Department of AERONAUTICS and ASTRONAUTICS
STANFORD UNIVERSITY

NASA CR 114634

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STANFORD TRANSPORTATION RESEARCH PROGRAM

Studies in Short Haul Air Transportation in the California Corridor: Effects of Design Runway Length, Community Acceptance, Impact of Return on Investment and Fuel Cost Increases

Volume II - Appendices

Richard S. Shevell, Principal Investigator
assisted by
David W. Jones, Jr.

July 1973

Submitted to
NASA-Ames Research Center
Contract No. NAS 2-7199

SUDAAR No. 460

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STUDIES IN SHORT HAUL AIR TRANSPORTATION IN THE CALIFORNIA CORRIDOR: Effects of Design Runway Length; Community Acceptance; Impact of Return on Investment and Fuel Cost Increases

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TABLE OF CONTENTS
VOLUME I

APPENDIX A

TOTAL TRAVEL DEMAND DEVELOPMENT

<u>Intercity Automobile Travel Data</u> - Method of using 1970 Traffic Volumes

Travel demand by automobile is difficult to determine and estimates of origin and destination traffic on a particular highway between the city-pair under consideration are difficult to make.

In general, the method used to determine automobile traffic to and from the Bay Area was as follows:

a) A chokepoint was found on all main routes between the Bay Area and the city under consideration (for this discussion, call the city "City M").

b) From the chokepoint traffic was subtracted a figure for local and through (LTT) traffic.

c) To estimate O and D traffic for several cities along the same route, weighting factors were calculated for each city using a gravity approach.

That is:

$$\text{Weighting Factor}_{\text{City M}} = WF_M = \frac{\text{Population}_{SF} \times \text{Population}_M}{r^2_{SF-M}}$$

where r_{SF-M} is the distance between the Bay Area and City M.

<u>Note</u>: Straight line distance in statute miles was used for r. Road distance was not used because of the difficulty and inherent uncertainity of the value obtained (as well as the lack of one value for each city due to several possible routes), and because of the need to correlate air travel with auto travel and the corresponding costs of each mode later in this study. Since the percentage difference between straight line and road mileage is similar for all city-pairs, the weighting factors are not affected significantly.

Now:

$$\frac{WF_1}{\sum_{i=1}^{N} WF_i} + \frac{WF_2}{\sum_{i=1}^{N} WF_i} + \ldots + \frac{WF_N}{\sum_{i=1}^{N} WF_i} = 1$$

Therefore,

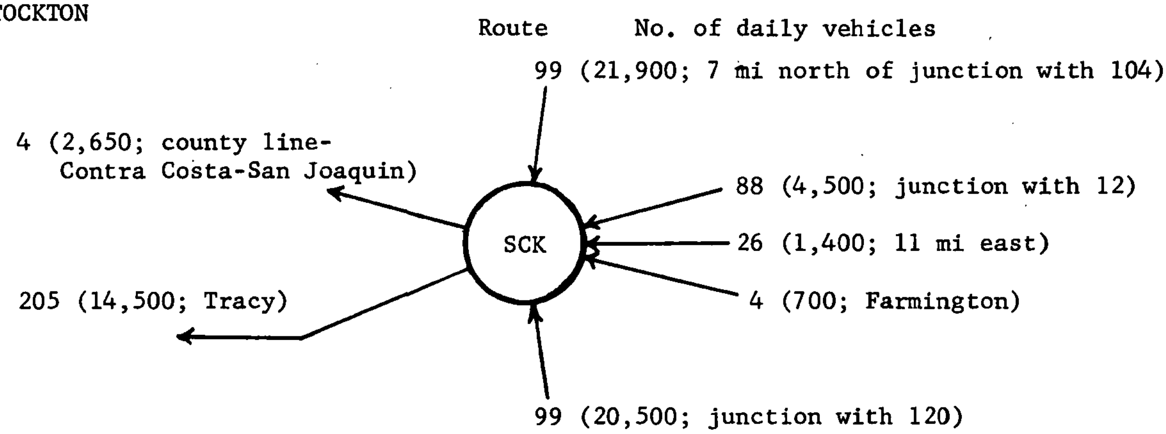
$$\frac{WF_M}{\sum_{i=1}^{N} WF_i} = \text{Fraction of total O and D traffic on a route bound from City M to the Bay Area along a particular route (\% - M)}$$

This is reducible,

$$\text{Fraction to M} = \frac{WF_M}{\sum_{i=1}^{N} WF_i} = \frac{\dfrac{P_{SF}P_M}{r^2_{SF-M}}}{\sum_{i=1}^{N} \dfrac{P_{SF}P_i}{r^2_{SF-i}}} = \frac{P_{SF}\dfrac{P_M}{r^2_{SF-M}}}{P_{SF}\sum_{i=1}^{N} \dfrac{P_i}{r^2_{SF-i}}} = \frac{\dfrac{P_M}{r^2_{SF-M}}}{\sum_{i=1}^{N} \dfrac{P_i}{r^2_{SF-i}}}$$

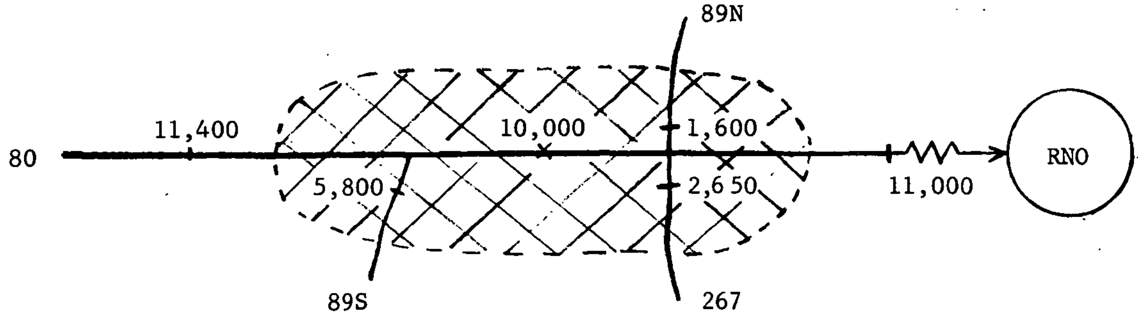
The fraction to M is multiplied by the adjusted chokepoint traffic or the chokepoint traffic, whichever is less, to arrive at the daily number of vehicles between the Bay Area and City M. This daily traffic figure is then checked against the chokepoint traffic between City M and the Bay Area. (Prior to this point, the chokepoint may have been prior to City M enroute to the Bay Area.)

STOCKTON



14,500 (chokepoint; 205)
+ 2,650 (chokepoint; 4)
17,150
- 5,717 (1/3 LTT)
11,433 veh/day, SFO-SCK

RENO



(Area shaded is Truckee, chokepoint traffic San Francisco-Reno is 10,000, located at the "x" in the diagram above.)

The most difficult portion of the analysis is determination of local traffic at the chokepoint, because of its location. The task was somewhat eased because 80 is a controlled access highway, with exits in the vicinity of the chokepoint only as shown.

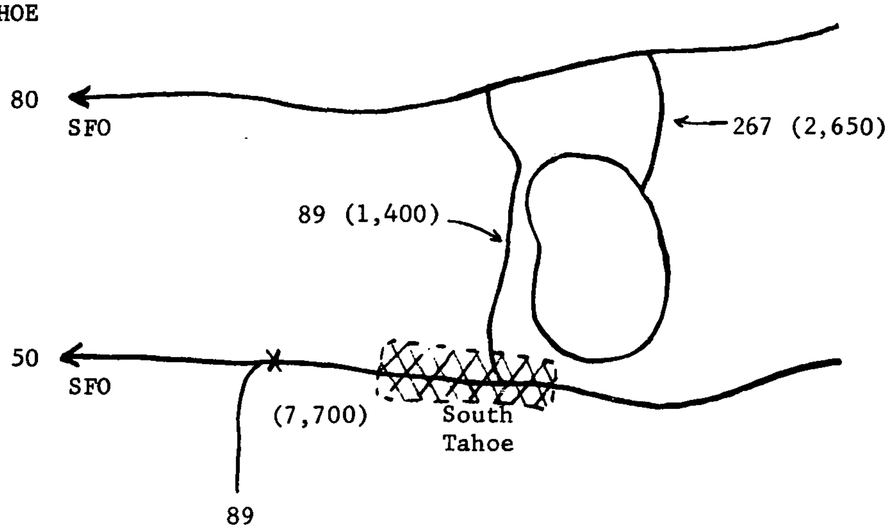
Breakdown of local traffic in immediate vicinity is as follows:

a) 89S: If all traffic is assumed to move eastward on 80, 3,600 autos must exit on 89S, and 2,200 must enter 80 from 89S. If all traffic is assumed to move westward on 80, 2,200 autos must exit on 89S, and 3,600 must enter 80 from 89S. In either case, 2,200 autos cross the chokepoint which are not origin and destination, San Francisco-Reno. (10,000 - 2,200 = 7,800)

b) 89N and 267: Treat this as one exit with traffic totalling 4,250 autos. The breakdown of this number is 2,625 and 1,625, with each entering or exiting 80 depending on assumed traffic direction, as described in a) above. The number of autos that cross the chokepoint in this analysis that are not origin and destination San Francisco-Reno is 1,625. (7,800 - 1,625 = 6,175)

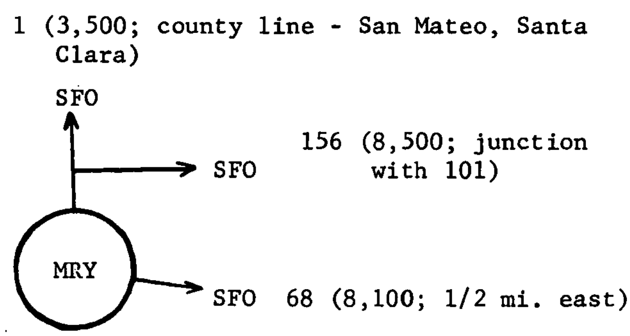
Assume that 1/2 of the 6,175 autos are local and/or not origin and destination San Francisco-Reno, leaving 3,088 autos daily, San Francisco-Reno. The large percentage of local traffic is justified because of the large number of ski resorts in the vicinity, and because of Lake Tahoe.

LAKE TAHOE



2,650 (chokepoint; 267)
+ 1,400 (chokepoint; 89)
+ 7,700 (chokepoint; 50)
11,750
- 5,875 (1/2 LTT)
5,875 veh/day, SFO-LTA

MONTEREY



3,500 (chokepoint; 1)
+ 8,500 (chokepoint; 156)
+ 1,000 (NLR; 68)
13,000
- 4,333 (1/3 LTT)
8,667 veh/day, SFO-MRY

FRESNO, BAKERSFIELD, LOS ANGELES, SAN DIEGO (interior route)

a) The gravity approach was used to determine traffic

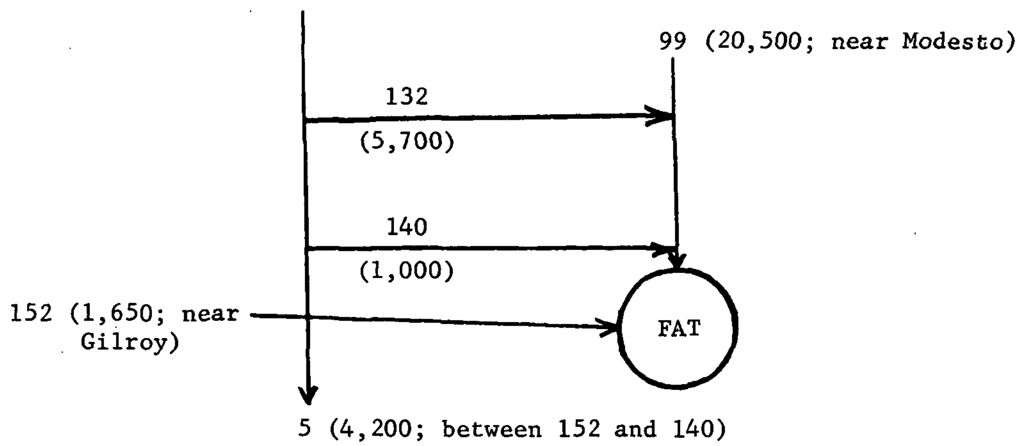
$$WF_{FAT} = \frac{P_{FAT}}{r^2_{SFO-FAT}} = \frac{407000}{(164)^2} = 15.1$$

$$WF_{BFL} = \frac{P_{BFL}}{r^2_{SFO-BFL}} = \frac{325000}{(247)^2} = 5.33$$

$$WF_{LAX} = \frac{P_{LAX}}{r^2_{SFO-LAX}} = \frac{9926000}{(354)^2} = 79.2$$

$$WF_{SAN} = \frac{P_{SAN}}{r^2_{SFO-SAN}} = \frac{1351000}{(456)^2} = 6.50$$

b) Chokepoint traffic (assume traffic flow from Bay Area)



1,650 (chokepoint; 152)
4,200 (chokepoint; 5)
1,000 (NLR; 99)
700 (NLR; 132)
150 (NLR; 140)
7,700
-2,567 (1/3 LTT)
5,133 veh/day, SFC-FAT, BFL, LAX, SAN

c) Calculation of O and D Traffic

(1) Fresno: $\dfrac{WF_{FAT}}{WF_{FAT} + WF_{BFL} + WF_{LAX} + WF_{SAN}} \times 5{,}133 = \dfrac{15.1}{106.73} (5133) =$

$\underline{\underline{730 \text{ veh/day, SFO-FAT}}}$

(2) Bakersfield: $\dfrac{WF_{BFL}}{WF_{BFL} + WF_{LAX} + WF_{SAN}} \times (5133 - 730) = \dfrac{5.33}{91.03} (4403) =$

$\underline{\underline{258 \text{ veh/day, SFO-BFL}}}$

(3) Los Angeles: $\dfrac{WF_{LAX}}{WF_{LAX} + WF_{SAN}} \times (4403 - 258) = \dfrac{79.2}{85.7} (4145) =$

$\underline{\underline{3830 \text{ veh/day, SFO-LAX}}}$

(4) San Diego: 5133 - 730 - 258 - 3830 = $\underline{\underline{315 \text{ veh/day, SFO-SAN}}}$

SANTA BARBARA, LOS ANGELES, SAN DIEGO (coastal route)

a) A modified gravity approach was used to determine traffic:

$$WF_{SBA}^{(1)} = \frac{P_{SBA}}{r^2_{SFO\text{-}SBA}} = \frac{260000}{(271)^2} = 3.54$$

$$WF_{LAX} = \frac{P_{LAX}}{r^2_{SFO\text{-}LAX}} = \frac{9926000}{(354)^2} = 79.2$$

$$WF_{SAN} = \frac{P_{SAN}}{r^2_{SFO\text{-}SAN}} = \frac{1351000}{(456)^2} = 6.50$$

b) Chokepoint traffic on 101 is 8400 vehicles/day, located well north of Santa Barbara, but south of all possible routes to Monterey. Highway 1 was considered NLR and no traffic along this route was used. Subtracting 1/3 LTT leaves 5600 vehicles/day as a bare figure.

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(1) The Santa Barbara value of $\dfrac{\text{air patronage}}{\text{(air + auto) patronage}}$ (% air) falls rather high on the modal split curve (page I-21). This is now believed due to an underestimation of auto traffic. Santa Barbara is largely a recreational city and its traffic attraction would be expected to be large compared to its population. Thus a factor of, say, 2 might well be applied to the weighting factor based on population. The resulting would be a 50% reduction in % air which would be in close agreement with the modal split curve.

c) Calculation of O and D traffic:

(1) Santa Barbara: $$\frac{WF_{SBA}}{WF_{SBA} + WF_{LAX} + WF_{SAN}} \times 5600 = \frac{3.54}{89.24}(5600) =$$

222 veh/day, SFO-SBA

(2) Los Angeles: $$\frac{WF_{LAX}}{WF_{LAX} + WF_{SAN}} \times 5378 = \frac{79.2}{85.7}(5378) =$$

4970 veh/day, SFO-LAX

(3) San Diego: 5600 - 222 - 4970 = 408 veh/day, SFO-SAN

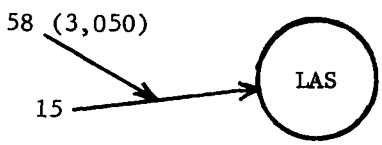
d) Total San Francisco-Los Angeles, San Diego Traffic

(1) Los Angeles: 3830 + 4970 = 8800

(2) San Diego: 315 + 408 = 723

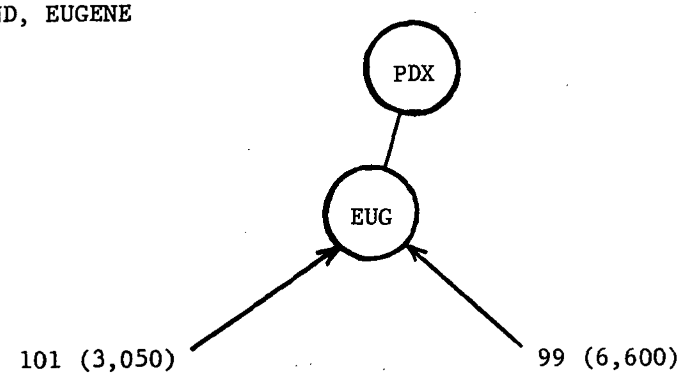
Note: These calculations show that more traffic travels over 101 to Los Angeles than on Interstate 5. It must be remembered that, in 1970, Interstate 5 was only partially completed.

LAS VEGAS



3,050 (chokepoint; 58)
- 2,287 (3/4 LTT)
763 veh/day, SFO-LAS

PORTLAND, EUGENE



Assume 7% of route 99 traffic and 5% of route 101 traffic are San Francisco-Portland O and D traffic.

616 veh/day, SFO-PDX

Assume 20% of traffic on 99 and 101 which go to Portland are O and D San Francisco-Eugene.

.20 (600) = 120 veh/day, SFO-EUG

TABLE A-1

Summary

Metropolitan Area	r	Chokepoint Traffic	Routes	Autos/Day	Load Factor[d]	People/Year
Bakersfield	247	a	a	258	2.56	237,773
Eugene	441	b	b	120	2.96	127,872
Fresno	164	7,700	152, 5, 99, 132, 140	730	2.40	630,720
Las Vegas	419	3,050	99, 58 15	763	2.92	802,066
Los Angeles	354	c	c	8,800	2.80	8,870,400
Monterey	87	13,000	1, 156, 68	8,667	2.24	6,989,069
Portland	541	9,650	99, 101	616	3.19	707,414
Reno	187	10,000	80	3,088	2.44	2,712,499
Sacramento	79	34,000	80	15,891	2.22	12,700,087
San Diego	456	c	c	723	3.00	780,840
Santa Barbara	271	8,400	101	222	2.61	208,591
Stockton	65	17,150	205, 4	11,433	2.19	9,013,777
Lake Tahoe	154	11,750	80, 89, 267, 50	5,875	2.38	5,033,700

a - Bakersfield traffic was estimated by gravity approach from chokepoint traffic to Fresno

b - Eugene traffic was estimated by gravity approach from chokepoint traffic to Portland

c - Los Angeles and San Diego traffic was estimated by gravity approach from chokepoint traffic to Fresno and Santa Barbara.

d - From Figure A-1

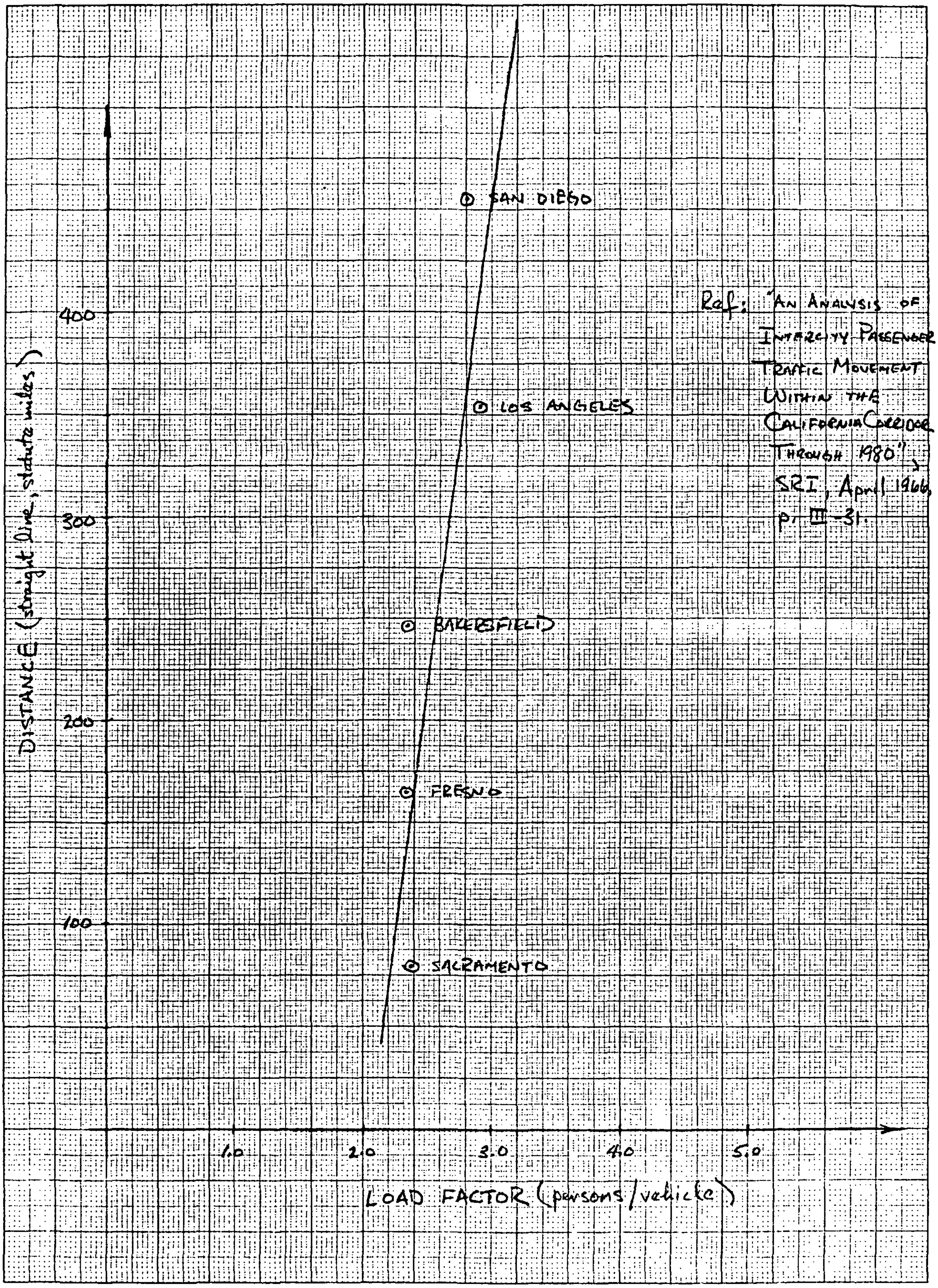

SAN DIEGO
LOS ANGELES
BAKERSFIELD
FRESNO
SACRAMENTO
400
300
200
100
1.0
2.0
3.0
4.0
5.0
DISTANCE (straight line, statute miles)
LOAD FACTOR (persons/vehicle)
Ref: "AN ANALYSIS OF INTERCITY PASSENGER TRAFFIC MOVEMENT WITHIN THE CALIFORNIA CORRIDOR THROUGH 1980", SRI, April 1966, p. III-31.

Figure A-1

TABLE A-2

1965-1970 Automobile Travel Demand

Metropolitan Area	1965	1966 (+ 7.0%)[a]	1967 (+ 3.9%)[a]	1968 (+ 5.6%)[a]	1969 (+ 6.3%)[a]	1970 (+ 4.1%)[a]
Bakersfield	180,259	193,827	201,693	213,658	228,024	237,773
Eugene	96,941	104,238	108,468	114,903	122,629	127,872
Fresno	478,160	514,150	535,016	566,754	604,860	630,720
Las Vegas	608,061	653,829	680,363	720,723	769,181	802,066
Los Angeles	6,724,805	7,230,974	7,524,427	7,970,791	8,506,714	8,870,400
Monterey	5,298,536	5,697,350	5,928,564	6,280,258	6,702,517	6,989,069
Portland	536,302	576,669	600,072	635,670	678,410	707,414
Reno	2,056,393	2,211,175	2,300,911	2,437,406	2,601,287	2,712,499
Sacramento	9,628,156	10,352,856	11,773,004	11,412,081	12,179,383	12,700,087
San Diego	591,969	636,526	662,358	701,650	748,826	780,840
Santa Barbara	158,137	170,040	176,941	187,437	200,039	208,591
Stockton	6,833,502	7,347,852	7,646,048	8,099,627	8,644,212	9,013,777
Lake Tahoe	3,816,136	4,103,372	4,269,898	4,523,197	4,827,318	5,033,700

a - Percentage increases of auto travel demand from previous year. Ref.: 1970 Traffic Volumes

Table A-3
YEARLY AIR TRAVEL BETWEEN BAY AREA AIRPORTS AND STUDY DESTINATIONS--1962-1964

(OUTBOUND + INBOUND)

Destination	1962			1963			1964		
	OAK	SFO*	SJC	OAK	SFO*	SJC	OAK	SFO*	SJC
Bakersfield		17,150	3,570		18,480	4,460		18,710	4,630
Boise		11,880	20		12,980	20		18,030	10
Eugene		12,490	0		15,290	10		17,760	20
Fresno		40,530	2,660		48,940	5,230		50,770	8,200
Las Vegas		75,810	2,670		110,520	3,390		101,400	3,110
Los Angeles**		1,521,765	70,450		1,909,772	62,660		2,354,019	58,300
Medford		8,580	50		10,820	20		14,320	30
Monterey (Salinas)		23,650	90		25,310	60		31,540	80
Portland		118,820	200		139,110	240		166,680	200
Reno		104,680	3,380		141,520	18,210		164,490	18,080
Lake Tahoe		0	0		600	50		4,680	660
Sacramento		31,040	1,340		34,690	1,670		37,580	1,850
San Diego		212,258	800		249,963	1,040		292,672	1,260
Santa Barbara		25,250	190		25,800	60		30,470	140
Stockton		3,770	10		4,940	30		4,710	140

(continued on next page)

* Includes San Francisco and Oakland Airports

** Includes Burbank, Long Beach, and Ontario Airports

Source: Civil Aeronautics Board; 10 % Origin-Destination Survey, 12 months ending Dec. 31; California PUC Transportation Division

Table A- 3 continued

YEARLY AIR TRAVEL BETWEEN BAY AREA AIRPORTS AND STUDY DESTINATIONS--1965-1967

(OUTBOUND + INBOUND)

Destination	1965			1966			1967		
	OAK	SFO*	SJC	OAK	SFO*	SJC	OAK	SFO*	SJC
Bakersfield		20,330	4,530		24,050	5,330		27,880	5,400
Boise		21,000	20		24,510	110		33,010	30
Eugene		22,500	80		25,450	30		35,410	60
Fresno		60,390	6,850		67,320	8,390		86,020	7,880
Las Vegas		133,550	1,660		162,670	1,300		181,870	6,760
Los Angeles***		2,837,770	56,060		3,140,653	315,480		3,153,738	572,149
Medford		15,540	100		19,430	110		25,220	90
Monterey (Salinas		36,670	50		45,970	50		54,020	50
Portland		193,580	270		234,200	400		261,420	300
Reno		177,120	16,490		184,000	9,780		223,340	13,350
Lake Tahoe		7,160	510		10,970	2,780		12,260	1,460
Sacramento		42,720	1,630		53,680	1,530		72,070	1,650
San Diego		73,650**	1,310*		94,100**	1,340*		439,159	21,822
Santa Barbara		36,000	140		42,410	170		55,090	60
Stockton		6,470	100		9,300	130		11,480	20
Long Beach		--	--		--	--		--	--
Burbank		--	--		--	--		--	--
Ontario		--	--		115,960	250		158,960	130
Santa Ana		--	--		710	50	15,990	257,703	19,921

* Includes San Francisco and Oakland Airports

** Not including PSA

*** Includes LGB, BUR, and ONT 1965
Includes LGB, BUR 1966-1967

(continued on next page)

Source: Civil Aeronautics Board; 10% Origin-Destination Survey, 12 months ending Dec. 31; California PUC Transportation Division

Table A -3 (continued)

YEARLY AIR TRAVEL BETWEEN BAY AREA AIRPORTS AND STUDY DESTINATIONS--1968-1970

(OUTBOUND + INBOUND)

Destination	1968			1969			1970
	OAK	SFO	SJC	OAK	SFO	SJC	BAY AREA
Bakersfield	1,370	31,810	2,620	1,300	30,600	220	30,700
Boise	970	35,270	290	1,410	39,220	340	
Eugene	950	43,780	620	1,120	48,480	2,430	50,200
Fresno	1,950	96,170	6,210	3,110	106,760	5,420	98,000
Las Vegas	24,780	181,260	11,660	23,350	170,660	33,520	149,540
Los Angeles	699,288	2,099,654	648,549	675,155	1,996,339	613,231	5,126,000(1)
Medford	480	26,800	580	500	29,170	210	
Monterey (Salinas)	460	50,590	140	1,820	49,210	0	44,700
Portland	35,050	257,790	2,210	39,270	247,920	4,070	208,890
Reno	32,610	213,800	21,990	35,670	191,560	26,760	142,690
Lake Tahoe	40	7,230	1,500	10	7,190	10	4,920
Sacramento	460	53,810	710	1,010	54,440	2,140	112,370
San Diego	108,575	91,840*	48,558	99,875	95,040*	52,787	594,000
Santa Barbara	1,030	63,770	400	2,100	67,930	340	75,250
Stockton	60	12,660	10	130	12,190	10	9,230
Long Beach	970	59,453	10	8,460	67,399	80	(2)
Burbank	35,708	376,978	48,018	189,742	389,184	246,855	(2)
Ontario	24,581	213,658	12,442	72,285	203,310	88,986	(2)
Santa Ana	128,871	303,579	153,944	146,797	320,383	181,064	(2)

* Not Including PSA

1 Includes Long Beach, Burbank, Ontario, Santa Ana   2 Included in Los Angeles

Source: Civil Aeronautics Board; 10% Origin-Destination Survey, 12 months ending Dec. 31; California PUC Transportation Division

TABLE A-4

1970 Annual Intermetropolitan Travel by Modes To and From Bay Area
Number of One-Way Trips

Metropolitan Area	r (st. mi.)	Air Travel[a]	% Air	Rail Travel	Bus Travel	% Rail and Bus	Auto Travel	% Auto	Total
Bakersfield	247	30,700	10.6	0	21,048	7.3	237,773	82.1	289,521
Eugene	441	50,200	27.5	0	4,752	2.6	127,872	70.0	182,824
Fresno	164	98,000	12.2	0	77,280	9.6	630,720	78.3	806,000
Las Vegas	419	149,540	15.6	0	4,872	0.5	802,066	83.8	956,478
Los Angeles	354	5,126,000	36.2	45,480	124,800	1.2	8,870,400	62.6	14,166,680
Monterey	87	44,700	0.6	0	0	0.0	6,989,069	99.4	7,033,769
Portland	541	208,890	22.3	4,680	17,616	2.4	707,414	75.4	938,600
Reno	187	142,690	4.8	0	126,240	4.2	2,712,499	91.0	2,981,429
Sacramento	79	112,370	0.9	0	283,440	2.2	12,700,087	97.0	13,095,897
San Diego	456	594,000	42.4	6,696	19,152	1.8	780,840	55.7	1,400,688
Santa Barbara	271	75,250	25.9	0	7,200	2.5	208,591	71.7	291,041
Stockton	65	9,230	0.1	0	67,152	0.7	9,013,777	99.2	9,090,159
Lake Tahoe	154	4,920	0.1	0	192,600	3.7	5,033,700	96.2	5,231,220

a - Ref.: Ltr.; Douglas Aircraft Company, Long Beach, California, C1-25-1274, 22 Feb. 73
Data Source: Civil Aeronautics Board; 10% Origin-Destination Survey, 12 months ending Dec. 31; California PUC Transportation Division

TABLE A-5

Travel from the Bay Area

	1965	1966	1967	1968	1969	1970
1. Auto:						
Bakersfield	180,259	193,827	201,693	213,658	228,024	237,773
Fresno	478,160	514,150	535,016	566,754	604,860	630,720
Santa Barbara	158,137	170,040	176,941	187,437	200,039	208,591
Stockton	6,833,502	7,347,852	7,646,048	8,099,627	8,644,212	9,013,777
2. Air:						
Bakersfield	24,860	29,380	33,280	35,800	32,120	30,700
Fresno	67,240	75,710	93,900	104,330	115,290	98,000
Santa Barbara	36,140	42,580	55,150	65,473	70,370	75,250
Stockton	6,570	9,430	11,500	12,730	12,330	9,230
3. Auto and Air:						
Bakersfield	205,119	223,207	234,973	249,458	260,144	268,473
Fresno	545,400	589,860	628,916	671,084	720,150	728,720
Santa Barbara	194,277	212,620	232,091	252,910	270,409	283,841
Stockton	6,840,072	7,357,282	7,657,548	8,112,357	8,656,542	9,023,007
4. Population:						
Bakersfield	325,600	328,900	331,000	334,500	340,000	325,500
Fresno	405,100	410,500	415,400	415,200	417,500	413,700
Santa Barbara	245,500	249,500	253,200	256,100	269,900	258,200
Stockton	275,200	282,100	285,400	290,700	293,900	291,900
Bay Area	4,255,000	4,331,100	4,433,000	4,512,500	4,565,200	4,578,293
5. k:						
Bakersfield	.0090	.0096	.0098	.0101	.0102	.0110
Fresno	.0085	.0089	.0092	.0096	.0102	.0103
Santa Barbara	.0137	.0145	.0152	.0161	.0161	.0176
Stockton	.0247	.0254	.0256	.0261	.0273	.0285

TABLE A-6

Determination of k and Future Travel Demand
for Various Bay Area City Pairs

Metropolitan Area	r (miles)	Population 1965	Auto + Air Travel - 1965	k_{1965}	Population 1969	Auto + Air Travel - 1969	k_{1969}	m
Bakersfield	247	325,600	205,119	.0090	340,000	260,144	.0102	.0003
Eugene	441	189,000	119,521	.0289	212,000	174,659	.0351	.00155
Fresno	164	405,100	545,400	.0085	417,500	720,150	.0102	.00043
Las Vegas	419	187,000	743,271	.1640	253,000	996,711	.1515	-.0031
Los Angeles	354	9,248,000	9,618,635	.0306	9,880,000	13,705,984	.0381	.0019
Monterey	87	214,800	5,335,256	.0442	244,900	6,753,547	.0457	.00038
Portland	541	540,000	730,152	.0930	550,000	969,670	.1130	.0050
Reno	187	103,000	2,250,003	.1795	116,000	2,855,277	.1886	.0023
Sacramento	79	760,100	9,672,506	.0187	799,600	12,236,973	.0209	.00055
San Diego	456	1,257,400[a]	1,123,339[a]	.0419	1,366,500	1,484,998[c]	.0495[c]	.0019[b]
Santa Barbara	271	245,500	194,277	.0137	269,900	270,409	.0161	.0006
Stockton	65	275,200	6,840,072	.0247	293,900	8,656,542	.0273	.00065
Lake Tahoe	154	43,000	3,823,806	.4956	46,000	4,834,528	.5460	.0126
Total Bay Area Travel			41,201,357			53,919,592[c]		

a - Air and total traffic figures are for 1967. See note (c).

b - Slope assumed to be same as that of Los Angeles. See note (c).

c - Figures for PSA not available for 1965 or 1969. Auto and air travel for 1969 calculated using Los Angeles slope with a k extrapolated from San Diego's 1965 k.

TABLE A-6 continued

Metropolitan Area	Population 1970[d]	Auto + Air Travel - 1970	k_{1970}	k_{1980}	Projected Population 1980[d]	Projected Travel 1980	k_{1985}	Projected Population 1985[d]	Projected Travel 1985
Bakersfield	325,500	268,473	.0110	.0140	362,200	451,400	.0155	383,800	582,126
Eugene	215,401	178,072	.0351	.0506	280,000	395,650	.0584	320,000	573,667
Fresno	413,700	728,720	.0103	.0146	453,900	1,338,150	.0168	480,000	1,789,934
Las Vegas	273,288	951,606	.1335	.1025	500,000	1,585,425	.0870	650,000	1,922,998
Los Angeles	9,925,900	13,996,400	.0386	.0576	11,551,400	28,835,691	.0671	12,690,800	40,567,600
Monterey	248,000	7,033,769	.0469	.0507	275,500	10,022,379	.0526	308,000	12,778,276
Portland	554,668	916,304	.1056	.1556	590,600	1,705,250	.1806	610,000	2,247,125
Reno	121,068	2,855,189	.1801	.2031	160,000	5,046,920	.2146	185,000	6,777,859
Sacramento	805,937	12,812,457	.0217	.0272	941,300	22,280,378	.0300	1,038,800	29,810,780
San Diego	1,245,100	1,374,840	.0502	.0692[b]	1,679,200	3,034,999	.0787[b]	1,919,400	4,336,954
Santa Barbara	258,200	283,841	.0176	.0236	315,000	549,748	.0266	368,400	796,727
Stockton	291,900	9,023,007	.0285	.0350	339,000	15,251,790	.0383	366,400	19,829,046
Lake Tahoe	42,000	5,038,620	.6214	.7474	54,000	9,242,409	.8104	61,000	12,444,061
Total Bay Area Travel		55,461,298				99,740,190			134,457,153

b - Slope assumed to be same as that of Los Angeles. Since figures for PSA not available for 1965 or 1969, auto and air travel for 1969 calculated using Los Angeles slope with a k extrapolated from San Diego's 1965 k.

d - Sources: California Department of Finance and U.S. Bureau of Census

Bay Area Population Figures
(Nine Counties)

1965 -- 4,255,000
1967 -- 4,433,000
1969 -- 4,565,000
1970 -- 4,578,293
1980 -- 5,431,000[d]
1985 -- 5,970,000[d]

Figure A-2
k vs. Time

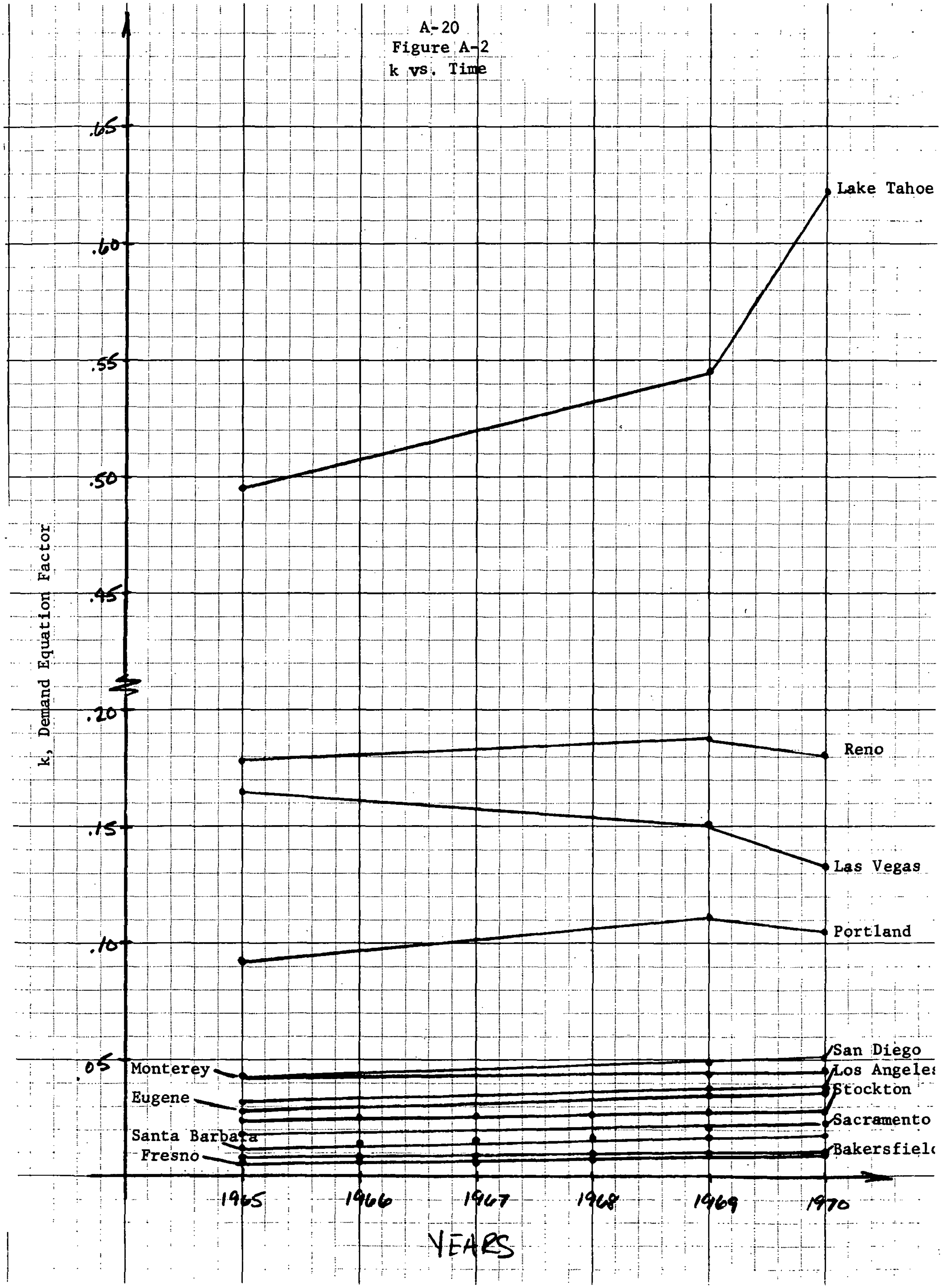


TABLE A- 7

CALIFORNIA POPULATION AND FORECASTS FOR COUNTIES AND METROPOLITAN STATISTICAL AREAS

Metropolitan Statistical Areas	Counties Included	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1980	1985
San Francisco-Oakland	Alameda	912,600	928,300	949,800	977,400	996,900	1,016,000	1,024,800	1,041,000	1,046,500	1,051,100	1,064,049	1,205,000	1,289,000
	Contra Costa	413,200	425,600	441,300	460,300	478,900	500,500	520,400	532,800	548,600	560,900	558,100	686,400	772,300
	Marin	148,800	154,900	161,500	170,000	177,100	185,200	190,600	196,400	202,200	203,600	203,300	259,200	296,200
	San Francisco	741,500	746,000	741,800	740,800	734,500	728,600	718,400	725,000	717,300	706,900	706,546	707,800	714,000
	San Mateo	449,100	460,200	475,700	488,500	499,200	511,300	520,200	533,000	545,900	550,400	556,000	612,800	644,700
San Jose	Santa Clara	658,700	706,800	759,200	814,900	856,300	893,600	926,400	963,600	1,001,100	1,032,600	1,070,000	1,383,800	1,571,500
Sacramento	Placer	57,500	60,100	63,800	66,900	70,900	75,500	77,600	77,800	78,500	80,300	77,600	95,000	109,600
	Sacramento	510,300	533,900	557,600	577,900	591,900	604,300	613,100	620,400	624,100	632,600	636,137	727,300	792,100
	Yolo	66,400	69,200	72,700	75,600	77,300	80,300	82,100	84,300	84,600	86,700	92,200	119,000	137,100
Stockton	San Joaquin	251,700	256,800	261,300	265,200	267,800	275,200	282,100	285,400	290,700	293,900	291,900	339,000	366,400
Fresno	Fresno	3[illegible]8,500	376,400	384,200	391,100	394,700	405,100	410,500	415,400	415,200	417,500	413,700	453,900	480,000
L.A.-Long Beach	Los Angeles	6,071,900	6,217,500	6,351,700	6,537,700	6,668,100	6,772,500	6,816,800	6,912,200	6,960,700	7,000,800	7,006,600	7,653,600	8,163,800
San Diego	San Diego	1,049,000	1,083,200	1,120,700	1,146,800	1,159,300	1,179,700	1,226,700	1,257,400	1,307,000	1,366,500	1,245,100	1,679,200	1,919,400
San Bernardino	San Bernardino	509,000	524,300	542,100	571,800	601,300	627,100	637,100	657,100	673,000	687,500	669,300	832,000	948,500
Riverside-Ontario	Riverside	311,700	320,600	337,900	351,800	382,600	403,200	419,900	427,500	434,300	442,500	454,600	565,900	646,900
Bakersfield	Kern	294,900	302,800	305,000	311,300	317,400	325,600	328,900	331,000	334,500	340,000	325,500	362,200	383,800
Santa Barbara	Santa Barbara	173,600	189,400	212,200	228,700	238,400	245,500	249,500	253,200	256,100	269,900	258,200	315,000	368,400
Anaheim-Santa Ana-Garden Grove	Orange	719,500	787,700	866,800	964,000	1,057,500	1,135,700	1,200,600	1,260,400	1,318,500	1,378,300	1,419,200	1,928,700	2,195,400
Vallejo-Napa	Napa	66,400	68,100	69,400	70,400	72,500	74,200	75,300	76,100	78,500	80,800	79,400	102,500	123,800
	Solano	137,100	139,800	144,100	152,000	157,000	163,000	167,800	173,200	175,900	174,800	156,200	198,600	238,600
Oxnard-Ventura	Ventura	203,100	218,200	235,800	257,100	285,000	309,200	329,300	344,800	353,000	369,100	376,200	571,200	736,200
Salinas-Monterey	Monterey	195,300	196,100	203,800	210,400	217,300	214,800	233,100	241,700	241,800	244,900	248,000	275,500	308,000

Source: U.S. Census, 1960, 1970.
State Department of Finance, Population Research Unit, October, 1971

TABLE A-8

OREGON POPULATION AND FORECASTS FOR COUNTIES AND METROPOLITAN STATISTICAL AREAS

Metropolitan Statistical Area	Counties Included	1960	1970	1980	1985
Eugene	Lane	162,890	215,401	280,000	320,000
Portland	Multnomah	522,813	554,668	590,600	610,000

Source: U.S. Bureau of the Census.
: Study Group Population Forecast

TABLE A-9

NEVADA POPULATION AND FORECASTS FOR COUNTIES AND STATISTICAL AREAS

Statistical Area	Counties Included	1960	1970	1980	1985
Reno	Washoe	84,773	121,068	160,000	185,000
Las Vegas	Clark	127,016	273,288	500,000	650,000

Source: U.S. Bureau of the Census
: Study Group Population Forecast

TABLE A-10

TAXABLE RETAIL SALES - CALIFORNIA 1960, 1962-1970

(Thousands of Dollars)

Metropolitan Area	Counties Included	1960	1962	1963	1964	1965	1966	1967	1968	1969	1970
San Francisco-Oakland	Alameda	1,455,551	1,602,466	1,713,600	1,834,037	1,977,638	2,063,250	2,054,136	2,232,226	2,392,676	2,396,807
	Contra Costa	418,502	488,480	529,858	589,221	667,894	712,485	735,029	833,865	897,625	938,130
	Marin	160,179	186,283	211,699	233,974	251,679	257,076	269,724	311,412	338,999	347,630
	San Francisco	1,753,372	1,787,803	1,817,056	1,914,069	1,960,762	2,047,415	2,096,289	2,208,810	2,281,352	2,232,644
	San Mateo	616,874	717,625	792,731	859,085	934,895	1,003,824	1,036,795	1,159,632	1,265,931	1,279,371
San Jose	Santa Clara	922,287	1,112,436	1,223,979	1,323,298	1,413,663	1,547,616	1,683,144	1,920,530	2,111,428	2,165,808
Sacramento	Placer	68,132	72,729	86,187	93,917	100,825	100,830	101,424	113,434	123,466	132,564
	Sacramento	734,789	813,186	901,113	944,249	987,279	1,021,045	1,031,330	1,158,340	1,227,974	1,293,460
	Yolo	81,646	95,833	106,959	115,401	125,902	133,140	130,765	146,274	154,113	157,291
Stockton	San Joaquin	309,647	342,806	364,408	409,868	436,846	464,930	471,137	511,485	545,157	570,158
Fresno	Fresno	518,718	541,592	567,056	613,884	653,354	692,671	680,856	752,747	798,958	833,810
L.A.-Long Beach	Los Angeles	9,841,136	10,809,944	11,411,081	12,178,719	12,479,288	13,397,815	13,574,999	14,783,633	15,953,701	15,839,730
San Diego	San Diego	1,183,883	1,229,971	1,282,044	1,385,419	1,451,292	1,616,441	1,740,422	2,068,844	2,343,600	2,478,538
San Bernardino	San Bernardino	547,571	637,719	719,867	803,663	818,692	861,623	877,687	1,011,146	1,113,188	1,171,515
Riverside-Ontario	Riverside	356,225	418,972	480,236	538,802	566,297	588,297	598,735	700,738	783,598	828,578
Bakersfield	Kern	398,021	422,174	449,451	475,669	515,575	532,642	546,056	601,060	634,017	654,158
Santa Barbara	Santa Barbara	245,655	307,503	324,535	334,510	347,308	375,687	404,658	438,144	479,907	481,963
Anaheim-Santa Ana-Orange Grove	Orange	906,118	1,176,459	1,367,460	1,566,955	1,668,286	1,829,456	2,006,977	2,391,968	2,732,289	2,876,776
Vallejo-Napa	Napa	67,166	78,936	82,686	89,371	97,974	100,931	111,217	123,387	134,184	127,523
	Solano	125,968	139,671	156,243	174,213	186,261	196,123	206,344	237,370	230,151	248,446
Oxnard-Ventura	Ventura	221,563	280,648	313,152	364,774	377,305	395,131	410,378	492,697	579,726	613,232
Salinas Monterey	Monterey	216,983	242,007	261,682	283,913	304,184	318,983	322,356	370,237	391,587	406,199
Sonoma	Sonoma	179,856	205,587	230,512	253,573	274,297	279,710	280,442	319,178	365,012	385,310
Lake Tahoe	El Dorado	43,196	44,910	51,590	57,411	63,935	59,943	56,352	63,157	68,824	75,628

Source: California Chamber of Commerce, Economic Development and Research Department, July, 1971.

