Polytechnic University

Department of Civil & Environmental Engineering

Project
Parking Meter Operability Study

Final Report 423-108-2F

Prepared for New York City Department of Transportation
Parking Division

by

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February 1998

This research project was undertaken by Polytechnic University and the State University of New York, Maritime College. Professors Dimitrios G. Goulias (Principal Investigator) and Shmuel Yahalom, directed the work and analysis based on the recommendations of the New York City Department of Transportation, Parking Division. Prof. John Falcocchio provided his guidance in the development and analysis of the study. Research assistants from Polytechnic University and the State University of New York – Maritime College assisted in the analysis of the study

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Chapter 1. Introduction

The New York City Department of Transportation (NYCDOT) Parking Division is responsible for the largest parking meter network in the United States. The efficient operation and maintenance of this system provides an important and sizable source of revenue for New York City. This study addressed the need of the NYCDOT Parking Division to review its current operations and evaluate operability measures. The study was undertaken in coordination with the research unit, the maintenance and revenue collection units, and the computer services unit. The objective of the study was to examine and evaluate the current definition of operability, review meter inspection/maintenance and revenue collection operations, identify improvements, and provide a systematic method of implementing these improvements to increase efficiency, and ultimately, revenue. The study was organized in two phases. In the first phase, the current practice was reviewed using one-year historical data for identifying potential improvements in meter inspection/maintenance and revenue collection operations. In the second phase, testing of the assumptions and fine-tuning of the suggested improvement methods were conducted using field data. Several meetings took place over the duration of the study for presenting the findings and fine-tuning the methodology. This document is the final report of the study.

There are approximately 66,000 parking meters in New York City, which are grouped into 224 geographic *areas*. Of these, approximately 63,000 are on-street meters, which account for 179 *areas*. Those remaining are off-street meters, located in municipal parking lots and garages. Because most of the off-street mechanical meters are being replaced by munimeters, which have a high level of operability, this study focuses on the on-street meters.

The NYCDOT Parking Division consists of four units: Meter Maintenance, Meter Revenue Collection, Parking Control, and Computer Services.

- The Meter Maintenance Unit inspects between 15,000 and 20,000 meters daily, with each inspector averaging 350 meters. Because some meters are inspected more frequently than others, all of the meters are inspected at least once within a 10-day cycle. Approximately 10% of the meters inspected require maintenance and are repaired on the spot. Examples of maintenance and inspection data records (described in detail in the interim report) collected during these operations are shown in Appendix A.

- Each agent in the Meter Revenue Collection Unit collects revenue from approximately 400 meters daily. Some meters are visited more frequently than others. The revenue from all the meters is collected at least once within a 24-day interval. Examples of the revenue collection records (described in detail in the interim report) are shown in Appendix A.

- The Parking Control Unit is responsible for issuing parking summonses, making arrests for meter vandalism, and making minor repairs to the meters, such as clearing coin jams and removing plastic strips. Each officer patrols approximately 200 meters daily.

- The Computer Services Unit maintains the Parking Information Management System (PIMS) and prepares reports regarding meter operations.

In April 1994, NYCDOT implemented the Meter Shield Program, which was adopted to increase the monitoring of meter *areas* with high revenue potential that have low levels of operability due to a history of vandalism. The targeted *areas* require the frequent and combined forces of the maintenance, revenue collection, and parking control personnel.

1.1 Background

In order to define problems and needs and to suggest improvements, it was important to fully understand the current conditions and the historical patterns of meter operability and revenue. The current maintenance and collection programs were studied and the PIMS structure and data retrieval methods were reviewed. To determine the historical patterns, it was necessary to determine the *area* characteristics and then group the *areas* into categories: by borough, by type of parking (on-street or off-street), by business type, by revenue level and characteristics, and by vandalism potential. The historical data for each grouping was then reviewed and analyzed in terms of operability, revenue, and inspection and revenue collection frequencies.

Once NYCDOT's meter operations were reviewed, the experiences and practices of other cities were examined. A survey was conducted in March 1996 in which questionnaires were sent to forty-five agencies responsible for parking meter networks throughout North America. The questionnaires included questions regarding meter operability, meter maintenance, revenue collection, and meter surveillance. Eleven agencies responded. Of these, the largest system was in Chicago (approximately 27,500 meters) and the smallest was in Ottawa (approximately 3,000 meters). A review of these surveys revealed that there is no standard practice in operating a parking meter system. With New York City□s parking meter system over two times as large as the largest responding city, it was evident that the intrinsic characteristics of this network are far more complex than any other system. Survey response details are shown in Appendix B.

1.2 Current Practice

Meter inspection/maintenance operations are conducted by *area*, with inspection/repair status reported by individual meter. The effectiveness of these operations is measured by the operability, which is defined as the percentage of operable meters out of the total number of meters. For meter revenue collection purposes, meters within an *area* are organized into smaller groups based on the key cables carried by the revenue collection agents. Each *cable* holds approximately 60 to 75 keys for meters in close proximity to one another. Revenue is collected and reported by *cable* unit, not by meter. Consequently, the revenue of individual meters is not known. The effectiveness of these operations is measured by comparing the actual revenue per *cable* to the maximum revenue achievable per *cable*. Although meter maintenance and revenue collection operations are intimately related, they cannot be readily coordinated because meters are grouped and their status reported differently, as described previously.

The efficiency level of the maintenance and revenue collection operations is improved by adjusting the inspection and collection frequencies based on the historical data. These adjustments are made empirically, and may even occur daily. Some consequences of this fine-tuning include: i) *cables* within the same *area* may or may not have the same revenue collection frequencies, resulting in inefficient use of resources, ii) *cables* are redefined frequently, and iii) the accuracy of long term evaluation of the operations is difficult because meter groupings and inspection/collection frequencies are dynamic in nature. For a parking meter network of this magnitude, these operations should be examined and appropriately adjusted with a systematic method, rather than empirically on a case-by-case basis. To this end, a systematic methodology for examining the current status of meter operations and identifying potential improvements is presented herein. The existing definition of operability has been reviewed and suggested improvements are presented along with methods for estimating daily operability. A suggested inspection frequency is proposed based on the analysis of the history of meter defects and their impact on operability. Similarly, a methodology which considers revenue based on the physical capacity constraints of the meter coin box and coin canister and which identifies an optimum collection frequency for each *cable* will be discussed. A method for evaluating the cost associated with an increase in meter operability is also presented.

1.3 Organization of Report

In Chapter 2 "Historical and Field Data", the one-year historical data, the method of selecting sample *cables*, and the field data collection are described. The analyses performed for identifying improvements related to operability are presented in Chapter 3 "Improvements in Operability Evaluation & Prediction Methods". Chapter 4 "Improvements in Revenue Collection Operations" presents the analyses and suggested improvements relating to revenue collection. The methodology for examining current meter revenue collection operations and implementing improvements relating to operability and revenue collection are presented in Chapter 5 "Step-by-Step Procedures for Implementing Operability-Related Improvements" and Chapter 6 "Step-by-Step Procedures for Implementing Revenue Collection-Related Improvements", respectively. Chapter 7 "Conclusions and Recommendations" presents an overview of the potential improvements and implications.

Chapter 2. Historical and Field Data

2.1 Historical Data

In examining the current practice of NYCDOT meter operations, in terms of inspection, maintenance, and revenue collection activities, and searching for potential improvements, the form and characteristics of data available at the NYCDOT Parking Division were examined. Due to the frequent changes in meter grouping and changes in inspection and revenue collection frequencies over the years, it was concluded (with NYCDOT's collaboration) to focus on the one-year historical data available at PIMS and the reports/records from the meter revenue and maintenance divisions. The analyses were based on an extensive review of: 1) the inspection and maintenance files provided by the maintenance group of the parking division, 2) the revenue collection data files provided by the revenue collection group, 3) information from the meter shield program, and 4) information from site visits, meetings, and communication with the research, maintenance, revenue collection and computer services groups.

In the current practice, revenue is aggregated and reported by *cable*, while meter inspection and maintenance is recorded and reported for each individual meter. In order to examine current meter maintenance and revenue collection practices, samples were selected from the 1200 *cable* areas identified by NYCDOT for revenue collection purposes, and then the maintenance records of the meters included in these *cables* were examined.

Thus, revenue analyses were conducted by *cable* area while meter inspection and maintenance history were tracked for each individual meter. The sample *cables* included in the study were randomly selected based on the information provided in Operability Reports, Monthly *Cable* Revenue Reports, and the Area Frequency Schedule. Specifically, a total of 45 *cables* were selected to represent:

- *cables* from the five boroughs (geographically distributed)
- *cables* with different revenue collection frequencies (i.e. 2, 4, 6, 8 days)
- *cables* with high, medium, and low revenue levels
- *cables* with high, medium, and low operability levels (evaluated by reviewing the field inspection sheets of the meters within the *cables*).

For a listing of these 45 sample *cables*, see Appendix C.

2.2 Field Data

The objective of the field data collection phase was to further examine meter operability and revenue within selected cables so as to test the assumptions and the methodology developed from the review of the historical data. Field experiments were designed and conducted on *cables* 101_2, 111H7 and 117L1. These *cables* were selected since they represented varied combinations of revenue level and collection cycle, revenue consistency over the year, and operability level. The meters in these *cables* were monitored daily for a two-week period by

NYCDOT personnel. In addition to other objectives, the field experiments were conducted to:

1) Monitor the number of days which elapsed between the meters becoming defective and the meters being repaired. The type of defect and its date of occurrence were recorded. With this data, the optimum inspection and maintenance cycle and the methods of defining, calculating, and predicting operability could be identified and tested.

2) Monitor the actual revenue per meter within a cycle. The revenue per meter was monitored with the use of a dipstick (i.e., measuring with a stick the level of coins within the meter coin box). Although this method is not completely accurate, it was found to provide satisfactory results. With this data, the optimum revenue collection cycle (as related to meter coin box and coin canister capacities) and the distribution of revenue among meters within a *cable* could be identified, and the revenue loss per defect could be more precisely evaluated

The analyses performed using this historical and field data in relation to operability and revenue collection are discussed in Chapters 3 and 4 and are summarized in Appendices D through I

Chapter 3. Improvements in Operability Evaluation & Prediction Methods

Meter operability is evaluated and reported to indicate the level at which a parking meter network (or portions thereof) is functioning. Meter inspection and maintenance operations have a direct impact on operability. Unsatisfactory measures of operability may lead to adjustment of the inspection frequency. In addition, revenue collection activities may also impact operability (e.g. full meters due to low collection frequencies may lead to coin jams or vandalism). Moreover, the methods used to calculate and report operability may overestimate or underestimate operability. Thus, the current practice of evaluating and reporting operability was examined using the historical and field data. Potential improvements were identified and are presented.

3.1 Current Practice

The parking meter operability indicates what percent of meters are operable at a particular time for a given location. Operability is computed primarily for each *area* and is then aggregated for each borough and the entire city. Currently, operability is defined as the percentage of operable meters out of <u>inspected</u> meters. NYCDOT computes two types of operability - *operability found* and *operability left*. The *operability found* is the percentage of operable meters out of inspected meters, on the inspection day, before defects are fixed. This represents the lowest value of operability. The *operability left* is the operability calculated after the defective meters are repaired. This operability is usually close to 100%, since most of the defects are fixed on site during inspection.

By calculating the *area operability* in this way, one might conclude that at the end of the day, the operability is near 100%. Since repairs are made only to those meters which are inspected, the operability of inspected meters may increase to near 100%, but the operability of those meters not inspected is still more closely represented by the *operability found*. These non-inspected meters within an area are not currently considered in the calculations. For example, the citywide daily operability is estimated on the basis of the inspected meters on a specific day. Since 15,000 to 20,000 meters, out of 66,000 meters (±30%), are inspected daily, it may be concluded, from a statistical point of view, that the calculated operability is a good estimator for the citywide operability. However, since repairs take place only for the inspected meters, the operability cannot be fully recovered (i.e. reach a level of 100%) after inspection.

The monthly operability is calculated as the average of the *operability found* of every inspection within a given month. Since the effect of recovering operability by repairing defects is not considered in this monthly operability value, it cannot represent the true operability.

Operability is computed based on data obtained during inspections. For those *areas* which are not inspected daily, there is no direct method to estimate operability for the days between inspections. Additionally, there is no prediction model available that can predict future operability patterns. In the following section, improvements are presented which relate to these issues.

3.2 Suggested Improvements

3.2.1 Calculating Operability Left

When only a portion of the meters within an *area* are inspected, the increase in operability due to the repair of defects is only applicable to those meters which were inspected. The non-inspected meters continue to function at a level of operability assumed to be equal to the value of the *operability found* of the inspected meters. The calculation of *operability left* should consider the effects of repair activities on all meters within an *area*. The following example illustrates the calculation of *operability found* and *operability left*.

Example 3.2.1:

Area 121

Inspection Date	# meters (A)	# meters inspected (B)	# defective meters (C)	# repaired meters (D)	Operability found (E)	Operability left (current) (F)	Operability left (recommended) (G)
1/6/96	372	184	46	41	75%	97%	86%
1/19/96	372	372	71	71	81%	100%	100%
1/20/96	372	218	23	23	89%	100%	96%

Where,

Operability found, E = ((B-C)/B)*100 = (1-(C/B))*100

Operability left (current method), F = [(B-(C-D))/B]*100 = [1-((C-D)/B)]*100

Operability left (recommended method), G = {[(A-B)/A]*E} + [(B/A)*F]

= {[1-(B/A)]*E} + [(B/A)*F]

For inspection date 1/6/96,

Operability found, E = (1-(46/184))*100 = 75%

Operability left (current method), F = [1-((46-41)/184)]*100 = 97%

Operability left (recommended method), G = {[1-(184/372)]*75%}+[(184/372)*97%]

= 86%

This calculation method should also be considered for borough and citywide operability evaluation, since only a portion of these meters are inspected daily.

3.2.2 Estimating Daily Operability for Areas Without Daily Inspections

Operability levels decrease during the period between the past and the upcoming inspection days. The highest value is observed on the past inspection day, since almost all meters were left operational with meter repairs completed, and the operability is equal to the *operability left*. The lowest value is reached at the beginning of the current inspection day before repairs have begun and is equal to the *operability found*. Based on the current practice, there is no indication of the rate of change of operability between inspection days. Without additional information, the only method available to estimate this daily operability is to assume that operability varies linearly with time and to interpolate between the high and low values. This linear relationship and the daily operability are represented in Figure 3.2.2a.

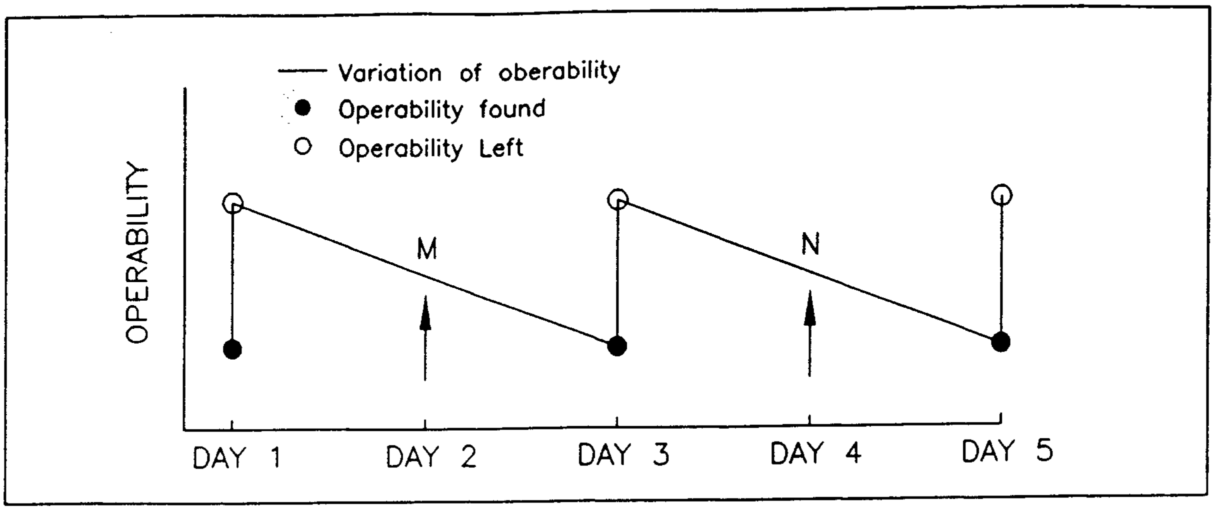

Figure 3.2.2a Estimation of Daily Operability

The following equations can be used to estimate the daily change in operability and the daily operability between inspection days:

Daily change in operability between inspection days = (B-A)/C

Daily operability for points M and N at time (t) = B-[((B-A)/C)*D] (3.2.2.1)

Where,

A = *operability found* from the current inspection

B = *operability left* from the previous inspection

C = number of days elapsed from the previous inspection to the current inspection

D = number of days elapsed from the previous inspection to the date of interest

As shown in Example 3.2.2, the daily operability of Area 126 was estimated using this methodology.

Example 3.2.2:

The meters in Area 126 are divided into Groups A and B. Each group is inspected on alternating days. The daily *operability found* and daily *operability left* (recommended method) were computed for each Group separately on its inspection day, and then *area*wide.

# days (A)	Insp. date	# meters (B)	# meters insp. (C)	Grp.	# defective meters (D)	Oper. found for group insp. (E)	Oper. left for group insp. (F)	Oper. for group not insp. (G)	Oper. found area wide (H)	Oper. left area wide (J)
1	1/23/96	1001	448	B	73	84%	100%			
2	1/24/96	1001	553	A	42	92%	100%	93.0%	92.5%	96.5%
3	1/25/96	1001	448	B	63	86%	100%	94.5%	90.3%	97.3%
4	1/26/96	1001	553	A	60	89%	100%	94.5%	91.8%	97.3%
5	1/27/96	1001	448	B	48	89%	100%	96.7%	92.8%	98.3%
7	1/29/96	1001	553	A	56	90%	100%	92.0%	91.0%	96.0%
8	1/30/96	1001	448	B	52	88%	100%	96.0%	92.0%	98.0%
9	1/31/96	1001	553	A	42	92%	100%			

Where,

Operability found for group inspected, E = (1-(D/C))*100

Operability left for group inspected, F = 100% (Assume all meters repaired).

Operability for group not inspected, G See equation 3.2.2.1

*Operability found area*wide, H = (E+G)/2

*Operability left area*wide, J = (F+G)/2

For inspection date 1/27/96,

Operability found for group inspected, E = (1-(48/448))*100 = 89%

Operability left for group inspected, F = 100%

Operability for group not inspected, G = 100% - {[(100%-90%)/(7-4)]*(5-4)} = 96.7%

*Operability found area*wide, H = (89%+96.7%)/2 = 92.8%

*Operability left area*wide, J = (100%+96.7%)/2 = 98.3%

The operability of Groups A and B and *area*wide *operability found and left* are represented graphically in Figure 3.2.2b.

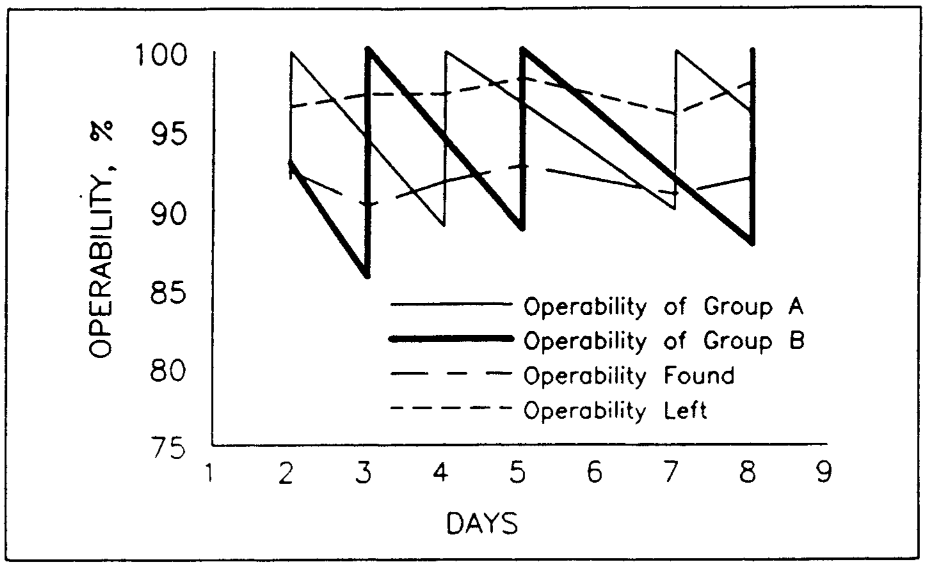

Figure 3.2.2b Estimating Operability for Area 126

3.2.3 Predicting Future Operability

Step 1. Determination of average daily change in operability for a given month

In order to predict the future operability of an *area*, the *daily change in operability* between inspection days needs to be determined with the use of historical data. For long term predictions, this parameter may be estimated by calculating the daily changes in operability between inspections for a given month and then taking the average value for that month. This *average* *daily change in operability* may be considered to describe the daily operability loss for that given month, thus correcting for seasonal variations. As discussed in Section 3.2.2, the following equation can be used to estimate the daily change in operability.

Daily change in operability between inspection days = (B-A)/C

Where,

A = *operability found* from the current inspection

B = *operability left* from the previous inspection

C = number of days elapsed from the previous inspection to the current inspection

In Example 3.2.3a, the procedures to estimate the daily change in operability and the average daily change in operability per month are demonstrated.

Example 3.2.3a

Area 121

Insp date	# elapsed days (A)	# meters (B)	# meters insp (C)	# defective meters (D)	# repaired meters (E)	Oper found (F)	Oper left (G)	Change in oper bet insp (H)	Daily change in oper bet insp (J)
1/6/96		372	184	46	41	75%	86%		
1/19/96	13	372	372	71	71	81%	100%	5%	0.4%
1/20/96	1	372	218	23	23	89%	96%	11%	11%
1/24/96	4	372	372	66	66	82%	100%	13%	3%
1/27/96	3	372	372	44	44	88%	100%	12%	4%
1/31/96	4	372	372	41	41	89%	100%	11%	3%
Total	25							52%	

Where,

Operability found, F = (1-(D/C))*100

Operability left, G = {[1-(C/B)]*F} + {(C/B)*[(1-((D-E)/C))*100]}

Change in operability, H = oper. left from previous insp. - oper. found from current insp.

Daily change in operability between inspections, J = H/A

For inspection date 1/27/96,

Number of elapsed days = 1/27/96 - 1/24/96 = 3 days

Operability found, F = (1-(44/372))*100 = 88%

Operability left, G = {[1-(372/372)]*88%}+{(372/372)*[(1-((44-44)/372))*100]}=100%

Change in operability, H = 100% - 88% = 12%

Daily change in operability between inspections, J = 12%/3 = 4%

After calculating the change in operability between inspections and the number of elapsed days between inspections, the ratio of the totals of these two values should be taken to obtain the average daily change in operability per month. For January 1996, this ratio is equal to 2.1% (52% / 25 days) for area 121.

Step 2. Prediction of Future Operability

Future values of operability can be predicted with the data from Step 1, if the inspection schedule is known. The average daily change in operability computed for a particular month should be used to predict future operability loss for the same month, because seasonal effects on meter use and operability are already taken into account. Example 3.2.3b indicates how this method may be used to predict future operability.

Example 3.2.3b:

Based on the historical data, the average daily change in operability for Area 121 for the month of January is 2.1%. The inspection schedule for January of this year is set for day 1, and then every four days thereafter (i.e. 1, 5, 9, etc.). Assume all 372 meters will be inspected on each inspection day and all defects will be repaired on site. The daily operability of the *area* is equal to:

Day 1, *operability left* = 100%

Day 2, operability = 100% - (2.1% * 1 elapsed day) = 97.9%

Day 3, operability = 100% - (2.1% * 2 elapsed days) = 95.8%

Day 4, operability = 100% - (2.1% * 3 elapsed days) = 93.7%

Day 5, *operability found* [a] = 100% - (2.1% * 4 elapsed days) = 91.6%*

operability left = 100%

[a] The matching of these two values will indicate the ability of the method to predict future operability

3.2.4 Estimating Cost of 1% Increase in Operability

One goal of the NYCDOT Parking Division is to maximize revenue. This can be accomplished by increasing meter operability. However, there are costs associated with the increased inspection, maintenance, and revenue collection activities that subtract from the additional revenue. Therefore, a balance between these costs and benefits should be established to maximize the net revenue. The improved level of service should be considered as a benefit. As an exercise, the costs and revenue associated with increasing the operability by 1% will be estimated.

While there are several alternatives for increasing operability (i.e., meter shield program, targeting specific areas and meters with low operability and high revenue potential, etc.) the approach considered here is based on the fact that an increase in the number of meters inspected and repaired raises the level of operability, because the percentage of meters within an *area* brought to 100% operability increases. Assuming that the change of operability from the *operability left* from the previous inspection day to the *operability found* of the current inspection day varies linearly with time, the *operability left* must be raised 1% to increase the *operability found* by 1%. The procedure to estimate the additional number of meters which must be inspected in order to increase the operability by 1% is demonstrated in Example 3.2.4a.

Example 3.2.4a:

The actual citywide operability data from 1/22/96 to 1/26/96 is used to demonstrate the application of the methodology. The total number of meters in the city is 65,643, based on data from February 1996. Assume all defective meters found are repaired on site.

Date	# meters insp. (A)	# defective meters (B)	Oper. found (C)	Oper. left (D)	Oper. found increased by 1% (E)	Oper. left increased by 1% (F)	# meters to be insp. (G)	# add. meters (H)	# add. defective meters (J)
1/22/96	13014	2686	79.36%	83.45%	79.36% *	84.45%	16194	3180	638
1/23/96	13211	2854	78.40%	82.74%	79.40%	83.74%	13852	641	129
1/24/96	12889	2879	77.66%	82.05%	78.66%	83.05%	13493	604	121
1/25/96	14124	2809	80.11%	84.39%	81.11%	85.39%	14872	748	150
1/26/96	15538	2581	83.39%	87.32%	84.39%	88.32%	16533	995	200
Total	68776	13809					74944	6168	1238
Average	13755	2762					14989	1234	248

* On 1/22/96 only *operability left* can be affected by increasing the number of inspected meters within the same day, day 1 in this example.

