips that directly impact economic activity and that can only be made by motor vehicles, which may be the most practical way to minimize the air pollution they generate.

Such a policy could be implemented in the following ways.

- The parkways would be opened to all commercial vehicles that can fit within present height constraints at overpasses (NYCDOT had proposed a pilot project to begin accomplishing this). Over time, the parkways would be reconstructed to eliminate these constraints so that they could eventually accommodate all commercial vehicles that can now use the expressways. This would expand the highway network for commercial vehicles by 88 percent (or 93 route miles) and eliminate such major gaps as the lack of an east/west highway for commercial vehicles across southern Brooklyn.

- Priority lanes on highways would be open to all vehicles bearing commercial license plates, rather than being limited only to buses and other high occupancy Passenger vehicles. On some highways, this might require establishing additional priority lanes to accommodate the volume of commercial vehicles without restricting the free flow of traffic in these lanes.

- Some highways would be reserved exclusively for commercial vehicles during high demand periods, with non-commercial vehicles being shifted to paralleling roadways. An example might be the Van Wyck Expressway between Northern Boulevard and the Nassau Expressway. Private automobiles making north/south trips across Queens could use the Cross-Island Parkway, the Grand Central Parkway, the Van Wyck's service roads, and Cross Bay/Woodhaven Boulevard. [*Project team note: these service roads are discontinuous which might be problematic.*]

- Some people argue that many goods movement trips within the city could be shifted from trucks to rail if better connections were available between the Booklyn/Queens/Long Island rail network and the rail networks north and west of the city. This issue needs to be evaluated seriously as part of developing a Long Range Transportation Plan for New York City. But two points should be kept in mind.

- There is no evidence as yet that better rail connections would significantly reduce the number of goods movement trips by motor vehicle. This is not to say that a major proportion of goods tonnage could not be moved by rail. But the number and distribution of individual pick-up and drop-off points for goods in the city implies the need for a truck component for each freight trip. The reality seems to be that the number of motor vehicle trips to move goods will remain high and be closely linked to the level of economic activity.

- For the most part, the other categories of commercial vehicle trips also cannot be shifted to rail. Therefore, the number of such trips will remain high and be closely linked to the level of economic activity.

All of which underscores the importance of recognizing the need to accommodate large potential increases in freight demand on the arterial system.

6.2.2 Findings and Recommendations Regarding Trucks on Parkways

It is readily apparent from the network analysis completed for this study and from the two reports cited above that the movement of goods to and from JFK and LaGuardia are being adversely affected by the congestion on the expressways in Queens. Furthermore, a significant portion of the air cargo affected consists of the higher value/lower volume commodities. This is cargo that could be transported in smaller vehicles and accommodated by the vertical clearances and pavement thickness on the parkways.

It is recommended that the New York State DOT continue the discussion with the City Department of Transportation regarding the use of small commercial vehicles on Parkways.

REFERENCES

[1] U.S. Department of Transportation, "Comprehensive Truck Size and Weight Study, Vol. 1, Summary Report", Publication Number: FHWA-PL-00-029 (Volume 1), HPTS/August 2000. (http://www.fhwa.dot.gov/reports/tswstudy/index.htm).

[2] Boyle, Susan, Transportation Alternatives, "Bicyclist Killed By Oversize Truck at 6th Ave. and 30th St." January 12, 1999.

[3] Bowles, Jonathan; "On a Wing and A Prayer", Center for an Urban Future, January 23, 2001. p. 8. (http://www.nycfuture.org/content/reports).

[4] Aztec Container, Storage container description, (http://www.azteccontainer.com/index2.htm).

[5] Canada Truck Reefer Container Service Ltd, Reefer Container description, (http://www.ctrc.qc.ca/hoe.htm).

[6] New York State Department of Transportation, *Official Description of Designated Qualifying and Access Highways in New York State*, Albany, NY, April 2001.

[7] New York City Department of Transportation, "Developing a Long Range Transportation Plan," December 1993, p. 90. (http://ntl.bts.gov/DOCS/lrp.html).

Chapter 7 – Conclusions and Recommendations

The purpose of this study was to consult for Region 11, NYSDOT to focus its planning efforts on freight-related actions. The Transportation Improvement Program (TIP) for New York City needs to more accurately reflect needs. The TIP is the list of projects approved for funding with federal monies, in this instance the New York Metropolitan Transportation Committee (NYMTC). The City's principle arterials are the major focus of the study, especially in the outer boroughs. The main question to be addressed: where would strategic investments in capacity, geometric improvements, and support services, such as Intelligent Transportation Systems (ITS), and changes in regulations affecting trucks and commercial vans have the greatest beneficial impacts on freight mobility.

To do this, the project team:

1) Accessed stakeholder needs;
2) Reviewed the previous studies focused on truck, rail, and other freight modes;
3) Located the freight-related problem spots on the arterial system (congestion, spillback, etc.);
4) Determined if the TIP contains projects that will correct or mitigate those problem spots;
5) Determined what the conditions will be in the future for freight mobility;
6) Identified potential solutions to the future problems;
7) Outlined several solution scenarios and evaluated benefits and costs; and
8) Developed preliminary consensus-based support among all stakeholders;
9) Assessed the impacts of the truck regulations on truck mobility; and
10) Explored issues related to allowing commercial vans using the parkways.

In general, the study concluded that:

- Opportunities exist to enhance the network and reduce truck delays
- Separation of truck and passenger car flows has value. Adding truckways in Brooklyn, Queens, and the lower end of the Bronx significantly alleviated congestion along adjacent corridors.
- Capital investment is needed to accommodate future growth in freight growth.
- Other goods movement issues need attention such as increasing truck curb space and local access.

7.1 STAKEHOLDER INPUT

The stakeholders wanted more attention to freight-related improvements within the TIP process. They wanted improvements in highway geometrics, better network connectivity (especially in certain spots like the connection from the Triborough Bridge to the Brooklyn-Queens Expressway), access to the parkways for commercial vans (especially for air cargo), and an easing of restrictions on truck length and width. Respondents in the 1979 NYMTC survey indicated they also wanted better lighting, better signage, more curb space for truck parking in commercial zones, and bigger loading areas. From an operating standpoint, they also asked for better parking enforcement (e.g., ticketing for double parking). In Chapter 2, the stakeholder needs pertaining to the city's arterial network were compared with the projects on the TIP. The conclusion was that many locations where freight-related network enhancements are needed were not addressed in the TIP.

The stakeholders at JFK Airport observed that there does not seem to be an appreciation for the condition of the air cargo and package industry in the City. Although JFK may appear to be thriving, and lacking for adequate warehousing space, in fact it is loosing ground to competitive airports and runs the risk of being usurped by other facilities in 50 or so years. Improvements they specifically requested were:

- Provide a new north-south route to the airport by extending the Clearview Expressway.
- Make further capacity improvements to the Van Wyck.
- Open the Belt Parkway and other parkways to small commercial vehicles.
- Create a new access to JFK from the Verrazano Bridge by using the LIRR right-of-way from Bay Bridge to Linden Boulevard, and then onto the Belt Parkway.
- Eliminate parking on the major city truck routes such as Linden Boulevard.

The Hunts Point Economic Development Corporation (HP-EDC) suggested several ways in which truck flows to and from Hunts Point could be improved and the area made safer while encouraging economic growth:

- Create a Hunts Point Truck Transportation Loop separate from the local streets.
- Develop a Hunts Point Color Coded Signage Plan. The signs should be highly visible and easy to follow for drivers unfamiliar with Hunts Point.
- Develop streetscaping along Hunts Point Avenue. This would increase safety for pedestrians and drivers and improve the quality of life. It would beatify the main roadway in the neighborhood.

- United Parcel Service (UPS) suggested that consideration should be given to increased use of off-street parking, special permits for freight carriers, development of truckways and other "special use" facilities, high-speed ferries for goods movement, improved incident management, more ITS on the arterials, and reserved parking locations for seasonal peaks.

7.2 PREVIOUS STUDIES

Previous studies, especially recent major efforts such as aligned with the comments from the stakeholders [1,2]. The reports that were reviewed (40+) urged the operating agencies to:

- Improve the city's local truck route network to facilitate the freight movement and patterns in neighborhoods with easier access to the main truck routes and bridges.
- Provide special, wider EZ-Pass toll lanes at the sides of the toll plazas, where physically feasible.

- Provide signage for the truck routes and directions to the through routes so that trucks do not use the local streets.
- Allow small commercial vehicles to use the parkways.
- Improve the signal timing and traffic controls on all roadways that lead to the entrances of major traffic generators.
- Use ITS technology to manage (by appointment or pricing) commercial parking spaces in the highly congested New York central business district.
- Review and revise the City's parking policies to take advantage of today's metering and enforcement technology.
- Create a new truck route in Brooklyn.
- Have trucks operate off-peak (e.g., at night)
- Add a third lane at the interchange of the Van Wyck Expressway, Jackie Robinson Parkway and the Grand Central Parkway.
- Use the existing trolley tunnel under the intersection under Ocean Parkway, Prospect Expressway, and NY Route 27, for through traffic.
- Improve the interchanges at Cross Bay Boulevard, Linden Boulevard, Belt Parkway, Conduit Avenue, and Nassau Expressway, including sign and guard rail replacements.
- Ensure better coordination between the port- and land-sides improvement projects.
- Remove curb parking along sections of Linden Boulevard to facilitate truck movement to and from warehouses adjacent JFK airport.
- Review curb regulations in area of heavy truck activity, with a view toward expanding truck loading zones, and creating additional on-street parking for trucks.
- Issue E-Z Passes at the tolled crossings to all commercial vehicles that regularly conduct business in the metropolitan area.
- Use ITS technology to provide drivers with up to date information on traffic conditions.
- Increase the use of rail to move freight across the Hudson River.
- Revitalize the Oak Point Link, the intermodal facility at Harlem River Yard, the Staten Island Railway, and Arlington Yard.
- Increase the railcar clearances along the Hudson River Line so that double-stack and TOFC cars can reach the Bronx from Albany.
- Create an intermodal terminal and a bulk transfer facility at Harlem River Yard.
- Find a way whereby rail freight traffic is less in conflict with the busy commuter lines.
- Provide a new rail freight yard (65th Street Rail yard) in Brooklyn. Give it access to the Long Island Rail Road and car float connections to New Jersey.
- Provide information systems that facilitate the handling of intermodal traffic.

7.3 PRESENT AND FUTURE CONDITIONS

A network capacity investment model was developed to examine future and present conditions affirmed that the current network is congested. Chapter 4 discusses the findings in detail. One can see that there are heavy truck flows on all the major freeways, like the Gowanus, BQE, LIE, and Cross Bronx Expressway.

The model's assessment of future conditions is that strategic, highly-focused network enhancements will be needed to accommodate truck traffic growth, even with a new rail tunnel under the Hudson River.

The year 2025 was selected as the horizon year for analysis purposes. This is consistent with the horizon year being used in many other current highway investment studies.

A group of Year 2025 scenarios was identified and investigated to determine the impacts on the network and the enhancement actions needed to mitigate those impacts. The following five scenarios were examined because they offer a wide range of options:

- S1: The existing Transportation Improvement Plan (TIP) / projects currently programmed
- S2: Add to S1:
    - Cross-harbor rail tunnel (from Brooklyn to either Staten Island or New Jersey)
    - Additional intermodal facilities at Maspeth, Fresh Pond, and the Pilgrim site
    - Full interchange at 39th Street on the Gowanus
    - Direct connection to Hunts Point from the Bruckner
    - Direct connection to the Harlem River Yard from the Bruckner
    - Connection from 65th Street Yard to the Gowanus
- S3: Add to S2:
    - New truckways: Verazzano to both Nassau Expressway and the LIE
    - Grand Central Parkway open to trucks (Triborough to BQE)
- S4: Add to S3:
    - Truckway from LIE across the Hell Gate Bridge to Harlem River Yard
    - Clearview Expressway extension
- S5: Add to S4:
    - Truck tunnel under the Hudson River

Scenario S1 reflects the existing TIP. It includes all projects presently slated for funding, all of which will be finished by Year 2025.

Scenario S2 adds to S1 other projects that are presently under serious consideration for funding. They have been proposed and have been given significant stakeholder support. The most significant of these are the cross-harbor rail tunnel, additional intermodal facilities at Maspeth, Fresh Pond and the Pilgrim site; locations that would be natural intermodal yards assuming the cross-harbor tunnel is constructed. In addition, two direct connections to the freeway network are assumed, one from Hunts Point to the Bruckner, the other is from Harlem River Yard to the Bruckner.

Scenario S3 adds to S2 network enhancements that have been proposed but are not yet clearly in the pipeline. Two of the most important are a reconfiguration of the Grand Central Parkway between the Triborough Bridge and the BQE, concomitant lifting of truck prohibitions on that section of the GCP, and a new truckway network in Brooklyn. The truckway network would have three sections. A picture of the network can be found in Chapter 5, Figure 5.4. The first section would run from the Verazzano Narrows Bridge to Linden Boulevard along the LIRR Bay Ridge Line. The second would run from Linden Boulevard north to the LIE, again along the Bay

Ridge Line, with an interchange at Atlantic Avenue. The third would run from the Bay Ridge Line at Linden Boulevard to the Nassau Expressway, along an alignment that parallels Linden Boulevard.

Scenario S4 adds three more "blue sky" ideas to S3. These facilities might significantly decrease truck traffic on the more heavily congested facilities in Brooklyn and Queens. The first would be a new truckway that follows the LIRR right of way north from the LIE (where the truckway in S2 ends), across the Hell Gate Bridge, to the Bruckner. Pictures of this truckway can be found in Chapter 5, Figure 5.6 . There would be ramp connections to the BQE. On the north side of the Hell Gate, the truckway would ramp around under the Hell Gate Bridge and end in Harlem River Yard. It could be that other, better ways to tie the truckway to the Bruckner might be found if a more detailed engineering study was conducted. We were not concerned with that level of detail. We only wanted to see if such a facility would be used if it existed. The second new facility would be an extension of the Clearview Expressway. A picture of where this might be is shown in Chapter 5, Figure 5.7. This would provide a relief route for the Van Wyck.

Scenario S5 adds a truck tunnel under the Hudson River that parallels the rail tunnel included in scenario S2. This idea was proposed at one juncture as part of the rail tunnel construction project. Presently, it has been set aside, but it would provide relief for the bridges and tunnels that presently cross the Hudson and at some juncture, it might be built.

Chapter 5 presents the findings from these investigations. The use of truckways in Brooklyn in Scenarios S3 and S4 is very evident. Most notable of all the changes is the major decrease in S4 of the use of the Gowanus, BQE, LIE, GCP, and Triborough Bridge when the whole Brooklyn-Queens-Bronx truckway exists. There is an overall decrease in total truck-miles and total truck-hours, but that is not the major point. Rather, the truck volumes have been shifted off facilities heavily used for other trips in the City onto facilities especially for trucks so that the congestion on those other facilities is reduced and their operation is improved.

It is important to note that the model is being made available to Region 11. This helps ensure that Region 11 will be able to analyze other scenarios in the future. Undoubtedly, many more will emerge as more inputs are received from the stakeholder community and other studies identify additional options.

7.4 NON-CAPITAL MEASURES

Responding to clear inputs from the stakeholders, two additional issues were investigated as part of the study:

- Geometric restrictions on truck use (e.g., 53 ft trailers)
- Commercial vehicles on parkways

The review of the truck restrictions led to the following conclusions:

- The restrictions on the use of the 53 foot long, 102 inch wide tractor-trailer in New York City are having a negative impact on the ability of the air cargo shippers at JFK to maintain their share of the air freight entering or leaving the United States resulting in the lost of jobs and other economic related activities.
- The absence of an east-west corridor for truck traffic through Brooklyn results in truck freight taking a longer and more circuitous route.
- There is no central source of information on the truck restrictions and truck routes in New York City. Anyone trying to obtain information on this subject has to click down three or four levels in either New York State DOT's or NYC DOT's web page to find material related to the subject.

The review of the use of parkways by commercial vans led to the conclusion, as before in other studies, that the movement of goods to and from JFK and LaGuardia is being adversely affected by the congestion on the expressways in Brooklyn and Queens. Furthermore, a significant portion of the air cargo affected is high in value and low in weight. Hence, this cargo could easily be transported in vans that fit within the restrictions for vertical clearances and pavement thickness that exist on the parkways.