Table A-11

1960, 1963, 1965-69 EMPLOYMENT FOR CALIFORNIA
(All Industries, Average Monthly Employment Covered by the Unemployment Insurance Code)

County	1960	1963	1965	1966	1967	1968	1969
Alameda	223,512	237,948	257,048	268,443	271,512	283,561	293,981
Contra Costa	66,502	76,141	85,140	89,693	90,026	95,412	101,097
El Dorado	5,404	5,676	6,724	7,471	6,545	7,044	7,675
Fresno	65,485	69,696	106,525	111,244	108,206	114,378	116,725
Kern	49,155	50,988	74,530	77,322	78,943	79,427	80,462
Los Angeles	1,846,260	1,977,648	2,066,473	2,208,555	2,265,318	2,344,417	2,427,931
Marin	18,082	22,406	26,020	26,445	27,210	28,966	31,321
Monterey	27,834	31,449	49,350	51,912	53,113	55,942	56,654
Napa	8,080	8,697	11,257	12,297	12,512	13,531	13,876
Orange	136,134	210,598	248,651	275,951	299,338	321,466	345,292
Placer	7,499	8,828	11,798	11,206	10,880	11,589	12,336
Riverside	50,699	61,269	81,453	85,181	82,904	88,395	95,027
Sacramento	99,530	114,086	116,736	120,214	117,945	119,022	120,780
San Bernardino	75,281	85,224	100,597	107,121	110,946	115,227	122,988
San Diego	196,251	189,677	199,306	219,416	232,091	254,529	278,744
San Francisco	337,049	341,835	347,058	354,594	362,070	368,861	381,490
San Joaquin	43,364	46,236	70,212	73,939	74,836	76,364	77,017
San Mateo	92,427	106,939	118,784	128,310	136,285	147,156	156,090
Santa Barbara	35,065	47,343	52,056	56,717	58,061	59,000	62,189
Santa Clara	153,733	196,591	218,552	248,770	268,955	289,789	307,939
Solano	13,979	16,129	20,339	22,200	23,147	24,610	25,171
Sonoma	22,463	26,633	33,867	35,325	34,212	36,651	38,833
Ventura	31,976	40,377	58,109	60,055	61,313	64,341	69,130
Yolo	9,171	10,274	16,763	17,691	17,402	18,225	17,885

Source: "Covered Employment" for the years 1960, 1963, 1965, 1966, 1967, 1968, 1969, by the Department of Employment, Research and Statistics.

Table A-12

NUMBER OF TELEPHONE STATIONS IN CALIFORNIA

County	1965[a]	1966[a]	1967[a]	1968[a]	1969[a]	1970[a]
Alameda	616,114	642,612	662,672	689,834	713,195	735,650
Contra Costa	247,185	264,704	281,905	300,550	314,404	328,771
El Dorado	22,503	23,485	24,166	25,236	26,596	28,534
Fresno	197,030	205,643	211,586	220,552	227,730	236,728
Kern	158,125	164,406	167,869	175,825	184,243	190,219
Los Angeles	4,251,132	4,451,315	4,639,004	4,851,001	5,019,829	5,102,157
Marin	111,032	117,264	123,240	129,759	134,877	137,403
Monterey	108,460	114,680	118,910	123,973	129,217	134,632
Napa	35,918	37,902	40,081	42,111	44,118	46,417
Orange	624,879	688,281	752,864	821,250	877,910	925,627
Placer	41,210	43,970	45,816	48,746	51,527	55,414
Riverside	205,658	222,192	236,698	255,777	270,273	285,718
Sacramento	352,421	370,591	383,570	397,806	409,513	424,979
San Bernardino	258,905	275,027	295,150	317,046	331,307	346,128
San Diego	634,136	678,352	718,610	771,355	820,093	866,726
San Francisco	636,154	658,216	671,801	693,787	713,534	723,909
San Joaquin	128,526	135,794	141,680	148,116	152,313	158,509
San Mateo	229,658	245,817	262,874	275,447	285,845	294,469
Santa Barbara	129,564	137,036	147,886	157,866	166,628	171,761
Santa Clara	554,560	600,576	640,367	685,459	730,689	763,282
Solano	80,115	85,636	90,989	95,064	97,751	102,351
Sonoma	95,152	100,824	105,858	112,613	118,997	125,393
Ventura	143,176	154,153	166,266	183,107	195,799	207,588
Yolo	27,182	30,122	32,359	34,368	36,547	38,724

Sources: California Statistical Abstract, 1970 and 1971.

[a]As of December 31 of the indicated year.

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APPENDIX B

A Study of the Distribution of
1985 AIR PASSENGER TRAFFIC IN THE SAN FRANCISCO BAY AREA
Forecast Model Using 98 BASAR Traffic Generation Zones

This study is concerned with the nine-county Bay Area as a generator and collector of commercial air passenger traffic in 1985. Any method for forecasting future travel must first consider the great number of factors which determine the level of air traffic demand. These factors must then be combined, with each factor given a relative weight of influence on air passenger travel.

Systems Analysis and Research Corporation (SARC) developed a forecast equation for use in the Regional Airport Systems Study (RASS) which analyzes the effects of alternate inputs for the three independent variable factors considered to be the most important indicators of air passenger travel: population, employment, and income.[1]

The equation is:

$$T_z = P_z A_j \left(3.8915 \frac{E_z}{P_z} + 1.5439 \frac{Y_z}{P_z} - 469.966\right)$$

where

T_z = annual enplaned and deplaned passenger traffic, in thousands, generated in the zone,

P_z = resident population of the zone in hundred thousands, and

A_j = adjustment factors 1975 = .885
1980 = .901
1985 = .969

Adjustment factors are used to reflect possible changes in future conditions and trends--they are derived from a number of assumptions/predictions in the following areas:[2]

- national and international economy
- national air traffic growth patterns
- number and location of markets
- tourism
- technological development of aviation; aircraft types and mix
- competing modes of transportation
- air travel cost and quality

- access and capacity
- flying patterns; percentage of business travel; origin and destination from home or work
- spending patterns and the use of discretionary income and leisure time

E_z = number of people working in the zone, in thousands

Y_z = total annual personal income of residents of the zone, in millions of dollars

It is important to note that connecting traffic is not computed in the above formula. The formula is for determining the zone's capacity as a point of origin or destination. Connecting traffic is estimated to be 15 per cent of total traffic; therefore, the product of this formula (T_z) is 85 per cent of the total traffic.

Clearly, the air passenger forecasts derived from the above equation depend on accurate forecasts of the three variable indicators. It is important that estimations of population, employment, and income be as reliable as possible.

Population:

Population is an important factor for determining the generating capability of an area and for "deflating" the effects of the other independent variables. The original BASAR forecast model used population figures computed by the Bay Area Transportation Study Commission (BATSC) in 1965. These projections are broken down by county in Chart B-1. Compared with later downward revisions by the Department of Finance, the BATSC forecast would appear to be a "ceiling" for 1985 population. The "floor" for 1985 population is the 1970 Census figure, with an assumed zero population growth, that is, a 1985 population which is identical to present population levels.

If estimation of population growth was ever easy because of well-defined historical trends, the task today is complicated by factors not previously applicable. These include concern for environmental quality, discussion of the Bay Area's "carrying capacity," and the desire for population growth control. It may no longer be sufficient to merely predict growth rates in an area where many people feel that growth trends must be consciously guided by public policy decisions.

Employment:

Employment figures indicate high employment areas from and to which business travel is likely to occur. (Business travelers currently make up at least 50 per cent of the total airline passenger traffic enplaned and deplaned at Bay Area airports.[3]) Projections listed by county in Chart B-2 show an estimate-range between the high employment estimate of 2,970,000 (BATSC forecast plus 5 per cent) and the low estimate of 2,011,000 (BATSC forecast less the percentage that Census Population in 1970 is lower than BATSC Population in 1985). Note that the BATSC forecast is by far the highest employment estimate,

Chart B-1

1985 Population (000) Projection Used for Equation Input

County	BATSC Forecast	Dept. of Finance Forecast	1970 Census (zero population growth)
Alameda	1548	1289	1078
Contra Costa	949	772	558
Marin	358	296	206
Napa	122	124	79
San Francisco	817	714	716
San Mateo	831	645	556
Santa Clara	1606	1572	1065
Solano	311	239	170
Sonoma	324	320	205
TOTAL	6866	5971*	4628

*Does not include 50,000 military personnel

Chart B-2

1985 Employment (000) Projection Used for Equation Input

County	BATSC Forecast	"OBERS" Forecast (Fed.) State Dept. of Water Resources)	BATSC Forecast plus 5%	BATSC Forecast less 10%
Alameda	659	562	692	593
Contra Costa	242	183	254	217
Marin	88	66	93	79
Napa	50	29	52	45
San Francisco	653	639	686	588
San Mateo	334	261	350	300
Santa Clara	607	540	637	546
Solano	95	63	100	86
Sonoma	101	79	106	91
TOTAL	2829	2422	2970	2545

County	BATSC Forecast less 20%	BATSC Forecast less the percentage that DOF Pop. is lower than BATSC Pop.	BATSC Forecast less the percentage that Census Pop. in 1970 is lower than BATSC Pop. in 1985
Alameda	528	547	462
Contra Costa	193	196	143
Marin	71	74	51
Napa	40	50	32
San Francisco	523	568	575
San Mateo	267	260	224
Santa Clara	486	595	401
Solano	76	83	59
Sonoma	81	100	64
TOTAL	2265	2473	2011

excepting, of course, the BATSC plus 5 per cent estimate. Downward revision may be necessary, thus the various other employment totals in Chart B-2.

Income:

Income is a good indicator of the economic ability of residents to use air service. (The median family income of travelers surveyed in the State Aviation Study by DMJM[4] was $17,700.) Chart B-3 shows various estimates of 1985 personal income (by county, in millions of dollars). The highest estimate is that made by Systems Analysis Research Corporation--SARC forecast (61,163), also SARC forecast plus 5 per cent (64,218). The lowest income estimate is one using the SARC forecast less the percentage that Census Population is lower than BATSC Population (on a county-by-county basis).

Given the variations in these indicators (which cause consequent variations in the 1985 passenger forecasts, since the forecasts are a function of these indicators), it is necessary to apply several values to population, employment, and personal income. The goal is to obtain predictions for future travel which give a useful range of estimates for each county in 1985.

To arrive at such a range, twelve combinations of 1985 estimates for population, employment, and personal income were plugged into the formula. All twelve configurations are listed in Supplement 1. The annual air passenger traffic is derived for each of the nine counties in every configuration. Configuration 1 is the base run, which is the set of estimates used by SARC in the BASAR Aviation Forecast, May 1970. Chart B-4 summarizes the results of these calculations. For example, Configuration 1 yields passenger estimates of 14,237,000 for Alameda County, 8,648,000 for Contra Costa County, and so on, for a total annual passenger estimate of 71,075,000 for the nine-county region (83,500,000 when connecting traffic is included). Regional totals appear along the left-hand margin of Chart B-4. Reading down each column shows how the county's estimated 1985 traffic varies depending on the configuration of the population/employment/income values. The symbol (L) denotes the configuration yielding the lowest estimated 1985 traffic in each county--this is Configuration 9 for six counties, Configuration 6 for two counties, and Configuration 10 for one county. Similarly, (H) denotes the configuration yielding the highest estimated 1985 traffic in each county--this is Configuration 12 for eight counties, and Configuration 2 for one county. The base run (Configuration 1) is, in the case of every county, definitely closer to the value of (H) than the value of (L). Regional totals align themselves in nearly the same manner--Configuration 9 being the lowest estimate for 1985 traffic, Configuration 12 being the highest estimate, and the base run being closer to (H) than (L).

Some detailed comparisons between the base run and other configurations are as follows:

BATSC Population:

- Increase of per capita employment and income by 5 per cent yields

  Increase of total passengers by 5.1 million (Configuration 2).

Chart B-3

Personal Income (000) Projection Used for Equation Input

County	SARC Forecast	SARC Forecast plus 5%	SARC Forecast less 10%	SARC Forecast less 20%
Alameda	12,566	13,194	11,300	10,053
Contra Costa	8,059	8,462	7,260	6,447
Marin	3,974	4,173	3,580	3,179
Napa	864	907	776	691
San Francisco	9,088	9,542	8,160	7,270
San Mateo	9,196	9,655	8,260	7,356
Santa Clara	13,405	14,075	12,080	10,724
Solano	1,893	1,987	1,700	1,514
Sonoma	2,118	2,223	1,904	1,694
TOTAL	61,163	64,218	55,020	48,928

County	SARC Forecast less the percentage that DOF Pop. is lower than BATSC Pop.	SARC Forecast less the percentage that Cen. Pop. is lower than BATSC Pop.	SARC Forecast less the percentage that OBERS Empl. is lower than BATSC Employment
Alameda	10,430	8,796	10,720
Contra Costa	6,528	4,755	6,050
Marin	3,338	2,305	2,977
Napa	872	553	505
San Francisco	7,906	7,997	8,900
San Mateo	7,173	6,161	7,350
Santa Clara	13,137	8,847	11,760
Solano	1,647	1,173	1,243
Sonoma	2,096	1,334	1,657
TOTAL	53,127	41,921	51,162

- Decrease of per capita employment and income by 10 per cent yields

  Decrease of total passengers by 12.0 million (Configuration 4).

DOF Population:

- No change in per capita employment and income yields

  Decrease of total passengers by 11 million (Configuration 5).

- OBERS figures used, which generally decrease per capita employment; income proportionally decreased yields

  Decrease of total passengers by 14.8 million (Configuration 6).

- OBERS figures used, which generally decrease per capita employment; increase of per capita income by approximately 10-15 per cent yields

  Increase of total passengers by 2.7 million (Configuration 7).

1970 Census Population (zero population growth):

- No change in per capita employment and income yields

  Decrease of total passengers by 25.6 million (Configuration 9). Lowest regional 1985 traffic estimate.

- Increase of per capita employment and income by approximately 30 per cent yields

  Increase of total passengers by 12 million (Configuration 12). Highest regional 1985 traffic estimate.

Although data have been presented for total county traffic, one can further narrow the scope of 1985 traffic estimates by studying the generation capability of 98 BASAR zones--shown in the large accompanying map of the nine-county Bay Area (See Supplement 2 for a discussion of the basis for establishing these traffic generation zones).

SARC has estimated the 1985 totals (also 1975 and 1980, see Supplement 3) for "Enplaning and Deplaning Passengers Generated by BASAR Zone." These estimates are identical to the base run forecasts discussed earlier - they do not, of course, include the 15 per cent connecting traffic.

The following tables (Charts B-5 through B-11) summarize the 1985 traffic generation totals for each zone derived from the base run - configuration 1. Note that each "County Total" is the total found in the first row (base run) of Charts B-4 and B-5). Calculations were then performed to determine what percent of each county's traffic for 1985 would be generated in particular zones. This percentage figure appears in the third column, e.g., 1 per cent of Alameda County's traffic in 1985 will be generated by BASAR zone

Chart B-4

1985 ANNUAL PASSENGER TRAFFIC (000) GENERATED BY COUNTY

Regional Total (000) for Each Configuration (15% Connecting Traffic Not Included)	Configuration Number	Alameda	Contra Costa	Marin	Napa	San Francisco	San Mateo	Santa Clara	Solano	Sonoma
(71,075)[a]	1	14,237[a]	8,498[a]	4,651[a]	927[a]	12,341[a]	11,234[a]	15,030[a]	2,111[a]	2,074[a]
(76,183)	2	15,302	9,296	4,965	1,001	13,144 (H)	11,984	16,147	2,093	2,251
(75,649)	3	15,177	9,251	4,948	992	13,020	11,921	16,033	2,075	2,232
(60,811)	4	12,093	7,357	4,027	777	10,707	9,706	12,819	1,609	1,716
(61,617)	5	11,797	6,989	3,926	930	10,720	8,775	14,737	1,687	2,056
(58,472)	6	12,286	6,223	3,354	300 (L)	12,472	9,040	12,471	1,006 (L)	1,320
(73,332)	7	15,047	9,229	4,746	837	12,753	11,801	14,932	1,978	2,009
(74,978)	8	15,416	9,453	4,931	916	12,807	12,078	15,184	2,101	2,092
(49,218) (L)	9	10,014 (L)	5,110 (L)	2,704 (L)	588	10,871	7,529 (L)	9,897 (L)	1,203	1,302 (L)
(60,661)	10	12,142	7,834	4,085	824	9,587 (L)	9,480	13,025	1,778	1,906
(77,999)	11	15,653	10,053	5,201	1,053	12,503	12,068	16,715	2,279	2,474
(81,094) (H)	12	16,399 (H)	10,427 (H)	5,341 (H)	1,121 (H)	12,798	12,484 (H)	17,493 (H)	2,415 (H)	2,616 (H)
(55,417)	$\left(\frac{5+9}{2}\right)^b$	10,905	6,049	3,315	759	10,795	8,152	12,317	1,445	1,679

[a] Base Run.

[b] Recommended 1985 level (see page 17).

Chart B-5

ALAMEDA COUNTY

BASAR Zone No.	1985 BASAR Forecast (Base Run)	% of Total County Traffic	Lowest Forecast Configuration 9	Highest Forecast Configuration 12	Revised % of Total County Traffic	Revised 1985 Forecast Configuration $\left(\frac{5+9}{2}\right)$
40	225,111	1.0	100,140	163,990	1.0	109,050
41	447,127	3.0	300,420	491,970	2.0	218,110
42	370,842	3.0	300,420	491,970	2.0	218,110
43	237,127	2.0	200,280	327,980	1.0	109,050
44	696,126	5.0	500,700	819,950	3.0	327,165
45	1,169,995	8.0	800,120	1,311,920	6.0	654,330
46	226,904	2.0	200,280	327,980	1.0	109,050
47	525,247	4.0	400,560	655,960	3.0	327,165
48	1,244,820	9.0	901,260	1,475,910	8.0	872,440
49	1,872,024	13.0	1,301,820	2,131,870	14.0	1,526,770
50	934,168	6.0	600,840	983,940	6.0	654,330
51	865,797	6.0	600,840	983,940	6.0	654,330
52	795,856	6.0	600,840	983,940	6.0	654,330
53	648,296	5.0	500,700	819,950	4.0	436,220
54	492,790	3.0	300,420	491,970	5.0	545,275
55	455,446	3.0	300,420	491,970	5.0	545,275
56	640,604	4.0	400,560	655,960	5.0	545,275
57	262,065	2.0	200,280	327,980	2.0	218,110
58	552,115	4.0	400,560	655,960	4.0	436,220
59	591,481	4.0	400,560	655,960	5.0	545,275
60	342,926	2.0	200,280	327,980	4.0	436,220
61	640,780	5.0	500,700	819,950	5.0	545,275
	14,237,647		10,014,000	16,399,000		10,905,000

Chart B-6

CONTRA COSTA COUNTY

BASAR Zone No.	1985 BASAR Forecast (Base Run)	% of Total County Traffic	Lowest Forecast Configuration 9	Highest Forecast Configuration 12	Revised % of Total County Traffic	Revised 1985 Forecast Configuration $\left(\frac{5+9}{2}\right)$
62	692,618	8.0	408,800	834,160	10.0	604,950
63	225,766	3.0	153,300	312,810	4.0	241,980
64	560,713	6.0	306,600	625,620	8.0	483,960
65	508,144	6.0	306,600	625,620	6.0	362,970
66	759,115	9.0	459,900	938,430	7.0	423,465
67	685,328	8.0	408,800	834,160	7.0	423,465
68	596,547	7.0	357,700	729,890	8.0	483,960
69	585,321	7.0	357,700	729,890	6.0	362,970
70	1,204,211	14.0	715,400	1,459,780	16.0	967,920
71	1,384,394	16.0	817,600	1,668,320	15.0	907,425
72	152,578	2.0	102,200	208,540	1.0	60,495
73	661,024	8.0	408,800	834,160	7.0	423,465
74	482,535	6.0	306,600	625,620	4.0	241,980
	8,498,293		5,110,000	10,427,000		6,049,500

Chart B-7

MARIN COUNTY

BASAR Zone No.	1985 BASAR Forecast (Base Run)	% of Total County Traffic	Lowest Forecast Configuration 9	Highest Forecast Configuration 12	Revised % of Total County Traffic	Revised 1985 Forecast Configuration $\left(\frac{5+9}{2}\right)$
93	490,613	10.0	270,400	534,100	9.0	298,350
94	1,196,905	26.0	703,040	1,388,660	20.0	663,000
95	1,062,400	23.0	621,920	1,228,430	26.0	861,900
96	468,839	10.0	270,400	534,100	9.0	298,350
97	1,025,530	22.0	594,880	1,175,020	26.0	861,900
98	406,664	9.0	243,360	480,690	10.0	331,500
	4,650,951		2,704,000	5,341,000		3,315,000

NAPA COUNTY

BASAR Zone No.	1985 BASAR Forecast (Base Run)	% of Total County Traffic	Lowest Forecast Configuration 9	Highest Forecast Configuration 12	Revised % of Total County Traffic	Revised 1985 Forecast Configuration $\left(\frac{5+9}{2}\right)$
81	69,885	28.0	84,000	313,880	22.0	166,980
82	129,877	39.0	117,000	437,190	41.0	311,190
83	15,727	5.0	15,000	56,050	5.0	37,950
84	45,884	12.0	36,000	134,520	15.0	113,850
85	51,922	16.0	48,000	179,360	17.0	129,030
	926,888		300,000	1,121,000		759,000

Chart B-8

SAN FRANCISCO COUNTY

BASAR Zone No.	1985 BASAR Forecast (Base Run)	% of Total County Traffic	Lowest Forecast Configuration 9	Highest Forecast Configuration 12	Revised % of Total County Traffic	Revised 1985 Forecast Configuration $\left(\frac{5 + 9}{2}\right)$
1	733,446	6.0	575,220	788,640	8.0	863,640
2	1,745,838	15.0	1,438,050	1,971,600	17.0	1,835,235
3	825,665	7.0	671,090	920,080	7.0	755,684
4	907,650	7.0	671,090	920,080	9.0	971,595
5	1,135,499	9.0	862,830	1,182,960	8.0	863,640
6	1,402,125	11.0	1,054,570	1,445,840	11.0	1,187,505
7	1,263,833	10.0	958,700	1,314,400	10.0	1,079,550
8	740,736	6.0	575,220	788,640	5.0	539,775
9	823,422	7.0	671,090	920,080	6.0	647,730
10	1,102,954	9.0	862,830	1,182,960	7.0	755,685
11	435,378	3.0	287,610	394,320	3.0	323,865
12	805,655	7.0	671,090	920,080	5.0	539,775
13	418,314	3.0	287,610	394,320	3.0	323,865
	12,340,515		9,587,000	13,144,000		10,795,000

Chart B-9

SAN MATEO COUNTY

BASAR Zone No.	1985 BASAR Forecast (Base Run)	% of Total County Traffic	Lowest Forecast Configuration 9	Highest Forecast Configuration 12	Revised % of Total County Traffic	Revised 1985 Forecast Configuration $\left(\frac{5+9}{2}\right)$
14	921,334	8.0	602,320	998,720	6.0	489,120
15	1,944,675	17.0	1,279,930	2,122,280	13.0	1,059,160
16	570,819	5.0	376,450	624,200	3.0	244,560
17	841,131	7.0	527,030	873,880	10.0	815,200
18	1,000,611	9.0	677,610	1,123,560	13.0	1,059,760
19	1,421,354	13.0	978,770	1,622,920	11.0	896,720
20	360,721	3.0	225,870	374,520	2.0	163,040
21	1,724,734	15.0	1,129,350	1,872,600	16.0	1,304,320
22	1,585,439	14.0	1,054,060	1,747,760	16.0	1,304,320
23	581,599	5.0	376,450	624,200	6.0	489,120
24	281,293	3.0	225,870	374,520	2.0	163,040
	11,233,710		7,529,000	12,484,000		8,152,000

Chart B-10

SANTA CLARA COUNTY

BASAR Zone No.	1985 BASAR Forecast (Base Run)	% of Total County Traffic	Lowest Forecast Configuration 9	Highest Forecast Configuration 12	Revised % of Total County Traffic	Revised 1985 Forecast Configuration $\left(\frac{5+9}{2}\right)$
25	944,137	6.0	593,820	1,049,580	10.0	1,231,700
26	960,850	6.0	593,820	1,049,580	8.0	985,360
27	371,433	2.0	197,940	349,860	3.0	369,510
28	551,133	4.0	395,880	699,720	4.0	492,680
29	1,478,862	10.0	989,700	1,749,300	11.0	1,354,870
30	665,966	4.0	395,880	699,720	5.0	615,850
31	730,146	5.0	494,850	874,650	4.0	492,680
32	1,407,286	10.0	989,700	1,749,300	9.0	1,108,530
33	1,090,007	7.0	692,790	1,224,510	7.0	862,190
34	1,617,374	11.0	1,088,670	1,924,230	12.0	1,478,040
35	1,087,236	7.0	692,790	1,224,510	8.0	985,360
36	1,196,470	8.0	791,760	1,399,440	6.0	739,020
37	1,584,232	11.0	1,088,670	1,924,230	7.0	862,190
38	1,117,569	8.0	791,760	1,399,440	4.0	492,680
39	227,165	1.0	98,970	174,930	1.0	123,170
	15,029,867		9,897,000	17,493,000		12,317,000

Chart B-11

SOLANO COUNTY

BASAR Zone No.	1985 BASAR Forecast (Base Run)	% of Total County Traffic	Lowest Forecast Configuration 9	Highest Forecast Configuration 12	Revised % of Total County Traffic	Revised 1985 Forecast Configuration $\left(\frac{5+9}{2}\right)$
75	683,506	33.0	331,980	796,950	42.0	606,900
76	418,470	20.0	201,200	483,000	15.0	216,750
77	478,389	23.0	231,380	555,450	20.0	289,000
78	51,986	2.0	20,120	48,300	2.0	28,900
79	263,674	12.0	120,720	289,800	12.0	173,400
80	215,529	10.0	100,600	241,500	10.0	144,500
	2,111,554		1,006,000	2,415,000		1,445,000

SONOMA COUNTY

BASAR Zone No.	1985 BASAR Forecast (Base Run)	% of Total County Traffic	Lowest Forecast Configuration 9	Highest Forecast Configuration 12	Revised % of Total County Traffic	Revised 1985 Forecast Configuration $\left(\frac{5+9}{2}\right)$
86	410,980	20.0	260,400	523,200	20.0	335,800
87	240,034	12.0	156,240	313,920	12.0	201,480
88	185,002	9.0	117,180	235,440	7.0	117,530
89	546,010	26.0	338,520	680,160	31.0	520,490
90	232,167	11.0	143,220	287,760	12.0	201,480
91	162,069	8.0	104,160	209,280	10.0	167,900
92	297,270	14.0	182,280	366,240	7.0	117,530
	2,073,532		1,302,000	2,616,000		1,679,000

No. 40. (See Supplement 4 for tables concerning each county's percent of total regional traffic in 1962, 1967, 1968, 1975, 1980, and 1985.)

Assume that these "relative strength" zone percentages are the same for the totals derived from each of the twelve configurations; i.e., the third column was derived from a "what percent of the county total is the zone estimate?" calculation, now, using these percentages (from base run), plug in eleven other county totals (Configurations 2 through 12), multiply by given percentages, and one obtains eleven new estimates for each zone--in fact, an estimate range for 1985 generated travel in each zone.

Charts B-5 through B-11 show four 1985 air travel forecasts for each of the 98 Bay Area zones--enplaning and deplaning passengers generated by zone, not including 15 per cent connecting traffic. The first column of each chart shows the zone breakdown for the original BASAR forecast for 1985--Configuration 1 in Supplement 1. Column 2 shows the percentage relationship between the zone and the county traffic in 1985. Columns 3 and 4 show the zone estimates for each county which are the lowest and highest 1985 forecasts, respectively. (See Chart B-4). These are the totals derived from the configurations yielding the lowest traffic forecasts--usually Configuration 9--and the highest forecast--usually Configuration 12.

From an aviation planning perspective, one can reasonably expect that 1985 traffic will be between the two extreme estimates. Note that for each zone this is a numerical range of approximately 200,000 to 300,000 passengers annually. (Where BASAR Forecasts--Column 1, Charts 5 through 11--do not lie between high and low estimates, error is due to rounding and subsequent multiplying of rounded numbers in the calculation process.)

One must note, however, that Configuration 9 (which gives the lowest 1985 forecast--see Chart B-4) assumes NO POPULATION GROWTH, a highly improbable, if not impossible assumption for 1985. Similarly, Configuration 12 (which yields the highest 1985 forecast--see Chart B-4) is based on an even more unlikely assumption--that population will be at the 1970 level, with large increments in per capita employment and income.

It was decided, therefore, that a realistic 1985 traffic forecast would be between Configuration 9 (a lower bound) and Configuration 5 (an upper bound). Configuration 5 assumes a population forecast (Department of Finance) which is lower than the original BASAR base run, while per capita employment and income are assumed to be the same as the base run.

Further, the zone percentages in column 2 (derived from 1985 base run estimates for each county) were revised to represent more realistic growth forecasts for each zone. Revised estimates are derived from the 1975 forecasts (instead of the 1985 forecasts) in the tables of Supplement 3. In this way, account is made for the recent changes in public attitude toward development and population growth that has occurred since the base run estimate was calculated in 1968 for the BASAR report. The assumption is that the revised percentages better reflect the decelerated growth rate of air travel to and from each zone in recent years.

Using these revised percentages and a configuration compromise

$$\frac{\text{Config. 5 + Config. 9}}{2}$$

which falls between the realistic upper and lower bounds of the forecast range, the last column of Charts B-5 through B-11 is derived. This is the revised forecast for 1985 air travel. (Note that the totals under the columns on Charts B-5 through B-11 show at a glance the range of configuration-dependent forecasts for each county in 1985.)

It is difficult to summarize findings which have such wide variation in traffic forecasts--such as in each zone. Yet it is important to realize that this degree of flexibility does exist, due to the wide spectrum of possible development in each zone and county, as well as economic development at a regional or national level.

Further, other factors affecting air travel (access, travel comfort, etc.) may be quantified, pending more study in this area. This should yield more refined estimates and narrower estimate ranges, thus raising the confidence level of the forecast. Lastly, one must note the fact that it is very likely that one of the configurations discussed (especially the revised estimate) will be an accurate representation of population, employment, and income in 1985. The given forecasts--variable though they be--are an important basis from which a useful aviation system may be planned.

Another way to look at confidence levels in these forecasts is to relate to probable time bands, rather than to the traffic percentage ranges as of a particular time usually used. This way of viewing the confidence range in the forecasts is prompted by the long lead-times in airport planning and the rapid rates of growth in air traffic. For example, if two domestic passenger traffic forecasts were to differ by 20 percent for 1985--an apparently large disagreement--the actual difference with traffic growing 10 percent annually, would be that the higher forecast would project a particular level of traffic that would be attained in 1984, while the lower one would expect the same level in 1986. In an airport's long-range planning for expansion, such a variation would be a matter of fine-tuning the timing of later development phases. As a practical matter this would be done anyway, based on actual experience accumulated during the course of the next decade.

Footnote References

1. Regional Airport Systems Study Committee, "Aviation Forecast: Assumptions/Issues Paper."

2. Systems Analysis and Research Corporation, Aviation Forecast, pp. III-147 to III-149, May 1970.

3. Daniel, Mann, Johnson, and Mendenhall, Statewide Master Plan of Aviation, pp. 25, 37, March 1971.

4. Ibid.

Selected References

1. Regional Airport Systems Study Committee, Airport Access, Phase III (Wilbur Smith and Associates), September 1971.

2. Association of Bay Area Governments, Regional Plan 1970: 1990-San Francisco Bay Region, July 1970.

3. Association of Bay Area Governments, Regional Airport Systems Study, Technical Memorandum 11-3: Commercial Aviation Passenger Forecasting, February 1972.

4. Air Transport Association, A.T.A. Airline Airport Demand Forecasts, San Francisco/Oakland Report, pp. 5-6, January 1971.

5. Department of Finance, Financial and Population Research Section, Preliminary Projections of California Areas and Counties to 1985, April 20, 1967.

Appendix B - Supplement 1

	Alameda	Contra Costa	Marin	Napa	San Francisco	San Mateo	Santa Clara	Solano	Sonoma	Total
CONFIGURATION 1 (Base Run)*						Population: BATSC Employment: BATSC Income : SARC				
Annual Passengers (000)	14,237	8,498	4,651	927	12,341	11,234	15,030	1,933	2,074	71,075
						With 15% Connecting Traffic . . .				83,500
CONFIGURATION 2*						Population: BATSC Employment: BATSC + 5 % Income : SARC + 5%				
Annual Passengers (000)	15,302	9,296	4,965	1,001	13,144	11,984	16,147	2,093	2,251	76,183
						With 15% Connecting Traffic . . .				89,600
CONFIGURATION 3*						Population: BATSC Employment: BATSC Income : SARC + 5%				
Annual Passengers (000)	15,177	9,251	4,948	992	13,020	11,921	16,033	2,075	2,232	75,649
						With 15% Connecting Traffic . . .				89,000

Configuration 1 — *Note: BASE RUN (Original Forecast Done by Systems Analysis and Research Corp. in Aviation Forecast).

Configuration 2 — *Note: Per Capita Employment and Income 5% Higher than Base Run.

Configuration 3 — *Note: Per Capita Employment Same as Base Run; Per Capita income 5% higher than Base Run.

	Alameda	Contra Costa	Marin	Napa	San Francisco	San Mateo	Santa Clara	Solano	Sonoma	Total
CONFIGURATION 4*						Population: BATSC Employment: BATSC less 10% Income : SARC less 10%				
Annual Passengers (000)	12,093	7,357	4,027	777	10,707	9,706	12,819	1,609	1,716	60,811
						With 15% Connecting Traffic . . .				71,500
CONFIGURATION 5*						Population: DOF Employment: BATSC less % that DOF population is lower than BATSC population Income : SARC less % that DOF population is lower than BATSC population				
Annual Passengers (000)	11,797	6,989	3,926	930	10,720	8,775	14,737	1,687	2,056	61,617
						With 15% Connecting Traffic . . .				72,500

*Note (Configuration 4): Per Capita Employment and Income 10% Lower than Base Run

*Note (Configuration 5): Population Lower than Base Run; Per Capita Employment and Income Same as Base Run

	Alameda	Contra Costa	Marin	Napa	San Francisco	San Mateo	Santa Clara	Solano	Sonoma	Total
		CONFIGURATION 6*				Population: DOF Employment: OBERS Income : SARC less % that OBERS employment is lower than BATSC employment				
Change in per capita Employ.	+ 2%	- 2%	- 10%	- 43%	+ 12%	negligible	- 9%	- 25%	- 20%	
Change in per capita Income	+ 2%	- 2%	- 10%	- 43%	+ 12%	negligible	- 9%	- 25%	- 20%	
Annual Passengers (000)	12,286	6,223	3,354	300	12,472	9,040	12,471	1,006	1,320	58,472
						With 15% Connecting Traffic . . .				68,700
*Note: Population Lower than Base Run; See Above for Per Capita Employment and Income Changes from Base										
		CONFIGURATION 7*				Population: DOF Employment: OBERS Income : SARC				
Change in per capita Employ.	+ 2%	- 2%	- 10%	- 43%	+ 12%	negligible	- 9%	- 25%	- 20%	
Change in per capita Income	+ 17%	+ 19%	+ 16%	- 1%	+ 13%	+ 22	+ 2%	+ 13%	+ 1%	
Annual Passengers (000)	15,047	9,229	4,746	837	12,753	11,801	14,932	1,978	2,009	73,332
						With 15% Connecting Traffic . . .				86,200
*Note: Population Lower Than Base Run; See Above for Per Capita Employment and Income Changes from Base										

	Alameda	Contra Costa	Marin	Napa	San Francisco	San Mateo	Santa Clara	Solano	Sonoma	Total
CONFIGURATION 8*						Population: DOF Employment: BATSC Income : SARC				
Change in per capita Employ.	+ 17%	+ 19%	+ 16%	- 1%	+ 13%	+ 22%	+ 2%	+ 13%	+ 1%	
Change in per capita Income	+ 17%	+ 19%	+ 16%	- 1%	+ 13%	+ 22%	+ 2%	+ 13%	+ 1%	
Annual Passengers (000)	15,416	9,453	4,931	916	12,807	12,078	15,184	2,101	2,092	74,978
						With 15% Connecting Traffic . . .				88,200

*Note: Population Lower than Base Run; See Above for Per Capita Employment and Income Changes from Base

	Alameda	Contra Costa	Marin	Napa	San Francisco	San Mateo	Santa Clara	Solano	Sonoma	Total
CONFIGURATION 9*						Population: 1970 Census Employment: BATSC less % that Census Population is lower than BATSC Population Income : SARC less % that Census Population is lower than BATSC Population				
Annual Passengers (000)	10,014	5,110	2,704	588	10,871	7,529	9,897	1,203	1,302	42,218
						With 15% Connecting Traffic . . .				57,900

*Note: Population Lower; Per Capita Employment and Income Same as Base Run

	Alameda	Contra Costa	Marin	Napa	San Francisco	San Mateo	Santa Clara	Solano	Sonoma	Total
CONFIGURATION 10*						Population: 1970 Census Employment: BATSC less 20% Income : SARC less 20%				
Change in per capita Employ. and Income	+ 10%	+ 21%	+ 22%	+ 16%	+ 2%	+ 13%	+ 14%	+ 18%	+ 17%	
Annual Passengers (000)	12,142	7,834	4,085	824	9,587	9,480	13,025	1,778	1,906	60,661
						With 15% Connecting Traffic . . .				71,400
*Note: Population Lower than Base Run; See Above for Per Capita Employment and Income Changes from Base Run.										
CONFIGURATION 11*						Population: 1970 Census Employment: DATSC Employment less % that Census Population is Lower than BATSC population. Income : SARC				
Change in per capita Income	+ 30%	+ 41%	+ 42%	+ 36%	+ 12%	+ 33%	+ 34%	+ 38%	+ 37%	
Annual Passengers (000)	15,653	10,053	5,201	1,053	12,503	12,068	16,719	2,279	2,474	77,999
						With 15% Connecting Traffic . . .				91,700
*Note: Population Lower than Base Run; Per Capita Employment Same as Base Run; See above for Per Capita Income										

	Alameda	Contra Costa	Marin	Napa	San Francisco	San Mateo	Santa Clara	Solano	Sonoma	Total
	CONFIGURATION 12*					Population: 1970 Census Employment: BATSC Income : SARC				
Change in per capita Employ. and Income	+ 30%	+ 41%	+ 42%	+ 36%	+ 12%	+ 33%	+ 34%	+ 38%	+ 37%	
Annual Passengers (000)	16,399	10,427	5,341	1,121	12,798	12,484	17,493	2,415	2,616	81,094
						With 15% Connecting Traffic . . .				95,500

*Note: Population Lower than Base Run; See above for per capita Employment and Income Changes from Base Run

Appendix B - Supplement 2

PASSENGER TRAFFIC GENERATION ZONES*

To fulfill the objective of preparing traffic forecasts by sub-regional zones, several zonal breakdowns for the nine-county Bay Area were evaluated. It was decided that approximately one hundred zones would be necessary to provide the geographical detail required for the airport access part of the overall analysis. Ideally, each zone should represent, as closely as possible, a circular geographic form of approximately equal traffic generating potential. That is, areas of high traffic generating potential should be broken down into more zones than areas of lower traffic generating potential. In addition, insofar as possible, the zones should be designed in such a way as to facilitate collection of basic data necessary to derive equation inputs.

The ninety-eight "districts" established as part of the Bay Area Transportation Study (BATS) appeared to best fulfill these requirements. These "districts" were comprised of combinations of census tracts established for the 1960 federal census. In addition they were made up of one or a combination of BATS "map zones" for which forecasts of population and employment through 1990 had already been prepared as part of previous BATS work. Therefore, it was agreed early in the analysis that these 98 BATS "districts" would be the passenger traffic generating zones used in this analysis.

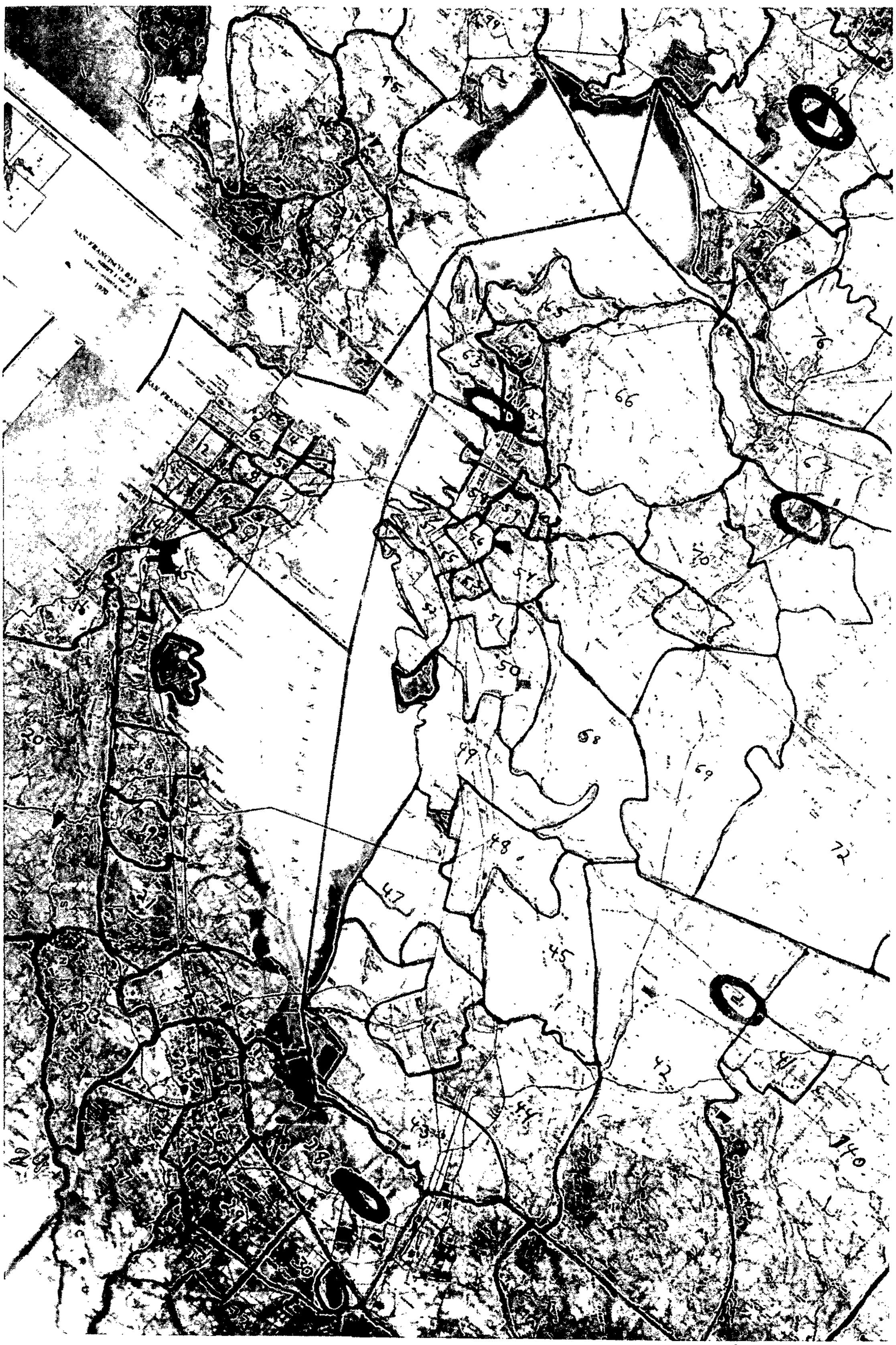
A map of the approximate boundary of each of these ninety-eight zones is shown in the large map.[+] Each zone is wholly contained within one of the nine counties making up the Bay Area Region.

At the time these zones were adopted for this study the 1970 federal census tracts had not been completely designed. However, we were led to believe after talking with people from the Census Bureau in Washington that the 1970 census tracts could be relegated into any zonal definition defined in terms of the 1960 tracts. This later proved to be nearly true but there were some exceptions. A definition of the BASAR passenger traffic generating zones in terms of census tracts and BATS map zones are shown in Appendix A of BASAR.[a] In a few cases, the 1970 census data will have to be broken down below the census tract level in order to accurately reflect these data in terms of the BASAR traffic generating zones established for this study. Because these cases are the exception rather than the rule, they are not expected to create a major problem in using the 1970 census data, when it becomes available, to update inputs for the BASAR traffic generating zones.

