AN APPLICATION OF DISCRIMINANT ANALYSIS TO DETERMINE THE DEMAND FOR INDUSTRIAL FLOOD PLAIN LOCATION

A Report Submitted to the:
U. S. Army Engineer Institute for Water Resources
Kingman Building
Fort Belvoir, Virginia 22060

by
University of Missouri (St. Louis)

Under Contract No. DACW73-73-C-0044

DECEMBER 1974 IWR PAPER 74-P8

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This study was undertaken to accumulate more information about the factors which motivate firms to locate on a flood plain. The objectives were twofold: to gather data on the characteristics of industrial and commercial establishments in the St. Louis region, and to analyze these data to determine any statistical differences between those establishments located on the flood plain and those located off the flood plain.

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SUMMARY

The purpose of this study was to identify the factors which motivate firms to locate on flood plains. This objective was accomplished by gathering data on the characteristics of manufacturing and commercial establishments in the St. Louis area and analyzing these data to determine and quantify any statistical differences between firms located both on and off flood plains. The research effort may be divided into four major phases: data collection, isolation of potential classification variables, determination of appropriate functions to classify a given firm as either on or off the flood plain, and simulation of these functions to determine the effect of flood risk on location decisions.

Three hundred firms were interviewed during the data collection phase of the study, and information such as annual dollar sales, annual total shipping cost, employee cost, and square footage of the site were obtained. A total of forty-two items is included in the final data base.

A list of potential candidates to be classification variables was next developed, using the statistical technique of factor analysis. Of the original forty-two variables collected, thirty-one were selected to be possible for inclusion in the classification functions.

This set of thirty-one was then reduced to six for manufacturing firms, and four for commercial by applying the technique of discriminant analysis to the data of the candidate variables. This final set of classification variables, which includes flood risk, constitutes the arguments of the classification functions generated by the discriminant analysis technique for the manufacturing and commercial observations available.

Simulation of these functions to study the effect of flood hazard on location decisions was accomplished by varying the values of the flood risk variable and observing how the functions then classify on flood plain observations as off, and vice versa. The flood risk variable is the frequency of flooding in years to which a particular flood-prone firm is susceptible. By increasing the flood frequency, thus decreasing the flood risk, the functions developed by discriminant analysis should classify currently-located on flood plain firms as off flood plain. By comparing the number and type (by flood frequency) of firms misclassified as the flood risk level is varied, the effect of flood risk on location may be found.

INTRODUCTION

This study was implemented to accumulate more information about the factors which motivate firms to locate on a flood plain. The objectives were twofold: to gather data on the characteristics of industrial and commercial establishments in the St. Louis region and to analyze these data to determine any statistical differences between those establishments located on the flood plain and those located off the flood plain.

The procedures and techniques used in the research were based upon a similar study on coal shipments in the upper Ohio River region, "An Application of Discriminant Analysis to the Division of Traffic Between Transport Modes" (4). For this project, observations of several variables, e.g., annual tonnage, travel time and cost of shipment were gathered; discriminant analysis was used as a statistical tool to classify observations into one of two populations; and finally, a demand function was developed for waterway transportation. The success of this project prompted the initiation of the research described in this report.

DATA COLLECTION PROCEDURE

The procedures developed and implemented to gather the requisite data for the analysis may be divided into three segments:

A. Determination of the flood plains in the survey area.
B. Mechanical processes of data collection.
C. Computer data management and software system.

A. Determination of the flood plains in the survey area. The delineation of the flood plains, defined to be of a maximum one-hundred year frequency, was developed in conjunction with the St. Louis District Corps of Engineers. The determination of specific flood hazard areas was based upon hydrologic data applied to recent topographic maps. A portion of East St. Louis and Granite City, Illinois was also examined for flood plain extent but, upon field investigation, it was found that there was insufficient occupancy on these flood plains to merit further consideration.

B. Mechanical process of data collection. The rationale for the data collection processes which were developed and implemented was based upon the fact that part of the information sought from the firms to be included in the survey was sensitive and could best be obtained through personal interviews. A list of establishments located on the flood plain was generated with their SIC (Standard Industrial Classification) code. These SIC codes were used to generate a matching list of firms located off the flood plain.

Initial contact with the firms selected was by means of an introductory letter. The letter was followed within a few days by a telephone call arranging an appointment with the appropriate person at the company. Thus the data collection process consisted of four parts: building an inventory of on-off firms to be contacted, constructing an effective letter of introduction to be mailed to the manager or officer of the selected companies, designing the questionnaire to be used during the interview, and training the field personnel who would perform the interviews.

The list of industrial and commercial establishments located on the flood plain was obtained through surveys of the areas designated. The name, address, and specific business of the firm was collected. To this information was added the telephone number, SIC code, and zip code (to be used in scheduling appointments). A corresponding list, matched by SIC code, was then generated for off flood plain industrial and commercial firms using various directories for the St. Louis region. The complete inventory of companies to be sampled was kept on index cards, one card per company, containing name, address, flood plain designation, SIC code, zip code, telephone number, and the name of the addressee (obtained by telephone inquiry of the firm).

The introductory letter was composed during the early stages of the survey so that it could be tested for effectiveness. The original version was found to be too long and too explicit. The letter was then revised to its present form, as shown in Exhibit A.

The questionnaire used during the interviews was revised several times before reaching its final form as shown in Exhibit B. The development of the questionnaire entailed the simultaneous solution of two problems: what information was to be collected, and how to extract it from the interviewee. The original list of items sought was revised only once, to include both book and insurance dollar valuations on contents and/or inventory in the building, and whether the firm was the original occupant of the site. The major effort was directed to the order in which the questions were asked and the specific phrasing of the more sensitive inquiries. Initial responses reported by the field personnel were especially helpful in developing the final version.

A few comments on some parts of the questionnaire are in order, since some of the items are not self-explanatory. Items 5, 6, 8, 9, 10, and the "cost" part of 7 are in dollar figures. Item 7 was tailored to manufacturing or commercial categories because of the difference in accounting for indirect employees. Item 8 represents an attempt to attach a dollar figure to represent the size of the site. Not all categories in this item will have entries per interview. For example, if a firm owns the land it occupies, it will neither lease nor rent the site. If the firm rents or leases, there should be no tax information available. Dollar values on any rent or lease item refer to the annual amount paid. Dollar values on the ownership items refer to market or replacement value.

Graduate students were employed to perform the actual interviews, and undergraduate students were used to make the telephone calls to obtain and schedule the interviews.

The graduate students were coached on the questionnaire, and trained to effectively obtain the data without introducing statistical bias. This was done by avoiding reference to flood plain location until the interview was nearly complete. All the interviewers were rehearsed to give complete assurance of the confidentiality of the data.

The telephone solicitors were also trained and provided with a script to recite when arranging appointments. In addition to obtaining appointments, the solicitors also had the responsibility of scheduling interviews within a time-geographic constraint to enable the interviewers to make the maximum number of calls per day.

C. Computer data management and software system. The information on the completed interview forms, and that on the corresponding index card for the firms, was coded on special forms and keypunched. Data management consisted of updating the master disk file, sorting this file, and creating subfiles for analytical computer runs. The Statistical Analysis System developed by North Carolina State University was used exclusively for this purpose. In addition, several Fortran interface programs were written to allow SAS-created subfiles to be accessed by the Biomedical Discriminant Analysis computer programs.

COMPOSITION OF DATA BASE

The information contained in the completed data base is shown in Exhibit C. The addresses of industrial and commercial establishments located on flood plains were supplied to the St. Louis District Corps of Engineers, who field checked the specific locations and attached to each the appropriate flood frequency in years. This variable can assume the values of 10, 25, 50 and 100 years.

The distribution and sample sizes are shown below:

	On Flood Plains	Off Flood Plains	Totals
Manufacturing	107	93	200
Commercial	49	52	101
Totals	156	145	301

A further breakdown by two-digit SIC code and flood plain designation may be found in Table 1. As this table indicates, the match by SIC between on and off flood plains is reasonably close. An exact one-to-one correspondence could not be obtained because of the geographic restrictions on the survey area. Once a category had been exhausted from the on flood plain inventory of firms, it could not be replaced. In other cases, there were no like-category firms off flood plains willing to participate. Finally, the presence of some off flood plain categories not matched is due to the fact that the off flood plain firms were interviewed simultaneously with on flood plain and the particular on flood plain establishment that generated an SIC category might later refuse to be interviewed, while the corresponding off flood plain interview has already been obtained.

