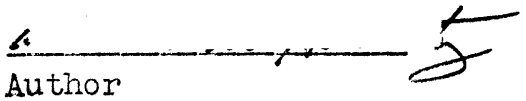
A DEVELOPMENT STUDY FOR NORTH PHILADELPHIA AIRPORT

by

Richard M. Horowitz

Submitted in Partial Fulfillment
of the Requirements for the Degree of
Master in Architecture on August 30, 1954

Massachusetts Institute of Technology



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Although the commercial aviation needs of the City of Philadelphia are presently served by a fine new installation, Philadelphia International Airport, the location of this field places it from 15 to 25 road miles from the area north of Lehigh Avenue, which is known as North Philadelphia. The existing Northeast Airport has few facilities to handle the rapidly expanding aviation need of this area.

A new installation is planned to include longer runways; more commercial, private, and business aircraft storage and maintenance; air passenger terminal; helicopter facilities; and air cargo facilities.

This paper will sketch the present general problems which beset the airport as well as the situation as concerns the development of anticipated air freight operations. In addition, the important question of proposed helicopter activities will be taken up since it is felt they will greatly affect this airport as well as the entire field of air transportation.

Thesis Supervisor: Laurence B. Anderson

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187 Beacon St.,
Boston 16, Mass.
August 30, 1954.

Dean Pietro Belluschi,
School of Architecture and Planning,
Massachusetts Institute of Technology.

Dear Sir:

In partial fulfillment of the requirements for the degree of Master in Architecture, I submit herewith my thesis report entitled, "A Development Study for North Philadelphia Airport".

Respectfully submitted,

Richard M. Horowitz

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INTRODUCTION.

The difficulty involved in attempting to isolate one particular portion of the over-all airport design dilemma for study is that the remainder of the planning, engineering, economic, aeronautic and architectural problems tend to force themselves once more into the foreground. While this paper will concern itself with one particular airport, many of the points to be discussed will remain valid in relation to the general airport situation as well. Although this thesis is partially concerned with the development of North Philadelphia Airport into an air freight terminal to serve the industrial air cargo potential of the Delaware Valley manufacturing and commercial area, it may serve as an indication of the validity of the general idea of separate airports* with their principal facilities devoted to the handling of air freight, as well as being an indication of the potential effectiveness of helicopter service in short shuttle and intercity operations. Both of these problems, basic to the future of ground facilities for air transportation, deserve further consideration.

No general attempt will be made to solve all of the planning and architectural problems involved in the redevelopment

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* Located in heavily populated and industrialized areas where such freight potential exists.

of such a large scale airport. Rather, an indication of the newest thinking upon some of these points would allow for a fuller and more complete understanding of the basic architectural problems with which this thesis should concern itself. It is important to note at this point that, whenever possible, every effort has been made to obtain the newest available information on this subject. With the attendant development of new types of aircraft (having greater speeds, larger payloads, variations in the economics of their operations, increased capacities and differing performance characteristics), and with new and improved engineering techniques, has come a rapid evolution in thinking on the subject; so rapid in fact, that one might even say that if it appears in print, it is obsolete. An engineering example of this is the fact that runway lighting installations undergo a complete change about every three years. This is no less true about those factors which govern the design of ground facilities for air transportation. Many of the basic problems have not yet been solved. One of the most glaring deficiencies in passenger terminal design, has been (and still is) the failure to provide adequate bridging of the gap between the aircraft and the terminal building, so as to give passengers (and freight) protection from the elements, and a direct, uncomplicated method of boarding the aircraft.

This obsolescence of early ideas even pertains to the helicopter, whose widespread operation has not even become accomplished fact. The early idea of roof-top heliports has become greatly modified, if not obviated, as a result of the observation of performance characteristics of the aircraft (and of the Newark-Elizabeth airplane disasters), which have been developed to date, and which can only serve as the precursors of the larger machines of tomorrow.

It must be noted that final solutions to these problems cannot be extrapolated from this accumulation of current data. The importance of the newest available information concerning progress in the aviation industry and its ground facilities, is that of affirming or denying the continuing validity of past concepts and the possibility of developing new ones.

PART I - GENERAL PROBLEMS OF AIRPORT USE AND LOCATION

In order to better understand the specific situation concerning the development of North Philadelphia Airport, it is necessary to set down some introductory material pertaining to the present-day dilemma which surrounds airport design and planning. The statement made in the Introduction to the effect that "if it is published it is obsolete" is literal. One has only to read the published material concerning this subject, and talk to people connected with the aeronautics industry and related fields, to realise that the entire matter is in a terrific state of flux. Thus it would greatly benefit the discussion to list the most troublesome problems and their anticipated solutions as presented by authoritative sources in the field. This section will, of necessity, draw heavily from the Report* of the President's Airport Commission;** which is perhaps the best single treatise to date on the subject. It may be said that for a more complete understanding of the problems besetting the air-

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* The Airport and Its Neighbors. Bibliography No. 43.

** This Commission was appointed by President Truman in 1952 to study the nation's policy on airport location and use after the terrible Newark and Elizabeth disaters.

ports of the United States, it is essential that this report be read in its entirity. Without incorporating the complete text into this paper, it would be indicative of the problems involved if the twenty-five specific recommendations of the Airport Commission were listed.

Recommendations.

1. Support required airport development. New Airports will be needed and present airports must be improved. State, County and Municipal Governments should be prepared to assume their proper share of this expense.

2. Expand Federal-Aid Airport Program. Authorization of matching funds for Federal aid to airports, should be implimented by adequate appropriations. Highest priority in the application of Federal aids should be given to runways and their protective extensions incorporated into the airport, to bring major municipal airports up to standards recommended in this report.

3. Integrate municipal and airport planning. Airports should be made a part of community master plans completely integrated with transportation requirements for passenger, express, freight and postal services. Particular attention should be paid to limited access highways and their transportation facilities to reduce time to the airport from sources of the air

transport business.

4. Incorporate cleared runways extension areas into airports. The dominant runways of new airport projects should be protected by cleared extensions at each end at least one-half mile in length and 1,000 feet wide. This area should be completely free from housing or any other form of obstruction. Such extensions should be considered an integral part of the airport.

5. Establish effective zoning laws. A fan-shaped zone, beyond the half-mile cleared extension described in Recommendation 4, at least 2 miles long and 6,000 feet wide at its outer limits should be established at new airports by zoning law, air easement or land purchase at each end of dominant runways. In this area, the height of buildings and also the use of the land should be controlled to eliminate the erection of places of public assembly, churches, hospitals, schools, etc., and to restrict residences to the more distant locations within the zone.

6. Improve existing airports. Existing airports must continue to serve their community. However, cities should go as far as practical toward developing the cleared areas and zoned runway approaches recommended for new airports. No further building should be permitted on runway extensions and, wherever possible, objectionable structures should be

removed. Operating procedures should be modified in line with Commission recommendations for minimizing hazard and nuisance to persons living in the vicinity of such airports.

7. Clarify laws and regulations governing use of airspace. Authority of the Federal State or municipal governments with respect to the regulation of the use of airspace should be clarified to avoid conflicting regulations and laws.

8. Define navigable airspace in approach zones. The limits of the navigable airspace for the glide path or take-off patterns at airports should be defined.

9. Extend Civil Aeronautics Act to certificate airports. The Civil Aeronautics Act should be amended to require certification of airports necessary for interstate commerce and to specify the terms and conditions under which airports so certified shall be operated. Certificates should be revoked if minimum standards for safety are not maintained. Closing or abandonment of an airport should be ordered or allowed only if clearly in the public interest.

10. Maintain positive air traffic control. Certain air traffic control zones in areas of high air traffic density should be made the subject of special regulations to insure that all aircraft within the zone are under positive air traffic control at all times regardless of weather.

11. Raise circling and maneuvering minimums. Present straight-in instrument approach minimums are considered satisfactory but the minimum ceilings and visibilities under which aircraft are permitted to circle or maneuver under the overcast in congested terminal areas should be raised.

12. Accelerate installation of aids to air navigation. Research and development programs and installation projects designed to improve aids to navigation and traffic control in the vicinity of airports, especially in congested areas, should be accelerated. Installation and adequate manning of radar traffic control systems should be given high priority.

13. Revise present cross-wind component limits. Existing cross-wind component limitations should be reviewed to establish more liberal cross-wind landing and take-off specifications for each transport type aircraft.

14. Develop and use cross-wind equipment. Although modern transport aircraft can operate successfully in any but very strong cross-winds, the further development and use of special cross-wind landing gears should be accelerated.

15. Extend use of Single runway system. New airports should adopt a single or parallel runway design. This should be adequate except under strong wind conditions, in which

case a shorter runway at 90° to the main one may be required. Present airports should plan to develop the dominant runway at the expense of those less used. Airport expansion should be achieved through additional parallel runways.

16. Meet standard requirements for runway length. For each catagory of airport a standard runway length has been established consistent with its future planned use. Airports should bring their runways up to the standard. For intercontinental or transcontinental airports, the length of the dominant runways should be 8,400 feet with possibility of expansion to 10,000 feet if later required and with clear approaches as per Recommendations 4 and 5.

17. Accelerate ground noise reduction programs. Engine run-up schedules and run-up locations should be adjusted to minimize noise near airports. Adequate acoustical treatment in run-up areas and at test stands should be provided.

18. Instruct flight personnel concerning nuisance factors. A tight discipline with respect to airport approach and departure procedures to minimize noise nuisance to people on the ground (within the limits of safe operating procedures) should be maintained at all times.

19. Arrange flight patterns to reduce ground noise. Airways

and flight patterns near airports should be arranged to avoid unnecessary flight over thickly settled areas to minimize noise, but only within the limits of safe flight practice.

20. Minimize training flights at congested airports. Flight crew training should be conducted, as far as practicable, away from thickly-settled areas and with a minimum number of flights into and out of busy airports.

21. Minimize test flights near metropolitan areas. Production flyaway from aircraft factories under proper conditions is acceptable but all flights of experimental aircraft and test flying of production models near built-up areas should be reduced as far as possible.

22. Avoid military training over congested areas. Although the basing of reserve air units at airports near cities has been considered generally desirable, and a location of certain combat units there is sometimes necessary, training maneuvers, particularly with armed military aircraft, should be conducted only over open spaces. Rapid shuttle service to an outlying military training field offers minimum interference with civil air operations, and maximum safety and freedom from nuisance to people on the ground.

23. Separate military and civil flying at congested airports. Military aircraft should not be based on congested civil

airports except when it is not economically or otherwise feasible to provide separate facilities for them nor should commercial aircraft operate regularly from busy military airports.

24. Provide more flight crew training. Every flight crew should be required to have frequent drills in instrument and emergency procedures. This can be accomplished in part in flight simulators. These flight simulators should be located at convenient points and should be available to all operators on a fair basis.

25. Develop helicopters for civil use. Concurrent with military helicopter development, interested Government agencies should encourage civil helicopter development for inter-airport shuttle services, and for short-haul use, emphasizing safety, reliability and public toleration factors.

Certain of these points deserve further comment, as they pertain particularly to the problem at hand, especially Nos. 2, 3, 4, 5, 15, 17, and 25 (2, 15). It should be noted that the present Federal policy concerning aid to airports in constructing runways, is based upon the development and perfection of the castered (cross-wind) landing gear (Recommendation No. 14). The U.S. Government will usually undertake to subsidize (to the amount of one-half the total cost)

the instrument runway and/or any extension thereof, and/or any runway addition or extension to any runway parallel to the instrument runway. At the present time, those planes now operating with the castered gear, do so with the gear in locked position since a potentially dangerous "shimmy" occurs in the rear wheels. Eventually, it is claimed, this equipment will enable large aircraft to land with perpendicular cross-wind components of as much as 50 m.p.h. The planning advantages of the one-directional airport are obvious.

(3) This point deserves mention in conjunction with the discussion of the Philadelphia Planning Commission's program for the development of the Far Northwest area, and for a new system of expressways and truck routes. It will be seen that this is being done.

(4 and 5) It would be best to refer to these matters coincidentally with a general review of the report concerning North Philadelphia airport prepared in 1953 for the Department of Commerce of the City of Phiadelphia by a firm of Transportation consultants*.

(17) This problem is, unfortunately, on the increase with the continuing development of new and more powerful aircraft.

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* Bibliography No. 44.

The noise nuisance associated with the ground and flight operations is caused by the piston engine, the propellor, the jet engine, the jet engine with the after-burner, the rocket engine, and the supersonic propellor, in ascending order.* Considerable progress has been made in quieting piston-engined (propellor-driven) light planes, but in the high-powered jet engines, the possible problem of generating noise from the same mechanism that produces the propulsion power presents a most paradoxical situation, difficult of solution. Turbo-jets with afterburners, ram jets and rockets, also fall into this category.

Even greater problems are posed once an aircraft is airborn, and flight patterns should be arranged to minimize the noise nuisance.

(25) This problem will be dealt with at length in a later portion of this thesis (Part IV) together with a discussion of the latest available professional publications, bearing on the projected use and development of the helicopter and the facilities necessary to serve it.

"At practically every major airport, the investment in building construction will exceed the investments in the

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* For a more complete discussion, Bibliography 43, p. 46.

construction of the landing facilities. The operational aspects of a building poorly planned often result in financial penalties that are economically unbearable to the airport owner and the user."*

The prime requisites of an airport building are that it should be flexible and expansible. This report will include designs for two types of buildings; an air freight station, (which type has not received much consideration save from a few specific interested organizations until a short time ago) and an aerocab (airport to airport helicopter shuttle), intercity heliport, and short haul fixed-wing passenger terminal complex.

Comments on hangar design would have more specific meaning if applied directly to the projected master plan of North Philadelphia Airport.

Generally speaking, the problems of providing adequate terminal buildings, hangars, shops, etc., are serious and difficult ones. In many areas, the temptation exists to erect large and grandiose schemes which become financial liabilities because of the insufficient amount of air traffic into the terminal. Such an example is the airport at

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* Bibliography, No. 17, p.1.

Baltimore. On the other hand, terminal buildings that are too inadequate to handle the enormous volume of traffic now pouring into them, and which had no provision for expansion or flexibility have had to be replaced by new large and costly structures. This has happened at Newark airport and will eventually take place at North Philadelphia. Cities, such as Boston, which have large and heavily used airports with little more than basic ground facilities, now face the problem of having to expand their passenger terminals in order to cope with the growing demand imposed upon them by the rapid growth in air transportation, must build in a time of flux; that is, without having any positive assurance that any projected forecast of anticipated operations (no matter how authoritative the source - and this should be kept in mind while reading <u>any</u> projection figures - some of which have been considerably at variance with the actual developments in the past decade), will be fulfilled in actuality or not be modified by exterior circumstances not extant or apparent at the time of the forecast. Such a hidden factor may well be the future wide-spread use of helicopter operations in aerocab, intercity, and suburban routes, with its consequent impact upon ground facilities.

PART II - STATEMENT OF PURPOSE

Since this thesis is submitted in partial fulfillment of the requirements to be met for a degree in architecture, the purpose of this report is to serve as a general background to the design of the two relatively new specialized building types which form a part of this thesis. The present situation concerning North Philadelphia Airport (the proposed site for these buildings) in all its aspects is a fascinating one, and a great number of these factors bear directly upon the design of the ground facilities. It is for this reason that, placing the cart before the horse, the two large general sections which follow are taken into consideration before the specific problem of Northeast (Philadelphia) airport has been discussed. By so doing, the actual conditions and problems of development can be pursued in the light of the following simplified sections without having to interrupt the continuity for a long digression on one of the general phases of the evolution of air transportation facilities.

As much as the seeming postponement of pressing matters to later sections of this report may tend to become irksome and tedious, it is considered necessary in the interest of clarity and the avoidance of redundancy to attempt a clear-cut division and classification of the various components

of this complex series of interrelated questions. To further complicate matters, a complete report has been compiled upon the specific airport under consideration which covers a wide range of subjects pertaining to this problem. In this case, a separate section will be devoted to this professional report so as not to present it piecemeal or in fragmentary form, and thus preserve its coherency within the body of this paper. This method is better suited to the purpose of making critical comment within the limited province of the written and design portions of this thesis.

The great length of Part III of this paper was due to two factors: (1) An effort to discern the type and extent of air freight industry growth, and (2) An attempt to ascertain the feasibility of various types of airport-based industry. Much of the material in this section is taken from the CAA's Domestic Air Cargo Forecast, 1955 and 1960,* but an equally large amount has never seen publication before.

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* Bibliography No. 26.

PART III - AIR FREIGHT

(General Summary)

A general survey of forecasts for the air freight industry reveals that most sources indicate a steady increase in volume and extent of air cargo operations. However, a great number of economic and technological unknowns are involved in long term forecasts, which have in the past missed their mark with monotonous regularity.* This had been due in great part to the relative newness of the industry and to factors not easily seen until air freight had been in operation for some time. There is a much better chance for the latest forecast, based upon a larger and more complete understanding of the factors affecting air cargo growth, potential, and development, to give a truer picture of anticipated operations and potential.

To give an indication of past air cargo volume, extent and type of operations, and growth to date before going on with discussion of present problems and future growth, would serve the interests of clarity.

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* For differences between projections and actual developments, compare pages 16, Table V (Forecasts of Domestic Air Cargo-Ton-Miles) with Table I, Page (Domestic Air Cargo Ton-Miles Flown and Tons Carried, by Types of Carrier 1946-1951), Bibliography No. 26, p.10.

TABLE I

DISTRIBUTION OF COMMERCIAL INTER-CITY FREIGHT TRAFFIC IN U. S. - 1951

(millions of ton-miles)

TYPE	NUMBER	%
Steam railroads (including mail and express)	654,000	59.1
Oil Pipelines	150,000	13.6
Motor Trucks	137,000	12.4
Great Lakes Shipping (U.S. domestic traffic only)	108,000	9.8
River and Canal Shipping	55,000	5.0
Electric Railroads	1,000	0.1
Air Carriers	246	---
Total =	1,105,246	100 %

CONCENTRATION OF VOLUME:

It may be seen by the above table that all air carriers hauled only about 1/50 of 1% of the total freight moved in 1951. However, the percentage will probably grow considerably due to the special nature of the cargo carried and the particular factors affecting the growth of the air freight industry. It is interesting to note that in 1951, the fifty largest cargo centers generated 93% of the total cargo volume; ten communities alone generated 64%. 56% of the total tonnage originated in the Middle Atlantic and the East North Central States; 14% on the Pacific Coast, largely in California.

New York alone accounted for 17.6%, Chicago for 13.6%. The State of Pennsylvania shipped 5.1% (14,473.7 tons) of which Philadelphia (the eighth largest air freight traffic generator) originated 2.8% (8,104 tons) of the United States total.