[a]Aviation Forecast, May 1970.

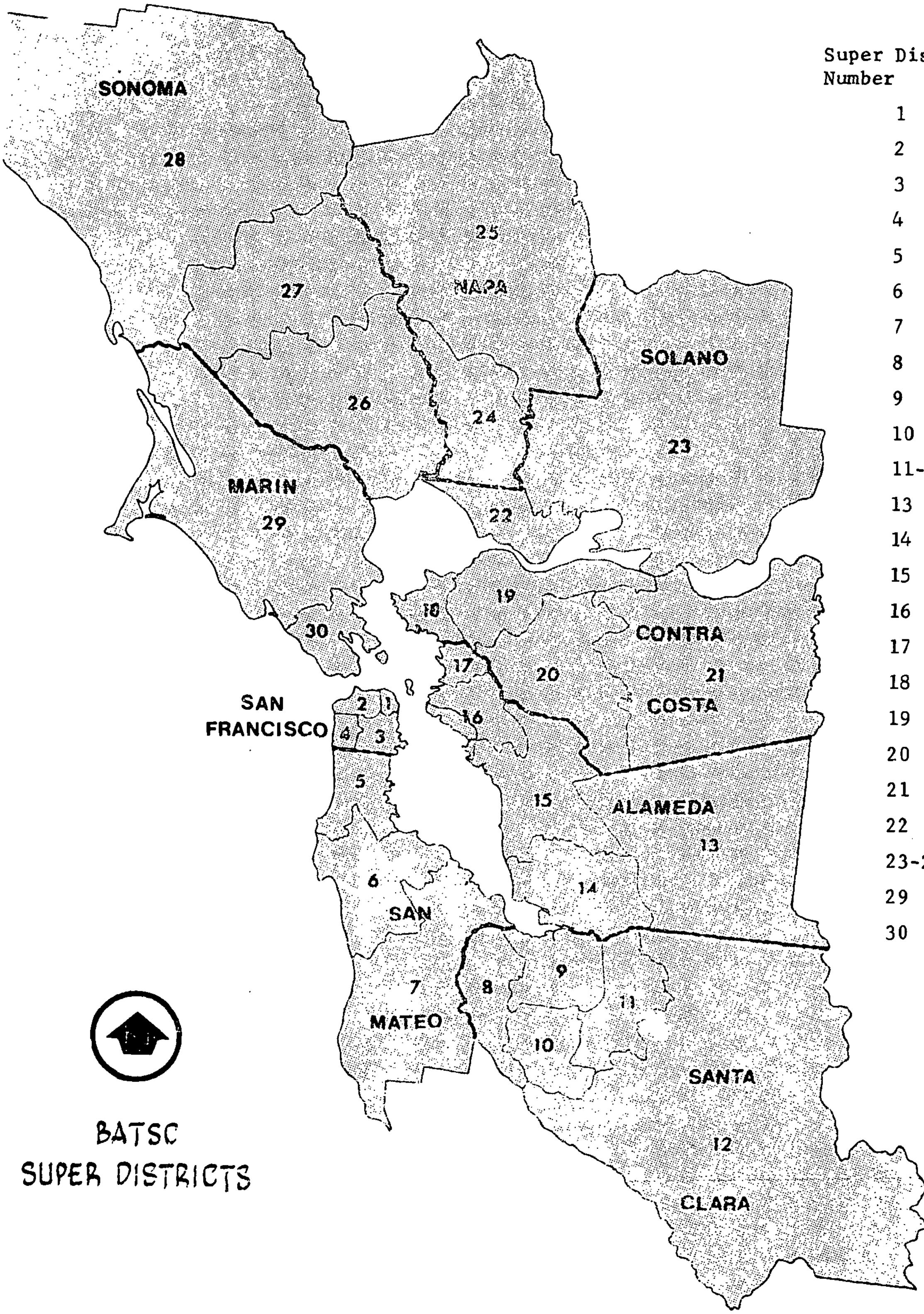
+See pages B-26 and B-27

*--SARC, Aviation Forecast, May 1970, pp. III-20, 21.



Bay Area Transportation Study (BATS) Zones used in this study

Figure B-1



Super District Number	Zonal Equivalents
1	1-3
2	4-6
3	7-10
4	11-13
5	14-17
6	18-20
7	21-24
8	25-27
9	28
10	29-32
11-12	33-39
13	40-42
14	43-46
15	45-49, 68
16	50-56
17	58-61
18	62-65
19	66-67
20	69-70
21	71-72
22	75-76
23-28	77-93
29	94-96
30	97-98

Figure B-2

Appendix B - Supplement 3

BASAR PREDICTION

ENPLANING AND DEPLANING PASSENGERS GENERATED BY BASAR ZONE

(1975 - 1985)

County	BASAR Zone Number	1975	Fraction of Total	1980	1985	Fraction of Total
Alameda	40	72,466	.01	128,492	225,111	.01
	41	132,875	.02	249,114	447,127	.03
	42	114,209	.02	197,609	370,842	.03
	43	68,506	.01	121,002	237,127	.02
	44	149,464	.03	354,726	696,126	.05
	45	343,533	.06	671,085	1,169,995	.08
	46	64,069	.01	119,920	226,904	.02
	47	153,294	.03	289,603	525,247	.04
	48	476,390	.08	773,611	1,244,820	.09
	49	785,607	.14	1,219,931	1,872,024	.13
	50	354,274	.06	578,062	934,168	.06
	51	360,646	.06	552,360	865,797	.06
	52	330,872	.06	500,759	795,856	.06
	53	257,006	.04	407,153	648,296	.05
	54	291,007	.05	368,286	492,790	.03
	55	273,504	.05	350,899	455,446	.03
	56	303,726	.05	428,436	640,604	.04
	57	110,106	.02	163,850	262,065	.02
	58	224,553	.04	349,922	552,115	.04
	59	276,041	.05	393,417	591,481	.04
	60	208,998	.04	265,350	342,926	.02
	61	301,994	.05	435,972	640,780	.05
County Total	(2,551,000)*	5,653,141		8,919,559	14,237,647	

*1968 totals computed from results of 1968 survey (SRI) adjusted to subtract connecting traffic.

County	BASAR Zone Number	1975	Fraction of Total	1980	1985	Fraction of Total
Contra Costa	62	238,351	.10	413,708	692,618	.08
	63	86,283	.04	142,233	225,766	.03
	64	198,597	.08	339,661	560,713	.06
	65	144,940	.06	270,450	508,144	.06
	66	161,559	.07	374,818	759,115	.09
	67	169,904	.07	348,665	685,328	.08
	68	206,681	.08	360,740	596,547	.07
	69	146,626	.06	317,735	585,321	.07
	70	391,255	.16	669,923	1,204,211	.14
	71	358,223	.15	705,871	1,384,394	.16
	72	31,019	.01	72,337	152,578	.02
	73	180,280	.07	354,944	661,024	.08
	74	93,827	.04	228,046	482,535	.06
County Total	(896,000)*	2,407,543		4,599,129	8,498,293	
Marin	93	125,779	.09	263,273	490,613	.10
	94	290,121	.20	605,650	1,196,905	.26
	95	363,644	.26	621,826	1,062,400	.23
	96	128,725	.09	251,913	468,839	.10
	97	373,915	.26	614,410	1,025,530	.22
	98	140,198	.10	230,609	406,664	.09
County Total	(341,000)*	1,422,383		2,587,680	4,650,951	
Napa	81	69,855	.22	138,799	261,239	.28
	82	129,877	.41	211,772	362,312	.39
	83	15,727	.05	29,394	46,625	.05
	84	45,884	.15	72,739	111,466	.12
	85	51,922	.17	89,363	145,246	.16
County Total	(52,000)*	313,295		542,067	926,888	

*1968 totals computed from results of 1968 survey (SRI) adjusted to subtract connecting traffic.

County	BASAR Zone Number	1975	Fraction of Total	1980	1985	Fraction of Total
San Francisco	1	526,543	.08	590,356	733,446	.06
	2	1,089,698	.17	1,330,509	1,745,838	.15
	3	442,994	.07	596,279	825,665	.07
	4	549,448	.09	688,554	907,650	.07
	5	521,361	.08	769,166	1,135,499	.09
	6	717,567	.11	984,593	1,402,125	.11
	7	594,447	.10	835,334	1,263,833	.10
	8	337,507	.05	503,798	740,736	.06
	9	368,491	.06	549,284	823,422	.07
	10	444,439	.07	688,909	1,102,954	.09
	11	225,551	.03	308,998	435,378	.03
	12	345,944	.05	532,225	805,655	.07
	13	210,902	.03	295,694	418,314	.03
County Total	(5,046,000)*	6,374,891		8,673,699	12,340,515	
San Mateo	14	259,302	.06	505,712	921,334	.08
	15	519,389	.13	940,181	1,944,675	.17
	16	125,863	.03	294,991	570,819	.05
	17	401,892	.10	556,861	841,131	.07
	18	513,285	.13	707,716	1,000,611	.09
	19	458,829	.11	838,004	1,421,354	.13
	20	80,717	.02	182,222	360,721	.03
	21	652,080	.16	1,061,047	1,724,734	.15
	22	647,717	.16	985,713	1,585,439	.14
	23	226,624	.06	373,090	581,599	.05
	24	95,715	.02	172,261	281,293	.03
County Total	(1,185,000)*	3,981,411		6,617,797	11,233,710	

*1968 totals computed from results of 1968 survey (SRI) adjusted to subtract connecting traffic.

County	BASAR Zone Number	1975	Fraction of Total	1980	1985	Fraction of Total
Santa Clara	25	536,633	.10	690,272	944,137	.06
	26	407,494	.08	607,285	960,850	.06
	27	136,358	.03	233,064	371,433	.02
	28	191,599	.04	308,817	551,133	.04
	29	587,479	.11	921,318	1,478,862	.10
	30	248,345	.05	408,932	665,966	.04
	31	201,712	.04	402,149	730,146	.05
	32	469,428	.09	814,089	1,407,286	.10
	33	375,866	.07	660,581	1,090,007	.07
	34	606,661	.12	1,000,759	1,617,374	.11
	35	407,802	.08	668,188	1,087,236	.07
	36	294,999	.06	631,796	1,196,470	.08
	37	395,877	.07	916,433	1,584,232	.11
	38	226,641	.04	610,907	1,117,569	.08
	39	53,148	.01	121,628	227,165	.01
County Total	(2,922,000)*	5,140,042		8,996,217	15,029,867	
Solano	75	283,104	.42	421,582	683,506	.33
	76	98,528	.15	317,249	418,470	.20
	77	132,658	.20	256,806	478,389	.23
	78	11,158	.02	27,540	51,986	.02
	79	81,513	.12	150,151	263,674	.12
	80	67,580	.10	129,098	215,529	.10
County Total	(133,000)*	674,542		1,302,426	2,111,554	

*<u>1968 totals</u> computed from results of 1968 survey (SRI) adjusted to subtract connecting traffic.

County	BASAR Zone Number	1975	Fraction of Total	1980	1985	Fraction of Total
	86	131,992	.20	239,775	410,980	.20
	87	77,788	.12	138,587	240,034	.12
	88	42,522	.07	94,953	185,002	.09
	89	202,805	.31	327,347	546,010	.26
	90	78,159	.12	137,175	232,167	.11
	91	66,599	.10	105,379	162,029	.08
	92	48,400	.07	141,660	297,270	.14
County Total	(185,000)*	648,266		1,184,876	2,073,532	
Nine County Total	(13,311,000)*	26,615,514		43,423,450	71,102,957	

*1968 totals computed from results of 1968 survey (SRI) adjusted to subtract connecting traffic.

-- SOURCE: Systems Analysis and Research Corporation

Appendix B- Supplement 4

PERCENTAGE DISTRIBUTION OF PASSENGER TRAFFIC IN THE BAY AREA BY COUNTY OF LOCAL ORIGIN AND DESTINATION*

County	1962 Percentage	1967 Percentage	1968 Percentage
Alameda	16.8	16.5	19.2
Contra Costa	5.6	6.2	6.7
Marin	3.8	3.3	2.6
Napa	0.4	0.3	0.4
San Francisco	40.9	30.5	37.8
San Mateo	13.5	20.8	9.0
Santa Clara	17.5	19.3	22.0
Solano	0.9	2.2	1.0
Sonoma	0.6	0.9	1.3
TOTAL	100.0	100.0	100.0

ZONAL PASSENGER DISTRIBUTION BY COUNTY*

County	1975 Percentage	1980 Percentage	1985 Percentage
Alameda	21.2	20.6	20.0
Contra Costa	9.0	10.6	12.0
Marin	5.3	6.0	6.5
Napa	1.2	1.2	1.3
San Francisco	24.1	20.0	17.4
San Mateo	15.0	15.2	15.8
Santa Clara	19.3	20.7	21.1
Solano	2.5	3.0	3.0
Solano	2.4	2.7	2.9
TOTAL	100.0	100.0	100.0

*Based on original BASAR Base Run Forecast.

--SOURCE: Systems Analysis and Research Corporation (From data developed in surveys by Port of Oakland, Wilbur Smith and Stanford Research Institute, op.cit.).

APPENDIX C

Details of Calculations of Airport Demand, Access Times and Access Costs

The access time and cost and the distribution of demand by airport was originally calculated for the 12 terminal system: 6 terminals in the Bay Area and 6 in the Los Angeles area. Preliminary system computer runs showed inadequate demand at some airports. Therefore, new airport networks were created.

In the Bay Area 5 STOLport and the 5 RTOLport systems, the Gnoss Field terminal is omitted and its traffic re-distributed to the CBD and Buchanan STOLport or to the San Francisco and Buchanan terminals as applicable. Data for San Carlos, San Jose and Hayward are the same as given for the 6 STOLport system.

In the Los Angeles 2000-ft STOLport system, Torrance and El Monte are eliminated. For the Los Angeles 3000-ft RTOLport system, only Torrance is dropped. In each case, the new calculations are shown for the affected airports at which patronage is increased.

Table C-1

COST OF TRAVEL FROM BASAR ZONE TO STOLPORT
2000 Foot Runways

BAY AREA 6
STOLPORT SYSTEM

BASAR TRAFFIC GENERATION ZONE	NEAREST STOLPORT	MILES ON CITY STREET	TIME ON CITY STREET (30 MPH) (Minutes)	MILES ON FREEWAY	TIME ON FREEWAY (55 MPH) (Minutes)	TOTAL MILES	TOTAL TIME (Min.)*	MILEAGE COST AT 5 ¢/MI	TIME COST AT 6 $/HR	PARKING COST $2.00	TOTAL COST	PERCENTAGE OF TRAVEL FROM ZONE	WEIGHTED CONTRIBUTION TO AVERAGE COST
1	CBD	1	2	0	0	1	14	.05	1.40		3.45	1.56	5.38
2	CBD	1.8	3.6	0	0	1.8	15.6	.09	1.56		3.65	3.32	12.12
3	CBD	2.5	5	0	0	2.5	17	.12	1.70		3.82	1.37	5.23
4	CBD	3.5	7	0	0	3.5	19	.18	1.90		4.08	1.76	7.18
5	CBD	3.5	7	0	0	3.5	19	.18	1.90		4.08	1.56	6.36
6	CBD	2.5	5	3	3.3	5.5	20.3	.28	2.03		4.31	2.15	9.27
7	CBD	1.8	3.6	0	0	1.8	15.6	.09	1.56		3.65	1.95	7.12
8	CBD	3.6	7.2	0	0	3.6	19.2	.18	1.92		4.10	0.98	4.02
9	CBD	1	2	2.5	2.7	3.5	16.7	.18	1.67		3.85	1.17	4.50
10	CBD	1	2	4	4.4	5	18.4	.25	1.84		4.09	1.37	5.60
11	CBD	5.3	10.6	0	0	5.3	22.6	.26	2.26		4.52	0.59	2.67
12	CBD	6.7	13.4	0	0	6.7	25.4	.34	2.54		4.88	0.98	4.78
13	CBD	2.8	5.6	4.3	4.7	7.1	22.3	.36	2.23		4.59	0.59	2.71
14	CBD	2	4	6.8	7.4	8.8	23.4	.44	2.34		4.78	0.88	4.21
15	CBD	1	2	9	9.8	10	23.8	.50	2.38		4.88	1.90	9.27
16	CBD	5	10	9.5	10.4	14.5	32.4	.72	3.24		5.96	0.44	2.62
17	SCS	0.6	1.2	10.6	11.6	11.2	24.8	.56	2.48		5.04	1.46	7.36
18	SCS	1.6	3.2	5.3	5.8	6.9	21	.34	2.10		4.44	1.90	8.44
19	SCS	0.6	1.2	3	3.3	3.6	16.5	.18	1.65		3.83	1.61	6.17
20	SCS	11	22	1.5	1.6	12.5	35.6	.62	3.56		6.18	0.29	1.79
21	SCS	2	4	0	0	2	16	.10	1.60		3.70	2.34	8.66
22	SCS	3.2	6.4	1	1.1	4.2	19.5	.21	1.95		4.16	2.34	9.73
23	SCS	7.3	14.6	1	1.1	8.3	27.7	.42	2.77		5.19	0.88	4.57
24	SCS	25	50	3	3.3	28	65.3	1.40	6.53		9.93	0.29	2.88
25	SCS	2	4	9	9.8	11	25.8	.55	2.58		5.13	2.23	11.44
26	SCS	2.5	5	11	12	13.5	29	.68	2.90		5.58	1.78	9.93
27	SJE	3	6	14	15.3	17	33.3	1.66	3.33		6.99	0.67	4.68
28	SJE	4.5	9	0	0	4.5	21	.22	2.10		4.32	0.89	3.84
29	SJE	6	12	0	0	6	23	.30	2.30		4.60	2.45	11.27
30	SJE	2.5	5	0	0	2.5	17	.12	1.70		3.82	1.12	4.28
31	SJE	2	4	8	8.7	10	24.7	.50	2.47		4.97	0.89	4.42
32	SJE	3	6	3.5	3.8	6.5	21.8	.32	2.18		4.50	2.01	9.05
33	SJE	3	6	9	9.8	12	27.8	.60	2.78		5.38	1.56	8.39
34	SJE	3.5	7	1.5	1.6	5	20.6	.25	2.06		4.31	2.68	11.55
35	SJE	2	4	6	6.5	8	22.5	.40	2.25		4.65	1.78	8.28
36	SJE	3.5	7	4.5	4.9	8	23.9	.40	2.39		4.79	1.34	6.42
37	SJE	1	2	13.5	14.7	14.5	28.7	.72	2.87		5.59	1.56	8.72
38	SJE	1	2	33	36	34	50	1.70	5.00		8.70	0.89	7.74
39	SJE	18	36	6	6.6	24	53.6	1.20	5.36		8.56	0.22	1.88
40	HAY	4	8	30	32.7	34	52.7	1.70	5.27		8.97	0.20	1.79
41	HAY	2	4	23	25.1	25	41.1	1.25	4.11		7.36	0.39	2.87
42	HAY	4	8	18	19.6	22	39.6	1.10	3.96		7.06	0.39	2.75
43	SJE	2	4	10	10.9	12	26.9	.60	2.69		5.29	0.20	1.06
44	SJE	1	2	14	15.3	15	29.3	.75	2.93		5.68	0.59	3.35
45	HAY	4.5	9	9	9.8	13.5	30.8	.68	3.08		5.76	1.17	6.74
46	HAY	1	2	9.5	10.4	10.5	24.4	.52	2.44		4.96	0.20	0.99
47	HAY	4.5	9	0	0	4.5	21	.22	2.10		4.32	0.59	2.55
48	HAY	3	6	0	0	3	18	.15	1.80		3.95	1.56	6.16
49	HAY	1	2	4	4.4	5	18.4	.25	1.84		4.09	2.73	11.17
50	HAY	3	6	6	6.6	9	24.6	.45	2.46		4.91	1.17	5.74
51	HAY	3.5	7	7.5	8.2	11	27.2	.55	2.72		5.27	1.17	6.17
52	HAY	4	8	8.5	9.3	12.5	29.3	.62	2.93		5.55	1.17	6.49
53	HAY	2.5	5	10	10.9	12.5	27.9	.62	2.79		5.41	0.78	4.22
54	CBD	3	6	10	10.9	13	28.9	.65	2.89		5.54	0.98	5.43
55	CBD	1.5	3	10	10.9	11.5	25.9	.58	2.59		5.17	0.98	5.07
56	CBD	1	2	8	8.7	9	22.7	.45	2.27		4.72	0.98	4.63
57	CBD	2	4	7.8	8.5	9.8	24.5	.49	2.45		4.94	0.39	1.93
58	CBD	1	2	8.7	9.5	9.7	23.7	.48	2.37		4.85	0.78	3.78
59	CBD	1	2	10.5	11.4	11.5	25.5	.58	2.55		5.43	0.98	5.32

Table C-1 continued

COST OF TRAVEL FROM BASAR ZONE TO STOLPORT
2000 Foot Runways

BAY AREA 6
STOLPORT SYSTEM

BASAR TRAFFIC GENERATION ZONE	NEAREST STOLPORT	MILES ON CITY STREET	TIME ON CITY STREET (30 MPH) (Minutes)	MILES ON FREEWAY	TIME ON FREEWAY (55 MPH) (Minutes)	TOTAL MILES	TOTAL TIME (Min.)*	MILEAGE COST AT 5 ¢/MI	TIME COST AT 6 $/HR	PARKING COST $2.00	TOTAL COST	PERCENTAGE OF TRAVEL FROM ZONE	WEIGHTED CONTRIBUTION TO AVERAGE COST
60	BUC	2	4	12	13.1	14	29.1	.70	2.91		5.61	0.78	4.38
61	CBD	2.5	5	12	13.1	14.5	30.1	.72	3.01		5.73	0.98	5.62
62	CBD	2	4	13.5	14.7	15.5	30.7	.78	3.07		5.85	1.09	6.38
63	CBD	2	4	16.5	18	18.5	34	.92	3.40		6.32	0.44	2.78
64	CBD	2	4	16.5	18	18.5	34	.92	3.40		6.32	0.87	5.50
65	BUC	1.5	3	16.5	18	18	33	.90	3.30		6.20	0.65	4.03
66	BUC	2	4	10	10.9	12	26.9	.60	2.69		5.29	0.76	4.02
67	BUC	1	2	5	5.4	6	19.4	.30	1.94		4.24	0.76	3.22
68	HAY	5.5	11	5.5	6	11	29	.55	2.90		5.45	0.87	4.74
69	BUC	1	2	14	15.3	15	29.3	.75	2.93		5.68	0.65	3.69
70	BUC	1	2	5.6	6.1	6.6	20.1	.33	2.01		4.34	1.74	7.55
71	BUC	1	2	1	1.1	2	15.1	.10	1.51		3.61	1.64	5.92
72	BUC	5	10	8.5	9.3	13.5	31.3	.68	3.13		5.81	0.11	0.64
73	BUC	1	2	11.2	12.2	12.2	26.2	.61	2.62		5.23	0.76	3.97
74	BUC	10	20	18	19.6	28	51.6	1.40	5.16		8.56	0.44	3.77
75	BUC	2	4	13	14.2	15	30.2	.75	3.02		5.77	1.13	6.52
76	BUC	1	2	7	7.6	8	21.6	.40	2.16		4.56	0.41	1.87
77	BUC	1	2	23.2	25.3	24.2	39.3	1.21	3.93		7.14	0.54	3.86
78	BUC	2.5	5	40	43.6	45	60.6	2.12	6.06		10.18	0.05	0.51
79	BUC	2	4	36	39.3	38	55.3	1.90	5.53		9.43	0.32	3.02
80	BUC	2	4	48	52.4	50	68.4	2.50	6.84		11.34	0.27	3.06
81	BUC	1	2	23	25.1	24	39.1	1.20	3.91		7.11	0.31	2.20
82	BUC	1	2	29	31.6	30	45.6	1.50	4.56		8.06	0.57	4.59
83	BUC	3	6	34	37.1	37	55.1	1.85	5.51		9.36	0.07	0.66
84	BUC	1	2	46	50.2	47	64.2	2.35	6.42		10.79	0.21	2.27
85	GNO	5	10	50	54.5	55	76.5	2.75	7.65		12.40	0.24	2.98
86	GNO	1	2	10	10.9	11	24.9	.55	2.49		5.04	0.60	3.02
87	GNO	3	6	21	22.9	24	40.9	1.20	4.09		7.29	0.36	2.62
88	GNO	4	8	20	21.8	24	41.8	1.20	4.18		7.38	0.21	1.55
89	GNO	1	2	22	24	23	38	1.15	3.80		6.95	0.93	6.46
90	GNO	3	6	28	30.5	31	48.5	1.55	4.85		8.40	0.36	3.02
91	GNO	4	8	48	52.4	52	72.4	2.60	7.24		11.84	0.30	3.55
92	GNO	1	2	42	45.8	43	59.8	2.15	5.98		10.13	0.21	2.13
93	GNO	3	6	20	21.8	23	39.8	1.15	3.98		7.13	0.55	3.92
94	GNO	1	2	4	4.4	5	18.4	.25	1.84		4.09	1.22	4.99
95	GNO	2	4	10.5	11.4	12.5	27.4	.62	2.74		5.36	1.59	8.52
96	GNO	3	6	13	14.2	16	32.2	.80	3.22		6.02	0.55	3.31
97	GNO	2	4	16.5	18	18.5	34	.92	3.40		6.32	1.59	10.05
98	CBD	3	6	8.7	9.5	11.7	27.5	.58	2.75		5.33	0.61	3.25
											TOTAL	98.89	496.88
											Average		$5.02

* 12 minutes added to total time to allow for parking and travel from parking to terminal

STOLPORT DESIGNATIONS:

CBD - San Francisco Central Business District
SCS - San Carlos Airport
SJE - San Jose Municipal Airport
HAY - Hayward Air Terminal
BUC - Buchanan Field
GNO - Gnoss Field

BAY AREA 6
RTOLPORT SYSTEM

Table C-2
COST OF TRAVEL FROM BASAR ZONE TO RTOLPORT
3000 Foot Runways

BASAR TRAFFIC GENERATION ZONE	NEAREST STOLPORT	MILES ON CITY STREET	TIME ON CITY STREET (30 MPH) (Minutes)	MILES ON FREEWAY	TIME ON FREEWAY (55 MPH) (Minutes)	TOTAL MILES	TOTAL TIME (Min.)*	MILEAGE COST AT 5 ¢/MI	TIME COST AT 6 $/HR	PARKING COST $2.00	TOTAL COST	PERCENTAGE OF TRAVEL FROM ZONE	WEIGHTED CONTRIBUTION TO AVERAGE COST
1	SFO	0.5	1	12	13.1	12.5	34.1	.62	3.41		6.03	1.56	9.41
2	SFO	0.5	1	13	14.2	13.5	35.2	.67	3.52		6.19	3.32	20.55
3	SFO	1.0	2	13	14.2	14	36.2	.70	3.62		6.32	1.37	8.66
4	SFO	2	4	13.5	14.7	15.5	38.7	.77	3.87		6.64	1.76	11.69
5	SFO	0.5	1	13.5	14.7	14	35.7	.70	3.57		6.27	1.56	9.78
6	SFO	3.5	7	13.5	14.7	17	41.7	.85	4.17		7.02	2.15	15.09
7	SFO	0	0	11	12	11	32	.55	3.20		5.75	1.95	11.21
8	SFO	2	4	11	12	13	36	.65	3.60		6.25	0.98	6.13
9	SFO	0	0	9	9.8	9	29.8	.45	2.98		5.43	1.17	6.35
10	SFO	0	0	11.5	12.6	11.5	32.6	.57	3.26		5.83	1.37	7.99
11	SFO	3	6	11	12	14	38	.70	3.80		6.50	0.59	3.84
12	SFO	4.3	8.6	10	10.9	14.3	39.5	.71	3.95		6.66	0.98	6.53
13	SFO	1.5	3	10	10.9	11.5	33.9	.57	3.39		5.96	0.59	3.52
14	SFO	0.5	1	9	9.8	9.5	30.8	.47	3.08		5.55	0.88	4.88
15	SFO	1.5	3	4	4.4	5.5	27.4	.27	2.74		5.01	1.90	9.52
16	SFO	5	10	5	5.5	10	35.5	.50	3.55		6.05	0.44	2.66
17	SFO	1.5	3	0.5	0.5	2	23.5	.10	2.35		4.45	1.46	6.50
18	SFO	2	4	6	6.6	8	30.6	.40	3.06		5.46	1.90	10.37
19	SFO	1.5	3	8.5	9.3	10	32.3	.50	3.23		5.73	1.61	9.23
20	SFO	11	22	7.5	8.2	18.5	50.2	.92	5.02		7.94	0.29	2.30
21	PAO	2	4	8.5	9.3	10.5	25.3	.52	2.53		5.05	2.34	11.82
22	PAO	3.7	7.4	4	4.4	7.7	23.8	.38	2.38		4.76	2.34	11.14
23	PAO	9	18	0	0	9	30	.45	3.00		5.45	0.88	4.80
24	PAO	23	46	0	0	23	58	1.15	5.80		8.95	0.29	2.60
25	PAO	3	6	0	0	3	18	.15	1.80		3.95	2.23	8.81
26	PAO	3.5	7	2.5	2.7	6	21.7	.30	2.17		4.47	1.78	7.96
27	PAO	8	16	2	2.2	10	30.2	.50	3.02		5.52	0.67	3.70
28	SJE	4.5	9	0	0	4.5	21	.22	2.10		4.32	0.89	3.84
29	SJE	6	12	0	0	6	23	.30	2.30		4.60	2.45	11.27
30	SJE	2.5	5	0	0	2.5	17	.12	1.70		3.82	1.12	4.28
31	SJE	2	4	8	8.7	10	24.7	.50	2.47		4.97	0.89	4.42
32	SJE	3	6	3.5	3.8	6.5	21.8	.32	2.18		4.50	2.01	9.05
33	SJE	3	6	9	9.8	12	27.8	.60	2.78		5.38	1.56	8.39
34	SJE	3.5	7	1.5	1.6	5	20.6	.25	2.06		4.31	2.68	11.55
35	SJE	2	4	6	6.5	8	22.5	.40	2.25		4.65	1.78	8.28
36	SJE	3.5	7	4.5	4.9	8	23.9	.40	2.39		4.79	1.34	6.42
37	SJE	1	2	13.5	14.7	14.5	28.7	.72	2.87		5.59	1.56	8.72
38	SJE	1	2	33	36	34	50	1.70	5.00		8.70	0.89	7.74
39	SJE	18	36	6	6.6	24	53.6	1.20	5.36		8.56	0.22	1.88
40	HAY	4	8	30	32.7	34	52.7	1.70	5.26		8.96	0.20	1.79
41	HAY	2	4	23	25.1	25	41.1	1.25	4.11		7.36	0.39	2.87
42	HAY	4	8	18	19.6	22	39.6	1.10	3.96		7.06	0.39	2.75
43	SJE	2	4	10	10.9	12	26.9	.60	2.69		5.29	0.20	1.06
44	SJE	1	2	14	15.3	15	29.3	.75	2.93		5.68	0.59	3.35
45	HAY	4.5	9	9	9.8	13.5	30.8	.68	3.00		5.68	1.17	6.65
46	HAY	1	2	9.5	10.4	10.5	24.4	.52	2.44		4.96	0.20	0.99
47	HAY	4.5	9	0	0	4.5	21	.22	2.10		4.32	0.59	2.55
48	HAY	3	6	0	0	3	18	.15	1.80		3.95	1.56	6.16
49	HAY	1	2	4	4.4	5	18.4	.25	1.84		4.09	2.73	11.17
50	HAY	3	6	6	6.6	9	24.6	.45	2.46		4.91	1.17	5.74
51	HAY	3.5	7	7.5	8.2	11	27.2	.55	2.72		5.27	1.17	6.17
52	HAY	4	8	8.5	9.3	12.5	29.3	.62	2.93		5.55	1.17	6.49
53	HAY	2.5	5	10	10.9	12.5	27.9	.62	2.79		5.41	0.78	4.22
54	HAY	1	2	14	15.3	15	29.3	.75	2.93		5.68	0.98	5.57
55	HAY	4	8	10	10.9	14	30.9	.70	3.09		5.79	0.98	5.67
56	HAY	6	12	10	10.9	16	34.9	.80	3.49		6.29	0.98	6.16
57	HAY	4	8	11.5	12.6	15.5	35.5	.77	3.55		6.32	0.39	2.46
58	HAY	4	8	15	16.4	19	36.4	.95	3.64		6.59	0.78	5.14
59	HAY	1	2	16	17.5	17	31.5	.85	3.15		6.00	0.98	5.88

Table C-2 continued
COST OF TRAVEL FROM BASAR ZONE TO RTOLPORT
3000 Foot Runways

BAY AREA 6
RTOLPORT SYSTEM

BASAR TRAFFIC GENERATION ZONE	NEAREST STOLPORT	MILES ON CITY STREET	TIME ON CITY STREET (30 MPH) (Minutes)	MILES ON FREEWAY	TIME ON FREEWAY (55 MPH) (Minutes)	TOTAL MILES	TOTAL TIME (Min.)*	MILEAGE COST AT 5 ¢/MI	TIME COST AT 6 $/HR	PARKING COST $2.00	TOTAL COST	PERCENTAGE OF TRAVEL FROM ZONE	WEIGHTED CONTRIBUTION TO AVERAGE COST
60	BUC	2	4	12	13.1	14	29.1	.70	2.91		5.61	0.78	4.38
61	HAY	2	4	18.5	20.2	20.5	36.2	1.02	3.62		6.64	0.98	6.51
62	HAY	2	4	21	23	23	39	1.15	3.90		7.05	1.09	7.68
63	GNO	0.5	1	23	25.2	23.5	38.2	1.17	3.82		6.99	0.44	3.08
64	BUC	2	4	19.5	21.3	21.5	37.3	1.07	3.73		6.80	0.87	5.92
65	BUC	1.5	3	16.5	18	18	33	.90	3.30		6.20	0.65	4.03
66	BUC	2	4	10	10.9	12	26.9	.60	2.69		5.29	0.76	4.02
67	HAY	1	2	5	5.4	6	19.4	.30	1.94		4.24	0.76	3.22
68	BUC	5.5	11	5.5	6	11	29	.55	2.90		5.45	0.87	4.74
69	BUC	1	2	14	15.3	15	29.3	.75	2.93		5.68	0.65	3.69
70	BUC	1	2	5.6	6.1	6.6	20.1	.33	2.01		4.34	1.74	7.55
71	BUC	1	2	1	1.1	2	15.1	.10	1.51		3.61	1.64	5.92
72	BUC	5	10	8.5	9.3	13.5	31.3	.68	3.13		5.81	0.11	0.64
73	BUC	1	2	11.2	12.2	12.2	26.2	.61	2.62		5.23	0.76	3.97
74	BUC	10	20	18	19.6	28	51.6	1.40	5.16		8.56	0.44	3.77
75	BUC	2	4	13	14.2	15	30.2	.75	3.02		5.77	1.13	6.52
76	BUC	1	2	7	7.6	8	21.6	.40	2.16		4.56	0.41	1.87
77	BUC	1	2	23.2	25.3	24.2	39.3	1.21	3.93		7.14	0.54	3.86
78	BUC	2.5	5	40	43.6	45	60.6	2.12	6.06		10.18	0.05	.70
79	BUC	2	4	36	39.3	38	55.3	1.90	5.53		9.43	0.32	3.02
80	BUC	2	4	48	52.4	50	68.4	2.50	6.84		11.34	0.27	3.06
81	BUC	1	2	23	25.1	24	39.1	1.20	3.91		7.11	0.31	2.20
82	BUC	1	2	29	31.6	30	45.6	1.50	4.56		8.06	0.57	4.59
83	BUC	3	6	34	37.1	37	55.1	1.85	5.51		9.36	0.07	0.66
84	BUC	1	2	46	50.2	47	64.2	2.35	6.42		10.77	0.21	2.26
85	GNO	5	10	50	54.5	55	76.5	2.75	7.65		12.40	0.24	2.98
86	GNO	1	2	10	10.9	11	24.9	.55	2.49		5.04	0.60	3.02
87	GNO	3	6	21	22.9	24	40.9	.20	4.09		7.29	0.36	2.62
88	GNO	4	8	20	21.8	24	41.8	1.20	4.18		7.38	0.21	1.55
89	GNO	1	2	22	24	23	38	1.15	3.80		6.95	0.93	6.46
90	GNO	3	6	28	30.5	31	48.5	1.55	4.85		8.40	0.36	3.02
91	GNO	4	8	48	52.4	52	72.4	2.60	7.24		11.84	0.30	3.55
92	GNO	1	2	42	45.8	43	59.8	2.15	5.98		10.13	0.21	2.13
93	GNO	3	6	20	21.8	23	39.8	1.15	3.98		7.13	0.55	3.92
94	GNO	1	2	4	4.4	5	18.4	.25	1.84		4.09	1.22	4.99
95	GNO	2	4	10.5	11.4	12.5	27.4	.62	2.74		5.36	1.59	8.52
96	GNO	3	6	13	14.2	16	32.2	.80	3.22		6.02	0.55	3.31
97	GNO	2	4	16.5	18	18.5	34	.92	1.85		4.77	1.59	7.58
98	GNO	2	4	21	23	23	27	1.15	2.70		5.85	0.61	3.57
											TOTAL	98.89	550.80
											Average		$5.56

*12 minutes added to total time to allow for parking and travel from parking to terminal (20 minutes allowed at SFO)

RTOLPORT DESIGNATIONS:

- SFO - San Francisco International
- PAO - Palo Alto Airport
- SJE - San Jose Municipal Airport
- HAY - Hayward Air Terminal
- BUC - Buchanan Field
- GNO - Gnoss Field

Table C-3

COST OF TRAVEL FROM BASAR ZONE TO STOLPORT
2000 Foot Runways

BAY AREA 5
STOLPORT SYSTEM

Revisions of Zone Data Required when Gnoss Field is Eliminated to Produce Bay Area 5 STOLport System

BASAR TRAFFIC GENERATION ZONE	NEAREST STOLPORT	MILES ON CITY STREET	TIME ON CITY STREET (30 MPH) (Minutes)	MILES ON FREEWAY	TIME ON FREEWAY (55 MPH) (Minutes)	TOTAL MILES	TOTAL TIME (Min.)*	MILEAGE COST AT 5 ¢/MI	TIME COST AT 6 $/HR	PARKING COST $2.00	TOTAL COST	PERCENTAGE OF TRAVEL FROM ZONE	WEIGHTED CONTRIBUTION TO AVERAGE COST
60													
61													
62													
63													
64													
65													
66													
67													
68													
69													
70													
71													
72													
73													
74													
75													
76													
77													
78													
79													
80													
81													
82													
83													
84													
85	BUC	8	16	66	72	74	88	3.70	8.80	2.00	14.50	.24	3.48
86	BUC	7	14	38	41.5	45	55.5	2.25	5.55	"	9.80	.60	5.88
87	BUC	8	16	36	39.3	44	55.3	2.20	5.53	"	9.73	.36	3.50
88	BUC	13	26	51	55.6	64	81.6	3.20	8.16	"	13.36	.21	2.81
89	BUC	12	24	43	46.9	55	70.9	2.75	7.09	"	11.84	.93	11.01
90	BUC	14	28	49	53.5	63	81.5	3.15	8.15	"	13.30	.36	4.79
91	BUC	14	28	67	73.1	81	101.1	4.05	10.11	"	16.16	.30	4.85
92	BUC	15	30	59	64.4	74	94.4	3.70	9.44	"	15.14	.21	3.18
93	CBD	5	10	38	41.5	43	51.5	2.15	5.15	"	9.30	.55	5.12
94	BUC	6	12	28	30.5	34	42.5	1.70	4.25	"	7.95	1.22	9.70
95	CBD	9	18	15	16.4	24	44.4	1.20	4.44	"	7.64	1.59	12.15
96	CBD	26	52	14	15.3	40	67.3	2.00	6.73	"	10.73	.55	5.90
97	CBD	10	20	11	12.0	21	32	1.05	3.20	"	6.25	1.59	9.94
98													
										TOTAL		98.89	523.07
										Average			$5.29

Table C-4

COST OF TRAVEL FROM BASAR ZONE TO RTOLPORT
3000 Foot Runways

BAY AREA 5
RTOLPORT SYSTEM

Revisions of Zone Data Required when Gnoss Field is Eliminated to Produce Bay Area 5 RTOLport System

BASAR TRAFFIC GENERATION ZONE	NEAREST STOLPORT	MILES ON CITY STREET	TIME ON CITY STREET (30 MPH) (Minutes)	MILES ON FREEWAY	TIME ON FREEWAY (55 MPH) (Minutes)	TOTAL MILES	TOTAL TIME (Min.)*	MILEAGE COST AT 5 ¢/MI	TIME COST AT 6 $/HR	PARKING COST $2.00	TOTAL COST	PERCENTAGE OF TRAVEL FROM ZONE	WEIGHTED CONTRIBUTION TO AVERAGE COST
60													
61													
62													
63	BUC	0.5	1.0	25	27.3	26	28.3	1.30	2.83	2.00	6.13	0.44	1.65
64													
65													
66													
67													
68													
69													
70													
71													
72													
73													
74													
75													
76													
77													
78													
79													
80													
81													
82													
83													
84													
85	BUC	8	16	66	72	74	88	3.70	8.80	2.00	14.50	0.24	3.48
86	BUC	7	14	38	41.5	45	55.5	2.25	5.55	"	9.80	0.60	5.88
87	BUC	8	16	36	39.3	44	55.3	2.20	5.53	"	9.73	0.36	3.50
88	BUC	13	26	51	55.6	64	81.6	3.20	8.16	"	13.36	0.21	2.81
89	BUC	12	24	43	46.9	55	70.9	2.75	7.09	"	11.84	0.93	11.01
90	BUC	14	28	49	53.5	63	81.5	3.15	8.15	"	13.30	0.36	4.79
91	BUC	14	28	67	73.1	81	101.1	4.05	10.11	"	16.16	0.30	4.85
92	BUC	15	30	59	64.4	74	94.4	3.70	9.44	"	15.14	0.21	3.18
93	BUC	8	16	36	39.3	44	55.3	2.20	5.53	"	9.73	0.55	5.35
94	BUC	6	12	28	30.5	34	42.5	1.70	4.25	"	7.95	1.22	9.70
95	BUC	3	6	34	37.1	37	43.1	1.85	4.31	"	8.16	1.59	12.97
96	SFO	25	50	27	29.5	52	79.5	2.60	7.95	"	12.55	0.55	6.90
97	SFO	9	18	24	26.2	33	44.2	1.65	4.42	"	8.07	1.59	12.83
98	SFO	7	14	20	21.8	21	35.8	1.05	3.58	"	6.63	0.61	4.04
											TOTAL	98.89	583.44

Average $5.90

Table C-5

Access Time, Cost and Percentage of Travelers by Zone and Airport

Bay Area 6 STOLport System

STOLPORT: CENTRAL BUSINESS DISTRICT (CBD)

Runway Length 2000 Feet

BASAR Traffic Generation Zone	Total Time (Min.)	Out of Pocket Cost ($)	Percentage of Travel from Zone	Weighted Contribution to Access Time (Min.)	Weighted Contribution to Out of Pocket Cost
1	14	2.05	1.56	21.84	3.20
2	15.6	2.09	3.32	51.79	6.94
3	17	2.12	1.37	23.29	2.90
4	19	2.18	1.76	33.44	3.84
5	19	2.18	1.56	29.64	3.40
6	20.3	2.28	2.15	43.64	4.90
7	15.6	2.09	1.95	30.42	4.08
8	19.2	2.18	0.98	18.82	2.14
9	16.7	2.18	1.17	19.54	2.55
10	18.4	2.25	1.37	25.21	3.08
11	22.6	2.26	0.59	13.33	1.33
12	25.4	2.34	0.98	24.89	2.29
13	22.3	2.36	0.59	13.16	1.39
14	23.4	2.44	0.88	20.59	2.15
15	23.8	2.50	1.90	45.22	4.75
16	32.4	2.72	0.44	14.26	1.20
54	28.9	2.65	0.98	28.32	2.60
55	25.9	2.58	0.98	25.38	2.53
56	22.7	2.45	0.98	22.25	2.40
57	24.5	2.49	0.39	9.56	0.97
58	23.7	2.48	0.78	18.49	1.93
59	25.5	2.58	0.98	24.99	2.53
61	30.1	2.72	0.98	29.50	2.67
62	30.7	2.78	1.09	33.46	3.03
63	34	2.92	0.44	14.96	1.28
64	34	2.92	0.87	29.58	2.54
98	27.5	2.58	0.61	16.78	1.57
TOTAL			31.65	682.35	74.19
Average				21.56	$2.34

Table C-5 continued

Bay Area 6 STOLport System

STOLPORT: SAN CARLOS (SCS)

Runway Length 2000 Feet

BASAR Traffic Generation Zone	Total Time (Min.)	Out of Pocket Cost ($)	Percentage of Travel from Zone	Weighted Contribution to Access Time (Min.)	Out of Pocket Cost
17	24.8	2.56	1.46	36.21	3.74
18	21	2.34	1.90	39.90	4.45
19	16.5	2.18	1.61	26.56	3.51
20	35.6	2.62	0.29	10.32	0.76
21	16	2.10	2.34	37.44	4.91
22	19.5	2.21	2.34	45.63	5.17
23	27.7	2.42	0.88	24.38	2.13
24	65.3	3.40	0.29	18.94	0.99
25	25.8	2.55	2.23	57.53	5.69
26	29	2.68	1.78	51.62	4.77
TOTAL			15.12	348.53	36.12
Average				23.05	$2.39

STOLPORT: SAN JOSE

Runway Length 2000 Feet

BASAR Traffic Generation Zone	Total Time (Min.)	Out of Pocket Cost ($)	Percentage of Travel from Zone	Weighted Contribution to Access Time (Min.)	Out of Pocket Cost
27	33.3	3.66	0.67	22.31	2.45
28	21	2.22	0.89	18.69	1.98
29	23	2.30	2.45	56.35	5.64
30	17	2.12	1.12	19.04	2.37
31	24.7	2.50	0.89	21.98	2.23
32	21.8	2.32	2.01	43.82	4.66
33	27.8	2.60	1.56	43.37	4.06
34	20.6	2.25	2.68	55.21	6.03
35	22.5	2.40	1.78	40.05	4.27
36	23.9	2.40	1.34	32.03	3.22
37	28.7	2.72	1.56	44.77	4.24
38	50	3.70	0.89	44.50	3.29
39	53.6	3.20	0.22	11.79	0.70
43	26.9	2.60	0.20	5.38	0.52
44	29.3	2.75	0.59	17.29	1.62
TOTAL			18.85	476.58	47.21
Average				25.28	$2.51

Table C-5 continued
Bay Area 6 STOLport System

STOLPORT: HAYWARD (HAY)