As a point of interest, the companies from the pool that were not interviewed were classified by reason for their non-participation and aggregated. About nine hundred firms collected in the total inventory were not interviewed; over fifty percent simply refused, and six percent were found to be branch offices where no data were available. Over fifty-eight percent of the rejections were from off flood plain establishments. A more detailed statistical breakdown of the non-contributory companies may be found in Table 2.

The data were examined and initial statistical analyses performed preparatory to the discriminant analysis phase of the study. The result of this preliminary effort was to produce a subset of the variables which would subsequently be used for further analysis. This list of the major variables constitutes Exhibit D. The variables not included in this subset were eliminated in every instance because very few or no observations had values for them.

A punched card copy of the complete data base accompanies this report. The format for these cards may be found in Exhibit E.

STATISTICAL METHODOLOGY

The objectives of the statistical analysis phase of the study were to determine any significant differences between manufacturing and commercial establishments with respect to their location on or off the flood plain, and to quantify the differences by discriminant analysis. Further, the demand for flood plain location was to be estimated by simulating over the discriminant functions developed by varying the values of the flood frequency variable, and tracing the resultant misclassification of firms from on to off flood plain, and from off to on flood plain.

The analysis was begun with several sets of factor analysis, applied to selected subsets of the data. Factor analysis is a technique used to reduce the number of variables needed to characterize statistically a population. This reduction process is accomplished by the creation of surrogate variables or factors. The number of factors generated depends on how many are needed to capture the information represented by the original variables in aggregate and, in general, is considerably less than the number of original variables.

For this study, factor analysis was applied to yield a preliminary set of variables which might be used in the discriminant analysis phase of the research. The data were segmented into three categories, on flood plain, off flood plain and on-off flood plain combined, for both manufacturing and commercial establishments. Factor analysis was applied to each of the six data subsets described above and the results are displayed in Tables 3 through 8. Table 3 contains the factors for the on-off flood plain observations for manufacturing establishments, i.e., all manufacturing establishments. Six factors were developed for this data subset and the numbers indicate which variables constitute the specific factors. The largest number (absolute value) in each row identifies the factor for the variable. Thus, the variables DLR-SALE, OPR-CST, and SHIP-TOT are combined into factor 1 for all manufacturing firms. Similarly, the factors for the other subsets are contained in Tables 4 through 8.

Since the assumption underlying the research project was that the values for the variables for flood plain establishments would differ from the values for off flood plain firms, the results of the factor analysis were used as follows. Those variables which did not fall into a common factor under each subset, on, off, and combined, were considered as potential contributors to the discriminant analysis. For example, the industrial park code and length of occupancy constitute a factor in Tables 3, 4 and 5; consequently, these variables were dropped from further consideration. On the other hand, occupancy constitutes a factor by itself in Tables 3 and 4 but is combined with five others in Table 5. The difference between the on flood plain and off flood plain factors suggests that occupancy should be inserted into the discriminant analysis. For the commercial observations, comparing Tables 7 and 8, it may be observed that dollar sales, operating cost, and employee cost might reflect the difference between on and off flood plain locations.

That there is a difference between the on-off observations from either manufacturing or commercial firms can be seen from the number of factors representing the different populations. For manufacturing, seven factors are required for on flood plain, five factors for off. For commercial, only one factor was generated for the on observations, while two were needed for the off flood plains.

The results of the factor analysis indicated that the variables relating to building and inventory would be reasonable candidates for discriminant function variables; however, many of the observations for these variables were missing (either due to the nature of the variable or to the unwillingness of the establishment to provide the information). The resolution of this problem was to create two surrogate variables, as shown in Exhibit D. The building surrogate was defined to be the maximum of the dollar value of the building if owned, the insurance value, or the book or insurance valuation on the contents/ inventory.

The results of the factor analysis yielded a reduced set of variables as potential candidates for the discriminant analysis phase of the research. These variables were: square footage under roof, original occupancy code, building and inventory surrogates, length of occupancy, employee cost, shipping costs, and annual dollar sales.

The next stage was to apply discriminant analysis to attempt to quantify the difference in characteristics between on and off flood plain observations for both manufacturing and commercial firms. The discriminant analysis technique may be applied to any number of populations, assumed to be different from each other on the basis of some qualitative aspect. In this study there are two populations: on and off the flood plain.

The purpose of applying the technique is to statistically generate one linear function of the criterion variables for each population which will represent the properties of that population. Given the appropriate pair of functions, an observation may then be classified as on-off by evaluating both functions at the values of the criterion variables of the observation. The observation is then assigned to that population whose corresponding function has the greater absolute value.

For this study, the actual statistical analysis was produced by the Bio-Medical computer programs written at the University of California at Los Angeles. Initial computer runs of the discriminant analysis programs on the original data yielded cross-product matrices whose elements exceeded the field size allowed. In addition to being unable to obtain readable output, these extremely large numbers prevented inversion of the dispersion matrix; consequently, many of the variables were scaled by dividing by appropriate constants. The (scaled) values of the variables that were used for a series of various discriminant analysis runs are shown in Tables 10 - 13, while Table 9 contains the scale factors used for those variables so indicated.

In addition to variable scaling, the nature of the data base dictated another slight modification. Due to non-response, unavailability or other reasons, some observations for variables were missing. This problem was sclved by deleting from the analysis those manufacturing or commercial establishments whose number for employee cost, operating cost, or dollar sales was missing. Also for manufacturing only, the values for the building and inventory surrogates were required to be non-zero. These deletions led to varying sample sizes for the discriminant analysis runs.

Discriminant analysis was undertaken to develop functions for manufacturing establishments both on and off flood plains and for commercial establishments both on and off flood plains.

The most significant set of discriminant functions produced is displayed in Table 14. As may be observed from the Chi-Square values obtained, these functions are highly significant for both manufacturing and commercial firms. To reinforce these results, a stepwise discriminant analysis was performed employing all the variables listed in Tables 10 - 13. The statistical tests indicated that a more significant function could be obtained by replacing dollar sales with total shipping costs. This was attempted, and the resulting functions for both manufacturing and commercial were slightly more significant, but the classification was not as good as that for the functions in Table 14.

The various discriminant functions developed for the manufacturing and commercial establishments each indicated the importance of the variable, original occupancy, in the analysis. Because this variable may take one of only two values, it was decided that its inclusion may introduce an element of statistical bias. The variable was replaced by total shipping cost, to form the discriminant functions to be used in the simulations. These functions are shown in Table 15. The functions for manufacturing are significant at the 95% level; those for commercial are significant at the 99% level.

Table 16 contains the discriminant functions actually used in the simulations. For these simulations flood frequency was added as a variable, with those observations designated as off flood plains arbitrarily assigned a flood frequency value of 200 years. This value was deemed large enough for discriminating properly, but not so large as to cause numerical difficulties.

The rationale for simulating over these discriminant functions by varying the values of the flood frequency is to determine the effect of flood risk on location decisions. As the flood frequency is increased, thus decreasing the risk to the firms located on flood plains, the discriminant functions should misclassify these firms as off flood plain. Similarly, if flood frequency for the off flood plain firms is decreased, thus increasing the flood risk to these companies, the discriminant functions should misclassify these as on flood plain.

A total of four simulation runs was obtained, decreasing and increasing the flood risk to both manufacturing and commercial firms. The initial, correct classifications when the discriminant functions are applied to the original data are shown below.

Manufacturing		
	On	Off
On	50	0
Off	0	49

Commercial		
	On	Off
On	48	0
Off	0	50

A summary of the four simulations is shown in Table 17. For either manufacturing or commercial observations, the results labeled as "decrease risk" represent increasing the flood frequency of the on flood plain firms from their current values to a maximum of 200 years, in 30-year increments. The results labeled "increase risk" represent decreasing the flood frequency of the off flood plain firms from their artificial level of 200 years down to ten years, in decrements of 30 years. The "number changed" column reflects the number of firms subsequently misclassified as a result of a risk level change.