This concentration is higher than that for air passenger traffic but is due to the relative newness of the industry. It must also be realized that the carriers have expended their selling effort largely in big cities where most of the air cargo potential is located and also that schedules have been geared primarily to the needs of the major traffic points. As volume increases, and potential is

realized, however, the percentages of total tonnage generated by the large traffic hubs will decrease, although their general volumes will steadily rise, barring any general economic or world catastrophe.

While it is not the purpose of this report to treat the financial and aeronautical aspects of this situation at length, it is felt that a general summary of the present position of the air freight industry is necessary in order to completely comprehend the manifold factors which go into the design of terminal facilities (as regards both size of function as well as the operational inter-relationships with the other airport activities which exist in conjunction with these facilities). The operational and economic aspects of ground facilities for air transportation are almost impossible to separate for reasons outlined in the introduction to this paper, and any large loss of revenue due to poor, inadequate, or over ambitious planning would be a serious matter to an infant industry such as this. The same reasons will be seen to apply to the discussion of heliports in the next chapter.

ANALYSIS: BY CAA

The latest available CAA publication concerning domestic air cargo* contains a section which includes a

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* Bibliography No. 26.

summary and list of conclusions which will be inserted at this point in a condensed and paraphrased form.

(1) It is predicted that domestic air cargo will rise to 400 million ton-miles (450,000 tons) in 1955 and to a level between 600 to 800 million ton-miles (750-950,000 tons) by 1960. This last mean figure would be 2.8 times the actual volume carried in 1951.

(2) Cargo traffic in 1960 will require approximately 160 all-cargo aircraft which is about 50 over the number now in service.

(3) C-46 and DC-4 aircraft (not originally designed for economical commercial freight operation, but the only aircraft generally available after the war for this purpose), will be gradually supplanted by DC-6A and L-1049 B types which are specifically designed for air cargo operations.

The passenger airlines will continue to carry appreciable quantities of cargo in combination passenger-cargo aircraft because of cost considerations and the availability of capacity, but the proportion will decline as volume increases.

(4) There will be a small additional load on the Federal airways system and the nation's airport network due to the anticipated increase in the cargo fleet. This will also

necessitate a gradual increase in the CAA's airport building program.

(5) Air cargo has expanded, though not as rapidly as forecasted. Volume rose from 83 million ton-miles in 1946 to 246 million ton-miles in 1951, (307,000 tons). During 1951 and 1952, the industry's growth was hampered by a shortage of equipment.

(6) The growth of the industry has been due primarily to:

(a) Substantial savings in transit time.

(b) Increasing competitiveness of the air freight rate structure with respect to rail express and the other surface carriers.

(c) Gradual realization of advantages and economies possible by air shipment.

(d) Improvement in ground handling pick-up and delivery service, packaging and crating techniques, and dependability of operations.

(e) Increased selling effort on the part of the carriers.

(f) Certification of the all-cargo carriers by the CAB.

(g) Expansion of all-cargo service to additional routes and communities.

(h) CAB authorization of below-minimum specific commodity rates on eastbound and northbound shipments (to help ease the backhaul problem).

(i) The efforts of the freight forwarders to obtain

new business.

(j) The high level of national prosperity.

(7) Although new industry has created traffic, the bulk of air cargo volume has been diverted from railway express. Commodities carried have been largely high value items falling in the manufactured goods catagory. No significant change in type or characteristics of air freight traffic is anticipated during the forecast period except for the possibility of an increase in penetration of the potential in agricultural perishables.

(8) Average length of haul rose steadily. Air freight will primarily continue to consist of long-haul traffic.

(9) Any real reduction of freight rates is largely dependent upon:

(a) Improvement of ground handling techniques leading to lower costs.

(b) The development of an efficient low-cost aircraft specifically designed for all-cargo operations.

OTHER FORECASTS:

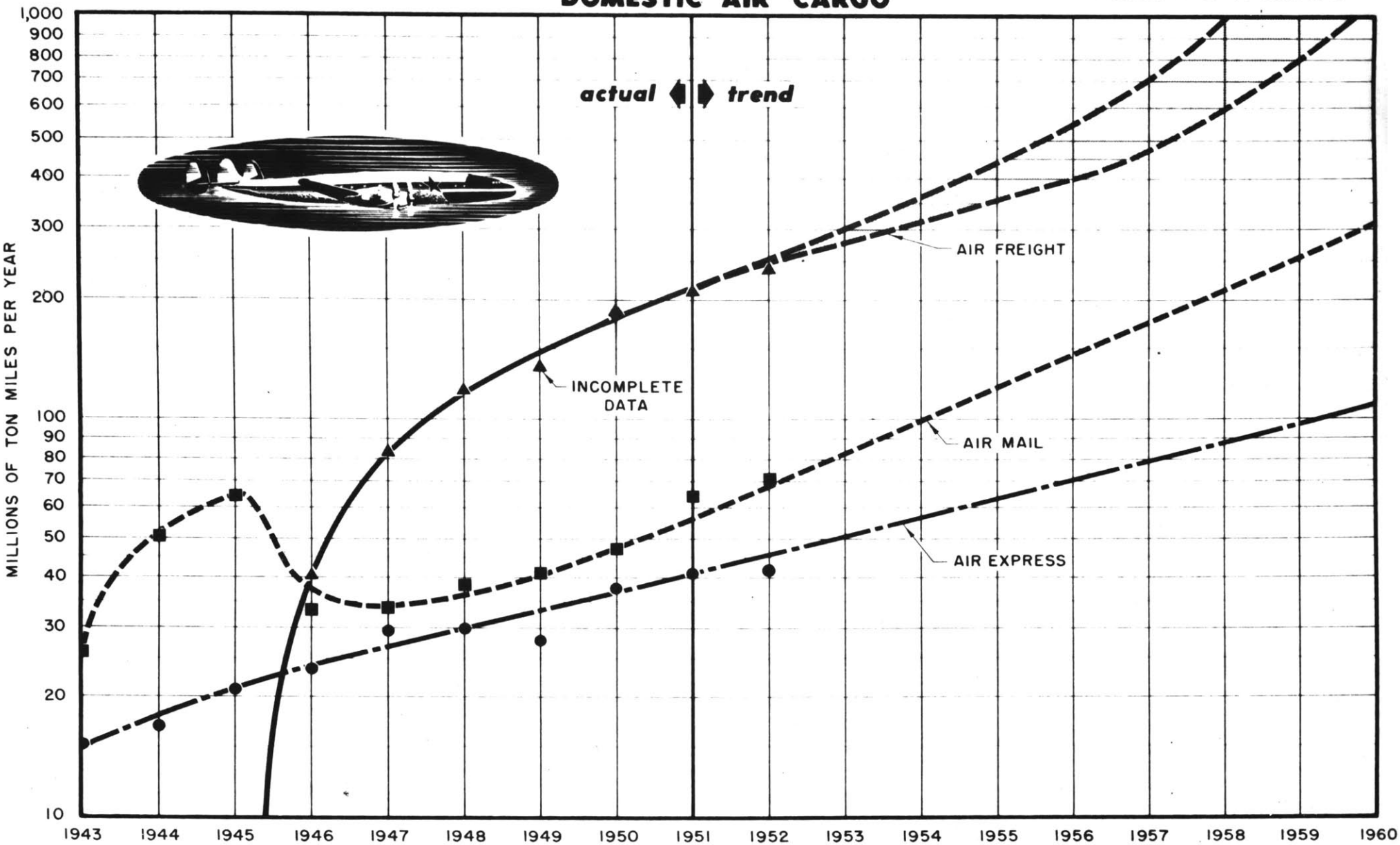
It is interesting to compare the CAA forecast contained in Conclusion No. (1) with a survey published by the Lockheed Aircraft Corporation. Here is their general summary:

TRENDS & PROJECTIONS

All carriers

source BASIC TON MILE DATA TO 1951 FROM C.A.B. REPORTS

notes IRREGULAR AIR CARRIERS NOT INCLUDED AFTER OCTOBER 1949



REVISED SEPT. ,1953

CHART 11

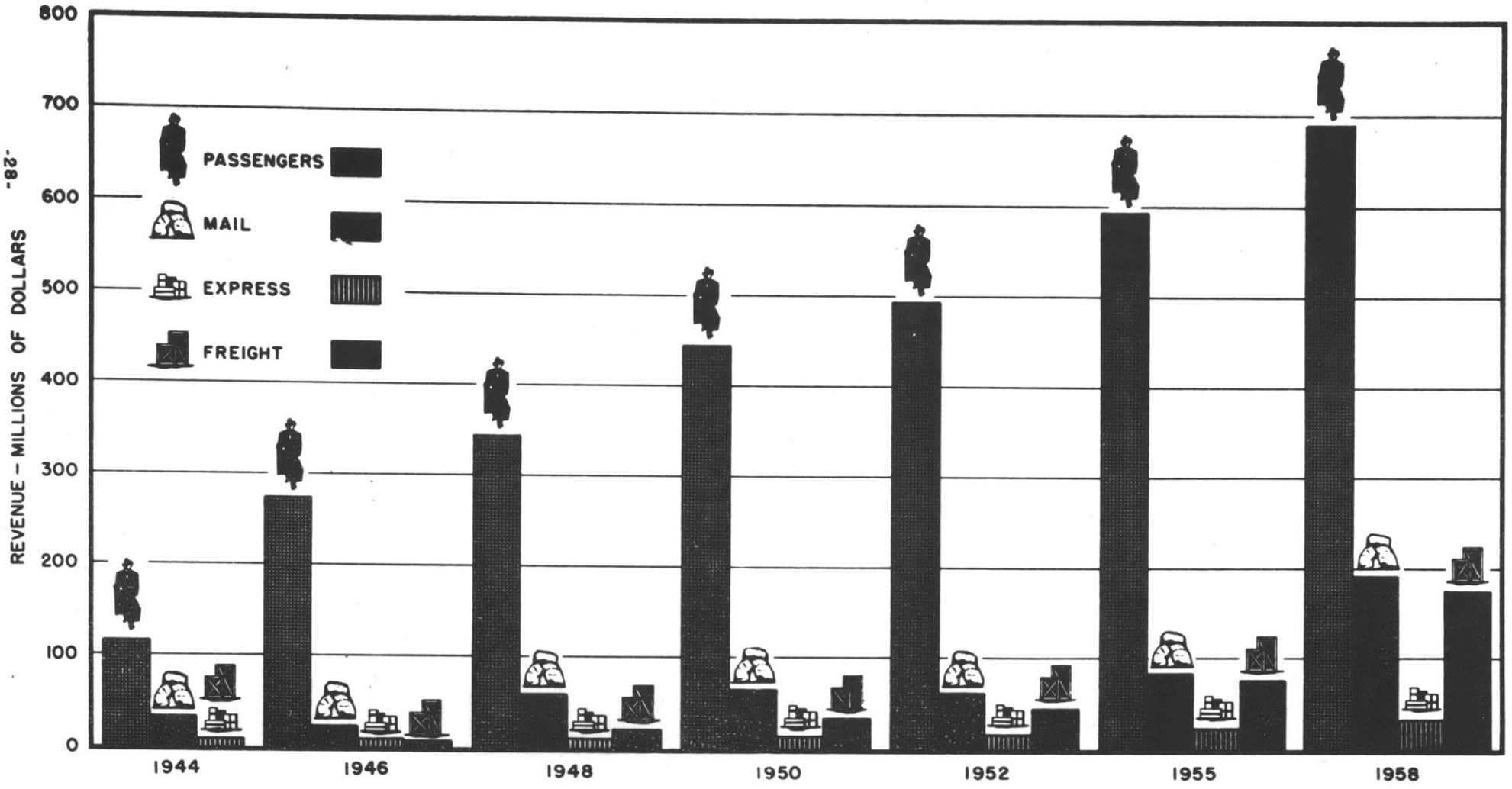


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CHART 12

TABLE II

(Ton-miles)	1955	1958	1960
Air mail + (Parcel post)	118,000,000	210,000,000	308,000,000
Air Freight			
Upper limit	440,000,000	1,000,000,000	
Lower limit	355,000,000	600,000,000	1,090,000,000
Air Express	63,000,000	87,000,000	109,000,000

Comparing the above forecast with Table I (Page 19) of this report, it is seen that the 1950 air freight estimate would be 0.1% of the 1951 total freight traffic in the United States, a four-fold increase. It is also forecast that in 1958, cargo revenue will constitute 36.71% of the total airline revenues in contrast to the actual 1950 figure of 19.66%.

VOLUME AND TYPES OF CARGO CARRIED:

A penetration of the major part of the nation's intercity freight traffic in the foreseeable future is extremely remote. The bulk of the volume consists of the products of mines, forests, andagriculture (coal, iron ore, grain, oil, and similar heavy, low-value commodities) which move at very low rates. In the present state of development, air cargo cannot hope to compete for this kind of traffic. However,

a portion of the vast freight movement, falling primarily in the manufactured and miscellaneous goods catagories, can be considered air cargo potential, especially in the light of recent rises in some surface transportation rates.

Based on the experience of the past six years, the air freight rate structure is expected to remain fairly stable in the immediate future except insofar as it is affected by increase in the general price level. While the average return of the carriers is not expected to show much change, the industry will undoubtedly continue to experiment with specific commodity or class rates in order to attract as much of the potential traffic as possible. There appears little doubt that lower rates will sharply stimulate volume in many commodities which have the characteristics needed to be air freight candidates, but cannot move in quantity at current general rate levels. On the other hand, it may be possible to raise rates on certain items without appreciably affecting volume.

In regard to volume, CAA studies show that (in the case of passenger traffic) once service becomes widely established, most cities maintain relatively the same position in the air passenger traffic pattern. This method must be used with considerable caution because of the relative immaturity of the air cargo industry. Air cargo's flow, traffic, and commodity patterns are not yet as well established

as that of air passenger operations. As service is expanded and improved and the potential in additional communities developed, the proportion emplaned at some of the larger cities, which were among the first to receive cargo service, may well decline. On the other hand, some cities whcih are not now receiving adequate service or which may in the future obtain the benefit of particularly low rates may substantially improve their position.

In 1960 combination (passenger-cargo) flights are expected to carry 235,000,000 ton-miles of freight. No direct flight costs are involved in this, and the cargo merely utilizes space which would otherwise be empty. However, much of the anticipated increase in air freight cannot be handled in combination equipment because of the size or special characteristics of the shipments.* Similarly, the concentration of freight shipments after the close of the business day will require additional cargo schedules during the night hours. Thus, much of the capacity in combination equipment cannot be effectively utilized because it will not be available at the time or place needed. In addition, it may be difficult to load large quantities of freight on passenger equipment because of the need for reducing station time and maintaining schedules on passenger flights. A study of

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* Table VIII.

aircraft ramp time made by the CAA at selected airports disclosed that the loading and unloading of cargo from combination aircraft required more than twice as much time as did the embarking or deplaning of passengers. Whereas almost all flights discharged or took on their passengers in two minutes or less, cargo was unloaded at the rate of about 200 lbs/minute and loaded at 150 lbs/minute. The handling of a greatly increased cargo volume on passenger equipment would therefore result in serious delays unless cargo handling procedures were greatly improved. Thus it is seen that as volume expands, the proportion carried in all-cargo equipment will rise; by 1960, approximately two-thirds of the total of 700 million ton-miles (or an estimated 465 million ton-miles) should be carried. The latter figure includes the entire traffic of the all-freight air carriers and about 50 percent of the freight ton-miles of the passenger airlines. The remaining 50 percent of the passenger air carriers' air freight and all of their air express should be carried on combination flights. (The matter of differences between combination and all-cargo operations is of great importance as regards Northeast Philadelphia airport as will be noted later.)

An extremely important situation (which directly relates to the question of airport-based industry to be discussed later concerns the relative tendencies of various

industries either to ship/ or not to ship, by air freight. Different air cargo companies, covering widely separated localities, tend to ship certain commodities in varying percentages. However, a general concensus of these percetage distributions may give some indication of which industries or commodity groups ship by air freight.

TABLE III

Source: CAA

PERCENTAGE DISTRIBUTION OF COMMODITIES

CARRIED BY AIR FREIGHT

Commodity Groups	All Carriers		Slick Airways	Major Airlines
	Weeks of 9/7/47 & 10/19/47	Sept. 1948	1950	1951
Wearing apparel	---	16.7	16.9	12.1
Dry Goods & Textiles	30.6	7.9	---	---
Auto parts & accessories	7.1	12.4	18.3	6.8
Machinery & parts	5.3	10.0	5.1	11.6
Cut flowers	13.5	7.4	7.0	7.1
Advertising & printed matter	4.3	6.4	3.6	7.7
Electric and electronic equipment and parts	5.8	4.5	7.2	14.3
Aircraft parts & accessories	2.5	2.3	2.8	5.7
Metal products, hardware.	0.8	2.1	---	4.7
Footwear	---	1.2	---	---
Radios and parts	1.1	1.2	7.0	---
Processed food farm products	---	1.0	---	---
Drugs and biologicals	3.0	0.9	6.2	4.9
Paper and paper products	0.3	0.8	---	1.5
Phonograph records	1.1	0.4	---	---
Vegetables	---	---	1.8	---
Plants and nursery	---	---	2.1	2.2
Hides, leather, fur, skins	---	---	---	---
Luggage and personal effects	---	---	---	3.5
Livestock, chicks, fish	---	---	---	3.4
Cameras, films, photo equipment	---	---	---	2.9
Fresh food, rubber goods	6.6	1.2	---	3.1 *
Professional and scientific	---	---	---	---
Instruments, engines and parts	---	---	---	2.4
Furniture	---	---	---	---
All other	18.0	23.6	21.0	6.1 **
Total	100.0	100.0	100.0	100.0

* foods only
** increased 1.4% to permit table to add to 100%

TABLE IV

Source: United Air Lines *

Commodity	Revenue (Thousands)		Rank by Revenue		
	1953	1952	1953	1952	1951
Cut flowers	$883	$767	1	2	2
Machines and Machine parts	874	777	2	1	1
Electrical Equipment & parts	718	633	3	3	3
Wearing Apparel	340	323	4	4	4
Automobile parts & accessories	305	197	5	8	6
Printed Matter	294	265	6	6	7
Aircraft parts & accessories	268	312	7	5	5
Live animals	257	250	8	7	-
Film	174	150	9	-	-
Advertising Matter	173	136	10	-	-

* It must be remembered that this airline ships in large proportion by combination flight.

TABLE V

Source: Flying Tiger Lines

1949	Commodity Ranking	1952*
1.	Automobile Parts	1.
2.	Clothing	6.
3.	Industrial Machinery	2.
4.	Aircraft Parts	4.
5.	Flowers	9.
6.	Radio-Television	-
7.	Electrical Products	3.
8.	Miscellaneous Metal Products	5.
9.	Nursery Stock	-
10.	Office Machines	7.
-	Machine Parts Weighing more than 1,000 Pounds.	8.
-	Photographic Film	10.

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* The largest gains were in industrial machinery which had more than doubled; electrical products, the volume of which was five times as large as the 1949 traffic; metal products, and office machines, each up four times, and aircraft parts, which had nearly doubled. Clothing traffic had moved up slightly and flowers were about even with the 1949 volume. Automobile traffic had increased about one-third.