Runway Length 2000 Feet

BASAR Traffic Generation Zone	Total Time (Min.)	Out of Pocket Cost ($)	Percentage of Travel from Zone	Weighted Contribution to Access Time (Min.)	Weighted Contribution to Out of Pocket Cost
40	52.7	3.70	0.20	10.54	0.74
41	41.1	3.25	0.39	20.14	1.27
42	39.6	3.10	0.39	15.44	1.21
45	30.8	2.68	1.17	36.04	3.14
46	24.4	2.52	0.20	4.88	0.50
47	21	2.22	0.59	12.39	1.31
48	18	2.15	1.56	28.08	3.35
49	18.4	2.25	2.73	50.23	6.14
50	24.6	2.45	1.17	28.78	2.87
51	27.2	2.55	1.17	31.82	2.98
52	29.3	2.62	1.17	34.28	3.07
53	27.9	2.62	0.78	21.76	2.04
68	29	2.55	0.87	25.23	2.22
TOTAL			12.39	319.62	30.84
Average				25.80	$2.49

STOLPORT: BUCHANAN (BUC)

Runway Length 2000 Feet

60	29.1	2.70	0.78	22.70	2.11
65	33	2.90	0.65	21.45	1.89
66	26.9	2.60	0.76	20.44	1.98
67	19.4	2.30	0.76	14.74	1.75
69	29.3	2.75	0.65	19.04	1.79
70	20.1	2.33	1.74	34.97	4.05
71	15.1	2.10	1.64	24.76	3.44
72	31.3	2.68	0.11	3.44	0.29
73	26.2	2.61	0.76	19.91	1.98
74	51.6	3.40	0.44	22.70	1.50
75	30.2	2.75	1.13	34.13	3.11
76	21.6	2.40	0.41	8.86	0.98
77	39.3	3.21	0.54	21.22	1.73
78	60.6	4.12	0.05	3.03	0.21
79	55.3	3.90	0.32	17.70	1.25
80	68.4	4.50	0.27	18.47	1.22
81	39.1	3.20	0.31	12.12	0.99
82	45.6	3.50	0.57	25.99	2.00
83	55.1	3.85	0.07	3.86	0.27
84	64.2	4.35	0.21	13.48	0.91
TOTAL			12.17	363.01	33.45
Average				29.83	$2.75

Table C-5 continued
Bay Area 6 STOLport System

STOLPORT: GNOSS (GNO)

Runway Length 2000 Feet

BASAR Traffic Generation Zone	Total Time (Min.)	Out of Pocket Cost ($)	Percentage of Travel from Zone	Weighted Contribution to Access Time (Min.)	Weighted Contribution to Out of Pocket Cost
85	76.5	4.75	0.24	18.36	1.14
86	24.9	2.55	0.60	14.94	1.53
87	40.9	3.20	0.36	14.72	1.15
88	41.8	3.20	0.21	8.78	0.67
89	38	3.15	0.93	35.34	2.93
90	48.5	3.55	0.36	17.46	1.28
91	72.4	4.60	0.30	21.72	1.38
92	59.8	4.15	0.21	12.56	0.87
93	39.8	3.15	0.55	21.89	1.73
94	18.4	2.25	1.22	22.45	2.74
95	27.4	2.62	1.59	43.57	4.17
96	32.2	2.80	0.55	17.71	1.54
97	34	2.92	1.59	54.06	4.64
TOTAL			8.71	303.56	25.77
Average				34.85	$2.96

Table C-6
Bay Area 6 RTOLport System

RTOLPORT: SAN FRANCISCO INTERNATIONAL (SFO)

Runway Length 3000 Feet

BASAR Traffic Generation Zone	Total Time (Min.)	Out of Pocket Cost ($)	Percentage of Travel from Zone	Weighted Contribution to Access Time (Min.)	Weighted Contribution to Out of Pocket Cost
1	34.1	2.62	1.56	53.20	4.09
2	35.2	2.67	3.32	116.86	8.86
3	36.2	2.70	1.37	49.59	3.70
4	38.7	2.77	1.76	68.11	4.88
5	35.7	2.70	1.56	55.69	4.21
6	41.7	2.85	2.15	89.66	6.13
7	32	2.55	1.95	62.40	4.97
8	36	2.65	0.98	35.28	2.60
9	29.8	2.45	1.17	34.87	2.87
10	32.6	2.57	1.37	44.66	3.52
11	38	2.70	0.59	22.42	1.59
12	39.5	2.71	0.98	38.71	2.66
13	33.9	2.57	0.59	20.00	1.52
14	30.8	2.47	0.88	27.10	2.17
15	27.4	2.27	1.90	52.06	4.31
16	35.5	2.50	0.44	15.62	1.10
17	23.5	2.10	1.46	34.31	3.04
18	30.6	2.40	1.90	58.14	4.56
19	32.3	2.50	1.61	52.00	4.02
20	50.2	2.92	0.29	14.56	0.85
TOTAL			27.83	945.24	71.65
Average				33.96	$2.57

RTOLPORT: PALO ALTO (PAO)

Runway Length 3000 Feet

BASAR Traffic Generation Zone	Total Time (Min.)	Out of Pocket Cost ($)	Percentage of Travel from Zone	Weighted Contribution to Access Time (Min.)	Weighted Contribution to Out of Pocket Cost
21	25.3	2.52	2.34	59.20	5.90
22	23.8	2.38	2.34	55.69	5.57
23	30.0	2.45	0.88	26.40	2.16
24	58.0	3.15	0.29	16.82	0.91
25	18.0	2.15	2.23	40.14	4.79
26	21.7	2.30	1.78	38.63	4.09
27	30.2	2.50	0.67	20.23	1.68
TOTAL			10.53	257.11	25.10
Average				24.42	$2.38

Table C-6 continued

Bay Area 6 RTOLport System

RTOLPORT: SAN JOSE (SJE)

Runway Length 3000 Feet

BASAR Traffic Generation Zone	Total Time (Min.)	Out of Pocket Cost ($)	Percentage of Travel from Zone	Weighted Contribution to Access Time (Min.)	Weighted Contribution to Out of Pocket Cost
28	21	2.22	0.89	18.69	1.98
29	23	2.30	2.45	56.35	5.64
30	17	2.12	1.12	19.04	2.37
31	24.7	2.50	0.89	21.98	2.22
32	21.8	2.32	2.01	43.82	4.66
33	27.8	2.60	1.56	43.37	4.06
34	20.6	2.25	2.68	55.21	6.03
35	22.5	2.40	1.78	40.05	4.27
36	23.9	2.40	1.34	32.03	3.22
37	28.7	2.72	1.56	44.77	4.24
38	50.0	3.70	0.89	44.50	3.29
39	53.6	3.20	0.22	11.79	0.70
43	26.9	2.60	0.20	5.38	0.52
44	29.3	2.75	0.59	17.29	1.62
TOTAL			18.18	454.27	44.82
Average				24.99	$2.47

RTOLPORT: HAYWARD (HAY)

Runway Length 3000 Feet

40	52.7	3.70	0.20	10.54	0.74
41	41.1	3.25	0.39	16.03	1.27
42	39.6	3.10	0.39	15.44	1.21
45	30.8	2.68	1.17	36.04	3.14
46	24.4	2.52	0.20	4.88	0.50
47	21	2.22	0.59	12.39	1.31
48	18	2.15	1.56	28.08	3.35
49	18.4	2.25	2.73	50.23	6.14
50	24.6	2.45	1.17	28.78	2.87
51	27.2	2.55	1.17	31.82	2.98
52	29.3	2.62	1.17	34.28	3.07
53	27.9	2.62	0.78	21.76	2.04
54	29.3	2.75	0.98	28.71	2.70
55	30.9	2.70	0.98	30.28	2.65
56	34.9	2.80	0.98	34.20	2.74
57	35.5	2.77	0.39	13.84	1.08
58	36.4	2.95	0.78	28.39	2.30
59	31.5	2.85	0.98	30.87	2.79
61	36.2	3.02	0.98	35.48	2.96
62	39.0	3.15	1.09	42.51	3.43
67	19.4	2.30	0.76	14.74	1.75
TOTAL			19.44	549.29	51.02
Average				28.26	$2.62

Table C-6 continued
Bay Area 6 RTOLport System

RTOLPORT: BUCHANAN (BUC)

Runway Length 3000 Feet

BASAR Traffic Generation Zone	Total Time (Min.)	Out of Pocket Cost ($)	Percentage of Travel from Zone	Weighted Contribution to Access Time (Min.)	Weighted Contribution to Out of Pocket Cost
60	29.1	2.70	0.78	22.70	2.11
64	37.3	3.07	0.87	32.45	2.67
65	33	2.90	0.65	21.45	1.88
66	26.9	2.60	0.76	20.44	1.98
68	29	2.55	0.87	25.23	2.22
69	29.3	2.75	0.65	19.04	1.79
70	20.1	2.33	1.74	34.97	4.05
71	15.1	2.10	1.64	24.76	3.44
72	31.3	2.68	0.11	3.44	0.29
73	26.2	2.61	0.76	19.91	1.98
74	51.6	3.40	0.44	22.70	1.50
75	30.2	2.75	1.13	34.13	3.11
76	21.6	2.40	0.41	8.86	0.98
77	39.3	3.21	0.54	21.22	1.73
78	60.6	4.12	0.05	3.03	0.21
79	55.3	3.90	0.32	17.70	1.25
80	68.4	4.50	0.27	18.47	1.22
81	39.1	3.20	0.31	12.12	0.99
82	45.6	3.50	0.57	25.99	2.00
83	55.1	3.85	0.07	3.86	0.27
84	64.2	4.35	0.21	13.48	0.91
TOTAL			13.15	405.95	36.58
Average				30.87	$2.78

RTOLPORT: GNOSS (GNO)

Runway Length 3000 Feet

BASAR Traffic Generation Zone	Total Time (Min.)	Out of Pocket Cost ($)	Percentage of Travel from Zone	Weighted Contribution to Access Time (Min.)	Weighted Contribution to Out of Pocket Cost
63	38.2	3.17	0.44	16.81	1.39
85	76.5	4.75	0.24	18.36	1.14
86	24.9	2.55	0.60	14.94	1.53
87	40.9	3.20	0.36	14.72	1.15
88	41.8	3.20	0.21	8.78	0.67
89	38	3.15	0.93	35.34	2.93
90	48.5	3.55	0.36	17.46	1.28
91	72.4	4.60	0.30	21.72	1.38
92	59.8	4.15	0.21	12.56	0.87
93	39.8	3.15	0.55	21.89	1.73
94	18.4	2.25	1.22	22.45	2.74
95	27.4	2.62	1.59	43.57	4.17
96	32.2	2.80	0.55	17.71	1.54
97	34	2.92	1.59	54.06	4.64
98	27	3.15	0.61	16.47	1.92
TOTAL			9.76	336.84	29.08
Average				34.51	$2.98

Table C-7

Access Time, Cost and Percentage of Travelers by Zone and Airport

Revisions to STOLport Data Required when Gnoss Field is Eliminated to Produce Bay Area 5 STOLport System

STOLPORT: CENTRAL BUSINESS DISTRICT (CBD)

Runway Length 2000 Feet

BASAR Traffic Generation Zone	Total Time (Min.)	Out of Pocket Cost ($)	Percentage of Travel from Zone	Weighted Contribution to Access Time (Min.)	Weighted Contribution to Out of Pocket Cost
1	14	2.05	1.56	21.84	3.20
2	15.6	2.09	3.32	51.79	6.94
3	17	2.12	1.37	23.29	2.90
4	19	2.18	1.76	33.44	3.84
5	19	2.18	1.56	29.64	3.40
6	20.3	2.28	2.15	43.64	4.90
7	15.6	2.09	1.95	30.42	4.08
8	19.2	2.18	0.98	18.82	2.14
9	16.7	2.18	1.17	19.54	2.55
10	18.4	2.25	1.37	25.21	3.08
11	22.6	2.26	0.59	13.33	1.33
12	25.4	2.34	0.98	24.89	2.29
13	22.3	2.36	0.59	13.16	1.39
14	23.4	2.44	0.88	20.59	2.15
15	23.8	2.50	1.90	45.22	4.75
16	32.4	2.72	0.44	14.26	1.20
54	28.9	2.65	0.98	28.32	2.60
55	25.9	2.58	0.98	25.38	2.53
56	22.7	2.45	0.98	22.25	2.40
57	24.5	2.49	0.39	9.56	0.97
58	23.7	2.48	0.78	18.49	1.93
59	25.5	2.58	0.98	24.99	2.53
61	30.1	2.72	0.98	29.50	2.67
62	30.7	2.78	1.09	33.46	3.03
63	34	2.92	0.44	14.96	1.28
64	34	2.92	0.87	29.58	2.54
93	51.5	4.15	0.55	28.32	2.28
95	44.4	3.20	1.59	70.60	5.09
96	67.3	4.00	0.55	37.02	2.20
97	32.0	3.05	1.59	50.88	4.85
98	27.5	2.58	0.61	16.78	1.57
TOTAL			35.93	869.17	88.61
Average				24.19	2.47

Table C-7 (cont'd)

Access Time, Cost and Percentage of Travelers by Zone and Airport

Revisions to STOLport Data Required when Gnoss Field is Eliminated to Produce Bay Area 5 STOLport System

STOLPORT: BUCHANAN (BUC)

Runway Length 2000 Feet

60	29.1	2.70	0.78	22.70	2.11
65	33	2.90	0.65	21.45	1.89
66	26.9	2.60	0.76	20.44	1.98
67	19.4	2.30	0.76	14.74	1.75
69	29.3	2.75	0.65	19.04	1.79
70	20.1	2.33	1.74	34.97	4.05
71	15.1	2.10	1.64	24.76	3.44
72	31.3	2.68	0.11	3.44	0.29
73	26.2	2.61	0.76	19.91	1.98
74	51.6	3.40	0.44	22.70	1.50
75	30.2	2.75	1.13	34.13	3.11
76	21.6	2.40	0.41	8.86	0.98
77	39.3	3.21	0.54	21.22	1.73
78	60.6	4.12	0.05	3.03	0.21
79	55.3	3.90	0.32	17.70	1.25
80	68.4	4.50	0.27	18.47	1.22
81	39.1	3.20	0.31	12.12	0.99
82	45.6	3.50	0.57	25.99	2.00
83	55.1	3.85	0.07	3.86	0.27
84	64.2	4.35	0.21	13.48	0.91
85	88	5.70	0.24	21.12	1.37
86	55.5	4.25	0.60	33.30	2.55
87	55.3	4.20	0.36	19.91	1.51
88	81.6	5.20	0.21	17.14	1.09
89	70.9	4.75	0.93	65.94	4.42
90	81.5	5.15	0.36	29.34	1.85
91	101.1	6.05	0.30	30.33	1.82
92	94.4	5.70	0.21	19.82	1.20
94	42.5	3.70	1.22	51.85	4.51
TOTAL			16.60	651.76	51.16
Average				39.26	3.08

Table C-8

Access Time, Cost and Percentage of Travelers by Zone and Airport

Revisions to RTOLport Data Required when Gnoss Field is Eliminated
to Produce Bay Area 5 RTOLport System

RTOLPORT: SAN FRANCISCO INTERNATIONAL (SFO)

Runway Length 3000 Feet

BASAR Traffic Generation Zone	Total Time (Min.)	Out of Pocket Cost ($)	Percentage of Travel from Zone	Weighted Contribution to Access Time (Min.)	Weighted Contribution to Out of Pocket Cost
1	34.1	2.62	1.56	53.20	4.09
2	35.2	2.67	3.32	116.86	8.86
3	36.2	2.70	1.37	49.59	3.70
4	38.7	2.77	1.76	68.11	4.88
5	35.7	2.70	1.56	55.69	4.21
6	41.7	2.85	2.15	89.66	6.13
7	32	2.55	1.95	62.40	4.97
8	36	2.65	0.98	35.28	2.60
9	29.8	2.45	1.17	34.87	2.87
10	32.6	2.57	1.37	44.66	3.52
11	38	2.70	0.59	22.42	1.59
12	39.5	2.71	0.98	38.71	2.66
13	33.9	2.57	0.59	20.00	1.52
14	30.8	2.47	0.88	27.10	2.17
15	27.4	2.27	1.90	52.06	4.31
16	35.5	2.50	0.44	15.62	1.10
17	23.5	2.10	1.46	34.31	3.04
18	30.6	2.40	1.90	58.14	4.56
19	32.3	2.50	1.61	52.00	4.02
20	50.2	2.92	0.29	14.56	0.85
96	79.5	4.60	0.55	43.73	2.53
97	44.2	3.65	1.59	70.28	5.80
98	35.8	3.05	0.61	21.84	1.86
TOTAL			30.58	1081.09	81.84
Average				35.35	2.68

Table C-8 (cond't)

Access Time, Cost and Percentage of Travelers by Zone and Airport

Revisions to RTOLport Data Required when Gnoss Field is Eliminated to Produce Bay Area 5 RTOLport System

RTOLPORT: BUCHANAN (BUC)

Runway Length 3000 Feet

BASAR Traffic Generation Zone	Total Time (Min.)	Out of Pocket Cost ($)	Percentage of Travel from Zone	Weighted Contribution to Access Time (Min.)	Weighted Contribution to Out of Pocket Cost
60	29.1	2.70	0.78	22.70	2.11
63	28.3	3.30	0.44	1.25	1.65
64	37.3	3.07	0.87	32.45	2.67
65	33	2.90	0.65	21.45	1.88
66	26.9	2.60	0.76	20.44	1.98
68	29	2.55	0.87	25.23	2.22
69	29.3	2.75	0.65	19.04	1.79
70	20.1	2.33	1.74	34.97	4.05
71	15.1	2.10	1.64	24.76	3.44
72	31.3	2.68	0.11	3.44	0.29
73	26.2	2.61	0.76	19.91	1.98
74	51.6	3.40	0.44	22.70	1.50
75	30.2	2.75	1.13	34.13	3.11
76	21.6	2.40	0.41	8.86	0.98
77	39.3	3.21	0.54	21.22	1.73
78	60.6	4.12	0.05	3.03	0.21
79	55.3	3.90	0.32	17.70	1.25
80	68.4	4.50	0.27	18.47	1.22
81	39.1	3.20	0.31	12.12	0.99
82	45.6	3.50	0.57	25.99	2.00
83	55.1	3.85	0.07	3.86	0.27
84	64.2	4.35	0.21	13.48	0.91
85	88	5.70	0.24	21.12	1.37
86	55.5	4.25	0.60	33.30	2.55
87	55.3	4.20	0.36	19.91	1.51
88	81.6	5.20	0.21	17.14	1.09
89	70.9	4.75	0.93	65.94	4.42
90	81.5	5.15	0.36	29.34	1.85
91	101.1	6.05	0.30	30.33	1.82
92	94.4	5.70	0.21	19.82	1.20
93	55.3	4.20	0.55	30.42	2.31
94	42.5	3.70	1.22	51.85	4.51
95	43.1	3.85	1.59	68.53	6.12
TOTAL			20.16	751.96	61.24
Average				39.21	3.19

Table C-9

COST OF TRAVEL FROM LOS ANGELES ZONE TO STOLPORT

2000 Foot Runways

LOS ANGELES
AREA 6
STOLPORT SYSTEM

TRAFFIC GENERATION ZONE	NEAREST STOLPORT	MILES ON CITY STREET	TIME ON CITY STREET (30 MPH) (Minutes)	MILES ON FREEWAY	TIME ON FREEWAY (55 MPH) (Minutes)	TOTAL MILES	TOTAL TIME (Min.)*	MILEAGE COST AT 5 ¢/MI	TIME COST AT 6 $/HR	PARKING COST $2.00	TOTAL COST	PERCENTAGE OF TRAVEL FROM ZONE	WEIGHTED CONTRIBUTION TO AVERAGE COST
1C	SMA	1.5	3	6.5	7.1	8	22.1	.40	2.21		4.61	5.47	25.22
2A	CBD	1	2	7.5	8.2	8.5	22.2	.42	2.22		4.64	3.00	13.92
2B	CBD	1	2	4	4.4	5	18.4	.25	1.8[illegible]		4.09	9.03	36.43
2N	CBD	3	6	5	5.5	8	23.5	.40	2.35		4.75	12.83	60.94
2S	TOR	2.5	5	7.5	8.2	10	25.2	.50	2.52		5.02	6.99	35.09
2W	SMA	1	2	0	0	1	14	.05	1.40		3.45	7.28	25.12
3A	VNS	1	2	4	4.4	5	18.4	.25	1.84		3.09	5.86	18.11
3N1	VNS	3	6	15	16.4	18	34.4	.90	3.44		6.34	3.72	23.58
3N2	CBD	3	6	5	5.5	8	23.5	.40	2.35		4.75	3.72	17.67
3N3	CBD	5	10	0	0	5	22	.25	2.20		2.45	3.72	9.11
3S	LBH	2.5	5	0	0	2.5	17	.12	1.70		3.82	9.34	35.68
4N1	VNS	8	16	18	19.6	26	47.6	1.30	4.76		8.06	0.80	6.45
4N2	ELM	4	8	0	0	4	20	.20	2.00		4.20	3.22	13.52
4N3	ELM	2.5	5	8	8.8	10.5	25.8	.52	2.58		5.10	3.22	16.42
4S	LBH	4	8	12.5	13.6	16.5	33.6	.82	3.36		6.18	7.90	48.82
4W	VNS	2	4	3.5	3.8	5.5	19.8	.27	1.98		4.25	4.50	19.13
5N	ELM	3	6	10	10.9	13	28.9	.65	2.89		5.54	2.52	13.96
5S	LBH	2	4	23	25.1	25	41.1	1.25	4.11		7.36	5.10	37.54
5W	VNS	1	2	13	14.2	14	28.2	.70	2.82		5.52	1.77	9.77

STOLPORT DESIGNATIONS:

SMA - Santa Monica Municipal Airport
CBD - Central Business District
TOR - Torrance Airport
VNS - Van Nuys Airport
ELM - El Monte Airport
LBH - Long Beach Municipal Airport

* Note: 12 minutes added to total time to allow for parking and travel from parking to terminal

Table C-10

COST OF TRAVEL FROM LOS ANGELES ZONE TO RTOLPORT

3000 Foot Runways

LOS ANGELES AREA
6 RTOLPORT SYSTEM

TRAFFIC GENERATION ZONE	NEAREST STOLPORT	MILES ON CITY STREET	TIME ON CITY STREET (30 MPH) (Minutes)	MILES ON FREEWAY	TIME ON FREEWAY (55 MPH) (Minutes)	TOTAL MILES	TOTAL TIME (Min.)*	MILEAGE COST AT 5 ¢/MI	TIME COST AT 6 $/HR	PARKING COST $2.00	TOTAL COST	PERCENTAGE OF TRAVEL FROM ZONE	WEIGHTED CONTRIBUTION TO AVERAGE COST
1C	SMA	1.5	3	6.5	7.1	8	22.1	.40	2.21		4.61	5.47	25.22
2A	BUR	3	6	8	8.7	11	26.7	.55	2.67		5.22	3.00	15.66
2B	SMA	2	4	13	14.2	15	30.2	.75	3.02		5.77	9.03	52.10
2N	SMA	3	6	8.5	9.3	11.5	27.3	.57	2.73		5.30	12.83	68.00
2S	TOR	2.5	5	7.5	8.2	10	25.2	.50	2.52		5.02	6.99	35.09
2W	SMA	1	2	0	0	1	14	.05	1.40		3.45	7.28	25.12
3A	VNS	1	2	4	4.4	5	18.4	.25	1.84		3.09	5.86	18.11
3N1	BUR	2	4	2.5	2.7	4.5	18.7	.23	1.87		4.10	3.72	15.25
3N2	BUR	2	4	12	13.1	14	29.1	.70	2.91		5.61	3.72	20.87
3N3	ELM	2.5	5	15	16.4	17.5	33.4	.88	3.34		6.22	3.72	23.14
3S	LBH	2.5	5	0	0	2.5	17	.12	1.70		3.82	9.34	35.66
4N1	BUR	8	16	7	7.6	15	35.6	.75	3.56		5.31	0.80	4.25
4N2	ELM	4	8	0	0	4	20	.20	2.00		4.20	3.22	13.52
4N3	ELM	2.5	5	8	8.7	10.5	17	.53	1.70		4.23	3.22	13.62
4S	LBH	4	8	12.5	13.6	16.5	33.6	.82	3.36		6.18	7.90	48.82
4W	VNS	2	4	3.5	3.8	5.5	19.8	.27	1.98		4.25	4.50	19.13
5N	ELM	3	6	10	10.9	13	28.9	.65	2.89		5.54	2.52	13.96
5S	LBH	2	4	23	25.1	25	41.1	1.25	4.11		7.36	5.10	37.54
5W	VNS	1	2	13	14.2	14	28.2	.70	2.82		5.52	1.77	9.77

RTOLPORT DESIGNATIONS:

SMA - Santa Monica Municipal Airport
BUR - Hollywood-Burbank Airport
TOR - Torrance Airport
VNS - Van Nuys Airport
ELM - El Monte Airport
LBH - Long Beach Municipal Airport

* Note: 12 minutes added to total time to allow for parking and travel from parking to terminal.

Table C-11

COST OF TRAVEL FROM LOS ANGELES ZONE TO STOLPORT
2000 Foot Runways

Revisions of Zone Data Required when El Monte and Torrance are Eliminated to Produce Los Angeles Area 4 STOLport System

LOS ANGELES AREA 4 STOLPORT SYSTEM

TRAFFIC GENERATION ZONE	NEAREST STOLPORT	MILES ON CITY STREET	TIME ON CITY STREET (30 MPH) (Minutes)	MILES ON FREEWAY	TIME ON FREEWAY (55 MPH) (Minutes)	TOTAL MILES	TOTAL TIME (Min.)*	MILEAGE COST AT 5 ¢/MI	TIME COST AT 6 $/HR	PARKING COST $2.00	TOTAL COST	PERCENTAGE OF TRAVEL FROM ZONE	WEIGHTED CONTRIBUTION TO AVERAGE COST
1C	SMA	1.5	3	6.5	7.1	8	22.1	.40	2.21		4.61	5.47	25.22
2A	CBD	1	2	7.5	8.2	8.5	22.2	.42	2.22		4.64	3.00	13.92
2B	CBD	1	2	4	4.4	5	18.4	.25	1.84		4.09	9.03	36.43
2N	CBD	3	6	5	5.5	8	23.5	.40	2.35		4.75	12.83	60.94
1/2 2S	LBH	2.5	5	14	15.3	16.5	20.3	.83	2.03		4.86	3.50	17.01
1/2 2S	SMA	2.5	5	18	19.6	20.5	24.6	1.03	2.46		5.49	3.50	19.22
2W	SMA	1	2	0	0	1	14	.05	1.40		3.45	7.28	25.12
3A	VNS	1	2	4	4.4	5	18.4	.25	1.84		3.09	5.86	18.11
3N1	VNS	3	6	15	16.4	18	34.4	.90	3.44		6.34	3.72	23.58
3N2	CBD	3	6	5	5.5	8	23.5	.40	2.35		4.75	3.72	17.67
3N3	CBD	5	10	0	0	5	22	.25	2.20		2.45	3.72	9.11
3S	LBH	2.5	5	0	0	2.5	17	.12	1.70		3.82	9.34	35.68
4N1	VNS	8	16	18	19.6	26	47.6	1.30	4.76		8.06	0.80	6.45
4N2	CBD	4	8	19	20.7	23	28.7	1.15	2.87		6.02	3.22	19.38
4N3	CBD	2.5	5	17	18.5	19.5	23.5	.98	2.35		5.33	3.22	17.16
4S	LBH	4	8	12.5	13.6	16.5	33.6	.82	3.36		6.18	7.90	48.82
4W	VNS	2	4	3.5	3.8	5.5	19.8	.27	1.98		4.25	4.50	19.13
5N	CBD	3	6	23	25.1	26	31.1	1.30	3.11		6.41	2.52	16.15
5S	LBH	2	4	23	25.1	25	41.1	1.25	4.11		7.36	5.10	37.54
5W	VNS	1	2	13	14.2	14	28.2	.70	2.82		5.52	1.77	9.77
											Total	100.00	476.41
											Average		$4.76

STOLPORT DESIGNATIONS:

SMA - Santa Monica Municipal Airport
CBD - Central Business District
TOR - Torrance Airport
VNS - Van Nuys Airport
ELM - El Monte Airport
LBH - Long Beach Municipal Airport

* Note: 12 minutes added to total time to allow for parking and travel from parking to terminal

Table C-12

COST OF TRAVEL FROM LOS ANGELES ZONE TO RTOLPORT

LOS ANGELES AREA 5 RTOLPORT SYSTEM

3000 Foot Runways

Revisions of Zone Data Required when Torrance is Eliminated to Produce Los Angeles Area 5 RTOLport System

TRAFFIC GENERATION ZONE	NEAREST STOLPORT	MILES ON CITY STREET	TIME ON CITY STREET (30 MPH) (Minutes)	MILES ON FREEWAY	TIME ON FREEWAY (55 MPH) (Minutes)	TOTAL MILES	TOTAL TIME (Min.)*	MILEAGE COST AT 5 ¢/MI	TIME COST AT 6 $/HR	PARKING COST $2.00	TOTAL COST	PERCENTAGE OF TRAVEL FROM ZONE	WEIGHTED CONTRIBUTION TO AVERAGE COST
1C	SMA	1.5	3	6.5	7.1	8	22.1	.40	2.21		4.61	5.47	25.22
2A	BUR	3	6	8	8.7	11	26.7	.55	2.67		5.22	3.00	15.66
2B	SMA	2	4	13	14.2	15	30.2	.75	3.02		5.77	9.03	52.10
2N	SMA	3	6	8.5	9.3	11.5	27.3	.57	2.73		5.30	12.83	68.00
1/2 2S	LBH	2.5	5	14	15.3	16.5	20.3	.83	2.03		4.86	3.50	17.01
1/2 2S	SMA	2.5	5	18	19.6	20.5	24.6	1.03	2.46		5.49	3.50	19.22
2W	SMA	1	2	0	0	1	14	.05	1.40		3.45	7.28	25.12
3A	VNS	1	2	4	4.4	5	18.4	.25	1.84		3.09	5.86	18.11
3N1	BUR	2	4	2.5	2.7	4.5	18.7	.23	1.87		4.10	3.72	15.25
3N2	BUR	2	4	12	13.1	14	29.1	.70	2.91		5.61	3.72	20.87
3N3	ELM	2.5	5	15	16.4	17.5	33.4	.88	3.34		6.22	3.72	23.14
3S	LBH	2.5	5	0	0	2.5	17	.12	1.70		3.82	9.34	35.66
4N1	BUR	8	16	7	7.6	15	35.6	.75	3.56		5.31	0.80	4.25
4N2	ELM	4	8	0	0	4	20	.20	2.00		4.20	3.22	13.52
4N3	ELM	2.5	5	8	8.7	10.5	17	.53	1.70		4.23	3.22	13.62
4S	LBH	4	8	12.5	13.6	16.5	33.6	.82	3.36		6.18	7.90	48.82
4W	VNS	2	4	3.5	3.8	5.5	19.8	.27	1.98		4.25	4.50	19.13
5N	ELM	3	6	10	10.9	13	28.9	.65	2.89		5.54	2.52	13.96
5S	LBH	2	4	23	25.1	25	41.1	1.25	4.11		7.36	5.10	37.54
5W	VNS	1	2	13	14.2	14	28.2	.70	2.82		5.52	1.77	9.77
											Total	100.00	495.97
											Average	$4.96	

RTOLPORT DESIGNATIONS:

SMA - Santa Monica Municipal Airport
BUR - Hollywood-Burbank Airport
TOR - Torrance Airport
VNS - Van Nuys Airport
ELM - El Monte Airport
LBH - Long Beach Municipal Airport

* Note: 12 minutes added to total time to allow for parking and travel from parking to terminal.

Table C-13

Access Time, Cost and Percentage of Travelers by Zone and Airport

Los Angeles Area 6 STOLport System

Traffic Generation Zone	(Min.) Total Time	Out of Pocket Cost	Percentage of Travel from Zone	Weighted Contribution to Access Time (Min.)	Weighted Contribution to Out of Pocket Cost
STOLPORT: CENTRAL BUSINESS DISTRICT (CBD) Runway Length 2000 Feet					
2A	22.2	2.42	3.00	66.60	7.26
2B	18.4	2.25	9.03	166.15	20.32
2N	23.5	2.40	12.83	301.51	30.79
3N2	23.5	2.40	3.72	87.42	8.93
3N3	22.0	2.25	3.72	81.84	8.37
TOTAL			32.30	703.52	75.67
Average				21.78	$2.34
STOLPORT: EL MONTE AIRPORT (ELM) Runway Length 2000 Feet					
4N2	20.0	2.20	3.22	64.40	7.08
4N3	25.8	2.52	3.22	83.08	8.11
5N	28.9	2.65	2.52	72.83	6.68
TOTAL			8.96	220.31	21.87
Average				24.58	$2.44
STOLPORT: LONG BEACH MUNICIPAL AIRPORT (LBH) Runway Length 2000 Feet					
3S	17.0	2.12	9.34	158.78	19.80
4S	33.6	2.82	7.90	265.44	22.28
5S	41.1	3.25	5.10	209.61	16.58
TOTAL			22.34	633.83	58.66
Average				28.37	$2.62
STOLPORT: SANTA MONICA (SMA) Runway Length 2000 Feet					
1C	22.1	2.40	5.47	120.89	13.13
2W	14.0	2.05	7.28	101.92	14.92
TOTAL			12.75	222.81	28.05
Average				17.47	$2.20
STOLPORT: TORRANCE AIRPORT (TOR) Runway Length 2000 Feet					
2S	25.2	2.50	6.99	176.15	17.48
TOTAL			6.99	176.15	17.48
Average				25.20	$2.50

Table C-13 continued

Los Angeles Area 6 STOLport System

STOLPORT: VAN NUYS AIRPORT (VNS)
Runway Length 2000 Feet

Traffic Generation Zone	(Min.) Total Time	Out of Pocket Cost	Percentage of Travel from Zone	Weighted Contribution to Access Time (Min.)	Weighted Contribution to Out of Pocket Cost
3A	18.4	2.25	5.86	107.82	13.19
3N1	34.4	2.90	3.72	127.97	10.79
4N1	47.6	3.30	0.80	38.08	2.64
4W	19.8	2.27	4.50	89.10	10.22
5W	28.2	2.70	1.77	49.91	4.78
TOTAL			16.65	412.88	41.62
Average				24.79	$2.49

Table C-14

Los Angeles Area 6 RTOLport System

RTOLPORT: HOLLYWOOD-BURBANK AIRPORT (BUR)
Runway Length 3000 Feet

Traffic Generation Zone	(Min.) Total Time	Out of Pocket Cost	Percentage of Travel from Zone	Weighted Contribution to Access Time (Min.)	Weighted Contribution to Out of Pocket Cost
2A	26.7	2.55	3.00	80.10	7.65
3N1	18.7	2.23	3.72	69.56	8.30
3N2	29.1	2.70	3.72	108.25	10.04
4N1	35.6	2.75	0.80	28.48	2.20
TOTAL			11.24	286.39	28.19
Average				25.47	$2.50

RTOLPORT: EL MONTE AIRPORT (ELM)
Runway Length 3000 Feet

3N3	33.4	2.88	3.72	124.25	10.71
4N2	20.0	2.20	3.22	64.40	7.08
4N3	17.0	2.53	3.22	54.74	8.15
5N	28.9	2.65	2.52	72.83	6.68
TOTAL			12.68	316.22	32.62
Average				24.93	$2.57

RTOLPORT: LONG BEACH MUNICIPAL AIRPORT (LBH)
Runway Length 3000 Feet

3S	17.0	2.12	9.34	158.78	19.80
4S	33.6	2.82	7.90	265.44	22.28
5S	41.1	3.25	5.10	209.61	16.58
TOTAL			22.34	633.83	58.66
Average				28.37	$2.62

RTOLPORT: SANTA MONICA (SMA)
Runway Length 3000 Feet

1C	22.1	2.40	5.47	120.89	13.13
2B	30.2	2.75	9.03	272.71	24.83
2N	27.3	2.57	12.83	350.26	32.97
2W	14.0	2.05	7.28	101.92	14.92
TOTAL			34.61	845.78	85.85
Average				24.43	$2.48

RTOLPORT: TORRANCE AIRPORT (TOR)
Runway Length 3000 Feet

2S	25.2	2.50	6.99	176.15	17.48
TOTAL			6.99	176.15	17.48
Average				25.20	$2.50

Table C-14 continued

Los Angeles Area 6 RTOLport System

RTOLPORT: VAN NUYS AIRPORT (VNS)
Runway Length 3000 Feet

Traffic Generation Zone	(Min.) Total Time	Out of Pocket Cost	Percentage of Travel from Zone	Weighted Contribution to Access Time (Min.)	Weighted Contribution to Out of Pocket Cost
3A	18.4	2.25	5.86	107.82	13.19
4W	19.8	2.27	4.50	89.10	10.22
5W	28.2	2.70	1.77	49.91	4.78
TOTAL			12.13	246.83	28.19
Average				20.34	$2.32

Table C-15

Access Time, Cost and Percentage of Travelers by Zone and Airport

Revisions to STOLport Data Required when Torrance and El Monte are Eliminated to Produce Los Angeles Area 4 STOLport System

STOLPORT: CENTRAL BUSINESS DISTRICT (CBD)

Runway Length 2000 Feet

Traffic Generation Zone	(Min.) Total Time	Out of Pocket Cost	Percentage of Travel from Zone	Weighted Contribution to Access Time (Min.)	Weighted Contribution to Out of Pocket Cost
2A	22.2	2.42	3.00	66.60	7.26
2B	18.4	2.25	9.03	166.15	20.32
2N	23.5	2.40	12.83	301.51	30.79
3N2	23.5	2.40	3.72	87.42	8.93
3N3	22.0	2.25	3.72	81.84	8.37
4N2	23.0	3.15	3.22	74.06	10.14
4N3	19.5	2.98	3.22	62.79	9.60
5N	26.0	3.30	2.52	65.52	8.32
TOTAL			41.26	905.89	103.73
Average				21.96	$2.51

STOLPORT: LONG BEACH MUNICIPAL AIRPORT (LBH)
Runway Length 2000 Feet

3S	17.0	2.12	9.34	158.78	19.80
4S	33.6	2.82	7.90	265.44	22.28
5S	41.1	3.25	5.10	209.61	16.58
1/2 2S	20.3	2.83	3.50	71.05	9.91
TOTAL			25.84	704.88	68.57
Average				27.28	$2.65

STOLPORT: SANTA MONICA (SMA)
Runway Length 2000 Feet

1C	22.1	2.40	5.47	120.89	13.13
2W	14.0	2.05	7.28	101.92	14.92
1/2 2S	24.6	3.03	3.50	86.10	10.61
TOTAL			16.25	308.91	38.66
Average				19.01	$2.38

Table C-16

Access Time, Cost and Percentage of Travelers by Zone and Airport

Revisions to RTOLport Data Required when Torrance is Eliminated to Produce Los Angeles Area 5 RTOLport System

RTOLPORT: LONG BEACH MUNICIPAL AIRPORT (LBH)
Runway Length 3000 Feet

3S	17.0	2.12	9.34	158.78	19.80
4S	33.6	2.82	7.90	265.44	22.28
5S	41.1	3.25	5.10	209.61	16.58
1/2 2S	20.3	2.83	3.50	71.05	9.91
TOTAL			25.84	704.88	68.57
Average				27.28	$2.65

RTOLPORT: SANTA MONICA (SMA)
Runway Length 3000 Feet

1C	22.1	2.40	5.47	120.89	13.13
2B	30.2	2.75	9.03	272.71	24.83
2N	27.3	2.57	12.83	350.26	32.97
2W	14.0	2.05	7.28	101.92	14.92
1/2 2S	24.6	3.03	3.50	86.10	10.61
TOTAL			38.11	931.88	96.46
Average				24.45	$2.53

Appendix D

STOLPORT INFRASTRUCTURE COSTS

Infrastructure costs at the proposed STOLports are a function of projected air traffic and the extent to which existing facilities can be used for STOL operations. STOLport costs were estimated on the basis of reports prepared by various industrial and consulting firms and interviews with private consultants and public officials. These methods can best be explained by example. The following pages illustrate the costing methods used in the course of preparing cost estimates for Palo Alto airport improvements.

Cost estimates for other STOLports developed from existing general aviation airports have been calculated by the same methods. The results are summarized on page III-5.

The cost of the San Francisco CBD STOLport is derived on page D-23.

Existing Facilities at Palo Alto

Palo Alto airport (PAO) is located at the east end of Embarcadero Road on land reclaimed from San Francisco Bay. The airport is operated as a general aviation facility by the County of Santa Clara. The facility is designed to handle the operations of small propeller aircraft. The airport does not currently provide the necessary support facilities (fuel systems, ILS, IFR rating, runway strength) to accomodate larger jet powered commercial aircraft. Major improvements would be necessary before Palo Alto airport could accomodate commercial STOL activity.

The Federal Aviation Administration records show that Palo Alto airport presently has the following pertinent characteristics:

Land Area	182 acres
Peak Daily Operations	670 flights
Yearly Operations	210,000 flights
Largest Aircraft Type Using Facility	General Aviation Propeller
Available Tie-downs	220

Runway Characteristics

Number of Runways	1
Runway Length	2500 ft.
Taxiway Length	2500 ft.
Runway Width	65 ft.
Taxiway Width	30 ft.
Bearing Strength of Pavement	can support 5000 lb. gross weight aircraft on single wheel main gear

Automobile Accomodation

Parking spaces	approximately 175

Future Development of Palo Alto Airport

It has been assumed that general aviation operations will not be displaced by the introduction of commercial service. It is anticipated that Palo Alto will accomodate 200,000 general aviation operations in 1985 - a small increase over current levels. STOLport sizing and costing are based on this expectation.

STOLport development will require the use of all or part of the existing general aviation apron area. For this reason, new apron area must be obtained. It is proposed that the new apron be located on land obtained from the golf course on the west side of the airport.

The area required to accomodate the necessary 220 tie-downs is approximately 21 acres. The cost of obtaining land from the golf course is estimated at \$70,000/acre. The result is a maximum land acquisition cost of \$1,470,000.

Calculation of Daily and Hourly Operations

On the basis of preliminary travel demand projections for the California corridor, it was estimated that 1.54 million passengers would use a Palo Alto STOLport in the year 1985. Assuming 365-day operating year, 4220 passengers would use PAO daily.

Assuming a 100-passenger STOLcraft similar in dimensions to the Douglas D-3210-7 operating with an average daily load factor of 60%, a Palo Alto STOL-port must be sized to accomodate 71 commercial operations per day.

The number of operations and passengers during peak hour is critical in determining the size of airport infrastructure. Figure D-1 (Ref. 14) shows a histogram of departures from San Francisco and Los Angeles during a 24-hour operating day. The STOL system is proposed to have a shorter 15-hour operating day (7 a.m.-10 p.m.). Flights shown on the histogram as occuring before 7 a.m. and after 10 p.m. are therefore reassigned to the hours shortly after opening and shortly before closing of the system. This results in peaks in early morning and late evening. An estimated 11% of the daily passengers travel during each peak hour. It was assumed that in these two peak hours, the aircraft load factor rises to 90%.

Thus:

Passengers at peak hour = 4220 passengers per day x .11 = 465 passengers per peak hour.

And, assuming 90% load factor:

Operations at peak hour = 465 passengers per peak hour / 90 passengers per operations = 5.15 operations.

Assuming the aircraft are slightly more than 90% full, this can be rounded down to 5 operations at peak hour.

DISTRIBUTION OF SCHEDULED AIRLINE SEATS, BY HOUR
BETWEEN LOS ANGELES AND SAN FRANCISCO
(a Friday in July, 1965)

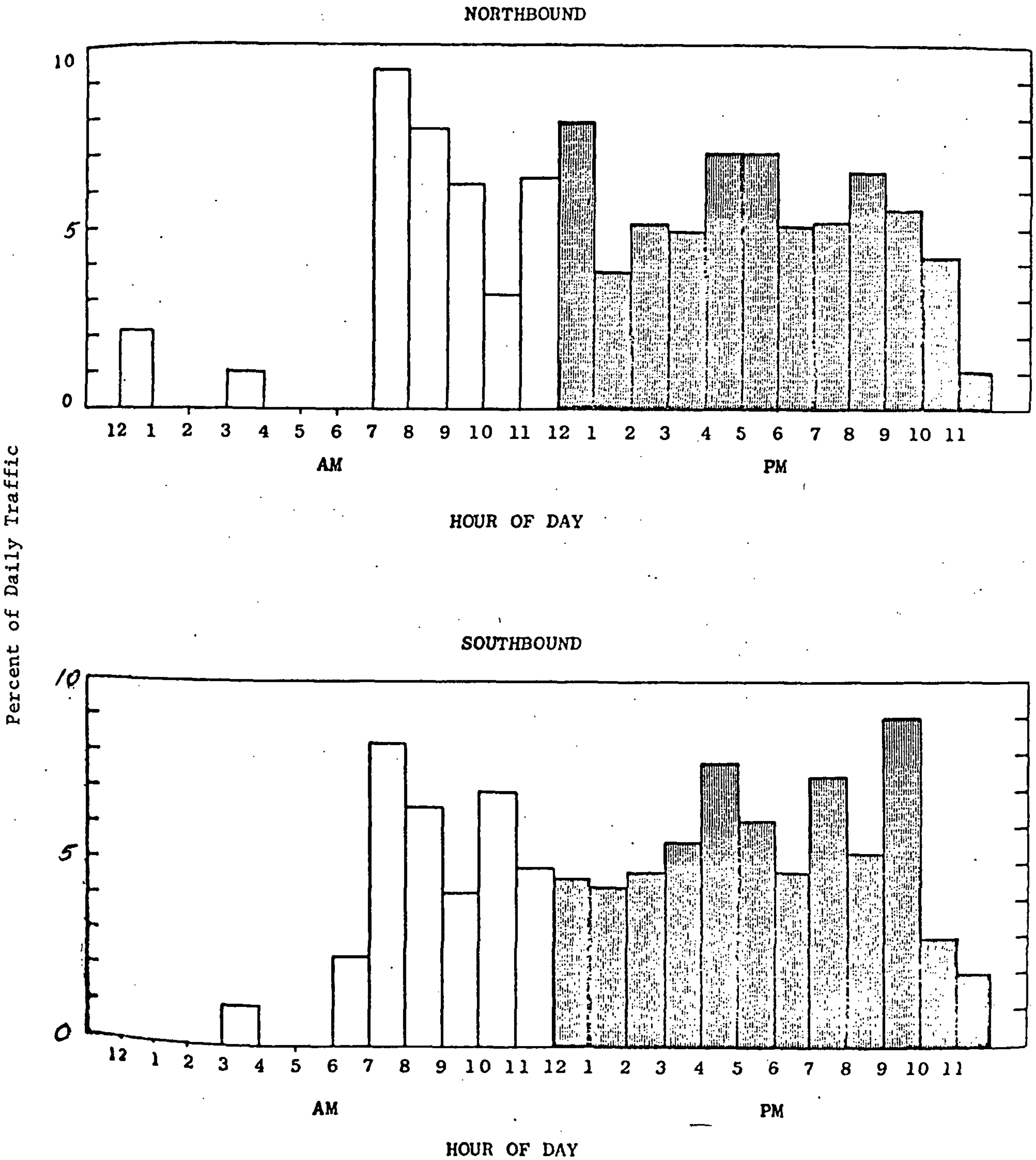


Figure D-1

Number of Aircraft Based in Palo Alto

It is assumed that a set fleet of planes will make all the flights between Palo Alto and the Los Angeles STOLports. During the night hours, the aircraft will not be in operation and could undergo light maintenance at their home base. The size of the fleet will determine the apron area necessary for overnight aircraft parking.