Examination of these simulation results appears to substantiate the difference in characteristics between on and off flood plain firms. For example, for either manufacturing or commercial firms, those located off flood plains are classified as on when the flood frequency drops to 140 years. Those firms located on flood plains, however, are not classified as off until the flood frequency is at least as high as 190 years for manufacturing and 160 years for commercial.

Tables 18 - 21 contain the detailed breakdown of the four simulations, consisting of the classification matrix for each level of risk change, the list of observation numbers misclassified and their corresponding SIC codes, and a tabulation of those misclassified by their original flood frequency values.

These tabulations may be used to develop some locational traits between manufacturing and commercial firms with respect to flood risk.

For example, observe the difference between manufacturing and commercial as to when the first misclassification of selected flood frequencies occurs. For manufacturing, the first 50 year missed is at a simulated value of 140, the first 50 year missed for commercial is a simulated value of 110, a difference of 30 years. This pattern may be seen to continue for the first 25 year missed, and the first 10 year missed.

It is apparent that the simulation approach using discriminant analysis, as attempted and illustrated by this project, is a promising area of research. To continue, however, requires understanding of the nature of the flood hazard data needed for effective analysis, and the flood frequency data obtained.

Since the discriminant analysis technique is designed to separate populations, based on the separate data of each, attributing consistently distinct values of a variable to one population will nullify latent differences embodied in the other variables; i.e: cause perfect but not necessarily existent classification. The use of appropriate, not automatically discriminatory, flood hazard data should enable useful results to be obtained with the statistical procedures presented here.

CONCLUSIONS

The principal finding of the research effort is that there is significant statistical difference between both manufacturing and commercial firms located on flood plains and those located off the flood plain. Further, the classification functions developed significantly classify on flood plain observations as on, and off flood plain observations as off. The techniques used to develop the set of criterion variables, the classification functions, and the simulation to produce the effects of flood hazard are well worth further research effort. The difficulty encountered during the simulation phase of this study was due to the nature of the flood risk data. By attempting to quantify flood hazard by the use of flood frequencies, an arbitrary but constant characteristic was required to be imposed on the off flood plain observations. This resulted in perfect, but not necessarily existent, classification regardless of the other variables which were included as the arguments of the functions.

SUGGESTIONS FOR FUTURE RESEARCH

The procedures and techniques used in this project should provide meaningful simulations for the study of flood risk in location decisions. However, it must be observed that quantification of the flood hazard variable should be such that automatic discrimination between on and off flood plains is avoided.

APPENDIX A

LIST OF EXHIBITS

EXHIBIT A

INTRODUCTORY LETTER

X
X
X
X

Dear

In the coming weeks the School of Business Administration, University of Missouri-St. Louis will conduct a research project for the United States Army Corps of Engineers. This project is designed to study the factors underlying the demand for industrial and commercial land in metropolitan areas.

Your firm has been selected randomly to participate in our project. The number of firms included in our sample is small, and your help is essential if the project is to be completed successfully.

Within the next few days we will contact your office to arrange an appointment with you or your representative for a fifteen-minute interview to gather the following information: annual dollar sales volume, tangible assets (insurance valuation) within broad ranges, and the following percentages of total operating costs: direct labor, transportation (by mode), state and local property taxes, and rent if applicable.

The University of Missouri-St. Louis and the Corps of Engineers appreciate your cooperation in this research activity, and assure you that all information acquired will be held in the strictest confidence and used only for statistical purposes.

Sincerely,

Andre B. Corbeau
Assistant Professor
Management Science

ABC:lml

EXHIBIT B
QUESTIONNAIRE

1. Length of occupancy _____ years.

2. Original occupant yes __ no __

(Not asked) 3. Industrial Park __

Shopping Center __

Office Building __

Other _______________

4. Sq. footage under roof (ground area if multi-storied)____

Site Acreage _________________

5. Annual sales volume _______________

6. Total Annual Operating Cost _______________
(Sales Minus Profit)

Shipping Cost-total ________________ Truck__________

Rail __________

Water__________

Air __________

7. Employees

	MFG. NUMBER	MFG. COST		COMM. NUMBER	COMM. COST
Total	______	____	Total	______	____
Direct	______	____	Sales	______	____
Indirect	______	____	Admin.	______	____
			Indirect	______	____

8. Own: Land _____ Bldg. _________ Equipment _____

Lease: Site _____ Equipment _____

Rent: Site _____ Equipment _____

(Optional) 9. State and local property tax __________

10.

	Insurance Value	Book Value
Building	_______________	__________
Equipment	_______________	__________
Contents/Inventory	_______________	__________

11. What consideration, if any, have you given to flood risk in your business planning?

EXHIBIT C
CONTENTS OF DATA BASE

Industrial Park Code; 1 = Yes, 0 = No

Shopping Center Code; 1 = Yes, 0 = No

Office Building Code; 1 = Yes, 0 = No

Square Footage Under Roof

Site Acreage

Dollar Sales (Annual)

Annual Operating Cost

Total Shipping Cost

Total Truck Cost

Total Rail Cost

Total Barge Cost

Total Air Freight Cost

Total Number of Employees

Total Employee Cost

Number of Direct or Sales Employees

Cost of Direct or Sales Employees

Number of Indirect or Administrative Employees

Cost of Indirect or Administrative Employees

Number of Commercial Indirect Employees

Cost of Commercial Indirect Employees

Dollar Valuation of Owned Land

Dollar Valuation of Owned Buildings

Dollar Valuation of Owned Equipment

Annual Amount of Lease on Site

Annual Amount of Lease on Equipment

Annual Amount of Rent on Site

Annual Amount of Rent on Equipment

Annual State and Local Property Taxes

Dollar Insurance Value of Building

Dollar Book Value of Building

Dollar Insurance Value of Equipment

Dollar Book Value of Equipment

Flood Plain Designation; 1 = On, 2 = Off

SIC Code, 4 digits

Length of Occupancy in Years

Type Code; 0 = Manufacturing, 1 = Commercial

Flood Frequency in Years

Dollar Insurance Value on Contents/Inventory

Dollar Book Value on Contents/Inventory

Original Occupancy Code; 0 = No Response

1 = Yes

2 = No

Location Designation

Location Reason

Company Name

Company Address

EXHIBIT D
MAJOR VARIABLES

NAME	UNITS	ABBREVIATION
Operating Cost	Dollars	OPR_COST
Shipping Total	Dollars	SHIP_TOT
Truck	Dollars	TRUCK
Rail Cost	Dollars	RAIL
Total Number Employees	Count	EMP_NUM
Total Cost of Employees	Dollars	EMP_CST
Number of Direct Employees	Count	DS_EMP_N
Cost of Direct Employees	Dollars	DS_EMP_C
Square Footage Under Roof	Dollars	SQ_FOOT
Site Acreage	Dollars	ACRES
Annual Dollar Sales Volume	Dollars	DLR_SALE
Number of Indirect Employees	Count	IA_EMP_N
Cost of Indirect Employees	Dollars	IA_EMP_C
Dollar Amount on Land Owned	Dollars	OWN_LAND
Dollar Amount on Building Owned	Dollars	OWN_BLDG
Dollar Amount of Equipment	Dollars	OWN_EQUIP
Annual Site Rental Cost	Dollars	RNT_SITE
Annual Site Lease Cost	Dollars	LES_SITE
Industrial Park Location	Coded yes-no	IND_PARK
Dollar Insurance Valuation of Building	Dollars	IVAL_BDG
Dollar Insurance Valuation of Equipment	Dollars	IVAL_EQP
Dollar Book Valuation of Equipment	Dollars	BVAL_EQP
Annual Equipment Leased Cost	Dollars	LES_EQIP
Dollar Book Valuation of Building	Dollars	BVAL_BDG
Dollar Insurance Valuation of Contents/Inventory	Dollars	CN_INV_I
Dollar Book Valuation of Contents/Inventory	Dollars	CN_INV_B
MAX (OWN_BLDG, BVAL_BDG, IVAL_BDG)	Dollars	BLDG
MAX (CN_INV_I, CN_INV_B)	Dollars	INVEN
Original Occupancy	0 = no response 1 = orig. occup. 2 = not orig. occup.	OCCUP
Length of Occupancy in Years	Number of Years	LNG_YRS
Flood Frequency in Years	Number of Years	FLD_FREQ

EXHIBIT E
DATA FORMATS

The data for any observation is contained on six cards. The formats and items contained on these cards is as follows. All numeric fields are right-justified, all alpha fields are left-justified.

