Analysis of Routes and Ridership of a Franchise Bus Service: Green Bus Lines

for

New York City Department of Transportation

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1: Introduction

Ridership on buses throughout New York City has been increasing in the last several years due to the combination of the economic boom and the use of Metrocard which allows passengers to make free transfers between subways and buses. The response to the free transfer was perhaps greater in Queens, where many neighborhoods were far from subways and previously using a bus to access the subway required paying two fares. This “two fare zone,” among other characteristics of Queens, led to the prevalence of the dollar vans, which diverted a significant share of the bus passengers.   Thus, since 1997 when the free transfer was implemented, much of the ridership has been returning to the public transit buses.

A significant portion of the bus service in Queens is provided by private companies (franchise bus companies) who have contracts with the New York City Department of Transportation (NYCDOT) to provide service. These companies have been operating since the first half of the 20th Century in well established service areas. With the increase in ridership, there is a need to examine the routes to determine if they are still best serving the riders’ travel needs.

Ridership by route is a basic piece of information for planning bus service. The electronic registering fareboxes (ERFs), which allow for the free transfer between bus and subway, are suppose to provide detailed counts of the passengers on each bus. However, there have been questions about the reliability of the ridership numbers provided by the ERFs.

This project had dual purposes: To establish a method for determining ridership by route and simultaneously checking the reliability of the boxes; and to analyze (based on existing data) whether the existing routes could be changed to better meet needs. NYCDOT has designated Green Bus, one of the private bus companies, for the study based on its high ridership.

To meet the project purposes, the study team undertook a series of tasks. The Green Bus routes and service area were analyzed using geographic information systems; socio-economic characteristics of the service area and school locations were mapped. The results are available in Working Paper No. 2. Study members rode several Green Bus routes, recording passenger boardings and alightings; much of this information is incorporated in a later chapter. Ridership data, max load counts, and schedules from Green Bus was analyzed. Information on the accuracy of the fareboxes were gathered from literature and from interviews with many people who use the data from the fareboxes.

The results of the study are reported in the next three chapters. Chapter 2 discusses various methods of counting ridership used in the industry and the problems with the electronic registering fareboxes. Chapter 3 provides a method for producing an accurate count of the Green Bus routes and checking the data provided by the electronic fareboxes. Chapter 4 is a route by route analysis of the exiting service with recommendations for changes.

2: Methods of Counting Riders

This chapter will discuss how bus companies count riders. The first section is a summary of a TCRP synthesis of practices among 33 North American transit agencies. The second section discusses the difficulties that Green Bus has encountered with using the electronic fareboxes to record ridership.

Passenger Counting Technologies

TCRP Synthesis 29 (Boyle, 1998) examines the current state of practice among transit operators for counting passengers. It is based on a literature review, a survey of 33 transit agencies, and detailed telephone interviews with six transit agencies.

The report categorized the counting techniques into four types:

$ Manual: Checkers may use either paper and pencil or lap top computers to record
$ Estimation from revenue
$ Automatic passengers counters (APCs)
$ Electronic Registering Fareboxes (ERFs)

Large bus systems are more likely to use manual methods and to have permanent checkers on staff. The method is labor intensive and absenteeism may create problems. Accuracy of manual methods tends to decrease with checker burnout. A major advantage of the method is the checkers can gather other information and can note unusual circumstances. One respondent noted that manual counters were more accurate when they were familiar with the route.

Estimating ridership from revenue requires that the agency have an accurate model or formula of ridership as a function of revenue, which requires an initial accurate count. Further, because the relation changes with time, particularly is there are changes in fare level, structure, or collection media, the formula has to be recalibrated periodically.

There are two types of APC:

$ Infra red beams cross stair wells and passengers are counted as they break the beams. The order in which the passenger breaks the beams determines if the passenger is boarding or alighting.
$ Treadle mats on the steps record when passengers step on them; the order of steps is similarly used to determine if the passenger is boarding or alighting.

The two systems are equally accurate but the treadle mats can be difficult to maintain in some climates. Other problems are: maintenance of the hardware, particularly in hard pressed maintenance departments which give keeping buses in service much higher priority than maintaining APCs: and uncooperative bus operators, who fear the information may be used to their disadvantage. APC data are most useful when the APC is integrated with an automatic vehicle location (AVL) system.

The main purpose of ERFs is revenue control and accountability, and therefore they are not ideally designed for counting passengers. They are most useful were determining system-wide ridership. Route level ridership, when there is interlining of buses between routes, depends on drivers' cooperation in recording the end and beginning of routes. Transit agencies report that uncooperative or forgetful drivers reduce the accuracy of the route-level information. Accuracy is usually verified by comparing the results to revenue. Other problems reported for ERFs were:

- Debugging. Agencies reported that debugging the software took from 6 months to 6 years. (All of the respondents who had ERFs had either GFI or Cubic.)
- Mechanical and equipment problems; for example, keeping the swipe head clean, currency jams, overloaded vaults.
- Software problems, such as data retrieval or limited data manipulation problems.
- Accuracy of ridership data and verification problems. TriMet found ERFs to be accurate at ±10%; at trip level, accuracy was ±3%.

Comprehensive and ongoing training of operators is necessary for effective use of the ERFs. Benefits that respondents reported for ERFs were:

- The data have more detail
- There is greater accountability
- They have better control over revenue
- Information is available sooner

Common methods that respondents used to verify the ridership data were:

- Comparing the counts with previous counts
- Comparing ridership with revenue
- Examining trip level data for unexplained variations
- Counting a random sample of trips in detail

Which method is best depends on the purpose for which the data will be used. ERFs are best for providing system level information and APCs are better at providing route and trip level information. Manual methods can provide other information, while electronic methods provide data sooner.

Green Bus's Electronic Registering Fareboxes

On July 4, 1997, the seven franchise bus operators and New York City Transit (NYCT) bus service switched to electronic registering fareboxes (ERF) under the leadership of NYCT. The new ERFs record the revenue collected along the route and the riders by type of rider, fare, or payment method. The type of rider might be local, express, senior citizen, school passenger, or employee. There are ten different fare categories (besides free) ranging from 50 cents to $4. Payment methods include Metrocard, universal, and time based as well as cash or token. The time based fares reflect the Green Bus fare structure which has an off-peak differential. Peak fares are $1.50, consistent with the flat fare charged by NYCT, but off peak fares are $1.00.

When the buses pull in to the garage, the revenue and ridership data are electronically probed and transferred to a PC in the garage. The fareboxes are then pulled and the money removed, counted , and kept by Green Bus. The fareboxes are then returned to the buses. Once per day the NYCT computer “polls” the PC. The NYCT sends back standardized reports on revenue and ridership.

Green Bus (Drantch, 2000), NYCDOT (Cohen, 1999), and Queens Surface, another of the franchise bus operators, (Clark, 2000) all say that the reports contain discrepancies. Some of these discrepancies are obvious (e.g., 16,470 school passenger on one day on one route) while others can only be detected by analyzing the data. Green Bus reported that they adjust the data in order to provide accurate information to NYCDOT. (Drantch, 2000)

Cubic, the manufacturer of the fareboxes, has made some adjustments, but they have not eliminated the problems. Various people at NYCT, when asked about the problem, said they were not aware of any problem.

A second issue concerning the accuracy of the ridership numbers is the special Metrocard distributed by the schools. This card is used by children traveling to and from school (a significant part of Green Bus ridership). Sometimes the cards are given to the children several days or weeks after school begins; additionally, the children often damage or lose the cards. The drivers let them ride, and are suppose to record them, but may not always do so.

3: Ridership Verification

Introduction

Ridership on buses throughout New York City, including on Green Bus routes, has been growing in the past several years due to the strong economy and the introduction of Metrocard and free transfers between buses and subway. This growth suggests that service needs to be reviewed, and increased or shifted to accommodate the increase in ridership and probable changes in travel patterns. In order to determine what specific changes need to be made, accurate ridership numbers are needed. but, given the problems with the data from the electronic registering fareboxes (see Chapter 2), NYCDOT lacks confidence in the numbers that they have. Therefore they need a method to verify the figures.