TABLE VI

Source: Flying Tiger Lines

1953 Commodity Ranking (by Traffic Volume)

1. Auto Parts
2. Miscellaneous Electrical Products
3. Mechandise Consolidates (mostly dress goods, textiles, etc.)
4. Industrial Machinery
5. Machinery weighing more than 1,000 pounds.
6. Aircraft Parts
7. Metal Products
8. Office Machines
9. Clothing
10. Textiles

TABLE VII

Source: Trans World Airlines *

Commodities Transported Into and Out of Philadelphia

(Month of May, 1954)

To Philadelphia	From Philadelphia
1. Electrical Appliances and parts	1. Machinery and machine parts
2. Metals	2. Footwear
3. Machinery and machine parts	3. Wearing Apparel
4. Printed Matter.	4. Electrical Appliances
5. Wearing Apparel	5. Drugs, pharmaceuticals, and biologicals

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* System-wide percentages show 75% of TWA's Airfreight moves on combination equipment and 25% on all-cargo aircraft.

TABLE VIII

Source: Trans World Airlines

Categories of Freight Carried on

All-Cargo Aircraft

1. Bulky.
2. Dimensions too large for passenger aircraft.
3. Extremely heavy items.
4. Livestock, animals, poultry, etc.
5. Human remains shipments. *
6. Horses and grooms.
7. Any other item that might not be compatible to passengers but is satisfactory for transportation on all-cargo aircraft.
8. Consolidation of a number of smaller shipments into one large shipment by a forwarder desiring that entire shipment move intact.

The CAA publication Domestic Air Cargo (December 1948)* supplies an attempted distribution of air cargo by rating groups, (p.48) but it must be remembered that this document is now over five years old and much of the data is at variance with newer material.

AIRPORT BASED INDUSTRY:

It can thus be seen that the bulk of air freight is shipped by a comparatively few industries. In the following section, devoted to the discussion of factors affecting the growth of air cargo, the matter of possible penetration of existing potential by the air carriers will be analysed. However, the determination of which industries could assume advantageous physical relationships with airports possessing adequate freight terminal facilities would be a matter for intensive study devoted to the particular problem involved. It will be seen that the proposed master plan** for Northeast airport calls for the establishment of airport based industry.

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* Bibliography No. 25.

** Bibliography No. 44.

FACTORS AFFECTING GROWTH OF AIR CARGO *

A. Speed of Service.

Speed is the primary advantage which air cargo offers the shipper and all other advantages stem more or less directly from it.

Examples:

(1) Wearing apparel, shoes and other style goods.

Air freight permits low inventories, "feeler" sales, meeting of peak seasonal demands, and protection against counter or inventory losses.

(2) Phonograph Records.

By using air freight, retailers can meet unexpected demands while carrying a low stock of records which do not sell.

(3) Television and Auto Parts.

Air freight permits a low stock so distributors would not be caught with obsolete merchandise.

(4) Flowers and Other Perishables.

Because of the factor of speed, there is little deterioration, plus the advantage of two or three extra days of sales that are lost in slower mail movement.

(5) Baby Chicks.

Shipment by air freight means a virtual elimination

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* Source: CAA

of chick mortality and a shipment weight saving due to the elimination of the necessity of feeding.

(6) Newspapers, Magazines, and Printed Matter.

The greater market area thus provided has meant larger circulations and higher advertising rates.

(7) Miscellaneous Emergency Shipments.

Shipping needed repair parts by air permits production line bottlenecks to be broken with a minimum of delay. Drugs and pharmaceuticals are also often needed in a hurry, as are many other products.

(c) Economies from Speed.

Some of these include: (a) less capital needed for smaller inventories; (b) less warehousing; (c) cut in crating costs; (d) lighter shipping weights; (e) lower insurance rates; (f) less pilferage; (g) less paperwork; and (h) elimination of commodity deterioration.

B. Average Length of Haul.

As distances decrease, the time differential between air shipment and surface transportation narrows to a point when no real time saving is achieved. Surface haulers can reach points 300-500 miles distant overnight. Slow ground handling of air cargo has often wiped out gains by speed, particularly if it constitutes such a large portion of door-to-door time as tends to occur in short-haul operations.

Thus, air freight is largely a long haul operation. The average haul in 1951 was 628 miles for trunk lines, and

1462 miles for the all-cargo carriers. This must be remembered in regard to possible operations between Philadelphia and such near-by large centers as New York.

C. Rate Structures.

The level of air freight rates is still too high to make the industry a competative threat to railcarload, motor, truckload, and inland waterways traffic, which move at extremely low rates. However, freight forwarder, rail less-than-carload, motor-less-than-truckload traffic move at somewhat higher rates, and air cargo may be able to compete for a portion of this market. Special commodity and directional rates have stimulated volume when applied with respect to existing non-realized potential. The major impact of the air freight industry has thus far been on railway express.

D. Availability of a Specially Designed All-Cargo Aircraft.

The lack of an adequate basic airplane is one of the chief factors hampering further expansion of air freight traffic. Freight carrier planes in operation today are largely C-46's, DC-4's and new DC-6A's*; these will carry the bulk of the traffic until 1955 when DC-6A's and L-1049B's

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* The DC-6A is the only all-cargo aircraft now in service which permits overnight delivery on coast-to-coast shipment.

will probably become the standard freight carrier aircraft. The year 1958 may see the development of a good plane, but such an aircraft will probably not make its appearance until after 1960. The impact of such a "standard plane" upon the design of ground facilities will be great, but to date, there is little way of knowing what the specific characteristics of such an airplane would be insofar as they would affect the planning of freight terminals, especially in the light of the various systems (to be discussed) being developed to facilitate the loading of cargo aircraft.

E. Commodities which are potential Air Cargo Candidates.

There has been a rather full discussion of this particular factor in the preceding section entitled Volume and Types of Cargo Carried. There remain a few items which deserve to be mentioned here.

(1) As volume increased and rates were reduced, the number and types of commodities carried broadened considerably. This should result in greater stability for the air freight industry with seasonal fluctuations and price changes in particular industries having less impact on volume and operations.

(2) Even so, a relatively small number of industries still make up the bulk of air freight shipments.

(3) Commodities which have been attracted to air freight are largely those with a relatively high value per pound, a fairly low density per cubic foot, or a particular need for speed in transportation. They fall primarily in the general catagory of manufactured goods.

(4) The relative volume of these commodities has also been affected by the urgency of general customer demand for the specific products. Many shippers who were originally attracted to air freight during periods of abnormal demand for their products, have continued to ship by air because they found it an advantageous means of transport.

(5) The most notable omission from the air freight commodity distribution has been fresh fruits and vegetables. The post-war boom in the frozen-food field has undoubtedly cut back air cargo development in this field. At least one major air carrier* firmly believes, however, that perishables (as well as clothing and phonograph records) would move in greater volume if rates were lowered. (Which of course depends on such factors as are now under consideration.)

(6) Low rates on eastbound and northbound shipments have been extremely successful in building up air freight volume in such commidities as nursery stock, business machines,

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* Flying Tiger Lines.

film, drugs and biologicals, cosmetics and toilet preparations, electronic equipment and parts. They have also been able to tap the fresh fruit and vegetable market for the first time. However, they have succeeded in attracting only a very small volume in such items as vending and amusement machines, oil field equipment, abrasives and adhesives, building material and tools, chemicals, furniture, hides and pelts, shoes, rubber goods, sporting goods, glass, rugs, leather goods, and candy.

The carriers themselves expect little change in the character and type of air freight traffic during the next few years. Thus, an inspection of any large Railway Express terminal should provide a fairly good preview of what kinds of air cargo will be carried during the forecast period.

F. Packaging and Refrigeration.

The development of advantageous special packaging techniques for products to be transportated by air has not kept pace with the growth of air freight service. Thus, research in this field has just begun.

Lack of adequate refrigeration and precooling facilities at air terminals has hampered the development of the air freight potential in perishables. Surveys show that perishable products have often been cooked into insalability

when on the ground; similarly, temperature control on aircraft has not been all that it should be. Installation of mechanical refrigeration not only is expensive but also reduces payload. On return hauls or other flights on which no perishables are carried, there is no offset to these costs.

G. The Back-Haul Problem.

This problem has been briefly touched on in the foregoing discussion. In the interests of completeness a few more points should be mentioned. The problem has been characterized by a heavy flow of traffic from east to west and from north to south, and a relatively light traffic in the opposite directions. However, it seems that the back-haul problem has been substantially alleviated and that an appreciable volume of traffic generated by special low rates in the off-direction.

H. Air Carrier Interest in Air Cargo.

Since this need not be of primary concern in relation to the problem at hand, the fact that, in the case of the major airlines, over 80 percent of their revenues was from passenger service while cargo amounted to only 5.4 percent, need only be compared with the charts included in the preceding section entitled Other Forecasts, to see how the matter stands.

I. Freight Forwarders.

Classified as indirect carriers, the freight forwarders collect and consolidate shipments at point of origin, and break bulk at point of destination. Acting in a sense as the shipper's traffic department and expert adviser, the air freight forwarder is able to choose the most efficient and cheapest routings. Basically, the forwarders are sales and service organizations and, as such, they have been selling air freight as a normal part of their everyday business.

J. Ground Handling and Terminal Facilities.

Much of the advantage gained by speed in the air has been wiped out by slow and relatively inefficient ground handling which threatens to retard the further development of air freight. Ground delays have had a particularly deterring effect on short-haul shipments of less than 500 miles.

Results of a study* showed, that in a typical air freight operation, 85% of the in-transit time for goods shipped from New York to Detroit represented ground handling and only 15% time in the air. For flights between New York and Chicago, ground handling took 81% of the elapsed time, while on flights from New York and Los Angeles, 67% of total transit

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* R. Dixon Speas - American Aviation Daily; Nov. 30, 1949; p.140.

time was spent on the ground if the goods were delivered the second morning, and 42% if first morning delivery was achieved.

An estimated 80% of total in-transit time of air freight is consumed by slow and inefficient ground handling, due to a lack of adequate centralized freight terminal facilities at most airports.* Only 11 airfreight terminals were in operation at 80 major airports and little planning was under way to provide modern freight-handling facilities at these or other fields. The so-called air freight terminal of today is either in the passenger terminal or adjacent to it in prefabricated sheds and obsolete hagars.

One of the principal problems in handling air cargo is found in the transfer of shipments from the floor of the terminal to the aircraft. An acute need exists for an efficient and economical bridging device which will allow this transfer with the least amount of handling. Some of the suggested devices will be described shortly.

The loading of the present airplane is inherently slow and cumbersome; it is essential that the load be so distributed that the center of gravity be maintained, and shipments must be secured against vertical and lateral movement as well

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* University of Tennessee Survey, American Aviation; June 15, 1950; p.50.

as fore and aft. Similarly, the doors of a plane limit the dimensions of a shipment and cylindrical fuselages often make utilization of space difficult. Ground time attributable to pick-up and delivery is relatively small compared with the time consumed in pick-ups in terminals and on the loading apron.

EFFECT ON AIRPORTS:

The effect of the concentration of air cargo at a relatively few communities of our airport system is somewhat mitigated by the fact that cargo moves in greatest quantities during the middle of the week and only small amounts more on Saturdays and Sundays, when passenger traffic is heaviest. Moreover, all-cargo flights tend to be heaviest during the night hours, between 9p.m. and 6a.m. On the other hand, the peak of passenger traffic occurs during the daylight and early evening hours. Thus, as the peak operations of the two types of traffic do not coincide, it is anticipated that landing facilities will be able to handle the increased operations generated by all-cargo flights.

The fact that a substantial volume of air freight will continue to move on combination passenger-cargo flights by the scheduled airlines seems to be a major consideration in the forecast of the CAA that separate air cargo airports will probably not come into existence by 1960.

NEW DEVELOPMENTS IN LOADING FACILITIES AND TERMINAL DESIGN:

At the present time, the bulk of air freight is loaded and unloaded from aircraft by means of fork-lift trucks, tractor-trains, makeshift conveyor belts and other over-numerous pieces of equipment that tend to clutter up the loading apron, cause frustrating delay in operations, and sometimes collide with, and damage, the aircraft itself. Moreover, these operations must be carried out under all-weather conditions, which greatly intensify the hazards involved. This is the obvious result of the design of the aircraft. Unlike a boxcar which can be brought directly to a level loading platform where the cargo can be transferred with ease, the airplane possesses an unfunctional (for these operations) aerodynamic shape, which causes a large physical gap to open up between the vessel being loaded and its terminal facilities. It is with the closing of this gap, the major source of delay and complication, that certain new loading systems are concerned.

The airplane is principally designed for motion aloft, but, on the ground it becomes a fairly cumbersome beast. It does not offer the ability of the automobile to park between two adjacent vehicles. Yet, in a sense, that is what it must do in order to get into ramp position to load or discharge cargo or passengers. Thus, large turning radii must be allowed

for such movements, thereby increasing the distance traveled by passenger or cargo. To this must be added the obvious hazard and drawback introduced by forcing passengers or cargo to traverse the gap between aircraft and terminal in any and all weather conditions. And the aircraft, existing or anticipated, cannot, of itself, surmount these difficulties singly because it is built to fly and its necessarily aerodynamic features stand in the way.

The Loadair System* attempts to circumvent these difficulties by means of a highly ingenious system of motor-driven dollies set into the ramp. The incoming plane taxies onto the three cars (dollies) and stops. By means of cable winches, controlled by a series of safety switches, the plane is then drawn perpendicularly into a fixed landing dock. It is claimed for this system that mechanical positioning of aircraft and automatic controls eliminate collision hazards, 20-25% more aircraft can be parked in front of a given terminal, and these aircraft spend 50% less time at the terminal; in other words, airport terminal utilization is better than doubled. The system has its basis in the fact that there is a surprising uniformity of cabin door heights and fore and aft location of present transport aircraft as well as in their wheel arrangements. To what extent new developments

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* developed by the Whiting Corporation, Harvey, Ill.

in aircraft design will hold to these established factors, and the capacity of the system for flexibility to adapt to any changes, are both difficult to predict. On paper, and seemingly in the freight installation at Barranquilla, Columbia, the system boasts impressive advantages. As claimed by the manufacturers, Loadair;

(1) Reduces ground time for planes and thus increases utilization.

(2) Eliminates expensive mobile equipment and the operators of such equipment.

(3) Reduces snow and ice removal costs.

(4) Fueling, servicing, and maintenance (line service) operations are speeded because facilities may be in fixed position.

(5) Improves control of passenger and cargo traffic routing.

(6) Protects passengers and cargo from unfavorable weather or temperature.

(7) Fragile merchandise is loaded and unloaded with greater care.

(8) Large savings are made in paving expenditures due to smaller overall area of pavement. Such savings, Whiting says, will often more than pay for the Loadair.

(9) Paving is eliminated or of considerably less thickness around the track area.

(10) Collision hazards are reduced because pilots do not have to taxi into close quarters.

Upon consideration, this system seems to offer many advantages but it seems to contain several drawbacks as well. One, already mentioned, is its possible difficulty in adapting itself to new and difficult types of aircraft, but this objection must be tempered by the fact there seems to be little possibility of a radical new type of design for cargo aircraft for quite a number of years and that a number of aircraft (or their types) now in service will continue to serve the industry. However, it must be noted that the DC-6A (no information seems to be available on the L-1049B at present), one of the anticipated workhorses of the coming cargo fleet, possesses two cargo doors (fore and aft of the wings), and that some modification of the design may be necessary to accomodate this type of loading. Also it might prove difficult to service different types of existing aircraft on this same installation. Another possible disadvantage is that limited terminal activities may not require such a high factor of utilization, especially in the face of an initial capital investment (per system) of between $25 to $45,000. However, it must be pointed out that certain extremely busy terminals which originate many cargo flights daily, this last point tends to lose force.

No mention has been made of the use of this system for passenger service, but the same advantages and possible objections would seem to apply here as well as to air freight. The obvious great single advantage of this system from a design point of view is that it eliminates the terminal-aircraft gap which has not been successfully bridged to date. Its equally obvious drawback is its seeming lack of flexibility to adjust itself for different existing and anticipated aircraft and to changes within the terminal building itself.

Another loading system attempting to close the gap between aircraft and terminal building has been developed by the Lockheed Aircraft Corporation. Their system has evolved from a study of large scale motor truck shipping techniques and involves a series of specially manufactured pieces of equipment and even a specific series of recommendations pertaining to the design and flow diagrams of the terminal building itself. The most important feature of this system, which was also the major advantage of Loadair, is straight-line loading, or carrying out all operations at the same level. The specially manufactured equipment includes the Aerobridge, Aerocart, Aerotruck, Aerogarmentrack and the Aerocooler. This furniture need not necessarily be used in conjunction with separate air freight terminals but can be adapted to the freight handling section of any existing passenger terminal.

The Aerobridge is the necessary adjunct to the material handling flow that permits bridging the gaps between the airplane and the terminal. It provides a portable, self-powered, flexible means whereby air freight, carried by wheeled conveyors, (or passengers) may be conveniently transferred into and out of an airplane which has been taxied to a position adjacent to the freight dock or passenger terminal. This function requires that the bridge be adjustable as to both length and height. It is self-powered for rotation through 180°, and also for movement along the length of the air terminal ramp area. It has a width of 8 feet and a basic length of 70 feet with an additional 15 foot extendable section on the airplane side, which is sufficient to adequately handle any existing air transport today. It is designed for terminals with a floor height at the airplane dock side of 100 or 108 inches. It is assumed that the truck court side will be graded and ramped up giving a dock height of 4 feet. This would provide the level loading operation which the manufacturer feels would provide a substantial reduction in handling costs, as well as a reduction in aircraft loading time.

The Aerocooler is a patented self-contained refrigeration unit designed for installation at the terminal. The remainder of the equipment are specially-designed varients of the four-wheel dolly (a pallet-on-wheels) which is intended for use in hand-push operation, tractor-train, or

with overhead trolley conveyors. This last type of terminal operating procedure seems to be coming more and more into favor because it permits a minimum of physical handling of air freight. The most preferred type of system is that employing an overhead drag-line. Floor installations are difficult to alter and their pattern once installed, is most inflexible. Before any further analysis of this question, the aircraft loading techniques should be summed up. This can be accomplished by:

(1) A combination pallet and fork-lift truck operation (felt to be costly, out-of-date, and time consuming). This system is planned for the new freight terminal at Newark.

(2) A complete roller, skate, or powered belt conveyor operation.

(3) Skate or roller conveyors used in conjunction with pallets and fork-lift trucks.

(4) Trackless train and trailers in conjunction with a powered booster belt conveyor unit.

(5) Trackless train and trailers in conjunction with a fork-lift truck.

(6) Hand push carts and Aerobridge.

