

1956

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Recommended Citation

John L. Donoghue, *Planning and Financing Chicago's Municipal Airports*, 23 J. AIR L. & COM. 34 (1956)
<https://scholar.smu.edu/jalc/vol23/iss1/6>

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PLANNING AND FINANCING CHICAGO'S MUNICIPAL AIRPORTS

By JOHN L. DONOGHUE

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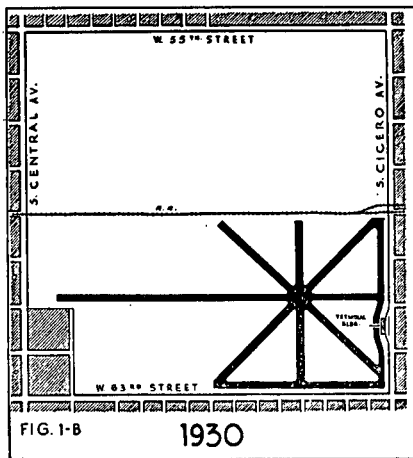
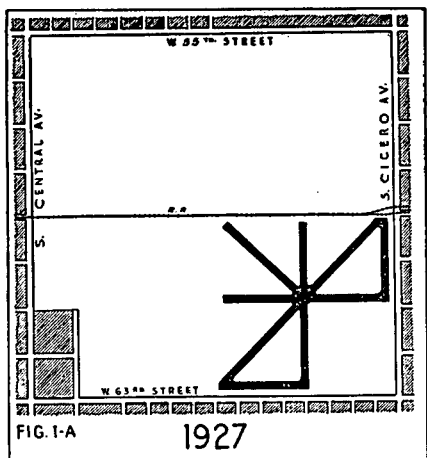
MIDWAY AIRPORT

NEARLY all of the world's terminal airports have one thing in common. They were either obsolete or inadequate on their dedication day. This has happened because of the rapid growth commercial aviation has been experiencing while these airports were being planned, financed and constructed. In most cases, immediately after the mayor of the city cut the ribbon commencing operations at the brand new facilities, the airline officials were pressing for longer runways, more gates for loading aircraft, additional automobile parking spaces or an expanded terminal building. In this respect Chicago has experienced the same pattern with its active municipal airport located 8.5 miles southwest of Chicago's loop.

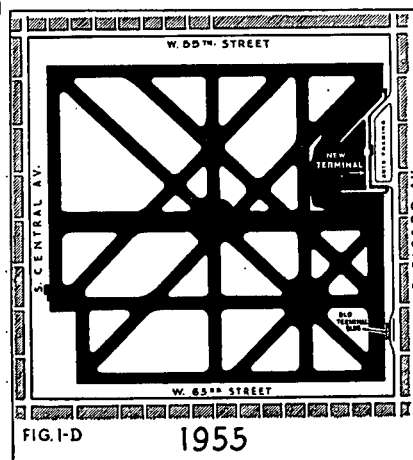
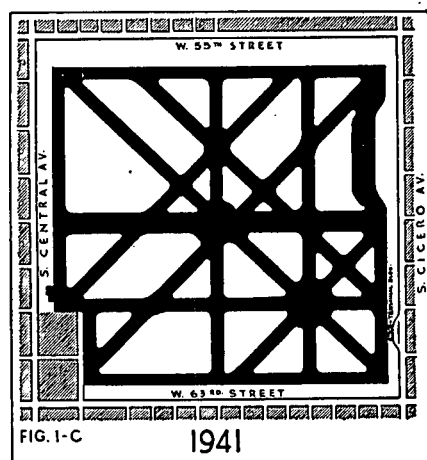
The Bureau of Parks and Aviation of the City of Chicago originally was in charge of the development and operation of Midway Airport. Shortly after World War II, this responsibility was transferred to the Department of Public Works and a separate Bureau of Aviation was established. While our organization's responsibility is limited to the design and development of the two new airports serving Chicago, namely, O'Hare Field and Meigs Field, no discussion of Chicago's terminal airports would be complete without at least a brief history and a bird's-eye view of the present development and activities of Midway Airport. This airport is of particular significance because of the fact that, of all the world's airports, it is the busiest.

In 1924, activity at Midway Airport consisted principally of a few World War I Jennys which were flown by barnstormers of that era. In 1926, Chicago's City Council voted an appropriation of \$10,000 for the operation of a municipal airport at this location. A 120 acre parcel of land lying west of Cicero Avenue and north of 63rd Street was leased from the Chicago Board of Education for this purpose. (See Figure 1A.)

The first commercial flight was made at the newly established



CHICAGO MIDWAY AIRPORT EXPANSION 1927-1955



0 1000 2000 3000
SCALE IN FEET

PREPARED BY
RALPH H. QUINN, INC.
AIRPORT CONSULTANTS
CHICAGO, ILLINOIS

Municipal Airport on December 13, 1927, when a pilot named Ira O. Biffle took off in a Boeing mail plane. Pilot Biffle is also distinguished for another accomplishment uncommon for pilots of his period; he died in bed of natural causes.

In 1930, the volume of traffic at Municipal Airport had increased so much that it was necessary to expand the airport to the west along 63rd Street until it was more than twice its original size. (See Figure 1B.) The sum of \$450,000 was invested in runways, aircraft parking ramps, storm sewers and boundary fencing. A terminal building was also erected near 63rd Street and Cicero Avenue.

In 1941, the airport was again doubled in size so that it was then more than five times as large as the original 120 acres. (See Figure

1C.) The ramp in front of the terminal building was expanded to provide for ten airplane parking gates. The airport now consisted of a square mile, less an 18 acre plot in the southwest corner which was occupied by Hale Elementary School. To accomplish this expansion it was necessary to relocate the tracks of the Chicago Outer Belt R.R. line which bisected the expanded airport site along 59th Street, which had been its north boundary previously. Additional runways, taxiways and parking ramps were laid as a part of this expansion with Public Works Administration funds. The runways were constructed in a pattern known as "dual-parallel" system. Normally one runway is used for take-offs and its parallel is used for landings. This configuration is capable of handling about 60 landings and 60 take-offs for a total of 120 movements per hour.

In 1947, a new passenger terminal with 15 gates was constructed about four blocks north of the old terminal. The old terminal was then converted for use by the non-scheduled and international flights. A total of 28 gates was provided by expanding the new terminal in 1953. During 1955 the old terminal was remodeled to provide additional space for the foreign carriers using Midway Airport. The ramp adjacent to the old terminal is large enough to accommodate 10 airplanes simultaneously today. Figure 1D shows the present layout of the airport. A recent inventory of the City's facilities indicated that its investment is in excess of \$12,000,000, including grants from other governmental agencies. This figure does not include the cost of the land. The airlines' investment in hangars and other facilities is in excess of \$24,000,000.

The year by year totals in scheduled passenger movements at Mid-

FIGURE 2

SCHEDULED PASSENGER MOVEMENTS AT MIDWAY AIRPORT

<i>Year*</i>	<i>Total Scheduled Passenger Movements</i>	<i>Year*</i>	<i>Total Scheduled Passenger Movements</i>
1928	15,498	1941	727,618
1929	23,164	1942	633,656
1930	54,048	1943	679,083
		1944	915,645
1931	91,367	1945	1,319,115
1932	92,112		
1933	117,593	1946	2,488,191
1934	125,944	1947	2,537,412
1935	176,246	1948	2,428,107
		1949	2,842,096
1936	240,677	1950	3,502,716
1937	262,590		
1938	307,860	1951	4,507,881
1939	408,893	1952	5,488,204
1940	621,524	1953	6,736,143
		1954	7,525,724
		1955	8,751,906

* For the calendar year January through December.

way Airport are shown in Figure 2, starting with 1928, which was its first full year in operation, and ending with 1955. Midway Airport is outstanding also by the fact that it is the only airport which has experienced an increase of nearly 60,000 percent in passenger traffic from its first full year to the present, and is still in business at the same site. (See Figure 3.) The magnitude of the traffic at Midway is also shown in Figures 4 and 5. An operation, by definition, is either a landing or take-off. This term is also commonly called an airplane movement. The air carriers referred to in Figure 4 are the scheduled

FIGURE 3

COMPARISON OF 1955 TRAFFIC WITH 1928 TRAFFIC AT MIDWAY AIRPORT

	1928	1955	% Increase
Airplane Movements	6,960	381,005	5,490%
Mail (lbs.)	1,688,888	24,459,709	1,450%
Air Express (lbs.)	32,775	58,085,238	178,000%
Scheduled Passenger Movements	15,498	8,751,906	56,400%

FIGURE 4

RANKING OF TWENTY-FIVE BUSIEST U. S. AIRPORTS
IN AIR CARRIER OPERATIONS

Ranking	City	Total Air Carrier Operations, Fiscal, 1955*	Carrier Operations As a % of Total
1.	Chicago (Midway)	297,731	82.5%
2.	New York (LaGuardia)	197,097	79.5
3.	Washington	176,820	83.1
4.	Los Angeles	151,774	54.5
5.	San Francisco	139,618	65.0
6.	Miami	132,903	50.0
7.	Dallas	113,693	50.8
8.	New York (Idlewild)	113,402	91.5
9.	Detroit (Willow Run)	109,961	83.0
10.	Cleveland	107,977	48.8
11.	Atlanta	103,710	49.7
12.	Greater Pittsburgh	101,619	58.1
13.	Newark	98,459	83.6
14.	Boston	86,110	65.4
15.	Kansas City, Mo.	86,017	51.7
16.	Philadelphia	85,416	57.3
17.	St. Louis	81,479	45.3
18.	Oakland	78,713	42.1
19.	Burbank	68,101	43.1
20.	Louisville (Standiford)	66,751	71.2
21.	Minneapolis	62,986	37.2
22.	Indianapolis	62,940	47.1
23.	Denver	62,179	27.1
24.	Cincinnati (Covington)	61,605	67.3
25.	Jacksonville	60,635	39.5
TOTALS OF 25 AIRPORTS		2,708,696	
TOTAL OF ALL U. S. FIELDS		5,727,373	30.0

* July 1, 1954 to June 30, 1955.

FIGURE 5

RANKING OF THE BUSIEST U. S. AIRPORTS IN TOTAL OPERATIONS IN 1955

<i>Rank</i>	<i>Airport</i>	<i>Total Operations</i>
1	Chicago—Midway	381,737
2	Miami	276,729
3	New York—LaGuardia	266,058
4	Los Angeles	263,516
5	Atlanta	246,709
6	Denver	239,861
7	Cleveland	226,768
8	Washington, D. C.	225,914
9	Teterboro, N. J.	221,637
10	Phoenix	221,419
11	Dallas	220,478
12	Albuquerque	212,560
13	Long Beach	211,085
14	San Francisco	204,498
15	Louisville	198,464
16	El Paso	198,188
17	Honolulu	195,591
18	Columbus	195,306
19	St. Louis	193,568
20	Oakland	193,478
21	Minneapolis	182,873
22	Birmingham	178,012
23	Kansas City, Kansas	176,689
24	Pittsburgh	176,528
25	Kansas City, Mo.	167,157
26	Knoxville	152,226
27	Detroit—Willow Run	144,690
28	Detroit—Wayne Major	144,327
29	Philadelphia	143,833
30	Boston	143,633
31	New York—Idlewild	138,292
32	Newark	127,198

FIGURE 6

SCHEDULED AIRLINES SERVING MIDWAY AIRPORT

<i>Trunk</i>	<i>International</i>
American Airlines	Air France
Braniff International Airways	British Overseas Airways Corporation
Capital Airlines	Lufthansa German Airlines
Delta Airlines	Pan American Airways
Eastern Airlines	Trans-Canada Airlines
Northwest Airlines	
Trans-World Airlines	<i>All Cargo</i>
United Airlines	Flying Tigers
	Riddle Airlines
<i>Local Service Lines</i>	
Lake Central Airlines	<i>Helicopter</i>
North Central Airlines	Helicopter Air Service
Ozark Airlines	

FIGURE 7

MIDWAY AIRPORT REVENUES FOR 1955

<i>Item</i>	<i>Total Amount</i>
Scheduled Passenger Landing Fees	\$569,481
Automobile Parking	479,416
Restaurants	156,335
New Terminal Rent	132,439
Land Rent	91,343
Insurance Machines	61,942
Limousines and Buses	60,949
Telephone	59,648
Hangar Rent	49,190
Observation Deck	38,868
Non-Scheduled Passenger Landing Fees	36,190
Freight Landing Fees	35,155
Old Terminal Rent	33,843
News Stand and Gift Shop	30,789
Storage and Service	23,466
Petroleum Products	21,427
Lockers	16,720
Dock Rental	10,789
Sightseeing	2,400
Barber Shop	2,158
Tie-Up Fees	1,380
Radio and Telescopes	762
Gasoline Lines	600
Vending Machines	281
TOTAL	\$1,915,671

combination passenger and cargo carriers. Figure 6 tabulates the various scheduled airlines serving Midway Airport. Figures 7 and 8 show the revenues and expenditures for Midway Airport in 1955. It should be noted that these are preliminary totals and are subject to final auditing.