Because the ridership figures are provided by route every month, the method proposed below is to verify the ridership of one or several routes for a specific month. A possible method is to do a total manual count of several routes. This would be very labor intensive. Instead, it is proposed that a random sample of one-way bus trips be manually counted, and the average of the counted trips be compared to the average ridership calculated from the figure from the electronic farebox (that is, the monthly ridership divided by the number of trips) for the month. However, an average calculated from a sample will almost inevitably be off from the actual average, although it will probably be close if the sample is not biased. Therefore, a confidence interval is estimated; there is a specific probability (called the confidence level) that the actual average is within that range. If the average ridership based on the electronic fareboxes is not within that range, the assumption is made that the fareboxes are not providing accurate counts.

The next section discusses the statistical background for choosing the sample. In the following section, the variance of ridership per trip is discussed and estimated. The final section describes the procedures for conducting the count of the sample. A manual for the procedure is included in Appendix A.

Sample Size

The confidence interval for a mean of a variable estimated from a sample (in other words, how far off the estimate can be) depends on the size of the sample, how much the individual variables vary around the average, and the confidence level desired. In this case, the variable is the ridership of one-way bus trips on the route. (If the desired level of confidence has been determined and the variance is known and the variable (ridership per trip) is normally distributed, the required sample size (n) can be determined as:

$$n = (z_{\alpha/2}^2 \ \sigma^2) / E^2$$

Where z = normalized deviation from the mean for a given probability

α = significance level = 1- β

β = confidence level
σ = standard deviation of ridership per bus trip (R)
E = Half the confidence interval (or the acceptable error in estimated mean)

The confidence level and confidence interval (or acceptable error) will be determined by NYCDOT based on balancing resources against the level of precision they desire. (See the next section.) The variance depends on the nature of the variable, in this case the number of riders who board a bus during one trip.

There are two issues concerning variance:

Is the variance of riders per trip constant between different bus routes? Passengers use buses at different rates per hour depending on the time of day. However, bus schedules usually reflect the differences. Thus, the mean ridership should vary over time but not as much as if buses maintained the same headway throughout the day. The variance ideally would simply reflect the randomness of passenger arrivals. However, if buses bunch due to a missed trip, traffic congestion, sick passenger or any other problem, those buses following closely behind another will have relatively low riderships while those buses that follow a long gap in service will have relatively high ridership. Thus, high variance may reflect irregular headways, low variance indicate regular headways and smooth service.

The second issue is the size of the variance. The greater the variance, the larger the sample size will have to be in order to maintain the same level of confidence.

Estimation of Variance

To answer both these questions, the study team obtained ridership data from NYCT for their routes in Queens. The data represent complete manual counts for one day for each of the routes. The counting is done at each bus stop. The number of riders who board and who alight from each bus along with the bus number, trip number, direction, and time are recorded. Each route is counted on two separate days, with the data from the two days in separate data sets.

Four route-days of data were analyzed, two for routes with extensive service (based on service times and headways), the Q1 and Q3, and one route with a low level of service, Q79, for two different days (to determine if variance or coefficient of variation is relatively constant for one route). The UTRC team first manipulated the data in order to calculate the total number of passengers for each one-way trip. Then the mean, standard deviation, and coefficient of variation were calculated for riders per one-way bus trip was calculated for the total days as well as for each time period within the day (AM peak, Midday, PM peak, evening, and night) and for each direction within the time periods. (Coefficient of variation is the standard deviation divided by the mean. Because variance is often larger for variables with larger means, the coefficient of variation is sometimes a more consistent measure.) Table 3-1 presents the results.

Mean ridership varies substantially between routes, with the highest mean ridership on the Q3 (67 riders per trip during the AM peak on northbound buses) and the lowest for the Q79 (14 riders per trip). The means for the two different days on the Q79 are reasonably close. The average riderships for the two extensive routes drop substantially in the evening and even more at night (defined as midnight to 6 AM). Also the average riderships during the peak period differs between the peak direction and non-peak direction, which is what would be expected.

Of more interest for this study, the standard deviations also vary, from a high of 24 (for the Q3) to a low of 10 (for the Q79). The standard deviation does appear to be related to the size of the means. When the coefficient of variation is used, there is consistency between three of the routes with values ranging only from 0.68 to 0.72, but the third route (Q3) has a much lower coefficient of variation at 0.49.

During the different periods of the day, the standard deviation varies from a low of 11.50 (during the evening and night service) to a high of 25.78 during midday, while the coefficient of variation varies from 0.28 (during AM peak) to 0.63 during night). One interesting observation is that the standard deviation on the two more extensive routes appears to be larger for the outbound direction regardless of the time period.

In summary, neither the standard deviation nor the coefficient of variation appear to be constant. For the purposes of determining sample size, this is inconvenient. A safe action, then, would be to use a value for the standard deviation that would be as large or larger than any likely value. this however means that for some routes, the sample size will be larger than needed. However, once actual counts have been made for a sample of trips on a specific route, a standard deviation for the route can be estimated; thus any future counts can be done for a sample size that is based on better data.

Table 3-2 presents sample sizes for different combinations of confidence level, confidence interval, and standard deviations. The standard deviations in the table range from a low of 20 riders per trip (just below the highest of the four routes analyzed) to a conservative estimate of 35 riders per trip. It should be pointed out that the most conservative assumption for standard deviation combined with the most stringent requirements for level of confidence and narrowness of confidence range require a sample size that is greater than the number of trips in one month for many of the routes. In that case, a total count would be done.

Counting Procedure

The procedure for estimating ridership consists of three phases: I. sample selection, II. data collection, and III. average ridership estimation and comparison. The sample will be used to calculate the confidence interval for average ridership per trip for one month for one route. Then the average calculated from the number provided by the fareboxes will be compared to the interval.

I. Sample Selection

This method is adapted from FTA circular C2710.1A (UMTA, 1988: describes the method required for collecting “Section 15" data).

Steps

1. Determine the total number of bus trips to be sampled from each route for one month (n)

based on the desired confidence level and confidence interval and the assumed standard deviation. (See previous section and Table 3-2.) For example, suppose that route Q8 is to be counted in the month of September 2000, and a 95% confidence level and error of no more than three from the actual average ridership are desired. Assuming a maximum standard deviation of 28 riders per trip, the required sample size (from Table 3-2) would be 336 trips (out of approximately 4700 scheduled trips per month).

2. For the route to be counted, create a unique identification number for each trip in the month based on the schedule of bus trips. Use a five digit number where the first two numbers represent the date within the month and the last three represent the trip on that day. Include all trippers, etc. It is not necessary to write out every number, but the first and last number for each date should be noted.

As an example, if the Q8 were to be counted during the month of September (September 2000 was used) the unique identifiers would be determined as follows (this is based on the trip schedule issued in October 1998). September has 30 days so the unique identifiers would start with numbers ranging from 01 to 30. The schedule indicates that there were 174 one-way trips scheduled, 122 Saturday trips, and 105 Sunday trips. Thus the final three digits would range from 001 to 174.

01001 -01174	represents all trips on Friday, September 1
02001-02122	" " " " Saturday, September 2
03001-03105	" " " " Sunday, September 3
04001-04105	" " " " Monday, September 4 (Labor Day)
05001-05174	" " " " Tuesday, September 5
. .	
. .	
30001-30122	" " " " Saturday, September 30

3. Use a random number to select specific trips to be counted. A random number in the ranges determined above may be generated using a spreadsheet or computer method or chosen from a random number table. (Appendix B provides a random number table.)

To use the table, proceed across each line of the table, reading each consecutive series of five numbers as a new number. For example, looking at Table 3-3 the first five digit number is 46119, the second is 61198, the third is 11986, and so forth.

Select the first number that you come to that is one of the unique identifiers assigned in step 2 and check it against a calendar to determine the day of the week that it represents. For example, continuing with the Q8 example and using the random numbers in Table 3-3, the first unique identifier encountered is 19063 (circled in the table) which is trip number 63 on Tuesday, September 19. The next unique identifier encountered is 22154, the 154th trip on Friday, September 22.

Thus the first seven trips selected would be:

Number	Date	Day	Trip
19063	9/19	Tuesday	63

22154	9/22	Friday	154	
04026	9/04	Monday*	26	* Labor day - use Sunday schedule
17083	9/17	Sunday	83	
03109	9/03	Sunday	109	
20098	9/20	Wednesday	98	
02058	9/02	Saturday	58	

Continue finding random numbers until 336 trips have been selected.

When all of the numbers in the random number table have been used, read the numbers from right to left (or down each row or any other systematic method) or use a different random number table.

