DATE: May 12, 1988

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	
LONG ISLAND LIGHTING COMPANY	Docket No. 50-322-OL-3 (Emergency Planning)
(Shoreham Nuclear Power Station, Unit 1)	

DIRECT TESTIMONY OF DAVID T. HARTGEN, Ph.D., P.E., ON BEHALF OF THE STATE OF NEW YORK REGARDING IMMATERIALITY ISSUES

I. Qualifications and Foundation

Q. Please state your name and occupation.

A. My name is David T. Hartgen. I currently am employed by the New York State Department of Transportation as a Principal Transportation Analyst.

Q. Please provide a brief description of your qualifications.

A. My professional career spans approximately 20 years. Throughout this period, I developed extensive experience with traffic planning matters, including traffic time estimates and assignment-based methods for computing such estimates in an

accurate manner.

I also have developed extensive experience in the field information systems management. As part of my duties with the New York State Department of Transportation, I have been responsible for the collection and analysis of transportation statistics pertaining to the State of New York's highways. I have been directly involved in assessing the performance of various aspects of the State of New York's highway system, including assessing traffic speeds, traffic volumes and highway capacities. Consequently, I am familiar with the use of sophisticated computerized transportation assignment models.

I have written more than 120 transportation-related articles and reports, more than half of which have been published in various professional journals. I have served on or chaired over 20 professional panels and committees on transportation issues. In addition, I am an Adjunct Professor at the State University of New York at Albany, where I assisted in establishing a transportation studies program and where I teach courses related to transportation analysis.

I have been found to be an expert qualified to testify on matters related to evacuation time estimates in two Shoreham proceedings: the 1984 emergency planning hearings and the 1987 reception center hearings. I submitted written testimony and defended my views on cross-examination in both hearings. As a result of my participation in those proceedings, I became familiar with the evidence and testimony sponsored by LILCO and

KLD Associates, Inc., concerning evacuation time estimates for Shoreham.

A copy of my resume is Attachment 1 hereto.

Q. What material have you examined in the process of preparing this testimony on immateriality issues?

A. I have reviewed portions of Revisions 3 and 5 of the LILCO Plan, particularly Appendix A. I also have inspected computer printouts underlying the Rev. 5 evacuation time estimates prepared by KLD Associates, Inc.

In addition, I have reviewed: "LILCO's Motion for Summary Disposition of Contentions 1, 2, and 9 - Immateriality," dated December 18, 1987, including Mr. Lieberman's December 14, 1987 affidavit; "Opposition of Suffolk County, the State of New York and the Town of Southampton to LILCO's Motion for Summary Disposition of Contentions 1, 2 and 9 -- Immateriality," dated February 1, 1988, including my February 1, 1988 affidavit; "NRC Staff Response to LILCO's Motion for Summary Disposition of Contentions 1, 2, and 9 - Immateriality," dated February 2, 1988, including Dr. Urbanik's January 25, 1988 affidavit; the Board's "Memorandum and Order (Denying in Part and Granting in Part LILCO's Motion for Summary Disposition of Contentions 1, 2, and 9 .. Immateriality)," dated March 11, 1988; relevant pages of "LILCO's Designation of Record and Prima Facie Case on the Legal Authority Issues (Contentions [illegible]2, 4-8, and 10)," dated April 1,

1988; the relevant portion of the transcript of the deposition of Mr. Lieberman and others on April 20, 1988; "LILCO's Responses and Objections to Suffolk County's Second Set of Interrogatories and Requests for Production of Document Regarding Contentions 1-2, 4-8 and 10 to the Long Island Lighting Company," dated April 22, 1988; the relevant portion of "Testimony of Dennis M. Behr, Douglas M. Crocker, Diane P. Dreikorn, Edward B. Lieberman, and John A. Weismantle on the 'Best Efforts' Contentions EP 1-2, 4-8, and 10," dated May 6, 1988; the relevant portion of "Direct Testimony of Gregory C. Minor and Steven C. Sholly on Behalf of Suffolk County Regarding 'Immateriality,'" dated May 6, 1988; and other related materials.

Q. Please describe your familiarity with the immateriality issues involved in this proceeding?

A. Prior to the 1984 emergency planning hearings, KLD Associates, Inc. utilized the DYNEV model to prepare the evacuation time estimates set forth in Rev. 3 of the LILCO Plan. KLD estimated the effect of non-compliance and traffic control on evacuation times. In this series of tests, "non-compliance" refers to the degree to which evacuees will evacuate via the routes that they perceive to be the most expedient, as opposed to the routes that LILCO has prescribed to the evacuees. LILCO does not use the phrase "non-compliance" to refer to failure to evacuate to a specific destination. LILCO assumes that even

evacuees who do not comply with LILCO's routes will go to the destinations selected and specified in advance by LILCO. "Traffic control" refers to the presence of traffic guides and/or traffic cones and other physical devices to discourage evacuees from diverging from the routes designated by LILCO.

Results of KLD's Rev. 3 analysis, i.e., the Rev. 3 evacuation time estimates, are set forth in the following combination of two tables presented in Mr. Lieberman's December 14, 1987 affidavit:

Comparison of Evacuation Time Estimates
(Hours:Minutes)

Percent Non-Compliance	Controlled/ Uncontrolled	Evac. Times Rev. 3	Evac. Times Rev. 5	Difference (Minutes) From Rev. 3 To Rev. 5
1. 0%	Controlled	4:55	5:05	+10
	(Difference)	(95)	(35)	
2. 0%	Uncontrolled	6:30	5:40	-50
3. 25%	Controlled	4:55	5:25	+30
	(Difference)	(95)	(35)	
4. 25%	Uncontrolled	6:30	6:00	-30
5. 50%	Controlled	5:30	5:25	-5
	(Difference)	(60)	(60)	
6. 50%	Uncontrolled	6:30	6:25	-5
Difference between scenario 1 and 6:		(95)	(80)	-15

The difference in time between a controlled and uncontrolled evacuation, with 0% non-compliance for both was 95 minutes (4:55 vs 6:30) under Rev. 3.[1]

[1]The Board has previously found this 95 minute difference to be significant.

In 1985, LILCO conducted a new round of tests (Rev. 5), which incorporated certain changes described below. These results are also shown in the above table. Under LILCO's revised analysis, assuming 0% non-compliance, the difference in evacuation times between the controlled and uncontrolled evacuation is now reported to be 35 minutes (5:05 vs 5:40).[2]

On the basis of these data points, LILCO argues that since this 35 minute difference is about the same as the range of error that the Board accepted for the DYNEV model itself (+ or - 1/2 hour), the 35 minute difference is of no significance. Accordingly, LILCO concludes that Contentions 1 and 2, which assert that LILCO does not have the legal authority to control traffic, should be dismissed as immaterial since the presence or absence of traffic control would not make a significant difference in terms of evacuation times.

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[2]LILCO arrived at this conclusion by making certain changes to the network and loading node structure in Zone Q of the EPZ. (Actually, certain other changes were also made in Zone F and Zones S & O.) Zone Q is on the far northwest corner of the EPZ, just to the east of Port Jefferson. It is a relatively small zone, elongated (on its north-south axis) in shape, and adjacent to Zone K. Attachment 4 hereto shows Zone Q and its street network as it existed under Rev. 3 and as it now exists under Rev. 5.

According to LILCO's Interrogatory Responses, KLD modified the modeling of traffic evacuating from Zone Q by:

1. Adding five new links and four new origin centroids (loading nodes).

2. Adding about 1500 vehicles to the Zone Q loading nodes.

3. Reassigning "traffic from an existing origin centroid so that it was consistent with the new network's configurations."

But even if 35 minutes is indeed the difference between a controlled and uncontrolled evacuation, that is true only when 0% non-compliance (or 100% compliance) is assumed. That approach is unsound because in an uncontrolled environment, substantial non-compliance can be expected. In particular, LILCO's revised estimates have the effect of prescribing new destinations for some evacuees from Zones Q and F. However, in the absence of traffic control, it can be expected that many evacuees will not comply with LILCO's destinations as well as not complying with LILCO's routes.

My testimony, therefore, will address the time differential which should be considered if we are to rely on LILCO's data. It is not at all clear, however, that LILCO's data are, in fact, reliable. My review of the revised analysis raises serious doubts about the validity of LILCO's results and LILCO's conclusion that the 35 minute differential is the appropriate comparison. Thus, this testimony will also discuss the bases of LILCO's Rev. 5 evacuation time estimates.

II. Theme of Testimony

Q. What is your opinion of the technical reliability of LILCO's Rev. 5 evacuation time estimates and LILCO's conclusions concerning those estimates?

A. According to the Board, the broad issue in this proceeding is

whether traffic control is immaterial to emergency planning for Shoreham. See "Memorandum and Order (Denying in Part and Granting in Part LILCO's Motion for Summary Disposition of Contentions 1, 2, and 9 . . Immateriality,) dated March 11, 1984, at 8. As the Board stated therein:

> If LILCO chooses to pursue an immateriality argument for resolution of these contentions. . . At a minimum we expect the parties to address the technical reliability of new time estimates that LILCO may present . . . (emphasis added)

The purpose of my involvement in this matter has been to determine the technical reliability of LILCO's Rev. 5 evacuation time estimates. My determinations are set forth below.

The purpose of evacuation time estimates is to provide a sound planning basis for critical decisions concerning the safety of EPZ residents. My review of LILCO's Rev. 5 evacuation time estimates and LILCO's conclusions concerning those estimates, described in detail below, does not convince me that this will be the case. This is because: (1) LILCO has made a series of critical, subtle, and largely unsupportable assumptions to bolster its conclusions; (2) the purported differential of 35 minutes between a controlled and an uncontrolled evacuation is based on an inappropriate comparison of the data; and (3) LILCO misapplies the error range in its model to bolster its position that the 35 minute difference between controlled and uncontrolled evacuations is of the same magnitude as the uncertainty of DYNEV.

In particular, I have found that LILCO made important selective changes to its computer model network and travel pattern. These changes, which include the deletion of a critical link in the network, and the deletion of a critical desire line[3] have the effect of partitioning the evacuation traffic in a different way than it was partitioned in Rev. 3. In Rev. 5, traffic evacuating from Zone Q is separated or "partitioned" from traffic evacuating from Zone F. The Rev. 5 partitioning consequently forces traffic supposedly evacuating in an uncontrolled evacuation to evacuate to the south and southwest in a manner that is inconsistent with that which the residents would perceive to be the most expedient (to the west).

These changes are made not to route designations, but to the street network and to the assumed travel patterns. While the changes appear to be small on the surface and involve only one zone, they reveal the DYNEV model's high degree of sensitivity to such small, isolated changes. In other words, the changes incorporated into the Rev. 5 network are essentially arbitrary, and, therefore, the time estimates are not technically reliable.

LILCO's addition of 1500 vehicles to the network in the vicinity of Zone Q also raises questions. In particular, the results appear to be counter-intuitive. Even though LILCO added approximately 1500 vehicles, evacuation times were reduced by 50

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[3] A "desire line" is a straight line showing the movement of traffic from an origin to a destination, which in this case is a destination "desired" by the evacuation planners, as opposed to a destination "desired" by the evacuees.

minutes, or about 13 percent (6 hours, 30 minutes vs. 5 hours, 40 minutes). One would expect that the addition of vehicles would place a greater demand on available capacity, thus increasing evacuation times.