The size of the fleet flying between Palo Alto and the Los Angeles area is affected by round-trip flight time.

The round trip between Palo Alto and Los Angeles is one hour in each direction plus turn around times at each airport. Reference 2 gives the turn around time for a fully loaded 150 passenger aircraft similar to the D-3210-7. The critical path servicing the aircraft between flights is the time needed to service the cabin (Ref. 2). The turn around time is given as 22 minutes.

Due to the projected smaller capacity of the D-3210-7, it is estimated that the following reductions can be made in turn around time:

- the time to deplane passengers can be reduced from 3 minutes to 2 minutes
- cabin service time can be reduced from 10.1 minutes to about 8 minutes
- time to enplane passengers can be reduced from 3.8 minutes to 3 minutes.

These corrections will reduce the total turn around time to less than 20 minutes. Allowing 2 minutes between the time a plane leaves a gate and the time the next plane arrives at the gate, we can estimate that a given gate will be able to handle 3 aircraft per hour.

The round trip time for an aircraft is then 2 hours and 40 minutes or 2.66 hours. The time for each one way trip is 1.33 hours.

Calculation of Number of Aircraft in Palo Alto Fleet

The following calculations yield the apron area necessary for overnight aircraft parking:

Given 71 operations per day at Palo Alto and a one way trip of 1.33 hours, Palo Alto based aircraft would be in operation 94.5 hours per day.

A value for yearly aircraft use is assumed to be 3000 hours. This gives an operating day per aircraft of 8.22 hours.

The number of aircraft operating between PAO-LA is:

94.5 hours per day / 8.22 hours per day per aircraft = approximately 12 aircraft.

An extra aircraft should be added to the fleet as a spare. This yields a total of 13 aircraft in the fleet operating between Palo Alto and Los Angeles.

Since half the PAO-LA fleet will be parked at PAO and half at the 6 LA STOLports, a maximum of 7 aircraft will be based at PAO.

Number of Boarding Gates

The number of boarding gates required for a Palo Alto STOLport can be estimated by the following equation (Ref. 4):

$$\text{No. of boarding gates} = 1/2 \bullet \frac{\text{total runway capacity}}{\text{gate capacity}}$$

With a modern microwave ILS installed at Palo Alto, the theoretical capacity of a single STOL runway is 90 operations/hour. Operations of STOLcraft at Palo Alto will not approach this maximum. Thus, the numerator of the equation was chosen to be the maximum anticipated operations at PA, not the theoretical runway capacity. The gate capacity was previously calculated at 3 aircraft/hour. Thus:

$$\text{Number of gates} = 1/2 \bullet 5/3 = 1/2 \bullet 1.66 \text{ approximately} = 1.$$

An extra gate should be added to account for unexpected surge demand or system breakdown, yielding a total of 2 gate positions.

Required Maintenance Facilities

Major maintenance on the entire Bay Area-Los Angeles STOLcraft fleet should be performed at a major airport such as San Francisco, Oakland or San Jose. Minor maintenance could be performed at the suburban STOLports. Such minor maintenance would involve visual checks and replacement of minor parts. Work could be performed on the aircraft at the gate position or at the aircraft's overnight parking space. The only additional facility required would be for the storage of tools, parts and documents. It is estimated that these requirements could be filled by a building of 2000 sq. feet.

Required Terminal Area

Figures D-2 and D-3 show empirical graphs used to tabulate required terminal area based on the number of peak hour passengers. The breakdown in terminal requirements for PAO (465 passengers at peak hour) is as follows:

Ticket Lobby	5,000 sq. ft.
Airline Operations	26,000 sq. ft.
Waiting Area	8,000 sq. ft.
Baggage Claim	2,700 sq. ft.
TOTAL	41,700 sq. ft.

Runway Alignment

With a maximum of 11 operations/hour expected at the PA STOLport, one runway will be sufficient to accomodate STOL operations. The runway should be aligned in the same direction as the current runway. The runway-taxiway centerline separation recommended by Douglas and the FAA is larger than the current spacing. This will prevent the use of the current runway for STOL operation. The present runway must be replaced with a strengthened runway with a greater runway-taxiway spacing.

The FAA recommends 750 ft. long clear zones commencing 100 ft. from the end of the STOL runway paving (Ref. 7). The bottom edge of the clear zone is defined by a plane with a 1/15 slope. It is not anticipated that any existing or future structure in the vicinity of the airport will penetrate this clear zone. The clear zone is illustrated in Figure D-4.

Runway length will depend on the technology of the STOLcraft employed. Aircraft with both 2000-ft and 3000-ft field lengths should be considered. Neither runway configuration would result in clear zone violations at Palo Alto airport.

In the 2000-ft case, the runway would fit on the land occupied by the existing runway. In construction, the runway should be placed as far south as regulations will allow. As a result, aircraft could reach higher altitudes before entering the air space over populated areas. Construction of a 3000-ft runway will require the filling of a portion of the small lake at the south end of the existing runway. The surface area to be filled is estimated to be 2.5 acres. The depth of the lake in the area of filling is estimated at 5 feet.

Runway and Taxiway Dimensions

The FAA recommends a minimum STOLport runway width of 100 feet and taxiway width of 60 feet. (These are recommendations and not requirements.) For the D-3210-7, Douglas recommends a runway width of 110 feet and a taxiway width of 55 feet. The taxiway would parallel the 2000-ft or 3000-ft runways and include a 197.5 foot connection to the runway at each end. The recommended spacing of runway and taxiway is 280 feet for the D-3210-7 (Ref. 2). These values would vary if a STOLcraft with dimensions other than those of the D-3210-7 was used. See Figures D-5 and D-6. However, the variance should not be so significant as to change the basic physical layout of PAO.

Runway Area is calculated as follows:

for the 2000-ft system: 2000 x 110 ft. = 220,000 sq. ft. = 24,500 sq. yd.

for the 3000-ft system: 3000 x 110 ft. = 330,000 sq. ft. = 36,500 sq. yd.

Taxiway Area is calculated as follows:

for the 2000-ft system: 2395 x 55 ft. = 132,000 sq. ft. = 14,600 sq. yd.

for the 3000-ft system: 3395 x 55 ft. = 187,000 sq. ft. = 20,800 sq. yd.

Calculation of Apron Area

The apron is defined as the paving occupied by each boarding gate plus the area of the ramp between the gate and the taxiway. For the D-3210-7 STOLcraft, the gate is recommended to be 135 ft. deep and 175 ft. wide.

The total width of the 2 PAO gates are: 2 gates x 175 ft/gate = 350 feet.

The recommended ramp depth is 200 ft. The width of the ramp is equal to the sum of the widths of the gates. The ramp dimensions at PAO are: 200 ft. x 350 ft. See Figure D-7

The dimensions of the entire apron are:

(135 ft. + 200 ft.) x 350 ft. = 335 ft. x 350 ft. Thus, the apron area is 117,000 sq. ft. or 13,000 sq. yd.

Total aircraft-supporting paving area is:

	2000-ft	3000-ft
Runway	220,000 sq. ft.	330,000 sq. ft.
Taxiway	132,000 " "	187,000 " "
Apron	117,000 " "	117,000 " "
	469,000 sq. ft.	634,000 sq. ft.
	52,000 sq. yd.	70,000 sq. yd.

The new general aviation area has been calculated previously to be approximately 100,000 sq. yd.

Paving Thicknesses

The existing runway at Palo Alto Airport is designed to accomodate the stress of a 5000 pound aircraft supported on single-wheel main gear. The PA STOLport runway must be designed to withstand stress up to 200,000 pounds in order to accomodate STOLcraft with dual tandem main gear. The required runway-taxiway separation and poor sub surface soil conditions at Palo Alto mean that a new runway, taxiway and apron surface must be constructed taking into account the recommended runway-taxiway spacing and the poor subsurface soil conditions.

The condition of the subgrade is a major determinant of required pavement thickness. Several methods exist for determining required pavement thickness given the condition of subgrade soils. These methods are empirical and require that the subgrade be classified according to its physical characteristics. The method chosen for soil classification and pavement thickness determination was the FAA method. Data needed to make the estimates was provided from soil borings made by a consultant for Santa Clara County (Ref. 9) and from Pavement Evaluation forms for regional general purpose airports obtained from the FAA.

The evaluations give soil classifications that can be used in combination with empirical graphs to obtain the required pavement thickness. The subgrade at Palo Alto is given the FAA soil classification of E-12 and is placed in the F-10 soil subgroup. This is a very poor classification. (See Fig. D-8) It reflects 3 to seven feet of poor quality fill on which much of the existing airport surfacing was built as well as the underlying layers of soft bay mud which tend to aggravate the ground subsidence problem. To build a new runway of reasonable thickness, the classification of the subgrade must be improved. It is proposed that this be done at Palo Alto by excavating 5 feet of the existing fill in areas where new paving is to be constructed. Approximately 30 inches of engineered fill should then be put in place in the excavated areas to provide a suitable subgrade on which to build aircraft supporting paving. It is estimated that by these techniques, the subgrade could be improved to the E-10 classification and the F-7 subgroup.

A flexible asphaltic concrete pavement was considered desirable for PAO as this type of pavement would reduce the risks of cracking due to subsoil subsidence and could easily be relevelled should subsidence occur. Under this set of circumstances, the pavement thickness for PAO was determined from Figure D-9.

For a 200,000 pound aircraft on dual tandem main gear, the following runway thicknesses would be required:

	Critical Area	Non-critical Area
Surface Course	3 in.	2 in.
Base Course	9 in.	8 in.
Subbase Course	19 in.	16 in.
TOTAL	31 in.	26 in.

Critical areas are defined as those locations where the weight of a stationary or slowly moving aircraft must be supported. The non-critical areas are the runway surfaces. On the runway, the aircraft's lift negates part of its weight making the required runway thickness somewhat less. However, the FAA recommends that all pavement surfaces at STOLports be considered critical (Ref. 7). Therefore, the critical thickness value for pavement should be used for all aircraft supporting paving at the STOLport.

At those general aviation airports where pre-existing runway dimensions meet STOLport requirements and when runway strength is close to that required to support STOLcraft, additional strength can be obtained by applying an asphalt overlay to the existing runway surface. Techniques for estimating the additional thickness of surfacing required are found in Reference 11.

The new general aviation apron that would be required at PAO would be designed to support a 12,500 pound aircraft on single wheel main gear. FAA graphs for light aircraft (similar to those in Figure D-9) indicate a 15 inch section is required on the E-12 classification, F-10 subgroup that is found at the Palo Alto airport. The section has the following breakdown:

Surface course	1 inch
Base course	5 inches
Subbase course	9 inches
TOTAL	15 inches

Automobile Accomodations

Parking area must be provided for STOL commuters who drive to the airport and for airport employees.

The advised number of parking spaces for passengers is determined from Figure D-10. With a peak hour passenger demand of 465 at PAO, it is recommended that 400 passenger parking spaces be provided.

Employment at the STOLports is estimated at the rate of one employee per 2900 yearly passengers. With an annual passenger volume at PAO of 1.54 million, the number of employees should be:

1.54 million passengers/2900 passengers per employee = 530 employees.

It is assumed that all these employees arrive by automobile and that there is an occupancy of 1.3 persons per vehicle. If a parking place is provided for every vehicle arriving, the number of required employee parking spaces is:

530 employees/1.3 employees per auto = 410 employee parking spaces

Therefore, the total number of parking spaces to be provided is 910.

Assuming a parking density of 158 cars per acre (Ref. 2), this requires:

5.75 acres of parking or 250,000 sq. ft. of parking area.

Reference 2 makes the estimate that there are 1.13 vehicles arriving and 1.13 vehicles departing the STOLport for every enplaned and deplaned passenger. For peak hour, the generated vehicle traffic should be:

465 passengers x 1.13 vehicles/passenger = 525 vehicles arriving and 525 vehicles leaving the airport at peak hour.

Since the early peak hour at the STOLport occurs in conjunction with the peak hour for commute traffic, the traffic generated by the airport could have a significant effect on congestion levels on major streets serving the airport. In Palo Alto the peak hour prediction for auto traffic on Embarcadero east of the Bayshore Freeway near the airport in 1985 is: 1000 vehicles east bound, 900 vehicles west bound. (These values were derived by taking 1972 peak volume and projecting them to 1985 with a 2 1/2% yearly growth factor. They do not include STOLport generated traffic.)

Adding traffic generated by the STOLport, we obtain 1525 vehicles east bound and 1425 vehicles west bound.

Improving Embarcadero to four lanes divided with access controls and favorable signal timing could give Embarcadero an estimated minimum capacity of 700 vehicles/lane/hour. With two lanes running each direction, this yields an hourly directional capacity of 1400 vehicles. It can be seen that projected traffic could exceed this capacity and cause congestion. The opening of the STOLport should prompt consideration for the need of other modes of transporting passengers to PAO at peak hours.

Paio Alto Cost Estimates

	Cost in Millions of Dollars	
Land Acquisition		
Up to 21 acres of land for moving of general aviation parking at $70,000/acre		1.470
Excavation		
87,500 cu. yd. for runway-taxiway-apron construction at $0.03/cu. yd.	.003	
100,000 sq. yd. x 15 in. for new general aviation apron at $0.03/cu. yd.	.001	.004
Fill		
43,500 cu. yd. for runway-taxiway-apron construction at $0.03/cu. yd.		.001
Runway Paving		
surface: 24,500 sq. yd. x 3 in. at $0.57/sq. yd./in.	.042	
base: 24,500 sq. yd. x 9 in. at $0.171/sq. yd./in	.038	
subbase: 24,500 sq. yd. x 19 in. at $0.085/sq. yd./in.	.039	.119
Taxiway-Apron Paving		
surface: 27,600 sq. yd. x 3 in. at $0.633/sq. yd./in.	.053	
base: 27,600 sq. yd. x 9 in. at $0.190/sq. yd./in	.047	
subbase: 27,600 sq. yd. x 19 in. at $0.095/sq. yd./in.	.050	.150
General Aviation Apron Paving		
surface: 100,000 sq. yd. x 1 in. at $0.633/sq. yd./in.	.063	
base: 100,000 sq. yd. x 5 in. at $0.190/sq. yd./in.	.095	
subbase: 100,000 sq. yd. x 9 in. at $0.095/sq. yd./in.	.085	.243
Terminal Construction		
41,700 sq. ft. at $25.00/sq. ft.		1.040

Maintenance Facility Construction		Millions of Dollars
2,000 sq. ft. at $15.00/sq. ft.		.030
Parking Area		
29,000 sq. yd. at $6.84/sq. yd.		.192
Miscellaneous		
Control Tower	.228	
ILS	.370	
Runway Lighting	.398	
Fire Equipment	.091	
Communications Equipment	.160	1.247
TOTAL COST FOR PAO WITH 2000-ft RUNWAY		4.496

For Palo Alto in the 3000-ft runway configuration, the following additions and changes should be made:

Additional Land Fill		
approximately 2.5 acres x 5 feet = 545,000 cu. ft. or 20,200 cu. yd. at $2.50/cu. yd.		.051
Runway Paving and Excavation		
surface: 36,500 sq. yd. x 3 in. at $0.57/sq. yd./in	.061	
base: 36,500 sq. yd. x 9 in. at $0.171/sq. yd./in.	.057	
subbase: 36,500 sq. yd. x 19 in. at $0.085/sq. yd./in	.058	.176
Taxiway-Apron Paving		
surface: 33,800 sq. yd. x 3 in. at $0.633/sq. yd./in.	.067	
base: 33,800 sq. yd. x 9 in. at $0.190/sq. yd./in.	.060	
subbase: 33,800 sq. yd. x 19 in. at $0.095/sq. yd./in.	.064	.191
TOTAL COST FOR PAO WITH 3000-ft RUNWAY		4.644

Under federal aid to airport programs, the FAA will pay for portions of the facilities built for aircraft operations and passenger access. The rates of FAA participation are as follows:

ILS	100%
Control Tower	100%
Lighting System	82%
Other (runway, taxiways, aprons, emergency)	53.72%

Subtracting the allowable FAA participation from the gross airport costs computed above, the following revised estimates are made as the local outlay toward Palo Alto construction:

<u>2000-ft Configuration Cost</u>	
without FAA money	$4,496,000
with FAA money	$3,096,000
<u>3000-ft Configuration Cost</u>	
without FAA money	$4,644,000
with FAA money	$3,184,000

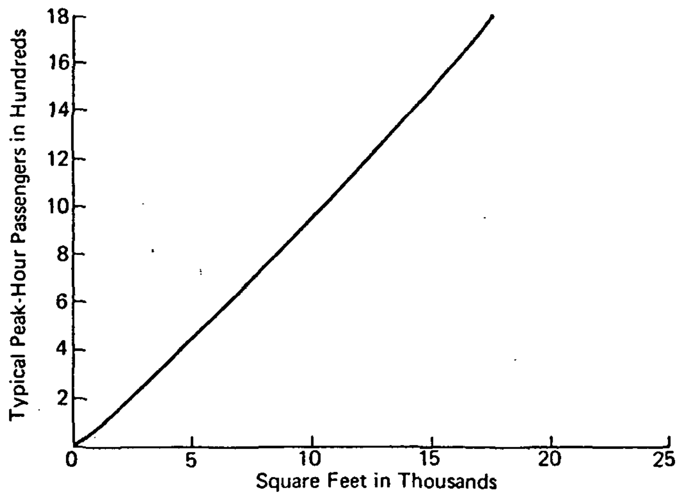


Fig. 17–12. Ticket lobby area. (Source: *Airport Terminal Buildings,* Federal Aviation Agency, September, 1960.)

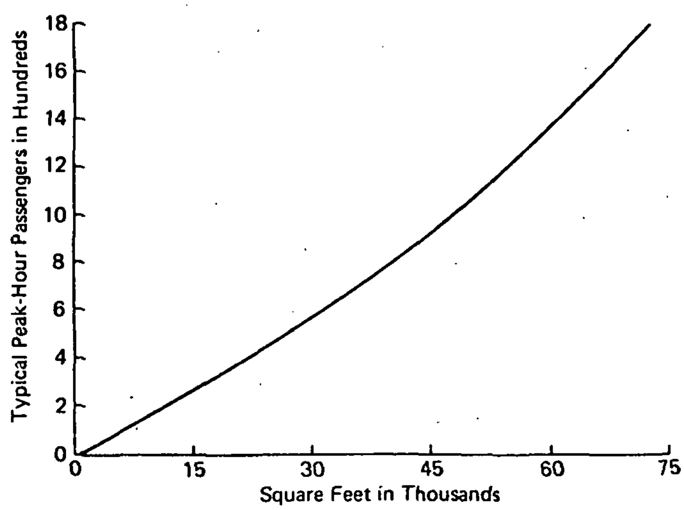


Fig. 17–13. Airline operations space. (Source: *Airport Terminal Buildings,* Federal Aviation Agency, September, 1960.)

Figure D-2

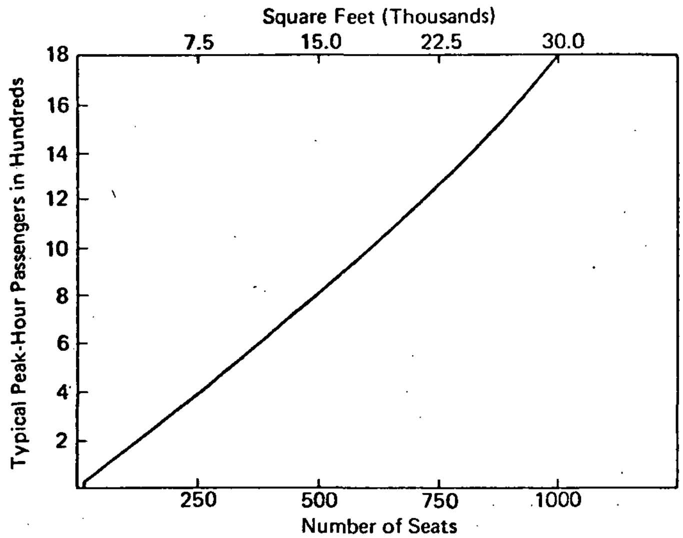


Fig. 17–14. Waiting area. (Source: *Airport Terminal Buildings,* Federal Aviation Agency, September, 1960.)

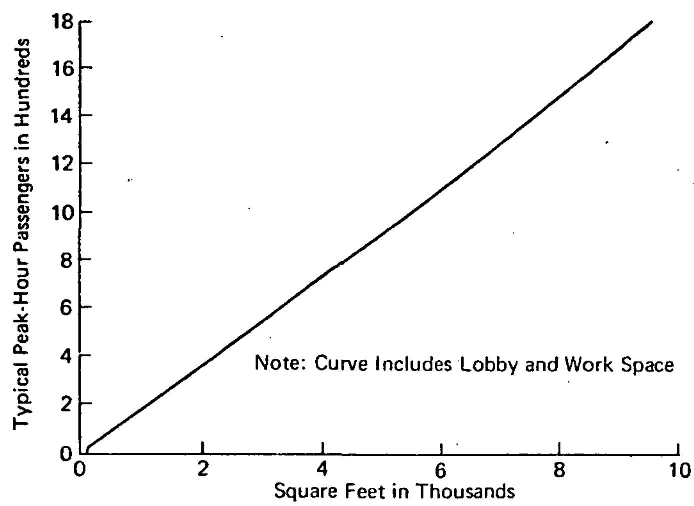
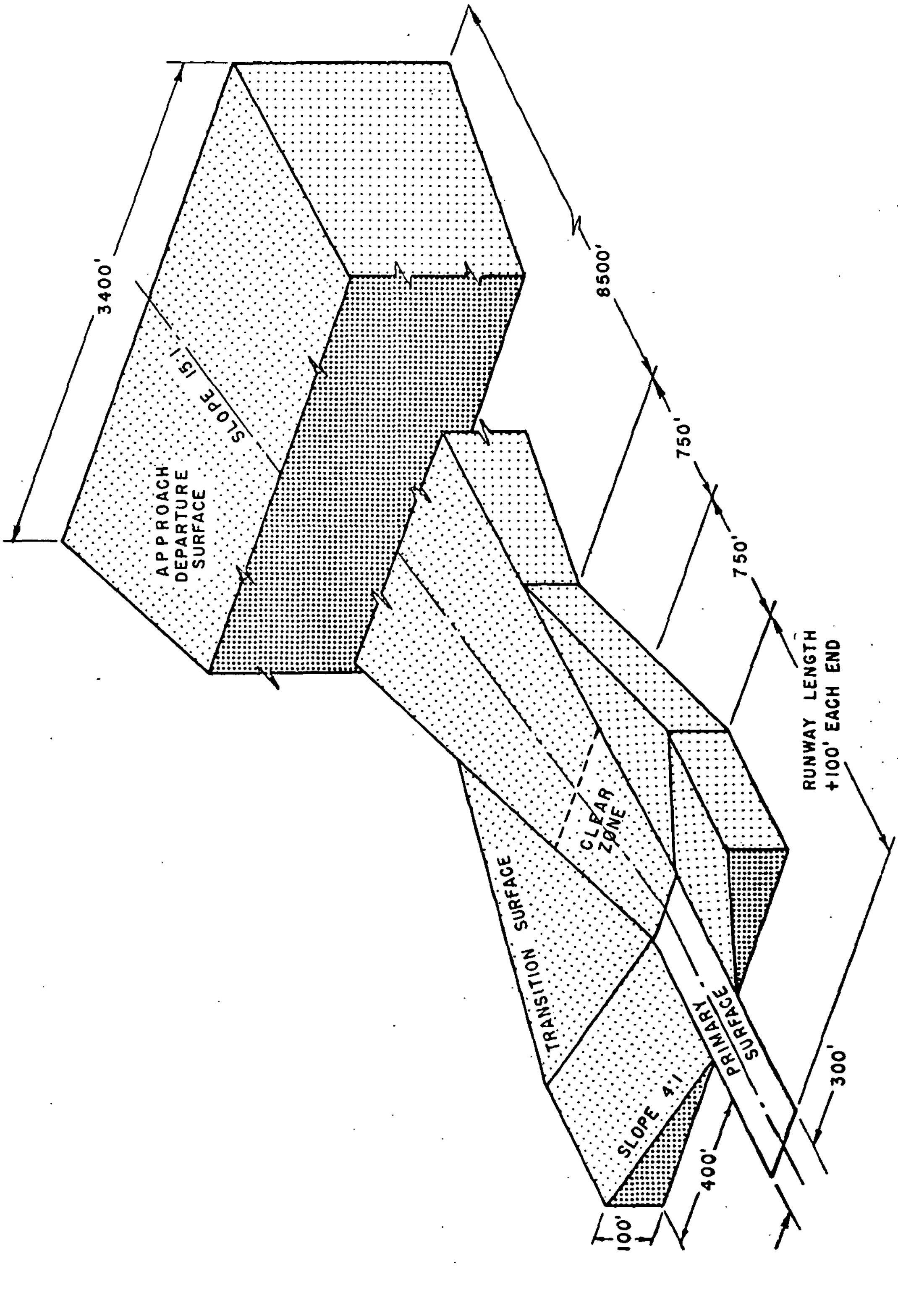


Fig. 17–15. Baggage claim area. (Source: *Airport Terminal Buildings,* Federal Aviation Agency, September, 1960.)

Figure D-3



Isometric of Protection Surfaces

Figure D-4

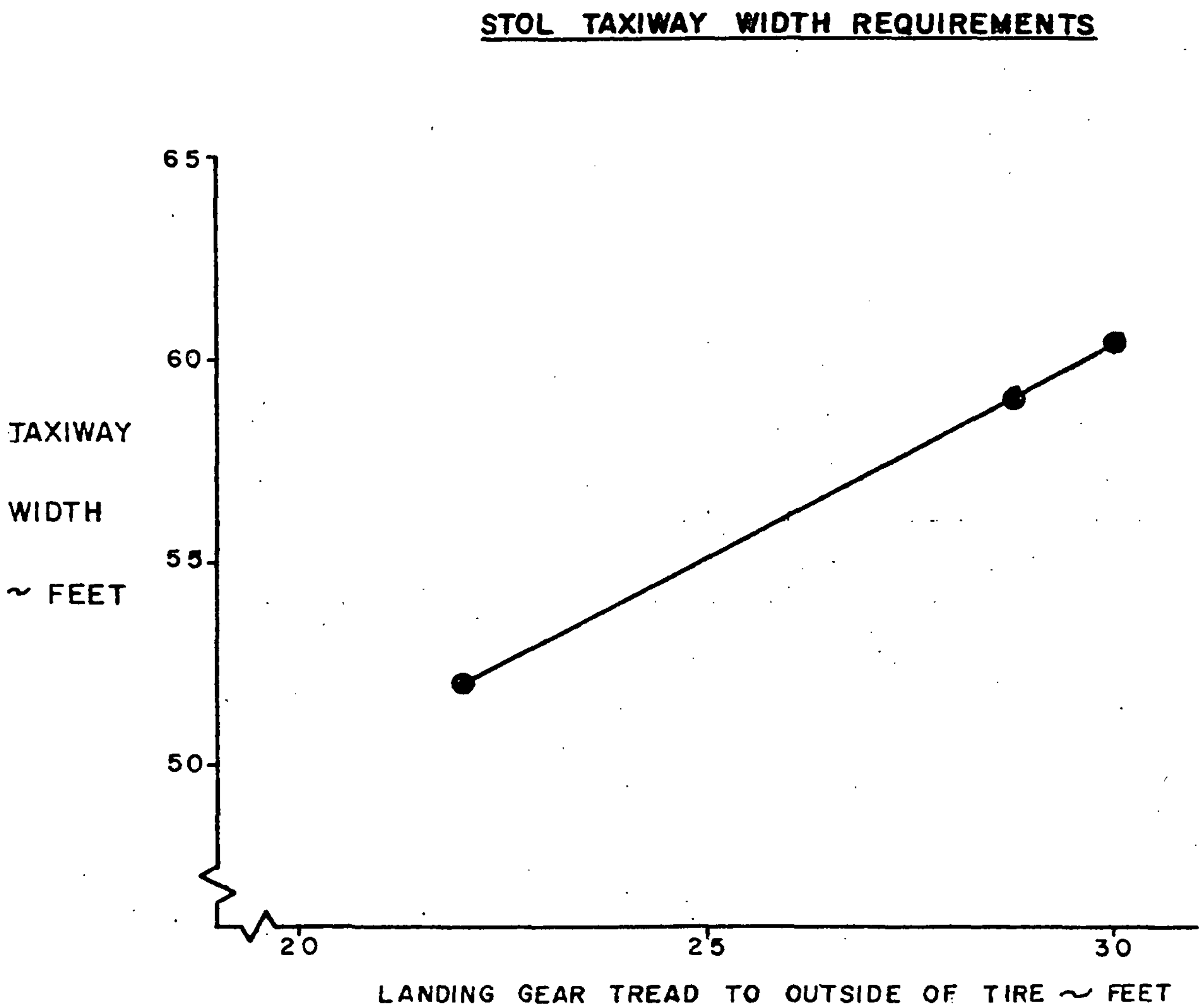

STOL TAXIWAY WIDTH REQUIREMENTS
65
60
55
50
TAXIWAY
WIDTH
~ FEET
20
25
30
LANDING GEAR TREAD TO OUTSIDE OF TIRE ~ FEET

Figure D-5

STOL RUNWAY WIDTH REQUIREMENTS

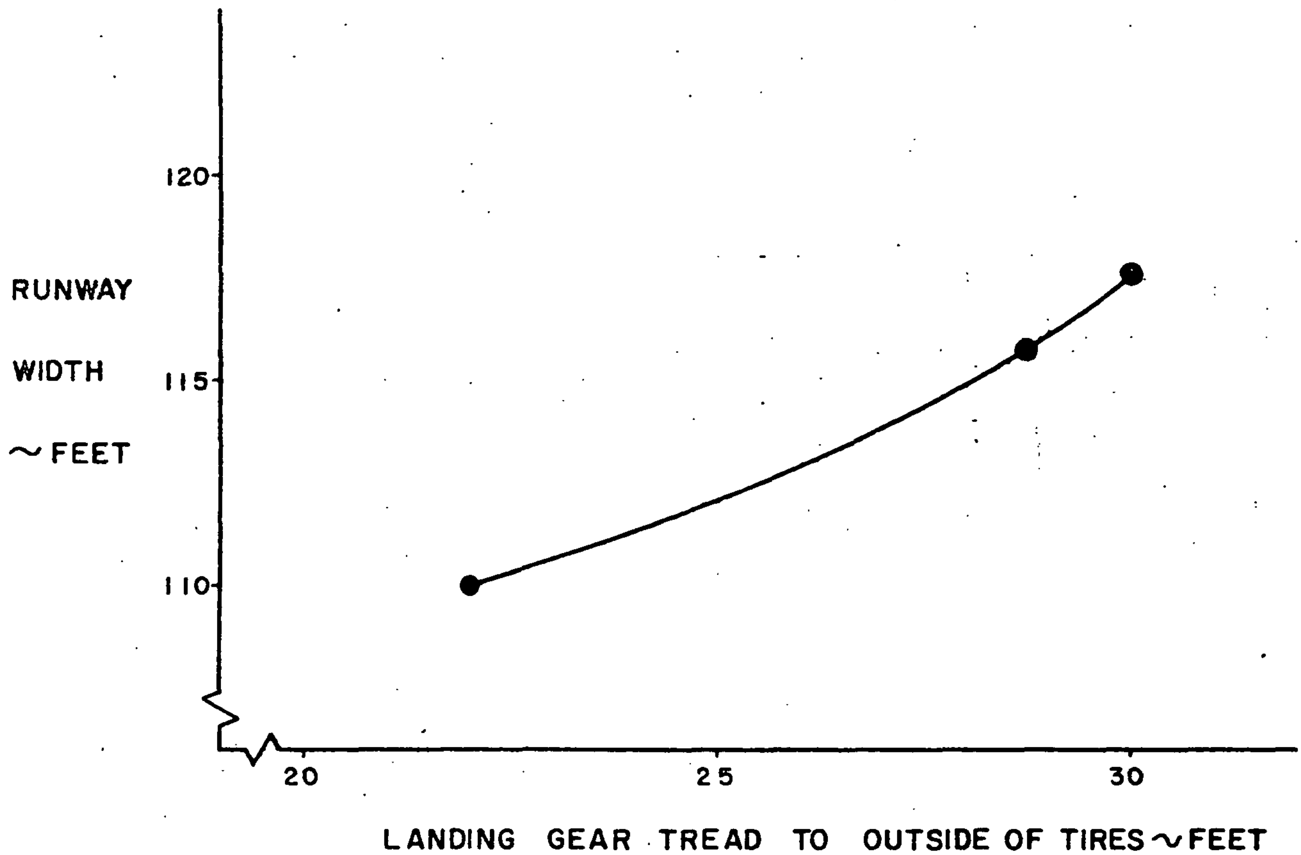


Figure D-6

RAMP DEPTH REQUIREMENTS

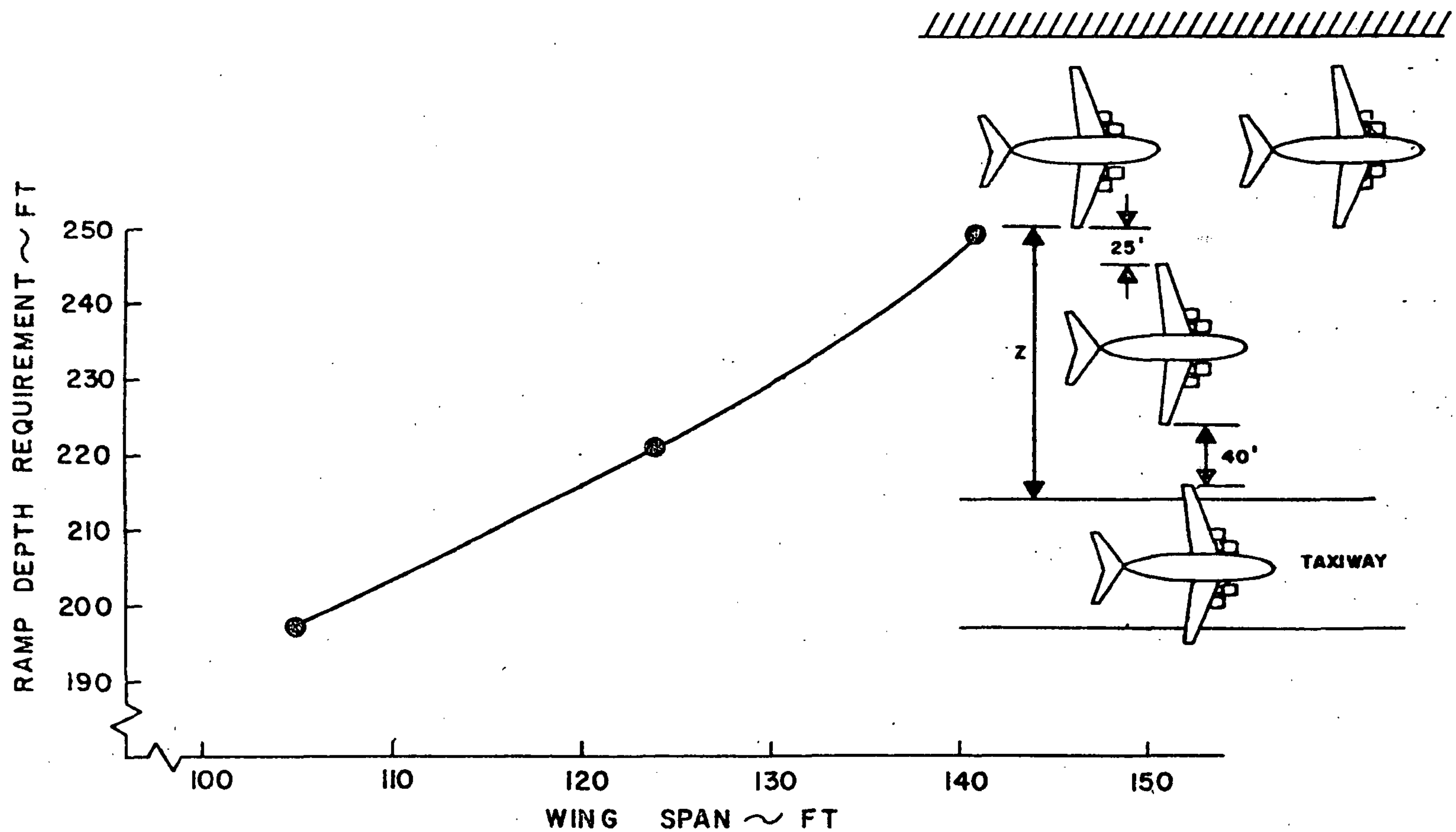


Figure D-7

CLASSIFICATION OF SOILS FOR AIRPORT PAVEMENT CONSTRUCTION

Soil group	Mechanical analysis				Liquid limit	Plasticity index
	Material retained on No. 10 sieve—percent [1]	Material finer than No. 10 sieve—percent				
		Coarse sand, passing No. 10; retained on No. 40	Fine sand, passing No. 40 retained on No. 200	Combined silt and clay; passing No. 200		
E-1	0-45	40+	60—	15—	25—	6—
E-2	0-45	15+	85—	25—	25—	6—
E-3	0-45	---------	---------	25—	25—	6—
E-4	0-45	---------	---------	35—	35—	10—
E-5	0-55	---------	---------	45—	40—	15—
E-6	0-55	---------	---------	45+	40—	10—
E-7	0-55	---------	---------	45+	50—	10-30
E-8	0-55	---------	---------	45+	60—	15-40
E-9	0-55	---------	---------	45+	40+	30—
E-10	0-55	---------	---------	45+	70—	20-50
E-11	0-55	---------	---------	45+	80—	30+
E-12	0-55	---------	---------	45+	80+	---------
E-13	Muck and peat—field examination					

[1] If percentage of material retained on the No. 10 sieve exceeds that shown, the classification may be raised, provided such material is sound and fairly well graded.

Figure D-8

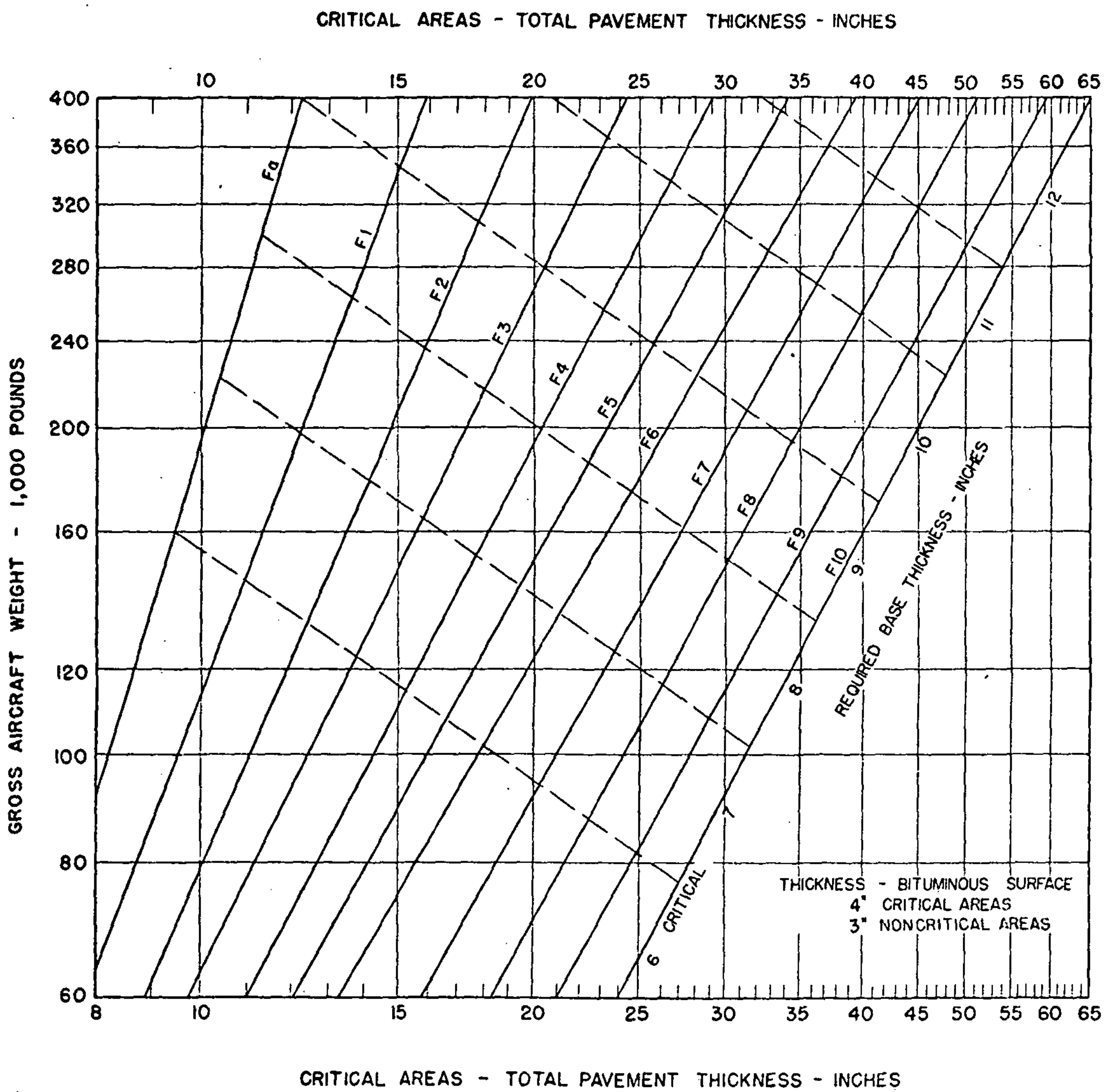

CRITICAL AREAS - TOTAL PAVEMENT THICKNESS - INCHES
10
15
20
25
30
35
40
45
50
55
60
65
400
360
320
280
240
200
160
120
100
80
60
GROSS AIRCRAFT WEIGHT - 1,000 POUNDS
Fa
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
6
7
8
9
10
11
12
CRITICAL
REQUIRED BASE THICKNESS - INCHES
THICKNESS - BITUMINOUS SURFACE
4" CRITICAL AREAS
3" NONCRITICAL AREAS
8
10
15
20
25
30
35
40
45
50
55
60
65
CRITICAL AREAS - TOTAL PAVEMENT THICKNESS - INCHES

Figure D-9

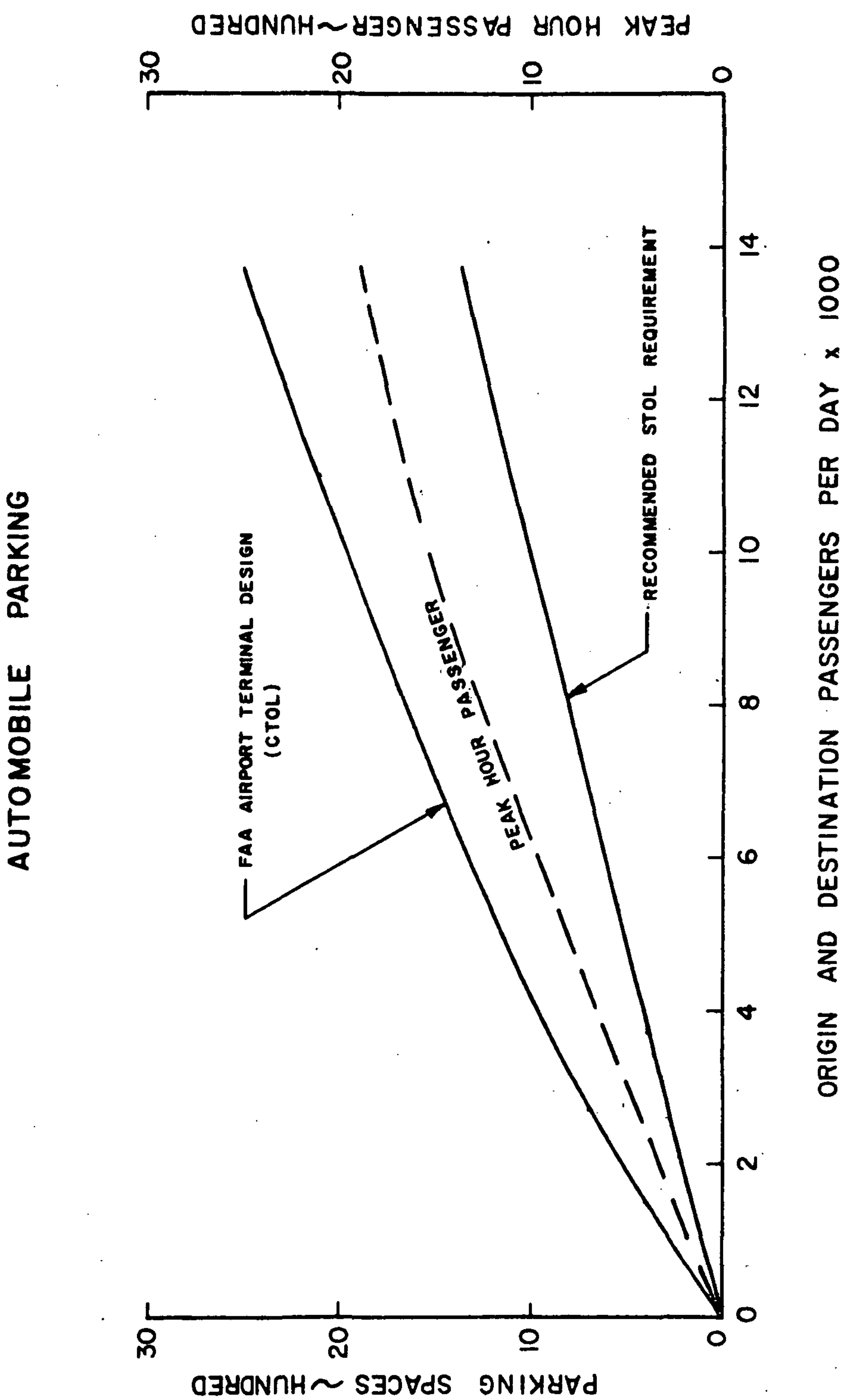

AUTOMOBILE PARKING
PEAK HOUR PASSENGER~HUNDRED
PARKING SPACES ~ HUNDRED
ORIGIN AND DESTINATION PASSENGERS PER DAY x 1000
FAA AIRPORT TERMINAL DESIGN
(CTOL)
PEAK HOUR PASSENGER
RECOMMENDED STOL REQUIREMENT
0
10
20
30
0
2
4
6
8
10
12
14

Figure D-10

San Francisco CBD STOLport Operations

Total 1985 SF-LA Traffic	40.56 million/year
1970 fraction of total by air	36.2%
Estimate of 1985 SF-LA air traffic	14.68 million/year
Fraction of % SF-LA air traffic in CBD	35.7%
Estimate of San Francisco 1985 CBD air traffic	5.24 million/year 100,850/week 16,808/day (effective 6-day week)

Assuming an operational day of 0700-2200 (departures until approximately 2100) we may expect a peak hour passenger load of 11% of the daily total, see Figure D-1, or 1849 passengers/hour. If operations are conducted at up to 90% load factor during the peak hour with airplanes of 100 passenger capacity capability of handling 20 operations/hour will be needed. It should be noted that the 5 full day, 2 half day week assumed is only applicable at the CBD site.