(7) Bar-handle trucks with telescoping mast and con-

veyor hook in conjunction with overhead trolley conveyor system and Aerobridge (Lockheed System).

(8) Skate or roller conveyors in conjunction with the Aerobridge.

(9) Overhead trolley conveyor system and trucks in conjunction with a powered belt conveyor.

(10) Hand push carts, fork-lift trucks and pallets, roller-skate or powered belt conveyor, overhead trolley system, trackless train and trailers or any of these in combination in conjuction with automatic level aircraft docking (Loadair).

(11) Other workable combinations of the above.

The systems involved in cargo handling within the terminal building itself are no less important than those employed to close the gap between airplane and building. There are two basic types of arrangement; the open and the closed system.

The closed system resembles a pipe-line in operation. Roller or endless belt type conveyors are often used. It is difficult to introduce late shipments into the so-called pipe-line once the system is filled. It also lacks versatility and ease for sorting of cargo provided by use of an overhead dragline conveyor or open system; for this pipe

line of cargo material flow is open to receiving freight at any point while obviating the need for cargo handling in the terminal except at the motor truck dock and in the airplane. This system utilizes an endless overhead chain conveyor which is continually moving in an oval flow pattern. The chain conveyor, hung from the ceiling of the warehouse, tows both empty and loaded hand trucks at a speed of approximately three miles per hour.

Cargo is received from the delivery truck and off-loaded by gravity down a conventional skate or roller conveyor. A section of the conveyor is attached on a dial weighing scale. Incoming shipments are then weighed, marked, and transferred to the moving trucks as they pass by. It is normal procedure* to have trucks, marked with the various cities along the route, interspersed throughout the revolving drag line.

Upon reaching the airplane dockside the freight is either transferred to another roller conveyor and then into the airplane or the trucks are disconnected from the overhead chain conveyor and wheeled over the extendible ramp into the airplane.

It would be extremely difficult to assess the com-

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* In the Lockheed model air freight terminal at Burbank, Cal.

parative values of these various projected systems from the design standpoint alone, the differences between them could (from the point of view of the operators) be economic ones and there is a very small amount of data available concerning their effectiveness in this respect. Nevertheless, the primary problem remaining to the air transportation industry is that of finding an effective method of bridging the gap between the aircraft and the terminal building.

PART IV - HELICOPTERS AND HELIPORTS

In the airport masterplans which are now being prepared, almost all of them contain either vague provision or reference to anticipated helicopter operations without any specific design requirements. The question of heliports will be discussed in direct relation to the Philadelphia area and to the North Philadelphia Airport. In view of the unexpected enormity of the preceding chapter, an effort will be made to cover only the most salient points, although for a more complete picture of this fascinating development in air transportation and its consequent effects on planning and architectural design of ground facilities, the reader is urged to consult the various sources listed in the Bibliography which bear upon the subject.

THE HELICOPTER:

The helicopter is a brand new vehicle with entirely new potentialities. It will expand in travel in the short-haul field, a vastly greater market than the long-haul field so successfully invaded by fixed-wing aircraft. The Korean War has advanced the day of the helicopter as a common carrier by five to ten years. Within the next few years a 10-place helicopter will be used in common carrier service and by 1958, 30-place helicopters will be available for common

carrier operations.

It will not be possible to land these newer helicopters on any and every rooftop, nor permit them to fly at random through the air over cities. Despite its versatility, the helicopter will require a carefully located specifically designed airstop facility. The helicopter will require the allotment of its own air-channels, landing and take-off procedures suited to its special capacities and standards of service, tailored to the markets it can expect to serve.

The potentialities of the helicopter cannot be realised within the time periods discussed, unless the Federal Government is prepared to include this new aircraft into its hitherto liberal policy of aid to commercial air transport and to include helicopter air stops in its airport aid programs.

While the earliest common carrier use of the helicopter has been as an airport shuttle service, it has even greater potentialities in the field of short-range intercity travel. The helicopter promises a vast expansion in the role of air transportation. The rotary-wing aircraft will be able to operate into and out of midtown city areas. It can, therefore, provide intercity air service from downtown to downtown, competing with established surface carriers in distances between 40 and 175 miles. It has only one important limitation,- its speed, which is not likely to exceed 150 miles per hour,

(except in a hybrid-type machine). As a result, the helicopter probably is barred from competing with faster fixed-wing aircraft for the travel market between 175 to 200 miles, as may be seen by Table IX.

The 10-place commercial helicopters now in limited transport service are all financial liabilities, regardless of what volume of traffic they are able to generate. The level of the direct operating costs of these machines ($0.09 per available seat-mile) is about 4 times the present level for fixed wing operations, which results in a fare of from 40 to 50 cents per passenger mile.

The degree of public acceptance likely to be accorded to future helicopter transportation will be related directly to the ability of its operators to equal or surpass competative performance in relation to dependability of operation, frequency of service, safety of operation, personal comfort, competitive fares and speed of service.

Helicopters will find their greatest potential in passenger transportation, in and around large metropolitan districts such as Washington, Philadelphia, New York and Boston. The environs of these cities are becoming increasingly saturated with fixed-wing aircraft traffic with little capacity left for the helicopter unless a fresh approach is made to the problem. The development of helicopters

TABLE IX

PROBABLE COMPETITIVE LIMITS OF INTERCITY HELICOPTER SERVICE - Where Intercity Speed Will Influence Passenger Participation.

New York/Newark Area 1955-1975

(SOURCE: Port of New York Authority)

Trip DISTANCE IN MILES	Combined Carrier and Limosine or Taxicab Running Time, (in mins.)from Local Points of Origin to Local Point of Destination.*				SUGGESTED LIMITS
	BUS	RAIL	AIRLINE	HELICOPTER	
40	82	68	70	40	Unable to compete with Railroad - Superior to Airlines.
60	128	82	80	58	Superior to Both Airlines & Railroads.
140	298	205	120	110	
160	340	234	130	123	Marginal With Airlines- Superior to Railroads.
240	510	350	170	176	
260	554	380	180	188	Unable to Compete with Airlines - Superior to Railroads.
300	640	438	200	212	

* Official schedules and timetables used for computation of rail, airline and bus times. Helicopter trend develop by using suggested routes and service patterns (1960-65), plus estimated block speeds of commercial type helicopters. 20 minutes each have been added to rail, bus and helicopter time to allow passengers to move from local point of origin to origin terminal and from destination terminal to local point of destination. 60 minutes have been added to the airline times for the same reason.

TABLE X

ESTIMATED FARES FOR HELICOPTER SERVICES

(in cents per passenger mile)

SOURCE: Port of New York Authority

TYPE OF SERVICE	1953-55	1955-60	1960-65	1965-75
Aerocab (airport shuttle service)	40-50	30-40	25-30	20-25
Intercity		12-13	9-10	6.5-7.5
Suburban			11-13	8-10

TABLE XI

DEVELOPMENT OF PASSENGER TRAFFIC BY TYPES OF MARKET AND PERIODS OF DEVELOPMENT

SOURCE: Port of New York Authority.

	Probable Periods of Development		
TYPE OF SERVICE	INITIAL PERIOD	PERIOD OF GROWTH	PERIOD OF MATURE EXPANSION
Aerocab	1953-60	1960-65	1965
Intercity	1955-58	1958-70	1970
Suburban	1963-65	1965-75	1975

capable of tapping the short-haul potential could conceivably be delayed many years if performance requirements and operating standards based on experience with fixed-wing aircraft are applied to the helicopter without due regard for its unique capabilities which cannot be duplicated by fixed-wing aircraft.

AEROCAB SERVICE:

As one of the primary possibilities in the development of North Philadelphia Airport is the establishment of an aerocab snuttle between it and Philadelphia International Airport, (the intercity routes coming shortly after), it would be well to consider the mixed use and possible conflict of helicopters and fixed-wing aircraft which must use the same facilities. A satisfactory solution to potential conflict between helicopters and fixed-wing aircraft can be obtained by recognizing that the problem falls into two categories: Where routes used (1) do or (2) do not, require crossing of aircraft approach and departure routes.

In the first (and complicated) case regulations and procedures must be so established that the helicopter's crossing altitude and crossing point will be clearly defined as a grade separation from conventional aircraft.

In the second case, a simple isolation of approach and departure areas can be based upon the capabilities of the

helicopter and the terminal area's traffic control.

The fares which will have to be charged for aerocabs will make it more expensive than a limosine, but cheaper than taxi service unless two or more people are riding together. A baggage weight limitation and charge for excess baggage will further limit patronage. The time savings which this service will make possible seldom will exceed a quarter of an hour so that aerocab patronage will have to come from those travelers to whom time and convenience have a relatively high value, perhaps for business reasons. Maximum convenience and time saving will not be realized until aerocab operations reach a high frequency of service, which will require operating with small and medium size equipment (requiring fares about 30 cents per mile). On the other hand, 30-40 place equipment with will make possible fares of 20 cents a mile may not generate sufficient traffic to support the necessary high frequency. The estimate* of the number of passengers using aerocab service reflects the expectation that by 1960, approximately 25% of passengers who would normally use taxi cabs will shift to aerocab, while 10% of those now using limosine service will shift to aerocab.

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* Port of New York Authority.

INTERCITY AND FEEDER MARKETS:

Eventually, helicopter operations will extend into those areas which today lack scheduled airlines service, (which cannot provide enough traffic to secure schedules of conventional aircraft), such as Trenton and New Brunswick and will enable these cities to receive direct air service from a local downtown terminal to the world's busiest airports.

A token helicopter service has already been instituted by New York Airlines to Trenton. Although it offers more novelty value than cash return, this route is but the first link in the coming network of intercity helicopter routes.

HELIPORTS:

At a conventional airport a helicopter is but another airplane. It can use the terminal apron, building, and other facilities in common with fixed-wing aircraft. The common problem is still that of efficiently handling passengers, commodities and service. So any "modern" terminal building and area with an expansible apron masterplan providing gate positions of 150 feet diameter has heliport facilities now.

Local governments, beseiged with innumerable demands for additional expenditures on streets and schools, sewerage

systems and other public works, have only limited financial resources. As a result, municipal financial speculation in the development of heliports seems to be a little premature in light of the unsettled status of the helicopter industry proper. The heliport field in 1954 is equivalent to the airport field in 1926. Even the helicopter industry cannot agree on standards for design and development of heliports.

If such stringent development limitations are not volunteered by the industry, public funds should not be used for such untried, and, as yet, wholy speculative ventures. However, city planning commisions can study and review local regulations and requirements, including such things as air space easements, air space zoning, noise problems, routes of ingress and egress from the general air space into the community center, and general city plan requirements pertaining to the development of this new mode of transportation.

Municipalities can reserve potential sites integrated with parks, parkways, waterfronts, railroad terminals, bus terminals, truck terminals, public buildings, or other places convenient to the center of transportation of a community. At snch time as heliports are required, the municipalities can offer long-term leases to private capital for the financing, construction, operation and maintenance of heliports on public property, if desired.

Although the most obvious and fascinating advantage to helicopter operations is the rotor-wing craft's ability to land and take-off vertically, it is a delusion to think that this is accordance with strictest economy. Actually, a helicopter can carry a much larger payload if it can slither down a runway and take off at an angle than when rising vertically.

Ground level heliports are more advantageously located* (no elevators or stairs) and inherently safer than roof-top heliports, if such ground locations can be secured. The desirable characteristics of the ultimate heliport are as follows:

(1) It should be located at or as near as possible to the center of traffic with direct connections with surface transportation.

(2) It should be large enough to provide safe operating procedures. It appears that a twin-engine helicopter could operate from a medium-sized heliport, approximately three times the maximum dimension of the helicopter. For the

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* John P.W. Vest (Chairman, Heliport Committee; Helicopter Council; Aircraft Industries Association of America, Inc.) in an address dated October 22, 1953, disagrees to the extent that he excepts major airports from this. "All considerations point to the desirability of placing the heliport as a structural component of the main terminal building." This address included in Heliports, Bibliography No. 32.

machines presently foreseen, the landing pad area should be:
Length: 350/400 feet (minimum); optimum 450-500 feet; preferably oriented into the prevailing wind with obstacles at either end not higher than 30 feet.
Width: Minimum 300 feet between 30 foot obstructions.
Obstruction limitations: From edge of pad, long axis, approximately 15 degrees (or 4 to 1) for the first 400 feet, 25 degrees (or 2 to 1) out to 1,000 feet. Short axis, from center of landing area 15 degrees out to 500 feet.

(3) It should be small enough to be economically feasible.

(4) The obstructions in the approach and departure areas should be kept to a minimum and the area should be so zoned by the local authorities so that no additional obstructions can be erected.

(5) It should be so laid out that the greatest possible number of operations can be realized within the smallest amount of space. The following operational times appear reasonable at a major heliport where a <u>complete</u> change of load is assumed:

1. Land and taxi into loading gate - 1 minute.
2. Passenger loading and unloading - 9 minutes.
3. Engine check-out period - 1 minute.
4. Taxi to take-off pad and take-off - 1 minute.

total - 12 minutes.

With five loading gates, a maximum of 25 operations an hour is possible, assuming 50 passenger helicopters (this seems doubtful in the case of aerocab service which might use smaller equipment), operating at a 60% load factor, will handle 1,350 passengers per hour. At in-between stations, where the traffic volume will not be as heavy, a less elaborate terminal facility and shorter stops (2-3 minutes) will be required.

(6) Special consideration may have to be given to maintenance area apart from the passenger loading area.

(7) The passenger loading areas must be designed with the viewpoint of minimum baggage handling, minimum or no reservations, minimum ticketing operations and minimum passenger records.

It is doubtful if the helicopter operators will ever be able to provide the luxuries that are found in fixed-wing aircraft service.

(8) Consideration should also be given to subsidiary activities such as concessions, restaurants, parking and the like, to defray the cost of heliport operation.

In the case of higher performance by conventional aircraft; airports and airport runway configurations have been made obsolete by airplane developments almost as fast as

they were built. In the case of the helicopters, it appears that this will not occur; the indications seem to be that with the higher-performing helicopters, future requirements may be reduced.

It should be pointed out that the helicopter derives its support in the air solely from the reaction of a stream of air driven downward by the rotors. Thus, in landing and taking off, a terrific wind disturbance would be set up in the vicinity of the aircraft. This should be kept in mind when designing the terminal facilities.

PART V - SPECIFIC EXISTING PROBLEM OF NORTH PHILADELPHIA AIRPORT.

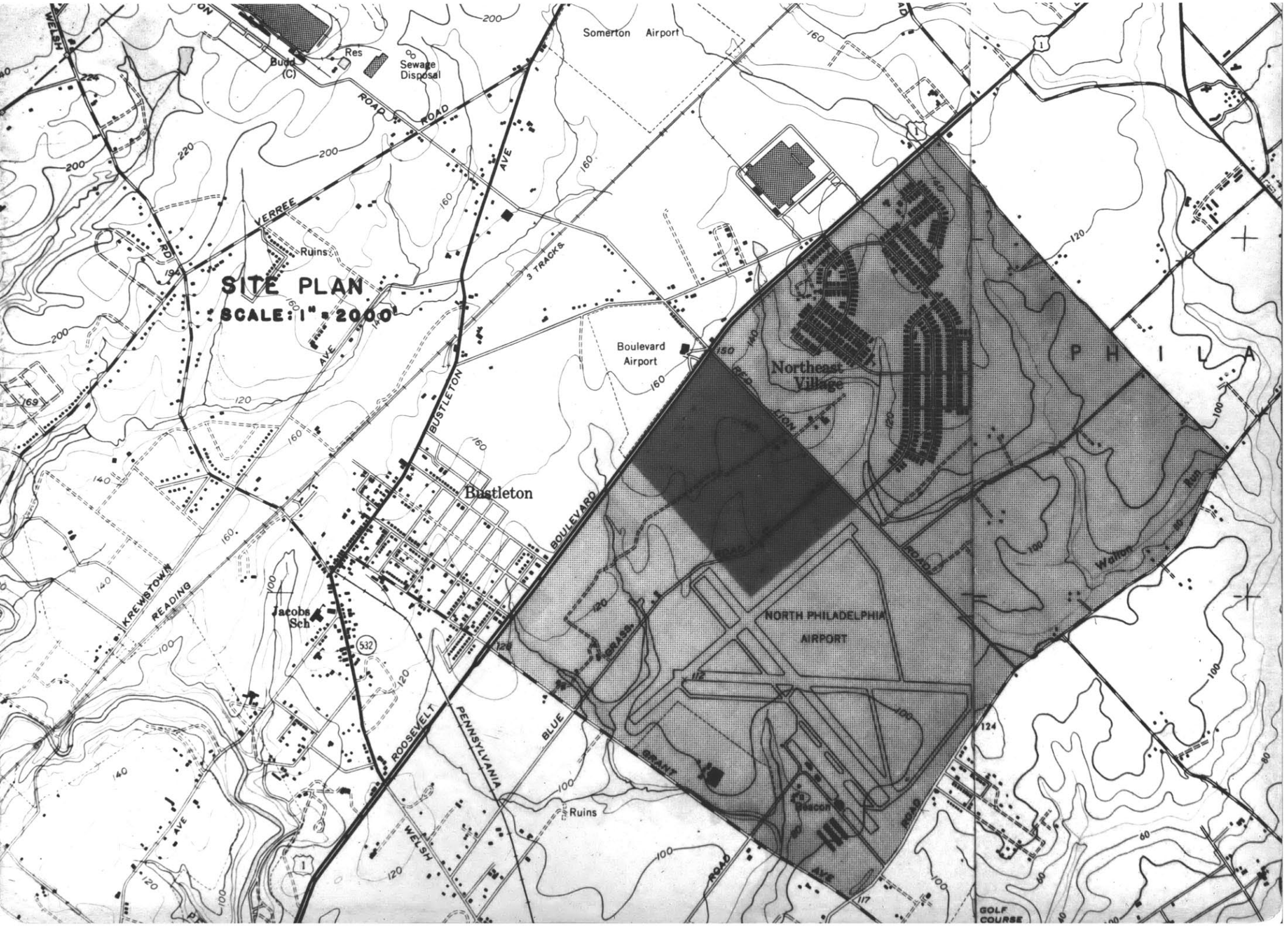
DESCRIPTION OF AREA AND EXISTING CONDITIONS:

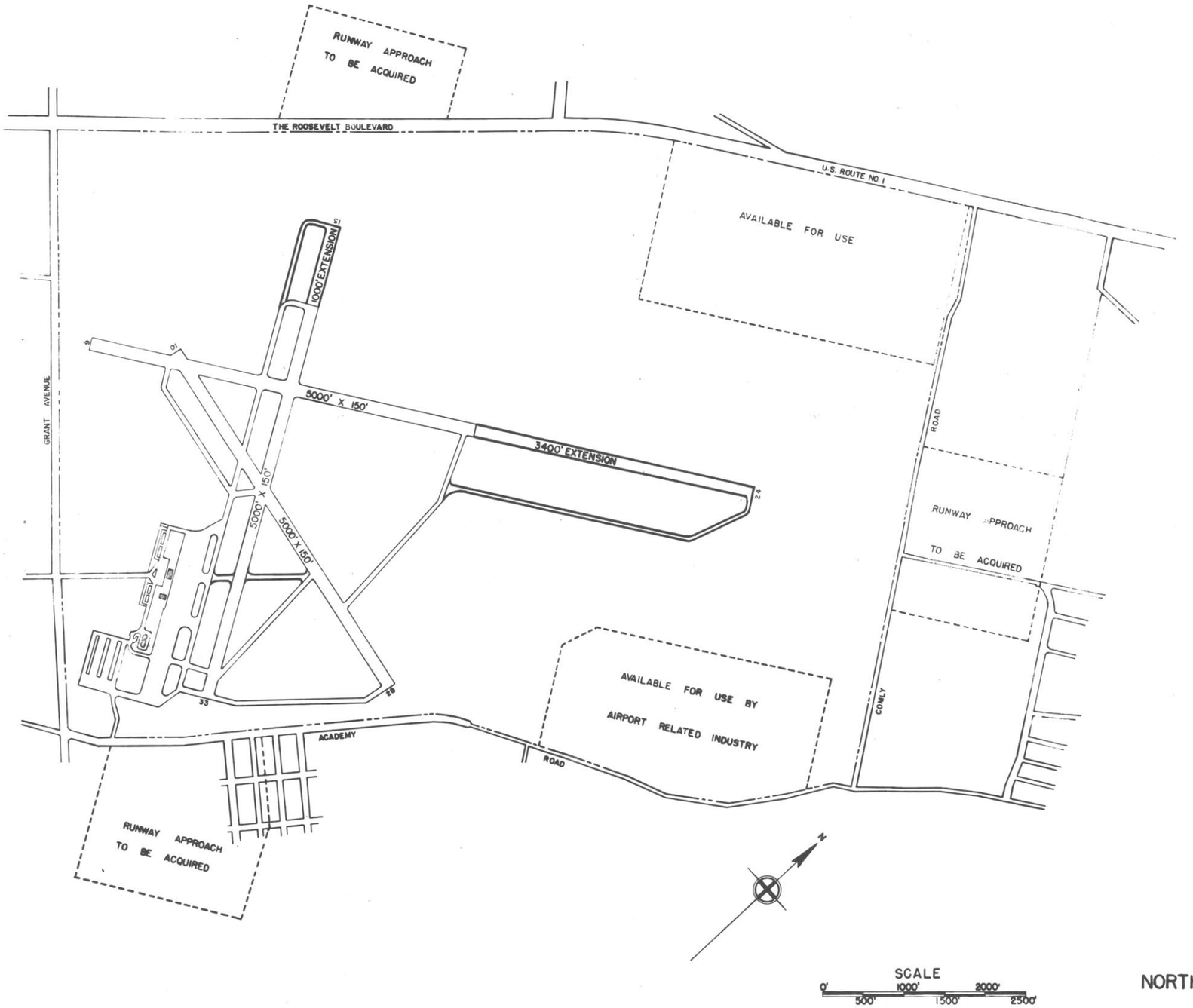
The City of Philadelphia spreads over an irregular area approximately 130 square miles along the Delaware River. Except for the bulge at Chestnut Hill and Roxborough, the City is predominantly long and narrow, measuring about 23½ miles from its southern boundary at the Delaware County line to the Bucks County line, which bounds it on the north.

Expansion of the City has been predominantly northward - to the northwest primarily for residential purposes, and to the northeast along the Delaware River for both industrial and residential purposes.

Because of historical development and differences in the emerging patterns of land use, the portion of Philadelphia lying north of Lehigh Avenue has long been considered a distinct entity as "North Philadelphia". The industrial complex of the region is predominantly light manufacturing - textiles, food, printing, and machine parts - in contrast to the heavy industry characteristic of Southern Philadelphia.

The Philadelphia International Airport is located at the southern tip of Philadelphia. It is admirably located in relation to downtown Philadelphia, being only six-and-one-half


SITE PLAN
SCALE: 1" = 2000'
Somerton Airport
Budd (C)
Res
Sewage Disposal
Ruins
3 TRACKS
Boulevard Airport
Northeast Village
Bustleton
NORTH PHILADELPHIA AIRPORT
Jacobs Sch
Ruins
GOLF COURSE
PHILA
BUSTLETON AVE
VERREE RD
ROOSEVELT BOULEVARD
PENNSYLVANIA AVE
BLUE GRASS ROAD
WELSH ROAD
KREWSTOWN READING AVE



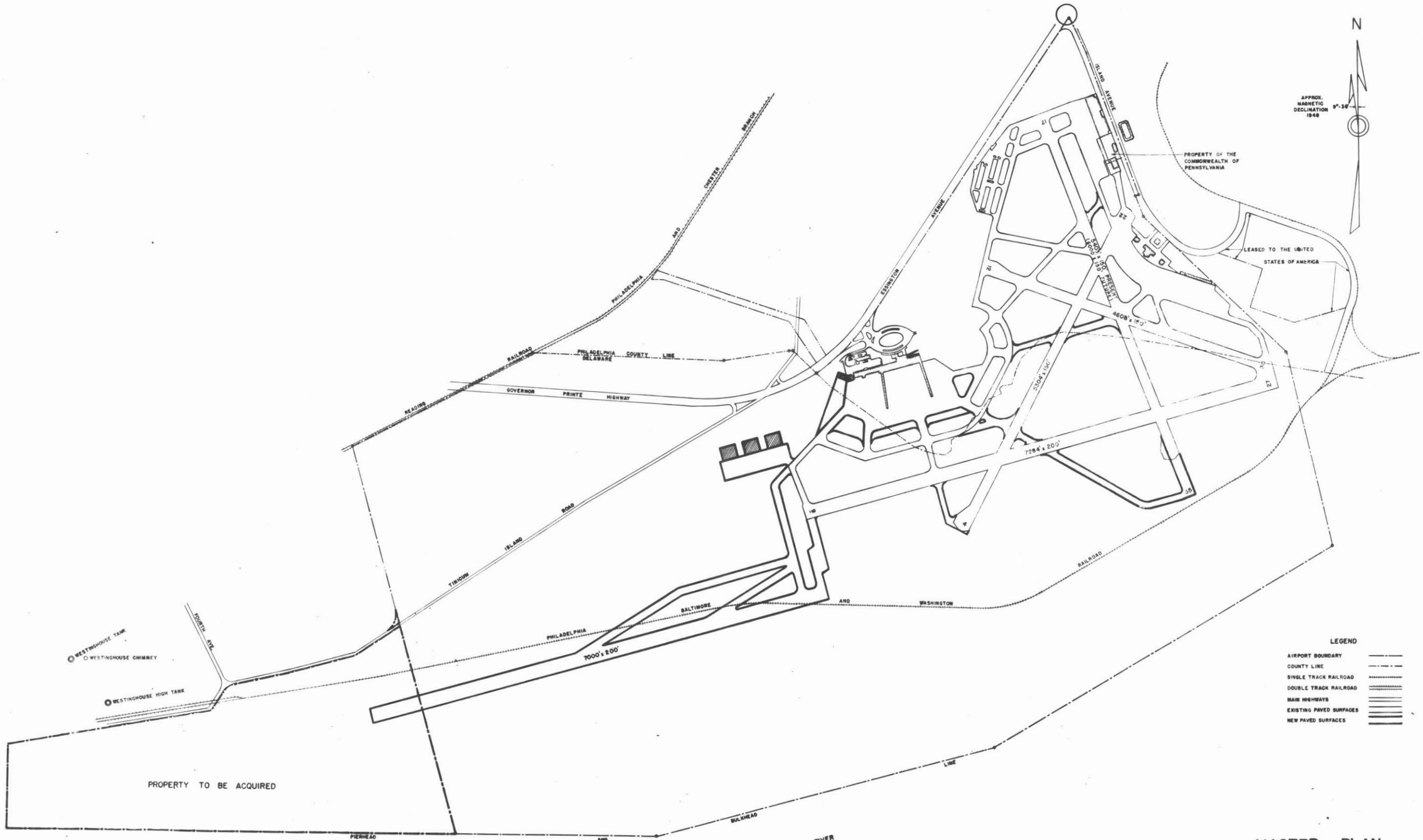
MASTER PLAN
OF THE
NORTH PHILADELPHIA AIRPORT

DEPARTMENT OF COMMERCE

DIVISION OF AVIATION

JULY 1953

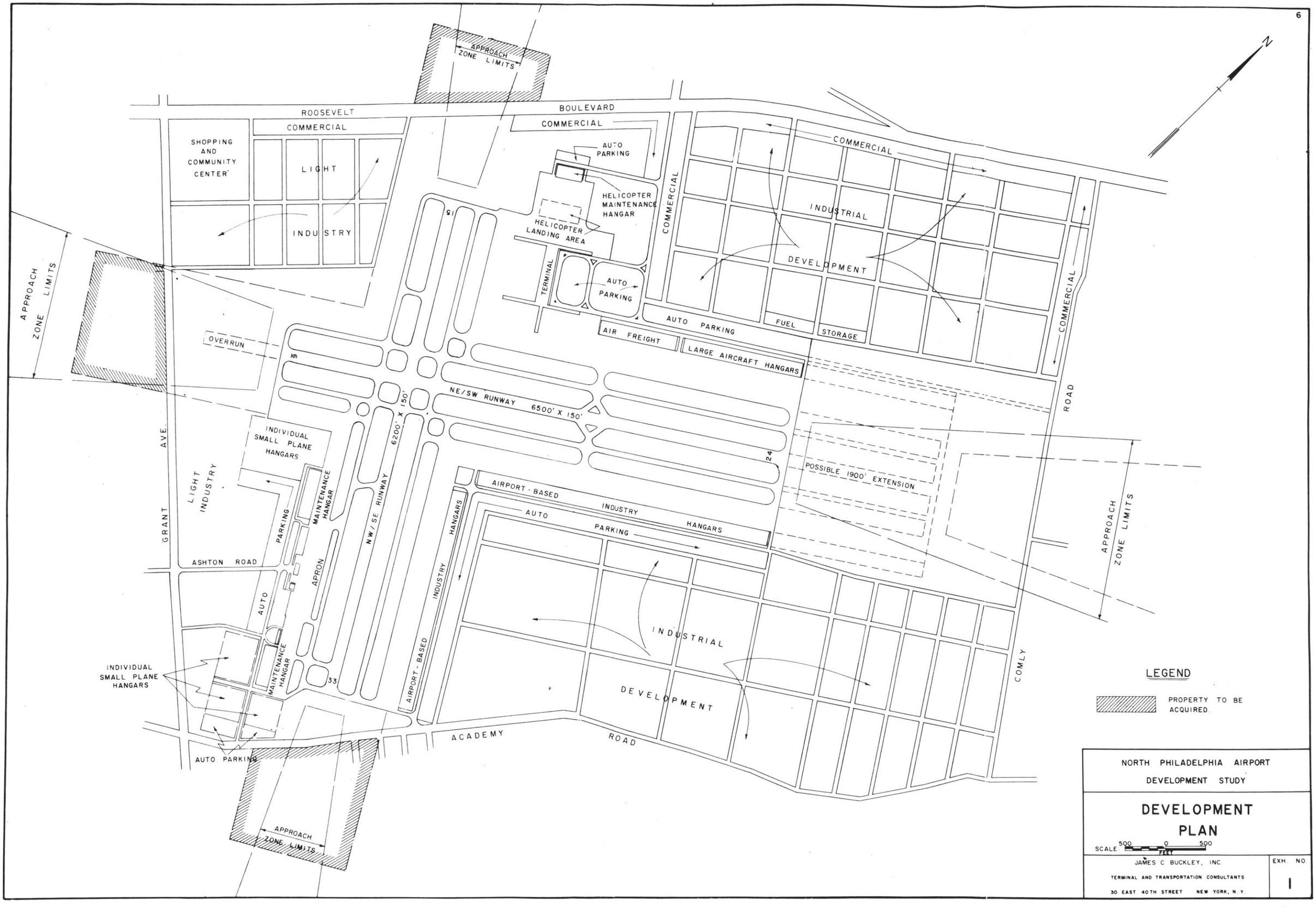
EXHIBIT C



MASTER PLAN OF THE PHILADELPHIA INTERNATIONAL AIRPORT

DEPARTMENT OF COMMERCE
DIVISION OF AVIATION
JULY 1953

EXHIBIT B



NORTH PHILADELPHIA AIRPORT
DEVELOPMENT STUDY

DEVELOPMENT PLAN

SCALE: 500 0 500 FEET

JAMES C. BUCKLEY, INC.
TERMINAL AND TRANSPORTATION CONSULTANTS
30 EAST 40TH STREET NEW YORK, N.Y.

EXH. NO. 1

miles southwest of City Hall. It is poorly located, however, with respect to the needs of North Philadelphia, (the area lying North of Lehigh Avenue), particularly with respect to those aviation activities which are inhibited by ground time and ground cost. All of North Philadelphia is ten miles or more from International Airport, while some areas are approximately 17 and 26 highway miles from it.

North Philadelphia already accounts for about half the City's population and industry, and its relative importance in the City's economy is expected to grow substantially in the next twenty-five years. In 1950, it had a population of 902,000 (43.5% City total); in 1980 it is expected that its population will increase to over 1,000,000 people (56.6% of the City's population). By 1970, the area serviced by the North Philadelphia Airport will have a population of 1,792,000. In 1945 its industrial activity utilized 5,046 acres (45.6% of the City total) whereas in 1980 it is expected that its industrial activity will utilize 8,280 acres (50% of the City total). While the City of Philadelphia as a whole is expected to decrease 9% in population between 1950 and 1980, that of the Northeast sections of the City is expected to increase during that period by more than 75%.

EXISTING NORTH PHILADELPHIA AIRPORT:

The North Philadelphia Airport is situated on a tract

of 1,838 acres bordering on Roosevelt Boulevard (U.S. Highway No. 1). There are three runways, each 5,000 feet long, hangars for small private planes, a small administration building, a restaurant and a few other general service buildings in a semi-comatose condition.

At the present time there is no commercial activity at the airport, nor has there been since Slick Airlines (an all-freight carrier) merged with Flying Tigers. A number of private planes are based there, but their number is limited because of present facilities. A range station exists along with tower facilities but all-weather nagivational aids must be installed if the present facilities and capabilities of the airport are to be expanded.

PROFESSIONAL DEVELOPMENT PROGRAM FOR NORTH PHILADELPHIA AIRPORT:

A master plan, developed by James C. Buckley Inc., Terminal and Transportation Consultants,* has been submitted to the City of Philadelphia. This rather complete study will, together with the general data already presented provide much of the basis upon which the design portion of this thesis will be drawn. Because of space and time limitations, only those portions which directly concern the development of the passenger and freight terminal facilities will be considered. However, certain other factors in the masterplan,

* Bibliography No. 44.

herein reproduced, deserve comment and they will be mentioned in the course of this discussion.

The findings and recommendations of this report may be summarized in this manner:

(1) There is a strong and growing need for a public air terminal directly available to the northern portion of the City of Philadelphia.

(2) The direct aviation need for the facility should be augmented in substantial measure by a demand for land for airport-based industry and airport-based commercial development.

(3) The land presently used by, and reserved for the North Philadelphia Airport, is well located for further development to meet this need.

(4) The demand available at the North Philadelphia site cannot reasonably be met by Philadelphia Airport, nor by privately-owned airports serving the portion of Philadelphia lying north of Lehigh Avenue.

(5) The further development of the North Philadelphia site will complement the general industrial development of the Northeast Sections of the City, and assist the community to maintain and improve its competitive position in this era of air transportation.

(6) Basing of military aircraft at the field is not desirable.

(7) Useof the site for airport purposes together with airport-based industrial and commercial development will return a greater benefit to the community and to the City than using the site exclusively for housing or for industry.

(8) A development of the site should include:

(a) Aquisition of privately-owned land to cover approach zones for extended runways (see development plan).

(b) Provision for space for the construction of individual plane hangars to an ultimate total of 200 or more, together with necessary aprons, parking area and access roads.

(c) Provision of space for the construction of large hangars for multi-engine business snd personal aircraft, together with aprons, parking and access roads.

(d) Provision of space for the construction of an air freight terminal and construction of such a facility to the extent that firm leases for the space in such a terminal for a reasonable period of time can be negotiated with airlines or other potential lessees.

(e) Provision of facilities for helicopter operations.

(f) Reservation of space for possible terminal requirements.

(g) Many other specific engineering and technical improvements and additions.

(9) Air-passenger Potential:

The national average per thousand of population of enplaned air passengers travelling 200 miles or less amounted in 1950 to 49. Eliminating the effect of population growth, this factor is expected to increase to 96.7 by 1960, and to 104.7 by 1970. Application of these ratios to the forecasted population of the North Philadelphia local air service area (all of the City of Philadelphia north of Lehigh Avenue) portions of Bucks and Montgomery Counties within 15 miles of the airport, portions of Burlington and Camden Counties within 10 miles), results in the following forecast of originating short-haul airpassengers available to local air service at North Philadelphia Airport:

YEAR	ESTIMATED ENPLANED SHORT-HAUL AIR PASSENGERS
1960	142,000
1970	188,000

It is seen that the demand for long-haul passenger facilities is already being taken up by facilities at Philadelphia International Airport, and passengers will be able to journey to this terminal for long flights.

(10) Air Freight Potential:

There is a present need for a terminal adequate to handle about 6,000 tons a year which is expected to increase to about

31,000 tons a year by 1960. This would indicate a need now for about 5,000 square feet of terminal space, and an ultimate requirement of perhaps 50,000 square feet.

Before air cargo operations ceased at North Philadelphia Airport, 41% of all air freight handled in the City originated here. The portion of Philadelphia north of Lehigh Avenue, generates almost as much air freight as the balance of the City, including the important central City area. The data was as follows:

Area	Pounds	Percent
North of Lehigh Ave.	133,357	45.82
South of Lehigh Ave.	157,744	54.18
Total.	291,101	100.00

The bulk of the Philadelphia air freight handled through the North Philadelphia Airport, originated or terminated in the area north of Lehigh Avenue, as shown in the following summary:

Area	Pounds	Percent
North of Lehigh Ave.	65,602	54.97
South of Lehigh Ave.	57,765	45.03
Total.	119,367	100.00

The above data is especially significant in view of the substantial differences in air freight services available at North Philadelphia Airport and International Airport. Philadelphia International was served by eight scheduled carriers including one all-freight carrier; North Philadelphia was served by only one all-freight carrier. The carriers at International offered 85% of the important (long-haul) all-freight schedules to the west, and only 15% originated at Northeast.

In 1951, more than 50% of the total airfreight handled by both Philadelphia airports moved through the North Philadelphia Airport; the portion of the total which can be expected to be handled at North Philadelphia in the future, depends on several factors. They include:

(1) The extent to which landing area and terminal facilities are provided at North Philadelphia Airport for all-freight operation.