7.5 RECOMMENDATIONS

The following conclusions and recommendations have resulted from the study.

It is recommended that:

- The Internet (www) support for truck operations and provision of goods movement information needs to be improved dramatically.
- Small commercial vehicles should be allowed on parkways as a pilot program with one or two corridors initially selected.
- The construction of truckways and special use lanes should receive serious citywide consideration. This study was limited to assessing the value of these facilities in Brooklyn, Queens, and the lower portions of the Bronx. Based on that assessment, there is merit to examining the use of truckways and special use lanes on a more general basis. Additional planning studies that relate to truckways (e.g., in Brooklyn, Queens) should be added to the TIP for funding.
- Extensive diversion of cross-Hudson truck trips to rail should be encouraged along with the use of intermodal facilities.
- Dedicated connections to major freight complexes from the expressway network should be constructed so that trucks do not have to use local city streets.
- Large-scale freight activities should be encouraged to concentrated in strategic locations like Hunts Point, Maspeth, Harlem River Yard, Fresh Pond, and the Pilgrim site so that high-quality highway facilities can be provided economically to support these operations.
- Regulatory policies regarding truck size and curbside access restrictions should be reviewed and revised.
- Redevelopment plans for lower Manhattan should include goods movement accessibility features and office support services.

- The list of truck geometric restrictions in the City should be updated and a program to eliminate or mitigate these restrictions should be initiated.
- A central clearinghouse be established where someone who desires information on bringing a truck into New York City can obtain all the information necessary regarding truck routes, truck restrictions, low vertical clearances and any other information that a driver might need to safety make a delivery in New York City in accordance with all the current rules.
- Expand the routes on which the 53-foot long, 102-inch wide tractor-trailers can operate in New York City.

REFERENCES

[1] Edwards and Kelcey, *Cross Harbor Freight Movement Major Investment Study, Final Report,* prepared for the New York City Economic Development Corporation, May, 2000.

[2] Cambridge Systematics, Inc., *NYMTC Regional Freight Plan: Task 5- Preliminary Identification of Improvements and Solutions*, prepared for New York Metropolitan Transportation Council, January, 2002.

Appendix A

Support for Chapter 2 Figures

Support for Figure 2.3

NYMTC Truck Terminals and Warehouses Inventory

Freight Transportation Project
NYS Department of Transportation, Region 11

NYMTC Truck Terminals and Warehouses Inventory

UTRC, Polytechnic University

ID	FACILITY	ADDRESS	CITY	STATE	ZIP
1	Manhattan Beer Distributors	400 Walnut Ave	Bronx	NY	10454
2	Browning Ferries industries of New York	910 East 138th St	Bronx	NY	10454
3	Stuyvesant Fuel Terminal Co	1040 East 149th St	Bronx	NY	10455
4	J. Santini & Bros Inc.	932 Southern Blvd	Bronx	NY	10459
5	Dun-Rite Movers Inc.	1546 Minford Pl	Bronx	NY	10460
6	Health Care Waste Services	3499 Rombouts Ave	Bronx	NY	10475
7	J C Duggan	320 Maspeth Ave	Brooklyn	NY	11201
8	Globe Storage and Moving Co. Inc	84 Hudson Ave	Brooklyn	NY	11201
9	Nick's Moving and Storage Co, Inc	5621 20th Ave	Brooklyn	NY	11204
10	Hall Street Cold Storage Warehouses Inc.	12-38 Hall St	Brooklyn	NY	11205
11	VM Trucking Co., Inc	Brooklyn Navy Yard, Bldg # 62,	Brooklyn	NY	11205
12	Rapid Armored Corp.	254 Scholes St	Brooklyn	NY	11206
13	Globe Storage and Moving Co. Inc	7 Rewe St	Brooklyn	NY	11211
14	Rizzo Truck Inc.	91 N. 5th St	Brooklyn	NY	11211
15	Consolidated Freightways	11 West St	Brooklyn	NY	11222
16	Samuel Feldman Lumber Co. Inc	300 N. Henry St	Brooklyn	NY	11222
17	Cornell Paper and Box Inc	162 Van Dyke St	Brooklyn	NY	11231
18	Van Brunt Stores (Warehouse)	480 Van Brunt St	Brooklyn	NY	11231
19	Tai Wing Hong Importer, Inc	1300 Metropolitan Ave	Brooklyn	NY	11237
20	T.C. Lee Distributors	1029 Dean St	Brooklyn	NY	11238
21	Globe Storage and Moving Co. Inc	36 Bleecker St	New York	NY	10012
22	Sun Warehouses Inc	79-101 Laight St	New York	NY	10013
23	J.A.G. Freight Systems Inc.	339 West 36th St	New York	NY	10018
24	Walton Hauling and Warehouse Corporation	609 West 46th St	New York	NY	10036
25	Endo Freight Forwarders	21-17 37th Ave	Long Island City	NY	11101
26	Steinway Van and Storage Corp	4245 12th St	Long Island City	NY	11101
27	LIC Trucking Corp.	5200 2nd St	Long Island City	NY	11101
28	Charmer Industries, Inc	1950 48th St	Astoria	NY	11105

29	United States Postal Service	142-02 20th Ave	Flushing	NY	11351
30	Jetro Cash and Carry	15-06 132nd St	College Point	NY	11356
31	JJT Trucking Corp.	35 Willets Point Blvd.	Corona	NY	11368
32	Century Worldwide Moving Inc.	34-02 Laurel Hill Blvd.	Maspeth	NY	11378
33	New York City Transit	55-04 Maspeth Ave	Maspeth	NY	11378
34	Route Messenger Services, Inc.	58-77 Maurice Ave	Maspeth	NY	11378
35	Hi-Way Trucking	12709 91st Ave	Richmond Hill	NY	11418
36	United States Postal Service -NY Intl Bl	JFK Intl Airport	Jamaica	NY	11430
37	Coty Enterprise Ltd.	600 Richmond Terr	Staten Island	NY	10301
38	Dolan Transportation Services, Inc	2351 Richmond Terr	Staten Island	NY	10302

Source: Truck Terminals and Warehouse survey results, NYMTC 1999

Support for Figure 2.4

Major stations and distributions centers for the three major carriers: United States Postal Service (USPS), Federal Express (FedEx), and United Parcel Service (UPS)

Freight Transportation Project
NYS Department of Transportation, Region 11

United Parcel Services (UPS) Major Centers

UTRC, Polytechnic University

ID	FACILITY	ADDRESS	CITY	STATE	ZIP
1	UPS 43rd Street Hub	643 West 43rd Street	New York	NY	10036
2	Foster Avenue Terminal	10400 Foster Avenue	Brooklyn	NY	11230
3	Maspeth Hub	46-05 56th Road	Maspeth	NY	11378
4	Laurelton Hub	132-20 Merrick Boulevard	Springfield	NY	11413

Source: UPS main facilities, NYMTC terminal and warehouses inventories, 1999.

Freight Transportation Project
NYS Department of Transportation, Region 11

FedEx Stations and Major Distribution Centers

UTRC, Polytechnic University

ID	FACILITY	ADDRESS	CITY	STATE	ZIP
1	Station	51 20th St	Brooklyn	NY	11232
2	Station	570 East 108th St	Brooklyn	NY	11236
3	Station	537 W 33rd St	New York	NY	10001
4	Station	20 E 20th St	New York	NY	10003
5	Station	110 Wall St	New York	NY	10005
6	Station	130 Leroy St	New York	NY	10014
7	Ramp	40 Houston St. and 12th Ave	New York	NY	10014
8	Station	Pier 40 West Side HWY	New York	NY	10014
9	Station	149 Madison Ave	New York	NY	10016
10	Station	480 Lexington Ave	New York	NY	10017
11	Station	135 W 50th St	New York	NY	10020
12	Station	880 Third Ave	New York	NY	10022
13	Station	560 W 42nd St	New York	NY	10036
14	Station	58-95 Maurice Ave	Maspeth	NY	11378
15	Ramp	Cargo Bldg 262	Jamaica	NY	11430
16	Station	2400 Richmond Ter	Staten Island	NY	10302

Source: Federal Express Facilities, 2000

United States Postal Services Stations and Distribution Centers

UTRC, Polytechnic University

ID	FACILITY	ADDRESS	CITY	STATE	ZIP
1	GENERAL POST OFFICE	558 GRAND CONCOURSE	BRONX	NY	10451
2	HIGH BRIDGE	1315 INWOOD AVE	BRONX	NY	10452
3	UNIVERSITY HEIGHT	1541 SHAKESPEARE	BRONX	NY	10452
4	MORRIS HEIGHTS	2024 JEROME AVE	BRONX	NY	10453
5	EAST SIDE PARCEL POST	500 East 132nd St	BRONX	NY	10454
6	MOTT HAVEN	517 E 139TH ST	BRONX	NY	10454
7	HUB	633 ST ANN'S AVE	BRONX	NY	10455
8	MORRISANIA	442 E 167TH ST	BRONX	NY	10456
9	TREMONT	575 EAST TREMONT AVE	BRONX	NY	10457
10	FORDHAM	465 E 188TH ST	BRONX	NY	10458
11	BOULEVARD	1132 SOUTHERN BLVD	BRONX	NY	10459
12	WEST FARM	362 DEVOE AVE	BRONX	NY	10460
13	WESTCHESTER	2619 PONTON AVE	BRONX	NY	10461
14	PARKCHESTER	1449 WEST AVE	BRONX	NY	10462
15	KINGSBRIDGE	5517 BROADWAY	BRONX	NY	10463
16	CITY ISLAND	199 CITY ISLAND AVE	BRONX	NY	10464
17	THROGS NECK	3630 E TREMONT AVE	BRONX	NY	10465
18	BRONX HASP	815 HUTCHINSON RIVER PKWY	BRONX	NY	10465
19	WAKEFIELD	4165 WHITE PLAINS RD	BRONX	NY	10466
20	WILLIAMSBRIDGE	711 E GUNHILL RD	BRONX	NY	10467
21	JEROME AVE	2549 JEROME AVE	BRONX	NY	10468
22	BAYCHESTER	1525 EAST GUNHILL RD	BRONX	NY	10469
23	WOODLAWN	4364 KATONAH AVE	BRONX	NY	10470
24	RIVERDALE	5951 RIVERDALE AVE	BRONX	NY	10471
25	SOUNDVIEW	1687 GLEASON AVE	BRONX	NY	10472
26	CORNELL	1950 LAFAYETTE AVE	BRONX	NY	10473
27	CO-OP CITY	3300 CONNER ST	BRONX	NY	10475
28	GENERAL POST OFFICE	271 CADMAN PLAZA EAST	BROOKLYN	NY	11201
29	RUGBY	726 UTICA AVE	BROOKLYN	NY	11203
30	PARKVILLE	6618 20TH AVE	BROOKLYN	NY	11204
31	PRATT	524 MYRTLE AVE	BROOKLYN	NY	11205
32	METROPOLITAN	47 DEBEVOISE ST	BROOKLYN	NY	11206
33	EAST NEW YORK	2645 ATLANTIC AVE	BROOKLYN	NY	11207
34	NEW LOTS	12231 SUTTER AVE	BROOKLYN	NY	11208
35	FT HAMILTON	8801 5TH AVE	BROOKLYN	NY	11209
36	VANDERVEER	2319 NOSTRAND AVE	BROOKLYN	NY	11210
37	WILLIAMSBURG	263 S 4TH ST	BROOKLYN	NY	11211
38	BROWNSVILLE	167TH BRISTOL ST	BROOKLYN	NY	11212
39	ST JOHNS	1234 ST JOHNS PL	BROOKLYN	NY	11213

40	BATH BEACH	1865 BENSON AVE	BROOKLYN	NY	11214
41	VAN BRUNT	275 9TH ST	BROOKLYN	NY	11215
42	BREVOORT	1205 ATLANTIC AVE	BROOKLYN	NY	11216
43	TIMES PLAZA	542 ATLANTIC AVE	BROOKLYN	NY	11217
44	KENSINGTON	419 MCDONALD AVE	BROOKLYN	NY	11218
45	BLYTHBOURNE	1200 51ST ST	BROOKLYN	NY	11219
46	BAY RIDGE	5501 7TH AVE	BROOKLYN	NY	11220
47	BUSHWICK	47 DEBEVOISE ST	BROOKLYN	NY	11221
48	GREEN POINT	66 MESEROLE AVE	BROOKLYN	NY	11222
49	GRAVESEND	344 AVENUE U	BROOKLYN	NY	11223
50	CONEY ISLAND	2727 MERMAID AVE	BROOKLYN	NY	11224
51	LEFFERTS	315 EMPIRE BLVD	BROOKLYN	NY	11225
52	FLATBUSH	2273 CHURCH AVE	BROOKLYN	NY	11226
53	DYKER HEIGHTS	8320 13TH AVE	BROOKLYN	NY	11228
54	HOMECREST	2370 E 19TH ST	BROOKLYN	NY	11229
55	MIDWOOD	1288 CONEY ISLAND AVE	BROOKLYN	NY	11230
56	RED HOOK	615 CLINTON ST	BROOKLYN	NY	11231
57	BUSH TERMINAL	824 3RD AVE	BROOKLYN	NY	11232
58	STUYVESANT	1915 FULTON ST	BROOKLYN	NY	11233
59	RYDER	1739 E 45TH ST	BROOKLYN	NY	11234
60	BAY STATION	2628 E 18TH ST	BROOKLYN	NY	11235
61	CANARSIE	102-01 FLATLANDS AVE	BROOKLYN	NY	11236
62	WYCKOFF HEIGHTS	86 WYCKOFF AVE	BROOKLYN	NY	11237
63	ADELPHI	950 FULTON ST	BROOKLYN	NY	11238
64	CANARSIE	102-01 FLATLANDS AVE	BROOKLYN	NY	11239
65	MORGAN STATION	341 9TH AVE	NEW YORK	NY	10001
66	JAMES FARLEY	421 8TH AVE	NEW YORK	NY	10001
67	KNICKERBOCKER	128 E BROADWAY	NEW YORK	NY	10002
68	COOPER	93 4TH AVE	NEW YORK	NY	10003
69	BOWLLING GREEN	25 BROADWAY	NEW YORK	NY	10004
70	WALL STREET	73 PINE ST	NEW YORK	NY	10005
71	CHURCH ST STATION	90 CHURCH ST	NEW YORK	NY	10007
72	PETER STUYVESANT	432 E 14TH ST	NEW YORK	NY	10009
73	MADISON SQUARE	149 E 23RD ST	NEW YORK	NY	10010
74	OLD CHELSEA	217 W 18TH ST	NEW YORK	NY	10011
75	PRINCE	103 CANAL ST	NEW YORK	NY	10012
76	CANAL STREET	350 CANAL ST	NEW YORK	NY	10013
77	VILLAGE	201 VARICK ST	NEW YORK	NY	10014
78	MURRARY HILL	115 E 34TH ST	NEW YORK	NY	10016
79	GRAND CENTRAL	450 LEXINGTON AVE	NEW YORK	NY	10017
80	MIDTOWN	221 W 38TH ST	NEW YORK	NY	10018
81	RADIO CITY	322 W 52ND ST	NEW YORK	NY	10019
82	ROCKEFELLER CTR.	610 5TH AVE	NEW YORK	NY	10020
83	LENOX HILL	217 E 70TH ST	NEW YORK	NY	10021