Any method of choosing random numbers can be used. However, do not substitute a process that will result in a "more representative" selection. Using the random numbers method will provide a distribution of peak, midday, night, etc. trips without unrecognized human bias influencing the results.

II. Data Collection

The procedure provides for the collection of a sample of data for one route from which to estimate monthly ridership for that route. It entails a surveyor (counter) to ride the bus for each trip selected from one end of the route to the other (i.e., one one-way bus trip) counting passengers boarding at each bus stop and recording the counts on the attached "Ridership Trip Sheet." The steps are listed below:

Steps

1. Prepare a separate "Rider Count Sheet" (see Appendix A) for each trip that has been selected in the sample selection process. Fill in as much of the information at the top of the sheet as possible before going to the field. Take along several sheets for each trip to be surveyed, a clip board or other hard surface to write on, and two or more pens or pencils..
   (Optional: The bus stop locations may also be recorded before going to the field. This will save time while counting; also it will not always be easy to see the street signs to determine the location while riding the bus. If this is done, the surveyor should be alert to missed stops.)
2. Proceed to the "start point" and wait for the bus. If the trip to be surveyed is a "missed trip," that is the bus does not arrive, board the next bus that comes. Record the missed trip under "notes."
3. Board the bus and take a seat from which the front door can be clearly seen. (Surveyor will need to have a direct line of sight that will not be blocked by standees.)
4. Record the start time, vehicle capacity, and all other information at top of sheet.
5. When the bus leaves the stop (stop 1), record the number of passengers who boarded at stop 1. Include any passengers who may have stayed on board from the previous trip.
6. At each stop, write the number of passengers who board.

7.* Also, at each stop, record the nearest cross streets (unless the bus stop locations have been pre-recorded. If the locations have been pre-recorded, verify the location. If the bus by-passes a pre-recorded bus stop due to no boardings or alightings, record zero riders in the appropriate column. If the bus bypasses a bus stop because there is no room for additional riders or because it is running express to correct bunching, record zero and explain the reason under comments.) Note that the location does not have to be exact.

8. At the last stop, note the ending time and the location. Fill in the sheet number (in order in which the sheets were filled in) in the first blank of "Sheet ___ of ___" and the total number of sheets used for this trip in the second blank. Make sure that the route number and trip number are filled in on all sheets.

9. After the trip, sum the total number of riders for that trip.

* Step 7 is not actually needed and at the discretion of the supervisor of the counting effort may be omitted. The advantage of including it is that if the total number of riders for the trip appears to be an anomaly, there is additional information with which to determine why it differs from other trips. Further, a better understanding of how the route is used by the riders is provided.

III. <u>Ridership Interval Estimation</u>

The average ridership per trip for the sample will be compared with the average ridership per trip based on the total ridership reported for the month on the route counted by Green Bus.

Steps

1. Set up a spreadsheet in which the total ridership for each trip (from step 9 above) in the sample along with the route number, the day, the trip number is recorded. Table 3- 4 provides a sample of how the spreadsheet might be laid out.

2. Using the spreadsheet commands, determine the average ridership per trip, the standard deviation, and the number of trips for the route.

3. Check that the number of trips in the spread sheet is equal to or larger than the number determined in phase I. step 1.

4. Check that the standard deviation is equal to or less than the confidence level and error chosen.

5. Calculate the confidence interval by subtracting and adding the error to and from the average ridership per trip from the spreadsheet.

6. When Green Bus provides the ridership information for the month that the count was done, determine the average ridership per trip for the route by dividing the total monthly ridership reported for that route by the total number of trips for that month.

7. Compare the average riderships per trip from step 6 to the interval calculated in step 5. If

the average is within the interval, the conclusion is that, at the chosen confidence level, the electronic fareboxes are providing an accurate count. If the average outside the interval, the conclusion is that the fareboxes are probably not providing an accurate count.

Continuing with the route Q8 example started above, Table 3-4 is a hypothetical result of the counting. The sample size (336) agrees with that established in step I (1) and the standard deviation from the sample (23.4 riders per trip) is less than the maximum of 28 used to establish the sample size. The confidence interval is calculated by subtracting 3 from the average and adding 3 to the estimated average. Thus, we can be 95% confident that the average riders per trip on route Q8 in September is with the range 29.9 to35.9.

Assume that the Green Bus ridership report indicates a total ridership of 158,455 for Route Q8 in September 2000. The total number of trips for September can be calculated as shown here:

weekday trips = 20 weekdays* 174 trips/weekday =	3654
Saturday trips = 4 Saturdays * 122 trips/Saturday =	488
Sunday trips = 5 Sundays * 105 trips/ Sunday =	525
All trips in September 2000 (sum)	4667

(The number of days of each type are counted from a calendar. Labor Day was counted as a Sunday rather than a weekday.)

The average riders per trip based on the Green Bus report thus would be 159132 riders ÷ 4667 trips = 34.1 riders per trip. Because 34.1 is within the confidence interval, we cannot conclude that the fareboxes are providing inaccurate counts. Therefore the count provided by the fareboxes can be assumed to be accurate.

4: Analysis of Routes

This chapter will discuss each route in the Green Bus system, including a description of the existing route, a discussion of possible changes, and a recommendation of a change (or changes) to be looked into. The first section is a brief description of how the study team analyzed the routes. The next section is a description of the route system as a whole, followed by descriptions and suggested changes for each route.

Method of Analysis

Each route was looked at by the study team. Information assembled included the route schedule and map published by Green Bus, the Queens Bus Map published by New York City Transit, the revenue and ridership counts submitted to NYCDOT by Green Bus, a GIS analysis of the Green Bus service area (see Working Paper No. 2, Thorson, 2000), maximum load counts, and on/off counts of selected routes performed by study team members. In suggesting changes, the study team considered the total ridership, ridership per bus trip, and recent growth or decline in ridership, alternative transit access to the area, duplication of access, the likely origins and destinations of passengers.

Green Bus routes are well established and generally relate well to the overall transit network in Queens as well as to the major traffic generators. Riders have based their travel patterns on the existing routes; thus major differences between patron needs and the existing routes are not likely. However there are some chances for innovations.

One such change considered was the use of limited stop service, in which some of the bus trips along a local route make stops spaced longer intervals at transfer points or major attractions, such as shopping areas or hospitals. Limited stop service provides faster bus speeds which benefit passengers going longer distances (at the cost to passengers wishing to board or alight at non-limited stops) and may reduce costs to the bus operator if the increase in speed is great enough to allow the removal of a bus from the route. New York City Transit has had great success with limited stop service, finding that passengers will frequently wait for the limited stop bus. NYCT has four limited routes operating in Queens.

In suggesting the use of limited stop service on Green Bus routes, the study team applied guidelines developed by NYCT (Silverman, 1998). These guidelines indicate that roues with the following characteristics are optimal for limited stop service:

$ Route operates on wide streets
$ Streets have progressive traffic signaling
$ Route is not parallel to subway
$ Route is long (i.e., longer than 5 miles)
$ Part of the route is extended (that is, short turning is used)
$ Route feeds a subway
$ Headways on the route are 5 minutes are less

The routes suggested for limited service meet some of these guidelines. The last one was, however, considered particularly important. If the existing headway is greater than five minutes, the headway on the non-limited buses after implementing limited service would become greater than ten minutes. This was considered to be too great of a penalty for those passengers who need shorter access distances, for example the older passengers.

Green Bus System - Overview

Green Bus operates a fleet of 235 buses over 13 local routes, primarily in the southwest corner of Queens, and five express routes (identified by route numbers that start with QM instead of Q) from Manhattan to the same section of Queens. The AM peak fleet is 200 buses, and the PM fleet is 201. (Drantch, 2000) Several of the local routes have variations, some of which are identified by the letter A added to the route number.

Most of the local routes radiate from the Jamaica Center area or from subway stations along Queens Boulevard into residential neighborhoods. The areas they serve encompass southwest Queens from Brooklyn to the area immediately north of JFK Airport and south of Queens Blvd. and Jamaica Center. Many of the local routes act as feeders to subway stations. The Q60 (Queens Blvd) differs from the other local routes in that it operates from Manhattan to the Southwest section of Queens as a local bus.