Employee and Patron Parking Areas

Freight and maintenance facilities are not anticipated as being included in the CBD STOLport. On the basis of PSA experience in Sacramento, one employee will be assumed for each 2900 annual passengers. It is further assumed that 20% of these employees will take advantage of public transportation and therefore not require parking facilities. For an average occupancy of 1.3 persons/car, the required employee parking will be 1110 spaces.

Because much of the San Francisco CBD traffic originates in the compact business district, for which public transportation is easily provided, it is assumed that only 1/2 of the passenger parking spaces recommended by the FAA for conventional airports will be needed for the STOLport. Based on 16,808 passengers/day, this results in a requirement of 1524 spaces (see Fig. D-10).

At the rate of 158 spaces/acre, this yields a total required parking area of 16.67 acres.

Terminal Area

Using the FAA estimates of total passenger processing area given in Fig. D-2 and D-3, a peak load of 1849 passengers/hour will necessitate an area of 135,480 ft.^{2}

Runway/Taxiway/Apron Areas

A single 2000-ft runway will be provided with a parallel taxiway. The runway and taxiway are assumed to be 110 feet and 55 feet wide respectively, and separated by 280 feet.

Assuming that each gate can handle three aircraft/hour, 4 gates will be needed. The Douglas recommendation of a 135 foot by 175 foot gate and 200 foot deep ramp result in an apron 335 ft. by 700 ft. Thus, total taxiway and apron area needed is 375,300 ft.^{2}. Total runway paving area of 220,000 ft.^{2} will also be needed. The soil characteristics in the CBD STOLport location are extremely variable, therefore the exact paving requirements would be highly dependent on the actual location of the runway. It will be assumed that the thicknesses derived for the Palo Alto STOLport will be used and no excavation will be accounted for. Thicknesses will be: surface, 4 inches; base, 9 inches; and sub-base, 19 inches.

Land Acquisition

In addition to the area required for the taxiway/runway complex, a clear zone around the strip is also needed. If areas having a height limitation of 30 ft. or less are to be purchased, then the restriction of a 15:1 slope recommended by the FAA requires acquisition of a strip of land 450 ft. wide around the perimeter of the taxiway/runway. Land in this clear zone may be used for the terminal and parking areas and no additional land need be acquired beyond the basic 1345 ft. by 2900 ft. area.

Miscellaneous

Several items of equipment necessary for a STOLport are essentially independent of passenger load. These include a control tower, instrument landing system (ILS) and runway lighting. Fire fighting vehicles and communications facilities are also items of relatively fixed cost.

CBD STOLport Costs (1973)

		Millions of Dollars
Land Acquisition:		
1345 ft. x 2900 ft. at \$4.00/ft.^{2} (based on reports from San Francisco industrial realtors)		15.602
Runway Paving:		
surface: 220,000 ft.^{2} x 4 in. at \$.570/yd^2-in		.056
base: 220,000 ft.^{2} x 9 in. at \$.171/yd^2-in		.038
sub-base: 220,000 ft.^{2} x 19 in. at \$.085/yd^2-in		.039
	Sub-total	.133
Taxiway Paving:		
surface: 375,300 ft.^{2} x 4 in. at \$.633/yd^2-in		.095
base: 375,300 ft.^{2} x 9 in. at \$.190/yd^2-in		.072
sub-base: 375,300 ft.^{2} x 19 in. at \$.095/yd^2-in		.075
	Sub-total	.242

		Millions of Dollars
Terminal Construction: 135,480 ft.^{2} at \$25.00/ft.^{2}		3.387
Parking Area Grading and Paving: 16.67 acres at \$6.84/yd^2		.552
Miscellaneous:		
control tower		.228
ILS		.370
runway lighting		.398
fire equipment		.091
communications equipment		.160
	Sub-total	1.247
	TOTAL	\$21.163

References

1. Bay Area Study of Aviation Requirements, Airport Inventory, Association of Bay Area Governments, 1970

2. STOLports Requirements Study - IRAD Report D-15-70-115; Douglas Aircraft Co.

3. Interim Report on Studies on Short Haul Transportation from the Bay Area, Stanford University, GS-420 A,B, 1972

4. Transportation Engineering, Paquette, Ashford, Wright, 1972

5. Study of Aircraft on Short Haul Transportation Systems, Vol. 2, Boeing Co. 1967

6. Study of Aircraft in Intraurban Transportation Systems in San Francisco Bay Area, Boeing Co., 1971.

7. Planning and Design Criteria for Metro STOLports, FAA, 1970

8. Fundamentals of Transportation Engineering, Hinnes and Eske, 1969

9. Soils Report done for Santa Clara County by W. A. Bahter & Associates, 1972

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11. Airport Paving, AC 150/5320-6A, FAA

12. Regional Airport Systems Study, Capital Cost Analysis of Airport Alternatives, Bechtel, Inc., 1971

13. Planning and Design of Airports, Horonjeff, 1962

14. Survey of Airline Passengers Departing the San Francisco Bay Area, Stanford Research Institute, May, 1968.

15. "Airport Terminal Buildings," FAA, September, 1960

Appendix E

Community Impact of Aircraft Noise
The Palo Alto Case

This appendix discusses the community impact of the noise environment resulting from 1985-level STOL operations.

A general discussion of noise and various measurement systems is presented first. It is followed by a presentation of noise contours and the expected noise environment levels in terms of NEF (Noise Exposure Forecast) levels for a specific airport site - Palo Alto Airport. A method for determining the likely number of residents that will be affected by noise intrusions is then presented using Palo Alto as a case example.

The procedure which guided this research is diagrammed in Figure E-1 on the following page.

Noise and Its Measurement

Noise is any sound at the wrong time or the wrong place. The loudness of sound, the Sound Intensity Level, is measured in decibels (dB), where:

$$\text{Intensity Level} = 10 \log_{10}\left(\frac{I}{I_o}\right)$$

I_o is the standard reference intensity of 10^{-12} watts per square meter. Thus a decibel is a relative unit of measurement; it expresses a relationship between two sound levels. The standard level, I_o, represents the threshold of hearing.

In general, the human ear does not respond to a doubling of the sound intensity level as a doubling in perceived loudness. Experiments show that in order for a human to perceive a doubling of loudness, the decibel level of the sound must increase by 10 dB. A rise in the decibel level of 1 dB is considered to be the minimum loudness increase detectable by a human, and, then only by direct comparison.

Since a person does not respond equally to all frequencies in the audible range, the A-weighted decibel (dBA) scale was developed. Most "common" sounds are measured on the dBA scale. Sound levels in dBA can be measured directly by A-weighted sound level meters. Figure E-2 shows an A-weighted frequency response curve and gives examples of A-weighted dB levels associated with familiar sounds.

Another subjective characteristic of sound is its capacity to annoy. For example, a jet engine at a given sound level will be more annoying to most people than will automobile traffic at the same sound level. This is caused by differences in the frequency content of the two sound sources. In general, a sound is more annoying when it has more discrete frequency components. Broad-band noise is less annoying.

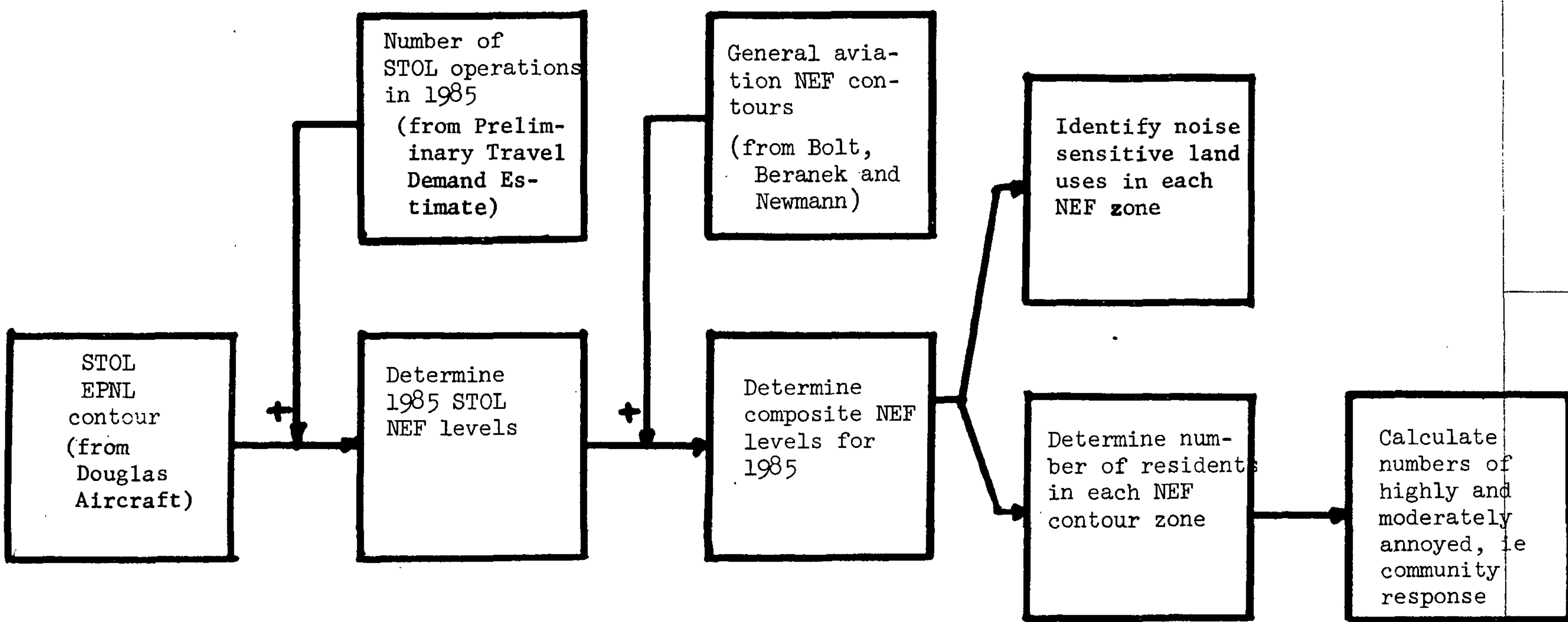


Figure E-1. Flow Chart Indicating Method for Projecting Noise Exposure and Community Reaction

(dBA)	Subjective impression	Community* (outdoor)	Home or industry* (indoor)	Relative loudness (human judgment of different sound levels)
130				32 times as loud
	Uncomfortably loud	Military jet aircraft takeoff with afterburner from aircraft carrier at 50 ft (130 dBA)	Oxygen torch (121 dBA)	
120				16 times as loud
		Turbofan aircraft at takeoff power under flight path at 200 ft (118 dBA)	Riveting machine (110 dBA). Rock-n-roll band (108–114 dBA)	
110				8 times as loud
	Very loud	Same jet flyover at 1,000 ft (103 dBA). Boeing 707, DC-8 at 6,080 ft before landing (106 dBA). Bell J-2A helicopter at 100 ft (100 dBA)		
100				4 times as loud
		Boeing 737, DC-9 at 6,080 ft before landing (97 dBA). Motorcycle at 25 ft (90 dBA)	Newspaper press (97 dBA)	
90				2 times as loud
	Moderately loud	Car wash at 20 ft (89 dBA). Prop. plane flyover at 1,000 ft (88 dBA). Diesel truck, 40 mph at 50 ft (84 dBA). Diesel train, 45 mph at 100 ft (83 dBA). Power mower at 25 ft (85 dBA)	Food blender (88 dBA). Milling machine (85 dBA). Garbage disposal (80 dBA)	
80				Reference loudness
		High urban ambient sound (80 dBA). Passenger car, 65 mph at 25 ft (77 dBA). Freeway at 50 ft from pavement edge 10 A.M. (76 ± 6 dBA)	Living room music (76 dBA). TV-audio, vacuum cleaner (70 dBA)	
70				$\frac{1}{2}$ as loud
			Cash register at 10 ft (65–70 dBA). Electric typewriter at 10 ft (64 dBA). Dishwasher, rinse at 110 ft (60 dBA). Conversation (60 dBA)	
60				$\frac{1}{4}$ as loud
		Air-conditioning condensing unit at 15 ft (55 dBA). Large transformers at 100 ft (50 to 60 dBA)		
50				$\frac{1}{8}$ as loud
	Quiet	Bird calls (44 dBA). Lower-limit urban daytime ambient noise (40 dBA)		
40				$\frac{1}{16}$ as loud
		[Scale interrupted]		
	Just audible			
10				
	Threshold of hearing			
0				

* Numbers in parentheses are A-weighted levels.

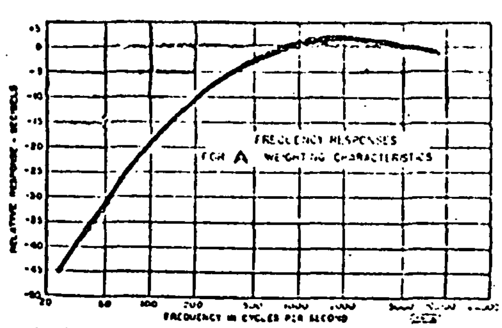


Fig E-2 . A-weighted sound levels of typical noises, and A-weighted frequency response curve (source: Reference 8, p 576)

The Perceived Noise Level (PNL) is an attempt to further weight sound levels according to their frequency content and the amplitude of those frequencies. PNL is used in some studies of aircraft noise. Further improvement is obtained by taking into account the duration of the sound. The Effective Perceived Noise Level (EPNL), measured in EPNdB, is equal to the PNL with pure tone and duration correction factors (Ref. 7). The EPNL is commonly used for measurement of jet engine sound levels as it is generally considered a reasonably accurate indicator of jet engine noisiness (Ref. 9).

The capacity of a given noise to annoy is also affected by the number of times the sound is heard in a specific time span. Furthermore, a sound of a given level heard at night is likely to be more annoying than the same sound heard during the day. This is due to the lower ambient noise levels at night and increased sensitivity to noise (e.g., while attempting to sleep). Therefore, several noise level scales have been developed which account for the number of times aircraft noise is heard and the time of day when it is heard. The Noise Exposure Forecast (NEF) is one such measure of the noise environment produced by aircraft operations.

NEF values are calculated from (a) measures of the aircraft flyover noise in EPNdB, and (b) the average number of flyovers per day (0700 to 2200 hours) and per night (2200 to 0700 hours). Each class of aircraft produces different EPNdB levels and the composite NEF value at any given location near an airport will represent the super-position of many NEF values, each calculated for a particular aircraft type, executing a particular operation (take-off, landing, runup, ground roll), on a particular segment of a particular flight path. For this specific study, however, we are considering only one aircraft type and an airport with only one runway. Hence, the NEF calculation is considerably simplified. Reference 2 gives details on the more involved NEF calculations. For a specific aircraft on a specific flight path:

$$NEF = EPNL + 10 \log (N_d + 16.7N_n)-88$$

where:

NEF = Noise Exposure Forecast produced by the specific aircraft on the specific flight path

EPNL = Effective Perceived Noise Level of the specific aircraft on the specific flight path

N_d = number of daytime operations

N_n = number of night-time operations.

Thus, given the EPNL at any given point on the ground and the number of daytime and night-time operations at that EPNL, one can calculate the NEF at that point.

There is no practical way of relating the degree of annoyance at a given NEF level to the annoyance felt upon hearing a common sound at a particular dBA level (such as those given in Figure E-2). However, the EPNdB level of a particular aircraft may be <u>very roughly</u> converted to the dBA scale by subtracting 13 dB from the EPNdB values, then comparing the result to common sounds given in Figure E-2. One must then imagine this sound heard overhead as frequently as the number of aircraft operations per day.

Despite the number of factors which NEF takes into account in producing a useful measure of a noise environment, different persons will still be annoyed to different degrees by the same NEF level (Ref. 6). Different age groups and persons of different educational levels will respond with different levels of annoyance -- high income well-educated individuals being prone to greater annoyance. The ambient noise level also has a direct bearing on the annoyance produced by the intrusion of noise at any given NEF level. People living in suburban environments are thus more likely to be annoyed by noise than people living in an already noisy urban environment. The "appropriateness" of a particular noise is another factor. For example, a man who earns his living in the aircraft industry is not as likely to be annoyed by a given NEF level as would be a forest ranger. A later part of this report presents a useful correlation between NEF levels and annoyance in human beings, based upon studies done by TRACOR, Inc. for NASA. Measures of annoyance can then be used as indicators of community response to aircraft noise.

It should be emphasized that the noise environment for communities near airports is such that ear damage or hearing loss is not a problem. Noise suppression technology developed to minimize speech and sleep disruption and to meet annoyance requirements will insure that hearing damage does not occur.

Noise Contours

The noise contour produced by a noise source is the locus of all points of equal sound intensity measured at ground level. The noise source under consideration is an aircraft in the process of take-off, landing, and ground roll (STOL and RTOL aircraft have no runup operation). Based upon engine performance predicted for 1985, Douglas Aircraft Co. has derived a set of noise contours appropriate to STOL operations. Each Douglas contour is actually a composite contour of a single aircraft's ground roll, take-off and landing operations. The use of contours in projecting noise impact and noise annoyance will be discussed in the context of a specific case setting, a Palo Alto STOLport.

Preliminary traffic estimates indicated that the 1985 level of STOL operations at the Palo Alto Airport would be 65 take-offs and 65 landings per day between 0700 and 2200 hours. No night operations were projected.

All take-offs from a Palo Alto STOLport would be towards the northwest. It follows that the noise contours produced at the northwest end of the runway (Figures E-3 and E-4) are produced solely by the 65 STOL take-off operations daily. Similarly, the noise contours produced at the southeast end of the runway are produced solely by the 65 STOL landing operations per day. Hence, using $N_d = 65$ and $N_n = 0$ in the NEF equation, the NEF levels corresponding to the various EPNL contours for each aircraft type can be calculated.* These are presented in Figure E-5. NEF values are calculated as the following example illustrates:

$$NEF = EPNL + 10 \log\left(N_d + 16.7\ N_n\right) - 88$$

with EPNL = 75, $N_d = 65$, and $N_n = 0$, we have:

$$NEF = 75 + 10 \log 65 - 88$$

$$NEF \cong 5$$

* It is more common to refer to the <u>total</u> number of daily operations at an airport. Hence, these NEF levels correspond to a total of 130 operations per day.

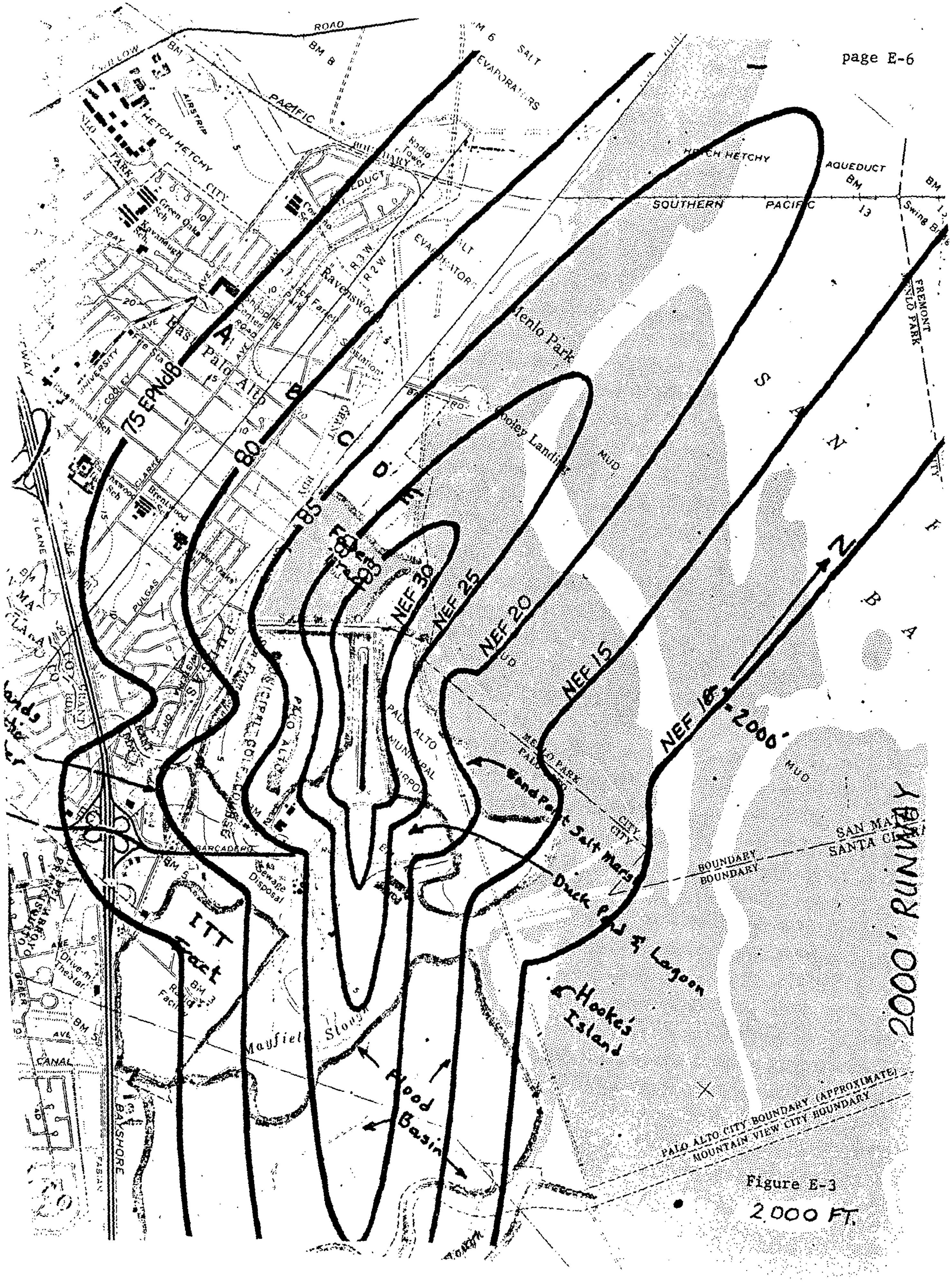


Figure E-3

2,000 FT.

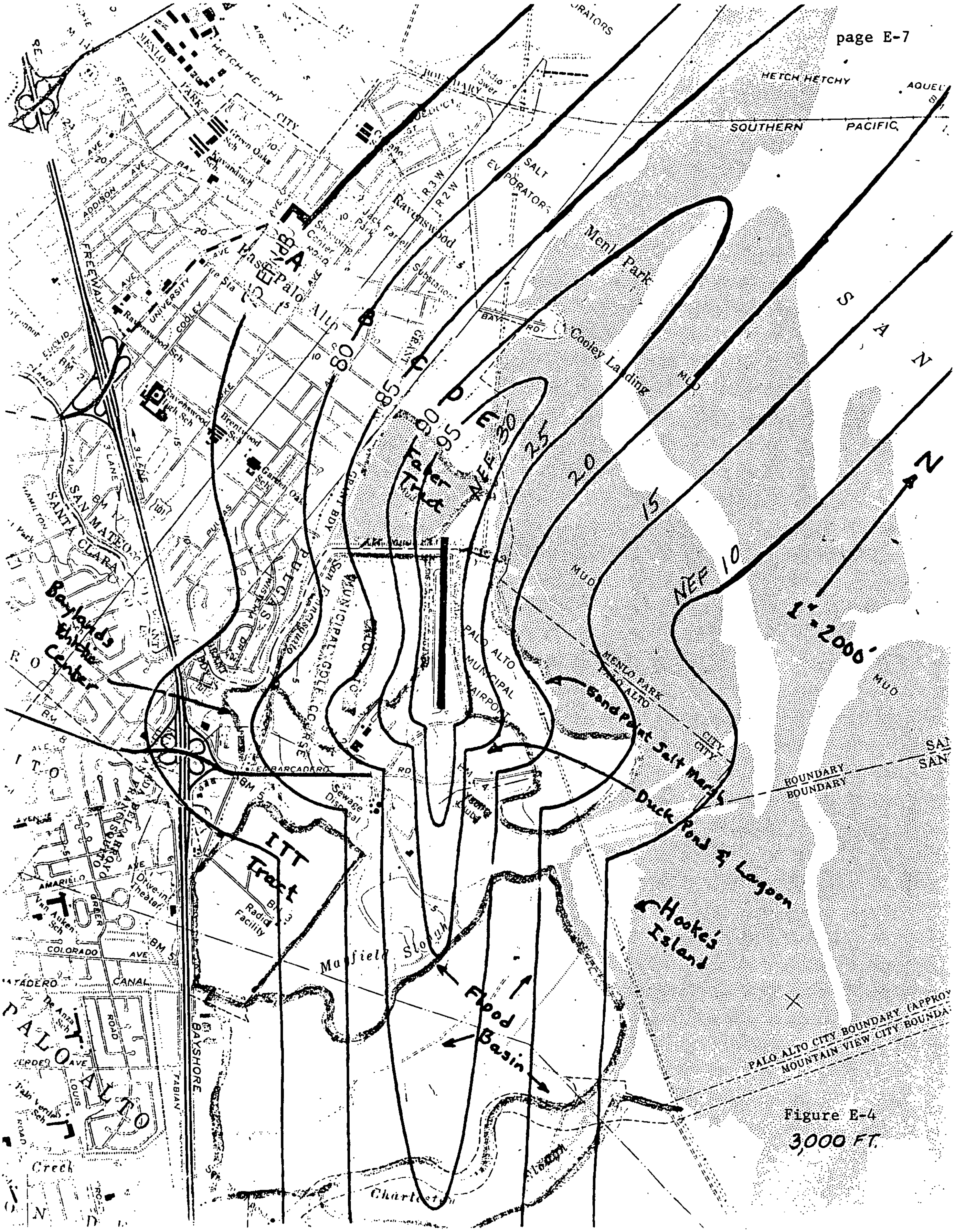


Figure E-4
3,000 FT.

CONTOUR	STOL/RTOL EPNL (dB)	STOL/RTOL NEF
A	75	5
B	80	10
C	85	15
D	90	20
E	95	25

Fig E-5 STOL NEF values corresponding to EPNLs
130 operations daily

The Shape of General Aviation Contours. In addition to STOL aircraft in 1985, general aviation aircraft will continue to use Palo Alto airport. Information obtained from the Palo Alto tower shows that the number of operations for 1972 was 186,000. The number of operations for 1985 has not been determined; however, an operations rate of 200,000/year will be assumed for this report. This figure was chosen because Palo Alto plans to limit the future growth of daily operations and because a rate of operations of 200,000 is readily translatable into NEF contours as shown later.

Calculation of General Aviation NEF Levels. In order to calculate the most accurate NEF contours corresponding to 200,000 operations per year, one must know the aircraft mix and their various flight paths. However, Bolt, Beranek and Newman, in a study for the Association for Bay Area Governments, have calculated NEF contours for a typical one-runway general aviation airport in the Bay Area with 200,000 operations yearly (Ref. 2). The Bolt, Beranek and Newman contours were used to approximate the 1985 general aviation NEF contours for Palo Alto. Figure E-6 compares the NEF contours for general aviation and STOL aircraft for 1985. Contours other than NEF 25 and NEF 30 for general aviation operations are not available. The STOL NEF values are those presented in Figure E-5.

It is interesting to note that projected 1985 STOL NEF levels for Palo Alto are actually less than 1985 general aviation NEF levels. The general aviation contours for 1985 are roughly the same as present (1972) contours since they were based on 200,000 operations/year -- only a 9% increase above actual 1972 operations. Thus one can see that 1985 STOL activities will have less impact on Palo Alto's noise environment than present general aviation activities. At first glance this is surprising because STOL aircraft will be somewhat noisier than small propeller aircraft. The anomaly is explained in the following manner.

The STOL contours are based upon 47,450 operations/year (130 per day), while the general aviation contours are based upon 200,000 operations/year -- a ratio of about 4:1. Figure E-7 shows that a four-fold increase in number of operations results in approximately a six-point rise in NEF level. Thus, if we were to increase the number of STOL operations to 200,000/year, the NEF 25 contour would increase to NEF 31. Then, the NEF 30 STOL contour would lie outside the NEF 30 general aviation contour, indicating that, for equal numbers of operations, the noise environment of the airport with STOL aircraft would be higher than with propeller aircraft -- as one might expect.

However, even assuming equal numbers of operations, one might expect the STOL NEF contours to be considerably larger than the propeller NEF contours, when, in fact, they are only slightly larger. This is explained by the fact that STOL aircraft, though louder than propeller aircraft, are designed to take-off and land in much shorter distances than propeller aircraft. More importantly, their climb and descent are steeper than propeller aircraft; hence, their increased altitude over a given point on the ground creates greater sound level attenuation which compensates for the louder noise produced by turbofan engines.

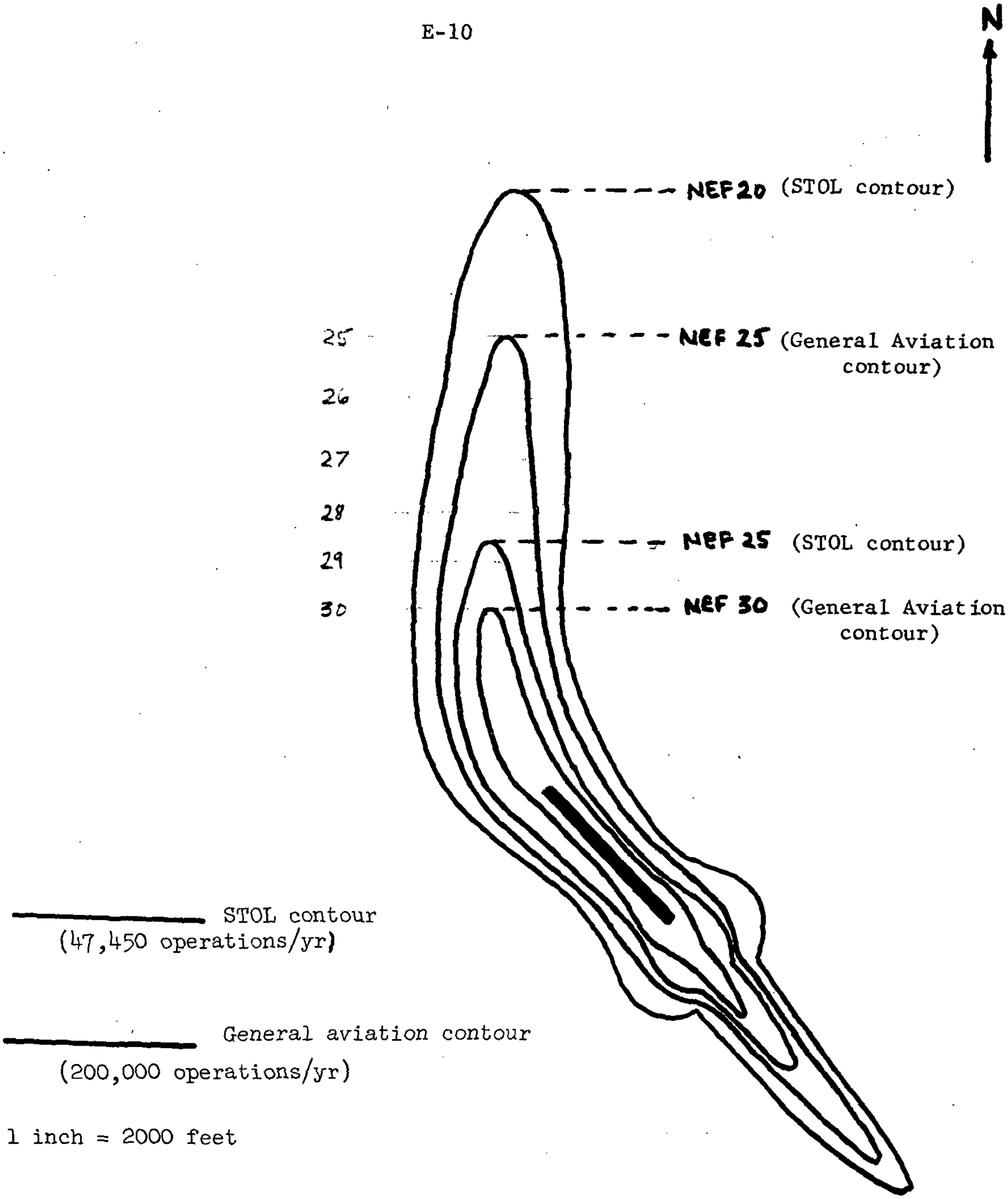


Fig E-6 Comparison of General Aviation and STOL contours for 1985

N_d	N_n	EPNL (dB)	Approximate NEF
65	0	80	10
62	3	80	12.5
60	5	80	13.5
57	8	80	15
90	[illegible]0	80	11.5
130	0	80	13
520	0	80	19
900	0	80	20

Fig E-7 Effect of changes in number of operations on the NEF values associated with the EPNL contour

Determination of Composite NEF Levels. In order to arrive at a set of composite NEF contours showing the NEF levels for all Palo Alto operations in 1985, it was necessary to superimpose the two sets of contours. By linear interpolation between the general aviation NEF 25 and NEF 30 contours in Figure E-6, it was determined that the STOL NEF 25 contour coincides approximately with the general aviation NEF 28.5 contour. Summing these two contours on a decibel basis results in a composite of NEF 30:

$$NEF_{total} = 10 \log(\text{antilog } \frac{28.5}{10} + \text{antilog } \frac{25}{10})$$

$$= 10 \log(700 + 316) = 10 \log 1016$$

$$NEF_{total} = 30.1$$

Thus, by adding 200,000 general aviation operations per year to the 47,450 STOL operations per year, the physical location formerly occupied by an NEF 25 STOL contour is now occupied by an NEF 30 composite contour. Similar calculations could be performed on the STOL NEF 20, 15, 10 and 5 contours if further general aviation contours were available. For lack of this data, we will arrive at a set of NEF contours for 1985 by adding a value of NEF 5 to each of the remaining STOL contours. Figure E-8 gives a tabulation of these composite NEF values associated with each contour plotted on the map of Figures E-3 and E-4. Naturally, there will be errors associated with this simple procedure of calculating composite NEFs. However, given the relative insensitivity of human loudness perception to small changes in NEF levels, these errors will not be of major significance. These errors will be further masked by the factors discussed on page E-15.

Figure E-9 shows the composite NEF 25 and NEF 30 contours (as calculated above) compared with the general aviation NEF 25 and NEF 30 contours taken from Figure E-6. As already noted previously, the present general aviation contours may be considered the same as the 1985 contours. Thus, Figure E-9 reveals that the addition of STOL aircraft to Palo Alto airport does not greatly increase the airport noise environment over levels currently associated with general aviation activities. By overlaying Figure E-9 on the map of Figures E-3 and E-4 (the scale is identical) one may compare the community areas affected by present and predicted 1985 operations between the NEF 25 and NEF 30 contours.

California airport noise regulations require that by 1986 no airport must subject the surrounding community to a noise level greater than CNEL 65 (Ref. 3). Though not directly translatable to NEF, Community Noise Equivalent Level (CNEL) may be considered to be roughly equivalent to NEF + 35 (Ref. 2). Thus CNEL 65 is approximately equivalent to NEF 30. By studying the noise contours of Figures E-3 and E-4 and the NEF values of Figure E-8, one can conclude that the 1985 Palo Alto airport operation will be well within California regulations.

CONTOUR	STOL EPNL (dB)	COMPOSITE NEF FOR ALL 1985 AVIATION ACTIVITIES
A	75	10
B	80	15
C	85	20
D	90	25
E	95	30

Fig E-8. Composite NEF values for all 1985 aviation activities

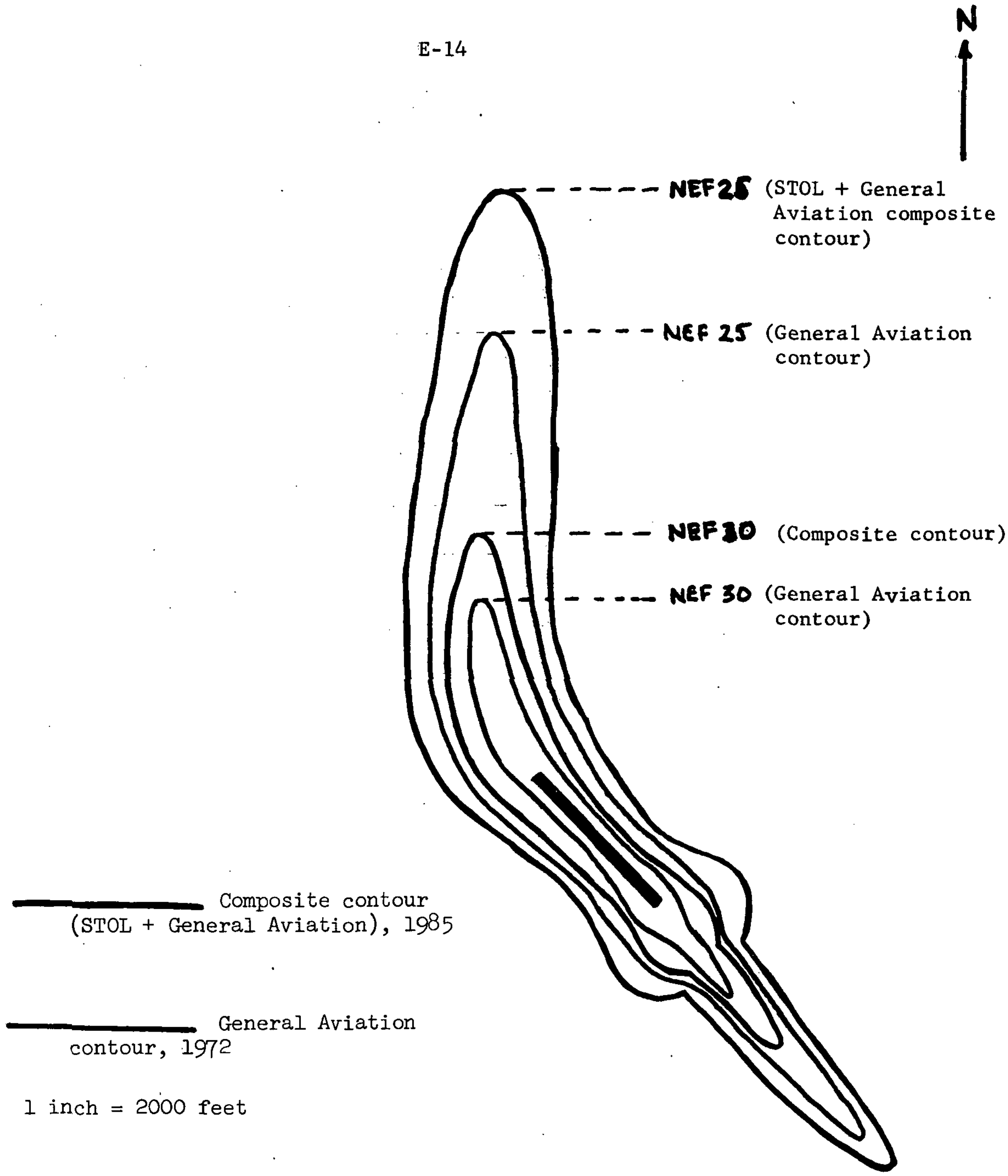


Fig E-9. Comparison of 1972 General Aviation and 1985 composite contours

Cautions in Use of the Contours. Noise contours do not represent discrete step changes in noise level; rather, noise level decreases gradually and continuously from the source. Thus, the contours may be used only as guidelines in determining where noise of a particular intensity falls. Persons living just outside the NEF 20 contour, for example, will be subjected to approximately the same noise intrusion as those just inside the contour. (Remember that a change of even 3 NEF is just barely detectable.)

NEF values are directly dependent upon aircraft power settings, flight paths, and percentages of utilization of the different runway directions. Any changes from predicted or assumed values will alter the position of the NEF contours. In addition, sound propagated along the ground from aircraft ground roll is affected by terrain or man made obstructions which cause shielding and reflections. These factors also confound the precision of NEF estimates.

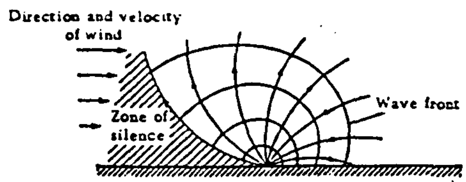
Sound propagated through the atmosphere from aircraft in flight may change in intensity even from hour-to-hour due to fluctuations in humidity, temperature and winds. The presence of wind and temperature gradients above the ground causes the speed of sound to vary with height. This results in the refraction of the sound waves, producing, in the case of positive wind gradients, zones of "silence" upwind (see Figure E-10). Since the speed of sound increases with increasing temperature, a temperature inversion (common at night) would tend to focus sound on the ground. The more common condition of temperature decreasing with altitude tends to produce shadow zones, or zones of "silence" radially about the source.

Vertical wind and temperature gradients almost always exist over open level areas. Generally wind gradients are positive and daytime temperature gradients are negative. Hence, the focusing of noise levels downwind is a normal occurrence (Ref. 1). Quantitive values of sound level increases due to wind and temperature gradients are difficult to determine and are not readily available in acoustical literature. However, Professor W. C. Reynolds of Stanford University has suggested an increase from 3 dB to 10 dB due to sound wave focusing downwind. These figures should be kept in mind as another example of the deviations to be expected from the calculated NEF levels.

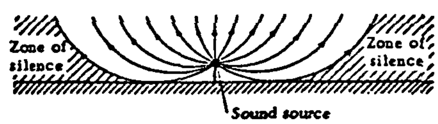
Community Impact of 1985 Aircraft Operations

The analysis in this section follows the work of TRACOR, Inc. for NASA (Ref. 5). The noise contours in Figures E-3 and E-4 and their associated NEF levels given in Figure E-8 represent an attempt to identify the physical locations, in the communities surrounding the airports, where particular airport-caused noise environment levels are found. However, as mentioned under Noise and Its Measurement at the beginning of this Appendix, different persons react with different degrees of annoyance to the same noise environment. Thus, determination of community reaction to a particular NEF level must be weighted using statistical averages.

TRACOR has conducted extensive studies of community annoyance levels around seven major and two smaller U.S. airports. TRACOR has defined categories of annoyance and has determined the proportion of community residents likely to be "highly" and "moderately" annoyed by each level of noise intrusion. TRACOR surveyed noise-impacted residents in each of nine cities using the annoyance "test"



a. Effect of a positive wind gradient



b. Effect of temperature decreasing with altitude

Fig E-10. Effects of wind and temperature gradients on sound propagation shown in Figure E-11. Each respondent answered "yes" or "no" to each disturbance category, then indicated to what degree he was bothered on a scale from 0 to 4, with 0 meaning no annoyance. For scoring purposes, the three "sleep" categories were averaged and treated as one category. The responses to the two "TV" categories were also averaged. There were thus nine major categories. With a maximum score of 5 in each category, the maximum possible score was thus 45. The following annoyance categories were then assigned to specific ranges of responses:

Range of Response	Annoyance Category
21-45	High
10-20	Medium
0-9	Low

As TRACOR points out, these categories were defined rather arbitrarily. However, in order to be "highly" annoyed, a respondent must have had scores of 3 or higher in at least 7 out of 9 activities. Describing such a person as "highly annoyed" seems reasonable (Ref. 5).

The results of the tests are shown in Figures E-12 and E-13. The data from the "two-city" study represent the results of study of the two smaller airports (Reno, Nevada and Chattanooga, Tennessee). Those sampled in the smaller cities were less annoyed at a given NEF level than were those in the larger cities. One might think that residents of small cities would be more annoyed by noise intrusion than the residents of large cities since life in a smaller city is generally quieter and less hectic. TRACOR suggests that the lower number of operations in the smaller cities contributes to a lower annoyance sensitivity. The consultants cite a recent Swedish study which found that, in airport areas with less than 70 take-offs per day, the level of annoyance was much lower than elsewhere (Ref. 5). The other most likely cause of the lower annoyance level at the smaller airports is a problem in research design. The two-city study was conducted in the late fall and early winter, while the seven-city study was conducted during the summer. The summer is a season of heightened noise sensitivity because many people are outdoors and leave residence windows open. The seasonal effect has been documented in other studies, but we cannot conclude with certainty that it was the seasonal effect which accounts for the lower annoyance levels in the two-city study (Ref. 5).

One might expect a suburban community such as Palo Alto to be more sensitive to noise than a tourist center such as Reno; however, this cannot be documented without replicating TRACOR's study in Palo Alto. If one includes general aviation activities, the number of take-offs per day far exceeds the cutoff figure found in the Swedish study. Thus, the analysis of community response in this report will be conducted on the basis of the seven-city data. This is reasonable since the two-city study may have underestimated the annoyance due to seasonal variations and because the use of less-conservative annoyance levels avoids underestimation of adverse community response.

Quantitative Determination of Community Reaction. The approximate percentage of the population that will be moderately annoyed can be determined using the graph in Figure E-13 and the expression NEF = CNR - 72* which TRACOR deduced from

---

* CNR (Composite Noise Rating) is another measure of the noise environment produced by aircraft operations. It is based on the Perceived Noise Level (PNL), and is given by:

$$CNR = PNL + 10 \log(N_d + 20 N_n) - 12$$

	DISTURBED			BOTHERED		
RELAXING/RESTING INSIDE	Yes	No		0 1 2 3 4		
RELAXING OUTSIDE	Yes	No		0 1 2 3 4		
CHILDREN SLEEPING/NAPPING	Yes	No		0 1 2 3 4		
CONVERSATION	Yes	No		0 1 2 3 4		
TELEPHONE CONVERSATION	Yes	No		0 1 2 3 4		
GOING TO SLEEP	Yes	No		0 1 2 3 4		
LISTENING TO RECORDS/TAPES	Yes	No		0 1 2 3 4		
LISTENING TO RADIO/TV	Yes	No		0 1 2 3 4		
WATCHING TV	Yes	No		0 1 2 3 4		
LATE SLEEP	Yes	No		0 1 2 3 4		
READING OR CONCENTRATION	Yes	No		0 1 2 3 4		
EATING	Yes	No		0 1 2 3 4		
OTHER	Yes	No		0 1 2 3 4		
NONE	Yes					

Fig E-11. Annoyance Test (source: Ref 5, p 81)

NEF Zone	Percentage Highly Annoyed	
	Seven-City	Two-City
15-20	6	3
20-25	14	7
25-30	22	10
30-35	30	14
35-40	38	18
40-45	46	21
45-50	54	25
50-55	62	29

Fig E-12. Percentage highly annoyed by NEF zone (source: Ref 5, p 58)

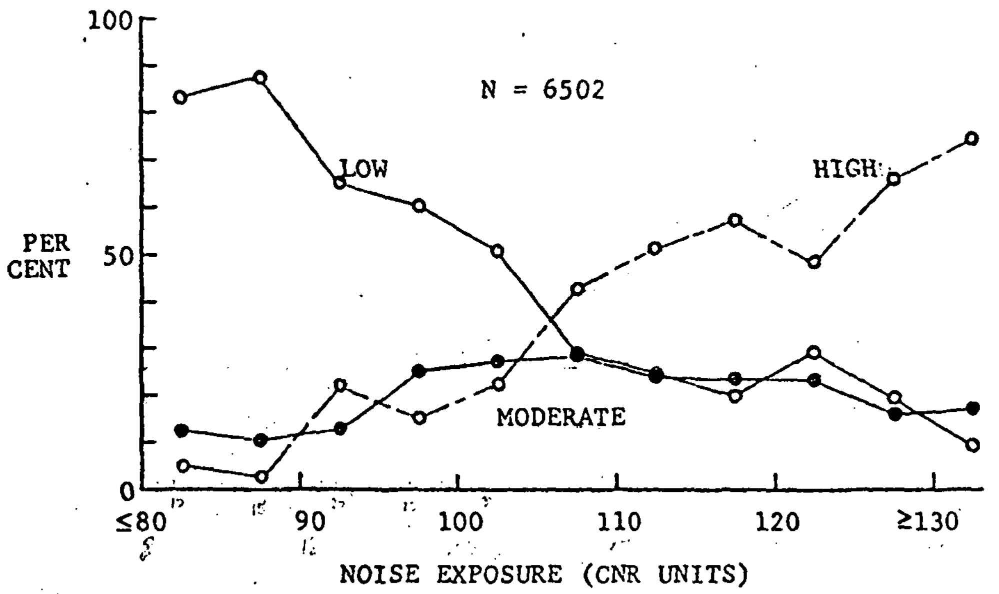


Fig E-13. Categories of annoyance as a function of noise exposure (source: Ref 5, p 25) the seven-city data. The percentage of moderately annoyed residents appears in Figure E-14. The same procedure is used to determine the percent of highly annoyed.