84	F.D.ROOSEVELT STATION	909 3RD AVE	NEW YORK	NY	10022
85	ANSONIA	1990 BROADWAY	NEW YORK	NY	10023
86	PLANETARIUM	127 W 83RD ST	NEW YORK	NY	10024
87	CATHEDRAL	215 W 104TH ST	NEW YORK	NY	10025
88	MORNINGSIDE	232 W 116TH ST	NEW YORK	NY	10026
89	MANHATTANVILLE	365 W 125TH ST	NEW YORK	NY	10027
90	GRACIE	229 E 85TH ST	NEW YORK	NY	10028
91	HELL GATE	153 E 110TH ST	NEW YORK	NY	10029
92	COLLEGE	217 W 140TH ST	NEW YORK	NY	10030
93	HAMILTON GRANGE	521 W 146TH ST	NEW YORK	NY	10031
94	AUDUBON	515 W 165TH ST	NEW YORK	NY	10032
95	WASHINGTON BRIDGE	555 W 180TH ST	NEW YORK	NY	10033
96	INWOOD	90 VERMILYEA AVE	NEW YORK	NY	10034
97	TRIBOROUGH	167 E 124TH ST	NEW YORK	NY	10035
98	TIMES SQUARE	340 W 42ND ST	NEW YORK	NY	10036
99	LINCOLNTON	2266 5TH AVE	NEW YORK	NY	10037
100	PECK SLIP	1 PECK SLIP	NEW YORK	NY	10038
101	COLONIAL PARK	99 MACOMBS PL	NEW YORK	NY	10039
102	FORT GEORGE	4558 BROADWAY	NEW YORK	NY	10040
103	BUILDING	55 WATER ST	NEW YORK	NY	10041
104	ISLAND	694 MAIN ST	NEW YORK	NY	10044
105	BUILDING	WORLD TRADE CTR	NEW YORK	NY	10048
106	PARK AVE PLAZA BLDG	55 E 52ND ST	NEW YORK	NY	10055
107	TISHMAN BLDG	666 5TH AVE	NEW YORK	NY	10103
108	BUILDING	1290 AVENUE OF THE AMERICA	NEW YORK	NY	10104
109	BURLINGTON BLDG	1345 AVENUE OF THE AMERICAS	NEW YORK	NY	10105
110	BUILDING	888 FASHION AVE	NEW YORK	NY	10106
111	FISK BLDG	250 W 57TH ST	NEW YORK	NY	10107
112	BUILDING	500 5TH AVE	NEW YORK	NY	10110
113	INTERNATIONAL BLDG	630 5TH AVE	NEW YORK	NY	10111
114	GENERAL ELECTRIC BLDG	30 ROCKEFELLER PLAZA	NEW YORK	NY	10112
115	BUILDING	475 RIVERSIDE DR	NEW YORK	NY	10115
116	EMPIRE STATE BLDG	350 5TH AVE	NEW YORK	NY	10118
117	BUILDING	1 PENN PLAZA	NEW YORK	NY	10119
118	BUILDING	112 W 34TH ST	NEW YORK	NY	10120
119	BUILDING	2 PENN PLAZA	NEW YORK	NY	10121
120	PENNSYLVANIA BLDG	225 W 34TH ST	NEW YORK	NY	10122
121	BUILDING	450 FASHION AVE	NEW YORK	NY	10123
122	BUILDING	745 5TH AVE	NEW YORK	NY	10151
123	SEAGRAM BLDG	375 PARK AVE	NEW YORK	NY	10152
124	GENERAL MOTORS BLDG	767 5TH AVE	NEW YORK	NY	10153
125	BRISTOL MYERS BLDG	345 PARK AVE	NEW YORK	NY	10154
126	ARCHITECT & DESIGN BLDG	964 3RD AVE	NEW YORK	NY	10155
127	BUILDING	605 3RD AVE	NEW YORK	NY	10158

128	PAVILION	500 E 77TH ST	NEW YORK	NY	10162
129	LINCOLN BLDG	60 E 42ND ST	NEW YORK	NY	10165
130	MET LIFE BLDG	200 PARK AVE	NEW YORK	NY	10166
131	BEAR STEARNS BLDG	245 PARK AVE	NEW YORK	NY	10167
132	CHANIN BLDG	122 E 42ND ST	NEW YORK	NY	10168
133	HELMSLEY BLDG	230 PARK AVE	NEW YORK	NY	10169
134	GRAYBAR BLDG	420 LEXINGTON AVE	NEW YORK	NY	10170
135	WEST VACO BLDG	299 PARK AVE	NEW YORK	NY	10171
136	CHEMICAL BANK BLDG	277 PARK AVE	NEW YORK	NY	10172
137	BUILDING	342 MADISON AVE	NEW YORK	NY	10173
138	CHRYSLER BLDG	405 LEXINGTON AVE	NEW YORK	NY	10174
139	BUILDING	521 5TH AVE	NEW YORK	NY	10175
140	FRENCH BLDG	551 5TH AVE	NEW YORK	NY	10176
141	MARINE MIDLAND BLDG	250 PARK AVE	NEW YORK	NY	10177
142	BUILDING	101 PARK AVE	NEW YORK	NY	10178
143	J.A. FARLEY	8TH AVE & 33 ST	NEW YORK	NY	10199
144	AMERICAN INT'L GROUP BLDG	70 PINE ST	NEW YORK	NY	10270
145	BUILDING	120 BROADWAY	NEW YORK	NY	10271
146	BUILDING	26 FEDERAL PLAZA	NEW YORK	NY	10278
147	WOOLWORTH BLDG	233 BROADWAY	NEW YORK	NY	10279
148	BUILDING	WORLD FINANCIAL CTR	NEW YORK	NY	10281
149	FLORAL PARK MAIN P.O.	35 TULIP AVE	FLORAL PARK	NY	11001
150	GLEN OAKS STATION	256-29 UNION TPKE	FLORAL PARK	NY	11004
151	INWOOD	143 DOUGHTY BLVD	FAR ROCKAWAY	NY	11096
152	PLAZA	24-18 QUEENS PLAZA S	LONG ISLAND CITY	NY	11101
153	LIC PARCEL POSTAL	43-10 10TH ST	LONG ISLAND CITY	NY	11101
154	LIC MAIN P.O.	46-02 21ST ST	LONG ISLAND CITY	NY	11101
155	AUTOMATIC MAILERS	47-00 34TH ST	LONG ISLAND CITY	NY	11101
156	ASTORIA	27-40 21ST ST	ASTORIA	NY	11102
157	STEINWAY ST STATION	43-04 BROADWAY	ASTORIA	NY	11103
158	GRAND	45-08 30TH AVE	ASTORIA	NY	11103
159	SUNNYSIDE	45-15 44TH ST	SUNNYSIDE	NY	11104
160	WOOLSEY	22-68 31ST ST	ASTORIA	NY	11105
161	BROADWAY	212-17 BROADWAY	LONG ISLAND CITY	NY	11106
162	QUEENS GMF	142-02 20TH AVE	FLUSHING	NY	11351
163	LINDEN HILL	29-50 UNION ST	FLUSHING	NY	11354
164	FLUSHING MAIN P.O.	41-65 MAIN ST	FLUSHING	NY	11355
165	COLLEGE POINT	120-07 15TH AVE	COLLEGE POINT	NY	11356
166	WHITESTONE	14-44 150TH ST	WHITESTONE	NY	11357
167	STATION A	40-03 164TH ST	FLUSHING	NY	11358
168	BAY TERRACE	212-71 26TH AVE	BAYSIDE	NY	11360
169	BAYSIDE MAIN P.O.	212-35 42ND AVE	BAYSIDE	NY	11361
170	HORACE HARDING	5601 MARATHON PKWY	LITTLE NECK	NY	11362
171	LITTLE NECK	250-10 NORTHERN BLVD	DOUGLASTON	NY	11363

172	OAKLAND GARDENS	61-43 SPRINGFIELD BLVD	OAKLAND GARDENS	NY	11364
173	POMONOK STATION	15805 71ST AVE	FRESH MEADOWS	NY	11365
174	FRESH MEADOWS	192-20 HARDING EXPWY	FRESH MEADOWS	NY	11365
175	UTOPIA STATION	18204 UNION TPKE	UTOPIA	NY	11366
176	STATION C	75-23 MAIN ST	FLUSHING	NY	11367
177	CORONA—"A"	103-28 ROOSEVELT AVE	FLUSHING	NY	11368
178	EAST ELMHURST	91-07 25TH AVE	EAST ELMHURST	NY	11369
179	TRAINSMEADOW	75-77 31ST AVE	FLUSHING	NY	11370
180	AMF LA GUARDIA STATION	MAIN TERMINAL, LA GUARDIA AIRPORT	FLUSHING	NY	11371
181	JUNCTION BLVD	3323 JUNCTION BLVD	JACKSON HEIGHTS	NY	11372
182	JACKSON HEIGHTS	78-02 37TH AVE	JACKSON HEIGHTS	NY	11372
183	CORONA-ELMHURST	59-01 JUNCTION BLVD	ELMHURST	NY	11373
184	ELMHURST—"A"	80-27 BROADWAY	ELMHURST	NY	11373
185	REGO PARK	89-12 ELIOT AVE	REGO PARK	NY	11374
186	REGO PARK	92-24 QUEENS BLVD	REGO PARK	NY	11374
187	PARKSIDE STATION	10119 METROPOLITAN AVE	FOREST HILLS	NY	11375
188	FOREST HILLS	106-28 QUEENS BLVD	FOREST HILLS	NY	11375
189	WOODSIDE	39-25 61ST ST	WOODSIDE	NY	11377
190	MASPETH	55-02 69TH ST	MASPETH	NY	11378
191	MIDDLE VILLAGE	71-34 METROPOLITAN AVE	MIDDLE VILLAGE	NY	11379
192	RIDGEWOOD	6060 MYRTLE AVE	GLENDALE	NY	11385
193	FRESH POND STATION	6080 WOODBINE ST	GLENDALE	NY	11385
194	GLENDALE STATION	6936 MYRTLE AVE	GLENDALE	NY	11385
195	CAMBRIA HEIGHTS	229-01 LINDEN BLVD	JAMAICA	NY	11411
196	ST ALBANS	195-04 LINDEN BLVD	ST ALBANS	NY	11412
197	SPRINGFIELD GARDENS	218-10 MERRICK RD	SPRINGFIELD GARDENS	NY	11413
198	B STATION	102-12 159TH AVE	HOWARD BEACH	NY	11414
199	HOWARD BEACH	160-50 CROSSBAY BLVD	HOWARD BEACH	NY	11414
200	KEW GARDENS	83-30 AUSTIN ST	KEW GARDENS	NY	11415
201	OZONE PARK	91-11 LIBERTY AVE	OZONE PARK	NY	11417
202	N RICHMOND HILL	122-01 JAMAICA AVE	RICHMOND HILL	NY	11418
203	S RICHMOND HILL	177-04 101ST AVE	S RICHMOND HILL	NY	11419
204	S OZONE PARK	126-15 FOCH BLVD	S OZONE PARK	NY	11420
205	WOODHAVEN	86-42 FOREST PKWY	WOODHAVEN	NY	11421
206	ROSEDALE	145-06 243rd St	ROSEDALE	NY	11422
207	HOLLIS	197-40 JAMAICA AVE	HOLLIS	NY	11423
208	BOROUGH HALL	120-55 QUEENS BLVD	KEW GARDENS	NY	11424
209	BELLROSE	237-15 BRADDOCK AVE	BELLROSE	NY	11426
210	QUEENS VILLAGE	209-20 JAMAICA AVE	QUEENS VILLAGE	NY	11428
211	JFK AMC	BUILDING 250 N BOUNDARY RD	JAMAICA	NY	11430
212	JAMAICA POSTMASTER	88-40 164th St	JAMAICA	NY	11431

213	JAMAICA MAIN P.O.	88-40 164th St	JAMAICA	NY	11432
214	ROCHDALE VILLAGE	165-100 BAISLEY BLVD	ROCHDALE VILLAGE	NY	11434
215	ARCHER AVE STATION	147-21 ARCHER AVE	JAMAICA	NY	11435
216	FAR ROCKAWAY MAIN P.O.	18-36 MOTT AVE	FAR ROCKAWAY	NY	11691
217	ARVERNE	329 BEACH 59TH ST	FAR ROCKAWAY	NY	11692
218	BROAD CHANNEL	724 CROSS BAY BLVD	FAR ROCKAWAY	NY	11693
219	ROCKAWAY BEACH	90-14 ROCKAWAY BEACH BLVD	FAR ROCKAWAY	NY	11693
220	ROCKAWAY PARK	113-25 BEACH CHANNEL DR	FAR ROCKAWAY	NY	11694
221	ROCKAWAY POINT	3 BEACH 209TH ST	FAR ROCKAWAY	NY	11697
222	FORT TILDEN	520 BROWNS BLVD	FAR ROCKAWAY	NY	11697
224	TERMINAL	1 RICHMOND TER	STATEN ISLAND	NY	10301
223	ST. GEORGE	45TH BY ST	STATEN ISLAND	NY	10301
225	PORT RICHMOND	364 PORT RICHMOND AVE	STATEN ISLAND	NY	10302
226	MARINERS HARBOR	2980 RICHMOND TER	STATEN ISLAND	NY	10303
227	STAPLETON	160 TOMPKINS AVE	STATEN ISLAND	NY	10304
228	ROSEBANK	567 TOMPKINS AVE	STATEN ISLAND	NY	10305
229	NEW DROP	2562 HYLAN BLVD	STATEN ISLAND	NY	10306
230	TOTTENVILLE	228 MAIN ST	STATEN ISLAND	NY	10307
231	GREAT KILLS	15 NELSON AVE	STATEN ISLAND	NY	10308
232	STATION #1	59 SEGUINE AVE	STATEN ISLAND	NY	10309
233	PRINCES BAY	665 ROSSVILLE AVE	STATEN ISLAND	NY	10309
234	WEST NEW BRIGHTON	1015 CASTLETON	STATEN ISLAND	NY	10310
235	ELTINGVILLE	4455 AMBOY RD	STATEN ISLAND	NY	10312
236	STATION # 10	931 ANNANDALE RD	STATEN ISLAND	NY	10312
237	NEW SPRINGVILLE	2845 RICHMOND AVE	STATEN ISLAND	NY	10313
238	STATEN ISLAND MAIN P.O.	550 MANOR RD	STATEN ISLAND	NY	10314

Source: United States Postal Services, Stations and Distribution Centers 2000

Support for Figure 2.5

Rail and Intermodal Facilities within the New York Metropolitan Area

Freight Transportation Project

NYS Department of Transportation, Region 11

Rail Facilities within New York Metropolitan Area

UTRC, Polytechnic University

POINTID	DESCRIPTION	STATE
1	Oak Point Yard	New York
2	LI Long Island City Bulk Transfer	New York
3	LI Garden City TOFC/COFC	New York
4	LI Farmingdale Bulk Transfer	New York
5	Hunts Point Terminal Market	New York
6	Harlem River Yard	New York
7	Fresh Pond Junction	New York
8	CR Selkirk Yard Vehicle Ramp	New York
9	Bulkmatic Transport: Bronx	New York
10	Baldwin Transportation: Bronx	New York
11	Powell Duffryn Terminal: Bayonne	New Jersey
12	NYSW N Bergen Land Bridge Terminal	New Jersey
13	National Distribution Svc: N Bergen	New Jersey
14	Mirrer Trucking Co: Saddle Brook	New Jersey
15	International-Matex: Bayonne	New Jersey
16	Gordon Terminal Service: Bayonne	New Jersey
17	Frey Industries Inc: Newark	New Jersey
18	CR Ridgefield Heights Vehicle Ramp	New Jersey
19	CR Newark Doremus Ave Vehicle Ramps	New Jersey
20	CR Linden GM Assembly Plant (Automobile)	New Jersey
21	CR Jersey City Flexi-Flo Terminal	New Jersey
22	CR Elizabeth Vehicle Ramp	New Jersey
23	CR Elizabeth TCS RoadRailer	New Jersey
24	CR Edison Ford Assembly Plant (Automobile)	New Jersey
25	Columbia Terminals: South Kearny	New Jersey
26	Bulkmatic Transport: Paterson	New Jersey
27	Bulk Transfer & Transport: N Bergen	New Jersey
28	Blue Circle Atlantic: Bayonne	New Jersey
29	APL Stacktrain S Kearny Terminal	New Jersey

Source: National Transportation Atlas Database 1999

Freight Transportation Project

NYS Department of Transportation, Region 11

Intermodal Facilities within New York Metropolitan Area

UTRC, Polytechnic University

POINTID	DESCRIPTION	STATE
1	LI Brooklyn 65th St Yd TOFC/COFC	New York
2	Arlington Yard	New York
3	Port Elizabeth Terminal & Warehouse	New Jersey
4	Matlack Bulk Intermodal: Newark	New Jersey
5	Matlack Bulk Intermodal: Elizabeth	New Jersey
6	Elizabeth E-Rail Terminal	New Jersey
7	CSXI/NYSW Little Ferry TOFC/COFC	New Jersey
8	CR South Kearny TOFC/COFC	New Jersey
9	CR North Bergen TOFC/COFC	New Jersey
10	CR Croxton Yd TOFC/COFC	New Jersey
11	CP Newark Oak Island Yd TOFC/COFC	New Jersey