Card 1	cc	Item
	1 - 4	Observation Number
	8 - 9	Industrial Park Code; 1 = Yes, 0 = No
	10 - 11	Shopping Center Code; 1 = Yes, 0 = No
	12 - 13	Office Building Code; 1 = Yes, 0 = No
	14 - 23	Square Footage Under Roof
	24 - 33	Site Acreage
	34 - 43	Dollar Sales (Annual)
	44 - 53	Annual Operating Cost
	54 - 63	Total Shipping Cost
	80	Card Number = 1

Card 2	cc	
	1 - 4	Observation Number
	8 - 17	Total Truck Cost
	18 - 27	Total Rail Cost
	28 - 37	Total Barge Cost
	38 - 47	Total Air Freight Cost
	48 - 52	Total Number of Employees
	53 - 62	Total Employee Cost
	63 - 67	Number of Direct or Sales Employees
	68 - 77	Cost of Direct or Sales Employees
	80	Card Number = 2

Card 3	cc	Item
	1 - 4	Observation Number
	8 - 12	Number of Indirect or Administrative Employees
	13 - 22	Cost of Indirect or Administrative Employees
	23 - 27	Number of Commercial Indirect Employees
	28 - 37	Cost of Commerical Indirect Employees
	38 - 47	Dollar Valuation of Owned Land
	48 - 57	Dollar Valuation of Owned Buildings
	58 - 67	Dollar Valuation of Owned Equipment
	68 - 77	Annual Amount of Lease on Site
	80	Card Number = 3

Card 4	cc	Item
	1 - 4	Observation Number
	8 - 15	Annual Amount of Lease on Equipment
	16 - 23	Annual Amount of Rent on Site
	24 - 31	Annual Amount of Rent on Equipment
	32 - 36	Annual State and Local Property Taxes
	37 - 46	Dollar Insurance Value of Building
	47 - 56	Dollar Book Value of Building
	57 - 66	Dollar Insurance Value of Equipment
	67 - 76	Dollar Book Value of Equipment
	80	Card Number = 4

Card 5	cc	Item
	1 - 4	Observation Number
	8 - 12	Flood Plain Designation; 1 = On, 2 = Off
	13 - 17	SIC Code, 4 digits
	18 - 22	Length of Occupancy in Years

Card 5 (cont.)	cc	Item
	23 - 27	Type Code; 0 = Manufacturing, 1 = Commercial
	28 - 32	Flood Frequency in Years
	33 - 42	Dollar Insurance Value on Contents/Inventory
	43 - 52	Dollar Book Value on Contents/Inventory
	53 - 62	Original Occupancy Code; 0 = No Response 1 = Yes 2 = No
	80	Card Number = 5

Card 6	cc	Item
	1 - 4	Observation Number
	8 - 23	Location Designation (Alpha)
	29 - 56	Location Reason (Alpha)
	80	Card Number = 6

APPENDIX B

LIST OF TABLES

TABLE 1

DISTRIBUTION OF TWO-DIGIT SIC CODE AND FLOOD PLAIN STATUS

SIC	ON	OFF	SIC	ON	OFF
14	0	1	39	0	1
15	4	5	42	13	3
16	0	1	47	1	1
17	3	5	50	15	10
20	4	3	51	5	6
22	1	2	52	1	0
23	0	4	53	0	1
24	2	1	55	2	4
25	1	1	56	0	1
26	4	4	57	5	6
27	6	7	58	0	2
28	11	14	59	0	3
29	1	0	65	1	0
30	5	1	70	1	0
31	1	1	72	0	3
32	6	5	73	0	1
33	6	2	75	3	9
34	16	17	76	0	1
35	21	13	89	1	0
36	9	2	94	1	1
37	1	0	TOTALS	156	145
38	5	3			

TABLE 2

FREQUENCY DISTRIBUTION OF NON-PARTICIPATING COMPANIES BY REJECTION CODE

REJC_CD*	FREQUENCY	PERCENT
1	451	50.731
2	59	6.637
3	50	5.624
4	94	10.574
5	235	26.434
TOTALS	889	100.000

*REJC_CD Rejection code:
1 refused
2 distance
3 branch only
4 non-existent
5 inappropriate

FREQUENCY DISTRIBUTION OF NON-PARTICIPATING COMPANIES BY FLOOD PLAIN CODE

FLDPLN*	FREQUENCY	PERCENT
F	368	41.395
X	521	58.605
TOTALS	889	100.000

*FLDPLN Flood plain code: F = on

X = off

TABLE 3

FACTOR ANALYSIS FOR ALL MANUFACTURING FIRMS

	1	2	3	4	5	6
IND_PARK	-0.00214	0.12868	0.24362	0.79464	-0.05743	-0.25764
SQ_FOOT	0.11769	0.40983	-0.65907	-0.18263	0.00315	-0.24865
ACRES	-0.13181	0.14172	-0.68672	-0.19186	0.02296	-0.10244
DLR_SALE	0.79025	0.33727	-0.24274	-0.16860	0.22690	-0.08956
OPR_COST	0.81217	0.35303	-0.27875	-0.10804	-0.18500	-0.07119
SHIP_TOT	0.85329	0.00173	-0.10630	0.02442	0.15904	0.10745
EMP_CST	0.31201	0.54176	-0.30369	-0.12093	0.17626	-0.24406
OWN_LAND	0.23051	0.08746	-0.66496	0.00902	0.25274	0.12732
OWN_BLDG	0.33270	0.15732	-0.79159	0.05217	0.26437	0.02520
OWN_EQIP	0.22357	0.11642	-0.20670	-0.07507	0.85619	0.05748
IVAL_BDG	0.35557	0.00788	-0.70564	-0.09940	0.11439	-0.25993
BVAL_BDG	0.07639	0.72484	-0.46621	0.06843	-0.04031	-0.02711
IVAL_EQP	0.17324	0.05193	-0.17041	-0.02393	0.84655	-0.12215
BVAL_EQP	-0.00856	0.75189	0.01365	-0.15148	0.51864	0.01158
LNG_YRS	0.14550	0.23614	-0.00173	-0.80411	0.06752	-0.19989
CN_INV_I	0.30710	0.02977	-0.52162	-0.06319	0.43209	0.06482
CN_INV_B	0.25651	0.85860	-0.05479	-0.01457	-0.01913	0.08051
OCCUP	0.02454	-0.00208	0.12183	-0.03478	-0.02730	0.91625

FACTOR	VARIANCE	PERCENT
1	2.69883	19.85
2	2.66978	19.63
3	3.35143	24.65
4	1.45546	10.70
5	2.20545	16.22
6	1.21656	8.95

TABLE 4

FACTOR ANALYSIS FOR ALL ON FLOOD PLAIN MANUFACTURING FIRMS

	1	2	3	4	5	6	7
IND_PARK	-0.10228	-0.05458	0.28568	-0.09498	-0.25165	0.78187	-0.06433
SQ_FOOT	0.10452	-0.29084	-0.18445	0.01568	0.00319	-0.32635	0.72677
ACRES	-0.07103	-0.07502	-0.80885	-0.01463	-0.09419	-0.29045	0.19466
DLR_SALE	0.76302	-0.29485	-0.06332	0.21350	-0.07444	-0.25283	0.31507
OPR_COST	0.77397	-0.31495	-0.05392	0.16275	-0.01094	-0.15882	0.42093
SHIP_TOT	0.93798	-0.03493	-0.11520	0.16189	0.06747	0.00208	0.02339
EMP_CST	0.18979	-0.39371	0.07745	-0.02033	-0.26365	-0.15799	0.65364
OWN_LAND	0.37691	-0.12044	-0.80559	0.24184	-0.04161	0.06417	0.09066
OWN_BLDG	0.47021	-0.24865	-0.39487	0.45990	0.14936	0.13258	0.41688
OWN_EQIP	0.33691	-0.25932	-0.25307	0.78655	0.02444	-0.09131	-0.01699
IVAL_BDG	0.38301	-0.02663	-0.27729	0.28963	0.01656	-0.02677	0.70155
BVAL_BDG	0.19942	-0.74907	-0.27055	0.08564	0.08793	0.11916	0.40578
IVAL_EQP	0.12832	-0.05558	0.03754	0.85546	-0.12972	-0.06149	0.21473
BVAL_EQP	0.08236	-0.85064	-0.06034	0.36114	-0.02580	-0.23743	-0.08772
LNG_YRS	0.11446	-0.32819	0.08453	0.04173	-0.23415	-0.72467	0.27880
CN_INV_I	0.09943	-0.04137	-0.18470	0.54211	0.19182	-0.03914	0.70223
CN_INV_B	0.24234	-0.77953	-0.02118	-0.01644	0.06336	-0.08746	0.39860
OCCUP	0.02948	-0.05536	0.09543	-0.05552	0.92853	-0.04609	-0.00160