Ridership statistics on all of the routes (from 1998) are presented in Table 4-1. It can be seen that annual ridership varies substantially from almost six million for the Q10 (Lefferts Blvd/JFK) to 238 thousand per year for the Q21 (Cross Bay Blvd) routes among the local routes. All of the express routes carry much fewer passengers, operating only a few runs per week day.

A large number of school children use the Green Bus service to travel to and from school. In 1998, 12% of the total 31.7 million riders were school passengers. On the 13 local routes, school passenger vary from 5% to 87% of total ridership. Green Bus personnel point out that this type of service is difficult to operate. One problem is that all of the ridership from school occurs within a five minute period. Also the children tend to be noisy and to leave behind more litter; they discourage some of the adult riders. (Drantch, 2000)

Figure 4-1 shows the relative riderships and the growth in ridership of the routes. Overall, ridership on local service has increased from 27.5 million in 1995 to 31.3 million in 1998, while ridership on the express buses has increased from 300 thousand to 400 thousand over the same period. The Q60 had the highest ridership until recently. The Q10's higher ridership is recent and due to a rapid increase from 1996 to 1998. Q6 and Q37 have both shown steady growth, while the Q7 has lost ridership steadily.

To see how the ridership of the Green Bus routes compared with other routes, average weekday NYCT ridership was obtained for Queens routes. To compute the equivalent weekday ridership for the Green Bus routes, the 1998 annual ridership figures for the local routes were divided by 300. The computed daily figures for the Green bus routes varied from 792 riders per day for the Q21 to 19,876 for the Q10. This is similar to the range for of the NYCT routes which varied from 545 riders per weekday for the Q79 to 20,588 for the Q58 (or to 24,735 for the combined routes of 20 and 44).

Table 4 - 2 Comparison of NYCT High Ridership Routes with Selected Green Bus Routes

NYCT routes	Average ridership/day	Green routes	Average ridership/day
Q 43 (Ltd)	14,253	Q 6 (L)	9,100
Q 44/20	24,735	Q 10 (L)	19,876
Q 46 (Ltd)	19,224	Q 11 (L)	11,224
Q58	20,588	Q 22	8,274
Q85 (Ltd)	12,484	Q 60 (L)	19,679
Average Weekday Bus Ridership (1999) - provided by NYCT - (Ltd) indicates routes with Limited stop service		Annual 1998 ridership adjusted for weekday ridership - (L) indicates suggested limited service	

Analysis of Individual Routes

The rest of this chapter discusses each route individually. Each route is described, including available information on ridership. (Note that there are some discrepancies in the number of one-way bus trips; the figures in Table 4-1 are based on the bus schedule for internal use, while the schedule information in the text is based on the published maps and schedules distributed to the public.) Then any suggested changes are described, followed by the reasons for the suggested changes. Table 4-3 summarizes the suggested changes.

Q6: Sutphin

Route description: The Q6 runs from the 65th St. Bus Terminal, through Jamaica Center to the cargo area of JFK Airport via Sutphin Avenue, Rockaway Blvd, and (within the airport) North Boundary Blvd. During the AM peak period the route takes about 30 minutes and has a two to four minute headway. Some of the buses short turn at Rockaway and Sutphin, in the morning for inbound (North Bound) buses and in the afternoon for the outbound (south bound) buses. There is supplemental service on school days afternoons: three buses from the Elizabeth Blackwell Junior High School at 94th St. and 101st Ave. and two buses from August Martin High School at 155th St. and Baisley.

The route feeds LIRR and the E, J, and Z subways at Archer and Sutphin. It also has transfer points with other buses along Jamaica Ave., Archer and Sutphin, at Sutphin and Liberty, Lakewood, Linden Blvd., and at the entrance to the airport. At the north end of the route it duplicates many other bus routes through the Jamaica Center; along the north end of Sutphin it duplicates the Q9, Q40, and Q41 briefly; the other three routes turn off of Sutphin by 108th Ave.

Traffic generators along the route include Jamaica Center shopping area and York College, Baisley Park, the JFK Post Office and the Halmar cargo area.

Ridership: In 1998, the Q6 carried 2.7 million riders, the fourth highest ridership among the Green Bus routes. Fifteen percent of the riders were school children. Ridership increased by 31% from 1995 to 1998.

This was one of the routes for which the UTRC team did on/off counts (see Figure 4-2); the south bound count done in the morning just after the peak shows a pattern of passengers getting on from the bus terminal through the Jamaica Center shopping street, a large number of passengers getting on at the LIRR, and then passengers getting off in small numbers throughout most of the rest of the route. The northbound count, done mid-morning, basically shows the pattern in reverse: small numbers getting on through most of the route (although 9 got on at Rockaway and Farmers), 60% of them getting off at the LIRR/subways at Archer and Sutphin, and the rest getting near Jamaica Center or at the terminal.

Suggested changes: Operate some peak hour/peak direction trips as limited service. Those buses that continue into JFK would run limited service from the 65th St Bus Terminal to Sutphin and Rockaway. The limited stops would be: the Bus Terminal, 153rd (or subway station), LIRR, Liberty Ave., Lakewood, Linden, either Foch or 119th St., and Rockaway. From Rockaway and Sutphin to the end of the route, the route would make all local stops.

Reasoning: Although Q6 is not a long route, it is heavily traveled with a short headway (less than 5 minutes) during the peak. The on/off counts indicates that many of the passengers are using the service as a feeder to the LIRR or subway, indicating that they are probably time sensitive. (This service would be similar to the Q4 limited service operated by NYCTA along Merrick Blvd.)

Q7: Rockaway

Route description: The Q7 runs from Euclid Ave. Station on the A/C subway (just inside Brooklyn) to the JFK cargo area, along Rockaway, Cross Bay, Sutter and Pitkin. According to the published schedule, the route takes about 33 minutes to operate during the AM peak period. Buses on about a third of the147 trips per weekday short turn at one or both ends of the route; all buses operate from Cross Bay and Liberty Ave. to 150th St. and Rockaway.
There is supplemental school service on school days to four different schools, a total of five trips during the AM peak and 17 trips in the afternoon.

The route serves the A and C subways at Euclid Avenue and the A at Ozone Park. The route includes transfer points to other buses at Euclid Avenue, Sheridan Ave., Rockaway and Cross Bay, Rockaway and 111th St., Lefferts, 131st St. 142nd St., 150h St. and Rockaway, and within the Cargo area. It does not duplicate any other route for more than a few blocks.

Other traffic generators along the route include: the Cargo area; the four schools - August Martin HS, Virgil Grissom JHS, John Adams HS, and Robert h. Goddard JHS, Baisley Park, and Aqueduct Race Track.

Ridership: In 1998, the Q7 carried 1.2 million passengers, making it 11th among the 13 local routes. About 32% of the riders are school passengers, either using a school issued Metrocard or paying the student half fare. Ridership *decreased* by 20% from 1995 to 1998.

Suggested changes: A schedule cut back may be warranted by the decrease in ridership. The route has headways of 4 to 6 minutes in the peaks.

Q8: 101 Avenue

Route description: The Q8 runs from 65th St. Bus Terminal to the Euclid Ave. Subway Station on the A and C lines, via Merrick, Jamaica, Sutphin and101st Ave. It is one of two Green Bus lines that run in a predominately east-west direction (along with Q7), both feeding the Euclid Station, just over the Brooklyn border. In the AM peak period, the west bound route is scheduled to take 36 minutes and runs on about a six minute headway. In the Midday, the headway is from 8 to 20 minutes long.
There is supplemental service to two schools: One afternoon trip from the Virgil Grissom JHS and one trip in the AM peak and two in the afternoon to Elizabeth Blackwell JHS.

The route feeds E, J, and Z subway stations at Jamaica Center and at Archer and Sutphin, as well as the LIRR Jamaica Station, also at Archer and Sutphin, and the Euclid Ave. Station for the A and C lines. There are transfer points to other buses at Euclid Ave., Woodhaven Blvd., 111st St., Lefferts, 127th St., and along the heavily traveled Sutphin-Archer/Jamaica corridor.

Other traffic generators along the route include Jamaica Center and York College.

Ridership: In 1998, the Q8 carried almost 2 million passengers, making it the sixth highest, in the midrange of Green Bus routes. School ridership accounts for 13% of the total. Ridership has been relatively steady from 1995 to 1998, showing only a 2.9% gain.