However, even if LILCO's Rev. 5 analysis is accepted, the appropriate comparison of evacuation times between controlled and uncontrolled scenarios would be 5:05 (0% non-compliance/ controlled evacuation) versus 6:25 (50% non-compliance/ uncontrolled evacuation), or 80 minutes, not 35 minutes as LILCO asserts. It is unreasonable to assume 0% non-compliance in an uncontrolled evacuation. It would be particularly unreasonable to assume 0% non-compliance in an uncontrolled evacuation when "0% non-compliance" means that all evacuees will select the same destinations LILCO selected for them, which is the case here. In any event, the 80 minute differential is only 15 minutes shorter than the 95 minute differential that the Board found to be significant.

Finally, I disagree with LILCO's inference that since the computer model itself, DYNEV, had been regarded by the Board as being accurate to no better than plus or minus 10%, or 30 minutes, DYNEV results which differed from each other by approximately 30 minutes (35 minutes in this case) were not significantly different from each other. The differences should stand - they do not relate to the overall accuracy of the DYNEV model. The key concept is that since the Rev. 3 and Rev. 5 tests had only marginally different inputs, test results that

were only marginally different would be significant. Given the small magnitude of the changes embodied in the Rev. 5 network and the high degree of correlation in the rest of the input data, the 35 minute difference, contrary to LILCO's assertions, is significant.

III. Findings

1. Network Structure

Q. Please describe your findings concerning the changes to the network and the zone structure in Rev. 5.

A. In LILCO's Interrogatory Responses, LILCO indicated that it made the following changes:

1. Added 4 new origin nodes to Zone Q;
2. Added five links to the network in Zone Q;
3. Reassigned traffic from an origin centroid.

I compared the maps of the networks and the desire lines (travel patterns) shown in Rev. 3 and Rev. 5. See Attachments 2 & 3 hereto, respectively. I determined that, on the basis of a comparison of maps, Rev. 5 differs from Rev. 3 in the following ways (see Attachments 4 & 5 hereto):

1. Rev. 5 added 2 loading nodes[4] in Zone Q (nodes 2 and 7).

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[4]A "node" is an intersection of two or more highway links. A "loading node" allows traffic to be added to the network.

2. Rev. 5 added 3 network nodes in Zone Q (134, 27, 103), which correspond to the intersections of a minor street, Crystal Brook Hollow Road, with other roads in the network.

3. Rev. 5 added 3 links in Zone Q (134-27, 27-103, 103-6) to represent Crystal Brook Hollow Road.

4. Rev. 5 created 4 other links (1-27, 27-35, 1-103, 103-79) by adding the above 3 network nodes (1-27, 27-35, 1-103, 103-79) and 4 access links[5], which connect loading nodes 2 & 7 to the network.

5. Rev. 5 deleted a key roadway link (12-79) connecting Route 25A to North County Road in Zone Q.

6. Rev. 5 deleted a key access link (loading node 15 to link 2-3) located in the east part of Zone F near North Country Road.

7. Rev. 5 deleted a key desire line (15-8001) from the middle portion of Zone F to Port Jefferson.

8. Rev. 5 added a desire line (load node 16 to destination node 8000) connecting the far west portion of Zone F to Port Jefferson.

9. Rev. 5 added 4 desire lines (2-8000, 2-8001, 7-8001, 7-8002) connecting the new loading nodes in Zone Q to existing destination nodes.

10. Rev. 5 deleted 2 nodes (53 and 54) in Zone Q.

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[5]An "access link" is a route or path that connects a loading node to the road network, providing a means by which traffic can be added to the network.

11. Rev. 5 added several links (75-128, 76-65) in the far southeast portion in the EPZ (Zones S & O).

12. Rev. 5 added 3 desire lines connecting the Grumman Airport to external destination nodes.

Most of these changes are shown on Attachments 4 and 5 hereto and are based on comparison of the Rev. 3 and Rev. 5 networks and desire lines. For convenience, the Rev. 3 and Rev. 5 networks and desire lines are reproduced as Attachments 2 and 3 hereto, respectively.

I also reviewed computer printouts which reflect the Rev. 5 assignments. These listings appear to show additional details that are not on the Rev. 5 maps, specifically:

The "0% Non-Compliance/Controlled" Evacuation Scenario

- Partitioning of Zone Q's loading nodes into 5 nodes (2002, 2102, 2007, 2107, 2055).
- Partitioning of Zone F's loading nodes into several sub-nodes (2016, 2116, 2015, 2215, 2014, 2114, 2017, 2113).
- Adding numerous desire lines connecting these sub-zones to exit destinations.
- Converted a section of street to one-way flow (two lanes westbound) specifically, links 2-102 and 102-1 in Zone F.

- Made two lanes available for westbound movement on Rt. 25A between Echo and Mt. Sinai-Coram Road (link 7-30).

The "50% Non-Compliance/Uncontrolled" Evacuation Scenario

- Spreading the traffic from loading node 14 and loading node 15 among 3 southern destinations, not to the west
- Deleting the desire lines between loading nodes 2 & 7 and destinations 8001 and 8002 (Rt. 25A).

These patterns are shown in Attachments 6 and 7 hereto, respectively. Here, I must emphasize that my findings on the computer printouts are tentative because they were received at a late date from LILCO and because it was not possible, to depose LILCO's traffic expert on the meaning and interpretation of some of the printouts. If, as the printouts appear to indicate, the above changes have been made, the evacuation has been severely constrained. In particular, according to the model, it would not be possible in either of the above controlled or uncontrolled scenarios for residents of the middle portion of Zone F to evacuate through Port Jefferson. That however, is what those evacuees in either of the above controlled or uncontrolled scenarios are likely to try to do because the edge of the EPZ is closer by heading directly west and westbound roads intersect the middle portion of Zone F.

Q. How do all of these changes affect evacuation times?

A. The effect is to change substantially the pattern of evacuation in and around Zone Q. These changes essentially separate the evacuees in Zone Q from those from Zone F. Residents from the middle of Zone F are forced under the model to evacuate to the south and southwest, rather than heading west toward Port Jefferson. This allows Zone Q residents and residents of the far west portion of Zone F to evacuate directly to the west without being hindered by other Zone F traffic, as had been the case under Rev. 3.

Overall, this spreads out the evacuation in space and compresses it in time, saving about 50 minutes in evacuation time.

Q. Are the assumptions underlying these changes valid?

A. No, for the following reasons.

First, LILCO misrepresents the "uncontrolled" scenario. See Attachment 7 hereto. In fact, the evacuation is NOT uncontrolled, but is subtly controlled through the network structure and desire line pattern. By deleting and adding links and nodes, and using desire lines to conform with those deleted or added links and nodes, LILCO "controls" the evacuation in the supposedly uncontrolled tests. The "control" actually present in the so-called "uncontrolled" scenario is the insertion and

deletion of certain desire lines and links in the network and model.

Further, the deletion of the 15-8001 desire line which ran from Zone F to the west (see Attachment 5 hereto), along with the deletion of the access link from loading node 15 to link 2-3 (see Attachment 4 hereto), constrains residents from the middle of Zone F (loading node 15) to evacuate to the south and southwest, rather than to the west along North Country Road or Old Post Road. North Country Road or Old Post Road would be most preferable to evacuees in an uncontrolled evacuation because those roads intersect the area, whereas Rt. 25A does not. Their normal behavior (i.e., heading west) would thus be thwarted. Accordingly, the evacuation tested by LILCO is not "uncontrolled" at all.

By removing the connection between Rt. 25A and North Country Road (link 12-79) from the network, LILCO artificially and unrealistically prevents evacuation traffic from travelling northwest on Rt. 25A. In a real evacuation, if congestion were to occur on Rt. 25A, evacuees would try other paths; the deletion of this link prevents them from doing so even in an uncontrolled evacuation.

Moreover, by deleting link 12-79, the model forces some residents of Zone Q to travel in a circuitous route (node 7 to node 103 to node 6 to node 12 to node 8002) when proceeding from the vicinity of node 7 to the vicinity of destination node 8002, rather than to travel on a more direct path along link 12-79.

This is also true for evacuees from loading node 2, for whom the only path is the circuitous route 2-27-103-6-12-8002.

Q. Why are these assumptions unsound?

A. Fundamentally, these changes are not proper because they manipulate the model's zone structure, network, and desire lines in an uncontrolled evacuation in a search for "room for improvement," but, in the process, however, LILCO has eliminated previously existing direct east-to-west evacuation paths for residents of Zone F. Thus, the changes produce traffic movements that are favorable to LILCO but cannot be relied on to occur in reality.

Q. Have you examined the effect of the one-way street in Zone F on evacuation times?

A. Yes. The street in question is a portion of North Country Road (that becomes lower Rocky Point Road) between Shore Road and Woodhull Landing Road (links 102-1 and 2-102 on Attachment 4 hereto). This street was converted to one-way (2 lanes westbound) in the "controlled" tests, but left as two-way (1 lane westbound) in the "uncontrolled" tests.

Q. What effect did this conversion to a one-way street have on evacuation times?

A. This conversion had virtually no effect on evacuation times. LILCO's shifting of the desire-line pattern southward, away from the westbound routes, appears to have offset any benefit that might have occurred as a result of the conversion to a one-way street.

The following table illustrates this phenomenon by revealing that the traffic volumes on link 101-1 are almost identical regardless of whether the conversion to a one-way street is implemented or not.

Road Section	2 lanes westbound 0% non-compliance controlled	1 lane westbound 50% non-compliance uncontrolled
2-102	1257	Not listed on the computer printouts
101-1	2966	2960

Q. What does this mean?

A. It means that LILCO incorrectly attributes a limited reduction in evacuation times to the increased capacity (750 vehicles) resulting from this one-way traffic treatment. LILCO presents no data to show that the particular link is responsible for causing the longest evacuation times in the first place, or concomitantly, that the conversion to a one-way street serves to

reduce the longest evacuation times. To the contrary, the data showing almost identical volumes on link 101-1 (set forth in the above table) indicates that virtually no additional vehicles took advantage of the additional capacity when it was available.

It appears that the real reason for the reported decrease in overall evacuation times is not this treatment, but the shifting of the desire-line patterns to the south, away from the westbound northern routes. LILCO did not, but should have, tested the effect of this one-way traffic treatment under circumstances where desire line patterns directed traffic from loading node 15 westward on the northern routes. It is quite possible that severe congestion could arise under these circumstances, thereby affecting evacuation times in a way other than by causing a "limited reduction." Regardless of these possibilities, this exercise confirms my belief that Rev. 5's changes in desire line patterns can easily affect evacuation times. The model's sensitivity to such desire line changes justifies approaching the model with caution and conducting sensitivity analyses.

Q. Did you review the capacity changes on Rt. 25A?

A. Yes. I reviewed, Rt. 25A between Echo Avenue & Mt. Sinai-Coram Road (link 7-30 in Attachment 4 hereto). LILCO gave this section two lanes westbound in controlled assignments, but one lane westbound in uncontrolled assignments.

Most traffic volumes were not listed in the printouts, but

surprisingly on Echo Avenue (link 4-7) traffic increased (from 1193 vehicles to 1735 vehicles), when the capacity of Rt. 25A was reduced. This counter-intuitive result is probably also caused by changes in the desire line patterns which force traffic to evacuate to the south. This again indicates the extreme sensitivity of the model to network and desire line assumptions.