FACTOR	VARIANCE	PERCENT
1	2.89247	19.01
2	2.58776	17.01
3	1.87095	12.30
4	2.24926	14.78
5	1.15987	7.62
6	1.55786	10.24
7	2.89713	19.04

TABLE 5

FACTOR ANALYSIS FOR ALL OFF FLOOD PLAIN MANUFACTURING FIRMS

	1	2	3	4	5
IND_PARK	-0.12891	0.23893	0.04743	-0.1313	0.77365
SQ_FOOT	0.15373	0.16003	-0.82019	0.29492	-0.02880
ACRES	0.09262	0.03995	-0.88321	0.12234	-0.06473
DLR_SALE	0.12106	0.32604	-0.20045	0.82302	0.07633
OPR_COST	0.09475	0.27263	-0.19415	0.80678	0.08674
SHIP_TOT	0.05499	-0.01231	-0.20112	0.85006	-0.03890
EMP_CST	0.38651	0.42085	-0.16523	0.71621	-0.04016
OWN_LAND	0.17977	0.04315	-0.17883	0.69683	-0.19410
OWN_BLDG	0.14650	-0.10926	-0.67722	0.57055	-0.09261
OWN_EQIP	0.93939	-0.04634	-0.01950	0.24043	-0.04762
IVAL_BDG	0.03831	-0.22452	-0.60767	0.48293	-0.12678
BVAL_BDG	-0.02581	0.59599	-0.62851	0.08652	-0.06157
IVAL_EQP	0.91153	-0.05901	-0.16013	0.28986	-0.08904
BVAL_EQP	0.68522	0.63811	-0.13520	0.03483	-0.02883
LNG_YRS	-0.00908	0.11404	0.01654	0.09413	-0.84376
CN_INV_I	0.19197	-0.25661	0.02308	0.73488	-0.08264
CN_INV_B	-0.05725	0.89915	0.03136	0.13159	0.13071
OCCUP	-0.00564	-0.04200	0.60444	-0.01113	-0.09826

FACTOR	VARIANCE	PERCENT
1	2.50390	18.14
2	2.16351	15.67
3	3.26697	23.67
4	4.42714	32.07
5	1.44266	10.45

TABLE 6

FACTOR ANALYSIS FOR ALL COMMERCIAL FIRMS

	1
SQ_FOOT	0.72045
ACRES	0.75262
DLR_SALE	0.82655
OPR_COST	0.83180
INVEN	0.87821
BLDG	0.80973
EMP_NUM	0.90647
EMP_CST	0.85725

TABLE 7

FACTOR ANALYSIS FOR ALL ON FLOOD PLAIN COMMERCIAL FIRMS

	1
SQ_FOOT	0.80889
ACRES	0.74162
DLR_SALE	0.85244
OPR_COST	0.86802
INVEN	0.90053
BLDG	0.81964
EMP_NUM	0.90157
EMP_CST	0.82731

TABLE 8

FACTOR ANALYSIS FOR ALL OFF FLOOD PLAIN COMMERCIAL FIRMS

	1	2
SQ_FOOT	0.88791	0.15416
ACRES	0.86889	0.00941
DLR_SALE	0.11325	0.98120
OPR_COST	0.05604	0.98750
INVEN	0.70990	0.19495
BLDG	0.76758	0.12486
EMP_NUM	0.84096	0.45685
EMP_CST	0.50581	0.83354

FACTOR	VARIANCE	PERCENT
1	3.61551	55.33
2	2.91888	44.67

TABLE 9

SCALE FACTORS

EMP_CST	100,000
DLR_SALE	1,000,000
SHIP_TOT	10,000
SQ_FOOT	10,000
INVEN	100,000
BLDG	10,000
FLD_FREQ	10

TABLE 10

VARIABLES AND SCALED VALUES USED IN
DISCRIMINATE SIMULATION FOR MANUFACTURING - ON

SEQ	SQ_FOOT	OCCUP	INVEN	BLDG	DLR_SALE	LNG_YRS	EMP_CST	SHIP_TOT
59	8.400	2	2.000	60.00	1.250	12	4.000	15.000
71	1.300	1	2.000	27.70	2.215	21	3.650	0.800
72	8.000	2	2.250	60.00	2.300	21	4.860	12.650
74	1.600	2	0.150	24.00	0.350	13	0.810	0.500
79	2.600	1	1.605	26.00	1.000	35	1.260	2.250
82	5.000	0	2.500	75.00	8.400	72	16.800	4.200
86	6.200	1	2.500	50.00	4.000	27	6.850	0.000
87	0.675	2	1.000	5.50	0.200	25	0.416	0.088
89	1.600	2	2.500	12.50	2.250	21	1.600	2.000
90	12.000	2	3.000	100.00	4.000	8	10.000	10.000
93	3.000	1	4.000	100.00	5.000	55	20.000	6.000
103	3.600	1	0.050	15.00	1.000	19	2.000	0.000
104	0.900	2	0.010	6.00	0.700	10	1.790	0.100
105	0.150	1	0.020	1.20	0.015	13	0.100	0.000
106	1.500	1	2.000	12.00	1.200	4	2.750	0.600
109	1.150	1	0.500	9.00	1.000	15	5.000	1.200
113	6.800	1	0.380	70.00	1.000	25	3.660	0.000
114	15.246	1	6.100	37.00	1.000	30	2.960	4.150
115	0.150	2	0.020	1.70	0.048	36	0.335	0.000
119	1.000	2	1.000	7.50	0.750	3	0.600	0.700
121	4.000	1	8.667	32.40	4.173	15	7.225	4.650
122	0.070	1	0.030	4.82	0.450	3	1.400	0.000
123	0.400	1	1.600	55.00	2.130	24	8.260	0.800
125	2.500	1	2.500	40.00	2.000	3	4.000	8.000
128	0.250	0	0.770	50.00	5.760	20	1.600	20.600
131	4.500	1	1.500	25.00	3.000	12	15.000	32.500
133	6.000	1	5.000	75.00	1.000	12	4.750	10.000
136	3.000	1	1.250	20.00	4.000	23	2.730	80.000
138	2.500	1	0.900	30.00	3.500	7	14.000	1.650
143	7.500	1	10.000	45.00	6.000	18	15.000	0.000
144	0.400	1	0.150	6.60	0.110	16	0.120	1.200
145	9.000	2	12.630	110.00	8.879	58	21.930	0.000
146	0.360	1	0.110	4.00	0.119	4	0.480	0.000
147	0.660	1	0.200	7.00	0.300	14	0.400	0.900
148	2.300	1	2.400	25.00	1.800	2	0.600	4.000
149	0.940	2	0.050	10.50	1.111	3	2.900	0.000
152	0.550	1	0.250	6.00	0.120	16	0.750	0.000
153	2.100	1	2.115	25.00	1.000	5	1.600	0.000
156	6.200	2	10.000	110.00	5.500	39	11.000	30.000
157	3.000	1	0.900	40.00	1.250	17	7.800	6.250
173	6.500	1	1.450	52.50	7.400	6	30.458	72.520
174	1.700	1	1.000	20.00	6.400	4	25.344	126.720
175	0.720	1	1.200	20.00	0.750	2	2.137	3.563
181	2.200	1	2.750	9.50	1.200	8	4.400	2.900
183	7.300	1	0.650	70.00	2.500	22	4.750	40.375
237	2.800	1	0.110	1.10	0.650	7	2.120	20.000
238	0.350	2	0.005	3.00	0.100	2	0.378	0.000
239	10.600	2	15.000	148.40	6.500	55	11.350	30.000
242	4.500	1	2.800	50.00	2.750	7	4.200	15.000
248	1.800	1	0.600	44.40	1.000	19	5.000	1.000