(2) Whether all-freight carriers will base at these facilities.

(3) Whether the combination carriers, or any of them, offer all freight service at the airport.

HELICOPTER FACILITIES:

A minimum requirement for any airport to serve North Philadelphia should be reasonable space for the development of an helicopter landing strip, helicopter loading positions and helicopter maintenance facilities. A reasonable preliminary estimate of the space required for these purposes would be somewhere between five and ten acres. Specifically :

(1) A landing strip, tentatively established at 200 by 500 feet.

(2) Loading positions, suggested as two in 1956, three in 1957, and eight as a possible ultimate.

(3) Adjacent area for automobile parking.

(4) Area adjacent to the landing strips for supporting maintenance facilities.

(5) Reasonable highway access, since volume helicopter operation will only develop by drawing on the surrounding area.

OTHER ELEMENTS:

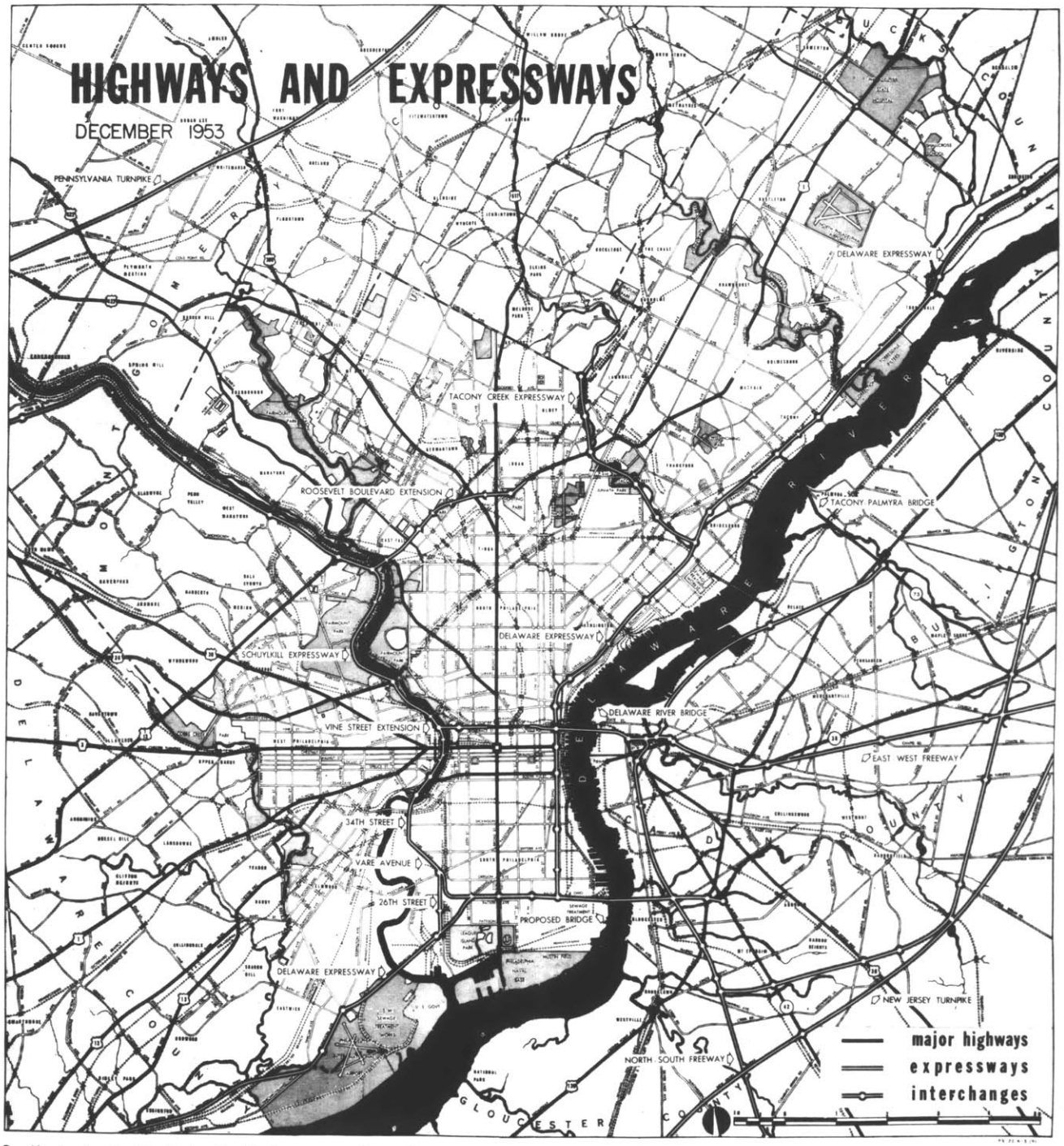
(1) Based multi-engine aircraft. No other airport within a 10-mile radius has the landing area and navigational facilities desired by operators of such aircraft. There is every reason to expect that the ownership of multi-engine aircraft by business organizations will continue to be one

of the rapidly growing segments of the aviation industry. A conservative forecast of the potential number of such aircraft ultimately available to the North Philadelphia Airport, based on national trends, would be 55 such aircraft sometime between 1965 and 1970.

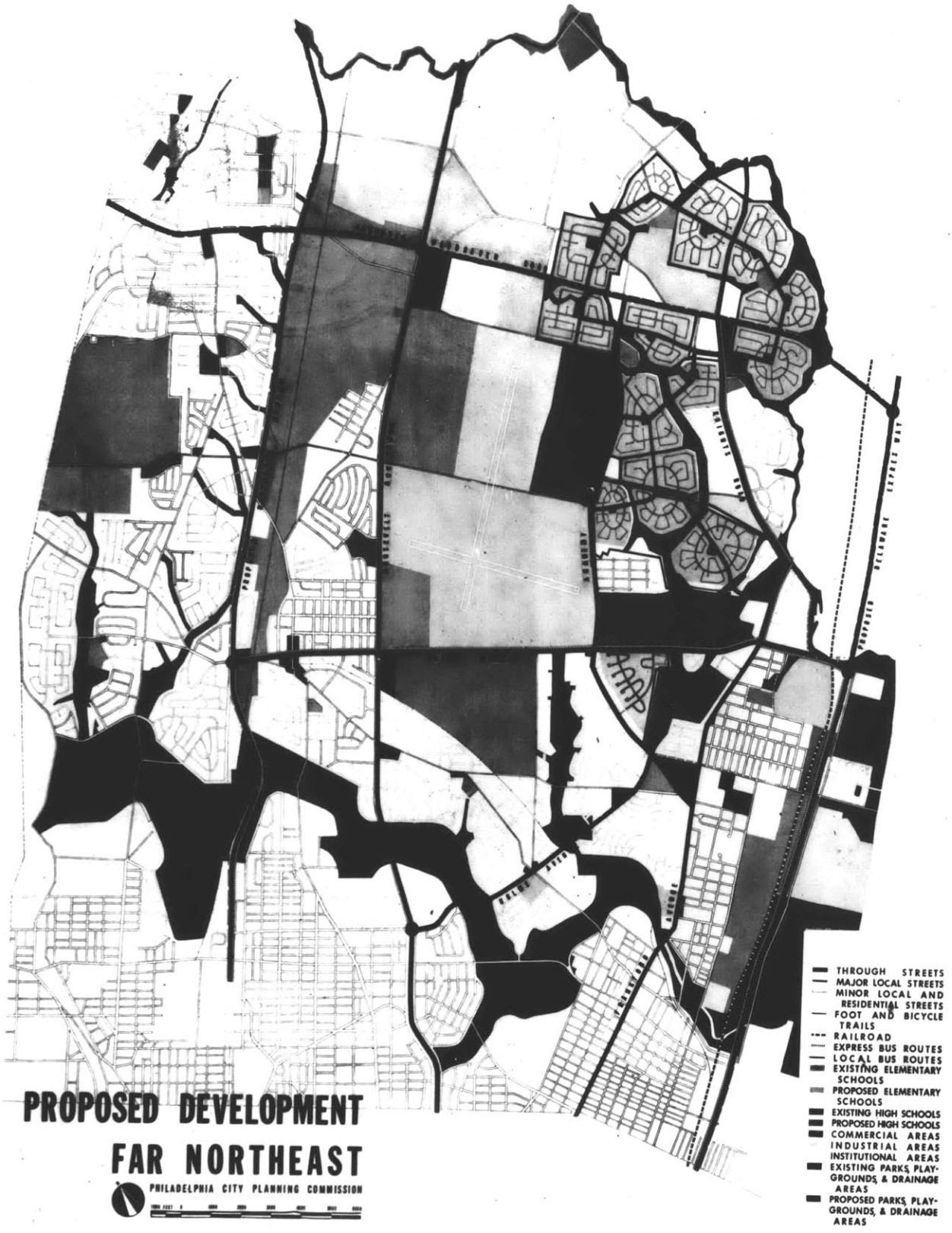
(2) Based single-engine aircraft. Of 39 airports in the area within 25 miles of North Philadelphia just a few years ago, 11 are now closed or in the process of closing. From the standpoint of ultimate provision to be made for single-engine aircraft at the airport, it would be reasonable to expect a total of somewhere between 175 and 200.

(3) Itinerant aircraft. During 1952, there were over 23,000 itinerant aircraft operations at the North Philadelphia airport. This was a gain of 31% over 1951, 63% over 1950, and 138% over 1948. The increasing use of aircraft by business firms coupled with actual experience at North Philadelphia Airport, indicates that about one-half of the users of itinerant aircraft may reasonably be assumed to be business men.

(4) On the basis of the foregoing discussion, the aeronautical activity at a major secondary airport serving North Philadelphia, may be forecast in terms of plane movements in 1960 about as follows:



PHILADELPHIA CITY PLANNING COMMISSION



PROPOSED DEVELOPMENT
FAR NORTHEAST

PHILADELPHIA CITY PLANNING COMMISSION

JUNE 1954

Type of Activity	Estimated Plane Movements
Air carrier aircraft	
1. All-cargo	10,000
2. Passenger	7,500
Itinerant aircraft	42,500
Local aircraft	36,000
Total:	96,000

This total may be compared with the reasonable capacity of a single-runway airport in this type of operation of 150,000 plane movements or more. Accordingly, it does not seem desirable to plan a parallel runway.

FURTHER FACTORS AND DISCUSSION:

From the foregoing section, the general outlines of a possible masterplan for North Philadelphia airport may be recognized. The future relation of this airport to the city and general service area, as well as to International Airport, will certainly be affected by the plans for the Far Northeast Area and for proposed Highways and Expressways (both herein reproduced) by the Philadelphia City Planning Commission. It is to be noted that the northern portion of the Delaware River Expressway will eventually link up with the Pennsylvania and New Jersey Turnpikes. The Philadelphia

Land Use Plan drawn up by the Planning Commission shows industrial areas to the west of Roosevelt Boulevard across from the airport. The proposed housing development adjacent to the east side of the airport, and the consequent desire to acquire that unused portion of the airport as a park to screen the area, should be carefully noted. It would seem in the interests of this housing development, as well as from the point of view of airport (parallel-runway) expansability, to give this land over to park facilities. This would create an unobjectionable screen for the proposed residential area, and free the airport from building encroachment on all sides.

The manner of hangar placement in the proposed development plan is open to some question. Maintenance hangars especially, are considered by the airlines crews* to be far more effectively planned if they are so located as to provide doors at front and rear with ample apron areas to both sides. This permits smoother flow of maintenance operations within the hangar and a reduction of time consumed in moving and inspecting the aircraft.

It is considered advisable to allow the present administration building to handle the facilities necessary for the operations of the privately owned planes based at the

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* Northeast Airline maintenance staff at Logan Airport, Boston.

airfield and for itinerant aircraft. The status of the adjoining restaurant remains in doubt, since the bulk of airport activity will be shifted to the opposite side of the field.

It will be seen that runway 10/28 is being dispensed with; runway 6/24 will become the instrument runway. The feasibility of shortening the proposed length of cross-wind runway 15/33 (and perhaps obviating the need for acquisitions of additional land), for reasons which are similar to those advanced by the staff at Logan International Airport in Boston, cannot adequately be discussed at this time. However, it is felt that this is a matter which deserves important consideration, as no Federal aid would be forthcoming on the development of this non-parallel runway.

It is to be noted that the attitude of the Philadelphia Department of Commerce, concerning the development of North Philadelphia Airport is a most flexible one. The general concensus of opinion seems to be that this airport is their ace-in-the-hole, and certainly some plan of action will soon be implemented. It should be stressed that the line of development outlined in this paper is that of the author alone, being dependent in large measure upon the Buckley report for much of the necessary basic data. For reasons of time and space, the economic aspects of the proposed development herein indicated cannot be fully treated. However, it is felt

that these proposals are not far removed from existing and future economic realities, which , in large measure must be a decisive factor in determining the size and extent of airport ground facilities.

The difficulty has now become clear in respect to meeting the proposals set down in Part I of this study. It is felt that adherence to these recommendations should be attempted wherever and whenever possible. Increasing community encroachments, coupled with noise and hazard factors, make the planning of airports extremely difficult, and many points have to be compromised. However, in the event that these Recommendations (Part I) become law at some future date, which is extremely possible, it would be best to adhere to them as much as is practicable.

PART VI - RECOMMENDED PLAN OF DEVELOPMENT

It is proposed to outline herein a plan of development for North Philadelphia Airport to serve the existing and anticipated needs of the area.

OUTLINE OF PASSENGER SERVICE:

Because of the existing long-flight service at Philadelphia International Airport, such services should not be offered at Northeast. However, with a huge population residing in the service area, short-haul service must be provided. However, for reasons previously stated and because of the current performance trends of newly-designed aircraft, it is doubtful whether the fixed-wing airplanes can make much successful penetration into the huge short-haul passenger potential. On the other hand, the helicopter promises a great ability to fulfill the requirements of such operations owing to the aeronautical and flight-economy factors which it possesses. However, it can be seen (Table XI) that a decade or more may pass before adequate and economical helicopter service comes to pass. It should also be noted that aerocab (airport to airport shuttle) service will be first developed, owing to the facts that potential demand already exists (certainly in the New York Metropolitan Area)

and few new costly ground facilities will have to be provided. Present aerocab facilities,* carrying mail, passengers, and cargo, are operating under Federal subsidy in order to make up the deficit involved in flying the present-day (uneconomical) helicopters. Thus, aerocab service can conceivably begin operations coincidentally with the first major steps taken in the development of the ground facilities at North Philadelphia Airport, with additional phases in the expansion of helicopter service to intercity and suburban operations following in time.

Since the facilities necessary for a secondary air passenger terminal such as this and those necessary for a major heliport are conceived to differ only in minor degree, the conception of the evolution of such a terminal building is felt to be this:

With the advent of complete and extended helicopter operation, the fixed-wing commercial transport will retire in large measure from the short-haul schedules, being unable to match the unique operational capacities of the rotor-wing craft. Such abilities are felt to be stimulators of new air passenger business and, as such, will add to the short-haul air passenger potential. Thus, the anticipated volume of

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* New York and Los Angeles.

188,000 passengers in 1970 should be disproportionally higher at the end of the following decade, or even earlier, depending upon the accuracy of forecasted helicopter development. Thus, it is felt that, while fixed-wing passenger aircraft will continue to fly from Northeast Airport in fair numbers, it is as a major heliport that this Airport will ultimately function, at least as regards commercial passenger transport.

OUTLINE OF AIR FREIGHT SERVICE:

Taking the analysis of the Buckley Report at face value there seems to be a justifiable need for a well-planned and well-functioning air freight terminal at Northeast Airport. It seems reasonable to assume, in the light of the facts that the area known as North Philadelphia contains a great deal of light industry (of the type which is most often shipped as air cargo) and more is being introduced to the north of the City line, that an all-freight carrier would base at the terminal. Some indication of the anticipated activity might be obtained by the following table (overleaf).

The situation even looks bright for one or more of the major airlines to fly all-cargo flights from an adequately designed, economically operating freight terminal facility at North Philadelphia Airport. It is, of course, impossible to change the destination of the combination passenger-cargo

TABLE XII

ALL-FREIGHT SCHEDULES AT PHILADELPHIA

JUNE 1952

SOURCE: Official Airline Guide, June, 1952.

Airline	North Philadelphia			International		
	WtoE	EtoW	Total	WtoE	EtoW	Total
Slick *	19	6	25	-	-	-
Flying Tiger	-	-	-	11	6	17
American	-	-	-	5	-	5
T W A	-	-	-	10	15	25
United	-	-	-	5	5	10
TOTAL	19	6	25	31	26	57
Total for each airport as a % of total for both airports:	38%	15%	30%	62%	85%	70%

	Total		
	WtoE	EtoW	Total
Slick	19	6	25
Flying Tiger	11	6	17
American	5	-	5
T W A	10	15	25
United	5	5	10
TOTAL	50	32	82
Total for each airport as a % of total for both airports:	100%	100%	100%

* Note that Slick has merged with Flying Tiger.

flights from International Airport, but helicopter and surface shuttle (via Delaware River Expressway) could serve to interchange cargo between airports when necessary. It should also be kept in mind that as the airfreight industry grows, combination flights will account for a decreasing percentage of total air cargo carried.

SERVICES WITHIN THE SCOPE OF THIS STUDY:

To cope with the planning and design of storage and maintenance buildings, hangars and other structures necessary to an airport of this size, would require more time and space than is available. Therefore, the design portion of this thesis will concern itself with the development of the airplane-helicopter terminal complex and the air freight terminal. Provision will be made for the transfer of control tower activities to the main terminal area when the main airport activities begin to function there. It may be necessary to accommodate the Civil Aeronautics Administration offices since they now occupy quarters in the existing terminal building on Ashton Road which will be devoted to secondary aviation activities. Some deliniation of the development of the adjacent commercial areas should be offered so as to present a coordinated and architecturally integrated complex of terminal activities and related areas.

Such a commercial area might possibly include such services as a florist's shop, a photo shop, a book store, a drug store, a branch bank, a haberdashery, valet services, gift shops, food stores, and airlines or business offices. The develppment of such an area must necessarily await the realization, to some degree at least, of the anticipated passenger potential at the airport terminal.

Due to the short-haul nature of the passenger traffic, a proportionately large amount of automobile parking facilities must be provided.

No coverage can be made of the proposed airport-based industry since the planning of these areas falls outside the scope of the immediate problem, except when these areas conflict with the requirements of this program.

DESIGN PROGRAM:

(A) AIR PASSENGER TERMINAL

Automobile parking should be in proximity to the terminal building for the convenience of passengers and visitors. Automobile parking can be divided into several parking lots to provide limited periods of parking close to the building for the use of those passengers and visitors who will require parking of a short duration. Longtime-parking areas can be provided at a greater distance from the building for visitors

and employees. Employee parking should be separate from passenger and visitor parking, preferably close to the facilities where they work. Cross-circulation between passengers and vehicles should be avoided wherever possible in the interest of safety and the rapid movement of traffic, a consideration mounting in importance with the increase in the size of the facility. No more than 300 parking spaces are required.