Source: National Transportation Atlas Database 1999

Support for Figure 2.6

Marine Terminal within the New York Metropolitan Area

Freight Transportation Project

NYS Department of Transporation, Region 11

Marine Terminal within New York Metropolitan Area

UTRC, Polytechnic University

POINTID	DESCRIPTION	STATE
1	South Brooklyn Marine Term'l	New York
2	Red Hook Container Term'l: Brooklyn	New York
3	NYCEMCO 21st St Pier: Brooklyn	New York
4	Metro Term'ls Corp: Brooklyn	New York
5	Howland Hook Term'l: Staten Island	New York
6	Green St Lumber Exchange: Brooklyn	New York
7	Domino Sugar: Brooklyn	New York
8	Atlantic Salt Co: Staten Island	New York
9	23rd St Marine Term'l: Brooklyn	New York
10	Universal Maritime: Port Newark	New Jersey
11	Sea-Land Term'l: Elizabeth	New Jersey
12	River Term'l Dstrbtn Co: Kearny	New Jersey
13	Port Newark Auto Term'l	New Jersey
14	Port Jersey Auto Term'l	New Jersey
15	Naporano Iron & Metal: Port Newark	New Jersey
16	Metro Metal Recycling: Port Newark	New Jersey
17	Maher Tripoli St Term'l: Elizabeth	New Jersey
18	Maher Fleet St Term'l: Elizabeth	New Jersey
19	Maersk Term'l: Port Newark	New Jersey
20	Global Marine Term'l: Jersey City	New Jersey
21	Azko Salt Co: Port Newark	New Jersey

Source: National Transportation Atlas Database 1999

Support for Figure 2.7

Major Airports within the New York Metropolitan Area

Freight Transportation Project

NYS Department of Transportation, Region 11

Major Airports within New York Metropolitan Area

UTRC, Polytechnic University

ID	DESCRIPTION	STATE
1	JOHN F KENNEDY INTL	New York
2	LA GUARDIA	New York
3	NEWARK INTL	New Jersey

Source: National Transportation Atlas Database 1999

Support for Figure 2.8

Annual Average Daily Traffic (AADT) on NYSDOT Bridge Structures

Freight Transportation Project

NYS Department of Transportation, Region 11

Annual Average Daily Traffic (AADT) on NYSDOT Bridge Structures

UTRC, Polytechnic University

ID	COUNTY	BIN	LOCATION	STN#	FCLASS	AADT, DIR 1	AADT, DIR 2	ADDT, TOTAL	YEAR
1	Bronx	1066220	E L GRANT HWY AND CROSS BRONX EXPWY	01E	16	15380	5269	20649	1998
2	Bronx	1066267	JEROME AVE AND CROSS BRONX EXPWY	02E	19	9986	5548	15534	1998
3	Bronx	1066270	WALTON AVE AND CROSS BRONX EXPWY	03E	19	5537	0	5537	1998
4	Bronx	1066289	GRAND CONCOURSE AND CROSS BRONX EXPWY	04E	16	9536	10196	19732	1998
5	Bronx	1066290	MORRIS AVE AND CROSS BRONX EXPWY	05E	19	2075	4383	6458	1998
6	Bronx	1066399	CROTONA PKWY AND CROSS BRONX EXPWY	06E	16	925	0	925	1998
7	Bronx	1066407	BOSTON ROAD AND CROSS BRONX EXPWY	07E	16	6017	3970	9987	1998
8	Bronx	1066439	ROSEDALE AVE AND CROSS BRONX EXPWY	08E	17	8586	22506	31092	1998
9	Bronx	1066450	WHITE PLAINS ROAD AND CROSS BRONX EXPWY	22E	19	6823	11850	18673	1998
10	Bronx	1066760	WILLIS AVE AND MAJOR DEEGAN EXPWY	23E	16	20127	0	20127	1998
11	Bronx	1066870	MAJOR DEEGAN EXPWY RAMP AND SEDGWICK AVE	16E	11	9755	0	9755	1998
12	Bronx	1066909	MAJOR DEEGAN EXPWY AND SEDGWICK AVE	18E	11	15923	0	15923	1998
13	Bronx	1066930	W TREMONT AVE AND MAJOR DEEGAN EXPWY	09E	19	383	1017	1400	1998
14	Bronx	1066960	W 230TH STREET AND MAJOR DEEGAN EXPWY	21E	17	7535	9922	17457	1998
15	Bronx	1067077	WESTCHESTER AVE AND BRONX	10E	16	5107	4221	9328	1998

			RIVER PKWY						
16	Bronx	1067130	E GUN HILL RD AND BRONX RIVER PKWY	19E	19	15159	20796	35955	1998
17	Bronx	1075480	E 174TH ST AND BRONX RIVER PKWY	11E	19	1964	4528	6492	1998
18	Bronx	1075530	HARLEM R AND MAJOR DEEGAN EXPWY	12E	19	2343	2009	4352	1998
19	Bronx	1076170	VAN CORTLAND PARK SOUTH AND PUTNAM AVE	20E	19	7306	12900	20206	1998
20	Bronx	1076470	E 174TH STREET AND WEST FARMS RD	13E	19	5684	7363	13047	1998
21	Bronx	2066671	BRUCKNER BLVD OVER BRONX RIVER	0045	11	60851	46691	107542	1998
22	Bronx	2075820	E TREMONT AVE AND HUTCHINSON RIVER PKWY	18J	19	7403	9692	17095	1998
23	Bronx	2076640	DEPOT PLACE AND EXTERIOR ST	07J	19	153	6093	6246	1998
24	Bronx	2230287	JEROME AVE AND MOSHOLU PKWY	01J	16	8802	9193	17995	1998
25	Bronx	2240200	PELHAM BRIDGE OVER EASTCHESTER CREEK	8001	16	8024	7444	15468	1998
26	Bronx	2241020	E 161ST ST AND PARK AVE	20J	16	5037	1929	6966	1998
27	Bronx	2241099	BRUCKNER BLVD AND LONGFELLOW AVE	21J	12	49895	29315	79210	1998
28	Bronx	2241129	E 149TH ST AND BRUCKNER BLVD	22J	17	2799	3012	5811	1998
29	Bronx	2241139	LEGGETT AVE AND GARRISON AVE	23J	19	9783	7636	17419	1998
30	Bronx	2241190	HUNTS POINT AVE AND GARRISON AVE	24J	19	5119	6916	12035	1998
31	Bronx	2241230	WESTCHESTER AVE AND EDGEWATER RD	08J	16	14106	10859	24965	1998
32	Bronx	2241269	E 177TH ST AND MORRIS PARK AVE	09J	17	5965	24058	30023	1998
33	Bronx	2241409	GRAND CONCOURSE AND E 151ST ST	25J	16	15538	10218	25756	1998
34	Bronx	2241470	W FORDHAM ROAD AND MAJOR DEEGAN EXPWY	10J	16	16702	21214	37916	1998
35	Bronx	2241490	W 230TH STREET AND MAJOR	02J	17	10628	10165	20793	1998

			DEEGAN EXPWY						
36	Bronx	2241610	E 161ST ST AND THIRD AVE	26J	16	7604	9452	17056	1998
37	Bronx	2241620	E 162ND ST AND ELTON AVE	27J	19	1738	2795	4533	1998
38	Bronx	2241710	CLAREMONT PKWY OVER METRO-NORTH HARLEM LINE	11J	19	8268	6629	14897	1998
39	Bronx	2241760	E TREMONT AVE OVER METRO-NORTH HARLEM LINE	12J	16	10571	8883	19454	1998
40	Bronx	2241839	E 189TH STREET OVER METRO-NORTH HARLEM LINE	13J	16	716	3029	3745	1998
41	Bronx	2241840	BEDFORD PARK BLVD OVER METRO-NORTH HARLEM LINE	14J	19	8398	7460	15858	1998
42	Bronx	2241860	E GUN HILL ROAD AND METRO-NORTH HARLEM LINE	03J	19	18830	15836	34666	1998
43	Bronx	2241870	E 233RD STREET AND METRO-NORTH HARLEM LINE	05J	19			NO DATA	1998
44	Bronx	2242029	SOUTHERN BLVD AND BOSTON ROAD	15J	16	3047	2999	6046	1998
45	Bronx	2242030	CROTONA AVENUE AND BOSTON ROAD	16J	19	3748	3622	7370	1998
46	Bronx	2242299	GRAND CONCOURSE OVER E 136TH ST	28J	16	10735	7861	18596	1998
47	Bronx	2242350	E FORDHAM ROAD OVER GRAND CONCOURSE	17J	16	9424	13227	22651	1998
48	Bronx	2242430	E GUN HILL ROAD AND BRONX BLVD	04J	12	20554	19060	39614	1998
49	Bronx	2242458	E 233RD STREET AND BRONX RIVER	06J	16	15187	17359	32546	1998
50	Bronx	2247900	EASTCHESTER ROAD OVER NYCTA DYRE AVE LINE	19J	16	6280	5205	11485	1998
51	Bronx	7702390	HUTCHINSON RIVER PKWY OVER EASTCHESTER CREEK	0922	12	44219	43629	87848	1998
52	Bronx	106685A	CROSS BRONX EXPWY AND MAJOR DEEGAN EXPWY	14E	11	12174	0	12174	1998
53	Bronx	106685B	I 95 AND I 87 OVER SEDGWICK AVE	15E	11	12421	0	12421	1998
54	Bronx	106687A	SB I 87 RAMP TO I 95 OVER I 87	17E	11	15479	0	15479	1998
55	Bronx	107581A	ACC I 895 SHERIDAN EXPWY	045	11	33615	57396	91011	1998

56	Brooklyn	1065220	92ND ST AND BROOKLYN QUEENS EXPWY	6087	19	8741	9230	17971	1998
57	Brooklyn	1065230	86TH ST AND BROOKLYN QUEENS EXPWY	6088	16	13378	10207	23585	1998
58	Brooklyn	1065270	BAY RIDGE PKWY OVER BROOKLYN QUEENS EXPWY	6089	19	8065	6934	14999	1998
59	Brooklyn	1065470	LEE AVENUE AND BROOKLYN QUEENS EXPWY	24E	16			NO DATA	1998
60	Brooklyn	1065507	BROADWAY AND BROOKLYN QUEENS EXPWY	25E	19	5599	6072	11671	1998
61	Brooklyn	1065530	S 3RD STREET AND BROOKLYN QUEENS EXPWY	26E	16	1635	0	1635	1998
62	Brooklyn	1065549	GRAND STREET AND BROOKLYN QUEENS EXPWY	27E	16	5724	11007	16731	1998
63	Brooklyn	1066020	ELEVENTH AVENUE AND PROSPECT EXPWY	28E	19	9666	0	9666	1998
64	Brooklyn	1076500	FORT HAMILTON PKWY AND PROSPECT EXPWY	29E	16	4363	0	4363	1998
65	Brooklyn	1076750	GOWANUS EXPWY SB AND 17TH ST	30E	19			NO DATA	1998
66	Brooklyn	2067889	PROSPECT EXPWY AND 4TH AVENUE	94J	12	33319	25733	59052	1998
67	Brooklyn	2230000	HIGHLAND BLVD W AND INTERBOROUGH PKWY	34J	19	4374	0	4374	1998
68	Brooklyn	2230010	HIGHLAND BLVD W AND INTERBOROUGH PKWY	33J	19	5374	0	5374	1998
69	Brooklyn	2231359	CROPSEY AVENUE AND OCEAN PKWY	0904	12	70761	66081	136842	1998
70	Brooklyn	2231370	E 8TH ST ACCESS RAMP AND BELT PKWY	6075	19	7504	0	7504	1998
71	Brooklyn	2231380	CONEY ISLAND AVENUE AND SHORE PKWY	51J	16	10942	13320	24262	1998
72	Brooklyn	2231390	E 12TH STREET AND SHORE PKWY	50J	19	2006	2523	4529	1998
73	Brooklyn	2231419	CONEY ISLAND AVENUE AND KNAPP STREET	0905	12	67651	67186	134837	1998
74	Brooklyn	2231439	SHORE PKWY AND NOSTRAND	0905	11	4290	4250	8540	1998

			AVENUE						
75	Brooklyn	2231449	KNAPP STREET AND SHORE PKWY	53J	16	6514	9697	16211	1998
76	Brooklyn	2231450	KNAPP STREET AND FLATBUSH AVENUE	906	12	67911	50074	117985	1998
77	Brooklyn	2231519	PENNSYLVANIA AVE AND BELT PKWY	47J	16	8234	7824	16058	1998
78	Brooklyn	2240240	9TH ST BRIDGE AND GOWANUS CANAL	8004	16			NO DATA	1998
79	Brooklyn	2240260	CARROL ST BRIDGE AND GOWANUS CANAL	8005	19	382	1081	1463	1998
80	Brooklyn	2240290	METROPOLITAN AVE AND ENGLISH KILLS	8006	14	17303	19015	36318	1998
81	Brooklyn	2240370	GREENPOINT AVE AND NEWTOWN CREEK	8007	14	12091	11539	23630	1998
82	Brooklyn	2243050	CATON AVENUE AND NYCTA BRIGHTON LINE	29J	19	7713	7486	15199	1998
83	Brooklyn	2243100	BEVERLY ROAD AND NYCTA BRIGHTON LINE	44J	17	5377	3997	9374	1998
84	Brooklyn	2243130	DITMAS ROAD AND NYCTA BRIGHTON LINE	43J	19	5269	4162	9431	1998
85	Brooklyn	2243260	FLATBUSH AVENUE AND NYCTA FRANKLIN LINE	30J	16	8588	10150	18738	1998
86	Brooklyn	2243380	18TH AVENUE AND CONRAIL BAY RIDGE	45J	19	4242	0	4242	1998
87	Brooklyn	2243439	OCEAN PKWY AND LIRR BAY RIDGE	918	14	39150	34087	73237	1998
88	Brooklyn	2243480	OCEAN AVENUE AND CONRAIL BAY RIDGE	42J	16	12525	12106	24631	1998
89	Brooklyn	2243490	BEDFORD AVENUE AND LIRR BAY RIDGE	48J	19	20199	5533	25732	1998
90	Brooklyn	2243570	86TH STREET AND NYCTA SEA BEACH	52J	19	4524	5331	9855	1998
91	Brooklyn	2243620	FORT HAMILTON PKWY AND NYCTA	46J	16	8801	9525	18326	1998
92	Brooklyn	2243660	NEW UTRECHT AVENUE AND CONRAIL BAY RIDGE	37J	19	4162	3282	7444	1998
93	Brooklyn	2243690	17TH AVENUE AND NYCTA SEA	38J	19	4978	5559	10537	1998