TABLE 11

VARIABLES AND SCALED VALUES USED IN DISCRIMINATE SIMULATION FOR MANUFACTURING - OFF

SEQ	SQ_FOOT	OCCUP	INVEN	BLDG	DLR_SALE	LNG_YRS	EMP_CST	SHIP_TOT
24	1.300	2	0.400	2.000	2.000	36	0.800	3.100
46	9.700	1	3.000	100.000	3.000	50	8.000	3.000
47	0.400	2	0.100	4.000	0.100	28	0.400	0.010
48	1.200	2	0.150	30.000	0.160	1	0.655	0.030
50	2.400	2	1.800	20.000	1.500	4	1.500	2.000
51	0.400	2	0.006	1.103	0.078	13	0.410	0.100
52	0.190	2	0.005	1.600	0.100	5	0.500	0.100
53	3.900	1	0.050	150.000	1.570	28	8.340	0.100
57	2.200	2	1.000	39.600	1.500	9	5.400	4.050
58	3.000	2	1.800	15.000	1.000	42	2.000	5.000
60	0.750	2	0.200	9.000	1.500	5	1.250	0.000
61	9.200	1	6.250	120.000	3.000	7	2.530	5.500
62	0.227	2	0.010	2.500	0.075	11	0.350	0.100
65	8.200	2	7.500	100.000	5.000	2	10.000	2.379
66	0.800	2	0.250	6.000	0.120	16	0.270	0.000
67	1.700	2	1.000	25.000	1.200	14	0.850	11.520
68	0.600	2	0.410	3.000	0.600	8	0.875	0.200
84	0.800	1	0.010	6.000	0.200	32	0.300	0.000
160	2.750	2	2.000	50.000	2.500	15	4.750	35.625
188	4.500	1	5.000	50.000	5.000	9	7.510	0.000
194	0.420	2	0.090	1.800	0.180	3	0.256	0.900
206	0.500	1	0.100	8.000	0.250	30	1.000	0.050
209	4.000	2	0.120	70.000	3.500	22	8.000	6.000
211	1.830	1	1.500	22.500	2.000	19	6.000	0.000
212	0.750	1	1.170	10.000	1.000	13	2.240	0.260
214	0.280	2	0.050	4.000	0.075	13	0.200	0.750
218	0.800	1	0.300	6.500	0.300	95	1.000	0.000
219	1.200	2	0.240	4.000	0.800	5	3.030	0.000
220	2.000	2	0.170	10.000	0.300	7	0.740	0.000
221	1.300	1	0.175	80.000	2.000	69	8.750	3.100
222	1.200	2	0.001	7.500	0.200	15	1.200	0.500
224	0.378	1	0.095	2.500	0.150	30	0.360	0.000
226	0.500	2	0.500	3.500	0.300	25	0.320	2.500
227	1.000	2	7.200	11.000	4.000	11	3.060	7.200
261	0.750	2	0.050	7.000	0.200	2	0.850	0.000
262	4.000	1	2.000	35.000	3.000	10	7.000	0.000
274	5.500	2	0.100	10.000	1.000	1	8.000	0.500
278	2.600	2	1.000	5.000	1.000	2	0.800	0.000
281	0.250	2	0.120	4.000	2.000	42	5.250	0.000
284	2.000	2	1.500	22.500	1.000	40	1.500	2.000
290	1.900	2	3.500	7.000	2.775	3	4.000	1.960
291	1.300	1	0.350	30.000	2.100	6	0.280	0.000
292	0.600	2	2.000	3.200	0.500	22	0.500	0.000
295	0.260	2	0.150	2.500	0.600	8	2.920	0.000
296	10.000	1	18.000	151.379	3.946	5	31.087	0.000
297	0.900	2	0.260	13.500	0.200	15	0.800	0.000
301	0.500	2	0.200	8.000	0.455	7	2.014	0.000

TABLE 12

VARIABLES AND SCALED VALUES USED IN DISCRIMINATE SIMULATION FOR COMMERCIAL - OFF

SEQ	OCCUP	EMP_CST	DLR_SALE	LNG_YRS	SHIP_TOT	SQ_FOOT
1	0	0.583	0.150	40	0.110	0.240
2	0	0.600	0.270	17	1.000	0.700
3	0	0.700	0.175	7	0.100	0.240
4	0	0.200	0.100	9	0.017	0.420
5	0	0.450	0.125	5	0.000	0.500
7	0	0.640	0.440	2	7.500	1.000
9	0	0.250	0.150	3	0.000	0.350
10	1	1.842	1.197	32	0.574	0.420
11	0	3.000	8.000	15	16.000	8.000
14	0	0.350	0.125	4	0.000	0.050
20	0	0.355	0.260	5	0.015	2.830
21	0	0.961	0.048	23	0.000	0.350
22	0	3.152	1.750	11	3.940	3.800
23	0	3.970	6.000	3	2.000	4.800
26	0	2.724	0.850	141	0.000	2.250
27	0	0.500	0.215	25	0.000	0.380
28	0	2.354	1.300	8	0.000	4.986
30	0	1.120	0.500	1	3.500	0.500
31	0	0.937	0.032	46	0.000	0.495
36	0	0.241	0.148	2	0.080	0.160
44	2	0.140	0.023	2	0.025	0.120
49	2	0.540	0.110	8	0.030	4.000
55	0	12.500	4.000	33	24.000	11.000
83	2	0.065	0.500	3	0.000	0.080
85	2	1.090	0.700	9	0.000	0.750
179	0	0.684	0.800	2	0.540	0.500
193	2	0.250	0.185	2	0.100	0.480
205	2	0.350	0.700	6	0.010	0.288
207	2	0.190	0.125	9	0.150	0.260
208	2	0.440	0.300	8	0.053	0.500
210	2	0.240	0.279	5	0.000	0.210
217	2	0.450	0.130	20	0.000	0.750
225	2	1.400	0.500	1	0.000	0.900
230	2	0.400	0.024	2	0.000	0.099
231	2	0.600	0.300	9	0.600	0.600
241	1	3.370	3.000	4	1.000	7.080
247	2	4.000	0.550	13	0.000	2.080
254	1	1.520	1.400	2	1.300	0.880
255	1	0.800	0.450	2	0.400	2.300
256	1	1.050	0.300	3	0.900	0.125
260	1	3.300	0.800	15	0.000	6.500
263	2	0.150	0.050	1	0.000	0.480
266	1	5.700	8.500	15	8.000	3.000
269	2	1.800	0.750	1	0.000	1.200
270	1	3.500	3.200	3	0.000	0.250
279	2	0.250	0.250	4	0.000	0.750
282	2	0.150	0.100	3	0.000	0.150
283	2	0.200	0.065	2	0.000	1.500
285	2	10.000	5.500	73	0.000	15.000