A service court should be adjacent to the terminal building to provide for the loading and unloading of items of a building service nature and, when handled from the terminal building, express, mail and food.

Expansibility and flexibility should be the prime considerations of design and construction.

Space requirements:* (Based upon the projected 188,000 passengers anticipated by 1970 - approx. 500 passengers/day 114 peak hour passengers).

(1) Passenger Service Counter and Ticket Lobby - Counter 60 lineal feet, Work Area 500 square feet, Ticket Lobby 1,000 square feet.

These facilities are for reservations, ticket selling,

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* Determined by methods and graphs in Airport Terminal Buildings; Bibliography No. 17 and No. 16.

baggage weighing and checking, and should be located within sight of, and close to, the passenger vehicle unloading platforms from which the main flow of enplaning passenger traffic proceeds. A minimum depth of 15 feet in fromt of the passenger service counter is desirable.

(2) Airline Operations and Apron Service. - These functions include station management, airline communications, baggage handling, load control, and necessary employee toilet and locker facilities. 4,200 square feet.

(3) Baggage Claims - Counter 18 lineal feet, Work Area and lobby 270 square feet each plus additional area to allow for the turning and maneuvering of the towing devices.

(4) Waiting Room - The waiting room should provide:

(a) A view of the loading apron and the landing area,

(b) easy access to the principal concessions, public telephones, and restrooms, and

(c) direct connection to the baggage claiming area and the vehicular platforms.

First aid space and nurse's station should be readily available from the waiting room. 3,000 square feet, 54 seats.

(5) Public Restrooms - Locker, shower and toilet facilities for employees working in the building are subject to wide variations as to unit and area requirements and must be determined from the requirements of the intended occupants.

(a) Men's restroom area 475 square feet, 6 water closets, 7 lavatories, 10 urinals.

(b) Women's Restroom and Nursery Area (A nursery in conjunction with the women's restroom is a mandatory requirement) - Nursery 100 square feet, toilet room and lounge 425 square feet, 5 lavatories, 7 water closets.

(6) Eating Facilities - The size of an eating facility is not always dependent upon the amount of traffic at the airport, due perhaps to a good location, unusual cuisine, or other local considerations. In determining the space requirements, the number of typical peak-hour customers is divided equally between dining room and coffee shop. An allowance of 15 square feet is made per seat in the dining room, and 12.5 square feet per seat. The kitchen area would be equivalent to 50 percent of the eating area.

(a) Dining room should be on the same level with, and directly off, the waiting room, and should have toilet room and check room facilities conveniently located. Cocktail lounge should be adjacent to the dining room and waiting room.

(b) Coffee shop should have counter and table (or booth) service.

(c) A separate eating facility for employees, usually

a cafeteria, is desirable if large numbers of people are to be employed. It should be located in an area as convenient as possible to where most of the employees work.

(d) Kitchen and Storage Facilities are usually equivalent to 50 percent of the eating area with additional space for storage.

Public eating facilities - 2,000 square feet, kitchen and storage facilities - 1,000 square feet.

(e) Manager's office.

(7) News, Novelties and Gifts - The most suitable location for these facilities is in or around the waiting room. 250 square feet.

(8) Public Telephones - These should be located as follows:

(a) In or immediately adjacent to the waiting room on the off-field side;

(b) near the baggage claim counter; and

(c) in conjunction with the public eating facilities. A PBX control center and equipment room should also be provided. 10 Public Telephones.

(9) Telegraph Service - At least two direct telephone lines should be installed in or near the waiting room.

(10) Insurance Dispensing Machines - Provision for at

least one insurance dispensing machine should be made at all airport terminal buildings. A prominent location in the waiting room, convenient to enplaning passengers who have just purchased their tickets, is desirable.

(11) Parcel Lockers - These should be located in or adjacent to, the baggage claim lobby.

(12) Ground Transportation Dispatch - Deplaning passengers should be directed toward a principal exit, adjacent to which should be located a dispatcher's office for limousines and taxicabs. Auto rental facilities are often provided in conjunction with ground transportation dispatch.

(13) Barber Shop - A one or two chair shop will be adequate in this case.

(14) Advertising Displays - These can be of educational value depicting local industry or features. They can be an important source of revenue and should be considered for inclusion. The most effective location is in the main waiting room and along the path of the main passenger and visitor circulation.

(15) Public Observation Concourse - Access to this area directly through the waiting room past the concessions is desirable; other entrance from the auto parking areas may be provided for convenience of visitors. This is frequently a

major source of revenue, although at International Airport, there is an entrance fee.

(16) Operational and Administrative Facilities -

(a) U.S. Weather Bureau services requires space adjacent or accessable to roof deck usually on the Northwest side of the building. Spaces necessary include an observation room, a teletype room, a map room, a forecaster and research room, and administrative offices. Approximately 2,000 square feet.

(b) Control tower facilities (C A A) functions require a control room, an operating equipment room, and a chief controller's office with an outer office as an entry. Approximately 3,500 square feet.

(c) Communications services demand space allocations for a teletype recorder room, communication chief and assistandt's offices, a radio broadcast room, and a maintenance shop room. Approximately 1,800 square feet.

(d) Control Tower Facilities. Approximately 400 square feet.

(e) An outside power source (or airport power plant located elsewhere on the property) is assumed.

(f) The entire building is to be air conditioned. Space must be provided for this and other mechanical equipment. Approximately 4,000 square feet.

(g) Airport manager's office and administrative areas. Public address. Approximately 1,500 scuare feet.

(h) Postal service. Approximately 500 scuare feet.

Specific planning and exact space requirements of these facilities (a through g), which vary as to extent and specification with every airport, is a task which surpasses the capacity of the designer unless he is supplied with adequate and competant aid from qualified and experienced sources. This is a planning task of immense complexity which cannot be adequately dealt with here, nor can it be neglected altogether. An attempt will be made to provide space for these facilities proportional to the specified space allocations made for the public functions; a proportion has been drawn both from available plans of certain major air terminals available in material listed in the bibliography, and from advice upon these matters given by the staffs of Newark, Philadelphia International, and Logan International Airport.

The planning task is further complicated by the anticipated major development of helicopter operations at North Philadelphia. Coupled with the dubious nature of the data upon which these forecasts are founded, it is seen that extreme flexibility and expansibility are necessary at North Philadelphia in even larger measure (if that be possible) than at other airports.

(B) AIR CARGO TERMINAL

The cargo terminal is at once a simpler, and yet more complex, design problem than the passenger terminal. This seeming paradox comes about by the very nature of the transported material. People can be inconvenienced to some little degree by poor and inadequate planning without appreciable loss of business within the passenger terminal, but cargo cannot of itself circumvent obstacles placed in its path by the designer. If, on a long-haul of refrigerated material, the cargo aircraft is forced to stop en route, and the freight removed to temporary storage in a cooler, all profit resulting from the flight is lost. Thus, with such a delicate margin facing him, the designer must carefully plan for the quick, easy, unobstructed, and uncomplicated movement of air freight through the terminal facilities.

Space Requirements:

(1) Ultimately 50,000 square feet of freight handling space; 5,000 to be built immediately. Of this, 200 square feet shall be a vault for valuable inbound freight. There shall be a refrigerated room of 300 square feet. There shall be a lobby for customers, supervisor and clerks' offices, 500 square feet; also lockers and lavatories for employees, 300 square feet. It is felt that an open loading system with overhead dragline offers the best possibility for easy and flexible operations.

PART VII - BIBLIOGRAPHY

1. Air Cargo: Loading on the Level by L.R.Hackney; August 1950; Lockheed Aircraft Corporation, Burbank, Cal.

2. Air Cargo Trends by L.R.Hackney and C.V.Rausch; September 1952 (with charts revised September 1953), Lockheed Aircraft Corporation, Burbank, Cal.

3. Airline Passengers (Revised Edition) Civil Aeronautics Administration; December 1951; U.S. Department of Commerce, Washington D.C.

4. Airmail Potentials, CAA; December 1948; U.S. Department of Commerce, Washington D.C.

5. Airport Activities; CAA; December 1948; U.S. Department of Commerce, Washington D.C.

6. Airport Buildings; CAA; January 1946; U.S. Department of Commerce, Washington D.C.

7. Airport Design; CAA; January 1949; U.S. Department of Commerce, Washington D.C.

8. Airport Drainage; CAA; 1952; U.S. Department of Commerce, Washington D.C.

9. Airport Facilities; CAA; December 1948; U.S. Department of Commerce, Washington D.C.

10. Airport Landscape Planting; CAA; May 1950; U.S. Department of Commerce, Washington D.C.

11. Airport Operation and Management; by Charles A. Zweng; 1947; Pan American Navigation Service, New York.

12. Airport Planning by Charles Froesch and Walther Prokosch; 1946; John Wiley and Sons, New York.

13. Airport Planning; CAA; July 1952; U.S. Department of Commerce, Washington D.C.

14. Airport Planning for Urban Areas; CAA; June 1945; U.S. Department of Commerce, Washington D.C.

15. Airports by John Walter Wood; 1940; Coward-McCann Inc., New York.

16. Airport Terminal Activities and Space Utilization; CAA; July 1950; Department of Commerce, Washington D.C.

17. Airport Terminal Buildings; CAA; April 1953; U.S. Department of Commerce, Washington D.C.

18. Air Traffic Forecast; New York - New Jersey Port District, 1950-1980 Aviation Division, Port of New York Authority; June 1950; New York.

19. Annual Report; Flying Tiger Line, Inc. (for year ended June 30, 1953); Lockheed Air Terminal, Burbank, Cal.

20. Cargo Aircraft by W. W. Davies; 1946; Pitman Publishing Corp., New York.

21. City to Airport Highways; CAA; April 1953; U.S. Department of Commerce, Washington D.C.

22. Class Notes; Airport Design; (1.322) Prof. Vincent Roggeveen; Spring Term 1954; Massachusetts Institute of Technology, Cambridge, Massachusetts.

23. Community Airport Requirements; CAA; January 1950; U.S. Department of Commerce, Washington D.C.

24. Design of Concrete Airport Pavement; Portland Cement Association; 1950; Chicago, Ill.

25. Domestic Air Cargo Forecast, 1955 and 1960; CAA: October 1952; U.S. Department of Commerce, Washington D.C.

26. Domestic Air Cargo; CAA; December 1948; U.S. Department of Commerce, Washington D.C.

27. Domestic Air Freight Origin-Destination Survey 1950; Aviation Division; Port of New York Authority; December 1952; New York.

28. Economic Character of Communities, CAA; November 1948; U.S. Department of Commerce, Washington D.C.

29. Economic Development in Lower Bucks County, Bucks County Planning Commission; February 1954; Doylestown Pa.

30. Effective Community Air Traffic Potential, CAA; June 1950; U.S. Department of Commerce, Washington D.C.

31. Federal Policy Regarding the Development of Commercial Transport Helicopters, as Approved by the Air Coordinating Committee; July 1951; Washington D.C.

32. Heliports? (How..? When..? Who Pays?) Leigh Fisher and Associates, Airport Trade Analysts and Financial Counsellors; May 1954; South Bend, Indiana.

33. Industrial Flying; CAA; July 1948; U.S. Department of Commerce, Washington D.C.

34. Industrial Land Use Plan: City of Philadelphia, Philadelphia Planning Commission; December 1950; Philadelphia, Pa.

35. Manual on Airfields; February 1952; The Asphalt Institute.

36. Mercer County Industrial Firms and Products, Mercer County Industrial Commission; 1954; Trenton, N.J.

37. Monthly Summary Reports of Aviation Activities; Four New York Region Airports, Aviation Division, Port of New York Authority; 1954; New York.

38. Personal Aircraft, CAA; December 1948; U.S. Department of Commerce, Washington D.C.

39. Planning the Air Freight Terminal, by L. R. Hackney; December 1949; Lockheed Aircraft Corporation, Burbank, California.

40. Proceedings: Conference on Ground Facilities for Air Transportation; September 12 to 14, 1950; Massachusetts Institute of Technology, Cambridge, Mass.

41. Results of Loadair Operation in South America, by H. W. Anderson, Whiting Corporation; October 1952; Harvey, Ill.

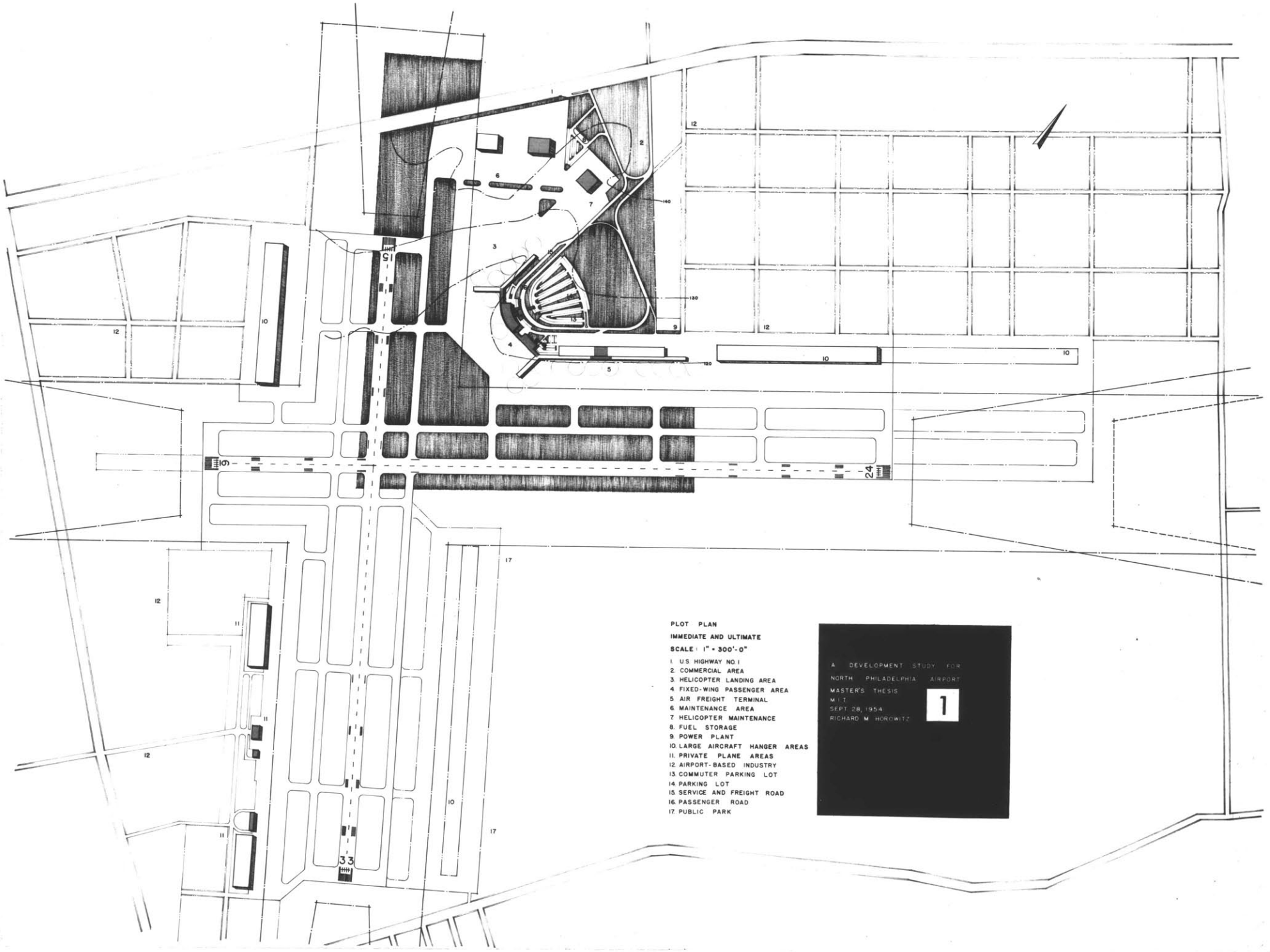
42. Sectional Aeronautical Charts; U.S. Coast and Geodetic Survey, Washington, D.C.

43. The Airport and Its Neighbors: The Report of the President's Airport Commission; May 1952; U. S. Printing Office, Washington D.C.

44. The North Philadelphia Airport: A Development Study, by James C. Buckley, Inc., Terminal and Transportation Consultants; 1953; New York.