In order to determine the numbers of people which reside in each NEF zone, 1970 census block data was analyzed. The approximate number of people residing in each zone was estimated using the census map and a noise footprint overlay. By considering the numbers of people highly and moderately annoyed, and by studying the definitions of these annoyance categories as determined by the annoyance "test," one can obtain a "feel" for the effect of the 1985 airport operation on the surrounding human population. The true level of noise annoyance is not susceptible to quantification except in the following respect. TRACOR has developed a formula that quite accurately predicts the number of complaints from impacted residents. High annoyance was found to be a necessary, but not sufficient, condition for complaint (Ref. 5). The complaint formula is:

$$\% \text{ Complaints} = (\% \text{ Community highly annoyed}/14.3)^2$$

where: $\% \text{ Community highly annoyed} = \dfrac{\text{number highly annoyed}}{\text{total population in NEF 15 to NEF 55 zones}} \times 100$

The complaints for Palo Alto are presented in Figure E-14.

Sources of Error

Several stages of the procedure used in this study are prone to error. Other caveats have already been mentioned in the course of the report. It is possible that the basic estimated STOL noise contours (Figures E-3 and E-4) may be in error. The contours represent a hoped for level of engine performance. The failure to accomplish this optimistic goal could significantly increase the noise impact of STOL and RTOL aircraft.

The projected frequency of operations was based on preliminary estimates of travel demand. The noise estimates are somewhat inflated in light of the final estimates of travel demand reported in Section IV (System Analysis Results).

No night-time operations have been assumed; however, unforeseen night operations would tend to increase noise level calculations. If 16 of Palo Alto's 130 daily STOL operations were at night, the NEF level would rise by 5 units.

The effects of noise propagation through the atmosphere and along the ground were discussed under Noise Contours(E-5 to E-15). The noise contours of Figures E-3 and E-4 have been determined for calm atmospheric conditions; hence, depending upon wind direction, these noise levels will vary.

The determination of the residential population within each contour zone is an important source of error. Due to the peculiarities of the census block maps, it was necessary to make educated guesses as to whether certain blocks should be included or not. Aerial photographs were used to aid in this effort. The assumption was made that population in the affected areas would not increase by 1985. This was predicated on the fact that most of the residential areas are already built up and that nearly all Palo Alto Baylands are dedicated to park

CONTOUR ZONE	COMPOSITE NEF ZONE	NUMBER OF RESIDENTS IN ZONE	PERCENTAGE HIGHLY ANNOYED	NUMBER HIGHLY ANNOYED	APPROXIMATE PERCENTAGE MODERATELY ANNOYED	APPROXIMATE NUMBER MODERATELY ANNOYED
A - B	10 - 15	7538	0	0	11	829
B - C	15 - 20	432	6	26	11	48
C - D	20 - 25	0	14	0	17	0
D - E	25 - 30	0	22	0	25	0
TOTAL ALL ZONES		7970		26		877

Total in NEF zones NEF 15 to NEF 30 = 432

% complaints $\doteq [\frac{26}{432} \times 100/14.3]^2 = 0.18\%$

Fig E-14. Analysis of community response
Palo Alto -- 2000' Case

purposes. However, there are areas in Mountain View, northwest of Moffett Field, which may experience further residential development.

Finally, the analysis of community response presented in Figure E-14 determines that, out of 7538 residents in the A-B contour zone, 829 will be moderately annoyed. However, census data shows that approximately 59% of the residents in this zone live southeast of the airport in an area close to major noise sources -- Moffett Field and Bayshore Freeway. It may well be, then, that high ambient noise levels in these areas will mask the noise environment of the Palo Alto airport, thus reducing the number of moderately annoyed persons.

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Appendix F

Determination of Airline Fares to Achieve a Specified Rate of Return on Investment

DETERMINATION OF AIRLINE FARES TO ACHIEVE A SPECIFIED RATE OF RETURN ON INVESTMENT

The purpose of this analysis is to demonstrate a method of determining air fare charges based upon a desired rate of return on investment. Throughout this analysis, the phrase "rate of return on investment" is used as the rate of "interest" at which an investment is repaid by an excess in the net cash receipts over expenses.

The basic problem of determining air fare may be outlined as follows:

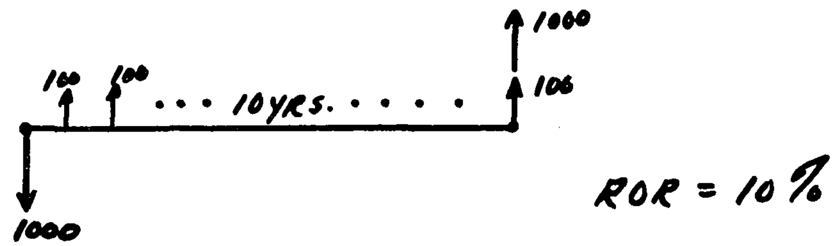
An airline company must make some large initial investment to purchase the new aircraft and all the associated equipment that is necessarily a part of the new system. Additionally, they have decided that the system will have a life of twelve years and that each year the system will have associated with it annual costs composed of maintenance, operations, and crew salary expenditures. The company has a policy that they must have a rate of return on their investment of 12% after taxes. Experience has shown that at the end of the proposed life of the system, they can sell all the equipment for perhaps 10% of the initial cost. The question then becomes, "how much should the airlines take in each year in fare" to meet the company's policy of 12% rate of return.

Before proceeding to answer that question, it is best to illustrate by way of a few simple examples, the method that will be used for the analysis of this problem.

If a company puts $1000 in a bank and at the end of one year that bank returned the $1000 + $100 in interest, then clearly the interest earned on that investment by the company is 10%.

If the company put $1000 in the bank and at the end of each year for ten years, the bank repaid the company $100 plus $1000 at the end of the tenth year, then again, the interest is clearly 10%.

A picture can be drawn schematically of the preceeding example as follows:



From the preceeding examples, it can be seen that interest was paid each year on the amount invested by the company. Where money is invested for a period of years, the usual business practice is for the interest to be paid annually or oftener. For this analysis, it will be annually. This practice, in effect, involves compound interest when considered from the viewpoint of the investor.

It will now be shown how compound interest formulas may be used to handle problems of a more complex nature.

If P is invested at interest rate i, the interest for the first year is iP and the total amount at the end of the first year is $P + iP = P(1+i)$. The second year the interest is $iP(1+i)$ and similarly, the amount at the end of year two is $P(1+i)^2$. From this argument, there results the well known formula $F = P(1+i)^n$ where P is the principal and F is the compound amount at the end of n year at interest rate i.

If A is invested at the end of each year for n years, the total amount at the end of n years will be the sum of the compound amounts of the individual investments. The money invested at the end of the first year will earn interest for (n-1) years and its amount will be $A(1+i)^{n-1}$; the second years payment will amount to $A(1+i)^{n-2}$ and so on. The total amount F is $A\left(1+(1+i) + (1+i)^2 + \ldots (1+i)^{n-1}\right)$. From this expression, the value of A in terms of F may be simplified to:

$$A = F \left[\frac{i}{(1+i)^n - 1}\right]$$

A fund established to produce a desired amount at the end of a given period of time by means of a series of payments throughout the period is called a sinking fund. And $\dfrac{i}{(1+i)^n - 1}$ is called the sinking fund factor.

To find the uniform end of year payments, A, which must be obtained from a present investment, P, to yield the same amount in n years as investing P at i % compounded annually.

$$A = F\left[\frac{i}{(1+i)^n - 1}\right] = P(1+i)^n\left[\frac{i}{(1+i)^n - 1}\right] = P\left[\frac{i}{(1+i)^n - 1} + i\right]$$

This expression is called the capital recovery factor. It is always equal to the sinking fund factor + interest rate. When multiplied by a present investment, it gives the uniform end-of-year returns necessary to repay the company's investment in n years with interest rate i.

Now consider another example. A company invests \$1000 in a project for ten years at an interest rate of 10%. How much will the company get back at the end of each year in order to secure that 10% rate of return on their investment.

From the above discussion, it should be clear that by multiplying the present investment by the capital recovery factor, we will get a uniform end-of-year return necessary to repay the company's investment in ten years with interest of 10% or $A = \$1000\left[\dfrac{i}{(1+i)^n - 1} + i\right] = \$1000\ (.16275)$

$A = \$162.75/\text{year}$

Remember, in earlier examples, the company received not only \$100/year for ten years, but also had the initial investment of \$1000 returned at the end of the tenth year to secure a ten per cent return. In this case, the sum of \$62.75 invested annually at 10%, compounded annually, will provide the \$1000 original investment.

Returning now to the airline problem, the following list of abbreviations will be used:

IC = initial cost = total equipment cost

AC = annual cost = yearly cost of maintenance, operations and crew

L = salvage value

f = annual revenue from fares

D_p = Depreciation/year using straight line method

n = system life = 12 years

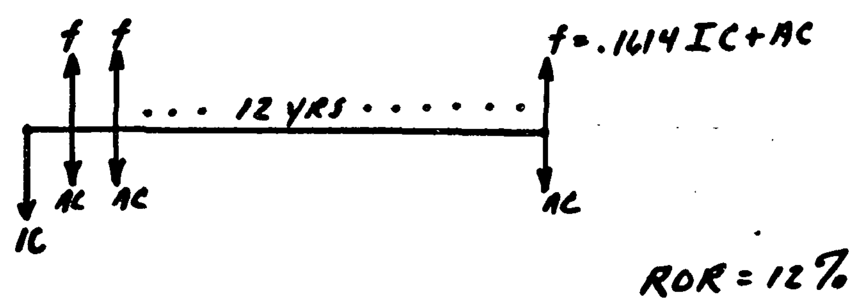
ROR = rate of return on investment = i = 12% (after taxes)

Tax rate = 48% of net earnings

Consider an airline company that wants to make some investment (IC) for 12 years and obtain a return of 12%. Neglecting all other factors of the problem, we can multiply the IC by the capital recovery factor to find the uniform end-of-year returns necessary to repay the airline's IC at 12%. These yearly returns will be the money that the company gets from fares for passenger tickets. Hence, fare/year = $IC\left[\frac{i}{(1+i)^n - 1} + i\right] = .1614\ IC$

Now, consider the fact that in addition to the company's IC they also have to pay out annually an AC for each of the 12 years. Hence, the fare or net end of year receipts must be increased by AC to keep their ROR at 12% or fare/year = .1614 IC + AC.

A cash flow diagram can be drawn of what has been presented thus far:



We have neglected thus far the salvage value, L, of the investment after 12 years. Since the value of L will exist after 12 years, the amount of net income the company must collect each year may be reduced by the annual amount needed, at 12%, to accumulate this value, L, after 12 years.

Thus the amount needed in 12 years = IC $(1+i)^n$ - L and the annual income, A,

$$A = \left[IC(1+i)^n - L\right]\left[\frac{i}{(1+i)^n - 1}\right]$$

$$= IC(1+i)^n \left[\frac{i}{(1+i)^n - 1}\right] - L\left[\frac{i}{(1+i)^n - 1}\right]$$

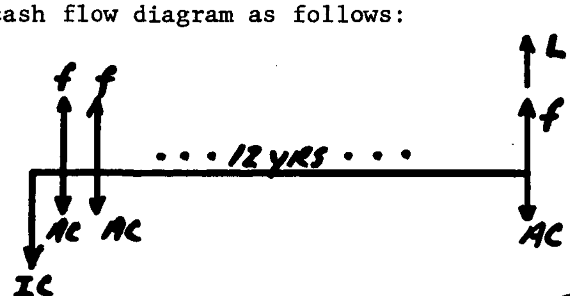
$$= IC\left[\frac{i}{(1+i)^n - 1} + i\right] - L\left[\frac{i}{(1+i)^n - 1}\right]$$

Adding the annual operating cost,

$$A = IC\left[\frac{i}{(1+i)^n - 1} + i\right] - L\left[\frac{i}{(1+i)^n - 1}\right] + AC$$

so that at 12% and 12 years: A = .1614 IC + AC - .0415 L

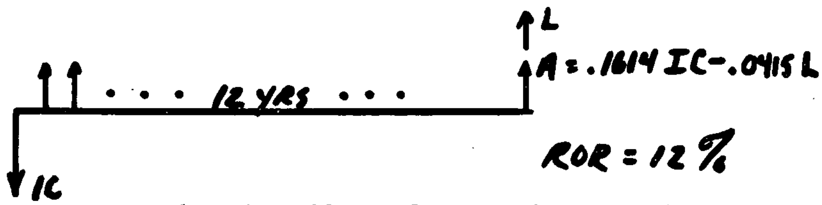
We now have a cash flow diagram as follows:



ROR = 12%

It is interesting to note the similarity between this cash flow diagram and the one presented in the initial example on page 2 for a ROR = 10%.

The diagram above can be reduced to show only the net cash flows:



Finally the company must consider the effect of taxes that must be paid each year on the net revenue as well as the effect that depreciation has on taxes. Obviously, whatever amount the company pays out in taxes each year must be offset by increasing the fare by that same amount to keep their ROR at 12%.

In computing the effect of taxes on the revenue from the airline's investment and hence, the amount that the fare must be increased, an important fact must be taken into consideration. Cash flows are what matter. Book depreciation is irrelevant except as it affects taxes. This is demonstrated in the following way.

First, the depreciation/year by the straight line method is:

$$D_p = \frac{IC-L}{12 \text{ years}}$$

$$D_p/\text{year} = .0833\ IC - .0833\ L$$

Thus, the government allows the airline to treat the depreciation, D_p, as a yearly loss deductible from their net revenue. After this deduction is made, the airline must pay 48% of their net revenue/year for taxes.

To cover taxes:

$$\text{Fare} = .1614\ IC + AC - .0415\ L + \text{Tax}$$

$$\text{Tax} = (\text{Fare} - AC - D_p)\ .48$$

$$= (.1614\ IC + AC - .0415\ L + \text{Tax} - AC - .0833\ IC + .0833\ L)\ .48$$

$$= (.0781\ IC + .0418\ L + \text{Tax})\ .48$$

$$\text{Tax} = .0375\ IC + .0201\ L + .48\ \text{Tax}$$

$$.52\ \text{Tax} = .0375\ IC + .0201\ L$$

$$\text{Tax} = .0722\ IC + .0385\ L$$

Then Fare/year = .1614 IC + AC - .0415 L + .0722 IC + .0385 L

Fare/year = .2336 IC - .0030 L + AC

If we consider this equation to apply to each aircraft,[1] and let:

N = number of seats per airplane

lf = load factor (average)

V_B = block speed

T_B = block time for a trip of distance, d

TOC = total operating cost per seat ride

$$\text{Fare/seat/year} = .2336\,\frac{IC}{N} + \frac{AC}{N} - .003\,\frac{L}{N}$$

$$\text{Fare/pass/year} = \frac{1}{lf}\ (.2336)\,\frac{IC}{N} + \frac{AC}{lf \cdot N} - .003\,\frac{L}{lf \cdot N}$$

$$\text{Fare/pass/mile} = \frac{1}{V_B U} \cdot \frac{1}{lf}\ (.2336\,\frac{IC}{N}) + \frac{AC}{V_B U \cdot lf \cdot N} - \frac{.003\ L}{V_B U \cdot lf \cdot N}$$

but, since depreciation life = 12 years

$$\frac{AC}{N} + \frac{IC-L}{12N} = (TOC)\ (V_B U)$$

so that

$$\frac{AC}{N} = (TOC)\ (V_B U) - \frac{IC-L}{12N}$$

Therefore:

$$\text{Fare/pass/mile} = \frac{.2336\ IC}{V_B \cdot U \cdot lf \cdot N} - \frac{.003\ L}{V_B \cdot U \cdot lf \cdot N} + \frac{TOC \cdot V_B \cdot U}{V_B \cdot U \cdot lf} - \frac{(IC - L)}{V_B \cdot U \cdot lf \cdot 12N}$$

$$= \frac{.2336\ IC}{V_B \cdot U \cdot lf \cdot N} + \frac{TOC}{lf} - \frac{.0883\ IC}{V_B \cdot U \cdot lf \cdot N} + \frac{.0833\ L}{V_B \cdot U \cdot lf \cdot N} - \frac{.003\ L}{V_B \cdot U \cdot lf \cdot N}$$

$$= \frac{.1503\ IC}{V_B \cdot U \cdot lf \cdot N} + \frac{.0803\ L}{V_B \cdot U \cdot lf \cdot N} + \frac{TOC}{lf}$$

$$\text{Fare/pass/trip} = \frac{(d)\ .1503\ IC}{V_B \cdot U \cdot lf \cdot N} + \frac{(d)\ .0803\ L}{V_B \cdot U \cdot lf \cdot N} + \frac{(d)\ TOC}{lf}$$

(1) This assumes that each aircraft produces the same rate of return. For the relatively simple commuter system considered here, with all segments having nearly the same range, this is reasonable. In a larger system, making each segment pay its own share leads to rather high fares at very short ranges. These fares are often reduced, in effect subsidizing the short ranges, by higher fares at long range.

$$\text{Fare/pass/trip} = \frac{T_B\ (.1503)\ IC}{U \cdot 1f \cdot N} + \frac{T_B\ (.0803)\ L}{U \cdot 1f \cdot N} + \frac{TOC \cdot d}{1f}$$

Fares are sometimes estimated by applying a "profit factor," pf, to total operating cost, namely Fare/passenger trip = pf • cost per trip.

Then:

$$\text{Fare/pass trip} = pf \bullet \frac{TOC \cdot d}{1f} = \frac{T_B\ (.1503)\ IC}{U \cdot 1f \cdot N} + \frac{TOC \cdot d}{1f} + \frac{T_B\ (.0803)\ L}{U \cdot 1f \cdot N}$$

$$pf = 1 + \frac{T_B}{U}\ (.1503)\ \frac{IC}{N}\ \frac{1}{TOC \cdot d} + \frac{T_B}{U}\ (.0803)\ \frac{L}{N}\ \frac{1}{TOC \cdot d}$$

For a typical case where:

d = 350 statute miles

TOC = 3.25 cents/seat/statute mile

N = 150 seats

IC = \$15.34 x 10^6

T_B = 0.94 hours

U = 3,000 hours/year.

then pf = 1.424 to achieve a 12%, after tax, discounted cash flow return on investment.

Also, if we define ROR as the effective interest rate each year based on the total initial cost, and count depreciation as an expense, recovering each year the prorated portion of the investment, then:

$$\text{Total expenses} = AC + D_p$$

$$\text{Fare/year} = AC + D_p + (ROR\ IC)\ \frac{1}{(1 - \text{Tax rate})}$$

For 12% and 12 years life, and 48% tax rate:

$$\text{Fare/year} = AC + \frac{IC-L}{12} + \frac{(.12)\ IC}{1 - .48}$$

$$= AC + .0833\ IC - .0833\ L + .231\ IC$$

$$= .3143\ IC - .0833\ L + AC$$

This is about 15% higher than obtained by the present value method.

The discounted cash flow fare equation, with an appropriate change of constants, can be applied to any desired rate of return and system life. For purposes of this analysis, constants A and B, as seen in the equation below, have been computed for after-tax rates of return of 6%, 8%, 10% and 12% and a system life of 12 years.

Thus:

$$\text{Fare/pass/trip} = \frac{T_B\ (A)\ IC}{U \bullet lf \bullet N} + \frac{T_B\ (B)\ L}{U \bullet lf \bullet N} + \frac{TOC \bullet d}{lf}$$

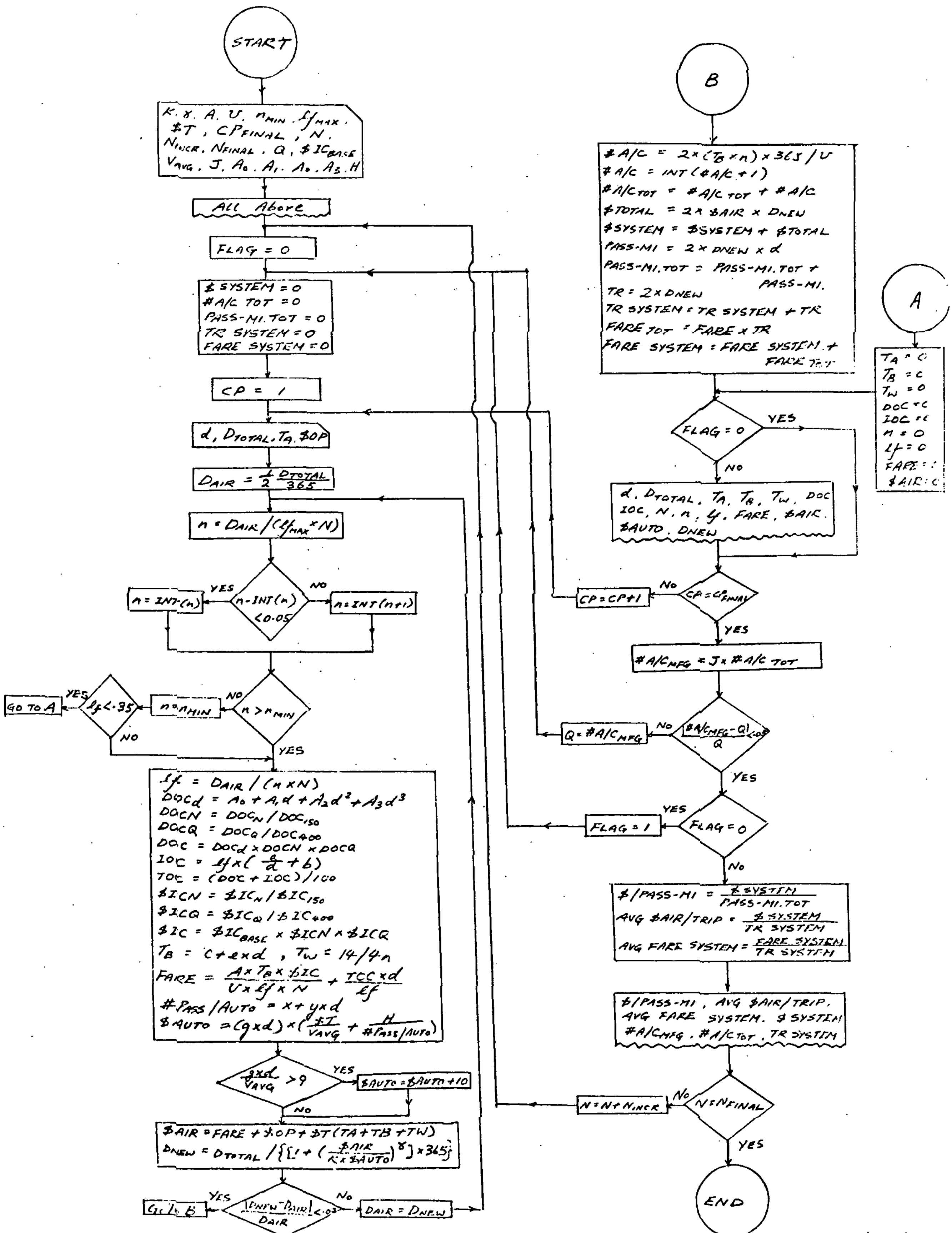
	A	B
6%	.0692	.0460
8%	.0948	.0586
10%	.1219	.0701
12%	.1503	.0803

Appendix G

Systems Analysis Computer Program and Typical Printouts

AIRLINE OPERATIONS PROGRAM

AIRCRAFT SIZE SELECTION, FARES & SYSTEM COSTS



SL/JB/TS

Variable Names for Systems Analysis Program

Name in Flow Chart	Name in Program	Explanation of Function
K	K	Weighting factor for modal split equation
γ	G	Exponent for modal split equation
A	AROI	Constant (depending upon ROI) for fare calculation
U	U	Yearly Utilization (hours) of A/C
\$T	ST	Dollar value of time
\$OP	SOP	Out-of-pocket expenses (\$)
n_{MIN}	NMIN	Minimum allowable frequency
lf_{MAX}	LFMAX	Maximum allowable load factor
CP_{FINAL}	M	Number of airport pairs in system
N	N	Size (Number of seats) of A/C
N_{INCR}	NINCR	Increment in A/C size
N_{FINAL}	NFINAL	Final allowable A/C size
Q	Q	Initial assumed production quantity of A/C
$\$IC_{BASE}$	SICB	Initial cost of base A/C (400 Q, 150 N)
c	0.215	Constant in block time equation
e	0.00416	Constant in block time equation
FLAG	FLAG	Flag to signify termination of production quantity
CP	L	Airport pair identifier
d	DIST(L)	Distance between airport pairs
D_{TOTAL}	DTOT(L)	Total round trips by all modes for each route

Name in Flow Chart	Name in Program	Explanation of Function
T_A	TA(L)	Access time for each route
D_{AIR}	DAIR	Total round trips by air for each route
n	NF	Frequency of departures from Bay Area airports
lf	LF	Load factor on air trips
DOC_d	DOCD	Component of DOC that is a function of distance
A_0	A0	Constant in DOC_d equation
A_1	A1	Constant in DOC_d equation
A_2	A2	Constant in DOC_d equation
A_3	A3	Constant in DOC_d equation
DOCN	DOCN	Component of DOC that is a function of plane size
DOCQ	DOCQ	Component of DOC that is a function of quantity
DOC	DOC	Direct Operating Cost (cents/statute mile)
IOC	IOC	Indirect Operating Cost (cents/statute mile)
TOC	TOC	Total Operating Cost ($/statute mile)
$ICN	SICN	Component of Initial Cost of A/C that is a function of size
$ICQ	SICQ	Component of Initial Cost of A/C that is a function of quantity
$IC	SIC	Initial cost of given A/C
T_B	TB	Block time of air trip
FARE	FARE	Fare for air trip

Name in Flow Chart	Name in Program	Explanation of Function
T_W	TW	Waiting time for air trip
a	300	Constant in IOC equation
b	.625	Constant in IOC equation
$AUTO	SAUTO	Auto costs for trip on ground
H	H	Constant in $AUTO equation
# pass./auto	NPPA	Number of passengers assumed to be in auto
g	1.17	Constant in $AUTO equation
V_{AVG}	VAVG	Average velocity of auto
D_{NEW}	DNEW	New generated number of round trips by air
x	2.025	Constant in # pass/auto equation
y	0.0021	Constant in # pass/auto equation
$SYSTEM	SSYS	Total cost of air travel, all trips, all routes
# A/C TOT	ACTOT	Number of A/C required to cover system
PASS-MI	PM	Trips times distance per route
# A/C	NAC	Number of A/C on a route
$TOTAL	STOT	Total cost of air travel, all trips, per route
PASS-MI TOT	PMTOT	Total passenger-miles, all trips, all routes
$/PASS-MI	SPPM	Cost of air travel per passenger mile weighted average, all routes
# A/C MFG	ACMFG	Production Quantity for world market for one A/C manufacturer

Name in Flow Chart	Name in Program	Explanation of Function
J	J	Percentage of world A/C market to California market, per manufacturer
TR	TR	Number of trips, one way, per route
TR_{SYSTEM}	TRSYS	Number of trips, one way, all routes
$FARE_{TOT}$	FTOT	Total air fare, all trips, per route
$FARE_{SYSTEM}$	FSYS	Total air fare, all trips, all routes
AVG $AIR/TRIP	ASAT	Average air cost per trip in entire system
AVG FARE SYSTEM	AFS	Average air fare in entire system

Systems Analysis Computer Program Listing

```
$WATFIV
C MEMORY SPACE IS SAVED FOR INDEXED AIRPORT-PAIR PARAMETERS
10    DIMENSION DIST(20),DTOT(20),TA(20),SOP(20)
C APPROPRIATE FORMS OF VARIABLES ARE DEFINED (REAL OR INTEGER)
11    REAL K,LFMAX,NF,LF,IOC,NPPA,NAC,J
12    INTEGER Q
C UNCHANGING BASIC PARAMETERS ARE READ IN
20    READ (5,21) K,G,AROI,U,NMIN,LFMAX,ST,M,N,NINCR,NFINAL,Q,SICB
21    FORMAT (4F10.4,I10,2F10.4/5I10,E10.3)
30    READ (5,31) VAVG,J,H,A0,A1,A2,A3
31    FORMAT (4F10.4,3E10.3)
C AIRPORT-PAIR PARAMETERS, IDENTIFIED BY THE INDEX IN BRACKETS, ARE
C READ IN AND STORED IN ARRAYS
40    DO 60 I=1,M
50    READ (5,51) DIST(I),DTOT(I),TA(I),SOP(I)
51    FORMAT (4F10.0)
60    CONTINUE
C THE BASIC PARAMETERS ARE PRINTED OUT
70    WRITE (6,71) K,G,AROI,U,NMIN,LFMAX,ST,M,N,NINCR,NFINAL,Q,SICB,
     1A0,A1,A2,A3,VAVG,J,H
71    FORMAT (/,/,/,/,/,/,19X,' AIRLINE OPERATIONS PROGRAM',/,/,/,/,13X,
     1' A/C SIZE SELECTION, FARES, SYSTEM COSTS',/,/,/,/,/,
     125X,' 2000 FT. RUNWAY',/,/,/,/,/,
     1' BASIC PARAMETERS-',/,/,/,' K=',F10.2,5X,' GAMA=',F10.2,5X,
     1' AROI=',F10.4,/,' U=',F10.1,5X,
     1' N-MIN=',I10,5X,' LF-MAX=',F10.2,/,' $TIME=',F10.2,5X,
     1' NO. OF PORTPAIRS=',I10,/,' N-SIZE=',I10,5X,
     1' N-INCR=',I10,5X,' N-FINAL=',I10,/,' QUANTITY=',I10,5X,
     1' $IC-BASE=',E10.3,/,' A0=',F10.4,5X,
     1' A1=',E10.3,5X,' A2=',E10.3,5X,' A3=',E10.3,/,
     1' AUTO V-AVG=',F10.2,5X,' J=',F10.2,5X,' H=',F10.2,/,/)
C THE CURRENTLY ASSUMED PLANE SIZE IS PRINTED OUT
80    WRITE (6,81) N
81    FORMAT (/,/,/,/,7X,' PLANE SIZE=',I10)
C THE FLAG CONTROLLING THE PRINTING OF PORT-PAIR QUANTITIES IS
C INITIALIZED TO ZERO
250   FLAG=0
C VARIABLES REPRESENTING TOTAL SYSTEM QUANTITIES ARE INITIALIZED TO ZERO
260   SSYS=0
270   ACTOT=0
280   PMTOT=0
290   TRSYS=0
300   FSYS=0
C THE CALCULATIONS FOR THIS PLANE SIZE ARE STARTED WITH PORT-PAIR
C NO. 1 (L)
320   L=1
C THE AIR DEMAND IS FIRST GIVEN THE ARBITRARY VALUE OF 1/2 THE TOTAL
C DAILY DEMAND
330   DAIR=0.5*DTOT(L)/730
C A COUNTER N1 IS INITIALIZED TO ZERO TO COUNT THE NO. OF ITERATIONS
C GONE THROUGH FOR THE MODAL SPLIT OF THIS PORT-PAIR
      N1=0
C THE NO. OF FLIGHTS IS CALCULATED WITH THE CURRENT DAIR
340   NF=DAIR/(LFMAX*N)
C THESE STATEMENTS SET NF TO THE NEXT HIGHER INTEGER IF THE
```

```
C FRACTIONAL PART IS GREATER THAN .05. OTHERWISE THE FRACTION
C IS DROPPED
350    IF((NF-INT(NF)).LE.0.05) GO TO 380
360    NF=INT(NF+1)
370    GO TO 390
380    NF=INT(NF)
C NF IS COMPARED TO THE MINIMUM ALLOWED NO. OF FLIGHTS. IF IT IS
C GREATER THAN NMIN, THE NEXT STEPS ARE JUMPED
390    IF (NF.GT.NMIN) GO TO 410
C IF NF IS LESS THAN NMIN, IT IS SET TO NMIN, AND THE LOAD FACTOR
C IS CALCULATED
400    NF=NMIN
       LF=DAIR/(NF*N)
C IF THE LOAD FACTOR IS GREATER THAN .35 WITH NF=NMIN, WE JUMP
C THE NEXT STEPS AND CONTINUE WITH THE PROGRAM
       IF ((LF.GT.0.35) GO TO 411
C OTHERWISE, IF LF IS LESS THAN .35, WE SET NF, LF, FARE, DOC, IOC,
C $IC, $AIR, DAIR, TB, AND TW FOR THIS PORT-PAIR TO ZERO (I.E.
C NO SERVICE), AND THE PROGRAM GOES ON TO THE NEXT PAIR, IF ANY
       NF=0
       LF=0
       FARE=0
       DOC=0
       IOC=0
       SIC=0
       SAIR=0
       DNEW=0
       TB=0
       TW=0
       GO TO 670
C THE PROGRAM COMES HERE IF NF IS GREATER THAN NMIN, AND THE LOAD
C FACTOR IS FOUND
410    LF=DAIR/(NF*N)
C WITH THE NF AND LF SO FOUND, AND WITH THE APPROPRIATE INDEXED
C PORT-PAIR PARAMETERS, THE DOC, IOC, TB, TOC, $IC, FARE, TW,
C NPPA, $AUTO, AND $AIR ARE CALCULATED
411    DOCD=A0+A1*DIST(L)+A2*DIST(L)**2+A3*DIST(L)**3
412    DOCN=3.354-3.711E-02*N+1.997E-04*N**2-3.791E-07*N**3
413    DOCQ=1.429-.001801*Q+2.234E-06*Q**2-1.031E-09*Q**3
420    DOC=DOCD*DOCN*DOCQ
430    IOC=LF*(300/DIST(L)+.625)
440    TB=.215+.002087*DIST(L)
460    TOC=(DOC+IOC)/100
461    SICN=.37001+.00419972*N-2.99775E-06*N**2+1.99945E-08*N**3
462    SICQ=2.03016-.00469533*Q+6.59019E-06*Q**2-3.30456E-09*Q**3
470    SIC=SICB*SICN*SICQ
480    FARE=AROI*TB*SIC/(U*LF*N)+TOC*DIST(L)/LF
490    TW=14/(4*NF)
500    NPPA=2.025+.0021*DIST(L)
510    SAUTO=(1.17*DIST(L))*(ST/VAVG+H/NPPA)
C THIS NEXT EQUATION CHECKS IF THE GROUND TRAVEL TIME IS MORE THAN
C 9 HOURS. IF SO, $10 IS ADDED TO $AUTO
511    IF ((1.17*DIST(L)/VAVG).GT.9) SAUTO=SAUTO+10.
520    SAIR=FARE+SOP(L)+ST*(TA(L)+TB+TW)
C THIS EQUATION ALLOWS THE PROGRAM TO SKIP OUT OF THE MODAL SPLIT LOOP
C IF 15 ITERATIONS HAVE PASS WITHOUT DAIR AND DNEW CONVERGING
       IF (N1.GT.15) GO TO 570
C DNEW IS CALCULATED FROM THE MODAL SPLIT EQUATION
530    DNEW=DTOT(L)/((1+(SAIR/(K*SAUTO))**G)*730)
C THE COUNTER IS INCREMENTED BY ONE TO SHOW 1 MORE ITERATION
```

```
      N1=N1+1
C IF DNEW AND DAIR CONVERGES TO WITHIN 2 PERCENT, THE PORT-PAIR
C CALCULATIONS ARE ASSUMED COMPLETE AND WE JUMP OUT OF THE MODAL SPLIT
540   IF ((ABS(DNEW-DAIR)/DNEW).LE.0.02) GO TO 570
C HERE WE CHECK FOR 15 ITERATIONS HAVING GONE THROUGH. IF NOT, CAIR
C IS SET TO DNEW AND WE JUMP BACK FOR ANOTHER GO. IF YES, WE SET CAIR TO
C 1/2 OF DAIR AND THE NEWLY CALCULATED DNEW, AND GO BACK TO OBTAIN THE
C FINAL QUANTITIES FOR THIS PORT-PAIR. THEN WE EXIT THE MODAL SPLIT LOOP
      IF (N1.GT.15) GO TO 565
550   DAIR=DNEW
560   GO TO 340
565   DAIR=(DAIR+DNEW)/2.
      GO TO 340
C AFTER COMPLETING THE MODAL SPLIT FOR THIS PORT-PAIR, WE COME HERE AND
C WITH THE CALCULATED QUANTITIES WE COMPUTE NAC, $TCT, PM, TR, AND FTCT
C FOR THIS PAIR. THEY ARE THEN ADDED TO THE RESPECTIVE TOTAL-SYSTEM VARIABL
570   NAC=2*TB*NF*365/U
580   ACTOT=ACTOT+NAC
590   STOT=2*SAIR*DNEW
600   SSYS=SSYS+STOT
610   PM=2*DNEW*DIST(L)
620   PMTOT=PMTOT+PM
630   TR=2*DNEW
640   TRSYS=TRSYS+TR
650   FTOT=FARE*TR
660   FSYS=FSYS+FTOT
C WE CHECK IF THE FLAG IS ZERO. IF NOT THEN THE QUANTITIES FOR THIS PORT-
C PAIR ARE PRINTED OUT. OTHERWISE THESE STEPS ARE SKIPPED
670   IF (FLAG.EQ.0.0) GO TO 770
680   WRITE (6,690) L,DIST(L),DTOT(L),SOP(L),NF,LF,FARE,DOC,IOC,SIC,
     1SAIR,SAUTO,CAIR,TA(L),TB,TW,NPPA
690   FORMAT (/,/,/,' AIRPORT PAIR NO.',I10,/,/,' AIR DISTANCE=',F10.2,
     15X,' TOTAL DEMAND (YEARLY 1-WAY TRIPS)=',E12.5,5X,' $OP=',F10.2,/,
     1' NO. OF DAILY DEPARTURES=',F10.1,5X,' LOAD FACTOR=',F10.3,5X,
     1' $FARE=',F10.2,5X,' DOC( )=',F10.2,/,' IOC( )=',F10.2,5X,
     1' $IC=',E12.5,5X,' $AIR=',F10.2,5X,' $AUTO=',F10.2,/,
     1' AIR DEMAND (DAILY ROUNDTRIPS)=',F10.2,5X,
     1' ACCESS TIME=',F10.2,5X,' BLOCK TIME=',F10.2,/,' WAIT TIME=',
     1F10.2,5X,' PASS/AUTO=',F10.2)
C WE CHECK IF PORT-PAIRS HAVE BEEN EXHAUSTED. IF NOT, GO TO NEXT PAIR
C AND RETURN TO MODAL SPLIT LOOP
770   IF (L.EQ.M) GO TO 800
780   L=L+1
790   GO TO 330
C ALL PORT-PAIRS NOW THROUGH MODAL SPLIT LOOP AND HAVE OWN CALCULATED
C QUANTITIES. TOTAL-SYSTEM VARIABLES ALSO CONTAIN FINAL VALUES (SUM
C OF ALL INDIVIDUAL PORT-PAIR VALUES). THE ACMFG IS FOUND FROM THE
C ACTOT AND COMPARED TO INITIALLY ASSUMED Q
800   ACMFG=J*ACTOT
810   IF ((ABS(ACMFG-Q)/Q).LE.0.05) GO TO 850
C IF NO CONVERGENCE OF ACMFG AND Q, SET Q TO ACMFG AND RETURN TO MODAL
C SPLIT LOOP STARTING WITH FIRST PORT-PAIR
820   Q=ACMFG
840   GO TO 260
C HOWEVER, IF ACMFG AND Q CONVERGE TO .05, CHECK IF FLAG HAS BEEN SET TO
C 1. IF NOT, WE SET IT TO 1 AND RETURN TO MODAL SPLIT LOOP STARTING WITH
C FIRST PORT-PAIR. THE RESET FLAG WILL THEN CAUSE PRINTING OF PORT-PAIR
C QUANTITIES. IF FLAG IS ALREADY 1, THE SYSTEM IS COMPLETE
850   IF (FLAG.EQ.1.0) GO TO 890
860   FLAG=1
```

```
880    GO TO 260
C WE COME HERE FINALLY TO CALCULATE $PPM, ASAT, AND AFS FOR THE WHOLE
C SYSTEM AND PRINT THESE
890    SPPM=SSYS/PMTOT
900    ASAT=SSYS/TRSYS
910    AFS=FSYS/TRSYS
920    WRITE (6,930) SSYS,SPPM,ACMFG,ACTOT,ASAT,AFS,TRSYS
930    FORMAT (/,/,/,' $SYSTEM=',E12.5,5X,' $/PASS MI=',F10.4,/,
      1' NO. A/C MFG=',F10.1,5X,' NO. A/C SYSTEM=',F10.1,/,
      1' AVG $AIR/TRIP=',F10.2,5X,' AVG $FARE SYSTEM=',F10.2,
      1/,' NO. OF TRIPS SYSTEM=',F10.1,/,/)
C NOW WE CHECK IF FINAL PLANE SIZE IS REACHED. IF NOT, WE INCREMENT
C THE SIZE AND GO THROUGH WHOLE PROCEDURE AGAIN, STARTING WITH THE
C STATEMENT THAT PRINTS THE SIZE
970    IF (N.EQ.NFINAL) GO TO 2000
980    N=N+NINCR
990    GO TO 80
2000   STOP
       END
$DATA
        .82        3.5      .1503     3000.          2        .65        6.
         20        100         10       200        200   17.4E06
        60.         6.        .05     7.311-2.977E-02 6.311E-05-4.616E-08
        380    3773770       .831      4.96
        361    1584590       .856      5.01
        342    1975498       .893      5.13
        363    1298544       .902      5.11
        379    1731901       .969      5.37
        347    2432198       .772      4.83
        329    1021228       .797      4.88
        309    1273159       .834      5.00
        331     836879       .843      4.98
        346    1116165       .910      5.24
        363    6026930       .722      4.68
        346    2530681       .747      4.73
        327    3154987       .784      4.85
        348    2074851       .793      4.83
        364    2765946       .860      5.09
        358    2372939       .650      4.54
        339     996387       .675      4.59
        321    1242189       .712      4.71
        342     816522       .721      4.69
        358    1089015       .788      4.95
$STOP
/*
```