TABLE 13

VARIABLES AND SCALED VALUES USED IN DISCRIMINATE SIMULATION FOR COMMERCIAL - ON

SEQ	OCCUP	EMP_CST	DLR_SALE	LNG_YRS	SHIP_TOT	SQ_FOOT
13	0	1.132	0.200	47	3.000	0.700
15	0	1.600	3.900	14	4.050	0.850
17	0	0.882	0.150	32	0.106	0.315
18	0	0.579	0.350	5	0.466	1.000
19	0	0.484	0.608	11	0.000	0.080
42	1	8.750	2.250	6	96.525	22.000
43	1	8.774	1.450	13	137.090	1.960
77	2	0.180	0.180	10	0.100	0.276
80	2	0.060	0.022	18	0.220	0.150
81	2	0.250	0.079	7	0.800	0.053
129	1	3.643	2.225	6	27.317	2.100
130	1	3.840	2.500	5	12.800	7.700
132	1	1.200	3.000	13	216.000	1.200
137	2	1.050	1.500	1	5.640	2.060
139	1	5.480	1.250	7	7.000	2.000
140	1	1.400	7.000	2	5.000	5.000
162	1	18.432	6.400	4	61.440	1.650
168	1	3.395	1.000	6	13.580	0.500
170	2	4.000	1.100	5	10.000	0.753
172	1	3.500	0.500	3	7.500	0.650
176	1	14.143	5.400	4	52.380	2.500
177	0	5.250	1.200	2	11.000	0.500
191	2	0.600	0.400	5	1.000	0.800
196	2	2.400	2.500	25	36.750	2.750
197	2	2.250	0.500	1	2.450	0.900
198	2	4.760	2.000	5	12.000	2.000
199	1	5.990	3.000	5	170.000	1.600
200	1	17.120	5.000	1	400.000	4.000
202	1	0.300	0.155	73	0.000	0.090
203	2	0.700	0.450	18	0.200	0.500
204	2	0.180	0.049	7	0.005	0.600
215	1	0.600	0.450	27	0.000	0.900
216	2	0.200	0.070	7	0.000	0.200
246	1	1.750	0.500	30	0.500	0.300
251	2	0.300	0.039	3	0.000	0.130
252	1	1.366	0.670	7	0.076	0.475
265	1	7.250	5.000	8	0.000	1.020
267	1	3.620	0.800	9	0.000	0.900
272	1	4.400	7.000	10	45.000	8.700
276	2	5.441	0.940	15	8.454	1.600
277	1	9.500	0.180	12	0.000	0.490
286	2	5.200	0.800	1	0.000	0.660

TABLE 14

DISCRIMINANT FUNCTION
(Without Flood Frequency)

MANUFACTURING

Variables	Means on	Means off	Standard Deviation on	Standard Deviation off	Coefficients on	Coefficients off	F Levels
SQ_FOOT	3.51141	2.14755	3.45072	2.53626	.16164	-.06467	3.3906
OCCUP	1.24000	1.70213	.51745	.46227	6.20314	8.16343	21.4173
INVEN	2.40343	1.82940	3.33434	3.07889	-.40465	-.41768	.0136
BLDG	36.80638	27.13152	34.02855	38.89909	.02542	.04395	1.7863
DLR_SALE	2.38260	1.36242	2.36147	1.36761	.91487	.71924	1.6778
					-5.89438	-8.33809	

Classifications:

	ON	OFF	
ON	37	13	50
OFF	12	35	47

$X^2 = 30.194$, d.f. = 5

COMMERCIAL

Variables	Means on	Means off	Standard Deviation on	Standard Deviation off	Coefficients on	Coefficients off	F Levels
OCCUP	1.21428	.97959	.68202	.92398	2.05015	1.61703	2.6345
EMP_CST	3.85597	1.63383	4.43041	2.40472	.27192	.06554	9.1827
DLR_SALE	1.73254	1.13114	2.01169	1.98442	.29172	.32686	.0604
					-2.71484	-1.72356	

Classifications:

	ON	OFF	
ON	24	18	42
OFF	10	39	49

$X^2 = 12.19246$, d.f. = 3

TABLE 15

SIMULATION FUNCTION
(Without Flood Frequency)

MANUFACTURING

Variables	Means On	Means Off	Standard Deviation On	Standard Deviation Off	Coefficients On	Coefficients Off	F Levels
DLR_SALE	2.38260	1.36242	2.36147	1.36761	.49704	.30999	.5142
SQ_FOOT	3.51141	2.14755	3.45072	2.53626	.30266	.13888	3.2119
INVEN	2.40343	1.52940	3.33434	3.07889	- .14277	- .11825	.0535
BLDG	36.80638	27.13152	34.02855	38.89909	.00035	.00914	.8648
SHIP_TOT	11.45731	2.09647	23.70131	5.53401	.00794	- .01253	6.9700
					-1.69697	-1.07388	

Classifications:

	ON	OFF	
ON	22	28	50
OFF	10	37	47

$\chi^2 = 12.09709$, d.f. = 5

COMMERCIAL

Variables	Means On	Means Off	Standard Deviation On	Standard Deviation Off	Coefficients On	Coefficients Off	F Levels
DLR_SALE	1.73254	1.13114	2.01169	1.98442	.15963	.22500	.2137
EMP_CST	3.85597	1.63383	4.43041	2.40472	.24853	.09718	9.1827
SHIP_TOT	32.10590	1.46824	75.22220	4.29169	.00188	- .00546	2.1240
					-1.34076	- .89578	

Classifications:

	ON	OFF	
ON	22	20	42
OFF	4	45	49

$\chi^2 = 11.79964$, d.f. = 3

TABLE 16

DISCRIMINANT FUNCTIONS USED IN SIMULATIONS

MANUFACTURING

Variables	On	Off	F Level With Flood Frequency	F Level Without Flood Frequency
DLR_SALE	.26200	-.85714	10.0570	.5142
SQ_FOOT	.28365	.04448	.4793	3.2119
INVEN	-.14449	-.12680	.0025	.0535
BLDG	-.00025	.00615	.0394	.8648
SHIP_TOT	.01616	.02828	.0434	6.9700
FLD_FREQ	.74485	3.69857	1002.4141	N/A
Constant	-3.16048	-37.15889		

COMMERCIAL

Variables	On	Off	F Level With Flood Frequency	F Level Without Flood Frequency
DLR_SALE	-.16256	-.73021	7.2543	.2137
EMP_CST	.25405	.11355	.3073	9.1827
SHIP_TOT	-.00304	-.02004	2.4401	2.1240
FLD_FREQ	1.22244	3.62424	636.3491	N/A
Constant	-5.40284	-36.60056		

TABLE 17

SIMULATION SUMMARY

Manufacturing

Decrease risk		Increase risk	
Amount	Number changed	Amount	Number changed
30 years	9	30 years	8
60 years	12	60 years	49
90 years	24		
120 years	49		
150 years	52		
180 years	53		

Commercial

Decrease risk		Increase risk	
Amount	Number changed	Amount	Number changed
30 years	23	30 years	1
60 years	34	60 years	50
90 years	41		
120 years	45		

TABLE 18

SIMULATIONS - MANUFACTURING
DECREASE RISK

1. Original flood hazard data:

	ON	OFF
ON	53	0
OFF	0	49

2. Increase frequency by 30 (decrease risk):

	ON	OFF
ON	44	9
OFF	0	49

Of the 9 on-off missed, all were originally 100 year.

Sequence numbers missed are:	72	74	106	122	133
	136	138	149	248	
SIC numbers missed are:	2653	3441	3831	3498	2648
	3559	3674	3648	3729	

3. Increase frequency by 60 (decrease risk):

	ON	OFF
ON	41	12
OFF	0	49

Of the 12 on-off missed, all were originally 100 year.