			BEACH						
94	Brooklyn	2243700	18TH AVENUE AND CONRAIL BAY RIDGE	39J	19	6227	5436	11663	1998
95	Brooklyn	2243730	65TH STREET AND NYCTA SEA BEACH	41J	16	12342	11972	24314	1998
96	Brooklyn	2243740	BAY PKWY AND NYCTA SEA BEACH	40J	16	2346	9436	11782	1998
97	Brooklyn	2243839	4TH AVENUE AND NYCTA BMT	31J	16	15428	14080	29508	1998
98	Brooklyn	2243870	PITKIN AVENUE AND LIRR BAY RIDGE	32J	17	3246	5292	8538	1998
99	Brooklyn	2244460	CONDUIT BLVD AND ATLANTIC AVE	36J	16	20057	16135	36192	1998
100	Manhattan	1066889	ALEXANDER HAMILTON BRIDGE AND HARLEM RIVER	0004	11	80383	74152	154535	1998
101	Manhattan	2229309	HENRY HUDSON PKWY AND RIVERSIDE PK	0009	12	51801	52441	104242	1998
102	Manhattan	2229349	HENRY HUDSON PKWY AND 158TH ST	0911	12	64572	65069	129641	1998
103	Manhattan	2233060	HENRY HUDSON PKWY OVER TOPOGRAPHY	0012	12	33556	38445	72001	1998
104	Manhattan	2240027	MANHATTAN BRIDGE AND EAST RIVER	8012	14	24673	25422	50095	1998
105	Manhattan	2240028	MANHATTAN BRIDGE AND EAST RIVER	8011	14	17071	17079	34150	1998
106	Manhattan	2245100	WEST 44TH STREET AND AMTRACK	6098	17	5290	0	5290	1998
107	Manhattan	2245130	WEST 47TH STREET AND AMTRACK	6099	17			NO DATA	1998
108	Manhattan	2245210	W 42ND STREET AND AMTRACK	6100	16	5036	10939	15975	1998
109	Manhattan	2245220	W 57TH STREET AND AMTRACK	6101	16	7336	0	7336	1998
110	Manhattan	2245380	W 66TH STREET AND BRIDLE PATH W END	6102	16	16371	0	16371	1998
111	Manhattan	2245420	W 65TH STREET EB AND BRIDLE PATH W END	6103	16			NO DATA	1998
112	Manhattan	2246000	WEST DRIVE BETWEEN 61ST AND 62ND ST	6104	19			NO DATA	1998
113	Manhattan	2246050	CENTRAL DRIVE AND 63RD ST	6105	19			NO	1998

								DATA	
114	Manhattan	2246490	A.C. POWEL BLVD NB	6093	19	408	554	962	1998
115	Manhattan	2246720	RIVERSIDE DRIVE AND 158TH ST	6094	19	9347	7387	16734	1998
116	Manhattan	2246970	RIVERSIDE DRIVE AND 96TH ST	6096	19	4052	5584	9636	1998
117	Manhattan	2246980	RIVERSIDE DRIVE AND W 138TH ST	6097	19	7515	7531	15046	1998
118	Manhattan	2266230	HENRY HUDSON PKWY AND PED INWOOD PK	0013	12	22711	27981	50692	1998
119	Queens	2055801	FLUSHING AVE AND FLUSHING RIVER	0086	14	23501	30507	54008	1998
120	Queens	2240410	BORDEN AVENUE AND DUTCH KILLS	8013	16	3054	10556	13610	1998
121	Queens	2240450	HUNTERS POINT AVE AND DUTCH KILLS	8014	17	2689	2854	5543	1998
122	Queens	2300130	ROCKAWAY BLVD AND HOOK CREEK	8015	19	24183	28404	52587	1998
123	Queens	223021A	MIDTOWN HWY BRIDGE AND DUTCH KILLS	0056	11	33056	0	33056	1998
124	Staten Island	2240350	RICHMOND AVE BRIDGE AND RICHMOND CREEK	8017	14	27096	26422	53518	1998

Source: NYS Department of Transportation, Region 11, Bridge Counts Data, 1998.

2000 HIGHWAY SUFFICIENCY RATINGS FOR NEW YORK STATE

INTRODUCTION AND SUMMARY

The New York State Department of Transportation annually conducts a highway condition survey in cooperation with the U.S. Department of Transportation. The purpose of this survey is to determine the surface condition for each section of highway on both the New York State Touring Route and Thruway Systems, and the overall surface condition of these systems. This report presents updated pavement condition and physical characteristics data, developed from an inventory of the complete State Touring Route and the Thruway Authority Highway System conducted during the summer of 2000.

HIGHWAY CHARACTERISTICS AND CONDITION DATA

This survey covers all facilities on the NYS Touring and Reference Route Systems. The touring route system consists of state numbered highways owned by the State, and certain non-state roads signed as state highways for continuity in driving. The main body of the Sufficiency Ratings publication contains information on touring routes as well as parkways. Starting in 1990, service roads were included as part of the condition survey and are defined as those roads that segregate local traffic from the higher speed through-traffic. Information on the New York State Thruway is presented in the Appendix.

A description of the information contained in the various columns of this report is presented below. Immediately following that is a description of selected items that are included in the Sufficiency computer file but are not published in this report.

LOCATION/IDENTIFICATION

1. **Route Number**

The touring route number contains from one to three numerals and, where required, one alphabetic suffix. For example, Route 5A is designated as 5A and Interstate 787 is designated 787I. Please see the Glossary for a description of this field.

2. **County Name**

The abbreviated county name in which the highway section is contained appears in this column. Please refer to the Glossary for the definitions of the abbreviations.

3. **Region & County Identification**

The region/county numbers are the one-digit DOT region number with the specific one-digit county number which has been assigned to each county, in alphabetic order, within that region. For example, Essex County is identified as 12 (second county in Region 1).

4. **County Order Number**

The county order identification is a two-digit number. It is 01 at the beginning of a route in the county in which the route originates and increases by one each time the route crosses a county line, whether it is entering the county for the first time or has previously traversed that county.

5. **Control Segment Number**

The control segment number is a single digit which helps to locate the specific portion of a touring route within a county. Upon entering a county, the control segment starts at 1 and increases by one each time it crosses a city line, whether entering or leaving a city.

6. **End Milepoint**

A control segment is divided into shorter lengths called sections. The last four digits of the milepoint number denote the end mileage of a particular section from the beginning of the route or from the previous control segment. Mileage is cumulative through the control segment, starting with 00.00 at the beginning of the segment. Therefore, the end milepoint for the last section in a control segment is also the length of the entire control segment.

7. **End Reference Marker**

Reference markers are small roadside signs used to mark a particular location along a highway. These markers consist of a green shield about eight inches square with three rows containing up to four characters each. The first row contains the route number. The second row contains the region/county numbers and the county order number. The third row contains the control segment number and the first three digits of the end milepoint, expressed in tenths of a mile, for that control segment. The reference marker legends listed in this column represent the last reference marker on their respective sections.

8. **State Highway Number**

The state highway number is the contract number under which a section of highway was originally built, or the number assigned to a section of highway upon takeover by the Department from another political subdivision. If the route is on a city or village street, county or town road, parkway or toll bridge, the following abbreviations are used:

Appendix C

Prior Studies

INVENTORIES OF FREIGHT STUDIES AND REPORTS

ID	Title	SponsorAgency	PreparedBy	ReportDate	Status
1	Some Issues of Freight Planning in New York	French Government Ministry of Transport	Ecole Nationale des Ponts et Chaussees, France	6/1/95	Final Report
2	Bruckner Boulevard Traffic Study	New York City Department of City Planning	New York City Department of City Planning	1/1/00	Final Report
3	Citywide Congestion Bottleneck Study	New York City Department of City Planning	New York City Department of City Planning	10/1/99	Final Report
4	Southern Gateway Corridor Information Exchange	New York City Department of City Planning	New York City Department of City Planning	8/30/99	Final Report
5	Off-Peak Delivery and Service Study	New York City Department of City Planning	New York City Department of City Planning	6/1/99	Final Report
6	Freight Synthesis	New York City Department of City Planning	New York City Department of City Planning	6/1/99	Summary Report
7	Greenpoint-Williamsburg Truck Traffic Study	New York City Department of City Planning	New York City Department of City Planning	7/1/97	Final Report
8	Long Island City Truck Traffic & Access Study	New York City Department of City Planning	New York City Department of City Planning	1/1/95	Final Report
9	Potential for Small Commercial Vehicles on Selected Parkways	New York City Department of City Planning	New York City Department of City Planning	7/1/94	Final Report
10	Cross Harbor Freight Movement: Major Investment Study Task 2	New York City Economic Development Corporation	Edwards and Kelcey, Inc. Cambridge Systematics, Inc. KKO and Associates, Inc. A.Strauss-Wieder, Inc. VMZ TransSystem	5/1/00	Draft Technical Memorandum
11	Cross Harbor Freight Movement MIS	New York City Economic Development Corporation	New York City Economic Development Corporation	10/14/99	Draft Report
12	Cross Harbor Freight Movement MIS	New York City Economic Development Corporation	New York City Economic Development Corporation	10/14/99	Executive Summary

INVENTORIES OF FREIGHT STUDIES AND REPORTS

ID	Title	SponsorAgency	PreparedBy	ReportDate	Status
13	Strategic Plan for the Redevelopment of the Port of New York	New York City Economic Development Corporation	New York City Economic Development Corporation	2/1/99	Executive Briefing
14	Feasibility Study of "Hub Port" Development	New York City Economic Development Corporation	Booz.Allen & Hamilton Inc.	3/20/97	Final Report
15	Intermodal Goods Movement Study: NYC Rail Freight Access	New York City Economic Development Corporation	Mercer Management Consulting, Inc.	1/31/97	Final Report
16	NYC Freight Issues, Creating a Rationalized Rail Freight, Warehouse and Distribution Network.	New York City Economic Development Corporation	Transportation and Commerce Unit.	3/1/94	Final Report
17	Freight Focus Sessions	New York Metropolitan Transportation Council	New York Metropolitan Transportation Council	10/7/99	Summary of Results
18	Mobility for the Millennium	New York Metropolitan Transportation Council	New York Metropolitan Transportation Council	6/8/99	Final Report
19	Regional Transportation Statistical Report	New York Metropolitan Transportation Council	New York Metropolitan Transportation Council	3/1/99	Final Report
20	Truck Toll Volumes	New York Metropolitan Transportation Council	New York Metropolitan Transportation Council	3/1/99	Technical Notes
21	Freight Movement Issues in the Region: First Steps towards Implementing Solutions	New York Metropolitan Transportation Council	Howard/Stein-Hudson Associates, Inc.	3/13/98	Final Summary
22	Goods Movement in the New York Metropolitan Area	New York Metropolitan Transportation Council	Baruch College	1/1/98	Final Report
23	Truck Terminal and Warehouse Survey Results	New York Metropolitan Transportation Council	New York Metropolitan Transportation Council	3/1/96	Final Report
24	Freight Facilities and System Inventory	New York Metropolitan Transportation Council	New York Metropolitan Transportation Council	9/1/95	Final Report

INVENTORIES OF FREIGHT STUDIES AND REPORTS

ID	Title	SponsorAgency	PreparedBy	ReportDate	Status
25	Final Workplan and Preliminary Inventory Report Intermodal Freight Management System	New York Metropolitan Transportation Council	New York Metropolitan Transportation Council	12/1/94	Final Report
26	Critical Issues Critical Choices	New York Metropolitan Transportation Council	New York Metropolitan Transportation Council	3/1/94	Final Report
27	Gowanus Expressway News	New York State Department of Transportation	New York State Department of Transportation	7/1/99	Newsletter
28	Oak Point Link	New York State Department of Transportation	Transmode Consultants, Inc.	3/1/95	Executive Report
29	Industrial Areas Transportation Study	New York State Department of Transportation	New York City Department of City Planning	2/1/95	Phase II
30	Industrial Areas Transportation Study	New York State Department of Transportation	New York City Department of City Planning	6/1/94	Phase I
31	An Analysis of the Proposed Tunnel and Deepwater Port in Brooklyn	New York University	Taub Urban Research Center	11/1/98	Final Report
32	Tunnel Vision	New York University	Taub Urban Research Center, R. F. Wagner Graduate School of Public Services	11/1/98	Final Report
33	Regional Economy (Review and Outlook for the New York-New Jersey Metropolitan Region)	The Port Authority of New York & New Jersey	The Port Authority of New York & New Jersey	8/1/99	Final Report
34	Summary of Port Development Plans for Container Terminals	The Port Authority of New York & New Jersey	Harris	10/1/98	Presentation
35	Regional Truck Freight Network Strategic Plan	The Port Authority of New York & New Jersey	Cambridge Systematics, Inc. Parsons Brinckerhoff Quade & Douglas, Inc. Eng-Wong, Taub and Associates	3/1/97	Final Report
36	The Economic and Air Quality Impacts of Alternative Channel Depths on The New York/New Jersey Metropolitan Region	The Port Authority of New York & New Jersey	The Port Authority of New York & New Jersey	10/1/96	Final Report

INVENTORIES OF FREIGHT STUDIES AND REPORTS

ID	Title	SponsorAgency	PreparedBy	ReportDate	Status
37	The Red Hook Barge Study	The Port Authority of New York & New Jersey	Audits & Surveys Worldwide	5/1/96	Presentation
38	Economic Impact of the Port Industry on the New York-New Jersey Metropolitan Region	The Port Authority of New York & New Jersey	The Port Authority of New York & New Jersey	7/1/95	Final Report
39	Improving Regional Mobility	The Port Authority of New York & New Jersey	The Port Authority of New York & New Jersey	9/1/94	Final Report
40	Truck Commodity Survey Volume 2 / The George Washington Bridge	The Port Authority of New York & New Jersey	The Port Authority of New York & New Jersey	11/19/93	Final Report
41	Comprehensive Truck Size and Weight Study	U.S. Department of Transportation	U.S. Department of Transportation	6/1/97	Draft Volume II
42	ITS/Intermodal Freight operational Test Project	U.S. Department of Transportation Office of the Secretary Office of Intermodalism	Cambridge Systematic, Inc. in association with VZM/T	1/29/99	Proceedings

Appendix D

NYMTC Survey Results

Truck Terminal and Warehouse Survey Results
New York Metropolitan Transportation Council
March 1996

Objective:

Compile data regarding the truck terminals and warehouses in the NYMTC region and North Jersey to materialize transportation issues those industries face. It is known that 95% of freight was transported and distributed in the metropolitan area. That underscores the importance of truck industry in our economic activities.

Findings:

The survey of truck terminals and warehouses indicated that the primary problem is congestion on the highway network. The survey resulted in locating the highway bottleneck for truck movements, which are more localized in nature than the previous air, marine, and rail surveys performed by the NYMTC Central Staff.

Warehouse/Distribution Center

Basically, a warehouse has six functions: stocking, product mixing, production logistics, consolidation, distribution, and customer service.

- Public Warehouse: Can be rented on a short term basis.
- Private Warehouse: Owned by a company or manufacturer for the owner's use.
- Contract Warehouse: Can be rented on a long term basis.

Truck Terminal

Typically a building for the handling and temporary storage of freight pending transfer between locations.

Classification based on fleet load:

- LTL (less than a truck load): a quantity less than required for the application of a truckload rate.
- TL (truck load): a quantity of freight required to fill a truck that usually will qualify the shipment for a truck load.

Classification based on revenue:

- Class I (annual revenue is more than $1M)
- Class II (annual revenue is less than $1M)

Bottlenecks in the New York City area according to the survey respondents

Borough	Problem	Town
Manhattan	*Holland Tunnel*: crowded; inadequate vertical clearance; access to tunnel chocks the neighborhood streets; ongoing construction work on neighborhood streets.	New York City
	Lincoln Tunnel: congested; insufficient turning lanes; inadequate lighting; inadequate vertical clearance.	
	George Washington Bridge: congested; insufficient turning radius and lane width; insufficient lighting; inadequate vertical clearance; suggested more truck access route to I-495. *Tonnelle Avenue*, leading to GWB (New Jersey side): congested; poor surface condition.	
	11th Avenue, Greenwich Street, Laight Street (downtown Manhattan): congestion; ongoing construction during the workday hours; insufficient enforcement (double parking); insufficient loading zone access for commercial vehicles; narrow lane.	
	Midtown Tunnel: congestion; inadequate vertical clearance.	
	46th Street area: planned zoning change from industrial to residential opposed by local industry; this will increase truck parking problem.	
	West 24th, 25th, 55th, and other mid-Manhattan streets: congested; poor surface condition; insufficient turning radius; inadequate lighting/signing.	
	Brooklyn Battery Tunnel, Williamsburg Bridge: congested; insufficient vertical clearance; insufficient lane width.	
Brooklyn	Allow small trucks on parkways.	
	East River Bridges to Manhattan: crowded; insufficient height.	
	Van Brunt Street: congested; poor surface condition; ongoing construction; lack of traffic enforcement;(double parking, alternate parking); high accident rate. Local businesses plan (by community board) to reroute truck traffic from Van Brunt to a circular route around the main artery.	
	Kosciuszko Bridge: congested; insufficient lane with.	
	Brooklyn Queens Expressway (Rt.278): congested; narrow lanes; low clearance; ongoing construction (Hamilton Ave. and Navy Yard areas); it was suggested that height restriction on overpasses (near Atlantic Ave., and at 31st St. near Triboro Bridge) should be evaluated; and construction scheduled for non-rush hours.	
	Cherry Street: poor surface condition.	
	Mill Avenue: restriction for trucks traffic.	
	Meeker Avenue, Gardner Avenue, Vandervoort Avenue, Lombardy Street: congested; insufficient lane width; insufficient turning radius.	