Where,

Operability found, C = (1-(B/A))*100

Operability left, D = {[1-(A/65643)]*C} + [(A/65643)*100%]

Operability found increased by 1%, E = C + 1%

Operability left increased by 1%, F = D + 1%

F = {[1-(G/65643)]*E} + [(G/65643)*100%] (Solve for G) (3.2.4.1)

Number of additional meters to be inspected, H = G - A

Number of additional expected defective meters, J = H * (Total B)/(Total A)

For inspection date 1/24/96,

Operability found, C = (1-(2879/12889))*100 = 77.66%

Operability left, D = {[1-(12889/65643)]*77.66%} + [(12889/65643)*100%] = 82.05%

Operability found increased by 1%, E = 77.66% + 1% = 78.66%

Operability left increased by 1%, F = 82.05% + 1% = 83.05%

$$83.05\% = \{[1-(G/65643)]*78.66\%\} + [(G/65643)*100\%]$$

Total number of meters to be inspected, G = 13493 meters

Number of additional meters to be inspected, H = 13493 - 12889 = 604

Number of additional defective meters found, J = 604 * (13809/68776) = 121

The number of meters which must be inspected to obtain this increase of 1% is shown in Column G and is computed using Equation 3.2.4.1. To increase operability by 1% during the period of 1/22/96 to 1/26/96, an additional 6168 meters would have to be inspected. The expected number of additional defective meters encountered with the increased inspection is presented in Column J. An average of 248 additional defective meters per day would require repair. The potential revenue increase which might be generated by these 248 additional meters repaired per day may be estimated by considering the average citywide meter rate, meter operating hours, and current level of meter usage. The calculation of this revenue is shown in Example 3.2.4b. The cost to inspect, repair, and collect revenue from the additional meters can be estimated by considering the associated labor cost.

Example 3.2.4b:

Assuming that:

- the citywide average meter rate is equal to \$0.25/30 minutes (or \$0.50/hour)
- operating hours per meter are equal to 10 hours per day
- the current level of usage is equal to 60%

Since the repair of 248 meters (daily average from example 3.2.4a) will occur throughout the day of inspection and not all at once, it may be assumed that 50% of the meters will provide revenue. Therefore, the revenue potential can be calculated as follows:

Revenue potential = 248 meters * $0.50/1 hour * 10 hours * 60% * 50% = $372/day

During the five-day period examined, a total of $1,860 ($372 * 5) would be generated due to the repair of the additional defective meters.

3.2.5 Operability Simulation (Optimum Inspection/Maintenance Cycle)

One way to determine the optimum inspection and maintenance cycle length for a given *area* is to simulate the operability for various inspection cycle lengths. As a basis for the simulation, inspection and repair operations should be performed for a given sample *area* on a daily basis for a certain period of time (i.e. 2 weeks). Then, using this data, the operability should be determined as if the inspections ("hypothetical inspections") had been performed every two days; then, every three days, etc.

When an extended cycle length is applied, defects occurring between daily inspection days would remain unrepaired, and the number of defects would accumulate. However, if the same meter is found to have defects on concurrent days between the hypothetical inspection days, the meter should be treated as though it had been defective from the first day the defect was detected, and the subsequent defects, *(overlapping defects)*, should not be counted toward the total number of accumulated defects. The calculation of accumulated defects is shown in Example 3.2.5a.

Example 3.2.5a:

Assuming that:

- the hypothetical inspection cycle length is 2 days
- 5 defective meters were found on the first day after inspection
- 10 defective meters were found on the second day after inspection
- 3 of the meters found to be defective on the first day were also found to be defective on the second day.

On the first day after inspection, the number of defective meters is 5. Since these defects will not be repaired until the next hypothetical inspection day (2 days later), they will be added to the 10 defective meters found on day 2, resulting in a total of 15 defective meters. However, 3 of the 10 defects overlap (that is, they are found on the same meters) with defects found on day 1 and cannot be counted as new defects. Therefore, the total number of defects found on the assumed inspection day is 15 - 3 = 12.

Based on the number of overlapping defects out of the total number of defects found between hypothetical inspection days, the frequency of inspections should be adjusted so as to avoid the over investment associated with repairing these overlapping defects. In Example 3.2.5b, operability is simulated for a lengthened inspection cycle of three days.

Example 3.2.5b:

The following data was obtained from the field study conducted from 4/14/97 to 4/25/97.

Area 117, Cable L1

Meter #	4/14*	4/15	4/16	4/17	4/18	4/19	4/20	4/21	4/22	4/23	4/24	4/25
136	441**	[redacted]										
147	441											
148		443										443
149								441				
150												441
152				441	[redacted]			441				542
162	441											
163	342											
166	441							441				
168												441
171	442	[redacted]	[redacted]		542/444							
175								441				
177								441				
186	442				441							542
187								443				
188	443											441
662					441							

* Inspection date
** Code indicating type of defect found

The *overlapping defects* are highlighted in the above Table. The *operability found* was calculated based on the daily inspections conducted during the field study and is shown below.

Insp date	4/14	4/15	4/16	4/17	4/18	4/19	4/20	4/21	4/22	4/23	4/24	4/25
# meters insp	49	49	49	49	49	49	49	49	49	49	49	49
# defects	8	3	0	1	4	0	0	6	0	0	0	6
Oper. found	84%	94%	100%	98%	92%	100%	100%	88%	100%	100%	100%	88%

Where,

Operability found = (1 - (# defective meters/# inspected meters))*100

For 4/15,

Operability found = (1 - (3/49))*100 = 94%

At this point, assuming that the inspections are scheduled with a cycle length of 3 days, the *operability found* was simulated.

Insp. date	4/14	4/15	[illegible]	4/17	4/18	[illegible]	4/20	4/21	[illegible]	4/23	4/24	[illegible]
# meters insp.	49	49	49	49	49	49	49	49	49	49	49	49
# defects	8	3	0	1	4	0	0	6	0	0	0	6
# overlap. def.	0	2	0	0**	1	0	0	0	0	0	0	0
# accum. def.	8	9	9	1	4	4	0	6	6	0	0	6
Oper. found	84%	82%	82%	98%	92%	92%	100%	88%	88%	100%	100%	88%

* Inspection dates are highlighted

** On the day after inspection, there are no overlapping defects, because defective meters found on the previous day would have been repaired.

Where,

\# accumulated defects = # accumulated defects from previous day + # defects on current day - # overlapping defects

Operability found = (1 - (# accumulated defects/# inspected meters))*100

For 4/15,

\# accumulated defects = 8 + 3 - 2 = 9

Operability found = (1 - (9/49))*100 = 82%

The values of *operability found* for both inspection cycle lengths are shown graphically in Figure 3.2.5.

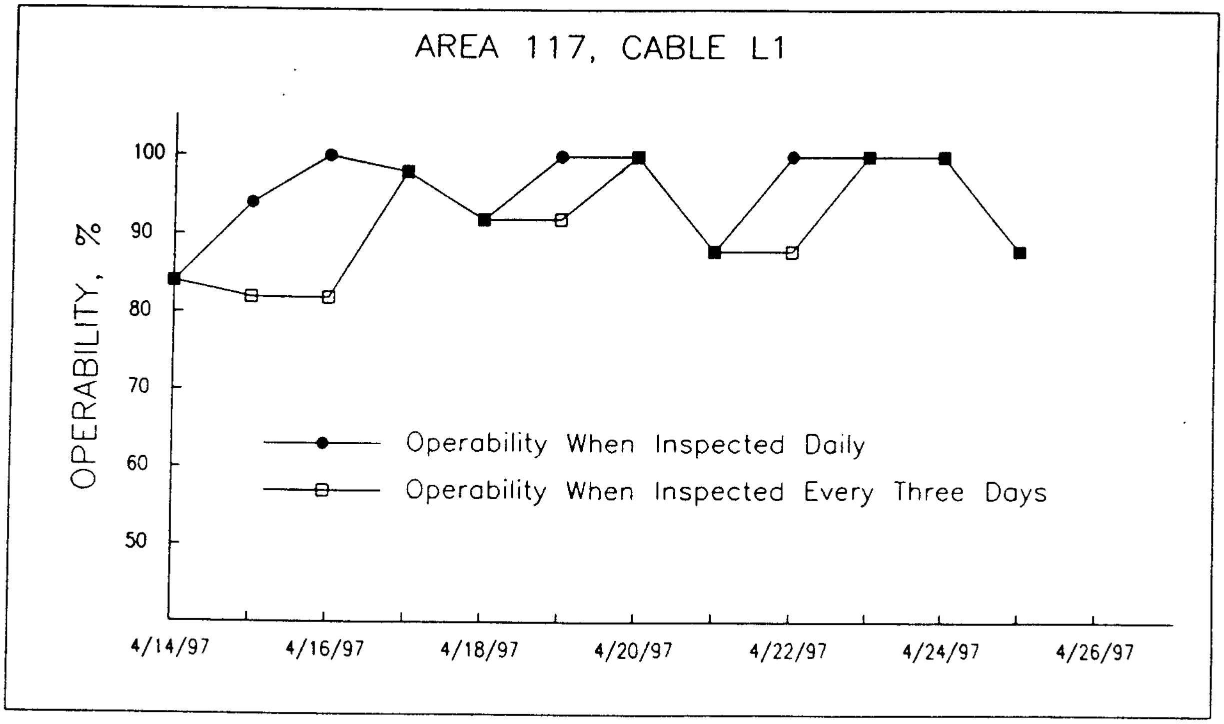

Figure 3.2.5 Operability Simulation – From 1-Day to 3-Day Inspection Cycle Length

Chapter 4. Improvements in Revenue Collection Operations

The amount of revenue collected is a function of the number of operable meters, the level of use of the meters, and the frequency and effectiveness of revenue collection activities. Low revenue may indicate a need for adjustments to the revenue collection frequency. The methods currently in use for collecting revenue were evaluated using historical and field data and potential improvements are presented.

4.1 Current Practice

Currently, the revenue collection frequency is adjusted empirically using actual revenue history and on a corrective rather than preventive basis. Furthermore, the grouping of meters into cables is adjusted on a frequent basis to take into account the capacity limitations of the coin canister.

The maximum revenue that can be generated by, and therefore collected from, a meter is identified by the meter rate, hours of operation, and coin box capacity. However, actual revenue is affected by meter usage and meter operability. Methods to calculate these parameters were identified, and the current meter revenue was compared to these parameters for evaluating the performance of collection activities and the adequacy of the revenue collection frequency. Details on this methodology are described in the next section, along with suggested improvements in revenue collection operations.

4.2 Suggested Improvements

4.2.1 Evaluating Current Revenue Collection Practice

The actual revenue collected per *cable* could not theoretically exceed the maximum potential revenue (achieved at 100% meter usage and 100% meter operability). However, such instances were observed as shown in example 4.2.1. Whenever this situation occurs, it indicates that the cable revenue from the previous collection date was not completely collected. This may occur due to collector illness, harsh environmental conditions, or interruption of the collection at the end of a workday. When the revenue from a cable exceeds the canister capacity, the excess revenue is added to the canister of a nearby cable. As a consequence, the reliability of the reported revenue is affected and adjustments in revenue collection frequency and cable size are made to prevent future instances where the actual revenue exceeds the canister capacity.

Thus, by comparing the actual revenue per cycle to the expected maximum revenue per cycle for a given *cable*, the quality of collection activities can be evaluated and appropriate action can be taken. The method of this analysis is shown in Example 4.2.1.

Example 4.2.1:

The following data was obtained from the "Collection History Report By Cable Area" from 10/1/95 to 10/31/95.

Area 120, Cable L4

	Collection date	Actual revenue (per cycle) (A)	Elapsed days* from collection (B)	Max. rev.** at 100% oper. (C)	Actual rev. exceeds max. rev. (D)
1	10/2/95	$475	2	$770	
2	10/4/95	$305	2	$770	
3	10/6/95	$936	2	$770	X
4	10/11/95	$440	4	$1,540	
5	10/13/95	$494	2	$770	
6	10/16/95	$463	2	$770	
7	10/18/95	$443	2	$770	
8	10/20/95	$426	2	$770	
9	10/24/95	$765	3	$1,155	
10	10/26/95	$412	2	$770	
11	10/27/95	$406	1	$385	X
12	10/30/95	$294	2	$770	
	Average	$488		$834	

* Sundays are not counted. Sundays for this month: 1, 8, 15, 22, & 29

** Daily maximum revenue = $385 (based on meter rates and operating hours)

Where,

Maximum revenue at 100% operability for B operating days, C = $385 * B

The actual revenue exceeds the maximum revenue at 100% operability on 10/6/95 and 10/27/95. This indicates a potential revenue collection problem.

This type of analysis was performed for all the selected sample *cables*, using the historical data from June 1995 through May 1996. The number of times that the actual revenue exceeded the maximum revenue at the 100% operability level was recorded on a monthly basis. A brief summary is given in the following table. A more detailed summary is provided in Appendix D.

Borough	# sample cables per borough	# sample cables w/ at least 1 occurrence of actual rev. exceeding max. rev. at 100% oper. from 6/95 - 5/96 (A)	Sample cables with # of occurrences from (A) cable # (# of occurrences)
Manhattan	12	3	111H7 (1), 111SC3 (6), 120L4 (7)
Bronx	9	3	209L1 (1), 217H2 (24), 230L1 (29)
Brooklyn	8	4	301L10 (1), 304H14 (2), 308L3 (2), 307H1 (8)
Queens	10	2	406L4 (7), 405H2 (15)
Staten Island	6	0	--
Total	45	13	

As can be seen from the table, 13 of the 45 sample *cables* had at least one occurrence of the actual revenue exceeding the maximum revenue at 100% operability. The two *cables* in the Bronx, with 24 and 29 occurrences within the year, require particular attention and potential consideration for the meter shield program, assuming they generate revenue to compensate for the extra cost of a potentially increased rate of monitoring.

Further in-depth evaluation could be conducted by comparing the actual revenue with the maximum revenue at the current level of usage and current level of operability. The maximum revenue at the current level of operability is equal to the maximum revenue (per *cable*) generated during a cycle when all the operable meters are fully utilized. The monthly *area*wide operability can be used, since operability is currently calculated by: i) *area* (not *cable*) and ii) inspection date (not revenue collection date). This monthly value is reported on a regular basis. The current level of usage is defined as the ratio of the actual revenue to the maximum revenue at the current level of operability for a given month.

4.2.2 Evaluation of Revenue Collection Frequency (Cycle Length)

The revenue collection frequency (i.e., collection cycle length) is primarily a function of the meter usage and constrained by the capacity of the meter coin box and the coin canister. The meter coin box stores coins between collection days. Two types of coin boxes are currently used. The coin box developed in the 1980's has a capacity of approximately $50 and the coin box developed in 1995 can hold approximately $75. A value of $50 was used in this analysis in order to be conservative.

When the revenue collection agent empties the meters, the revenue from each *cable* is deposited into its own coin canister. The revenue collected per canister is typically limited not by the physical canister capacity, but by the weight which can be manipulated by the collection agent. This weight has been determined to be approximately 125 pounds, which translates into approximately $2,250 to $2,500. In order to be conservative regarding the maximum weight that can be carried by the collectors, the value for these analyses was chosen to be equal to $2,250.

It is possible to evaluate the appropriateness of the collection frequency by calculating the ratio of the actual revenue collected to the capacity constraints of the meter coin box and the coin canister. As the ratio approaches 1, efficiency of the revenue operations is maximized, that is, the revenue collection cycle becomes long enough to provide the maximum revenue per collection in relation to the above capacity limitations.

With the current collection practice, only cable revenue (and not meter) data is available. Thus, revenue per meter is not known. The average revenue per meter can be calculated by dividing the cable revenue by the number of meters in the *cable*. Obviously, this value does not account for variations in meter usage and revenue within the cable. It is the physical constraint of the coin box of the highly utilized meters which limits the collection frequency. Optimization of the collection frequency, discussed in the next section, requires information regarding meter revenue distribution within the *cable*. One objective of phase II of this study was to research meter revenue distribution within a cable.

In order to evaluate the current collection frequency (based on the data from the current collection practice), the average revenue per meter was used. In order to examine the adequacy of the collection cycle, without relying on data from a single collection, the revenue was normalized over a period of a month (that is, the actual revenue and the actual average revenue per meter were aggregated for a month and averaged for the number of collections within that month). These parameters account for seasonal and/or monthly variations in revenue. Example 4.2.2 shows how this concept is applied for a one-month period.

Example 4.2.2:

The following data was obtained from the "Collection History Report By Cable Area" from 10/1/95 to 10/31/95 for Cable L4 of Area 120.

Area 120, Cable L4

	Collection date	Elapsed days * from previous collection (A)	Actual rev. (per cycle) (B)	Actual*** rev./meter (per cycle) (C)	Actual*** rev./meter/day of the cycle (D)
1	10/2/95	2	$475	$4.20	$2.10
2	10/4/95	2	$305	$2.61	$1.31
3	10/6/95	2	$936	$8.59	$4.30
4	10/11/95	4	$440	$3.86	$0.97
5	10/13/95	2	$494	$4.70	$2.35
6	10/16/95	2	$463	$4.09	$2.05
7	10/18/95	2	$443	$3.86	$1.93
8	10/20/95	2	$426	$3.77	$1.89
9	10/24/95	3	$765	$6.77	$2.26
10	10/26/95	2	$412	$3.52	$1.76
11	10/27/95	1	$406	$3.63	$3.63
12	10/30/95	2	$294	$2.51	$1.26
	Monthly Average		$488	$4.34	$2.15

* Sundays are not counted. Sundays for this month: 1, 8, 15, 22, & 29

** Daily maximum revenue = $385 (based on meter rates and operating hours)

*** Revenue is averaged for all meters within the *cable*.

Where,

Actual revenue/meter/day of the cycle, D = C/A

For collection date 10/4/95,

Actual revenue/meter/day of the cycle, D = $2.61/2 = $1.31

The efficiency of the collection frequency is calculated as follows:

Monthly avg. of actual revenue/coin canister capacity = ($488/$2250)*100 = 22%

Monthly avg. of actual revenue per meter/coin box capacity = ($4.34/$50)*100 = 9%

From the above comparison, it appears that the cycle length could be increased considerably. Only 22% of the canister capacity and 9% of the meter coin box capacity are utilized per cycle, according to these monthly values. Considering the maximum values, monitored on 10/6/95, of 42% (100*$936/$2,250) and 17% (100*$8.59/$50) for the coin canister and meter coin box capacities respectively, the efficiency is still low. It is likely, that even if the revenue per meter within a cable was available, the highly utilized meters may still yield low revenue in relation to meter coin box capacity.

The ratios of the actual revenue to the coin canister capacity and the actual revenue to the meter coin box capacity were calculated for the selected sample *cables* on a monthly basis. Examples of the analyses are provided in Appendices E1 and E3 and graphical representations are provided in Appendices E2 and E4. Most of the selected *cables* had monthly ratios of actual revenue to coin canister capacity equal to 50% or less. Approximately 10 *cables* had ratios between 50% and 75% and 3 *cables* had ratios between 75% and 100%. One *cable* in Queens had ratios greater than 100% for June and July. None of the selected sample *cables* had ratios of actual revenue to coin box capacity greater than 70%. Most *cables* had ratios less than 50%. Based on the overall values of these analyses, revenue collection cycles could be lengthened for most *cables*. A method for optimizing the collection frequency is presented in the next section.

4.2.3 Optimization of Revenue Collection Frequency (Cycle Length)

In order to maximize the efficiency of revenue collection operations, the cable collection frequency could be adjusted so that the revenue per cycle is close to the coin canister capacity, and the revenue per meter per cycle is close in value to the limiting meter coin box capacity. Since revenue is proportional to the cycle length and inversely proportional to the number of collections, the following equations identify the cycle length and collection frequency:

i) $$\frac{\text{Current revenue collection cycle length}}{\text{Actual revenue per cycle}} = \frac{C_1}{\$2{,}250 * 0.9}$$

$$\frac{\text{Current revenue collection cycle length}}{\text{Actual revenue per meter per cycle} * \Delta} = \frac{C_2}{\$50 * 0.9}$$

Solve for C_1 and C_2.

ii) $$\frac{1 / \text{current \# of collections}}{\text{Actual revenue}} = \frac{1 / F_1}{\$2{,}250 * 0.9}$$

$$\frac{1 / \text{current \# of collections}}{\text{Actual revenue per meter} * \Delta} = \frac{1 / F_2}{\$50 * 0.9}$$

Solve for F_1 and F_2.

Where,

C_1 = optimal rev. collection cycle length when considering coin canister usage/capacity

C_2 = optimal rev. collection cycle length when considering coin box usage/capacity

F_1 = optimal number of revenue collections when considering coin canister usage

F_2 = optimal number of revenue collections when considering meter coin box usage

$2,250 = coin canister capacity

$50 = meter coin box capacity

0.9 = a safety factor limiting the canister and coin box capacity to 90% capacity

Δ = a factor representing the variation between actual average revenue per meter and the revenue of the highly utilized meters

The Δ factor considers the variability in meter revenue within a cable. The most highly utilized meters within the *cable* are the most critical when considering changes in the collection frequency. The collection frequency should be determined, such that the highly utilized meters within the *cable* are not overfilled during the given cycle. Example 4.2.3a demonstrates the procedure to estimate Δ.

Example 4.2.3a:

The following meter revenue distribution data was obtained during the field study conducted between 4/14/97 and 4/25/97 using a dipstick.

Area 101, Cable 2

Date *	Elapsed days	Coin Box Status						Actual revenue/ cable (A)	Average revenue/ meter (B)	Revenue of highly used meters (C)	Variation between (B) & (C)
		$0	$10	$20	$30	$40	$50				
[redacted]	7	0	2**	20	11	7	0	$1,030	$26	$40	55%
4/15	1	6	34	0	0	0	0	$340	$9	$10	18%
4/16	2	0	25	15	0	0	0	$550	$14	$20	45%
4/17	3	0	9	31	0	0	0	$710	$18	$20	13%
4/18	4	0	6	34	0	0	0	$740	$19	$20	8%
4/21	6	0	1	36	3	0	0	$820	$21	$30	46%
4/22	7	0	1	20	19	0	0	$980	$25	$30	22%
[redacted]	0***	0	0	0	0	0	0	$0	$0	$0	—
										Average Variation:	30%
										Maximum Variation:	55%

* Collection days are highlighted. Sunday (4/20) is not counted.

** Number of meters within the *cable* with $10.

*** The meter coin box was emptied without the dipstick measurement being taken.

Total # of meters = 40

Where,

Average revenue per meter, B = A/40

Variation between Column B and Column C = ((C-B)/B)*100

For 4/14,

Average revenue per meter, B = $1,030/40 = $26

Variation between Column B and Column C = (($40-$26)/$26)*100 = 55%

The average variation between the average revenue per meter and the revenue of the highly utilized meters is 30% (maximum variation for the collection period is 55%). Therefore, the value Δ for this *cable* may be set to 1.3.

Prior to the dipstick field study conducted in April 1997, it was assumed that, on average, the highly utilized meters yield revenue 15% greater than the other meters, resulting in a Δ value of 1.15. The value of Δ was calculated for the three *cables* in the field study (two in addition to the *cable* in Example 4.2.3a). All three Δ values were found to be equal to 1.3. This factor, however, should be evaluated on a *cable*-by-*cable* basis to increase accuracy. The data for all three *cables* is given in Appendix F.

The optimal revenue collection cycle length can be estimated as the minimum value of C_1 or C_2, and the optimal revenue collection frequency can be estimated as the maximum value of F_1 or F_2. The revenue which can be expected based on the optimal collection cycle or frequency can be calculated as follows:

i) $$\frac{\text{Actual revenue per cycle}}{\text{Current revenue collection cycle length}} = \frac{\text{Expected revenue per cycle}}{\text{Optimal revenue collection cycle length}}$$

$$\frac{\text{Actual revenue per meter per cycle}}{\text{Current revenue collection cycle length}} = \frac{\text{Expected revenue per meter per cycle}}{\text{Optimal revenue collection cycle length}}$$

ii) $$\frac{\text{Actual revenue}}{1 \,/\, \text{current \# of collections}} = \frac{\text{Expected revenue}}{1 \,/\, \text{optimal \# of collections}}$$

$$\frac{\text{Actual revenue per meter}}{1 \,/\, \text{current \# of collections}} = \frac{\text{Expected revenue per meter}}{1 \,/\, \text{optimal \# of collections}}$$

The procedure to calculate the optimal revenue collection cycle length and the expected revenue is shown in Example 4.2.3b.

Example 4.2.3b:

The following data was obtained from the "Collection History Report By Cable".

Area 101, Cable 2

Collection date	Cycle length (days)* (A)	Actual revenue (per cycle) (B)	Actual** revenue/meter (per cycle) (C)	Actual** revenue/meter/ day of the cycle (D)
4/7/97	7	$2,076	$28.00	$4.00
4/15/97	7	$1,504	$23.10	$3.30
4/23/97	7	$1,548	$23.80	$3.40
Average	7	$1,709	$24.97	$3.57

* Sundays are not counted. Sundays for this month: 6, 13, 20, & 27

** Revenue is distributed equally among all meters within the *cable*.

Where,

Actual revenue/meter/day of the cycle, D = C/A

For collection date 4/7/97,

Actual revenue/meter/day of the cycle, D = \$28.00/7 = \$4.00

Using the average values of cycle length and actual revenue per meter per cycle in the following equations, the optimal revenue collection cycle length was estimated:

$$\frac{\text{Current revenue collection cycle length}}{\text{Actual revenue per cycle}} = \frac{C_1}{\$2,250 * 0.9}$$

$$\frac{7 \text{ days}}{\$1,709} = \frac{C_1}{\$2,250 * 0.9} \qquad C_1 = 8.3 \text{ days}$$

$$\frac{\text{Current revenue collection cycle length}}{\text{Actual revenue per meter per cycle} * \Delta} = \frac{C_2}{\$50 * 0.9}$$

$$\frac{7 \text{ days}}{\$24.97 * 1.3} = \frac{C_2}{\$50 * 0.9} \qquad C_2 = 9.7 \text{ days}$$

Therefore, the optimal revenue collection cycle length would be 8 days for this *cable* in the given month. The expected revenue for this optimal collection cycle length was estimated using the following equations:

$$\frac{\text{Actual revenue per cycle}}{\text{Current revenue collection cycle length}} = \frac{\text{Expected revenue per cycle}}{\text{Optimal revenue collection cycle length}}$$

$$\frac{\$1{,}709}{\text{7 days}} = \frac{\text{Exp. rev.}}{\text{8 days}} \qquad \text{Exp. rev.} = \$1{,}953$$

$$\frac{\text{Actual revenue per meter per cycle}}{\text{Current revenue collection cycle length}} = \frac{\text{Expected revenue per meter per cycle}}{\text{Optimal revenue collection cycle length}}$$

$$\frac{\$24.97}{\text{7 days}} = \frac{\text{Exp. rev./meter}}{\text{8 days}} \qquad \text{Exp. rev./ meter} = \$28.54$$

Increasing the revenue collection cycle by one day would not only yield an additional $244 ($1,953 - $1,709) per cycle in revenue, but would also reduce the labor costs associated with revenue collection activities because less collections would be scheduled.