In connection with the expenses of the airport it is interesting to note the terms of the lease for the land occupied by Midway Airport. As mentioned earlier, the land is owned by the Chicago Board of Education, which is a local governmental body and not a part of the City of Chicago corporate government. It is a separate entity with its own taxing powers. The Board of Education derives a large amount of money each year from real estate rentals. The Midway lease requires an annual payment of \$30 per acre, plus ten percent of the gross revenues of the airport operations up until December 31, 1964. From this latter date until the expiration of the lease on December 31, 1980, the City must pay an annual rental of 6 percent of its then appraised valuation. Preliminary estimates indicate that if the lease were on this latter basis the rental payments might be three to four times as large as they are today. Because of the possible large change in rental after 1964 the present airline agreements for use of Midway Airport all contain provisions for readjusting the rates based upon the new land rentals at that time.

FIGURE 8
MIDWAY AIRPORT EXPENDITURES FOR 1955

<i>Item</i>	<i>Total Amount</i>	
Payroll	\$444,569	
Board of Education percentage of net Receipts Rent	157,091	
Repairs to Runways and Taxiways	147,642	
Repairs to Buildings and Structures	73,822	
Electric Current	38,608	
Machinery and Equipment	31,641	
Material and Supplies	24,615	
Fuel	19,960	
Repairs to Machinery and Equipment	18,836	
Board of Education Fixed Ground Rent	17,660	
Miscellaneous Expense of Airport	2,916	
Telephone Service	2,384	
Auto Allowance	2,208	
Impersonal Services and Benefits	1,849	
Printing, Stationery, and Office Supplies	1,217	
Passenger Transportation	692	
Hire of Teams, Carts, and Trucks	90	
	Sub-Total	\$985,800
The following items are not part of the airport budget but are reasonable estimates of the charges that might be assigned to the airport.		
Bureau of Aviation Administration	100,000	
Fire Department	90,000	
Pension Fund Payments	31,000	
Police Department	21,000	
Water Department	5,000	
	Sub-Total	\$247,000
	GRAND TOTAL	\$1,232,800

O'HARE FIELD

In 1946, we were commissioned to initiate a study to determine Chicago's future airport needs. It was quite apparent that Midway Airport would never be able to accommodate all of the future traffic that Chicago was capable of generating. This study indicated the need of at least two additional municipally operated airports. The larger of these should be an intercontinental type according to CAA standards and capable of expansion to the intercontinental express classification, and the smaller airport should start as a secondary airport and be capable of expanding into an express airport. After much additional study to determine the requirements of these airports, sites were selected and approved by City, State and CAA officials for immediate development. The larger airport, which is approximately 19 miles northwest of the central business district has been named O'Hare Field. The smaller airport is located about one and one-half miles from the central business district and has been named Meigs Field.

The selection of the O'Hare site involved an analysis of many factors. Some of the principal reasons for the choice will be discussed

here. Midway Airport is very convenient for south side residents but for those living on the far north side it can be reached only after a trip of $1\frac{1}{2}$ to 2 hours through very congested parts of the City. A north side location would alleviate this situation. A study of the total future traffic indicated that the Chicago potential was so great that at least two airports could easily be justified economically and they would serve the passengers more conveniently than one large airport for all the traffic. Therefore, early in the planning it was decided that it would be desirable if the new airport were located on the north side of Chicago.

As desirable as it may appear to be, it is economically unsound to try to build a major airport in a supposed central location. O'Hare field occupies 6,325 acres or nearly ten square miles. This is about one-third larger than Idlewild Airport which previously was the largest commercial airport in the United States. Studies were made of slum clearance projects and in all cases it cost about \$1.00 to \$1.50 per square foot for land acquisition. On an acre basis these costs range from about \$43,000, to \$65,000. This would make the cost of the airport site range somewhere between \$280 million and \$425 million. It would cost about the same amount to fill in the lake front area east of the downtown area. The amount set up in the tentative budget for land acquisition of the new airport was only \$10 million. Therefore, it is obvious that it was not realistic to consider either of these sites for a major airport. However, it was decided that a smaller airport to serve a different need and to be located near the heart of the City and used by smaller executive type aircraft and personal flying could be justified since the land requirements were so much less. Meigs Field was developed by expanding an unused portion of Northerly Island, which had lain idle since the close of the Century of Progress Exposition in 1934.

One of the sites considered in the northern area for the larger airport was the former Douglas Airport which was constructed during the war to manufacture C-54 airplanes. It was offered to the City of Chicago as a surplus property item. It has a basic runway system and nearly 1100 acres of land. While the site was not large enough to satisfy the total requirements it could be expanded economically by purchasing adjacent farm lands. It was also a most desirable area since it was about as far away as possible from the heavy industrial areas located at the southeast corner of the city. The smoke which industry causes is most undesirable from an airport visibility standpoint.

Another important consideration in selection of the O'Hare site was the fact that it was adjacent to a planned superhighway which would connect directly with the downtown district and also connect into the comprehensive city-wide expressway system. This was most advantageous and essential. The introduction of jets by the airlines will only aggravate the ground transportation problems of aviation if comparable improvements are not made in surface transportation.

ACTUAL & ESTIMATED GROWTH OF SCHEDULED AIRLINE
PASSENGER MOVEMENTS AT CHICAGO BY YEARS

Annual Passenger
Movements in Millions

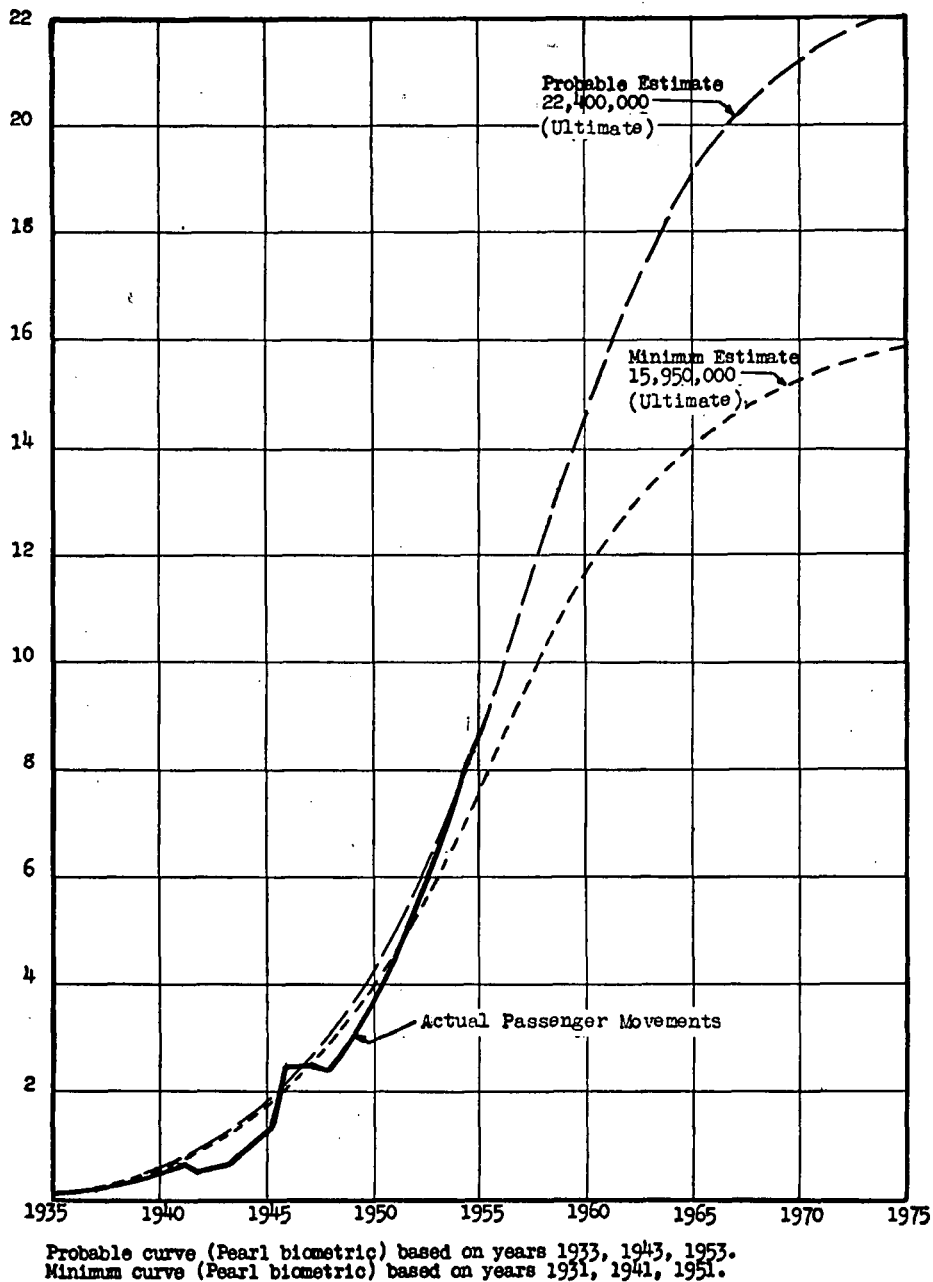


FIGURE 9

It is paramount that convenient, high-speed access be provided to any modern commercial airport. Provision must be made for many types of transportation to serve the traveling public. For instance, it is planned to have the following types of service at O'Hare:

1. Airport limousines
2. Suburban and city buses
3. Suburban and city taxicabs
4. Rapid Transit
5. Helicopter shuttle
6. Car rental service

In connection with this problem the airport designer must exert his influence outside the airport to see that the ground transportation problem is solved. It is necessary to work with transportation companies to see that adequate service is available and also to work with county and state highway officials to provide sufficient and convenient access roads.

Traffic Estimates

The study of future airport requirements indicated that each of the three airports should serve the following functions:

1. Meigs Field: Private, corporate and charter users initially and later expanded for use by local service airlines.
2. Midway Airport: Short haul and medium haul scheduled carriers primarily with a modest amount of private, charter and corporate use.
3. O'Hare Field: Medium and long haul domestic and international flights, all-cargo flights, military flights and some corporate use.