Q. Did you review other model results for the Rev. 5 tests?

A. Yes, I also reviewed the results for the "0% non-compliance/ controlled" and the "50% non-compliance/uncontrolled" tests in the vicinity of Zone Q. I found numerous unexplained problems, which are documented in Attachment 8 hereto. These are:

(1) Traffic loading for some origin nodes in the "50% non-compliance/uncontrolled" scenario were inexplicably reduced by over 2/3 compared with "0% non-compliance/controlled" scenario, while other loadings were unchanged. For instance, the number of vehicles leaving nodes 7, 2, and 55 was reduced from 1805 to 512 vehicles, but traffic leaving nodes 34, 35 and 17 was unchanged. LILCO offers no explanation why all nodes were not treated similarly.

(2) Connections for loading nodes 2 and 7 appear to have been deleted from the "50% non-compliance/uncontrolled" scenario. This means that Zone Q evacuates directly west even in this uncontrolled test, but some of its residents

would certainly evacuate southwest. Therefore, deletion of these desire lines constrains the supposedly "uncontrolled" evacuation.

(3) I could not verify from LILCO's computer printouts that 2000 vehicles were loaded from Zone Q. In particular, it would appear that the 512 vehicles loaded from Zone Q in the "50% non-compliance uncontrolled" scenario is erroneous.

(4) Only a portion of the resulting network volumes (every other line) have been listed, but surprisingly the traffic volumes in the "50% non-compliance uncontrolled" case are almost identical to those in the "0% non-compliance controlled" case. It is inconceivable that these slight differences in volumes would produce an 80 minute difference in evacuation time.

(5) Traffic volumes on Crystal Brook Hollow Road are very low, less than two cars per minute (over the 5-7 hour evacuation) on the heaviest portion (link 103-6). Volumes this low should have had no effect on evacuation time. This means that the original stated purpose of adding Crystal Brook Hollow Road (to provide movement between the east-west routes) was not achieved. In fact, it was probably rendered difficult to achieve by the changes in desire lines shown in Attachments 6 & 7 hereto. Essentially, LILCO's adjustments of the travel pattern destroyed its argument for adding this road in

the first place.

Q. What is the effect of not incorporating these changes into Rev. 5?

A. The results of Rev. 3 would stand: the difference between controlled and uncontrolled evacuation times would be 95 minutes, because the effect of traffic control would not have been diluted by changes to the network or traffic patterns.

2. Vehicles Added to the Network

Q. Mr. Lieberman's affidavit and LILCO's Interrogatory Responses state that about 1500 vehicles from Zone Q were added to the Revision 5 network. Please state your opinion on the validity of LILCO's new approach to modeling an increased number of vehicles within Zone Q.

A. First, LILCO has admitted that not all evacuating vehicles in Zone Q were modeled in LILCO's original effort. LILCO's data for other zones are, therefore, suspect and should be scrutinized.

Second, LILCO argues that its review of local streets in Zone Q was based on a disparity between 690 evacuating vehicles and 2300 total vehicles. If there are 2300 cars in Zone Q, then they should all be evacuated, not 690 (the Rev. 3 number), 2000 (the Rev. 5 number) or some other number. There should be no

disparities in any of the zones.

Further, the fact that 1500 vehicles were added to the Rev. 5 network reveals (1) that the decision reflected in Rev. 3 about how many cars to load the network with in Zone Q was quite questionable since the number of vehicles is now being changed, (2) the magnitude of the changes themselves was also arbitrary, and (3) the Rev. 3 network itself was also incomplete. These are the points that the State of New York raised in the 1984 emergency planning hearings concerning the too-coarse network and zone structure.

I agree with LILCO's Interrogatories Response that the effect of the network changes in the model "outweighed" the increase in traffic in Zone Q, but I was frankly skeptical about the ability of the small changes noted by LILCO to have such a large effect on evacuation times. A possible explanation could be that the more extensive network and desire line changes that I found in the computer printouts (see above), could have been large enough to overshadow the increase in traffic. For the reasons stated above, this raises questions about the accuracy of the model.

Q. Please comment on Mr. Lieberman's explanation of why it is not counter-intuitive for an increase in traffic to cause a decrease in evacuation times.

A. Mr. Lieberman maintained during his deposition (see Lieberman Deposition Tr. 192-193, March 25, 1988) that an increase in

traffic could be consistent with a decrease in evacuation time. He stated that this was not counter-intuitive because it was similar to the phenomenon of using ramp metering on an access ramp to facilitate freeway flow downstream.

The ramp metering argument for overall traffic control does not apply here because those systems have inter-connected signals, while the traffic guide system proposed by LILCO does not. In other words, there is no practical way for LILCO's traffic guides to interact with each other to facilitate smooth traffic flow during an evacuation in a manner similar to the ramp metering systems mentioned by LILCO. In sum, if cars were added to the network, they should increase evacuation times, if they had not been outweighed by the changes noted earlier.

Q. Is there any significance to the apparent sensitivity of the model to the changes in traffic, zone structure, and desire lines reflected in LILCO's Rev. 5 analysis?

A. Absolutely. The Rev. 5 network changes and difference in amount of traffic (less than 3 percent of the cars in the EPZ), have apparently had a substantial effect on evacuation times, as evidenced by the data presented in the table set forth earlier in this testimony. One would not normally expect an assignment model to be so sensitive to such small network and traffic changes. This is a tip-off that the model itself is very sensitive to small changes, and, therefore, must be viewed with

great caution. Small changes in other areas not considered by LILCO in Rev. 5 could also cause substantial fluctuations, either up or down, in evacuation times.

Q. Since the model is so sensitive, shouldn't LILCO have studied the effect that other small changes, not considered in Rev. 5, could have had on evacuation times?

A. Yes. If changes were going to be made to Zone Q, then LILCO should have carefully examined whether changes in the entire network and the zone structure within the network could also have affected evacuation times. There is no basis for knowing that an "improvement" in Zone Q would not have been offset or affected in any way by a change occurring elsewhere.

Also, traffic previously left out of Rev. 3 should have been loaded to the network, not just in Zone Q, but in all zones. LILCO has presented no indication that it has attempted to do this, and, therefore, has only made a selective, partial accounting of such previously unmodeled traffic.

3. Appropriateness of Comparisons

Q. What comparisons of scenarios do you feel are appropriate to determine the effect of traffic control on evacuation times?

A. The table set forth earlier in this testimony shows the 6

scenarios studied by LILCO and corresponding evacuation times.

First, it should be noted that any comparisons involving Rev. 5 data are inappropriate because the Rev. 5 network changes are essentially arbitrary and force an "uncontrolled" evacuation to adhere to unlikely desire lines that actually are "controlled."

However, accepting for purposes of this testimony but not conceding that Rev. 5 data might be reliable, the appropriate comparison would not be between the 0% non-compliance controlled and uncontrolled scenario. An uncontrolled evacuation that is characterized by 0% non-compliance is totally unrealistic. Rather, the correct comparison should be between the "0% non-compliance/controlled" and the "50% non-compliance/uncontrolled" scenarios. In other words, the correct comparison should be between 5:05 and 6:25 (80 minutes). This comparison is more valid because it is realistic to expect that non-compliance and degree of control are related, that is, as traffic control is relaxed, non-compliance with prescribed routes and destinations increases. And if the network and desire line pattern is inconsistent with the natural flow of evacuation movements, as LILCO's pattern is, then even more non-compliance in an uncontrolled evacuation can be expected. In my view, the appropriate, comparative time difference for Rev. 5 is 80 minutes, not 35 minutes.

This means that in an uncontrolled evacuation, it could take longer for evacuees to be cleared from the area, and queues

forming in the EPZ as a result of congestion will take longer to dissipate.

4. Appropriateness of a 30-minute Standard

Q. Do you have any concerns about by LILCO's argument that differences in scenarios that are about 30 minutes (the DYNEV margin of error) imply that traffic control is not a material element for the LILCO Plan?

A. Yes, I have several concerns with this argument. First, the argument reveals confusion by LILCO about the accuracy of model differences when used in a comparative set of tests. Model accuracy is different from comparison-based analysis. In the latter, very small changes in the inputs can be tested, by holding constant all other factors and then comparing the two runs of the model. That is the case we have here - the network and zone structure, except for the changes noted above, were held constant. Because the model inputs are identical except for these changes, the model runs are highly similar (i.e., correlated) and, therefore, the differences in the tests, however small, are significant because they reflect the differences in the inputs. So, even assuming that the 35 minute difference is correct, LILCO should have accepted that as a difference caused by traffic control, and not argued that it should have been dismissed. In any event, the appropriate difference is in the

range of 80-95 minutes, and, as the Board has already recognized, that difference is significant.

IV. Summary

Q. Please summarize your analysis.

A. LILCO's argument (that the proported 35 minute difference in controlled versus uncontrolled scenarios is about the same as the uncertainty in the model itself, and, therefore, that traffic control is immaterial) is inappropriate and its evacuation time estimates are technically unreliable, for the following reasons:

1. LILCO incorrectly relies on a series of unrealistic assumptions about which destinations evacuees will select, and arbitrarily prevents direct flight to the west from the middle of Zone F.

2. LILCO incorrectly assumes that evacuees will dutifully follow only the routes that LILCO included in the network. In fact, evacuees can be expected to use other streets too.

3. LILCO makes subtle but critical changes to the network, zone structure, and particularly the desire line pattern, which are unjustified. These changes radically affect

the evacuation pattern and hence the evacuation times.

4. LILCO does not explain or support its rationale for partitioning zones or loading additional vehicles in Zone Q, and does not justify the counter-intuitive reduction in evacuation times that follow.

5. LILCO's model strains credulity by demonstrating very high sensitivity to apparently small changes in the network and zone structure, casting doubt on whether actual evacuation times would be similar to Rev. 5's evacuation times if other changes were considered.

6. LILCO fails to make the appropriate comparisons between controlled and uncontrolled tests, versus the degree of non-compliance.

7. LILCO confuses model errors with differences obtained in comparative analysis.

Q. Should LILCO's analysis be accepted?

A. No.

Q. Does that conclude your testimony?

A. Yes.

ATTACHMENT 1

DAVID T. HARTGEN
August 1987

Home

5720 Normanskill Road
Slingerlands, NY 12159
(518) 765-3623

Office

Information Resource Management, 5-308
New York State Dept. of Transportation
Albany, New York 12232
(518) 485-8627

GOAL: Transportation, engineering, or information systems management.

QUALIFICATIONS: Outstanding transportation policy analysis, management, and research background. Over 20 years experience in transportation planning and information systems management. Expert at managing large complex organizations and implementing change. Very strong writing and speaking skills. Over 120 papers and reports; widely published. National and international reputation. Strong academic and teaching credentials. Extensive professional activities.

EDUCATION:

Ph.D., Civil Engineering/Transportation, Northwestern Univ., 1973
M.S., Civil Engineering/Transportation, Northwestern Univ., 1967
B.S., Civil Engineering, Duke Univ., 1966

EXPERIENCE:

July 1987 - Present

Principal Transportation Analyst, Information Resource Management
New York State Department of Transportation, Albany, New York

Develop, evaluate and implement Management Information Systems for the Department. Provide technical expertise on DOT business functions to IRM Office. Review, evaluate, negotiate, and manage consultant studies.

Feb. 1981 - July 1987

Director, Transportation Statistics & Analysis, NYSDOT
Managed 60+ persons responsible for collection and analysis of statistics on NYS highway system: (1) transportation systems extent, condition and needs; (2) design and conduct of traffic and travel surveys, speeds, and trucks; (3) travel trends and forecasts; (4) urban transportation systems analysis.