4.2.4 Calculating Cable Operability and Net Revenue Loss

Currently, operability is calculated by *area*, by borough, and citywide. If operability were calculated by *cable*, the inspection/maintenance and revenue collection activities could be more easily coordinated, as the revenue loss due to operability could be estimated by *cable*. As a result, specific problem *cables* within an *area* could be targeted, focusing energies where they would be most effective. The *cable* operability can be computed since the maintenance records are reported per individual meter. Typically, the number of inspections per *cable* is the same as the number of inspections *area*wide, within a month. The *cable* operability would be calculated as shown in Example 4.2.4a.

Example 4.2.4a:

Assume the following:

- the number of inspections within a month = 2
- the number of meters per *cable* = 70
- total number of defective meters = 28

The number of inspected meters per month = 2*70 = 140.

Operability = (1-(28/140))*100 = 80%.

The maximum revenue per cycle per *cable* is based on the rate per meter and the hours of meter operation with 100% usage and 100% operability. The maximum revenue loss is defined as the difference between the maximum revenue at 100% operability and the maximum revenue at the current operability. It may also be calculated as follows:

$$\text{Max. rev. loss/cycle/}\textit{cable} = \frac{\text{Max. rev./meter/day * Total \# of defects * Elapsed days}}{\text{\# of collections within a month}}$$

Where,

- The maximum revenue per meter per day is calculated based on the rate per meter and the operating hours.

- The # of elapsed days represents the number of days elapsed from when a meter becomes defective until it is repaired. This parameter can be estimated by assuming that meters are defective for half the days between inspections. For example, if there are 2 inspections per month, the inspection cycle is approximately 15 days. Therefore, the number of elapsed days during which meters are defective is 7.5 days.

The maximum revenue loss does not take into account that meters are not always fully utilized. The net revenue loss is defined as the revenue loss per cycle per *cable* under the current level of operability and the current level of usage. The net revenue loss can be estimated as follows:

Net revenue loss = Maximum revenue loss * Current level of usage

The current level of usage can be obtained from the ratio of the actual revenue and the maximum revenue at the current level of operability, with both values averaged for a month. Example 4.2.4b shows the method to calculate the *cable* operability and estimate the net revenue loss.

Example 4.2.4b:

Area 101, Cable 2

	Total # def. (A)	# insp./ month (B)	Oper. found (C)	Elapsed days (D)	# coll./ month (E)	Max.* rev. loss/ cycle (F)	Actual rev./ cycle (G)	Max. rev. at 100% oper. (H)	Max. rev. at current oper. (J)	Net rev. loss (K)	Net rev. loss/ month (L)
6/95	29	4.00	88%	3.75	4	$123	$1,298	$2,056	$1,933	$82	$330
7/95	20	2.05	84%	7.32	3	$220	$1,430	$2,252	$2,032	$155	$465
8/95	25	2.00	80%	7.50	4	$212	$1,437	$2,130	$1,918	$159	$635
9/95	20	1.96	84%	7.65	3	$231	$1,225	$2,154	$1,923	$147	$441
10/95	32	1.95	74%	7.69	4	$278	$1,182	$2,203	$1,925	$171	$683
11/95	19	3.00	90%	5.00	3	$143	$1,329	$2,350	$2,207	$86	$259
12/95	39	2.85	78%	5.26	3	$309	$1,151	$2,350	$2,041	$174	$523
1/96	43	1.14	39%	13.16	2	$1,278	$1,177	$3,966	$2,688	$560	$1,120
2/96	40	3.99	84%	3.76	3	$227	$1,087	$2,448	$2,221	$111	$333
3/96	53	5.11	83%	2.94	3	$234	$1,166	$2,252	$2,018	$135	$406
4/96	79	6.08	79%	2.47	4	$220	$1,296	$2,130	$1,910	$149	$598
5/96	55	5.19	83%	2.89	3	$239	$1,391	$2,056	$1,817	$183	$550
								Yearly Revenue Loss:			$6,342

* Maximum revenue per meter per day = $4.519 (based on meter rates and operating hours)
Total # meters = 62

Where,

Operability found, C = (1-(A/(B*62)))*100

Elapsed days, D = 0.5*30/B

Maximum revenue loss per cycle, F = (A/E)*D*$4.519

Maximum revenue at current operability, J = H - F

Net revenue loss/cycle, K = F*G/J

Net revenue loss per month, L = E*K

For June 1995,

Operability found, C = (1-(29/(4.00*62)))*100 = 88%

Elapsed days, D = 0.5*30/4.00 = 3.75

Maximum revenue loss per cycle, F = (29/4)*3.75*$4.519 = $123

Maximum revenue at current operability, J = $2,056 - $123 = $1,933

Net revenue loss/cycle, K = $123*$1,298/$1,933 = $82

Net revenue loss per month (for 6/95), L = 4*$82 = $330

The yearly revenue loss, $6,342, is the sum of the previous twelve months.

The method was applied to the selected sample *cables* and examples are shown in Appendix G. Examples of a graphical representation of maximum revenue at 100% operability, maximum revenue at current operability, and actual revenue are shown in Appendix H. The monthly net revenue loss for all the selected sample *cables* was in the range of $100 to $1,000, with the exception of one *cable* in Manhattan, which had a high value of $2,000 per month.

4.2.5 Meter Defect Study

Meter defects are mainly divided into two categories: *vandalism defects* and *non-vandalism defects*. An effective maintenance strategy can be established based on the number and types of defects found. For example, a high number of non-vandalism defects may indicate that adjustments to the inspection frequency may reduce the elapsed time a meter remains defective, thereby increasing operability and revenue. For *cables* with a high incidence of vandalism defects, measures should be taken to prevent meter vandalism, such as the Meter Shield Program conducted by NYCDOT.

Currently, only the four types of defects which interfere with the revenue collection function of the meter are considered when evaluating operability. The vandalism defect is represented by the code #41 and the three non-vandalism defects are represented by the code #'s 42, 43, and 44. The defects found for Area 101, Cable 2 between June 1995 and May 1996 are summarized in the following table.

	6/95	7/95	8/95	9/95	10/95	11/95	12/95	1/96	2/96	3/96	4/96	5/96
Defect 41	0	4	8	10	9	7	6	11	5	4	2	2
Def. 42-44	36	22	30	27	30	21	19	31	49	37	22	16
Total # def.	36	26	38	37	39	28	25	42	54	41	24	18
# insp.	5	3	4.4	4.5	5	6	4.8	1.7	5.6	7	5.8	5.2

The number of inspections per month was obtained from the NYCDOT Parking Division and is based on the ratio of the number of meters inspected during the month and the number of meters in the *area*. For example, if there are 500 meters in an *area* and 1,500 meters were inspected within the month, the number of inspections would be equal to 1,500/500 = 3.

The data from the table above is plotted in Figure 4.2.5. With this visual aid, the seasonal variations of the number and types of defects become apparent. Samples of the defect data for the selected sample cables are shown graphically in Appendix I. Based on these figures, meter vandalism is not prevalent in the Bronx, Brooklyn, Queens, or Staten Island. Data for one half of the Manhattan cables indicates relatively high levels of vandalism.

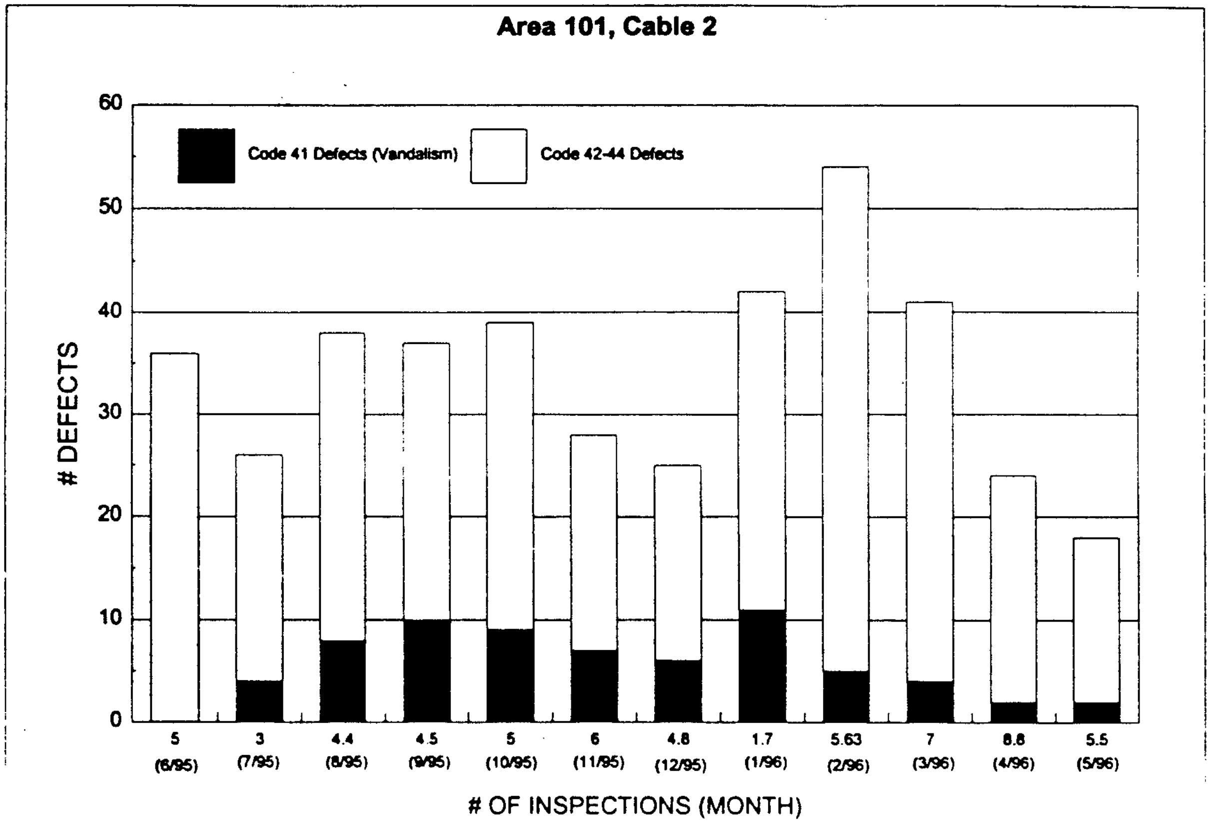

Figure 4.2.5 Number of Revenue-Related Defects per Month

Chapter 5. Step-by-Step Procedures for Implementing Operability-Related Improvements

Based on the analysis of Chapter 3, step-by-step procedures for implementing the suggested operability-related improvements are presented herein.

5.1 Calculating Operability Left

This procedure can be used to calculate *operability left* when only a portion of the meters within a given location are inspected on the inspection day. This applies to meters within a *cable*, meters within an *area*, and/or within a borough, and/or citywide.

- Calculate *operability left* by following these steps:

1) Determine the total number of meters within the *area* of interest

2) Determine the number of meters inspected on the inspection date

3) Determine the number of defective meters found

4) Determine the number of defective meters repaired

5) Calculate the *operability found*, %

   = (1-(# defective meters/# meters inspected))*100

6) Calculate the *operability left* of the inspected meters (use the current method), %

   = [(1-(# defective meters - # meters repaired))/# meters inspected]*100

7) Calculate the *operability left* for the *area* of interest (use the recommended method), %

= [(1-(# meters inspected/total number of meters))**operability found*] +

[(# meters inspected/total number of meters)**operability left* of inspected meters]

Example:

Area 121

Insp. date	# meters	# meters inspected	# defective meters	# repaired meters	Operability Found	Oper. Left (current)	Oper. left (recommended)
1/6/96	372	184	46	41	75%	97%	86%

1) Determine the number of meters within the *area* of interest
   - within Area 121 there are 372 meters

2) Determine the number of meters inspected on the inspection date
   - on 1/6/96, 184 meters were inspected

3) Determine the number of defective meters found
   - on 1/6/96, 46 defective meters were found

4) Determine the number of defective meters repaired
   - on 1/6/96, 41 meters were repaired

5) Calculate the *operability found*
   - on 1/6/96, *operability found* = (1-(46/184))*100 = 75%

6) Calculate the *operability left* of the inspected meters (using the current method), %
   - on 1/6/96, *operability left* of the inspected meters = [1-((46-41)/184)]*100 = 97%

7) Calculate the *operability left* of the *area* of interest, %
   - on 1/6/96, *operability left* = [(1-(184/372))*75%] + [(184/372)*97%] = 86%

5.2 Estimating Daily Operability for Areas Without Daily Inspections

This procedure can be used to calculate daily operability for *areas* without daily inspections. In order to calculate the daily operability between inspection days, the daily change in operability must first be determined. Inspection and maintenance data for two consecutive inspection days must be known.

- Calculate the change in operability, the daily change in operability, and the daily operability between inspection days by following these steps:

1) Determine the total number of meters within the *area* of interest

2) Determine the number of meters inspected on two consecutive inspection dates

3) For each inspection date, determine the number of defective meters found

4) For each inspection date, determine the number of defective meters repaired

5) For each inspection date, calculate the *operability found*, %

   = (1-(# defective meters/# meters inspected))*100

6) For each inspection date, calculate the *operability left*, %

   = [(1-(# meters inspected/total number of meters))**operability found*] +

   {(# meters inspected/total number of meters) *

   [(1-(# defective meters - # meters repaired))/# meters inspected]*100}

7) Calculate the change in operability between inspection days

   = *operability left* on first insp. day - *operability found* on second insp. day

8) Calculate the daily change in operability between inspection days

= change in operability between insp. days/number of insp. days

9) Calculate the daily operability between inspection days

= *operability left* on first inspection day - (daily change in operability * number of elapsed days between the first inspection day and the day of interest)

Example:

Area 121

Insp. date	# elapsed days bet. insp.	# meters	# meters insp.	# defective meters	# repaired meters	Oper. found	Oper. left	Change In oper. Bet. insp.	Daily change in oper. bet. insp.
1/6/96		372	184	46	41	75%	86%		
1/19/96	13	372	372	71	71	81%	100%	5%	0.39%

1) Determine the total number of meters within the *area* of interest
   - within Area 121 there are 372 meters

2) Determine the number of meters inspected on two consecutive inspection dates
   - on 1/6/96, 184 meters were inspected;
   - on 1/19/96, 372 meters were inspected

3) For each inspection date, determine the number of defective meters found
   - on 1/6/96, 46 defective meters were found;
   - on 1/19/96, 71 defective meters were found

4) For each inspection date, determine the number of defective meters repaired
   - on 1/6/96, 41 meters were repaired
   - on 1/19/96, 71 meters were repaired

5) For each inspection date, calculate the *operability found*, %

- on 1/6/96, *operability found* = (1-(46/184))*100 = 75%
- on 1/19/96, *operability found* = (1-(71/372))*100 = 81%

6) For each inspection date, calculate the *operability left*, %
   - on 1/6/96, *operability left* =

     [(1-(184/372))*75%] + {(184/372)*[(1-(46-41))/184]*100} = 86%

   - on 1/19/96, *operability left* =

     [(1-(372/372))*81%] + {(372/372)*[(1-(71-71))/372]*100} = 100%

     (100% *operability left* indicates that all meters within the *area* of interest were inspected, and all defective meters were repaired.)

7) Calculate the change in operability between inspection days
   - change in operability between inspection days = 86% - 81% = 5%

8) Calculate the daily change in operability between inspection days
   - daily change in operability between inspection days = 5% / 13 days = 0.39%

9) Calculate the daily operability between inspection days
   - on 1/6/97, Day 1, *operability left* = 86%

     on 1/7/97, Day 2, operability = 86% - (0.39% * 1 elapsed day) = 85.6%

     on 1/8/97, Day 3, operability = 86% - (0.39% * 2 elapsed days) = 85.2%

     ...etc,

     on 1/19/97, Day 13, *operability found* = 86% - (0.39% * 13 elapsed days) = 81%

5.3 Predicting Future Operability

This procedure can be used to predict the future daily operability of an *area*, based on the current or past patterns. For a given month, the changes in operability between inspection days are calculated, then the *average daily change in operability* is estimated for that month. Because seasonal effects on meter use and operability are already taken into account, this parameter should only be used to predict future operability loss for the same month in the future. Future inspection schedules must be known to use this procedure.

- Calculate the change in operability between inspection days, the average daily change in operability for a given month, and the future daily operability by following these steps:

1) Calculate the change in operability between inspection days for a given month, by following steps 1 through 7 outlined in Section 5.2

2) Determine the average daily change in operability for the given month, %

   = sum of change in operability between inspection days / sum of elapsed days between inspection days in the given month

3) Calculate the future daily operability for the same month, based on the future inspection schedule

   = *operability left* on first inspection day - (average daily change in operability * number of elapsed days between the first inspection day and the day of interest)

Example:

Area 121

Insp Date	# elapsed days	# meters	# meters insp	# defective meters	# repaired meters	Oper. found	Oper. left	Change in oper. bet. insp.
1/6/96		372	184	46	41	75%	86%	
1/19/96	13	372	372	71	71	81%	100%	5%
1/20/96	1	372	218	23	23	89%	96%	11%
1/24/96	4	372	372	66	66	82%	100%	13%
1/27/96	3	372	372	44	44	88%	100%	12%
1/31/96	4	372	372	41	41	89%	100%	11%
Total	25							52%

1) Calculate the change in operability between inspection days for a given month, by following steps 1 through 7 outlined in Section 5.2
   - for example, between 1/6/96 and 1/19/96, the change in operability between insp. days = 86% - 81% = 5%

2) Determine the average daily change in operability for the given month, %
   - the average daily change in operability for the month of January = 52% / 25 = 2.1%

3) Calculate the future daily operability for the same month, based on the future inspection schedule
   - assume the inspection schedule for January 1997 is set for day 1, and then every four days thereafter (i.e. 1, 5, 9, etc.).

on Day 1, assume *operability left* = 100%

on Day 2, operability = 100% - (2.1% * 1 elapsed day) = 97.9%

on Day 3, operability = 100% - (2.1% * 2 elapsed days) = 95.8%

on Day 4, operability = 100% - (2.1% * 3 elapsed days) = 93.7%

on Day 5, *operability found* = 100% - (2.1% * 4 elapsed days) = 91.6%

operability left = 100%

5.4 Estimating Cost of 1% Increase in Operability

This procedure can be used to calculate the additional number of meters which must be inspected to increase the operability by a given percent and the increased revenue associated with repairing the additional defective meters found. Assume all defective meters found are repaired on site.

- Calculate the number of additional meters which must be inspected to increase the operability by a given percent and the number of additional defective meters which will be found by following these steps:

1) Determine the total number of meters within the *area* of interest

2) Determine the number of meters inspected on the date of interest

3) Determine the number of defective meters found

4) Calculate the *operability found*, %

   = (1-(# defective meters/# meters inspected))*100

5) Calculate the *operability left*, %

   = [(1-(# meters inspected/total number of meters))*operability found] +

   [(# meters inspected/total number of meters) * *operability left* of insp. meters]

   (The *operability left* of the inspected meters is assumed to be 100%, indicating that all the defective meters were repaired.)

6) Increase the current *operability found* and *operability left* by the desired amount

   = current *operability found* + desired amount = future *operability found*

   = current *operability left* + desired amount = future *operability left*

7) Calculate the total number of meters which must be inspected to generate operabilities equal to the desired values

   - use equation given in step number 5 with operability equal to the future operability calculated in step 6, and solve for the number of meters inspected

8) Calculate the additional number of meters which must be inspected to generate operabilities equal to the desired values

   = number of meters to be inspected calculated in step 7 - original number of meters inspected

9) Calculate how many of these additional inspected meters would be found to be defective

= number of additional meters to be inspected * (total number of original defective meters for the period evaluated/total number of meters inspected for the period evaluated)

- Calculate the increase in revenue associated with the repair of the additional defective meters found by following these steps. (The cost to inspect, repair, and collect revenue from the additional meters can be calculated based on the associated labor costs.)

10) Determine/estimate the meter rate for the *area* of interest

11) Determine/estimate the operating hours for the *area* of interest

12) Determine/estimate the current level of meter usage

13) Calculate the revenue potential of the additional defective meters

= # defective meters * meter rate * meter operating hours * meter usage * 50% (Since repairs of the defective meters will occur throughout the day of inspection and not all at once, assume 50% of the meters will provide revenue).

14) Calculate the revenue potential for the period evaluated

= revenue potential of additional defective meters * # days of period evaluated

Example:

Calculate values required to increase operability by 1%.

Citywide Operability Data

Date	# meters insp.	# defective meters	Oper. found	Oper. Left	Oper. found increased 1%	Oper. left increased 1%	# meters to be insp.	# add. meters	# add. defective meters
1/22/96	13014	2686	79.36%	83.45%	79.36% *	84.45%	16194	3180	638
1/23/96	13211	2854	78.40%	82.74%	79.40%	83.74%	13852	641	129
1/24/96	12889	2879	77.66%	82.05%	78.66%	83.05%	13493	604	121
1/25/96	14124	2809	80.11%	84.39%	81.11%	85.39%	14872	748	150
1/26/96	15538	2581	83.39%	87.32%	84.39%	88.32%	16533	995	200
Total	68776	13809					74944	6168	1238
Average	13755	2762					14989	1234	248

* *Operability found* on 1/22/96 is not affected.

1) Determine the total number of meters within the *area* of interest
   - citywide there are 65643 meters

2) Determine the number of meters inspected on the date of interest
   - on 1/24/96, 12889 meters were inspected

3) Determine the number of defective meters found
   - on 1/24/96, 2879 defective meters were found

4) Calculate the *operability found*, %
   - on 1/24/96, *operability found* = (1-(2879/12889))*100 = 77.66%

5) Calculate the *operability left*, %
   - on 1/24/96, *operability left* =

     {[1-(12889/65643)]*77.66%} + [(12889/65643)*100%] = 82.05%

6) Increase the current *operability found* and *operability left* by the desired amount
   - on 1/24/96, future *operability found* = 77.66% + 1% = 78.66%
   - on 1/24/96, future *operability left* = 82.05% + 1% = 83.05%

7) Calculate the total number of meters which must be inspected to generate operabilities equal to the desired values

   – on 1/24/96, the number of meters which would need to be inspected = 13493

   83.05% = {[1-(# meters insp./65643)]*78.66%} + [(# meters insp./65643)*100%]

8) Calculate the additional number of meters which must be inspected to generate operability equal to the desired values

   – on 1/24/96, the number of additional meters to be inspected = 13493 - 12889 = 604

9) Calculate how many of these additional inspected meters would be found to be defective

   – number of additional defective meters found = 604 * (13809/68776) = 121

10) Determine/estimate the meter rate for the *area* of interest

   – meter rate = $0.50 per hour

11) Determine/estimate the operating hours for the *area* of interest

   – operating hours = 10 hours per day

12) Determine/estimate the current level of meter usage

   – current level of meter usage = 60%

13) Calculate the revenue potential of the additional defective meters

   – revenue potential = 121 * $0.50/hour * 10 hours/day * 0.60 * 0.50 = $372/day

14) Calculate the revenue potential for the period evaluated

   – revenue potential for period evaluated = $372 * 5 days = $1860

5.5 Operability Simulation (Optimum Inspection/Maintenance Cycle)

This procedure can be used to determine the optimum inspection and maintenance cycle length for a given *area* by simulating the operability for various inspection cycle lengths. Inspection and repair operations should be performed for a given sample *area* on a daily basis for a certain period of time (i.e. 2 weeks). During this inspection period, the type of defect, its date of occurrence and the number of days which elapse between the meter becoming defective and the meter being repaired should be recorded.

- Determine the *operability found* for various inspection cycle lengths and determine the optimum inspection and maintenance cycle length by following these steps:

1) Perform inspection and repair operations for a given sample *area* on a daily basis for a certain period of time (i.e. 2 weeks). Record the type of defect, its date of occurrence and the number of days which elapse between the meter becoming defective and the meter being repaired

2) Determine the total number of meters within the sample *area*

3) Determine the number of meters inspected

   (The same meters should be inspected each day during the specified inspection period, so that data may be compared.)

4) Determine the number of defective meters found

   (Note which meters were found to be defective on consecutive days. It may be useful to display this data in a matrix - see example provided below).

5) Calculate the *operability found*, %

   = (1-(# defective meters/# meters inspected))*100

   (This data will be the basis for comparing various inspection cycle lengths).

6) Choose the inspection cycle length to be simulated

7) Overlay this inspection schedule on the data previously collected

   (If an inspection cycle of three days was chosen, Day 1 of the theoretical inspection corresponds to Day 1 of the original inspection, Day 2 of the theoretical inspection corresponds to Day 4 of the original inspection, Day 3 corresponds to Day 7, etc.)

8) Calculate the number of overlapping defects

9) Calculate the number of accumulated defects

   = previous # accumulated defects + # defects - # overlapping defects

   (On the day after inspection, there are no overlapping defects, because defective meters found on the previous day would have been repaired).

10) Calculate the *operability found*, %

    = (1-(# defective meters/# meters inspected))*100

11) Two parameters should be evaluated: a) Compare the simulated *operability found* with the *operability found* when the meters were inspected every day. Determine if the simulated values would be acceptable, and b) review the number of overlapping defects out of the total number of defects found between theoretical inspection days.