To determine the future needs for Chicago's airports it was necessary to make estimates of the Chicago traffic potential. This was done by making two completely different estimates. The first projection of future growth is identified as the Probable Estimate and was based on the following assumptions:

1. Economic activity would be either at normal or slightly higher than normal levels.
2. The airline safety record would show continued improvement until it was consistently equal or better than that experienced by the first class railroads.
3. All first class mail would be carried by air.
4. The concept of the 3-cent mile airline fare would be approached.
5. Continued improvement would be made in electronic navigation and landing aids which would permit safe operation of aircraft during periods of lower weather minimums than are permitted today.

The second projection, which is identified as the Minimum Estimate, reflected a much more conservative attitude on each of the five factors listed above.

Using the past records of growth of passenger movements by years, these two estimates were developed by means of Pearl biometric growth curves. Figure 9 portrays the actual traffic curve superimposed on the

FIGURE 10

PROBABLE ESTIMATE CURVE OF TRAFFIC DATA FOR SCHEDULED PASSENGER AIRLINES AT O'HARE FIELD

Item	1956	1960	1965	1970	1975	Ultimate
1. Annual passenger movements at Chicago	10,174,000	14,955,000	19,231,000	21,256,000	22,029,000	22,437,000
2. Less Midway fixed number	8,500,000	5,500,000	5,500,000	5,500,000	5,500,000	5,500,000
3. Annual passenger movements at O'Hare	1,674,000	9,455,000	13,731,000	15,756,000	16,529,000	16,937,000
4. Scheduled passenger line plane landings—O'Hare	28,600	153,000	203,000	225,000	236,000	242,000
5. Average seats per plane	49	53	58	60	60	60
6. Average gross weight of scheduled aircraft	61,200	68,400	77,400	81,000	81,000	81,000
7. Annual gallons of gasoline pumped—O'Hare	24,200,000	139,474,000	202,513,000	232,200,000	243,500,000	250,000,000
8. Square feet of hangar rentable	650,000	3,366,000	4,466,000	4,950,000	5,192,000	5,324,000
9. Number automobile parking spaces needed	465	2,630	3,820	4,390	4,600	4,720
10. Number of gates needed—O'Hare	8	41	54	60	64	65
11. Peak hour plane landings	12	57	73	82	85	88
12. Runways required—landing	.8	3.4	3.9	3.7	3.2	3.3
13. Runways required—take-off	.15	.6	.6	.7	.7	.7
14. Military plane movements	78,600	86,000	86,000	86,000	86,000	86,000
15. Plane movements—other than passenger & military	60,000	75,000	100,000	112,000	118,000	121,000
16. Total plane movements	195,800	467,000	592,000	648,000	676,000	691,000

Probable Estimate and the Minimum Estimate. Because the present traffic is so closely following the Probable Estimate curve, which indicates an ultimate potential of 22,400,000 passenger movements annually, statistics relating only to it will be discussed in this paper.

An analysis of the present facilities at Midway Airport indicates that the facilities are capable of comfortably accommodating approximately 5,500,000 passenger movements annually. In reality, nearly 8,800,000 passenger movements were handled during 1955. Needless to say, this caused much congestion and resulted in delays and other inconvenience to passengers. It should be emphasized, however, that it was accomplished without any increase in risk or lowering of safety standards. The CAA operates the control tower and does not permit aircraft to land until they can come in safely. Because of the improvement in landing aids installed at Midway Airport the tower personnel handled nearly three times as much traffic in 1955 as in 1948 and the total accumulated delays due to bad weather were less than one tenth of the 1948 figure. The Midway problem is principally one of ground congestion. The runway configuration as described earlier is capable of accommodating considerably more traffic than the terminal can handle without resorting to double or even triple parking of aircraft at the gate positions.

The O'Hare Field growth is based upon the assumption that during the next several years flights will be transferred from Midway until this optimum figure of 5,500,000 passenger movements is achieved. O'Hare is also to receive all the new medium and long haul traffic which will be generated. Figure 10 contains a tabulation of the growth of the expected O'Hare traffic based on this assumption. Study of it indicated that in a very few years O'Hare Field will become the busiest airport in the world. It also contains many other design criteria which determine the need for items such as gasoline storage, number of gates, hangar areas, automobile parking spaces and number of runways for simultaneous use.

Further extensions of these data were made to study peak hour conditions in the terminal area. In this way it was possible to size the concourse, its incidental public facilities, concession areas and other essential features such as the parking lot, cab stand, and the limousine loading and unloading platforms. Figure 11 indicates the total number of passengers, visitors, spectators and employees in the terminal area for the peak day of the peak month of the ultimate year.

Runway Capacity

In the past it has been considered proper to design an airport for its good weather capacity using one arrival per minute per runway. The reduction caused by bad weather was just accepted more or less philosophically. It was assumed that some day technical improvement would remedy this situation and ultimately the bad weather capacity

would equal the good. As a result, as long as good weather prevailed all would go well; but as soon as bad weather developed, the traffic would stack up due to the poor approach rate.

A new approach to this problem was taken in the planning of O'Hare Field. First of all, if aviation is to grow and to continue to prosper, bad weather delays must be either eliminated entirely or reduced at least to a point where they are comparable to those suffered by the railroads. Because of this fundamental idea sufficient runway

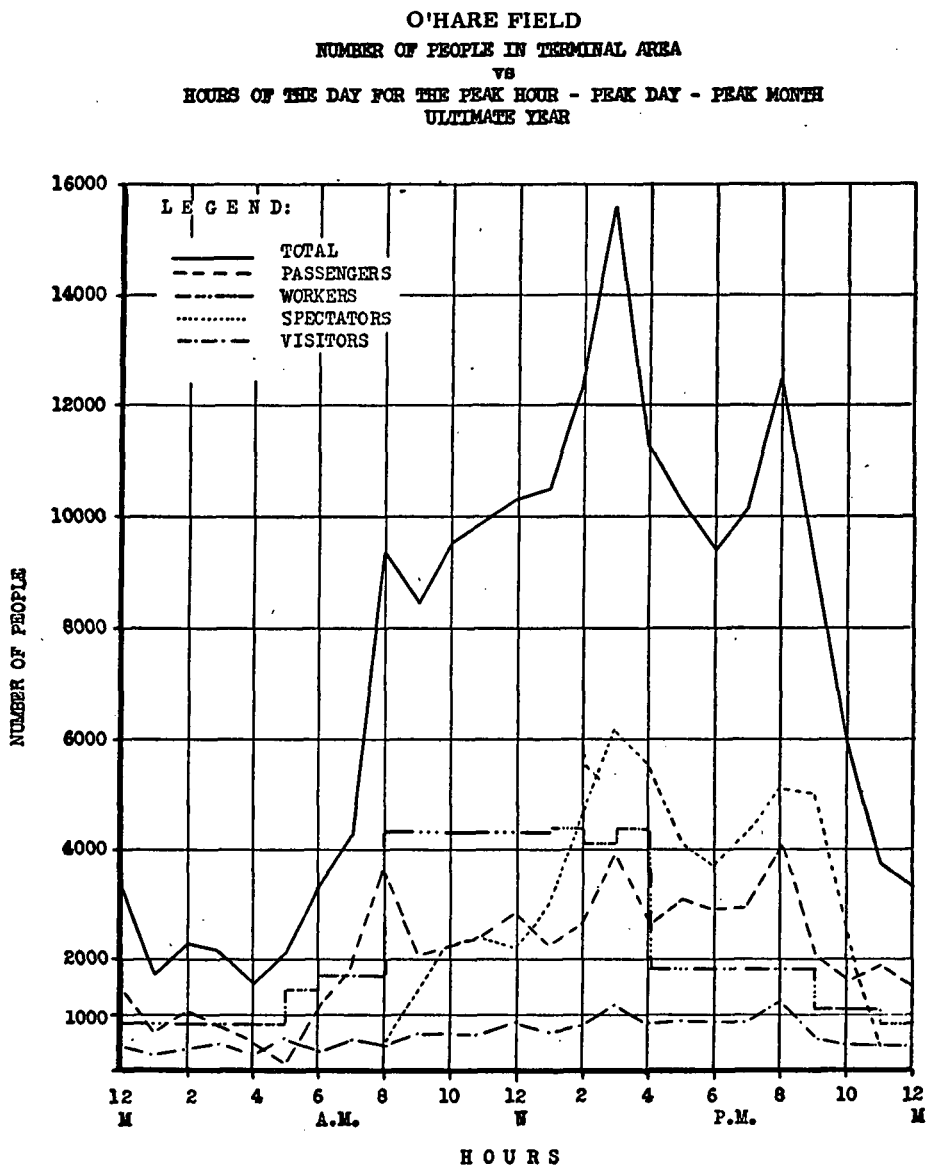


FIGURE II

capacity is being provided for the present day traffic using the average safe approach interval during instrument weather at O'Hare Field. This requires more than one runway because of the heavy traffic. Year by year the arrival rate will be improved as technical developments are made and the capacity will be increased. The increased capacity will be absorbed by the greater traffic which will result as aviation continues to grow. Finally, the point will be reached where the bad weather arrival rate will equal the good weather rate and the capacity will be constant regardless of weather.