Borough	Problem	Town
Bronx	*Cross Bronx Expressway*: congested; insufficient turning radius; insufficient lane width; poor surface condition.	New York City
	East Tremont Avenue, Boston Road, and East 173rd Street: congested; ongoing construction; insufficient signing.	
	West Farm Road entrance to Rt. 98 and Sheridan Expressway: inadequate signing for truck traffic especially out of town vehicles. *Boston Road, East 173rd Street*: inadequate truck signing.	
Queens	*Maspeth area*: local bridges need repairs.	
	48th Street, 56th Road, Maspeth: congested; ongoing construction; inadequate traffic control; insufficient turning radius; 48th is not a through street, which causes delay. Suggestion: construction work on roads traveled by commercial vehicles should be done during the night time.	
	Steinway Street (LIC): inadequate traffic control enforcement (double parking)	
	37th Avenue, 22nd Street (LIC): too many auto body shops; double-parked cars.	
	Access from LIE to 59th Street Bridge (Astoria): congested; insufficient turning radius.	
	37th Street and 19th Avenue (Astoria): congested.	
	Astoria Boulevard (near Triboro Bridge ramp): safety problem created by portable weighing station.	
	Flushing area: inadequate preparation for winter hazard (snow removal)	
	5th Street (LIC): insufficient lane width radius; it was suggested to reverse direction of one way traffic.	
	Rockaway Boulevard: insufficient truck parking space (Jamaica).	
Richmond	Verazzano Bridge toll, and tolls on other bridges to Staten Island are too high for trucks.	
	Richmond Terrace: congested.	

Appendix E

Mathematical Description of the Model

Appendix E - Model Description

This appendix describes the network capacity investment model developed for the Region 11 freight network project. It describes the mathematical structure of the model, experiments that were conducted to ensure that the model was sound, and a customized solution procedure that was developed to deal with the project's large-scale network dataset. Several technical memoranda describe the development of the model (Jones, Konieczny and List, 2000; Konieczny and List, 2000; Konieczny and List, 2001a; Konieczny and List, 2001b). This appendix summarizes those efforts.

E.1 MODEL DESCRIPTION

The model is intended to be a network capacity investment analysis tool. It's aim is to find the most important places where link or node enhancements should be made to improve truck flow, increase mobility, reduce delays, reduce costs, etc. In that sense, it fits a piecewise-linear mathematical programming model structure.

In its transshipment-based formulation, ***P1*,** the model assumes:

- Sets of arcs and nodes form the network.
- The arcs are one-way links from one node to another.
- Each arc has a capacity for truck flows that is a certain percentage (e.g., 5%) of the link's annual average daily traffic (AADT).
- Each arc has a generalized cost (e.g., based on travel time) by which routing (path choice) decisions can be made.
- Each arc has a generalized cost for adding capacity; i.e., a metric by which the relative value of network enhancements can be assessed.

P1 uses the following variables:

- x_{ija}: volume of traffic on arc a going from node i to node j.
- d_{ij}: total volume going from node i to node j.
- v_a: total traffic volume on arc a.
- C_a: capacity of arc a.
- y_a: capacity added to arc a.
- c_a: cost per unit of flow for using arc a.
- ΔC_a: cost per unit of additional capacity on arc a.

The objective of ***P1*** is to minimize the generalized cost of network flows and capacity additions:

Minimize:

$$\sum_a c_a v_a + \sum_a \Delta C_a y_a \qquad \text{(E-1)}$$

Subject to:

$$d_{ij} = \sum_{a \in B_i} x_{ija} \quad \forall\, i, j \qquad \text{(E-2)}$$

$$\sum_{a \in E_j} x_{ija} = d_{ij} \quad \forall\, i, j \tag{E-3}$$

$$\sum_{a \in B_n} x_{ija} = \sum_{a \in E_n} x_{ija} \quad \forall\, i, j, n \neq i, j \tag{E-4}$$

$$\sum_{i,j} x_{ija} = v_a \quad \forall\, a \tag{E-5}$$

$$v_a \leq \quad C_a + y_a \quad \forall\, a \tag{E-6}$$

Equation (A-1) is the generalized cost function being minimized. Equations (E-2), (E-3), and (E-4) are transshipment constraints. They ensure that the origin-to-destination flows are accommodated. Equation (E-2) ensures that all flow from i to j originates from i. Set B_i is the set of all arcs originating at i. Equation (E-3) ensures that all flows destined to j are assigned to one of the arcs inbound to j (set E_j). Equation (E-4) ensures that all of the flow from i to j coming into node n ($a \in B_n$) is subsequently assigned to one or more arcs leaving node n ($a \in E_n$). Equation (E-5) computes the flow on arc a, and equation (E-6) ensures that that flow is less than or equal to the capacity of the arc. Or, capacity has been added to the arc to accommodate the flow.

P1 is a *transshipment*-based formulation of the problem in that equations (E-2), (E-3), and (E-4) are used to ensure that the flow going from i to j reaches j through some path. The paths actually used are *implicitly* defined by the set of x_{ija}'s which are non-zero for OD pair ij.

An alternate form of the model, ***P2***, relies on the analyst to specify the paths that can be employed. This is the version of the model which has been used in the project. A new variable is introduced:

- y_p: volume of traffic on path p.

as well as two new sets:

- P_a: set of paths p traversing arc a.
- P_{ij}: set of paths that start at i and end at j. Flow from i to j can be assigned to these paths.

Equations (E-2), (E-3), and (E-4) are replaced by:

$$d_{ij} = \sum_{p \in p_{ij}} y_p \quad \forall\, i, j \tag{E-7}$$

and equation (5) becomes:

$$\sum_{p \in P_a} y_p = v_a \quad \forall\, a \tag{E-8}$$

The new model is then:

Minimize: (E-1) *subject to*: (E-6), (E-7), (E-8).

The main advantage to this model is that it is much smaller in size. That means it solves faster and requires less computer space. The reduction in constraints and choice variables can be two orders of magnitude (e.g., 2,000 to 20). The drawback is that no ability exists to create paths "on the fly." The analyst must specify paths a priori. If a situation arises where significant congestion exists *because* poor paths were chosen, the model will not be able to work around that limitation. Typically speaking, however, in practice this does not occur. It is usually possible to identify paths likely to be sufficient to deal with whatever traffic flow conditions emerge. In the analyses below, solutions have been obtained using both the transshipment (***P1***) and path-based (***P2***) formulations.

E.2 MODEL TESTING

The network used for model testing is shown in Figure E-1. It has 6 nodes and 14 arcs. In the first tests, the reserve capacities were set to zero so that any growth in demand would require investments in additional network capacity.

In the second set of tests, reserve capacity was added to chosen arcs in the network.

Figure E-1. Case Study Network

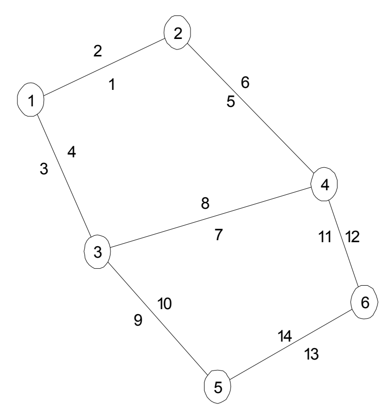

Table E-1. Network Demands

Fr\To	1	2	3	4	5	6
1	0	1	2	1	4	1
2	3	0	1	2	1	2
3	2	1	0	1	3	2
4	1	3	2	0	1	3
5	2	1	4	3	0	1
6	4	2	4	3	2	0

The nominal (base) demands are shown in Table E-1. Although no specific units are intended, one can think of the entries as being hundreds of trucks per day.

When the reserve capacities on the arcs are set to zero, (in the first series of tests) arc investments are always required to allow growth in the demands, as shown in Table E-2. This table shows where investments are made for unit increases in demand. Some investments are interesting since they are not intuitive. The model is able to consider changes in routing among all OD pairs and find the cheapest overall solution. Effectively, the model acts strategically, not myopically, to solve the problem. It is also important to note which arcs are the most and least used for demand increases. From Table E-2, it is seen that arc 14 is the most "popular" arc, while arcs 3, 8, and 12 are the least used.

The second series of tests extended this analysis by looking at a situation where some reserve capacity exists in the network. Table E-3 shows the scenario used, with its capacities, listed in the "cap" column.

Table E-2. Arc investments for each OD pair

		Arc													
Orig	Dest	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	2	X													
1	3	X				X									
1	4	X				X									
1	5					X						X			X
1	6	X				X						X			
2	1		X												
2	3					X									
2	4													X	X
2	5					X									
2	6					X						X			X
3	1					X						X			
3	2				X										
3	4	X			X										
3	5							X							
3	6									X				X	
4	1		X				X								
4	2						X								
4	3										X				X
4	5											X			X
4	6											X			
5	1				X							X			
5	2	X			X						X				
5	3										X				
5	4										X			X	X
5	6													X	
6	1				X						X				X
6	2						X				X				X
6	3										X				X
6	4										X				X
6	5														X
Count		6	2	0	5	8	3	1	0	1	8	7	0	4	11
Capacity Cost		1	2	5	5	1	2	2	5	4	3	4	8	1	1

The first experiment added a unit of demand to the OD pairs one at a time. Here there were only 19 instances where arc investments are required, versus 30 without reserve capacity; and there were only 23 instances where some arc investment was required versus 56 before. The model used the reserve capacity to keep down the cost of capacity investments. Routing decisions focused on finding system-level flow patterns that obviated capacity investments.

Table E-4 shows the increases in *total* cost resulting from these one-at-a-time increases in demand. The values correspond to a 0.8% to 1.4% increase in cost. This range is much lower than the 0.8% to 4.4% found in the first experiment. It shows that adding reserve capacity reduces the capacity investment required, as should be the case.

Table E-3. New Arc Attributes

Network Arcs						
Arc	Fr	To	cv	cap	cx	xlim
1	1	2	4	3	1	50
2	2	1	4	5	2	50
3	1	3	3	12	5	50
4	3	1	3	11	5	50
5	2	4	6	4	1	50
6	4	2	6	5	2	50
7	3	4	5	8	2	50
8	4	3	5	12	5	50
9	3	5	4	10	4	50
10	5	3	4	10	3	50
11	4	6	2	9	4	50
12	6	4	2	16	8	50
13	5	6	4	4	1	50
14	6	5	4	8	1	50

The second experiment involved increasing the demand to or from specific nodes. The analysis is akin to seeing what capacity investments would be required to accommodate large flows to or from a proposed sports complex or other major land use development. We learned that the cumulative investment exceeds the sum of the investments for the individual OD pairs involved (e.g., all origins to a destination) because the reserve capacity can be used only once.

The third experiment involved increasing the demand both to and from a given node. This analysis is akin to studying the capacity investments for the change in the all-day trip pattern for land use development within a given zone. We again saw that the cumulative investment exceeds the sum of the investment for the individual OD pairs and that supporting land use growth for some zones is far more expensive than for others.

Table E-4. Cost increases from demand increases

		To					
From		1	2	3	4	5	6
	1	X	5	3	8	7	12
	2	6	X	9	7	13	11
	3	8	12	X	5	4	9
	4	13	8	5	X	8	4
	5	12	16	4	8	X	5
	6	16	11	8	3	4	X

The last experiment involved exploring the capacity investments required for randomly selected combinations of demand growth.. In a real-world scenario, this would provide clear guidance about which arcs should see investments as economic growth occurs.

These experiments allowed an examination of the optimal network investments when reserve capacity is present. The findings are that: things change less when reserve capacity is present, less investment is required, more shifting occurs in the flows, and the average, minimum and maximum investments decrease. The fact that some arcs have reserve capacity also makes it easier to see why investments that accommodate demand growth one-OD-pair-at-a-time is different from and less expensive than accommodating growth simultaneously. In the first instance, reserve capacity is used repeatedly to accommodate the growth in demand while in the latter situation, that re-use is not possible. When it is "used" it's gone. Since demand does not typically increase one OD pair at a time, this says that it's always important to examine multiple-OD-growth scenarios when trying to see what investments will be required. There is therefore significant value in the one-node-at-a-time analyses and the random scenario analyses. Different situations causes different movements, so by viewing many situations, the model predicted more accurately where it will be most expensive to expand the network and where capacity investments would be most valuable.

E.3 EFFICIENT SOLUTION METHODOLOGY

To implement ***P2*** in the context of the project's large-scale network dataset, a gradient-based search technique was developed and implemented to identify an optimal network enhancement solution. The mathematical formulation of the problem is the same as it was stated earlier, but the solution technique is different. Experience with other, similar large-scale network problems suggests that a standard linear programming solver will have difficulty accommodating the problem we eventually have to solve. Thus, a gradient-based search procedure was developed that obviates the need to use a standard linear programming solver.

The new procedure starts by reading the input data. This includes the nodes and links in the network, the OD volumes, and the paths that can be used. For the test cases, there are six nodes, fourteen arcs, and 30 OD pairs with non-zero flows (all of the cases where the origin and destination are not the same). Moreover, as with the previous path-based problem formulation, up to three paths are specified for each OD pair. (In addition, for this simple network, the maximum number of arcs per path is three.)

The program then creates data tables for all the problem inputs, and sets the assigned flows for all OD pairs to zero. The solution procedure then makes iterative passes through the OD pairs to increase the assigned flows from zero to the actual demands.

As the flow assignments grow, one iteration at a time, the following procedure is used. A random sequencing is created for the 30 OD combinations. Then, small flow assignments to the lowest cost paths. Specifically, all of the paths for a given OD pair are evaluated (given all preceding flow assignments for all OD pairs), and the one with the smallest cost is selected for the next assignment of incremental flow. A small amount of flow is assigned to the selected path, the OD table is updated, and the methodology then moves on to the next OD pair. This sequence is repeated until all of the demand in the system has been assigned.

After all the volume or demand is assigned the model then reevaluates the path choices originally made in attempt to improve the objective function value. In each iteration, the OD pairs are considered again in random order. The lowest and highest cost paths are found. If the volume on the highest cost path is non-zero, a small amount is moved from it to the lowest cost path. The iterations continue until the new objective function value obtained from this shift is less than a minimum change percentage (a value input by the user) than the previous one.

Similar runs were performed with the new iterative procedure as have been in the past. Sensitivity analyses were done for many situations, including individual OD pair demand increase, random multiple OD pair demand increase, demand increase for all OD pairs from a node, then all OD pairs to a node, and lastly all OD pairs both originating and destined to a particular node. A comparison of the objective value results of the original model to the new one can be seen in Figures E-2 and E-3. Figure E-2 represents values for individual OD pair increments, while Figure E-3 shows values for random multiple OD pair increments. As can be seen from these figures, the new model results are very close to those obtained with the previous model. Additional data tables and graphs that further illustrate this conclusion can be found in Konieczny and List (2001a).

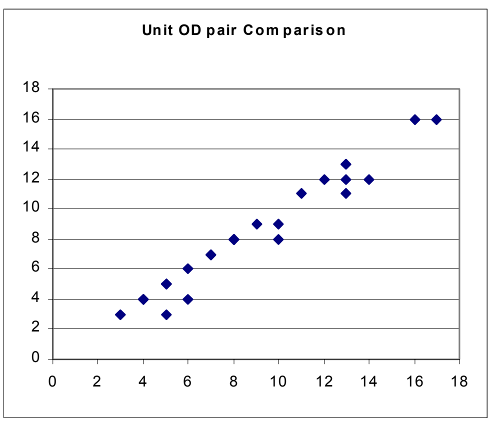

Figure E-2. Original Unit OD Pair Path-based Solution vs. New Solution

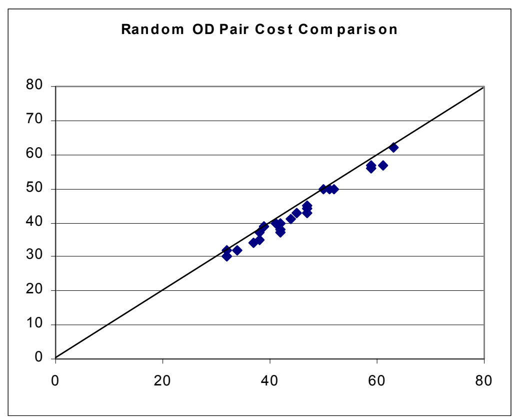

Figure 3. Original Unit OD Pair Path-based Solution vs. New Solution

E.4 CONCLUSION

This technical report has described a new procedure that searches for an optimal solution to the network capacity investment problem. Whereas the previous solution methodology employed a standard LP solver, prior experience suggested that this technique would be too slow and complex for the large-scale network problem that must eventually be solved. Hence, the search procedure was created and tested with the same, small dataset that has been used previously with the LP code. So far, we have demonstrated that the new procedure can read the requisite datasets and produce a solution which is nearly optimal.