An on/off count by UTRC associates (Fig. 4-3) found that the east bound and west bound load profiles suggest different types of routes. The mid-morning west bound trip (feeding the Euclid Subway station) suggests a maximum load point at Lefferts, with a slightly lower peak at the LIRR/subway station (where Green Bus takes their maximum load counts). the overall west bound pattern shows the bus rapidly filling between the bus terminal and the LIRR station, maintaining high ridership until Lefferts, and then gradually dispersing the passengers. The east bound load profile shows most boardings occurring at 94th St. (Woodhaven) and 101st Ave., a shopping area and transfer point from the Q11, then fairly steady on-off activity resulting in fairly constant on-board passengers until the LIRR/subway stations where most of the passengers disembarked.

Suggested change: None.

Reasoning: The route seems to be holding steady. The large amount of on-off traffic and existing headways over 5 minutes make it a poor choice for limited service.

Q9 and Q9A: Lincoln

Route description: The Q9 runs from the 165th St. Bus Terminal to Rockaway and Lincoln in South Ozone Park via Jamaica (and Archer in reverse direction), Sutphin, Liberty, the Van Wyck Expressway (return on 135th St), and Lincoln St. The Q9A operates one trip per hour from 10 AM to 5 PM between the same terminals but along Linden and Merrick Blvds. In the AM peak, the inbound or northbound trip of the Q9 is scheduled for 21 minutes and the headway is 6 to 8 minutes. Midday headways are 15 minutes. The inbound Q9A takes 24 minutes.

There is no supplemental school service on this route.

The route feeds the LIRR and E, J, Z subway stations and the Jamaica Center subway station. There are transfer points to other buses at Lincoln and Rockaway, Van Wyck and Liberty, Sutphin and Liberty, and along the Sutphin-Jamaica/Archer corridor.

Traffic generators include Jamaica Center and York College.

Ridership: In 1998, the Q9 carried 1.3 million passengers; the Q9A carried another 21 thousand. The Q9 had the tenth highest ridership of the Green Bus routes. Twelve percent of the riders were school children. Growth from 1995 to 1998 was 28%.

Suggested changes: None

Q10/Q10A: Lefferts

Route description: The Q10 operates from the Union Turnpike/Kew Gardens subway station on the E and F lines to the central passenger terminals at JFK Airport via Lefferts and the Van Wyck Expressway. Within the airport the route travels past all the terminals starting at Terminal 5 and ending at Terminal 4. Some of the buses short turn back to Kew Gardens at Rockaway and Lefferts. Those buses that do not short turn travel between Rockaway/Lefferts and South Conduit/130th St either by Lefferts and Conduit (the C route) or by Rockaway, 131st St., 135th Ave., and 130th St (the R route). The AM peak, north bound trips is schedule to take about 55 minutes; the inbound AM peak headways are ever two to three minutes for the short turned buses and about eight to ten minutes for the trips that start at JFK. Midday headways are five minutes.

There are three supplemental trips to Virgil Grissom JHS, one in the morning and two in the afternoon.

The Q10A is a variant of the Q10 in which six of the over 200 weekday trips are run express (on the Van Wyck) from Union Turnpike to the airport. These six trips are outbound (toward JFK) only and only in the AM peak period. They leave Kew Gardens and 80th Rd. every 20 minutes starting at 7:14 AM and take 26 minutes to reach Terminal 4 (the end of the route) at JFK.

The route feeds the end of the A subway line at Lefferts and Liberty Ave., the Kew Gardens LIRR Station, and E and F lines at Kew Gardens. There are transfer points with other bus lines at JFK, Rockaway and Lefferts, 135th Ave. at either Lefferts (on the C route) or 130th St. (on the R route), 111th St. and Lefferts, Liberty, 101st Ave., Atlantic, Jamaica, Metropolitan, Queens Blvd., and Union Turnpike.

Other traffic generators include Borough Hall and the Airport Hotel (at 130th St. and 150th Ave.).

Ridership: The Q10 carries more passengers than any other route in the Green Bus system; in 1998 almost 6 million passengers. This is after rapid growth; from 1995 to 1998 ridership by 50%. Only 6% of the 1998 passengers were school children, one of the lowest proportions in the system.

A UTRC on/off count (See Figure 4-4) in early evening (in bound) shows a gradual build up of passengers to the Liberty Ave. subway station on the A and C lines, where many passengers got off and many more boarded, then a steady pattern of on and off until Jamaica Ave. were many got on and off, several boardings at the LIRR station, and a large exodus at Queens Blvd.

Suggested Changes: Operate some trips as limited stop service. Specifically, the peak hour trips that extend into JFK can be run as limited service from Union Turnpike to Rockaway and Lefferts, with stops at Metropolitan Ave., Jamaica, Atlantic, 101th Ave., Liberty, and 111th Ave. The buses would make all stops from Rockaway and Lefferts to the end of the route. It is suggested that this be tried during the two peak periods; if it is successful, it might be extended through the midday period.

Reasoning: The Q10 is a long route with short headways, making it ideal for limited service. Boardings and alightings are concentrated at major intersecting transit lines, as well as at the two main route terminals. Additionally, it feeds several subway stations and a LIRR station; people making these trips are likely to be time sensitive. Passengers going to JFK also are likely to be time sensitive.

Q11: Woodhaven

Route description: The Q11 runs from Queens Center (Queens Blvd and 59th Avenue) to Howard Beach or Hamilton Beach, via Woodhaven, Pitkin, 101st St. (return on 102nd) , and ending either at 165th Ave. and 99th St. (in Howard Beach) or 165th Ave. and 104th St. (in Hamilton Beach). About half the buses short turn at Liberty and Cross Bay; about half of the buses that go beyond that point end in Howard Beach and the other half in Hamilton Beach. In the inbound (north bound) AM peak, the headway is four to five minutes for buses between Liberty/Cross Bay and Queens Center and 30 minutes for buses that go to the two ends of the route. The scheduled travel time from the end (either end) to Queens Center is 35 minutes; from Cross Bay and Liberty it is 21 minutes. Most midday headways are five minutes, a few are seven to eight minutes.

The Q11 shares much of its route with the Q53, but the Q53 (the Woodhaven/Rockaway Park Express) makes no stops in the Q11 service area.

There are two supplemental trips to Robert H. Goddard JHS (at Lafayette and Conduit), one in the morning and one in the afternoon.

The Q11 feeds the Howard Beach subway station on the A, Rockaway Blvd. subway station on the A line, the Woodhaven Blvd. subway station on the J and Z lines, and the Queens Center/Woodhaven Blvd. subway station on the G and R lines. there are transfer points to other bus routes at South Conduit and Cohancy, Cross Bay and Pitkin, Cross Bay and Rockaway, 101st and Woodhaven (or 94th in reverse direction), Atlantic Avenue and Woodhaven, Jamaica, Myrtle Avenue, Union Turnpike, Metropolitan, Penelope/63rd Dr., Dry Harbor and Woodhaven, and Queens Blvd.

Other traffic generators include St. Johnson's Hospital and the Queens Center shopping area, Forest Park, and Aqueduct Race Track.

Ridership: In 1998, the Q11 carried 3.9 million passengers, making it the third heaviest traveled routes in the Green Bus system. the increase in ridership from 1995 to 1998 was a relatively low 7%. Nine percent (9%) of the 1998 passengers were school children.

The UTRC on/off count of a AM peak inbound trip (Fig. 4-5) shows a steadily increasing number of passengers on-board with high on/off activity at subway stations, a large number of passengers exiting at Metropolitan, and a full busload exiting at Queens Blvd. (See Figure 4-3) The bus operated with standees for more than a third of the trip.

Suggested changes: Combine the south end of Q41 with Q11. The resulting route would have three branches, one each to Lindenwood, Howard Beach, and Hamilton Beach. There would be no short turning of buses on the new route. A third of the buses (one of the three branches) would run limited service up until the first split at Pitkin and Cross Bay during the peak periods in the peak direction only. Limited stops would be at Dry Harbor Rd., Penelope/63rd Drive, (a mid point between 63rd Dr and Metropolitan if the half mile guideline is to be adhered to), Metropolitan, Union Turnpike, Myrtle Ave., Jamaica Ave., Atlantic Ave., 101st Ave., Rockaway, and Pitkin. Another possibility is to extend one of the three branches across the Bay to connect

with the Q22. (See Q41 for additional description of change.)
Reasoning: The three neighborhoods (Lindenwood, Howard Beach, and Hamilton Beach) are similar. This will allow a simplified Q41. The Q11 is a heavy traveled route, with many passengers using it as a feeder to the subways, indicating time sensitive passengers many of whom are making long trips (note how few passengers get off before the subway stations).