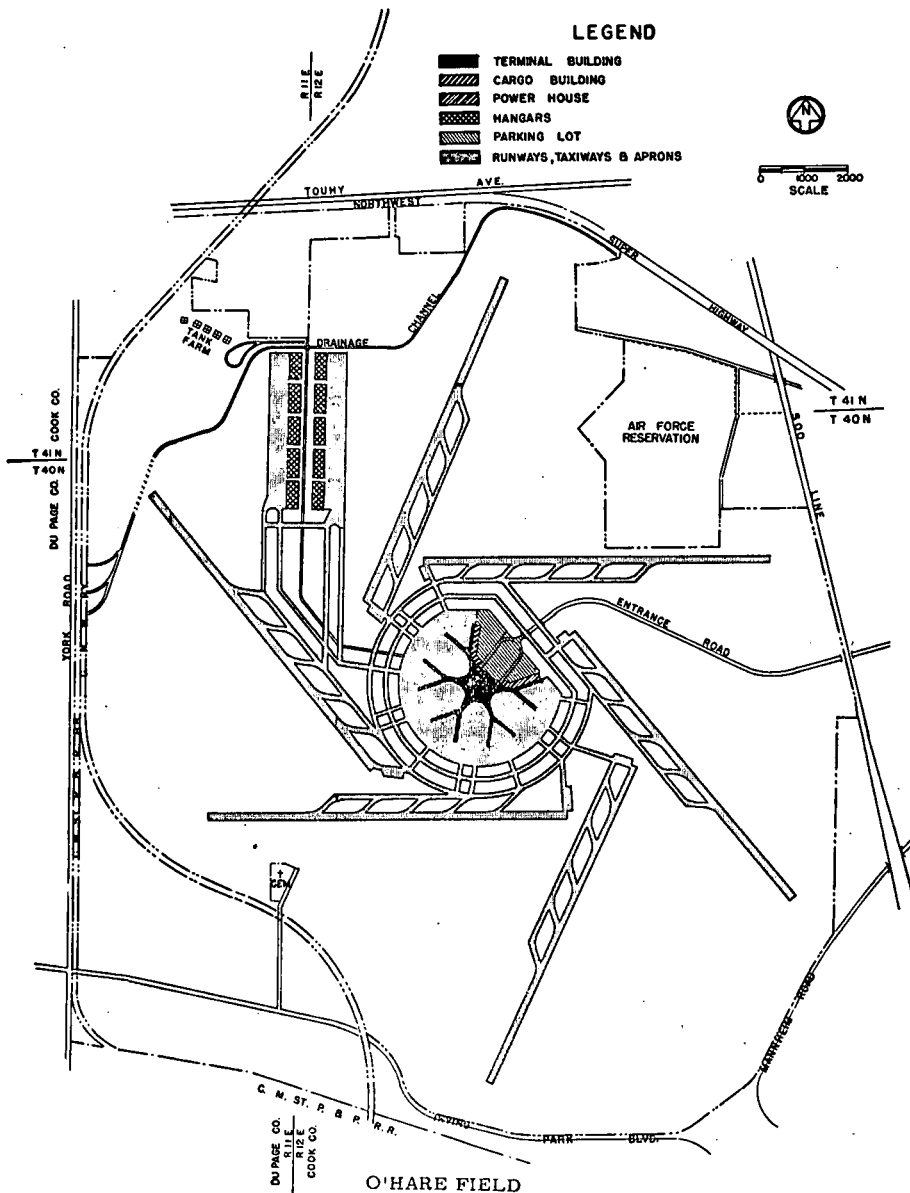
Stage Construction and Financing

The basic concept of the Master Plan for O'Hare Field anticipates many electronic developments for the handling of aircraft, both en-route and in the landing pattern and also on the ground. It further anticipates among other things, the requirements of future aircraft for runway lengths and strengths and apron services. No need exists today for many of these future requirements but the plan is so flexible and comprehensive it will permit increments of the plan to be accomplished from time to time as the needs appear. The steps are sized according to the demands of period for which they will be required and the ability to finance each step as needed. Much study of the various stage requirements has been made to insure that the expansion plan is very flexible. The entire O'Hare Master Plan (Figure 12) is based on the premise that small increments of the total plan can be built independently as the demands are felt and yet they will all be integrated harmoniously into the ultimate plan. The competitive growth of airline A over airline B make it necessary that airline A's facilities must be readily expandable without requiring any major involvement of other airlines. Ideally, the other airlines should not be disturbed at all. In most cases the O'Hare plan will be able to provide for individual expansion most readily. This will be done either by extending the legs of the fingers, by paving the interior portions of the finger or by adding an additional finger at the appropriate time.

While the total development of O'Hare Field involves many stages of construction, only the first three will be described here. They are identified as follows:

1. Initial Stage
2. Stage II
3. Stage III

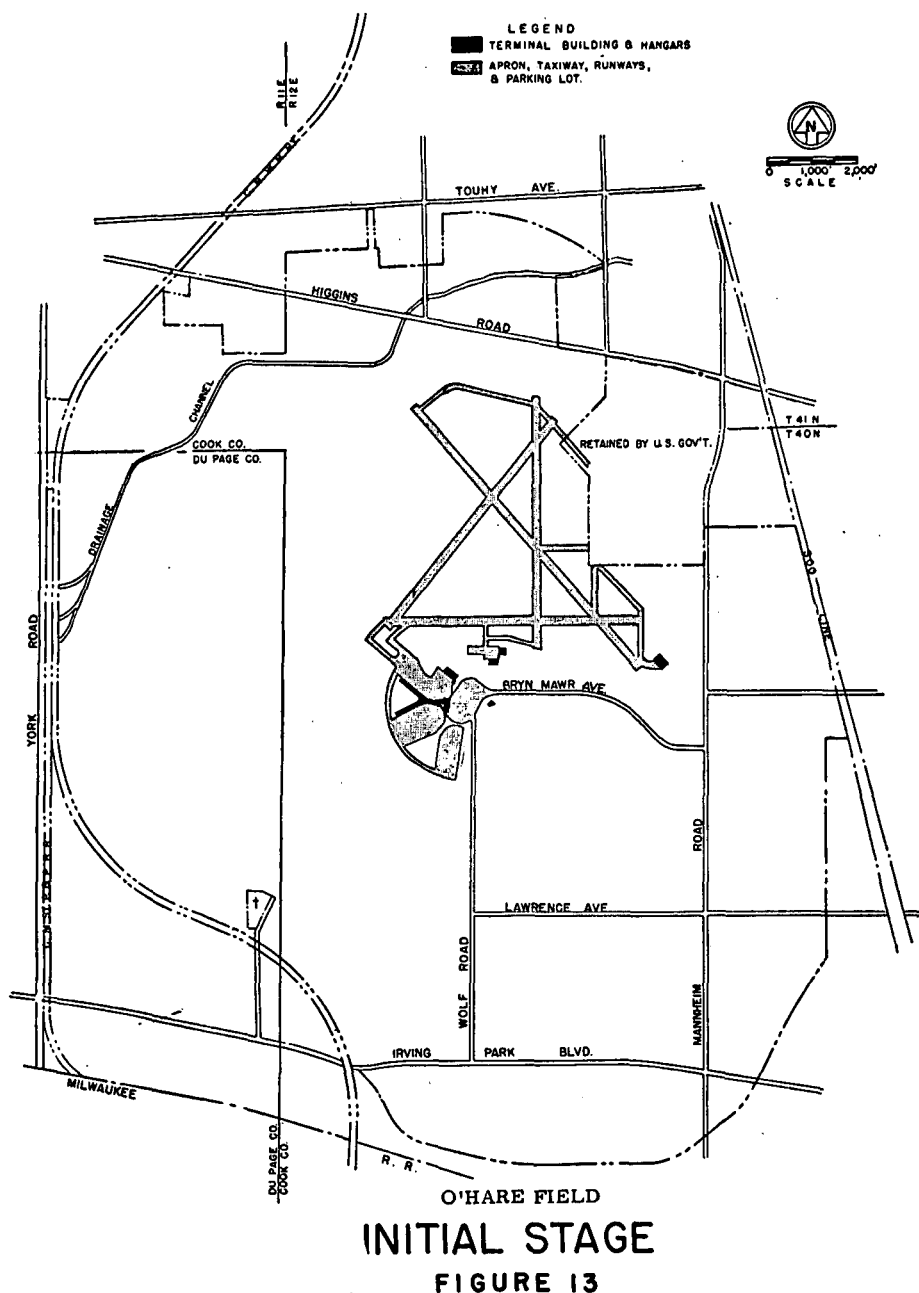
The Initial Stage was completed shortly before the field was opened for commercial passenger operations on October 30, 1955. Figure 13 indicates the facilities available in this stage. Briefly, it consists of a 16 gate terminal building, a parking lot with room for 1250 cars, an entrance road, first unit of the boiler house, 40 acres of 15 inch concrete



MASTER PLAN

FIGURE 12

apron for airplane servicing, and taxiways connecting the new terminal area to the existing runways. Included in this stage is the acquisition of about 80 percent of the total land required for the ultimate development. The relocation of the railroad tracks bisecting the site and the consolidation of a swamp in the western portion of the airport is also included. The main sanitary sewer outfall has also been constructed. Among other items included are the seven-story control



tower, communications and power distribution center, an 800,000 gallon underground gasoline tank farm, much of the underground utility tunnel system, and apron service pits both for fueling and other airplane services. Figure 14 contains a tabulation of the costs of the various items contained in the Initial and later stages. The completion of the Initial Stage required an expenditure of about \$20 millions. This money was obtained from the following sources:

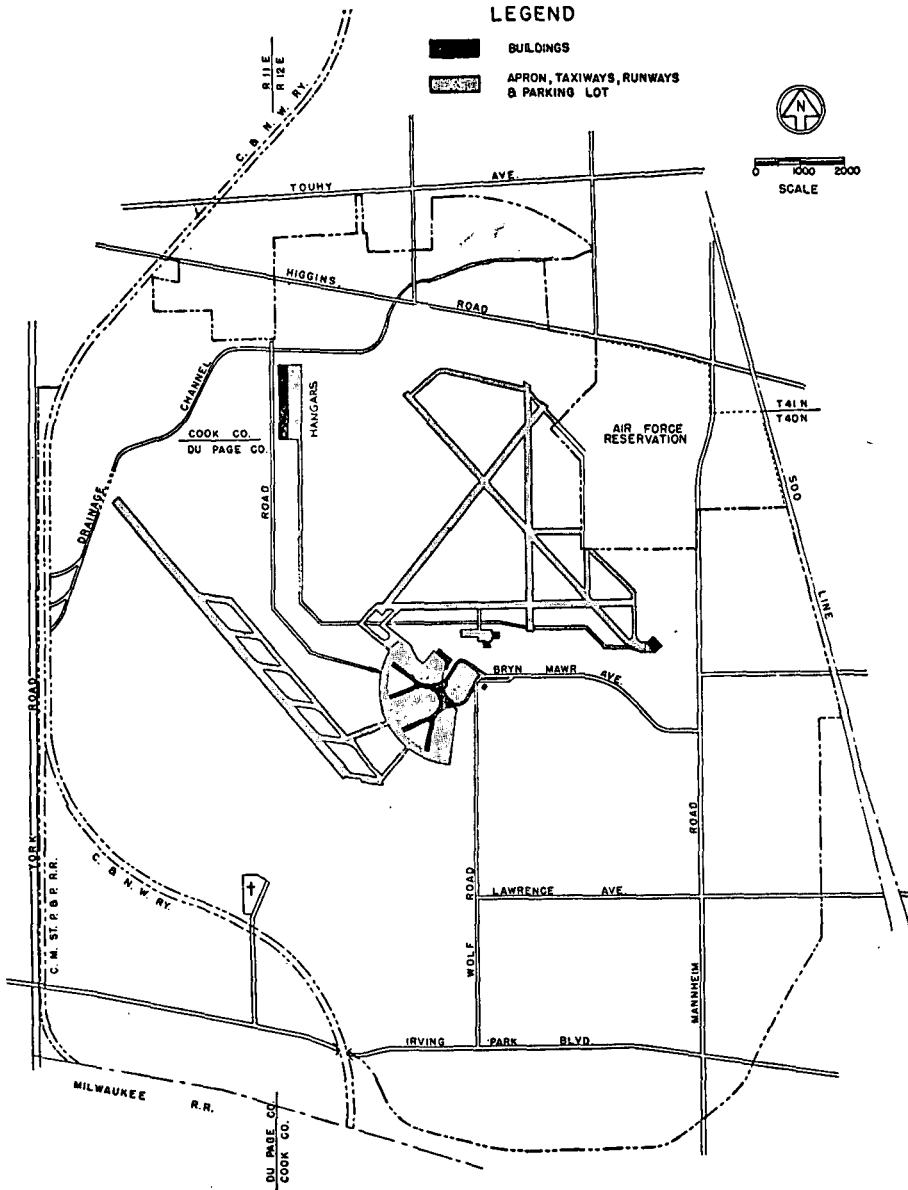
City of Chicago, General Obligation Bonds \$9,000,000
 State of Illinois, Dept. of Aeronautics, Grants in Aid 4,140,000
 U. S. Government, Federal Airport Act, Grants in Aid 6,835,000

Construction of Stage II is now underway at O'Hare. Figure 15 shows the development upon the completion of this stage. The major