REFERENCES

Jones, Nicola, Laura Konieczny and George List (2000). Recent Advances in Capacity Investment Modeling Capabilities, Technical Report, Department of Civil Engineering, Rensselaer Polytechnic Institute, Troy, N.Y.

Konieczny, Laura and George List (2000). Exploring the Impacts of Reserve Capacity in Network Investment Decision Making, Technical Report, Department of Civil Engineering, Rensselaer Polytechnic Institute, Troy, N.Y.

Konieczny, Laura and George List (2001a). Gradient Search Based Network Enhancement Solver, Technical Report, Department of Civil Engineering, Rensselaer Polytechnic Institute, Troy, N.Y.

Konieczny, Laura and George List (2001b). Moving the Gradient Search Based Network Enhancement Solver to Stand-Alone Operation, Technical Report, Department of Civil Engineering, Rensselaer Polytechnic Institute, Troy, N.Y.

Appendix F

Network Model Data

Appendix F - Network Model Data

This appendix describes the input data used by the network capacity investment model. Other working papers describe the model's development [1, 2] and experiments performed with investment decisions with and without reserve capacity [3, 4].

Listed in the order they will be discussed, the data files needed by the model are:

- *links*: generic name for the file containing the network links
- *nodes*: a list of the nodes in the network
- *znodes*: a description of the centroids for each zone.
- *flows*: generic name for the file containing the origin-zone-to-destination-zone truck volumes
- *files*: file containing the names that are to be used for the network data (*links*) and flow data (*flows*) in a given model run
- *aadtcost*: costs for adding AADT-based capacity, by functional class
- *avgaadt*: average AADT, by functional class
- *pcttrk*: truck percentages by functional class
- *params*: a set of parameters used by the model to assign flows to the network

Files *links*, *nodes*, *znodes*, and *flows* are large. The others are small. Each file's structure and origin is described in the text that follows as well as the data it contains.

F.1 LINKS DATAFILE

The study network on which the project is focused is shown in Figure F.1. It contains nearly 40,581 links and 27,180 nodes.

Each record in the *links* dataset has values for 20 fields:

- Name (alpha description of the link)
- County (the county in which the link exists)
- link ID (a unique identifier)
- A node (from node)
- B node (to node)
- directional flag (0 => two way, 1 => only AB, -1 => only BA)
- truck use flag (0 = trucks are not permitted, 1 = trucks are permitted, 2 = trucks can use to get to and from local destinations, 3 = the link is a connector to or from a zone centroid; see later text)
- length (miles)
- travel time (minutes)

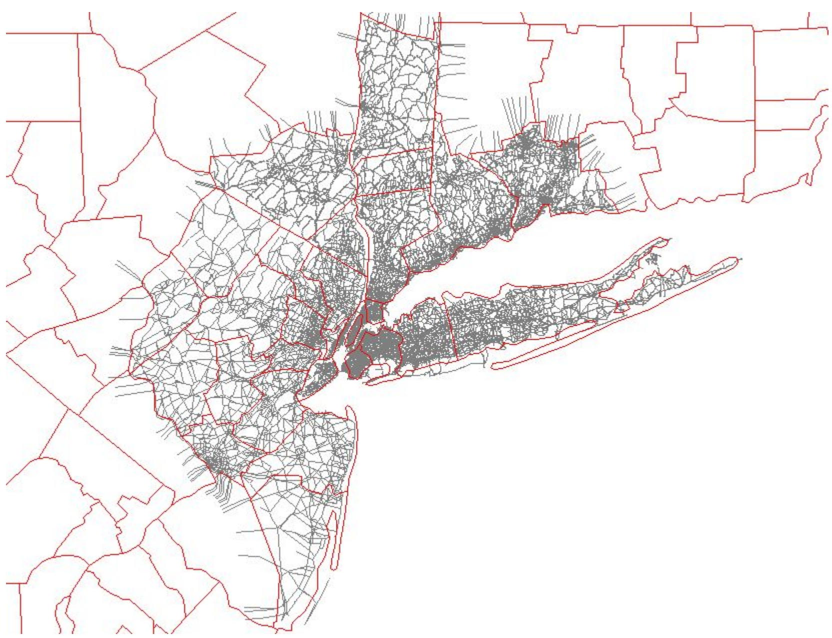

Figure F.1 Study network

- generalized cost (dollars per truck passage)
- observed AADT (where it is available)
- truck volume observations (AB and BA), where available – 2 fields
- truck volume observation (B => A), where it is available
- functional class
- total number of lanes
- percent change in AADT capacity for scenarios S1, S2, S3, and S4/S5 (four fields)
- link tracking flag, to indicate whether the OD flows utilizing the link are to be monitored

The tab-delimited text file used as input for a given run is derived from the worksheet in the following manner. (Clicking here provides an example.) The first record is deleted, since it contains the names of the fields. The name and county fields are omitted. One of the "percentage changes in capacity" fields is kept (the others are deleted) based on the analysis being done (e.g., S1 to S5) or the field entry is set to zero for all links (for the existing conditions). The link tracking flags are set to 1.0 for those links where the OD flow utilization is to be monitored. Finally, the truck use flag and the directional flags are set to appropriate values based on the guidance found in the scenario guide worksheet (see later text).

All but the AADT values and the percentage changes in "AADT capacity" for scenarios S1 through S5 and the link tracking flags were obtained from the BPM project [5]. (See later text that describes how the percentage changes in AADT capacity were derived.)

Data regarding truck volumes and AADT values were received from several sources:

- AADT data and truck volume observations were derived from the Best Practices Model effort.[6]
- Additional truck volume and AADT data were derived from the sources listed in Technical Memorandum #1 [7].

Table F.1 presents a breakdown of the links by functional class. The vast majority are urban major collectors followed by urban minor arterials, ramps, and urban freeways and expressways. The urban interstate links represent only 1,946 of the total links.

The links in functional class 50 were added. They are the truckways, connectors to the truckways, and access roads to places like Hunts Point and Maspeth Avenue that were added to create the 2025 scenarios.

Table F.1 Links by functional class

Functional Class	Type	Number of Links
1	Rural Interstate	406
2	Rural Principle Interstate	2785
6	Rural Minor Arterial	2705
7	Rural Major Collector	1039
8	Rural Minor Collector	305
9	Rural Local	812
11	Urban Interstate	1946
12	Urban Freeway and Expressway	2582
14	Urban Minor Arterial	9235
16	Urban Major Collector	11642
17	Urban Minor Collector	2114
19	Urban Local	778
20	Ramp	3401
50	New Network Links	31
991	External Station Connector	683
997	Centroid Connector	111

The scenario guide is a spreadsheet that indicates which links have what properties in the various 2025 scenarios. For the year 2025 conditions, certain links have properties that need to be changed to correctly model a given scenario. The guide walks the user through a series of steps to ensure that all of the correct actions are taken for a given scenario. This guarantees replicability in the results and that the network will be configured as desired for each scenario.

In the *scenario guide*, there is a reminder to go to the demand matrix spreadsheets and generate the correct diversion percentages associated with the different scenarios that are to be modeled. Section F.4 has a discussion about how those flow matrices are developed.

A second tab in the *scenario guide* shows the links monitored during the Year 2025 scenario investigations. Reproduced in Table F.2, the first column shows the name of the facility being monitored. The next four columns show the link numbers being used to monitor traffic flows on that facility. For example in the case of the BQE south of the LIE on the Kosciusko Bridge, link 60524 is the source of the data about northbound flows while link 60653 is source for southbound flows. Both of these links are one-way. In some cases, the same link is used for both directions, as in the case of Hunts Point Avenue south of the Bruckner Expressway. These links both accommodate two-way flows.

Table F.2 Links Monitored in the Year 2025 Model Runs

Name	Link Number			
	NB	SB	EB	WB
Atlantic Ave on West side of Van Wyck			63887	63887
BQE South of LIE on the Kosciusko Bridge	60524	60653		
Cross Bronx Expressway West of the Sheridan Expressway			65843	65844
Goethals Bridge			90836	90835
Hunts Point Ave South of the Bruckner	65241	65241		
LIE West of Van Wyck			64278	64289
Northern Blvd East of the BQE			63605	63605
Rockaway Blvd East of the intersection with Nassau Blvd			97848	97848
Tappan Zee Bridge	76398	76408		
Van Wyck Expressway South of Conduit Ave	63994	63990		

The next step is to identify the correct capacity enhancement for each link for a given scenario. One set of capacity enhancements has to be selected for a given run. In some instances, moving between scenarios means a new set of capacity enhancements must be selected. The links that have capacity increases can be identified in the *links* dataset because they have non-zero values in one or more of the "percentage increase in capacity" columns. To run the model for one of the 2025 scenarios, the appropriate column of values has to be selected. To run the model for existing conditions, all of the percentage increases have to be set to zero. If they are not, capacity will erroneously be added to the network.)

Lastly, before a scenario run can be done, changes must be made to the truck use flag and in some cases the directional flag in the *links* datafile. The *scenario guide* indicates which links need to be edited and how. Each record in the scenario guide pertains to a specific link. The entries in that record indicate how the link attributes are supposed to change across the scenarios. For instance, in certain cases, parkways are opened to truck use, so the truck use flag has to be changed from 0 to 1. In a few cases, a one-way link becomes a two-way link (e.g., on the Gowanus, there are one-way links that represent ramps exiting the freeway that are changed into two-way links representing both off and on ramps. The scenario guide is a comprehensive list of all the edits that must be done to the *links* dataset for each and every scenario.

F.2 NODES DATAFILE

The *nodes* worksheet contains an exhaustive listing of all the nodes in the network. There are 27,180 entries in the node number list. Each record has one field: the numerical identity of the node. This list of node numbers does not vary unless a new node is added to the network. The text file, *nodes.txt*, used in model runs is derived from this worksheet. The only editing that takes place is to remove the first record containing the field definition.

F.3 ZONE CENTROID NODES DATAFILE

Of the 27,180 nodes in the network, 405 serve as zone centroids. A zone centroid is a location where truck trips can originate and terminate. The *znodes* worksheet defines these locations. The locations are based on the Best Practices Model [8]. It contains six fields: the network node number for the centroid, a label for the node (filled in but not presently used), a node number, the name of the zone (only some fields have values), the number of the county in which the zone is located, and the name of the county. The tab-delimited text file actually used by the program is derived from this spreadsheet file. The county number and county name fields are omitted since the program does not need to know them to solve the problem and the first record, which contains the field names, is deleted. An example *znodes.txt* file can be seen by clicking here.

F.4 FLOWS DATAFILE

A number of *flows* datasets exist. There is one for the existing conditions, one for Scenario 1 in Year 2025, and one for Scenarios 2-5 in 2025. Each record in a given *flows* worksheet has four fields: the origin zone number (matching the third field in the *znodes* dataset), destination zone number (again matching the third field in the *znodes* dataset), the zone-to-zone flow (trucks per day), and a flag indicating whether the flow is to be assigned (1) or not (0) during the model run. Except when debugging, the assignment flag should be set to 1.

Since there are 405 zones in *znode* database, 404 destinations are possible for each origin. That means the OD matrix could include as many as 153,620 non-zero flows.

For the "existing conditions" scenario, the base case flows used in the NYMTC-sponsored Best Practice Model (BPM) are employed [9]. (Click here to see that dataset.) The data set contains 11,652 non-zero flows representing 640,726 daily truck trips with the trip length distribution shown in Figure F-2. Almost 35% of the trips are 10 miles long or less. 13% are between 10 and 20 miles and an additional 12% are between 20 and 30 miles in length. The last class with a significant percentage of trips is 30-40 miles with 14% of the total. The remaining categories each have 5% or less.

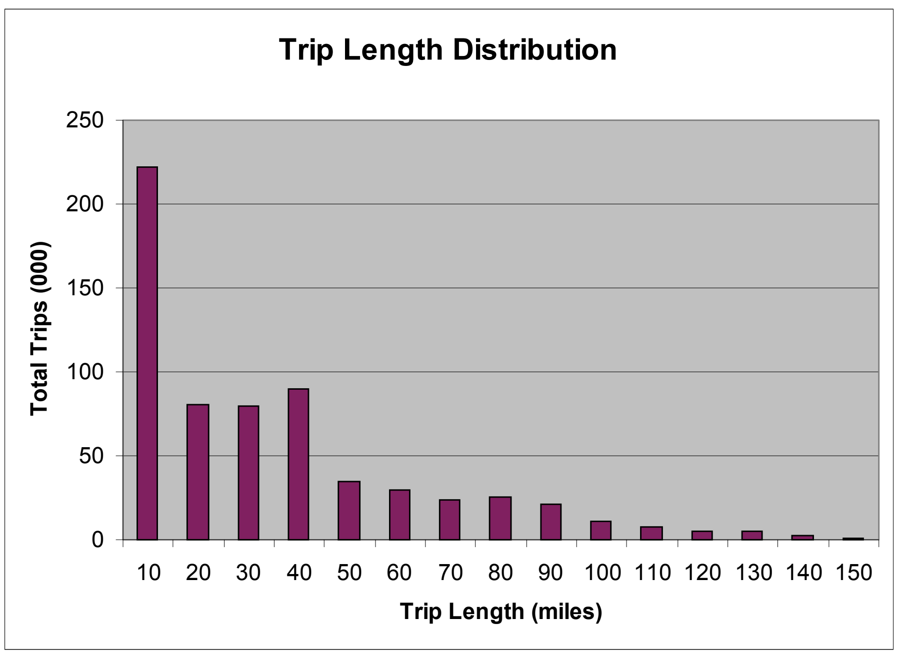

Figure 2. Trip length distribution

For Scenario 1 in Year 2025, a spreadsheet is used to generate the new truck trip table. The total number of trips for a given origin-destination pair is expanded from "existing conditions" to 2025 based on the product of the employment increase expected for the county where the origin zone is located times the employment increase expected for the county where the destination zone is located. This is explained further in Chapter 5. The employment forecasts were obtained from the Best Practices Model effort [10]. The trends specified there until Year 2020 were extended to Year 2025 by extrapolation. To account for the construction of a rail tunnel under the Hudson River and other rail-related improvements and enhancements, a table of intermodal trip diversion percentages is specified for each combination of intermodal terminal and origin/destination county. The values selected by the study team for the various Year 2025 spreadsheets are based on the Cross Harbor Tunnel MIS study. By changing the diversion percentages in the table and clicking the "Go" button, the desired trip table is created.

For Scenarios 2-5 in Year 2025, a second spreadsheet is used to generate the new truck trip table. It differs from the one used in Scenario 1 only in the intermodal trip diversion percentages.

To create a comma-delimited text file used as input for the model, the following actions are taken. (Click here to see an example.) For Scenarios 1-5 in Year 2025, the appropriate trip generation spreadsheet is selected and the intermodal trip diversion percentages are set to their desired values. The "Go" button is clicked to create the new trip table. The OD flags are set to their desired values and the dataset is saved in comma-delimited format. Finally, the first record in the dataset is deleted since it contains the field names.

F.5 FILES DATAFILE

The *files* datafile contains two file names. The first record in the file gives the name of the network data file to be used by the model in doing the current model run. The second record gives the name of the flows data file to be employed.

F.6 AADTCOST DATAFILE

The *aadtcost* datafile has 13 records, one for every functional class in the links dataset. Each record has two fields. The first is the functional class to which the record pertains. The second is the cost (on a per day basis) to add one unit of "AADT capacity" to the link. Only two different costs are reflected in the dataset. One is the cost to add one unit of "AADT capacity" to a typical urban arterial. The other is the cost to add one unit of "AADT capacity to a typical urban freeway. Appendix G describes how the cost coefficients were developed.