Revitalized an extensive data collection activity into an efficient information system. Designed and implemented new methods of rapidly assessing highway condition based on photograph scales; cut data delivery time by 90% and improved accuracy and reliability. Streamlined the traffic count program, decentralized traffic equipment and information flows, reduced data access time by 95%. Implemented rapid-access low-cost speed and truck monitoring systems. Revised urban travel simulation procedures using microcomputers and stand-alone traffic forecast methods.

Developed and implemented a Canal Management System. Prepared draft MIS Task Force report charting agency MIS directions. Began implementation of a Highway Database. Developed an Infrastructure Needs Assessment Model to forecast repair needs for highways and bridges. Principal Investigator on 4 federal studies on traffic monitoring and forecasts, and transportation energy use. Testified before the NRC on evacuation plans for the Shoreham Nuclear Power Station.

May 1984 - March 1985

Special Assistant to the Director of Planning, Fed. Highway Admin. Initiated and implemented this assignment for training, education, and experience. Designed and conducted analysis of information needs for FHWA and the States. Prepared the "Highway Information Resources Study", recommending improvements to FHWA's planning-related data systems; implementation by FHWA is underway. Undertook pavement initiatives studies, long-term monitoring of pavements, and management systems. Reviewed and analyzed bridge and highway deterioration models and funding needs, traffic monitoring, and highway condition studies.

Nov. 1971 - Feb. 1981

Head, Planning Research Unit, NYSDOT
Designed and developed analytic and planning methods studies for the Department. Directed staff of 10-15 analysts. Developed analysis methods and procedures; prepared travel forecasts; developed methods of economic, social and environmental impacts, travel behavior and consumer response. Analyzed urban transit pricing, service, and fare policies. Designed and collected 15 travel data sets. Analyzed energy price and supply shortfalls and their effects on travel. Assessed special transit services for elderly and handicapped persons. Conducted and analyzed 7 public opinion surveys on transportation investments. Prepared policies and recommendations to NYS Legislature on transit operating assistance. Studied travel behavior of persons and households.

1967-1971

Transportation Analyst, NYSDOT
Conducted research, data collection, and analysis on transportation systems and travel for numerous New York State cities, rural areas, and statewide.

ACADEMIC:

1978 - Present

Adjunct Professor, Dept. of Geography, SUNY at Albany.
Helped set up transportation program. Teach graduate courses in transportation analysis, including demand models, statistics, travel characteristics, energy, financing.

1974- Present

Initiated and operate NYSDOT student intern program with area colleges; over 60 interns have served. Advisor on 2 Ph.D. and several M.S. studies.

1976-1979

Adjunct Professor, Civil Engineering Department, Union College. Taught transportation analysis.

1974

Adjunct Professor, Syracuse University. Taught undergraduate course in transportation covering travel characteristics, legislation, analysis.

1971- Present

Guest lectures at University of Oklahoma, Rensselaer Polytechnic Institute, Syracuse, SUNY Buffalo, Union, Ohio State University, University of Illinois, Brooklyn Polytechnic Institute, Purdue, Clark, Oxford & Warwick Universities (England), City of Amsterdam (Holland), University of Wisconsin, and others.

PUBLICATIONS: Authored over 120 reports and papers, 63 of which are published in the refereed professional literature. Selected most recent:

1984 "Highway Information Resources Study" report for FHWA, Dec. 1984.

"Application of the Highway Condition Projection Model to Interstate I4R Repairs", Transportation Research Record 955, TRB, 1985.

1985 "How Good is HPMS: Comparison with State Results", Transportation Research Record 1060, TRB, 1986.

"The FHWA Highway Information Resources Study: Overview, Status, Direction", Transportation Analysis Report 60, NYSDOT.

"Network-level Pavement Condition Rating: Balancing Quality, Quantity and Timeliness", with E. Herschenhorn, Transportation Research Record 1060, TRB, 1986.

1986 "Integrating Highway Information: The New York Approach", paper presented at the FHWA File Linkage Conference, Salt Lake City.

"Are Truck Weights Really Increasing?", with D.M. Eager, Transportation Analysis Report 59, NYSDOT.

"A Strategy For Change", Draft report of the MIS Task Force, New York State Department of Transportation, 1986.

"A Plan to Develop a Comprehensive MIS for New York DOT", MIS Task Force, NYSDOT, December (with others).

1987 "Pol[illegible] Opportunities for Travel Behavior Analysis", paper prepared for the 5'th International Conference on Travel Behavior.

"Testimony on Behalf of New York Regarding LILCO's Reception Centers", for the Nuclear Regulatory Commission, April 13, 1987.

PROFESSIONAL: Served on or chaired over 20 national and international panels and committees. Presently, Chair of TRB's Subcommittee on Statewide Information Systems. Chaired the International Conference on Travel Demand (1982), and TRB Committee on Travel Behavior, 1977-1983. Associate Editor, Transportation, 1974-present.

Registered Professional Engineer, Maine #5762.

AFFILIATIONS: American Public Works Association
Transportation Research Board

David T. Hartgen
Publications and Reports
August, 1987

1966 "A Comprehensive Report of Parking and Traffic on Duke University", Civil Engineering Department, Duke University, Durham, North Carolina (with C.N. Holland) (Senior Thesis).

1967 "Optimum Location and Capacity of University Parking Facilities", Northwestern University, Department of Civil Engineering, June 1967 (Master's Thesis).

1968 "Calibration of Transit Networks in Medium Sized Urban Areas", Transportation Research Record No. 297, TRB, Washington, DC.

1969 "Modal Split in Small Urban Areas", Preliminary Research Report No. 15, NYSDOT, July.

1969 "Optimal Design of a Surface Transit System", NYSDOT Report, Albany, NY 12232.

1970 "A Behavioral Model of Mode Choice", Preliminary Research Report No. 19, NYSDOT, March (with G.H. Tanner).

1970 "Mode Choice and Attitudes: A Literature Review", Preliminary Research Report No. 21, NYSDOT, April.

1970 "Individual Attitudes and Family Activities: A Behavioral Model of Traveler Mode Choice", High Speed Ground Transportation Journal, Volume IV:3, p. 439-467 (with George H. Tanner).

1971 "Investigation of the Effect of Traveler Attitudes in a Model of Mode Choice Behavior", Transportation Research Record No. 369, Transportation Research Board (TRB), Washington, DC (with George H. Tanner).

1972 "A Note on the Ability of Socioeconomic Variables to Explain Attitudinal Bias Toward Alternative Travel Modes", High Speed Ground Transportation Journal, Volume IV:2.

1972 "Forecasting Remote Park & Ride Transit Usage", Preliminary Research Report No. 39, NYSDOT, December.

1973 "The Influence of Attitudinal and Situational Variables on Urban Mode Choice", Preliminary Research Report No. 41, NYSDOT, March (Ph D. Dissertation).

1973 "Design for Buffalo Home-Interview Travel Survey", Preliminary Research Report No. 47, NYSDOT, June.

1973 "Disaggregate Travel Demand Models for Special Context Planning: A Dissenting View", Transportation Research Board Special Report No. 143, TRB, Washington, DC (with Martin Wachs), 1974.

1973 "Forecasting Demand for Improved Quality Transit Surveys with Small-Sample Surveys", Preliminary Research Report No. 51, NYSDOT, November.

1973 "Variations in Reference Scale and Perception of Modal Attributes for Different Traveler Groups", Preliminary Research Report No. 55, NYSDOT, November.

1974 "Development of Intercity Travel Demand Models for NYS Urban Areas", Preliminary Research Report No. 58, NYSDOT, March, (with G.S. Cohen and R. Albertin).

1974 "A Systems-Level Planning Application of the Disaggregate Modeling Technique", Preliminary Research Report No. 62, NYSDOT, June, (with P.S. Liou and G.S. Cohen).

1974 "Design for the Genesee Transportation Study Travel Survey", Preliminary Research Report No. 64, July, NYSDOT.

1974 Position Bias in Transportation Opinion Questions", Preliminary Research Report No. 68, NYSDOT, August.

1974 "A Dynamic Model of Travel Mode-Switching Behavior", Transportation 3 (1974) 45-58.

1974 "Attitudinal and Situational Variables Influencing Urban Mode Choice: Some Empirical Findings", Transportation 3, (1974) 377-392.

1975 "1973 Buffalo Travel Survey: Design, Conduct, Processing", (Editor), Preliminary Research Report No. 82, NYSDOT, August.

1975 "Individual Travel Behavior Under Energy Constraints", Preliminary Research Report No. 86, NYSDOT, August.

1975 "Equity in New York State Transit Fares", Preliminary Research Report No. 93, NYSDOT, October (with D.L. Weiss and G.S. Cohen).

1975 "Disaggregate Access Mode and Station Choice Models for Rail Trips", Transportation Research Record No. 526, TRB, Washington, DC (with P.S. Liou and others).

1975 "Public Transportation Operating Assistance: Evaluation and Options - Summary Report", NYSDOT, February 1975 (submitted to the New York State Legislature (with C. Keck, et al)).

1975 "Issues for Implementating Disaggregate Travel Demand Models", (with P.S. Liou), in Stopher, P.R. and Meyburg, A.N. Behavioral Travel Demand Models, Lexington Press, 1976 (NYSDOT PRR 81).

1975 "Application of Disaggregate Mode Choice Models to Travel Demand Forecasting for Urban Transit Systems", Transportation Research Record No. 534, TRB, Washington, DC, p. 52-62, (with P.S. Liou and G.S. Cohen).

1975 "Transit Deficits: A Projection for New York State", Transportation Research Record No. 589, TRB, Washington, DC, (with S.M. Howe), 1976.

1975 "Energy Analysis for Urban Transportation Systems: A Preliminary Assessment", Transportation Research Record No. 599, TRB, Washington, DC, 1976.

1976 "Long Range Transportation Planning Under Energy Constraints: A Critical Review of Current Capacity", Transportation Research Record No. 592, TRB, Washington, DC.

1976 "Irondequoit-Wayne Expressway: Before-After Study Design", Preliminary Research Report No. 101, NYSDOT, June (with S.M. Howe).

1976 "Differential Time-of-Day Transit Fares: Revenue, Ridership & Equity", Transportation Research Record No. 625, TRB, Washington, DC, 1977 (with D.L. Weiss).

1976 "Analysis and Prediction of Non-Work Travel Patterns of the Elderly and Handicapped", Transportation Research Record No. 637, TRB, Washington, DC, (with S.M. Howe & M. Pasko), 1977.

1976 "Forecasting Dial-A-Bus Ridership in Small Urban Areas", Transportation Research Record No. 563, TRB, Washington, DC, p. 53-62, (with C.A. Keck).

1976 "Intercity Travel Demand Models: State-of-the-Art", Office of University Research, USDOT, (with G.S. Cohen).

1977 "Intercity Rail Patronage in NYC-Buffalo Corridor", Preliminary Research Report No. 115, NYSDOT (with G.S. Cohen and N.S. Erlbaum), April.

1977 "Cost-Effective Bus Transit Barrier Removal Policies for Elderly and Handicapped", Preliminary Research Report No. 118, NYSDOT (with D.L. Weiss) July.