12) Based on these findings, if the new inspection schedule yields satisfactory results, adopt this inspection cycle length. If it does not, repeat steps 6 through 11.

Example:

Area 117, Cable L1

Meter #	4/14*	4/15	4/16	4/17	4/18	4/19	4/20	4/21	4/22	4/23	4/24	4/25
136	441**	[redacted]										
147	441											
148		443										443
149								441				
150												441
152				441	[redacted]			441				542
162	441											
163	342											
166	441							441				
168												441
171	442	[redacted]			542/444							
175								441				
177								441				
186	442				441							542
187								443				
188	443											441
662					441							

* Inspection date
** Code indicating type of defect found
Overlapping defects are highlighted; Total # of meters = 49

1) Perform inspection and repair operations for a given sample *area* <u>on a daily basis</u> for a certain period of time. Record the type of defect, its date of occurrence and the number of days which elapse between the meter becoming defective and the meter being repaired
   - see results in table above

2) Determine the total number of meters within the *area* of interest
   - within Area 117, Cable L1 there are 49 meters

3) Determine the number of meters inspected
   - on each inspection day, 49 meters were inspected

4) Determine the number of defective meters found
   - on 4/15/97, 3 defective meters were found

Insp. date	4/14	4/15	4/16	4/17	4/18	4/19	4/20	4/21	4/22	4/23	4/24	4/25
# meters insp.	49	49	49	49	49	49	49	49	49	49	49	49
# defects	8	3	0	1	4	0	0	6	0	0	0	6
Oper. found	84%	94%	100%	98%	92%	100%	100%	88%	100%	100%	100%	88%

5) Calculate the *operability found*, %

- on 4/15/97, *operability found* = (1- (3/49))*100 = 94%

Insp. date	4/14	4/15	[redacted]	4/17	4/18	[redacted]	4/20	4/21	[redacted]	4/23	4/24	[redacted]
# meters insp.	49	49	49	49	49	49	49	49	49	49	49	49
# defects	8	3	0	1	4	0	0	6	0	0	0	6
# overlap. def.	0	2	0	0**	1	0	0	0	0	0	0	0
# accum. def.	8	9	9	1	4	4	0	6	6	0	0	6
Oper. found	84%	82%	82%	98%	92%	92%	100%	88%	88%	100%	100%	88%

* Inspection dates are highlighted

6) Choose the inspection cycle length to be simulated
   - simulate an inspection cycle length of three days

7) Overlay this inspection schedule on the data previously collected
   - inspection days are 4/16, 4/19, 4/22, and 4/25

8) Calculate the number of overlapping defects
   - on 4/15/97, two meters have overlapping defects, meters #136 and #171

9) Calculate the number of accumulated defects
   - on 4/15/97, number of accumulated defects = 8 + 3 - 2 = 9

10) Calculate the *operability found*, %
   - on 4/15/97, *operability found* = (1- (9/49))*100 = 82%

11) Two parameters should be evaluated: a) Compare the simulated *operability found* with the *operability found* when the meters were inspected every day. Determine if the simulated values would be acceptable, and b) review the number of overlapping defects out of the total number of defects found between theoretical inspection days.

- on the inspection days, the *operability found* decreases from 100% to 82%, 92%, and 88% for 4/16, 4/19, and 4/22, respectively. On 4/25, the *operability found* is the same.

- Overlapping defects are only found on 4/15 and 4/18.

Chapter 6. Step-by-Step Procedures for Implementing Revenue Collection-Related Improvements

Based on the analysis of Chapter 4, step-by-step procedures for implementing the suggested revenue collection improvements are presented herein.

6.1 Evaluating Current Revenue Collection Practice

This procedure can be used to evaluate the current revenue collection activities by comparing the actual revenue collected per cycle to the potential maximum revenue per cycle for a given *cable.*

- <u>Calculate potential maximum revenue per cycle and compare with actual revenue collected by following these steps</u>:

1) Determine the actual rev. collected per cycle for the *cable* of interest for the given month

2) Calculate the # of days elapsed between collection days for each cycle in the given month (Because no revenue is generated on Sundays, exclude them from the calculations).

3) Calculate the maximum revenue at 100% operability per cycle for the *cable* of interest for the given month

   = daily maximum revenue * elapsed days from collection date

   (The daily maximum revenue is based on meter rate and operating hours).

4) Compare the actual revenue collected to the maximum revenue at 100% operability for each cycle within the month. If the actual revenue is greater than the maximum revenue at 100% operability for any cycle, revenue collection activities should be examined.

Example:

Area 120, Cable L4

	Collection date	Actual revenue (per cycle)	Elapsed days from collection	Max. rev. at 100% oper.	Actual rev. exceeds max. rev.
1	10/2/95	$475	2	$770	
2	10/4/95	$305	2	$770	
3	10/6/95	$936	2	$770	X
4	10/11/95	$440	4	$1,540	
5	10/13/95	$494	2	$770	
6	10/16/95	$463	2	$770	
7	10/18/95	$443	2	$770	
8	10/20/95	$426	2	$770	
9	10/24/95	$765	3	$1,155	
10	10/26/95	$412	2	$770	
11	10/27/95	$406	1	$385	X
12	10/30/95	$294	2	$770	
	Average	$488		$834	

Daily maximum revenue = $385

1) Determine the actual rev. collected per cycle for the *cable* of interest for the given month
   - on 10/4/95, the actual revenue is equal to $305

2) Calculate the # of days elapsed between collection days for each cycle in the given month
   - between 10/2/95 and 10/4/95, 2 days elapsed

3) Calculate the maximum revenue at 100% operability per cycle for the *cable* of interest for the given month
   - on 10/4/95, maximum revenue at 100% operability = $385 * 2 = $770

4) Compare the actual revenue to the maximum revenue at 100% operability for each cycle within the month
   - on 10/6/95 and 10/27/95, the actual revenue collected exceeds the maximum revenue at 100% operability. This indicates a potential revenue collection problem and the revenue collection activities for this *cable* should be examined.

6.2 Evaluation of Revenue Collection Frequency (Cycle Length)

This procedure can be used to evaluate the efficiency of the revenue collection frequency or cycle length by calculating the ratio of the actual revenue collected to the size constraints of the meter coin box and coin canister. As the ratio approaches 1, efficiency of the revenue operations is maximized (that is, the revenue collection cycle becomes long enough to provide the maximum revenue per collection).

- Calculate the ratios of the actual revenue per cycle to the canister capacity and the actual revenue per cycle per meter to the coin box capacity by following these steps:

1) Determine the actual revenue collected per cycle for the *cable* of interest for the given month

2) Calculate the number of days elapsed between collection days for each cycle in the given month

   (Because no revenue is generated on Sundays, exclude them from the calculations).

3) Calculate the actual revenue per meter per cycle for the *cable* of interest for the given month

   = actual revenue per cycle ÷ meters in the *cable*

   (Revenue is distributed equally among all meters within the *cable*).

4) Calculate the ratio of the actual revenue per cycle to the coin canister capacity

   = (average of actual revenue per cycle in the given month/$2250)

5) Calculate the ratio of the actual revenue per meter per cycle to the meter coin box capacity

   = (average of actual revenue per meter per cycle in the given month/$50)

6) Evaluate the efficiency of the collection cycle by the values of these ratios. As the ratio approaches a value of 1, efficiency is maximized.

Example:

Area 120, Cable L4

	Collection date	Elapsed days from collection	Actual rev. (per cycle)	Actual rev./meter (per cycle)
1	10/2/95	2	$475	$4.20
2	10/4/95	2	$305	$2.61
3	10/6/95	2	$936	$8.59
4	10/11/95	4	$440	$3.86
5	10/13/95	2	$494	$4.70
6	10/16/95	2	$463	$4.09
7	10/18/95	2	$443	$3.86
8	10/20/95	2	$426	$3.77
9	10/24/95	3	$765	$6.77
10	10/26/95	2	$412	$3.52
11	10/27/95	1	$406	$3.63
12	10/30/95	2	$294	$2.51
	Average		$488	$4.34

1) Determine the actual rev. collected per cycle for the *cable* of interest for the given month

- on 10/4/95, the actual revenue is equal to $305

2) Calculate the # of days elapsed between collection days for each cycle in the given month

- between 10/2/95 and 10/4/95, 2 days elapsed

3) Determine the actual rev. per meter per cycle for the *cable* of interest for the given month

- on 10/4/97, the actual revenue per meter per cycle is equal to $2.61

4) Calculate the ratio of the actual revenue per cycle to the coin canister capacity

- average actual revenue/coin canister capacity = ($488/$2250) = 0.22

5) Calculate the ratio of the actual revenue per meter per cycle to the meter coin box capacity
   - average actual revenue per meter/coin box capacity = ($4.34/$50) = 0.09

6) Evaluate the efficiency of the collection cycle by the values of these ratios. As the ratio approaches a value of 1, efficiency is maximized.
   - The cycle length could be increased considerably since only 22% of the canister capacity and 9% of the meter coin box capacities are utilized per cycle.

6.3 Optimization of Revenue Collection Frequency (Cycle Length)

This procedure can be used to maximize the efficiency of revenue collection operations by adjusting the revenue collection frequency or cycle length, so that: i) the revenue collected per cycle is close in value to the limiting coin canister capacity and ii) the revenue collected per meter per cycle is close in value to the limiting meter coin box capacity. In addition, the revenue which can be expected based on the optimal collection cycle can be estimated. Revenue collection activities should be performed for a given sample *cable* on a daily basis for a certain period of time (i.e. 2 weeks) within the month of interest. During this collection period, the actual revenue per meter should be estimated daily by use of a dipstick or other methods.

- Calculate Δ (a factor representing the variation between actual revenue per meter and the revenue of the highly used meters) by following these steps:

  1) Revenue collection activities should be performed for a given sample *cable* on a daily basis for a certain period of time within the month of interest. During this collection period, the actual revenue per meter should be estimated daily by use of a dipstick.

  2) Determine the total number of meters within the sample *cable*

3) Calculate the daily actual revenue measured with the dipstick for the sample *cable*

   = [(# meters with $10)*$10] + [(# meters with $20)*$20] +...+ [(# meters with $50)*$50]

4) Calculate the daily actual revenue per meter for the sample *cable*

   = daily actual revenue/# meters in the sample *cable*

   (Revenue is distributed equally among all meters within the *cable*).

5) Determine the revenue of the highly utilized meters

6) Calculate the variation between the actual revenue per meter and the revenue of the highly utilized meters

   = [(rev. of highly used meters - actual rev. per meter)/actual rev. per meter]*100

7) Calculate Δ

   = (average variation between actual revenue per meter and revenue of highly used meters/100) + 1

- Estimate the optimal revenue collection cycle length for the given *cable* for the given month by following these steps:

8) Calculate the current revenue collection cycle length (elapsed days between collection days)

   (Because no revenue is generated on Sundays, exclude them from the calculations).

9) Determine the actual revenue per cycle

10) Determine the actual revenue per meter per cycle

11) Calculate the optimal revenue collection cycle length relative to the coin canister capacity

= ($2,250*0.9*current revenue collection cycle length)/(average actual revenue per cycle)

12) Calculate the optimal revenue collection cycle length relative to the meter coin box capacity

= ($50*0.9*current revenue collection cycle length)/(average actual revenue per meter per cycle*Δ)

13) The optimal revenue collection cycle length is equal to the minimum value of the cycle lengths calculated in steps 11 and 12

14) Calculate the revenue expected per cycle when using the optimal revenue collection cycle length determined in step 13

= average actual revenue per cycle * (optimal revenue collection cycle length/current revenue collection cycle length)

15) Calculate the revenue expected per meter per cycle when using the optimal revenue collection cycle length determined in step 13

= average actual revenue per meter per cycle * (optimal revenue collection cycle length/current revenue collection cycle length)

The optimal revenue collection frequency can be estimated by replacing the equations in steps 11 and 12 with the following equations, respectively. The optimum revenue collection frequency is the maximum of these two values.

- optimal revenue collection frequency = (current # collections * average actual revenue)/($2,250*0.9)
- optimal revenue collection frequency = (current # collections * average actual revenue per meter*Δ)/($50*0.9)

The expected revenue per collection can be estimated by replacing the equations in steps 14 and 15 with the following equations, respectively:

- expected revenue = avg. actual revenue*(current # collections/optimal # collections)
- expected revenue per meter = average actual revenue per meter*(current # collections/optimal # collections)

Example 4.2.3a:

Area 101, Cable 2

Date *	Coin Box Status						Actual revenue/ cable (A)	Average revenue/ meter (B)	Revenue of highly used meters (C)	Variation between (B) & (C)
	$0	$10	$20	$30	$40	$50				
[redacted]	0	2***	20	11	7	0	$1,030	$26	$40	55%
4/15	6	34	0	0	0	0	$340	$9	$10	18%
4/16	0	25	15	0	0	0	$550	$14	$20	45%
4/17	0	9	31	0	0	0	$710	$18	$20	13%
4/18	0	6	34	0	0	0	$740	$19	$20	8%
4/21	0	1	36	3	0	0	$820	$21	$30	46%
4/22	0	1	20	19	0	0	$980	$25	$30	22%
[redacted]	0	0	0	0	0	0	$0	$0	$0	–
									Average Variation:	30%
									Maximum Variation:	55%

* Collection days are highlighted. Sunday (4/20) is not counted.

** The meter coin box was emptied without the dipstick measurement being taken.

*** Number of meters within the *cable* with $10.

Total # of meters = 40

1) Revenue collection activities should be performed for a given sample *cable* <u>on a daily basis</u> for a certain period of time within the month of interest. During this collection period, the actual revenue per meter should be estimated daily by use of a dipstick.
   - see results in table above

2) Determine the total number of meters within the sample *cable*
   - within Area 101, Cable 2 there are 40 meters

3) Calculate the daily actual revenue measured with the dipstick for the sample *cable*

   – on 4/14, actual revenue = [2*$10]+[20*$20]+[11*$30]+[7*$40]=$1030

4) Calculate the daily actual revenue per meter for the sample *cable*

   – on 4/14, daily actual revenue per meter = $1030/40 = $26

5) Determine the revenue of the highly utilized meters

   – on 4/14, the revenue of the highly utilized meters is equal to $40

6) Calculate the variation between the actual revenue per meter and the revenue of the highly utilized meters

   – on 4/14, this variation = [($40 - $26)/$26]*100 = 55%

7) CalculateΔ

   – Δ = (30%/100) + 1 = 1.3

Area 101, Cable 2

Collection date	Cycle length (days)*	Actual revenue (per cycle)	Actual revenue/meter (per cycle)
4/7/97	7	$2,076	$28.00
4/15/97	7	$1,504	$23.10
4/23/97	7	$1,548	$23.80
Average	7	$1,709	$24.97

8) Calculate the current revenue collection cycle length (elapsed days between collection days)

   – for the period of 4/7 to 4/15, the revenue collection cycle length is 7 days

9) Determine the actual revenue per cycle

   – on 4/7, actual revenue per cycle is equal to $2076

10) Determine the actual revenue per meter per cycle

- on 4/7, actual revenue per meter per cycle is equal to $28.00

11) Calculate the optimal revenue collection cycle length relative to the coin canister capacity

- optimal cycle length = ($2,250*0.9*7 days)/($1709) = 8.3 days

12) Calculate the optimal revenue collection cycle length relative to the meter coin box capacity

- optimal cycle length = ($50*0.9*7 days)/($24.97*1.3) = 9.7 days

13) The optimal revenue collection cycle length is equal to the minimum value of the cycle lengths calculated in steps 11 and 12

- optimal cycle length is equal to 8 days (8.3 days < 9.7 days)

14) Calculate the revenue expected per cycle when using the optimal revenue collection cycle length determined in step 13

- expected revenue per cycle = $1709 * (8 days/7 days) = $1953

15) Calculate the revenue expected per meter per cycle when using the optimal revenue collection cycle length determined in step 13

- expected revenue per meter per cycle = $24.97 * (8 days/7 days) = $28.54

6.4 Calculating Cable Operability and Net Revenue Loss

This procedure can be used to estimate the monthly revenue loss due to *cable* operability.

- <u>Calculate *cable* operability for a given month by following these steps</u>:

1) Determine the total number of meters within the *cable* of interest

2) Determine the number of inspection dates for the given month

3) Calculate the number of meters inspected for the given month

= # meters within the *cable* * # inspections within the given month

4) Determine the number of defective meters found

5) Calculate the *operability found*, %

= (1-(# defective meters/# meters inspected))*100

- Calculate the net revenue loss for a given month due to the *cable* operability by following these steps:

6) Calculate the number of elapsed days between when a meter becomes defective and when it is repaired

= (0.5 * 30)/ # inspections within the given month

7) Determine the number of revenue collections within the given month

8) Determine the maximum revenue per meter per day

(The daily maximum revenue per meter is based on meter rate and operating hours).

9) Calculate the maximum revenue loss per cycle for the *cable* of interest

= (maximum revenue per meter per day * total # defective meters * # elapsed days) / # collections within the given month

10) Determine the actual revenue per cycle

11) Determine the maximum revenue at 100% operability

(This value is based on meter rate and operating hours).

12) Calculate the maximum revenue at the current operability per cycle

= maximum revenue at 100% operability - maximum revenue loss per cycle

13) Calculate the current level of usage

= (actual revenue per cycle/maximum revenue at current operability)*100

14) Calculate the net revenue loss per cycle

= maximum revenue loss per cycle * (current level of usage/100)

15) Calculate the net revenue loss per month

= # collections per month * net revenue loss per cycle

The yearly net revenue loss can be calculated by summing the net revenue loss per month for 12 months.

Area 101, Cable 2

	Total # def (A)	# insp / month (B)	Oper found (C)	Elapsed days (D)	# coll / month (E)	Max.* rev loss cycle (F)	Actual rev./ cycle (G)	Max. rev. at 100% oper. (H)	Max. rev. at current oper. (J)	Net rev. loss (K)	Net rev. loss/ month (L)
6/95	29	4.00	88%	3.75	4	$123	$1,298	$2,056	$1,933	$82	$330
7/95	20	2.05	84%	7.32	3	$220	$1,430	$2,252	$2,032	$155	$465
8/95	25	2.00	80%	7.50	4	$212	$1,437	$2,130	$1,918	$159	$635
9/95	20	1.96	84%	7.65	3	$231	$1,225	$2,154	$1,923	$147	$441
10/95	32	1.95	74%	7.69	4	$278	$1,182	$2,203	$1,925	$171	$683
11/95	19	3.00	90%	5.00	3	$143	$1,329	$2,350	$2,207	$86	$259
12/95	39	2.85	78%	5.26	3	$309	$1,151	$2,350	$2,041	$174	$523
1/96	43	1.14	39%	13.16	2	$1,278	$1,177	$3,966	$2,688	$560	$1,120
2/96	40	3.99	84%	3.76	3	$227	$1,087	$2,448	$2,221	$111	$333
3/96	53	5.11	83%	2.94	3	$234	$1,166	$2,252	$2,018	$135	$406
4/96	79	6.08	79%	2.47	4	$220	$1,296	$2,130	$1,910	$149	$598
5/96	55	5.19	83%	2.89	3	$239	$1,391	$2,056	$1,817	$183	$550
								Yearly Revenue Loss:			$6,342

1) Determine the total number of meters within the *cable* of interest

   - within Area 101, Cable 2 there are 62 meters

2) Determine the number of inspection dates for the given month

   - for 6/95, there are 4.00 inspections

3) Calculate the number of meters inspected for the given month

   - for 6/95, # inspected meters = 62*4.00 = 248

4) Determine the number of defective meters found

   - for 6/95, 29 defective meters were found

5) Calculate the *operability found*, %

   - for 6/95, *operability found* = (1-(29/248))*100 = 88%

6) Calculate the number of elapsed days between when a meter becomes defective and when it is repaired

   - for 6/95, # elapsed days = (0.5 * 30)/ 4.00 = 3.75

7) Determine the number of revenue collections within the given month

   - for 6/95, 4 collections were made

8) Determine the maximum revenue per meter per day

   - for Area 101, Cable 2 the maximum daily revenue per meter is equal to $4.519

9) Calculate the maximum revenue loss per cycle for the *cable* of interest

   - for 6/95, the maximum revenue loss per cycle = (29*4) * $4.519 * $3.75 = $123

10) Determine the actual revenue per cycle

   - for 6/95, the actual revenue per cycle is equal to $1298

11) Determine the maximum revenue at 100% operability

- for 6/95, the maximum revenue at 100% operability is equal to $2056

12) Calculate the maximum revenue at the current operability per cycle

- for 6/95, the maximum revenue at current operability = $2056 - $123 = $1933

13) Calculate the current level of usage

- for 6/95, the current level of usage = ($1298/$1933)*100 = 67%

14) Calculate the net revenue loss per cycle

- for 6/95, the net revenue loss per cycle = $123 * (67%/100) = $82

15) Calculate the net revenue loss per month

- for 6/95, the net revenue loss per month = 4 * $82 = $330

The yearly net revenue loss from 6/95 to 5/96 is equal to $6342.

6.5 Meter Defect Study

This procedure can be used to establish an effective maintenance strategy based on the number and types of defects found.

- Summarize and examine the number and types of defects occurring for a given month by following these steps:

1) Determine the number of vandalism-related defects (code 41) which occurred for the *cable* of interest for the given month

2) Determine the number of non-vandalism-related defects (codes 42 - 44) which occurred for the *cable* of interest for the given month

3) Calculate the total number of defects which occurred (codes 41 - 44)

   = # vandal-related defects + # non-vandal-related defects

4) Determine the number of inspections for the *cable* of interest for the given month

5) Review the number and types of defects occurring within each month. If the number of vandalism-related defects is high, take measures to prevent meter vandalism. If the number of non-vandalism defects is high, consider adjusting the inspection frequency.

Example

Area 101, Cable 2

	6/95	7/95	8/95	9/95	10/95	11/95	12/95	1/96	2/96	3/96	4/96	5/96
Defect 41	0	4	8	10	9	7	6	11	5	4	2	2
Def. 42-44	36	22	30	27	30	21	19	31	49	37	22	16
Total # def.	36	26	38	37	39	28	25	42	54	41	24	18
# insp.	5	3	4.4	4.5	5	6	4.8	1.7	5.6	7	5.8	5.2

1) Determine the number of vandalism-related defects (code 41) which occurred for the *cable* of interest for the given month
   - for 7/95, the number of vandalism-related defects which occurred is 4

2) Determine the number of non-vandalism-related defects (codes 42 - 44) which occurred for the *cable* of interest for the given month
   - for 7/95, the number of non-vandalism-related defects which occurred is 22

3) Calculate the total number of defects which occurred (codes 41 - 44)
   - for 7/95, the total # of defects = 4 + 22 = 26

4) Determine the number of inspections for the *cable* of interest for the given month
   - for 7/95, 3 inspections were made

5) Review the number and types of defects occurring within each month.
   - within Area 101, Cable 2, the range of vandalism-related defects varies from 0 to 11, the range of non-vandalism-related defects varies from 18 to 54. Compare these values to established criteria to determine if the number of occurrences is high. If the number of vandalism-related defects is high, take measures to prevent meter vandalism. If the number of non-vandalism defects is high, consider adjusting the inspection frequency.

- *3.2.4 Estimating Cost of 1% Increase in Operability*

  By simulating an increase in operability, the associated costs and revenues can be evaluated to determine future management options. The simulation also provides the data necessary to implement the change - the number of additional meters to be inspected and repaired to achieve the desired increase in operability.

- *3.2.5 Operability Simulation (Optimum Inspection/Maintenance Cycle)*

  The simulation in Section 3.2.4 started with a desired level of operability and calculated the resulting inspection frequency. In the simulation discussed in Section 3.2.5, the inspection frequency is varied to produce a desired/minimum acceptable operability, based on the numbers of overlapping and accumulated defective meters.

- *4.2.1 Evaluating Current Revenue Collection Practice*

  By comparing the actual revenue collected to the potential maximum revenue, it is possible to identify how well the current revenue collection activities are being performed.

- *4.2.2 Evaluation of Revenue Collection Frequency (Cycle Length)*

  By comparing the actual revenue collected to the meter coin box and coin canister capacities, the current revenue collection frequency can be evaluated.

- *4.2.3 Optimization of Revenue Collection Frequency (Cycle Length)*

  By adjusting the revenue collection frequency to coincide with the maximum coin box and coin canister capacities, the revenue yield per collection can be maximized (the labor costs associated with collection activities are minimized).

- *4.2.4 Calculating Cable Operability and Net Revenue Loss*

  By using *cable* data to evaluate operability and the associated net revenue loss, rather than areawide operability, more accurate results are achieved. Areawide operability values do not hint at the variations in *cable* operability. One *cable* with low operability, hence low revenue, may be overlooked, resulting in a missed opportunity to maximize revenue and improve service.

- *4.2.5 Meter Defect Study*

  By studying the number, types, and trends of defects occurring, an effective strategy can be established to reduce/eliminate the defects associated with vandalism.

The review of the current parking meter operation practices, in conjunction with the historic and field data analyses, identified the above areas for potential improvements. The benefits from the implementation of these methods would potentially result in: i) an increase of meter operability and ii) the efficiency of revenue collection and inspection/maintenance activities with a potential increase in net revenue.

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Polytechnic University. March 1996. "Parking Meter Operability Questionnaire" and Questionnaire responses from Departments of Transportation and Parking Authorities in Chicago, San Francisco, Philadelphia, Miami, Cincinnati, Minneapolis, Detroit, Sacramento, Milwaukee, Hamilton, and Ottawa.