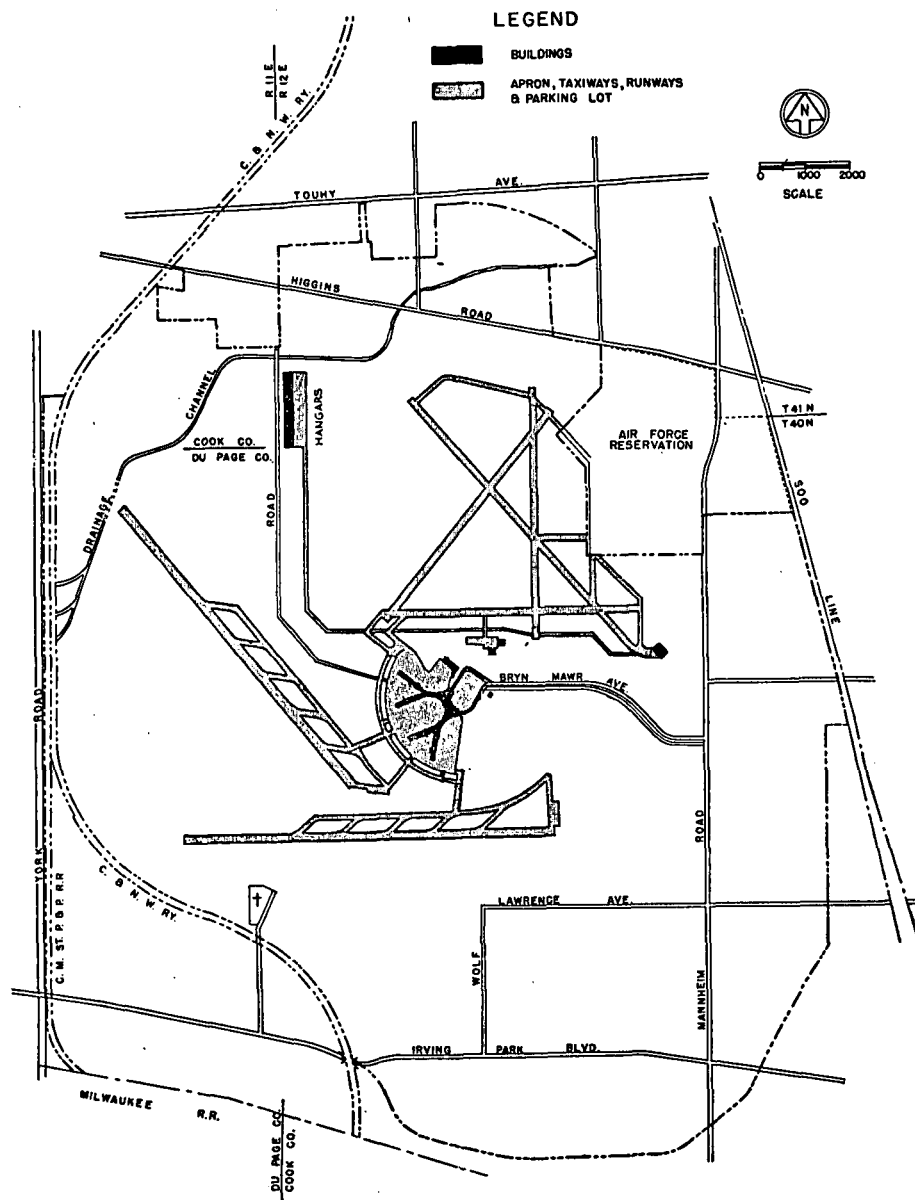
FIGURE 14
 O'HARE FIELD
 COST ESTIMATE OF DEVELOPMENT STAGES
 SHOWING COST OF INITIAL CONSTRUCTION AND BALANCES REQUIRED FOR COMPLETION OF STAGES II AND III

ITEM	INITIAL STAGE SPENT OR OBLIGATED	STAGE II BALANCE REQUIRED	STAGE II TOTAL COST	STAGE III BALANCE REQUIRED	STAGE III TOTAL COST
1. LAND	\$ 5,579,000	\$ -	\$ 5,579,000	\$ 1,957,576	\$ 7,536,576
2. CLEARING & GRUBBING	22,750	-	22,750	-	22,750
3. EARTHWORK & GRADING	405,560	382,000	787,560	300,440	1,088,000
4. FENCING	4,710	39,600	44,310	-	44,310
5. MARKING	-	18,000	18,000	6,100	24,100
6. FUELING	1,121,910	336,910	1,458,820	1,275,990	2,734,810
7. TERMINAL BUILDING	1,638,677	5,314,953	6,953,630	5,907,370	12,861,000
8. CONTROL TOWER	282,928	-	282,928	-	282,928
9. CARGO AND SERVICE BUILDINGS	-	767,000	767,000	-	767,000
10. SIDEWALKS, PARKING & ROADWAYS	251,398	245,000	496,398	175,000	671,398
11. REMOVAL OF OBSTRUCTIONS	-	12,000	12,000	12,000	24,000
12. RAILROAD RELOCATION	3,487,890	-	3,487,890	-	3,487,890
13. LANDSCAPING OR SEEDING	750	15,200	15,950	12,845	28,795
14. RUNWAYS	-	1,249,000	1,249,000	1,263,000	2,512,000
15. TAXIWAYS	545,000	1,376,000	1,921,000	571,000	2,592,000
16. APRON	1,243,970	86,660	1,330,630	175,000	1,506,630
17. MOBILE EQUIPMENT & OFFICE FIXTURES	-	322,000	322,000	-	322,000
18. DRAINAGE	426,190	792,000	1,218,190	100,000	1,318,190
19. SANITARY SEWER	254,401	-	254,401	-	254,401
20. WATER SUPPLY	154,085	784,915	939,000	200,000	1,139,000
21. LIGHTING AND COMMUNICATION	570,320	755,680	1,326,000	520,000	1,846,000
22. POWER AND STEAM	379,352	495,000	874,352	-	874,352
23. UTILITY TUNNELS	754,840	50,000	804,840	107,000	911,840
24. ELEVATORS, ESCALATORS, CONVEYORS AND BRIDGES	142,000	492,000	634,000	1,530,000	2,214,000
SUB-TOTAL	\$17,265,731	\$13,533,918	\$30,799,649	\$14,264,321	\$45,063,970
ENGINEERING & CONTINGENCIES	2,210,000	1,466,082	3,676,082	1,135,572	4,811,761
TOTAL COST ESTIMATE	\$19,475,731	\$15,000,000	\$34,475,731	\$15,400,000	\$49,875,731

improvements include an 8,000 foot runway paralleling the present 7,350 foot ILS runway. It combines both flexible and rigid pavements. The taxiways leading to the runway and the first 500 feet of the runway are 15-inch thick concrete designed for 100,000 pound single wheel loads. The remaining 7500 feet of the runway and the bleed-off taxiways are flexible pavement. The concrete portions are required because of the operational problems introduced by jet aircraft. The



blast velocities, high tail pipe temperatures and fuel spillage have only minimum deleterious effects on the concrete pavement, whereas they may be very damaging to flexible pavements in the areas where airplanes either are standing or moving slowly. The terminal building will be expanded to include a total of 29 gates by partially constructing a second finger. A connecting concourse, including concession and restaurant areas will also be included. Taxiways and utilities to the