Table F.3 Average AADT per lane by functional class

Fclass	Average AADT/Ln	# in class
1	9487	19
2	4912	26
6	4248	41
7	2860	49
8	1093	49
9	1621	15
11	19859	534
12	17229	371
14	7383	959
16	5505	749
17	4591	153
19	1392	19
20	6719	24

F.7 AVGAADT DATAFILE

The *avgaadt* datafile lists average AADT values by functional class. Each record has two fields. The first is the functional class to which the record pertains. The second is the average AADT for that functional class. The numerical values are shown in Table F.3. These values were developed from the AADT data in the *links* dataset, stratified by functional class.

F.8 PERCENT TRUCKS DATAFILE

The *pcttrk* datafile lists percentage truck values by functional class. Each record has two fields. The first is the functional class to which the record pertains. The second is the truck percentage for that functional class. Three different values are employed. For urban freeways, the value is 10%. For all other freeways, it is 7%. For minor arterials and other urban streets, it is 5%.

F.8 PARAMETERS DATAFILE

The model parameters data file, *params*, contains three parameter values. The first parameter is the maximum flow increment that the model is to use in the assignment process. Presently it is set to 1. The second parameter is the maximum percentage increment of flow that can be assigned per step. That value is set to 5%. The minimum of these governs the actual incremental flow that can be assigned. The last parameter is a flag that indicates whether the network file contains centroid connectors (1 = yes). If so, the path building module cannot create paths that pass through the zone nodes.

REFERENCES

[1] Jones, N., L. Konieczny and G. List. Recent Advances in Capacity Investment Modeling Capabilities, Technical Report, Department of Civil Engineering, Rensselaer Polytechnic Institute, Troy, N.Y, 2000.

[2] Konieczny, L. and G. List. Exploring the Impacts of Reserve Capacity in Network Investment Decision Making, Technical Report, Department of Civil Engineering, Rensselaer Polytechnic Institute, Troy, N.Y, 2000.

[3] Konieczny, L. and G. List. Moving the Gradient Search Based Network Enhancement Solver to Stand-Alone Operation, Technical Report, Department of Civil Engineering, Rensselaer Polytechnic Institute, Troy, N.Y, 2001.

[4] Konieczny, L. and G. List. Gradient Search Based Network Enhancement Solver, Technical Report, Department of Civil Engineering, Rensselaer Polytechnic Institute, Troy, N.Y, 2001.

[5] New York Metropolitan Transportation Committee. Network dataset description.

[6] New York Metropolitan Transportation Committee. AADT and truck volume observations.

[7] Polytechnic University. Technical Memorandum #1, Existing Conditions, Existing Problems, and Public Input, prepared for NYSDOT Region 11, New York, NY, March 28, 2001.

[8] New York Metropolitan Transportation Committee. Truck node definitions, Best Practices Model documentation, New York, NY.

[9] New York Metropolitan Transportation Committee. Truck flow matrix, Best Practices Model documentation, New York, NY.

[10] New York Metropolitan Transportation Committee. Employment forecasts.

Appendix G

Cost of Adding Capacity to the System

Appendix G - Cost of Adding Capacity to the System

G.1 INTRODUCTION

There are numerous improvements that can be made to the surface arterial network to increase the capacity of the system to accommodate freight. Some of these will have a relatively minor physical impact upon the system while at the same time having a significant impact upon its capacity. One such improvement is the installation of intelligent transportation system technologies (ITS). Other improvements are very site specific, i.e., increase the vertical clearance at a low bridge, or widen the radius of the curbs at an intersection. Because of the specificity of these improvements it is not possible to generalize their cost on a system wide basis.

However, there are three types of capital improvements that can be made to the existing surface arterial system to increase capacity where the cost can be reasonably estimated. These are the construction of a freeway or surface arterial on new location, a bored tunnel, and the widening of existing freeways or surface arterials with additional lanes.

The estimated costs developed in the following sections are based, in part, on the guidelines used by Region 11 of the NYSDOT in estimating project costs before the project scope is defined. These costs are based on a broad composite of past projects. Because the guidelines do not include the cost of bridges that may be incident to a surface arterial project, utility costs, and engineering costs, these have been estimated using generally acceptable percentages of the construction costs. Region 11 Design and Structures Groups reviewed the initial version of this document and their comments are referenced, incorporated in this paper and edited versions are attached for the reader’s convenience.

G.2 NEW SIX-LANE FREEWAY

Through a dialog with the Region 11 design group [1, 2], cost estimating factors were developed for a new six-lane freeway. The resulting values are shown in Table G-1.

Table G-1. Cost Estimating Factors for Freeway on New Location

Project Element	Estimated Cost
Six Lane Roadway on Embankment	$20 Million per mile
Bridges /Structures	$600 per square foot
Real Estate	$5 Million per acre ($115 per square foot)
Noise Walls	$2.5 Million per mile per side
Retaining Walls	$.4.0 Million per mile per side
Ramps for Full Interchange	$ 94 Million
Utilities	20 % of the roadway costs
Design and Construction Inspection	20% of cost of construction (excluding land)

Commentary is useful regarding the values in Table G-1 for the following entries: Bridges/Structures, Noise Walls, Retaining Walls, Ramps for Full Interchange, and Design and Construction Inspection.

- *Bridges/Structures*: This figure is important. It contributes about half of the total cost. Region 11 uses at least $500/sq.ft for these types of costs. A more realistic value is $600/sq.ft with the recognition that bridge widening can be as much as $750/sq.ft. [2, paragraph 1]
- *Noise Walls*: This value should be at least $2.0-$2.5M. It could be even higher if the walls are installed in areas of extremely poor soil, such as many parts of Queens along the Parkways. [1, paragraph 2]
- *Retaining Walls*: Region 11 can build freeways in rights-of-way about 10 ft. wider than the entire roadway when retaining walls are used. A 135-ft wide right-of-way could be assumed if one adds about $3-4 M/mile per side for retaining walls. This allows for noise walls on top of the retaining walls. Noise walls cost $1.5 M/mile/side for this option. This does not account for the additional right-of-way cost for temporary easements. [2, paragraph 4]
- *Ramps for Full Interchange*: It is important to note that the ramp costs reflected here only cover a small diamond-type interchange. For full interchanges with directional type ramps, 2-3 miles of 20-ft-wide ramps should be assumed. About 30-40% of these ramps would be on structures. The at-grade portions of these ramps would cost $8-10 M/mile. [2, paragraph 3]
- *Design and Construction Inspection*: Design, CSS, and CI costs are about 20% of construction costs. This value can be even greater when an environmental impact statement or environmental assessment is required. [2, paragraph 11]

To develop from these values a composite cost per mile for a new six-lane freeway, it was assumed that:

- There would be one full interchange with ramps per mile, with 3 lane miles of ramp about 20 feet wide, with 40% on structure. The at grade portion would be about $10 Million per mile. [2, paragraph 3],
- 80% of the freeway would be on embankment and 20% on structures,
- Landscaping costs about 1% [1, paragraph 6], and, for purposes of this estimate is included in the roadway costs,
- 135 feet wide strip of land would have to be purchased [2, paragraph 4],
- Retaining walls would be constructed on each side of the embankment portion to minimize the amount of real estate to be acquired [2, paragraph 4],
- Bridges would be 118 feet wide to accommodate all six lanes in both directions [2, paragraph 2],
- Noise walls would be required on both sides,
- Utilities relocation would be required for the portion on embankment,
- Design and construction inspection cost are 20% of the construction costs.

Based on these assumptions and the unit costs in Table G-1, the estimated total cost to construct a new six-lane freeway on new location is $320.0 Million per mile as shown in Table G-2.

Table G-2. Estimated Cost of New Six-Lane Freeway

Element	Cost (Millions) per Mile
Embankment	$16.0
Structures	$74.8
Retaining Walls	$6.4
Noise Walls	$5.0
Ramps	$94.0
Utilities	$3.2
Design & Construction Inspection	$38.6
Real Estate	$82.0
Total (One Mile)	$320.0

Region 11 Structures Group believes that a realistic freeway costs would be about $250 Million per mile for a new freeway assuming only minor interchanges [2, paragraph 10]. The above estimate includes $94 Million for a full interchange. Backing out that number and adding $15-20 Million for a simpler interchange and the above estimate would agree very closely with the Structures' estimate.

G.3 NEW SIX-LANE SURFACE ARTERIAL ON NEW LOCATION

As with the unit costs for a new six-lane freeway in Table G-1, unit costs for a new six-lane surface arterial were developed through a dialog with the Region 11 design group [1, 2]. The resulting cost estimating factors for a new six-lane surface arterial on new location with at grade intersections and the control of access are shown in Table G-3.

Table G-3. Cost Estimating Factors for Surface Arterial on New Location

Project Element	Estimated Cost
Six Lane Roadway on Embankment	$25 Million per mile
Real Estate	$5 Million per acre ($115 per square foot)
Noise Walls	$2.5 Million per mile per side
Retaining Walls	$8.0 Million per mile (both sides)
Utilities	20 % of the roadway costs
Design and Construction Inspection	20% of cost of construction (excluding land)

To expand these unit cost factors into an average cost for a new six-lane surface arterial it was assumed that:

- Entire roadway would be on embankment,
- Landscaping costs about 1%, and is included in the roadway costs,
- Noise walls on both sides,
- Retaining walls on both sides to minimize ROW Taking,
- Utilities,
- Design and construction inspection,
- 135 feet wide strip of land would have to be purchased.

The estimated total cost to construct a new six-lane surface arterial is $132.0 Million per mile as shown in Table G-4.

Table G-4. Estimated Cost for New Six-Lane Surface Arterial with at Grade Intersections and Access Control

Element	Cost (Millions) per Mile
Roadway	$25.0
Noise walls	$5.0
Retaining walls	$8.0
Utilities	$5.0
Design & Construction Inspection	$7.0
Real Estate	$82.0
Total (one mile)	$132.0

G.4 WIDENING-ADDING ONE LANE IN EACH DIRECTION TO AN EXISITNG FREEWAY

The cost estimating factors for widening an existing six-lane freeway or parkway are shown in Table G-5. As with Tables G-1 and G-3, these were developed through a dialog with the Region 11 design group [1, 2].

Table G-5. Cost Estimating Factors for Widening an Existing Freeway

Project Element	Estimated Cost
Roadway on Embankment	$10 Million per mile
Bridges/Structures	$750 per square foot
Noise walls	$2.5 Million per mile per side
Retaining walls	$8.0 Million per mile (both sides)
Utilities	20 % of the roadway costs
Real Estate	$5 Million per acre ($ 115 per square foot)
Design and Construction Inspection	20% of the construction costs

A small commentary is useful regarding the cost factor for Bridges and Structures. This value can range from $500-750/ sq. ft. Widening is often more expensive per unit area than new construction because the railings or parapets have to be replaced and portions of the existing structure have to be demolished. This particular cost factor is important because it influences about half of the overall unit cost.

To extend the unit cost factors into an overall average cost per mile for the widening of an existing freeway with the addition of one lane in each direction, it was assumed that:

- An additional lane 12 feet wide would be added in each direction,

- 80% of the freeway would be on embankment and 20% on structures,
- Bridges would be widened 15 feet,
- 20 feet wide strip of land would have to be purchased on each side to accommodate the width of the improvement and the construction equipment,
- Retaining walls would be provided on both sides of the embankment portion to minimize ROW Taking,
- Noise walls would be required on both sides along the embankment portion,
- Utilities relocation would be required for the portion on embankment,
- Landscaping costs about 1%, and is included in the roadway costs,
- Design and construction inspection cost are 20% of the construction costs.

The estimated total costs to add a lane to an existing freeway is $ 85.8 Million per mile as shown in Table G-6.

Table G-6. Estimated Cost of Widening an Existing Freeway

Element	Cost (Millions) per Mile
Roadway	$8.0
Structures	$23.8
Noise walls	$4.0
Retaining walls	$6.4
Utlities	$1.6
Design & Construction Inspection	$5.6
Real Estate	$36.4
Total (one mile)	$85.8

It is interesting to note that the Region 11 Structures Group assumes the cost of widening an existing freeway is typically more than one-third the cost of a new freeway [2, paragraph 10]. (They also indicate the latter is assumed to cost about $250 Million per mile.) The above estimate agrees very closely with their estimate.

G.5 WIDENING-ADDING ONE LANE IN EACH DIRECTION TO AN EXISTING SURFACE ARTERIAL

The cost estimating factors for widening an existing six-lane surface arterial are shown in Table G-7. (These are again based on a dialog with the Region 11 design staff [1, 2].)

Table G-7. Cost Estimating Factors for Widening an Existing Surface Arterial

Project Element	Estimated Cost
Roadway on Embankment	$12 Million per mile
Noise walls	$2.5 Million per mile per side
Utilities	20 % of the roadway costs
Real Estate	$5 Million per acre ($ 115 per square foot)
Design and Construction Inspection	20% of the construction costs

Commentary is useful regarding the values in Table G-7 for two entries: Roadway on Embankment and Design and Construction Inspection.

- *Roadway on Embankment*: The costs of intersections, signals, and appurtenances are included in the roadway cost.
- *Design and Construction Inspection*: Design, CSS, and CI costs are about 20% of construction costs. This value can be even greater when an environmental impact statement or environmental assessment is required. [2, paragraph 11]

In extending these cost factors to the cost per mile for the widening of an existing surface arterial with the addition of one lane in each direction, it was assume that:

- An additional lane 12 feet wide would be added in each direction,
- Intersections, signals, etc would need to be upgraded,
- 30 feet wide strip of land would have to be purchased on each side to accommodate the width of the improvement and the construction equipment,
- Noise walls would be required on both sides,
- Landscaping costs about 1%, and is included in the roadway costs,
- Utilities relocation would be required,
- Design and construction inspection cost are 20% of the construction costs.

The estimated total costs to add an additional lane in each direction to an existing surface arterial is $62.6 Million per mile as shown in Table G-8.

Table G-8. The Cost of Widening by Adding One Lane in Each Direction to an Existing Surface Arterial

Element	Cost (Millions) per Mile
Roadway	$12.0
Intersections, signals, etc	$2.0
Noise walls	$5.0
Utilities	$2.8
Design and Construction Inspection	$4.4
Real Estate	$36.4
Total (one mile)	$62.6

G.6 BORED TUNNEL

The cost of a bored tunnel was estimated at $2 Billion per mile for a 6-lane tunnel, three lanes in each direction, based on the very limited information available. While this estimate is adequate for preliminary network analysis, if the analysis indicates that a bored tunnel should receive further consideration, then a more detail estimate would be required.

G.7 AVERAGE CAPITAL COST PER AADT

For the model to distribute flows over the network, investment costs are captured through a coefficient that reflects the cost of adding one additional unit of AADT. To develop these values, the following process was employed.

First, the costs of adding capacity to existing freeways and surface arterials were developed. Those values are reflected in sections 4.0 and 5.0 of this appendix. Second an average AADT by functional class was developed. The derivation of these values is described in Appendix F. Then, to estimate a cost per AADT, the following equation was employed:

$$\text{AADT Cost} = C_{est}CRF(1000000/365)/(AADT*H_{cap}) \quad \text{(G-1)}$$

Where: C_{est} = Estimated cost of the facility
CRF = Capital Recovery Factor
AADT = Average Annual Daily Traffic
H_{cap} = Number of hours facility is at capacity/day

The CRF which we calculated was equal to 0.106, and the H_{cap} we used was 13 hours for freeways and parkways, and 10 hours for arterials. It has been observed that freeways generally experience more hours at capacity than arterials which is reflected above. The general costs that were computed were $0.74/day/AADT and 0.85/day/AADT for arterial and freeways respectively. Truckways were assumed to have the same characteristics as freeways.

REFERENCES

[1] New York State Department of Transportation, Region 11 Design Group, email correspondence, August 14, 2002.

[2] New York State Department of Transportation, Region 11 Design Group, email correspondence, August 19, 2002.

Appendix H

Additional Maps for Year 2000 and Year 2025 Model Runs

Table of Contents