1977 "Ridesharing Behavior: A Review of Recent Findings", paper presented at FHWA's FCP Meeting, Columbus, Ohio, November 8 (NYSDOT, PRR #130).

1977 "Automotive Energy Forecasts: Impact of Price, Availability and Efficiency", Preliminary Research Report No. 133, NYSDOT (with G.S. Cohen and N.S. Erlbaum), December.

1977 "Automotive Energy Forecasts: Impact of Carpooling, Trip Chaining, and Auto Ownership", Preliminary Research Report No. 134, NYSDOT, December (with N.S. Erlbaum and G.S. Cohen).

1977 "Incorporating Barrier Effects in Elderly and Handicapped Transit Demand Forecasts", Transportation Research Record No. 660, TRB, Washington, DC, 1978 (with R. Knighton).

1977 "Who Favors Work-Schedule Changes, and Why", Transportation Research Record No. 677, TRB, Washington, DC, 1978 (with A.A. Tannir).

1977 "Traffic Impacts of Work Schedule Changes in Medium-Sized Areas", Transportation Research Record No. 677, TRB, Washington, DC, 1978 (with A.A. Tannir).

1977 "Pedestrian Movement at the Ski Jump, 1980 Winter Olympics", Transportation Research Record No. 683, TRB, Washington, DC (with Peter L. Wolf), 1978.

1978 "Intercity Rail Travel Models", Transportation Research Record No. 673, TRB, Washington, DC (with G.S. Cohen and N.S. Erlbaum).

1978 "NYS Gasoline Use: Impact of Supply Restrictions and Embargoes", Preliminary Research Report No. 142, NYSDOT (with N.S. Erlbaum and G.S. Cohen), August.

1978 "Distance-Based Transit Fares: Robin Hood or Sheriff of Nottingham?" Preliminary Research Report No. 145, NYSDOT (with D. Ballou and L. Mohan).

1978 "Can Current Transportation Planning Methods Analyze Women's Travel Issues?", paper presented at the Conference on Women's Travel Issues, Washington, DC (Preliminary Research Report No. 149).

1978 "Foreign Oil Dependence: A State-Level Analysis", (with R. Margiotta and L. Reilly), Transportation Research Record No. 726, TRB, Washington, DC, 1979.

1978 "Transit's Role", Editorial for Transportation, 6:3.

1978 "Transportation Energy: An Overview with Emphasis on New York State", Transportation Research Record No.710, TRB, Washington, DC, 1979.

1978 "Behavioral Science Applications to Issues in Transportation Planning", in Richard M. Michaels, Transportation Planning and Decision Making: Behavioral Science Contributions, Praeger Press 1980.

1978 "Upstate New York's Response to the Mandates of the Clean Air Act." Transportation Research Record No. 714, TRB, Washington, DC, 1979 (with R. Zabinski and G.S. Cohen).

1979 Carpool Coordination Demonstration Study: Overview and Analysis of 'Before' Data", Preliminary Research Report No. 150, NYSDOT, March (with J.M. Brunso).

1979 "Toward a Leading Travel Indicator", Preliminary Research Report No. 154, NYSDOT June (with P. Koeppel).

1979 "Guidelines for Transportation Energy Contingency Plans", Preliminary Research Report No. 157, NYSDOT, May 1979 (with others).

1979 "A Note on Representing Multiple-Alternative Competition", Preliminary Research Report No. 166, NYSDOT, August (with others).

1979 "Behavioral Models in Transportation: Perspectives, Problems, Prospects", in David Bannister and Peter Hall, Transport and Public Policy Planning, Munsell Press (1981).

1979 "Family REACTions to Energy Constraints", (with S.P. Phifer and A.J. Neveu) Transportation Research Record No. 765, TRB, Washington, DC.

1979 "Energy Considerations in Transportation Planning: The New York State Approach", in State Energy Conservation Activities, FHWA report, June 1980.

1979 "Changes in Travel in Response to the 1979 Energy Crisis", (with others), Preliminary Research Report No. 170, NYSDOT, (November).

1980 "Traffic Adjustments from Energy, Economy and Population Changes", Preliminary Research Report No. 175, NYSDOT (with others).

1980 "Long-Range Forecasts of Transportation Energy Consumption in New York State", Transportation Research Record No. 764, TRB, Washington, DC (with N.S. Erlbaum).

1980 "Who Reads the Transportation Planning Literature?", Transportation Research Record No. 793, TRB, Washington DC, (with G.S. Cohen and F. McEvoy), 1981.

1980 "An Assessment of Games as Methods of Providing Information on Gasoline Conservation", Transportation Research Record No. 801, TRB, Washington, DC (1981) (with D. Cabrera).

1980 "Transportation Energy Impact Assessment: Current Capabilities and Future Needs", Preliminary Research Report No. 178, NYSDOT, July (with N.S. Erlbaum).

1980 "Procedures and Data Needs for Estimating Gasoline Use in Urban Areas", Preliminary Research Report No. 187, NYSDOT, July 1980 (with N.S. Erlbaum).

1980 "Research Design for the Neighborhood Ridesharing Demonstration Study", Preliminary Research Report No. 189, NYSDOT, 1980 (with J.M. Brunso and W.R. Ugolik).

1980 "Transportation Energy Contingencies: A Status Report on Public Response and Government Roles", Journal of Advanced Transportation, Spring, 1980.

1980 "The 1979 Energy Crisis - Who Conserved How Much" (with A.J. Neveu), paper presented at the National Energy Users Conference; San Antonio, April 1980 (published in Transportation Research Board Special Report 191, TRB, Washington, DC 1981).

1980 "Urban Passenger Strategies [for Transportation Energy Contingencies]", Workshop Summary, Transportation Research Board Special Report No. 191, TRB, Washington, DC, 1980.

1980 "What Will Happen to Travel in the Next 20 Years", Transportation Research Record No. 807, TRB, Washington, DC, 1981.

1980 "Issues for Developing State Transportation Energy Emergency Conservation Plans", (with R. Bixby and M. Kocis), Transportation Research Record No. 801, TRB, Washington, DC, 1981.

1981 "Transportation and the Behavioral Sciences", in Irwin Altman, Jack Wohlwill and Peter Everett, Transportation and Behavior, Plenum Press, 1981.

1981 "Transportation Energy Assessment for Local Governments" (with J.M. Gross and C.E. Meyers) Institute of Traffic Engineers Journal, 51:7, July, 1981.

1981 "Can Employer-Based Carpool Coordinators Increase Ridesharing", (with J.M. Brunso), Transportation Research Record No. 823, TRB, Washington, DC, 1981.

1981 "Energy Conservation in Transportation Systems Performance", International Symposium on Surface Transportation System Performance, U.S. Department of Transportation, May 11-13, 1981.

1981 "Transit Price and Service Variations", Workshop Summary, TSC Conference on Future Directions for Transit Pricing, 1981 (with L. Doxsey).

1981 "Analysis and Prediction of Highway Condition", Transportation Analysis Report No. 2, September, 1981, NYSDOT.

1981 "Visual Scales of Pavement Condition: Development, Validation, and Use", Transportation Research Record No. 893, TRB, Washington, DC, (with J. Shufon & F. Parella), 1982.

1981 "The Pavement Condition of N.Y.'s Highways: 1981", Transportation Analysis Report No. 4, 1981, December, 1981, NYSDOT.

1981 "Ridesharing Behavior and Marketing", summary of workshop, Transportation Research Board Special Report 193, TRB, Washington, DC, 1981.

1982 "Revised Procedures for Factoring Short Traffic Counts to AADT", Transportation Analysis Report No. 10, NYSDOT, July (with J. Lemmerman).

1982 "Equity Impacts of Gasoline Shortages and Price Rises", Transportation Analysis Report No. 20, NYSDOT, August (with J.M. Brunso and S. Kupferman).

1982 "Neighborhood Ridesharing Demonstration Study: Final Report" (with J.M. Brunso) U.S. Department of Transportation, March, 1982.

1982 "Statistical Controls in Ridesharing Demonstration Programs", Transportation Research Record No. 914, TRB, Washington, DC, (with J.M. Brunso).

1982 "Community Based Ridesharing: An Overlooked Option", Transportation Research Record No. 914, TRB, Washington, DC (with J.M. Brunso).

1982 "New York's Perspective on Transportation Energy Contingency Planning", paper presented at the Conference on Transportation Contingency Planning Purdue University, April 29-30, 1982 (Energy - The International Journal, August-September, 1983, p. 603-608).

1982 "Transportation Energy Contingency Planning" Editorial for Transportation, 11:2, August.

1982 "Streamlining the Collection and Processing of Traffic Count Statistics", (with J. Lemmerman) Transportation Research Record No. 928, TRB, Washington, DC, 1983.

1982 "Long-Term Prediction of Highway Condition", Transportation Research Record No. 940, TRB, Washington, DC, 1983.

1982 "Windshield Surveys of Pavement Condition: A Feasible Input to Pavement Management", (with J.J. Shufon), Transportation Research Record No. 938, TRB, Washington, DC, 1983.

1982 "Where Panels Work: Some Examples from Transportation Planning", paper presented at the World Conference on Transportation Research, Hamburg, Germany, April 1983.

1982 "The Pavement Condition of New York's Highways: 1982", report for NYSDOT, December, 1982.

1983 "Initial and Subsequent Consumer Response to Gasoline Shortages", (with J.M. Brunso and A.J. Neveu), paper presented at the Conference on Energy Contingency Planning in Urban Areas, Houston, Texas, April 7-9, 1983 (Published in Transportation Research Board Special Report 203, 1983).

1983 "Research And Risks: How to Beat the Odds", Transportation News, May-June, 1983.

1983 "Travel Analysis Methods for the 1980's: Executive Summary", Transportation Research Board Special Report 201, TRB, Washington, DC, 1983.

1983 "An Update on Household Trip Generation Rates" (with J.M. Brunso) Transportation Research Record No. 987, TRB, Washington, DC, 1984.

1983 "Status of Highway Condition Scoring in New York", Transportation Research Record 997, TRB, 1984.

1983 "Application of the Highway Condition Projection Model to Interstate I-4R Analysis", Transportation Research Record No. 955, TRB, Washington, DC, 1984.

1983 "Perception of the Infrastructure" (with A.J. Neveu) Transportation Analysis Report No. 34, NYSDOT, July 1987.

1983 "Characteristics of Double-Trailer Trucks in New York State", Transportation Research Record No. 966, TRB, Washington, DC, 1984.

1983 "The Pavement Condition of New York's Highways: 1983" Report to NYSDOT, October, 1983.

1984 "Testimony of LILCO's Evacuation Plan for Shoreham", prepared for the Nuclear Regulatory Commission (with others), March, 1984.

1984 "Consumer Trade-Offs between Mobility Maintenance and Gasoline Savings", Transportation Research Record No. 1049, TRB, Washington, DC, 1985 (with J.M. Brunso).

1984 "Concept Paper for an Infrastructure Data Base", NYSDOT, April, 1984.

1984 Incorporating Energy Analysis in TIP Process", report for FHWA, Washington, DC, 1984 (with others).

1984 "Uncertainty in Traffic Forecasts and Its Impact on Pavement Design", with A.J. Neveu, paper prepared for FHWA, February, 1984 (NYSDOT Transportation Analysis Report No. 49).

1984 "Eight States Join in Study of Pavement Performance", article for FOCUS, Newsletter of Strategic Highway Research Program, Nov.-Dec., 1984.