Q21: Cross Bay

Route description: The Q21 runs from the Rockaway Blvd. subway station on the A line (in Ozone Park) to the Ocean Promenade in Rockaway Park via Cross Bay (with a short excursion into a residential neighborhood in Lindenwood), and Rockaway Beach Blvd. It has an irregular headway, with two peak headways of eight minutes, but most are much longer - 40 to 45 minutes. (there are only 17 inbound trips per weekday.) During the midday, headways are 30 minutes to an hour and a half. The scheduled inbound trip time is 31 minutes.

There are four supplemental school trips in the morning and five in the afternoon to three schools in the Rockaway Park and Seaside neighborhoods (Stella Maris HS, Rockaway Beach JHS, and Beach Channel HS).

The Q21 runs parallel to the S branch of the A line in the Rockaway peninsula, but probably does not feed or receive passengers from it. It does feed passengers to the Rockaway Blvd. station of the A line. It has transfer points with other buses at 116th and Rockaway Beach Blvd., Cross Bay Bridge and Rockaway Beach Blvd., 164th Ave. and Cross Bay Blvd., South Conduit and Cross Bay, Pitkin Ave., Sutter Ave., and Rockaway Blvd.

Other traffic generators include Rockaway Beach, and Jamaica Bay National Wildlife Refuge.

Ridership: In 1998, the Q21 carried 238,000 passengers, the lowest number among the Green Bus local buses. Additionally, the ridership has been going down, by 14 percent from 1995 to 1998. Of the 1998 passengers, 38 % were school children. (Ridership among the school children dropped only about 5% from 1995 to 1998.)

Suggested changes: Given the low ridership per trip (16 per trip), reducing or eliminating service should be considered. If the route is to continue, then the following modification might be considered. The Q21 follows the same detour from Cross Bay Blvd. as the Q41 through a Lindenwood neighborhood. It might run straight along Cross Bay in this section, thus saving the passengers and the driver time and perhaps allowing the reduction in the number of buses needed to operate the route. However this would depend on who uses the route. There may be school children in the Lindenwood neighborhood who use this route to travel to schools on the Rockaway peninsula. (Also this change is in conflict with one made for the Q41.)

Finally, as noted above the headways vary considerably. An effort to reschedule the route using a policy headway system of 30 and 60 minutes should be studied.

Reasoning: The Q21 and Q41 follow the same route between the Rockaway station (at Cross Bay and Rockaway) and 164th and Cross Bay Blvd. Further, there would seem to be little reason for people to travel from Lindenwood to the Rockaway peninsula except for the possibility mentioned above. As for the headway change, with headways this long, passengers will need to know the schedule; it is very difficult to remember a schedule when the times have no pattern, thus requiring people to carry a paper schedule if they intend to use the bus.

Q22: Rockaway Beach

Route description: The Q22 runs from one end of the Rockaway peninsula to the other; more specifically it runs from Roxbury (Beach 169th St. and Rockaway Pt., on the east end of Rockaway peninsula) to Far Rockaway (Beach 21st St. and Mott) via Rockaway Beach and Beach Channel. This route makes 154 one-way trips per weekday. AM peak headways vary from one to eight minutes and scheduled time for an east bound trip is 36 minutes. Midday headways are 15 minutes. In the morning, 12 trips are short turned at Beach 116th and Rockaway Beach back to Far Rockaway.

There are 27 supplemental trips to several schools, parks and neighborhoods, including Brian Piccolo IS, Beach Channel HS, Rockaway Beach JHS, Jacob Riis Park, and the Breezy Point neighborhood.

The route feeds the end station of the S branch of the A subway line (Rockaway Park Beach Station) and parallels both branches of the A line. At the east end the Q22 has transfer point with other buses. It parallels the Q35 from its west end to Beach 116th St. and has transfer points with the Q21 and Q53 from Beach 116th St. to the Cross Bay Bridge.

Besides the places and transportation already mentioned, traffic generators include St. John's Hospital, the Peninsula Hospital, and Stella Maris High School.

Ridership: In 1998, the Q22 carried 2.5 million passengers. From 1995 to 1998, ridership grew by a slight 3% and 29% of the 1998 passengers where school children.

Suggested changes: Consolidation with the Q35, which runs from Beach 116th St. on the peninsula to terminus of the 2 and 5 subway lines in Brooklyn.

Reasoning: This consolidation would eliminate the duplication of the Q22 and Q35 and would provide access to Brooklyn for people living on the east end of the peninsula.

Q22A: Bayswater

Route Description: The Q22A makes one trip east bound trip in the morning from Dunbar and Mott Ave. to Mott Ave. and Beach 21st St. (the east end of the Q22 route) and one west bound trip in the afternoon.

The route feeds the end of the A line.

Ridership: In 1998, the Q22A carried about 17,600 passengers (about 68 per day) or an average of 34 passengers per trip, which is about average for the Green Bus routes. The majority of the 1998 riders (87%) were school children. the growth of ridership since 1995 is very large - it increased by 20 times. This is presumably because the route started about then.

Suggested changes: None

Q35: Marine Parkway

Route description: The Q35 runs from Rockaway Park (Beach 116th St. and Newport) to the subway station (2 and 5 lines) at Flatbush and Nostrand via Newport, Rockaway Beach, the Marine Parkway Bridge, and Flatbush. It makes 162 one-way trips per weekday, with a AM peak headway of 10 to 12 minutes. The scheduled travel time in the inbound (west bound) direction is 30 minutes. The midday headways are 15 minutes.

There are supplemental trips to Brooklyn College and Midwood HS in Brooklyn (one in morning and one in afternoon) and on the Rockaway peninsula, there are supplemental trips to Jacob Riis Park (summer only) and to Beach Channel HS and Stella Maris HS.

The route feeds the end terminus of the 2 and 5 subway lines (west end of route) and the end of the S branch of the A subway (east end of the route). It has transfer points with other bus routes at its east end and along Flatbush at Avenue U, Avenue S, Fillmore, Flatlands, Kings Highway, Avenue L, Avenue K, and Nostrand .

Other traffic generators include Floyd Bennett Field, Marine Park Golf Course, and Kings Plaza.

Ridership: In 1998, the Q35 carried 1.1 million passengers or about 21 per one-way bus trip. This has held almost steady since 1995, showing a 0.8% loss in three years. School children make up only 8% of the passengers.

Suggested changes: Consolidation with Q22.

Reasoning: This consolidation would eliminate the duplication of the Q22 and Q35 and would provide access to the to Brooklyn for people living on the east end of the Rockaway peninsula. The low passengers per bus trip (21 - one of the lowest) suggests that the number of bus trips might be reduced. The consolidation would also serve to increase ridership.

Q37: 111 Street

Route description: The Q37 runs from South Ozone Park (131st St. and 135th Ave.) to Kew Gardens (Union Turnpike and Queens Blvd.) via 135 th Ave., 111th Street, Park On a weekday, the Q37 makes 167 one-way trips. The AM inbound (north bound) headways varies from three to eight minutes and the scheduled travel time is 24 minutes. Midday headways are 20 minutes.

There are four supplemental trips to the Robert H. Goddard JHS and five supplemental trips to Virgil Grissom JHS.

The Q37 feeds the A subway at Liberty Ave., the J at Jamaica, and the E and F at Queens Blvd. It has transfer points to other bus routes at Lefferts and 135th Ave., Rockaway and 111th St., 109th and 111th St., Liberty and 111th St., 101st Ave. and 111th St., Atlantic and 111th St., Jamaica and 111th St., Myrtle and 11th St., Metropolitan and Park Lane South, and Queens Blvd.

Other traffic generators along the route include Aqueduct Race Track and Borough Hall.

Ridership: The 1998 ridership on the Q37 was 1.6 million, which was an 26% increase over 1995 ridership. Thirteen Percent (13%) of the passengers were school children.

Suggested changes: None.

Q40: 142nd St.