APPENDIX A

FIELD INSPECTION SHEET

[illegible]P3 REV. 11/93 AREA 201 LAST UPDATE: 12/18/95

Page 1

MAINTAINER: M. Duffy DATE: 2.20.96 # of ACTIVE METERS: 1003

**** M E C H A N I S M S ***

9W pe2

REPAIRED + # UNREPAIRED = TOTAL # of INSPECTED METERS: 448

56 + 0 = 56 SEQ.START: METER 910, TIME 7:35

SEQ.END: METER 937, TIME 12.45

EXCHANGED = 8 Start #422 LUNCH at: 11:00

* SFV >Time: [illegible] >Supv Int.: [illegible] *** E Summary Attached?(y/n): N *

Meter	Code	Q	T	Meter	Code	Q	T	Meter	Code	Q	T	Meter	Code	Q	T
1128				1127				1126				1125	10		
1124				1123				1122	343			1121	443		
1120	343			1119	10			1118				1117			
1116				1835				1834				1833			
1832				1831				1830				1829			
1115				1114				1113				1112	441 425	6	
1111	441			1110				1109				1108			
1107	70			1106				1105				1104			
1103				1102	70			1101				1100			
1099				1098				1097				1096			
1095				1094	441.425	2		1093				1092	441.425	10	
1091	441			1090	10			1089				1088			
2013				2014	70			1324				1325			
1326				1327				1322				1323			
1086				1085				1084				1083			
1082				1081				1080				1319			
1320				1321				1079				1078			
1077				1076				1075				1074			
1073				1963	443.425	1		1069				1068	73		
1067				1066				1065				1064			
1063				1062	10			1061				1060	442.425	4	
1959	443			1046				1045				1044			
1043	10			1042				1041				1040			
1039				1038	442.425	90		1037				1036			
1035	70			1034	70			1033				1032			
1031				1030				1029				1028	70		
1027	10			1026				1779				0273			
0274				0275				0276				0277			
0278				0279	442			0280				0281			
0282				0283				0284				0285			
0286				0287				0288				1212	10		
1214				[illegible]	[illegible]			1216				1217			
1218				[illegible]				1932				1933			
1934				1935				1936				1937			
1938				1939				1940				1504	942		
1503				1502				1501				1500			

Sign >> TDM. Michael Duffy SUPV.: [illegible]

REMARKS:

1996 FEB 21 P 12:47

OPERABILITY REPORT BY AREA/DATE

AREA	# METERS	# INSP	CODE 42/44 RPD	CODE 43 RPD	OUT DEF	TOTAL DEFS	% OPER FND	% OPER LFT	DATE OF % OPERABLE
125	91	91	18	0	0	18	80.22	100.00	01/27/96
** Subtotal **		182	29	0	0	29			
** AREA 126									
126	1001	492	55	0	0	55	88.82	100.00	01/02/96
126	1001	403	46	0	0	46	88.59	100.00	01/03/96
126	1001	340	57	0	0	57	83.24	100.00	01/04/96
126	1001	553	64	0	0	64	88.43	100.00	01/05/96
126	1001	403	73	0	0	73	81.89	100.00	01/06/96
126	1001	379	69	0	0	69	81.79	100.00	01/16/96
126	1001	312	58	0	1	59	81.09	99.68	01/17/96
126	1001	340	75	0	1	76	77.65	99.71	01/18/96
126	1001	436	62	0	1	63	85.55	99.77	01/19/96
126	1001	497	66	0	3	69	86.12	99.40	01/20/96
126	1001	620	66	0	1	67	89.19	99.84	01/21/96
126	1001	448	71	0	2	73	83.71	99.55	01/23/96
126	1001	553	42	0	0	42	92.41	100.00	01/24/96
126	1001	448	61	0	2	63	85.94	99.55	01/25/96
126	1001	553	60	0	0	60	89.15	100.00	01/26/96
126	1001	448	45	0	3	48	89.29	99.33	01/27/96
126	1001	553	56	0	0	56	89.87	100.00	01/29/96
126	1001	448	50	0	2	52	88.39	99.55	01/30/96
126	1001	553	42	0	0	42	92.41	100.00	01/31/96
** Subtotal **		8779	1118	0	16	1134			

CITYWIDE OPERABILITY BY DATE FOR THE MONTH OF JANUARY 1996

DATE January 1996	#METERS INSPECTED	#METERS REPAIRED	COIN JAMS (PIMS) **	% REPAIRS DUE TO COIN JAMS	%OPERABLE FOUND	% OPERABLE MINUS COIN JAMS	ROUTES CANCELLED
1/2/96	9976	1632	1261	77.27	83.64	96.28	24
1/3	9530	1602	1140	71.16	83.19	95.15	16
1/4	11413	1589	1010	63.56	86.08	94.93	17
1/5	10436	1957	1316	67.25	81.25	93.86	18
1/6*	7459	753	375	49.8	89.9	94.93	0
1/8	Cancelled by Snow						
1/9	Cancelled by Snow						
1/10	Cancelled by Snow						
1/11	Cancelled by Snow						
1/12	Cancelled by Snow						
1/13*	Cancelled by Snow						
1/16	4624	693	427	61.62	85.01	94.25	47
1/17	7821	1740	1236	71.03	77.75	93.56	32
1/18	8689	1582	987	62.39	81.79	93.15	34
1/19	8982	1646	1066	64.76	81.67	93.54	30
1/20*	7775	1114	709	63.64	85.67	94.79	0
1/21***	6289	754	390	51.72	88.01	94.21	0
1/22	13014	2686	1992	74.16	79.36	94.67	12
1/23	13211	2854	2060	72.18	78.4	93.99	11
1/24	12889	2879	2027	70.41	77.66	93.39	10
1/25	14124	2809	1889	67.25	80.11	93.49	11
1/26	15538	2581	1802	69.82	83.39	94.99	9
1/27*	8162	746	402	53.89	90.86	95.79	0
1/29	15955	2470	1680	68.02	84.52	95.05	8
1/30	17778	2940	1983	67.45	83.46	94.62	2
1/31	13507	2212	1437	64.96	83.62	94.26	13
TOTAL	217172	37239	25189	67.64	82.85	94.45	294

*SATURDAY

*** SUNDAY

**THE NUMBER OF COIN JAMS DOES NOT INCLUDE ANY COIN JAMS ASSOCIATED WITH THE 341 AND 441 CODES (VANDALISM)

AREA FREQUENCY SCHEDULE

AREA FREQUENCY SCHEDULE

Revised Date: 4/24/96

Areas	[illegible]	Frequency	Days of schedule
101	3	6	4,10,16,22
102	22	3	2,5,8,11,14,17,20,23
103	17	4	1,5,9,13,17,21
104	12	3	1,4,7,10,13,16,19,22
105	14	6	3,9,15,21
106	4	8	6,14,22
107	4	3	1,4,7,10,13,16,19,22
108	6	2	2, 4, 6, 8, 10,12, 14, 16,18, 20, 22, 24
110	1	12	4,16
111	12	4	3,7,11,15,19,23
* 111 PM	2	2	2,4,6,8,10,12,14,16,18,20,22,24
111 sp.	6	2	2,4,6,8,10,12,14,16,18,20,22,24
113	9	4	4,8,12,16,20,24
114	8	3	1,4,7,10,13,16,19,22
115	13	3	1,4,7,10,13,16,19,22
* 115 PM	2	3	1,4,7,10,13,16,19,22
116	4	3	2,5,8,11,14,17,20,23
117	4	2	2,4,6,8,10,12,14,16,18,20,22,24
118	6	3	1,4,7,10,13,16,29,23
119	8	3	3,6,9,12,15,18,21,24
120	7	2	2,4,6,8,10,12,14,16,18,20,22,24
121	6	2	2,4,6,8,10,12,14,16,18,20,22,24
122	6	8	6,14,22
123	4	8	6,14,22
124	4	3	2,5,8,11,14,17,20,23
125	2	8	5,13,21
126	13	3	2,5,8,11,14,17,20,23
127	10	3	3,6,9,12,15,18,21,24
128	2	12	4,16
129	2	2	2,4,6,8,10,12,14,16,18,20,22,24
130	10	3	3,6,9,12,15,18,21,24
132	5	4	4,8,12,16,20,24
133	1	2	1,3,5,7,9,11,13,15,17,19,21,23
134	4	3	1,4,7,10,13,16,19,22
135	9	4	2,6,10,14,18,22
136	1	12	4,16
137	1	12	4,16
138	4	6	4,10,16,22
139	6	4	2,6,10,14,18,22

COLLECTION HISTORY REPORT BY CABLE

DATE: 06/17/96
TIME: 11:09:44.5
REQUESTOR: COLLECTIONS

PARKING INFORMATION MANAGEMENT SYSTEMS
COLLECTION HISTORY REPORT BY CABLE AREA

COLLECTION AREA:
CABLE AREA: L1

FROM DATE: 06/01/95 TO DATE: 06/30/95

COLLECT DATE	ACTUAL REVENUE	-- REVENUE PER -- METER DAY ACTUAL	EXPECTED	MUTILATED REVENUE	CANADIAN COINS	- WEIGHT - FOREIGN COINS	OTHER SLUGS
06/01/95	$ 689.01	$ 7.8296	$ 0.0000	$ 0.00	$ 0.00	0.00	0.15
06/02/95	$ 826.96	$ 17.9773	$ 0.0000	$ 0.26	$ 1.00	0.00	0.60
06/05/95	$ 750.35	$ 5.3216	$ 0.0000	$ 0.00	$ 0.00	0.00	0.10
06/07/95	$ 747.91	$ 7.3324	$ 0.0000	$ 0.00	$ 2.00	0.00	0.00
06/09/95	$ 627.02	$ 6.5314	$ 0.0000	$ 1.00	$ 0.00	0.00	0.15
06/13/95	$ 1,136.24	$ 7.2835	$ 0.0000	$ 0.00	$ 0.05	0.00	0.25
06/15/95	$ 621.35	$ 5.8617	$ 0.0000	$ 0.25	$ 1.00	0.00	0.00
06/16/95	$ 872.75	$ 16.4669	$ 0.0000	$ 0.00	$ 0.00	0.00	0.00
06/21/95	$ 769.05	$ 2.9020	$ 0.0000	$ 1.25	$ 0.50	0.00	0.15
06/23/95	$ 853.07	$ 14.2178	$ 0.0000	$ 0.00	$ 0.00	0.00	0.00
06/27/95	$ 1,409.35	$ 8.0076	$ 0.0000	$ 0.50	$ 0.00	0.00	0.15
06/29/95	$ 622.22	$ 6.6193	$ 0.0000	$ 0.25	$ 0.00	0.00	0.29
06/30/95	$ 770.05	$ 14.5292	$ 0.0000	$ 0.00	$ 0.00	0.00	0.00
TOTAL FOR COLLECTION AREA: 117 CABLE AREA: L1							
	$ 10,695.33			$ 3.51	$ 4.55	0.00	1.84

APPENDIX B

RECIPIENTS OF PARKING METER OPERABILITY QUESTIONNAIRE

Following is a partial list of the cities/counties whose parking meter management agencies received the Parking Meter Operability Questionnaire. Eleven agencies responded.

City/County	Response received
Los Angeles	
Chicago	X
San Francisco	X
Philadelphia	X
Washington D.C.	
Miami Beach	
Montreal	
Baltimore	
Montgomery County	
St. Louis	
Miami	X
Oakland	
White Plains	
Boston	
Cincinnati	X
Pittsburgh	
Minneapolis	X
Detroit	X
Sacramento	X
Milwaukee	X
Louisville	
Columbus	
Coral Gables	
Dallas	
Fort Lauderdale	
Denver	
Cleveland	
Calgary	
Arlington	
Des Moines	
Lansing	
Cambridge	
Yonkers	
Hamilton	X
Savannah	
Clearwater	
Ottawa	X
Tampa	

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March 14, 1996

Parking Meter Operability - Questionnaire

Definition of Meter Operability

Please circle all that apply.

1. Does your agency use meter operability index for :
   a. reporting meter operability to the public and official report
   b. examining planning of meter maintenance
      ex: target maintenance of areas with low operability, other
   c. evaluating frequency of inspection
   d. assessing revenue collection
   e. other Please specify: ____________________________

2. How is meter operability defined?
   Please specify for each case selected above. — Please circle
   - percentage of operable meters out of inspected meters — a, b, c, d, e
     ex: 800 operable meters out of 1000 inspected
   - percentage of operable meters out of selected sample meters* — a, b, c, d, e
     ex: 80 operable meters out of 100 sample meters representing population of 1000 meters
   - other Please specify ____________________________ — a, b, c, d, e

* note : Sample meters selected by
   - random sampling ___   - stratified sampling ___
   - representative sampling   - other Please specify ___

3. How is meter operability being reported?
   - by county — a, b, c, d, e
   - citywide — a, b, c, d, e
   - by borough — a, b, c, d, e
   - by maintenance area — a, b, c, d, e
   - by cable area — a, b, c, d, e
   - other Please specify ______________ — a, b, c, d, e

   - daily — a, b, c, d, e
   - weekly — a, b, c, d, e
   - monthly — a, b, c, d, e
   - depending on the inspection schedule — a, b, c, d, e
   - other Please specify ______________ — a, b, c, d, e

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4. Please identify the defects for evaluating meter operability for the cases of question 1.

Regular Meters

	Please circle		*Please circle*
WHOLE HEAD		*MECHANISM*	
head missing	a, b, c, d, e	mech. missing	a, b, c, d, e
loose head	a, b, c, d, e	mech. vandalized	a, b, c, d, e
insert exists	a, b, c, d, e	mech. defective	a, b, c, d, e
		plastic strip or similar device	a, b, c, d, e
DOME CAP		fast/short time	a, b, c, d, e
dome cap missing/defect.	a, b, c, d, e		
UPPER HOUSING		*BATTERY*	
mech. lock	a, b, c, d, e	battery defective	a, b, c, d, e
coins in housing	a, b, c, d, e		
meter number plate	a, b, c, d, e	*PIPE*	
rate plate(missing/wrong)	a, b, c, d, e	pipe missing(head missing)	a, b, c, d, e
		pipe stump	a, b, c, d, e
		pipe loose	a, b, c, d, e
LOWER HOUSING		pipe bent	a, b, c, d, e
vault lock	a, b, c, d, e	pipe missing	a, b, c, d, e

munimeters

battery	a, b, c, d, e	coin acceptor	a, b, c, d, e
bill acceptor	a, b, c, d, e	debit card reader	a, b, c, d, e
main board	a, b, c, d, e	power supply	a, b, c, d, e
paper roll	a, b, c, d, e	external power source	a, b, c, d, e
full coin box/bill box	a, b, c, d, e	head missing	a, b, c, d, e
loose head	a, b, c, d, e	door lock	a, b, c, d, e
lexan lens	a, b, c, d, e	coins in housing	a, b, c, d, e
rate/institution card	a, b, c, d, e	short/fast time	a, b, c, d, e

5. Please identify efforts undertaken for improving meter operability?

____ increasing monitoring frequency for quick meter repair
____ reducing or eliminating parking time at broken meters for reducing vandalism
____ implementing meter patrol
____ using intelligent meters and new meters
____ other: Please specify ____________________________

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Meter Maintenance

1. Please identify the following characteristics of your parking system.

On-Street Meters

Number of:	Parking Spaces ___________	
	Single space meters _______	Munimeters______________
	Intelligent meters _________	

Off-Street Meters

Number of:	Parking Spaces ___________	
	Single space meters _______	Munimeters______________
	Intelligent meters _________	

2. Please identify the number of meters inspected daily.________

3. Please identify criteria for grouping meters into inspection areas.
   ___ geographic location
   ___ level of use (high revenue potential, medium revenue potential, ...)
   ___ other Please specify ___________________________________

4. Please identify the cycle of inspection for parking meters.

	% of meters monitored
- more than once a day	______
- once a day	______
- every three days	______
- every four days	______
- every seven days	______
- other Please specify	______
total	100 %

5. Identify the cycle that all meters are inspected at least once _______
   ex all meters inspected once in a 7 day cycle

6. Please identify methods used for improving meter monitoring Check all that apply.
   ___collection and meter patrol personnel report meter status
   ___ increase meter monitoring based on maintenance history
   - increase area/cable monitoring frequency ________
   - increase monitoring frequency of selected meters___
   ___ other Please specify ___________________________

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7. Identify strategies used for reducing lapsed time between meter monitoring and meter repair.
   ___ repair on site
   ___use meter inventory
   ___collection personnel reports meter status
   ___other Please specify:________________________

8. Inspection and maintenance is conducted: ___ together ___ separately
   conducted by: ___ agency personnel ___ contractors ___ both

Revenue Collection

1. Is meter grouping the same for meter monitoring and revenue collection?
   Yes No (If no, please identify differences ______________________________)

2. Please identify criteria for grouping meters into collection areas.
   ___ geographic location/cable area
   ___ level of use (high revenue potential, medium revenue potential,)
   ___ other Please specify ______________________________

3. Please identify the revenue collection cycle for parking meters

	% of meters
- more than once a day	______
- once a day	______
- every three days	
- every four days	
- every seven days	
- other Please specify	
total	100 %

4. Please identify the cycle that revenue is collected from all the meters at least once ___

5. Is revenue collection of an area cable adjusted based on revenue history?
   No Yes (If yes Please specify ______________________________)

6. Is it possible to track revenue history of each individual meter? Yes ___ No ___

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7. Please identify methods used for improving meter revenue collection.
   Check all that apply.
   - reports of coins in housing by inspection personnel _____
   - increase meter collection based on meter revenue history
     - increase area/cable collection frequency ____________
     - increase collection frequency for selected meters ________
   - other Please specify: ______________________________

8. How is revenue collection being reported?
   ___ by county
   ___ citywide
   ___ by borough
   ___ by collection area
   ___ by cable area
   ___ other Please specify: ___________________________
   ___ daily
   ___ weekly
   ___ monthly
   ___ depending on the collection schedule
   ___ other Please specify: ___________________________

9. Revenue collection is conducted by: __ agency personnel __ contractors __ both

Meter Surveillance(Meter Shield)

1. Is meter surveillance being practiced? Yes ___ No ___

2. On the average, how many meters are patrolled per day? ____________

3. Identify techniques used for selecting meters or area (highly vandalized) to be patrolled
   - examining maintenance records
   - other Please specify

4. Identify method used for reducing meter vandalism potential?
   - increase surveillance frequency
   - reduce allowable parking time at broken meters
   - prohibit parking at broken meters
   - apprehend vandals
   - introduce electronic meters with magnetic card
   - replace single parking meter with multimeters
   - other Please specify

Summary of Parking Meter Operability Questionnaire

DEFINITION OF METER OPERABILITY	Chicago	San Fran	Philadelphia	Miami	Cincinnati	Minneapolis	Detroit	Sacramento	Milwaukee	Hamilton	Ottawa
1 PURPOSE OF USING METER OPERABILITY INDEX											
Reporting			#				#				
Examining planning of maintenance	#			#					#		
Evaluating frequency of inspection	#		#								
Assessing revenue collection			#						#		
Other		official report + goal setting			customer relations	no such index					
2 DEFINITION OF METER OPERABILITY											
% of operable meters out of inspected meters	b c	a	a	#			a		b,d		
% of operable meters out of selected sample meters	b		a,d				a				
Other					# of complaints						
Sampling technique											
Random sampling	#		#								
Stratified sampling							#				
Representative sampling											
Other											

Summary of Parking Meter Operability Questionnaire

DEFINITION OF METER OPERABILITY	Chicago	San Fran	Philadelphia	Miami	Cincinnati	Minneapolis	Detroit	Sacramento	Milwaukee	Hamilton	Ottawa
3 HOW IS OPERABILITY REPORTED?											
By county											
Citywide	b c	e	a	#	e		a				
By borough											
By maintenance area	b c		a				a		b,d		
By cable area											
Other							Route #				by meter number
Daily			a	#			a		b,d		
Weekly	b c										
Monthly		e									
Depending on inspection schedule											
Other					yearly, e						
5 EFFORTS FOR IMPROVING OPERABILITY											
Increase monitoring rate			#				#		#	#	#
Reduce or eliminate parking time at broken meters											
Implement meter patrol											
Using intelligent meters and new meters		#									
Other	fully electronic meter mech				respond to complaint within 1 hour					discuss with enforce. staff	

Summary of Parking Meter Operability Questionnaire

METER MAINTENANCE	Chicago	San Fran	Philadelphia	Miami	Cincinnati	Minneapolis	Detroit	Sacramento	Milwaukee	Hamilton	Ottawa
1 NUMBER OF METERS											
On street meters											
Parking spaces	26500	21350	14500	6000	6885	6200	3400	12-15000	5665	1882	2630
Single space meters	26500	21350		6000	6885	6200	3400	5300	5665		2630
Munimeters											
Intelligent meters		30				150					
Off street meters											
Parking spaces	1000	650	1100	1500	236	300	182	9560	586	457	335
Single space meters	1000	650		1500	236	300	182	60	586		335
Munimeters								962			
Intelligent meters											
2 NUMBER OF METERS INSPECTED DAILY	7000-8000	5000+	15600	120	2300	0 (no insp.)	3582	5300	3000+	800	600-800
3 CRITERIA FOR GROUPING METERS INTO INSPECTION AREAS											
Geographic location	#	#	#	#	#		#	#	#	#	
Level of use (revenue potential)	#	#						#			
Other											
4 CYCLE OF INSPECTION (% OF METERS MONITORED)											
More than once a day							100				
Once a day			100					#	50		
Every three days	70	#			100				50	25	
Every four days		#									
Every seven days										75	100
Other	30 (every other day)			As needed to verify operation							
5 CYCLE OF INSPECTING ALL METERS (DAYS)	3	8	1		3		1	1	2	weekly	weekly

Summary of Parking Meter Operability Questionnaire

METER MAINTENANCE	Chicago	San Fran	Philadelphia	Miami	Cincinnati	Minneapolis	Detroit	Sacramento	Milwaukee	Hamilton	Ottawa
6. METHODS TO IMPROVE METER MONITORING											
Collection and patrol personnel report meter status	#		#	#	#	#	#	#	#	#	#
Increase monitoring rate based on history	#			#	#					#	
Increase are monitoring rate											
Increase rate for selected meters									#		
Other	problems (vandalism)		public reporting violation ticketing								call from public
7. STRATEGY TO REDUCE LAPSED TIME BETWEEN MONITORING AND REPAIR											
Repair on site	#	#	#	#	#		#	#	#	#	#
Use meter inventory				#							
Collection personnel report meter status				#		#	#		#	#	
Other	meter history data base		replace meter on repair vehicle					replace on site		enforce. staff report	
8. INSPECTION AND MAINTENANCE IS CONDUCTED											
Together	#	#	#	#			#	#	#	#	#
Separately	#					#			#		
Conducted by											
Agency personnel		#	#	#	#	#	#	#		#	#
Contractors											
Both									#		

Summary of Parking Meter Operability Questionnaire

REVENUE COLLECTION	Chicago	San Fran	Philadelphia	Miami	Cincinnati	Minneapolis	Detroit	Sacramento	Milwaukee	Hamilton	Ottawa
1 IS METER GROUPING THE SAME FOR MONITORING AND COLLECTION?											
Yes	#			#					#	#	
No		by route	separate		#	#	#	#			
2 CRITERIA FOR GROUPING METERS INTO COLLECTION AREAS											
Geographic location/cable area	#	#	#	#		#	# route grp.	#	#	#	
Level of use (revenue potential)	#	#	#	#		#	#	#			
Other											
3 CYCLE OF COLLECTION (% OF METERS COLLECTED)											
More than once a day								60			
Once a day											
Every three days	30					60(2x/wk)				25	
Every four days		25									
Every seven days	67(every 7-14 days)					38	20		100	75	
Other	3(every) 2 days)	twice a week	varies, depends on area	monthly		0.5(monthly) 1.5 (semi-monthly)	70(every 2 days) 10(every 2 weeks)	40(2x/ week)			
4 CYCLE OF COLLECTING ALL METERS (DAYS)	2 weeks	4	weekly	monthly		weekly	2 weeks	weekly	weekly	weekly	
5 IS COLLECTION AREA ADJUSTED BASED ON REVENUE HISTORY?											
No	#								#		
Yes		construction	#	#		#	#	for heavily used areas		for heavy areas	

Summary of Parking Meter Operability Questionnaire

REVENUE COLLECTION	Chicago	San Fran	Philadelphia	Miami	Cincinnati	Minneapolis	Detroit	Sacramento	Milwaukee	Hamilton	Ottawa
6 POSSIBLE TO TRACK REVENUE HISTORY OF EACH METER											
Yes										400 elect. m	
No	#	in process	#	#	#	#	#	#	#		
7 METHOD TO IMPROVE METER COLLECTION											
Reports of coin in housing by inspection personnel			#								
Increase collection frequency based on revenue history			#								
Increase area collection frequency						#		#		#	
Increase frequency for selected meters		#				#		#	#		
Other	revenue by area rate change									rev. coll. and insp. people are one unit	
8 HOW IS REVENUE COLLECTION REPORTED?											
By county											
Citywide	#	#								#	
By borough											
By collection area	#	#	#			#		#	#	#	
By cable area											
Other											

APPENDIX C

Sample Cables in New York City

Manhattan

2-Day Cycle of Collection			
Area	Cable #	Operability Level	Revenue Level
111	SC3	Low	High
117	L1	Medium	High
120	L4	High	Low

4-Day Cycle of Collection			
Area	Cable #	Operability Level	Revenue Level
103	L4	Low	Medium
111	H7	Low	High
135	H4	Medium	Medium

6-Day Cycle of Collection			
Area	Cable #	Operability Level	Revenue Level
101	2	High	Low
105	L4	Low	Low
138	L1	Low	Medium

8-Day Cycle of Collection			
Area	Cable #	Operability Level	Revenue Level
106	L1	Low	Medium
123	L2	Low	Low
125	L1	High	Low

Bronx

4-Day Cycle of Collection			
Area	Cable #	Operability Level	Revenue Level
209	L1	High	Medium
216	H3	High	Low
230	L1	High	High

6-Day Cycle of Collection			
Area	Cable #	Operability Level	Revenue Level
201	H2	High	Medium
202	L1	High	Low
217	H2	High	High

8-Day Cycle of Collection			
Area	Cable #	Operability Level	Revenue Level
204	H2	High	Low
208	H1	High	Medium
229	L1	High	Medium

Sample Cables in New York City

Brooklyn

4-Day Cycle of Collection			
Area	Cable #	Operability Level	Revenue Level
301	L10	Low	High
308	L3	High	Medium
--	--	--	--

6-Day Cycle of Collection			
Area	Cable #	Operability Level	Revenue Level
307	H1	Low	High
309	L2	Low	Low
314	L1	High	Medium

8-Day Cycle of Collection			
Area	Cable #	Operability Level	Revenue Level
304	H14	High	Medium
318	L2	Low	Low
333	L3	Medium	High