45. Transportation by Helicopter: 1955-1975, Aviation Division, Port of New York Authority; November 1952; New York.

46. Whiting's Loadair Impressive in First Tests, by Eric Bramley; American Aviation Magazine; December 24, 1951.


PLOT PLAN
IMMEDIATE AND ULTIMATE
SCALE: 1" = 300'-0"
1. U.S. HIGHWAY NO. 1
2. COMMERCIAL AREA
3. HELICOPTER LANDING AREA
4. FIXED-WING PASSENGER AREA
5. AIR FREIGHT TERMINAL
6. MAINTENANCE AREA
7. HELICOPTER MAINTENANCE
8. FUEL STORAGE
9. POWER PLANT
10. LARGE AIRCRAFT HANGER AREAS
11. PRIVATE PLANE AREAS
12. AIRPORT-BASED INDUSTRY
13. COMMUTER PARKING LOT
14. PARKING LOT
15. SERVICE AND FREIGHT ROAD
16. PASSENGER ROAD
17. PUBLIC PARK
A DEVELOPMENT STUDY FOR
NORTH PHILADELPHIA AIRPORT
MASTER'S THESIS
M.I.T.
SEPT. 28, 1954
RICHARD M. HOROWITZ
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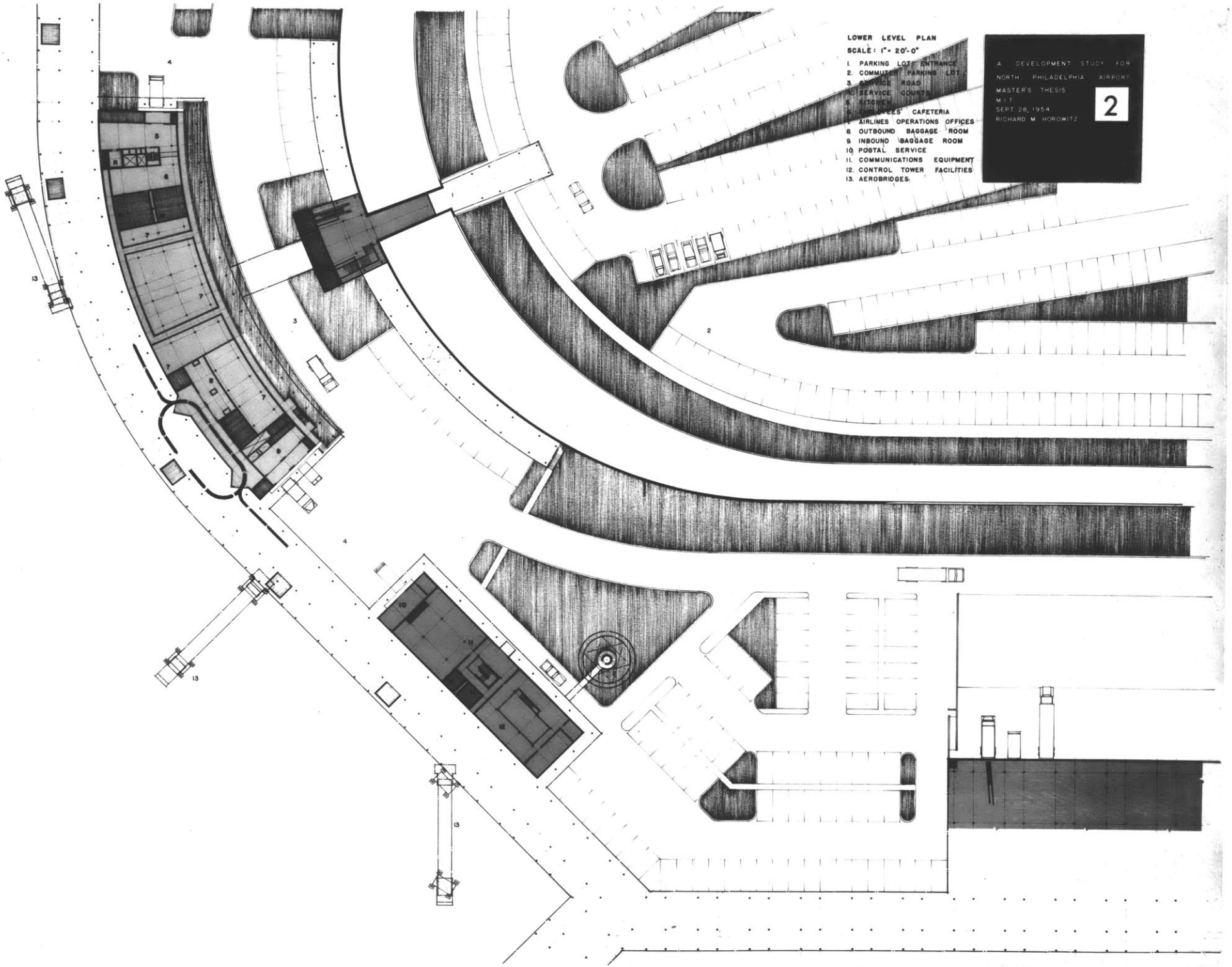
LOWER LEVEL PLAN
SCALE: 1"= 20'-0"
1. PARKING LOT ENTRANCE
2. COMMUTER PARKING LOT
3. SERVICE ROAD
4. SERVICE COURTS
5. EMPLOYEES' CAFETERIA
6. AIRLINES OPERATIONS OFFICES
8. OUTBOUND BAGGAGE ROOM
9. INBOUND BAGGAGE ROOM
10. POSTAL SERVICE
11. COMMUNICATIONS EQUIPMENT
12. CONTROL TOWER FACILITIES
13. AEROBRIDGES.
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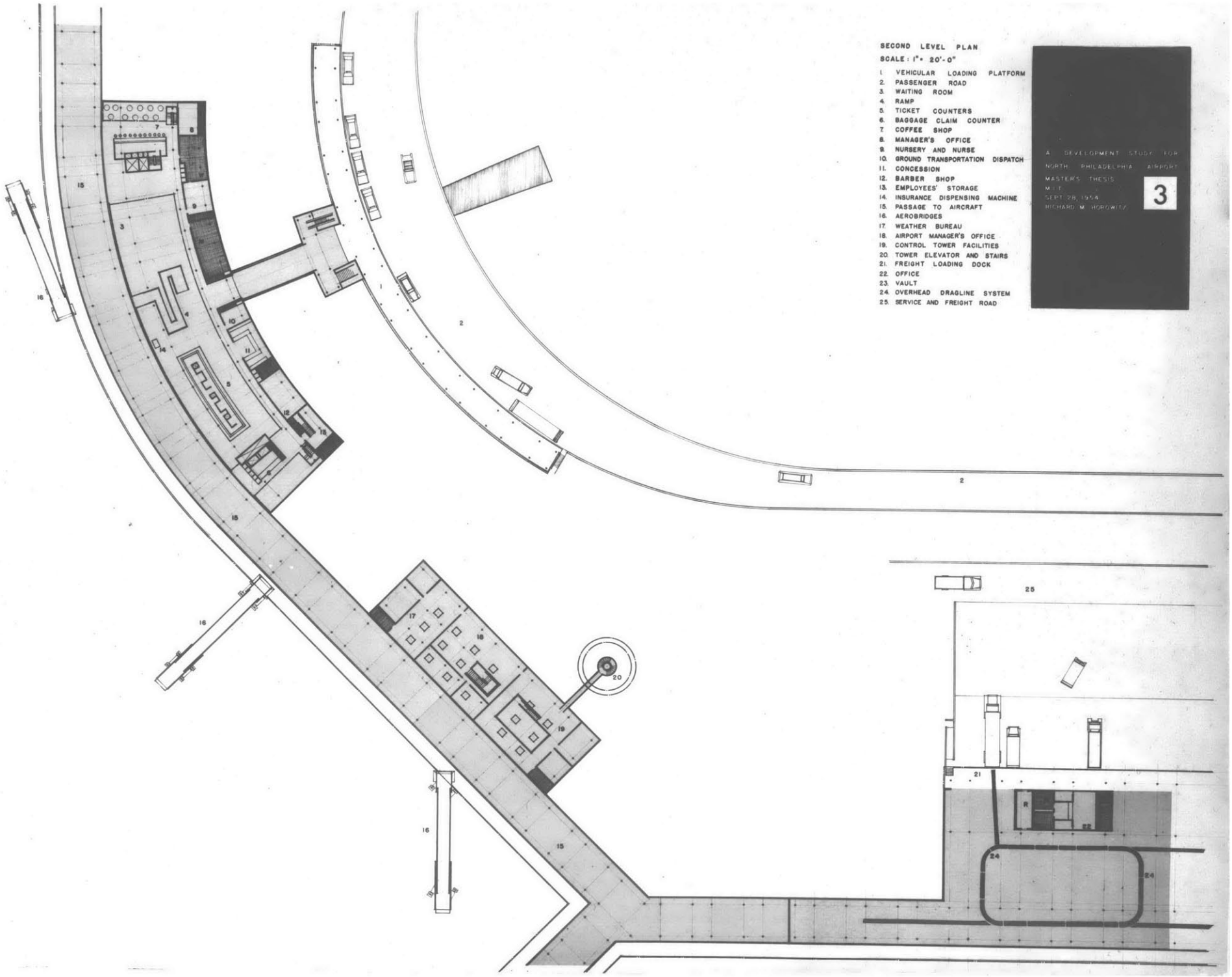

SECOND LEVEL PLAN

SCALE : 1" = 20'-0"

1. VEHICULAR LOADING PLATFORM
2. PASSENGER ROAD
3. WAITING ROOM
4. RAMP
5. TICKET COUNTERS
6. BAGGAGE CLAIM COUNTER
7. COFFEE SHOP
8. MANAGER'S OFFICE
9. NURSERY AND NURSE
10. GROUND TRANSPORTATION DISPATCH
11. CONCESSION
12. BARBER SHOP
13. EMPLOYEES' STORAGE
14. INSURANCE DISPENSING MACHINE
15. PASSAGE TO AIRCRAFT
16. AEROBRIDGES
17. WEATHER BUREAU
18. AIRPORT MANAGER'S OFFICE
19. CONTROL TOWER FACILITIES
20. TOWER ELEVATOR AND STAIRS
21. FREIGHT LOADING DOCK
22. OFFICE
23. VAULT
24. OVERHEAD DRAGLINE SYSTEM
25. SERVICE AND FREIGHT ROAD

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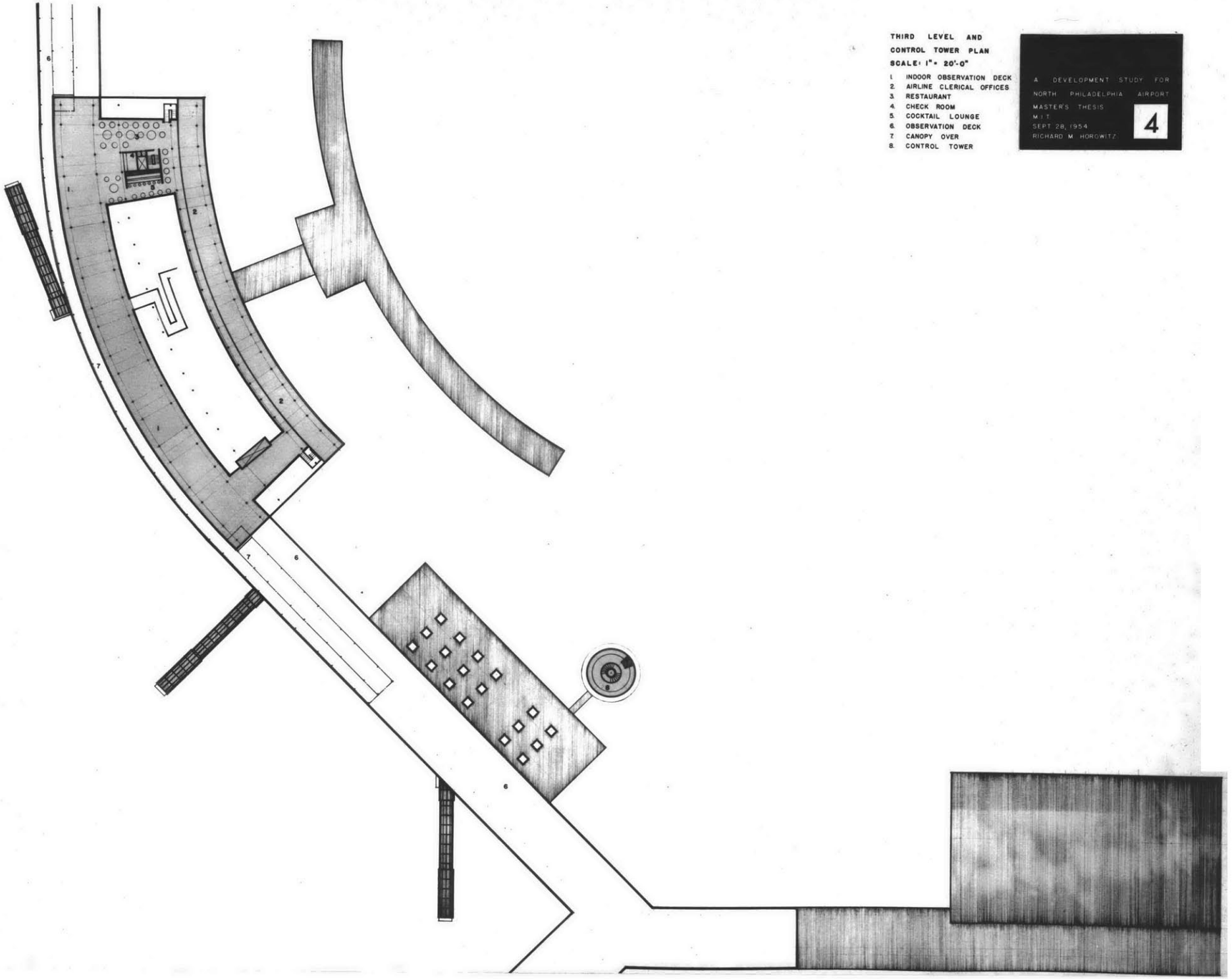

THIRD LEVEL AND CONTROL TOWER PLAN

SCALE: 1"= 20'-0"

1. INDOOR OBSERVATION DECK
2. AIRLINE CLERICAL OFFICES
3. RESTAURANT
4. CHECK ROOM
5. COCKTAIL LOUNGE
6. OBSERVATION DECK
7. CANOPY OVER
8. CONTROL TOWER

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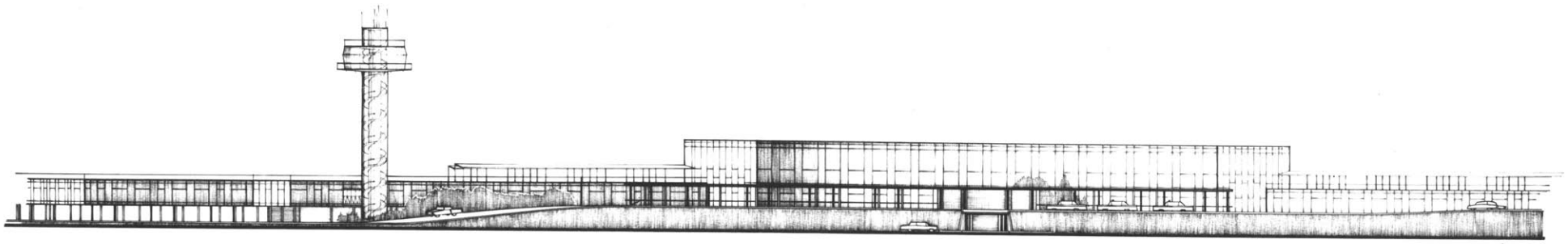
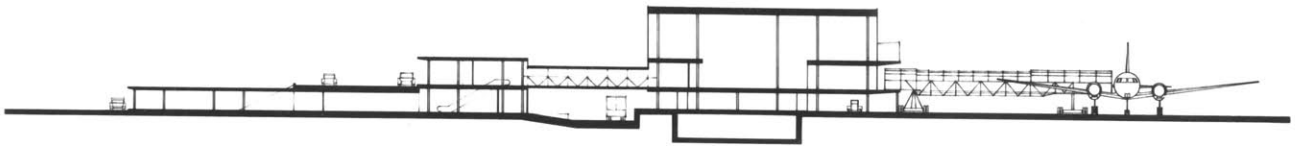
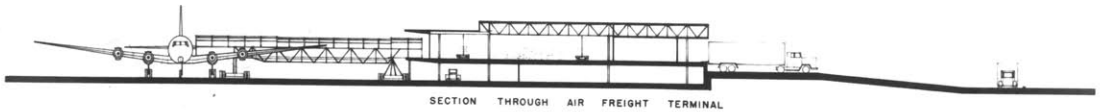


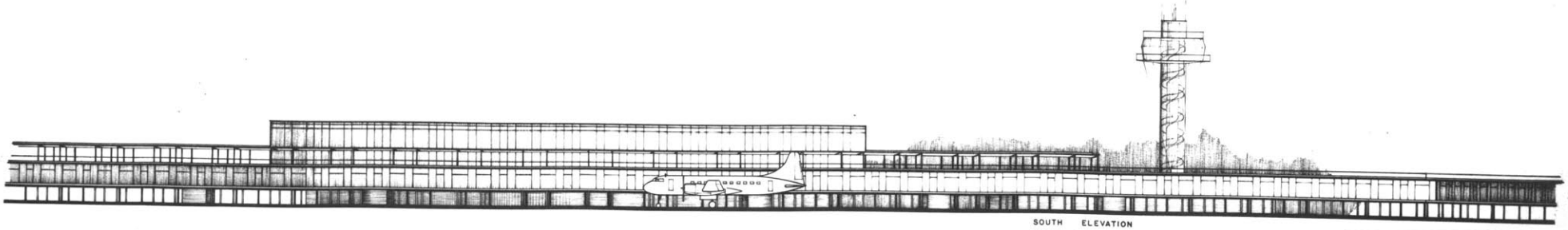
NORTH ELEVATION



SECTION THROUGH PASSENGER TERMINAL



SECTION THROUGH AIR FREIGHT TERMINAL



SOUTH ELEVATION

SCALE: 1" = 20'-0"

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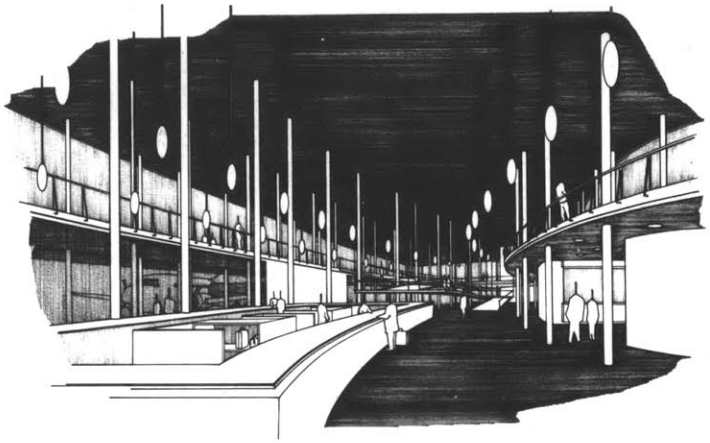

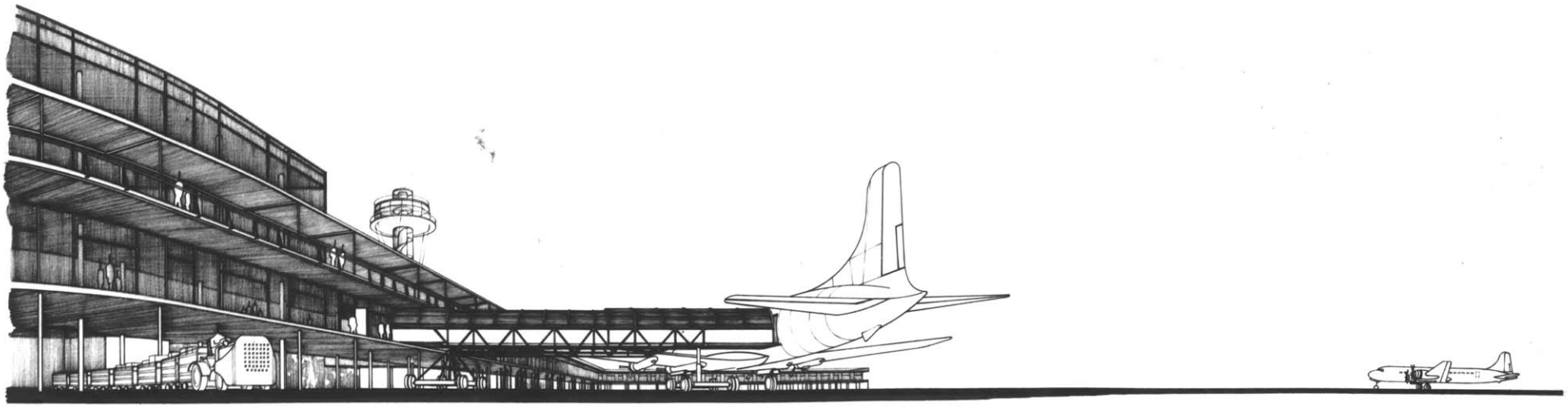

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