Route description: The Q 40 runs from south Jamaica to the Sutphin Ave. subway station (at Sutphin and Hillside) on the F line via 140th St. (or 143rd St. and 135th Ave. in reverse direction), Rockaway, 142nd St, Lakewood, and Sutphin. there are 209 one-way trips on a week day, with AM peak north bound headways of five to ten minutes and a scheduled travel time of 21 minutes. Midday headways are about 12 minutes. There is no supplemental school service.

The Q40 feeds the Jamaica LIRR and E, J, and Z subways at Sutphin and Archer and the F subway at the end of the route. there are transfer points with other bus routes at Rockaway and 142nd St. Linden and 142nd St., Sutphin and Lakewood, South Road and Sutphin, Liberty and Sutphin, 94th Ave. and Sutphin, Archer and Sutphin, and Hillside and Sutphin. The Q40 parallels several bus routes along Sutphin in the congested area from Hillside to Lakewood.

Ridership: In 1998, the Q40 carried about 1.5 million passengers or an average of 23 per bus trip. From 1995 to 1998, ridership increased by 44%. In 1998, 11% of the passengers were school children.

Suggested changes: None.

Note that while the average passengers per bus trip are low, the ridership has grown rapidly in the last few years, suggesting that any cut in service should be re-evaluated when ridership stabilizes.

Q41: 127 Street

Route description: The Q41 runs from Lindenwood (164th Ave. and Cross Bay) to the 165th St. Bus Terminal via Cross Bay (with several detours through residential neighborhoods), Rockaway, 111th Ave., 127th St., 94th Ave., Sutphin, Archer (Jamaica on the reverse trip), and a 68th St. It makes 150 one-way trips per weekday. The inbound (north bound) AM peak headway is eight to 12 minutes and the scheduled ravel time is 51 minutes. The midday headway is 10 to 20 minutes.

There is supplemental service to the Elizabeth Blackwell JHS and the Robert H. Goddard JHS.

The Q41 feeds the Ozone Park station on the A line (at Rockaway and Cross Bay), the Jamaica LIRR and E, J, and Z subway stations at Sutphin and Archer, and the Jamaica Center subway station on the E, J, and Z lines. It has transfer points with other bus routes at Cross Bay and 164th Ave., Cross Bay and 157th Ave., Pitkin and Cross Bay, Cross Bay and Rockaway, Rockaway and 109th Ave., Lefferts and 111th Ave., Liberty and 127th St., 101st Ave. and 127th St., 134th St and 94th Ave., at Sutphin and Archer, along Archer, and at the Bus Terminal. It parallels other routes along the densely served route from the bus terminal to Sutphin and 94th Ave. It also parallels the Q 21 from Rockaway and Cross Bay to the end of the route.

Other traffic generators include Aqueduct Race Track, York College, and the Jamaica Center shopping area.

Ridership: In 1998, the Q41 carried 1.9 million riders or an average of 39 passengers per one-way bus trip. From 1995 to 1998 ridership was stable, showing a small 0.9% growth. School children represented 16% of 1998 riders.

UTRC associates made on/off counts on a south bound afternoon trip and a north bound evening trip. (see Figure 4-6) The afternoon count shows steady passenger loadings through Jamaica Center and at the LIRR/subway station, then gradual reduction of onboard passengers until the second subway station at Rockaway and Cross Bay, with gradual reduction of on-board passengers to the end of the line. The north bound early evening count shows a different pattern of use. There is maximum load and greatest activity are at the Cross Bay/Rockaway subway station and somewhat less activity at the Sutphin and Archer LIRR and subway stations but without the peak in on-board passengers. There is a small peak in on-board passengers in north Lindenwood residential area.

Suggested change: Combine the south end of the Q41 route (from Cross Bay and Rockaway to 164th and Cross Bay) with the Q11 (see description under Q11). The Q41 route in Lindenwood could be simplified and shortened by running straight from 157th Ave. and 84th St. to 160th Ave. and 84th St., eliminating the jog back to Cross Bay.

The section of the Q41 from Cross Bay and Rockaway to the Bus Terminal would operate as a shorter route.
An additional possibility is to extend the Q41 across the Bay to connect to the Q22 on the Rockaway peninsula. This should be considered in conjunction with any changes made in the Q21 route (see Suggested Changes for the Q21).

Reasoning for combining with Q11: Many of the passengers (north bound and south bound) on the Q41 use it to access the subway at Cross Bay and Rockaway, making the need to have continuous service through this point low. Also, the Lindenwood neighborhood is similar to the Howard Beach and Hamilton Beach neighborhoods.

Reasoning for simplified route: The simplified route will be shorter, saving time for passengers and bus. The Q21 follows the existing path through the Lindenwood neighborhood, so this change will reduce the duplication of the two routes.

Q60: Queens Blvd.

Route description: The Q60 runs from Manhattan (2nd Ave. at 60th St.) to South Jamaica in Queens (109th Ave. and 157th St.) via Queens Blvd. to the Jamaica Center area and Sutphin. In 1998, it made 266 one-way trips per day with an average of 67 passengers per trip, the highest in the system. Inbound (toward Manhattan) Am peak headways are seven minutes and the scheduled one-way trip time was one hour and 5 minutes. (Note the long trip time; this is a long route, which partially explains the high average passengers per trip ratio.) Midday headways remain at seven minutes. This indicates that this is not a typical commute route; commuters generally being time sensitive, presumably choose either the parallel subway or an express bus.

There is one supplemental school trip in the afternoon to Russell Sage JHS.

The Q60 runs above the Queens Blvd. subway, which carries the E, F, R, and G lines, for much of its route and under the number 7 elevated line for part of the route. it also feeds the Jamaica LIRR station and the adjacent E, J, and Z subway station. It has transfer points with the Roosevelt tramway in Manhattan and many bus routes along Queens Blvd. and in the Sutphin Archer area.

Other traffic generators along the Q60 route include Queens Plaza, Queens Center and St. John's Hospital, and the end of Jamaica Center.

Ridership: In 1998, the Q60 carried 5.9 million riders, the second highest ridership in the Green Bus system, after the Q10. From 1995 to 1998, ridership first went up by about seven per cent, but in the last year dropped to almost the same as 1995 for a small net increase (0.8%). The Q60 carries the lowest percent of school children (5%) of any of the Green routes.

The UTRC on/off count show a pattern of steady ons and offs, with the highest load just before the Queens Center and St. John's Hospital area and the greatest activity at the Queens Center. (See Figure 4-7.) Note that while all passengers had disembarked by or at the Jamaica LIRR station, more passengers boarded at that point for the remaining part of the route (the counter stopped at this point). Also, maximum load counts for this route are taken at three different locations, indicative of a route that does not feed one or two locations only.

Suggested changes: Consider ending the route or short turning alternative buses at Sutphin and Archer. Consider using articulated buses on the route with a longer headway. Also consider limited service. Although given the alternative faster services (subway and express buses) available to passengers along this route, the Q60 may not be the best place for limited stop service, a similar service along the Grand Concourse in the Bronx has had success.

Reasoning for shorter route: The apparent fact that most passengers (all for the one trip observed) disembarked at LIRR station suggests that the section of the route that travels south on Sutphin serves a different market; the Q 60 and Q40 are already serving the same route on Sutphin.

Reasoning for articulated buses: The route is heavily traveled but is not ideally suited for limited service because the headway is 6 minutes (that is, greater than the guideline of 5 minutes) and it is likely that many of the passenger trips are for shopping along Queens Blvd., suggesting shorter passenger trips and less time sensitive passengers.

Reasoning for limited stop service: The route is very long, and during the peak periods has a five minute headway.

Express Bus Routes: Green Bus operates five express bus routes between Manhattan and Queens. Four of the five express routes are basically the same until they arrive near their destination. They start at 34th Street and 3rd Ave. in Manhattan, travel up 6th Avenue, east on 57th Street to Queens Borough Bridge, and southeast on Queens Blvd. They leave Queens Blvd. at different points to distribute in specific neighborhoods. The Q23, the exception, starts at Penn Station (33rd St. and 8th Ave.), crosses Manhattan on 34th St. and uses the Queens-Midtown Tunnel to Long Island Expressway. The return trip for all five is via Long Island Expressway and through the Queens-Midtown Tunnel to 34th St. and 3rd Ave. The specifics on the Queens end for each route are given below.

For all of the express routes, there is a policy issue as to whether they should be run in competition with the subway. One possible change is to run all of these routes express from their neighborhood to subway stations on the A line, J and Z lines, and E and F lines. However, it should be noted that ridership has been increasing at a significant rate for all of the express routes.