1984 "Government Roles in Transportation Energy Conservation", prepared for the ASCE meeting, August, 1984 (with N.S. Erlbaum).

1984 "Highway Information Resources Study" report for FHWA, Dec. 1984.

1985 "State Views of a State & Local Highway Program", paper for FHWA, March 1985.

1985 "Use of a Simplified Urban Traffic Forecasting Procedure for Project Analysis" with A.J. Neveu, paper presented at Conference on Microcomputers in Transportation, San Diego, June, 1985.

1985 "How Good is the Highway Performance Monitoring System?: Comparison with State Results", paper prepared for Conference on HPMS Analytical Process, July 16-18, Kansas City, MO (Published in Transportation Research Record No. 1060, TRB, Washington, DC, 1986).

1985 "The FHWA Highway Information Resources Study: Overview, Status, Direction", Transportation Research Record 1090, TRB, Washington, DC, 1986.

1985 "Emerging Trends in NYS Double-Trailer Traffic", with D.C. Fifield, Transportation Analysis Report No. 58, NYSDOT, 1985.

1985 "Network-level Pavement Condition Rating: Balancing Quality, Quantity and Timeliness", (with E. Herschenhorn), Transportation Research Record No. 1060, TRB, Washington, DC, 1986.

1986 "Integrating Highway Information: The New York Approach", presented at the FHWA File Linkage Conference, Salt Lake City, 1986.

1986 "Are Truck Weights Really Increasing?", paper submitted to the Transportation Research Board, Washington, DC.

1986 "A Strategy for Change", Draft report of the MIS Task Force, NYSDOT, 1986.

1986 "A Plan to Develop a Comprehensive MIS for NYSDOT", MIS Task Force, NYSDOT, December (with others).

1987 Testimony Before the Nuclear Regulatory Commission on Evacuation Plans for Shoreham Nuclear Power Station, April 1987.

1987 "Viewpoint on Activity Analysis", Remarks delivered at the Annual Meeting of TRB, January (in press, Transportation).

1987 "Policy Opportunities for Travel Behavior Analysis", paper prepared for the 5'th International Conference on Travel Behavior, Aix-En-Provence, France, October.

Professional Affiliations and Panels

Associate Editor, Transportation, 1975-Present.
Associate Editor, Journal of Advanced Transportation, 1974-1980.
Associate Editor, Newsletter of Association of Travel Behavior, 1985-Present.
Chairman, TRB Committee on Travel Behavior and Values (A1C04), 1977-1982.
Chairman, TRB Subcommittee on Statewide Information Systems, 1985-Present.
Chairman, Conference on Travel Analysis Methods for the 1980's, 1982.
Chairman, U.S. Committee on Fourth International Conference on Travel Behavior, 1979.
Chairman, NCHRP Panel on Fuel Supply Limitations on Travel (NCHRP 8-23), 1976-1978.
Chairman, NCHRP Panel on New Approaches on Travel Behavior (NCHRP 8-14), 1975-1980.
Chairman, NCHRP Panel on Transit Service for Disadvantaged (NCHRP 8-27), 1981-1983.
Secretary, TRB Executive Committee, Subcommittee on TRB Financing, 1976-77.
Member, TRB Committee on Passenger Travel Demand Forecasting, 1976-82.
Member, TRB Committee on Travel Behavior & Values, 1983-Present.
Member, TRB Committee on Energy, 1981-Present.
Member, TRB Committee on Information Systems, 1983-Present.
Member, TRB Committee on Public Transportation Planning & Development, 1975-77.
Member, ITE Committee on Energy Conservation, 1985-Present.
Member, NCHRP Panel on Peak Period Traffic Congestion (NCHRP 7-10), 1974-79.
Member, Advisory Panel, Collection of a Disaggregate Data Set, 1975-78.
Member, Advisory Panel, Alternative Roles of the Automobile, 1975-76.
Member, Advisory Panel, Second Conference on Travel Behavior, 1975.
Member, Advisory Panel, Conference on Behavioral Applications to Travel, 1978.
Member, Advisory Panel, Conference on Urban Transportation Planning in the 1980's, 1981.
Member, Advisory Panel, Conference on Transportation Energy Contingency Planning, 1983.
Member, Advisory Panel, 1985 Conference on Travel Behavior.
Member, Advisory Panel, 1987 Conference on Transportation Applications.
Principal Reviewer, National Academy of Sciences.
Who's Who in the East, 1974-Present.
Who's Who in Government, 1977-Present.
Charter Member, International Association for Travel Behavior, 1985.
American Public Works Association