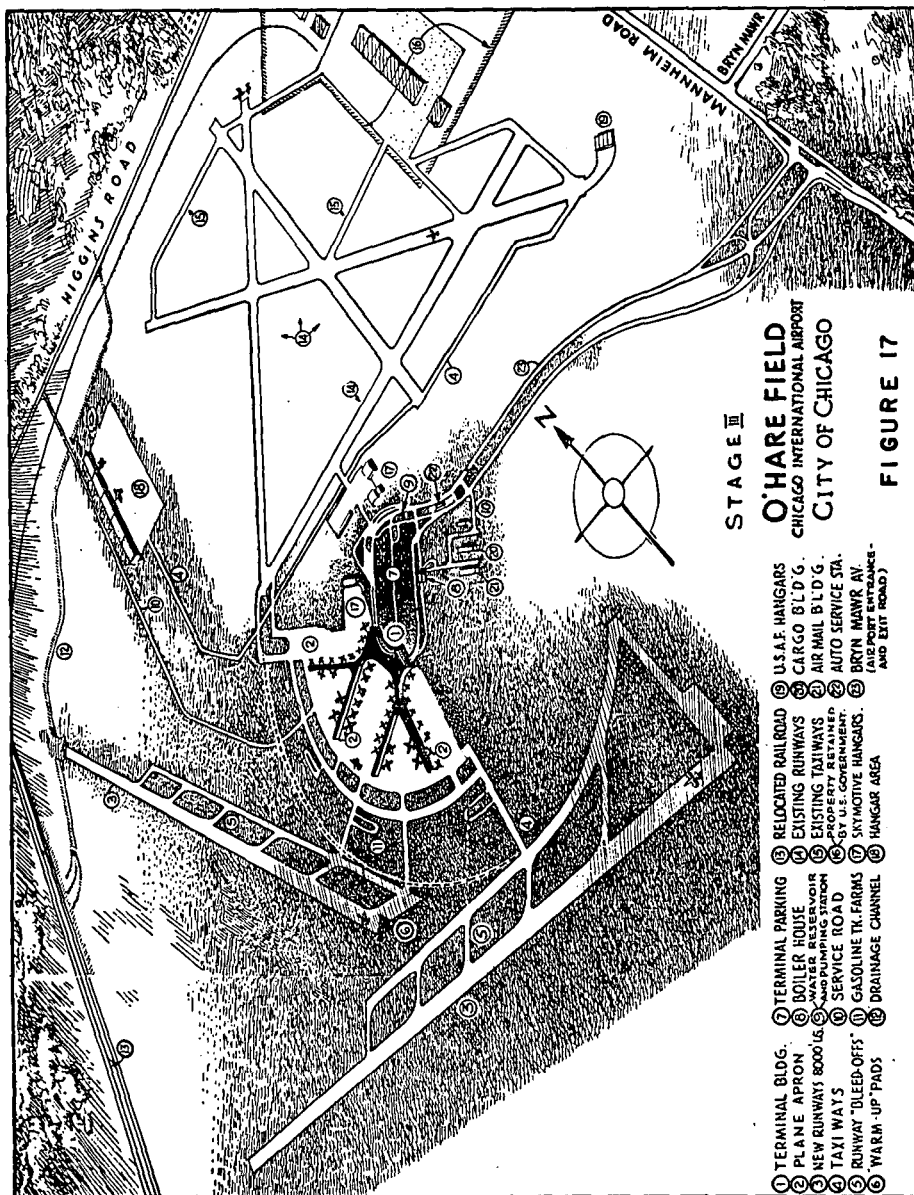


STAGE III

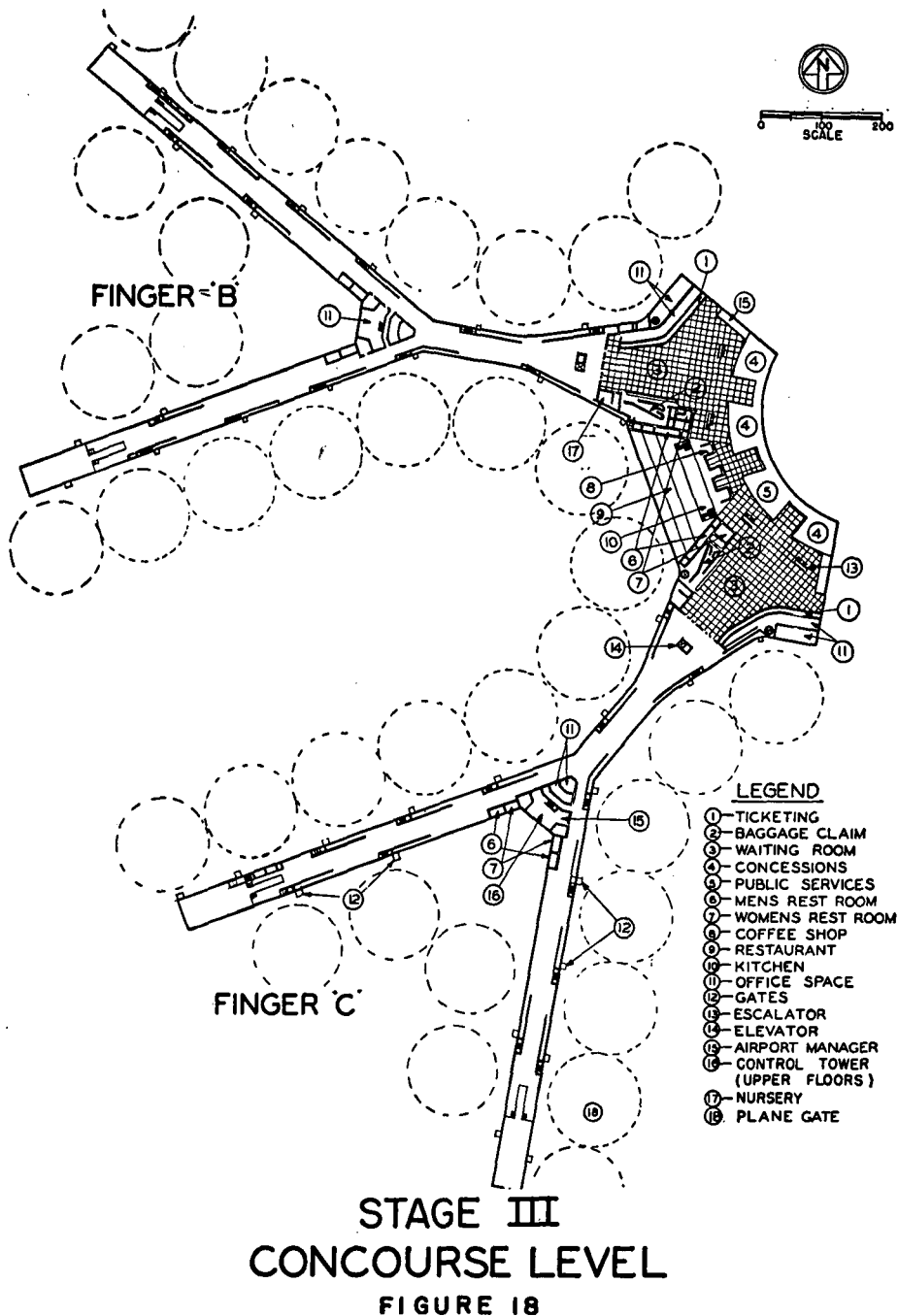
FIGURE 16

hangar area will be built in this stage. Additional buildings to be constructed include a consolidated airline cargo building, the combined airport maintenance shops and mobile equipment shelter, a two-company fire station and the second unit of the boiler house. Three of the four existing runways will be extended in length and will be reinforced by overlaying them with a 3-inch asphaltic concrete surface. This will extend their useful life for at least ten years and defer the cost of several of the new runways for a good period of time. From Figure 14 it is seen that this Stage will cost an additional \$15,000,000.

Stage III, which is shown in Figures 16 and 17, will cost an addi-



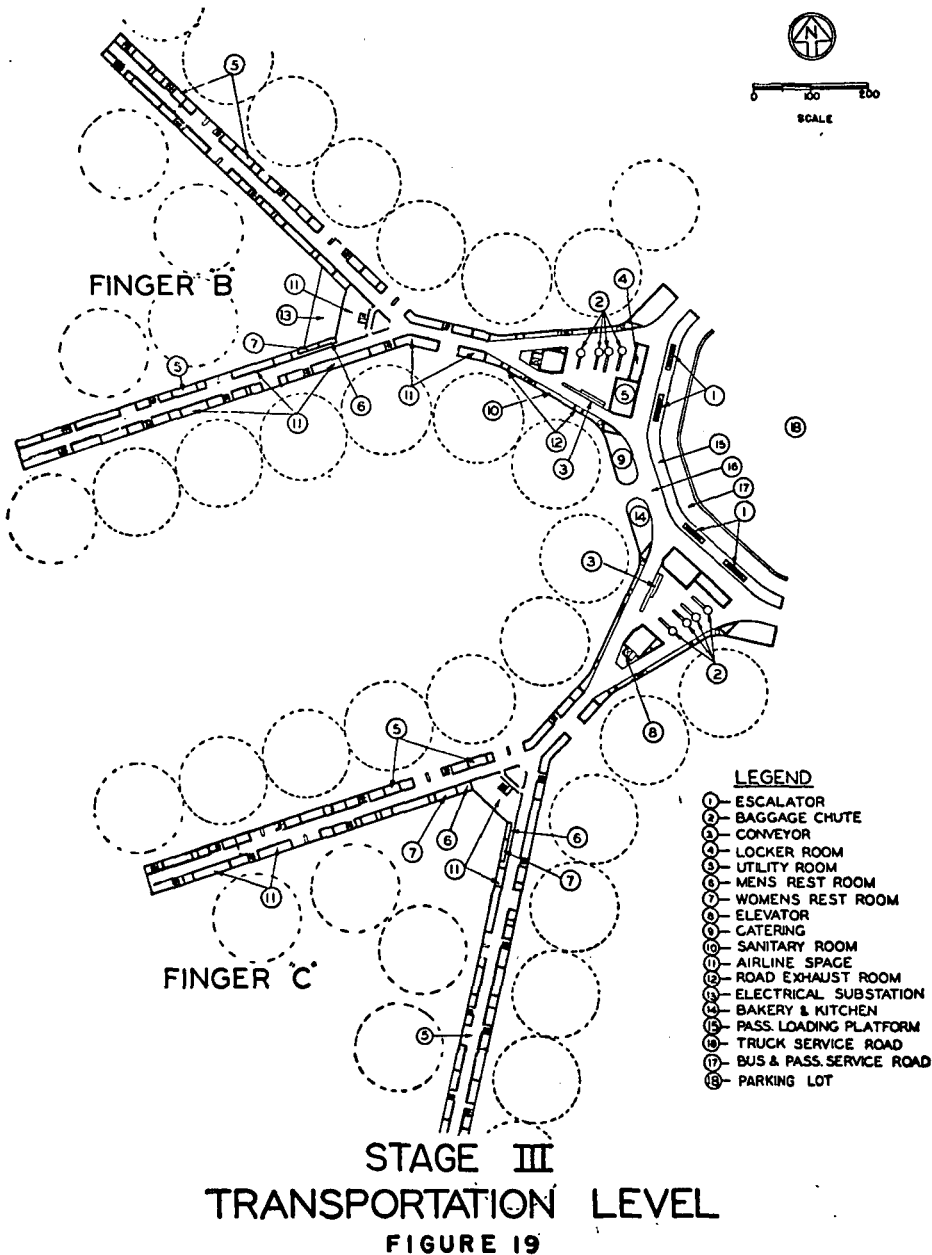
tional \$15,400,000. It will include another 8,000 foot runway paralleling the present east-west runway. At this time the terminal will be expanded again to provide for a total of 37 gates. The upper story of the terminals will be constructed at this time so that second-story loading will then be possible. All of the underground fueling and service



pits will be activated at this time. The balance of the land required for the airport is also to be purchased in this Stage.

Figures 18 and 19 show the arrangement of the concourse level (2nd floor) and the transportation level (1st floor) of the Stage III terminal building. It can be seen that all passenger traffic is separated vertically from the vehicular traffic on the transportation level. The functions of each of the various areas are indicated on these layouts.

It is planned to finance Stage II and Stage III principally from the



proceeds of a \$26,000,000 revenue bond issue which will be supported by all the airline fees and concession incomes from O'Hare Field. It is anticipated that the balance of the required funds will be obtained from additional State and Federal grants. Construction beyond Stage III will probably be financed in the same manner as Stages II and III. Estimates of the future requirements and their costs indicate that the expansion can be primarily self-liquidating. Any grants received will reduce the amount of revenue bonds required and thus provide better coverages for debt service.

On every major engineering project, the financial structure upon which the project rests is as vital as the very physical foundations which support the improvements. The engineer should be responsible, therefore, not only for the soundness of the structure he plans, but also for the financial integrity of the project.

These financial aspects should guide the physical planning in many respects. It may be stated that it is both desirable and reasonable that airports should be self-supporting. Gone is the day when an airport is merely a monument to local pride. Gone is the day when a set of runways are laid out on some convenient or expedient site and accommodations for the public added as an after-thought. It is now generally recognized that the welfare of a community is dependent on a sound plan for an airport consistent with the present and probable future needs of the community providing air transportation for persons, mail, and cargo.

It is equally true that the airport plan must envision a facility which will pay its way and which will not be a continual drain on the public budget. To this end the capital costs of an airport should be divided between first, the public benefits to be derived from its creation and, second, the proprietary interests it may serve.

Recent studies indicate that a portion of the capital cost of an airport may logically be considered to represent its public benefits to the local community, benefits to the region, generally recognized on the state level, and benefits to the national government, both as a part of a national system of airways for interstate commerce in peace time and for military or other defense activities in times of national emergency.

The balance of capital costs may be considered as the direct responsibility of the users of the airport.

In addition to the debt service on the portions of the cost not attributable to public benefit, the entire cost of maintenance and operation of the airport becomes the responsibility of the airport users. The income from operations, including fees, rentals, and charges for aircraft operations as well as incidental income from concessions and public services must therefore be such that the project will be self-sustaining. The designer of airports is charged with the duty of so balancing the plan as to insure first, adequate service and, second,

facilities so inviting to the public as to secure the use and support which will result in financial stability.

As a guide in establishing such financial stability the designer should allocate costs and assign reasonable returns for the various component parts of the airport, as landing fees for runway use, building rentals, and hangar rental. The analysis should also cover costs and charges for observation decks, auto parking lots, and rentals or charges for a variety of concessions covering incidental services to the public who may patronize the airport.

Legal Aspects

O'Hare Field is about three miles beyond the Chicago city limits. While the bulk of it is located in Cook County for which Chicago is the county seat, about twenty percent of the airport is located in DuPage County. This geographical location has caused some problems in jurisdiction and zoning.

Existing State of Illinois legislation makes it possible for a municipality to establish restrictions on the height of buildings within two miles of an airport even though the airport is outside the city limits. For larger airports this two mile distance is not sufficient since the approach path for an instrument runway extends nearly ten miles from the end of the runway. Because of this, the zoning is being worked out jointly between the two counties involved. This will accomplish the purpose since all of the zoned areas are within the two counties.

In the past there has been some question about the right of airplanes to fly at low altitudes over private property. It is possible to establish zoning which would protect a flight path but which might be a serious invasion of the rights of private owners immediately adjacent to an airport. Recently the Civil Aeronautics Administration has adopted a policy which will partially correct this deficiency. It is a slight modification of one of the recommendations of the President's Airport Commission which was headed by General James Doolittle. The CAA now requires that a community which is requesting federal funds for either construction or expansion of a runway must own or control a strip of land at the end of the runway which is identified as a clear zone. For all runways at O'Hare Field this zone must be at least 1000 feet wide and 2700 feet long. The 50:1 glide path which starts 200 feet from the end of the runway will now be 50 feet high before it crosses into uncontrolled property. This will be a substantial improvement over the previous criteria.

The clear zone requirement was established because a statistical analysis of many airplane accidents for the period between 1938 and 1951 indicated that the bulk of the crashes near airports have occurred in areas adjacent to the end of runways. Because of this, the CAA wants the airport operators to own or control the area to prevent the construction or establishment of places of public assembly. It should be

noted that while this clear zone was not established for zoning purposes as mentioned above it will actually serve to limit the height at which airplanes, in their normal approaches, may fly over private property.