Sequence numbers missed are:	72	74	82	106	122
	136	138	145	149	239
SIC numbers missed are:	2653	3441	3469	3831	3498
	3559	3674	3312	3648	3842

4. Increase frequency by 90 (decrease risk):

	ON	OFF
ON	29	24
OFF	0	49

Of the 24 on-off missed: 12 were originally 100 year

12 were originally 50 year

Sequence numbers missed are:

72	74	82	86	90	93	106	113	114	119
121	122	128	131	133	136	138	145	146	149
174	239	242	248						

SIC numbers missed are:

2653	3441	3469	2782	2512	3323	3831	3479	3271	2824
3585	3498	2812	3444	2648	3559	3674	3312	3561	3648
3679	3842	3272	3729						

5. Increase frequency by 120 (decrease risk):

	ON	OFF
ON	4	49
OFF	0	49

Of the 49 on-off missed: 12 were originally 100 year

13 were originally 50 year

15 were origianlly 25 year

9 were originally 10 year

Sequence numbers missed are:

59	71	72	74	79	82	86	87	89	90
93	103	104	105	106	109	113	114	115	119
121	122	123	125	128	131	133	136	138	143
144	145	146	147	148	149	152	153	156	157
174	175	181	183	237	238	239	242	248	

SIC numbers missed are:

3079	3451	2653	3441	3545	3469	2782	3542	2512	3323
2087	3423	3565	2831	3544	3479	3271	3443	3352	2824
3585	3498	3569	2819	2812	3444	2648	3559	3674	3494

2842 3313 3561 2651 3585 3648 3544 3559 2851 3079

3679 3841 1541 2823 3273 2221 3842 3272 3729

6. Increase frequency by 150 (decrease risk):

	ON	OFF
ON	1	52
OFF	0	49

Of the 52 on-off missed: 12 were originally 100 year

15 were origianlly 50 year

16 were originally 25 year

9 were originally 10 year

Sequence numbers missed are:

59	71	72	74	79	82	86	87	89	90
93	95	103	104	105	106	109	113	114	115
117	119	121	122	123	125	128	131	133	136
138	143	144	145	146	147	148	149	152	153
156	157	173	174	175	181	183	237	238	239
242	248								

SIC numbers missed are:

3079	3451	2653	3441	3545	3469	2782	3542	2512	3323
2087	2842	3423	3565	2831	3544	3479	3271	3443	3352
3352	2824	3585	3498	3569	2819	2812	3444	2648	3559
3674	3494	2842	3313	3561	2651	3585	3648	3544	3559
2851	3079	3469	3679	3841	1541	2823	3273	2221	3842
3272	3729								

7. Increase frequency by 180 (decrease risk):

	ON	OFF
ON	0	53
OFF	0	49

Of the 53 on-off missed: 12 were originally 100 year

15 were originally 50 year

16 were originally 25 year

10 were originally 10 year

Sequence numbers missed are:

59	71	72	74	79	82	86	87	89	90
93	95	103	104	105	106	109	111	113	114
115	117	119	121	122	123	125	128	131	133
136	138	143	144	145	146	147	148	149	152
153	156	157	173	174	175	181	183	237	238
239	242	248							

SIC numbers missed are:

3079	3451	2653	3441	3545	3469	2782	3542	2512	3323
2087	2842	3423	3565	2831	3544	3479	2752	3271	3443
3352	3352	2824	3585	3498	3569	2819	2812	3444	2648
3559	3674	3494	2842	3313	3561	2651	3585	3648	3544
3559	2851	3079	3469	3679	3841	1541	2823	3273	2221
3842	3272	3729							

TABLE 19

SIMULATIONS - MANUFACTURING INCREASE RISK

1. Original flood hazard data:

	ON	OFF
ON	53	0
OFF	0	49

2. Decrease frequency by 30 (increase risk):

	ON	OFF
ON	53	0
OFF	8	41

Of the 8 on-off missed, all were originally 200 year.

Sequence numbers missed are:

46	61	63	65	188	213	227	296

SIC numbers missed are:

2653	2842	2842	2599	2851	2084	3964	2899

3. Decrease the frequency by 60 (increase risk):

	ON	OFF
ON	53	0
OFF	49	0

Of the 49 on-off missed, all were 200 year.

Sequence numbers missed are:

24	46	47	48	50	51	52	53	57	58
60	61	62	63	65	66	67	68	84	160
188	194	206	209	211	212	213	214	218	219
220	221	222	224	226	227	261	262	274	278
281	284	290	291	292	295	296	297	301	

SIC numbers missed are:

3496	2653	3599	2393	2819	3444	3544	3548	2752	3496
3581	2842	3421	2842	2599	3272	3498	3566	2824	3232
2851	3441	3599	2753	3831	3429	2084	2819	1442	1731
3079	3321	3423	2499	2851	3964	3429	2891	3679	3143
1611	3442	3861	2893	3425	1731	2899	3642	3292	

TABLE 20

SIMULATIONS - COMMERCIAL
INCREASE RISK

1. Original flood hazard data:

	ON	OFF
ON	48	0
OFF	0	50

2. Decrease frequency by 30 (increase risk):

	ON	OFF
ON	48	0
OFF	1	49

The one on-off missed was originally 200 year.

Sequence number missed: 38

SIC number missed: 5719

3. Decrease frequency by 60 (increase risk):

	ON	OFF
ON	48	0
OFF	50	0

Of the 50 on-off missed, all were originally 200 year.

Sequence numbers missed are:

1	2	3	4	5	7	9	10	11	14
20	21	22	23	26	27	28	30	31	36
38	44	49	55	83	85	179	193	205	207
208	210	217	225	230	231	241	247	254	255
256	260	263	266	269	270	279	282	283	285

SIC numbers missed are:

7261	5999	5531	5331	5812	5712	7513	5531	5722	9441
7525	7538	5148	5722	5812	5531	7531	5086	7538	5531
5719	7231	4225	5064	5144	5014	5072	5014	7539	5712
7534	5148	7539	7629	5999	5112	5999	4212	4083	4783
5084	5039	5039	5039	7374	5112	5732	7299	6511	5111

TABLE 21

SIMULATIONS - COMMERCIAL
DECREASE RISK

1. Original flood hazard data:

	ON	OFF
ON	48	0
OFF	0	50

2. Increase frequency by 30 (decrease risk):

	ON	OFF
ON	25	23
OFF	0	50

Of the 23 on-off missed, all were originally 100 year.

Sequence numbers missed are:

18	19	132	137	139	140	168	170	176	196
197	198	199	203	204	215	246	252	265	267
272	276	286							

SIC numbers missed are:

8911	5084	4226	5099	5039	5014	5072	5141	5081	5013
5713	5023	4212	5712	7538	7538	5511	5722	4212	4212
5211	5761	4214							

3. Increase frequency by 60 (decrease risk):

	ON	OFF
ON	14	34
OFF	0	50

Of the 34 on-off missed: 28 were originally 100 year
6 were originally 50 year

Sequence numbers missed are:

18	19	129	130	132	137	139	140	162	168
170	172	176	177	187	191	196	197	198	199
200	202	204	215	216	246	252	265	267	268
272	275	276	286						

SIC numbers missed are:

8911	5084	5039	5039	4426	5099	5039	5014	5031	5076
5141	5039	5081	4783	4225	5074	5013	5713	5023	4212
4212	6531	7538	7538	7539	5511	5722	4212	4212	4212
5211	7011	5761	4214						

4. Increase the frequency by 90 (decrease risk):

	ON	OFF
ON	7	41
OFF	0	50

Of the 41 on-off missed: 28 were originally 100 year
6 were originally 50 year
6 were originally 25 year
1 was originally 10 year

Sequence numbers missed are:

15	18	19	77	80	81	129	130	132	137
139	140	162	168	170	172	176	177	187	191
196	197	198	199	200	202	203	204	215	216
246	251	252	265	267	268	272	275	276	277
286									

SIC numbers missed are:

5147	8911	5084	5085	5712	5531	5039	5039	4226	5099
5039	5014	5031	5072	5141	5039	5081	4783	4225	5074
5013	5713	5023	4212	4212	6531	5712	7538	7538	7539
5511	9441	5722	4212	4212	4212	5211	7011	5761	4212
4214									

5. Increase the frequency by 120 (decrease risk):

	ON	OFF
ON	3	45
OFF	0	50

Of the 45 on-off missed: 28 were originally 100 year

6 were originally 50 year

8 were originally 25 year

3 were originally 10 year

Sequence numbers missed are:

13	15	17	18	19	42	43	77	80	81
129	130	132	137	139	140	162	168	170	172
176	177	187	191	196	197	198	199	200	202
203	204	215	216	246	251	252	265	267	268
272	275	276	277	286					

SIC numbers missed are:

5148	5147	4221	8911	5084	4214	4214	5085	5712	5531
5039	5039	4226	5099	5039	5014	5031	5072	5141	5039
5081	4783	4225	5074	5013	5713	5023	4212	4212	6531
5712	7538	7538	7539	5511	9441	5722	4212	4212	4212
5211	7011	5761	4212	4214					

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