ATTACHMENT 2

REV. 3 NETWORK AND DESIRE LINES

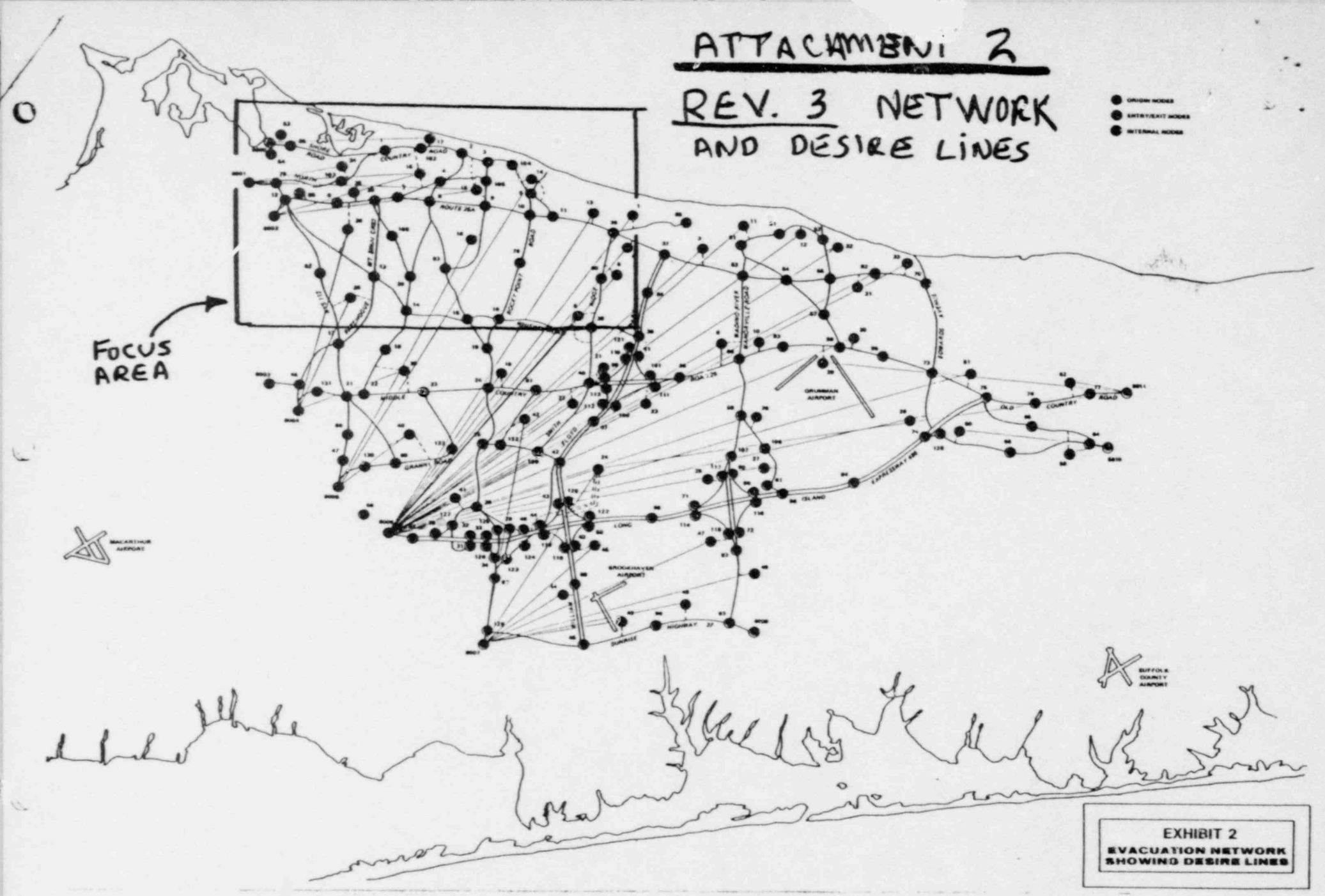


EXHIBIT 2
EVACUATION NETWORK
SHOWING DESIRE LINES

ATTACHMENT 3

REV. 5. NETWORK AND DESIRE LINES

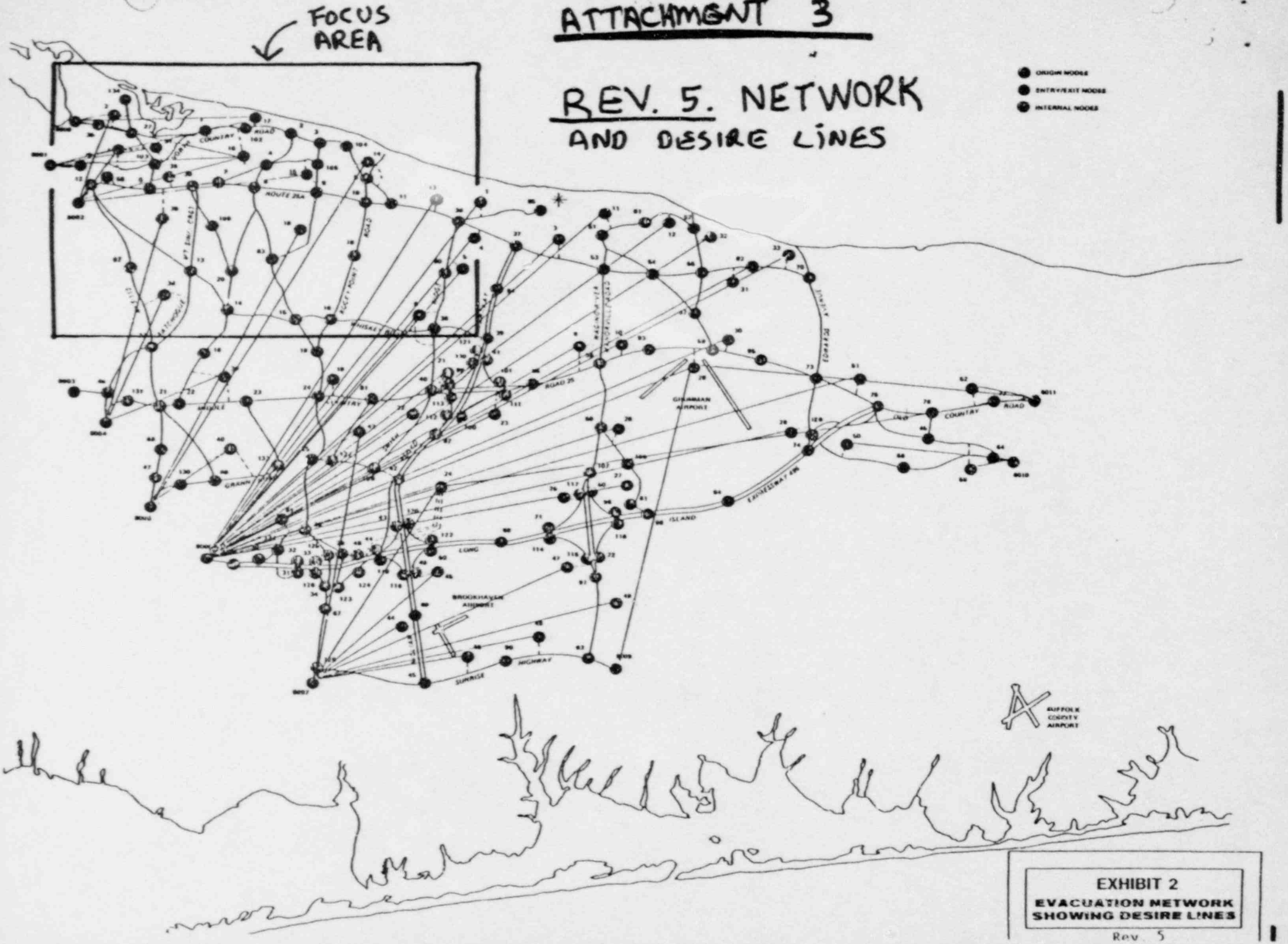
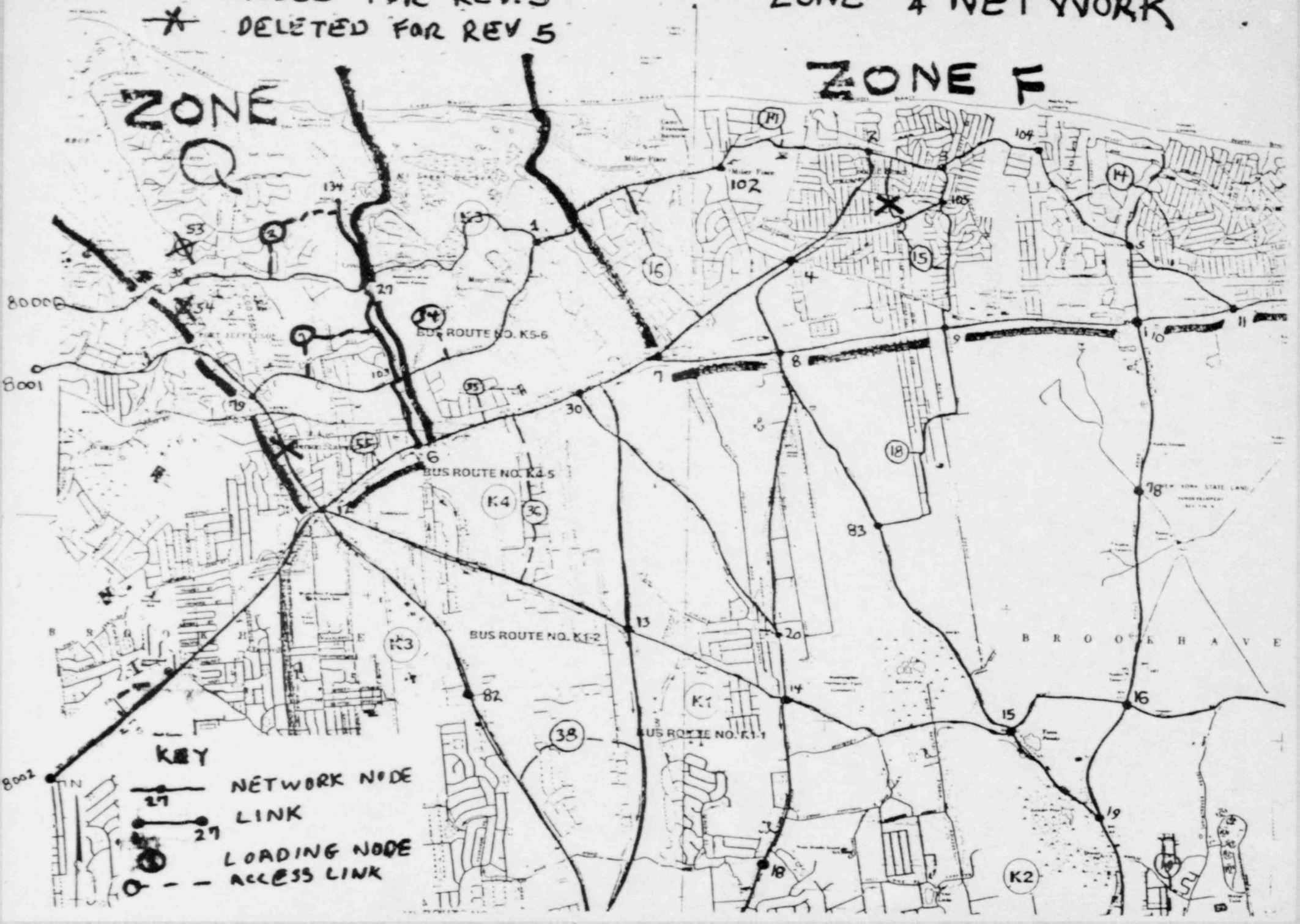


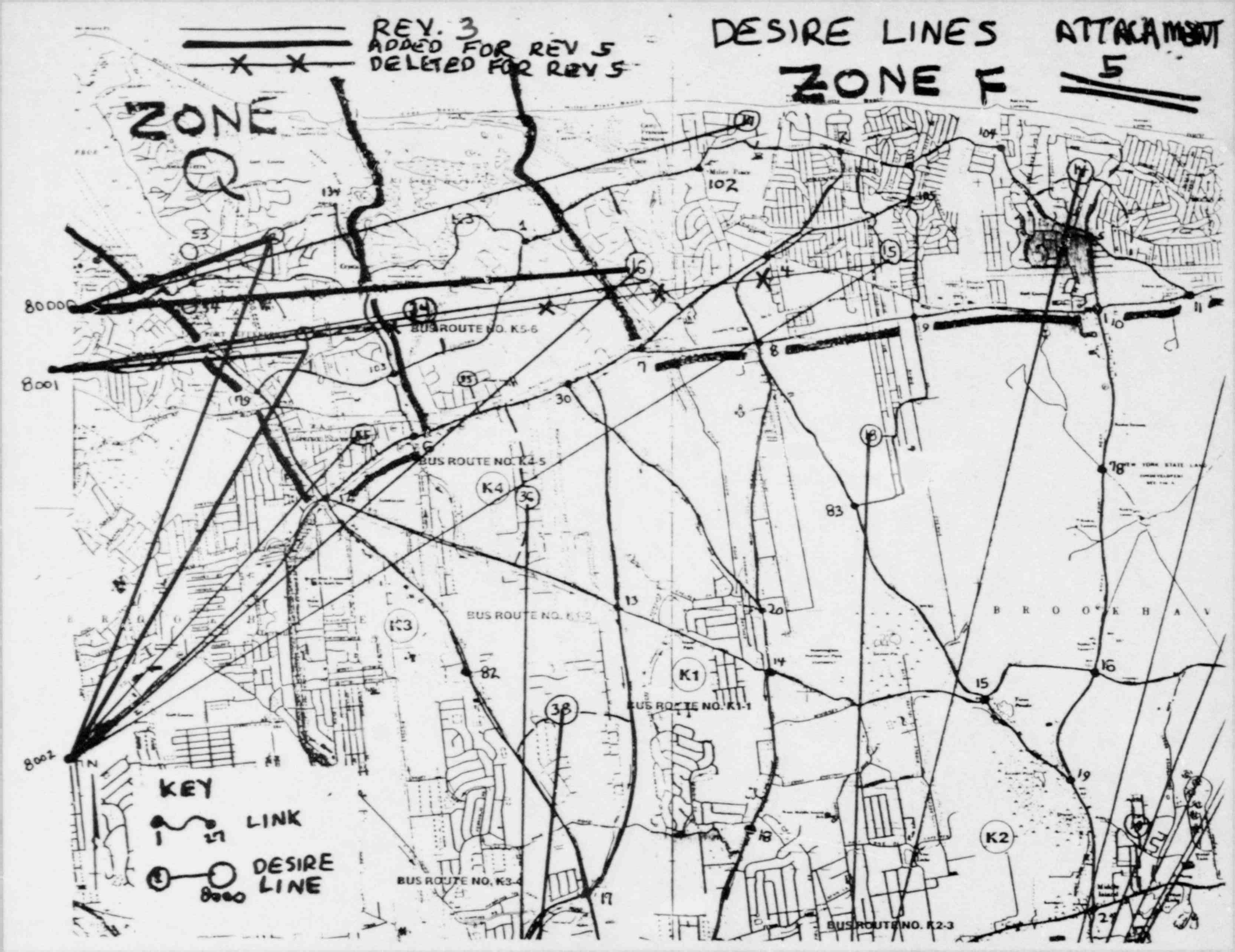
EXHIBIT 2
EVACUATION NETWORK SHOWING DESIRE LINES
Rev. 5

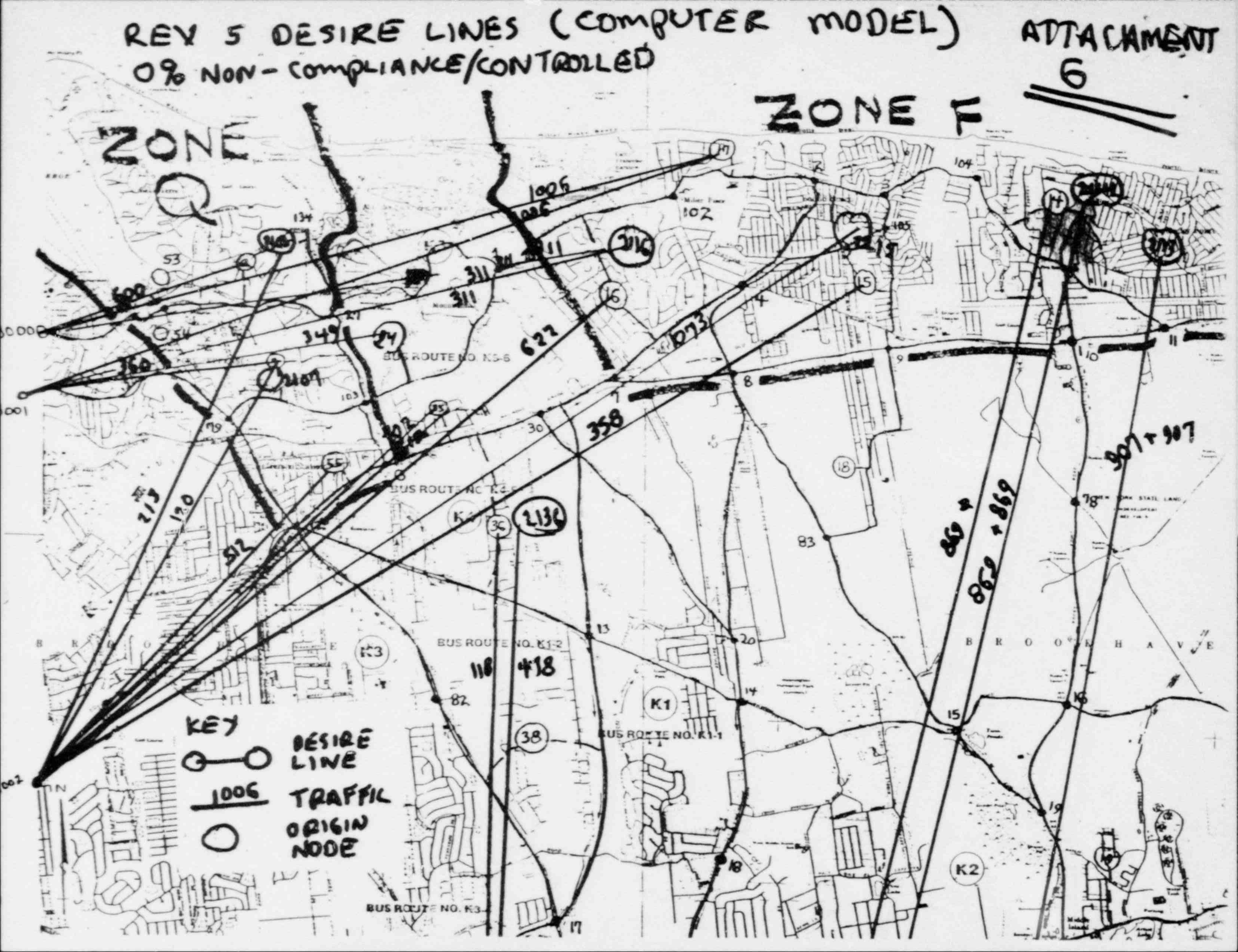
ATTACHMENT 4
ZONE & NETWORK

ADDED FOR REV. 5

DELETED FOR REV 5




REV. 3
ADDED FOR REV 5
DELETED FOR REV 5
DESIRE LINES
ATTACHMENT 5
ZONE F
ZONE Q
80000
8001
8002
BUS ROUTE NO. K5-6
BUS ROUTE NO. K4-5
BUS ROUTE NO. K1-2
BUS ROUTE NO. K1-1
BUS ROUTE NO. K3-4
BUS ROUTE NO. K2-3
K1
K2
K3
K4
BROOKHAVEN
KEY
LINK
DESIRE LINE