Airport zoning only establishes limiting heights for structures near airports. It does not specify or limit use in any manner. Because of this it is possible for an industry to construct near an airport a blast furnace, smelting plant or any other type plant which would exhaust large quantities of smoke. Needless to say, such air pollution would be most harmful to an airport because of the consequent reduction in visibility. In view of such possible hazard it was recommended that all of the land between the runways be purchased and included as a part of the airport. It is intended that this land will be leased to industries which in their operation will not conflict with airport uses. These sites will be leased for long term periods and provide an additional source of non-aviation revenue. Nearly 2300 acres will be available for industrial development of this character at O'Hare Field. It is believed that this will make it the largest leased industrial district anywhere in the area. The tenants will be furnished streets, sewer, water, police and fire and other municipal services as a part of their ground rent.

Another knotty legal problem was the question of the Air Force's rights to use O'Hare Field. The original deed transferring the 1080 acres to the City contained a provision that they had the right to use the field "in common with others." It also contained the usual statement about the right to "reclaim possession of all transferred facilities and additions thereto" in the event of national emergency. This right has been commonly referred to as the "Recapture Clause." Both the "common use" and "Recapture" clauses have caused many problems in connection with the city's negotiations with the airlines for the use of O'Hare.

In regard to "common use," it might be proper to examine what type of use the military has made of O'Hare Field. There are many different activities based at O'Hare. The largest of these, from a personnel standpoint, is the Air Materiel Command unit which maintains the old airplane assembly plant and operates it as a machine tool storage center. The Air Defense Command unit is the next largest. This activity operates two jet fighter squadrons whose mission is to provide tactical air defense for the northern Illinois area. The Air Force Reserve Training Command supports a Reserve Troop Carrier Wing which operates primarily on Saturdays and Sundays. The smallest activity is the Illinois Air National Guard Unit, which at the present time consists of one jet fighter squadron. This latter use in fact is not covered by the provisions of the deed since it is not strictly a Federal service. In addition to these other uses, O'Hare serves as an operations base for Air Force transient aircraft coming from anywhere in the United States to do business in the Chicago area.

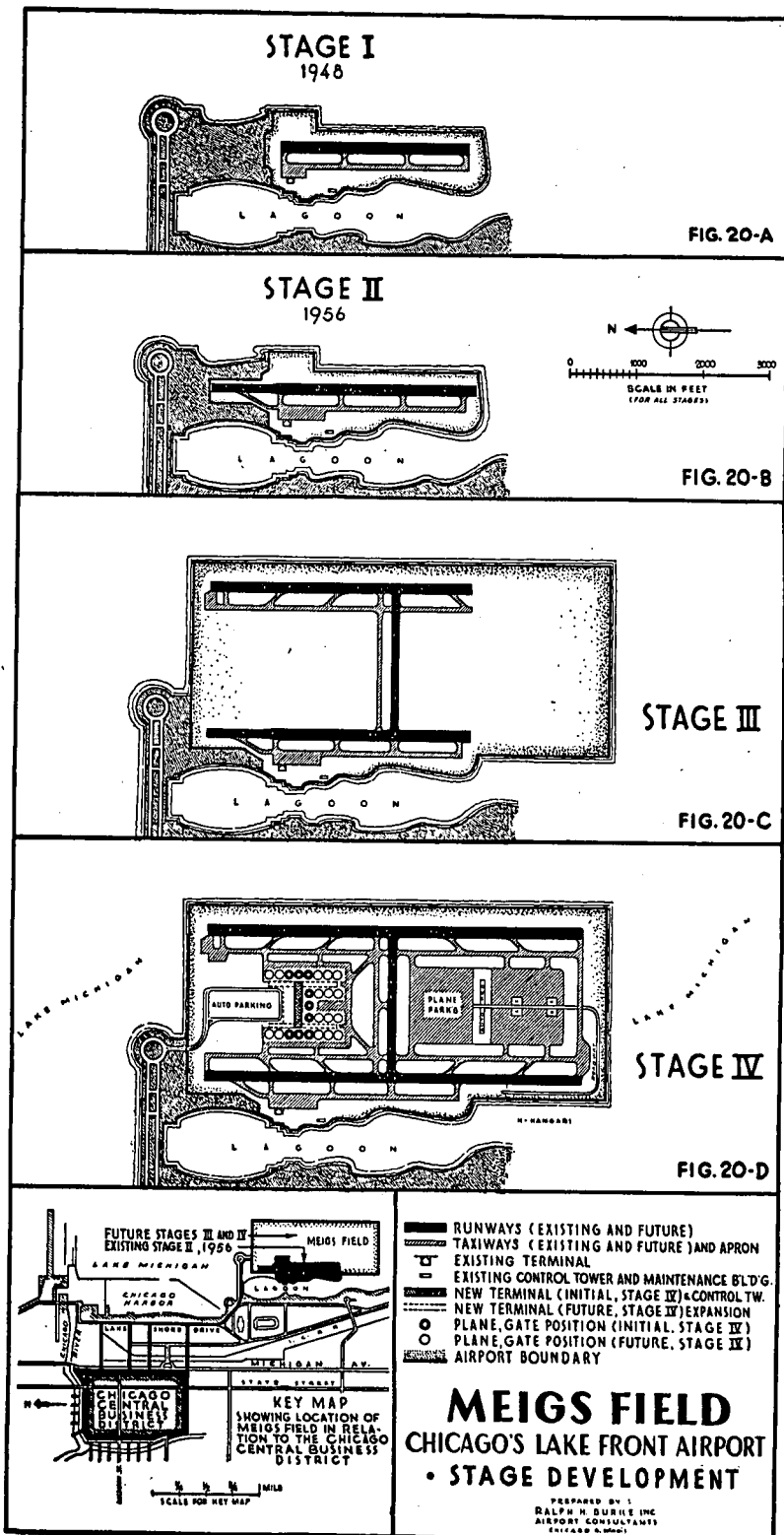
Needless to say, all the above mentioned units generate considerable traffic. For the last five years the military traffic has been more than 60% of the total. It is particularly congested during the week-end and summer training periods. During one two-week training period over 1300 movements were recorded daily on several occasions. This is nearly one landing or take-off per minute for 24 hours around the clock. Because of this large volume of military traffic the airlines were most concerned since they felt that there would not be sufficient capacity at O'Hare Field for all of the traffic which was to be transferred to O'Hare and also that which would result from the future growth of travel by air. This problem reached the critical stage when the Air Reserve Training Command proposed a major enlargement of their unit which would have multiplied their activity about five fold. At this point the airlines and City officials joined forces and made appeals to both the CAA and the Department of Defense to stop any planned expansion and also to cut back the military operations to a reasonable volume.

The airlines were most concerned about the "recapture clause" and what effect it might have on later financing of facilities at the airport. It was their feeling that they might have a difficult time obtaining mortgage financing for the construction of hangars and other similar long term investments if the Defense Department could take possession of the airport merely by serving notice.

Hearings were held before the Airport Use Panel of the Air Coordinating Committee, which is made up of members from all of the principal departments of the federal government which are concerned with air traffic. Some of the activities represented are the Air Force, Navy, Army, Civilian airport operators, CAA and CAB.

The committee became deadlocked with the military units opposing the civilian interests represented and they could not arrive at a decision. Therefore, they submitted their reports to higher authorities and finally a decision was reached at the Presidential level. This decision prevented the training command from expanding their activities and called for a shift of the defense units as soon as funds could be appropriated for a new base to be constructed north of Chicago. The transient activity was shifted to the Naval Air Station at Glenview, Illinois, which is only about eight miles northeast of O'Hare. It was then planned to build a new base at the south end of Chicago which would serve the training command and National Guard Unit. The new defense base is now in the construction stage but the necessary congressional authorization has not yet been received for the new training base.

In the meantime, however, the military activity has been served notice that as soon as the civilian traffic needs the capacity, the military is to cut down to 25 percent of total capacity. This was possible because the deed contains a clause stating that in the event of conflict with



civilian use of the airport the CAA had the authority to limit the amount of military traffic but in no case was it to be less than 25 percent of capacity. Based on this clause, the CAA made a determination of the airport's capacity on a daily and hourly basis, for both IFR and VFR conditions. Copies of this determination were delivered by the City to the Secretary of Defense for further transmittal to the appropriate military units based at O'Hare Field.

It was not possible to amend the deed to remove the "recapture clause" provisions but finally it was decided that this really was not too serious a problem. It was the concensus of opinion that in an emergency the military can readily take any facility it needs regardless of the existence or lack of existence of a deed giving them this right. In view of this, it was considered that the recapture clause would not interfere with future financing.

MEIGS FIELD

As mentioned earlier, this airport is located just 1½ miles from the downtown area and was developed to serve the private and corporate users initially and the local service carriers later.

Because of its convenient location to the central business district Meigs has had a good volume of activity since its start and has experienced a healthy growth each successive year. For the last four years the increases have averaged over twenty percent per year. The number of landings or take-offs since its first full year of operation in 1949 are as follows:

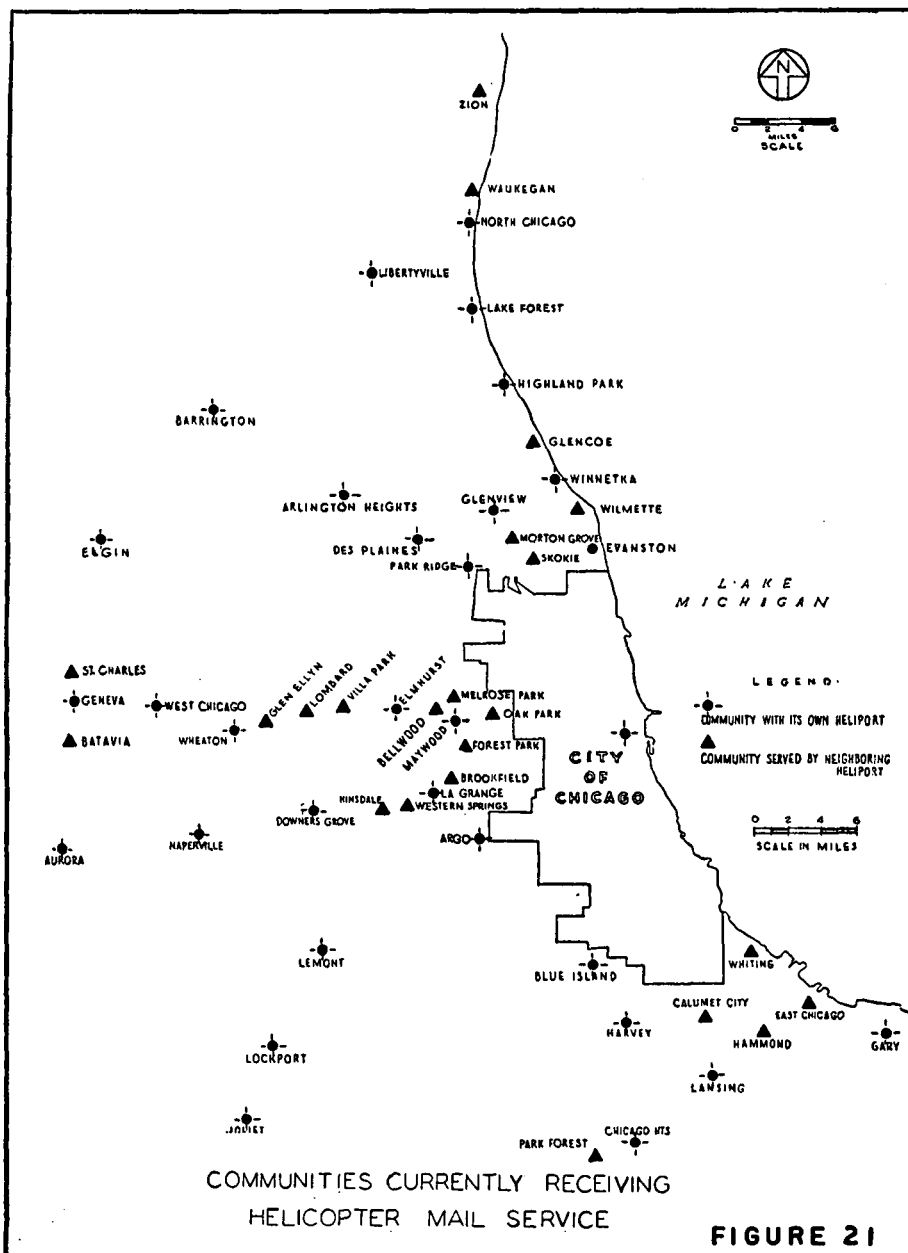
<i>Year</i>	<i>Total Aircraft Movements</i>
1949	23,589
1950	25,612
1951	26,394
1952	32,438
1953	37,611
1954	46,573
1955	56,178

The development of this airport is similarly planned for stages. Construction of Stage I was completed early in 1949. This involved the construction of a steel bulkhead and pumping in 800,000 cubic yards of sand fill to expand the island sufficiently to have room for a secondary airport. A 2800 foot runway with a parallel taxiway and aircraft parking areas were constructed. A small temporary terminal building, with an automobile parking lot, and a combination control tower and airport maintenance building were also constructed. These facilities are shown in Figure 20A.