QM15: Lindenwood Express Leaves Queens Blvd. via Woodhaven and Cross Bay to the Lindenwood neighborhood, where it follows the same route as the Q41 and Q21 - 155th Ave., 84th St., and 157th Ave. A few buses continue from 157th Ave. and Cross Bay to the Howard Beach subway station. The route has about 18 trips into Manhattan on weekday mornings and one on Saturday and about the same number outbound in the afternoon, with headways of 10 to 30 minutes (or one hour for the inbound service). Inbound service from Howard Beach is scheduled for about 50 minutes (or one hour and ten minutes to 57th and 3rd Ave.).

Ridership: In 1998, the QM15 carried 226,885 passengers or about 29 passengers per one-way trip. Ridership has grown 23% since 1995.

Suggested changes: See above.

QM16: Rockaway Park Express; and **QM17: Far Rockaway Express** Leaves Queens Blvd. at Woodhaven and proceeds to Rockaway Peninsula. The QM16 turns west on Rockaway Beach to Beach 116th St. (A subway station) and the QM17 turns east to Mott and Beach 121st St. (the other branch of the A). The QM16 operates one trip in each direction and the QM17 operates two. Travel time is about an hour and 20 minutes.

Ridership: The QM16 carried 18,473 passengers in 1998 or 36 per one-way trip. ridership increase by 33% from 1995 to 1998. The QM17 carried 40,820 passengers in 1998 or 39 passengers per trip. Ridership on the QM17 increase 77% in the four year period.

Suggested change: Eliminate the QM16.

Reasoning: This route duplicates the Q53 (operated by Triboro Coach) from Queens Blvd. to the end of the route in Rockaway Park; the Q53 has a more extensive service throughout the day.

QM18: Lefferts Express The Q18 leaves Queens Blvd. at Union Turnpike and 83rd Ave. and travels down Lefferts to 150th Ave. in South Ozone Park. It makes nine Manhattan-bound trips in the morning, starting at just before 7 AM until 10 AM and four Queens-bound trips in the afternoon from 2:30 PM until 5:40 PM. The Manhattan-bound trip is scheduled to take 52 minutes to 34th and 3rd Avenue and an additional 20 minutes to 57th and 3rd Avenue.

Ridership: The Q18 carried 104,023 passengers in 1998, and increase of 46% over 1995 ridership. The average riders per one-way trip was 29 in 1998.

Suggested changes: See above.

QM23: Brooklyn Manor Express Leaves the Long Island Expressway at Woodhaven and proceeds to Rego Park (Austin and 63rd Drive) before continuing south on Woodlawn.. The route turns on to Jamaica Blvd. and ends at 102nd St. and Jamaica. There is one trip inbound in the morning and one outbound at 5:45 in the afternoon. The trip is scheduled to take 45 minutes.

Ridership: The Q23 carried 13,161 passengers in 1998 for an average of 25 passengers per one way trip. In the 1995 to 1998 period ridership has almost doubled, showing an increase of 92%.

Suggested change: See above.

References:

Boyle, D.K. (1998) *TCRP Synthesis of Transit Practice 29: Passenger Counting Technologies and Procedures*, Transportation Research Board, National Research Council, Washington, D.C.

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UMTA C2710.1A (1988) Circular: "Sampling Procedures for Obtaining Fixed Route Operating Data Required Under the Section 15 Reporting System," U.S. Department of Transportation, July 18.

Appendix A

Counting Manual

Counting Procedure

I. Sample Selection

This method is adapted from FTA circular C2710.1A (UMTA, 1988: describes the method required for collecting "Section 15" data).

Steps

1. Determine the total number of bus trips to be sampled from each route for one month (n) based on the desired confidence level and confidence interval and the assumed standard deviation.

2. For the route to be counted, create a unique identification number for each trip in the month based on the schedule of bus trips. Use a five digit number where the first two numbers represent the date within the month and the last three represent the trip on that day. Include all trippers, etc. It is not necessary to write out every number, but the first and last number for each date should be noted.

3. Use a random number to select specific trips to be counted. A random number in the ranges determined above may be generated using a spreadsheet or computer method or chosen from a random number table. (Appendix B provides a random number table.)

To use the table, proceed across each line of the table, reading each consecutive series of five numbers as a new number. Select the first number that you come to that is one of the unique identifiers assigned in step 2 and check it against a calendar to determine the day of the week that it represents.

When all of the numbers in the random number table have been used, read the numbers from right to left (or down each row or any other systematic method) or use a different random number table.

Any method of choosing random numbers can be used. However, do not substitute a process that will result in a "more representative" selection. Using the random numbers method will provide a distribution of peak, midday, night, etc. trips without unrecognized human bias influencing the results.

II. Data Collection

Steps

1. Prepare a separate "Rider Count Sheet" (see last page of this appendix) for each trip that has been selected in the sample selection process. Fill in as much of the information at the top of the sheet as possible before going to the field. Take along several sheets for each trip to be surveyed, a clip board or other hard surface to write on, and two or more pens or pencils..
   (Optional: The bus stop locations may also be recorded before going to the field. This will save time while counting; also it will not always be easy to see the street signs to determine the location while riding the bus. If this is done, the surveyor should be alert to missed stops.)
2. Proceed to the "start point" and wait for the bus. If the trip to be surveyed is a "missed trip," that is the bus does not arrive, board the next bus that comes. Record the missed trip under "notes."
3. Board the bus and take a seat from which the front door can be clearly seen. (Surveyor will need to have a direct line of sight that will not be blocked by standees.)
4. Record the start time, vehicle capacity, and all other information at top of sheet.
5. When the bus leaves the stop (stop 1), record the number of passengers who boarded at stop 1. Include any passengers who may have stayed on board from the previous trip.
6. At each stop, write the number of passengers who board.

7.* Also, at each stop, record the nearest cross streets (unless the bus stop locations have been pre-recorded. If the locations have been pre-recorded, verify the location. If the bus by-passes a pre-recorded bus stop due to no boardings or alightings, record zero riders in the appropriate column. If the bus bypasses a bus stop because there is no room for additional riders or because it is running express to correct bunching, record zero and explain the reason under comments.) Note that the location does not have to be exact.

8. At the last stop, note the ending time and the location. Fill in the sheet number (in order in which the sheets were filled in) in the first blank of "Sheet ___ of ___" and the total number of sheets used for this trip in the second blank. Make sure that the route number and trip number are filled in on all sheets.
9. After the trip, sum the total number of riders for that trip.

* Step 7 is not actually needed and at the discretion of the supervisor of the counting effort may be omitted. The advantage of including it is that if the total number of riders for the trip appears to be an anomaly, there is additional information with which to determine why it differs from other trips. Further, a better understanding of how the route is used by the riders is provided.

III. Ridership Interval Estimation

The average ridership per trip for the sample will be compared with the average ridership per trip based on the total ridership reported for the month on the route counted by Green Bus.

Steps

1. Set up a spreadsheet in which the total ridership for each trip (from step 9 above) in the sample along with the route number, the day, the trip number is recorded.

2. Using the spreadsheet commands, determine the average ridership per trip, the standard deviation, and the number of trips for the route.

3. Check that the number of trips in the spread sheet is equal to or larger than the number determined in phase I step 1.

4. Check that the standard deviation is equal to or less than the confidence level and error chosen.

5. Calculate the confidence interval by subtracting and adding the error to and from the average ridership per trip from the spreadsheet.

6. When Green Bus provides the ridership information for the month that the count was done, determine the average ridership per trip for the route by dividing the total monthly ridership reported for that route by the total number of trips for that month.

7. Compare the average riderships per trip from step 6 to the interval calculated in step 5. If the average is within the interval, the conclusion is that, at the chosen confidence level, the electronic fareboxes are providing an accurate count. If the average outside the interval, the conclusion is that the fareboxes are probably not providing an accurate count.

Rider Count Sheet

Sheet ____ of ______

Route no. ________ | Date: ________________ | Direction: _______
Trip no. _________ | Day of week: _________ | Vehicle capacity: ________
Start point: ______________ | Start time: ___________ | Weather: ________________
End point: _______________ | End time: ____________ | Surveyor: ________________________

Bus stop number	Location	Riders Boarding	Notes

Appendix B

Random Numbers