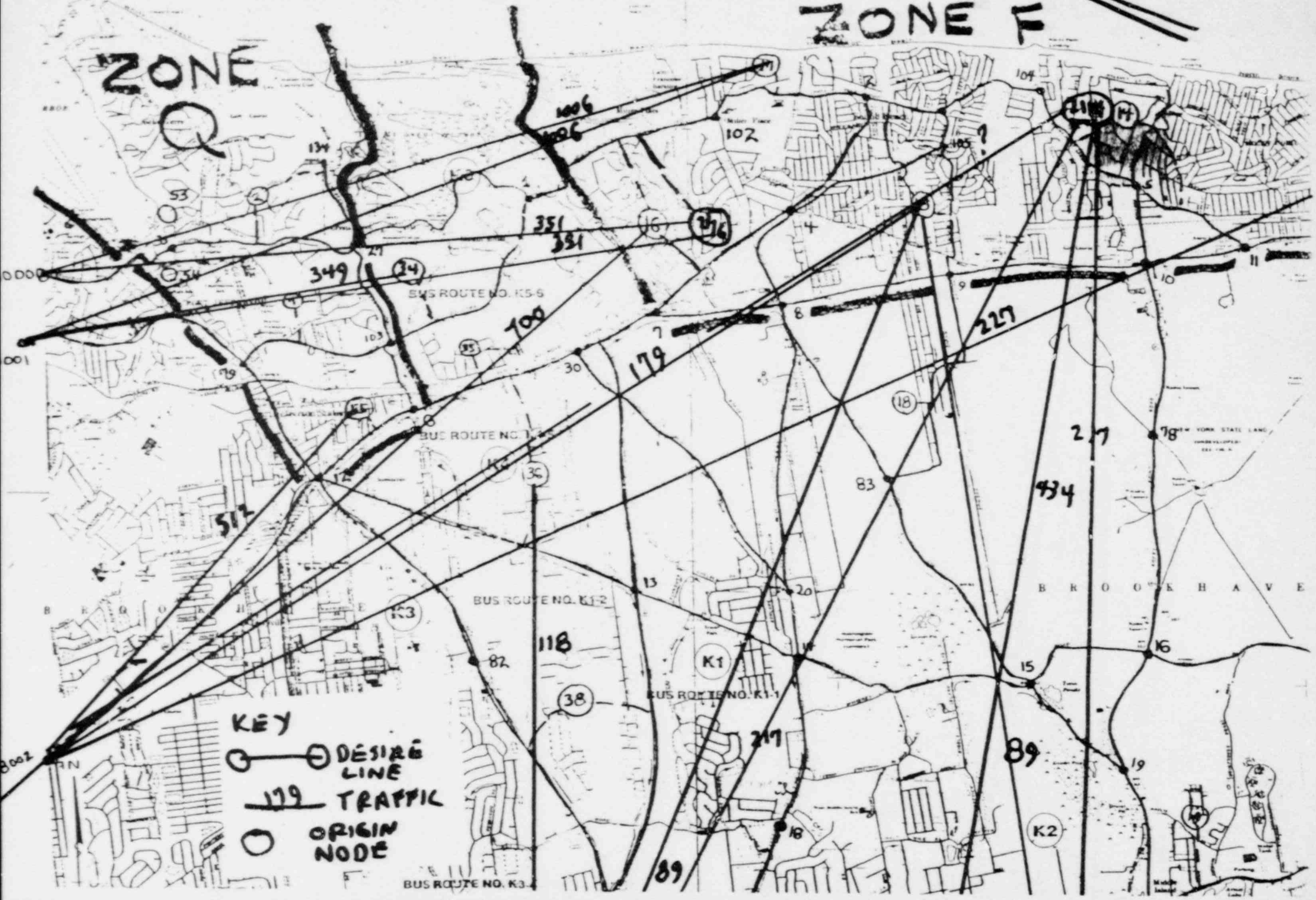


REV 5 DESIRE LINES (COMPUTER MODEL)
0% NON-COMPLIANCE/CONTROLLED
ATTACHMENT
6
ZONE F
ZONE Q
1006
311
349
622
1073
358
2136
118
418
512
213
120
869 + 869
907 + 907
BUS ROUTE NO. K5-6
BUS ROUTE NO. K1-2
BUS ROUTE NO. K1-1
BUS ROUTE NO. K3
K1
K2
K3
B R O O K H A V E
KEY
DESIRE LINE
1006 TRAFFIC
ORIGIN NODE

REV 5 DESIRE LINES (COMPUTER MODEL)

50% NON-COMPLIANCE/UNCONTROLLED

ATTACHMENT 7



ATTACHMENT 8
COMPARISON OF LILCO ASSIGNMENTS

Loadings/O.D. Pattern		--------Number of Vehicles---------- 40 A & B 0% Non-Compliance/ Controlled	TU50/E9 50% Non-Compliance/ Uncontrolled
	2002-8000	600	Not present
Load	2102-8002	213	"
Node	2007-8001	360	"
2,7	2107-8002	120	"
55	2055-8002	512	512
		1805	512
Node	2034-8001	349	349
34,35	2035-8002	702	702
Node	2014-8005	869	Not present
14	2114-8055	869	434
		1738	2114-8004 217
			2114-8005 217
			868
Node	2015-8002	358	179
15	2115-8002	1073	2015-8004 89
		1431	2015-8006 89
			257
Node	2016-8002	622	700
16	2116-8001	311	351
	2116-8000	311	351
		1244	1402
Node	2017-8000	1006	1006
17	2017-8001	1006	1006
Link Volumes			
Crystal	(134, 27)	207	208
Bk	(27, 103)	486	Not listed
Hollow	(103, 6)	611	679
Old Post	(102, 1)	2966	2960
	(1, 27)	1709	1932
	(27, 35)	1911	Not listed
North	(1, 103)	1920	Not listed
Country	(103, 79)	2276	2081
Rt. 25A	(30, 6)	2176	Not listed
	(6, 12)	3541	Not listed

DATE: May 12, 1988

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	
LONG ISLAND LIGHTING COMPANY	Docket No. 50-322-OL-3 (Emergency Planning)
(Shoreham Nuclear Power Station Unit 1)	

CERTIFICATE OF SERVICE

I hereby certify that copies of the "Direct Testimony of David T. Hartgen, Ph.D., P.E., on Behalf of the State of New York Regarding Immateriality Issues," have been served on the following this 12th day of May 1988 by U.S. Mail, first class, except as noted by asterisks.

Mr. Frederick J. Shon**
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Spence W. Perry, Esq.**
William R. Cumming, Esq.
Office of General Counsel,
Federal Emergency Management Agency
500 C Street, S.W., Room 840
Washington, D.C. 20472

Dr. Jerry R. Kline**
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Mr. James P. Gleason, Chairman**
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Anthony F. Earley, Jr., Esq.
General Counsel
Long Island Lighting Company
175 East Old Country Road
Hicksville, New York 11801

Ms. Elisabeth Taibbi
Clerk
Suffolk County Legislature
Suffolk County Legislature
Office Building
Veterans Memorial Highway
Hauppauge, New York 11788

Mr. L.F. Britt
Long Island Lighting Company
Shoreham Nuclear Power Station
North Country Road
Wading River, New York 11792

Ms. Nora Bredes
Executive Director
Shoreham Opponents Coalition
195 East Main Street
Smithtown, New York 11787

Adrian Johnson, Esq.
New York State Department of Law
120 Broadway, 3rd Floor
Room 3-16
New York, New York 10271

MHB Technical Associates
1723 Hamilton Avenue
Suite K
San Jose, California 95125

E. Thomas Boyle
Suffolk County Attorney
Building 158 North County Complex
Veterans Memorial Highway
Hauppauge, New York 11788

Mr. Jay Dunkleburger
New York State Energy Office
Agency Building #2
Empire State Plaza
Albany, New York 12223

Joel Blau, Esq.
Director, Utility Intervention
N.Y. Consumer Protection Board
Suite 1020
Albany, New York 12210

Mr. Donald P. Irwin**
Hunton & Williams
707 East Main Street
P.O. Box 1535
Richmond, Virginia 23212

Stephen B. Latham, Esq.
Twomey, Latham & Shea
33 West Second Street
Riverhead, New York 11901

Docketing and Service Section
Office of the Secretary
U.S. Nuclear Regulatory Commission
1717 H Street, N.W.
Washington, D.C. 20555

Hon. Patrick G. Halpin
Suffolk County Executive
H. Lee Dennison Building
Veterans Memorial Highway
Hauppauge, New York 11788

Dr. Monroe Schneider
North Shore Committee
P.O. Box 231
Wading River, New York 11792

Lawrence Coe Lanpher, Esq.**
Kirpatrick & Lockhart
1800 M Street, N.W.
South Lobby - Ninth Floor
Washington, D.C. 20036

Edwin J. Reis**
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Mr. James P. Gleason
Chairman
Atomic Safety and Licensing Board
513 Gilmoure Drive
Silver Spring, MD 20901

David A. Brownlee, Esq.
Kirkpatrick & Lockhart
1500 Oliver Building
Pittsburgh, Pennsylvania 15222

Mr. Stuart Diamond
Business/Financial
NEW YORK TIMES
229 W. 43rd Street
New York, New York 10036

Douglas J. Hynes
Town Board of Oyster Bay
Town Hall
Oyster Bay, New York 11771

Mr. Philip McIntrie
FEMA
26 Federal Plaza
New York, New York 10278

Adjuicatory File
Atomic Safety and Licensing
Board Panel Docket
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Richard J. Zahnleuter, Esq.
Deputy Special Counsel to
the Governor
Executive Chamber
Capitol, Room 229
Albany, New York 12224
(518) 474-1273

* By Telecopier also

** By Federal Express