Stage II was completed early in 1956 after the terminal apron was doubled in size, the runway was extended to 3945 feet and a runway lighting system was installed. The new length corresponds to the requirement of a 3500 foot uncorrected length runway for a trunk type airport. The extended runway is now long enough to permit operation

of DC-3's by the local service airlines. It is anticipated that they will initiate operations into Meigs during the latter part of this year. This Stage is shown in Figure 20B.

Stage III requires the construction of a new bulkhead and placing of additional fill. This work will more than quintuple the area of the present airport. At this time a 3945 foot parallel instrument runway, additional taxiways and more aircraft parking areas will also be completed. A shorter runway at right angles to the pair of parallels



will be constructed to serve the smaller aircraft which are handicapped by cross-winds. It is anticipated that these facilities will be required in 1958 or 1959.

Stage IV will require the extension of both runways to 5700 feet to accommodate aircraft comparable to the Convair and Martin series. At this time the temporary terminal will be devoted entirely to use by corporate, charter and private flyers. The permanent terminal located between the runways to serve the additional anticipated scheduled passenger traffic will be put into operation. Initially, the terminal apron will have to be large enough for about eight airplane loading gates. Its ultimate expansion will require three times this number. Airline maintenance hangars, a large automobile parking lot and other terminal facilities will be required. These are shown in Figure 20D.

The land Meigs Field occupies was leased from the Chicago Park District for one dollar per year for a period of 50 years. Similar to the Chicago Board of Education, which owns the Midway airport site, the Chicago Park District is a separate governmental body having jurisdiction over most of the parks and all of the boulevards within the City of Chicago proper. Not counting the cost of the original site before expansion, the total investment in the airport is \$2,200,000.

HELIPORTS AND HELICOPTERS

For the last seven years Helicopter Air Service has been flying the mail to over 50 suburban communities surrounding the City of Chicago. These communities and the many heliports from which they operate are shown in Figure 21. H.A.S. has a petition before the Civil Aeronautics Board requesting permission to carry passengers and property in addition to the mail. The CAB examiner who conducted the public hearing on this request has submitted his report recommending approval by the Board. If this is acted upon favorably, it will have tremendous effect on air transportation in the Chicago area.

H.A.S. is proposing to carry passengers over a triangular route serving O'Hare Field, Midway Airport and downtown Chicago. One helicopter would fly around the triangular circuit in one direction and another vehicle would fly in the opposite direction. After this shuttle service between the airports and between the airports and downtown has built up volume, additional equipment will be used to provide service between the airports and the nearby suburban areas. As the suburban service develops, it will be extended until all communities within a 75-mile radius of O'Hare Field will be reached by routes radiating into the various areas requiring service.

The future development of the short haul market in air travel is the last frontier in commercial aviation. The helicopter and other similar vehicles, such as the convertiplanes or STOL* aircraft, can confidently be expected to revolutionize short haul travel. All of these

* Abbreviation for "short take-off or landing" aircraft.

vehicles have one outstanding feature in common, namely, that they can land or take-off from relatively small areas. Because of this, it is possible to locate heliports very near the centers of the central business districts of major metropolitan areas. The unique quality of these vehicles which permits them to operate in the congested areas makes it possible to offer tremendous time savings over conventional surface transportation on the routes H.A.S. is proposing to serve. For instance, at present it now requires about forty-five to fifty minutes to go from Midway Airport to downtown Chicago during rush hour periods. H.A.S. will be able to transport their passengers over this route in seven minutes. Therefore, they will deliver a passenger downtown in about one-sixth or one-seventh of surface travel time during rush hours, and in about one-fourth to one-fifth of the usual time during non-rush periods.

This same advantage will be utilized for trips up to 250 or 300 miles, though the time savings ratios will not be as great. Because of the fact that these vehicles can pick up a passenger in downtown Chicago and deliver him in downtown Detroit or some other similar city it is possible to avoid the long trip to and from the airport. This factor overcomes the drawback of limited top speed in level flight for these aircraft. However, an analysis of time factors involved for travel between two average cities each requiring at least a half hour travel time to reach the airport, indicates that a convertiplane with a top speed of only 250 mph will reach any city within 700 miles sooner than a jet airliner with a top speed of 550 mph. On trips in the short haul segment it is possible to cut the passenger's total time by as much as sixty and seventy percent.

It is this time saving feature which will be responsible for the tremendous expansion anticipated in the short haul market. Our estimates indicate that, when aviation travel reaches its maturity, about twenty years from now, over forty percent of the passengers will be carried in vertical rising aircraft such as are mentioned earlier. Because of these factors we have made very detailed studies of the heliport requirements for the City of Chicago proper and for the Chicago Metropolitan area. It is most important that preparations be made for the heliports well in advance of their immediate need. If nothing else, the sites must be selected and protective zoning be enacted before the mushrooming growth in the suburban areas overruns all the desirable sites.

While there will be heliports developed inside Chicago's central business district to serve the airport and suburban shuttles, all of the short haul traffic in vertical rising aircraft is planned for initial assignment to Meigs Field. Because of the large volume of activity, it is not economically feasible to construct the required facilities in the business district. However, it will be a relatively simple job to provide these facilities at Meigs Field. It is anticipated that the short haul market will be developed by the local service carriers.

GENERAL COMMENTS AND CONCLUSION

In planning the airport too much emphasis cannot be placed on the importance of convenient access to the airport. The planner should realize that the passenger's trip begins when he leaves his home or his place of business. The car, cab, or limousine ride are all a part of his whole trip. Improvements in airport to airport travel time is the responsibility of the airlines, but improvement in access to the airport is strictly a local problem. Expressways and rapid transit service to the airport will be very helpful in this respect. In congested cities the helicopter will provide good service to distant suburban areas.

As mentioned in the very first paragraph of this article, air traffic estimates traditionally are too conservative and as a result facilities become inadequate much too quickly. In many cases it is necessary to abandon airports since they cannot be expanded economically. In view of this, it is recommended that future projections be prepared only after sufficient study has been given to the growth potential of the community. By using a high estimate and a low estimate of future traffic the designer can be assured on the one hand that the Master Plan will be capable of handling the larger volume if it develops and on the other the lower estimate will be useful for revenue and expense analyses in connection with financing the airport. If an error is made in over-estimating the higher traffic it will not be serious since it will only result in acquiring a slightly larger site than necessary. Since the total land costs will be only about ten percent of the cost of the project an error in this capital item will be relatively minor. However, an error which results in an undersized terminal can cause the whole airport investment to be placed in jeopardy.

Extensive plans are being made for the requirements of future short haul air travel in the Chicago area. This market will experience a tremendous expansion. As an example, North Central Airlines, a local service carrier operating DC-3s had three flights a day between Chicago and Milwaukee as recently as three years ago. Now they have forty-one flights a day. The round trip coach train fare for this 90 mile trip is \$4.24 and North Central's fare is \$14.80. By comparison American Airline's fare is \$11.30, Northwest Airline's fare is \$12.90, and first class rail fare is \$7.60. Train service between these cities is most inadequate. The North Central service, which has a fare more than three times as much as rail coach, has been extremely successful because of the convenience offered by the high frequency of schedules. This illustration of development of the short haul potential will be duplicated all over the country in the near future.

The airlines are paid to fly a passenger from point A to point B by the most direct route. Any delays on the ground or in the air result in additional expense by the airline. Stacking delays caused by decreased airport capacity during periods of reduced visibility or congested terminal conditions which result in a loaded aircraft waiting

fifteen minutes to use a gate position for unloading are common examples of this problem. The airlines have no way of increasing their fares when these situations prevail, therefore, the net effect is a decrease in net income. If these needless delays can be eliminated, it will be possible to reduce fares and broaden the market even more. Throughout the O'Hare design many features have been provided which will save seconds in some cases and minutes in others. Some of these items will be described briefly to illustrate the point. First of all, the new runways will be non-intersecting and will be fully instrumented so that landings or take-offs can be made on two or more runways simultaneously. The "bleed-off taxiways" leading from the new runways are designed so that an airplane can safely turn-off at speeds up to fifty miles per hour as compared with turn-off speeds of fifteen to twenty miles per hour on most airports. By providing many exiting taxiways leading from the runway the aircraft will not remain on the runway longer than necessary. Thus, the runway capacity will be increased and more airplanes can be landed per given interval. Warm-up pads are provided at the take-off end of the runway. These are wide enough to permit succeeding aircraft to by-pass either a disabled airplane or one which is awaiting a flight clearance from the CAA. Provision has been made for installation of underground service pits. These pits will eliminate the need for much of the mobile equipment on the ramp and will also make it possible to service the aircraft in a shorter time than now possible. This will reduce gate delays and also result in a less expensive terminal since fewer gates are required. As a passenger convenience item, a self-propelled loading bridge is being provided to load the passenger directly from the second story of the terminal into the airplane cabin. This will eliminate the passenger's descent to the apron, his unsheltered walk across the pavement to the airplane and his ascent to the cabin by means of the portable stairs the airlines currently have in use. While this is intended primarily as a passenger convenience it will permit the airline to operate vehicles safely around the aircraft while passenger loading is in operation and thus further reduce aircraft gate time.

Extreme effort must be made to develop the maximum amount of non-aviation revenue for the airport. Today's airport budgets are big business. Midway's annual income is nearly \$2,000,000 and the O'Hare income in the years to come will be more than double that amount. If attractive concessions and services are offered to the passengers, visitors and spectators, they will be patronized widely and provide the terminal operator with income to offset some of the heavy expense of maintaining the landing area facilities.

The airport design must be economical. In no way should the buildings be monumental in character. By careful selection of building materials available to the designer it is possible to provide buildings which are functional, easily maintained and attractive. The overall appearance is important from a civic pride standpoint since

this is the first contact that the air traveler will have with the city. As more and more people fly, this becomes of increasing importance. In most cities the railroad tracks lead through the least attractive parts of the cities on their approach to the center of town. Unfortunately, the traveler tends to form an impression that these sights are typical of the whole city. An attractively landscaped superhighway connecting the airport with the center of the city will do much to create a better impression.

Finally, because of the detailed study of the many factors involved, and the fact that the Master Plan for O'Hare Field is so far-reaching and capable of flexible development it is confidently believed that this is one airport which will grow with the traffic and not be obsoleted either by increases in traffic or by changes in the character of the traffic throughout its useful economic life.