2000/12

2000-ft System/12% ROI

```
     PLANE SIZE=        140


AIRPORT PAIR NO.         1

AIR DISTANCE=    380.00      TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.37633E 07       $OP=        5.12
NO. OF DAILY DEPARTURES=        21.0      LOAD FACTOR=       0.634        $FARE=       33.50       DOC( )=        2.87
IOC( )=        0.90      $IC= 0.19221E 08        $AIR=       50.81        $AUTO=       52.33
AIR DEMAND (DAILY ROUNDTRIPS)=   1863.45        ACCESS TIME=        0.85        BLOCK TIME=        1.01
WAIT TIME=        0.17       PASS/AUTO=        2.82


AIRPORT PAIR NO.         2

AIR DISTANCE=    361.00      TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.15849E 07       $OP=        5.04
NO. OF DAILY DEPARTURES=         7.0      LOAD FACTOR=       0.637        $FARE=       32.21       DOC( )=        2.91
IOC( )=        0.93      $IC= 0.19221E 08        $AIR=       51.09        $AUTO=       49.83
AIR DEMAND (DAILY ROUNDTRIPS)=    623.97        ACCESS TIME=        0.84        BLOCK TIME=        0.97
WAIT TIME=        0.50       PASS/AUTO=        2.78


AIRPORT PAIR NO.         3

AIR DISTANCE=    342.00      TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.19759E 07       $OP=        5.16
NO. OF DAILY DEPARTURES=         9.0      LOAD FACTOR=       0.627        $FARE=       31.49       DOC( )=        2.96
IOC( )=        0.94      $IC= 0.19221E 08        $AIR=       49.81        $AUTO=       47.31
AIR DEMAND (DAILY ROUNDTRIPS)=    789.75        ACCESS TIME=        0.88        BLOCK TIME=        0.93
WAIT TIME=        0.39       PASS/AUTO=        2.74


AIRPORT PAIR NO.         4

AIR DISTANCE=    363.00      TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.12988E 07       $OP=        5.14
NO. OF DAILY DEPARTURES=         6.0      LOAD FACTOR=       0.588        $FARE=       34.56       DOC( )=        2.90
IOC( )=        0.85      $IC= 0.19221E 08        $AIR=       54.34        $AUTO=       50.09
AIR DEMAND (DAILY ROUNDTRIPS)=    494.13        ACCESS TIME=        0.88        BLOCK TIME=        0.97
WAIT TIME=        0.58       PASS/AUTO=        2.79


AIRPORT PAIR NO.         5

AIR DISTANCE=    379.00      TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.17401E 07       $OP=        5.73
NO. OF DAILY DEPARTURES=         8.0      LOAD FACTOR=       0.638        $FARE=       33.24       DOC( )=        2.87
IOC( )=        0.90      $IC= 0.19221E 08        $AIR=       54.29        $AUTO=       52.20
AIR DEMAND (DAILY ROUNDTRIPS)=    714.76        ACCESS TIME=        1.11        BLOCK TIME=        1.01
WAIT TIME=        0.44       PASS/AUTO=        2.82
```

```
AIRPORT PAIR NO.        6

AIR DISTANCE=    347.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.24249E 07      $OP=        4.96
NO. OF DAILY DEPARTURES=       12.0       LOAD FACTOR=      0.642       $FARE=      31.15      DOC( )=       2.95
IOC( )=       0.96      $IC= 0.19221E 08        $AIR=      48.39       $AUTO=      47.97
AIR DEMAND (DAILY ROUNDTRIPS)=    1078.79       ACCESS TIME=      0.82      BLOCK TIME=      0.94
WAIT TIME=       0.29       PASS/AUTO=       2.75


AIRPORT PAIR NO.        7

AIR DISTANCE=    329.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.10212E 07      $OP=        4.88
NO. OF DAILY DEPARTURES=        4.0       LOAD FACTOR=      0.608       $FARE=      31.53      DOC( )=       3.01
IOC( )=       0.93      $IC= 0.19221E 08        $AIR=      51.85       $AUTO=      45.58
AIR DEMAND (DAILY ROUNDTRIPS)=     340.38       ACCESS TIME=      0.80      BLOCK TIME=      0.90
WAIT TIME=       0.88       PASS/AUTO=       2.72


AIRPORT PAIR NO.        8

AIR DISTANCE=    309.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.12732E 07      $OP=        5.00
NO. OF DAILY DEPARTURES=        5.0       LOAD FACTOR=      0.574       $FARE=      31.87      DOC( )=       3.09
IOC( )=       0.92      $IC= 0.19221E 08        $AIR=      51.23       $AUTO=      42.91
AIR DEMAND (DAILY ROUNDTRIPS)=     401.47       ACCESS TIME=      0.83      BLOCK TIME=      0.86
WAIT TIME=       0.70       PASS/AUTO=       2.67


AIRPORT PAIR NO.        9

AIR DISTANCE=    331.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.83690E 06      $OP=        4.98
NO. OF DAILY DEPARTURES=        3.0       LOAD FACTOR=      0.449       $FARE=      41.05      DOC( )=       3.00
IOC( )=       0.69      $IC= 0.19221E 08        $AIR=      63.53       $AUTO=      45.85
AIR DEMAND (DAILY ROUNDTRIPS)=     188.54       ACCESS TIME=      0.84      BLOCK TIME=      0.91
WAIT TIME=       1.17       PASS/AUTO=       2.72


AIRPORT PAIR NO.       10

AIR DISTANCE=    346.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.11212E 07      $OP=        5.57
NO. OF DAILY DEPARTURES=        4.0       LOAD FACTOR=      0.543       $FARE=      35.84      DOC( )=       2.95
IOC( )=       0.81      $IC= 0.19221E 08        $AIR=      58.69       $AUTO=      47.84
AIR DEMAND (DAILY ROUNDTRIPS)=     303.91       ACCESS TIME=      1.07      BLOCK TIME=      0.94
WAIT TIME=       0.98       PASS/AUTO=       2.75
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AIRPORT PAIR NO.        11

AIR DISTANCE=    363.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.60091E 07       $OP=        4.98
NO. OF DAILY DEPARTURES=       33.0       LOAD FACTOR=       0.650        $FARE=       31.76        DOC( )=          2.90
TOC( )=         0.94       $IC= 0.19221E 08        $AIR=       47.83        $AUTO=       50.09
AIR DEMAND (DAILY ROUNDTRIPS)=    3004.59        ACCESS TIME=        0.77        BLOCK TIME=        0.97
WAIT TIME=        0.11        PASS/AUTO=        2.79


AIRPORT PAIR NO.        12

AIR DISTANCE=    346.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.25307E 07       $OP=        4.90
NO. OF DAILY DEPARTURES=       13.0       LOAD FACTOR=       0.640        $FARE=       31.19        DOC( )=          2.95
TOC( )=         0.95       $IC= 0.19221E 08        $AIR=       47.83        $AUTO=       47.84
AIR DEMAND (DAILY ROUNDTRIPS)=    1164.18        ACCESS TIME=        0.75        BLOCK TIME=        0.94
WAIT TIME=        0.27        PASS/AUTO=        2.75


AIRPORT PAIR NO.        13

AIR DISTANCE=    327.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.31550E 07       $OP=        5.02
NO. OF DAILY DEPARTURES=       15.0       LOAD FACTOR=       0.620        $FARE=       30.91        DOC( )=          3.01
TOC( )=         0.96       $IC= 0.19221E 08        $AIR=       47.43        $AUTO=       45.31
AIR DEMAND (DAILY ROUNDTRIPS)=    1301.13        ACCESS TIME=        0.79        BLOCK TIME=        0.90
WAIT TIME=        0.23        PASS/AUTO=        2.71


AIRPORT PAIR NO.        14

AIR DISTANCE=    348.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.20739E 07       $OP=        5.00
NO. OF DAILY DEPARTURES=       10.0       LOAD FACTOR=       0.618        $FARE=       32.24        DOC( )=          2.94
TOC( )=         0.92       $IC= 0.19221E 08        $AIR=       49.76        $AUTO=       48.10
AIR DEMAND (DAILY ROUNDTRIPS)=     864.89        ACCESS TIME=        0.80        BLOCK TIME=        0.94
WAIT TIME=        0.35        PASS/AUTO=        2.76


AIRPORT PAIR NO.        15

AIR DISTANCE=    364.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.27785E 07       $OP=        5.59
NO. OF DAILY DEPARTURES=       13.0       LOAD FACTOR=       0.639        $FARE=       32.30        DOC( )=          2.90
TOC( )=         0.93       $IC= 0.19221E 08        $AIR=       51.48        $AUTO=       50.22
AIR DEMAND (DAILY ROUNDTRIPS)=    1162.54        ACCESS TIME=        1.02        BLOCK TIME=        0.97
WAIT TIME=        0.27        PASS/AUTO=        2.79
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AIRPORT PAIR NO.        16

AIR DISTANCE=    358.00      TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.23667E 07      $OP=       4.85
NO. OF DAILY DEPARTURES=       13.0      LOAD FACTOR=      0.616       $FARE=     32.91      DOC( )=        2.92
IOC( )=        0.90       $IC= 0.19221E 08       $AIR=      49.47        $AUTO=      49.43
AIR DEMAND (DAILY ROUNDTRIPS)=    1121.71       ACCESS TIME=       0.72      BLOCK TIME=       0.96
WAIT TIME=       0.27       PASS/AUTO=       2.78

AIRPORT PAIR NO.        17

AIR DISTANCE=    339.00      TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.99670E 06      $OP=       4.77
NO. OF DAILY DEPARTURES=        4.0      LOAD FACTOR=      0.571       $FARE=     33.88      DOC( )=        2.97
IOC( )=        0.86       $IC= 0.19221E 08       $AIR=      53.64        $AUTO=      46.91
AIR DEMAND (DAILY ROUNDTRIPS)=     319.63       ACCESS TIME=       0.70      BLOCK TIME=       0.92
WAIT TIME=       0.88       PASS/AUTO=       2.74

AIRPORT PAIR NO.        18

AIR DISTANCE=    321.00      TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.12426E 07      $OP=       4.89
NO. OF DAILY DEPARTURES=        5.0      LOAD FACTOR=      0.576       $FARE=     32.47      DOC( )=        3.04
IOC( )=        0.90       $IC= 0.19221E 08       $AIR=      51.30        $AUTO=      44.51
AIR DEMAND (DAILY ROUNDTRIPS)=     403.41       ACCESS TIME=       0.74      BLOCK TIME=       0.88
WAIT TIME=       0.70       PASS/AUTO=       2.70

AIRPORT PAIR NO.        19

AIR DISTANCE=    342.00      TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.81680E 06      $OP=       4.87
NO. OF DAILY DEPARTURES=        3.0      LOAD FACTOR=      0.560       $FARE=     34.64      DOC( )=        2.96
IOC( )=        0.84       $IC= 0.19221E 08       $AIR=      56.56        $AUTO=      47.31
AIR DEMAND (DAILY ROUNDTRIPS)=     235.17       ACCESS TIME=       0.75      BLOCK TIME=       0.93
WAIT TIME=       1.17       PASS/AUTO=       2.74

AIRPORT PAIR NO.        20

AIR DISTANCE=    358.00      TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.10943E C7      $OP=       5.46
NO. OF DAILY DEPARTURES=        4.0      LOAD FACTOR=      0.644       $FARE=     31.71      DOC( )=        2.92
IOC( )=        0.94       $IC= 0.19221E 08       $AIR=      54.02        $AUTO=      49.43
AIR DEMAND (DAILY ROUNDTRIPS)=     360.88       ACCESS TIME=       0.97      BLOCK TIME=       0.96
WAIT TIME=       0.88       PASS/AUTO=       2.78

$SYSTEM= 0.16850E 07       $/PASS MI=     0.1421
NO. A/C MFG=      267.1       NO. A/C SYSTEM=       44.5
AVG $AIR/TRIP=       50.30       AVG $FARE SYSTEM=      32.38
NO. OF TRIPS SYSTEM=   33496.9
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3000/12

3000-ft System/12% ROI

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PLANE SIZE=       140


AIRPORT PAIR NO.         1

AIR DISTANCE=    371.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.32056E 07       $OP=        5.33
NO. OF DAILY DEPARTURES=          22.0       LOAD FACTOR=       0.629        $FARE=       26.43        DOC( )=        2.27
IOC( )=        0.90      $IC= 0.13756E 08        $AIR=       44.94        $AUTO=       51.15
AIR DEMAND (DAILY ROUNDTRIPS)=   1936.96        ACCESS TIME=        1.05        BLOCK TIME=        0.99
WAIT TIME=       0.16       PASS/AUTO=        2.80


AIRPORT PAIR NO.         2

AIR DISTANCE=    353.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.11038E C7       $OP=        5.03
NO. OF DAILY DEPARTURES=           7.0       LOAD FACTOR=       0.620        $FARE=       25.84        DOC( )=        2.30
IOC( )=        0.92      $IC= 0.13756E 08        $AIR=       44.75        $AUTO=       48.77
AIR DEMAND (DAILY ROUNDTRIPS)=    608.01        ACCESS TIME=        0.86        BLOCK TIME=        0.95
WAIT TIME=       0.50       PASS/AUTO=        2.77


AIRPORT PAIR NO.         3

AIR DISTANCE=    342.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= C.19058E 07       $OP=        5.12
NO. OF DAILY DEPARTURES=          12.0       LOAD FACTOR=       0.635        $FARE=       24.87        DOC( )=        2.32
IOC( )=        0.95      $IC= 0.13756E 08        $AIR=       42.53        $AUTC=       47.31
AIR DEMAND (DAILY ROUNDTRIPS)=   1066.08        ACCESS TIME=        0.87        BLOCK TIME=        0.93
WAIT TIME=       0.29       PASS/AUTO=        2.74


AIRPORT PAIR NO.         4

AIR DISTANCE=    363.C0       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= C.20378E 07       $OP=        5.27
NO. OF DAILY DEPARTURES=          14.0       LOAD FACTOR=       0.621        $FARE=       26.31        DOC( )=        2.28
IOC( )=        0.90      $IC= 0.13756E 08        $AIR=       44.47        $AUTO=       50.09
AIR DEMAND (DAILY ROUNDTRIPS)=   1217.12        ACCESS TIME=        0.93        BLOCK TIME=        0.97
WAIT TIME=       0.25       PASS/AUTO=        2.79


AIRPORT PAIR NO.         5

AIR DISTANCE=    379.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.21133E C7       $OP=        5.84
NO. OF DAILY DEPARTURES=          14.0       LOAD FACTOR=       0.544        $FARE=       26.33        DOC( )=        2.25
IOC( )=        0.91      $IC= 0.13756E 08        $AIR=       46.36        $AUTO=       52.2C
AIR DEMAND (DAILY ROUNDTRIPS)=   1261.37        ACCESS TIME=        1.11        BLOCK TIME=        1.01
WAIT TIME=       0.25       PASS/AUTO=        2.82
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AIRPORT PAIR NO.          6

AIR DISTANCE=     362.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.15730E 07        $OP=        5.25
NO. OF DAILY DEPARTURES=        10.0       LOAD FACTOR=       0.616         $FARE=       26.42        DOC( )=         2.28
IOC( )=         0.90       $IC= 0.13756E 08         $AIR=       45.61         $AUTO=        49.96
AIR DEMAND (DAILY ROUNDTRIPS)=     862.82        ACCESS TIME=        1.00        BLOCK TIME=        0.97
WAIT TIME=        0.35        PASS/AUTO=        2.79


AIRPORT PAIR NO.          7

AIR DISTANCE=     344.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.54170E 06        $OP=        4.95
NO. OF DAILY DEPARTURES=         3.0       LOAD FACTOR=       0.450         $FARE=       33.11        DOC( )=         2.32
IOC( )=         0.67       $IC= 0.13756E 08         $AIR=       55.59         $AUTO=        47.57
AIR DEMAND (DAILY ROUNDTRIPS)=     188.81        ACCESS TIME=        0.82        BLOCK TIME=        0.93
WAIT TIME=        1.17        PASS/AUTO=        2.75


AIRPORT PAIR NO.          8

AIR DISTANCE=     333.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.93520E 06        $OP=        5.04
NO. OF DAILY DEPARTURES=         5.0       LOAD FACTOR=       0.651         $FARE=       23.96        DOC( )=         2.35
IOC( )=         0.99       $IC= 0.13756E 08         $AIR=       43.64         $AUTO=        46.11
AIR DEMAND (DAILY ROUNDTRIPS)=     455.79        ACCESS TIME=        0.83        BLOCK TIME=        0.91
WAIT TIME=        0.70        PASS/AUTO=        2.72


AIRPORT PAIR NO.          9

AIR DISTANCE=     354.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.10000E 07        $OP=        5.18
NO. OF DAILY DEPARTURES=         6.0       LOAD FACTOR=       0.652         $FARE=       24.89        DOC( )=         2.30
IOC( )=         0.96       $IC= 0.13756E 08         $AIR=       44.61         $AUTO=        48.90
AIR DEMAND (DAILY ROUNDTRIPS)=     547.68        ACCESS TIME=        0.89        BLOCK TIME=        0.95
WAIT TIME=        0.58        PASS/AUTO=        2.77


AIRPORT PAIR NO.         10

AIR DISTANCE=     368.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.10370E 07        $OP=        5.76
NO. OF DAILY DEPARTURES=         6.0       LOAD FACTOR=       0.626         $FARE=       26.39        DOC( )=         2.27
IOC( )=         0.90       $IC= 0.13756E 08         $AIR=       47.96         $AUTO=        50.75
AIR DEMAND (DAILY ROUNDTRIPS)=     525.58        ACCESS TIME=        1.07        BLOCK TIME=        0.98
WAIT TIME=        0.58        PASS/AUTO=        2.80
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AIRPORT PAIR NO.        11

AIR DISTANCE=    338.00      TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.15048E 07      $OP=       5.00
NO. OF DAILY DEPARTURES=         9.0       LOAD FACTOR=      0.650       $FARE=     24.23        DOC( )=       2.33
IOC( )=       0.98       $IC= 0.13756E 08        $AIR=      42.65       $AUTO=      46.78
AIR DEMAND (DAILY ROUNDTRIPS)=     818.59        ACCESS TIME=       0.93       BLOCK TIME=       0.92
WAIT TIME=       0.39       PASS/AUTO=       2.73


AIRPORT PAIR NO.        12

AIR DISTANCE=    320.00      TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.51820E 06      $OP=       4.70
NO. OF DAILY DEPARTURES=         2.0       LOAD FACTOR=      0.605       $FARE=     24.78        DOC( )=       2.38
IOC( )=       0.95       $IC= 0.13756E 08        $AIR=      49.76       $AUTO=      44.38
AIR DEMAND (DAILY ROUNDTRIPS)=     169.41        ACCESS TIME=       0.75       BLOCK TIME=       0.88
WAIT TIME=       1.75       PASS/AUTO=       2.70


AIRPORT PAIR NO.        13

AIR DISTANCE=    309.00      TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.89460E 06      $OP=       4.79
NO. OF DAILY DEPARTURES=         5.0       LOAD FACTOR=      0.566       $FARE=     25.59        DOC( )=       2.42
IOC( )=       0.90       $IC= 0.13756E 08        $AIR=      44.27       $AUTO=      42.91
AIR DEMAND (DAILY ROUNDTRIPS)=     396.47        ACCESS TIME=       0.75       BLOCK TIME=       0.86
WAIT TIME=       0.70       PASS/AUTO=       2.67


AIRPORT PAIR NO.        14

AIR DISTANCE=    331.00      TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.95660E 06      $OP=       4.94
NO. OF DAILY DEPARTURES=         6.0       LOAD FACTOR=      0.558       $FARE=     27.00        DOC( )=       2.35
IOC( )=       0.85       $IC= 0.13756E 08        $AIR=      45.74       $AUTO=      45.85
AIR DEMAND (DAILY ROUNDTRIPS)=     468.78        ACCESS TIME=       0.81       BLOCK TIME=       0.91
WAIT TIME=       0.58       PASS/AUTO=       2.72


AIRPORT PAIR NO.        15

AIR DISTANCE=    346.00      TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.99200E 06      $OP=       5.51
NO. OF DAILY DEPARTURES=         5.0       LOAD FACTOR=      0.645       $FARE=     24.74        DOC( )=       2.31
IOC( )=       0.96       $IC= 0.13756E 08        $AIR=      46.03       $AUTO=      47.84
AIR DEMAND (DAILY ROUNDTRIPS)=     451.33        ACCESS TIME=       0.99       BLOCK TIME=       0.94
WAIT TIME=       0.70       PASS/AUTO=       2.75
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AIRPORT PAIR NO.        16

AIR DISTANCE=    344.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.13944E C7      $OP=        5.18
NO. OF DAILY DEPARTURES=        9.0       LOAD FACTOR=      0.587      $FARE=      26.57      DOC( )=        2.32
IOC( )=        0.86       $IC= 0.13756E 08       $AIR=      45.76       $AUTO=      47.57
AIR DEMAND (DAILY ROUNDTRIPS)=     739.38       ACCESS TIME=       1.01       BLOCK TIME=       0.93
WAIT TIME=        0.39       PASS/AUTO=        2.75


AIRPORT PAIR NO.        17

AIR DISTANCE=    326.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.46010E 06      $OP=        4.88
NO. OF DAILY DEPARTURES=        0.0       LOAD FACTOR=      0.000      $FARE=       0.00      DOC( )=        0.00
IOC( )=        0.00       $IC= 0.00000E 00       $AIR=       0.00       $AUTO=      45.18
AIR DEMAND (DAILY ROUNDTRIPS)=      83.86       ACCESS TIME=       0.83       BLOCK TIME=       0.00
WAIT TIME=        0.00       PASS/AUTO=        2.71


AIRPORT PAIR NO.        18

AIR DISTANCE=    315.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.82900E 06      $OP=        4.97
NO. OF DAILY DEPARTURES=        4.0       LOAD FACTOR=      0.626      $FARE=      23.88      DOC( )=        2.40
IOC( )=        0.99       $IC= 0.13756E 08       $AIR=      44.38       $AUTO=      43.71
AIR DEMAND (DAILY ROUNDTRIPS)=     350.76       ACCESS TIME=       0.84       BLOCK TIME=       0.87
WAIT TIME=        0.88       PASS/AUTO=        2.69


AIRPORT PAIR NO.        19

AIR DISTANCE=    336.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.88640E 06      $OP=        5.12
NO. OF DAILY DEPARTURES=        5.0       LOAD FACTOR=      0.653      $FARE=      24.03      DOC( )=        2.34
IOC( )=        0.99       $IC= 0.13756E 08       $AIR=      44.22       $AUTO=      46.51
AIR DEMAND (DAILY ROUNDTRIPS)=     457.20       ACCESS TIME=       C.89       BLOCK TIME=       0.92
WAIT TIME=        0.70       PASS/AUTO=        2.73


AIRPORT PAIR NO.        20

AIR DISTANCE=    351.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.91920E 06      $OP=        5.69
NO. OF DAILY DEPARTURES=        5.0       LOAD FACTOR=      0.583      $FARE=      27.07      DOC( )=        2.30
IOC( )=        0.86       $IC= 0.13756E 08       $AIR=      49.11       $AUTO=      48.50
AIR DEMAND (DAILY ROUNDTRIPS)=     407.97       ACCESS TIME=       1.08       BLOCK TIME=       0.95
WAIT TIME=        0.70       PASS/AUTO=        2.76
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AIRPOPT PAIR NO.        21

AIR DISTANCE=     350.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.47277E 07       $OP=        5.21
NO. OF DAILY DEPARTURES=        32.0        LOAD FACTOR=       0.638        $FARE=       25.14       DOC( )=        2.31
IOC( )=        0.94        $IC= 0.13756E 08          $AIR=       42.67         $AUTO=       48.37
AIR DEMAND (DAILY ROUNDTRIPS)=     2856.35          ACCESS TIME=        1.00         BLOCK TIME=        0.95
WAIT TIME=        0.11         PASS/AUTO=         2.76


AIRPORT PAIR NO.        22

AIR DISTANCE=     332.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.16279E 07       $OP=        4.91
NO. OF DAILY DEPARTURES=        10.0        LOAD FACTOR=       0.652        $FARE=       23.90       DOC( )=        2.35
IOC( )=        1.00        $IC= 0.13756E 08          $AIR=       41.25         $AUTO=       45.98
AIR DEMAND (DAILY ROUNDTRIPS)=      912.27          ACCESS TIME=        0.81         BLOCK TIME=        0.91
WAIT TIME=        0.35         PASS/AUTO=         2.72


AIRPORT PAIR NO.        23

AIR DISTANCE=     321.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.28107E 07       $OP=        5.00
NO. OF DAILY DEPARTURES=        18.0        LOAD FACTOR=       0.630        $FARE=       24.06       DOC( )=        2.38
IOC( )=        0.98        $IC= 0.13756E 08          $AIR=       40.48         $AUTO=       44.51
AIR DEMAND (DAILY ROUNDTRIPS)=     1586.61          ACCESS TIME=        0.82         BLOCK TIME=        0.88
WAIT TIME=        0.19         PASS/AUTO=         2.70


AIRPORT PAIR NO.        24

AIR DISTANCE=     342.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.30055E 07       $OP=        5.15
NO. OF DAILY DEPARTURES=        20.0        LOAD FACTOR=       0.645        $FARE=       24.55       DOC( )=        2.32
IOC( )=        0.97        $IC= 0.13756E 08          $AIR=       41.60         $AUTO=       47.31
AIR DEMAND (DAILY ROUNDTRIPS)=     1805.56          ACCESS TIME=        0.88         BLOCK TIME=        0.93
WAIT TIME=        0.17         PASS/AUTO=         2.74


AIRPORT PAIR NO.        25

AIR DISTANCE=     358.00       TOTAL DEMAND (YEARLY ONE-WAY TRIPS)= 0.31168E 07       $OP=        5.72
NO. OF DAILY DEPARTURES=        20.0        LOAD FACTOR=       0.644        $FARE=       25.32       DOC( )=        2.29
IOC( )=        0.94        $IC= 0.13756E 08          $AIR=       44.24         $AUTO=       49.43
AIR DEMAND (DAILY ROUNDTRIPS)=     1802.69          ACCESS TIME=        1.06         BLOCK TIME=        0.96
WAIT TIME=        0.17         PASS/AUTO=         2.78


$SYSTEM= 0.13164E 07        $/PASS MI=      0.1261
NO. A/C MFG=       342.7        NO. A/C SYSTEM=        57.1
AVG $AIR/TRIP=        44.00        AVG $FARE SYSTEM=      25.40
NO. OF TRIPS SYSTEM=    43558.2
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APPENDIX H

STOLport Impact:

Two Brochures Used In Community Presentation

for

Hayward and Palo Alto

THE COMMUNITY IMPACTS OF A NEW AVIATION CONCEPT: A CASE STUDY IN HAYWARD, CALIFORNIA

An Excerpt from
A Study being prepared
for the
National Aeronautics and Space Administration

by

David W. Jones
and
Richard S. Shevell

Stanford University

I. STOL -- A New Aircraft Technology

As the Bay Area's three metropolitan airports become more crowded, time delays will become a significant factor in the passenger cost of short-haul trips between San Francisco and Los Angeles. Already many travelers are spending more time on freeways and in airport terminals than in the air between the Bay Area and Los Angeles.

In response to this problem, aircraft manufacturers are considering the development of a new breed of jet aircraft capable of using short runways located close to downtown areas. This next generation of aircraft are called STOL's -- shorthand for Short Take-Off and Landing. In order to operate near downtown areas, STOL's would be designed to meet strict noise standards and to climb rapidly to minimize the hazards and annoyance caused by aircraft flyovers.

Aircraft manufacturers and airlines are currently examining whether STOL service between Los Angeles and the Bay Area would make sense in economic terms.

But it is equally important to learn whether the public would favor the development of STOLports. Would the citizens of Hayward, for example, favor the expansion of the city's existing general aviation airport to accomodate STOL operations?

II. Community Reaction

Community reaction to a commercial aviation proposal is likely to depend on how local citizens and community policymakers view and weigh the relative importance of the economic, environmental and social impacts of airport development and aircraft operations.

On the benefit side of the STOLport equation are:

1. Air travel convenience;
2. New employment opportunity;
3. New income, payroll and economic activity;
4. New property and purchases which contribute to the community's tax base.

On the negative side of the STOLport equation are a number of social and environmental costs which technology can minimize but not eliminate. These include:

1. Noise pollution;
2. Air pollution;
3. Impact of airport construction of the terrestrial ecology;
4. Increases in local ground traffic;
5. Increased population and development pressure -- the other side of the employment-opportunity coin.

III. <u>The Hayward Case Study</u>

A research team from Stanford University has examined the magnitude of the social, environmental and economic impacts which would be likely to occur if Hayward expanded its municipal air terminal to provide commercial STOL service between the Bay Area and Los Angeles.

The Stanford study is <u>not</u> a planning study or a development proposal. The impact analysis is <u>not</u> an Environmental Impact Statement. Rather, it is a preliminary analysis to determine whether a new aircraft technology and a new airport location concept are acceptable to community residents. Hayward and five other Bay Area communities were chosen for a test of public reaction to the STOLport concept.

The Stanford research team used both traditional and innovative methods to arrive at assessments of STOL impacts which have been collected in a document of almost 200 pages. You are reading a capsule summary of the findings.

IV. The Benefits of a Hayward STOLport

Passenger convenience. By 1985, Alameda County will generate approximately 2.2 million passenger trips to and from Los Angeles each year. Seventeen to 20 daily STOL flights to each of 5 or 6 airports in the Los Angeles area are feasible in terms of this market demand and would provide frequent and convenient service 10 minutes from Hayward's downtown area.

Employment Opportunity. A Hayward STOLport would be a major local employer -- providing employment for approximately 625 people. Airport development would also stimulate employment in closely related sectors of the economy -- hotel services, government and retail trade. The total increase in employment due to the introduction of STOL service is estimated at 1300 jobs. Short-term demand for construction work would employ another 1000.

New Payroll and Income. New financial investments infused in a region and recycled through the local economy create what economists refer to as a "multiplier effect." The new income -- payroll, visitor expenditures and local purchases -- recycled through the East Bay economy and focused in Hayward due to STOLport development is estimated at $41.5 million per year. Of this amount, $6 million would be due to STOLport payroll,$4.5 million to local purchases by the airport, $9 million in visitor expenditures and almost $1 million in local tax payments.

Land Use and Tax Base Impacts. STOLport employment would stimulate development activity in the East Bay and increase the area's tax base. It is estimated that airport and airport related employment will create a demand for the development of 180 acres of new housing and 20 acres of commercial property.

Property owners, renters and commercial establishments owing their livelihood to airport and airport-related employment would contribute to East Bay tax revenues in the following annual magnitudes:

New Property Taxes: Approximately $725,000

New Sales Tax Revenues: Approximately $200,000

V. The Social and Environmental Costs of STOLport Development

The Airport Setting:

Hayward Air Terminal is located west of the Nimitz Freeway near San Francisco Bay.

The air terminal is bounded on the east by Hesperian Boulevard -- an area characterized by strip commercial development intermixed with single-family housing. The neighborhood which extends east from Hesperian to the Nimitz is part of Hayward's extremely limited supply of low-to-moderate income housing. Some parts of the neighborhood are declining to conditions of blight.

The airport is bounded on the north by a golf course which provides a buffer zone between the airport and the San Lorenzo neighborhood known as the Village. San Lorenzo Village is a stable middle income residential area; more than two-thirds of its residents have lived in the neighborhood for more than five years. The airport currently receives noise complaints from San Lorenzo homeowners when the airport is used by the Air National Guard and the airport's lone jet client.

The airport is bounded on the south by the Cabot, Cabot and Forbes Industrial Park, a trailer park, a school, and another moderate income residential area. Hayward's Chabot College is located several miles southeast of the airport.

The airport is bounded on the west by the C,C & F Industrial Park, the city's refuse disposal site, and vacant bayland. The bayland area is zoned for industrial use but the city Planning Department is currently examining the possibility of rezoning flood plain areas for recreation and open space uses.

<u>Aircraft Noise--Its Impact on Residential Areas</u>. The extent to which community residents are annoyed by aircraft noise depends on both the loudness and frequency of airplane overflights.

Although STOL aircraft are powered by turbofan engines, they will produce only a fraction of the noise and noise annoyance associated with conventional jet airliners. STOL noise reduction is due to both engine design and the aircraft's ability to climb quickly and steeply away from populated areas.

If a Hayward STOLport generated the projected 130 flights per day, approximately 27,000 residents of Hayward and San Lorenzo would live within hearing distance of STOL flight patterns. Of these approximately 27,000 people, about 755 would be very annoyed by noise intrusions while watching television, listening to the radio, or while talking over the telephone or in face-to-face conversation. Some 30 residents would be sufficiently annoyed by aircraft operations to register complaints--a judgment based on home location and carefully calibrated noise contours.

The number of people who would experience given levels of aircraft noise is expressed below in terms of a familiar loudness equivalent:

Residents	A Loudness Equivalent	Noise Level in EPNdB
326	A fast freight train at 100' away	90-95 EPNdB
1709	A Freeway 50' away	85-90 EPNdB
7568	Vacuum cleaner in the same room	80-85 EPNdB

Aircraft Noise -- Its Impact on Non-Residential Areas

Schools, libraries, medical facilities and wilderness recreation areas are particularly sensitive to aircraft noise intrusion. In Hayward, a number of schools would be affected by aircraft noise below critical tolerance levels for schools but still sufficiently loud to cause some classroom distraction. Projected noise levels, the affected schools and a familiar loudness equivalent are shown below:

Noise Level	School	A Loudness Equivalent
80-85 EPNdB	Longwood Winton Grove Russell	A vacuum cleaner in the same room
75-80 EPNdB	Del Rey Linda Vista Bohannon Sunset Mohrland St. Joachim	A BART train at full speed 100 feet away

Other areas prone to noise intrusion would be Longwood Park and the Hayward Baylands. Noise in the Bayland area would be objectionable only if the city decides to preserve the tidal flats for wilderness-style recreation purposes -- hiking, nature observation and the like. Aircraft noise would not seriously disturb the tideland wildlife population; it would be likely to conflict with open-space recreation uses similar to those at Coyote Hills Park.

Air Pollution. STOL aircraft will be designed to minimize the emission of toxic air pollution. Despite advances in engine technology, STOL emissions should be examined carefully in areas which currently experience episodes of serious air pollution. The Bay Area Air Pollution Control District rates Hayward as a moderate-to-severe air pollution zone.

Aircraft pollution has some of the characteristics of both stationary and mobile emission sources. Approximately two-thirds of the pollutants from STOLport activities would be emitted within the airport boundaries. In this sense, the airport's pollution impact would be similar to that of an industrial polluter. The remaining third of the pollution tonnage would be emitted by the aircraft in flight. These emissions would be distributed over a large area and diluted by diffusion.

Thus, the major pollution problem associated with airport expansion is the ground-level pollution which results from aircraft take-off and taxiing, from fuel handling and from vehicle traffic. These operations create a pollution hot spot in the immediate airport vicinity.

The pollution tonnage that would result from STOL operations would account for less than 1% of the total pollutants emitted in Alameda County. However, in the airport vicinity, pollution standards for nitrogen oxide would be regularly exceeded. Nitrogen oxide combines with hydrocarbons to produce the eye-smarting, visibility-reducing, photochemical smog prevalent in Los Angeles. Both state and Federal agencies are considering revising nitrogen oxide standards in light of new evidence which indicates that the current standards are unnecessarily restrictive.

The STOLport's daily contribution to localized pollution levels can be expressed in terms of automobile equivalents for each species of aircraft pollutant.

Emissions in the immediate airport vicinity would reach the following daily totals:

Particulate matter:	.33 tons	=	682,000 car miles
Carbon monoxide:	3.4 tons	=	50,000 car miles
Nitrogen oxide:	.8 tons	=	125,000 car miles
Hydrocarbons:	.8 tons	=	64,000 car miles

Ground Access and Traffic Congestion. STOLport passengers would be likely to approach the airport using Hesperian Avenue, A Street and Winton Avenue. Each of these boulevards is currently at or near capacity during the morning and evening rush hour periods. The STOLport would generate approximately 600 additional vehicles during rush hour, doubling current congestion levels and straining these arterials well beyond capacity.

Effective airport access would require:

- widening of arterial links between the airport and the Nimitz Freeway

and/or - the construction of a bay front arterial to service the airport from the west.

Neither strategy would completely resolve the problem of through-traffic in residential areas east of Hesperian. Neither strategy would completely relieve the problem which neighborhood residents would encounter in using these arterials for shopping and parking purposes.

The Impact of Airport Construction

It is anticipated that the construction necessary to upgrade Hayward's terminal facilities, runway, apron areas, and parking lots would not significantly disrupt general aviation operations. It would be necessary to repave the airport taxiways and build a new passenger terminal. However, because the existing runways and apron areas are sufficiently strong for STOL use there would be no need to discontinue general aviation operations during construction.

VI. Financing Airport Development

The capital improvement program necessary to convert Hayward Airport to a commercial STOL facility would be partially financed through the federal Airport Development Trust Fund. Under trust fund procedures, the federal government would share 50% of development costs. The local share--the remaining 50%--would be financed through special purpose revenue bonds.

Airport revenues--landing and rental fees, parking fees and fuel sales--would be sufficient to service the debt and retire the airport bonds after 30 years.

THE COMMUNITY IMPACTS OF A NEW AVIATION CONCEPT: A CASE STUDY IN PALO ALTO, CALIFORNIA

An Excerpt from
A Study Being Prepared
for the
National Aeronautics and Space Administration

by
David W. Jones
and
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I. STOL--A New Aircraft Technology

As the Bay Area's three metropolitan airports become more crowded, time delays will become a significant factor in the passenger cost of short-haul trips between San Francisco and Los Angeles. Already many travelers are spending more time on freeways and in airport terminals than in the air between the Bay Area and Los Angeles.

In response to this problem, aircraft manufacturers are considering the development of a new breed of jet aircraft capable of using short runways located close to downtown areas. This next generation of aircraft are called STOL's--shorthand for Short Take-Off and Landing. In order to operate near downtown areas, STOL's would be designed to meet strict noise standards and to climb rapidly to minimize the hazards and annoyance caused by aircraft flyovers.

Aircraft manufacturers and airlines are currently examining whether STOL service between Los Angeles and the Bay Area would make sense in economic terms.

But it is equally important to learn whether the public would favor the development of STOLports. Would the citizens of Palo Alto, for example, favor the expansion of the city's existing general aviation airport to accomodate STOL operations?

II. Community Reaction

Community reaction to a STOLport proposal is likely to depend on how local citizens and community policymakers view the relative importance of the economic, environmental and social impacts of airport development and aircraft operations.

On the benefit side of the STOLport equation are:

1. Air travel convenience.
2. New employment opportunity.

3. New income, payroll and economic activity.
4. New property and purchases which contribute to the community's tax base.
5. The elimination of existing airport deficits.

On the negative side of the STOLport equation are a number of social and environmental costs which technology can minimize but not eliminate. These include:

1. Noise pollution.
2. Air pollution.
3. Impact of airport construction on the terrestrial ecology.
4. Increases in local ground traffic.
5. Increased population and development pressure--the other side of the employment-opportunity coin.

III. The Palo Alto Case Study

A research team from Stanford University has examined the magnitude of the social, environmental and economic impacts which would be likely to occur if Palo Alto expanded its municipal airport to provide commercial STOL service to Los Angeles.

The Stanford study is not a planning study or a development proposal. The impact analysis is not an Environmental Impact Statement. Rather, it is a preliminary analysis to determine whether a new aircraft technology and a new airport location concept are acceptable to community residents. Palo Alto and five other Bay Area communities were chosen for a test of public reaction to the STOLport concept.

The Stanford research team used both traditional and innovative methods to arrive at assessments of STOL impacts which have been collected in a document of almost 200 pages. You are reading a capsule summary of the findings.

IV. The Benefits of a Palo Alto STOLport

Passenger convenience. By 1985, the Mid-Peninsula area will generate approximately 2.9 million passenger trips to and from Los Angeles each year.

Eight to ten daily STOL flights to each of 5 or 6 airports in the Los Angeles area are feasible in terms of this market demand and would provide frequent and convenient service 10 minutes from Palo Alto's downtown area.

Employment Opportunity. A Palo Alto STOLport would be a major local employer--providing employment for approximately 970 people. Airport development would also stimulate employment in closely related sectors of the economy--hotel services, government and retail trade. The total increase in employment due to the introduction of STOL service is estimated at 2500 jobs. Short-term demand for construction work would employ another 1075.

New Payroll and Income. New financial investments infused in a community and recycled through the local economy create what economists refer to as a "multiplier effect." The new income -- payroll, visitor expenditures and local purchases -- recycled through the mid-Peninsula economy due to STOLport development is estimated at $30 million per year. Of this amount, $9 million would be due to STOLport payroll alone.

Land Use and Tax Base Impacts. STOLport employment would stimulate development activity in the Mid-Peninsula and increase the area's tax base. It is estimated that airport and airport related employment will create a demand for the development of 350 acres of new housing and 37 acres of commercial property.

Property owners, renters and commercial establishments owing their livelihood to airport and airport-related employment would contribute to mid-Peninsula tax revenues in the following annual magnitudes:

New Property Taxes:	Approximately $1.4 million
New Sales Tax Revenues:	Approximately $.4 million

Current Airport Deficits. The commercial airline providing STOL service to Palo Alto would pay user fees sufficient to operate the airport on a break-even basis. This would erase the annual deficit of $23,000 which Santa Clara County incurs in operating the existing general aviation facility.

V. The Social and Environmental Costs of STOLport Development

The Airport Setting. Palo Alto Municipal Airport is located on the edge of San Francisco Bay at the boundary between San Mateo and Santa Clara Counties. Physical facilities in the immediate airport environs include Palo Alto's sewage treatment plant, a yacht harbor, golf course, nature interpretation center and a solid waste disposal site which will be converted to park use by 1985.

The marshland habitat near the present airport is a significant wildlife sanctuary that is compatible with limited recreation activities such as hiking and bicycling. Palo Alto's current Bayland policies emphasize "maintaining natural ecological processes and preserving one of the last remnants of wetland in the San Francisco Bay Area as a wildlife preserve." The conservation element of the City's general plan states:

> Recent public awareness of the delicate, but vital, ecological importance of the Baylands and related mudflats and waters has led to a re-examination of past policies and goals for the Baylands. Therefore the current emphasis is upon retention and preservation of the natural areas remaining in the Baylands, and allowing recreation activities only when they are compatible with these higher priority conservation goals.

The Palo Alto airport is bounded on the north by a low-income residential area--the predominantly black community of East Palo Alto. The noise and air pollution impacts of STOL operations must be examined with particular care in light of the limited housing alternatives available to East Palo Alto residents due to both racial discrimination and the cost of housing on the mid-Peninsula. STOLport employment must be weighed as a countervailing benefit to the jobless in East Palo Alto.

Aircraft Noise--Its Impact on Residential Areas. The extent to which community residents are annoyed by aircraft noise depends on both the loudness and frequency of airplane overflights.

Although STOL aircraft are powered by turbofan engines, they will produce only a fraction of the noise and noise annoyance associated with conventional jet airliners. STOL noise reduction is due to both engine design and the aircraft's ability to climb quickly and steeply away from populated areas.

If a Palo Alto STOLport were developed to a projected maximum of 130 flights per day, approximately 3400 people--all residents of East Palo Alto--would live within hearing distance of STOL flight patterns. Of these 3400 people, about 300 would be moderately annoyed by noise intrusions while watching television, listening to the radio, or while talking over the telephone or in face-to-face conversation. Only 20 people are expected to be sufficiently annoyed by aircraft operations to register complaints--a judgement based on home location and carefully calibrated noise contours.

At no point in the airport's expansion would noise over residential areas excede 85 EPNdB. For comparative purposes, this means that:

1. The loudest STOL noise audible to residents relaxing outdoors would be slightly louder than a vacuum cleaner and one half as loud as the sound of a BART train passing 50 feet away at 70 miles per hour. This noise level would be experienced 65 times daily by residents on the southernmost rim of East Palo Alto.

2. Each STOL operation would be only slightly noisier than the propeller-driven planes which currently use Palo Alto airport.

3. At its loudest, the combined noise associated with STOL and general aviation activities would be considerably lower than the noise level at which the law requires noise insulation in new residential construction.

4. The maximum noise levels experienced in East Palo Alto would be one-eighth as loud as those experienced by residents living nearest litigation-plagued Los Angeles International Airport.

5. No households in East Palo Alto would experience noise levels which excede the maximum noise levels for construction equipment recently adopted by the City of Palo Alto. At its loudest STOL noise would be one half as loud as the maximum allowable levels for construction equipment in Palo Alto.

Aircraft Noise--Its Impact on Bayland Open Space Resources. The impact of noise on open space activities--human recreation and biotic processes--is an area of scientific inquiry typified by conspicuous neglect. The noise tolerances of wildlife and the noise annoyance thresholds associated with recreation activities such as yachting, golfing and hiking are poorly understood.

However, it seems reasonable to expect that the most severe noise annoyance would be registered by people who desire to use the Baylands for relaxation or solitary revery--respites from the rapid pace of life in the jet age.

The following chart shows expected noise levels at several bayland locations, a familiar loudness equivalent and the number of people that would be impacted by the combined noise from STOL and general aviation aircraft.

Location	Loudness	An Equivalent	Number Impacted
Palo Alto Yacht Club	90 EPNdB	Freeway noise fifty feet away	400 Yachts by 1980.
Duck Pond And Lagoon	90 EPNdB	Freeway noise fifty feet away	20 people observed during one weekday lunch hour.
Some parts of Municipal Golf Course	Up to 95 EPNdB	Southern Pacific train from 100 feet	100,000 rounds of golf per year.
Flood Basin Trail Area	85 EPNdB	Vacuum cleaner in same room	Hikers, dog trainers and future bicyclists in unknown numbers.

If preliminary Environmental Protection Agency data is accurate, noise will have little impact on marshland wildlife. The extent to which aircraft noise would conflict with the City's stated goal in increasing the density and diversity of marshland wildlife species seems likely to be small.

Air Pollution. STOL aircraft will be designed to minimize the emission of toxic air pollution. Despite advances in engine technology, STOL emissions should be examined carefully in areas which currently experience episodes of serious air pollution. The Bay Area Air Pollution Control District rates the mid-Peninsula as a moderate-to-severe air pollution zone.

Aircraft pollution is similar to automobile pollution in the sense that the emission source is mobile; this means that aircraft emissions are distributed over a large area and their impact dilluted by diffusion. On the other hand, airport activities including fuel handling and ground traffic create a pollution "hot spot" in the immediate airport vicinity.

In the context of present air pollution levels in Santa Clara County, STOL operations would represent a small fraction of the whole:

Particulates:	363 lbs. daily	.5 %	of daily county emissions by weight
Organics:	363 lbs. daily	.05 %	
Nitrogen Oxides:	2178 lbs. daily	.6 %	
Sulfur Oxides:	172 lbs. daily	.2 %	
Carbon Monoxide:	1420 lbs. daily	.06 %	

A meaningful analysis of pollution impact must include the location, concentration and diffusion of STOL emissions. Palo Alto STOLport operations can most accurately be compared to the volume and dispersion of pollutants which result from automobile travel on the Bayshore Freeway between Menlo Park and San Jose, a 15 mile corridor with the same alignment as STOL aircraft would use in approaching Palo Alto airport. The introduction of STOL operations at Palo Alto combined with reduced freeway travel to San Francisco Airport would have a net impact on air quality equivalent tc the following changes in today's daily traffic on the Bayshore Freeway:

Particulate matter	26% increase in daily freeway traffic between San Jose and Menlo Park.
Organics	2% decrease in freeway traffic.
Nitrogen oxides	13% increase in freeway traffic.
Sulfur oxides	54% increase in freeway traffic.≠ *
Carbon monoxide	2% decrease in freeway traffic.

There would also be a small but concentrated increase in air pollution levels near the airport facility. This localized pollution impact would result from ground traffic, jet rev-up, and aircraft fueling. The volume of emissions would be equivalent to an additional 15% increase in Bayshore traffic between the University and Embarcadero Exits.

Displacement and Other Terrestrial Impacts of Airport Construction. The present Palo Alto airport cannot accomodate commercial STOL service without the construction of additional parking and terminal facilities, an enlarged apron area, and a more durable runway. Expansion of the airport to its maximum 2.9 million passenger capacity per year would require the acquisition of 35 acres of the 185 acre golf course adjoining the existing airport facility.

Reconstruction of the existing runway would be necessary to bear the weight of STOL aircraft. Runway reconstruction would require excavating to a depth of six feet and replacement of the unstable foundation materials which support the existing runway. This excavation and construction would have the following impacts:

1. General aviation flights would have to be discontinued for a period of approximately one year.

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* Aircraft/auto equivalents are based on emission levels for automobiles currently on the road and the expected performance of STOL aircraft. As an absolute number, the tonnage of aircraft pollution emissions will decline with improvements in technology. As a percentage of all transportation emissions, aircraft pollution tonnage will increase due to more rapid progress in automobile emission controls. In terms of 1976 emission standards, for example, the Nitrogen oxide equivalent of Palo Alto STOL operations would be a freeway traffic increase of 188%.

≠ The high percentage increase is partially accounted for by the small percentage of sulfur in automobile fuel.

2. The disposal of excavation spoils would compound Palo Alto's current dilemma over the disposal of yacht harbor dredging spoils.

3. With precautionary engineering measures, runway excavation and construction would not result in any fouling of adjacent waterways or the estuarine habitat.

<u>Increased Local Ground Traffic</u>. It is estimated that 680 vehicles would arrive and depart from a Palo Alto STOLport during peak hour periods. Embarcadero Avenue east of the Bayshore freeway would have to be widened to a four-lane divided highway with access controls and favorable signal timing.

Airport development would not increase traffic in residential areas. The widening of Embarcadero east of Bayshore would not create a barrier which impedes the movement of either pedestrian or vehicular cross-traffic.

<u>Population Growth and Development Pressure</u>. Airport and airport-related employment would create a demand for approximately 2000 units of moderate income housing. Because undeveloped land is scarce in the Mid-Peninsula, STOLport development would bolster market pressures for the conversion of older residential areas to apartment densities.

Most STOLport employees would be unable to afford the cost of housing in Palo Alto. Airport development could therefore create a fundamental equity issue: Palo Alto benefiting from new commercial tax base while neighboring Mountain View and Sunnyvale are forced to cope with the burden of providing public services such as parks and schools for the airport's work force and their families. Federal Impact Aid--compensation to school districts which must educate the children of employees who work at tax-exempt federal installations--is not awarded in the case of civilian airport employment.

The disparity of home-location and job-location would aggravate the problems of freeway congestion which are caused by Palo Alto's status as major employment importer.

VI. Financing Airport Development

The capital improvement program necessary to convert Palo Alto Airport to a commercial STOL facility would be partially financed through the federal Airport Development Trust Fund. Under trust fund procedures, the federal government would share 50% of development costs. The local share--the remaining 50%--would be financed through special purpose revenue bonds.

Airport revenues--landing and rental fees, parking fees and fuel sales--would be sufficient to service the debt and retire the airport bonds after 30 years.