Queens

2-Day Cycle of Collection			
Area	Cable #	Operability Level	Revenue Level
405	H2	High	Medium
406	L4	High	High
--	--	--	--

4-Day Cycle of Collection			
Area	Cable #	Operability Level	Revenue Level
412	H8	Medium	High
432	L1	High	Low
--	--	--	--

6-Day Cycle of Collection			
Area	Cable #	Operability Level	Revenue Level
401	L2	Medium	Medium
431	H2	Low	Medium
442	H1	High	Medium

8-Day Cycle of Collection			
Area	Cable #	Operability Level	Revenue Level
419	L1	Medium	Medium
424	L1	Medium	Low
449	L1	Low	Medium

Sample Cables in New York City

Staten Island

4-Day Cycle of Collection			
Area	Cable #	Operability Level	Revenue Level
505	1	--	Medium
505	L3	--	Medium
505	H4	--	Medium

8-Day Cycle of Collection			
Area	Cable #	Operability Level	Revenue Level
501	H1	High	Low
504	H1	Low	High
506	H1	Medium	Medium

APPENDIX D

Number of Occurrences That Actual Revenue Exceeds Revenue at 100% Operability

Manhattan

	101 2	103 L4	105 L4	106 L1	111 H7	111 SC3	117 L1	120 L4	123 L2	125 L1	135 H4	138 L1
Jun-95	0	0	0	0	0	2	0	0	0	0	0	0
Jul-95	0	0	0	0	0	1	0	0	0	0	0	0
Aug-95	0	0	0	0	0	0	0	1	0	0	0	0
Sep-95	0	0	0	0	0	3	0	1	0	0	0	0
Oct-95	0	0	0	0	0	0	0	2	0	0	0	0
Nov-95	0	0	0	0	0	0	0	2	0	0	0	0
Dec-95	0	0	0	0	0	0	0	0	0	0	0	0
Jan-96	0	0	0	0	0	0	0	0	0	0	0	0
Feb-96	0	0	0	0	0	0	0	0	0	0	0	0
Mar-96	0	0	0	0	0	0	0	0	0	0	0	0
Apr-96	0	0	0	0	0	0	0	0	0	0	0	0
May-96	0	0	0	0	1	0	0	1	0	0	0	0
Total	0	0	0	0	1	6	0	7	0	0	0	0

Bronx

	201 H2	202 L1	204 H2	208 H1	209 L1	216 H3	217 H2	229 L1	230 L1
Jun-95	0	0	0	0	0	0	3	0	2
Jul-95	0	0	0	0	0	0	1	0	2
Aug-95	0	0	0	0	0	0	4	0	2
Sep-95	0	0	0	0	0	0	4	0	3
Oct-95	0	0	0	0	0	0	2	0	2
Nov-95	0	0	0	0	0	0	2	0	2
Dec-95	0	0	0	0	0	0	1	0	5
Jan-96	0	0	0	0	0	0	1	0	1
Feb-96	0	0	0	0	0	0	0	0	2
Mar-96	0	0	0	0	0	0	1	0	2
Apr-96	0	0	0	0	1	0	2	0	3
May-96	0	0	0	0	0	0	3	0	3
Total	0	0	0	0	1	0	24	0	29

Number of Occurrences That Actual Revenue Exceeds Revenue at 100% Operability

Brooklyn

	301 L10	304 H14	307 H1	308 L3	309 L2	314 L1	318 L2	333 L3
Jun-95	0	0	1	0	0	0	0	0
Jul-95	0	0	2	0	0	0	0	0
Aug-95	0	0	2	0	0	0	0	0
Sep-95	0	0	1	1	0	0	0	0
Oct-95	0	0	0	0	0	0	0	0
Nov-95	0	1	0	0	0	0	0	0
Dec-95	1	0	0	0	0	0	0	0
Jan-96	0	0	0	1	0	0	0	0
Feb-96	0	1	0	0	0	0	0	0
Mar-96	0	0	0	0	0	0	0	0
Apr-96	0	0	1	0	0	0	0	0
May-96	0	0	1	0	0	0	0	0
Total	1	2	8	2	0	0	0	0

Queens

	401 L2	405 H2	406 L4	412 H8	419 L1	424 L1	431 H2	432 L1	442 H1	449 L1
Jun-95	0	2	0	0	0	0	0	0	0	0
Jul-95	0	0	1	0	0	0	0	0	0	0
Aug-95	0	1	2	0	0	0	0	0	0	0
Sep-95	0	1	1	0	0	0	0	0	0	0
Oct-95	0	0	1	0	0	0	0	0	0	0
Nov-95	0	2	0	0	0	0	0	0	0	0
Dec-95	0	1	0	0	0	0	0	0	0	0
Jan-96	0	0	2	0	0	0	0	0	0	0
Feb-96	0	0	0	0	0	0	0	0	0	0
Mar-96	0	1	0	0	0	0	0	0	0	0
Apr-96	0	2	0	0	0	0	0	0	0	0
May-96	0	5	0	0	0	0	0	0	0	0
Total	0	15	7	0	0	0	0	0	0	0

Number of Occurrences That Actual Revenue Exceeds Revenue at 100% Operability

Staten Island

	501 H1	504 H1	505 1	505 H4	505 L3	506 H1
Jun-95	0	0	0	0	0	0
Jul-95	0	0	0	0	0	0
Aug-95	0	0	0	0	0	0
Sep-95	0	0	0	0	0	0
Oct-95	0	0	0	0	0	0
Nov-95	0	0	0	0	0	0
Dec-95	0	0	0	0	0	0
Jan-96	0	0	0	0	0	0
Feb-96	0	0	0	0	0	0
Mar-96	0	0	0	0	0	0
Apr-96	0	0	0	0	0	0
May-96	0	0	0	0	0	0
Total	0	0	0	0	0	0

APPENDIX E1

Ratio of Actual Revenue to Coin Canister Capacity

Manhattan

	101 2	103 L4	104 L4	105 L4	106 L1	111 H7	111 SC3	117 L1	120 L4	123 L2	125 L1	135 H4	138 L1
Jun-95	0.58	0.79	0.34	0.18	0.63	0.88	0.66	0.37	0.31	0.34	0.26	0.39	0.52
Jul-95	0.64	0.69	0.34	0.23	0.68	0.72	0.73	0.35	0.16	0.34	0.22	0.43	0.54
Aug-95	0.64	0.70	0.37	0.23	0.64	0.97	0.66	0.37	0.20	0.37	0.21	0.48	0.42
Sep-95	0.54	0.80	0.36	0.28	0.66	0.75	0.67	0.34	0.23	0.36	0.15	0.46	0.43
Oct-95	0.53	0.81	0.39	0.23	0.70	0.73	0.55	0.33	0.22	0.39	0.18	0.47	0.44
Nov-95	0.59	0.89	0.40	0.25	0.66	0.57	0.39	0.31	0.23	0.40	0.17	0.51	0.47
Dec-95	0.51	0.65	0.33	0.22	0.56	0.57	0.51	0.30	0.17	0.33	0.16	0.52	0.38
Jan-96	0.52	0.57	0.27	0.23	0.39	0.39	0.47	0.32	0.13	0.27	0.19	0.37	0.51
Feb-96	0.48	0.73	0.33	0.20	0.52	0.85	0.44	0.33	0.11	0.33	0.17	0.48	0.46
Mar-96	0.52	0.66	0.31	0.24	0.60	0.80	0.52	0.41	0.13	0.31	0.22	0.48	0.45
Apr-96	0.58	0.76	0.34	0.26	0.65	0.87	0.57	0.33	0.16	0.34	0.25	0.48	0.65
May-96	0.62	0.86	0.39	0.30	0.68	0.73	0.57	0.37	0.14	0.39	0.27	0.52	0.63
Average	0.56	0.74	0.35	0.24	0.61	0.74	0.56	0.34	0.18	0.35	0.20	0.47	0.49

Bronx

	201 H2	202 L1	204 H2	208 H1	209 L1	216 H3	217 H2	229 L1	230 L1
Jun-95	0.56	0.24	0.22	0.58	0.43	0.44	0.44	0.67	0.48
Jul-95	0.51	0.25	0.19	0.63	0.39	0.47	0.43	0.76	0.38
Aug-95	0.41	0.23	0.19	0.57	0.40	0.42	0.35	0.46	0.37
Sep-95	0.51	0.25	0.24	0.61	0.42	0.40	0.35	0.33	0.42
Oct-95	0.48	0.23	0.19	0.59	0.43	0.35	0.36	0.46	0.44
Nov-95	0.46	0.25	0.20	0.56	0.42	0.47	0.40	0.36	0.43
Dec-95	0.43	0.24	0.20	0.54	0.41	0.44	0.42	0.38	0.35
Jan-96	0.29	0.26	0.12	0.40	0.36	0.51	0.34	0.17	0.47
Feb-96	0.37	0.22	0.18	0.52	0.38	0.41	0.37	0.41	0.46
Mar-96	0.45	0.21	0.20	0.48	0.34	0.32	0.52	0.50	0.36
Apr-96	0.46	0.20	0.26	0.57	0.37	0.45	0.43	0.50	0.43
May-96	0.49	0.23	0.27	0.59	0.41	0.44	0.34	0.51	0.41
Average	0.45	0.23	0.21	0.55	0.40	0.43	0.40	0.46	0.42

Ratio of Actual Revenue to Coin Canister Capacity

Brooklyn

	301 L10	304 H14	307 H1	308 L3	309 L2	314 L1	318 L2	333 L3
Jun-95	0.82	--	0.73	0.47	0.34	0.44	0.39	0.64
Jul-95	0.81	0.27	0.71	0.48	0.27	0.38	0.38	0.54
Aug-95	0.82	0.24	0.70	0.44	0.37	0.33	0.38	0.56
Sep-95	0.79	0.31	0.80	0.31	0.38	0.35	0.37	0.62
Oct-95	0.81	0.27	0.71	0.39	0.38	0.34	0.37	0.53
Nov-95	0.86	0.27	0.73	0.26	0.29	0.33	0.38	0.59
Dec-95	0.92	0.26	0.74	0.19	0.28	0.31	0.43	0.65
Jan-96	0.62	0.18	0.49	0.28	0.17	0.32	--	0.63
Feb-96	0.79	0.28	0.61	0.28	0.32	0.28	0.47	0.48
Mar-96	0.77	0.43	0.74	0.31	0.42	0.33	0.40	0.62
Apr-96	0.82	0.28	0.73	0.27	0.41	0.33	0.41	0.78
May-96	0.84	0.34	0.78	0.31	0.38	0.30	0.45	0.85
Average	0.81	0.28	0.71	0.33	0.33	0.34	0.40	0.62

Queens

	401 L2	405 H2	406 L4	412 H8	419 L1	424 L1	431 H2	432 L1	442 H1	449 L1
Jun-95	0.56	0.39	0.65	0.41	0.35	0.30	0.60	0.18	0.49	1.03
Jul-95	0.62	0.39	0.46	0.44	0.42	0.37	0.50	0.18	0.55	1.15
Aug-95	0.59	0.43	0.49	0.40	0.41	0.35	0.52	0.19	0.50	0.76
Sep-95	0.64	0.41	0.54	0.40	0.49	0.31	0.54	0.18	0.54	0.74
Oct-95	0.64	0.41	0.52	0.38	0.67	0.35	0.54	0.19	0.51	0.87
Nov-95	0.62	0.37	0.61	0.38	0.43	0.35	0.59	0.18	0.53	0.77
Dec-95	0.62	0.44	0.53	0.43	0.37	0.26	0.61	0.19	0.55	0.76
Jan-96	0.38	0.37	0.44	0.34	0.30	0.27	0.56	0.21	0.39	0.48
Feb-96	0.57	0.32	0.48	0.40	0.40	0.37	0.68	0.17	0.47	0.66
Mar-96	0.61	0.33	0.37	0.42	0.46	0.34	0.48	0.18	0.45	0.71
Apr-96	0.61	0.28	0.26	0.48	0.48	0.33	0.64	0.17	0.44	0.70
May-96	0.47	0.33	0.23	0.46	0.51	0.33	0.50	0.17	0.50	0.72
Average	0.58	0.37	0.47	0.41	0.44	0.33	0.56	0.18	0.49	0.78

Ratio of Actual Revenue to Coin Canister Capacity

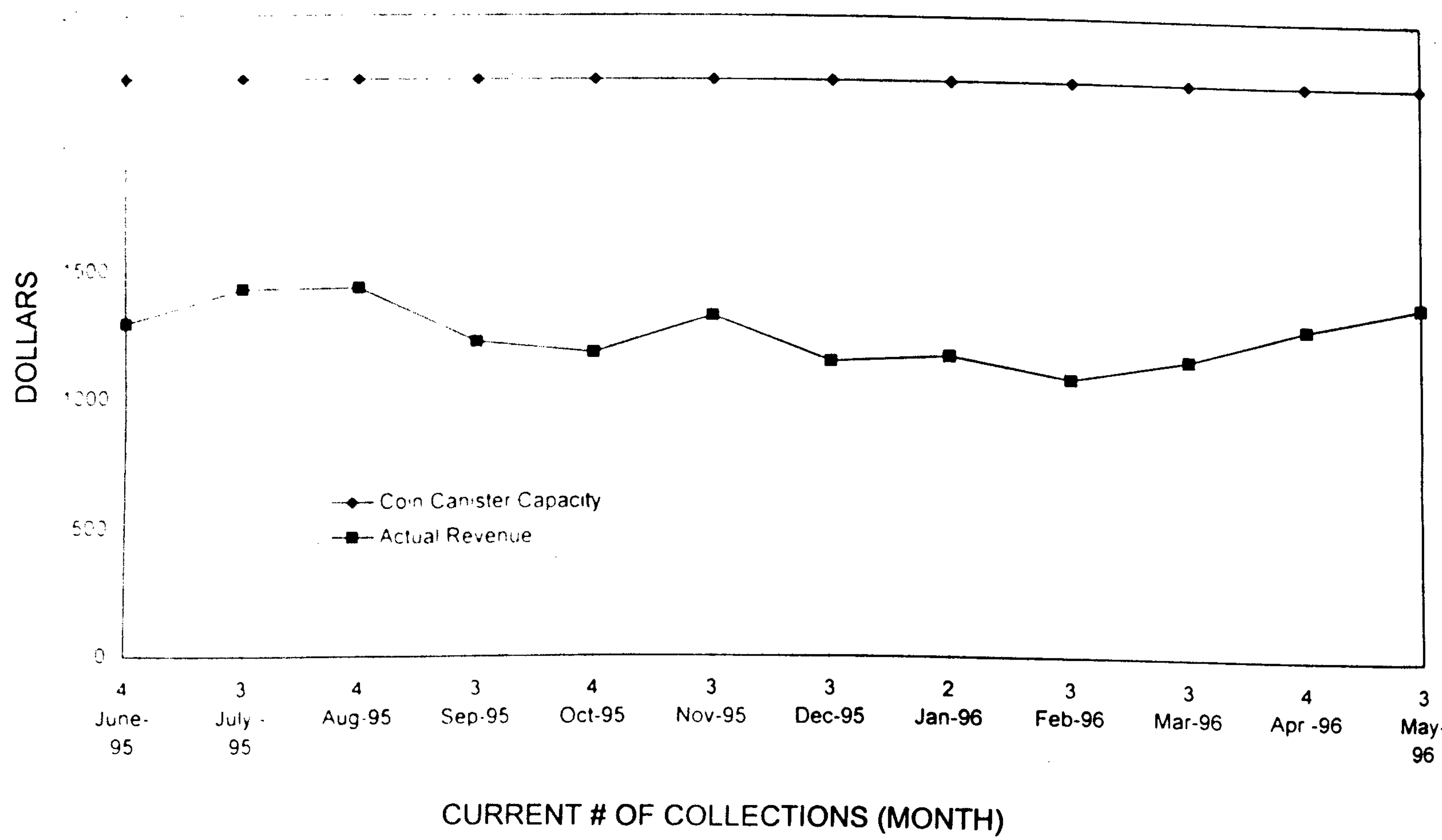
Staten Island

	501 H1	504 H1	505 1	505 H4	505 L3	506 H1
Jun-95	0.26	0.48	0.36	0.44	0.47	0.29
Jul-95	0.28	0.45	0.55	0.46	0.46	0.45
Aug-95	0.28	0.42	0.44	0.43	0.44	0.27
Sep-95	0.34	0.37	0.39	0.43	0.47	0.28
Oct-95	0.31	0.45	0.42	0.47	0.51	0.31
Nov-95	0.31	0.42	0.42	0.46	0.44	0.30
Dec-95	0.35	0.36	0.42	0.47	0.47	0.25
Jan-96	0.36	0.60	0.45	0.47	0.48	0.34
Feb-96	0.28	0.53	0.37	0.40	0.45	0.30
Mar-96	0.32	0.49	0.40	0.42	0.42	0.27
Apr-96	0.27	0.67	0.41	0.38	0.48	0.33
May-96	0.30	0.51	0.42	0.42	0.48	0.32
Average	0.31	0.48	0.42	0.44	0.46	0.31

APPENDIX E2

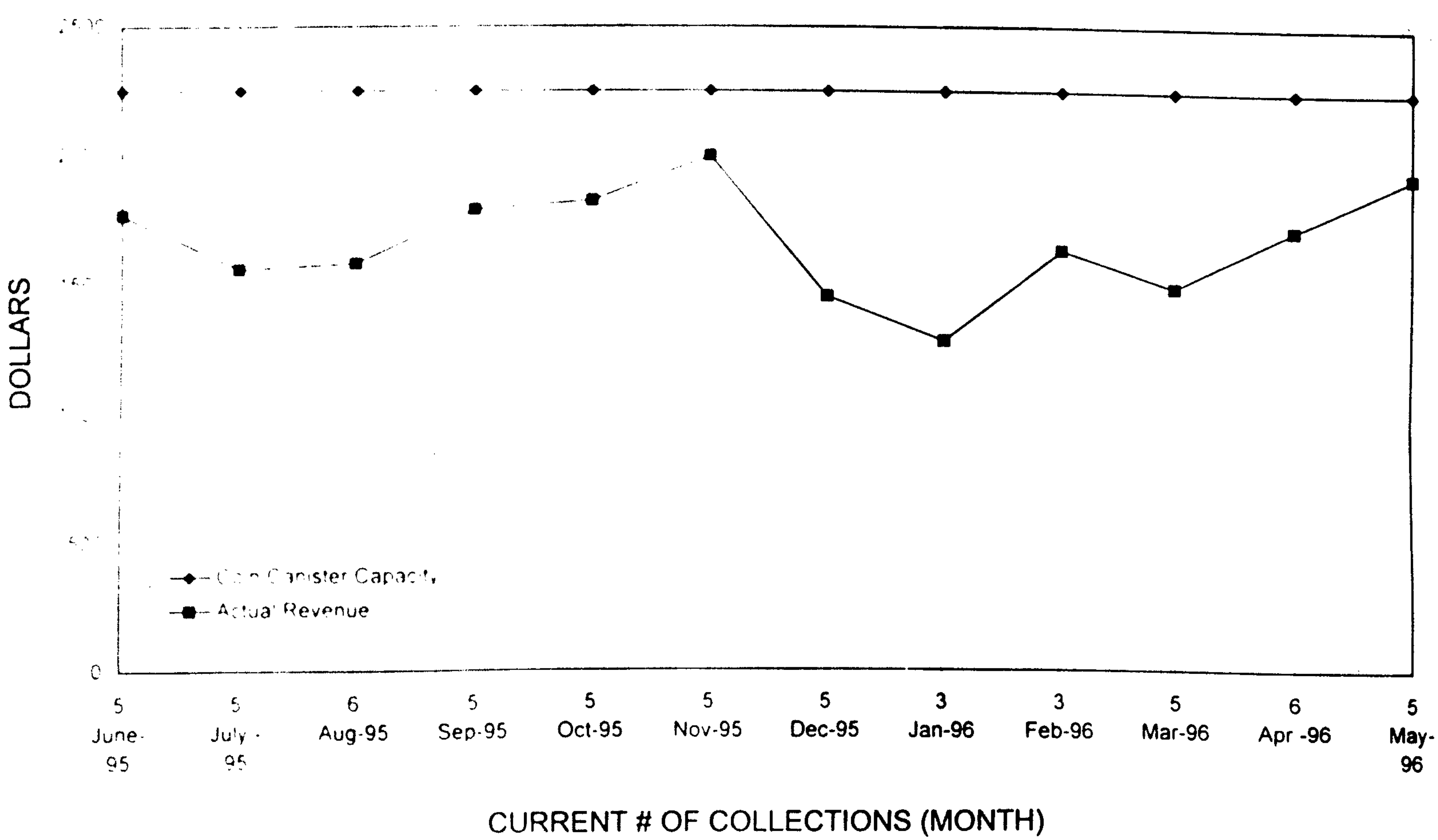
ACTUAL REVENUE vs. COIN CANISTER CAPACITY

AREA 101, CABLE 2



ACTUAL REVENUE vs. COIN CANISTER CAPACITY

AREA 103, CABLE L4



APPENDIX E3

Ratio of Actual Revenue/Meter/Cycle to Coin Box Capacity

Manhattan

	101 2	103 L4	104 L4	105 L4	106 L1	111 H7	111 SC3	117 L1	120 L4	123 L2	125 L1	135 H4	138 L1
Jun-95	0.45	0.44	0.38	0.17	0.44	0.62	0.27	0.37	0.15	0.38	0.28	0.25	0.32
Jul-95	0.51	0.37	0.70	0.21	0.46	0.39	0.30	0.32	0.08	0.70	0.24	0.27	0.32
Aug-95	0.60	0.35	0.41	0.28	0.46	0.65	0.27	0.36	0.09	0.41	0.23	0.30	0.28
Sep-95	0.43	0.35	0.38	0.26	0.44	0.47	0.27	0.32	0.09	0.38	0.16	0.29	0.28
Oct-95	0.45	0.43	0.43	0.23	0.50	0.51	0.22	0.33	0.09	0.43	0.20	0.29	0.30
Nov-95	0.49	0.42	0.63	0.27	0.24	0.39	0.16	0.31	0.09	0.63	0.23	0.33	0.32
Dec-95	0.39	0.29	0.47	0.19	0.38	0.35	0.21	0.28	0.11	0.47	0.17	0.31	0.24
Jan-96	0.47	0.28	0.27	0.30	0.29	0.22	0.19	0.27	0.09	0.27	0.20	0.21	0.37
Feb-96	0.41	0.33	0.36	0.19	0.37	0.50	0.18	0.32	0.08	0.36	0.38	0.30	0.31
Mar-96	0.45	0.30	0.35	0.27	0.42	0.52	0.21	0.39	0.10	0.35	0.38	0.30	0.35
Apr-96	0.51	0.37	0.37	0.24	0.46	0.47	0.23	0.31	0.11	0.37	0.28	0.30	0.46
May-96	0.52	0.41	0.50	0.26	0.48	0.44	0.23	0.35	0.10	0.50	0.30	0.31	0.43
Average	0.47	0.36	0.44	0.24	0.41	0.46	0.23	0.33	0.10	0.44	0.25	0.29	0.33

Bronx

	201 H2	202 L1	204 H2	208 H1	209 L1	216 H3	217 H2	229 L1	230 L1
Jun-95	0.43	0.33	0.35	0.27	0.26	0.32	0.32	0.32	0.32
Jul-95	0.54	0.40	0.38	0.33	0.24	0.36	0.31	0.35	0.25
Aug-95	0.33	0.40	0.34	0.32	0.25	0.36	0.26	0.22	0.25
Sep-95	0.41	0.30	0.42	0.34	0.26	0.32	0.26	0.20	0.28
Oct-95	0.49	0.41	0.46	0.35	0.28	0.29	0.27	0.40	0.29
Nov-95	0.37	0.47	0.36	0.30	0.26	0.42	0.30	0.33	0.28
Dec-95	0.34	0.30	0.34	0.29	0.27	0.36	0.28	0.35	0.22
Jan-96	0.20	0.34	0.21	0.21	0.25	0.39	0.23	0.17	0.33
Feb-96	0.50	0.29	0.32	0.29	0.25	0.33	0.28	0.34	0.31
Mar-96	0.44	0.48	0.34	0.28	0.24	0.28	0.39	0.48	0.24
Apr-96	0.43	0.26	0.40	0.33	0.24	0.37	0.32	0.50	0.29
May-96	0.57	0.48	0.45	0.37	0.26	0.43	0.25	0.43	0.28
Average	0.42	0.37	0.36	0.31	0.26	0.35	0.29	0.34	0.28

Ratio of Actual Revenue/Meter/Cycle to Coin Box Capacity

Brooklyn

	301 L10	304 H14	307 H1	308 L3	309 L2	314 L1	318 L2	333 L3
Jun-95	0.41	--	0.43	0.28	0.34	0.33	0.35	0.39
Jul-95	0.43	0.18	0.44	0.28	0.25	0.36	0.33	0.32
Aug-95	0.42	0.16	0.36	0.29	0.40	0.32	0.33	0.36
Sep-95	0.39	0.22	0.41	0.18	0.34	0.36	0.31	0.37
Oct-95	0.43	0.18	0.37	0.24	0.45	0.36	0.36	0.33
Nov-95	0.49	0.18	0.37	0.15	0.27	0.31	0.34	0.36
Dec-95	0.42	0.15	0.39	0.10	0.24	0.30	0.40	0.37
Jan-96	0.30	0.11	0.23	0.16	0.16	0.29	--	0.35
Feb-96	0.40	0.20	0.32	0.16	0.30	0.29	0.38	0.30
Mar-96	0.41	0.31	0.39	0.18	0.47	0.36	0.30	0.38
Apr-96	0.47	0.19	0.40	0.16	0.39	0.38	0.30	0.47
May-96	0.41	0.23	0.40	0.18	0.35	0.29	0.32	0.51
Average	0.42	0.19	0.38	0.20	0.33	0.33	0.34	0.38

Queens

	401 L2	405 H2	406 L4	412 H8	419 L1	424 L1	431 H2	432 L1	442 H1	449 L1
Jun-95	0.42	0.28	0.45	0.30	0.21	0.25	0.48	0.23	0.34	0.55
Jul-95	0.44	0.28	0.31	0.31	0.25	0.30	0.40	0.22	0.44	0.59
Aug-95	0.43	0.33	0.33	0.31	0.27	0.33	0.44	0.23	0.35	0.41
Sep-95	0.46	0.29	0.37	0.29	0.31	0.28	0.43	0.22	0.36	0.40
Oct-95	0.47	0.31	0.37	0.29	0.46	0.30	0.44	0.24	0.36	0.48
Nov-95	0.43	0.28	0.46	0.27	0.27	0.32	0.46	0.23	0.46	0.41
Dec-95	0.47	0.31	0.36	0.32	0.22	0.22	0.55	0.22	0.37	0.37
Jan-96	0.28	0.32	0.26	0.23	0.18	0.26	0.42	0.26	0.26	0.25
Feb-96	0.44	0.23	0.33	0.29	0.28	0.32	0.61	0.21	0.34	0.35
Mar-96	0.46	0.27	0.30	0.32	0.33	0.30	0.40	0.23	0.32	0.38
Apr-96	0.53	0.22	0.28	0.35	0.30	0.28	0.53	0.22	0.33	0.38
May-96	0.35	0.26	0.23	0.32	0.32	0.28	0.39	0.22	0.40	0.37
Average	0.43	0.28	0.34	0.30	0.28	0.29	0.46	0.23	0.36	0.41

Ratio of Actual Revenue/Meter/Cycle to Coin Box Capacity

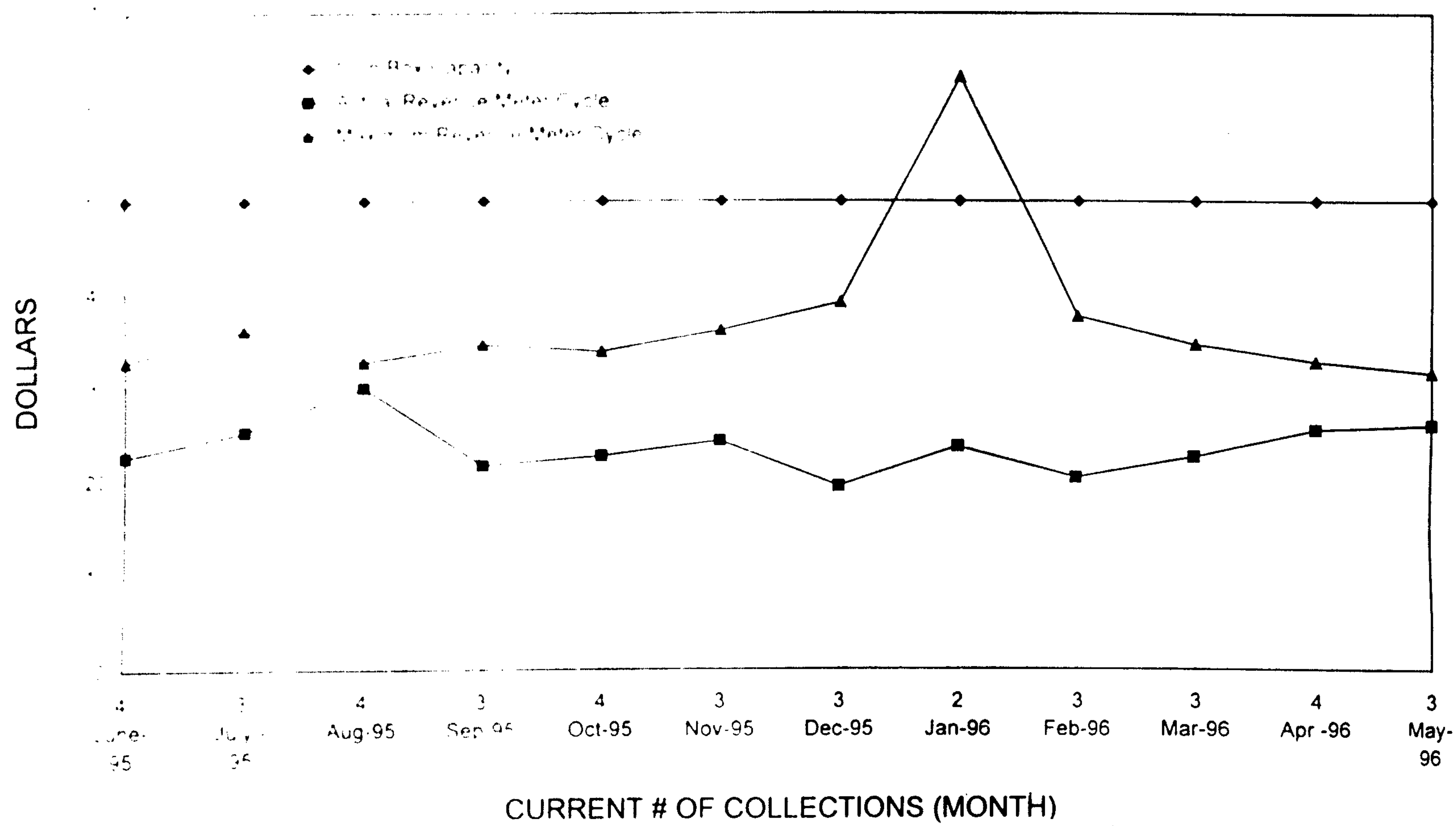
Staten Island

	501 H1	504 H1	505 1	505 H4	505 L3	506 H1
Jun-95	0.23	0.39	0.24	0.38	0.34	0.31
Jul-95	0.28	0.37	0.36	0.38	0.31	0.37
Aug-95	0.26	0.35	0.31	0.38	0.33	0.30
Sep-95	0.31	0.30	0.27	0.36	0.32	0.29
Oct-95	0.30	0.37	0.30	0.35	0.37	0.34
Nov-95	0.28	0.33	0.28	0.38	0.30	0.32
Dec-95	0.29	0.27	0.28	0.41	0.32	0.26
Jan-96	0.31	0.50	0.30	0.34	0.34	0.38
Feb-96	0.25	0.42	0.27	0.37	0.34	0.32
Mar-96	0.28	0.40	0.27	0.38	0.30	0.30
Apr-96	0.24	0.56	0.28	0.34	0.34	0.39
May-96	0.25	0.42	0.28	0.36	0.33	0.35
Average	0.27	0.39	0.29	0.37	0.33	0.33

APPENDIX E4

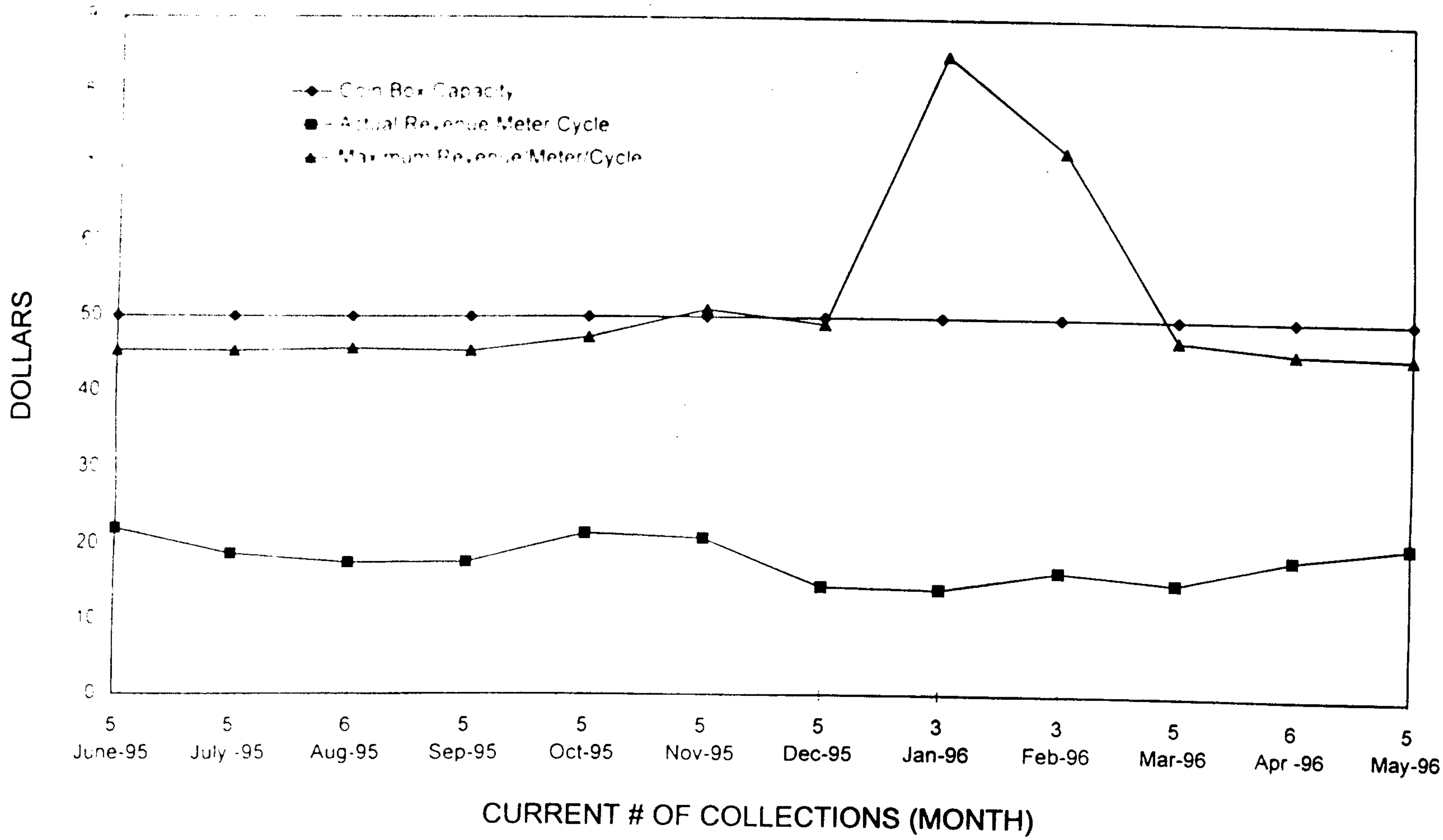
ACTUAL REVENUE/METER/CYCLE & MAXIMUM REVENUE/METER/CYCLE vs. COIN BOX CAPACITY

AREA 101, CABLE 2



ACTUAL REVENUE/METER/CYCLE & MAXIMUM REVENUE/METER/CYCLE vs. COIN BOX CAPACITY

AREA 103, CABLE L4



APPENDIX F

METER REVENUE DISTRIBUTION

The following meter revenue distribution data was obtained during the field study conducted between 4/14/97 and 4/25/97 using a dipstick.

Area 101, Cable 2

Date *	Elapsed days	Coin Box Status						Revenue of meters measured (A)	Average revenue/ meter (B)	Revenue of highly used meters (C)	Variation between (B) & (C)	Revenue**** per cable (extrapolated)	Actual***** revenue/ cable
		$0	$10	$20	$30	$40	$50						
[redacted]	7	0	2***	20	11	7	0	$1,030	$26	$40	55%	$1,674	$1,504
4/15	1	6	34	0	0	0	0	$340	$9	$10	18%	$553	
4/16	2	0	25	15	0	0	0	$550	$14	$20	45%	$894	
4/17	3	0	9	31	0	0	0	$710	$18	$20	13%	$1,154	
4/18	4	0	6	34	0	0	0	$740	$19	$20	8%	$1,203	
4/21	6	0	1	36	3	0	0	$820	$21	$30	46%	$1,333	
4/22	7	0	1	20	19	0	0	$980	$25	$30	22%	$1,593	
[redacted]	0**	0	0	0	0	0	0	$0	$0	$0	—	$0	$1,548
									Average Variation:		30%		
									Maximum Variation:		55%		

* Collection days are highlighted. Sunday (4/20) is not counted.

** The meter coin box was emptied without the dipstick measurement being taken.

*** Number of meters measured within the cable with $10.

**** Although there are 65 meters within this cable, only 40 meters had revenue measured with a dipstick. The data was extrapolated to 65 meters on the assumption that the revenue distribution pattern would be similar for the 25 meters not included in the study. The values were obtained using the following equation: (Revenue of meters measured)*(65/40)

***** Actual revenue collected in the coin canister for this cable on the collection date.

METER REVENUE DISTRIBUTION

The following meter revenue distribution data was obtained during the field study conducted between 4/14/97 and 4/25/97 using a dipstick.

Area 111, Cable H7

Date *	Elapsed days	Coin Box Status						Revenue of meters measured (A)	Average revenue/ meter (B)	Revenue of highly used meters (C)	Variation*** between (B) & (C)	Actual**** revenue/ cable
		$0	$10	$20	$30	$40	$50					
4/14	2	0	3**	80	0	0	0	$1,630	$20	$20	2%	
[redacted]	3	0	0	29	54	0	0	$2,200	$27	$30	[redacted]	$1,687
4/16	1	0	81	2	0	0	0	$850	$10	$20	95%	
4/17	2	11	65	7	0	0	0	$790	$10	$20	110%	
4/18	3	0	29	53	1	0	0	$1,380	$17	$30	80%	
[redacted]	5	0	2	33	27	21	0	$2,330	$28	$40	[redacted]	$2,834
4/22	1	49	2	5	4	0	23	$1,390	$17	$50	199%	
4/23	1	16	65	1	1	0	0	$700	$8	$30	256%	
4/24	2	1	40	38	4	0	0	$1,280	$15	$30	95%	
[redacted]	3	0	11	38	34	0	0	$1,890	$23	$30	[redacted]	$2,264
										Average Variation:	29%	
										Maximum Variation:	42%	

* Collection days are highlighted. Sunday (4/20) is not counted.

** Number of meters measured within the cable with $10.

*** Highlighted variations are useful in determining the average variation between the average revenue per meter and the revenue of the highly utilized meters.

**** Actual revenue collected in the coin canister for this cable on the collection date.

METER REVENUE DISTRIBUTION

The following meter revenue distribution data was obtained during the field study conducted between 4/14/97 and 4/25/97 using a dipstick.

Area 117, Cable L1

Date *	Elapsed days	Coin Box Status						Revenue of meters measured (A)	Average revenue/ meter (B)	Revenue of highly used meters (C)	Variation***** between (B) & (C)	Actual****** revenue/ cable
		$0	$10	$20	$30	$40	$50					
[redacted]	3	0	0	40	9****	0	0	$1,070	$22	$30	[redacted]	$875
4/15	1	0	49	0	0	0	0	$490	$10	$10	0%	
4/16	2	0	48	1	0	0	0	$500	$10	$20	96%	
[redacted]	0**	0	0	0	0	0	0	$0	$0	$0	--	$1,206
[redacted]	1	0	12	37	0	0	0	$860	$18	$20	[redacted]	$751
[redacted]	0	0	0	0	0	0	0	$0	$0	$0	--	$719
4/22	1	1	33	5	0	0	0	$430	$9	$20	128%	
[redacted]	0.5***	36	13	0	0	0	0	$130	$3	$10	277%	$717
4/24	1	2	26	21	0	0	0	$680	$14	$20	[redacted]	
[redacted]	0	0	0	0	0	0	0	$0	$0	$20	--	$776
									Average Variation:		32%	
									Maximum Variation:		44%	

* Collection days are highlighted. Sunday (4/20) is not counted.

** The meter coin box was emptied without the dipstick measurement being taken.

*** The dipstick measurement was taken during the revenue collection.

**** Number of meters measured within the cable with $30.

***** Highlighted variations are useful in determining the average variation between the average revenue per meter and the revenue of the highly utilized meters.

****** Actual revenue collected in the coin canister for this cable on the collection date.

APPENDIX G

CABLEWIDE OPERABILITY & NET REVENUE LOSS ESTIMATION

Area 101, Cable 2

	Total # def.	# insp./ month	Oper. found	Elapsed days	# coll./ month	Max. rev. loss/ cycle	Actual rev./ cycle	Max. rev. at 100% oper.	Max. rev. at current oper.	Net rev. loss	Net rev. loss/ month
6/95	29	4.00	88%	3.75	4	$123	$1,298	$2,056	$1,933	$82	$330
7/95	20	2.05	84%	7.32	3	$220	$1,430	$2,252	$2,032	$155	$465
8/95	25	2.00	80%	7.50	4	$212	$1,437	$2,130	$1,918	$159	$635
9/95	20	1.96	84%	7.65	3	$231	$1,225	$2,154	$1,923	$147	$441
10/95	32	1.95	74%	7.69	4	$278	$1,182	$2,203	$1,925	$171	$683
11/95	19	3.00	90%	5.00	3	$143	$1,329	$2,350	$2,207	$86	$259
12/95	39	2.85	78%	5.26	3	$309	$1,151	$2,350	$2,041	$174	$523
1/96	43	1.14	39%	13.16	2	$1,278	$1,177	$3,966	$2,688	$560	$1,120
2/96	40	3.99	84%	3.76	3	$227	$1,087	$2,448	$2,221	$111	$333
3/96	53	5.11	83%	2.94	3	$234	$1,166	$2,252	$2,018	$135	$406
4/96	79	6.08	79%	2.47	4	$220	$1,296	$2,130	$1,910	$149	$598
5/96	55	5.19	83%	2.89	3	$239	$1,391	$2,056	$1,817	$183	$550
								Yearly Revenue Loss:			$6,342

meters = 62 Maximum revenue/meter/day = $4.519

Area 103, Cable L4

	Total # def	# insp / month	Oper found	Elapsed days	# coll / month	Max. rev. loss/ cycle	Actual rev./ cycle	Max. rev. at 100% oper.	Max. rev. at current oper.	Net rev. loss	Net rev. loss/ month
6/95	63	4.46	81%	3.36	5	$401	$1,771	$4,493	$4,092	$173	$867
7/95	77	3.51	70%	4.27	5	$622	$1,560	$4,493	$3,871	$251	$1,254
8/95	44	4.90	88%	3.06	6	$212	$1,584	$4,524	$4,312	$78	$468
9/95	72	3.37	71%	4.45	5	$606	$1,793	$4,493	$3,887	$280	$1,398
10/95	81	3.89	72%	3.86	5	$591	$1,827	$4,680	$4,089	$264	$1,319
11/95	71	2.85	66%	5.26	5	$707	$1,999	$5,054	$4,347	$325	$1,625
12/95	96	2.82	54%	5.32	5	$966	$1,458	$4,867	$3,901	$361	$1,804
1/96	78	2.12	50%	7.08	3	$1,739	$1,284	$8,424	$6,685	$334	$1,002
2/96	172	4.44	48%	3.38	3	$1,831	$1,638	$7,176	$5,345	$561	$1,684
3/96	70	5.08	81%	2.95	5	$391	$1,494	$4,680	$4,289	$136	$681
4/96	69	8.07	88%	1.86	6	$202	$1,719	$4,524	$4,322	$80	$482
5/96	100	7.91	83%	1.90	5	$359	$1,926	$4,493	$4,134	$167	$835
								Yearly Revenue Loss:			$13,419

meters = 74 Maximum revenue/meter/day = $9.455

CABLEWIDE OPERABILITY & NET REVENUE LOSS ESTIMATION

Area 120, Cable L4

	Total # def.	# insp./ month	Oper. found	Elapsed days	# coll./ month	Max. rev. loss/ cycle	Actual rev./ cycle	Max. rev. at 100% oper.	Max. rev. at current oper.	Net rev. loss	Net rev. loss/ month
6/95	33	12.69	96%	1.18	8	$27	$707	$1,251	$1,224	$16	$126
7/95	73	15.88	93%	0.94	13	$30	$360	$740	$710	$15	$195
8/95	26	12.30	97%	1.22	13	$14	$456	$770	$756	$8	$107
9/95	25	14.60	98%	1.03	13	$11	$515	$740	$729	$8	$101
10/95	37	14.00	96%	1.07	12	$18	$488	$834	$816	$11	$132
11/95	19	13.33	98%	1.13	12	$10	$516	$802	$792	$6	$78
12/95	13	8.66	98%	1.73	10	$13	$376	$963	$950	$5	$50
1/96	19	6.06	95%	2.48	9	$29	$301	$1,155	$1,126	$8	$70
2/96	18	10.90	98%	1.38	11	$13	$252	$840	$827	$4	$42
3/96	28	12.90	97%	1.16	12	$15	$299	$834	$819	$6	$66
4/96	24	14.00	98%	1.07	13	$11	$364	$770	$759	$5	$69
5/96	33	13.58	96%	1.10	14	$15	$319	$743	$728	$6	$89
								Yearly Revenue Loss:			$1,125

\# meters = 69 Maximum revenue/meter/day = $5.58

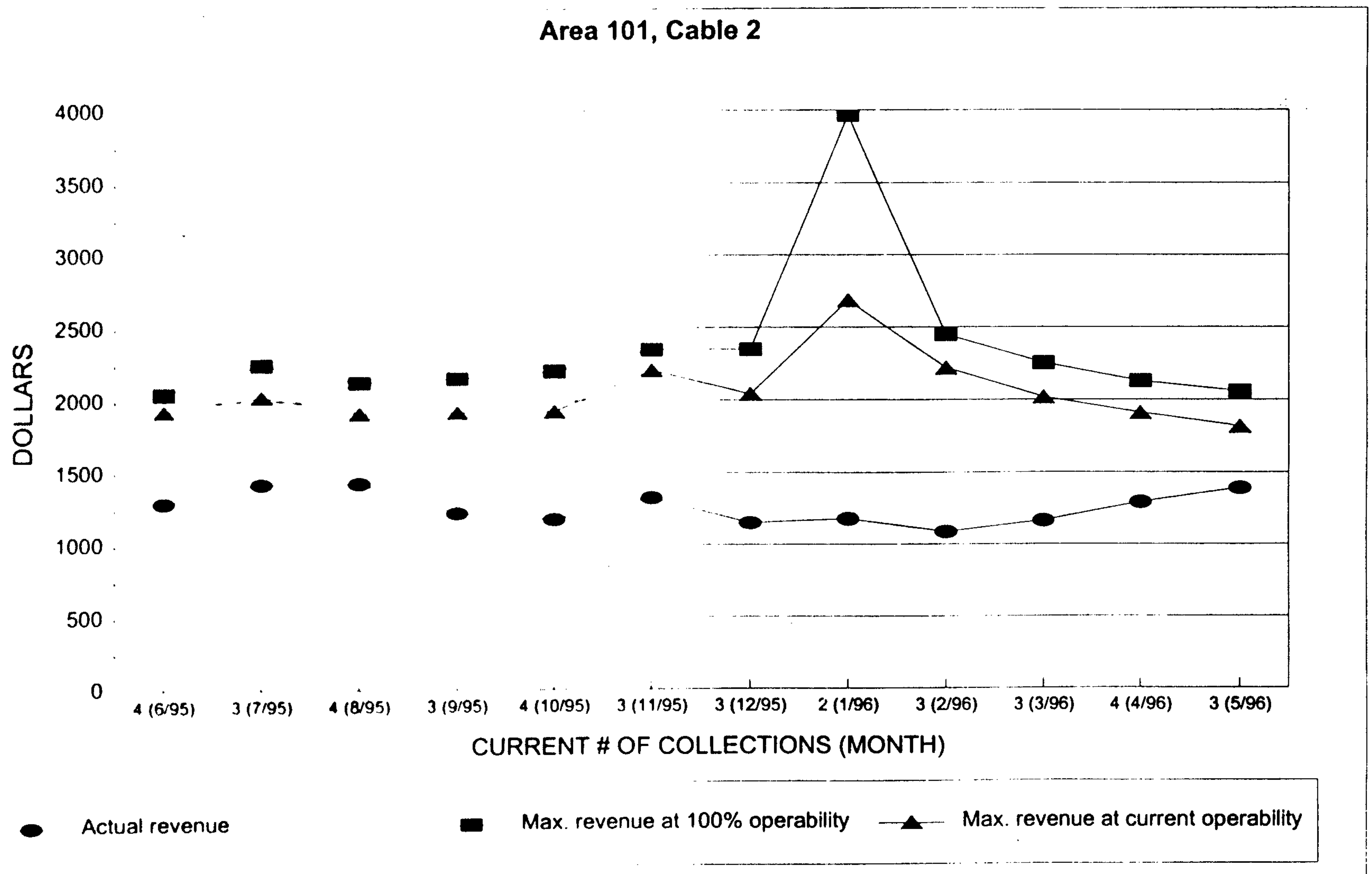
Area 123, Cable L2

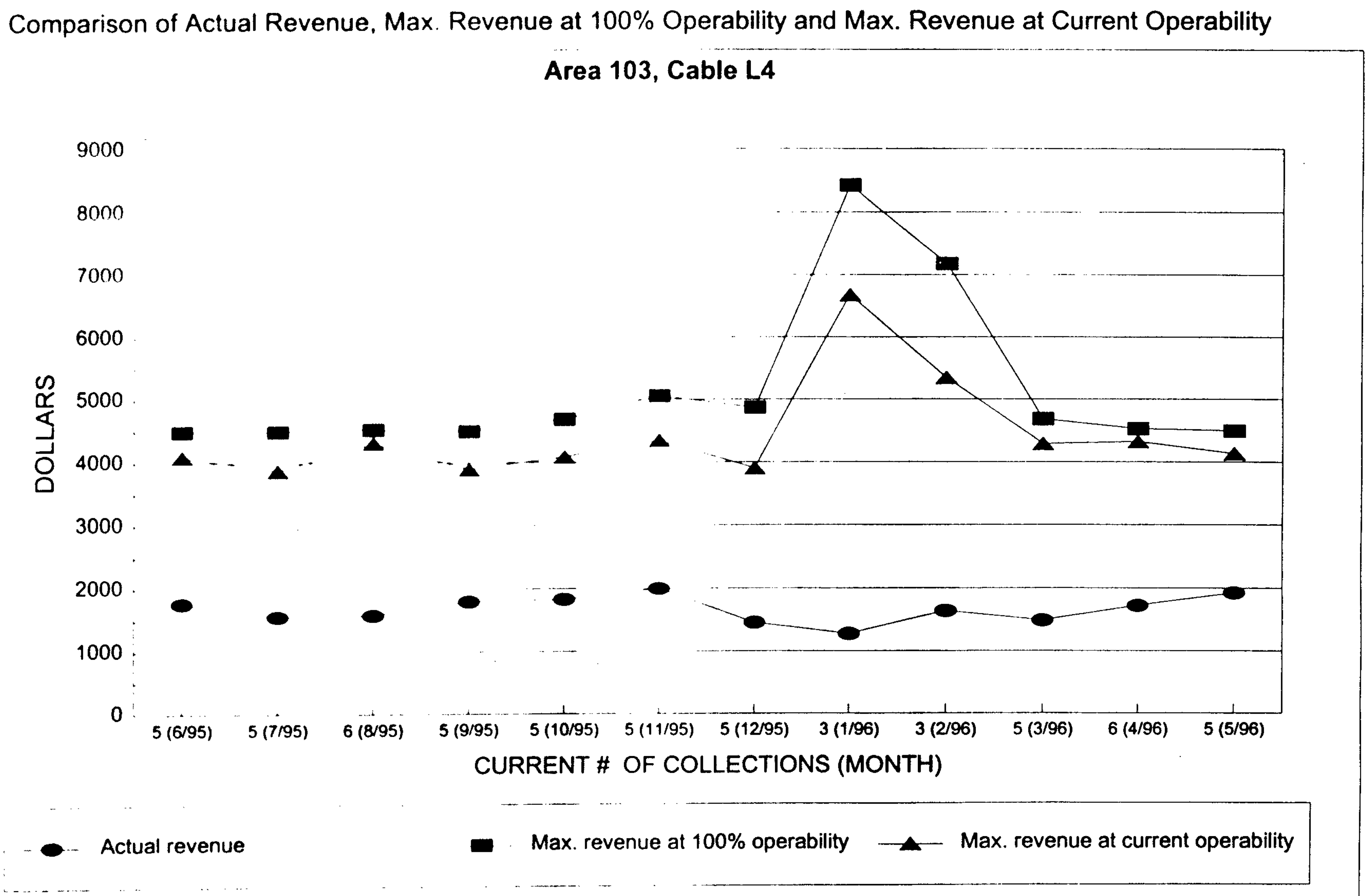
	Total # def	# insp / month	Oper found	Elapsed days	# coll month	Max. rev loss/ cycle	Actual rev / cycle	Max. rev. at 100% oper.	Max. rev. at current oper	Net rev. loss	Net rev loss/ month
6/95	35	2.00	57%	7.50	2	$743	$760	$2,204	$1,461	$386	$773
7/95	106	3.00	14%	5.00	3	$1,000	$776	$2,243	$1,243	$624	$1,873
8/95	68	3.04	45%	4.93	3	$633	$832	$2,243	$1,610	$327	$981
9/95	63	3.00	49%	5.00	2	$891	$812	$2,204	$1,313	$551	$1,103
10/95	61	4.00	63%	3.75	3	$432	$872	$2,320	$1,888	$199	$598
11/95	52	3.36	62%	4.46	2	$657	$911	$2,436	$1,779	$336	$673
12/95	28	1.62	58%	9.26	2	$734	$749	$2,204	$1,470	$374	$748
1/96	0	0.20	100%	75.00	3	$0	$614	$2,707	$2,707	$0	$0
2/96	62	3.47	56%	4.32	2	$758	$744	$2,784	$2,026	$279	$557
3/96	31	2.31	67%	6.49	3	$380	$708	$2,243	$1,863	$144	$433
4/96	42	2.99	66%	5.02	2	$596	$759	$2,204	$1,608	$282	$563
5/96	37	2.99	70%	5.02	3	$350	$884	$2,243	$1,893	$164	$491
								Yearly Revenue Loss:			$8,792

\# meters = 41 Maximum revenue meter day = $5.66

APPENDIX H

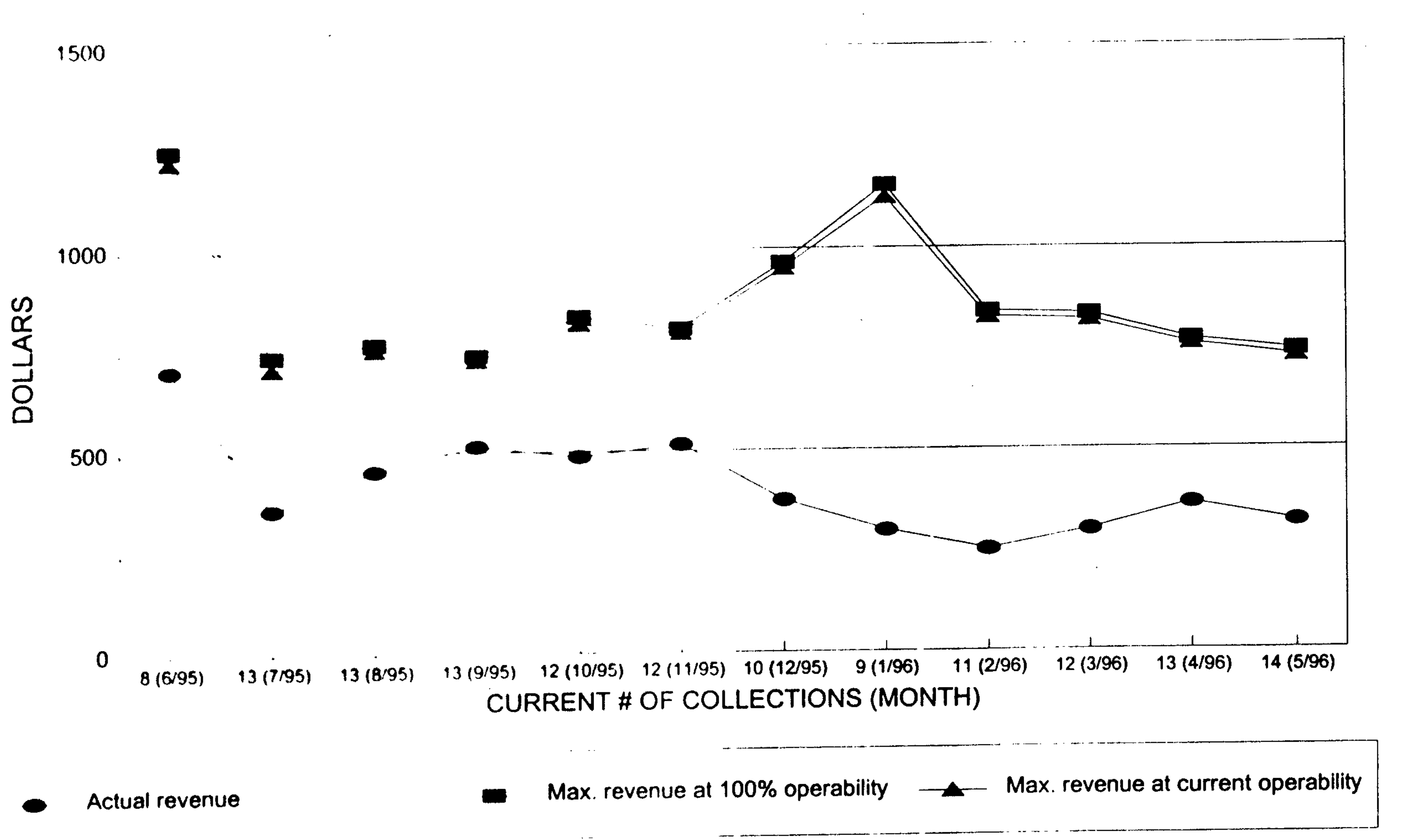
Comparison of Actual Revenue, Max. Revenue at 100% Operability and Max. Revenue at Current Operability




Comparison of Actual Revenue, Max. Revenue at 100% Operability and Max. Revenue at Current Operability
Area 103, Cable L4
DOLLARS
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
5 (6/95)
5 (7/95)
6 (8/95)
5 (9/95)
5 (10/95)
5 (11/95)
5 (12/95)
3 (1/96)
3 (2/96)
5 (3/96)
6 (4/96)
5 (5/96)
CURRENT # OF COLLECTIONS (MONTH)
Actual revenue
Max. revenue at 100% operability
Max. revenue at current operability

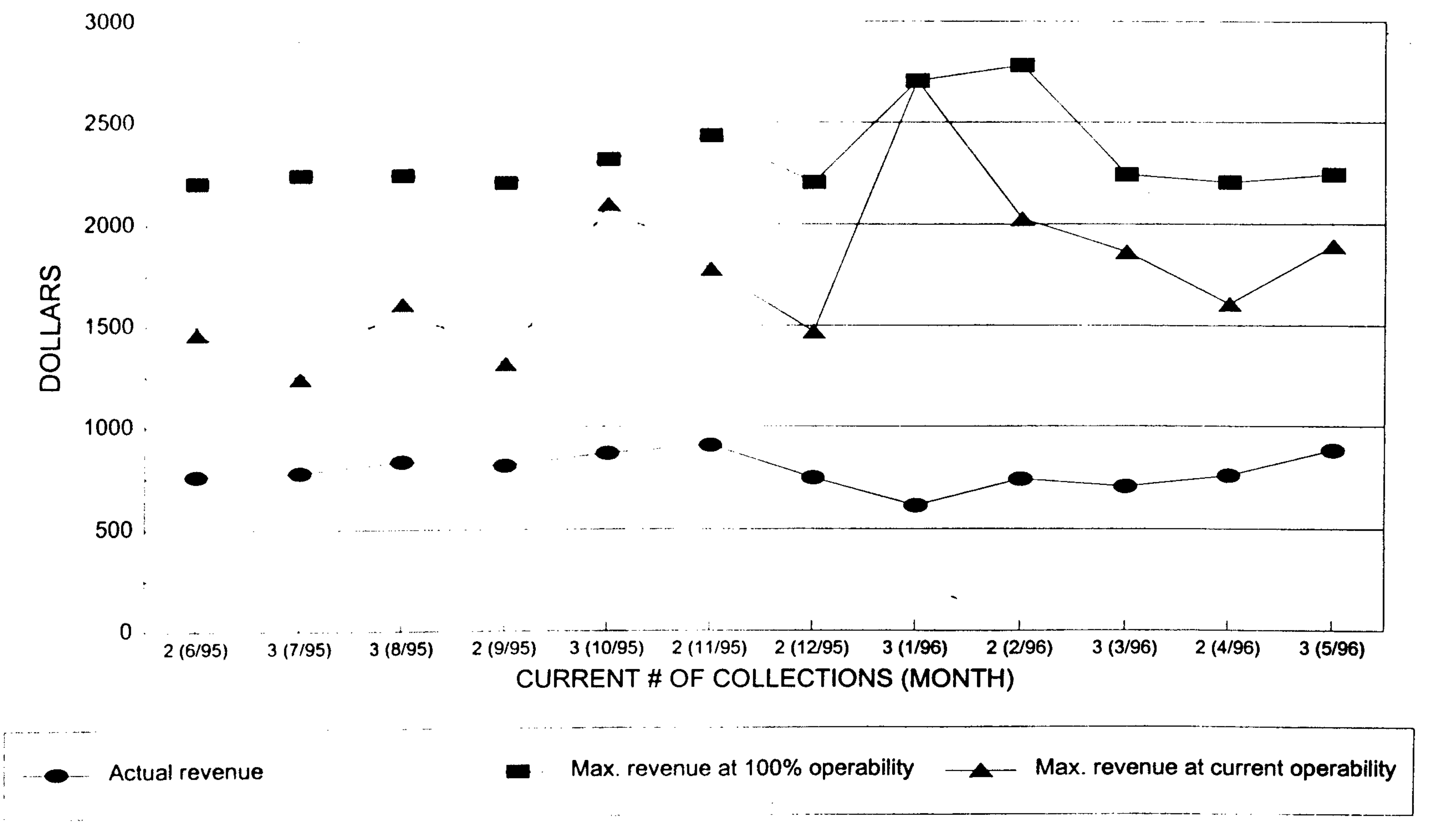
Comparison of Actual Revenue, Max. Revenue at 100% Operability and Max. Revenue at Current Operability

Area 120, Cable L4



Comparison of Actual Revenue, Max. Revenue at 100% Operability and Max. Revenue at Current Operability

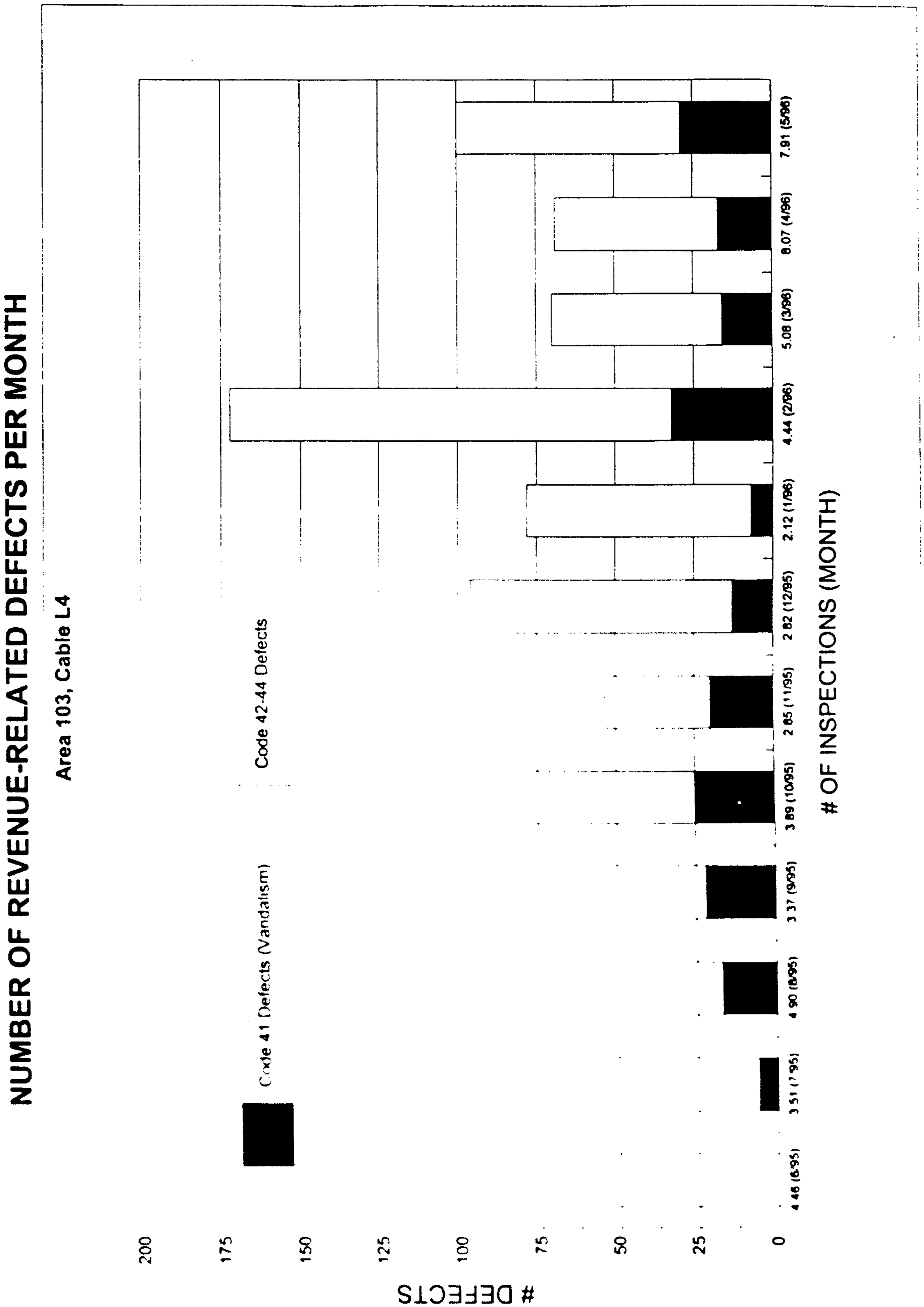
Area 123, Cable L2

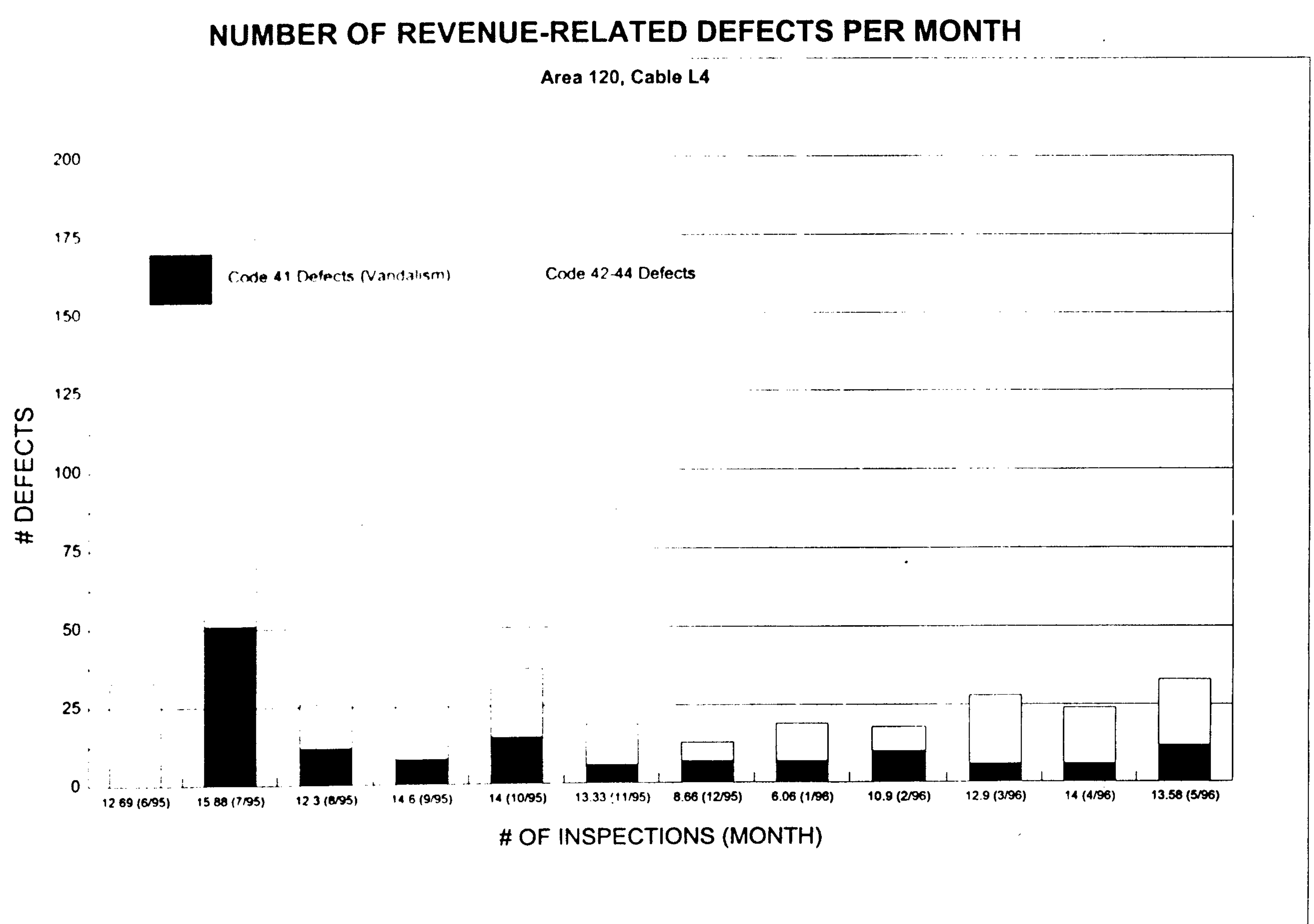


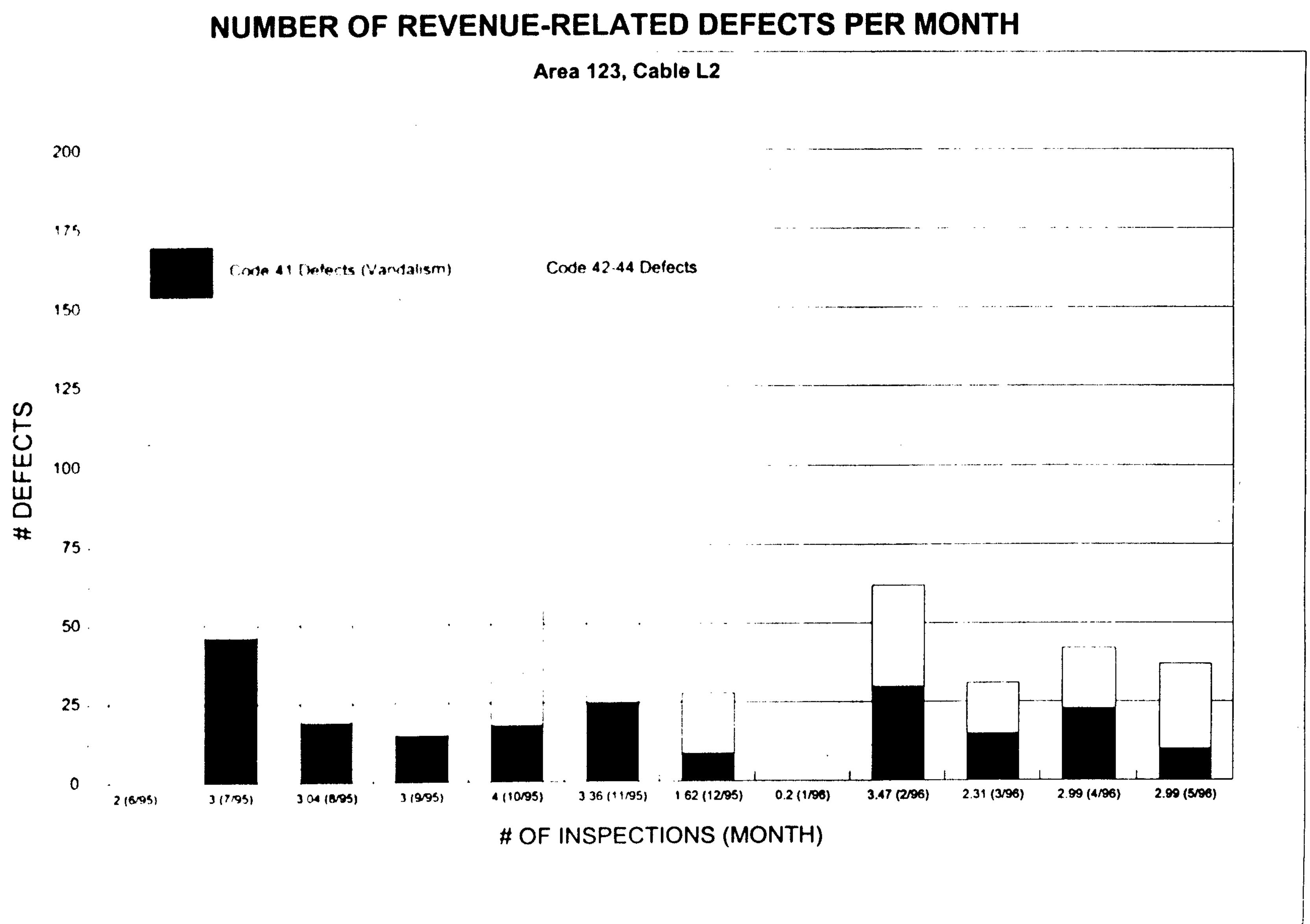
APPENDIX I

NUMBER OF REVENUE-RELATED DEFECTS

	Area 103, Cable L4 (74 meters)				Area 120, Cable L4 (69 meters)				Area 123, Cable L2 (41 meters)			
	# defects code 41	# defects code 42-44	Total # defects	# insp	# defects code 41	# defects codes 42-44	Total # defects	# insp.	# defects code 41	# defects codes 42-44	Total # defects	# insp.
Jun-95	0	63	63	4.46	0	33	33	12.69	0	35	35	2
Jul-95	6	71	77	3.51	51	22	73	15.88	46	60	106	3
Aug-95	17	27	44	4.9	12	14	26	12.3	19	49	68	3.04
Sep-95	22	50	72	3.37	8	17	25	14.6	15	48	63	3
Oct-95	25	56	81	3.89	15	22	37	14	18	43	61	4
Nov-95	20	51	71	2.85	6	13	19	13.33	25	27	52	3.36
Dec-95	13	83	96	2.82	7	6	13	8.66	9	19	28	1.62
Jan-96	7	71	78	2.12	7	12	19	6.06	0	0	0	0.2
Feb-96	32	140	172	4.44	10	8	18	10.9	30	32	62	3.47
Mar-96	16	54	70	5.08	6	22	28	12.9	15	16	31	2.31
Apr-96	17	52	69	8.07	6	18	24	14	23	19	42	2.99
May-96	29	71	100	7.91	12	21	33	13.58	10	27	37	2.99
Total	204	789	993		140	208	348		210	375	585	


NUMBER OF REVENUE-RELATED DEFECTS PER MONTH
Area 103, Cable L4
Code 41 Defects (Vandalism)
Code 42-44 Defects
DEFECTS
0
25
50
75
100
125
150
175
200
4.46 (6/95)
3.51 (7/95)
4.90 (8/95)
3.37 (9/95)
3.89 (10/95)
2.85 (11/95)
2.82 (12/95)
2.12 (1/96)
4.44 (2/96)
5.08 (3/96)
8.07 (4/96)
7.91 (5/96)
OF INSPECTIONS (MONTH)


NUMBER OF REVENUE-RELATED DEFECTS PER MONTH
Area 120, Cable L4
Code 41 Defects (Vandalism)
Code 42-44 Defects
DEFECTS
200
175
150
125
100
75
50
25
0
12 69 (6/95)
15 88 (7/95)
12 3 (8/95)
14 6 (9/95)
14 (10/95)
13.33 (11/95)
8.66 (12/95)
6.06 (1/96)
10.9 (2/96)
12.9 (3/96)
14 (4/96)
13.58 (5/96)
OF INSPECTIONS (MONTH)


NUMBER OF REVENUE-RELATED DEFECTS PER MONTH
Area 123, Cable L2
Code 41 Defects (Vandalism)
Code 42-44 Defects
DEFECTS
200
175
150
125
100
75
50
25
0
2 (6/95)
3 (7/95)
3.04 (8/95)
3 (9/95)
4 (10/95)
3.36 (11/95)
1.62 (12/95)
0.2 (1/96)
3.47 (2/96)
2.31 (3/96)
2.99 (4/96)
2.99 (5/96)
OF INSPECTIONS (MONTH)